REPORT

CSO CONTROL PLANNING
LONG TERM CONTROL PLAN

NORWICH PUBLIC UTILITIES
NORWICH, CONNECTICUT

Revised - June 2020

CDM Smith

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June 12, 2020

Ms. Stela Marusin P.E.
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79 Elm Street
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Subject: Norwich, Connecticut: Revised CSO Long-Term Control Plan
CSO Consent Order WRMU17001

Dear Ms. Marusin:

CDM Smith Inc. has completed the attached Revised CSO Long-Term Control Plan (LTCP) on behalf of Norwich Public Utilities. This LTCP has been developed pursuant to workshops and meetings that occurred since the submission of our original LTCP, dated August 14, 2018.

Our 2018 LTCP was submitted in accordance with CSO Consent Order WRMU17001, Sections B.3.b and B.3.c. This revised LTCP supersedes the 2018 submission per DEEP's request.

This report is being submitted in electronic format. A paper copy can be provided upon request. Please let me know if you have any questions. I can be reached directly at 860-808-2255.

Very truly yours,

D. Craig Wagner, P.E., BCEE
Principal Environmental Engineer
CDM Smith Inc.

Attachments: Revised CSO Long-Term Control Plan Report (Dated June 12, 2020)

cc: Larry Sullivan, Chris LaRose – NPU
Tim Dupuis, Brendan Ennis – CDM Smith

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Appendices

Appendix A – Materials from Public Information Session

Appendix B – Satellite Facility Site Assessments

Appendix C – EPA 1994 CSO Policy Document

Appendix D – CT DEEP 1990 CSO Strategy Document

Appendix E – Original March 22, 2018 Baseline Conditions Report Submission

Appendix F – Original August 14, 2018 CSO LTCP Submission

Executive Summary

Executive Summary

ES.1 Introduction

A Long-Term Control Plan (LTCP) for controlling combined sewer overflows (CSO) was submitted to the Connecticut Department of Energy and Environmental Protection (DEEP) by Norwich Public Utilities (NPU) in August 2012. The 2012 LTCP recommended sewer separation in the form of public inflow removal (i.e. disconnecting catch basins from the combined sewers) in all remaining combined sewer areas of the City of Norwich. DEEP approved the 2012 LTCP on May 26, 2016. However, NPU subsequently requested permission to update the 2012 LTCP due to several changed conditions described in Section 1 of this report.

On July 3, 2017, DEEP issued Consent Order WRMU17001 to NPU. This order allowed 500 days for development of a revised LTCP from approval of an engineering agreement. DEEP approved the LTCP scope of work on September 8, 2017. This included:

- Implementation of system-wide flow metering and modeling for improved characterization of the NPU system and assessment of CSO;
- Development of a Baseline Conditions Report to document existing conditions and CSO performance under a range of conditions;
- Development and evaluation of system improvements and CSO abatement strategies to address a range of design storm conditions;
- Development of a refined and updated affordability analysis;
- Planning for ongoing public outreach during implementation of the LTCP; and
- Development of recommended projects with an implementation schedule.

NPU submitted the *CSO Control Planning Baseline Conditions Report* to DEEP on February 12, 2018. This report characterized NPU sewer system performance across a range of design storm conditions, including the 2-year storm, as well as average annual performance to establish a benchmark for alternatives development in this 2018 LTCP. Based on comments from DEEP, a revised and final Baseline Conditions Report was submitted March 28, 2018 (Appendix E to this report).

Following the Baseline Conditions Report, NPU submitted a *CSO Long-Term Control Plan Report* to DEEP on August 14, 2018. This report built upon the extensive model work developed for the Baseline Conditions Report, developed alternatives for CSO control for all selected design storms (levels of control), considered NPU's financial constraints, and summarized the proposed approach for CSO control. The August 14, 2018 LTCP Report followed EPA methodology for determining the most cost-effective plan using the Knee-of-the-Curve approach, and recommended 3-month CSO control. The recommended approach from this study also included provisions for future expansion to a 2-year level of control.

Following submittal of the 2018 report, NPU and DEEP participated in multiple meetings and workshops. DEEP asserted that the recommended 3-month level of control was not adequate. Although the plan complied with EPA policy, DEEP requested that NPU achieve a higher water quality benefit over a shorter timeframe and required that the 2-year control level be achieved. DEEP acknowledged NPU's financial limitations, and agreed that after constructing a large capital project, NPU would need a capital recovery period to pay down its loans prior to taking the next steps on any capital program. DEEP also acknowledged that without grant and loan funding, NPU would not be able to afford a capital improvement program such as the 2-year level of control program DEEP had requested.

DEEP requested that NPU's financial capability analysis be re-assessed assuming maximum grant eligibility and low interest loans under the Clean Water Fund. DEEP also acknowledged that if funding is lost, NPU and DEEP would need to reevaluate both the Recommended Plan and project schedule. Ultimately DEEP and NPU agreed to a CSO program and schedule deemed acceptable to both parties as long as CWF grant and loan funding was provided to the maximum extent possible.

This revised CSO LTCP Report has been prepared to reflect progress made during discussions with DEEP and describes the new recommended CSO program and schedule. Section 1 includes more information on the organization of this revised report.

To make this submission a complete record of the last several years of CSO planning, the Baseline Conditions Report from March 28, 2018 and the CSO LTCP from August 14, 2018 are appended to this revised report as Appendices E and F.

ES.2 Existing Collection System

NPU's wastewater collection system is located primarily in Norwich and also accepts flows from the neighboring communities of Franklin, Lisbon, Montville, Preston, and Sprague. Norwich is served by both sanitary and combined sewers that are concentrated in the more densely populated areas along the Shetucket, Thames, and Yantic rivers. Large portions of Norwich outside the central region of the city are served by private septic systems. Sewage is conveyed to the Hollyhock Island Water Pollution Control Facility (WPCF) for treatment.

Key characteristics of the collection system include:

- 16 CSO regulators discharging to 14 CSO outfalls
- Five major interceptors: Laurel Hill, Thamesville, Salem Turnpike, Shetucket, and Yantic
- 117 miles of gravity sewer up to 42-inch diameter in Norwich and three miles outside Norwich
- 11 miles of force main in Norwich and four miles outside Norwich
- 39 NPU-maintained wastewater pumping stations (PS), six private pumping stations, and one state-owned pumping station

CDM Smith updated and calibrated a computer model of the NPU wastewater collection system to sewer flow metering data collected in 2017. Findings were documented in the Baseline Conditions Report. Key findings that would shape alternatives development were carried forward into this LTCP.

For alternatives development and analysis, CDM Smith considered future development and planned for additional flow expected over the next 30 years. These future flows were added into the model on top of the existing "Baseline Conditions" to create a "Future Baseline Conditions" scenario. Future baseline flows were used to simulate CSO conditions under the various alternatives evaluated. Table ES-1 summarizes NPU's existing wastewater collection system performance under existing and future baseline flows (i.e. no changes to the system except anticipated increased flows).

Table ES-1: Average Annual Performance under Current and Future Baseline Conditions

Condition	CSO Volume (Mgal)	Events	Duration (hrs)	Precipitation (in)
Current Baseline	43.3	60	355	55.0
Future Baseline	47.0	63	355	55.0

Section 2 was not revised from the August 14, 2018 CSO LTCP Submission; it is included in Appendix F of this revised report.

ES.3 Norwich Water Pollution Control Facility

The Norwich WPCF is located on Hollyhock Island at the mouth of the Yantic River. The first WPCF was built in 1936 but was replaced with a larger facility at the same location in 1957. Both early plants provided primary treatment. In the early 1970s, the plant was expanded and upgraded to provide secondary treatment. Since 1976, the WPCF has provided secondary treatment for all flow it receives.

The WPCF is aging and will need to be rehabilitated to continue to address National Pollution Discharge Elimination System (NPDES) permit requirements. A design for new plant upgrades was completed in 2015, but NPU could not proceed with construction due to changing flood control regulations. CSO control alternatives included consideration of upgrading the facilities to treat more collection system wet weather flow.

The existing WPCF treats dry weather and a portion of the wet weather flow generated by the Norwich sewer system. The facility is designed for a peak flow rate of 17 million gallons per day (mgd) but receives up to 20 mgd wet weather flow which can overwhelm the facility. Its infrastructure is aging, with many systems having far exceeded their useful operational life. This has increased operation and maintenance costs.

It is recommended that the facility receive substantial upgrades in the near term to revitalize operations, extend the useful life of the facility, improve reliability, and reduce operations and maintenance costs. In addition, an upgraded WPCF will provide significant wet weather treatment and help avoid untreated CSO discharges. CSO control alternatives will continue to rely on this critical wet weather treatment capacity. It is expected that, at a minimum, the facility will

be upgraded to reliably treat up to 20 mgd. This was assumed as a baseline for future CSO control recommendations. The need for future facility improvements to consistently treat 20 mgd should be considered in the implementation plan. Section 8 presents an assessment of required improvements at the WPCF to address CSO control.

Section 3 was not revised from the August 14, 2018 CSO LTCP Submission; the complete Section can be found in Appendix F of this revised report.

ES.4 Water Quality Objectives

In Connecticut, DEEP has primacy, meaning that EPA has delegated primary enforcement responsibility to DEEP. This section discusses current EPA and DEEP policies, highlighting the applicability of both policies to NPU. EPA CSO Policy and DEEP CSO Strategy documents are also included as Appendices C and D.

Under strict interpretation of DEEP CSO Strategy, Connecticut's Surface Water Quality Standards, and EPA CSO Policy, NPU must attempt to eliminate CSO discharges to the waters of the state or mitigate it to a level deemed adequate to support designated uses. For the purposes of this LTCP, the two receiving waterbodies were deemed equal in sensitivity due to their equivalent water quality classification. Possible upstream pollution sources, as indicated in the 2012 LTCP, could make it difficult to quantify and achieve water quality standards within NPU's receiving bodies even if CSO discharges from Norwich were eliminated.

ES.5 Assessment of CSO Abatement Technologies

Section 5 describes CSO abatement technologies and assesses their applicability to NPU CSO control objectives. Many alternate strategies are available to control pollutants discharged from CSOs ranging from no action to complete separation of the combined sewer system (CSS) into separate sanitary and stormwater systems. This assessment considers technologies presented in EPA guidance manuals. The purpose of this assessment is to select appropriate technologies for further evaluation and comparison in later sections. Specific factors that identify whether a technology is appropriate include current condition of the sewer system, wet weather flow characteristics (e.g. peak flow rate, volume, frequency, and duration), hydraulic and pollutant loading, climate, implementation requirements (e.g. land, neighborhood, noise, and disruption), and maintenance requirements.

CSO abatement technologies were classified into five categories:

- Quantity source control measures;
- Quality source control measures;
- Collection system controls;
- Storage technologies; and
- Treatment technologies.

This assessment identified 12 technologies to carry forward into alternatives evaluation in Sections 6, 7, and 8. Collection system controls, along with conveyance, storage and treatment technologies, were found to be the most applicable to NPU's collection system.

Section 5 was not revised from the August 14, 2018 CSO LTCP Submission. The complete Section can be found in Appendix F of this revised report.

ES.6 Separation

Two methods of separation were considered for this report: public inflow removal and complete public and private separation.

Public inflow removal is a method of sewer separation where public catch basin connections are removed from the combined sewer system. This can be achieved through construction of new sewer systems or new drain systems. Public inflow removal effectiveness was evaluated assuming that inflow removal was completed after completion of the "Planned Projects" described in Section 7, and that CSOs remained open. Public inflow removal citywide is estimated to cost $240 million in fiscal year (FY) 2018 dollars. This cost includes $160 million for collection system improvements and $80 million for WPCF reliability upgrades but **does not** include renewal of aging pumping stations and force mains. When public inflow removal is implemented citywide with these assumptions, 10 of the 14 CSO outfalls were controlled to the 3-month level or less and the entire system will not achieve even a 1-month control level.

Complete public and private separation is a more comprehensive approach to sewer separation than public inflow removal. For this approach, in addition to disconnecting catch basins from the sewer system, private property inflow sources including sump pumps, yard drains, and roof leaders are also removed in combined and previously separated areas, and substantial pipe rehabilitation is intended to curb infiltration. There are two different approaches to achieving this separation – new sewer systems or new drainage systems. To achieve complete public and private separation each building must either have a dedicated storm drain lateral or property that allows private stormwater to be retained on site.

The effectiveness of complete citywide public and private separation was also evaluated. This scenario assumed brick and mortar closure of CSO regulators. This means that there would no longer be any CSO allowed from the permitted outfalls, but there would be risk of flooding and basement backups during larger storm events. To minimize the risk of sewer system flooding in up to a 5-year storm, extensive public and private sewer separation would be needed throughout the entire collection system, including in areas that are currently categorized as having separated sewers. Complete public and private separation citywide is estimated to cost approximately $460 million (FY 2018 dollars). This cost includes $380 million for collection system improvements and $80 million for WPCF reliability upgrades but **does not** include renewal of aging pumping stations and force mains.

Although both public inflow removal and complete public and private inflow removal are expensive for citywide application, localized public inflow removal is addressed in Section 8. Additionally, citywide separation strategies will be reevaluated in future LTCP updates.

Section 6 was not revised from the August 14, 2018 CSO LTCP Submission. The complete Section can be found in Appendix F of this revised report.

ES.7 Consent Order Projects and System Optimization

As discussed in Section ES.1, DEEP issued Consent Order WRMU17001 to NPU allowing 500 calendar days for development of a revised LTCP. As part of this process, DEEP required NPU to proceed immediately with design of separation of the Eastside area tributary to CSO 025. Separation of this area was identified in the 2012 LTCP as the recommended CSO control plan to control discharges at CSO 025 during a 2-year design storm.

Design of this separation project was to be concurrent with development of the updated LTCP submitted in 2018. The Consent Order then required that upon completion of the Eastside project, NPU proceed with CSO reduction projects in Thamesville to achieve 2-year control at CSO 004, CSO 005, and CSO 040. The Consent Order requires that the Eastside separation project be completed by December 31, 2020 and that a Thamesville CSO project be completed by December 31, 2025.

Sewer separation in Eastside was ultimately determined to be infeasible to control the 2-year storm. Section 7 explores the background and existing conditions of the Eastside sewershed and discusses the hydraulic issues making the original East Side separation project infeasible. Ultimately an agreement was reached with DEEP to complete the "Planned Projects" in lieu of Eastside sewer separation. These projects and their status as of June 2020 are described below.

- *Construction of Conveyance Improvements across the Eighth Street Bridge to control CSO 024 to the 2-year storm and CSO 025 to the 10-year storm.* This project was developed with DEEP staff, has been fully designed and was submitted to DEEP for approval to bid in August 2019. This project is expected to be constructed in 2026 as described in Section 10. This design includes the following items:
  - Replacement of an undersized 8-inch / 12-inch sewer pipeline with a new 24-inch pipeline to increase conveyance from CSO 025 to the Shetucket Interceptor. This added conveyance will allow a new CSO 025 weir to be initially set to control the 10-year storm, with the intent to fully close CSO 025 after a suitable monitoring period to demonstrate that full closure will not pose a risk to human health.
  - Installation of a new CSO 024 regulator chamber in Eighth Street with a 30-inch connection to the Shetucket Interceptor and a relocated CSO discharge to the NPU power canal instead of the Shetucket River. The NPU power canal ultimately discharges to the Shetucket River 2500 feet downstream of the old CSO 024 outfall. This will improve water quality in a stretch of the Shetucket River often used for fishing and other recreation.
- *Installation of Supervisory Control and Data Acquisition (SCADA) controls to improve Rose Alley Pumping Station operations and maximize wet weather flow to the WPCF*. This project was designed, bid, and fully constructed as of December 2019.

- *Raising weirs at select regulators to retain additional volume in the system during wet weather events*. Eleven weirs were raised and reconstructed throughout the system, and CSO 040 has been permanently closed. These improvements have enhanced the quality of flow monitoring data, and decreased CSO events and volumes by holding more flow in the system. This project was fully completed in 2019.

Full implementation of the alternative "Planned Projects" is expected to reduce average annual CSO by 30 percent from 43 million gallons (Mgal) to 30 Mgal and reduce system wide annual overflow from 60 to 44 events.

ES.8 Alternatives Evaluation

Alternatives evaluation in the report is organized to follow the process for development of alternatives. First, multiple CSO management strategies are identified for each area of the city. Next, effectiveness of each strategy for CSO reduction is assessed. Effective solutions in each area of the city are then combined into comprehensive alternatives for systemwide CSO control. In accordance with EPA guidance manual for developing LTCPs, CSO control alternatives were developed for 1-month, 3-month, 6-month, 1-year, 2-year, and 5-year design storms.

After hydraulic effectiveness and performance statistics are developed, project costs, construction and environmental impacts, and CSO benefits achieved by implementing each design storm control strategy are also identified. Alternatives are then evaluated based on community impacts, constructability, operation and maintenance considerations and cost effectiveness. Performance and cost summary tables are presented toward the end of the section. Top-performing plans were selected for financial evaluation in Section 9. Section 10 describes the Recommended Plan.

The report methodology is predicated on 2-year control per the Consent Order. The least cost and most cost effective 2-year CSO control plan was determined to be Alternative 1 (Conveyance and Centralized Treatment to a total of 80 mgd). This 2-year control alternative is estimated at an approximate total of **$270 million** (2018 US Dollars), including $190 million for CSO projects in the collection system and $80 million for WPCF improvements necessary to update the existing facility and increase its reliable peak flow capacity to a nominal 20 mgd. There will be additional costs for O&M of new infrastructure and for planning as LTCP updates are required every five years throughout the CSO program. These costs are not included in the $270 million, but are accounted for in Section 9.

The least cost 2-year control plan was evaluated via a financial capability analysis as described in Section 9. This project was originally considered to be unaffordable to NPU per the financial analysis presented in Section 9 of the August 14, 2018 LTCP submittal (Appendix F). In this original financial analysis, it was assumed that Clean Water Fund loans and grants from DEEP would not be available for the duration of the CSO program, as these generally cannot be guaranteed to remain throughout the planning period. Due to this determination, NPU was originally forced to consider less costly control plans that could be implemented over a reasonable period. As the 3-month control level was the most cost-effective plan overall and corresponds to the knee-of-the-curve, this plan was originally recommended in the August 14,

2018 submittal. The least cost and most cost effective 3-month CSO control plan is Alternative 2 (Conveyance and Storage).

During discussions and workshops following submittal of the August 14, 2018 LTCP, DEEP heavily emphasized goals of achieving 2-year CSO control in Norwich and larger water quality benefits earlier in the program schedule**. In these workshops, DEEP stated a clear intent to fund NPU's CSO program via the Clean Water Fund**. While unaffordable without Clean Water Fund grant and loan funding, the 2-year Conveyance and Centralized Treatment alternative is achievable with the maximum allowable financial support from DEEP.

At DEEP's request, CDM Smith has revised this LTCP and assumed that Clean Water Fund grant and loan percentages will be available to NPU (at the same percentages available today) to the maximum extent possible throughout the planning period. Under these conditions, 2-year CSO control becomes affordable for NPU and its rate payers. Section 9 of this revised report presents this revised financial analysis assuming Clean Water Fund grant and loan funding is available throughout the planning period. **If DEEP funding is reduced or becomes unavailable, the Recommended Plan and/or implementation schedule will need to be reevaluated**.

The 2-year CSO control alternative for Conveyance and Centralized Treatment has been selected as the Recommended Plan. The schedule of projects has been rearranged based on DEEP input to focus early in the program on improvement at the WPCF, wet weather treatment facilities at the WPCF, and improved conveyance from the Shetucket Interceptor via a new Rose Alley Pumping Station and force mains. Section 10 further explores the merits and limitations of the Recommended Plan.

ES.9 Financial Capability Assessment

EPA has published guidance for a financial capability assessment which estimates the impact of anticipated capital improvements on the average residential ratepayer by evaluating household burden. Household burden is a metric defined by EPA that assesses the typical residential sewer bill as a percent of a community's median household income (MHI). Under the EPA guidance process, a household burden exceeding two percent of MHI is generally deemed a high burden.

The August 2018 LTCP was developed per EPA CSO Policy to seek the most cost-effective plan for reducing CSO discharges using the knee-of-the-curve. Although many alternatives were developed and evaluated (including 2-year control), the 3-month level of control was ultimately recommended. The corresponding financial capability assessment was developed under the presumption that the Connecticut Clean Water Fund may not be available in its current form for the duration of the program, and/or that DEEP may not be able to fund NPU's program due to limited funding availability. Thus, the 2018 LTCP assumed that NPU's CSO program would have to be completely self-funded. The 3-month level of CSO control plan, if self-funded, would have exceeded the EPA threshold for household burden as described in the appended 2018 LTCP.

Following the submittal of the August 2018 LTCP, NPU engaged in multiple discussions and workshops with DEEP on the proposed Recommended Plan. Based on these discussions with DEEP, a revised plan achieving 2-year control was developed. This is a high level of control compared with mandates issued by EPA and other regulatory authorities throughout the US.

NPU's new Recommended Plan also carries a significant capital investment in the early years of the program.

Based on discussions with DEEP, this analysis assumes NPU will receive State Revolving Fund (SRF) grants and loans through the Connecticut Clean Water Fund to finance capital costs. Grants for CSO projects are understood to be 50% of project cost. Grants for WPCF nutrient upgrades are understood to be 30% of related project cost, and grants for general upgrades to wastewater infrastructure are understood to be 20% of project cost. Loans through the Clean Water Fund are understood to have a 2.0 percent interest rate, a term of 20 years, and issuance costs of 1.0 percent. In requesting that NPU pursue the Recommended Plan presented herein for 2-year CSO control, DEEP committed in meetings to provide maximum allowable funding for the recommended CSO program through the Clean Water Fund. **As stated previously, if DEEP funding is reduced or becomes unavailable, the financial analysis presented in Section 9 will no longer be valid, and the Recommended Plan and/or implementation schedule will need to be reevaluated.**

With the funding assumptions stated above, the residential indicator (household burden) reaches 2 percent in FY 2040 under the recommended program as shown in Figure ES-1. The residential indicator reaches 1.9 percent in FY 2029 and remains at that level until it reaches the 2 percent threshold in FY 2040. Under these conditions, 2-year CSO control becomes achievable for NPU and its rate payers. Without grant funding or SRF loans, the burden would exceed 3.1 percent of MHI if the same program and schedule are maintained. This would require average annual rate increases of 20 percent from FY 2020 to FY 2027. The burden would exceed 2.5 percent of MHI throughout the 30-year projection period.

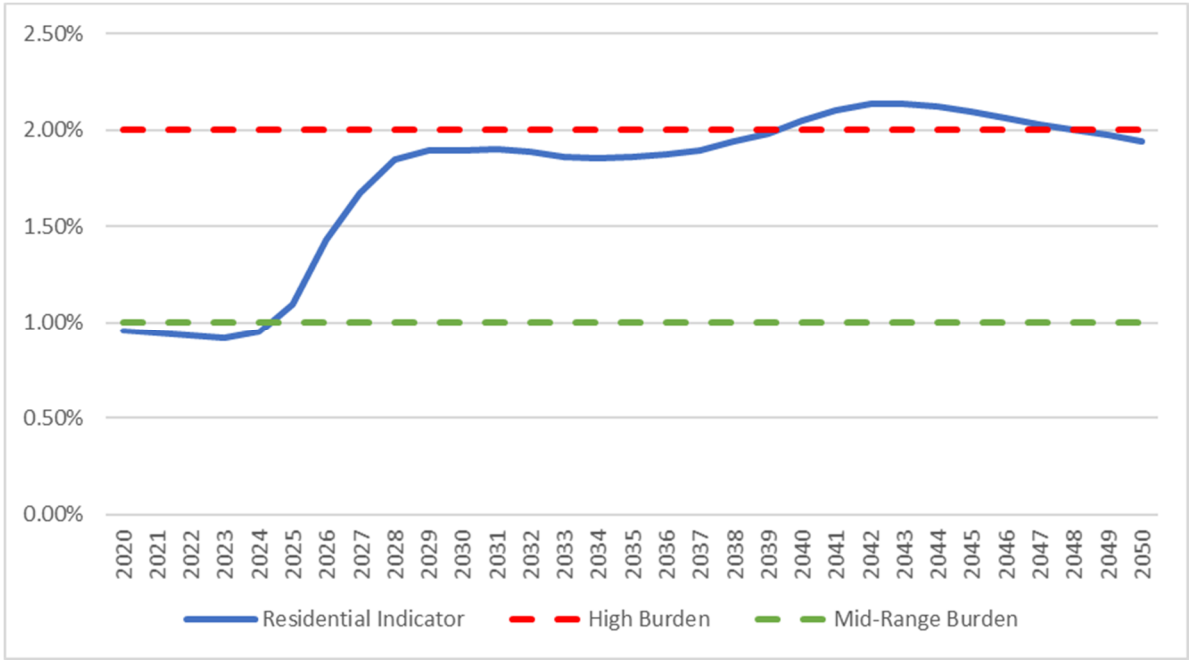


Figure ES-1
Projected Household Burden and Residential Indicator

ES.10 Recommended Plan

In consideration of the Consent Order, it is recommended that NPU do as much as financially practical to control CSO discharges and benefit water quality. With grant and loan funding, NPU can achieve the least cost 2-year level control alternative, "2-Year Conveyance and Treatment," over a 35-year planning horizon. The components of the Recommended Plan are illustrated in Figure ES-2 at the end of this section. This figure depicts the new pipelines, pumping stations, and storage tank required to achieve 2-year control. The planning-level capital cost of CSO improvements as well as the necessary facility upgrades to the WPCF, over 35 years is $270 million (FY 2018 dollars). The planning period of the LTCP would extend from 2018 (start of the Planned Projects) to 2053.

The Recommended Plan for 2-Year Conveyance and Treatment consists of the following components and associated capital costs (all in FY 2018 dollars):

- Completion of CSO weir reconstruction and SCADA improvements to the existing Rose Alley Pumping Station per the Planned Projects described in Section 7 (completed in 2019).
- Improvements to the WPCF to increase capacity from 17 mgd to 20 mgd, improve reliability, and improve nitrogen removal ($80 million)
- Improvements to the Rose Alley Pumping Station and wet weather expansion at the WPCF site totaling $87 million including:
  - Replace Rose Alley pumping station (65 mgd) and force mains (dry weather and wet weather)
  - Construct an enhanced high rate clarification (HRC) facility on Hollyhock Island (WPCF site - 60 mgd wet weather expansion)
- Construction of the Eighth Street Conveyance Improvements per the Planned Projects described in Section 7 ($6 million).
- Improvements in the Laurel Hill neighborhood totaling $15 million including:
  - Replace the River Avenue pumping station (16 mgd) and force main
  - Increase the diameter of dry weather flow pipes near regulators 31 and 32 (960 linear feet [LF], 24-in to 30-in diameter)
  - Raise CSO regulator weirs beyond the Planned Projects level
- Improvements in the Thamesville neighborhood totaling $27 million including:
  - Replace the Shipping Street pumping station (3.5 mgd) and force main
  - Relocate the regulator structure for CSO 004

- Reconfigure the gravity sewer system to convey flow from Route 32 and the new Shipping Street pumping station to the new CSO 004 regulator (2,310 LF, 15-in to 24-in diameter)
- Remove and replace sewer pipe tributary to the existing Shipping Street force main
- Replace the South Thames Street pumping station (16 mgd) and force main
- Install a new gravity sewer from existing South Thames Street pumping station to new pumping station (580 LF, 15-in to 30-in diameter)

- Improvements in the Shetucket area (Greeneville and Downtown sewersheds) totaling $55 million including:
  - 0.9 Mgal storage tank at the Rose Alley commuter parking lot site
  - Install Shetucket Relief Interceptor in two phases (5,680 LF, 36-in to 48-in diameter)
  - Raise CSO regulator weirs beyond the Planned Projects level
  - Increase the diameter of dry weather flow pipe diameter at several locations (830 LF, 12-in to 32-in diameter)
- LTCP updates will be completed every five years throughout the recommended program. These updates will evaluate the effectiveness of implemented CSO projects, and refine model projections to guide future improvements.

Approximately $1 million per year (FY 2018 dollars) in O&M has been estimated for the completed 2-year level of control. This is due to the additional relief pipeline that is needed, as well as the HRC facility at the treatment plant and increased pumping station sizes.

Annual performance benefits based on simulation of the 2009-2011 representative period associated with the Recommended Plan are summarized below:

- Average annual frequency of overflow will be reduced from 60 events (current baseline) to an average of 0.7 events, a 99% reduction;
- Average annual CSO volume is reduced from 43.3 million gallons (current baseline) to 0.26 million gallons, a 99% reduction. The Recommended Plan performance includes the addition of the future baseline flows.

Average annual CSO characteristics are displayed in Table ES-2.

Table ES-2: Performance of the Least Cost Plan

Condition	Annual CSO Volume (Mgal)	Annual Number of CSO Events
Baseline	43.3	60
Recommended: 2-Year Control	0.26	0.7

As described later in Section 10.4.1, some of the storms within the representative period exceeded the 2-year ARI at various durations. Although the Recommended Plan simulation indicates two CSO events over the three-year representative period, these events are extreme and exceed the 2-year ARI. Overall, the representative period selected is conservative.

The recommended project improvements will provide at least a 2-year level of CSO control throughout the entire NPU combined sewer system. The early focus is given to improvements at the WPCF site at Hollyhock Island and the Rose Alley PS, followed by the construction of the Eighth Street Conveyance Improvements. After the completion of these large projects a period of capital recovery is planned to give NPU a chance to recover from significant early borrowing.

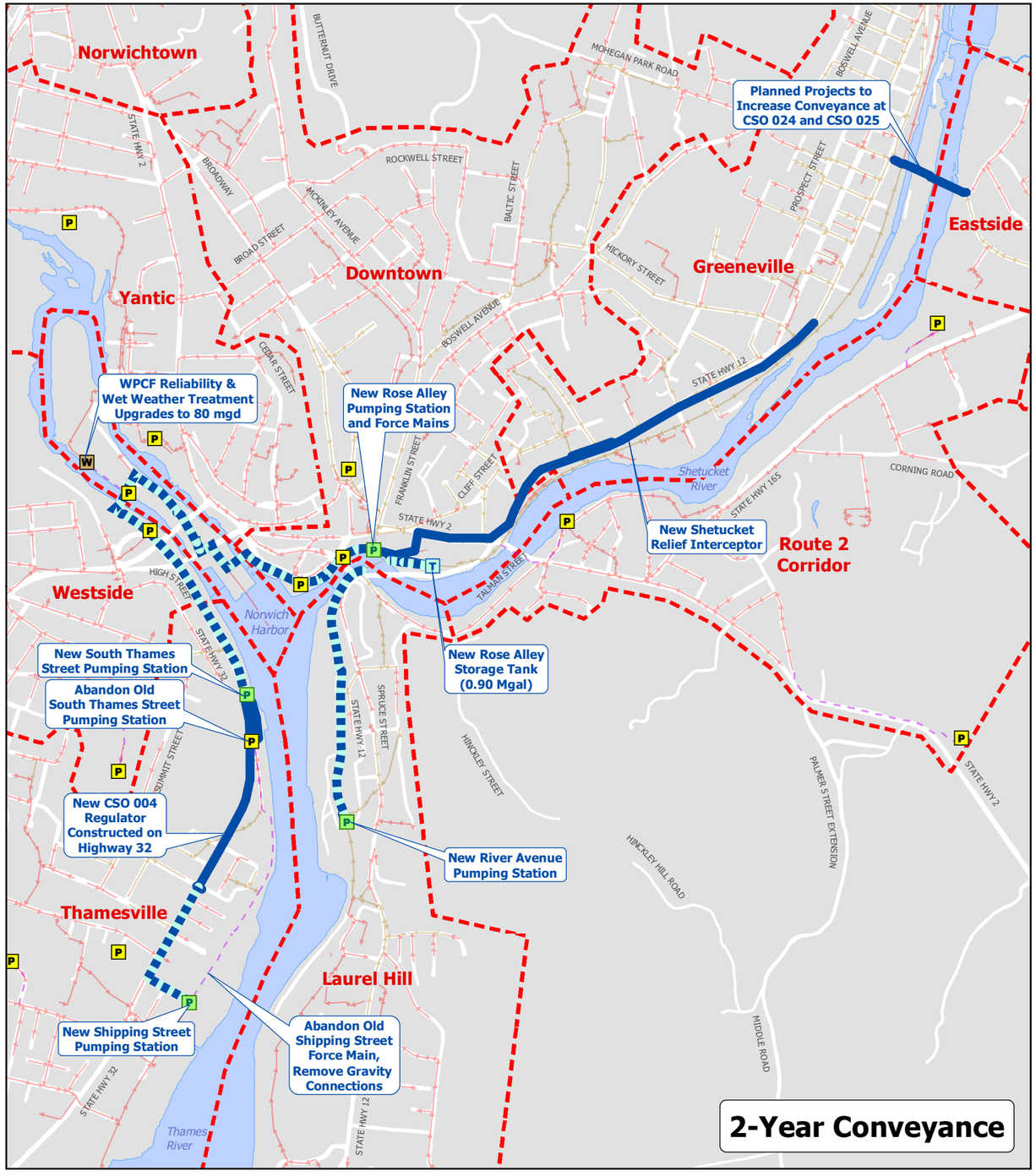
Following the capital recovery period, additional CSO projects in the Downtown, Greeneville, Laurel Hill, and Thamesville areas are proposed to convey additional CSO flow to the early improvements made at Rose Alley and Hollyhock Island. A proposed schedule and map of the project components is included as Figure ES-2 following this Executive Summary.

As future projects are implemented, the sizes of conveyance piping and the storage tank will be reevaluated to ensure proper sizing to accommodate future conditions. NPU will revisit the Recommended Plan and publish an update every five years during program implementation to reevaluate effectiveness of implemented projects and review proposed future projects. This will help NPU evaluate existing controls and stay on course to meet CSO program objectives.

In most cases, it is not recommended that CSO regulators or outfalls be closed as these improvements are made. NPU recently closed CSO 040, but in general, these relief points are needed to alleviate surcharging in events larger than the 2-year storm. Closure of regulators can lead to basement backups, street flooding, and general risk to public health. A phased approach will generally be recommended, similar to achieving 10-year control at CSO 025 prior to further assessment and intended permanent closure.

The potential to safely close additional CSO regulators will be evaluated regularly as the LTCP is implemented and LTCP updates are completed in the future. Each active CSO regulator is monitored by continuous flow metering to track CSO performance over time. The data obtained by these meters will allow for evaluation of each CSO improvement that is constructed and allow for phased closure of regulators where it is deemed to be safe. This active monitoring will also help guide the direction of future LTCP updates and the final sizing of project components.

This CSO abatement program represents a major financial, economic, and environmental challenge. NPU can afford to achieve this 2-year level of control only with Clean Water Fund grant and loan funding as presented in Section 9. **If Clean Water Fund grant and loan funding become unavailable for any reason, the analysis in Section 9 will become invalid, and NPU will need to reevaluate the Recommended Plan and/or the proposed schedule.** The ability to achieve the 2-year control goal will be revaluated every five years in LTCP updates to determine if funding or affordability conditions have changed.



Project Order	Duration (Years)	Area	Item	Totals ($2018)	Program Years	Calendar Year	Average Annual CSO over Representative Period (Mgal)	CSO Remaining In 2-Year Storm (Mgal)
-	-	-	Existing Conditions	-	0	-	43.3	5.86
1	1	Shetucket	Rose Alley SCADA Improvements and Weir Reconstruction at 11 CSO Regulators	-	1	2019	10.5	2.23
2	6	WPCF	WPCF Core Upgrades (20 MGD)	$80,000,000	3-8	2021-2026		
3	3	WPCF	WPCF HRC Facility (60 MGD) including Allowance for Contamination and Business Disruption	$53,000,000	6-8	2024-2026		
4	3	Shetucket	New Rose Alley Pumping Station and Force Mains (42-inch equivalent)	$34,000,000	6-8	2024-2026		
5	1	Eastside	Eastside Conveyance Improvements	$ 6,000,000	8	2026		
-	10	-	Capital Recovery Period	-	9-18	2027-2036	-	-
6	3	Laurel Hill	New River Avenue Pumping Station (12 MGD) and Force Main (20-inch)	$12,000,000	19-21	2037-2039	9.79	1.89
7	3	Laurel Hill	Raising Weirs Beyond Early Projects Level, Replace Dry Weather Flow Pipes from 032 and 031	$ 2,000,000	19-21	2037-2039		
8	3	Shetucket	Shetucket Relief Interceptor - Phase 1 (48-inch)	$16,000,000	21-23	2039-2041	6.11	1.22
9	2	Shetucket	Various Dry Weather Flow Pipe Increases, Raise Seven Weirs Beyond Planned Project Level	$ 2,000,000	21-22	2039-2040		
10	3	Thamesville	Gravity Pipe down Highway 32 to New Regulator (24 & 30-inch)	$ 4,000,000	22-24	2040-2042	5.79	1.16
11	3	Thamesville	Cahoon Street, Thames Terrace, and Kinney Avenue Gravity Sewers. Raising Weirs. Abandoning Old CSO 004 Regulator. New Building Services near Old CSO Regulator 004	$ 2,000,000	25-27	2043-2045		
12	3	Thamesville	New Shipping Street Pumping Station (3.5 MGD) and Force Main (12-inch)	$ 5,000,000	25-27	2043-2045		
13	3	Thamesville	South Thames Pumping Station (17 MGD) & Force Main (24-inch) & Property Purchase Allowance	$15,000,000	29-31	2047-2049	4.95	0.96
14	3	Thamesville	South Thames New Gravity Sewer (Old Pumping Station to New Pumping Station)	$ 2,000,000	29-31	2047-2049		
15	3	Shetucket	Shetucket Relief Interceptor - Phase 2 (36 & 48-inch)	$14,000,000	33-35	2051-2053	0.26	0
16	3	Shetucket	Rose Alley Commuter Lot Tank: (0.90 Mgal) Storage tank, Dewatering Pumping Station (2 mgd), New Force Main, New Gravity Pipe, Sluice Gate Diversion Structure, and Allowance for Disruption	$23,000,000	33-35	2051-2053		

***LTCP Updates will be completed every five years throughout the recommended program, with the first update anticipated in 2025.**

CDM Smith

Legend

- Recommended Storage Tanks
- Recommended Pumping Stations
- Recommended Sewers
- Recommended Pressurized Mains
- Water Pollution Control Facility
- Pumping Stations
- Force Mains
- Combined Sanitary Sewers
- Separated Sanitary Sewers

1 inch = 1,400 feet

0 700 1,400 Feet

N

2020 Long Term Control Plan
Norwich Public Utilities

Figure ES-2
Recommended 2-Year Control Plan

Section 1

Section 1
Introduction

1.1 General

Norwich Public Utilities (NPU) is a municipally-owned utility that provides sewer, water, electric, and gas services to customers in Norwich and surrounding communities. NPU owns and operates the sewer collection and treatment system. The sewer system is comprised of sanitary sewers and combined sewers. A combined sewer system (CSS) is one in which both stormwater and sewage are combined into a single pipe and conveyed to the water pollution control facility (WPCF) for treatment. This approach was the standard for cost-effective sewer design for many decades, and was quite common across the country, especially in early New England.

Large rain storms can overwhelm combined collection systems, causing surcharge and discharges from the system at designed hydraulic relief points called combined sewer overflow (CSO) structures. CSO discharges contain raw sewage diluted with stormwater and can create environmental issues for local receiving waters.

NPU's CSS is located within the City of Norwich, and impacted waterbodies include the Shetucket River and Thames River.

1.2 CSO Compliance History

Since the 1970s, NPU has implemented CSS improvements to address CSO discharges and to comply with evolving CSO regulations.

In the 1970s, NPU adopted an initial sewer system facilities plan to eliminate CSOs by separating all the combined sewers. Six of the proposed 33 separation projects were completed. Due to a reduction in state and federal funding, NPU suspended the implementation of the remaining sewer separation projects in the 1980s.

The United States Environmental Protection Agency (EPA) issued a 1989 interim CSO Control Policy. In response, Connecticut Department of Energy and Environmental Protection (DEEP) established its own *Combine Sewer Overflow Strategy* in May 1990 (DEEP CSO Strategy) to match the intent of the 1989 interim federal CSO policy and to identify state goals for CSO reduction.

Accordingly, NPU issued a second plan, the *Norwich CT CSO Modified Facilities Plan,* in 1994 to address these CSO control policies. This facilities plan recommended eight sewer separation projects to reduce CSO volume; NPU completed these projects and the number of CSO outfalls was further reduced.

On April 11, 1994, the EPA issued the final *Combined Sewer Overflow (CSO) Control Policy* (EPA CSO Policy). The EPA CSO Policy established a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities, and the public engage in a coordinated planning effort to develop and implement cost-effective CSO controls that ultimately meet appropriate environmental and health objectives. The EPA CSO Policy is

implemented through the National Pollution Discharge Elimination System (NPDES) permit program under the provisions of the Clean Water Act (CWA). The national policy mandated that each CSO community develop and implement a Long-Term Control Plan (LTCP) to eliminate or reduce untreated CSO discharges to the nation's receiving waterways.

On July 10, 2007, DEEP issued Consent Order WC 5445 to NPU. This order required NPU to submit an updated LTCP by October 2010 in accordance with the planning requirements of the EPA CSO Policy and the DEEP CSO Strategy.

Accordingly, NPU developed its third CSO Long-Term Control Plan, which recommended sewer separation for most combined sewers in Norwich. Comments to the plan were received and the *CSO Long-Term Control Plan, Final Report* was submitted in August 2012 (2012 LTCP) recommending public sewer separation in the remaining combined sewer areas to achieve CSO reduction up to the 2-year return frequency storm event. The 2012 LTCP also recommended leaving at least one CSO discharge open to protect public health (excessive system surcharge causing basement backups) during wet weather events greater than the 2-year storm. DEEP approved the plan on May 26, 2016.

Since the approval of the 2012 LTCP, a number of conditions had changed including increasing costs for sewer separation and inflow removal, modifications to the EPA's affordability criteria (which helps guide the implementation schedule), and Norwich was classified by the State of Connecticut as a "distressed community", which indicated a diminished ability to pay for the implementation of CSO and other capital projects. Accordingly, NPU requested permission to update the 2012 LTCP.

On July 3, 2017, DEEP issued Consent Order WRMU17001 to NPU, which allowed 500 calendar days for the development of a revised LTCP to meet the requirements of the DEEP Order and to be consistent with the EPA CSO Policy and guidance documents on the development of LTCPs. DEEP approved the LTCP scope of work on September 8, 2017. This included,

- Implementation of system-wide flow metering and modeling for improved characterization of the NPU system and assessment of CSO;
- Development of a Baseline Conditions Report to document existing conditions and CSO performance under a range of conditions;
- Development and evaluation of system improvements and CSO abatement strategies to address a range of design storm conditions;
- Development of a refined and updated affordability analysis;
- Planning for ongoing public outreach during implementation of the LTCP; and
- Development of recommended projects with an implementation schedule.

NPU submitted the *CSO Control Planning Baseline Conditions Report* on February 12, 2018. This report characterized the NPU sewer system performance in a range of design storm conditions, including the 2-year storm, as well as average annual performance to establish a benchmark for

alternatives development in the 2018 LTCP. An updated Baseline Conditions Report addressing DEEP's comments was submitted on March 28, 2018 (Appendix E to this report).

NPU submitted a *CSO Long-Term Control Plan Report* to DEEP on August 14, 2018. This report built upon the extensive model work developed for the Baseline Conditions Report, developed alternatives for CSO control at all the selected design storms (levels of control) considered the financial limitations of NPU, and summarized the proposed approach for CSO control. The August 14, 2018 LTCP Report followed the EPA methodology for determining the most cost-effective plan using the Knee-of-the-Curve approach, and ultimately recommended the 3-month level of CSO control. It is noted that the recommended approach from this study included provisions for a future expansion to the 2-year level of control.

Following submittal of this 2018 report, NPU and DEEP participated in multiple meetings and workshops. DEEP asserted that the recommended 3-month level of control was not adequate. Although the plan complied with EPA policy, DEEP requested that NPU achieve a higher water quality benefit over a shorter timeframe and required that the 2-year control level be achieved. DEEP acknowledged NPU's financial limitations, and agreed that after constructing a large capital project, NPU would need a capital recovery period to pay down its loans prior to taking the next steps on any capital program. DEEP also acknowledged that without grant and loan funding, NPU would not be able to afford a capital improvement program such as the 2-year level of control program DEEP had requested.

DEEP requested that NPU's financial capability analysis be re-assessed assuming maximum grant eligibility and low interest loans under the Clean Water Fund. DEEP also acknowledged that if funding is lost, NPU and DEEP would need to reevaluate both the Recommended Plan and project schedule. Ultimately DEEP and NPU agreed to a CSO program and schedule that was deemed acceptable to both parties as long as CWF grant and loan funding was provided to the maximum extent possible.

This revised CSO LTCP Report has been prepared to reflect the progress made during discussions with DEEP and describe the new recommended CSO program and schedule. Section 1.6 describes the organization of this revised report.

In order to make this submission a complete record of the last several years of CSO planning work, the original Baseline Conditions Report from March 28, 2018 and the CSO LTCP from August 14, 2018 are appended to this revised report as Appendix E and Appendix F.

1.3 Purpose

The purpose of this revised LTCP is to summarize the NPU system investigations, alternatives evaluation, and proposed plan to further minimize CSO discharges in compliance with the July 3, 2017 Consent Order, EPA CSO Policy, DEEP CSO Strategy, and the Connecticut State Water Quality Standards.

NPU contracted with CDM Smith to update its sewer system model, prepare a Baseline Conditions Report, and prepare a revised LTCP to address changes since the 2012 LTCP update. As part of the Consent Order, CDM Smith has worked concurrently on a series of projects to control CSOs in the Eastside Area and reduce CSO volumes throughout the system. Design of these projects began

in 2018 and design has since been completed. These projects are referred to as "Planned Projects" throughout this LTCP and are explained in detail in Section 7.

1.4 Baseline Conditions

The *CSO Control Planning Baseline Conditions Report* submitted in March of 2018 presented model calibration and metering results, as well as the existing conditions of CSOs in Norwich today. The Baseline Conditions Report characterized baseline overflow statistics and associated impacts to receiving waters. Baseline conditions were established using the InfoWorks model, from the 2012 LTCP, which was subsequently modified to better reflect existing field conditions and calibrated to flow metering data that was collected as part of the 2018 LTCP update.

In this report, a future baseline was developed to incorporate projected population, commercial, and industrial changes in Norwich over the coming decades. The future baseline scenario was used to develop alternatives to address CSO and provided a benchmark of the existing system to assess future conditions as CSO control alternatives are implemented. Reliability improvements to the WPCF and implementation of the Planned Projects were included in each alternative that was considered in this LTCP.

The LTCP alternatives were developed and evaluated to balance issues including impacts to water quality, impacts to public health, NPU's ability to finance alternatives, and community concerns.

1.5 LTCP Approach

The CSO planning process was developed to comply with the EPA CSO Policy and address the requirements of the Consent Order and those identified through technical meetings and workshops with DEEP. In general, the following steps were taken to arrive at the recommended LTCP:

- Screening of CSO abatement technologies to identify those most suitable for mitigation of NPU CSOs;
- Assessment of available sites for satellite storage or treatment;
- Assessment of sewer separation approaches to remove extraneous wet weather flow from the sewer system;
- Development of specific applications of viable technologies and combinations of technologies into CSO control alternatives;
- Evaluation of CSO control alternatives in terms of feasibility, cost-effectiveness, water quality benefits, affordability, and community needs;
- Recommendation given in the August 14, 2018 LTCP Submittal;
- Additional discussions and consultation with DEEP; and
- Selection of the Final Recommended Plan included in this 2020 LTCP Report.

1.6 Report Organization

This report is organized into ten sections as follows:

- **Section 1 (Revised)** – Introduces the regulatory history and purpose of this study with commentary on what evolved after the original LTCP submittal in 2018;
- **Section 2** – Describes the existing collection system, system model, and defines the future baseline condition;
- **Section 3** – Provides a summary of NPU's Water Pollution Control Facility, which is a critical resource for handling dry and wet weather flows;
- **Section 4 (Revised)** – Discusses the EPA CSO Policy and DEEP CSO Strategy and applicability to NPU;
- **Section 5** – Includes an assessment of available CSO abatement technologies and their applicability to NPU;
- **Section 6** – Discusses sewer separation and wet weather inflow reduction approaches;
- **Section 7 (Revised)** – Provides a summary of NPU's consent order, and the Planned Projects implemented since 2018 and anticipated in the near future;
- **Section 8 (Revised)** – Explains the alternatives development and analysis process, and presents the planning level costs of the alternatives developed;
- **Section 9 (Revised)** – Analyzes affordability of different CSO mitigation programs; and
- **Section 10 (Revised)** – Presents NPU's proposed LTCP program, including the components of the Recommended Plan, and a timeline of project implementation.

This revised LTCP Report includes republished sections that were revised from the original 2018 submission. In order to make this submission a complete record of the last several years of CSO planning work, the original Baseline Conditions Report from March 28, 2018 and the CSO LTCP from August 14, 2018 LTCP are appended to this revised report as Appendix E and Appendix F.

Section 2

This Section Unchanged from 2018 Report, See Appendix F

Section 3

This Section Unchanged from 2018 Report, See Appendix F

Section 4

Section 4
Water Quality Objectives

4.1 General

For the first two decades of implementation of the federal Clean Water Act (CWA), regulatory agencies focused on cleanup of continuous waste discharges. Publicly owned treatment works (POTWs) were typically required to provide secondary treatment, or at least provide a level of treatment greater than primary sedimentation. Industrial dischargers were required to install best available treatment for their discharges.

Combined sewer overflow (CSO) control presents communities with distinct challenges as system improvements for CSO control can be expensive and water quality impacts from CSOs are temporary and limited to periods when discharges occur during storms. In addition, many studies indicate that CSO control alone may not meet water quality objectives as stormwater runoff also adversely affects water quality during and after wet weather conditions.

In recent years, regulators have sought coherent policies that tie the environmental benefits of CSO control with the costs to achieve these benefits. Both federal and state agencies recognize that compliance with state water quality standards for CSO discharges is costly. Accordingly, both governments have developed separate, but similar, CSO control policies to guide the abatement of CSO discharges given the technical, social, and economic challenges for communities.

In Connecticut, the Department of Energy and Environmental Protection (DEEP) has primacy, meaning the federal entity United Sates Environmental Protection Agency (EPA) has delegated primary enforcement responsibility to the state entity (DEEP). This section discusses current EPA and DEEP policies, highlighting the applicability of both policies to Norwich Public Utilities (NPU).

4.2 EPA Policy

CSOs are point source discharges to the waters of the United States, subject to the CWA and the National Pollution Discharge Elimination System (NPDES). Like other point source discharges, CSOs are subject to both technology-based and water quality-based requirements of the CWA. The 1994 *Combined Sewer Overflow (CSO) Control Policy* (EPA CSO Policy) provides EPA guidance for controlling CSOs. The policy was adopted as law in 2000. The EPA CSO Policy is included as Appendix C. There are two key objectives of the policy: implementation of the Nine Minimum Controls (NMC), and development and implementation of Long-Term Control Plans (LTCPs).

4.2.1 Nine Minimum Controls

NMC measures represent low-cost, technology-based actions that can reduce CSO and its receiving water quality impacts. In 1995, EPA issued the guidance document *Combined Sewer Overflows: Guidance for Nine Minimum Controls*. The intent of NMCs is not to eliminate CSO, but to provide some CSO reduction while control plans are developed and implemented. NMCs do not require significant engineering studies or construction and can generally be implemented in a short time frame through careful operation and maintenance of combined sewer systems. It is the

intent of the EPA CSO Policy that the NMCs be compatible with the LTCP. The EPA CSO Policy required all combined sewer communities to implement NMCs by 1997.

The NMCs are:

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

Selection and implementation of actual control measures is based on site-specific considerations. Documentation of the NMCs may include: operation and maintenance plans, revised sewer use ordinances for industrial users, sewer system inspection reports, infiltration/inflow studies, pollution prevention programs, public notification plans, and facility plans for maximizing capacities of the existing collection, storage, and treatment systems. NMC documentation may also include contracts and schedules for minor construction projects to improve operation of the existing system.

4.2.2 Long-Term Control Plan

The NPDES permitting authority in Connecticut determines whether NMCs satisfy the technology-based requirements of the CWA. If further controls are necessary to meet water quality standards, then the NPDES permitting authority will require development of a LTCP. In Connecticut, DEEP is the NPDES permitting authority. This subsection describes the EPA requirements for a LTCP. NPU will ultimately need to meet the requirements of the DEEP consent order and DEEP's CSO guidance policy, as described below.

In 2001, EPA issued the document titled *Guidance: Coordinating CSO Long-Term Planning with Water Quality Standards Reviews*. The document identifies two approaches for CSO communities to consider while evaluating CSO control and selecting alternatives. These are the "presumption" and "demonstration" approaches. These approaches are defined in the document as:

- The "presumption approach," under which achievement of certain performance criteria (i.e., four to six untreated overflow events or 85% by volume capture) would be presumed to provide an adequate level of control to attain water quality standards;

- The "demonstration approach," developing and implementing an LTCP that meets applicable water quality standards.

In general, if sufficient data is available to demonstrate that the proposed plan will result in an appropriate level of CSO control, the demonstration approach is selected. If the data collected by a community cannot provide enough evidence that CSO controls will provide an appropriate level of protection to meet water quality standards, the presumption approach may be considered. These approaches are further discussed below.

4.2.2.1 Demonstration Approach

Under the "demonstration approach," communities collect and present data in the LTCP sufficient to show that proposed controls are adequate to meet appropriate water quality standards. Through technical and financial analysis, the demonstration approach identifies the maximum pollution reduction benefits reasonably attainable, to ultimately demonstrate that the level of control proposed complies with state water quality standards and the CWA. The level of control proposed under the demonstration approach may be more or less than that required under the presumption approach. The CSO Control Policy states that four criteria must be met for successful use of the demonstration approach:

- The control program will protect water quality standards, unless standards cannot be met as a result of natural conditions or other pollution sources;
- Overflows remaining after implementation of the control program will not preclude attainment of water quality standards;
- The control program will achieve maximum reasonably attainable pollution reduction benefits; and
- The control program is designed to allow cost effective expansion or cost retrofitting if additional controls are subsequently determined necessary to meet water quality standards.

Where water quality standards cannot be met because of natural conditions or other pollutant sources, a total maximum daily load (TMDL) approach or other means should be used to apportion pollutant loads within the watershed.

4.2.2.2 Presumption Approach

The "presumption approach" assumes that achievement of certain performance criteria will be sufficient to meet current applicable water quality standards. The presumption approach requires meeting one of the following three criteria:

- No more than an average of four overflow events per year;
- Elimination or capture of no less than 85% by volume of the combined sewage collected in the combined sewer system during precipitation events on a system-wide annual average basis; or

- Elimination or removal of no less than the mass pollutants identified as causing water quality standards impairment.

As part of the presumption approach, there must be sufficient information available to indicate that these levels of control can reasonably be expected to meet state water quality standards. Communities following the presumption approach are also expected to conduct post-LTCP monitoring, to show that water quality standards are being met.

Regardless of whether the demonstration or presumption approach is used, the CSO control program ultimately selected must be sufficient to meet water quality standards and other CWA requirements. The 2001 guidance document also indicates that, if the receiving water is on the state's 303(d) list for development of a TMDL, then TMDL studies and the LTCP should be linked and contain a schedule for water quality reviews. This could facilitate future re-evaluation of planned CSO controls based upon whether water quality improvements are already achieved.

As set forth in the CWA, CSO discharges that remain after implementation of CSO controls must not interfere with attainment of the state's water quality standards. Under the CSO Control Policy, communities with combined sewer systems are expected to develop LTCPs to provide for attainment of water quality.

4.3 Connecticut Policy for Abatement of CSOs

As discussed previously, DEEP is the NPDES permitting authority in Connecticut, and a summary of their CSO strategy is described below.

DEEP developed a *Combined Sewer Overflow Strategy* in May 1990 (DEEP CSO Strategy) as a guidance document for municipalities in the process of developing CSO control strategies. DEEP lays out in this document that their goal is to protect public health and the environment from the impacts of combined sewer overflows. The interim objective of the strategy is to eliminate the discharge of untreated sewage from CSOs and achieve fishable/swimmable water quality. The long-term goal of DEEP is to eliminate CSO discharges entirely. DEEP divides their CSO strategy into immediate corrective actions, intermediate corrective actions, and long-term corrective actions.

The Long-Term corrective action laid out in the DEEP CSO Strategy involves the continual implementation of a CSO abatement program with periodic reviews until the long-term goal of CSO abatement has been attained. Regular review of facilities planning recommendations at reasonable intervals assure that the goals of CSO abatement are being attained and that the program is still appropriate. Regular review can also redirect the course of the planning based on changes to technologies, fiscal status, priority waterbodies, and assessment of previous CSO program impacts. The DEEP CSO Strategy document is provided as Appendix D.

4.4 Connecticut Water Quality Standards

The federal government requires individual states to develop and adopt surface water quality standards applicable to their water bodies. Section 22a-426 of the Connecticut General Statutes requires that the Commissioner of Environmental Protection adopt standards of water quality

consistent with the federal CWA. To fulfill this requirement, Connecticut has established the Connecticut Water Quality Standards.

Three elements comprise the Connecticut Water Quality Standards: The Standards themselves, the Criteria, and the Classification Maps. The standards include the text of the policy statements that discuss designated use, anti-degradation, allowable types of discharges, fundamental principles of waste assimilation, and a variety of other subjects. The criteria are descriptive and numerical figures that describe the allowable parameters and goals for various water quality classifications. The classification maps show the class assigned to each surface and ground water resource throughout Connecticut.

As defined in the Connecticut Water Quality Standards, discharges to surface waters shall be limited as follows:

Class AA - Inland water source of uniform good to excellent quality. These waters are very close to natural quality with designated uses that include drinking water supply, fish and wildlife habitat, recreational use (may be restricted), agricultural and industrial supply.

Class A - Inland water source of uniform good to excellent quality. Inland Surface water is known or presumed to meet Water Quality Criteria which support designated uses, which may include potential drinking water supply; fish and wildlife habitat; recreational use; agricultural, industrial supply and other legitimate uses, including navigation.

Class B - Inland surface water source that may be of good to excellent quality. Uses include fishing, swimming, and recreation, industrial supply, and agricultural use. These waters generally have a healthy aquatic habitat, are generally rivers or large streams, and may have point source wastewater discharge.

Class SA - Coastal or marine surface water of uniform good to excellent quality. These waters are very close to natural quality. Uses include fishing, swimming, and recreation. These waters are a healthy marine habitat, and direct shellfish consumption is possible. These waters usually do not accept treated wastewater.

Class SB - Coastal or marine surface water of uniform good quality. Uses include fishing, swimming, and recreation, industrial supply, commercial shellfish harvesting (may require purification). These waters generally have a healthy marine habitat and may have point source wastewater discharges.

NPDES discharge permit applicants must comply with Connecticut Surface Water Quality Standards, as well as Sections 22a-426, 22a-430, and 22a-436 of the General Statutes. In addition, a discharge permit may also require additional treatment measures deemed necessary to prevent pollution and maintain high water quality.

The state's goal of achieving a level of water quality that provides for protection and propagation of fish, shellfish, and wildlife and recreation, in and on the water, must be met except where the following conditions apply:

- A use attainability analysis is prepared pursuant to federal regulation 40 CFR §131.10(g) and (j), that demonstrates that the surface water has been irreparably altered to the extent that certain designated uses have been permanently lost; and
- Quality criteria necessary to protect all other existing and designated uses of the surface water have been adopted by the Commissioner, as a revision to the Connecticut Water Quality Standards, in accordance with Section 22a-426 of the General Statutes.

Use Attainability Analyses are studies that use technical data and that follow procedural steps to show that fully achieving Class B designated uses everywhere, all the time, is not attainable. This process is used to formally change the water quality standards of a receiving body. This process requires a demonstration to the Commissioner that the proposed new classification is consistent with all existing or designated uses made of, or presently possible in, such surface waters. This type change in a Water Quality Classification is considered a revision to the Connecticut Water Quality Standards and would only be initiated after a CSO LTCP process is complete and it is determined water quality standards still cannot be met.

4.5 Applicability to NPU

CSO planning efforts in Norwich are influenced by a few critical factors, as described below.

4.5.1 Receiving Body Water Quality Classifications

The Shetucket River and the Thames River Estuary are the receiving water bodies for all Norwich CSO discharges. As described in the Baseline Conditions Report, both waterbodies are impaired and are designated as Class SB waterbodies with equal sensitivity.

4.5.2 Lack of Receiving Water TMDL Designations

No TMDL has been established for the receiving waters of the NPU CSO outfalls. In the 2018 Integrated Water Quality Report (IWQR), DEEP lists the Thames River in Norwich on the priority list of waters for action plan development including TMDL development. The expected plan completion timeframe as stated in the 2018 IQWR was by the end of 2019, and as of April 2020 a TMDL does not yet exist. DEEP has identified the Shetucket River in Norwich as a waterbody that will receive a TMDL by the end of 2020.

4.5.3 Upstream Pollutant Sources

Lastly, there are many pollution sources upstream of Norwich contributing to water quality degradation. The IWQR lists the Shetucket River as having impaired use for recreation due to E. coli. The IWQR lists the Thames River Estuary as impaired for recreation, commercial shellfish harvesting, and habitat for marine fish, other aquatic life and wildlife uses due to enterococci bacteria, fecal coliform, and low dissolved oxygen concentrations respectively. The Susquetonscut Brook, which is tributary to the Yantic River, was added to the IWQR in 2018 with an impairment caused by E. coli.

Potential sources of these impairments as listed in the IWQR include stormwater, illicit discharges, CSO, municipal discharges, landfills, insufficient on-site treatment systems, and/or septic systems. All these potential sources could be present upstream of the impaired sections of the Shetucket River and Thames River Estuary. Both the Quinebaug and Shetucket Rivers are

tributary to the impaired sections and extend north towards Massachusetts. The tributary rivers receive effluent from other communities' WPCF facilities, including Willimantic, Griswold, and Killingly. Additionally, numerous stormwater communities discharge to these rivers that must comply with the General Permit for the Discharge of Stormwater from Small Municipal Storm Sewer Systems (MS4 General Permit).

As presented in the Baseline Conditions Report, the 2012 LTCP concluded that:

- pH and dissolved oxygen in the saline portion of the Thames River were below water quality standards, but the cause did not appear to be CSO-related because the problems also occurred during dry weather.
- Bacteria levels in the rivers upstream of Norwich CSOs can exceed water quality criteria for days after a storm. This was primarily attributed to nonpoint source runoff. During wet weather, CSOs contributed less than half the bacteria loading in the receiving waters. Even if all CSOs in Norwich were eliminated, the Shetucket and Thames Rivers would not meet bacteria water quality standards.
- Norwich CSOs contribute significantly to bacteria levels in the receiving waters during storms. However, bacteria levels recede relatively quickly after wet weather events. In the Thames River, bacteria concentrations downstream of CSOs returned to background levels within one to three days after storms.

The 2012 LTCP also concluded that even if NPU were to fully eliminate CSO discharges, it is unknown if there would continue to be water quality impairment in the Shetucket River and Thames River Estuary segments within Norwich.

4.6 Summary

Under strict interpretation of DEEP CSO Strategy, Connecticut's Surface Water Quality Standards, and the EPA CSO Policy, NPU must attempt to eliminate CSO discharges to the waters of the state or mitigate it to a level deemed adequate to support designated uses. For the purposes of this LTCP, the two receiving waterbodies were deemed equal in sensitivity due to their equivalent water quality classification. Possible upstream pollution sources (as indicated in the 2012 LTCP) could make it difficult to quantify and achieve water quality standards within NPU's receiving bodies even if CSO discharges from Norwich were eliminated.

Section 5

This Section Unchanged from 2018 Report, See Appendix F

Section 6

This Section Unchanged from 2018 Report, See Appendix F

Section 7

Section 7

Consent Order Projects and System Optimization

7.1 Introduction

As discussed in Section 1, the Connecticut Department of Energy and Environmental Protection (DEEP) issued Consent Order WRMU17001 to Norwich Public Utilities (NPU) allowing 500 calendar days for development of a revised long-term control plan (LTCP). As part of this process, DEEP required NPU to proceed immediately with design of separation of the Eastside area tributary to CSO 025. Separation of this area was identified in the 2012 LTCP as the recommended combined sewer overflow (CSO) control plan to control discharges at CSO 025 during a 2-year design storm.

Design of this separation project was to be concurrent with development of the updated LTCP submitted in 2018. The Consent Order then required that upon completion of the Eastside project, NPU proceed with CSO reduction projects in Thamesville to achieve a 2-year level of control at CSO 004, CSO 005, and CSO 040. Consent Order WRMU17001 requires that the Eastside separation project be completed by December 31, 2020 and that a Thamesville CSO project be completed by December 31, 2025.

Sewer separation in Eastside was ultimately determined to be infeasible to control the 2-year storm. Section 7 explores the background and existing conditions of the Eastside sewershed and discusses the hydraulic issues making the original East Side separation project infeasible. Ultimately an agreement was reached with DEEP to complete the "Planned Projects" in lieu of Eastside sewer separation. These projects and their status as of June 2020 are described below.

- *Construction of Conveyance Improvements across the Eighth Street Bridge to control CSO 024 to the 2-year storm and CSO 025 to the 10-year storm.* This project was developed with DEEP staff, has been fully designed and was submitted to DEEP for approval to bid in August 2019. This project is expected to be constructed in 2026 as described in Section 10. This design includes the following items:
    - Replacement of an undersized 8-inch / 12-inch sewer pipeline with a new 24-inch pipeline to increase conveyance from CSO 025 to the Shetucket Interceptor. This added conveyance will allow a new CSO 025 weir to be initially set to control the 10-year storm, with the intent to fully close CSO 025 after a suitable monitoring period to demonstrate that full closure will not pose a risk to human health.
    - Installation of a new CSO 024 regulator chamber in Eighth Street with a 30-inch connection to the Shetucket Interceptor and a relocated CSO discharge to the NPU power canal instead of the Shetucket River. The NPU power canal ultimately discharges to the Shetucket River 2500 feet downstream of the old CSO 024 outfall. This will improve water quality in a stretch of the Shetucket River often used for fishing and other recreation.

- *Installation of Supervisory Control and Data Acquisition (SCADA) controls to improve Rose Alley Pumping Station operations and maximize wet weather flow to the WPCF.* This project was designed, bid, and fully constructed as of December 2019.
- *Raising weirs at select regulators to retain additional volume in the system during wet weather events.* Eleven weirs were raised and reconstructed throughout the system, and CSO 040 has been permanently closed. These improvements have enhanced the quality of flow monitoring data, and decreased CSO events and volumes by holding more flow in the system. This project was fully completed in 2019.

This section discusses the background and existing conditions of the East Side sewershed. The infeasibility of the original East Side separation project is discussed, as well as the expected benefits that will be achieved by the alternative "Planned Projects" outlined above. Alternatives for CSO reduction in Thamesville are discussed in Section 8.

7.2 Eastside CSO Control (CSO 025)

7.2.1 Background

CSO 025 serves the Eastside sewershed. It is the most upstream CSO along the Shetucket River. It receives flow from 68 acres of combined sewerage and 57 acres of sanitary sewerage. Dry weather flow is conveyed through the CSO regulator and across the 8th Street Bridge into the Shetucket Interceptor, via a pipe with an 8-inch segment and a 12-inch segment in series, as shown in Figure 7-1. During wet weather, flow exceeding the capacity of the 8th Street Bridge pipes overtops a weir and discharges as CSO into the Shetucket River.

As discussed in the Baseline Conditions Report, on average, CSO 025 discharges 2 million gallons (Mgal) per year over 60 events. By comparison, the 2012 LTCP reported 8 Mgal and 23 CSO events per year. The updated model indicates higher peak flow but shorter overflow durations.

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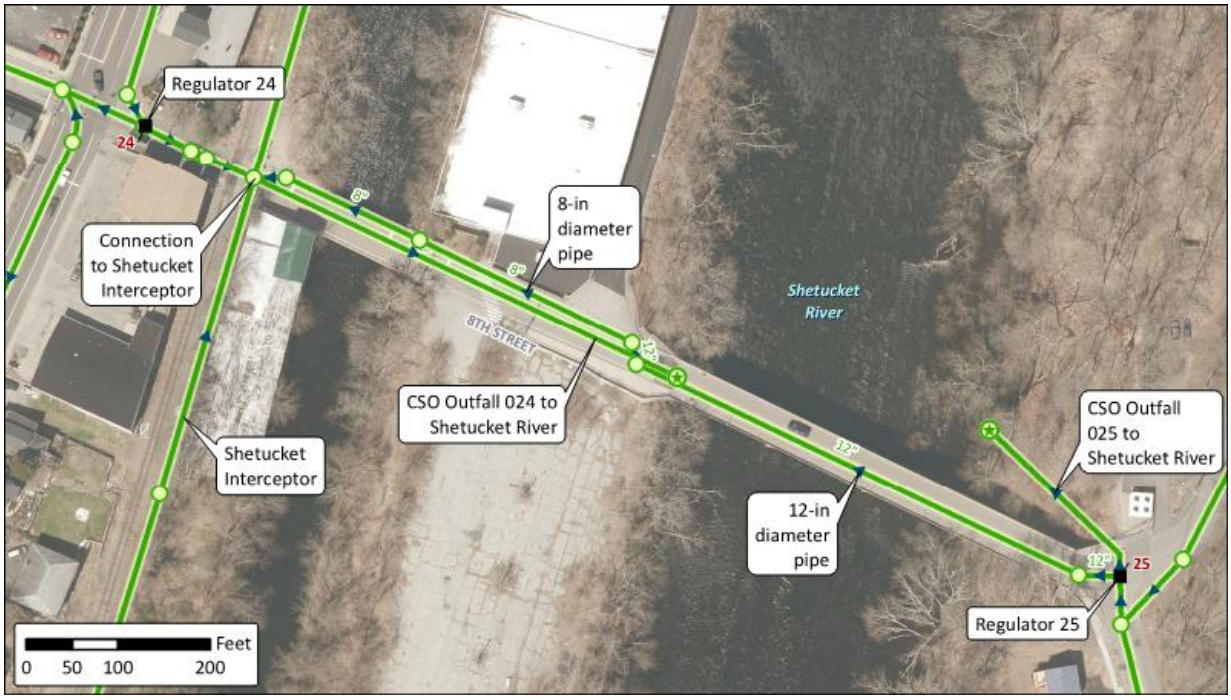

Figure 7-1
Plan View Showing Regulator 25 to the Shetucket Interceptor

7.2.2 Implementing Sewer Separation for CSO 025

7.2.2.1 Introduction

CDM Smith developed a preliminary design for separation of public inflow from the Eastside combined sewer area in early 2018. This design was prepared concurrently with the LTCP update to meet the goals of the Consent Order and the 2012 LTCP. Separation by both installation of new sewers or drains was considered during the design. Installation of new sewers was determined to be the best approach for NPU, as it operates the sewer system and would gain a new collection system that didn't need to be rehabilitated, thereby helping to reduce infiltration and inflow. This approach may also remove more extraneous flow from the system. Approximately 3,800 feet of new sewer would be installed to divert the city's catch basins from the sewer system. Section 6 of this report identifies challenges associated with public and private inflow separation programs.

7.2.2.2 Public Inflow Reduction

Flow metering for this project indicated that both the combined and sanitary systems tributary to CSO 025 contribute wet weather flow. Model simulations indicated that if only public inflow separation were completed in the Eastside area (i.e. removal of city catch basins) and CSO 025 were closed, remaining private inflow from the combined area and from the existing sanitary service area would still create excessive surcharge at the 8th Street Bridge during storm events.

Figure 7-2a shows the existing hydraulic grade line (HGL) from the upstream tributary area in Eastside to the Shetucket Interceptor during the 2-year design storm. Figure 7-2b shows the expected reduction in sewer flow levels, during the same storm, if NPU completed public inflow removal. Both figures show hydraulic profiles assuming CSO 025 remains open with the weir at

the existing elevation. During the 2-year storm, peak CSO flow would be reduced from 5.5 mgd to 2.0 mgd and CSO volume would be reduced from 0.28 Mgal to 0.10 Mgal.

While public inflow removal offers substantial CSO reduction, there would be remaining CSO discharges at even the 1-month design storm. If CSO 025 were closed, sewer system flooding could occur in a 3-month storm, and there would be significant flooding in a 2-year storm (and larger storms) as shown in Figure 7-2c. To avoid flooding and sewer backup problems following public inflow removal, a relief structure and CSO outfall would be needed, or larger diameter pipes would be needed to convey flow across the 8th Street Bridge to the Shetucket Interceptor.

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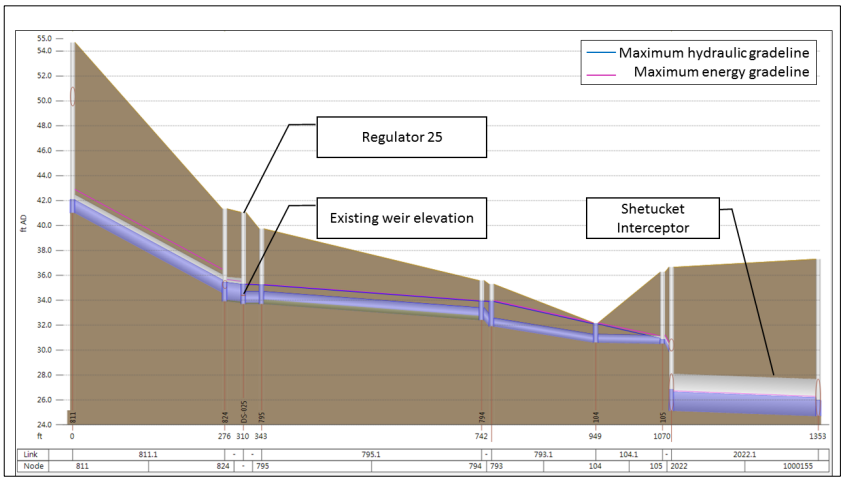

Figure 7-2a - Future Baseline with Regulator 25 Open

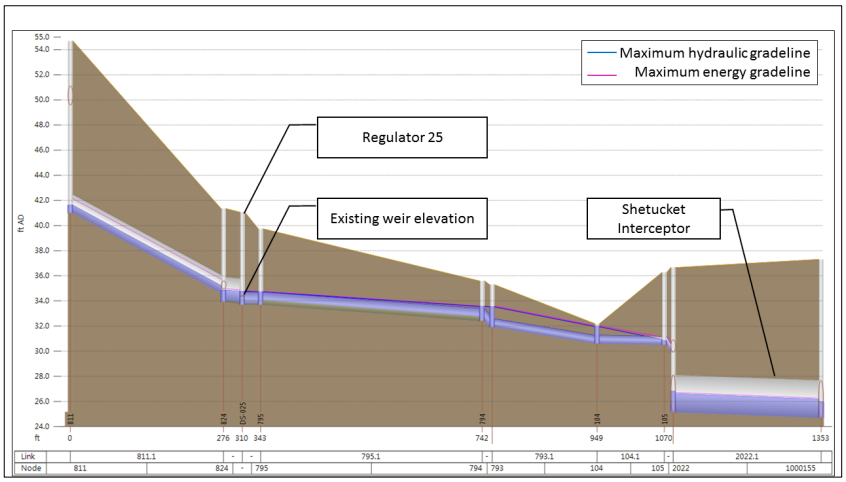

Figure 7-2b - Eastside Public Inflow Removal with Regulator 25 Open

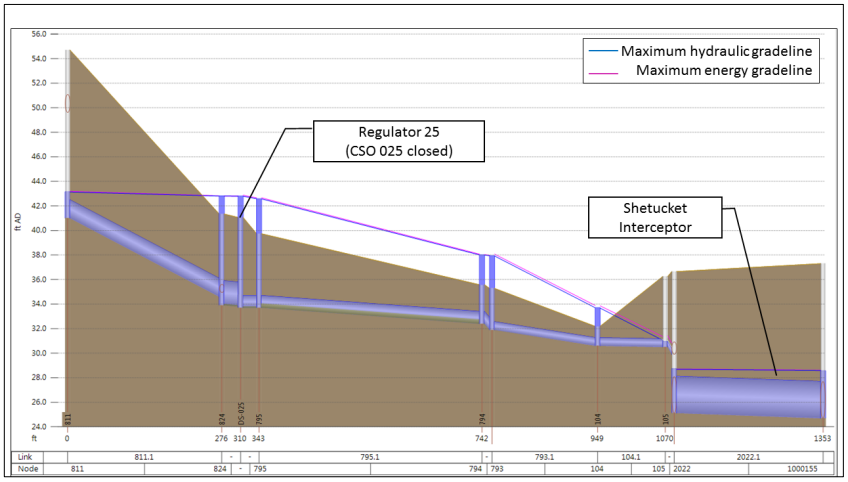

Figure 7-2c - Public Inflow Removal with Regulator 25 Closed

Figure 7-2
Peak HGL in Eastside to Shetucket Interceptor During 2-Year Storm

7.2.2.3 Public and Private Inflow Elimination

If both public and private inflow were removed in the Eastside combined sewer area, CSO 025 could be managed to a 1-month level of control with a 95 to 99 percent overflow reduction anticipated for the remaining design storms. In the 2-year storm, overflow volume would be reduced from 0.28 Mgal to 0.004 Mgal and peak CSO flow would be reduced from 4.7 mgd to 0.2 mgd. Consequently, surcharge would be significantly reduced from future baseline levels, as shown in Figure 7-3a.

However, even with the substantial reduction in peak flow, remaining flow during storms exceeding the 1-month event would still exceed the conveyance capacity of the 8th Street Bridge pipes, causing CSO. If this level of inflow removal were accompanied by closure of CSO 025, street flooding would likely occur for storms equaling or exceeding the 2-year event (Figure 7-3b). During a 5-year storm, flooding would likely occur at additional manholes over the bridge, and sewer surcharge near the regulator could reach within 2-3 feet of ground surface (Figure 7-3c), potentially causing basement backups.

Even with both public and private inflow reduction, if the CSO regulator was eliminated, additional conveyance across the 8th Street Bridge would be required to achieve 2-year control at CSO 025 and avoid excessive system surcharge.

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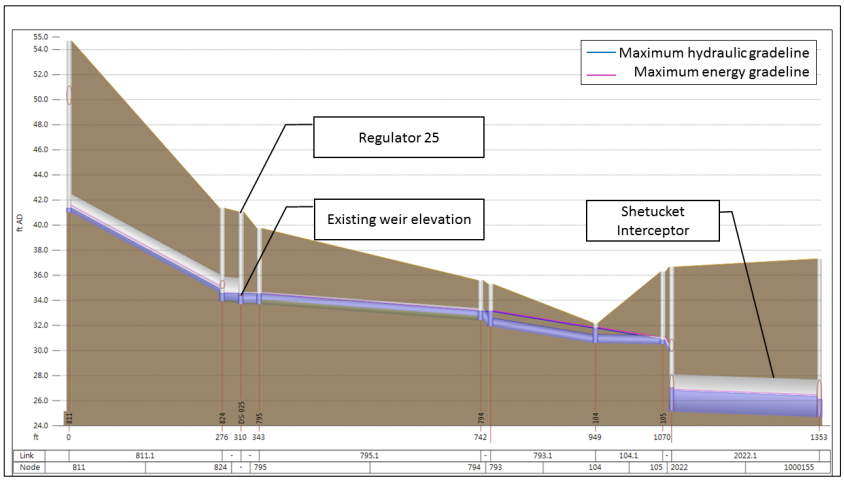


Figure 7-3a - Public and Private Inflow Removal with Regulator 25 Open, 2-Year Storm

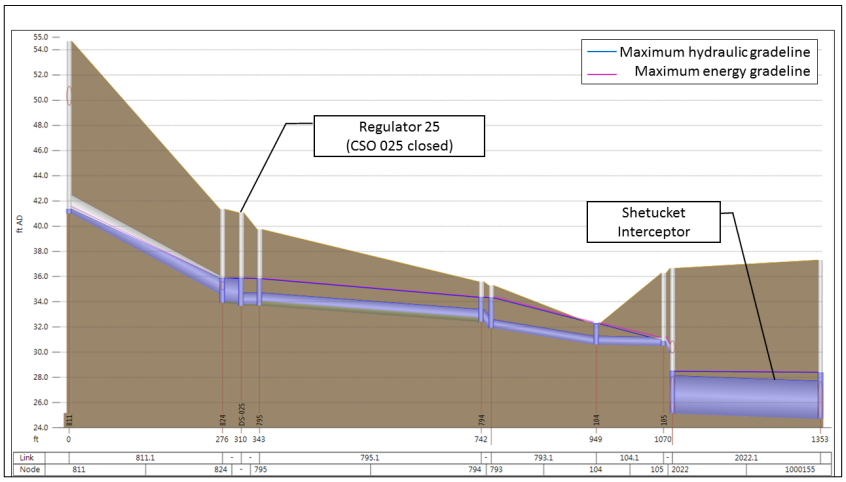


Figure 7-3b - Public and Private Inflow Removal, Regulator 25 Closed, 2-Year Storm

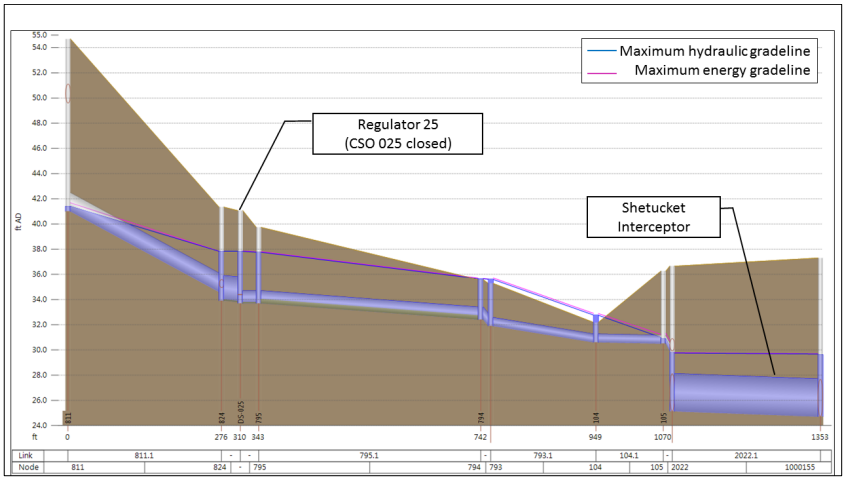


Figure 7-3c - Public and Private Inflow Removal, Regulator 25 Closed, 5-Year Storm

Figure 7-3
Peak HGL in Eastside to Shetucket Interceptor for Different Storms

7.2.3 Other CSO 025 Control Alternatives

Due to the surcharge and flooding concerns associated with separation and potential CSO closure, CDM Smith considered alternative methods for control of CSO 025. It was determined that replacement of the 8th Street sewer pipes would be required along with public and private inflow removal if the CSO 025 regulator were closed. Thus, it made sense to consider what size pipe would be required to convey the design flow across the river without upstream sewer separation.

Design storm simulations indicated that the upstream segments of the Shetucket Interceptor near CSO 025 have capacity to convey more flow downstream. Simulations also showed that a new 780-foot-long, 24-inch pipe replacing the existing 8-inch and 12-inch pipeline over the bridge would convey the 2-year storm flow from Eastside to the Shetucket Interceptor in conjunction with weir adjustments at the CSO regulators.

Flow conveyed across the bridge would be small in comparison with total flow in the Shetucket Interceptor and would not adversely affect downstream conditions. CSO 025 flow could then be managed cost-effectively with existing Shetucket Interceptor flows in downstream consolidated system improvements. Alternatives to manage CSO along the Shetucket Interceptor are discussed in detail in Section 8. With this improvement, CSO 025 would be managed to a 2-year level of control. During design, conversations with DEEP led to additional model runs and the determination that the weir could be initially set to control the 10-year storm at CSO 025, with the potential for complete closure of the regulator after a reasonable monitoring period to confirm operation during a variety of storms. The project also evolved to include 2-year control at CSO 024 as described below.

While satellite storage was also considered as an option for mitigating Eastside CSO, there are no suitable locations for storage facilities in the locale of CSO 025.

7.2.4 Summary

Installation of a 24-inch equivalent diameter conveyance pipe along the 8th Street Bridge, downstream of CSO 025, represents the best approach to attain the required 2-year control at CSO 025 (and higher levels of control as later requested by DEEP). This alternative precludes potential system flooding and public health impacts due to excessive surcharge in large storms if the CSO regulator were eliminated. NPU has moved forward with this alternative approach to CSO control in the East Side area and has completed the Eighth Street CSO Conveyance design to implement these improvements. As noted previously, the project is currently awaiting DEEP approval to bid and is expected to be constructed in 2026 as described in Section 10.

7.3 System Optimization

The collection system model was also used to evaluate these “Planned Projects” improvements that could be readily implemented to reduce NPU’s CSO discharges. The Rose Alley Pumping Station SCADA improvements, CSO 024 alterations, and CSO weir improvements are described in the following text. Significant progress on these projects has been made by NPU since the time of the August 14, 2018 LTCP submission.

7.3.1 Supervisory Control and Data Acquisition (SCADA) at Rose Alley PS

Maximizing flow to the water pollution control facility (WPCF) is one of the Nine Minimum Controls (NMC) recommended by the US Environmental Protection Agency (EPA). Under current wet weather flow operations, the Yantic Interceptor discharges to the WPCF by gravity, while the Cove Street, South Thames Street, and Rose Alley pumping stations (PS) discharge directly to the WPCF. Previously, to avoid exceeding WPCF capacity, NPU staff would need to manually adjust the variable frequency drive pumps at the Rose Alley Pumping Station during storms. As Rose Alley and WPCF flow rates vary semi-independently, WPCF capacity may have been inadvertently underutilized at times.

It was not feasible for NPU staff at Rose Alley to continuously adjust pumping rates to match WPCF flows and capacity. Accordingly, implementation of a real-time control (RTC) system at Rose Alley was identified to provide better control, allowing NPU to better utilize WPCF capacity during wet weather. These RTC controls are expected to reduce CSO at regulators 17-1 and 17-2. RTC automatically adjusts pumping at Rose Alley to match WPCF design capacity during wet weather. Although the WPCF is rated for 17 mgd design flow, it sometimes receives up to 20 mgd under existing conditions. Section 8 discusses WPCF improvements needed to reliably treat up to 20 mgd.

NPU has implemented RTC at Rose Alley to help modulate pumping station operations. This project has been designed, bid, and fully constructed. The Rose Alley Pumping Station is currently operating via SCADA. As additional WPCF improvements are implemented, consistent wet weather treatment up to 20 mgd can be implemented on a regular basis and additional CSO reduction will be achieved. In the interim, RTC will still improve the overall system performance versus manual pump control.

7.3.2 CSO 024

Alternatives evaluation for Eastside separation indicated that there is available capacity in the upstream portion of the Shetucket Interceptor. To improve Shetucket River water quality and facilitate the proposed improvements in Eastside, NPU proposed replacing and relocating the CSO 024 regulator to attain 2-year control. Replacement of the CSO 024 regulator has been designed, but not yet constructed as part of the Eighth Street conveyance design. A new regulator chamber was designed to be installed on the eastern side of the existing train tracks, and a portion of the existing CSO 024 overflow pipe will be redirected into the new chamber and repurposed to carry sanitary flows. The existing 100-foot long, 12-inch to 18-inch diameter dry weather flow pipe, shown in Figure 7-4, will remain connected to the Shetucket Interceptor. A new 30-inch dry weather connection from the new CSO 024 regulator will be connected to the Shetucket Interceptor, and an alternate CSO 024 outfall will discharge to the NPU power canal. The existing CSO-024 outfall would be abandoned.

CSOs 024 and 025 are the most upstream overflows along the Shetucket River. With the improvements to CSO 024 discussed above, and the conveyance improvements to relieve CSO 025 discussed previously, a 2-year level of control (or better) will be achieved at both regulators, protecting the half-mile reach shown in Figure 7-5. CSO along this section of the Shetucket River will be significantly reduced from its current frequency of approximately 60 events per year. The "Eighth Street CSO Reduction Improvements" project includes increasing bridge conveyance,

modifying the CSO 025 weir, and building a new CSO 024 structure. This project was designed in 2019 and is currently awaiting DEEP approval to bid. Construction is expected to occur in 2026.

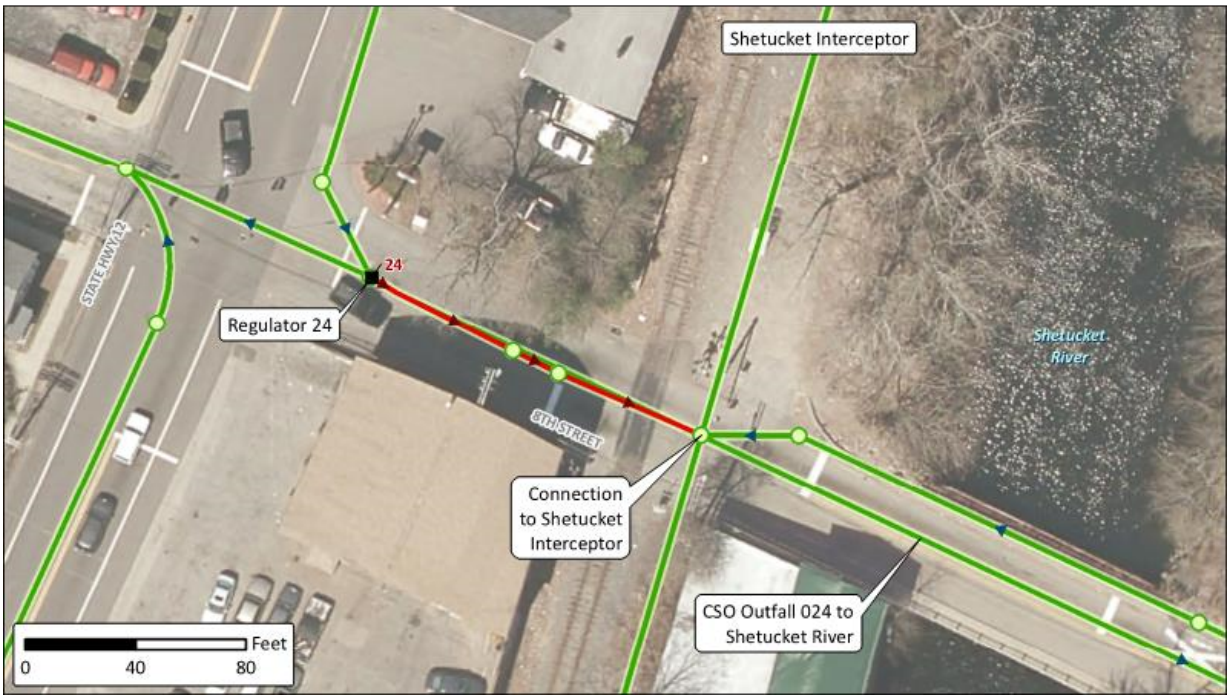


Figure 7-4
Plan View Showing Combined Sewer Pipes from the Regulator to CSO 024 to the Shetucket Interceptor (red)

7.3.3 CSO Regulator Modifications

As discussed in Section 5, regulator modifications are a low-cost method of retaining more flow in the collection system and providing CSO reduction. Model simulations indicated that CSO reduction would be achieved if weirs were raised by approximately 3 to 6 inches (depending on the location) at CSO regulators 4, 5, 18, 19-1, 19-2, 21, 22, 23, 29, and 40. Weirs cannot be safely raised at CSO regulators 17-1, 17-2, 31, and 32. Regulators 17-1 and 17-2 are the most downstream relief in the combined sewer system. Without further WPCF improvements, adjusting these regulators would cause adverse system impacts. Regulator 31 consists of a high outlet pipe with a raised invert rather than a weir and could not be readily modified. The weir at regulator 32 is already 2.5 ft higher than the dry weather flow pipe and could not be readily raised in this round of system improvements.

Raising weir heights also provided the opportunity for NPU to repair any structural deficiencies that may have contributed to CSO discharges. Increasing the size of the dry weather flow connector pipes may provide additional CSO benefit. Such work is considered as part of individual alternatives described in Section 8.

Since the submission of the original August 2018 LTCP NPU has made significant progress on CSO weir improvements. The weirs at CSO regulators 4, 5, 18, 19-1, 19-2, 21, 22, 23, and 29 have all been raised, and CSO regulator 40 has been permanently closed. Weir reconstruction and raising was also completed at the existing regulators 24 & 25 as an interim measure until the approval

and construction of the Eighth Street conveyance improvements. In aggregate, these measures will reduce CSO overflows and increase flow metering reliability.

Documentation on each weir reconstruction follows the text of this Section as Figure 7-6 though Figure 7-16.

7.3.4 Additional System Optimization Activities

In addition to the Planned Projects described above NPU has been making progress on collection system maintenance and operations activities. NPU has appointed a collection system manager to direct and lead collection system projects and maintenance. Routine collection system cleaning activities have been completed with increased frequency and improved record keeping. NPU has completed highly focused cleaning efforts with the help of a third-party contractor in areas where additional manpower and specialized equipment was required. Additionally, NPU has recently lined the force main of the River Avenue pumping station as a temporary repair measure. They are planning to complete more lining projects throughout the collection system. This lining will help address the structural integrity of older pipes and reduce system inflow and infiltration.

Although not included as part of these "Planned Projects" the activities described above will help increase overall conveyance throughout the collection system and reduce CSO volumes.

7.4 Summary

Consent Order WRMU17001 required NPU to implement a proposed Eastside separation project. However, model simulations during the development of the August 2018 LTCP indicated that if CSO 025 were closed in conjunction with separation, remaining extraneous wet weather flow would cause excessive, dangerous surcharge and risk to human health. Other alternatives to achieve 2-year CSO control in the Eastside area were thus evaluated during the development of the August 2018 LTCP.

Based on analyses described above, NPU identified three initial system improvement projects that could be implemented in the near future to help reduce CSO discharges. These were presented in the August 14, 2018 LTCP, and since that time NPU has made significant progress on these "Planned Projects".

1. The Eighth Street CSO Reduction Improvements Design (conveyance improvements) has been completed and is awaiting DEEP approval to bid. Construction of these improvements will be completed in 2026 as described in Section 10. This project will control overflows at CSO 024 to the 2-year level and 025 to the 10-year level and improve water quality for approximately a half mile stretch of the Shetucket River. The major components of this design are outlined below.

    a. Replacement of undersized 8-inch and 12-inch pipes with a new 24-inch pipeline to increase conveyance from CSO 025 to the Shetucket Interceptor.

    b. Installation of a new CSO 024 regulator chamber in Eighth Street with a 30-inch connection to the Shetucket Interceptor and a relocated CSO discharge to the NPU power canal.

2. Implementation of SCADA control at the Rose Alley Pumping Station have been completed. This project has improved Rose Alley PS operations and maximizes wet weather flow to the WPCF. This project has been designed, bid and fully constructed. The Rose Alley PS is currently operating on SCADA control rather than the previous manual control.

3. Weirs have been raised at CSO regulators 4, 5, 18, 19-1, 19-2, 21, 22, 23, 24, 25, and 29 as described above. In addition to the raised and reconstructed weirs, CSO regulator 40 has been permanently closed. Documentation of weir reconstruction can be found following this section as Figure 7-6 through Figure 7-16.

Implementation of the described improvements were predicted by the collection system model to reduce average annual CSO by 30 percent from 43 Mgal to 30 Mgal and reduce system wide annual overflow from 60 to 48 events, as summarized in Table 7-1.

Table 7-1: Average Annual CSO Reduction with Proposed "Planned Projects"[1]

	CSO Volume (Mgal)		Event Duration (hrs)		Events	
CSO	Baseline Conditions	Planned Projects	Baseline Conditions	Planned Projects	Baseline Conditions	Planned Projects
004	0.93	1.03	53	46	25	25
005	0.16	0.19	28	26	15	16
017	25.9	19.0	218	146	50	37
018	2.27	2.15	200	176	45	44
019	2.27	1.79	153	117	42	39
021	0.18	0.08	12	11	13	11
022	1.03	0.57	112	42	36	24
023	4.20	3.97	210	170	46	44
024	3.68	0.02	255	<1	51	<1
025	2.00	<0.01	355	<1	60	<1
029	0.02	0.01	3	0.4	5	1
031	0.45	0.63	30	31	14	17
032	0.19	0.17	5	4	8	8
040	0.01	0	<1	0	1	0
Total	**43.3**	**29.6**	**355**	**163**	**60**	**44**

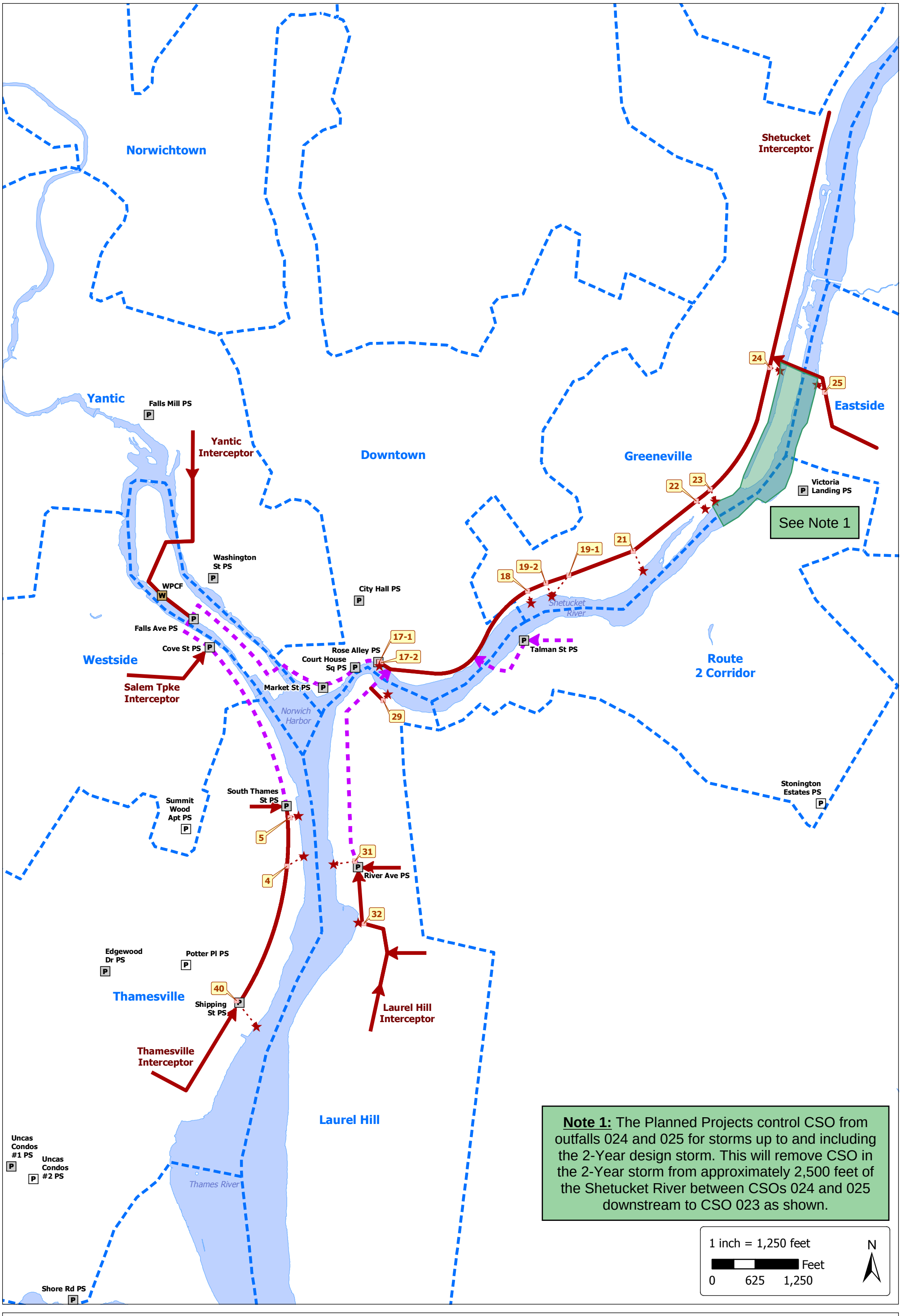
Notes: 1) Statistics based on three-year simulation. Overflow increases slightly at some locations

The statistics presented in Table 7-1 include the completed SCADA improvements at Rose Alley Pumping Station and assume that 20 mgd can be reliably treated at the WPCF during wet weather. While the plant has treated up to 20 mgd in the past, it is not known whether this can be consistently sustained given its current condition. Section 8 identifies proposed plant improvements that would be necessary to ensure reliable treatment up to 20 mgd. In the interim, if NPU determines that operating the WPCF at 20 mgd would cause significant operational issues, there would be less CSO reduction than presented in Table 7-1 until the proposed WPCF projects are implemented. The WPCF reliability upgrades, as well as the Eighth Street conveyance

improvements are expected to be completed in the early phase of the LTCP program, as described in Section 10.

The improvements also significantly reduce total CSO duration on an average annual basis. By replacing the (ineffective) Eastside separation project required by the Consent Order with these alternative projects, NPU will achieve nearly three times the CSO benefit (improving from 0.28 Mgal reduction to 0.8 Mgal reduction in the 2-year storm). Given their wide-reaching benefit, the in-progress status of the work, and applicability to all future work, these projects are included in all subsequent alternatives and are referred to as the "Planned Projects".

Section 8 reviews the Consent Order requirement to implement Thamesville CSO reduction.


Norwichtown
Yantic
Falls Mill PS
Yantic Interceptor
Downtown
Greeneville
Shetucket Interceptor
Victoria Landing PS
See Note 1
Washington St PS
WPCF
City Hall PS
Falls Ave PS
Cove St PS
Westside
Salem Tpke Interceptor
Rose Alley PS
Court House Sq PS
Market St PS
Norwich Harbor
Shetucket River
Talman St PS
Route 2 Corridor
Stonington Estates PS
South Thames St PS
Summit Wood Apt PS
River Ave PS
Edgewood Dr PS
Potter Pl PS
Thamesville
Shipping St PS
Thamesville Interceptor
Laurel Hill Interceptor
Laurel Hill
Uncas Condos #1 PS
Uncas Condos #2 PS
Thames River
Shore Rd PS
24
25
22
23
21
19-1
19-2
18
17-1
17-2
29
31
32
5
4
40
Note 1: The Planned Projects control CSO from outfalls 024 and 025 for storms up to and including the 2-Year design storm. This will remove CSO in the 2-Year storm from approximately 2,500 feet of the Shetucket River between CSOs 024 and 025 downstream to CSO 023 as shown.
1 inch = 1,250 feet
Feet
0
625
1,250
N
Legend
CSO Overflow Regulator
CSO Outfall
Gravity Pipe
Force Main
Pump Stations (Norwich Public Utilities)
Pump Stations (Private)
Water Pollution Control Facility
Sewershed Boundary
CDM Smith
2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-5
Planned Projects

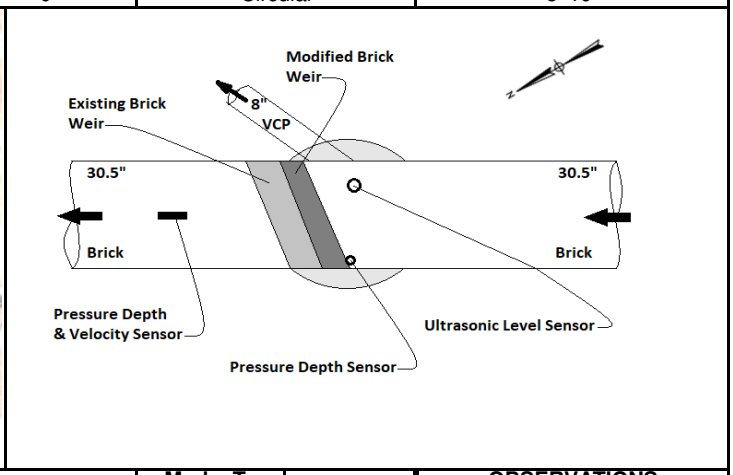
2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-6: Regulator 004 Reconstruction

FLOW ASSESSMENT SERVICES

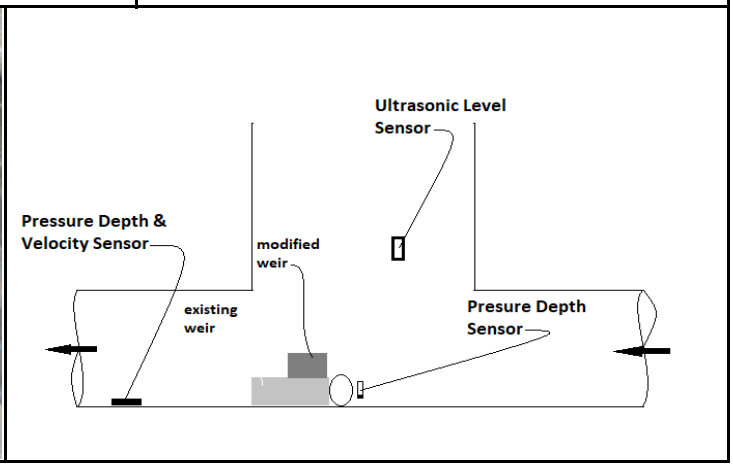
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** January 23, 2019	**JOB#:** 17063
LOCATION: 76 Thames Street (rear)	**MH#:** ~	**METER SITE:** 004
GPS/COMMENTS: 41.515727, -72.080033. Updated to reflect weir modification & sensor placement.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	30.5	Brick	1.5	0	Circular	5' 7"
Incoming						
Overflow	30.5	Brick	0	0	Circular	5' 8"
Outgoing	8	VCP	3	0	Circular	5' 10"



SURCHARGE	**None Evident**	X	**Current**		**Marks To**		**OBSERVATIONS**
WEIR DIMENSIONS	**Length**	**Breadth**	**Level**	**Area Above**			
	40.5	8	Y	~			



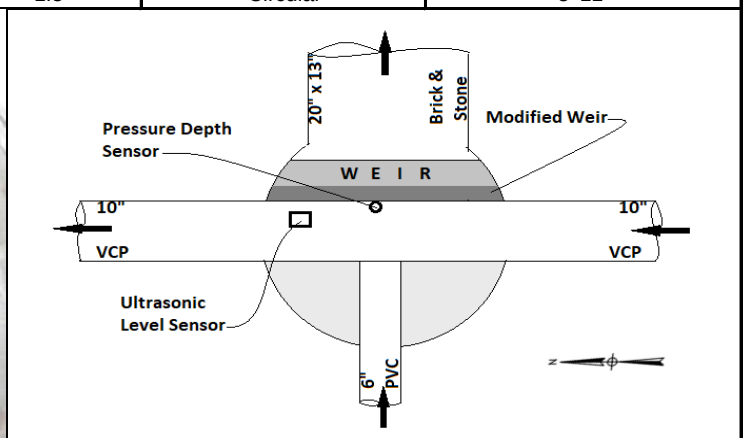
2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-7: Regulator 005 Reconstruction

FLOW ASSESSMENT SERVICES

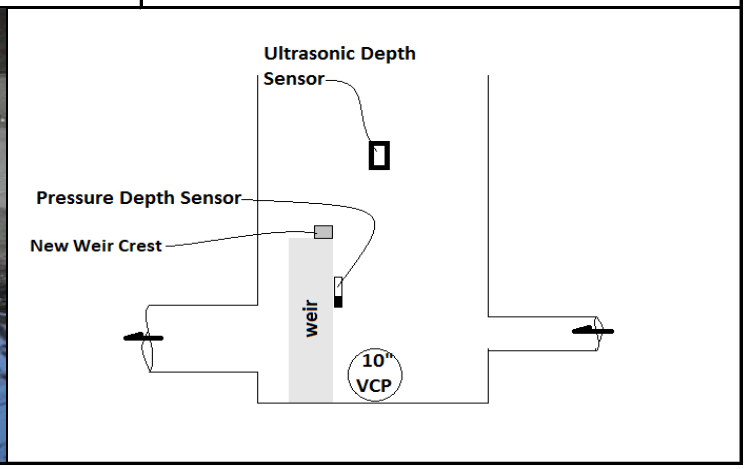
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** January 22, 2019	**JOB#:** 17063
LOCATION: 17 South Thames Street	**MH#:** ~	**METER SITE:** 005
GPS/COMMENTS: 41.517828, -72.079675. Updated to reflect weir modification.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	10	VCP	1.5	1.5	Circular	5' 10"
Incoming	6	PVC	0	0	Circular	5' 7"
Overflow	20 x 13	Stone, BRK	0	0	Rectangular	5' 5"
Outgoing	10	VCP	1.5	1.5	Circular	5' 11"



SURCHARGE	**None Evident**		**Current**		**Marks To**	3'	**OBSERVATIONS**
WEIR DIMENSIONS	**Length**	**Breadth**	**Level**	**Area Above**			
	43.3	4.2	Yes	~			

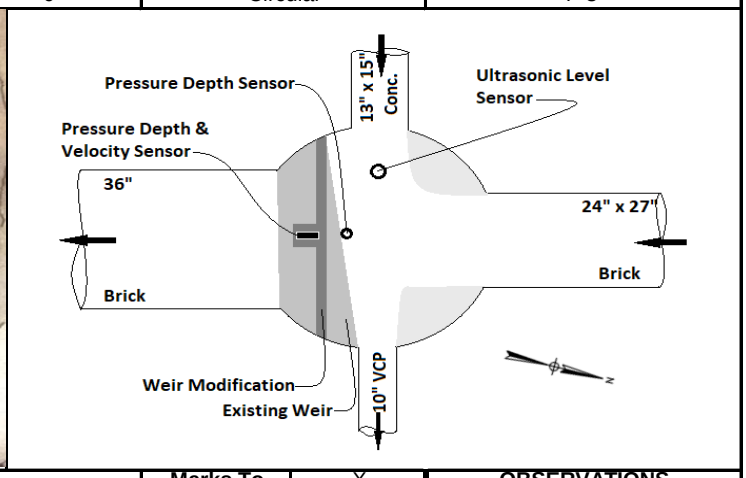


2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-8: Regulator 018 Reconstruction

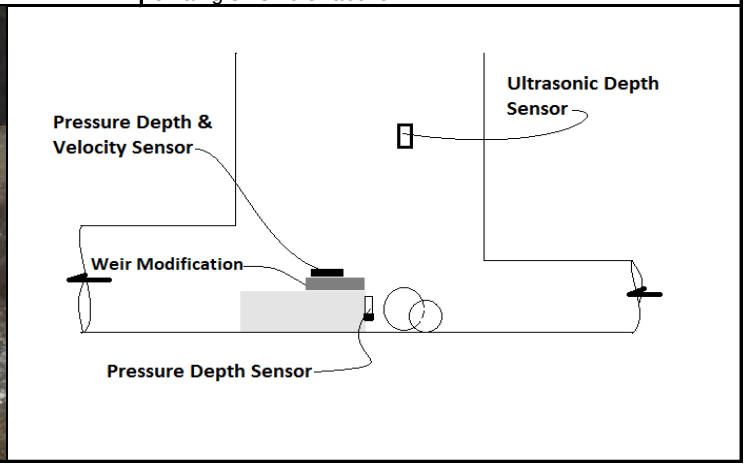
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** February 5, 2019	**JOB#:** 17063
LOCATION: 104 North Main Street	**MH#:** ~	**METER SITE:** 018
GPS/COMMENTS: 41.526710, -72.066926. Updated to reflect weir modification.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24 x 27	Brick	2.1	0	Oval	7' 2"
Incoming	13 x 15	Conc.	1.5	0	Oval	7' 1"
Overflow	36	Brick	0	18	Circular	7' 2"
Outgoing	10	VCP	2	0	Circular	7' 3"



SURCHARGE	**None Evident**		**Current**		**Marks To**	X	**OBSERVATIONS**
WEIR DIMENSIONS	**Length**	**Breadth**	**Level**	**Area Above**	* 44.75" length is 18" above the outgoing sewer invert. The remaing 3" is 19.5" above.		
	47.75	3.5	Yes*				



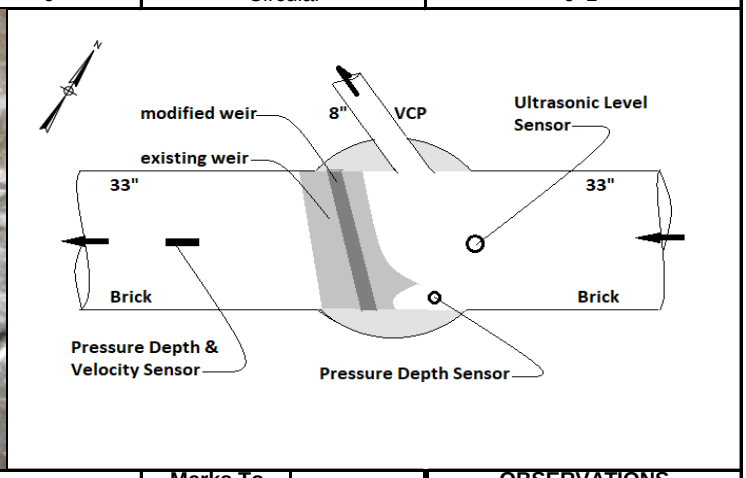
2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-9: Regulator 019-1 Reconstruction

FLOW ASSESSMENT SERVICES

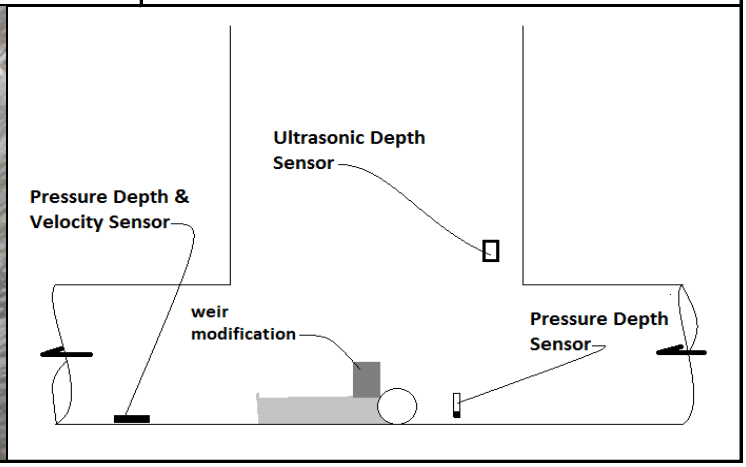
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** January 30, 2019	**JOB#:** 17063
LOCATION: 154 North Main Street	**MH#:** 2647	**METER SITE:** 019-1
GPS/COMMENTS: 41.527287, -72.064815. Updated to reflect weir modification.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	33	Brick	4.3	0.25	Circular	9' 8.7"
Incoming						
Overflow	33	Brick	0	0	Circular	9' 10"
Outgoing	8	VCP	4	0	Circular	9' 1"



SURCHARGE	**None Evident**	X	**Current**		**Marks To**		**OBSERVATIONS**
WEIR DIMENSIONS	**Length**	**Breadth**	**Level**	**Area Above**			
	32.5	3.25	Yes	~			



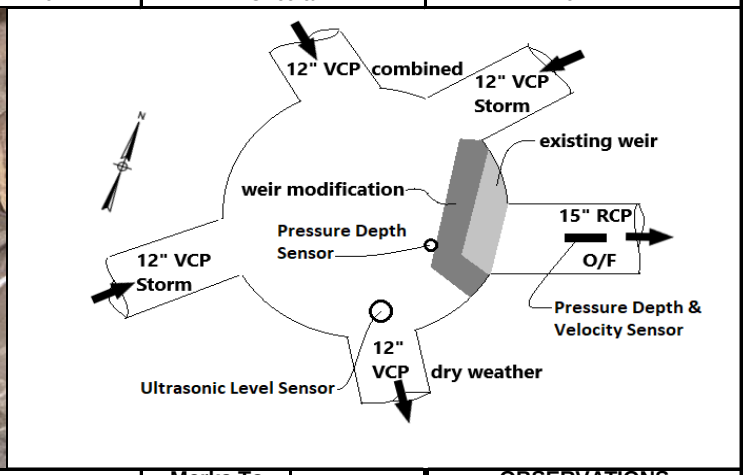
2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-10: Regulator 019-2 Reconstruction

FLOW ASSESSMENT SERVICES

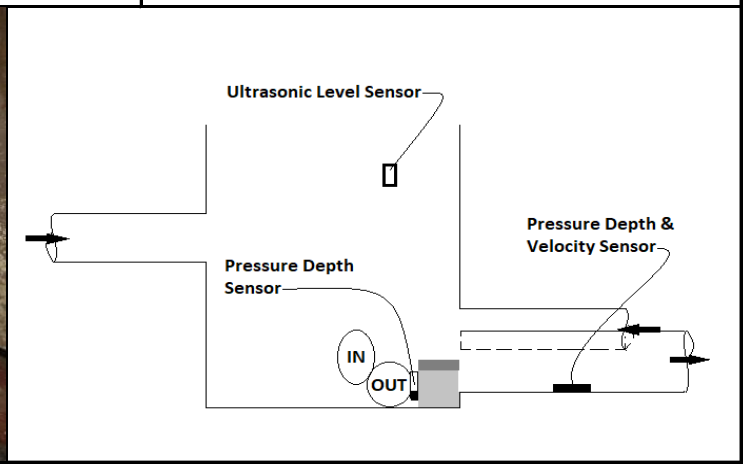
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** February 5, 2019	**JOB#:** 17039
LOCATION: Roath Street at North Main Street	**MH#:**	**METER SITE:** 019-2
GPS/COMMENTS: 41.527012, -72.065984. Updated for weir modification & sensor placement.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	12	VCP	0.7	0	Circular	6' 7"
Incoming	12	VCP	0	0	Circular	3' 8"
Overflow	15	RCP	0	0	Circular	6' 9"
Outgoing	12	VCP	1.5	0	Circular	6' 10"
Incoming	12	VCP	0	0	Circular	6' 1"



SURCHARGE	**None Evident**	X	**Current**		**Marks To**		**OBSERVATIONS**
WEIR DIMENSIONS	**Length**	**Breadth**	**Level**	**Area Above**			
	21	4	Yes	~			



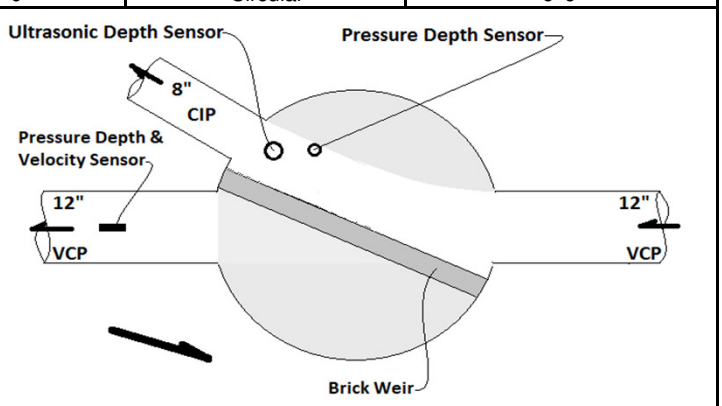
2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-11: Regulator 021 Reconstruction

FLOW ASSESSMENT SERVICES

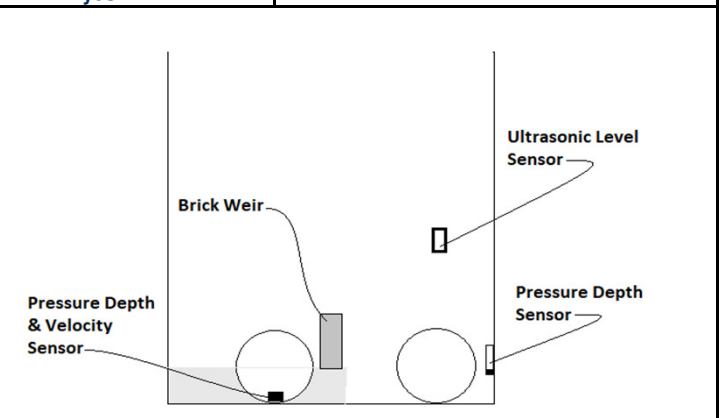
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** January 22, 2019	**JOB#:** 17063
LOCATION: Erin Street north of tracks	**MH#:** ~	**METER SITE:** 021
GPS/COMMENTS: 41.528243, -72.061323. Updated to reflect weir modification.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	12	VCP	1.5	0	Circular	6' 4"
Incoming						
Overflow	12	VCP	2	6	Circular	6' 4"
Outgoing	8	CIP	2	0	Circular	6' 6"



SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH: 44.0"**	**ULS face above crest: 23.0"**
SURCHARGED MARKS TO:	**BREADTH: 4.0"**	**Activation Depth: 13.25"**
SURCHARGE CURRENTLY TO:	**LEVEL: yes**	



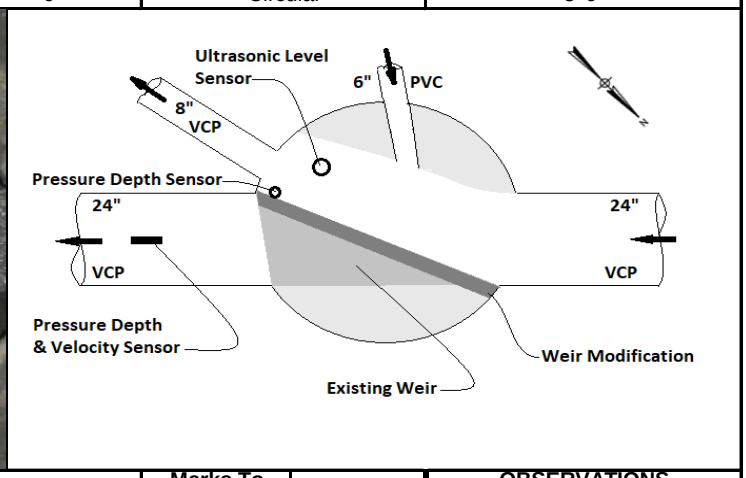
2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-12: Regulator 022 Reconstruction

FLOW ASSESSMENT SERVICES

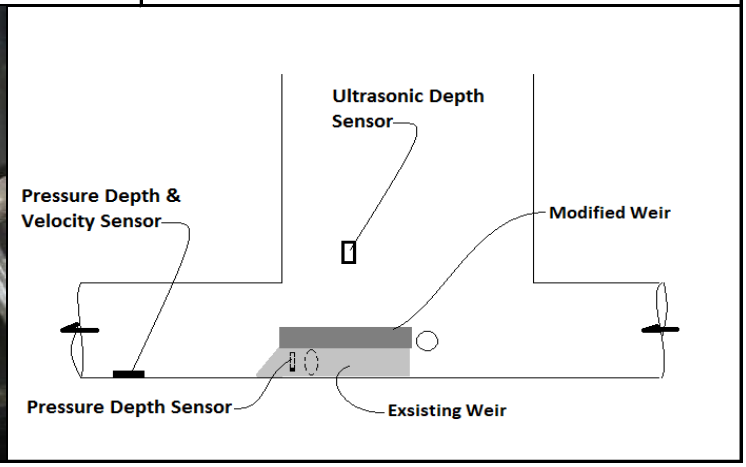
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** January 28, 2019	**JOB#:** 17063
LOCATION: 352 West Main Street	**MH#:** ~	**METER SITE:** 022
GPS/COMMENTS: 41.530229, -72.057994. Updated to reflect weir modification.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24	VCP	1.5	0	Circular	5' 9"
Incoming	6	PVC	0.25	0	Circular	5' 1"
Overflow	24	VCP	0	0	Circular	5' 11"
Outgoing	8	VCP	4	0	Circular	5' 9"



SURCHARGE	**None Evident**	X	**Current**		**Marks To**		**OBSERVATIONS**
WEIR DIMENSIONS	**Length**	**Breadth**	**Level**	**Area Above**			
	45.6	3.75	Yes	~			



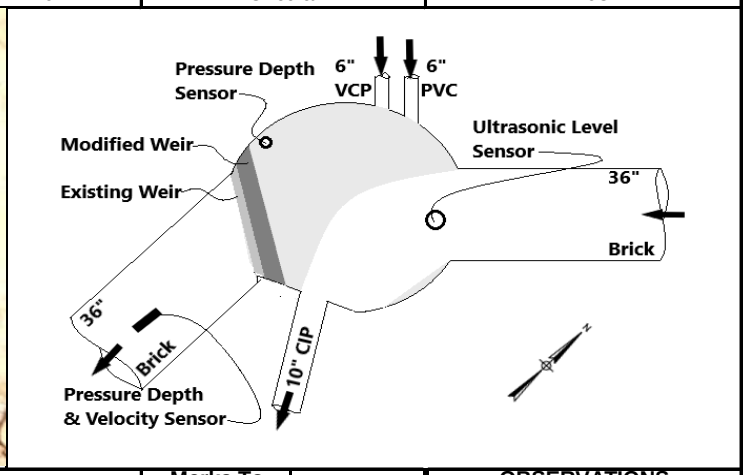
2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-13: Regulator 023 Reconstruction

FLOW ASSESSMENT SERVICES

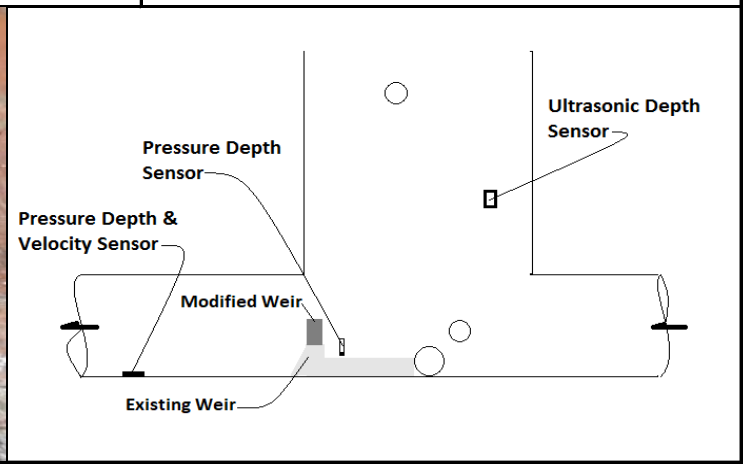
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** January 31, 2019	**JOB#:** 17063
LOCATION: 352 North Main Street	**MH#:**	**METER SITE:** 023
GPS/COMMENTS: 41.530703, -72.057248. Updated to reflect weir modification.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	36	Brick	6	3	Circular	14' 09"
Incoming	6	VCP	0	0	Circular	13' 01"
Incoming	6	PVC	0	0	Circular	05' 00"
Outgoing	10	CIP	4	0	Circular	14' 07"
Overflow	36	Brick	0	0	Circular	14' 08"



SURCHARGE	**None Evident**	X	**Current**		**Marks To**		**OBSERVATIONS**
WEIR DIMENSIONS	**Length**	**Breadth**	**Level**	**Area Above**			
	21.15	3.5	Yes	~			



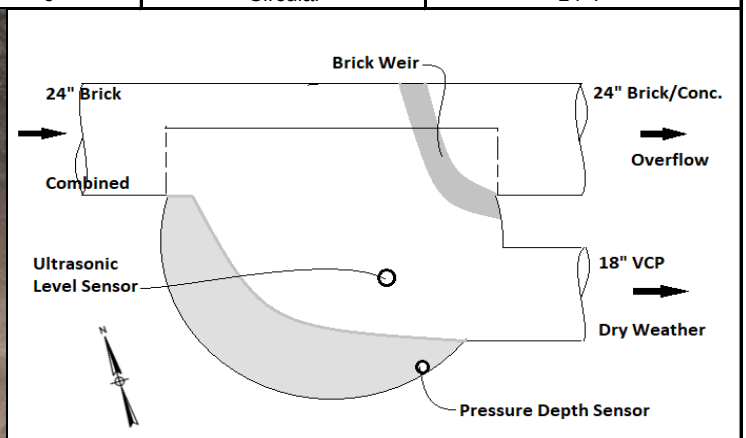
2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-14: Regulator 024 Reconstruction

FLOW ASSESSMENT SERVICES

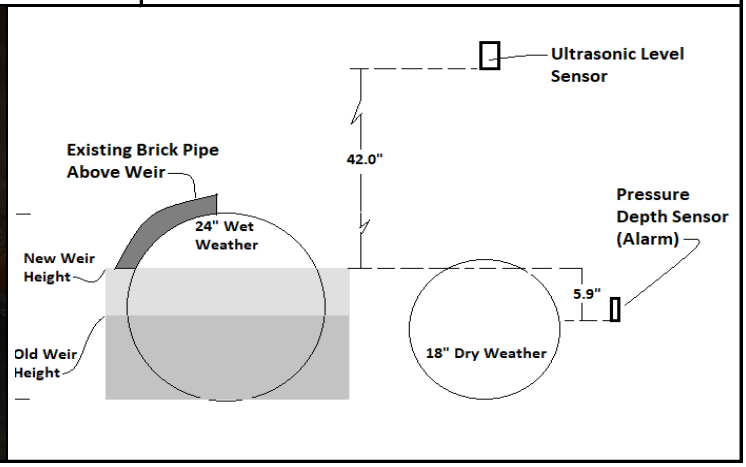
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** October 29, 2019	**JOB#:** 17063
LOCATION: Eighth Street near railroad tracks	**MH#:**	**METER SITE:** 024
COMMENTS: 41.535523, -72.053981 Original install 6.7.17. Updated to reflect weir modification.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24	Brick	5	0	Circular	14' 8"
Incoming						
Overflow	24	Brk/Conc.	0	0	Circular	14' 10"
Dry Weather	18	VCP	6	0	Circular	14' 7"



SURCHARGE	**None Evident**		**Current**		**Marks To**	5'	**OBSERVATIONS**
WEIR DIMENSIONS	**Length**	**Breadth**	**Level**	**Area Above**	* Portion of existing brick pipe remains above weir.		
	29.3	4	yes	*			



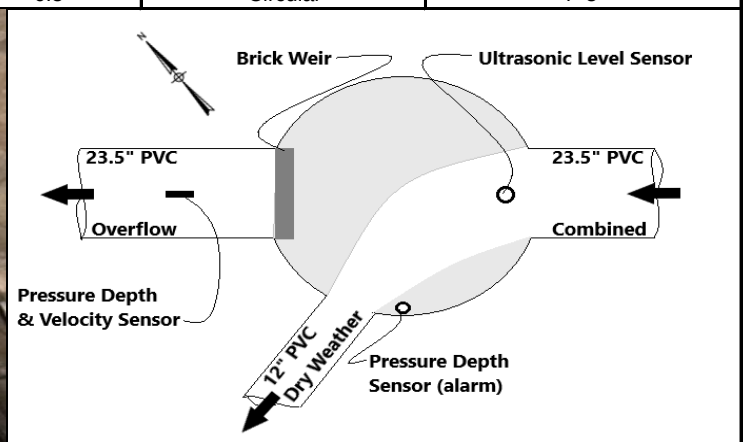
2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-15: Regulator 025 Reconstruction

FLOW ASSESSMENT SERVICES

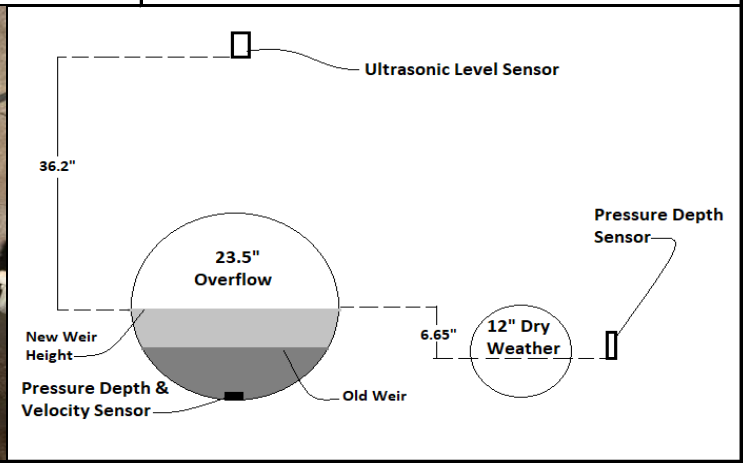
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** October 29, 2019	**JOB#:** 17063
LOCATION: Eighth Street at Smith Avenue	**MH#:**	**METER SITE:** 025
COMMENTS: 41.534515, -72.051136 Original install on 6.12.19. Updated to reflect weir modification.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	23.5	PVC	5	0.5	Circular	7' 3"
Incoming						
Overflow	23.5	PVC	0	0	Circular	7' 4"
Dry Weather	12	PVC	4.5	0.5	Circular	7' 5"



SURCHARGE	**None Evident**	X	**Current**		**Marks To**		**OBSERVATIONS**
WEIR DIMENSIONS	**Length**	**Breadth**	**Level**	**Area Above**			
	23.25	4	yes	na			



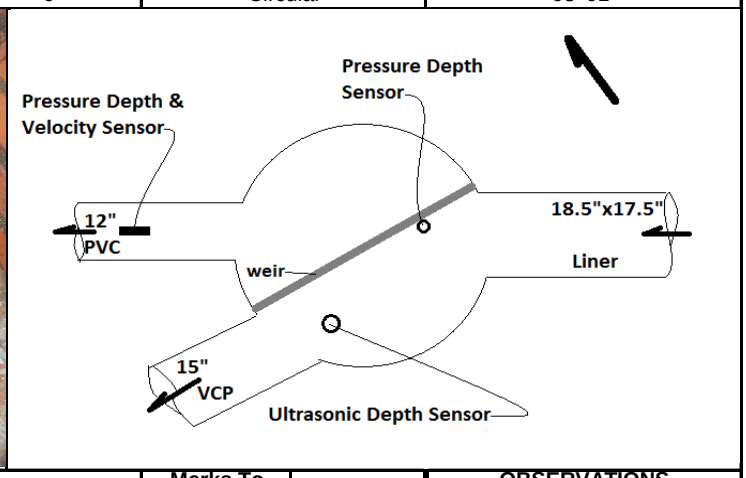
2020 Long Term Control Plan
Norwich Public Utilities
Figure 7-16: Regulator 029 Reconstruction

FLOW ASSESSMENT SERVICES

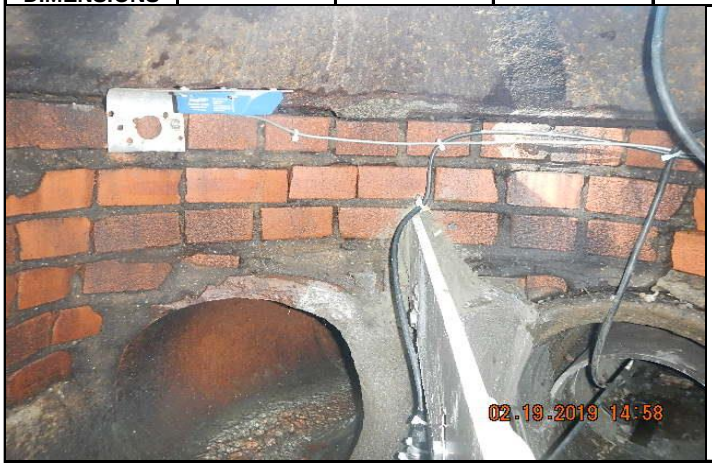
METER SITE INFORMATION FIELD LOG

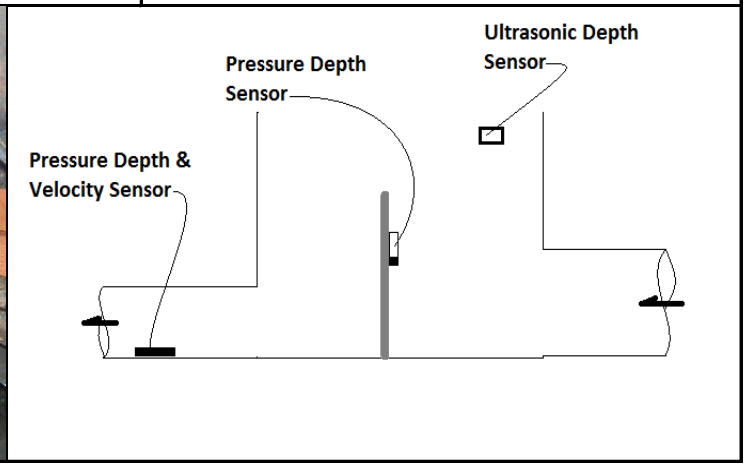
PROJECT: Norwich, CT	**DATE:** February 19, 2019	**JOB#:** 17063
LOCATION: 76 Tallman Street	**MH#:**	**METER SITE:** 029
GPS/COMMENTS: 41.522366, -72.074627. Updated for weir modification.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	18.5 x 17.5	Liner	1.3	0	Oval	02' 10"
Incoming						
Overflow	12	PVC	0	0	Circular	03' 01"
Outgoing	15	VCP	1.5	0	Circular	03' 01"



SURCHARGE	**None Evident**	X	**Current**		**Marks To**		**OBSERVATIONS**
WEIR DIMENSIONS	**Length**	**Breadth**	**Level**	**Area Above**			
	36	0.5	Yes	~			





Section 8

Section 8
Alternatives Evaluation

8.1 General

8.1.1 Introduction

Section 5 described available combined sewer overflow (CSO) control technologies and identified those most appropriate for application in Norwich. Section 6 discussed how sewer separation in particular could be implemented in Norwich, and the expected impact of its implementation on CSO and collection system function. This section builds on those discussions by presenting how selected CSO technologies can be strategically implemented in combination with one another to create a comprehensive CSO control plan.

This Section of the report is organized to follow the development of alternatives. First, multiple CSO management strategies are identified for each area of the city. Next, effectiveness of each strategy for CSO reduction is assessed. Effective solutions in each area of the city are then combined into comprehensive alternatives for systemwide CSO control. In accordance with the United States Environmental Protection Agency (EPA) guidance manual for developing long-term control plans (LTCPs), CSO control alternatives were developed for 1-month, 3-month, 6-month, 1-year, 2-year, and 5-year design storms.

After hydraulic effectiveness and performance statistics are developed, project costs, construction and environmental impacts, and CSO benefits achieved by implementing each design storm control strategy are also identified. Alternatives are then evaluated based on community impacts, constructability, operation & maintenance (O&M) considerations and cost effectiveness for managing CSO. Performance summary tables and cost summary tables are presented towards the end of this Section. Top performing plans were selected for evaluation in Section 9, and Section 10 describes the Recommended Plan. The Recommended Plan will ultimately be the one that achieves the highest level of control that NPU can afford over a reasonable planning period (assumed to be 35 years as beyond this duration, CSO technology, economics, demographics, and other key factors are highly uncertain).

8.1.2 Alternatives Development

Section 5 identified LTCP technologies not currently practiced by NPU that could reduce CSO. These technologies were further assessed as part of alternatives development. They include:

- Sewer separation, consisting of area drain and leader disconnection, sewer separation, and infiltration/inflow control;
- Inline and offline storage;
- Increased conveyance including larger and supplemental pipes, larger pumping stations, regulator modifications, regulating devices and backwater gates;

- Increased capacity to accept wet weather flow at the Water Pollution Control Facility (WPCF) through addition of enhanced high-rate clarification and disinfection; and
- Combinations of each of the above to achieve the best fit for any given area.

CSO control strategies were first developed separately for Thamesville, Laurel Hill, and the Shetucket Interceptor sewersheds. These are the three hydraulically distinct sections of the system with combined sewers. The Shetucket Interceptor serves Greeneville, Downtown, and the Eastside. CSO control for the Eastside area was addressed in Section 7 via the "Planned Projects" which are included as a part of every alternative discussed in this Section 8.

Combined and separate sewer flows from Thamesville are conveyed directly to the WPCF via Shipping Street Pumping Station (PS) and South Thames Street PS. The Shetucket Interceptor conveys combined and separated flows from Eastside, Greeneville, and Downtown to Rose Alley PS. The Laurel Hill Interceptor collects combined and separated flow from the Laurel Hill area and discharges it to the lower Shetucket Interceptor (via the River Avenue PS) just upstream of Rose Alley PS. The Rose Alley PS conveys flow directly to the WPCF via a force main which also receives flow from Market Street PS. The WPCF also receives flow directly from the Yantic and Westside separated areas via Yantic Interceptor and Cove Street PS respectively. CSO control strategies focused on alternatives for the areas of the city with combined flows.

CSO control strategies could be considered for each section of the city in isolation due to the divided hydraulic nature of the system. These separate solutions are then combined to achieve citywide control. When the solutions are merged, the effects on downstream conditions must be considered. For example, since Laurel Hill and the area tributary to the Shetucket Interceptor both drain to Rose Alley PS, Rose Alley's capacity to pump flow from both areas must be considered. The WPCF's capacity to accept flow is a consideration for increased conveyance options for all three areas.

The WPCF was evaluated with two future flow capacity scenarios. In the first scenario, the WPCF receives necessary upgrades, secondary treatment capacity is expanded from 17 million gallons per day (mgd) to 20 mgd, and the sewer collection system is managed within this constraint. In the second scenario, WPCF wet weather capacity is increased to a total of 80 mgd (20 mgd through secondary and an additional 60 mgd through a new wet weather treatment process) and each sewershed can deliver increased flow. For every alternative, consideration was given to which area of the city had priority for sending flow directly to the WPCF versus areas that should detain or reduce flow to free capacity at the WPCF for flow from other parts of the city. Citywide CSO control alternatives were developed to manage CSO to each of the six design storms. To manage CSO in each area, four broad CSO control strategies were considered as discussed below.

- Complete citywide public and private separation – extensive public and private sewer separation throughout the entire sewer system would include areas that are currently categorized as having sanitary sewers. The result would be dedicated sanitary sewers and a complete storm drainage system conveying all public and private inflow, as described in Section 6.

- Local public inflow removal – This alternative removes stormwater from the collection system by disconnecting catch basins currently draining to the combined sewer system, as described in Section 6. This alternative reduces CSO in targeted areas and can be implemented in conjunction with other CSO control technologies to mitigate CSO.
- Conveyance to the WPCF – This alternative conveys all sewer system flow to the WPCF. This alternative requires upgrading the WPCF to treat up to 80 mgd.
- Storage – This alternative stores peak wet weather flow at strategic locations in the system and maintains existing conveyance to the WPCF.

Combination or hybrid approaches were also developed as described later in this Section.

8.2 Thamesville

Three CSOs serve Thamesville:

- Furthest south, at the upgradient end of the system, CSO 040 relieves Shipping Street PS.
- CSO 004 relieves flow from Route 32/West Thames Street that cannot be conveyed into the Shipping Street force main (FM).
- CSO 005, the northernmost relief point, is triggered when flow exceeds capacity at the South Thames Street PS.

Table 8-1 presents Thamesville design storm CSO statistics after completion of the Planned Projects described in Section 7. Since submission of the 2018 LTCP, the Planned Projects have been revised to include the closure of CSO 040. This work was completed in January 2019, therefore, the Planned Projects include elimination of CSO at CSO 040. Total peak discharge for the three CSOs ranges from 2 to 17.3 mgd, while CSO volume ranges from 0.01 to 0.5 million gallons (Mgal), from the 1-month to the 5-year storms, respectively.

Table 8-1 Thamesville CSO Statistics After Completion of Planned Projects

CSO Statistics	Design Storm	CSO 004	CSO 005	CSO 040	Thamesville Total	System Total
CSO Peak Flow (mgd)	1-month	1.8	0.2	0	2.0	25
	3-month	4.7	0.6	0	5.3	52
	6-month	7.7	1.0	0	8.7	86
	1-year	8.9	1.8	0	11	99
	2-year	10.3	2.1	0	12	114
	5-year	15.0	2.3	0	18	152
CSO Volume (Mgal)	1-month	0.01	<0.01	0	0.01	0.49
	3-month	0.05	0.01	0	0.06	1.24
	6-month	0.11	0.02	0	0.13	2.38
	1-year	0.18	0.04	0	0.22	3.54
	2-year	0.31	0.08	0	0.39	5.10
	5-year	0.40	0.10	0	0.51	5.79

8.2.1 Necessary Upgrades

Some components of the combined sewer system in Thamesville require upgrades to correct deficiencies. These upgrades are incorporated into each alternative. The upgrade of Shipping Street PS and FM is part of every control plan. As discussed in Section 2, these facilities are old and require immediate repair. The pump capacity required to pass the full wet weather flow exceeds current capacity in the 6-month design storm. Shipping Street FM parallels a railroad along the west bank of the Thames River. NPU staff recall that the pipe proved challenging to access and repair when there was a FM break some years ago. Due to the difficult construction encountered previously along the railroad, removal and replacement of the Shipping Street FM in its current location is not possible. Additionally, the FM currently accepts two gravity connections, which is a challenging hydraulic configuration. All alternatives, therefore, propose upgrading Shipping Street PS, abandoning the existing FM along the railroad, and installing a new FM up Shipping Street and Route 32 until a high point where the FM can discharge to a new gravity sewer. The gravity sewer will connect to an existing manhole near the intersection of West Thames Street and Cahoon Street. Sewer laterals from properties along the Thames River that connect to the existing Shipping Street FM will be redirected to the new FM discharging to a new gravity line in Route 32.

Due to the change in direction and magnitude of flow coming from southern Thamesville, additional system modifications will be required near CSOs 004 and 005. The manhole into which the new gravity line down West Thames Street will tie will be converted into a new, intra-system regulator, replacing existing regulator 4. Under existing conditions, this manhole in Route 32 directs flow to regulator 4. High flows overtop the weir and discharge to CSO 004 while dry weather flow drains into the existing Shipping Street FM (Figure 8-1). With the abandonment of this FM, dry weather flow pipes from the existing regulator will be disconnected from the FM and instead connect to the 10-inch sewer in South Thames Street. These dry weather flow pipes are undersized and difficult to access due to their location on a hillside at a residential property. Rather than enlarge these pipes to accommodate increased flow from Shipping Street, regulator 4 will be relocated to Route 32 to route flow away from the existing regulator and down West Thames Street instead via a new gravity pipe. The regulator weir and relief pipe size can be set to pass all flow and manage CSO 004 to the desired control level. The existing regulator 4 will be converted into a standard manhole to convey overflow to CSO 004. Dry weather flow pipes extending from the existing regulator will be sealed so that they only collect sanitary flow from three properties that currently tie into this portion of the system. Figure 8-2 summarizes the proposed relocation of regulator 4 and the surrounding reconfiguration.

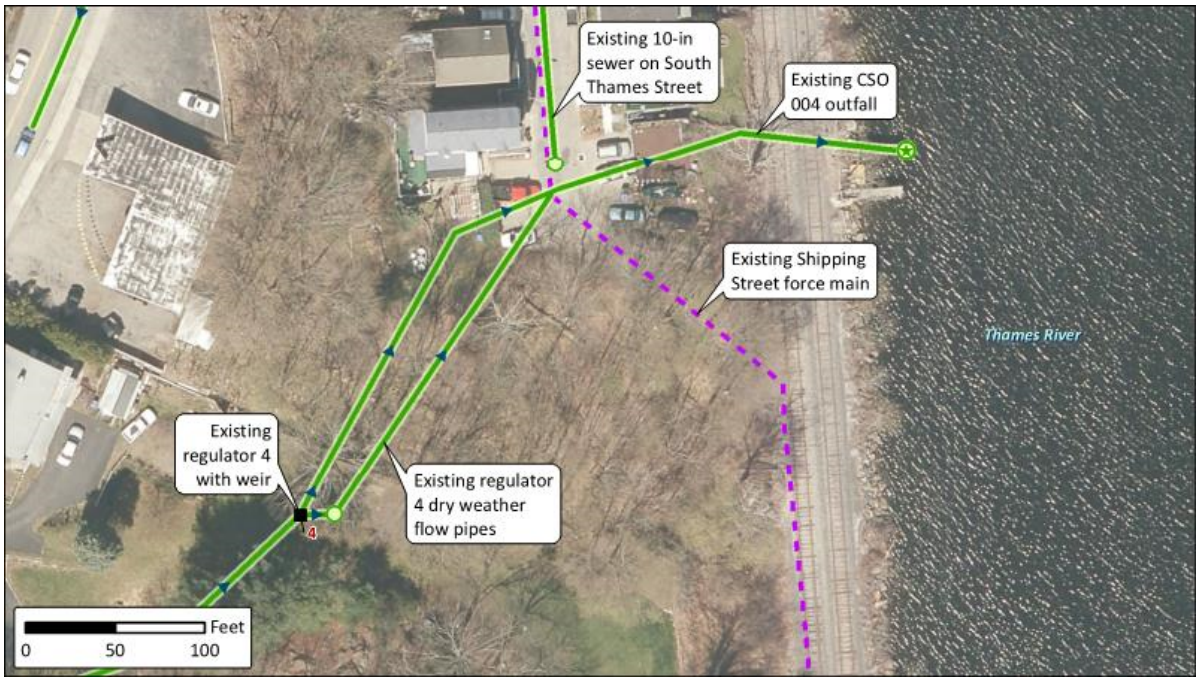


Figure 8-1
Existing Configuration of Pipes Around Regulator 4

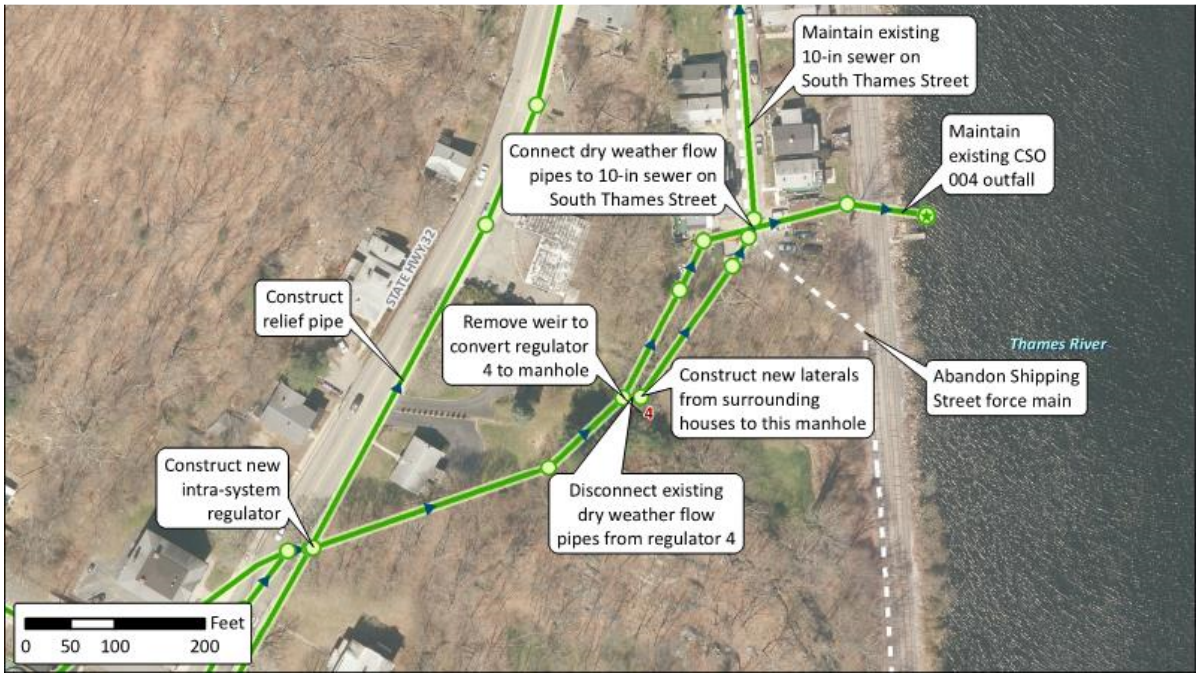


Figure 8-2
Relocation of Regulator 4 and Associated Reconfiguration of Downstream System

Flow from the new West Thames Street gravity pipe and from the South Thames Street 10-inch sewer will converge at a central location downstream. Depending on the alternative and the level of control the alternative aims to achieve, flow will either be pumped directly to the WPCF or will flow to an inline storage tank to be released after the peak flow recedes at the WPCF.

8.2.2 Separation

Section 6 describes the effectiveness of citywide complete public and private separation in Norwich and local public inflow removal in Thamesville.

8.2.2.1 Complete Public and Private Separation

Complete removal of public and private inflow is expected to control through the 5-year storm. This level of separation is both costly and difficult to guarantee, as impediments to complete separation may reduce effectiveness. For example, complete separation depends on the willingness of each homeowner to approve work on private property to disconnect roof leaders and yard drains and/or install new sewer laterals. Furthermore, if complete separation is accompanied by closure of overflows, sanitary sewer overflow (SSO) and basement flooding may occur during large storms, posing public health risks.

8.2.2.2 Local Public Inflow Removal

Local public inflow removal in Thamesville was identified in Section 6 as a feasible option for cost-effective CSO mitigation. The reduction in CSO allows remaining flow to be managed with smaller, lower cost, supplementary technologies. Thamesville is a medium density, suburban area. Construction to separate public inflow may be less disruptive and costly than in more densely developed areas of the city. Public inflow removal in Thamesville is expected to control CSO 004 to a 1-month storm and CSO 005 to a 3-month storm, while CSO 040 was eliminated in the Planned Projects (Table 8-2). The collection system model estimates that public inflow removal will reduce CSO volume in the 2-year storm by 62 percent and peak flow by 78 percent.

Table 8-2 CSO Statistics with Public Inflow Removal in Thamesville as Compared to Future Baseline CSO Statistics

CSO Statistics	Design Storm	CSO 004	CSO 005	CSO 040	Total	Future Baseline	Reduction
CSO Peak Flow (mgd)	1-month	0.0	0.0	0.0	0.0	2	100%
	3-month	0.9	0.0	0.0	0.9	5	83%
	6-month	2.5	0.4	0.0	2.9	9	66%
	1-year	3.1	0.6	0.0	3.7	11	66%
	2-year	3.9	0.7	0.0	4.6	12	62%
	5-year	5.9	1.0	0.0	6.9	18	62%
CSO Volume (Mgal)	1-month	0.00	0.00	0.00	0.00	0.01	100%
	3-month	0.01	0.00	0.00	0.01	0.06	91%
	6-month	0.02	0.00	0.00	0.03	0.13	80%
	1-year	0.03	0.01	0.00	0.04	0.22	81%
	2-year	0.06	0.03	0.00	0.09	0.39	78%
	5-year	0.09	0.03	0.00	0.13	0.51	75%

8.2.3 Conveyance

To convey total flows in Thamesville to the WPCF, the Shipping Street and South Thames Street pump stations must be upgraded, and pipe capacity must be increased. As described in Section 8.2.1, Shipping Street PS and FM urgently need repair and replacement. All alternatives include

upgrading Shipping Street PS, abandoning the existing FM along the Thames River, and installing a new FM up Shipping Street and Route 32. Multiple other changes in configuration are necessary downstream to accommodate the new capacity and direction of the Shipping Street FM.

The existing Shipping Street PS has a maximum pumping capacity of 3.3 mgd and a 12-inch FM leaving the station. For the 1-month to 2-year level of control, the recommended upgrade would have a 3.5 mgd capacity and a 12-inch FM. A 3.5 mgd PS was selected to provide a small increase in capacity that when combined with regulator and dry weather flow connector modifications, would be capable of conveying the 2-year peak flow downstream towards the WPCF. To convey the 5-year peak flow, Shipping Street PS must be enlarged to a capacity of 7 mgd with an 18-inch FM.

The South Thames Street PS has an existing 4.2 mgd capacity that would need to be upgraded to 5 mgd to convey the 1-month storm. It is expected that the existing PS could be upgraded in place to 5 mgd. The existing 12-inch FM from the PS to the WPCF is still adequate to pass the minor increase in flow from the PS. Flow from the new West Thames Street relief pipe is directed to the upgraded South Thames Street PS. The relief pipe must have a 15-inch diameter to convey the peak flows in a 1-month storm. The South Thames Street 10-inch sewer conveys flows to the South Thames Street PS under existing conditions and does not need to be replaced for 1-month control. The 1-month conveyance configuration in Thamesville is summarized in Figure 8-3.

Figure 8-3
Configuration of 1-Month Conveyance Alternative in Thamesville

Starting with the 3-month storm, peak flows reaching the South Thames Street PS require more pumping capacity than the PS could be upgraded in place to support. The PS must be relocated to a location with additional land area available for a larger PS. Appendix B identifies the potential locations for storage tanks in each part of the city. The best location for a storage tank in Thamesville is on a vacant lot on the eastern side of Thames Street, north of a condominium

complex. This is also the most suitable location for a larger PS in Thamesville. For the 3-month through 5-year storms, a PS and FM of varying sizes are proposed on this lot to pump flows from Thamesville directly to the WPCF.

For the 3-month through 5-year storms, the relief pipe down West Thames Street would be constructed to convey flows to the new PS, rather than to the existing South Thames Street PS, as in the 1-month storm configuration. The existing PS would be abandoned and flows that are currently connected to the PS (the 10-inch sewer on South Thames Street and flow from Mopsic Street to the north) would be conveyed to the new PS via new pipes running between the condominiums and the Thames River. The sizes of relief pipes and the conveyance pipes from the existing PS increase with increasingly intense design storms. The configurations of the 3-month through the 5-year conveyance alternatives are the same and are summarized in Figure 8-4. Sizes of the PS and pipes are not included in the figure but are summarized in Table 8-3.

Figure 8-4
Configuration of 3-Month through 5-Year Conveyance Alternatives in Thamesville

Table 8-3 Size of Main Components of the Thamesville Conveyance Alternative

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Shipping Street PS (mgd)	3.5	3.5	3.5	3.5	3.5	7
Shipping Street FM (diameter, inches)	12	12	12	12	12	18
West Thames Street Relief Pipe (diameter, inches)	15	21	24	24	24	30
South Thames Street PS (Existing Location, mgd)	5	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned
Relocated PS (mgd)	NA	10	14	15	16	23
South Thames Street FM (diameter, inches)	12	18	20	24	24	30

8.2.4 Storage

Another method of CSO control evaluated in Thamesville was storing sewer flow until the peak flow has passed the WPCF. A storage tank is needed for the 3-month through 5-year levels of control. As described in Section 8.2.1, Shipping Street PS and FM are in urgent need of repair and replacement. All alternatives include upgrading Shipping Street PS, abandoning the existing FM along the Thames River, and installing a new FM up Shipping Street and Route 32. Multiple other changes in configuration are necessary downstream to accommodate the new capacity and direction of the Shipping Street FM.

For the 1-month storm, total system sewer flows are low enough that Thamesville flows can be conveyed directly to the WPCF with no storage. Shipping Street PS is upgraded to a capacity of 3.5 mgd with a 12-inch FM from the 1-month to pass the 2-year peak flow. The existing Shipping Street PS has a maximum pumping capacity of 3.3 mgd and a 12-inch FM leaving the station. For the 1-month to 2-year level of control, the recommended upgrade would have a 3.5 mgd capacity and a 12-inch FM. A 3.5 mgd PS was selected to provide a small increase in capacity that when combined with regulator and dry weather flow connector modifications, would be capable of conveying the 2-year peak flow downstream towards the WPCF. To convey the 5-year peak flow, Shipping Street PS must be enlarged to 7 mgd with an 18-inch FM.

Achieving the 1-month level of control in Thamesville under the storage configuration requires the same components as the 1-month conveyance scenario. Shipping Street PS and FM would need to be upgraded as described above, South Thames Street PS would need to be upgraded in place to 5 mgd, and the West Thames Street 15-inch new sewer would also be required. Figure 8-3 shows this identical 1-month control layout.

In the 3-month and larger storms, managing Thamesville CSO by increasing its conveyance to the WPCF would limit the plant's capacity to accept flow from other parts of the system. A Thamesville storage tank is therefore needed to detain flows during the peak of the storm. As described in Appendix B, based on preliminary research the best storage location in Thamesville is the vacant lot on the eastern side of Thames Street, north of a condominium complex. For the 3-month through 5-year storms, an inline storage tank of varying capacity is proposed on this lot to store combined sewer flow until the WPCF passes the peak flow and has sufficient capacity to

receive additional flow. A 4 mgd pump from the tank is proposed for the 3-month through 2-year storms to maintain approximately the same flow rate from Thamesville to the WPCF as under existing conditions. The dewatering pump would connect to a new FM (diameter varies by level of control), which would run parallel to the existing FM to the WPCF. Dry weather flows would be pumped continuously through the tank without filling. During rain events, the pump rate would be reduced, allowing the tank to fill. This can be accomplished via a real-time control relating the dewatering pump rate to flows at another location in the system, either upstream flows or directly at the WPCF. As discussed in Appendix B, the maximum size storage tank that could fit at this location is estimated at 0.63 Mgal. The maximum size storage tank is not needed until the 1-year storm. In the 5-year storm, flows reach 23 mgd and would overwhelm the 0.63 Mgal storage tank. To prevent the tank from flooding, the dewatering pump would have to be increased to 9 mgd with an 18-inch FM.

For the 3-month through 5-year storms, the relief pipe down West Thames Street would be constructed to convey flows to the storage tank, rather than to the existing South Thames Street PS, as in the 1-month storm. The existing PS would be abandoned and flows that are currently connected to the PS (the 10-inch sewer on South Thames Street and flow from Mopsic Street to the north) would be conveyed to the storage facility via new pipes running between the condominiums and the Thames River. The sizes of relief pipes and the conveyance pipes from the existing PS increase with increasingly intense design storms. The configurations of the 3-month through the 5-year storage alternatives are the same as one another and are summarized in Figure 8-5. Sizes of the storage tank, pump, and pipes are not included in the figure but are summarized in Table 8-4.

Figure 8-5
Configuration of 3-Month through 5-Year Storage Alternatives in Thamesville

Table 8-4 Size of Main Components of the Thamesville Storage Alternative

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Shipping Street PS (mgd)	3.5	3.5	3.5	3.5	3.5	7
Shipping Street FM (diameter, inch)	12	12	12	12	12	18
West Thames Street Relief Pipe (diameter, inch)	15	21	24	24	24	30
South Thames Street PS (Existing Location, mgd)	5	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned
Storage Tank (Mgal)	NA	0.3	0.4	0.6	0.6	0.6
Storage Tank Dewatering Pump (mgd)	NA	4	4	4	4	9
South Thames Street FM (diameter, inch)	12	12	12	12	12	18

8.3 Laurel Hill

Flow from the southern portion of Laurel Hill are collected at River Avenue PS and conveyed to the north end of Laurel Hill. The FM then merges with flows from northern Laurel Hill, and the total sewer flow is conveyed over a bridge to the Shetucket Interceptor, just upstream of Rose Alley PS. There are three overflows located in Laurel Hill. CSOs 031 and 032 discharge into the Thames River and are located approximately 1,000 ft from each other. These overflows serve to protect the River Avenue PS, which is located between the two regulators. The pipes conveying flow from the regulators to River Avenue PS run between a railroad and a steep hillside, limiting access. CSO 029 is located in the northern end of Laurel Hill near the intersection of Talman Street and Winchester Place. Flows that pass regulator 29 merge with the FM from River Avenue PS before being piped over a railroad bridge to the Shetucket Interceptor. Table 8-5 presents CSO statistics for the design storms after completion of the Planned Projects described in Section 7. With completion of the Planned Projects, the collection system model simulates that CSO outfall 029 will be managed to the 1-year level of control and CSO outfall 032 will be managed at the 1-month level of control. Peak Laurel Hill CSO flows range from 0.4 mgd in the 1-month storm to 19 mgd in the 5-year storm while CSO volumes range from <0.01 Mgal in the 1-month storm to 0.39 Mgal in the 5-year storm.

Table 8-5 Laurel Hill CSO Statistics

CSO Statistics	Design Storm	CSO 029	CSO 031	CSO 032	Laurel Hill Total	System Total
CSO Peak Flow (mgd)	1-month	0	<1	0	<1	25
	3-month	0	2	1	3	52
	6-month	0	5	4	9	86
	1-year	1	6	5	11	99
	2-year	1	6	6	13	114
	5-year	2	8	9	19	152
CSO Volume (Mgal)	1-month	0.00	<0.01	0.00	<0.01	0.49
	3-month	0.00	0.03	0.01	0.04	1.24
	6-month	0.00	0.07	0.03	0.10	2.38
	1-year	<0.01	0.11	0.05	0.16	3.54
	2-year	<0.01	0.20	0.08	0.28	5.10
	5-year	0.02	0.24	0.13	0.39	5.79

8.3.1 Necessary Upgrades

Some components of the combined sewer system in Laurel Hill require upgrades to correct deficiencies. As discussed in Section 2, the River Avenue PS and FM need immediate repair. The collection system model indicates inflows exceed River Avenue PS capacity even in the 1-month design storm. The River Avenue FM suffered a recent break in May 2018, highlighting the need for an upgrade of the FM as well. The lining work completed in 2019 reduced FM capacity and is viewed as a short-term repair measure. Due to the inadequacy of this existing infrastructure, all alternatives include an upgrade of River Avenue PS and the construction of a new FM. The size and route of the new FM varies between alternatives and levels of control.

8.3.2 Separation

Section 6 describes the effectiveness of citywide separation in Norwich and local public inflow removal in Laurel Hill.

8.3.2.1 Complete Public and Private Inflow Separation

Complete public and private separation is expected to achieve CSO control through the 5-year storm. This level of separation is both costly and difficult to guarantee, as impediments to complete separation may reduce the effectiveness. For example, complete separation will depend on the willingness of each homeowner to approve work on private property to disconnect roof leaders and yard drains and/or install new sewer laterals. If complete separation is accompanied by the closure of overflows, SSOs may occur during very large storms, creating a public health risk.

8.3.2.2 Local Public Inflow Removal

Local public inflow removal in Laurel Hill was identified in Section 6 as one option for reducing CSO volumes to a limited extent. The reduction in CSO allows remaining flows to be managed with smaller, lower cost, supplementary technologies. Laurel Hill is a medium density, suburban area. Construction to separate public inflow may be less disruptive and costly than in more densely

developed areas of the city. Construction in Laurel Hill is, however, challenging due to steep slopes and the presence of pipes adjacent to railroad tracks and the Thames River floodway.

Public inflow removal in Laurel Hill is expected to control CSOs 031 and 032 to a 3-month level of control and to control CSO 029 through the 5-year level of control (Table 8-6). The collection system model estimates that public inflow removal will reduce CSO volume in the 2-year storm by 74 percent and peak flow by 70 percent.

Table 8-6 CSO Statistics with Public Inflow Removal in Laurel Hill as Compared to Future Baseline CSO Statistics

CSO Statistics	Design Storm	CSO 029	CSO 031	CSO 032	Total	Future Baseline	Reduction
CSO Peak Flow (mgd)	1-month	0.0	0.0	0.0	0.0	0.1	100%
	3-month	0.0	0.0	0.0	0.0	3	100%
	6-month	0.0	1.7	0.5	2.2	9	75%
	1-year	0.0	2.2	1.0	3.2	11	71%
	2-year	0.0	2.5	1.5	4.0	13	70%
	5-year	0.0	4.0	3.6	7.6	19	60%
CSO Volume (Mgal)	1-month	0.00	0.00	0.00	0.00	0.1	100%
	3-month	0.00	0.00	0.00	0.00	0.04	100%
	6-month	0.00	0.02	0.00	0.02	0.1	80%
	1-year	0.00	0.03	0.01	0.04	0.16	76%
	2-year	0.00	0.06	0.01	0.07	0.28	74%
	5-year	0.00	0.08	0.04	0.12	0.39	69%

8.3.3 Conveyance

To convey total flow from Laurel Hill to the Shetucket Interceptor and Rose Alley PS, River Avenue PS must be upgraded, and conveyance pipes must be replaced with larger pipes. Since CSOs 031 and 032 serve to relieve River Avenue PS, the PS must be upgraded to a larger capacity to avoid overflows at these discharge locations. The required sizes of River Avenue PS and FM increase with larger design storms. Depending on the design storm to be controlled, some of the dry weather flow connector pipes from regulators 31 and 32 to River Avenue PS must also be enlarged to convey the total flows. Enlarging these dry weather flow pipes is not trivial as they are located between a railroad and a steep hill side. In each alternative, the length of pipe along this stretch to be replaced was kept as low as possible while maintaining acceptable levels of surcharge. With increased flows coming from River Avenue PS, the pipe conveying total Laurel Hill flows to the Shetucket Interceptor becomes overwhelmed. This pipe must be enlarged starting in the 6-month storm to reduce surcharge and avoid overflow at CSO 029. To convey the 5-year storm, one of the dry weather flow connector pipes downstream of regulator 29 must also be enlarged. The overall configuration of the conveyance alternatives for all design storms in Laurel Hill is the same and is depicted in Figure 8-6. The sizes of the components vary by design storm and are summarized in Table 8-7.

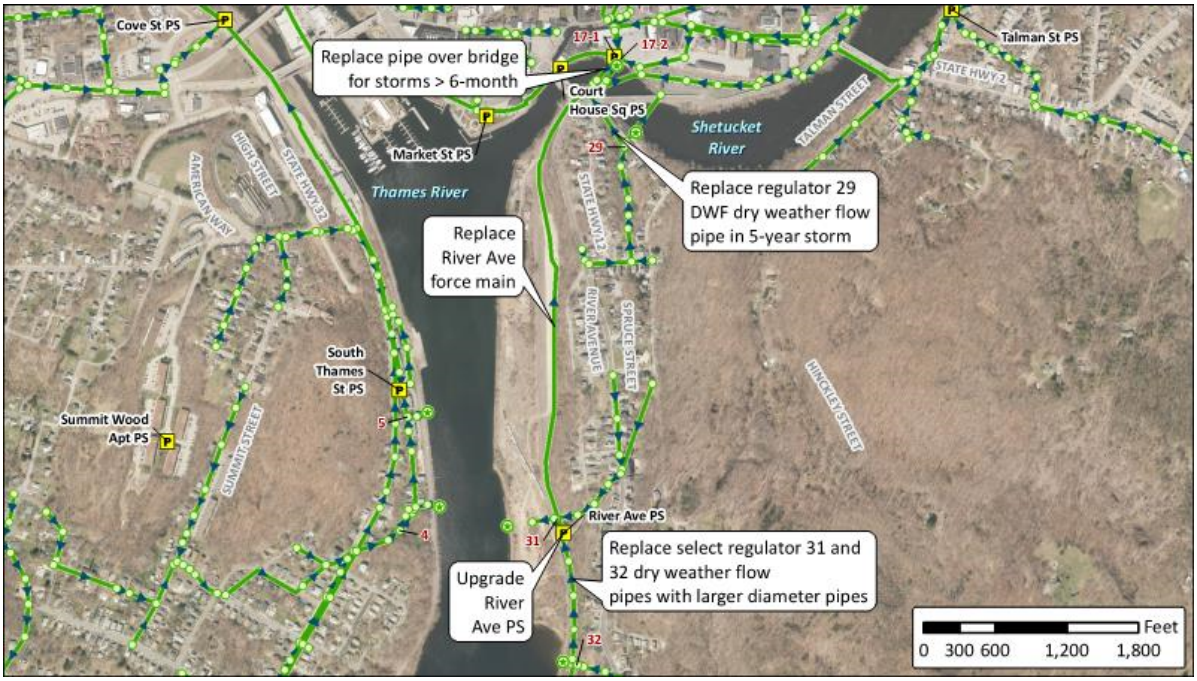


Figure 8-6
Configuration of Conveyance Alternatives in Laurel Hill

Table 8-7 Principal Components of Laurel Hill Conveyance Alternative

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
River Ave PS (mgd)	4	4	10	10	12	18
River Ave FM (diameter, inches)	14	14	20	18	20	24
Pipe replacement along Railroad (length, feet)	31	141	141	141	743	953
Pipe over Bridge to Shetucket Interceptor (diameter, inches)	As-is	As-is	30	30	30	30

8.3.4 Storage

To store flow in Laurel Hill until the peak flow has passed the Rose Alley PS downstream, a storage tank is needed for the 6-month through 5-year levels of control. Flows from Laurel Hill in the 1-month and 3-month storms are low enough that they can be conveyed directly to the Shetucket Interceptor and Rose Alley PS without storage. As was done for the conveyance alternatives, CSO at 031 and 032 can be controlled by upgrading River Avenue PS, replacing the FM, and enlarging dry weather flow pipes from regulators 31 and 32 (Figure 8-7).

Figure 8-7
Configuration of 1-Month and 3-Month Storage Alternatives in Laurel Hill

As the flow rate that must be pumped from River Avenue PS to achieve higher levels of control increases, the Shetucket Interceptor and Rose Alley PS become overwhelmed. Starting at the 6-month level of control, some storage in Laurel Hill is necessary to detain peaks. As discussed in Appendix B, two potential storage locations were considered:

- The floodway between the railroad and the Thames River, across the railroad tracks from the existing River Avenue PS
- A park at the intersection of Laurel Hill Avenue and Center Street. The park area was identified as the better alternative due to the challenging construction that would be encountered working adjacent to a railroad and in a floodway.

For the 6-month and larger storms, the River Avenue PS will be upgraded to pump higher flows and the FM will be re-routed up River Avenue to the park site. The FM will discharge before the park into a gravity line, allowing the storage tank to be operated off-line. A sluice gate operated by real time controls (RTC) is proposed in the gravity line to allow low flow to bypass the storage tank and continue down Laurel Hill Avenue to the Shetucket Interceptor via the bridge. During rain events, the sluice gate will close to send all flow to the storage tank. A 1 mgd pump will dewater the tank as capacity becomes available downstream. Figure 8-8 summarizes the overall configuration of the 6-month through 5-year storage alternatives in Laurel Hill. Figure 8-9 provides additional detail on the proposed configuration around the storage tank.

The main components that vary in Laurel Hill are the length of pipe adjacent to the rail road that must be replaced, the size of River Avenue PS and FM, and, when storage is required, the size of

the storage tank, dewatering pump, and gravity line down Laurel Hill Avenue. These are summarized in Table 8-8.

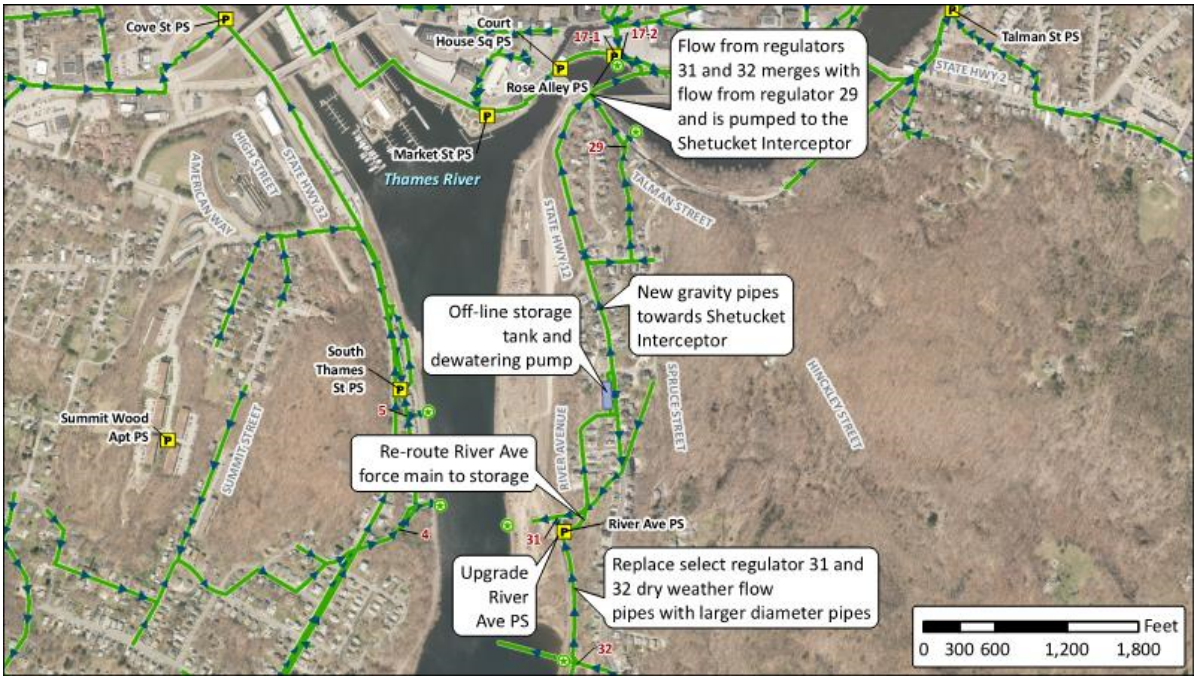


Figure 8-8
Configuration of 6-Month through 5-Year Storage Alternatives in Laurel Hill

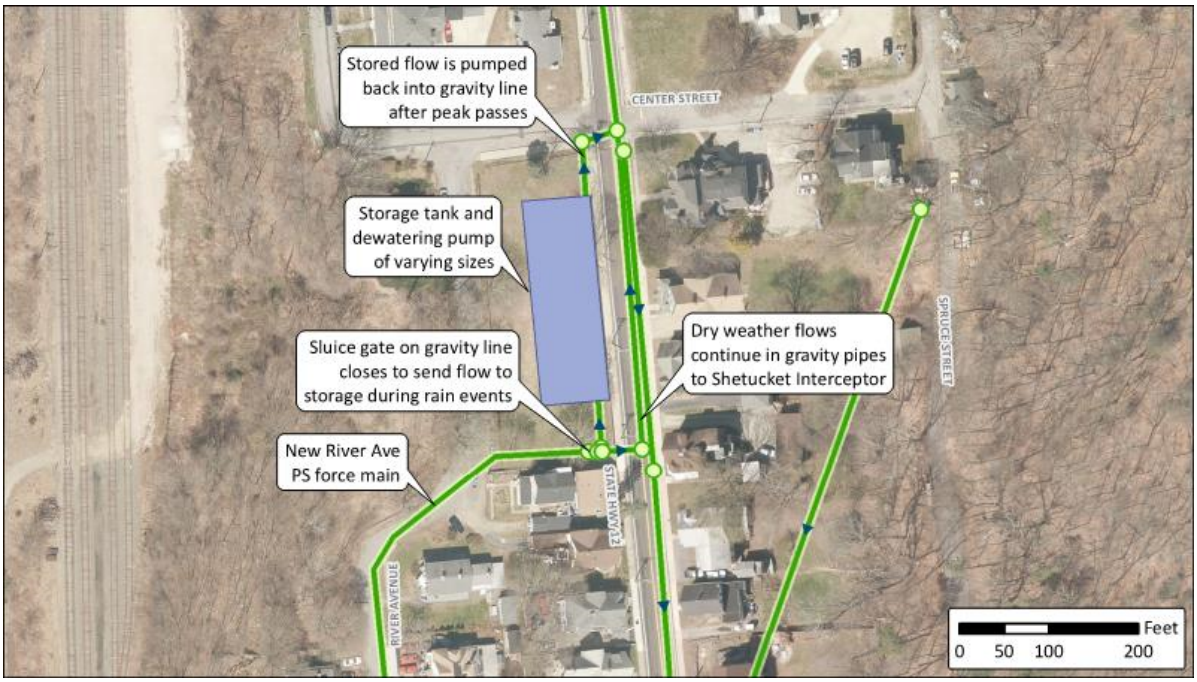


Figure 8-9
Configuration Around Proposed Storage Tank in Laurel Hill for 6-Month through 5-Year Levels of Control

Table 8-8 Size of Main Components of the Laurel Hill Storage Alternative

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
River Ave PS (mgd)	4	4	10	10	11	18
River Ave FM (diameter, inches)	14	14	18	18	18	24
River Ave FM Route	To Shetucket Interceptor, as existing	To Shetucket Interceptor, as existing	To Storage Tank	To Storage Tank	To Storage Tank	To Storage Tank
Storage Tank (Mgal)	NA	NA	0.53	0.84	1.05	1.05
Storage Tank Dewatering Pump (mgd)	NA	NA	1	1	1	1
Gravity Pipe to Shetucket (diameter, inches)	NA	NA	12	12	12	15
Pipe Replacement Along Railroad (length, feet)	97	141	141	532	743	953

8.4 Shetucket

The Shetucket Interceptor runs from the border of Taftville and Greeneville in the north to Rose Alley PS in the south, collecting flows from Greeneville and Downtown along the way. Flows from Eastside discharge from across the river to the upper Shetucket Interceptor, and flows from Laurel Hill discharge to the lower Shetucket Interceptor just upstream of the PS. Seven overflows serve to protect the Shetucket Interceptor and downstream infrastructure from excess flows. There are nine regulators to these seven overflows. Overflows from regulators 17-1 and 17-2 are combined into one outfall pipe, as are overflows from regulators 19-1 and 19-2. As such, these overflows are reported as one CSO each. Table 8-9 presents CSO statistics for the design storms after completion of the Planned Projects described in Section 7 (CSO 025 from Eastside is also included in Table 8-9 as its flows will be conveyed to the Shetucket Interceptor with the completion of the Planned Projects). CSO 024 (Greeneville) and CSO 025 (Eastside) are managed to the 2-year control level by conveying the total flows into the Shetucket Interceptor. Remaining peak CSO flows along the Shetucket range from 23 mgd in the 1-month storm to 115 mgd in the 5-year storm while CSO volumes range from 0.48 Mgal in the 1-month storm to 4.9 Mgal in the 5-yr storm.

Table 8-9 Shetucket CSO Statistics after completion of Planned Projects

CSO Statistics	Design Storm	CSO 017	CSO 018	CSO 019	CSO 021	CSO 022	CSO 023	CSO 024	CSO 025	Shetucket Total	System Total
CSO Peak Flow (mgd)	1-month	12	2.4	2.7	0	1.2	4.5	0	0	23	25
	3-month	19	5.1	5.8	1.0	3.3	8.6	0	0	43	52
	6-month	32	7.4	8.6	1.6	5.5	13	0	0	68	86
	1-year	37	8.3	10	1.7	6.2	14	0	0	77	99
	2-year	41	10	12	1.7	7.5	16	0	0	88	114
	5-year	51	15	18	1.9	10	20	0	0	115	152
CSO Volume (Mgal)	1-month	0.36	0.03	0.03	0	0.01	0.06	0	0	0.5	0.5
	3-month	0.80	0.08	0.07	0.01	0.03	0.15	0	0	1.1	1.2
	6-month	1.5	0.15	0.15	0.02	0.07	0.29	0	0	2.1	2.4
	1-year	2.2	0.21	0.21	0.02	0.09	0.39	0	0	3.2	3.5
	2-year	2.9	0.37	0.35	0.03	0.16	0.62	0	0	4.4	5.1
	5-year	3.1	0.44	0.44	0.06	0.21	0.67	0	0	4.9	5.8

8.4.1 Necessary Upgrades

There are no known necessary upgrades along the Shetucket Interceptor that will be part of every solution. All modifications to the existing system will vary by solution and design storm.

8.4.2 Separation

Section 6 describes the effectiveness of citywide separation in Norwich and local public inflow removal in the areas draining to the Shetucket Interceptor.

8.4.2.1 Complete Public and Private Inflow Separation

Complete removal of public and private inflow is expected to achieve 5-year CSO control. However, this level of separation is both costly and difficult to guarantee, as impediments to complete separation may reduce the effectiveness. For example, complete separation will depend on the willingness of each homeowner to approve work on private property to disconnect roof leaders and yard drains and/or install new sewer laterals. If complete separation is accompanied by the closure of overflows, SSOs may occur during very large storms, creating public health risks.

8.4.2.2 Local Public Inflow Removal

Local public inflow removal in the areas draining to the Shetucket Interceptor is costly for a moderate CSO benefit. Greeneville and Downtown both have combined areas that drain to the Shetucket Interceptor. While Laurel Hill and Eastside also have combined area draining to the Shetucket Interceptor, public inflow removal there is evaluated in other sections (Section 8.3.2 and Section 7.3, respectively). As described in Section 6.4.1, Greeneville and Downtown are high-density urban areas. Greeneville has residential and commercials properties while Downtown is largely commercial. Costs for separation in these areas is estimated to be higher than other areas of Norwich because of the high concentration of homes and businesses that would be impacted during construction. With public inflow removal, four CSOs are still active in the 1-month storm (Table 8-10). In the 2-year storm, CSO volume is reduced by 66 percent and peak flow is reduced 52 percent. Due to the higher costs and construction impacts and smaller percentage reduction of

CSO volume in these areas compared to other areas, it is not recommended that Greeneville or Downtown have contributing public inflow removed at this time. This recommendation can be reevaluated in the next LTCP update.

Table 8-10 CSO Statistics with Public Inflow Removal for the Area Draining to the Shetucket Interceptor as Compared to Future Baseline CSO Statistics

CSO Statistics	Design Storm	CSO 017	CSO 018	CSO 019	CSO 021	CSO 022	CSO 023	CSO 024	Total	Future Baseline	Reduction
CSO Peak Flow (mgd)	1-month	1.8	0.3	0.1	0.0	0.0	0.4	0.00	2.6	23	88%
	3-month	6.1	1.5	1.5	0.0	0.3	2.6	0.00	12.0	43	72%
	6-month	18.2	2.5	2.7	0.2	1.2	4.6	0.00	29.4	68	57%
	1-year	23.6	2.8	3.3	0.4	1.5	5.3	0.00	36.9	77	52%
	2-year	26.0	3.5	3.9	0.6	2.0	6.5	0.00	42.5	88	52%
	5-year	32.1	5.1	7.0	1.4	3.2	9.5	0.00	58.3	115	49%
CSO Volume (Mgal)	1-month	0.02	<0.01	<0.01	0.00	0.00	<0.01	0.00	0.02	0.48	95%
	3-month	0.13	0.01	0.01	0.00	0.00	0.02	0.00	0.18	1.1	84%
	6-month	0.41	0.03	0.03	0.00	0.01	0.05	0.00	0.53	2.1	75%
	1-year	0.66	0.03	0.03	0.00	0.01	0.07	0.00	0.82	3.2	74%
	2-year	1.21	0.06	0.06	0.00	0.02	0.13	0.00	1.47	4.4	66%
	5-year	1.41	0.08	0.09	0.01	0.03	0.17	0.00	1.80	4.9	63%

8.4.3 Conveyance

To increase conveyance of flows from the area draining to the Shetucket Interceptor to the WPCF, the capacity of Rose Alley PS must be upgraded. Modifications are needed upstream as well to convey flow to Rose Alley PS. Regulators 23, 22, 21, 19-1, 19-2, and 18 can be modified to raise the weirs and enlarge the dry weather flow pipes connecting to the Shetucket Interceptor to force all flow into the interceptor. For the 1-month and 3-month storms, these changes are sufficient to convey all flow to Rose Alley PS. Rose Alley PS would have to be upgraded to 26 mgd and 38 mgd to pass the incoming 1-month and 3-month flows, respectively.

In the 6-month design storm, conveying flow from all CSOs into the Shetucket Interceptor would overwhelm the capacity of the interceptor. Additional conveyance is needed to transport total flows to Rose Alley PS. The Shetucket Interceptor is already at capacity upstream of where regulator 23 discharges to it and would be overwhelmed by the addition of regulator 23 flows into the system. A relief pipe is proposed from regulator 23 down North Main Street and into the Shetucket Interceptor just before the storage tank at the Rose Alley commuter parking lot (Figure 8-10). This proposed relief pipe routing in North Main Street was selected due to the space limitations near the current interceptor. The Shetucket Interceptor is currently located in a tight window between the railroad tracks and the Shetucket River, with no room for construction of a parallel interceptor. Therefore, North Main Street was selected for an easier construction location, while staying close to the CSO regulators to be able to redirect excess flow from the overburdened Shetucket Interceptor.

Even after the removal of regulator 23 flow from the interceptor, capacity becomes an issue again where flows from regulators 18 and 19 enter the interceptor. The dry weather connector pipe

carrying the combined flow from regulators 18 and 19 can be disconnected from the Shetucket Interceptor and a new pipe can be constructed to convey this flow to the relief pipe. The relief pipe will also accept flow downstream from Park Street before reaching Rose Alley PS. The upper section of the relief pipe has a 30-inch pipe at a 0.5 percent slope to get down the hill from regulator 23 to the low point near CSO 019. Topography slopes upward again moving towards the storage tank, so the relief pipe flattens out to a 0.1 percent slope to minimize the depth of the pipe. Due to the smaller slope and the additional flows from regulators 18 and 19 and from Park Street, the relief pipe diameter increases to 48 inches in the lower section to maintain adequate capacity. Rose Alley PS would need a capacity of 61 mgd to pass the 6-month storm.

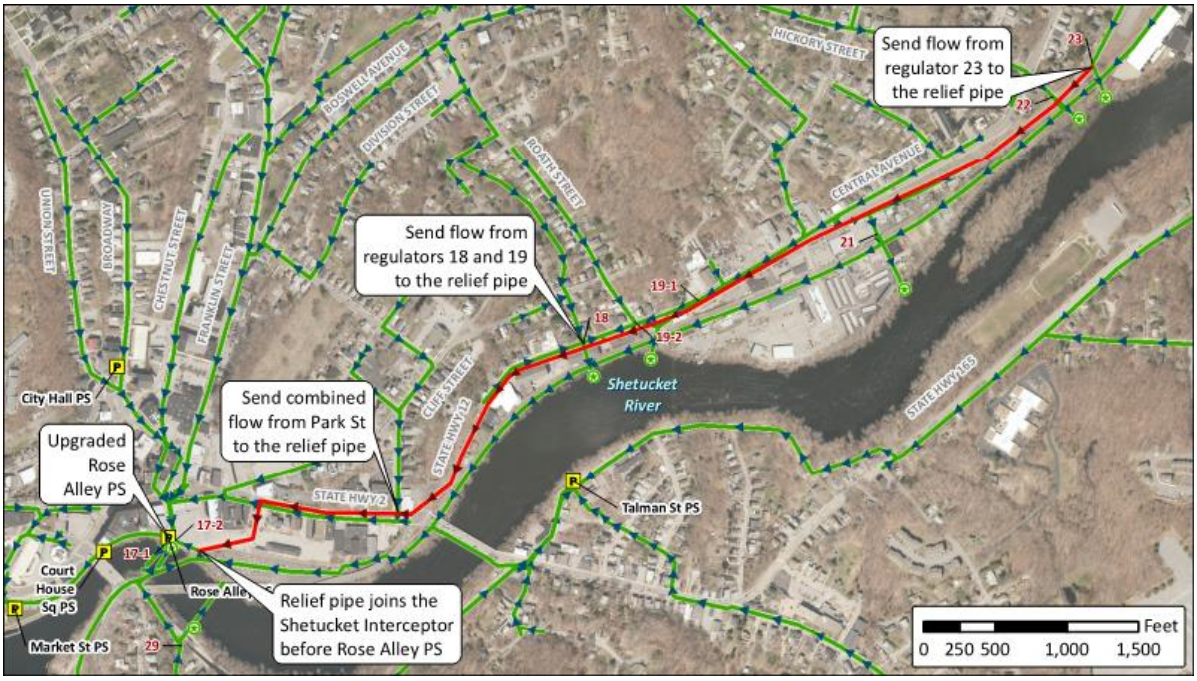


Figure 8-10
Configuration of 6-Month Conveyance Alternative Along the Shetucket

In the 1-year storm, flows coming to Rose Alley PS exceed 87 mgd. The capacity of possible WPCF expansion is limited to 80 mgd due to available space at Hollyhock Island, so for the 1-year through 5-year design storms, the capacity of the WPCF becomes a limiting factor. For the development of conveyance alternatives for the Shetucket Interceptor area only, it is assumed that Rose Alley PS can send 65 mgd to the WPCF to maintain capacity for other areas of the system (separated and combined). Excess flows from the Shetucket Interceptor must be held back in storage. Excess flows in the 1-year storm can be held back by a 0.35 Mgal storage tank in the Rose Alley commuter lot. This storage tank would be constructed with modular box culverts (likely 12' wide by 13' deep by 6' long sections) to accommodate the most simplistic construction approach. The 1-year storm tank would require approximately 52 box culvert sections. These would be configured in series, so that when one row of culverts filled, it would spill over a weir connection and fill the next row of box culverts. The rows of box culvert sections would be sloped slightly, and a pump chamber to dewater the tank would be located on the downstream end. A tank of this size could be constructed adjacent to where the interceptor runs through the lot. A sluice gate operated by RTC can send high flows to the storage tank while a dewatering pump, also operated by RTC, pumps flows back into the interceptor as downstream capacity becomes available.

To control the 2-year storm, the configuration stays the same as in the 1-year storm except the storage tanks and relief pipes are larger to accommodate increased flows (Figure 8-11). In the 5-year storm, the storage tank required at the Rose Alley commuter lot is too large to be constructed adjacent to the Shetucket Interceptor and the interceptor must be re-routed to accommodate the larger storage tank (Figure 8-12). This would involve moving the conduit for dry weather interceptor flow closer to the railroad tracks to the north. It would likely be recommended that this conduit be made of box culvert sections to maximize inline storage, and excess flow would be directed into the storage tank. Relocating in the interceptor would likely require bypass pumping of the interceptor during construction.

In all conveyance alternatives, it is expected that relief pipes and storage tanks would be constructed later in the project timelines, so that future flow monitoring and model re-calibration can guide the selection and final sizing of these later infrastructure improvements. The main components of the conveyance alternatives for each level of control along the Shetucket Interceptor, assuming the WPCF may accept 80 mgd, are summarized in Table 8-11.

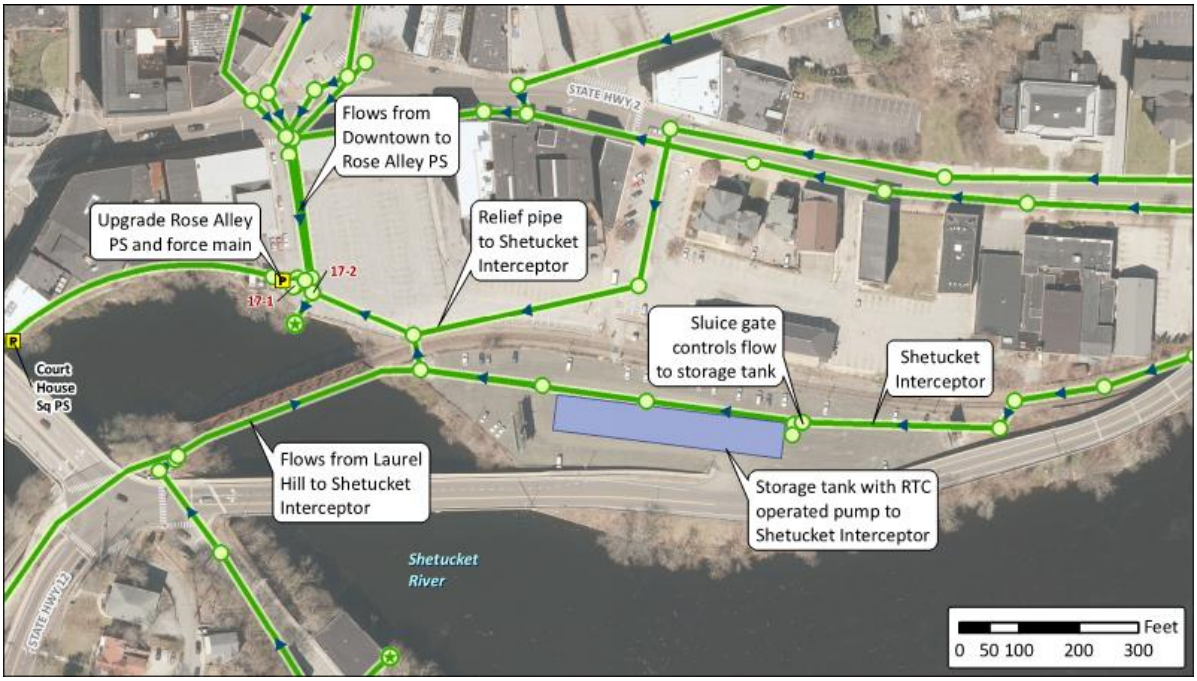


Figure 8-11
Configuration near Rose Alley PS and Proposed Commuter Lot Storage Tank in 1-Year to 2-Year Conveyance Alternatives

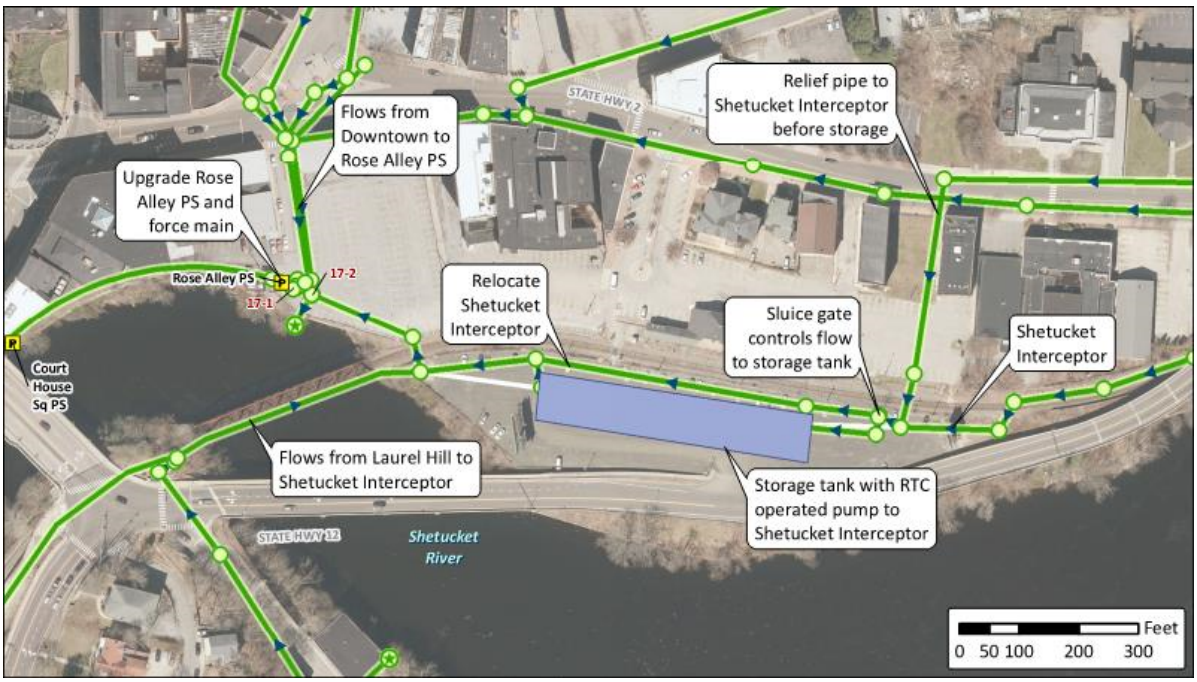


Figure 8-12
Configuration Near Rose Alley PS and Proposed Commuter Lot Storage Tank in 5-Year Conveyance Alternative

Table 8-11 Size of Main Components of the Shetucket Maximum Conveyance Alternatives

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Rose Alley Lot Storage (Mgal)	NA	NA	NA	0.35	0.9	2
Rose Alley Lot Storage Dewatering Pump (mgd)	NA	NA	NA	0.35	2	4
Re-Route Shetucket to Accommodate Storage Tank	No	No	NA	No	No	Yes
Shetucket Interceptor Relief Pipe (diameter, inches)	NA	NA	30 to 48	30 to 48	36 to 48	42 to 60
Relief Culvert North of Rose Alley PS	NA	NA	NA	NA	NA	NA
Rose Alley PS (mgd)	26	38	61	65	65	65
Rose Alley FM (diameter, inches)	30	36	42	42	42	42
WPCF Capacity (mgd)	35	49	80	80	80	80

8.4.4 Storage

To store flows in the areas draining to the Shetucket Interceptor until peak flows pass Rose Alley PS and the WPCF, up to two storage tanks are required. The storage alternatives assume the WPCF maintains its existing 20 mgd capacity and Rose Alley PS maintain its 11.5 mgd capacity. Opportunities to utilize existing storage capacity in the system are targeted before new storage facilities are proposed.

1-Month Storage Alternative on the Shetucket

In the 1-month design storm, there is remaining capacity in the Shetucket Interceptor that is not being utilized even with the addition of all flow from regulators 24 and 25. To utilize that available capacity, regulators 23, 22, 21, 19-1, 19-2, and 18 can be modified to raise the weirs and enlarge the dry weather flow pipes connecting to the Shetucket Interceptor to force all the flow into the interceptor. With these modifications, 18 mgd reaches Rose Alley PS from the Shetucket Interceptor. Rose Alley PS also receives 4 mgd from Laurel Hill and 8 mgd directly from the portion of Downtown that doesn't flow to the interceptor. Figure 8-13 shows incoming flows to Rose Alley PS. With an existing capacity of 11.5 mgd, the PS cannot handle the full 30 mgd reaching it. Regardless of how much capacity is available at the WPCF, storage is needed upstream to prevent the backups at the PS that cause CSO at 017.

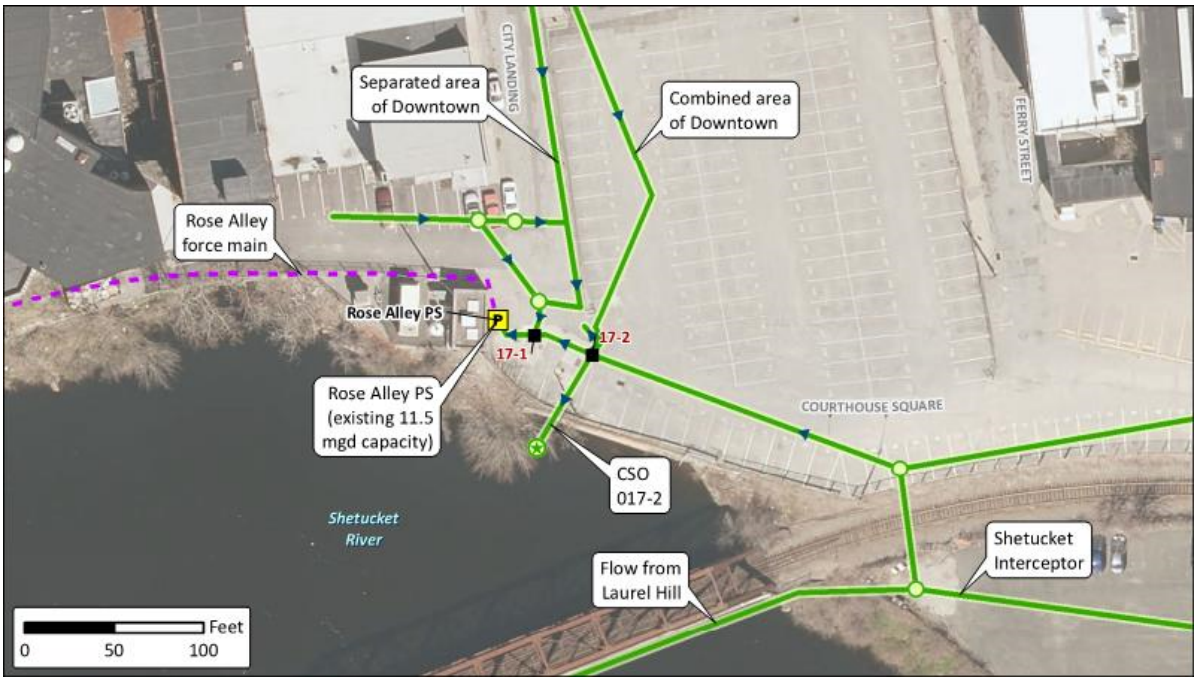


Figure 8-13
Configuration of Incoming and Outgoing Pipes at Rose Alley PS

Flows from the Shetucket Interceptor in the 1-month storm can be held back from the PS with a 1 Mgal storage tank at the Rose Alley commuter lot. The storage tank can be constructed adjacent to where the Shetucket Interceptor passes through the parking lot. This storage tank would be constructed with modular box culverts (likely 12' wide by 13' deep by 6' long sections) to accommodate the most simplistic construction approach. These culvert rows would also fill in series and be sloped towards a dewatering pump chamber. This 1-month storm tank would require approximately 146 box culvert sections. It is expected that this tank could be built without relocation of the existing Shetucket Interceptor. A 30-inch pipe would connect the interceptor to the storage tank. The storage tank would operate off-line by installing a sluice gate in the interceptor. Operated by RTC, the sluice gate would remain open to allow low flows to pass by the storage tank to the Rose Alley PS and would close during high flows to force all flow into the storage tank. Once peak flows pass the PS and WPCF, a 2 mgd dewatering pump would empty the tank via a 10-inch pipe connected to the Shetucket Interceptor. The dewatering pump would also be operated by RTC to adjust the pumping rate based on downstream capacity at the PS and WPCF.

3-Month Storage Alternative on the Shetucket

In the 3-month design storm, the Shetucket Interceptor still has sufficient capacity to convey all flows from regulators 23 to 18. However, the northern section of the interceptor has more capacity than the southern, flatter section of the interceptor. To utilize the capacity upstream and reserve downstream capacity, a modulating sluice gate can be installed in the interceptor just upstream of CSO 023. The pipes upstream of CSO 023 have available capacity and are deep. Surcharge caused by holding back flow is not expected to cause local flooding (Figure 8-14).

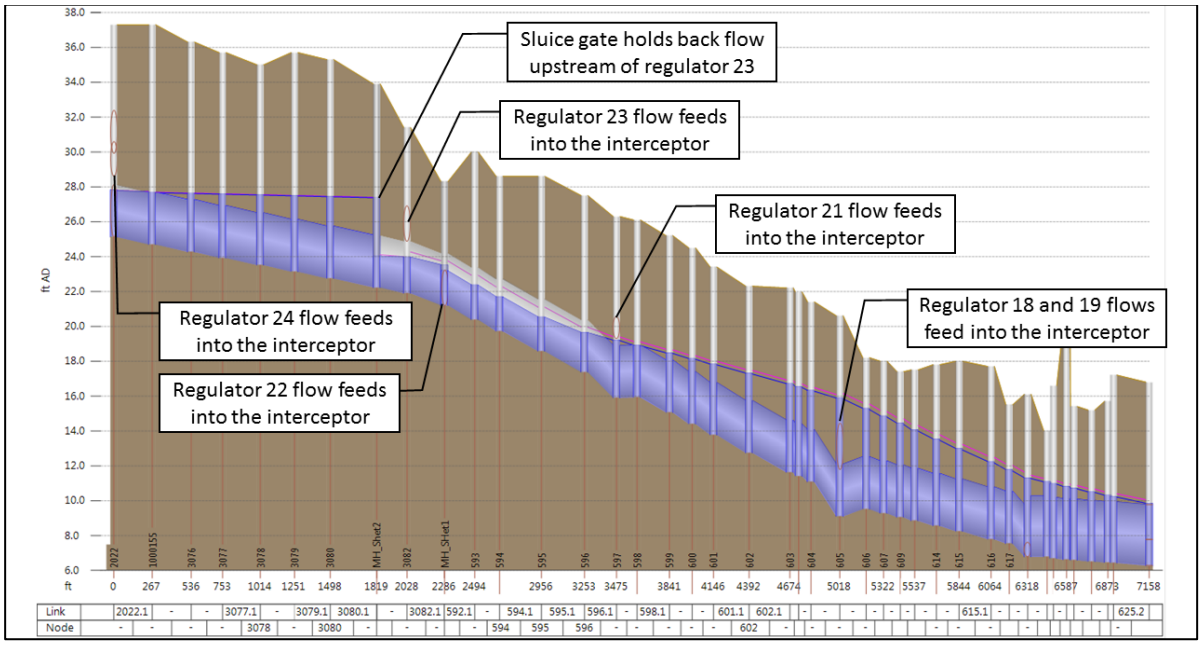


Figure 8-14
Profile of the Shetucket Interceptor in the 3-Month Storage Alternative

With higher flows coming to Rose Alley PS, more storage capacity is needed at the Rose Alley commuter lot than in the 1-month storm. A 1.45 Mgal storage tank with a 2 mgd dewatering pump is sufficient to capture and store excess flows. This storage tank would also be constructed with modular box culverts (likely 12' wide by 13' deep by 6' long sections) to accommodate the most simplistic construction approach. This storage tank would require approximately 210 box culvert sections. As with the other tank set ups, the storage culverts would fill in series, and drain to a dewatering pump after the passage of a storm event. In the 3-month storm, peak flow coming from Downtown exceeds 13 mgd and peak flow from Laurel Hill exceeds 5 mgd. Even with all flow from the Shetucket Interceptor conveyed into storage, Rose Alley PS still does not have capacity to pass incoming flows without causing overflow at regulator 17-1. Of the 13 mgd flow from Downtown, 10 mgd comes to Rose Alley PS via a large culvert that serves the Downtown combined area. It is necessary to connect a relief pipe from this culvert to the Rose Alley commuter lot storage tank to intercept some of this flow before it gets to the PS. A new weir would be constructed on the combined culvert, which would redirect flow into this relief pipe. The relief pipe would intercept the culvert at Rose Alley and would convey flow back to the storage tank by crossing under at least one other gravity sewer line and the existing railroad tracks via pipe jacking. Construction of a relief pipe in this area is expected to be difficult due to utility and railroad crossing; however, it is needed to control overflow at CSO 017-1 and 017-2. This relief pipe for the combined culvert will be necessary (with varying diameters) for the 3-month through 5-year storage alternatives.

6-Month Storage Alternative on the Shetucket

As with the conveyance alternative, conveying flow from all CSOs into the Shetucket Interceptor in the 6-month design storm would overwhelm the interceptor's capacity. Additional conveyance is needed to transport total flow to the storage tank. A relief pipe is proposed from CSO 023 down

North Main Street and into the Shetucket Interceptor just before the storage tank at the Rose Alley commuter lot, following the route described in the conveyance section (Figure 8-15). Even after the removal of regulator 23 flow from the interceptor, capacity becomes an issue again where flows from regulators 18 and 19 enter the interceptor. The dry weather connector pipe carrying the combined flow from regulators 18 and 19 can be replaced by two pipes; one pipe will connect regulator 18/19 to the relief pipe, then a second pipe with a raised invert will connect the relief pipe to the Shetucket Interceptor (Figure 8-16). With this configuration, the relief pipe accepts 60 percent of the 18/19 flow and the remaining 40 percent flows to the Shetucket Interceptor, relieving the surcharge on the interceptor. The relief pipe will also accept flow from Park Street. By connecting the Park Street flows into the relief pipe, flow that is conveyed directly to Rose Alley PS under existing conditions instead is conveyed upstream of the storage tank where it may be stored during high flows. The relief pipe starts at a 30-inch diameter in the upper section of the pipe and increases to 42 inches in the lower, flatter section (Figure 8-17). The relief pipe lowers the surcharge in the Shetucket Interceptor to acceptable levels (Figure 8-18).

Figure 8-15
Route of the Relief Pipe in the 6-Month Storage Alternative (Highlighted in Red)

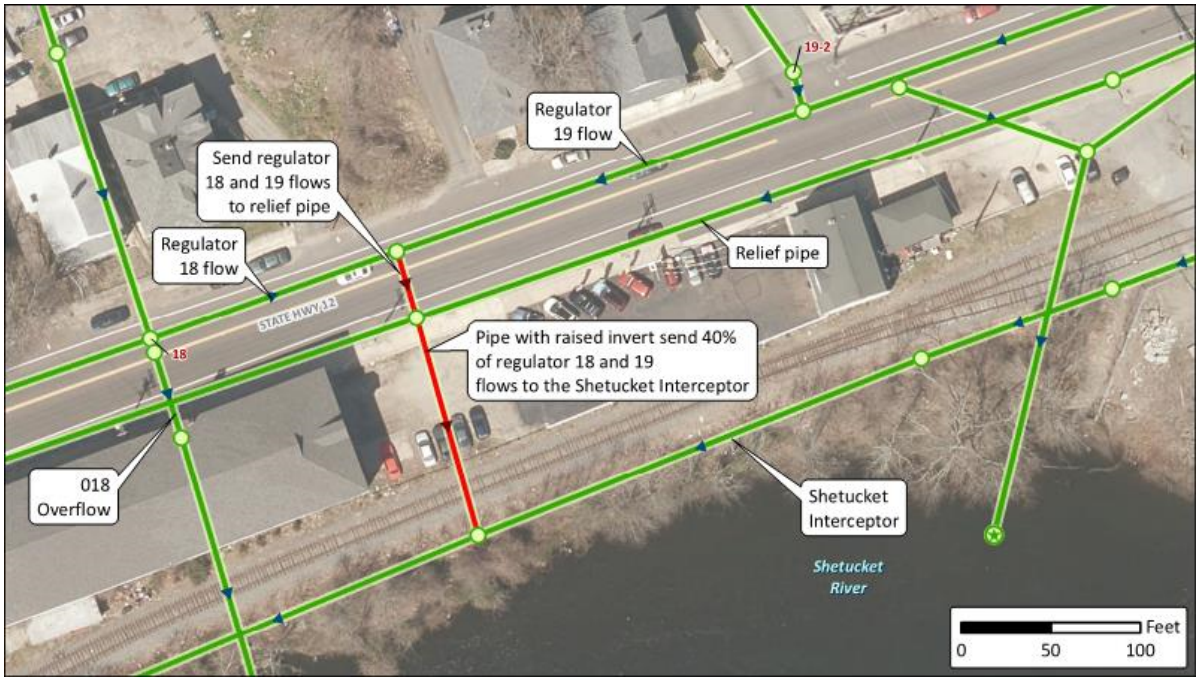


Figure 8-16
Configuration Near 018/019 to Convey 60 percent of Flow to the Relief Pipe and 40 percent to the Shetucket Interceptor

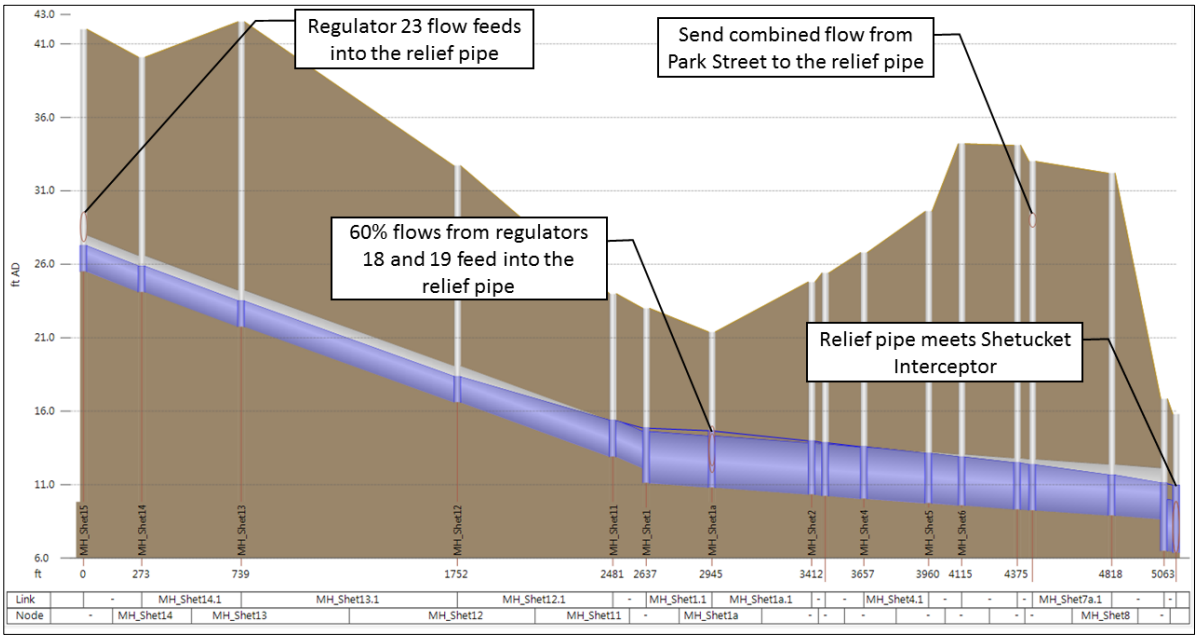


Figure 8-17
Profile of the Relief Pipe in the 6-Month Storage Alternative

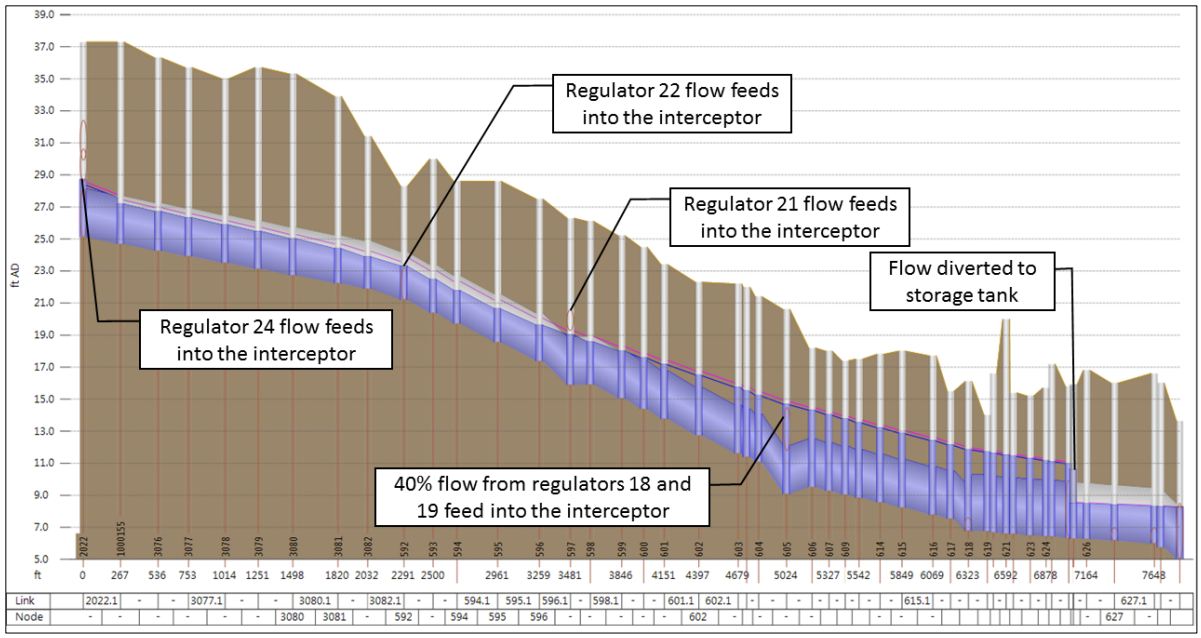


Figure 8-18
Profile of the Shetucket Interceptor in the 6-Month Storage Alternative

To manage CSO on the Shetucket to a 6-month level of control, the maximum available storage at the Rose Alley commuter parking lot is utilized. A 3 Mgal tank with a 4 mgd pump is proposed at this location. This tank would be built using numerous box culverts for ease of construction. It would require approximately 435 box culvert sections (assuming a 12' wide by 13' deep by 6' long size). Like the other storage tanks, the tank would fill in series when each row of culvert sections spills into the next. The tank floor would be sloped towards a dewatering pump. To accommodate the larger storage tank, the Shetucket Interceptor must be relocated through the parking lot. This would be done using an inline box culvert conduit directly adjacent to the northern railroad tracks to convey the Shetucket Interceptor flows. As in the smaller design storms, the sluice gate directing flow to the storage tank and the dewatering pump operate on RTC based on capacity at Rose Alley PS and WPCF.

1-Year Storage Alternative on the Shetucket

With capacity at the Rose Alley commuter lot maxed out in the 6-month storm, storage upstream on the Shetucket at the NPU facilities yard becomes necessary to manage CSO to a 1-year level of control. A 1.3 Mgal storage tank at the NPU yard functions in the same way as the tank in the commuter lot, with a sluice gate sending high flows to the off-line storage tank and a dewatering pump emptying the tank as capacity downstream becomes available (Figure 8-19). Flow would be intercepted from the Shetucket Interceptor on South Golden Street and redirected into the NPU Headquarters parking lot. The storage tank would be located beneath the parking lot and would then pump out the storage tank following a storm event. This storage tank would require approximately 205 box culvert sections for storage (assuming a 12' deep by 12' wide, by 6' long box culvert section). The culvert rows would fill in series and drain to a dewatering PS. The upper Shetucket Interceptor still does not have enough capacity to accept flows from regulator 23, so the relief pipe from regulator 23 to the storage tank at the commuter lot is required and will

follow the same route as shown in Figure 8-15. The storage tank at the NPU parking lot would discharge into the relief pipe in North Main Street.

Because the NPU storage tank removes additional flow from the Shetucket Interceptor during the peak of the storm, there is capacity in the interceptor to accept all 18/19 flows and not send any of this flow to the relief pipe. The size of the lower portion of the relief pipe can be reduced from the 42-inch required in the 6-month storm to 36-inch for the 1-year storm. With a portion of the Shetucket Interceptor flow being held upstream in the NPU storage tank, a 2.3 Mgal storage tank at the Rose Alley commuter lot is sufficient to manage CSO. This orientation at the Rose Alley commuter lot would require approximately 334 box culvert sections (assuming a 13' deep by 12' wide by 6' long box culvert section). It would also require the relocation of the Shetucket Interceptor north against the railroad tracks for additional storage capacity as discussed under the previous alternatives. This tank would fill in series and drain via a dewatering PS on the downstream end.

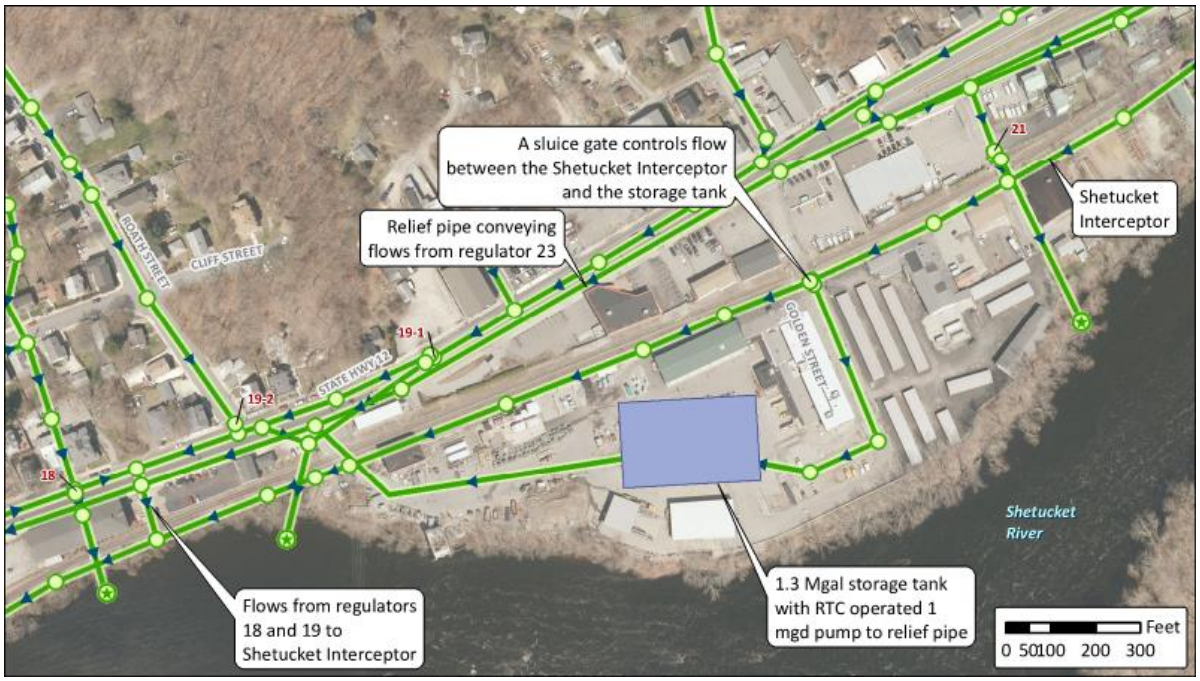


Figure 8-19
Configuration of NPU Yard Storage Tank in the 1-Year Storage Alternative

2-Year Storage Alternative on the Shetucket

The 2-year storage alternative has the same configuration as the 1-year storage alternative, only with larger conveyance and storage components. To achieve the 2-year level of control, the maximum available storage capacity at the two Shetucket storage locations is utilized, with 3 Mgal stored at the Rose Alley commuter lot and 2.24 Mgal stored at the NPU yard. The storage tank at the Rose Alley commuter lot has a 4 mgd dewatering pump and the storage tank at the NPU yard has a 1 mgd dewatering pump. The configuration at the Rose Alley commuter parking lot would require approximately 435 box culvert sections (assuming a 13' deep by 12' wide by 6' long box culvert section). These would be configured in series, so that when one row of culverts

filled, it would spill and fill the next row of box culverts. The floor of the tank would be sloped slightly towards the western side of the tank where it would be dewatered following a storm event.

The relief pipe conveys flow from regulator 23 and Park Street to the storage tank (same route as shown in Figure 8-15). To provide sufficient capacity for these flows, the upper stretch of the relief pipe is 30-inch and the lower stretch is 42-inch. A sluice gate upstream of the NPU yard sends wet weather flows from the upper Shetucket Interceptor (minus flows from regulator 23) to the NPU storage tank. The NPU headquarters storage tank would be 2.24 Mgal under this alternative, which would require approximately 352 box culvert sections (assuming a 12' deep by 12' wide by 6' long box culvert section). This tank would be configured in series, as with the other storage tanks, with a dewatering PS on the downstream side.

With the relief pipe and upstream storage redirecting and detaining flows, the Shetucket Interceptor has capacity to accept the full regulator 18/19 flows. The relief pipe from the combined culvert north of Rose Alley PS conveys 10 mgd of the 13 mgd from the combined area of Downtown away from Rose Alley PS and to the commuter lot storage tank as described under previous alternatives.

5-Year Storage Alternative on the Shetucket

In the 5-year storm, the Shetucket Interceptor is overwhelmed by the addition of flows from regulators 24 and 25. To relieve this upper stretch of the Shetucket Interceptor, the relief pipe is extended further upstream to capture flows from regulator 24 (relief pipe is highlighted in red in Figure 8-20). Flows from regulator 23 exceed 40 mgd in the 5-year storm and cannot be conveyed by the Shetucket Interceptor (even if there were no other flows). Regulator 23 flows are instead directed to the relief pipe. Flow from regulators 025, 022, and 021 remain in the interceptor, and is conveyed to the NPU storage yard tank by the RTC operated sluice gate in the interceptor. Even when all wet weather flows from the 5-year storm are conveyed to the storage tank, the tank only fills to 1.6 Mgal. This is because storage in the NPU tank is limited by how much flow can be conveyed in the interceptor to enter the tank. The 5-year design storm selected for this analysis consists of one intense peak (Figure 8-21), whereas the 2-year design storm had a large peak followed by multiple smaller increases in intensity (Figure 8-22); it is these later increases in intensity that allowed the NPU storage tank to fill to capacity in the 2-year storm.

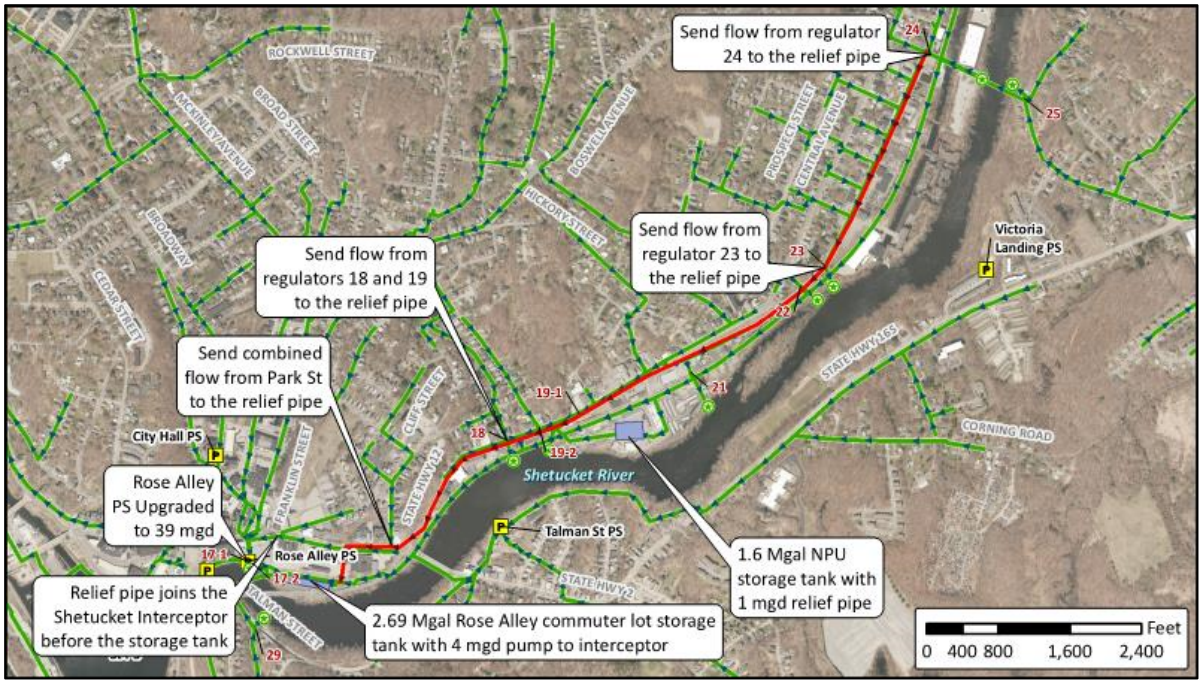


Figure 8-20
Shetucket Configuration in the 5-year Storage Alternative

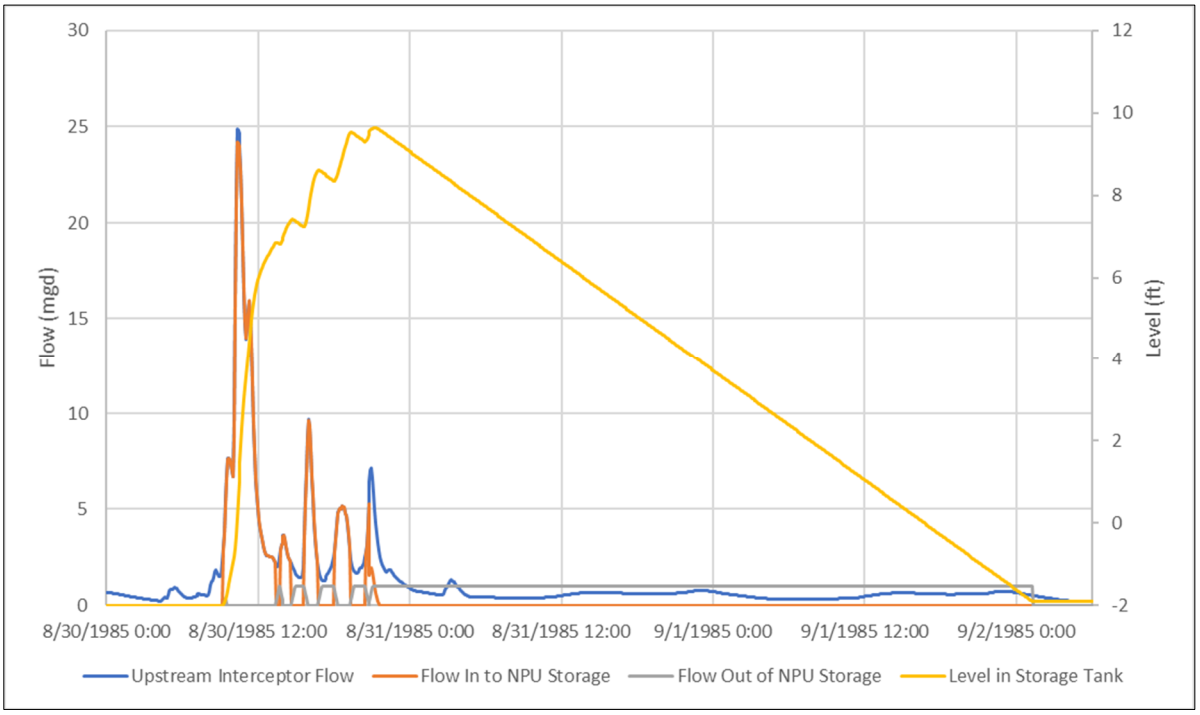


Figure 8-21
Flows in and out of the NPU Yard Storage Tank and Levels in the Storage Tank in the 2-Year Design Storm

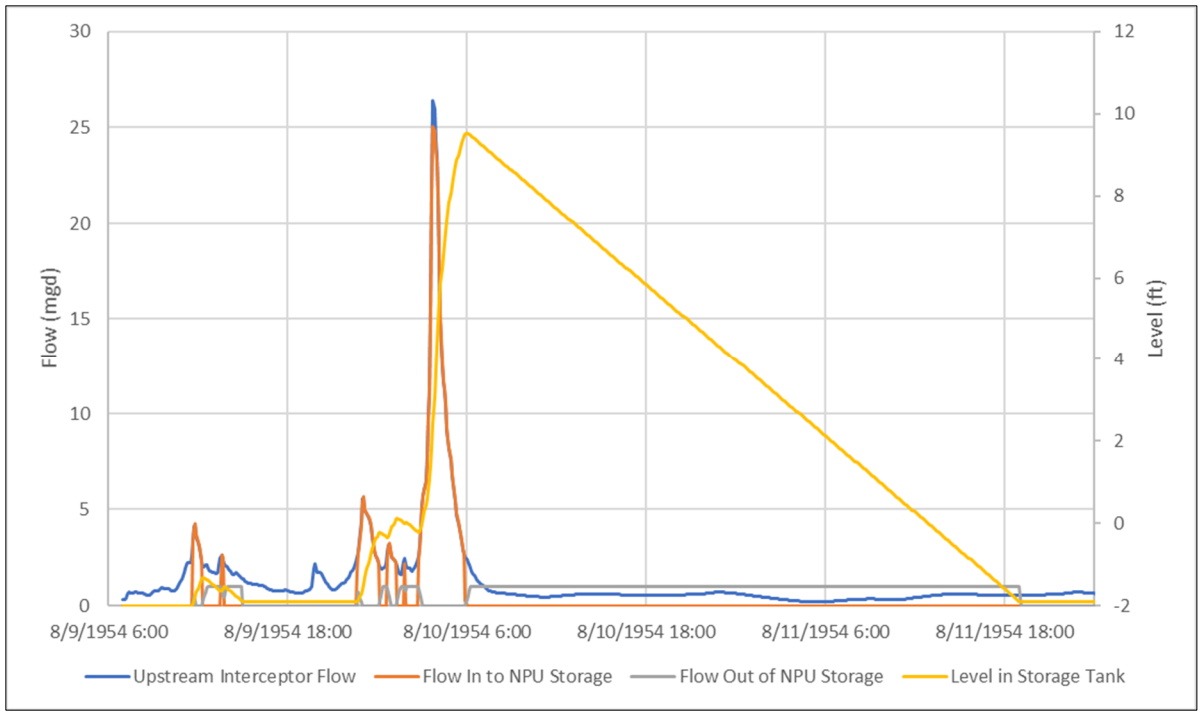


Figure 8-22
Flows in and out of the NPU Yard Storage Tank and Levels in the Storage Tank in the 5-Year Design Storm

The drainage areas to regulators 18/19 generate a peak flow of 37 mgd in the 5-year storm, which is too high to all be conveyed into the Shetucket Interceptor. This alternative proposes splitting this flow between the relief pipe and the Shetucket Interceptor, with 10 mgd being allotted to the interceptor. Where the Shetucket Interceptor and relief interceptor merge upstream of the commuter lot storage tank, peak flows reach 70 mgd. There is not enough slope from this point to the storage tank to force all this flow into storage, so 15 mgd of this peak flow must bypass the storage tank and flow to Rose Alley PS. The PS also receives 5 mgd from Laurel Hill, 10 mgd from the separated portion of Downtown, and 7 mgd from the combined portion of Downtown (10 mgd is conveyed via the culvert relief pipe to storage). With the addition of the 15 mgd from the Shetucket Interceptor, the PS is overwhelmed. To manage CSO at Rose Alley to the 5-year level of control, Rose Alley PS must be upgraded to convey 39 mgd to the WPCF. Consequently, the WPCF must be upgraded to accommodate 50 mgd total wet weather flow. This includes the 20 mgd WPCF upgrade recommended in Section 3, and an additional 30 mgd of wet weather treatment that would be provided by a high rate clarification (HRC) facility at Holly Hock Island. Figure 8-20 summarizes the configuration of the 5-year storage alternative along the Shetucket.

The main components of the storage alternatives on the Shetucket Interceptor are summarized in Table 8-12.

Table 8-12: Size of Main Components of the Shetucket Storage Alternative

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Rose Alley Lot Storage (Mgal)	1	1.45	3	2.3	3	2.69
Rose Alley Lot Storage Pump (mgd)	2	2	4	4	4	4
Re-Route Shetucket to Accommodate Storage Tank	No	No	Yes	Yes	Yes	Yes
NPU Storage (Mgal)	NA	NA	NA	1.31	2.24	1.62
NPU Storage Pump (mgd)	NA	NA	NA	1	1	1
Shetucket Relief Pipe (diameter, inches)	NA	NA	30 to 40 (5,100 ft)	30 to 36 (5,100 ft)	30 to 42 (5,100 ft)	30 to 60 (7,100 ft)
Relief Culvert North of Rose Alley PS (diameter, inches)	NA	24	24	30	30 to 36	36
Rose Alley PS (mgd)	As-is	As-is	As-is	As-is	As-is	39
Rose Alley FM (diameter, inches)	As-is	As-is	As-is	As-is	As-is	42
WPCF Capacity (mgd)	20	20	20	20	20	50

8.5 WPCF

To address the alternatives described in the preceding sections for Thamesville, Laurel Hill, and Shetucket, upgrades are needed to the WPCF. The current conditions at the plant including its limitations and a description of the 2015 WPCF Upgrade Design are included in Section 3. The WPCF is older than its intended design life and still aging. Improvements to the WPCF are necessary to ensure successful operation while addressing CSO. This section presents a revised design intent and recommended upgrades to the WPCF.

8.5.1 Revised Design Intent

The 2012 LTCP recommendation to increase peak WPCF capacity to 33 mgd was a focus of the 2015 design. This LTCP explores additional options which may provide a cost benefit over conveyance and treatment. Regardless of the alternatives considered, CDM Smith recommends a base increase in plant peak capacity to 20 mgd (not 33 mgd), reliably matching the existing peak flows that are already realized (but which are problematic) at the WPCF. This 20 mgd capacity will ensure successful operation of the treatment plant while any CSO controls are implemented. Expansions beyond the 20 mgd base increase in plant peak capacity are discussed later in the alternatives analysis.

This revised 20 mgd design has some impacts on the 2015 design:

- Depending on what biological process is finally selected for the upgrade, one less secondary clarifier may be needed.

- A smaller headworks could be constructed with narrower screen channels and smaller diameter grit basins. These will have a smaller overall footprint, requiring less concrete overall and fewer piles for the foundation.
- Reduced influent and effluent pumping station capacity.
- Reduced UV disinfection system capacity.
- The IFAS recommendation should be revisited to determine if another technology would be favored given the reduced plant capacity and the time that has passed since the 2011 technology preselection.
- Reduced sizes of liquid train yard piping.
- Fewer secondary tanks, a smaller headworks, smaller influent and effluent pumping stations, and less excavation would result in relocation of less material to the landfill on the island. Landfill design would need to be modified to account for the reduced size.
- The hydraulic profile of the plant would need to be revisited for the revised flow rate and changes in process. This could result in the elimination of the need for an effluent or influent pumping station.
- Other changes may result from changes in building codes since the time of design.

Additionally, all future designs must consider new flood protection and resiliency requirements which were not in effect during preparation of the in the 2015 design. Flood protection regulations and WPCF components which may require modification are presented in Section 3.

To properly plan for the revised peak capacity and flood control issues, CDM Smith recommends a WPCF Facility Plan update or other senior technical review to fully address needed changes from the 2015 WPCF Upgrade Design. The Facility Plan update would integrate the selected CSO approach to ensure the WPCF and collection system are upgraded and operated properly.

This LTCP provides an overview and costs for potential WPCF improvements needed to meet CSO goals of the collection system but defers specific details to a future WPCF Facility Plan update.

8.5.2 WPCF Base Improvements

Regardless of the alternative selected, CDM Smith recommends a base upgrade of the WPCF to 20 mgd. This upgrade will likely be comprised of some components from the 33 mgd WPCF Upgrade Design from 2015. A WPCF Facility Plan update should establish sequencing guidelines to aid transitions between projects. In total there are eight major components anticipated to increase the capacity of the plant and upgrade aging equipment which needs replacement. **It would be ideal to construct all of these as part of a single overall WPCF upgrade**. If needed, these components could be taken as individual projects, though we note there any economy of scale in design, or construction would be lost. If the projects are constructed over time, inflation would also play a role in the cost of projects.

8.5.2.1 WPCF Component / Project 1: New Secondary Tanks, Landfill Modifications, Main Electrical System Upgrades, and New Headworks

The first project will include upgrades to major components of the plant which will increase headworks and secondary treatment capacity and replace aging electrical system equipment allowing for easier electrical connections on future projects.

Upgrade of the Headworks is desired as the mechanical bar screen installed cannot pass current peak flows. At flows higher than 10 mgd, the screen floods, putting strain on downstream processes. A new headworks would be constructed in the location of the existing smaller secondary clarifiers. The headworks would include new mechanical bar screens to remove large debris and rags, fine screens to remove smaller debris as required by the IFAS biological treatment process, and grit removal by vortex grit units. Screening and grit washers would also be included in the headworks building. Screens would be provided for all flow ranges up to peak capacity with a standby screen offline for redundancy. This new headworks would provide a much-improved preliminary treatment system and provide proper protection for downstream processes.

If needed, as determined by a Facility Plan update, an influent pumping station would also be constructed after the headworks to account for additional headloss from new processes and provide proper head conditions for the remainder of the plant.

At least two new secondary tanks will be needed to replace the tanks removed to provide space for the new headworks. The 2015 design called for three new 85-foot diameter clarifiers. These tanks will be constructed northeast of the existing plant limits, along with a new sludge pumping station to convey RAS and WAS. One tank could be constructed adjacent to the existing 85-foot secondary clarifier, but this is the most challenging location to build a single tank due to yard piping constraints in the vicinity. Construction of these secondary tanks will provide sufficient secondary clarification for 20 mgd of flow.

Excavation for two new secondary clarifiers will yield excavated material that is planned to remain on site to reduce hauling and disposal costs. This will require constructing the proposed landfill closure on the north end of the island to accommodate these soils. The landfill may need to remain open for future projects, so this component may need to be separated from the other components in this project.

8.5.2.2 WPCF Component / Project 2: New Administration and Laboratory Building

The second project includes replacement of the administration building as designed in 2015. The building will be demolished to its foundation and a new one-story building will be built in its place on the existing foundation. This building will house the main WPCF SCADA control center, the electrical distribution gear for the new UV disinfection equipment and effluent pumping station, and the wastewater testing laboratory. The ability to adequately disinfect peak flows and effectively push treated effluent out of the plant against a flooded river are deemed critical to wet weather operations and CSO reduction in the collection system.

8.5.2.3 WPCF Component / Project 3: Ultraviolet Disinfection and Effluent Pumping Station

The next recommended project includes upgrading the disinfection and constructing an effluent pumping station after disinfection. Disinfection is currently accomplished with sodium hypochlorite dosed upstream of two serpentine channels to provide plug flow conditions for adequate contact time. The recommended Facility Plan should evaluate whether this treatment is viable at the increased plant capacity of 20 mgd. If chemical disinfection is not viable with the existing tanks, then UV disinfection will be retrofit into the existing structure as designed in 2015. The UV system is advantageous over chemical disinfection as it requires a smaller footprint and chemical purchase, storage, and pumping is not needed. This results in a cheaper life cycle cost even when considering capital and electricity costs.

Depending on a final hydraulic profile developed as part of a recommended facility plan, an effluent pumping station may be required as a part of this project. Under lower flows and low river stages, the plant can discharge to the Thames River by gravity. At higher river stages the plant may be able to discharge to the Yantic River by gravity, but this may restrict the plant hydraulically and an effluent pumping station may be required. If effluent pumping is required, a station will be included in this project like the one designed in 2015. The station should be capable of delivering the entire plant capacity at high river stage, while also allowing the plant to discharge by gravity when pumping is not needed.

8.5.2.4 WPCF Component / Project 4: Secondary Digester Upgrade and Secondary Clarifier Retrofit

Secondary digesters B and C are currently used for digested sludge storage, but their covers and mixing systems are over 40 years old and have far exceeded their useful life. This project will replace the covers and mixing systems as designed in 2015. The biosolids disposal market has been changing in Connecticut since the 2010 when the prior design was started. As such, NPU has expressed an interest in evaluating their disposal options and may opt to demolish or abandon the digesters if it provides an economic advantage vs. the capital cost for their upgrade. More work is needed in this area as part of a Facility Plan update.

This project also includes a retrofit to the 85-foot secondary clarifier mechanism. The existing mechanism is over 40 years old and has also far exceeded its useful life. This retrofit would complete the secondary clarifier upgrades to provide a minimum of three working clarifiers. The walls of this clarifier are only slightly above the 100-year flood elevation, and they may need to be raised as part of an upgrade. Conversely, NPU could have a “Flood Operations Plan” that included automatic (or remote) isolation of this clarifier so that it would not pose a risk to the facility or quality of treatment during a flood. When flood waters receded, the tank could be cleaned and put back into service.

8.5.2.5 WPCF Component / Project 5: Sludge Pumping and Piping and Gravity Thickener Upgrades

The sludge handling building houses primary sludge, thickened primary sludge, return activated sludge, waste activated sludge, and thickened waste activated sludge pumps. Most of these pumps are over 40 years old and have exceeded their useful life. This project will replace some of these

pumps and suction and discharge piping to provide better reliability of plant operations. This project will also replace the gravity thickener mechanism and cover for improved longevity.

8.5.2.6 WPCF Component / Project 6: Primary, Aeration, and Chemical Addition Upgrades

This project will consist of three main components: upgrades to the primary mechanisms, aeration tanks, and chemical addition systems.

The primary traveling bridge mechanisms need replacement after more than 40 years of operation. These will be replaced with new chain and rake mechanisms in the existing tanks. Additional tanks will not be required for the increased design flows.

The aeration tanks may be insufficient for conventional activate sludge treatment at higher design flows. This should be evaluated in an updated Facility Plan. If the existing tanks cannot be operated through a conventional process, then IFAS, as designed in 2015, or another process may be used to increase the capacity of the tanks and eliminate the need for additional tanks. This project component will upgrade the existing aeration tanks as needed to meet the increased design flows.

Depending on the secondary treatment process selected by the Facility Plan, upgrades to chemical addition will be necessary to supplement the process. These may include carbon and soda ash as designed in 2015 or other chemical systems. For example, NPU has been using Magnesium Hydroxide for alkalinity and pH control with good success and will likely want to design a permanent storage and feed system for this chemical in lieu of the soda ash system included in the 2015 design.

8.5.2.7 WPCF Component / Project 7: Sludge Pumping and Piping

The sludge handling building houses primary sludge, thickened primary sludge, return activated sludge, waste activated sludge, and thickened waste activated sludge pumps. Most of these pumps are over 40 years old and have far exceeded their useful life. This project will replace the remaining pumps and suction and discharge piping which were not replaced under the first sludge pumping and piping project listed in Section 3.5.2.5.

8.5.2.8 WPCF Component / Project 8: Odor Control and Final Sitework Improvements

The final recommended project comprises an odor control system and final sitework improvements.

The WPCF does not currently have a functional odor control system. While odors are mild at the site, the plant is located close to commercial and residential areas of Norwich. NPU desires an odor control system for the upgraded plant. The 2015 design intended construction of a biofilter with piping to the headworks, influent pumping station, sludge handling building, gravity thickener, and influent channel to the primary settling tanks. Covers would also be installed over relevant tanks to provide a comprehensive odor control system. It could also be explored to cover some systems and use smaller localized treatment in lieu of a larger centralized system. This system (odor control in general) is not critical to WPCF operation and could also be removed from the design if determined cost prohibitive or if there are funding limitations.

The second component of this project will include sitework to provide final paving, landscaping, security, and fencing. This will restore the site to finished condition following the various preceding projects.

8.5.3 WPCF Wet Weather Improvements

For some CSO alternatives presented in this LTCP, the 20 mgd base upgrade proposed for the core primary / secondary treatment systems will be sufficient. For other alternatives, increased wet weather capacity will be required to treat peak flows. However, space is limited on the WPCF site. CDM Smith has estimated a maximum of 60 mgd additional flow could be treated on site for a maximum total of 80 mgd. Wet weather treatment of 60 mgd is based on preliminary sizing performed by I. Kruger, Inc. for CDM Smith assuming HRC treatment at the location of the existing laboratory building, south of the existing digesters. This facility would provide wet weather treatment to produce better effluent water quality, increase capacity to reduce CSO volumes, streamline wet weather treatment, and improve WPCF operations. The following paragraphs describe the upgrades required to treat additional wet weather flow.

8.5.3.1 Wet Weather Headworks

A junction box could be designed as a diversion structure to direct flow to the plant or the wet weather treatment facility. Gates or weirs could be used to accomplish this diversion. Details such as the size of the structure and diversion concept should be considered in a future design.

A wet weather pretreatment facility will be required for alternatives requiring additional wet weather treatment. This could be an integrated facility to treat all flow or a standalone facility to provide treatment only for flow above 20 mgd. If an integrated facility is desired, then careful planning will be needed to facilitate expandable facilities and coordinated designs. Pretreatment for wet weather flows would consist of screening, though grit removal could also be considered.

Screening mechanical details such as number and type of screens, and the depth and width of screen channels should be considered in a future design. However, the following conceptual issues should be considered in any future screening design efforts:

- The facility must be low enough to allow free discharge from the interceptors to the Headworks, but also high enough to be above the CT Department of Energy and Environmental Protection (DEEP) mandated flood protection elevations.
- The facility should be designed to withstand the velocities and sediment loading associated with wet weather flow.
- The facility should be designed to efficiently provide free flowing conditions across the range of flows expected at the WPCF.
- Screening channels must be free-flowing to avoid surcharging the Yantic Interceptor or reducing upstream PS capacities. The facility should be designed to monitor liquid level at the screening channels and automatically increase cleaning rates or bring more screening channels on line in the event of elevated liquid levels.

- The facility will need fine screening capabilities to facilitate the wet weather treatment processes proposed in this section.
- The facility should have adequate screenings storage to accommodate prolonged wet weather flow and pump-out of upstream storage.

Inclusion of grit removal and mechanical details such as number and type of units and the structure sizes will be considered in a future design. However, the following conceptual issues should be considered in any future grit removal design:

- The facility should be designed to receive sediment loads associated with wet weather flow.
- The facility should provide high removal efficiency to protect downstream processes.
- The facility should provide free flowing conditions across the range of flows expected at the WPCF.
- The facility should have adequate grit storage, handling and disposal capabilities to accommodate prolonged wet weather flow and pump-out of upstream storage.

A fundamental issue not addressed in this report is the type of grit removal system to be installed if grit removal is deemed necessary. Aerated grit removal technology is currently utilized at the WPCF, but the 2015 design included a vortex type removal system. Technology selection for basic grit removal is not the focus of this document and will be left for a future design.

8.5.3.2 Wet Weather Treatment

CSO alternatives that include flows to the plant above 20 mgd are beyond the capacity of the base WPCF upgrades. A High Rate Clarification (HRC) wet weather treatment facility is recommended.

Design of the HRC facility at the WPCF should consider the reduced treatment efficiency that will be experienced during startup. It may prove beneficial to start running the wet weather treatment facility before flow to the secondary process exceeds 20 mgd so that wet weather treatment is functioning at full effectiveness during periods when flows peak above 20 mgd.

It is anticipated that HRC effluent will need to be disinfected on a seasonal basis prior to discharge to the Thames and Yantic Rivers to remain consistent with current requirements. NPU currently disinfects effluent using sodium hypochlorite at a chlorine contact tank. Upgrades to the plant may include a transition to UV. Dechlorination is not required. Effluent from the HRC process may continue to be disinfected in this fashion, provided there is sufficient contact time for increased flows. For planning purposes, UV disinfection will be considered as the primary option given the relatively small footprint required and the fact that chemicals for chlorination and potential future dechlorination would not be needed. However, UV Disinfection of wet weather HRC effluent has limitations, and sodium hypochlorite may need to be the final answer if UV manufacturers cannot guarantee an adequate kill of pathogens of concern.

To limit costs of outfall construction, effluent from the HRC facility is proposed to be blended with effluent from secondary processes and discharged via the existing outfalls pending approval from regulators. Final configuration of the HRC facility and seasonal disinfection system should be

evaluated during the WPCF Facility Plan Update and during detailed design to consider both the effluent quality limits of the HRC facility and the effect of HRC effluent on the blended effluent from the HRC and secondary processes. Future design should also consider the adequacy of the current outfall for high flows. A new outfall is recommended only if the existing outfall proves inadequate to handle the proposed flow rates, operational benefits are realized during the design process, or National Pollutant Discharge Elimination System (NPDES) permit requirements or DEEP require separate outfalls.

Future design should also consider the need for an effluent pumping station, as the plant may not be able to convey high flow when discharging to high river stage. The PS should be able to pump all flow it receives, but only when pumping is required. If the wet weather treatment facility is built high enough, gravity discharge from this portion of the facility would be practical.

8.6 Citywide CSO Control Alternatives

This section considers the effectiveness and anticipated impacts associated with each of the area-specific solutions described above and combines the solutions to create alternatives that manage CSO citywide. Solutions for each area of the city are combined to create alternatives that, with components scaled up or down in size, achieve varying levels of CSO control.

8.6.1 Alternative 1 – Conveyance and Centralized Treatment

The first set of CSO control alternatives combines the conveyance options from every area of the city. For these alternatives, capacity of the WPCF is increased up to the maximum the available land can support, 80 mgd. To achieve CSO control throughout the system, the first objective is to increase conveyance capacity to convey total flows to the WPCF. For larger design storms, incoming system flows exceed even the increased capacity of the plant and storage is required to manage the excess flows.

When the separate solutions for each area are combined, some modifications are needed to adjust for the solutions' effects on their common downstream conditions. For the 1-month through 6-month storms, all flows from each area can be conveyed to the WPCF. The required WPCF capacities for these three storms are 35 mgd, 49 mgd, and 80 mgd, and the required Rose Alley PS capacities are 26 mgd, 38 mgd, and 61 mgd. For larger storms, if pump stations in each area are upgraded to convey all flows, the 80 mgd capacity of the expanded WPCF will be exceeded. For the 1-year and 2-year storms, storage at the Rose Alley commuter lot is sufficient for holding back the maximum flows from Rose Alley PS and allows flows from Thamesville and Laurel Hill to be pumped directly downstream. In the 5-year storm, flows from Thamesville become so high that they take up over a quarter of the capacity at the WPCF and a small storage tank in Thamesville becomes necessary. To manage CSO to a 5-year level of control in Thamesville, 23 mgd would need to be pumped to the WPCF. In comparison, if there were no storage in Rose Alley, in the 5-year storm, 144 mgd would reach Rose Alley PS. Rather than construct a second storage tank on the Shetucket to hold back these large flows, a storage tank in Thamesville can help achieve the same level of systemwide control and can be constructed for a lower cost and with a smaller impact than a second Shetucket storage tank at the NPU yard. The 5-year solution therefore includes a 0.63 Mgal storage tank with a 12 mgd pump in Thamesville. The main components for each design storm using the conveyance strategy are summarized in Table 8-13.

In these alternatives, the required WPCF wet weather capacity ranges from 35 mgd in the 1-month storm to 80 mgd in the 6-month through 5-year storms. These increases in treatment plant capacity beyond the 20 mgd capacity that was recommended in Section 3 are achieved by utilizing a high rate clarification (HRC) facility at Hollyhock Island for additional wet weather treatment. Conveying flows from each part of the city to the upgraded WPCF minimizes construction costs associated with storage tanks, particularly those in challenging locations (as in Laurel Hill and the NPU yard) or with potentially contaminated soils (NPU yard). Reducing the number of storage tanks by prioritizing the conveyance of wet weather flows eases the operation and maintenance burden on NPU staff. At the same time, additional staff would likely be required to manage the enlarged WPCF. This alternative does not include private or public inflow removal, reducing construction impacts by not requiring construction on every street and/or adjusting sewer or drainage connections from private properties. Without any type of inflow removal, stormwater flows from the combined areas will pass through the WPCF for wet weather treatment, rather than discharging untreated to the river as would occur if inflows were separated. Despite these benefits, these alternatives will have large, expensive pumping stations. The construction of the relief pipe will disrupt traffic, particularly at the intersection of Main Street and North Main Street/Route 12. The expansion of wet weather capacity at the WPCF will also add significantly to the costs of these alternatives. Costs are presented in Section 8.7.

Table 8-13: Components of Comprehensive Conveyance Alternatives

Component		Control Level					
		1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Thamesville	Shipping Street PS (mgd)	3.5	3.5	3.5	3.5	3.5	7
	Shipping Street FM (diameter, inches)	12	12	12	12	12	18
	South Thames Street PS (Existing Location, mgd)	5	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned
	Relocated Thamesville PS (mgd)	NA	10	14	15	16	NA
	Storage Tank (Mgal)	NA	NA	NA	NA	NA	0.63
	Storage Tank Pump (mgd)	NA	NA	NA	NA	NA	12
	Thamesville FM (diameter, inches)	12	18	20	24	24	20
	West Thames Street Relief Pipe (diameter, inches)	15	21	24	24	24	30
	Separation	NA	NA	NA	NA	NA	NA
Laurel Hill	River Ave PS (mgd)	4	4	10	10	12	18
	River Ave FM (diameter, inches)	14	14	20	18	20	24
	Storage Tank	NA	NA	NA	NA	NA	NA
	Storage Tank Pump	NA	NA	NA	NA	NA	NA
	Gravity Pipe to Shetucket	NA	NA	NA	NA	NA	NA
	Pipe Replacement Along Railroad (length, feet)	31	141	141	141	743	953
	Pipe over Bridge to Shetucket (diameter, inches)	As-is	As-is	30	30	36	36
	Separation	NA	NA	NA	NA	NA	NA
Shetucket	Rose Alley Lot Storage (Mgal)	NA	NA	NA	0.35	0.90	2.02
	Rose Alley Lot Storage Pump (mgd)	NA	NA	NA	0.35	2	4
	Re-Route Shetucket to Accommodate Storage	No	No	NA	No	No	Yes
	NPU Storage	NA	NA	NA	NA	NA	NA
	NPU Storage Pump	NA	NA	NA	NA	NA	NA
	Shetucket Relief Pipe (diameter, inches)	NA	NA	30 to 48	30 to 48	36 to 48	42 to 60
	Relief Culvert from Rose Alley PS	NA	NA	NA	NA	NA	NA
	Rose Alley PS (mgd)	26	38	61	64	65	70
	Rose Alley FM (diameter, inches)	30	36	42	42	42	42
	WPCF Capacity (mgd)	35	49	80	80	80	80
	Separation	NA	NA	NA	NA	NA	NA

8.6.2 Alternative 2 – Storage

The second set of CSO control alternatives combines the storage options from every area of the city to achieve citywide CSO control. These alternatives maintain existing WPCF and Rose Alley PS capacities and focus on managing excess flows using storage facilities. The size and number of storage tanks required varies with the size of the design storm controlled. For the largest, 5-year storm, peak flows are so large that the WPCF capacity must be increased.

In Norwich, limited capacity of conveyance pipes poses a challenge for CSO planning. Pipes throughout the system were not originally designed to convey the full system peak flows, as the overflows are designed to relieve the system under these conditions. Therefore, storage alternatives include increased conveyance to transport flows into the storage tanks. Increased conveyance ranges from increasing the size of dry weather flow connector pipes to constructing a parallel relief interceptor for the larger storms.

Appendix B describes the process for identifying potential storage sites in Norwich and assessing which are most feasible. Based on this assessment, the storage alternatives include storage tanks in up to four locations:

- The Rose Alley commuter lot (maximum capacity of 3.0 Mgal),
- The NPU facilities lot (maximum capacity of 2.24 Mgal),
- The park at the intersection of Laurel Hill Avenue and Center Street (maximum capacity of 1.05 Mgal), and
- The vacant lot on the eastern side of Thames Street and north of a condominium complex (maximum capacity of 0.63 Mgal).

The general strategy for development of the storage alternatives was to minimize the number and size of storage tanks required for each level of control to limit capital and O&M costs and ease the O&M burden on NPU staff. With the constraint that the WPCF maintain its existing capacity, the three areas must be managed so that a maximum of 20 mgd reaches the WPCF. To manage CSO for smaller design storms, storage can be strategically employed in one area of the city to allow other areas to discharge their full flow downstream. For larger storms with higher peak flow, storage will be required at multiple sites to hold back flow.

When flows in the system exceed conveyance and treatment capacity, the first location storage is proposed is in the Rose Alley commuter lot. The Rose Alley commuter lot has the most available area for storage and the Rose Alley PS, just downstream, contributes the most flow to the WPCF. The construction of a storage tank in this lot will hold back Shetucket Interceptor flows until after peak passes through the PS and the WPCF. Combined with increased conveyance in other areas of the city, one storage tank at the Rose Alley commuter lot is sufficient to manage CSO to a 1-month level of control.

For the 3-month design storm, a second storage tank is necessary and is added in Thamesville. The South Thames Street PS in Thamesville would need to be upgraded to 10 mgd to pass the 3-month storm, which would take up half the capacity of the WPCF and prevent Rose Alley PS from being able to operate at its capacity during wet weather. A storage tank here reduces the peak

flows from Thamesville to 4 mgd, freeing up capacity at the WPCF for other areas. A storage tank in Thamesville is needed in the 3-month through 5-year storage alternatives.

For the 6-month design storm, a third storage tank is added in Laurel Hill. In the 6-month storm, 10 mgd would need to be pumped from River Avenue PS to Rose Alley PS to manage CSO, which, combined with flows from Downtown, would overwhelm Rose Alley PS. A storage tank in Laurel Hill can reduce peak flows to the Shetucket Interceptor to approximately 1 mgd, freeing up capacity at Rose Alley PS for flows from Downtown and the Shetucket Interceptor. A storage tank in Laurel Hill is needed in the 6-month through 5-year storage alternatives.

In the 1-year through 5-year design storms, CSO volumes on the Shetucket exceed what can be stored at the commuter lot and additional storage is required upstream at the NPU facilities site. Adding storage at the NPU site is a last alternative due to the difficult nature of construction at this site. The lot is used by NPU staff for storing and maintaining vehicles. Additionally, the soil on this site is expected to be contaminated and may require off-site disposal. A storage tank at the NPU yard is needed in the 1-year through 5-year storage alternatives.

Storage tanks alone are not sufficient to manage the 5-year storm, and the capacities of the WPCF and Rose Alley PS must be increased to manage CSOs to a 5-year level of control. For all design storms, necessary upgrades are assumed at the WPCF to manage 20 mgd as discussed previously. Any alternative that exceeds the 20 mgd treatment capacity of the upgraded WPCF includes an HRC facility for additional wet weather treatment. Table 8-14 summarizes the main components of the storage alternatives for each level of control.

The 1-month through 2-year alternatives also manage CSO with 20 mgd WPCF capacity, reducing the costs associated with WPCF wet weather flow upgrades. These alternatives do not include private or public inflow removal, reducing construction impacts by not requiring construction on every street and/or adjusting sewer or drainage connections from private properties. Without any type of inflow removal, stormwater flows from the combined areas will pass through the WPCF for wet weather treatment, rather than discharging untreated to the river as would occur if inflows were separated. Despite these benefits, these alternatives will have large, and in some cases, multiple, storage tanks. While the number of storage tanks for each level of control was minimized, the operation of each storage tank requires additional, trained NPU staff. The NPU facilities yard may contain contaminated soils that would be more challenging and costly to manage during construction. The construction of storage tanks in the Rose Alley commuter lot and the NPU yard will drastically impact the normal activities occurring at these sites. Parking in the lot will be limited and NPU will need to relocate their activities. As noted in the conveyance alternatives description, the construction of the relief pipe will disrupt traffic, particularly at the intersection of Main Street and North Main Street/Route 12. The expansion of wet weather capacity at the WPCF to attain 5-year control will also add significantly to the costs of this alternatives. Costs are presented in Section 8.7.

Table 8-14 Components of Comprehensive Storage Alternatives

Component		Control Level					
		1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Thamesville	Shipping Street PS (mgd)	3.5	3.5	3.5	3.5	3.5	7
	Shipping Street FM (diameter, inches)	12	12	12	12	12	18
	South Thames Street PS (Existing Location, mgd)	5	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned
	Relocated Thamesville PS	NA	NA	NA	NA	NA	NA
	Thamesville Storage Tank (Mgal)	NA	0.26	0.42	0.63	0.63	0.63
	Thamesville Storage Tank Pump (mgd)	NA	4	4	4	4	9
	Thamesville FM (diameter, inches)	12	12	12	12	12	18
	West Thames Street Relief Pipe (diameter, inches)	15	21	24	24	24	30
	Separation	NA	NA	NA	NA	NA	NA
Laurel Hill	River Ave PS (mgd)	4	4	10	10	11	18
	River Ave FM (diameter, inches)	14	14	18	18	18	24
	Storage Tank (Mgal)	NA	NA	0.53	0.84	1.05	1.05
	Storage Tank Pump (mgd)	NA	NA	1	1	1	1
	Gravity Pipe to Shetucket (diameter, inches)	NA	NA	12	12	12	18
	Pipe Replacement Along Railroad (length, feet)	97	141	141	532	743	953
	Pipe over Bridge to Shetucket	As-is	As-is	As-is	As-is	As-is	As-is
	Separation	NA	NA	NA	NA	NA	NA
Shetucket	Rose Alley Lot Storage (Mgal)	1	1.45	3	2.3	3	2.69
	Rose Alley Lot Storage Pump (mgd)	2	2	4	4	4	4
	Re-Route Shetucket to Accommodate Storage	No	No	Yes	Yes	Yes	Yes
	NPU Storage (Mgal)	NA	NA	NA	1.31	2.24	1.62
	NPU Storage Pump (mgd)	NA	NA	NA	1	1	1
	Shetucket Relief Pipe (diameter, inches)	NA	NA	30 to 42	30 to 36	30 to 42	30 to 60
	Relief Culvert from Rose Alley PS (diameter, inches)	NA	24	24	30	30 to 36	36
	Rose Alley PS (mgd)	As-is	As-is	As-is	As-is	As-is	40
	Rose Alley FM (diameter, inches)	As-is	As-is	As-is	As-is	As-is	42
	WPCF Capacity (mgd)	20	20	20	20	20	49
	Separation	NA	NA	NA	NA	NA	NA

8.6.3 Alternative 3 – Public Inflow Removal in Thamesville with Storage as Needed

The third set of alternatives also maintains existing WPCF capacity but aims to reduce the storage volume required by using local public inflow removal in areas where it appears to be most cost effective. These alternatives combine the public inflow removal solution in Thamesville with the storage solutions in Laurel Hill and along the Shetucket. Section 6 and Section 8.2.1 identified public inflow removal in Thamesville as promising due to development being less dense than in other areas of the city and the reduction in CSO predicted by the collection system model. After public inflow is removed, remaining wet weather flows for small design storms are small enough that they can be pumped downstream to the WPCF and not take up too large a portion of the WPCF's capacity. To make up for the increase in flows to the WPCF from Thamesville, additional flow from the Shetucket can be held back in storage. In the larger storms, a small storage tank is needed in Thamesville to dampen the flow rate sent to the WPCF.

These alternatives, combining public inflow removal in Thamesville with satellite storage facilities, were developed for the 3-month, 6-month, 1-year, and 2-year levels of control to demonstrate how this alternative would work for the DEEP desired level of control and three intermediate levels of control. For the 3-month storm, public inflow removal is implemented in Thamesville and the remaining wet weather flows can be handled with the existing South Thames Street PS and FM. The relief pipe down West Thames Street to the South Thames Street PS must be 15-inch. With the same peak flow rate reaching the WPCF from Thamesville as in the 3-month storage solution, the 3-month storage solutions in Laurel Hill and along the Shetucket described in the previous sections can be implemented in combination with the public inflow removal solution in Thamesville.

For the 6-month storm, a larger, 7 mgd PS is needed to convey remaining wet weather flows from Thamesville to the WPCF. This size PS requires more land area than is available at the current South Thames Street PS site and must be constructed in the vacant lot to the north. The WPCF can accept the full 7 mgd from Thamesville by holding additional flows back from Rose Alley PS at the Rose Alley commuter lot. The 6-month storage solutions in Laurel Hill and along the Shetucket, with some modifications in sizing of components, can be combined with this solution in Thamesville to achieve citywide CSO control at the 6-month level.

In the 1-year storm, a 0.42 Mgal storage tank in Thamesville is required to reduce the area's peak flow from 9 mgd to 1 mgd. With only 1 mgd from Thamesville, additional flow can be sent to the WPCF from Rose Alley PS, so that only one storage tank at the Rose Alley commuter lot is required. In the storage only, 1-year alternative (Section 8.5.2), peak flow from the Thamesville storage tank is 4 mgd, requiring a second storage tank at the NPU yard to hold back additional flow from Rose Alley PS. A storage tank is also needed in Laurel Hill.

In the 2-year storm, a 0.16 Mgal tank is used to reduce peak flows from Thamesville to the WPCF from 9.3 mgd to 4 mgd. This solution in Thamesville is combined with the 2-year storage solutions in Laurel Hill and along the Shetucket to control CSO to a 2-year level. The maximum storage tank sizes are needed in Laurel Hill and along the Shetucket, to hold back high flows. For the 2-year solution, the benefit of the public inflow reduction in Thamesville is seen in the reduction in size of the Thamesville storage tank.

This set of alternatives resembles the all-storage alternatives, except storage in Thamesville is eliminated or reduced because the cost to remove public inflow in Thamesville is similar to the cost of the necessary storage infrastructure. By removing public inflow, a storage tank in Thamesville is not needed until the 1-year storm. For these smaller storms, NPU does not have the operation and maintenance requirements associated with a Thamesville storage tank; they would, however, need to operate and maintain the existing or an upgraded PS. Outside of Thamesville, the system has the benefit of having less overall flow which can mean more flow from other parts of the city can be sent to the treatment plant. One downside of this solution, is the separated stormwater flows in Thamesville will be discharged directly to the river, whereas in the conveyance or storage alternatives, they are eventually treated at the WPCF. Overall though, the solutions in Laurel Hill and the area draining to the Shetucket are very similar to what is required in the all storage alternatives, with some variation in sizing. Components required in Alternative 3 under different design storms are shown in Table 8-15. Costs are presented in Section 8.7.

Table 8-15: Components of Alternative Set 3 with Public Inflow Removal in Thamesville and Storage as Needed

Component		Control Level					
		1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Thamesville	Shipping Street PS (mgd)		3.5	3.5	3.5	3.5	
	Shipping Street FM (diameter, inches)		12	12	12	12	
	South Thames Street PS (Existing Location)		As-is	Abandoned	Abandoned	Abandoned	
	Relocated Thamesville PS (mgd)		NA	7	NA	NA	
	Thamesville Storage Tank (Mgal)		NA	NA	0.42	0.16	
	Thamesville Storage Tank Pump (mgd)		NA	NA	1	4	
	Thamesville FM (diameter, inches)		As-is	18	12	12	
	West Thames Street Relief Pipe (diameter, inches)		15	18	20	20	
	Separation		Public Inflow Removal	Public Inflow Removal	Public Inflow Removal	Public Inflow Removal	
Laurel Hill	River Ave PS (mgd)		4	10	10	11	
	River Ave FM (diameter, inches)		14	18	18	18	
	Storage Tank (Mgal)		NA	0.34	0.72	1.05	
	Storage Tank Pump (mgd)		NA	1	1	1	
	Gravity Pipe to Shetucket (diameter, inches)		NA	12	12	12	
	Pipe Replacement Along Railroad (length, feet)		As-is	141.3	532.8	744.1	
	Pipe over Bridge to Shetucket (diameter, inches)		As-is	As-is	As-is	18	
	Separation		NA	NA	NA	NA	
Shetucket	Rose Alley Lot Storage (Mgal)		1.38	1.9	3	3	
	Rose Alley Lot Storage Pump (mgd)		2	4	4	4	
	Re-Route Shetucket to Accommodate Storage		No	Yes	Yes	Yes	
	NPU Storage (Mgal)		NA	NA	NA	2.24	
	NPU Storage Pump (mgd)		NA	NA	NA	1	
	Shetucket Relief Pipe (diameter, inches)		NA	30 to 42	36 to 48	30 to 42	
	Relief Culvert from Rose Alley PS (diameter, inches)		24	24	30	30	
	Rose Alley PS (mgd)		As-is	As-is	As-is	As-is	
	Rose Alley FM (diameter, inches)		As-is	As-is	As-is	As-is	
	WPCF Capacity (mgd)		20	20	20	20	
	Separation		NA	NA	NA	NA	

8.6.4 Alternative 4 – Public Inflow Removal in Thamesville and Laurel Hill with Storage as Needed

The fourth set of alternatives resembles the third set in that it maintains existing WPCF capacity and aims to reduce storage volume required by using local public inflow removal in areas where it appears to be most cost effective. These alternatives remove public inflow in Laurel Hill in addition to Thamesville, with storage elsewhere as needed to manage remaining flows. Section 6 and Section 8.3.2 also noted public inflow removal in Laurel Hill as promising and worth being investigated further as part of a hybrid alternative. Constructing storage in Laurel Hill is challenging due to a lack of feasible storage sites. The best storage site requires a pump station to pump against roughly 70 ft of head to the top of a hill; a new, 920-ft force main; and a new, 2,150-ft gravity line. Alternatively, public inflow removal appears promising in Laurel Hill due to development being less dense than in other areas of the city and the substantial reduction in CSO predicted by the collection system model. Furthermore, because Laurel Hill flows to the Shetucket Interceptor then to Rose Alley PS, the wet weather flows from Laurel Hill that remain after public inflow removal can be accommodated at Rose Alley PS by holding back additional flows from the Shetucket Interceptor with storage at the Rose Alley commuter lot. (Doing this the other way, with public inflow removal in the areas draining to the Shetucket and storage in Laurel Hill, would be far more costly and likely unable to reduce flows to Rose Alley sufficiently since Shetucket flows are so much higher.)

This set of alternatives was developed for the 3-month, 6-month, and 2-year levels of control. For the 3-month level of control, public inflow is removed in Thamesville and Laurel Hill. In both areas of the city, no additional work is required beyond the "Necessary Upgrades" described in previous sections. In Thamesville, the existing South Thames Street PS and FM are sufficient to pass the reduced wet weather flows, and a 15-in relief pipe down West Thames Street is required to convey flow to the PS. In Laurel Hill, River Avenue PS must be upgraded to 4 mgd and the 14-inch FM can be replaced to follow the existing route to the Shetucket Interceptor in the north. Along the Shetucket, the 3-month Shetucket storage solution described in Section 8.4.4 can be used in combination with the public inflow removal solutions in Thamesville and Laurel Hill.

For the 6-month storm, Thamesville requires a 7 mgd PS to replace the existing South Thames Street PS. The PS must be relocated to the vacant lot to the north. The FM and relief pipe must be 18-inch to pass the remaining wet weather flows. In Laurel Hill, River Avenue PS must be upgraded to 5 mgd with a 15-inch FM to pass the remaining wet weather flows. Along the railroad, 141 ft of dry weather flow pipe must be replaced with larger pipe. The storage solution along the Shetucket is like the 6-month Shetucket storage solution with some variation in component size.

For the 2-year storm, a small storage tank is needed in Thamesville to reduce the flow rate to the WPCF. With a 0.43 Mgal tank, the maximum flow rate reaching the WPCF is 1 mgd. An 8-inch FM is required to pass this pumping rate, and a 20-inch relief pipe down West Thames Street is needed to convey flows to the storage tank and pump. In Laurel Hill, River Avenue PS must be upgraded to 6 mgd with a 15-inch FM following the existing route. No storage is needed, as this flow can be conveyed directly to the Shetucket Interceptor and Rose Alley PS. Along the Shetucket, the storage solution is similar to the 2-year Shetucket storage solution.

As with alternative set 3 discussed above, these alternatives remove public inflow in areas where it is expected the cost of inflow reduction will be similar to the cost of storing and slowly releasing flows. The need for a storage tank in Thamesville is eliminated through the 6-month storm. In Laurel Hill, a storage tank is not even needed to achieve 2-year control. This reduces the required size of River Avenue PS and eliminates the need to have it pump up to the storage tank at the top of the hill. Reducing the number of storage tanks in these solutions eliminates operation and maintenance requirements for NPU; they would, however, need to operate and maintain the existing or upgraded pump stations. One downside of this solution, is the separated stormwater flows in Thamesville and Laurel Hill will be discharged directly to the Thames river, whereas in the conveyance or storage alternatives, they are eventually treated at the WPCF. Overall, the solutions in the area draining to the Shetucket are very similar to what is required in the all storage alternatives, with some variation in sizing. Components of the Alternative 4 variations for different design storms are presented in Table 8-16. Costs are presented in Section 8.7.

Table 8-16: Components of Alternative Set 4 with Public Inflow Removal in Thamesville and Laurel Hill with Storage as Needed

Component		Control Level					
		1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Thamesville	Shipping Street PS (mgd)		3.5	3.5		3.5	
	Shipping Street FM (diameter, inches)		12	12		12	
	South Thames Street PS (Existing Location)		As-is	Abandoned		Abandoned	
	Relocated Thamesville PS (mgd)		NA	7		NA	
	Thamesville Storage Tank (Mgal)		NA	NA		0.43	
	Thamesville Storage Tank Pump (mgd)		NA	NA		1	
	Thamesville FM (diameter, inches)		As-is	18		8	
	West Thames Street Relief Pipe (diameter, inches)		15	18		20	
	Separation		Public Inflow Removal	Public Inflow Removal		Public Inflow Removal	
Laurel Hill	River Ave PS (mgd)		4	5		6	
	River Ave FM (diameter, inches)		14	15		15	
	Storage Tank		NA	NA		NA	
	Storage Tank Pump		NA	NA		NA	
	Gravity Pipe to Shetucket		NA	NA		NA	
	Pipe Replacement Along Railroad (length, feet)		As-is	141.3		141.3	
	Pipe over Bridge to Shetucket (diameter, inches)		As-is	As-is		18	
	Separation		Public Inflow Removal	Public Inflow Removal		Public Inflow Removal	
Shetucket	Rose Alley Lot Storage (Mgal)		1.38	1.9		3	
	Rose Alley Lot Storage Pump (mgd)		2	4		4	
	Re-Route Shetucket to Accommodate Storage		No	Yes		Yes	
	NPU Storage (Mgal)		NA	NA		2.24	
	NPU Storage Pump (mgd)		NA	NA		1	
	Shetucket Relief Pipe (diameter, inches)		NA	30 to 42		30 to 42	
	Relief Culvert from Rose Alley PS (diameter, inches)		24	24		30	
	Rose Alley PS (mgd)		As-is	As-is		As-is	
	Rose Alley FM (diameter, inches)		As-is	As-is		As-is	
	WPCF Capacity (mgd)		20	20		20	
	Separation		NA	NA		NA	

8.6.5 Alternative 5 – Complete Public and Private Separation

As described in section 6 and again in Sections 8.2 through 8.4, complete public and private separation is necessary to manage CSO to a 5-year level of control. This would require extensive and intrusive construction in roadways and on private properties. Components of this work include new storm drains or sewer pipes, disconnection of all private inflows, pipe rehabilitation (when the combined sewer becomes the sanitary sewer, 100 percent sewer lining is required), and new catch basins and river outfalls. This type of construction will cause disruption from digging up roads, changing traffic patterns, restricting access to commercial establishments, and disrupting other utilities. One benefit of this work however, is that no storage tanks are required, and pumping stations can stay close to their existing capacity, and the WPCF does not require additional wet weather capacity beyond the 20 mgd described above. This also limits O&M costs for pumping and treatment systems. Furthermore, aging sewer infrastructure can be upgraded or replaced. This includes other nearby underground utilities (such as water mains) and surface pavement. However, by separating the drainage and sewage systems, untreated stormwater would be discharged to waterways. If complete public and private separation were accompanied by CSO closure, sanitary sewer overflows (SSOs) would occur in large storms since there is no longer relief to receiving rivers. The SSOs could occur out of manholes in roadways and grassy areas or in buildings if sewage backs up from the main line into the sewer connection. Depending on the location, SSOs may pose a more acute public health risk than a CSO to the river.

8.7 Cost Analysis

8.7.1 Cost Estimating Methodology

Following the development of each of the alternatives under the different design storm conditions, a planning level cost was developed for each alternative. Details on the components of each alternative were extracted from the model and used for cost estimating. These components included pipe size, pipe length, pipe depth, facility sizes, acres of inflow reduction, and other relevant information for cost estimating.

An inventory list was created for each alternative that included all the components needed for that specific alternative. Costs for components were estimated using base costs described in Section 8.7.1.1. In addition to the base costs, additional costs were added for special conditions, as described in Section 8.7.1.2. A total cost for each alternative was estimated by the sum of all its components with project contingency and an engineering cost (described in Section 8.7.1.3) added on top of the cost of the components. The total costs of each alternative can be seen in Section 8.7.2.

8.7.1.1 Base Costs

CDM Smith established base costs for pipe, facilities, and inflow removal based upon real project bid costs seen in other areas of the Northeast. All costs were escalated to FY 2018 US dollars.

Construction costs for sewer and drain pipe were established primarily based on projects in the Hartford, CT area. These costs per linear foot of pipe can be seen in Table 8-17. Construction of pipeline projects in the Hartford are typically higher than other small cities in New England because of local regulations and construction challenges. CDM Smith believes these costs are appropriate for planning level costs in Norwich since the two cities are only 40 miles apart and

there is a level of expected difficulty of construction in Norwich. The topography of Norwich is steep with rocky slopes descending toward the Yantic, Shetucket, and Thames River at the center of downtown. Construction in rock and near floodways presents challenges that will add complexity and cost to pipeline projects. When developing cost estimates, it is useful to have recent bids for similar projects for comparison. However, NPU has not bid pipeline projects similar to the scope of the proposed LTCP work in recent years. Cost estimates in future LTCP updates will have the benefit of data from construction projects in Norwich.

These base costs for pipeline work include trenching, pipe installation, manhole structures, service connections, utility relocation, backfill, and restoration. Since installing deep pipes has a significantly higher cost than installing shallow pipes, two depth classes were considered, 5 to 18 feet, and 19 to 30 feet deep. These pipe costs apply to all standard pipe materials including ductile iron, polyvinyl chloride, and prestressed concrete cylinder pipe. Cured-in-place pipe (CIPP) lining costs were included in this table for pipe rehabilitation costs.

Table 8-17 Base Costs for Pipeline Work (Dollars/Linear Foot)

Pipe Diameter (in)	Base Costs (Depth 5-18 Feet)	Base Costs (Depth 19-30 Feet)	CIPP Lining
6	$425	$1955	-
8	$555	$2000	$55
10	$595	$2040	$60
12	$640	$2085	$70
15	$680	$2210	$85
18	$850	$2550	$125
24	$1275	$3400	$250
30	$1700	$3615	$350
36	$2125	$3825	$400
42	$2550	$4335	$450
48	$2975	$4675	$500
54	$3190	$4890	$550
60	$3400	$5100	$600
66	$3615	$5315	$650
72	$3825	$5525	$700

Facility costs were established using EPA cost curves and curves developed for previous planning projects in New England. It is expected that facilities costs in Norwich will be comparable with these values. Costs for pumping, high rate clarification (HRC), and satellite storage are shown in Table 8-18**.** These costs were included in estimates for each alternative based on expected peak flows or required storage volumes. Costs for facilities that did not match these benchmark sizes were extrapolated to find the relevant value.

Table 8-18 Base Costs for Facilities ($M, 2018)

Flow (mgd)	Volume (Mgal)	Pumping Cost ($M)	HRC Cost ($M)	Satellite Storage Tank ($M)
0.1	0.1	$0.2	$0.4	$1.6
0.2	0.2	$0.3	$0.6	$2.8
0.3	0.3	$0.3	$0.8	$3.9
0.4	0.4	$0.4	$0.9	$4.9
0.5	0.5	$0.5	$1.1	$5.9
0.6	0.6	$0.5	$1.2	$6.8
0.7	0.7	$0.6	$1.4	$7.8
0.8	0.8	$0.7	$1.5	$8.7
0.9	0.9	$0.7	$1.6	$9.6
1	1	$0.8	$1.7	$10.4
2	2	$1.2	$2.8	$18.5
3	3	$1.6	$3.6	$25.8
4	4	$2.0	$4.4	$32.8
5	5	$2.3	$5.1	$39.4
6	6	$2.6	$5.8	$45.8
7	7	$2.9	$6.4	$52.0
8	8	$3.2	$7.0	$58.1
9	9	$3.5	$7.6	$64.1
10	10	$3.7	$8.2	$69.9
20	20	$6.0	$13.0	$123.9
30	30	$8.0	$17.1	$173.1
40	40	$9.8	$20.7	$219.6
50	50	$11.4	$24.0	$264.0
60	60	$12.9	$27.1	$307.0
70	70	$14.4	$30.1	$348.6
80	80	$15.7	$32.9	$389.3
90	90	$17.1	$35.6	$429.1
100	100	$18.4	$38.2	$468.1

Costs for complete public and private separation and public inflow removal were developed based on bid results from multiple sources as presented in Tables 6-2 and 6-3. These costs were applied to alternatives that included inflow removal components. Applicable per acre costs were multiplied by the total acreage that received complete separation or public inflow removal under the alternative. These were considered as a component of these plans, in addition to other required components such as pipe, storage tanks, and pump stations.

8.7.1.2 Auxiliary Costs

In addition to the base costs included in final estimates for each alternative, allowances were included for costs beyond the base estimates that are expected to be incurred for the following items:

- Property purchase, where applicable
- Neighborhood disruption and redevelopment
- Disruption of business activities for construction
- Disruption of utility operations at NPU headquarters for facility construction
- Railroad crossings
- Hazardous soil removal
- Heavy dewatering
- Rock removal

These auxiliary costs were primarily added to alternatives that had a satellite storage facility or centralized treatment facility and would require significant disruption of both public and private areas to construct. A property purchase allowance was added in Thamesville to alternatives where there was a need to build on private property. The final three items on the above list were added in areas where CDM Smith expects to find soil contamination, high groundwater levels, or bedrock. This was determined based on available information from NPU, floodplain mapping resources, and limited boring data from the 1970s. A contingency was added to all costs to account for unforeseen expenditures as described below.

8.7.1.3 Contingency and Engineering Costs

Upon completion of estimating pipeline and facility base costs for each alternative, and addition of any auxiliary costs, a contingency and engineering value was added. A project contingency of 25 percent was added to the subtotals for each alternative, along with an engineering allowance of 20 percent of the sum of the alternative subtotal and project contingency. In total, this adds 50 percent to each alternative's cost.

8.7.2 Planning Level Costs of Alternatives

The final estimated planning cost for each alternative presented in Section 8.6 is shown in Table 8-19**.** These costs include base costs for piping and facilities, additional auxiliary costs as needed, and project contingency and engineering. All costs are presented in 2018 US dollars. The centralized treatment scenarios are shown in the table with a treatment capacity in mgd. This refers to the total capacity of both the treatment plant (assumed at 20 mgd after an upgrade as previously discussed) and any additional wet weather treatment capacity (i.e. HRC).

These planning level costs include the base costs and auxiliary costs outlined above, as well as the cost for the planned projects, but do not include the additional $80M required to improve reliability at the WPCF. These base WPCF projects to improve treatment reliability to 20 mgd are required in every plan order to achieve the stated levels of CSO control presented previously in this Section. However, any additional expansion of capacity beyond 20 mgd (i.e. HRC) is included in the cost presented for each alternative in Table 8-19.

Table 8-19 Alternative Cost Estimates ($M, 2018)

Design Storm	Technology or Approach (Alternative Number), Description	Cost ($M)
5-Year Storm	(Alt 1) Conveyance and Centralized Treatment (80 mgd)	$231
	(Alt 2) Storage (53 mgd)	$280
	(Alt 5) Complete Public and Private Separation	$381
2-Year Storm	(Alt 1) Conveyance and Centralized Treatment (80 mgd)	$190
	(Alt 2) Storage	$200
	(Alt 3) Thamesville Public Inflow Removal, Storage	$205
	(Alt 4) Thamesville/Laurel Hill Public Inflow Removal, Storage	$197
1-Year Storm	(Alt 1) Conveyance and Centralized Treatment (80 mgd)	$178
	(Alt 2) Storage	$174
	(Alt 3) Thamesville Public Inflow Removal, Storage	$155
6-Month Storm	(Alt 1) Conveyance and Centralized Treatment (80 mgd)	$161
	(Alt 2) Storage	$137
	(Alt 3) Thamesville Public Inflow Removal, Storage	$129
	(Alt 4) Thamesville/Laurel Hill Public Inflow Removal, Storage	$129
3-Month Storm	(Alt 1) Conveyance and Centralized Treatment (49 mgd)	$97
	(Alt 2) Storage	$70
	(Alt 3) Thamesville Public Inflow Removal, Storage	$72
	(Alt 4) Thamesville/Laurel Hill Public Inflow Removal, Storage	$87
1-Month Storm	(Alt 1) Conveyance and Centralized Treatment (35 mgd)	$74
	(Alt 2) Storage	$50

The cost estimates above show that "storage" (which is really conveyance and storage as described above) is less expensive under the smaller design storms, but as storm size increases, other alternatives become more affordable. Conveyance and Centralized Treatment ultimately becomes the most affordable alternative at the 2-year design storm control level.

8.7.3 Cost-Benefit & Knee-of-the-Curve Analysis

EPA's 1995 "Guidance for Long-Term Control Plan" guidance document recommends evaluation of present-worth cost values and measures of performance using cost/performance curves. The most common way to evaluate this is through "knee-of-the-curve" analysis. Knee-of-the-curve analysis acknowledges that incremental performance improvements become progressively smaller in relation to incremental increases in cost, i.e., marginal benefits diminish as control level and costs increase. Facility size and cost to capture increasingly rare storm events grows geometrically. The knee-of-the-curve identifies the point at which costs grow disproportionately with improvement in performance. The knee-of-the-curve measure is widely used to help size CSO control measures.

The cost/performance curves shown in Figure 8-23 and Figure 8-24 identify the knee-of-the-curve for two of the most promising control strategies, storage (Section 8.5.2) and centralized treatment (Section 8.5.1). These curves identify the average number of annual overflows on the x-axis and the estimated cost on the y-axis. The x-axis values are inversely proportional with the average recurrence intervals of the design storms. For example, 1-month control corresponds to 12 overflows per year, 3-month control corresponds with four overflows per year, and 1-year control corresponds with 1 overflow per year. The coordinate representing 60 overflows per year and zero cost is the baseline condition. The coordinate for 44 overflows per year is the anticipated system performance after implementation of WPCF reliability upgrades to 20 mgd and the Planned Projects. As described previously, the planned project costs, but not the WPCF reliability upgrades are included in the costs for every proposed alternative.

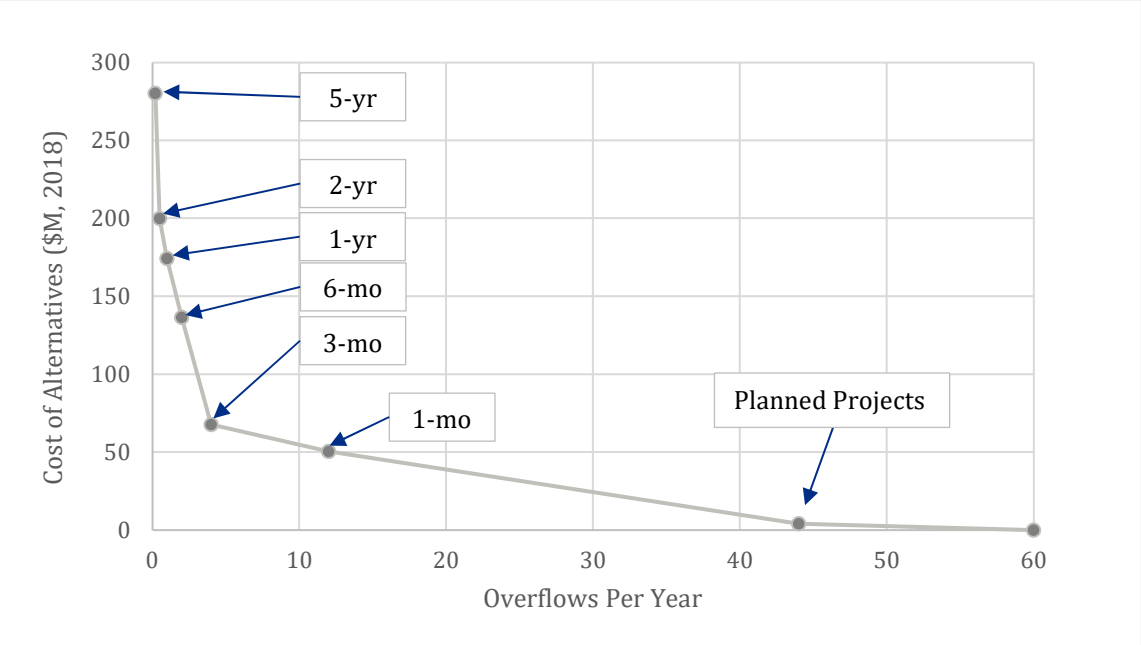


Figure 8-23
Cost vs. Performance for Storage

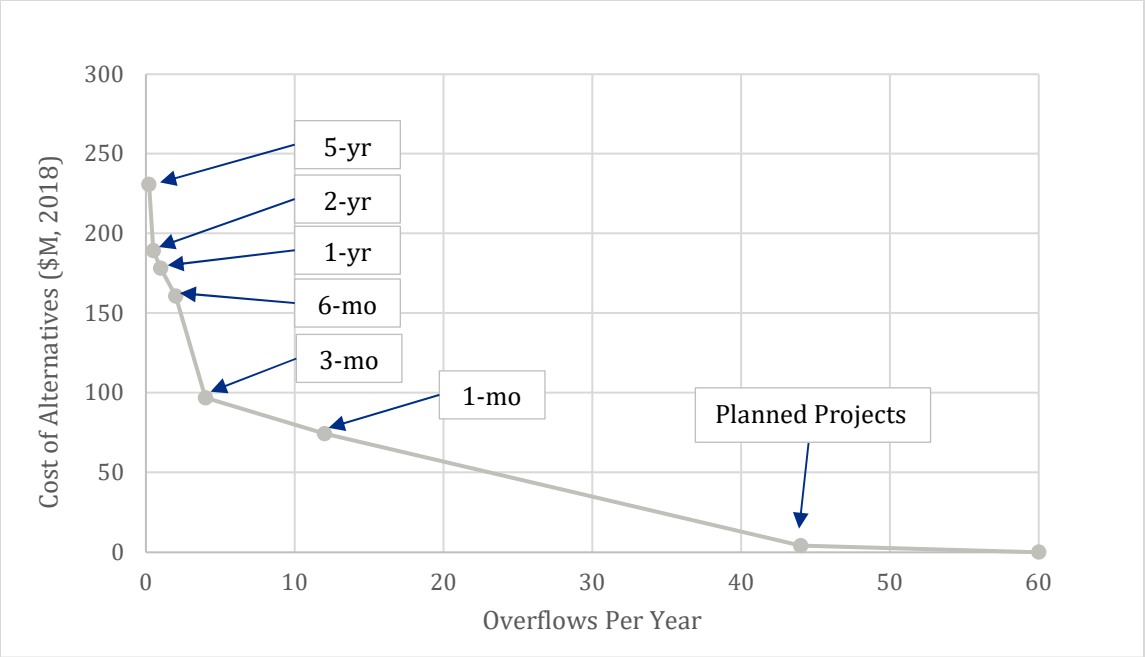


Figure 8-24
Cost vs. Performance for Conveyance and Centralized Treatment

Both figures show that costs increase beyond the 3-month control level. The 3-month control level is the knee-of-the-curve for both the storage and centralized treatment alternatives. The cost/performance curve shown in Figure 8-25 was developed using the least expensive alternative for each design storm.

The most cost-effective plans for each design storm are:

- 1-Month Storm, $50M, (Alt 2) Storage
- 3-Month Storm, $70M, (Alt 2) Storage
- 6-Month Storm, $128M, (Alt 3) Thamesville/Laurel Hill Public Inflow Removal, Storage
- 1-Year Storm, $155M, (Alt 3) Thamesville/Laurel Hill Public Inflow Removal, Storage
- 2-Year Storm, $190M, (Alt 1) Conveyance and Centralized Treatment (80 mgd)
- 5-Year Storm, $231M, (Alt 1) Conveyance and Centralized Treatment (80 mgd)

These costs represent the most affordable options developed to meet each control level. In Figure 8-25, the inflection point of the graph is also at four overflows per year (i.e. 3-month control). Three-month control appears as the inflection point at least partially due to the limited capacity of the Shetucket Interceptor. Under existing conditions, the Shetucket Interceptor can convey all flow in the 3-month design storm if some flow is stored in the underutilized upper sections. However, in the 6-month and larger storms, the Shetucket Interceptor cannot convey all flow it receives to Rose Alley PS, requiring significant cost to convey or limit these flows. The substantial

cost increases at the 6-month control level are due to the additional conveyance piping, storage tanks, or inflow removal needed to reduce or convey peak flows and mitigate CSO.

With 3-month control, NPU can expect 93 percent reduction in the number of CSO events, from the current average of 60 overflows to four events per year. As shown in Figure 8-25**,** advancing from 3-month to 6-month control would cost almost as much as the improvement from existing conditions to 3-month control.

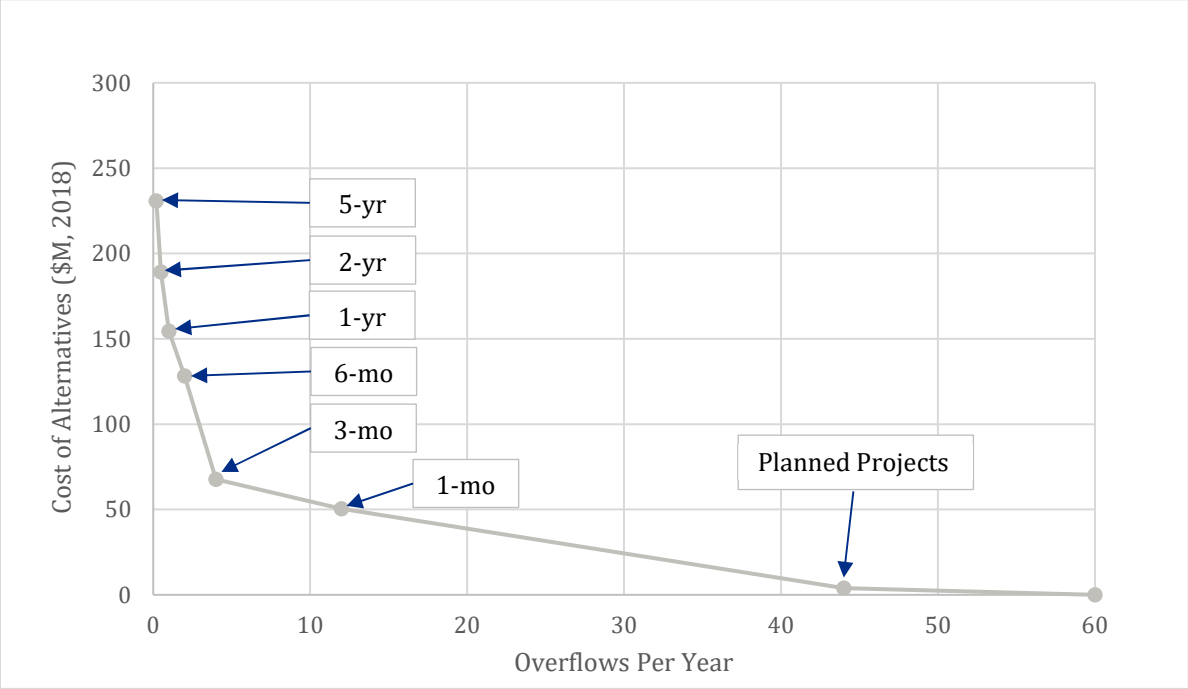


Figure 8-25
Cost vs. Performance for Most Affordable Alternatives

Annual CSO volume is another way to look at the knee-of-the-curve. Annual CSO volume has been plotted for the most affordable control alternatives as shown in Figure 8-26. The Baseline Conditions Report indicated that annual CSO averages 43.3 Mgal under existing conditions. Figure 8-26 depicts the annual volume reductions anticipated and respective cost at each control level. Again, we see that the 3-month level of control is the most cost-effective, and represents the inflection point of the knee-of-the-curve graph.

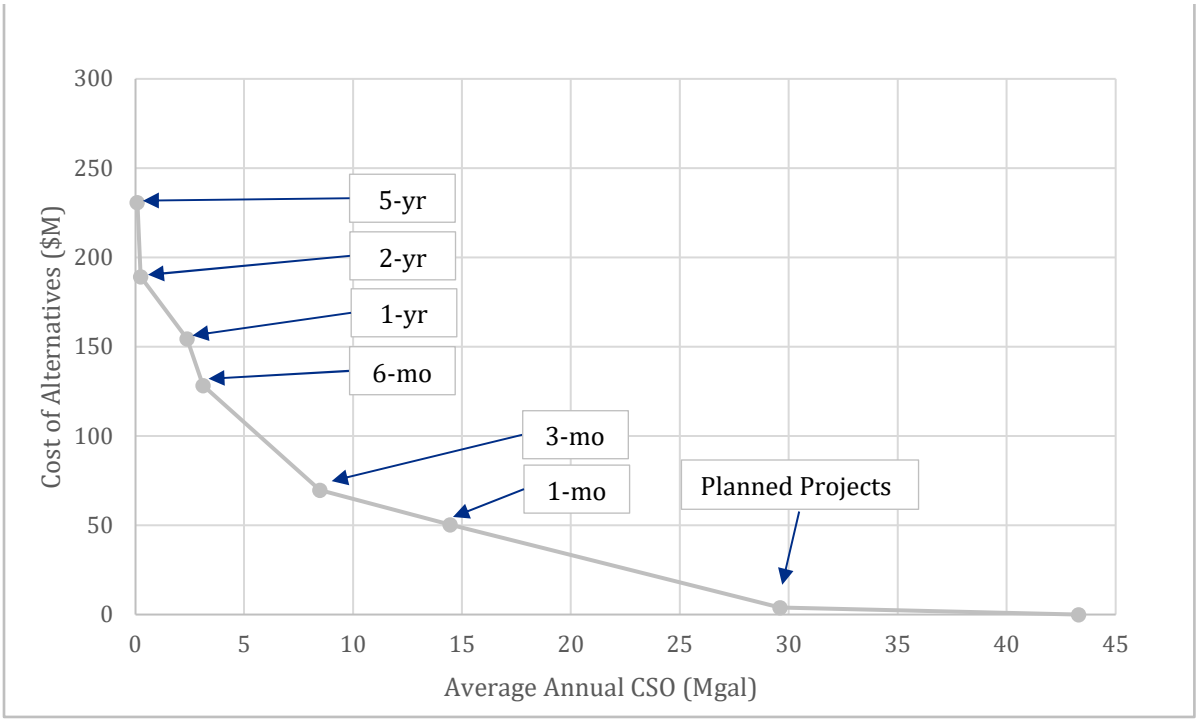


Figure 8-26
Cost vs. Performance for Most Affordable Alternatives (Mgal CSO)

As described in Section 1, the original August 2018 LTCP recommended pursuing the 3-month level of control with an eventual expansion to 2-year control. This recommendation was based upon the knee of the curve analysis described above and the financial analysis presented in the 2018 LTCP. A 3-month plan that could be expanded to achieve the 2-year control was selected to comply with the consent decree requirements.

Since the submittal of the 2018 LTCP submittal, DEEP and NPU have participated in a series of meetings and workshops. DEEP has requested a 2-year control level with greater water quality benefits earlier in the project schedule. DEEP has acknowledged NPU's concerns of exceeding the knee of the curve analysis, and the affordability of a large capital program. DEEP has also acknowledged that without grant and loan funding NPU will not be able to afford a 2-year control program. If grant and loan funding is unavailable, the 2-year control level and schedule will need to be reevaluated. A detailed affordability analysis including grant and loan funding can be found in Section 9.

8.8 Selection of Least Cost CSO Control Plans

As stated previously, the methodology of this report is predicated on 2-year control per the Consent Order. The least cost and most cost effective 2-year CSO control plan was determined to be Alternative 1 (Conveyance and Centralized Treatment to a total of 80 mgd). This 2-year control alternative is estimated at an approximate total of **$270 million** (2018 US Dollars), including $190 million for CSO projects in the collection system and $80 million for WPCF improvements necessary to update the existing facility and increase its reliable peak flow capacity to a nominal 20 mgd. There will be additional costs for O&M of new infrastructure and for planning as LTCP

updates are required every five years throughout the CSO program. These costs are not included in the $270 million, but are accounted for in Section 9.

The least cost 2-year control plan was evaluated via a financial capability analysis as described in Section 9. This project was originally considered to be unaffordable to NPU per the financial analysis presented in Section 9 of the August 14, 2018 LTCP submittal (Appendix F). In this original financial analysis, it was assumed that Clean Water Fund loans and grants from DEEP would not be available for the duration of the CSO program, as these generally cannot be guaranteed to remain throughout the planning period. Due to this determination, NPU was originally forced to consider less costly control plans that could be implemented over a reasonable time period. As the 3-month control level was the most cost-effective plan overall and corresponds to the knee-of-the-curve, this plan was originally recommended in the August 14, 2018 submittal. The least cost, and most cost effective, 3-month CSO control plan is Alternative 2 (Conveyance and Storage).

During discussions and workshops with DEEP following the submittal of the August 14, 2018 LTCP, DEEP heavily emphasized goals of achieving 2-year CSO control in Norwich and larger water quality benefits earlier in the program schedule**. In these workshops, DEEP stated a clear intent to fund NPU's CSO program via the Clean Water Fund**. While unaffordable without Clean Water Fund grant and loan funding, the 2-year Conveyance and Centralized Treatment alternative is achievable with the maximum allowable financial support from DEEP.

At DEEP's request, CDM Smith has revised this LTCP and assumed that Clean Water Fund grant and loan percentages will be available to NPU (at the same percentages available today) to the maximum extent possible throughout the planning period. Under these conditions, 2-year CSO control becomes affordable for NPU and its rate payers. Section 9 of this revised report presents this revised financial analysis assuming Clean Water Fund grant and loan funding is available throughout the planning period. **If DEEP funding is reduced or becomes unavailable, the Recommended Plan and / or implementation schedule will need to be reevaluated**.

The 2-year CSO control alternative for Conveyance and Centralized Treatment has been selected as the Recommended Plan. The schedule of projects has been rearranged based on DEEP input to focus early in the program on improvement at the WPCF, wet weather treatment facilities at the WPCF, and improved conveyance from the Shetucket Interceptor (via a new Rose Alley Pumping Station and force mains) in the near term. These projects will be followed by the construction of the designed Eighth Street conveyance improvements. Section 10 further explores the merits and limitations of the Recommended Plan.

Section 9

Section 9

Financial Capability Assessment

9.1 Introduction

This section provides an update to the financial capability analysis submitted to the Connecticut Department of Energy and Environmental Protection (DEEP) in the August 14, 2018 LTCP submittal. This update includes the impact of a revised LTCP and considers NPU's current financial situation.

Consistent with the previous submittal, this analysis follows the framework developed by the US Environmental Protection Agency (EPA) in *Combined Sewer Overflows — Guidance for Financial Capability Assessment and Schedule Development*, published in 1997 and updated in 2014. The focus of this updated financial capability analysis is the impact of the proposed plan on the average residential ratepayer through an evaluation of the household burden. Household burden is a metric defined by EPA that assesses the typical residential sewer bill as a percent of a community's median household income (MHI). Under the EPA guidance process, a household burden exceeding two percent of MHI is deemed a high burden.

The August 2018 LTCP was developed per the EPA CSO Policy to seek the most cost-effective plan for reducing CSO discharges using the knee-of-the-curve. Although many alternatives were developed and evaluated (including 2-year control), the 3-month level of control was ultimately recommended. The corresponding financial capability assessment was developed under the presumption that the Connecticut Clean Water Fund may not be available in its current form for the duration of the program, and/or that DEEP may not be able to fund NPU's program due to limited funding availability. Thus, the 2018 LTCP assumed that NPU's CSO program would have to be completely self-funded. The 3-month level of CSO control plan, if self-funded, would have exceeded the EPA threshold for household burden as described in the appended 2018 LTCP.

Following the submittal of the August 2018 LTCP, NPU engaged in multiple discussions and workshops with DEEP on the proposed Recommended Plan. Based on these discussions with DEEP, a revised plan achieving a 2-year level of control was developed. This is a high level of control compared with mandates issued by EPA and other regulatory authorities throughout the US. NPU's new Recommended Plan also carries a significant capital investment in the early years of the program.

The first phase of the program identifies approximately $173M (2018 dollars) in capital spending by FY 2027, which would result in NPU ratepayers facing average annual rate increases of 10 percent for that timeframe. For the period FY 2024 to FY 2028, the average annual rate increase is close to 20 percent per year. Increases of this magnitude would result in a projected typical residential household bills to increase from $547 in FY 2020 to $1,186 in FY 2028. **Note that these increases include substantial grant funding and SRF availability for the remainder of the program. If that proves not to be the case, the evaluation herein significantly understates the challenges facing NPU**. If no grant money or SRF loans were received by NPU,

but the current schedule maintained, the annual rate increase through FY 2028 would need to average 17 percent.

After the first phase of the program, the proposed capital plan identifies a capital recovery period through FY 2036 where NPU continues to spend on annual R&R but does not undertake any new major capital projects specifically related to the LTCP.

As the LTCP CSO improvements resume in FY 2037, the household burden increases and is projected to exceed 2 percent in FY 2040.

9.2 Methodology and Assumptions

This report and financial capability assessment have been prepared in accordance with EPA's financial capability assessment guidance document and standard industry practices. Data was obtained from various sources to develop a financial projection model to project the impact of the proposed capital program on future revenue requirements and rates for the City and its residents. All data used in this report have been gathered from NPU or other credible public sources.

This financial capability assessment projects financial changes over a 30-year time frame. Given the forecasting horizon, numerous assumptions are necessary and have been used in this assessment. The critical assumptions used for this analysis are described below.

- Consistent with EPA guidance, only sewer related costs are included in this analysis.
- Projections are based on cash basis; annual depreciation expense is not factored into revenue requirement.
- It is assumed NPU maintains an operating reserve equal to 2 months of annual operating expenses, and a debt service reserve fund balance equal to 2 months of annual debt service. The projections assume NPU meets a debt service coverage ratio of 120% on total annual debt service for all bond issues.
- The projections assume $325,000 in non-LTCP cash funded capital as an annual allowance for ongoing renewal and replacement (R&R). This represents the average anticipated cash-funded capital for NPU for items such as technology, main installations, service installations, manholes/frames/covers, and other capital categories.
- An annual allowance for projects related to the Capacity, Management, Operation, and Maintenance (CMOM) program are included. An allowance of $200,000 per year in included, increasing annually over 10 years to a maximum of $500,000 per year. The amounts are assumed cash funded.
- Operating and maintenance (O&M) costs are assumed to inflate at an average annual rate of 3.0 percent.
- Capital costs are projected to increase at an average annual rate of 4.0 percent.

- Miscellaneous revenues are assumed to remain constant over the projection period. Miscellaneous and non-rate revenues can be erratic and are generally beyond NPU's control, so NPU has been conservative in holding those constant at current budgeted levels.

- Incremental O&M resulting from program implementation has been estimated and included in the analysis. It is assumed that incremental O&M for the relevant projects starts at the end of project construction and is inflated annually at the rate of O&M inflation. The annual cost for incremental O&M for projects included in the analysis is presented in Table 9-1.

Table 9-1 Incremental O&M Costs Associated with Recommended Plan

Project	Annual Cost ($ 2018)
WPCF Core Upgrades (20 MGD)	$50,000
HRC Facility (60 MGD) at Treatment Plant, including allowance for contamination and business disruption	$500,000
New Rose Alley PS (65 MGD) and FM (42-inch)	$100,000
Shetucket Relief Interceptor	$25,000
Rose Alley Commuter Lot Tank: 0.90 Mgal storage tank, 2 mgd dewatering pump station, new FM, new gravity pipe, sluice gate diversion structure, and allowance for disruption.	$50,000

- Based on discussions with DEEP, this analysis assumes NPU will receive State Revolving Fund (SRF) grants and loans through the Connecticut Clean Water Fund to finance capital costs. Grants for CSO projects are understood to be 50% of project cost. Grants for WPCF nutrient upgrades are understood to be 30% of related project cost, and grants for general upgrades to wastewater infrastructure are understood to be 20% of project cost. Loans through the Clean Water Fund are understood to have a 2.0 percent interest rate, a term of 20 years, and issuance costs of 1.0 percent. In requesting that NPU pursue the aggressive Recommended Plan presented herein for 2-year CSO control, DEEP committed in meetings to provide maximum allowable funding for the recommended CSO program through the Clean Water Fund. **If at any point during the program SRF funding is not available, or is reduced from current levels, it will have a significant impact on the projected expenses and household burden and NPU will need to re-evaluate the program, their implementation schedule, or both**.

- NPU employs a fixed base charge, and consumption-based usage and mandatory upgrades charges. For FY 2020, the current sewer annual base charge is $104.28, the usage rate is $7.43 per hundred cubic feet (HCF) and the mandatory upgrades charge is $0.64 per HCF.

- MHI for Norwich in 2018 was $55,391 based on U.S. Census Bureau, American Community Survey (ACS) data. MHI is assumed to increase 1.5 percent annually, generally consistent with the historical pattern.

- To be consistent with EPA guidance, it was necessary to determine residential-only sewer consumption, and the associated residential dwelling units accounting for that consumption. NPU categorizes some large multi-unit residential properties as commercial

customers, so for this analysis total residential consumption has been assumed to be the total of the residential and commercial categories from NPU's billing system. Total annual consumption is 859,664 HCF, and the number of occupied residential dwelling units from Census estimates is 15,692. The typical residential dwelling unit is thus estimated to consume 54.78 HCF (41,000 gallons) annually.

9.3 Financial Analysis

This section summarizes projected sewer revenue requirements for NPU, including the impact of the recommended capital program. This analysis includes approximately $270M (2018 US Dollars) for major capital projects (CSO & WPCF), and $4M in LTCP Updates throughout the projection period. In discussions with DEEP, it was estimated that NPU would be eligible for $105M (2018 dollars) in grant funding for the program. Therefore, the projections are based on $169M in estimated capital through FY 2053. The projection period for this analysis spans a 30-year period (through FY 2050), which means that there are approximately $19M of capital expenditures related to the LTCP outside of the projection period.

Actual capital costs will be higher than the planned expenditures stated in 2018 dollars when construction commences, due to inflation. Factoring in the assumed 4 percent annual inflation rate, the total cost of the LTCP will be closer to $527M. This means that the estimated total grant funding in inflated dollars is $215M, with SRF financing available to NPU for the remaining $312M. To the extent grant funding or SRF financing is not available at these levels, the projected rates and household burden will increase significantly from what is presented in this analysis.

Figure 9-1 details annual capital spending for this program in inflated dollars. The figure shows the total capital spending by year, and the assumed grant funding based on discussions with DEEP. A more detailed description of the projects associated with the spending totals are in Section 10 of this report.

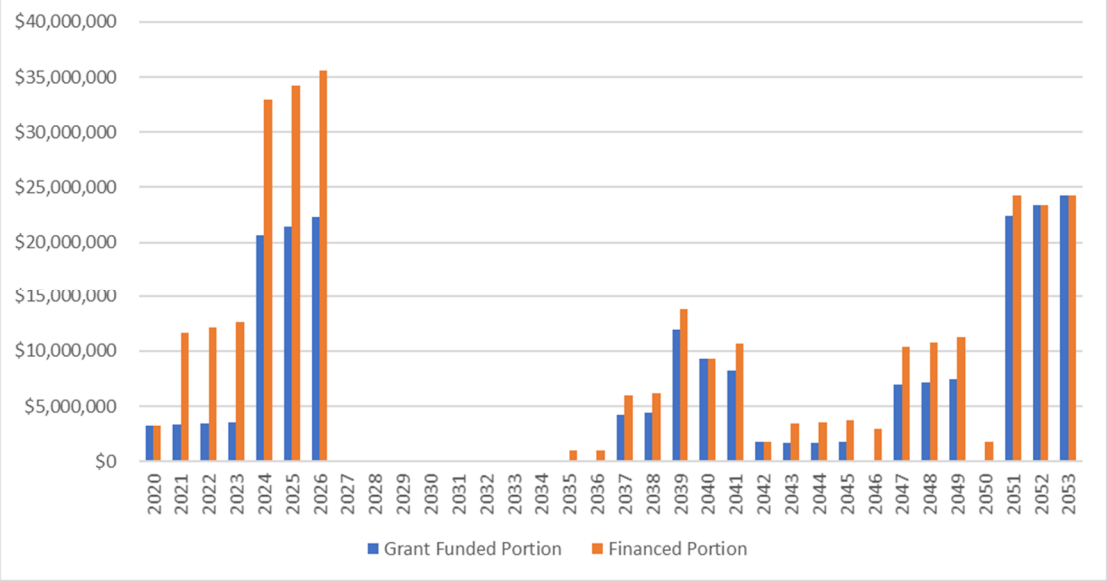


Figure 9-1
Proposed LTCP Spending by Year, with Grant Funding (Inflated $)

The $527M in capital spending represents the projects related to the LTCP and water pollution control facility (WPCF) upgrade in inflated dollars.

Projected revenue requirements will be summarized in four main components:

- O&M costs, which include incremental costs attributable to the LTCP.
- Debt service and capital expenditures.
- Miscellaneous revenue.
- Transfers for reserves.

The following sections summarize the projected sewer expenses and revenue requirements.

9.3.1 Operations and Maintenance

Operations and maintenance costs exist for all aspects of the sewer utility. O&M expenses have been separated into eight general categories, generally consistent with NPU's budget structure:

- Wages — salary costs related to the sewer utility.
- Employee Benefits — costs of benefits offered to employees.
- Operations and Maintenance — includes general sewer O&M costs for the treatment plant, laboratory, pump stations and collection system.
- Insurance — insurance costs associated with property and vehicles, directors and officers, claims, and liability.

- Customer Service —fees and costs related to outside services, utilities, software support, collections, payment processing, employee training, equipment, and postage.
- General and Administrative — general operating costs, including costs related to consulting, legal and software fees.
- Bad Debt Expense — allowance for expense incurred due to lack of customer payment.
- Incremental O&M — anticipated incremental O&M increases resulting from implementation of the capital program.

Total operating expenses are projected to grow from $6.1 million in FY 2020 to $16.5 million in FY 2050. This represents an average annual cost increase of 3.4 percent. Anticipated operating expenses over time are summarized in Table 9-2.

Table 9-2 Projected Operating Expenses

O&M Category	FY 2020	FY 2026	FY 2032	FY 2038	FY 2044	FY 2050
Operations Wages	$2,488,652	$2,971,581	$3,548,223	$4,236,763	$5,058,917	$6,040,612
Employee Benefits	$949,292	$1,133,504	$1,353,463	$1,616,106	$1,929,715	$2,304,181
Operations & Maintenance	$2,089,152	$2,493,998	$2,977,405	$3,554,618	$4,243,841	$5,066,810
Insurance	$174,153	$207,948	$248,301	$296,484	$354,017	$422,715
Customer Service	$84,871	$101,340	$121,006	$144,487	$172,525	$206,004
General & Administrative	$230,239	$285,019	$338,459	$402,270	$478,464	$569,443
Depreciation	$0	$0	$0	$0	$0	$0
Bad Debt Expenses	$49,000	$58,509	$69,862	$83,419	$99,607	$118,936
Incremental O&M	$0	$823,401	$983,183	$1,173,972	$1,455,699	$1,738,181
Total Operations and Maintenance	**$6,065,359**	**$8,075,299**	**$9,639,902**	**$11,508,121**	**$13,792,786**	**$16,466,881**

9.3.2 Debt Service and Capital Expenditures

Capital costs can be financed through current year cash generated from annual rate revenue and built into rate revenue requirements as cash funded capital, or through bonded debt as debt service. Debt service and capital expenditures have been separated into three categories: existing debt service, anticipated debt service, and cash funded capital.

Existing debt service represents sewer-related debt that is outstanding as of the start of FY 2020. Anticipated debt service describes annual debt service payments projected from implementation of the revised 2-year level of control plan.

Cash funded capital is annual capital projects that NPU elects to fund directly through current year rate revenue without issuing debt. As noted in the assumptions, based on discussions with DEEP, NPU assumes the availability of $215M in grant funding, and that the entirety of the $312M remaining LTCP capital costs will receive SRF loans. The allowances for CMOM and R&R, which are not included in the total LTCP costs, will be funded using current rate revenues.

Table 9-3 shows the projected capital and debt obligations through FY 2050, including costs associated with the proposed program.

Table 9-3 Debt Service and Capital Expenditures

	FY 2020	FY 2026	FY 2032	FY 2038	FY 2044	FY 2050
Existing Debt Service	$679,857	$626,897	$457,476	$0	$0	$0
Anticipated Debt Service	$193,945	$4,292,901	$9,329,739	$9,929,420	$11,782,612	$5,863,610
Cash Funded Capital	$603,893	$1,037,832	$1,428,633	$1,807,677	$2,287,288	$2,894,148
Total Debt Service and Capital	**$1,477,696**	**$5,957,630**	**$11,215,848**	**$11,737,096**	**$14,069,900**	**$8,757,758**

9.3.3 Reserve Transfers

The projections include an allowance for reserve fund transfers to fund an operating reserve and debt service reserve fund consistent with the covenants associated with NPU's loan agreements. The operating reserve fund balances is set to 2 months of annual operating expenses, and the debt service reserve fund is set to 2 monthly payments on the original principal of the loan. The existence of these funds and maintenance of an adequate balance is good practice to account for any large fluctuations in annual expenses or unforeseen cash flow issues. In addition, as part of the analysis it was assumed that NPU maintains a debt service coverage ratio of 120 percent.

Table 9-4 shows the reserve transfers in increments through FY 2050. No additional deposits for coverage are required after accounting for the projected rate increases to cover revenue requirements.

Table 9-4 Reserve Transfers

	FY 2020	FY 2026	FY 2032	FY 2038	FY 2044	FY 2050
Transfer to Operating Revenue	$14,400	$172,376	$46,735	$55,804	$66,895	$79,876
Transfer to Debt Service Reserve Fund	$18,676	$442,719	$0	$140,999	$37,862	$247,927
Total Reserve Transfers	**$33,076**	**$615,095**	**$46,735**	**$196,803**	**$104,757**	**$327,802**

9.3.4 Miscellaneous Revenue

Miscellaneous, or non-rate sewer revenue is not directly related to sewer rates. Table 9-5 summarizes miscellaneous revenues through the projection period.

Table 9-5 Projected Miscellaneous Revenue

Miscellaneous Revenue	FY 2020	FY 2026	FY 2032	FY 2038	FY 2044	FY 2050
Penalties	$50,400	$50,400	$50,400	$50,400	$50,400	$50,400
Other Revenues	$50,200	$50,200	$50,200	$50,200	$50,200	$50,200
Capital Connection Fees	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000
Capital Contributions	$325,000	$325,000	$325,000	$325,000	$325,000	$325,000
Total Miscellaneous Revenue	**$485,600**	**$485,600**	**$485,600**	**$485,600**	**$485,600**	**$485,600**

9.3.5 Revenue Requirement

The revenue requirement is the total revenue that must be generated annually through sewer rates to fund NPU's sewer expenses. The sewer revenue requirement is calculated by subtracting non-rate sewer revenue from total sewer expenses. Table 9-6 shows the total revenue requirement, which includes projections for implementing projects in the revised 2-year level of control plan. The total revenue requirement is projected to grow from $7.1 million in FY 2020 to $25.1 million in FY 2050, equivalent to an average annual increase of 4.3 percent. During the period FY 2024 to FY 2028, when the debt service for the first phase of the LTCP is expected to ramp up, the average annual increase in revenue requirement is close to 20 percent.

Table 9-6 Projected Revenue Requirement

	FY 2020	FY 2026	FY 2032	FY 2038	FY 2044	FY 2050
Operating Expenses	$6,065,359	$8,075,299	$9,639,902	$11,508,121	$13,792,786	$16,466,881
Debt Service and Capital	$1,477,696	$5,957,630	$11,215,848	$11,737,096	$14,069,900	$8,757,758
Reserve Transfers	$33,076	$615,095	$46,735	$196,803	$104,757	$327,802
Total Expenses	**$7,576,131**	**$14,648,024**	**$20,902,485**	**$23,442,020**	**$27,967,442**	**$25,552,442**
Less: Miscellaneous Revenue	($485,600)	($485,600)	($485,600)	($485,600)	($485,600)	($485,600)
Revenue Requirement	**$7,090,531**	**$14,162,424**	**$20,416,885**	**$22,956,420**	**$27,481,842**	**$25,066,842**

Figure 9-2 graphically depicts the projected revenue requirement for the $527M program. As noted, these projections include the availability of grant funding and SRF loans.

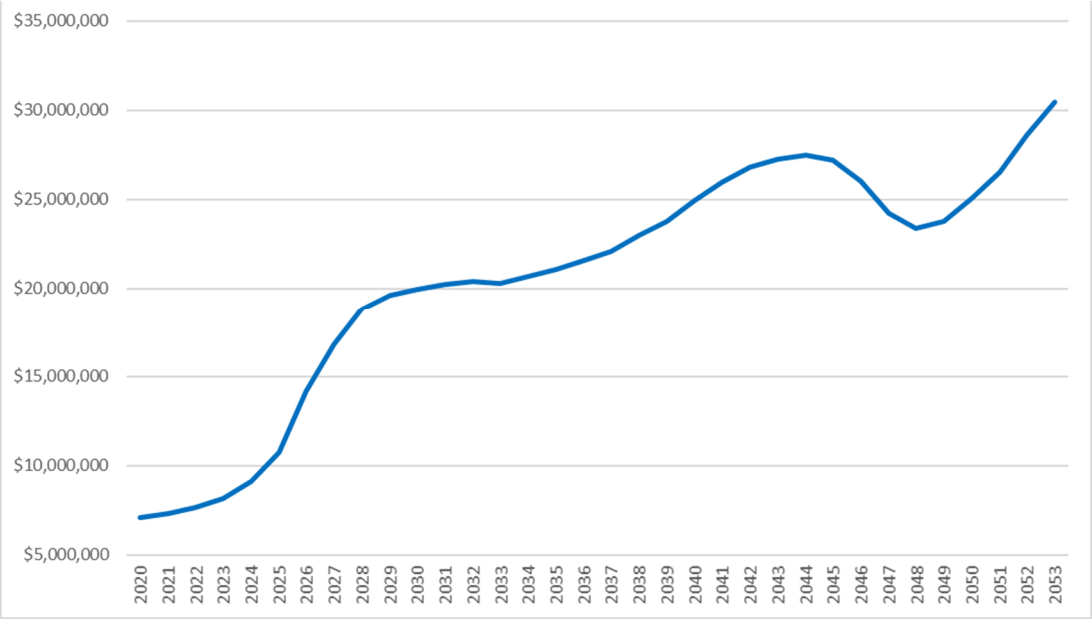


Figure 9-2
Projected Revenue Requirement – With Proposed Program

The projected revenue requirements shown in Figure 9-2 will directly translate into increased sewer rates and burden for City households. The first phase of the program identifies $236M in spending through FY 2027, with an estimated $83M in grant funding over that timeframe. The costs associated with these projects drive revenue requirements to an average annual increase of nearly 20 percent between FY 2024 and FY 2028.

The revenue requirement under the proposed program is expected to more than double over the next 10 years, and nearly triple in 20 years. Revenue requirement increases of this magnitude will cause significant rate increases in the short term and in the future.

9.4 Residential Indicator

The "Residential Indicator" is defined as the typical dwelling unit sewer bill compared to MHI and is used as a benchmark by EPA in assessing the affordability of a proposed program. The estimated sewer household bill for FY 2020 in Norwich is $547 based on annual sewer use of 54.78 HCF per residential dwelling unit.

The projected growth in the typical household sewer bill, MHI and the corresponding Residential Indicator are shown in Table 9-7 for the revised 2-year level of control plan. Figure 9-3 graphs the household burden increase through FY 2050.

Table 9-7 Projected Household Bill, MHI and Residential Indicator

	FY 2020	FY 2026	FY 2032	FY 2038	FY 2044	FY 2050
Estimated Household Bill	$547	$893	$1,288	$1,448	$1,733	$1,733
MHI	$57,065	$62,398	$68,228	$74,604	$81,575	$89,197
Residential Indicator	0.96%	1.43%	1.89%	1.94%	2.12%	1.94%

The residential indicator reaches 2 percent in FY 2040 under the program. The residential indicator reaches 1.9 percent in FY 2029 and remains at that level until it reaches the 2 percent threshold in FY 2040. The typical bill in the City would increase by a total of $1,186 over the 30-year period. A program of this size will create a significant burden on the City's residents.

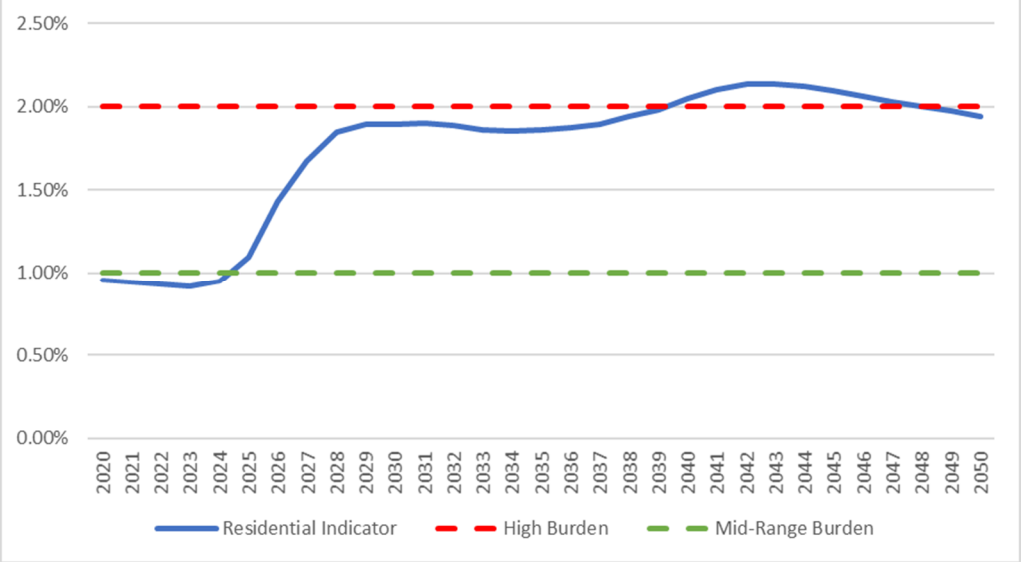


Figure 9-3
Projected Household Bill, MHI, and Residential Indicator

As discussed, if no grant money or SRF loans are received by NPU, but the recommended program and current schedule are maintained, in FY 2027 the typical bill is projected to be $1,957, and the burden would exceed 3.1 percent of MHI. This would require average annual rate increases of 20 percent from FY 2020 to FY 2027. The burden would exceed 2.5 percent of MHI throughout the 30-year projection period.

9.5 Phase 2 Evaluation

This section presents the Phase 2 financial impact indicators, which are benchmarks as defined by EPA. These indicators evaluate ancillary factors that may affect an entity's ability to fund the proposed LTCP. This assessment identifies three categories, each with two indicators as listed below:

- Debt: bond rating and overall net debt
- Socio-economic: MHI and unemployment rate
- Financial management: property tax revenue and property tax collection rate

While the Phase 1 assessment (residential indicator) is a time-series analysis, the Phase 2 assessment is a cross-sectional view of financial capability for the entity. To complete all of the Phase 2 indicators, the City of Norwich has been used as the proxy, as there are certain indicators that are not applicable to NPU and are not representative NPU's financial capability to undertake the program.

9.5.1 Debt Indicators

The two debt indicators used in Phase 2 of the financial capability assessment are bond rating and overall net debt. These indicators are indicative of the City's capacity to access capital

markets to raise the necessary capital for implementing the anticipated capital improvement plan.

9.5.1.1 Bond Rating

The bond rating indicator addresses a general capacity to undertake debt. While rating designations vary by credit rating agencies, long-term bond ratings range from AAA/Aaa (high grade) to C/D (in default). Table 9-8 shows the most recent ratings from Moody's Investors Service (MIS) and from Standard & Poor's (S&P). The scoring for this indicator includes the ratings as follows:

- ***Strong (Score = 3)*** — a high grade or strong bond (e.g., Aaa or AAA, Aa or AA, A).
- ***Mid-Range (Score = 2)*** — a medium grade bond (e.g., Baa or BBB). These are the minimum "investment grade" bond ratings.
- ***Weak (Score = 1)*** – a speculative or "junk" bond (e.g. Ba or BB, or lower)

Based on benchmarks provided in the EPA guidance document, this indicator for the City is rated strong and earns a score of 3. Both the MIS rating of Aa3 and the S&P rating of AA equate to a "Strong" rating, so for this assessment, these scores are the same.

Table 9-8 Current Bond Rating

Item	Rating
Standard & Poor's	AA
Moody's Investors Service (MIS)	Aa3
Bond Rating Indicator Score	3

9.5.1.2 Overall Net Debt as a Percent of Full Market Property Value

Overall net debt is the amount of tax-backed bonded debt for all taxing units not supported by revenue from sewer user fees. NPU does not have any tax-bonded debt, as it issues revenue bonds supported by user fees. For the purposes of this analysis, the City of Norwich has been used as the representative entity.

Indicator scores for overall net debt are based on the percentage of full-market property value. The EPA benchmarks for overall net debt are:

- ***Strong (Score = 3)*** — overall net debt is below two percent of the full-market property value.
- ***Mid-Range (Score = 2***) — overall net debt is two to five percent of the full-market property value.
- ***Weak (Score = 1)*** — overall net debt is more than five percent of the full-market property value.

Overall net debt for the City is taken from the City's 2019 CAFR, and the market value of property for the City is based on the State of Connecticut's Office of Policy Management Equalized Grand List. The information is shown in Table 9-9.

Table 9-9 Overall Net Debt Rating

Item	Value
Direct net debt (2019)	$46,196,000
Debt of overlapping entities (proportionate share of multi-jurisdictional debt)	$0
Overall net debt (2019)	$46,196,000
Market value of property (2019)	$2,801,852,000
Overall net debt as a percent of full market property value	1.6 percent
Overall Net Debt Indicator Score	3

Overall net debt for the City in 2019 was $46.2 million. The City's market value of property (equalized valuation) is $2.8 billion, making overall net debt 1.6 percent of full-market property value. This indicator is thus rated as "Strong".

9.5.2 Socio-economic Indicators

The socio-economic indicators used in Phase 2 of the financial capability assessment are unemployment rate and median household income. These indicate the City's general economic condition.

9.5.2.1 Unemployment Rate

Unemployment rate is a measure of the City's labor force that is unemployed but seeking employment. The EPA guidance document benchmarks for unemployment rate are:

- ***Strong (Score = 3)*** — unemployment rate is more than one percent below the national average.
- ***Mid-Range (Score = 2)*** — unemployment rate is within one percent of the national average.
- ***Weak (Score = 1)*** — unemployment rate is more than one percent above the national average.

The unemployment rate for Norwich, as compared to national average, is shown in Table 9-10. Since the City's unemployment rate is within one percent of the national average, it receives a "Mid-Range" rating for this indicator.

Table 9-10 Unemployment Rate Comparison

Item	Value
Norwich: Unemployment Rate (2018)	4.5 percent
Connecticut: Unemployment Rate (2018)	4.1 percent
U.S.: Unemployment Rate (2018)	3.9 percent
Comparison of Norwich with National (2018)	0.6 percent above
Unemployment Rate Indicator Score	2

9.5.2.2 Median Household Income

This indicator is related to the Residential Indicator in that they both consider MHI. While the Residential Indicator compares MHI and average annual household bills, the median household income indicator simply compares Norwich's MHI with national MHI. Thus, this benchmark is a measure of the relative wealth or poverty of the service area. The EPA guidance document benchmarks for median household income are:

- ***Strong (Score = 3)*** — MHI is more than 25 percent above the national average.
- ***Mid-Range (Score = 2)*** — MHI is within 25 percent (+/-) of the national average.
- ***Weak (Score = 1)*** — MHI is more than 25 percent below the national average.

City and national MHI values, shown in Table 9-11, are based on the most recent ACS data.

Table 9-11 Median Household Income Comparison

Item	Value
Most recent Norwich estimate (2018 ACS)	$55,391
Most recent National estimate (2018 ACS)	$60,293
Compare Permittee with Average National MHI	8.9 percent below
Median Household Income Indicator Score	2

Figure 9-4 compares City, state average and national average MHI. Since 1990, national and state average MHI have grown at average annual rates of 2.5 and 2.2 percent respectively, while MHI for Norwich has grown at a rate of 1.8 percent.

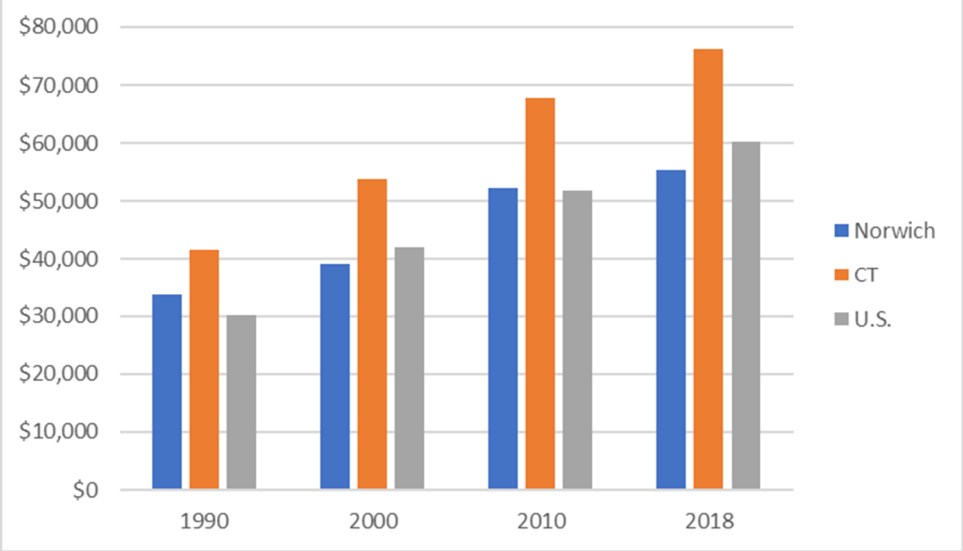


Figure 9-4
Median Household Income –Time Series

In addition to the City slightly lagging in MHI, the U.S. Census Bureau estimated that in 2018, 14.1 percent of the City's residents were living below the poverty line, consistent with the national average of 14.1 percent, and above the state average of 10.0 percent. Poverty in Norwich has increased during this decade, as the poverty rate was 11.5 percent in 2010.

9.5.3 Financial Management Indicators

Two financial management indicators assess a community's capacity to support debt as described below. NPU is not a taxing entity and does not utilize property taxes to support its operations, so the city of Norwich has been used as the representative entity.

9.5.3.1 Property Tax Revenues as a Percent of Full Market Property

Property tax revenue as a percent of full market property value indicates the funding capacity available to support debt, based on the wealth of the community. The EPA guidance document benchmarks for property tax revenues are:

- ***Strong (Score = 3)*** — property tax revenue is below two percent of the full-market property value.
- ***Mid-Range (Score = 2)*** — property tax revenue is two to four percent of the full-market property value.
- ***Weak (Score = 1)*** — property tax revenue is more than four percent of the full-market property value.

In the City, property tax revenues collected in 2019 were $74.4 million, with a full-market property value of $2.8 billion. As shown in Table 9-12, the calculated property tax revenue indicator for the City is 2.7 percent, rating the City as "Mid-Range".

Table 9-12 Property Tax Revenues

Item	Value
Full market value of real property (2019)	$2,801,852,000
Property tax revenue (2019)	$74,440,000
Property tax revenue as a percentage of full market property value	2.7 percent
Property Tax Revenue Indicator Score	2

9.5.3.2 Property Tax Collection Efficiency

The property tax collection rate represents the relationship of property taxes collected versus property taxes levied. The EPA benchmarks for property tax collection efficiency are:

- ***Strong (Score = 3)*** — property taxes collected are above 98 percent of the property taxes levied.
- ***Mid-Range (Score = 2)*** — property taxes collected are between 94 and 98 percent of the property taxes levied.
- ***Weak (Score = 1)*** — property taxes collected are less than 94 percent of the property taxes levied.

Computation of this indicator rating is shown in Table 9-13 and is based on the City's data for the 2019 tax year. The City's property tax collection rate is 97 percent of the taxes levied. This data is indicative of "Mid-Range" financial capability.

Table 9-13: Property Tax Collection Efficiency

Item	Value
Property tax revenue collected (2019)	$74,440,000
Property taxes levied (2019)	$76,713,000
Property tax revenue collection rate	97.0 percent
Tax Collection Efficiency Indicator Score	2

9.5.4 Summary of Financial Impact Indicators

Table 9-14 shows EPA's Phase 2 Financial Impact Indicator benchmarks used to evaluate the six indicators. The indicators are shown in the left-hand column. Corresponding EPA benchmarks for each indicator are shown for "Strong", "Mid-Range" or "Weak" ratings. The blue-shaded boxes in this table indicate where Norwich scores for each indicator.

Table 9-14 Financial Impact Assessment Benchmarks

Indicator	Strong (Score=3)	Mid-Range (Score=2)	Weak (Score=1)
1. Bond Rating	AAA to A (S&P) or	BBB (S&P) or	BB to D (S&P) or
	Aaa to A (MIS)	Baa (MIS)	Ba to C (MIS)
2. Overall Net Debt	Below 2 percent	2 percent to 5 percent	Above 5 percent
3. Unemployment Rate	>1 percent below National Average	±1 percent of National Average	>1 percent above National Average
4. Median Household Income	>25 percent above adjusted National MHI	±25 percent of adjusted National MHI	>25 percent below adjusted National MHI
5. Property Tax Revenue	Below 2 percent	2 percent to 4 percent	Above 4 percent
6. Property Tax Collection Rate	Above 98 percent	94 percent to 98 percent	Below 94 percent

Note: The highlighted values represent NPU's benchmark scores

Table 9-15 summarizes Norwich's values and scores for the EPA indicators. EPA considers an overall average score below 1.5 weak and an overall score above 2.5 strong. An overall score between 1.5 and 2.5 is considered mid-range. Overall, the unweighted average score for the Phase 2 evaluation is 2.33, within the mid-range of the financial capability scale.

Table 9-15 Financial Impact Assessment Summary

Financial Impact Indicator	Value	Score
1. Bond rating	AA/Aa3	3
2. Overall net debt as a percent of property value	1.6 percent	3
3. Unemployment rate compared with national average	0.6 percent above	2
4. Median household income compared with national average	8.9 percent below	2
5. Property tax revenue as a percent of property value	2.7 percent	2
6. Property tax collection rate	97 percent	2
Overall Financial Impact Indicator Score		**2.33**

As mentioned, NPU is an independent entity from the City of Norwich, with no taxing ability. There are several specific Phase 2 metrics that deal with property taxes, so are not relevant to NPU. Table 9-16 summarizes the Phase 2 metrics excluding the property tax related metrics.

Table 9-16 Financial Impact Assessment Summary – No Property Tax Metrics

Financial Impact Indicator	Value	Score
1. Bond rating	AA/Aa3	3
2. Unemployment rate compared with national average	0.6 percent above	2
3. Median household income compared with national average	8.9 percent below	2
Overall Financial Impact Indicator Score		**2.33**

9.6 Assessment of Funding the CSO Program via City Taxes

Roughly half of the City of Norwich is currently on septic systems, and Norwich Public Utilities only has roughly 6,000 sewer customers. By population, slightly more than half of the City is on sewer, but there remains a significant portion of the population that does not directly contribute sewer revenue to NPU. As such, DEEP had asked whether it would be financially advantageous to shift a portion of the cost of the CSO program to the City of Norwich tax base in lieu of the NPU sewer billing structure.

The political and legal effort to change NPU's charter and the City of Norwich's tax structure should not be overlooked or underestimated. While theoretically possible, this process would take years and delay implementation of the CSO LTCP program overall. However, in response to the DEEP request, CDM Smith evaluated the impact of moving 50% of the CSO program cost from capital spending paid for by the NPU sewer revenue to capital spending paid for from the City tax base. However, through the course of our evaluation, it became clear that this topic is not intuitive. The following is a summary of our assumptions and findings:

- For FY 2037, the average residential bill is projected to be $1,450/year.
- Operations and maintenance expenses are roughly 44% of the total.
- Cash funded capital will be roughly 11% of the total.
- CSO LTCP costs will be roughly 46% of the revenue requirement in that year.
- If you shift 50% of the LTCP program cost to the City tax base, this represents only 23% of the total.
- 23% of $1,450 is approximately $331 that would be moved to the tax base.
- $331 would then be spread over a larger population base, reducing the effective cost to approximately $192 per residential household to be paid on the tax bill.
- Sewer users also pay taxes. They will still pay the $192 as an increase to their tax bill. So, their household cost is effectively reduced by $139.
- This means the residential household sewer bill will be effectively reduced by $139, or approximately 10% of total bill.

While a 10% reduction in the sewer bill would make the sewer utility more affordable overall, we observe the following negative impacts that should be considered:

- The tax bill for non-sewer users would go up by $192 as a result. While everyone would benefit from cleaner rivers, this would necessitate a substantial public relations campaign which would take time and also have a cost. There is always a segment of the population that fights tax increases, regardless of the benefit.

- This shift to the tax base reduces the share of costs borne by both outside City customers and in-city tax exempt entities such as schools, churches, and many other current sewer customers.
- Reducing the sewer bill for customers outside of the City incentivizes large users to move outside the city or develop outside the city. In the long run this would actually reduce the revenue available to NPU for CSO projects. This simultaneously hurts NPU's ability to fund sewer projects and further reduces the tax roll. Both aspects would spiral unfavorably.

As an overall observation, it appears that the marginal short-term financial benefits from such a funding structure (10% reduction in sewer user cost) would not be worth the potential for larger long-term problems. After discussion with NPU and DEEP and careful consideration, this option was not carried forward.

9.7 Conclusion

The recommended LTCP represents a significant capital investment in system improvements and a commitment to improving water quality in Norwich. The largest investment is made early in the program, with a focus on WPCF improvements, wet weather CSO treatment at the WPCF and Rose Alley Pumping Station conveyance, followed by the construction of the Eighth Street Conveyance Improvements and a period of capital recovery. The significant capital investment in the early years of the program will cause significant rate increases to NPU's customer base with projected rate increases of nearly 10 percent annually over the first 8 years, even with the assumed level of grant funding and SRF availability. To the extent that the levels of DEEP grant funding and SRF loans are not fully available at the assumed levels, the impact to NPU and its customer base will be even more dramatic. Without grant funding or SRF loans, the projected household burden will exceed 3 percent, well above EPA's affordability threshold. **If at any point DEEP grants and SRF loans are not available as assumed, the recommended CSO program for 2-year level of control becomes unaffordable and it will be necessary to re-evaluate and modify the recommended program and schedule.**

Similarly, the 10-year long capital recovery period shown in the recommended program schedule stabilizes the rate increases of the program and allows the resulting household burden to stay approximately at the EPA's recommended affordability guideline of 2% of household MHI (although it does exceed this criteria).

Overall, when the program schedule is stretched out as shown and grant funding and SRF loans (at the same rates as today) are assumed, the program is achievable. The recommended LTCP program components and schedule for 2-year CSO level of control are outlined in Section 10.

Section 10

Section 10
Recommended Plan

10.1 General

Norwich Public Utilities (NPU), like many New England wastewater utilities, is burdened by aging infrastructure and increasing regulation. This Combined Sewer Overflow (CSO) Long-Term Control Plan (LTCP) focuses on the improvements required to address Connecticut Department of Energy and Environmental Protection's (DEEP's) Consent Order WRMU17001, which requires NPU to achieve a 2-year level of control for CSO discharges in Norwich. Through an extensive process of alternatives development and screening, model simulations, and comprehensive evaluation, as detailed in Sections 5 through 9 of this report, NPU has determined that the least costly and most cost-effective 2-year CSO control plan (Conveyance and Centralized Treatment to a total of 80 mgd) is estimated to cost an approximate total of **$270 million in 2018 US Dollars**. This includes $190 million for CSO projects in the collection system and $80 million for the Hollyhock Island WPCF improvements as necessary to update the existing facility and increase its reliable peak flow capacity to a nominal 20 mgd as discussed in Sections 3 and 8. The WPCF upgrades are critical for the proposed CSO control plan, as the WPCF treats a significant portion of the wet weather flow generated by the Norwich system.

It is important to note that there will be additional costs for O&M of new infrastructure and for planning as LTCP updates are required every 5-years throughout the CSO program. These costs are not included in the $270 million program cost stated above but have been accounted for in Section 9 of this report.

Section 9 of the original August 14, 2018 CSO LTCP submittal (see Appendix F) assessed the financial burden of implementing 2-year CSO control as part of a collective wastewater program on NPU ratepayers, based on US Environmental Protection Agency (EPA) affordability guidelines. When Clean Water Fund grants and loans were **not** included in the financial assessment, this extensive program was deemed unaffordable for NPU to implement over a typical planning horizon. Implementing 2-year CSO control without CWF grants and loans, along with other necessary infrastructure improvements, would push NPU rate payers to an average annual household burden over 3% of median household income even if implemented over a 30-year (or longer) planning horizon. This is why the 2018 LTCP recommended a more affordable 3-month level of CSO control.

However, during discussions and workshops with DEEP following the submittal of the 2018 LTCP, DEEP heavily emphasized goals of achieving 2-year CSO control in Norwich and larger water quality benefits earlier in the program schedule. In these workshops, DEEP stated a clear intent to fund NPU's CSO program via the Clean Water Fund. While unaffordable without Clean Water Fund grant and loan funding, the 2-year Conveyance and Centralized Treatment alternative is achievable with the maximum allowable financial support from DEEP.

At DEEP's request, CDM Smith has revised this LTCP and assumed that Clean Water Fund grant and loan percentages will be available to NPU (at the same percentages available today) to the

maximum extent possible throughout the planning period. Under these conditions, 2-year CSO control becomes affordable for NPU and its rate payers. Section 9 of this revised report presents this revised financial analysis assuming Clean Water Fund grant and loan funding is available throughout the planning period. **If DEEP funding is reduced or becomes unavailable, the Recommended Plan and / or implementation schedule will need to be reevaluated**.

The 2-year CSO control alternative for Conveyance and Centralized Treatment has been selected as the Recommended Plan. The schedule of projects has been rearranged based on DEEP input to focus early in the program on improvement at the wastewater treatment plant, wet weather treatment facilities at the WPCF, and improved conveyance from the Shetucket Interceptor (via a new Rose Alley Pumping Station and force mains) in the near term. These early WPCF and Rose Alley projects will be followed by the construction of the Eighth Street Conveyance Improvements as described in Section 7.

The revised Recommended Plan program schedule includes a large capital investment early in the program, which achieves the stated DEEP goal of making large gains in water quality early in the program. This large early expenditure also has a large impact on NPU user rates, and a period of capital recovery is needed to pay down some of NPU's incurred debt prior to continuing to build capital projects in the CSO program. During this time period, projects are limited to maintenance and any emergency repairs, and no CSO improvements are made. This strategy facilitates significant water quality benefit early in the program schedule and extends the schedule of the Recommended Plan to a total of 35 years.

The components of the Recommended Plan for 2-year CSO control are detailed in this Section. Other specifics, including average annual performance, cost-effectiveness, and implementation schedule are also discussed.

10.2 Public Participation Plan

Public outreach is an important part of the CSO planning process, where stakeholders and the planning entity (NPU) discuss CSO control requirements, alternatives, costs and benefits, and build consensus on the Recommended Plan. NPU will receive a better sense of what issues are most important to the community, while the community can learn more about the impact of CSOs. NPU is committed to gathering public input for the mitigation of CSOs, as the public bears the costs of implementing these solutions and benefits from improved water quality.

Public outreach is required as a part of NPU's Consent Order. A public information session was held on August 1, 2018, prior to submittal of the LTCP to DEEP. This session provided interested parties with a general background on the collection system, EPA policy, NPU's consent order, and the CSO planning process for the Norwich Sewer System. Materials from this meeting as well as a published news article are included as Appendix A to this report.

NPU plans to hold public information sessions like the one provided for this LTCP prior to construction of any individual CSO project. Additionally, the LTCP will be updated at 5-year intervals to evaluate the success of past projects, update financial projections and guide the direction of future CSO controls. Public information sessions will be held prior to submittal of

each 5-year LTCP update as well. NPU will keep the public informed of its progress in mitigating CSO discharges and of completed and planned system improvements.

10.3 Recommended Long-Term Control Plan Components

It is recommended that NPU do as much as financially practical to control CSO discharges and benefit water quality. With the support of DEEP and available Clean Water Funding, NPU can pursue the most affordable 2-year control alternative (the "2-Year Conveyance and Treatment Alternative") as the Recommended Plan. Figure 10-1 illustrates the components of the Recommended Plan. This figure depicts the new pipelines, pumping stations (PS), and storage tank required to achieve 2-year control.

As discussed previously in Section 8 and Section 9, this alternative (including CSO projects and the cost of WPCF reliability upgrades) has a total capital cost of approximately $270M. This Recommended Plan includes the following major components and associated capital costs (all in FY 2018 dollars):

- Completion of CSO weir reconstruction and SCADA improvements to the existing Rose Alley Pumping Station per the Planned Projects described in Section 7 (completed in 2019).
- Improvements to the WPCF to increase capacity from 17 mgd to 20 mgd, improve reliability, and improve nitrogen removal ($80 million)
- Improvements to the Rose Alley Pumping Station and wet weather expansion at the WPCF site totaling $87 million including:
  - Replace Rose Alley pumping station (65 mgd) and force mains (dry weather and wet weather)
  - Construct an enhanced high rate clarification (HRC) facility on Hollyhock Island (WPCF site - 60 mgd wet weather expansion)
- Construction of the Eighth Street Conveyance Improvements per the Planned Projects described in Section 7 ($6 million).
- Improvements in the Laurel Hill neighborhood totaling $15 million including:
  - Replace the River Avenue pumping station (16 mgd) and force main
  - Increase the diameter of dry weather flow pipes near regulators 31 and 32 (960 linear feet [LF], 24-in to 30-in diameter)
  - Raise CSO regulator weirs beyond the Planned Projects level
- Improvements in the Thamesville neighborhood totaling $27 million including:
  - Replace the Shipping Street pumping station (3.5 mgd) and force main
  - Relocate the regulator structure for CSO 004

  - Reconfigure the gravity sewer system to convey flow from Route 32 and the new Shipping Street pumping station to the new CSO 004 regulator (2,310 LF, 15-in to 24-in diameter)
  - Remove and replace sewer pipe tributary to the existing Shipping Street force main
  - Replace the South Thames Street pumping station (16 mgd) and force main
  - Install a new gravity sewer from existing South Thames Street pumping station to new pumping station (580 LF, 15-in to 30-in diameter)
- Improvements in the Shetucket area (Greeneville and Downtown sewersheds) totaling $55 million including:
  - 0.9 Mgal storage tank at the Rose Alley commuter parking lot site
  - Install Shetucket Relief Interceptor in two phases (5,680 LF, 36-in to 48-in diameter)
  - Raise CSO regulator weirs beyond the Planned Projects level
  - Increase the diameter of dry weather flow pipe diameter at several locations (830 LF, 12-in to 32-in diameter)
- LTCP updates will be completed every five years throughout the recommended program. These updates will evaluate the effectiveness of implemented CSO projects, and refine model projections to guide future improvements.

Approximately $1 million per year (FY 2018 dollars) in O&M has been estimated for the completed 2-year level of control. This is due to the additional relief pipeline that is needed, as well as the HRC facility at the treatment plant and increased pumping station sizes.

In Eastside, Greeneville, and Downtown the Planned Projects will make a substantial early reduction in CSO volumes along the Shetucket, following the initial WPCF and Rose Alley Projects. The completed Planned Projects (including the completed Eighth Street Conveyance design) are expected to control discharges from CSO 024 and CSO 025. The estimated cost of the Planned Projects is approximately $6M as discussed further in Section 7.

In the Greeneville and Downtown sewersheds, the 2-year recommended control plan involves extensive infrastructure changes. The components of the Recommended Plan along the Shetucket Interceptor can be seen in Table 10-1. As pipes connecting regulators 18 through 25 with the Shetucket Interceptor are replaced with larger pipes to convey the full 2-year peak flow into the interceptor, capacity in the Shetucket Interceptor is exceeded. Therefore, the relief pipe will need to be constructed adjacent to the existing Shetucket interceptor from regulator 23 to Rose Alley pump station. The Recommended Plan requires a 0.9 Mgal storage tank for peak flow attenuation at Rose Alley, as well as a larger Rose Alley pumping station with a dry and wet weather force main. At Hollyhock Island, a high rate clarification facility at the WPCF will be constructed to expand the total treatment capacity to 80 mgd (20 mgd through secondary and 60 mgd through the new wet weather HRC facility). The early focus of this LTCP will be the plant reliability

upgrades and installation of the HRC wet weather treatment facility at the plant. Since the storage tanks and relief interceptor will be constructed later in the timeline, future flow metering and model re-calibration during future LTCP update efforts will help guide selection and final sizing of the later infrastructure improvements.

The estimated cost of the 2-year recommended level of control along the Shetucket, including an HRC facility at the WPCF is approximately $142M.

Table 10-1 Shetucket and WPCF Recommended Plan Components

Component	Recommended Plan (2-Year)
Shetucket Relief Interceptor (diameter, inches)	36 to 48
Rose Alley Commuter Lot Storage Tank (Mgal)	0.9
Rose Alley Tank Dewatering PS (mgd, FM diameter in inches)	2, 10
Rose Alley Gravity Pipe into Storage Tank (diameter, inches)	36
Rose Alley PS Upgrade (mgd)	65
Rose Alley Dry and Wet Weather FM (equivalent diameter, inches)	42
WPCF Total Capacity (mgd)	80
Various Pipe Replacements 12-in to 32-in Diameter (length, feet)	830
Weirs Raised Beyond Planned Projects Level	7

In Laurel Hill, the major strategy to control CSO is conveyance of excess flow towards the downtown area. Existing pipe sections identified during modeling to cause bottlenecks are to be replaced, and flow is then pumped out of Laurel Hill to the Shetucket Interceptor. The River Avenue pumping station and force main are aging, and are an immediate priority for replacement. A larger pump station (12 mgd) would need to be installed to achieve the 2-year control level of control in Laurel Hill. Table 10-2 illustrates the major components of the Recommended Plan in Laurel Hill.

The estimated cost of the recommended 2-year control level in Laurel Hill is approximately $15M.

Table 10-2 Laurel Hill Recommended Plan Components

Component	Recommended Plan (2-Year)
River Avenue PS (mgd)	12
River Avenue FM (diameter, inches)	20
Pipe Replacement 18-inch to 30-inch diameter (length, feet)	960
Weirs Raised Beyond Planned Project Level	3

In Thamesville, an approach similar to Laurel Hill is taken to achieve 2-year control. Bottle necks and limitations in the system will be addressed, and the excess wet weather flow will be pushed to the WPCF via a large pumping station. The conveyance components of the Recommended Plan can be seen in Table 10-3**.** The Shipping Street Pumping Station upgrade is aging and insufficient and would need to be upgraded. A West Thames Street 24-inch relief pipe would need to be built to accommodate the 2-year level of control. The South Thames Street Pumping Station would

need to be expanded to a 16 mgd pumping station with a large force main to convey wet weather flow to the WPCF and avoid overflows.

The estimated cost of the recommended 2-year control level in Thamesville is approximately $27M.

Table 10-3 Thamesville Recommended Plan Components

Component	Recommended Plan (2-Year)
Shipping Street PS (mgd)	3.5
Shipping Street FM (diameter, inches)	12
West Thames Street Relief Pipe (diameter, inches)	24
New Relocated S. Thames PS (mgd)	16
South Thames Street FM (diameter, inches)	24
Weirs Raised Beyond Planned Projects Level	0, Regulator 4 relocated upstream

10.4 Performance and Benefits

The Recommended Plan provides system-wide 2-year level of control and reduces annual CSO volumes by 99% when compared to the baseline conditions. These results can be seen in Figure 10-1. These complete benefits will be achieved at the end of the program schedule. As the schedule progresses, some areas may achieve 2-year control before the entire collection system does. For example, the Planned Projects will control CSO's 024 and 025 to the 2-year level of control (or better) in the first phase of projects, prior to the capital recovery period. As the program progresses, the majority of overflow is expected to occur at the 017 outfall from regulators 17-1 and 17-2.

There will be combined sewer overflows in the CSS for storm events greater than 2-year return periods or for larger back-to-back storms with little recovery time between events. The combined sewer overflow volumes corresponding to storm events greater than a 2-year event, or consecutive storms in the course of a year, will be substantially smaller than they are today.

Although infrequent, CSOs will still contribute to exceedances of water quality standards. The only way to prevent CSO discharges from causing or contributing to exceedances of water quality standards under all conditions is to completely separate the combined sewer system throughout all of Norwich. As discussed in Section 6 and Section 8, the cost of this complete city-wide separation alternative is approximately $460M ($380M for separation and $80M for necessary WPCF upgrades). This alternative represents a complete solution for elimination of CSOs, and removes the need for other components (storage, larger pumping stations and force mains, and wet weather treatment at the WPCF) but at significant incremental cost. The cost of the city-wide separation alternative also neglects investment in NPU's aging infrastructure, as the existing pump stations and force mains would require improvements during the planning period. Separation also creates pollutant loading from urban stormwater to receiving waters, which will have its own impact to water quality. Sewer separation and private property inflow removal would also result in widespread disruption during construction. This alternative would also not

be affordable for NPU, as it is nearly twice the collection system related cost when compared the 2-year control plan described above.

As described in Section 8, the term knee-of-the-curve reflects the point along the cost-benefit curve where incremental improvements in performance become progressively smaller in relation to incremental increases in facility size and cost. In other words, the incremental cost-benefit of reducing CSO's become smaller and smaller as the level of control increases. This pattern is intensified in the case of CSO control since the size of facilities required to capture increasingly rare events grows geometrically. The knee-of-the-curve identifies the point at which costs increase disproportionately for only a marginal improvement in CSO capture and improved water quality. Therefore, the knee-of-the-curve is a measure widely used to help establish optimal cost effectiveness and the recommended size of an overall CSO control system.

As discussed in Section 8, the knee-of-the-curve for NPU's CSS is at the 3-month level of control, allowing approximately 4 overflows per year. The 2-year control level exceeds the knee of the curve, and therefore incremental cost-benefit of removing CSO has decreased. The Recommended Plan exceeds EPA affordability criteria without loans and grants, however, DEEP has requested that NPU assume that maximum allowable CWF funding at present levels will be available throughout the planning period. When funding is available, the Recommended Plan becomes affordable. **If CWF funding becomes unavailable for any reason, the Recommended Plan will become unaffordable and NPU will need to be reevaluate the selected program and / or implementation schedule**. More detail on affordability is provided in Section 9.

10.4.1 Design Storms and the Representative Period

The Baseline Conditions Report (attached as Appendix E) selected representative design storms for the 1-month, 3-month, 6-month, 1-year, 2-year, and 5-year average recurrence intervals (ARI). These storms were selected from historic rainfall data. Design storms are a valuable tool for planning or design of hydraulic control features and can be simulated much more quickly than a representative period, which can take many hours.

The Baseline Conditions Report also selected a representative period which contained the appropriate number of storms at each ARI. The selected three-year representative period from 2009 to 2011 was identified as a period that would yield appropriate annual statistics for CSO volume, duration, and frequency for present conditions, as well as for control levels up to 1-year. Obtaining robust statistics for assessing two-year control would require a six-year or longer simulation period, which would impose considerable computational burden.

The 2009 to 2011 representative period contains the appropriate number of storms at each ARI. However, some of the storms exceed a two-year ARI at various durations. Examples of storms with especially high ARIs at select durations:

- July 8, 2011: 10-year 15-minute rainfall, 20-year 30-minute rainfall, 8-year 1-hour rainfall, and 3-year 2-hour rainfall
- March 29-30, 2010: 3-year 6-hour rainfall, 10-year 12-hour rainfall, and 40-year 24-hour rainfall

It can thus be expected that model simulations of 2-year control scenarios may still have CSO or surcharge in the largest storms of the three-year representative period.

Similarly, while the representative period was chosen to have close to ideal numbers of events at various durations, simulations using these data may yield overflow frequencies that do not exactly correspond with the performance levels identified using design storms.

10.4.2 Modeled Results

The annual performance benefits (based on simulation of the 2009-2011 representative period) associated with the Recommended Plan are summarized below:

- Average annual frequency of overflow will be reduced from 60 events to an average of 0.7 events (2 events over a 3-year simulation), a 99% reduction;
- Average annual CSO volume is reduced from 43.3 million gallons to 0.26 million gallons, a 99% reduction.

Average annual event counts in the representative period are displayed in Table 10-4.

Table 10-4 Performance of the Least Cost Plan

Condition	Annual CSO Volume (Mgal)	Annual Number of CSO Events
Baseline	43.3	60
Recommended: 2-Year Control	0.26	0.7

As described in Section 10.4.1, some of the storms within the representative period exceeded the 2-year ARI at various durations. Although the Recommended Plan simulation indicates two CSO events over the three-year representative period, these events are extreme and exceed the 2-year ARI. Overall, the representative period selected is conservative.

10.4.3 Other Benefits

Other benefits of the Recommended Plan include significant improvements to system operation and performance that are not easily measurable through CSO reductions alone.

These improvements include:

- Renewal of failing infrastructure throughout NPU's CSS. The River Avenue pumping station has had multiple force main breaks in recent years. The South Thames Street Pumping Station and Shipping Street Pumping Station have also each had force main breaks in recent years. The Recommended Plan puts focus on these pumping stations as well as other failing infrastructure and can reduce CSO volumes while preventing future infrastructure failure.
- Improvement of treatment facilities and operations at the WPCF. Increasing treatment capacity slightly (to the recommended 20 mgd) and modernizing equipment and facilities here (as discussed in Sections 3 and 8) will improve treatment reliability and capacity therefore alleviating some CSO issues. The Recommended Plan includes a new HRC facility which will further increase treatment capacity during high flow conditions. WPCF improvements provide reliable treatment and water quality benefits on a year-round basis.

- An allowance for CMOM activities was included in the financial analysis presented in Section 9. These activities could not be quantified in the current modeling efforts, but it is likely that additional cleaning of the CSS would increase the conveyance of the system and reduce CSO occurrence further. An increase in CMOM activities is expected in the coming years, and effects of these could be evaluated in the next LTCP update.
- Improved supervisory control and data acquisition (SCADA) controls at the Rose Alley Pumping Station have been designed and constructed since the original August 14, 2018 LTCP submittal. As discussed in the Baseline Conditions report, NPU previously manually throttled this pumping station to maintain peak capacity at the WPCF and prevent junction chamber overflow at the WPCF during storm events. The new SCADA controls increase the flow sent to the WPCF, reduce CSO, and eliminate the need for manual throttling.

The Recommended Plan optimizes the existing facilities and infrastructure to the extent possible, however, during the 2-year control level, the existing system capacity is generally exceeded, and the Shetucket Relief Interceptor, larger pumping stations, and additional treatment capacity at the WPCF are all needed. Additionally, the Recommended Plan renews existing infrastructure and assets that have exceeded their useful life, while greatly reducing occurrence of CSOs in Norwich.

10.5 Balancing the Approach to Implementation

The Recommended Plan includes infrastructure renewal projects such as the WPCF upgrade and pumping station and force main replacements at Rose Alley, River Avenue, Shipping Street and South Thames Street. These projects, while necessary to maintain overall system reliability, have also been planned to generate a direct benefit in terms of CSO conveyance and/or treatment. Pumping station capacities will increase, and the WPCF will undergo a nominal but meaningful peak flow capacity expansion from 17 mgd to 20 mgd. The proposed levels of CSO control cannot be achieved without these projects. Conversely, upgrade of core infrastructure alone is not sufficient to achieve the stated levels of control of the Recommended Plan.

The Recommended Plan contains a balance of water pollution control facility improvements, CSO structure improvements, existing infrastructure renewal, storage, conveyance improvements, and sewer relief. The early focus is given to improvements at the WPCF site at Hollyhock Island and the Rose Alley PS, followed by the construction of the Eighth Street Conveyance Improvements. After the completion of these large projects a period of capital recovery is planned to give NPU a chance to recover from significant early borrowing. As future projects are implemented following the capital recovery period, the sizes of conveyance piping and the storage tank will be reevaluated to ensure proper sizing to accommodate future conditions. NPU will revisit the Recommended Plan and publish an update every five years during program implementation to reevaluate effectiveness of implemented projects and review proposed future projects. This will help NPU evaluate existing controls and stay on course to meet CSO program objectives.

10.6 Implementation Sequence

If one component is affected by other components within the Recommended Plan, then it is sensible to defer implementation of the dependent component until the independent components are implemented. This will ensure that the alternative is appropriately sized to achieve the

targeted level of control, and prerequisite projects are in place to accept design flows. In general, priority was based on addressing public health, water quality standards, CSO reduction, cost-effectiveness, and logical sequencing of work. Overall, the implementation schedule should allow sufficient time to construct projects in a planned and sensible manner, to minimize disturbance to neighborhoods, to evaluate the effectiveness of each project and resize controls as appropriate, and to ease the financial burden on NPU's ratepayers.

In terms of prioritization, it is recommended that projects that address public health issues be addressed first. NPU does not historically have problems with basement backups or SSOs, and the receiving waterbodies are all of the same classification, and therefore the potential for failed infrastructure and CSO reduction are the most important priorities. The initial focus of the plan is directed towards the aging WPCF, this was identified as the largest piece of infrastructure requiring renewal.

The WPCF has not received substantial improvements since the 1970's. The plant facilities and processes are in need of rehabilitation, which is not dependent on the size of CSO controls, as sizing the WPCF for the peak CSO flows would not be a practical or cost effective strategy. The WPCF was targeted as a primary project because improvements made here will produce a year-round benefit to water quality in Norwich. Additionally, increasing conveyance to the WPCF is not a viable strategy unless reliable treatment throughout the planning period is established at the WPCF. Improvements to the WPCF site at Hollyhock Island would likely include the following: new secondary tanks, landfill modifications, main electrical system upgrades, new headworks, new administration building, a new UV disinfection and effluent pumping station, a retrofit of digesters B and C and of an existing secondary clarifier, sludge pumping improvements, piping improvements, and odor control improvements. Sections 3 and 8 talk more about the specifics of the intended WPCF upgrades.

Following (and partially concurrent with) the upgrades at the WPCF, it is recommended that improvements to the Rose Alley Pumping Station be made, as well as the construction of the HRC wet weather treatment facility at the WPCF site on Hollyhock Island. The Rose Alley Pumping Station drives CSO overflows at CSOs 017-1 and 017-2, which produce the highest volume of CSO under existing conditions. The increased capacity at the Rose Alley PS will allow more flow to be conveyed to an upgraded treatment plant and new HRC wet weather system, thus reducing CSO at the largest contributing regulators in the system and reducing total CSO volumes significantly.

Near the completion of WPCF and Rose Alley improvement projects, the Eighth Street Conveyance Improvements (as described in Section 7) are recommended to be constructed. This project will provide 2-year control to the upstream most section of the Shetucket River. CSO 025 will be controlled to a 10-year level (with the intent to close this regulator after a sufficient monitoring period), and CSO 024 will be controlled to the 2-year level. This project is cost effective and provides substantial water quality benefits. A 2,500-foot section of the Shetucket River will be free of CSO up to and including the 2-year design storm.

After these large capital improvements to the WPCF, Rose Alley, and the completion of the Planned Projects in the first years of the program, NPU will utilize a "capital recovery period" of 10 years to pay down the significant loans required in the early years. Although NPU will make significant water quality gains early in the program, the initial cost is substantial, and this period

will allow NPU to stabilize financially. It is anticipated that NPU will continue to complete LTCP updates during this recovery period as required by the Consent Order.

Following the period of capital recovery, NPU will shift its focus to projects that increase conveyance to the newly upgraded WPCF and new wet weather treatment facility. Laurel Hill is the next area that warrants prioritization and will be addressed in the mid-point of the program. CSO control in this area is also fairly cost effective. As mentioned previously, the River Avenue Pumping Station had a force main break in 2018, and there have been infrastructure issues in this area in the past. It is recommended that this pumping station be replaced with a larger facility to convey wet weather flow, along with replacement a few pipes that need increased capacity, and additional weir modifications beyond the Planned Projects levels. Additionally, NPU is expecting to receive additional flow from the south side of Laurel Hill as described in Section 2. Completing these repairs and modifications as soon as possible ensures that NPU can accept these flows and thus provide themselves with more financial capacity to construct subsequent CSO projects.

It is recommended that following the projects in the Laurel Hill area, projects be completed along the Shetucket Interceptor to increase conveyance to the Downtown area and ultimately to the WPCF. These projects include design and construction of the first phase of the Shetucket relief interceptor (from regulators 18 and 19 to Rose Alley), the replacement of a dry weather flow pipes causing hydraulic restrictions at regulators 18 and 19, and an increase in various weir elevations to further reduce CSO.

Following the first phase of the Shetucket relief interceptor, Thamesville CSO projects will become the priority. Thamesville priority CSO projects include the West Thames Street relief pipe, removing gravity connections from the existing Shipping Street FM, and the construction of a new Shipping Street Pumping Station and force main. These improvements will increase the conveyance of wet weather flow to the WPCF and decrease CSO in Thamesville.

The final focus areas of the Recommended Plan are the Greeneville and Downtown sewershed areas. The second phase of the relief interceptor will be constructed from regulator 23 to regulators 18 and 19 to provide additional capacity for conveyance further east into the Greeneville sewershed and reduce overflows at the more upstream CSO regulators. The final project of the program will be the Rose Alley commuter lot storage tank. The size of the Rose Alley storage tank will ultimately be dependent on the effectiveness of the earlier CSO projects. It is anticipated that 5-year LTCP updates would evaluate the effectiveness of the previously constructed CSO projects, and the tank (as well as other infrastructure later in the schedule) would be sized accordingly to achieve the 2-year level of control. A facility layout for the Rose Alley Storage Tank and Tank Dewatering Pumping Station is included as Figure 10-2 following this section.

In summary, throughout the Recommended Plan (2-year control level) NPU will balance CSO projects and renewal of aging infrastructure. The initial focus will be on renewal of their existing WPCF and the addition of a wet weather treatment facility and increased capacity at the Rose Alley Pumping Station to increase overall conveyance and treatment capacity. Improvements to the CSO infrastructure in the collection system will follow, balancing the need to reduce CSO, while ensuring that their aging infrastructure does not fail. NPU will achieve significant reductions in CSO discharges with the Recommended Plan, reducing their annual occurrences by

99%, and their total annual CSO volume by 99%. Effectiveness of all implemented CSO controls will be evaluated with 5-year LTCP updates, which will continue to evaluate the CSS and guide the direction of the CSO program.

10.7 Recommended Plan Implementation

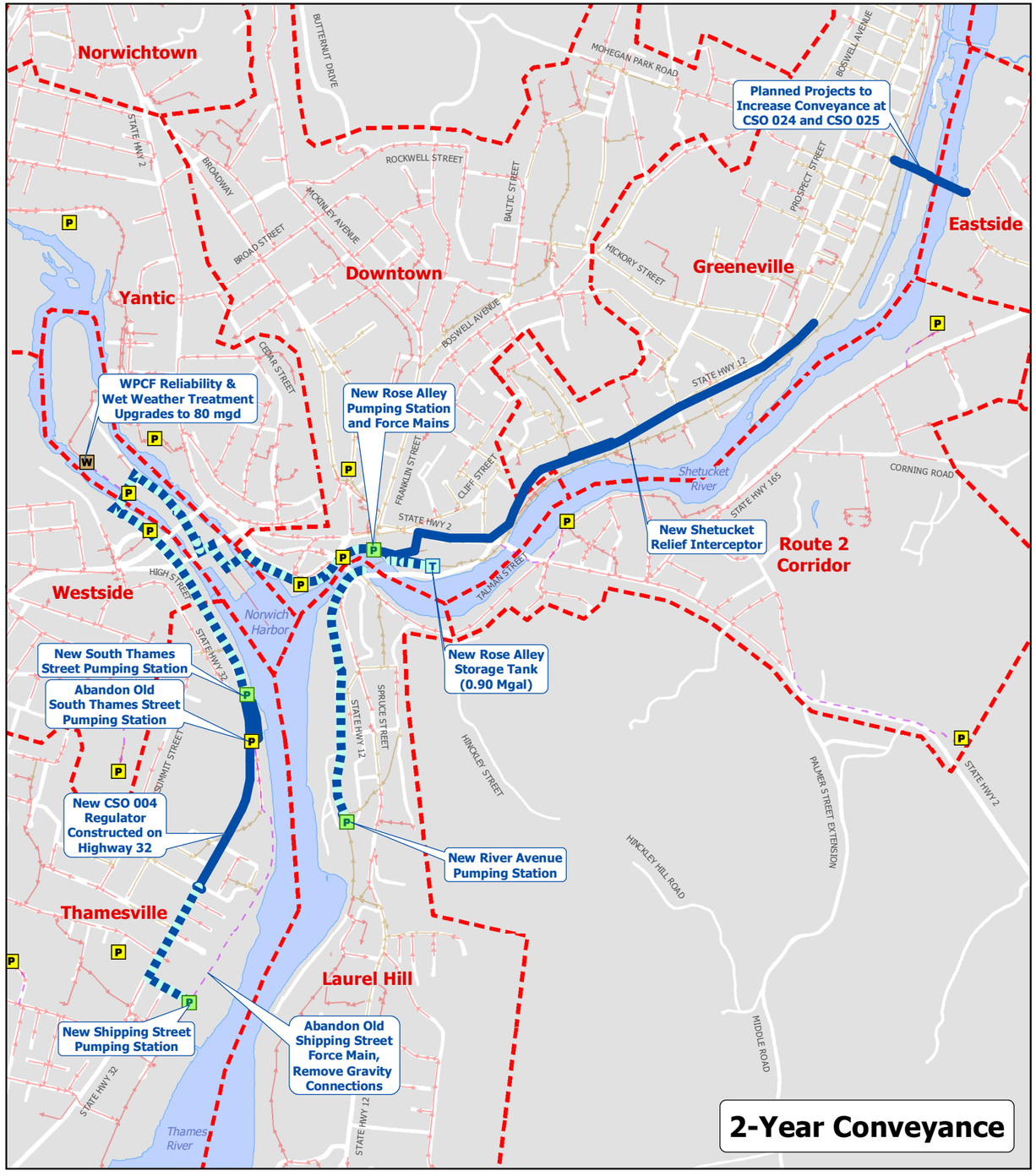
Based on the approach described above, these general timelines and areas of focus have been broken down into smaller projects with more specific implementation recommendations. The recommended projects and proposed durations for implementation are presented in Figure 10-1 at the end of this Section. The average annual CSO reduction benefits, as well as the CSO reduction benefits in the 2-year storm are shown for each major project milestone. The estimated capital costs of the Recommended Plan (2-year control) as well as the necessary facility upgrades to the WPCF over 35 years total $270M (FY 2018 dollars). The planning period of the LTCP would extend from 2018 (the start of the Planned Projects) to 2053.

The Recommended Plan will provide a 2-year level of control throughout the entire NPU combined sewer system. An early focus has been put on CSO reduction through upgrade of the WPCF, Rose Alley Pumping Station Improvements, and construction of the Eighth Street Conveyance Improvements after which additional CSO projects and renewal of failing infrastructure would be completed. LTCP updates completed throughout the program in 5-year intervals will evaluate constructed projects and reevaluate future projects through model evaluation and updated financial analysis. It is expected that the first LTCP update would occur in 2025.

In most cases, it is not recommended that CSO regulators or outfalls be closed as these improvements are made. NPU recently closed CSO 040, but in general, these relief points are needed to alleviate surcharging in events larger than the 2-year storm. Closure of regulators can lead to basement backups, street flooding and general risk to public health. A phased approach will generally be recommended, similar to achieving 10-year control at CSO 025 prior to further assessment and intended permanent closure.

The potential to safely close additional CSO regulators will be evaluated regularly as the LTCP is implemented and LTCP updates are completed in the future. Each active CSO regulator is monitored by continuous flow metering to track CSO performance over time. The data obtained by these meters will allow for evaluation of each CSO improvement that is constructed and allow for a phased closure of regulators where it is deemed to be safe. This active monitoring will also help guide the direction of future LTCP updates and the final sizing of project components.

This CSO abatement program represents a major financial, economic, and environmental challenge. NPU can afford to achieve this 2-year level of control only with Clean Water Fund grant and loan funding as presented in Section 9. **If Clean Water Fund grant and loan funding become unavailable for any reason, the analysis in Section 9 will become invalid, and NPU will need to reevaluate the Recommended Plan and / or the proposed schedule.** The ability to achieve the 2-year control goal will be revaluated every five years in LTCP updates to determine if funding or affordability conditions have changed.



Project Order	Duration (Years)	Area	Item	Totals ($2018)	Program Years	Calendar Year	Average Annual CSO over Representative Period (Mgal)	CSO Remaining In 2-Year Storm (Mgal)
-	-	-	Existing Conditions	-	0	-	43.3	5.86
1	1	Shetucket	Rose Alley SCADA Improvements and Weir Reconstruction at 11 CSO Regulators	-	1	2019	10.5	2.23
2	6	WPCF	WPCF Core Upgrades (20 MGD)	$80,000,000	3-8	2021-2026		
3	3	WPCF	WPCF HRC Facility (60 MGD) including Allowance for Contamination and Business Disruption	$53,000,000	6-8	2024-2026		
4	3	Shetucket	New Rose Alley Pumping Station and Force Mains (42-inch equivalent)	$34,000,000	6-8	2024-2026		
5	1	Eastside	Eastside Conveyance Improvements	$ 6,000,000	8	2026		
-	10	-	Capital Recovery Period	-	9-18	2027-2036	-	-
6	3	Laurel Hill	New River Avenue Pumping Station (12 MGD) and Force Main (20-inch)	$12,000,000	19-21	2037-2039	9.79	1.89
7	3	Laurel Hill	Raising Weirs Beyond Early Projects Level, Replace Dry Weather Flow Pipes from 032 and 031	$ 2,000,000	19-21	2037-2039		
8	3	Shetucket	Shetucket Relief Interceptor - Phase 1 (48-inch)	$16,000,000	21-23	2039-2041	6.11	1.22
9	2	Shetucket	Various Dry Weather Flow Pipe Increases, Raise Seven Weirs Beyond Planned Project Level	$ 2,000,000	21-22	2039-2040		
10	3	Thamesville	Gravity Pipe down Highway 32 to New Regulator (24 & 30-inch)	$ 4,000,000	22-24	2040-2042	5.79	1.16
11	3	Thamesville	Cahoon Street, Thames Terrace, and Kinney Avenue Gravity Sewers. Raising Weirs. Abandoning Old CSO 004 Regulator. New Building Services near Old CSO Regulator 004	$ 2,000,000	25-27	2043-2045		
12	3	Thamesville	New Shipping Street Pumping Station (3.5 MGD) and Force Main (12-inch)	$ 5,000,000	25-27	2043-2045		
13	3	Thamesville	South Thames Pumping Station (17 MGD) & Force Main (24-inch) & Property Purchase Allowance	$15,000,000	29-31	2047-2049	4.95	0.96
14	3	Thamesville	South Thames New Gravity Sewer (Old Pumping Station to New Pumping Station)	$ 2,000,000	29-31	2047-2049		
15	3	Shetucket	Shetucket Relief Interceptor - Phase 2 (36 & 48-inch)	$14,000,000	33-35	2051-2053	0.26	0
16	3	Shetucket	Rose Alley Commuter Lot Tank: (0.90 Mgal) Storage tank, Dewatering Pumping Station (2 mgd), New Force Main, New Gravity Pipe, Sluice Gate Diversion Structure, and Allowance for Disruption	$23,000,000	33-35	2051-2053		

***LTCP Updates will be completed every five years throughout the recommended program, with the first update anticipated in 2025.**

CDM Smith

Legend

- Recommended Storage Tanks
- Recommended Pumping Stations
- Recommended Sewers
- Recommended Pressurized Mains
- Water Pollution Control Facility
- Pumping Stations
- Force Mains
- Combined Sanitary Sewers
- Separated Sanitary Sewers

1 inch = 1,400 feet

0 700 1,400 Feet

N

2020 Long Term Control Plan
Norwich Public Utilities

Figure 10-1
Recommended 2-Year Control Plan

N

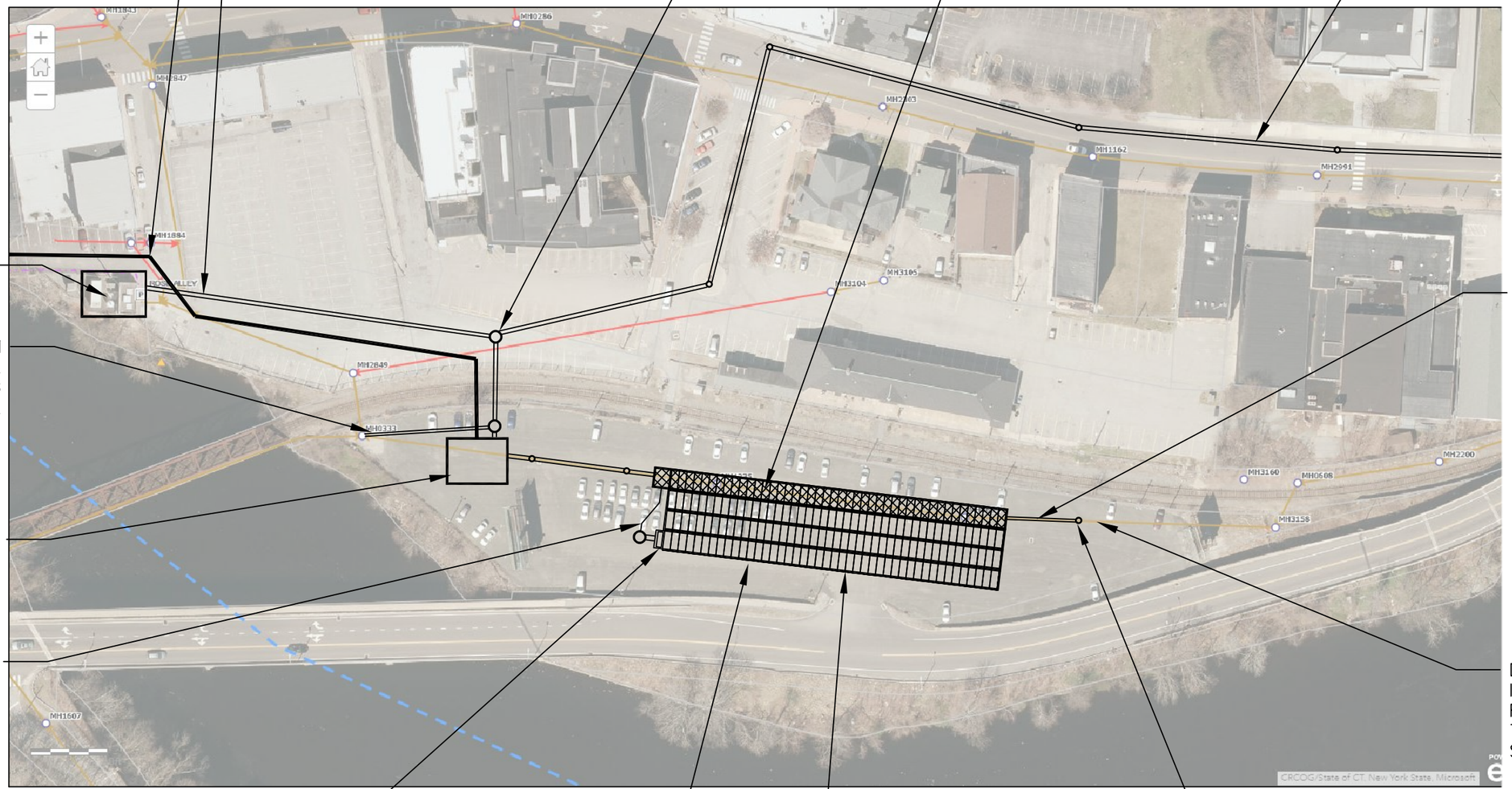
ROSE ALLEY DRY AND WET WEATHER FORCEMAINS (42" EQUIVALENT)

NEW 48" CONNECTION FROM OLD ROSE ALLEY PUMPING STATION TO NEW JUNCTION CHAMBER, ABANDON EXISTING ROSE ALLEY PS AND FM

NEW JUNCTION CHAMBER

BOX CULVERT PORTION OF INTERCEPTOR TO HAVE V-NOTCH BOTTOM WITH OVERFLOW WEIRS TO WET WEATHER STORAGE STRUCTURE

48" SHETUCKET RELIEF INTERCEPTOR



EXISTING ROSE ALLEY PUMPING STATION

CONNECTION FROM LAUREL HILL AREA TO NEW PUMPING STATION WET WELL

NEW 65 MGD ROSE ALLEY PUMPING STATION

10" FORCEMAIN CONNECTION TO TRANSITION STRUCTURE

42" DIA GRAVITY PIPE (TYP)

DEMOLISH EXISTING INTERCEPTOR AND ROUTE FLOW THROUGH STORAGE STRUCTURE

2 MGD DEWATERING PUMPING STATION WET WELL

MODULAR PRECAST WET WEATHER STORAGE STRUCTURE BELOW GRADE (0.90 MGAL)

PRECAST 13' X 12' X 6' LENGTH BOX CULVERT SECTION (TYP OF 132)

PRECAST MH CONNECTION TO EXISTING SHETUCKET INTERCEPTOR

CDM Smith

Not to Scale

2020 Long Term Control Plan
Norwich Public Utilities
Figure 10-2
Rose Alley Facility Layout
Storage Tank and Pumping Station
Recommended 2-Year Control Plan

Appendix A

Memorandum

To: *File*

Date: *April 2020*

Subject: *Appendix A Contents*

A public meeting was conducted on August 1, 2018 on the status of the Norwich Combined Sewer Overflow (CSO) Draft Long-Term Control Plan (LTCP). The purpose of this meeting was to share information and solicit input from the public prior to finalizing the plan and submitting the report to the Connecticut Department of Energy and Environmental Protection (DEEP). The meeting was held at 6:00pm at the NPU office at 16 South Golden Street, Norwich CT 06360. Materials from this meeting are provided in Appendix A. These include the following items:

- A public notice announcing the meeting and soliciting input,
- Slides of the presentation given at the public meeting,
- Notes from the public meeting, and
- A news article about the meeting from the Norwich Bulletin.

Public Meeting for Norwich Public Utilities CSO / Long-term Control Plan

Norwich Public Utilities (NPU) will conduct a public meeting on the updated draft of its existing Combined Sewer Overflow Long-Term Control Plan (CSO/LTCP) in accordance with the Connecticut Department of Energy and Environmental Protection (CT DEEP) Clean Water Fund regulations.

NPU invites residents and property owners of Norwich and any other interested parties to attend the public meeting on August 1, 2018 at 6:00 pm at the NPU office at 16 South Golden Street, Norwich, CT 06360.

The CSO / LTCP is the planning document for the construction of sewer improvements which establish the overall direction for NPU's wastewater system upgrades. This plan is being developed to comply with an enforcement actions by CT DEEP related to combined sewer overflows and the U.S. Environmental Protection Agency (EPA) related to sanitary sewer overflows.

This public meeting will include a presentation on the revisions to the original CSO / LTCP dated June 6, 2012, as well as the schedule for the work to be completed by NPU. The purpose of the meeting is to share information and solicit input from the public for consideration prior to finalizing the plan and securing final approval from CT DEEP.

The public meeting will also inform the public of possible subterranean easements that may be required for this important work to move forward.

A copy of the draft CSO / LTCP will be available for review at NPU's Administrative Offices at 16 South Golden Street, Norwich, CT 06360. The draft report may also be viewed on the NPU website at www.norwichpublicutilities.com / CSO-LTCP.

Written comments may be submitted to NPU prior to the meeting to:

Lawrence Sullivan, P.E.
Norwich Public Utilities
16 South Golden Street
Norwich, CT 06360

Or to:
larrysullivan@npumail.com

Norwich Public Utilities
CSO Long Term Control Plan

August 1, 2018

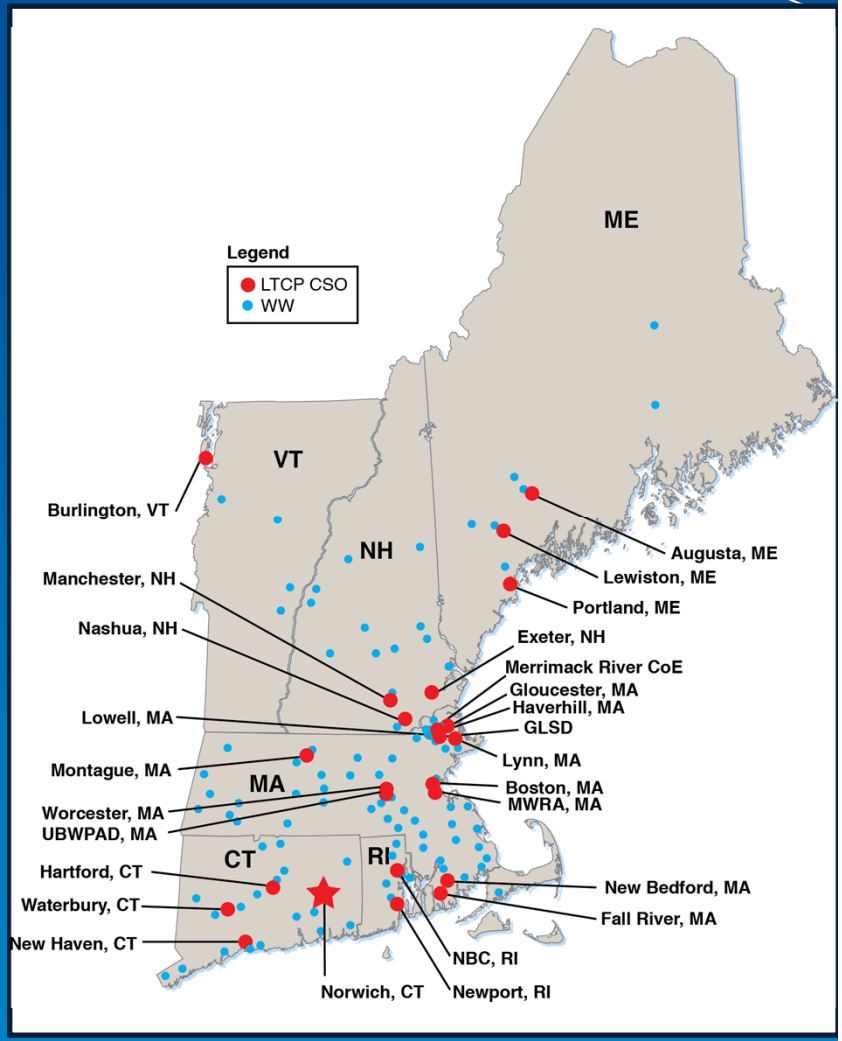
CDM Smith®

Agenda

1. Introductions
2. Sewer System
3. Water Pollution Control Facility
4. Modern CSO Policy / Regulation
5. DEEP CSO Consent Order
6. CSO Long Term Control Plan
7. Potential Alternatives
8. Balancing Infrastructure Needs
9. Next Steps

CDM Smith Brings Extensive CSO Experience

- National experience
- Affordable CSO programs
- More CSO experience in New England than anyone
- Extensive negotiating with DEEP, EPA and others
- Strong track record managing complex projects on budget
- Proven performance securing CWF and other funding

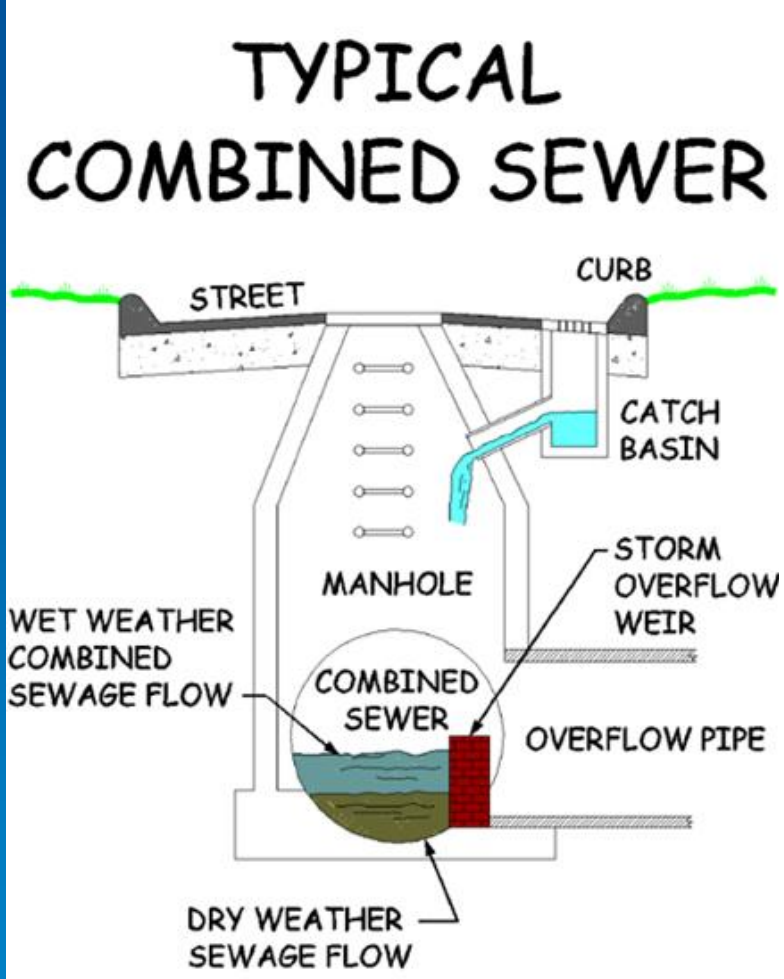


Historical Perspective on Sewers

Norwich has combined sewers

- Historical design standard
- Common in older systems
- Combines sewage and storm water into one pipe
- Hydraulic relief points needed: Combined Sewer Overflows (CSOs)

- www.sewerhistory.org



Historical Perspective on Sewers (continued)

- Sanitary Engineering, Volume I, 3rd Edition, p. 45, 1909: A combined sewer system allows small rain runoff to enter the sewer, while large (presumably cleaner) runoff is discharged into a river.

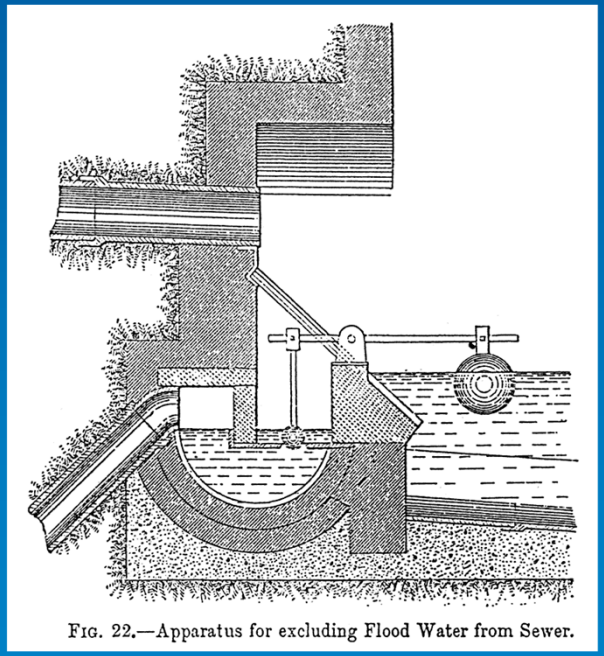


FIG. 22.—Apparatus for excluding Flood Water from Sewer.

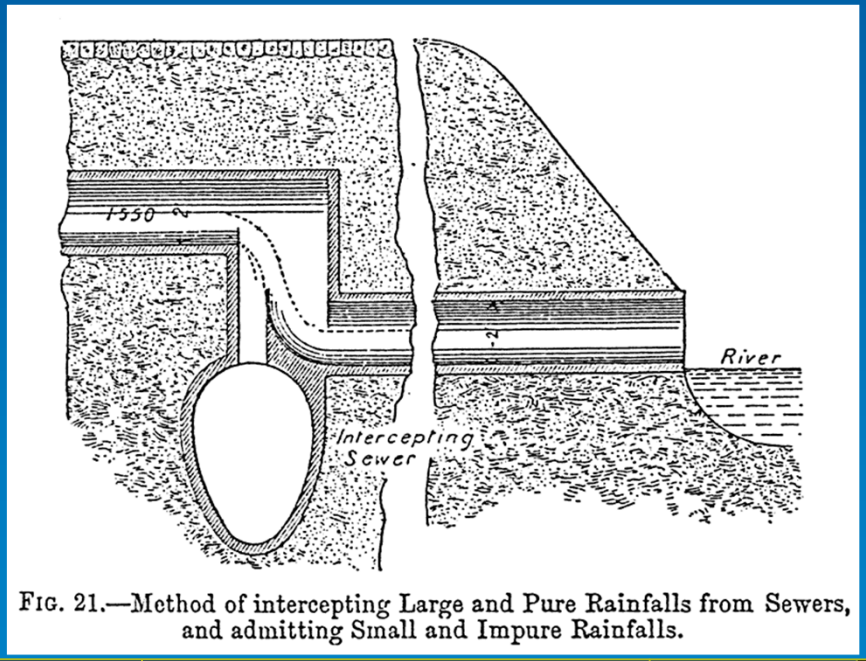
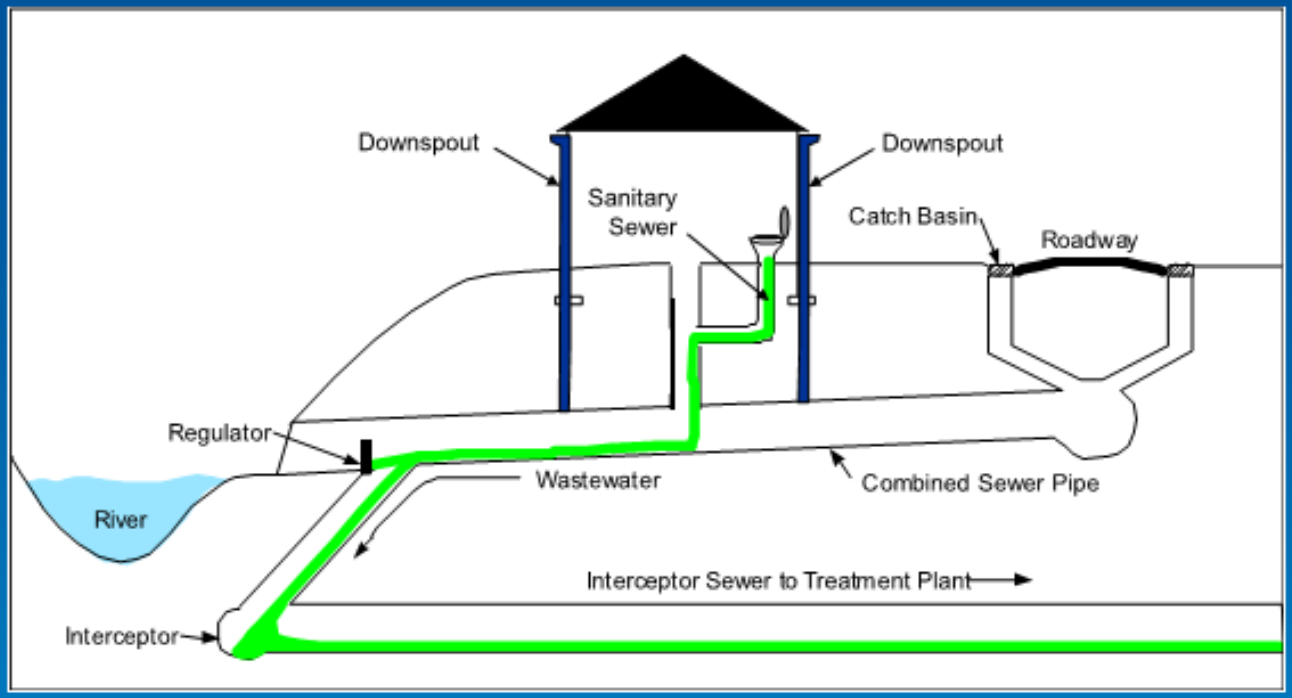


FIG. 21.—Method of intercepting Large and Pure Rainfalls from Sewers, and admitting Small and Impure Rainfalls.

Combined Sewer Operation (Dry Weather)

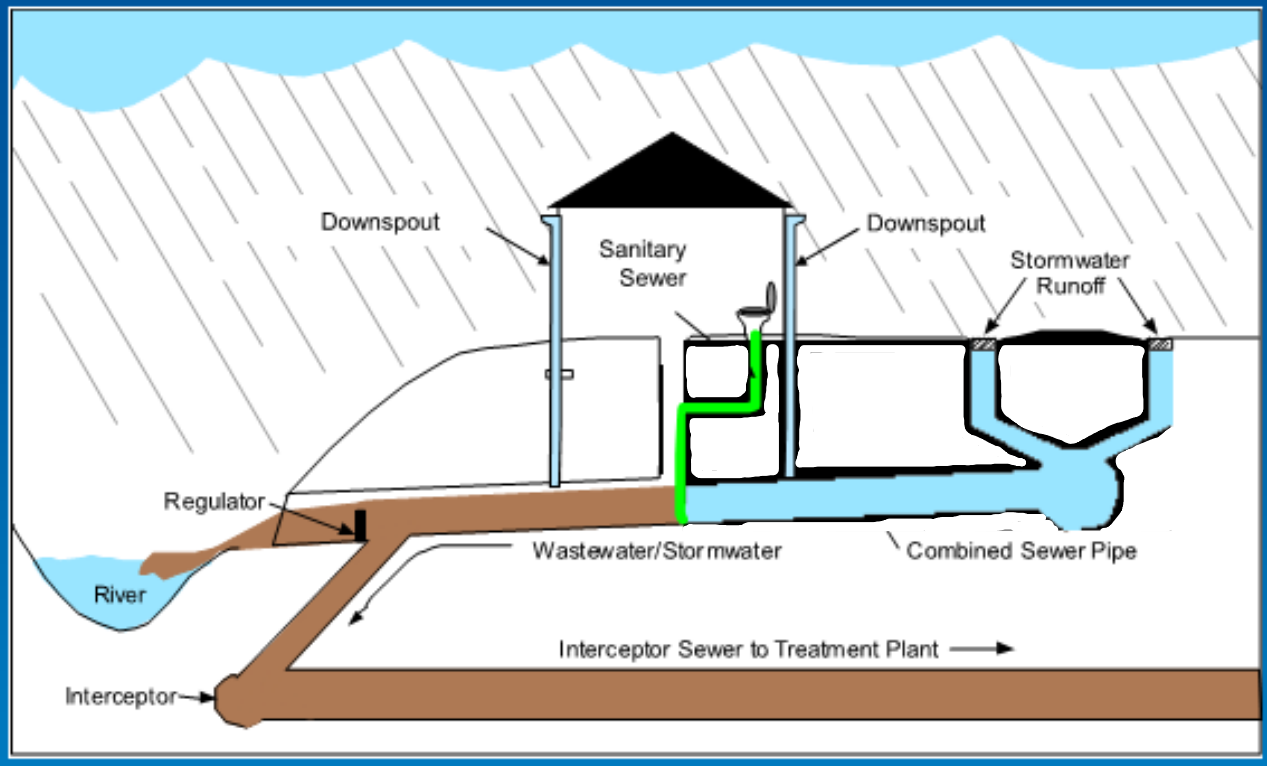
All sewer flows are routed to treatment facilities



Dry Weather Conditions

Combined Sewer Operation (Wet Weather)

Combined Sewer Overflows result from storm water inflow during rain events.



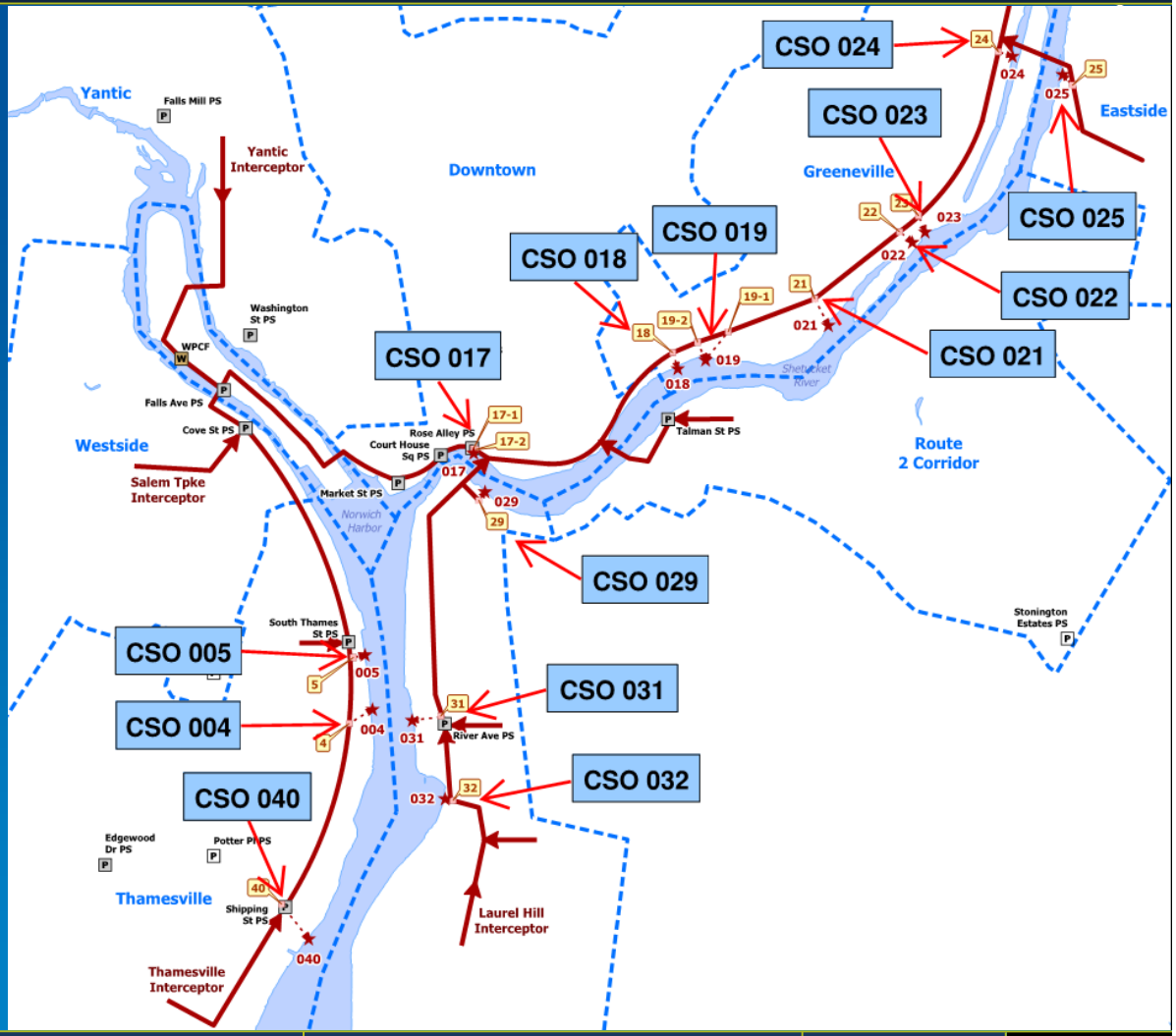
Wet Weather Conditions

What Do Combined Sewers Carry?

- Raw Sewage
- Storm water
- Bacteria
- Solid Materials
- Trash and Debris
- Nutrients
- Metals
- Sand and Road Salt
- Oils and Greases
- Leaves
- Other Contaminants

Norwich System Overview

- 16 overflow regulators
- 14 permitted outfalls
- CSOs Discharge to the Shetucket and Thames Rivers



Baseline Statistics

- In March 2018, NPU submitted a Baseline Conditions Report to CT DEEP.

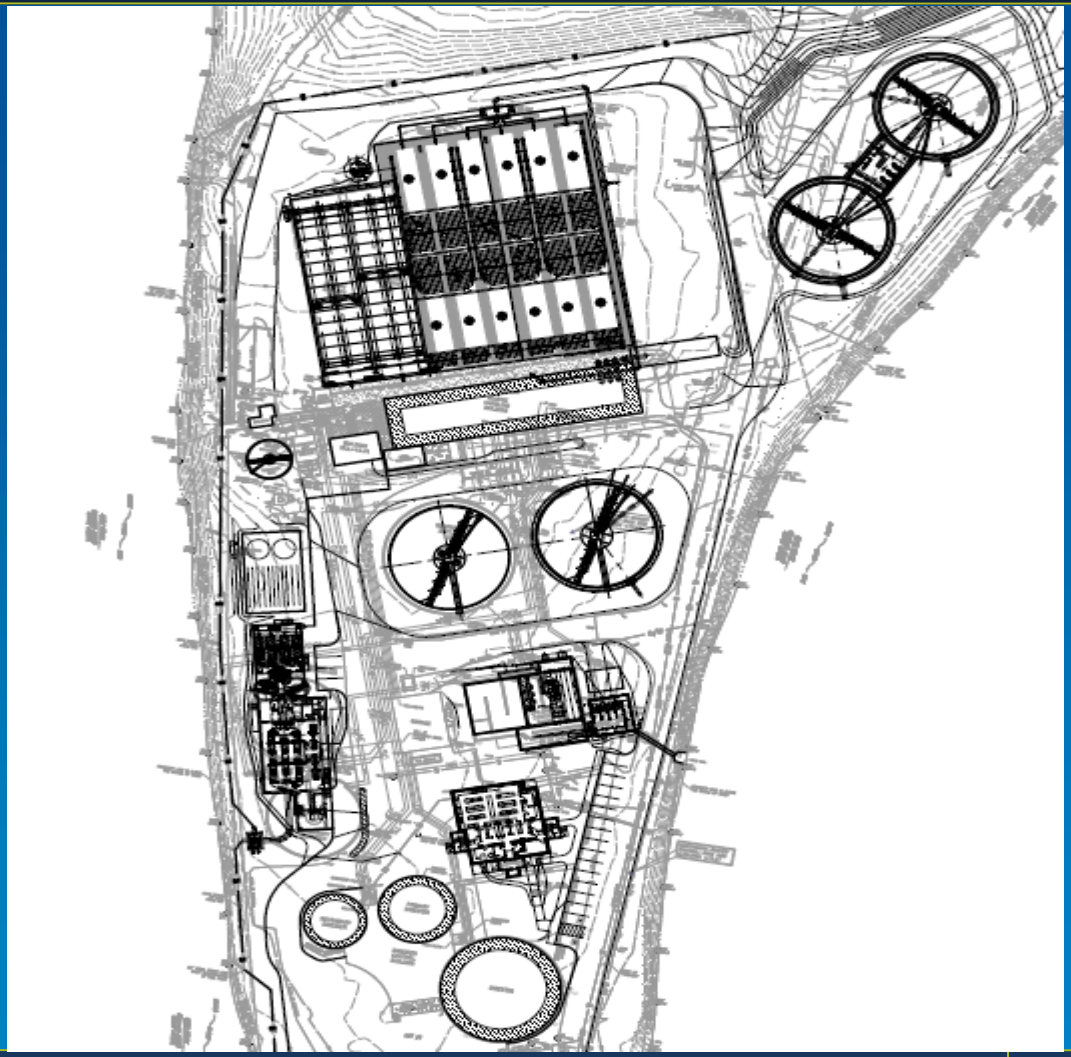
- Annual CSO numbers
  - 60 overflow events
  - 43 million gallons
  - 355 hours of overflow

Water Pollution Control Facility

WPCF Overdue for Upgrade

- 1950's construction
- Expanded in 1970's
- General O&M since
- Digester repairs
- Typical 20 year service
- Upgrade needed:
  - Aging equipment
  - Permit limits (Nitrogen)
  - Disinfection, reliability, SCADA, energy efficiency, safety, CSO flows, flood resiliency, landfill closure.

Anticipated WPCF Upgrade



- New headworks
- Influent pumping
- Upgrade primary
- Upgrade aeration
- New secondary
- Remove bottlenecks
- Upgrade sludge processing systems

Anticipated WPCF Upgrade (continued)

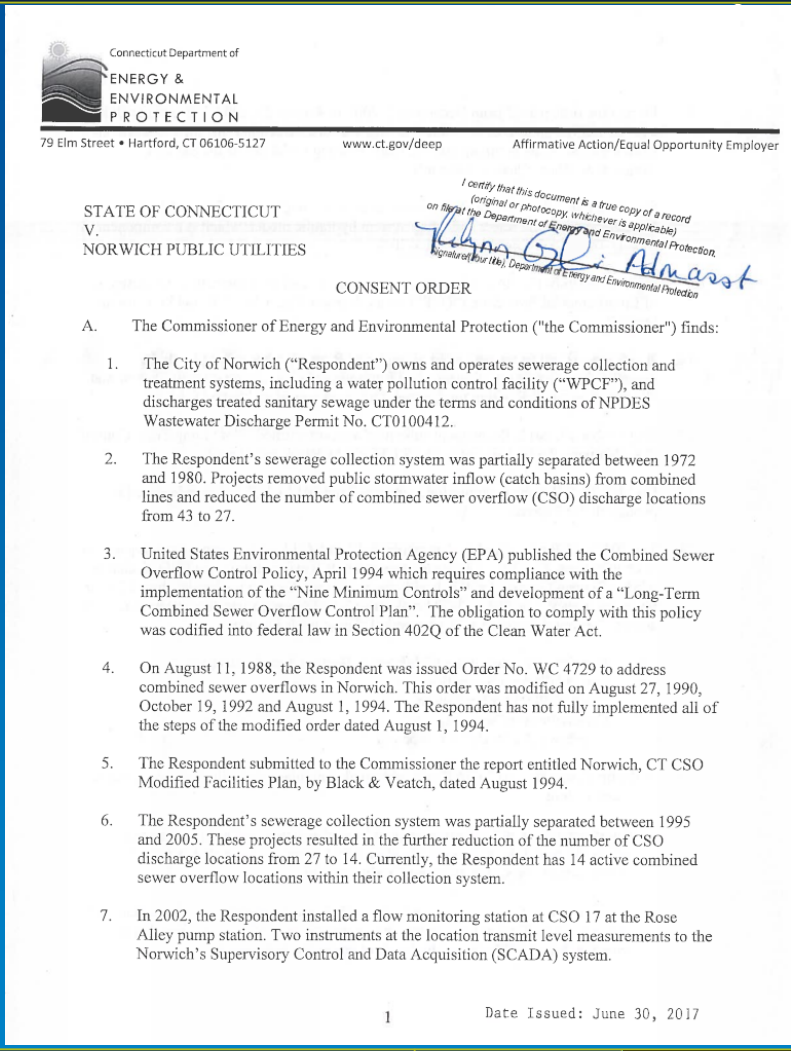
- New UV disinfection
- New electrical distribution
- New SCADA controls
- Effluent pumping
- Upgrade digesters
- Flood protection
- Modern lab facilities

Modern CSO Policy / Regulation

- CSOs no longer design standard
- 1994 EPA CSO policy set abatement guidelines
- DEEP governs in CT – goal to eliminate all CSOs
- Only 6 CSO communities remain in CT
- Many communities have made significant progress
- Norwich performed early CSO work in the 90's

DEEP CSO Consent Order

- Requires 2-year CSO control
- Water quality focused
- LTCP is evaluating engineering and economics
- Norwich's ability to pay for projects must be considered in any implementation plan



Connecticut Department of
ENERGY & ENVIRONMENTAL PROTECTION

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I certify that this document is a true copy of a record (original or photocopy, whichever is applicable) on file at the Department of Energy and Environmental Protection.
(Signature and Title), Department of Energy and Environmental Protection

STATE OF CONNECTICUT
V.
NORWICH PUBLIC UTILITIES

CONSENT ORDER

A. The Commissioner of Energy and Environmental Protection ("the Commissioner") finds:

1. The City of Norwich ("Respondent") owns and operates sewerage collection and treatment systems, including a water pollution control facility ("WPCF"), and discharges treated sanitary sewage under the terms and conditions of NPDES Wastewater Discharge Permit No. CT0100412.

2. The Respondent's sewerage collection system was partially separated between 1972 and 1980. Projects removed public stormwater inflow (catch basins) from combined lines and reduced the number of combined sewer overflow (CSO) discharge locations from 43 to 27.

3. United States Environmental Protection Agency (EPA) published the Combined Sewer Overflow Control Policy, April 1994 which requires compliance with the implementation of the "Nine Minimum Controls" and development of a "Long-Term Combined Sewer Overflow Control Plan". The obligation to comply with this policy was codified into federal law in Section 402Q of the Clean Water Act.

4. On August 11, 1988, the Respondent was issued Order No. WC 4729 to address combined sewer overflows in Norwich. This order was modified on August 27, 1990, October 19, 1992 and August 1, 1994. The Respondent has not fully implemented all of the steps of the modified order dated August 1, 1994.

5. The Respondent submitted to the Commissioner the report entitled Norwich, CT CSO Modified Facilities Plan, by Black & Veatch, dated August 1994.

6. The Respondent's sewerage collection system was partially separated between 1995 and 2005. These projects resulted in the further reduction of the number of CSO discharge locations from 27 to 14. Currently, the Respondent has 14 active combined sewer overflow locations within their collection system.

7. In 2002, the Respondent installed a flow monitoring station at CSO 17 at the Rose Alley pump station. Two instruments at the location transmit level measurements to the Norwich's Supervisory Control and Data Acquisition (SCADA) system.

1 Date Issued: June 30, 2017

Long Term Control Plan - Methodology

- Prescribed methodology defined by EPA
- Understand & meter existing sewer system
- Develop & calibrate computer model
- Identify system needs & potential solutions
- Test alternatives against modeled storms
- Identify least cost solution that meets stakeholder goals (DEEP, NPU, City)

Potential Alternatives

- Sewer separation
- Storage
- Conveyance
- Treatment
- Green technologies
- Mixture of all

- Each has strengths and weaknesses, and a cost

Sewer Separation

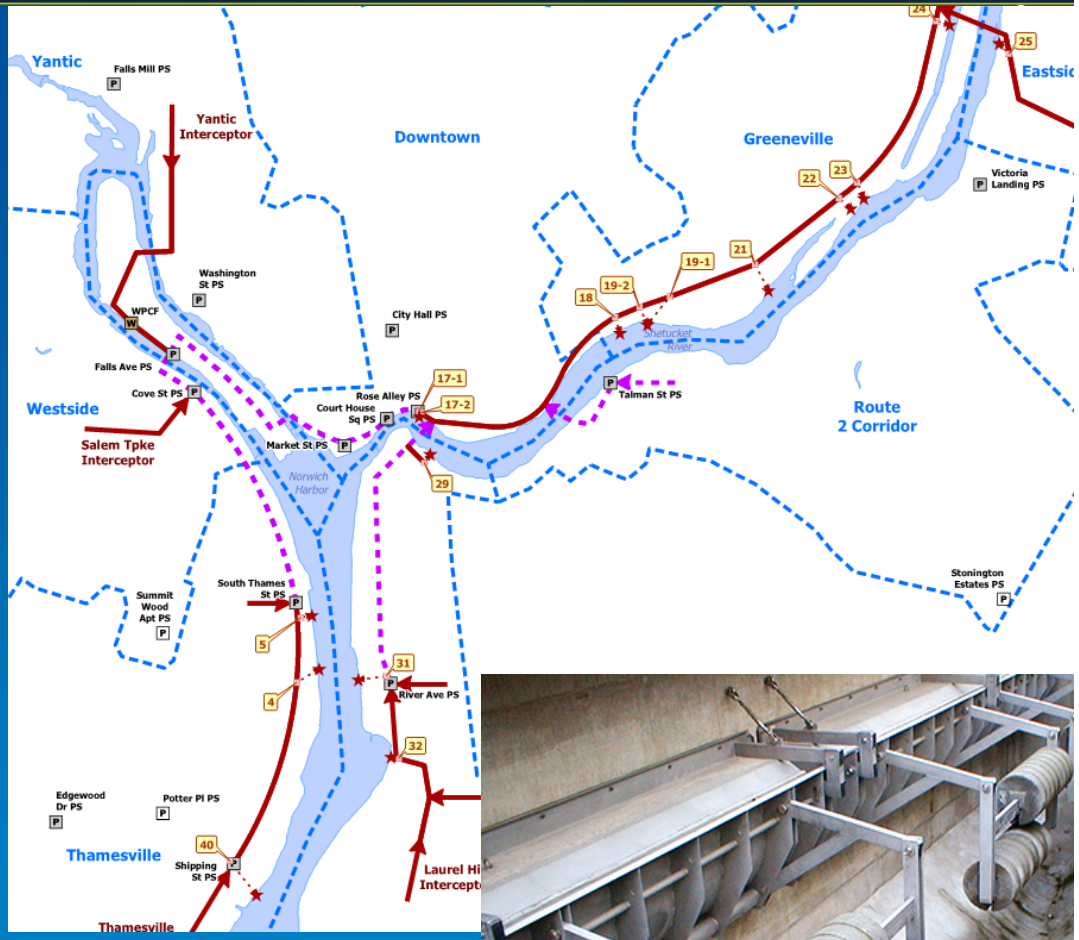
- Disruptive
- Costly
- Impacts other utilities
- Need to inspect & modify homes
- Can be effective

Storage of CSO flows

- Helpful for systems that peak quickly (like Norwich)
- Can be simple or complex
- Can be cost effective
- Underground (surface can be parking lot, ball field, etc.)

Conveyance of CSO flows

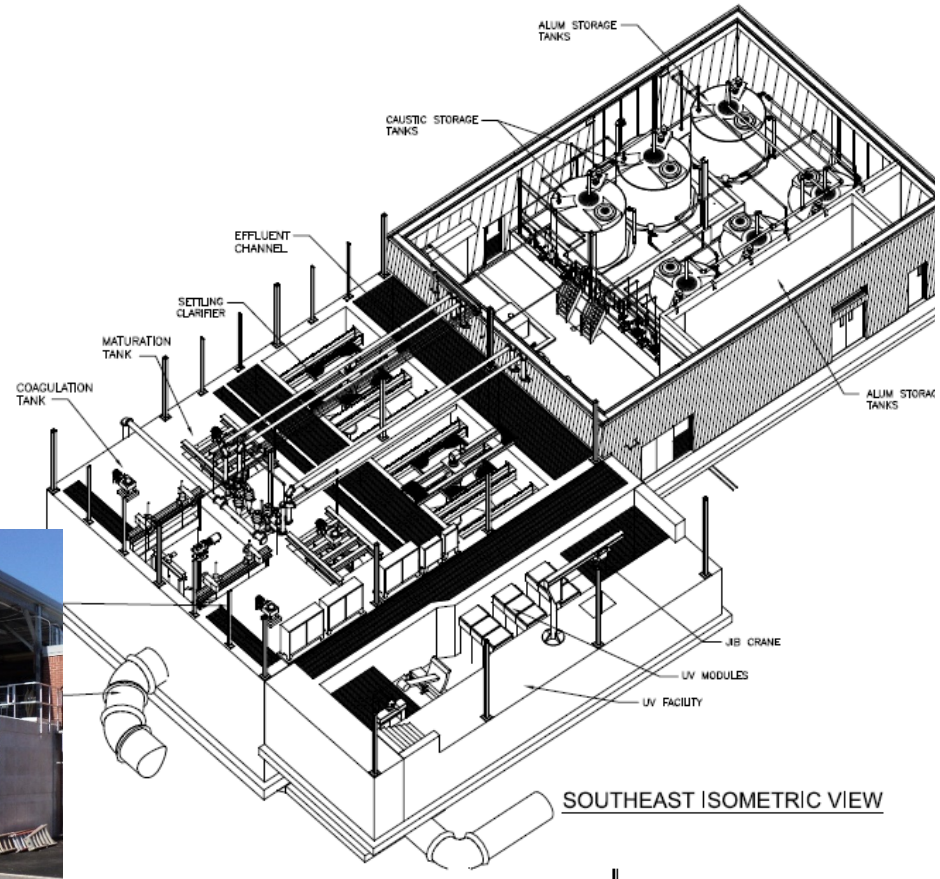
- Bring flows to where they can be better handled
- Need increased pumping
- Need increased pipe capacity
- Gates to hold water in pipes longer



CDM Smith

Treatment of CSO flows

- Construct new capacity and treatment process at WPCF
- High Rate Clarification (HRC) is viable option



Green Technologies

- Aim to reduce and retain flows
  - Reduce impervious areas
  - Green and blue roofs
  - Roadway infiltration sumps
  - Rain gardens
- Responsibility of City of Norwich DPW, who governs over the City's storm water systems
- Moderate initial expense
- Significant ongoing O&M responsibility
- Challenging in areas with steep topography

Green Infrastructure for Dense Urban Areas

Porous Pavements

Bioretention / Rain Gardens / Street Planters

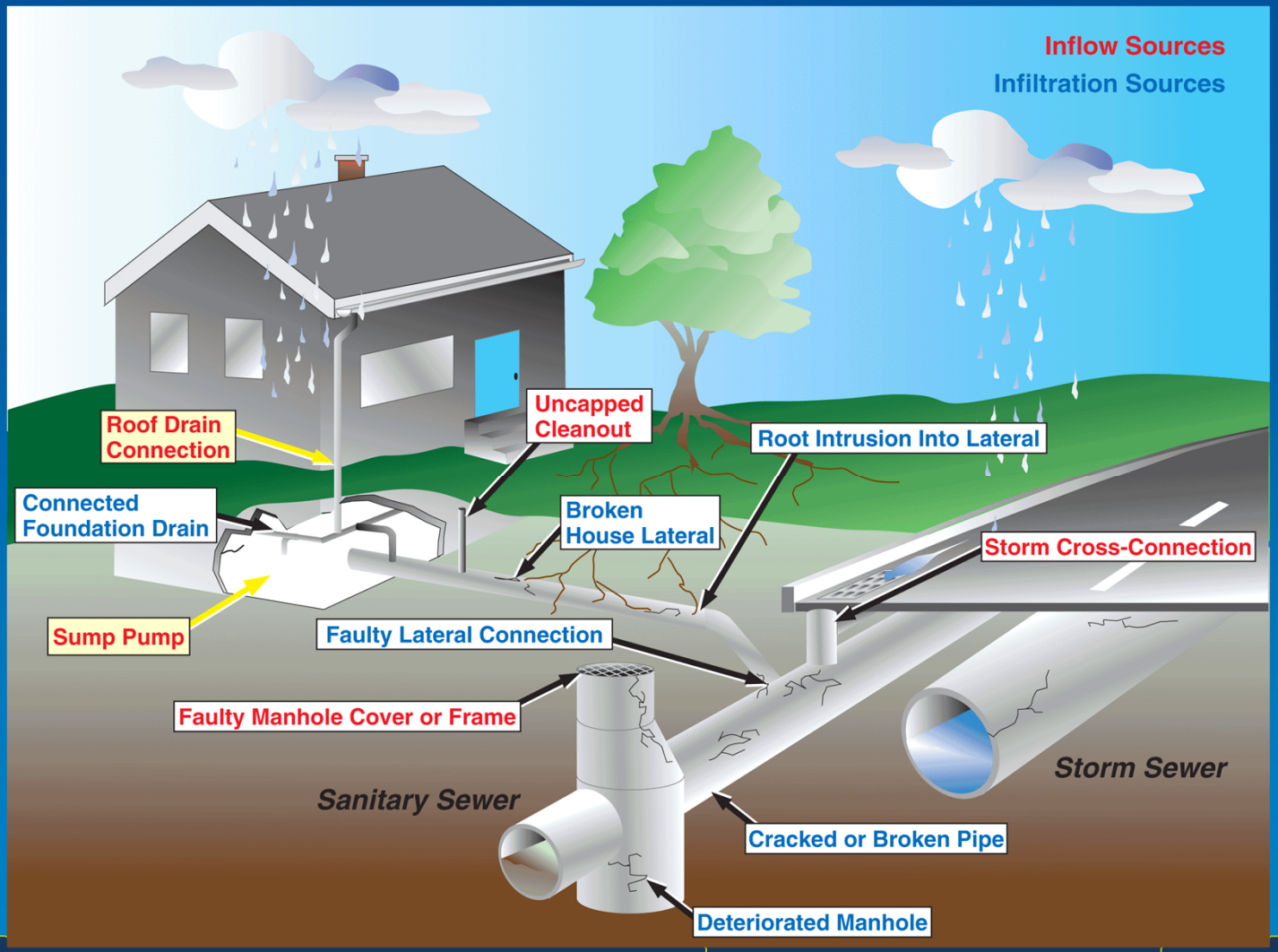
Subsurface Storage/Infiltration

Green Roof

Blue Roof

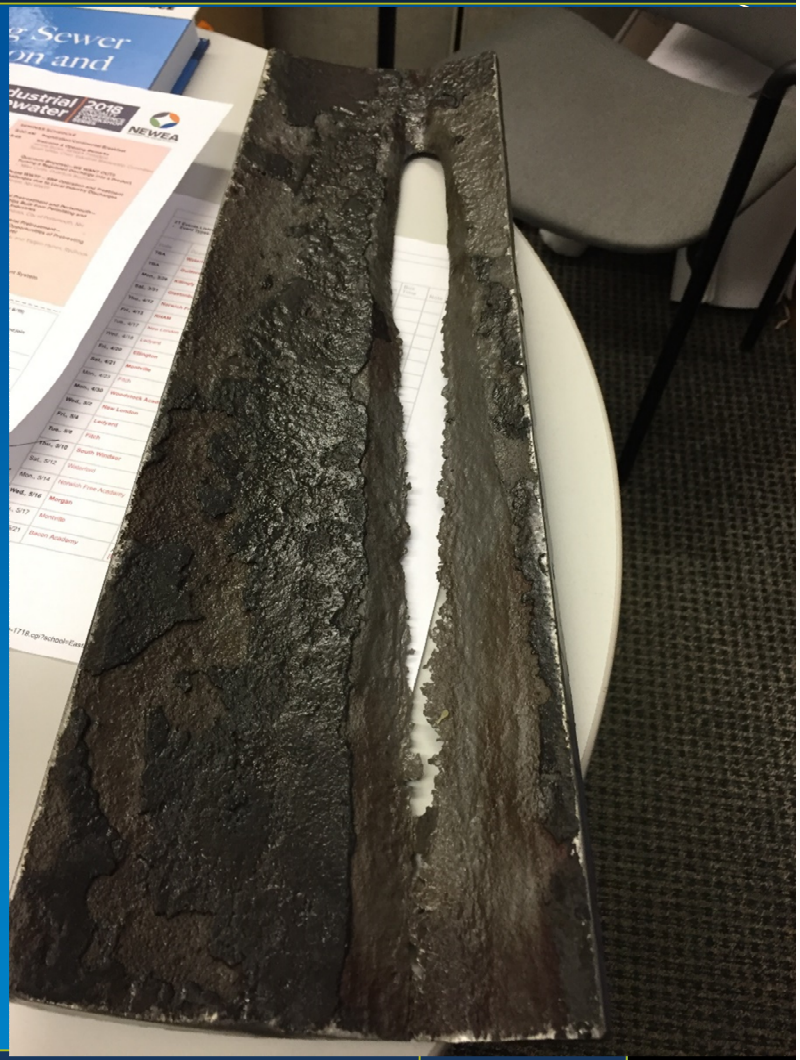
Rainwater Harvesting

Norwich Has an Aging System

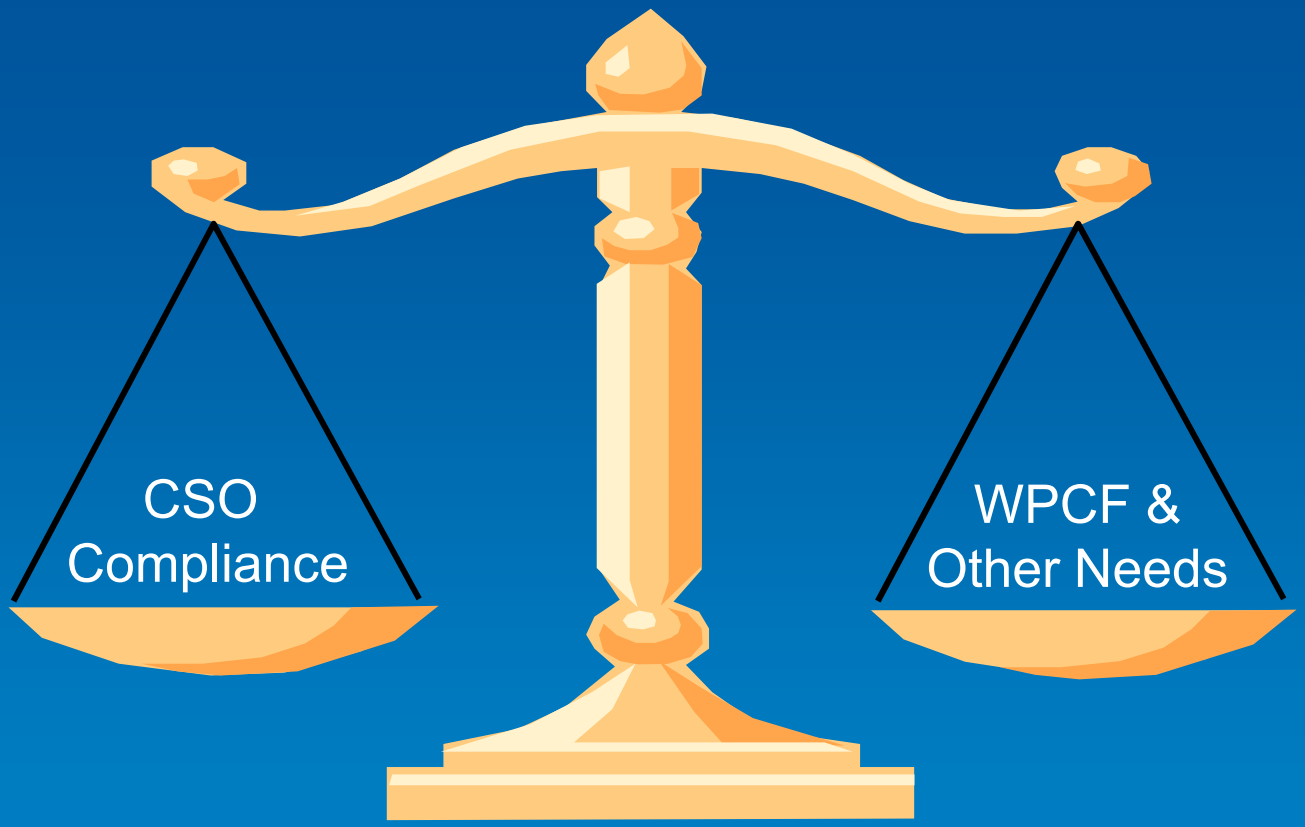


Many Pipes Have Exceeded Useful Life Expectancy

- Pipe breaks & pump failures impact water quality too
- Renewal is needed
- O&M must be included
- LTCP focuses on:
  - CSO abatement
  - System reliability
  - Balanced & fiscally responsible long term plan



Balancing Infrastructure Needs



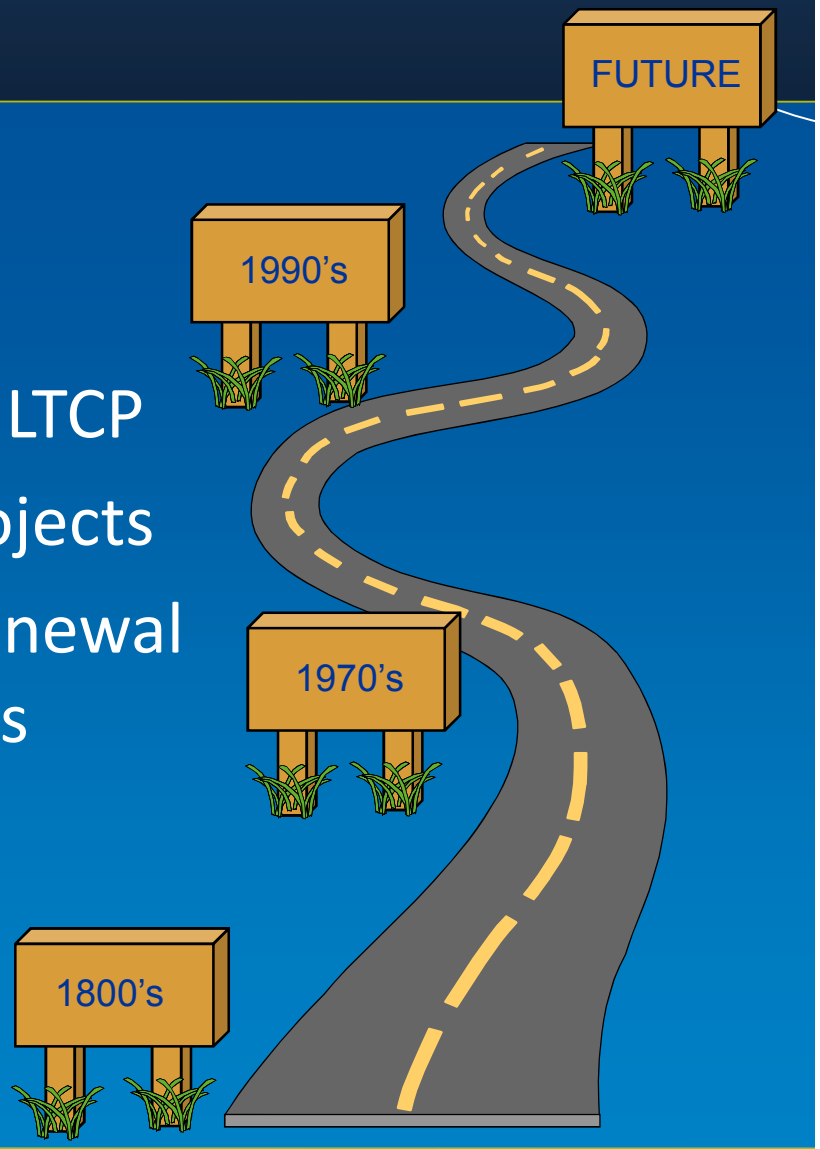
Approach Focused on Overall Environmental Benefit

Phasing of CSO and Other Capital Projects

- All CSO = infrastructure fails in the process
- All Infrastructure (and no CSO) = misses DEEP goals
- A compromise is needed
  - Break WPCF into pieces to address urgent needs
  - Upgrade failing infrastructure to prevent SSOs
  - Construct CSO plan in pieces
  - Address needs on a priority scale
  - Maintain balanced approach

Next Steps

- Refine cost and alternatives
- Final report to DEEP
- DEEP comment or approval of LTCP
- Design and construction of projects
- Comprehensive wastewater renewal program that will span decades



Meeting Notes: Norwich CSO LTCP Public Information Meeting

August 1, 2018 – Approximate Time 6:00-7:00 pm

Attendees:
Craig Wagner, CDM Smith– Presenter
Tim Dupuis, CDM Smith
Pat Hughes, CDM Smith
Brendan Ennis, CDM Smith

Chris LaRose, Norwich Public Utilities
Larry Sullivan, Norwich Public Utilities
Chris Riley, Norwich Public Utilities
Bill Coughlin, Norwich Public Utilities

Public Attendees (underlined):
Stewart Peil, Vice Chairman NPU Commissioners, asked a question regarding the status of the upgrades to the Wastewater Treatment Plant both Craig Wagner and Larry Sullivan explained that DEEP returned comments (after a considerable review period) indicating that the facility had to be elevated above the flood plain and that CSO work was reprioritized. Mr. Peil further asked if it made sense to just increase the capacity of the plant versus creating upstream storage and conveyance projects. Craig Wagner and Pat Hughes explained that it was hydraulically infeasible to increase the capacity of the plant to handle a 2-year storm without also building conveyance out in the collection system to help get flow to the plant.

Mr. Peil also asked what NPU had presently committed to fund. Mr. LaRose responded that NPU has funded the LTCP along with design of improvements to the East Side drainage area. The East Side Drainage area recommendations have already been modified based on the recent flow monitoring and modeling engineering results.

Mr. Peil also asked about priority of future funding on the collection system versus the WPCF. Mr. LaRose responded that the draft plan would recommend funding concurrent improvements to both in phases over an extended schedule of 30 years.

Kevin Aherne, Norwich Bulletin Reporter, provided a brief synapsis of Craig Wagner's presentation and asked for factual confirmation of his understanding of the presentation, which Craig Wagner provided. Mr. Aherne then wrote an article for the Norwich Bulletin, which is available at the following link, and is also included in Appendix A of the 2018 LTCP. http://www.norwichbulletin.com/news/20180801/npu-presents-updated-norwich-sewer-plan

Two additional people attended, Ben Lathrop and his wife. Both arrived prior to Craig Wagner's presentation and left before his presentation.

The Bulletin

NPU presents updated Norwich sewer plan

By Kevin Aherne kaherne@norwichbulletin.com (860) 425-4256

Posted Aug 1, 2018 at 8:10 PM
Updated Aug 1, 2018 at 8:10 PM

NORWICH - The city is one of six Connecticut municipalities that still utilize combined sewer overflow sewer systems, and state's environmental protection agency said that's a problem.

Norwich Public Utilities held a public informational meeting on Wednesday to present to the public an updated draft of its Combined Sewer Overflow Long Term Control Plan. CSOs are sewer systems that collect rainwater, sewage and industrial waste in one pipe.

The original plan was drafted following a June 2017 consent order from Department of Energy and Environmental Protection to NPU in order to compel compliance with CSO requirements.

"Nothing is wrong with Norwich's system," D. Craig Wagner, senior project manager for engineering design consultant CDM Smith said. "It works, but it's an antiquated system where overflow goes into the river."

Wagner said the efforts to upgrade the CSO system in Norwich have been going on since the 1990s, but there is much work to be done. He said there were originally 43 overflow regulators discharging wastewater into local rivers, but there are currently only 16.

In March 2018, NPU submitted a baseline conditions report to DEEP, indicating that last year Norwich's CSO experienced 60 overflow events with 43 million gallons of wastewater entering rivers. The DEEP consent order requires a system that produces only one overflow event every two years.

Wagner explained there are a number of potential alternatives that each have varying strengths, weaknesses and costs. These alternatives include sewer separation, storage, conveyance, treatment, green technologies, or a mixture of each.

"The methodology of this plan is to identify the least-cost solution that meets the goals for CT DEEP, NPU and the city of Norwich," Wagner said.

NPU operations manager Chris LaRose said this project is vital but complicated.

"It's a very complicated project that needs to be done in phases balancing the need for CSO compliance with the needs of an aging treatment plant," he said. "There is still a lot of work that needs to be done in order to identify the best solution."

Next, NPU and CDM Smith will work to refine the plan with specific alternatives and costs and submit a final report to DEEP for approval.

Appendix B

Memorandum

To: *File*

Date: *April 2020*

Subject: *2020 LTCP Appendix B – CSO Satellite Facility Site Selection Analysis*

The purpose of this memorandum is to provide background and detail on the combined sewer overflow (CSO) satellite facility site selection process for components of Norwich Public Utility's (NPU's) 2018 CSO Long Term Control Plan (LTCP). In general, a satellite facility is a CSO mitigation technology that is sited near a regulator structure to capture or treat overflows as they occur, and to take advantage of existing regulating structures to divert overflows to the satellite facility and minimize piping and possible pumping requirements. Early in the LTCP planning process, more than twenty potential satellite facility sites were screened for use in alternatives development. Eventually this was narrowed down to the ten sites for detailed analysis, which are outlined in this memorandum. The ten sites were evaluated based on size, location, topography, uses, ownership, and other criteria. Based on the evaluation, four sites were selected for detailed LTCP alternatives analysis. The LCTP will be implemented over several decades and over time the uses of individual sites may change. During each LTCP update, satellite facility sites should be re-evaluated.

Methodology

Site selection in Norwich is challenging. Norwich is a city with a hilly topography, and the major sewer interceptors are either pumped or flow by gravity in the highly developed riverfront areas. Early in the LTCP planning process, many parcels in Norwich that appeared to be unused or vacant were considered as potential sites for satellite facilities. These sites were then screened further, using the sewer model to identify areas where sewer system capacity was limited and identify the areas that satellite facilities would be the most effective. This narrowed the list of promising facility sites down to the ten presented in this memorandum. These sites were evaluated based on criteria including size, location, topography, availability, uses, ownership, and feasibility of construction. These sites are described further in the subsequent pages.

Sites were ultimately evaluated in the Downtown, Greeneville, Laurel Hill, and Thamesville sewersheds. These sewershed areas were targeted due to sewer model evaluation that indicated satellite facilities would be most helpful in these locations. Additionally, this is where the combined sewers are primarily located, and implementation of satellite facilities in sanitary sewer areas would be minimally helpful to CSO volumes. One potential site was desired in both the Laurel Hill and Thamesville sewersheds. However, two sites were desired along the Shetucket Interceptor (Downtown and Greenville sewersheds) due to the prevalence of CSO regulators in these areas and indication through the sewer model that multiple facilities might be desirable here.

Figures B-1 through B-10 are illustrations of the ten site summaries show the areas around the sites, including the area of interest, sewer infrastructure and imagery. The shapes outlined in blue on the figures represent the areas of interest. Combined sewers are shown in brown, sanitary sewers in red, and force mains are shown as purple dashed lines. Pumping stations (PS) are indicated by a boxed icon with a "P", including the PS name.

Data presented in these site summaries was obtained from a variety of sources. Primary information on ownership, property appraisals, areas, and elevation were obtained using the City of Norwich's Geographic Information Systems (GIS) online map services. According to the most recent disclaimer, property data on the City's GIS mapping services was last updated on August 8, 2018. The property assessment value represents 70% of the market value at the time of the last valuation.

This memorandum is focused on engineering feasibility of using sites in Norwich for satellite CSO facilities. It is understood that purchasing a property, obtaining an easement onto a property, and/or changing the use of a city-owned property for use in the sewer system is a process that involves many considerations beyond engineering feasibility. Therefore, CDM Smith subcontracted with Green Site Design, LLC, a Norwich-based company, to do research on potential sites to identify any issues that would prevent the re-development of the sites for use for a satellite facility. At this time, no specific concerns that would prevent the use of sites have been identified, but there are no agreements with property owners and it is understood that these sites would have to be further evaluated during the conceptual design phase.

List of Potential Sites for Satellite Facilities

- **Laurel Hill**
  - Site 1: River Avenue Floodway
  - Site 2: Laurel Hill Avenue Park
- **Shetucket (Downtown & Greeneville Sewersheds)**
  - Site 3: Rose Alley (Viaduct Road) Commuter Parking Lot
  - Site 4: Rose Alley and Ferry Street Parking Lot
  - Site 5: Norwich Public Utilities Headquarters
  - Site 6: Norwich Self Storage, South Golden Street
  - Site 7: North Main Street at 5th Street, Swift Performance Automotive

- **Thamesville**
  - Site 8: Shipping Street
  - Site 9: South Thames Street Condominium Site North
  - Site 10: South Thames Street Condominium Site South

Site 1: River Avenue Floodway

Location

This site is located off the end of River Avenue in the Laurel Hill sewershed area. The evaluated site is across the railroad tracks from the River Avenue PS. The site is bounded by the Thames River to the west and south, railroad tracks to the east, and the combined sewer overflow (CSO) 031 outfall pipe to the north. See Figure B-1 below.

Figure B-1
Site 1 – River Avenue Floodway

Ownership

This property parcel is owned by the Providence and Worcester Railroad Company, with a valuation of $162,100. The parcel itself extends further north and further south, following the railroad tracks.

Area
This total parcel has an approximate land area of 41 acres; the desired area depicted in Figure B-1 is approximately 3.1 acres.

Elevation
The elevation of this site ranges from approximately 2 feet to 8. This entire site falls within the FEMA Floodway designation.

Site Access and Traffic
Access at this site is difficult. Two narrow roads (River Avenue, New Wharf Road) can be used to reach this site, but there is no permanent railroad crossing at either road, and one would need to be established for construction. Access for large trucks and construction vehicles to this site would be very difficult. There is plenty of room here for construction staging once access to the site is established.

Current Land Use
This site appears to have no current residential or commercial use; however, it is within the Thames River Floodway. Above ground construction would obstruct the ability for the river to flood into this area and would make permitting difficult and construction challenging.

Advantages
This site is at a comparable elevation with the CSO regulators and the Laurel Hill interceptor which reduces the need for pumping flow to a facility. This site also has necessary space for construction of any type of facility. The site appears to have no current residential or commercial use.

Disadvantages
This site (or an easement) would need to be purchased from the railroad company and a permanent at-grade railroad crossing easement would need to be established to gain access to this site. Additionally, this site is located in the floodway, which would require additional permitting, it is likely that nothing critical could be built above grade, heavy dewatering would be needed, along with construction on piles to counter buoyant forces. Pipes would need to be jacked beneath the railroad tracks as well.

Site 2: Laurel Hill Avenue Park

Location

This site is located at the corner of Center Street and Laurel Hill Avenue. The evaluated site is currently an open park space. The site is bounded by Center Street to the North, River Avenue to the west, Laurel Hill Avenue to the east, and private property to the south. See Figure B-2 below.

Figure B-2
Site 2 – Laurel Hill Avenue Park

Ownership

This property parcel is owned by the City of Norwich with a valuation of $25,300 according to the City of Norwich property records.

Area

This total site has an approximate land area of 0.59 acres.

Elevation
This site is relatively flat and ranges from approximately 84 feet to 88 feet in elevation.

Site Access and Traffic
This site is easily accessible. Laurel Hill Avenue is a major road in Norwich and can easily accommodate construction vehicles and equipment. It is expected that there is enough room at this site to stage construction, and if needed River Avenue west of the site could also be utilized as a secondary staging area.

Current Land Use
This site is currently open park space, with benches and picnic tables. However, there are no buildings or facilities in this location.

Advantages
This site is owned by the City of Norwich and is not used for any critical activities. This location is one of the few open parcels available in Laurel Hill that is near the CSO regulators. This site has easy access and room for construction.

Disadvantages
This site is at least 70 feet higher in elevation than the River Avenue PS. To utilize this site for storage or other CSO mitigation facilities, flow must be pumped up the River Avenue hill to this location. Gravity piping from this site down towards the Shetucket Interceptor must be in place to utilize this site. Additionally, this site is in a neighborhood location instead of a lesser used area. It is likely that if this site is used, only below ground facilities, with an enhanced park area replaced on top of the new CSO facilities would be acceptable. Additionally, odor control technologies would need to be considered depending on the type of satellite facility located here.

Site 3: Rose Alley (Viaduct Road) Parking Lot

Location
This site is located at a commuter parking lot off of Viaduct Road. This is located on the southern side of the railroad tracks from the Rose Alley PS. See Figure B-3 below.

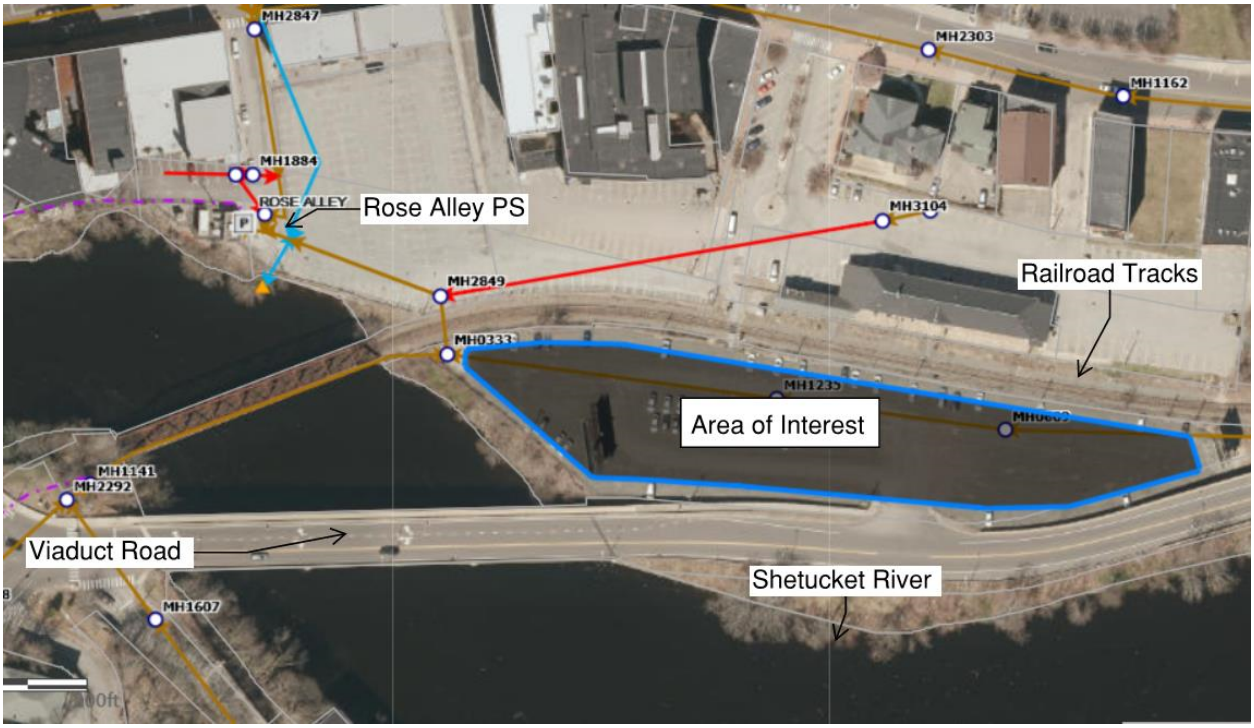


Figure B-3
Site 3 – Rose Alley Parking Lot

Ownership
This property parcel is owned by the City of Norwich with a valuation of $141,700 according to the City of Norwich property records.

Area
This total site has an approximate land area of 1.5 acres. The parking lot area presented in Figure B-3 has an approximate area of 1.4 acres.

Elevation
This site is relatively flat and ranges from approximately 14 feet to 17 feet in elevation.

Site Access and Traffic
This site is easily accessible. Viaduct Road is a major road in Norwich and should be able to easily accommodate construction vehicles and equipment. It is expected that there is enough room at this

site to stage construction of smaller facility sizes, but facilities for the larger design storms may be too large for the site.

Current Land Use
This site is currently used as a public commuter parking lot.

Advantages
This site is located near the end of the Shetucket interceptor, where capacity is needed. It is at an elevation that is comparable to the existing interceptor. It is owned by the City of Norwich and is does not have any uses beyond public parking. And winter snow storage by DPW. It is relatively accessible for construction.

Disadvantages
This site is currently utilized as public parking, which would be temporarily eliminated during the construction period, but could be restored post construction assuming facilities are built underground. Although the interceptor is near the site, it runs through the center of the parking lot, which could require relocation or bypass pumping during construction. Construction staging areas could be limited during construction of a larger design storm alternative.

Site 4: Rose Alley and Ferry Street Parking Lot

Location
This site is located at a commuter parking lot between Rose Alley and Ferry Street. This is located on the northern side of the railroad tracks from the Rose Alley PS. It is bounded at the north by private buildings, to the east by Ferry Street, to the west by Rose Alley, and to the south by an unnamed connecting road as well as the Shetucket River and railroad tracks. See Figure B-4 below.

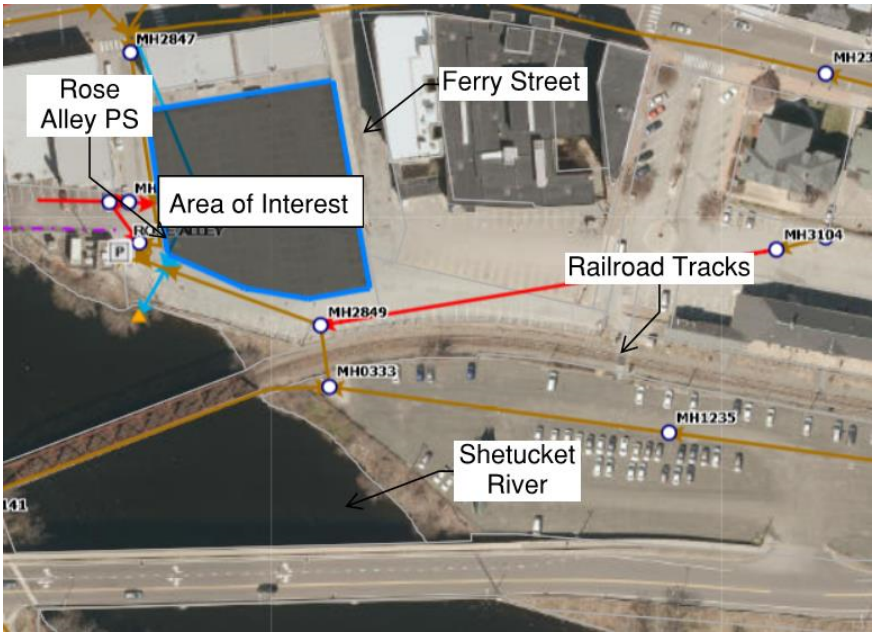


Figure B-4
Site 4 – Rose Alley and Ferry Street Parking Lot

Ownership
This area of interest is owned by two entities: "Lord Family Nominee Trustlord" and the City of Norwich according to the City of Norwich Assessor's Office property records. The privately-owned parcel is valued at $144,300, while the City of Norwich parcel is valued at $7,600.

Area
The two parcels have an approximate combined land area of 1.27 acres. The area of interest presented in Figure B-4 has an approximate area of 0.58 acres.

Elevation
This site is relatively flat and ranges from approximately 14 feet to 18 feet in elevation.

Site Access and Traffic
This site is moderately accessible for construction. Although Main Street is a major thoroughfare, two minor streets (Rose Alley & Ferry Street) provide access to this parking lot. It is expected that

construction staging, and construction here would be difficult due to narrow access and adjacent businesses.

Current Land Use
This site is currently used as a private commuter parking lot for business in downtown Norwich.

Advantages
This site is located near the end of the Shetucket interceptor, where the model has indicated that additional capacity is needed. It is partially owned by the City of Norwich. This is one of the few undeveloped parcels in the Downtown area.

Disadvantages
This site is currently utilized as public parking, which would be eliminated during the construction period, but could be restored post construction assuming the facilities are built underground.

Site 5: Norwich Public Utilities Headquarters

Location
This site is located at the NPU Headquarters on South Golden Street. The site is bound to the north by the railroad tracks and existing structures, to the east by South Golden Street, and to the south by the Shetucket River. The specific area of interest includes NPU's rear parking lot. See Figure B-5 below.

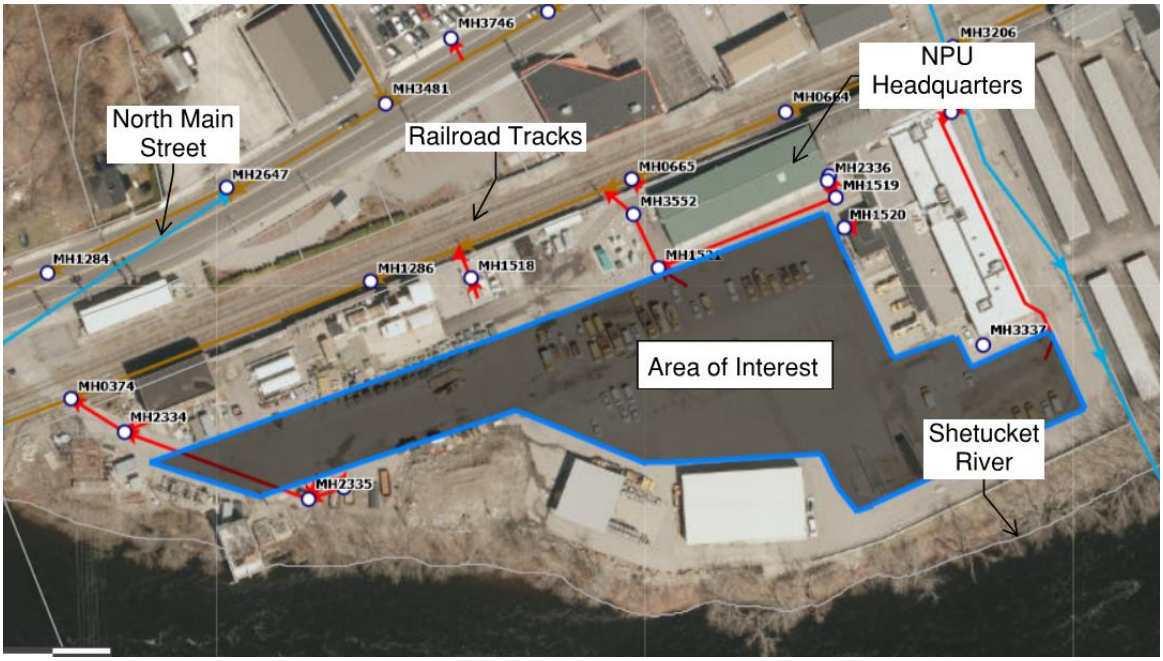


Figure B-5
Site 5 – NPU Headquarters

Ownership
This site is owned by Norwich Public Utilities and valued at $1,111,600 according to the City of Norwich Assessment records.

Area
The area of interest presented in Figure B-5 has an approximate area of 2.0 acres.

Elevation
This site is relatively flat and ranges from approximately 18 feet to 22 feet in elevation.

Site Access and Traffic

This site is very accessible for construction. North Main Street is a major road that is accessible for construction vehicles, and NPU currently uses their yard for vehicle storage and maintenance

activities. Although this site is not anticipated to create any traffic problems on North Main Street, it could cause congestion issues within NPU's yard and potentially cause issues in NPU's normal business operations.

Current Land Use

This site is currently used by NPU as parking for their headquarters building, as well as for vehicle storage and maintenance.

Advantages

This site is located near the interceptor, in a location where capacity is needed. The site is owned by NPU and would not provide any additional public disruption. The site has easy access for construction activities. Additionally, this site is already in an industrial area, and would have minimal impact on the public.

Disadvantages

The main disadvantage to this site is the implication to NPU's business operations. Building here could impede normal vehicle maintenance and office operations. Parking would be eliminated during the construction period but could be restored post construction assuming the facilities are built underground. Additionally, NPU has indicated that the soils on the site could be contaminated and require additional removal and disposal costs. Although the interceptor is on the south side of the tracks closer to the site, under some alternatives, pipe jacking under the railroad to a relief interceptor yields additional complications.

Site 6: Norwich Self Storage

Location
This site is located adjacent to the NPU Headquarters on South Golden Street. The site is bound to the north by the railroad tracks, to the east by Erin Street, to the West by South Golden Street and to the south by the Shetucket River. The specific area of interest includes an active self-storage business. See Figure B-6 below.

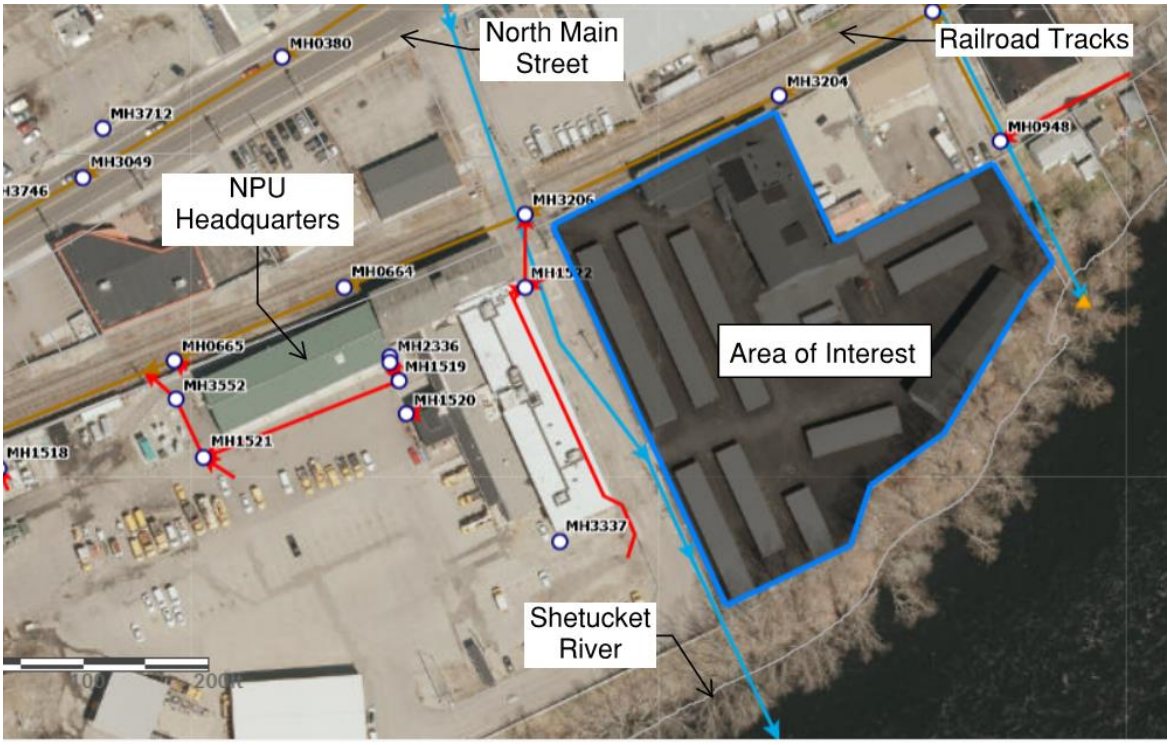


Figure B-6
Site 6 – Norwich Self Storage

Ownership
This site is privately owned by "43 Corporation" with a valuation of $880,300.

Area
The self-storage lot presented in Figure B-6 has an approximate area of 2.39 acres.

Elevation
This site is relatively flat and ranges from approximately 22 feet to 24 feet in elevation.

Site Access and Traffic

This site is moderately accessible for construction. North Main Street is a major road that is accessible for construction vehicles, however South Golden Street is a narrow access road for NPU headquarters and this site. Although this site is not anticipated to create any traffic problems on North Main Street, it could cause congestion issues on South Golden Street.

Current Land Use

This site is currently used by Norwich Self Storage as a storage business and rental facility.

Advantages

This site is located near the interceptor, in a location where capacity is needed. The site is adjacent to NPU and would provide easy access to any facilities built here. If facilities are built underground here, the area can be used for additional NPU parking, vehicle garages, or staging area.

Disadvantages

This site would need to be purchased and the buildings would need to be relocated to build any CSO facilities here, which presents a very large initial challenge. There is the potential that construction here could impede normal NPU vehicle maintenance and office operations. Additionally, NPU has indicated contaminated soil conditions at the neighboring NPU headquarters site; therefore, there is the potential that contaminated soils could be found at this adjacent site as well. Although the interceptor is on the south side of the tracks closer to the site, under some alternatives, pipe jacking under the railroad to a relief interceptor provides additional complications.

Site 7: North Main Street at 5th Street, Swift Performance Automotive

Location
This site is located at North Main Street and 5th Street. The site is bound to the north by 5th Street, to the east by the railroad tracks and the Shetucket River, to the west by North Main Street and to the south by 4th Street. See Figure B-7 below.

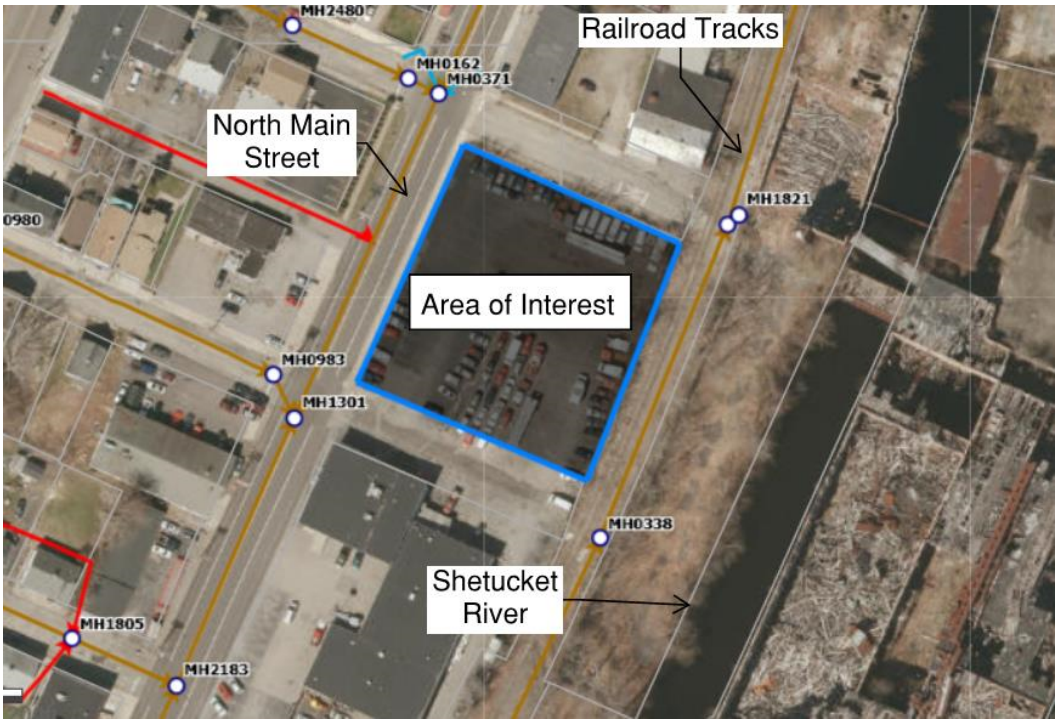


Figure B-7
Site 7 – North Main Street at 5th Street, Swift Performance Automotive

Ownership
This site is not listed on the City's assessors' records within the online GIS resources. The desired parcel appears to be a parking lot for the adjacent "Swift Performance Automotive" business. The adjacent parcel (Swift Performance Automotive) is privately owned by "401 North Main Realty LLC" with a valuation of $258,700.

Area
The parcel of interest presented in Figure B-7 has an approximate area of 0.87 acres.

Elevation
This site is moderately sloped and ranges from approximately 40 feet to 50 feet in elevation.

Site Access and Traffic

This site is very accessible for construction. North Main Street is a major road that is accessible for construction vehicles and this site. The dead ends of 4th Street and 5th Street could potentially be used as a construction staging area. It is not anticipated that construction here would impede traffic on North Main Street.

Current Land Use

This site appears to be used as a vehicle storage and parking lot for Swift Performance Automotive.

Advantages

This site is located near the interceptor, in a location where capacity is needed. The site has easy access to the sewer lines in North Main Street and relatively easy access to the interceptor. Although the lot is privately owned, it doesn't appear to have any critical uses. Use of this site would prevent disruption of the NPU Headquarters lot. If facilities are built underground, there is the potential for restoration of parking on top of the facilities.

Disadvantages

This site would need to be purchased from the current owner. If a facility was built to detain flows from North Main Street, and convey them to the Shetucket Interceptor, a pipe would need to be jacked under the railroad tracks.

Site 8: Shipping Street

Location
This site is located at Shipping Street and Terminal Way. The site is bound to the north and west by private property, to the east by the railroad tracks, and to the south by Shipping Street. See Figure B-8 below.

Figure B-8
Site 8 – Shipping Street

Ownership
This parcel is owned by the City of Norwich. The desired parcel is a vacant lot valued at $71,500

Area
The parcel of interest presented in Figure B-8 has an approximate land area of 1.5 acres.

Elevation
This site is relatively flat and the area of interest ranges from approximately 8 feet to 12 feet.

Site Access and Traffic
This site is moderately accessible for construction. West Thames Street is a major road that is accessible for construction vehicles. Additionally, Shipping Street, South Street, and Terminal Way

are lightly used but would be accessible for construction equipment. It is not anticipated that construction here would significantly impede traffic anywhere in Norwich.

Current Land Use
This site is currently an undeveloped empty lot owned by the City of Norwich.

Advantages
There is a substantial amount of room available at this lot for construction of a CSO satellite facility. The lot is owned by the City of Norwich and is conveniently located near the Shipping Street Pumping Station (PS) and CSO 040.

Disadvantages
Although this plot of available land is close to some of NPU's critical infrastructure, the system has sufficient capacity here. This location does not align with system capacity needs. Additionally, this site is listed as a brownfield that is in a "Remediation Started" category on the City GIS Viewer.

Site 9: South Thames Street Condominiums Site - North

Location

This site is located at the condominiums off South Thames Street on the north side. The site is bound to the north by a City of Norwich parcel, to the east by the railroad tracks and Thames River, to the west by West Thames Street, and to the south by condominiums. See Figure B-9 below.

Figure B-9
Site 9 – South Thames Street Condominiums Site - North

Ownership

This parcel is privately owned by 190 South Thames Street LLC. The valuation of the entire parcel is $92,800.

Area

The parcel of interest presented in Figure B-9 has an approximate land area of 0.4 acres.

Elevation
This site is moderately sloped and the area of interest ranges from approximately 10 feet to 24 feet in elevation.

Site Access and Traffic
This site has difficult access for construction of facilities. West Thames Street is a major throughway, but South Thames Street and the condo driveway are narrow and could potentially impede site access for construction vehicles. The area of interest itself is a tight construction area and could prove to be difficult for construction staging as well.

Current Land Use
This site is currently an unused grassy area within a private riverfront condominium complex.

Advantages
This site is conveniently located near existing infrastructure (South Thames Street Pumping Station & CSO 005) where CSO capacity is needed.

Disadvantages
Private ownership, as well as tight construction windows are the main disadvantages of this site. There is limited land available to build a facility, and for construction staging. The site is between West Thames Street and the railroad tracks which provide a narrow window of construction.

Site 10: South Thames Street Condominiums Site - South

Location

This site is located at the southern side of the condominium complex off South Thames Street. The site is bound to the north by condominium buildings, to the east by the railroad tracks and Thames River Estuary, to the west by West Thames Street, and to the south by private property. See Figure B-10 below.

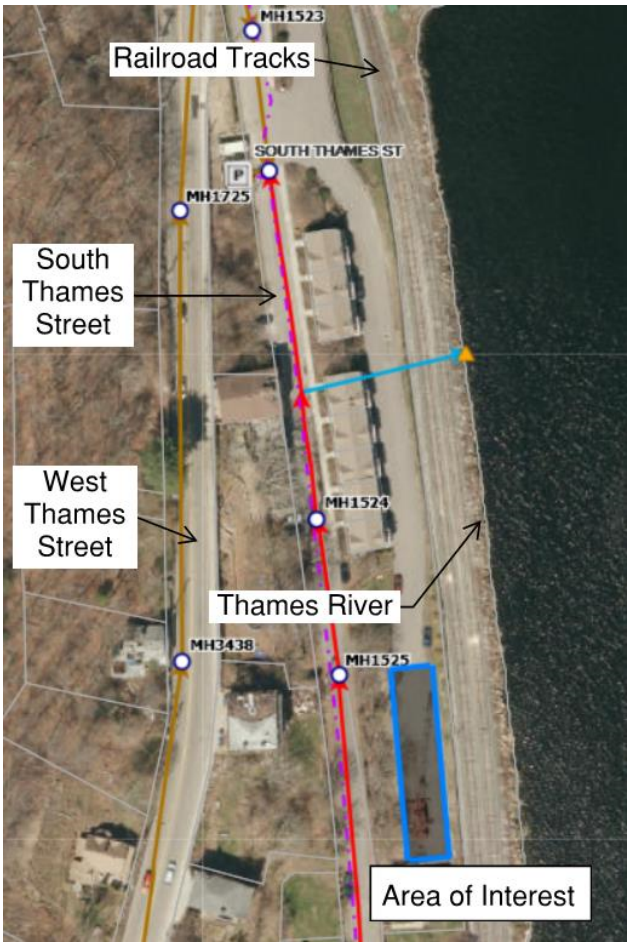


Figure B-10
Site 10 – Site 10: South Thames Street Condominiums Site - South

Ownership

This parcel is privately owned by 190 South Thames Street LLC. The valuation of the entire parcel is $92,800.

Area

The area of interest presented in Figure B-9 has an approximate land area of 0.1 acres.

Elevation
This site is relatively flat and the area of interest ranges from approximately 6 feet to 10 feet in elevation.

Site Access and Traffic
This site has difficult access for construction of facilities. West Thames Street is a major throughway, but South Thames Street and the condominium complex driveway are narrow and could potentially impede site access for construction vehicles. The area of interest itself is a tight construction area and could prove to be difficult for construction staging as well.

Current Land Use
This site is currently an unused paved area on the south side of a private riverfront condominium complex.

Advantages
This site is conveniently located near existing infrastructure (South Thames Street Pump Station & CSO 005) where CSO capacity is needed.

Disadvantages
Private ownership, as well as tight construction windows are the main disadvantages of this site. There is limited land available to build a facility, and for construction staging. The site is between West Thames Street and the railroad tracks which provide a narrow window of construction. Additionally, the western side of this site is a more significant elevation change than the northern condominium site. Finally, this site has less available land area than the northern site.

Evaluation

To identify the best sites for a CSO satellite facility, decision matrices were used to systematically identify, analyze, and rate the ten preliminary sites. The following is a description of each criteria and the matrices is presented in tables Table B-1 through B-3:

Location describes the type of location where the site is located.

Size refers to the available acreage of a site.

Constructability refers to the available construction windows, anticipated obstacles, and general feasibility of construction at the site. Sites that are anticipated to be straightforward areas to build in were given a good rating, while those with less desirable construction factors, such as floodplains or possible contamination were given a fair or poor rating.

Ownership refers to availability and use of a site. Site are indicated as owned by NPU, The City of Norwich, or under private ownership.

Public impact refers to the expected impact to the public while constructing CSO facilities on the given sites. Sites directly adjacent to public areas or residential areas were given a poor or fair rating. Sites that were more distant from the public and are anticipated to have less impact were given a good rating.

Topography refers to how flat the site is, and whether is situated significantly lower or higher in elevation than existing infrastructure, and proximity to a flood way. Generally, flat sites located at comparable elevations to existing infrastructure were given a good rating, while sloped sites and sites that were at a much different elevation than the existing infrastructure were given a fair or poor rating. Sites in a floodway were given a poor rating.

Based on this, four sites were selected sites for evaluation in Section 8 of the 2018 LTCP. These are highlighted in Tables B-1 through B-3 and explained below.

Laurel Hill Selection

In the Laurel Hill sewershed two sites were evaluated, and Site 2 at the Laurel Hill Avenue Park, was selected as the recommended CSO Satellite Facility site for the LTCP. Although Site 1 is at a comparable elevation with existing infrastructure in Laurel Hill, constructability in this floodway area was deemed too challenging. Pumping will be required to convey flow from the existing Laurel Hill interceptor to Site 2, but construction in this area was deemed more feasible. This site was evaluated using the model and ultimately presented as a facility location in the LTCP alternatives analysis, but no satellite facilities sited here were included in the recommended plan.

Table B-1 Evaluation of Satellite Sites, Laurel Hill

Site	Location	Size	Constructability	Ownership	Public Impact	Topography
1	Located in Floodway	3.1 Acres	Poor	Private	Low	Poor
2	Public Park	0.6 Acres	Good	City of Norwich	High	Fair

Shetucket (Greeneville and Downtown Sewersheds) Selection

Site 3 was ultimately selected as a facility site on the lower Shetucket Interceptor. This site has easy access to the interceptor, plenty of space for construction under most alternatives, and it is anticipated that its use could be restored if underground facilities are utilized. The Site 4 parking lot was similar in its advantages to Site 3, although smaller and privately owned. Additionally, this parking lot is typically more utilized than the parking lot at Site 3. Site 4 was ultimately eliminated due to a preference towards Site 3 in the Downtown Area. Site 3 was evaluated using the model and ultimately presented as a facility location in Section 8 of this LTCP. This location was used as a satellite facility location under many of the LTCP alternatives and was ultimately included in the recommended plan.

On the upper Shetucket Interceptor, three sites were evaluated. Site 5 is owned by NPU, would have enough room for construction of a facility, and construction would have minimal impact on the public. Site 6 is a fully developed private business and implementation of any CSO control technology here would be extremely difficult. Site 7 is a parking lot for a private business, which would also provide an obstacle for implementation of any CSO technology here as well. Site 5 was ultimately modeled as a CSO facility site in Section 8 of the 2018 LTCP but was not included in the current recommended plan. These sites on the upper Shetucket Interceptor will be reevaluated in future LTCP updates.

Table B-2 Evaluation of Satellite Sites, Shetucket

Site	Location	Size	Constructability	Ownership	Public Impact	Topography
3	Public Parking Lot	1.4 Acres	Good	City of Norwich	High	Good
4	Private Parking Lot	0.6 Acres	Good	Private	High	Good
5	NPU Parking Lot	2.0 Acres	Fair	NPU	Low	Good
6	Private Storage Center	2.4 Acres	Poor	Private	High	Good
7	Private Auto Lot	0.9 Acres	Good	Private	Medium	Fair

Thamesville Selection

Based on the site analysis, Site 8 originally was considered a promising site for a CSO technology due to its location near CSO 040, the Shipping Street PS, and the open space available. However, modeling indicated that capacity here was adequate and CSO mitigation technology would not be needed in this location. This site does appear to be a promising location to relocate the Shipping Street PS to if it is desired. Sites 9 and 10 were better positioned near critical infrastructure than Site 8. Although both of these sites are private, they appear to be unused land within a private parcel. Site 9, the northern site, was determined to be better positioned, and was preferred to Site 10. This site was evaluated by the model and presented as a location in several alternatives and included in the recommended plan as a satellite facility site.

Table B-3 Evaluation of Satellite Sites, Thamesville

Site	Location	Size	Constructability	Ownership	Public Impact	Topography
8	Empty Lot	1.5 Acres	Fair	City of Norwich	Medium	Good
9	Private Unimproved Area	0.4 Acres	Fair	Private	Medium	Fair
10	Private Unimproved Area	0.1 Acres	Poor	Private	Medium	Good

Appendix C

federal register

Tuesday
April 19, 1994

Part VII

Environmental Protection Agency

Combined Sewer Overflow (CSO) Control Policy; Notice

ENVIRONMENTAL PROTECTION AGENCY

[FRL-4732-7]

Combined Sewer Overflow (CSO) Control Policy

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final policy.

SUMMARY: EPA has issued a national policy statement entitled "Combined Sewer Overflow (CSO) Control Policy." This policy establishes a consistent national approach for controlling discharges from CSOs to the Nation's waters through the National Pollutant Discharge Elimination System (NPDES) permit program.

FOR FURTHER INFORMATION CONTACT: Jeffrey Lape, Office of Wastewater Enforcement and Compliance, MC-4201, U.S. Environmental Protection Agency, 401 M Street SW., Washington, DC 20460, (202) 260-7361.

SUPPLEMENTARY INFORMATION: The main purposes of the CSO Control Policy are to elaborate on the Environmental Protection Agency's (EPA's) National CSO Control Strategy published on September 8, 1989, at 54 FR 37370, and to expedite compliance with the requirements of the Clean Water Act (CWA). While implementation of the 1989 Strategy has resulted in progress toward controlling CSOs, significant public health and water quality risks remain.

This Policy provides guidance to permittees with CSOs, NPDES authorities and State water quality standards authorities on coordinating the planning, selection, and implementation of CSO controls that meet the requirements of the CWA and allow for public involvement during the decision-making process.

Contained in the Policy are provisions for developing appropriate, site-specific NPDES permit requirements for all combined sewer systems (CSS) that overflow as a result of wet weather events. For example, the Policy lays out two alternative approaches—the "demonstration" and the "presumption" approaches—that provide communities with targets for CSO controls that achieve compliance with the Act, particularly protection of water quality and designated uses. The Policy also includes enforcement initiatives to require the immediate elimination of overflows that occur during dry weather and to ensure that the remaining CWA requirements are complied with as soon as practicable.

The permitting provisions of the Policy were developed as a result of extensive input received from key stakeholders during a negotiated policy dialogue. The CSO stakeholders included representatives from States, environmental groups, municipal organizations and others. The negotiated dialogue was conducted during the Summer of 1992 by the Office of Water and the Office of Water's Management Advisory Group. The enforcement initiatives, including one which is underway to address CSOs during dry weather, were developed by EPA's Office of Water and Office of Enforcement.

EPA issued a Notice of Availability on the draft CSO Control Policy on January 19, 1993, (58 FR 4994) and requested comments on the draft Policy by March 22, 1993. Approximately forty-one sets of written comments were submitted by a variety of interest groups including cities and municipal groups, environmental groups, States, professional organizations and others. All comments were considered as EPA prepared the Final Policy. The public comments were largely supportive of the draft Policy. EPA received broad endorsement of and support for the key principles and provisions from most commenters. Thus, this final Policy does not include significant changes to the major provisions of the draft Policy, but rather, it includes clarification and better explanation of the elements of the Policy to address several of the questions that were raised in the comments. Persons wishing to obtain copies of the public comments or EPA's summary analysis of the comments may write or call the EPA contact person.

The CSO Policy represents a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities and the public engage in a comprehensive and coordinated planning effort to achieve cost effective CSO controls that ultimately meet appropriate health and environmental objectives. The Policy recognizes the site-specific nature of CSOs and their impacts and provides the necessary flexibility to tailor controls to local situations. Major elements of the Policy ensure that CSO controls are cost effective and meet the objectives and requirements of the CWA.

The major provisions of the Policy are as follows.

CSO permittees should immediately undertake a process to accurately characterize their CSS and CSO discharges, demonstrate implementation of minimum technology-based controls identified in the Policy, and develop long-term CSO control plans which evaluate alternatives for attaining compliance with the CWA, including compliance with water quality standards and protection of designated uses. Once the long-term CSO control plans are completed, permittees will be responsible to implement the plans' recommendations as soon as practicable.

State water quality standards authorities will be involved in the long-term CSO control planning effort as well. The water quality standards authorities will help ensure that development of the CSO permittees' long-term CSO control plans are coordinated with the review and possible revision of water quality standards on CSO-impacted waters.

NPDES authorities will issue/reissue or modify permits, as appropriate, to require compliance with the technology-based and water quality-based requirements of the CWA. After completion of the long-term CSO control plan, NPDES permits will be reissued or modified to incorporate the additional requirements specified in the Policy, such as performance standards for the selected controls based on average design conditions, a post-construction water quality assessment program, monitoring for compliance with water quality standards, and a reopener clause authorizing the NPDES authority to reopen and modify the permit if it is determined that the CSO controls fail to meet water quality standards or protect designated uses. NPDES authorities should commence enforcement actions against permittees that have CWA violations due to CSO discharges during dry weather. In addition, NPDES authorities should ensure the implementation of the minimum technology-based controls and incorporate a schedule into an appropriate enforceable mechanism, with appropriate milestone dates, to implement the required long-term CSO control plan. Schedules for implementation of the long-term CSO control plan may be phased based on the relative importance of adverse impacts upon water quality standards and designated uses, and on a permittee's financial capability.

EPA is developing extensive guidance to support the Policy and will announce the availability of the guidances and other outreach efforts through various means, as they become available. For example, EPA is preparing guidance on the nine minimum controls, characterization and monitoring of CSOs, development of long-term CSO control plans, and financial capability.

Permittees will be expected to comply with any existing CSO-related requirements in NPDES permits,

onsent decrees or court orders unless evised to be consistent with this Policy.

The policy is organized as follows:

I. Introduction
A. Purpose and Principles
B. Application of Policy
C. Effect on Current CSO Control Efforts
D. Small System Considerations
E. Implementation Responsibilities
F. Policy Development
II. EPA Objectives for Permittees
A. Overview
B. Implementation of the Nine Minimum Controls
C. Long-Term CSO Control Plan
1. Characterization, Monitoring, and Modeling of the Combined Sewer Systems
2. Public Participation
3. Consideration of Sensitive Areas
4. Evaluation of Alternatives
5. Cost/Performance Consideration
6. Operational Plan
7. Maximizing Treatment at the Existing POTW Treatment Plant
8. Implementation Schedule
9. Post-Construction Compliance Monitoring Program
III. Coordination With State Water Quality Standards
A. Overview
B. Water Quality Standards Reviews
IV. Expectations for Permitting Authorities
A. Overview
B. NPDES Permit Requirements
1. Phase I Permits—Requirements for Demonstration of the Nine Minimum Controls and Development of the Long-Term CSO Control Plan
2. Phase II Permits—Requirements for Implementation of a Long-Term CSO Control Plan
3. Phasing Considerations
V. Enforcement and Compliance
A. Overview
B. Enforcement of CSO Dry Weather Discharge Prohibition
C. Enforcement of Wet Weather CSO Requirements
1. Enforcement for Compliance With Phase I Permits
2. Enforcement for Compliance With Phase II Permits
D. Penalties

List of Subjects in 40 CFR Part 122

Water pollution control.

Authority: Clean Water Act, 33 U.S.C. 1251 *et seq.*

Dated: April 8, 1994.

Carol M. Browner,

Administrator.

Combined Sewer Overflow (CSO) Control Policy

I. Introduction

A. Purpose and Principles

The main purposes of this Policy are to elaborate on EPA's National Combined Sewer Overflow (CSO) Control Strategy published on September 8, 1989 at 54 FR 37370 (1989 Strategy) and to expedite compliance with the requirements of the Clean Water Act (CWA). While implementation of the 1989 Strategy has resulted in progress toward controlling CSOs, significant water quality risks remain.

A combined sewer system (CSS) is a wastewater collection system owned by a State or municipality (as defined by section 502(4) of the CWA) which conveys sanitary wastewaters (domestic, commercial and industrial wastewaters) and storm water through a single-pipe system to a Publicly Owned Treatment Works (POTW) Treatment Plant (as defined in 40 CFR 403.3(p)). A CSO is the discharge from a CSS at a point prior to the POTW Treatment Plant. CSOs are point sources subject to NPDES permit requirements including both technology-based and water quality-based requirements of the CWA. CSOs are not subject to secondary treatment requirements applicable to POTWs.

CSOs consist of mixtures of domestic sewage, industrial and commercial wastewaters, and storm water runoff. CSOs often contain high levels of suspended solids, pathogenic microorganisms, toxic pollutants, floatables, nutrients, oxygen-demanding organic compounds, oil and grease, and other pollutants. CSOs can cause exceedances of water quality standards (WQS). Such exceedances may pose risks to human health, threaten aquatic life and its habitat, and impair the use and enjoyment of the Nation's waterways.

This Policy is intended to provide guidance to permittees with CSOs, National Pollutant Discharge Elimination System (NPDES) permitting authorities, State water quality standards authorities and enforcement authorities. The purpose of the Policy is to coordinate the planning, selection, design and implementation of CSO management practices and controls to meet the requirements of the CWA and to involve the public fully during the decision making process.

This Policy reiterates the objectives of the 1989 Strategy:

1. To ensure that if CSOs occur, they are only as a result of wet weather;
2. To bring all wet weather CSO discharge points into compliance with the technology-based and water quality-based requirements of the CWA; and
3. To minimize water quality, aquatic biota, and human health impacts from CSOs.

This CSO Control Policy represents a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities and the public engage in a comprehensive and coordinated planning effort to achieve cost-effective CSO controls that ultimately meet appropriate health and environmental objectives and requirements. The Policy recognizes the site-specific nature of CSOs and their impacts and provides the necessary flexibility to tailor controls to local situations. Four key principles of the Policy ensure that CSO controls are cost-effective and meet the objectives of the CWA. The key principles are:

1. Providing clear levels of control that would be presumed to meet appropriate health and environmental objectives;
2. Providing sufficient flexibility to municipalities, especially financially disadvantaged communities, to consider the site-specific nature of CSOs and to determine the most cost-effective means of reducing pollutants and meeting CWA objectives and requirements;
3. Allowing a phased approach to implementation of CSO controls considering a community's financial capability; and
4. Review and revision, as appropriate, of water quality standards and their implementation procedures when developing CSO control plans to reflect the site-specific wet weather impacts of CSOs.

This Policy is being issued in support of EPA's regulations and policy initiatives. This Policy is Agency guidance only and does not establish or affect legal rights or obligations. It does not establish a binding norm and is not finally determinative of the issues addressed. Agency decisions in any particular case will be made by applying the law and regulations on the basis of specific facts when permits are issued. The Administration has recommended that the 1994 amendments to the CWA endorse this final Policy.

B. Application of Policy

The permitting provisions of this Policy apply to all CSSs that overflow as a result of storm water flow, including snow melt runoff (40 CFR 122.26(b)(13)). Discharges from CSSs during dry weather are prohibited by the CWA. Accordingly, the permitting provisions of this Policy do not apply to CSOs during dry weather. Dry weather flow is the flow in a combined sewer that results from domestic sewage, groundwater infiltration, commercial and industrial wastewaters, and any other non-precipitation related flows (e.g., tidal infiltration). In addition to

'he permitting provisions, the nforcement and Compliance section of .nis Policy describes an enforcement initiative being developed for overflows that occur during dry weather.

Consistent with the 1989 Strategy, 30 States that submitted CSO permitting strategies have received EPA approval or, in the case of one State, conditional approval of its strategy. States and EPA Regional Offices should review these strategies and negotiate appropriate revisions to them to implement this Policy. Permitting authorities are encouraged to evaluate water pollution control needs on a watershed management basis and coordinate CSO control efforts with other point and nonpoint source control activities.

C. Effect on Current CSO Control Efforts

EPA recognizes that extensive work has been done by many Regions, States, and municipalities to abate CSOs. As such, portions of this Policy may already have been addressed by permittees' previous efforts to control CSOs. Therefore, portions of this Policy may not apply, as determined by the permitting authority on a case-by-case basis, under the following circumstances:

1. Any permittee that, on the date of ublication of this final Policy, has .ompleted or substantially completed construction of CSO control facilities that are designed to meet WQS and protect designated uses, and where it has been determined that WQS are being or will be attained, is not covered by the initial planning and construction provisions in this Policy; however, the operational plan and post-construction monitoring provisions continue to apply. If, after monitoring, it is determined that WQS are not being attained, the permittee should be required to submit a revised CSO control plan that, once implemented, will attain WQS.

2. Any permittee that, on the date of publication of this final Policy, has substantially developed or is implementing a CSO control program pursuant to an existing permit or enforcement order, and such program is considered by the NPDES permitting authority to be adequate to meet WQS and protect designated uses and is reasonably equivalent to the treatment objectives of this Policy, should complete those facilities without further planning activities otherwise expected by this Policy. Such programs, however, should be reviewed and modified to be onsistent with the sensitive area, financial capability, and post-construction monitoring provisions of this Policy.

3. Any permittee that has previously constructed CSO control facilities in an effort to comply with WQS but has failed to meet such applicable standards or to protect designated uses due to remaining CSOs may receive consideration for such efforts in future permits or enforceable orders for long-term CSO control planning, design and implementation.

In the case of any ongoing or substantially completed CSO control effort, the NPDES permit or other enforceable mechanism, as appropriate, should be revised to include all appropriate permit requirements consistent with Section IV.B. of this Policy.

D. Small System Considerations

The scope of the long-term CSO control plan, including the characterization, monitoring and modeling, and evaluation of alternatives portions of this Policy may be difficult for some small CSSs. At the discretion of the NPDES Authority, jurisdictions with populations under 75,000 may not need to complete each of the formal steps outlined in Section II.C. of this Policy, but should be required through their permits or other enforceable mechanisms to comply with the nine minimum controls (II.B), public participation (II.C.2), and sensitive areas (II.C.3) portions of this Policy. In addition, the permittee may propose to implement any of the criteria contained in this Policy for evaluation of alternatives described in II.C.4. Following approval of the proposed plan, such jurisdictions should construct the control projects and propose a monitoring program sufficient to determine whether WQS are attained and designated uses are protected.

In developing long-term CSO control plans based on the small system considerations discussed in the preceding paragraph, permittees are encouraged to discuss the scope of their long-term CSO control plan with the WQS authority and the NPDES authority. These discussions will ensure that the plan includes sufficient information to enable the permitting authority to identify the appropriate CSO controls.

E. Implementation Responsibilities

NPDES authorities (authorized States or EPA Regional Offices, as appropriate) are responsible for implementing this Policy. It is their responsibility to assure that CSO permittees develop long-term CSO control plans and that NPDES permits meet the requirements of the CWA. Further, they are responsible for coordinating the review of the long-term CSO control plan and the development of the permit with the WQS authority to determine if revisions to the WQS are appropriate. In addition, they should determine the appropriate vehicle (i.e., permit reissuance, information request under CWA section 308 or State equivalent or enforcement action) to ensure that compliance with the CWA is achieved as soon as practicable.

Permittees are responsible for documenting the implementation of the nine minimum controls and developing and implementing a long-term CSO control plan, as described in this Policy. EPA recognizes that financial considerations are a major factor affecting the implementation of CSO controls. For that reason, this Policy allows consideration of a permittee's financial capability in connection with the long-term CSO control planning effort, WQS review, and negotiation of enforceable schedules. However, each permittee is ultimately responsible for aggressively pursuing financial arrangements for the implementation of its long-term CSO control plan. As part of this effort, communities should apply to their State Revolving Fund program, or other assistance programs as appropriate, for financial assistance.

EPA and the States will undertake action to assure that all permittees with CSSs are subject to a consistent review in the permit development process, have permit requirements that achieve compliance with the CWA, and are subject to enforceable schedules that require the earliest practicable compliance date considering physical and financial feasibility.

F. Policy Development

This Policy devotes a separate section to each step involved in developing and implementing CSO controls. This is not to imply that each function occurs separately. Rather, the entire process surrounding CSO controls, community planning, WQS and permit development/revision, enforcement/compliance actions and public participation must be coordinated to control CSOs effectively. Permittees and permitting authorities are encouraged to consider innovative and alternative approaches and technologies that achieve the objectives of this Policy and the CWA.

In developing this Policy, EPA has included information on what responsible parties are expected to accomplish. Subsequent documents will provide additional guidance on how the objectives of this Policy should be met. These documents will provide further guidance on: CSO permit writing, the nine minimum controls, long-term CSO

control plans, financial capability, sewer system characterization and receiving water monitoring and modeling, and application of WQS to CSO-impacted waters. For most CSO control efforts however, sufficient detail has been included in this Policy to begin immediate implementation of its provisions.

II. EPA Objectives for Permittees

A. Overview

Permittees with CSSs that have CSOs should immediately undertake a process to accurately characterize their sewer systems, to demonstrate implementation of the nine minimum controls, and to develop a long-term CSO control plan.

B. Implementation of the Nine Minimum Controls

Permittees with CSOs should submit appropriate documentation demonstrating implementation of the nine minimum controls, including any proposed schedules for completing minor construction activities. The nine minimum controls are:

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

Selection and implementation of actual control measures should be based on site-specific considerations including the specific CSS's characteristics discussed under the sewer system characterization and monitoring portions of this Policy. Documentation of the nine minimum controls may include operation and maintenance plans, revised sewer use ordinances for industrial users, sewer system inspection reports, infiltration/inflow studies, pollution prevention programs, public notification plans, and facility plans for maximizing the capacities of the existing collection, storage and treatment systems, as well as contracts and schedules for minor construction programs for improving the existing system's operation. The permittee should also submit any information or data on the degree to which the nine minimum controls achieve compliance with water quality standards. These data and information should include results made available through monitoring and modeling activities done in conjunction with the development of the long-term CSO control plan described in this Policy.

This documentation should be submitted as soon as practicable, but no later than two years after the requirement to submit such documentation is included in an NPDES permit or other enforceable mechanism. Implementation of the nine minimum controls with appropriate documentation should be completed as soon as practicable but no later than January 1, 1997. These dates should be included in an appropriate enforceable mechanism.

Because the CWA requires immediate compliance with technology-based controls (section 301(b)), which on a Best Professional Judgment basis should include the nine minimum controls, a compliance schedule for implementing the nine minimum controls, if necessary, should be included in an appropriate enforceable mechanism.

C. Long-Term CSO Control Plan

Permittees with CSOs are responsible for developing and implementing long-term CSO control plans that will ultimately result in compliance with the requirements of the CWA. The long-term plans should consider the site-specific nature of CSOs and evaluate the cost effectiveness of a range of control options/strategies. The development of the long-term CSO control plan and its subsequent implementation should also be coordinated with the NPDES authority and the State authority responsible for reviewing and revising the State's WQS. The selected controls should be designed to allow cost effective expansion or cost effective retrofitting if additional controls are subsequently determined to be necessary to meet WQS, including existing and designated uses.

This policy identifies EPA's major objectives for the long-term CSO control plan. Permittees should develop and submit this long-term CSO control plan as soon as practicable, but generally within two years after the date of the NPDES permit provision, Section 308 information request, or enforcement action requiring the permittee to develop the plan. NPDES authorities may establish a longer timetable for completion of the long-term CSO control plan on a case-by-case basis to account for site-specific factors which may influence the complexity of the planning process. Once agreed upon, these dates should be included in an appropriate enforceable mechanism.

EPA expects each long-term CSO control plan to utilize appropriate information to address the following minimum elements. The Plan should also include both fixed-date project implementation schedules (which may be phased) and a financing plan to design and construct the project as soon as practicable. The minimum elements of the long-term CSO control plan are described below.

1. Characterization, Monitoring, and Modeling of the Combined Sewer System

In order to design a CSO control plan adequate to meet the requirements of the CWA, a permittee should have a thorough understanding of its sewer system, the response of the system to various precipitation events, the characteristics of the overflows, and the water quality impacts that result from CSOs. The permittee should adequately characterize through monitoring, modeling, and other means as appropriate, for a range of storm events, the response of its sewer system to wet weather events including the number, location and frequency of CSOs, volume, concentration and mass of pollutants discharged and the impacts of the CSOs on the receiving waters and their designated uses. The permittee may need to consider information on the contribution and importance of other pollution sources in order to develop a final plan designed to meet water quality standards. The purpose of the system characterization, monitoring and modeling program initially is to assist the permittee in developing appropriate measures to implement the nine minimum controls and, if necessary, to support development of the long-term CSO control plan. The monitoring and modeling data also will be used to evaluate the expected effectiveness of both the nine minimum controls and, if necessary, the long-term CSO controls, to meet WQS.

The major elements of a sewer system characterization are described below.

a. Rainfall Records—The permittee should examine the complete rainfall record for the geographic area of its existing CSS using sound statistical procedures and best available data. The permittee should evaluate flow variations in the receiving water body to correlate between CSOs and receiving water conditions.

b. Combined Sewer System Characterization—The permittee should evaluate the nature and extent of its sewer system through evaluation of available sewer system records, field inspections and other activities necessary to understand the number, location and frequency of overflows and their location relative to sensitive areas and to pollution sources in the collection system, such as indirect significant industrial users.

c. CSO Monitoring—The permittee should develop a comprehensive, representative monitoring program that measures the frequency, duration, flow rate, volume and pollutant concentration of CSO discharges and assesses the impact of the CSOs on the receiving waters. The monitoring program should include necessary CSO effluent and ambient in-stream monitoring and, where appropriate, other monitoring protocols such as biological assessment, toxicity testing and sediment sampling. Monitoring parameters should include, for example, oxygen demanding pollutants, nutrients, toxic pollutants, sediment contaminants, pathogens, bacteriological indicators (e.g., Enterococcus, E. Coli), and toxicity. A representative sample of overflow points can be selected that is sufficient to allow characterization of CSO discharges and their water quality impacts and to facilitate evaluation of control plan alternatives.

d. Modeling—Modeling of a sewer system is recognized as a valuable tool for predicting sewer system response to various wet weather events and assessing water quality impacts when evaluating different control strategies and alternatives. EPA supports the proper and effective use of models, where appropriate, in the evaluation of the nine minimum controls and the development of the long-term CSO control plan. It is also recognized that there are many models which may be used to do this. These models range from simple to complex. Having decided to use a model, the permittee should base its choice of a model on the characteristics of its sewer system, the number and location of overflow points, and the sensitivity of the receiving water body to the CSO discharges. Use of models should include appropriate calibration and verification with field *measurements.* The sophistication of the model should relate to the complexity of the system to be modeled and to the information needs associated with evaluation of CSO control options and water quality impacts. EPA believes that continuous simulation models, using historical rainfall data, may be the best way to model sewer systems, CSOs, and their impacts. Because of the iterative nature of modeling sewer systems, CSOs, and their impacts, monitoring and modeling efforts are complementary and should be coordinated.

2. Public Participation

In developing its long-term CSO control plan, the permittee will employ a public participation process that actively involves the affected public in the decision-making to select the long-term CSO controls. The affected public includes rate payers, industrial users of the sewer system, persons who reside downstream from the CSOs, persons who use and enjoy these downstream waters, and any other interested persons.

3. Consideration of Sensitive Areas

EPA expects a permittee's long-term CSO control plan to give the highest priority to controlling overflows to sensitive areas. Sensitive areas, as determined by the NPDES authority in coordination with State and Federal agencies, as appropriate, include designated Outstanding National Resource Waters, National Marine Sanctuaries, waters with threatened or endangered species and their habitat, waters with primary contact recreation, public drinking water intakes or their designated protection areas, and shellfish beds. For such areas, the long-term CSO control plan should:

a. Prohibit new or significantly increased overflows;

b. i. Eliminate or relocate overflows that discharge to sensitive areas wherever physically possible and economically achievable, except where elimination or relocation would provide less environmental protection than additional treatment; or

ii. Where elimination or relocation is not physically possible and economically achievable, or would provide less environmental protection than additional treatment, provide the level of treatment for remaining overflows deemed necessary to meet WQS for full protection of existing and designated uses. In any event, the level of control should not be less than those described in Evaluation of Alternatives below; and

c. Where elimination or relocation has been proven not to be physically possible and economically achievable, permitting authorities should require, for each subsequent permit term, a reassessment based on new or improved techniques to eliminate or relocate, or on changed circumstances that influence economic achievability.

4. Evaluation of Alternatives

EPA expects the long-term CSO control plan to consider a reasonable range of alternatives. The plan should, for example, evaluate controls that would be necessary to achieve zero overflow events per year, an average of one to three, four to seven, and eight to twelve overflow events per year. Alternatively, the long-term plan could evaluate controls that achieve 100% capture, 90% capture, 85% capture, 80% capture, and 75% capture for treatment. The long-term control plan should also consider expansion of POTW secondary and primary capacity in the CSO abatement alternative analysis. The analysis of alternatives should be sufficient to make a reasonable assessment of cost and performance as described in Section II.C.5. Because the final long-term CSO control plan will become the basis for NPDES permit limits and requirements, the selected controls should be sufficient to meet CWA requirements.

In addition to considering sensitive areas, the long-term CSO control plan should adopt one of the following approaches:

a. "Presumption" Approach

A program that meets any of the criteria listed below would be presumed to provide an adequate level of control to meet the water quality-based requirements of the CWA, provided the permitting authority determines that such presumption is reasonable in light of the data and analysis conducted in the characterization, monitoring, and modeling of the system and the consideration of sensitive areas described above. These criteria are provided because data and modeling of wet weather events often do not give a clear picture of the level of CSO controls necessary to protect WQS.

i. No more than an average of four overflow events per year, provided that the permitting authority may allow up to two additional overflow events per year. For the purpose of this criterion, an overflow event is one or more overflows from a CSS as the result of a precipitation event that does not receive the minimum treatment specified below; or

ii. The elimination or the capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis; or

iii. The elimination or removal of no less than the mass of the pollutants, identified as causing water quality impairment through the sewer system

haracterization, monitoring, and odeling effort, for the volumes that would be eliminated or captured for treatment under paragraph ii. above. Combined sewer flows remaining after implementation of the nine minimum controls and within the criteria specified at II.C.4.a.i or ii, should receive a minimum of:

- Primary clarification (Removal of floatables and settleable solids may be achieved by any combination of treatment technologies or methods that are shown to be equivalent to primary clarification.);
- Solids and floatables disposal; and
- Disinfection of effluent, if necessary, to meet WQS, protect designated uses and protect human health, including removal of harmful disinfection chemical residuals, where necessary.

b. "Demonstration" Approach

A permittee may demonstrate that a selected control program, though not meeting the criteria specified in II.C.4.a. above is adequate to meet the water quality-based requirements of the CWA. To be a successful demonstration, the permittee should demonstrate each of the following:

i. The planned control program is adequate to meet WQS and protect designated uses, unless WQS or uses cannot be met as a result of natural background conditions or pollution sources other than CSOs;

ii. The CSO discharges remaining after implementation of the planned control program will not preclude the attainment of WQS or the receiving waters' designated uses or contribute to their impairment. Where WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load, including a wasteload allocation and a load allocation, or other means should be used to apportion pollutant loads;

iii. The planned control program will provide the maximum pollution reduction benefits reasonably attainable; and

iv. The planned control program is designed to allow cost effective expansion or cost effective retrofitting if additional controls are subsequently determined to be necessary to meet WQS or designated uses.

5. Cost/Performance Considerations

The permittee should develop appropriate cost/performance curves to demonstrate the relationships among a comprehensive set of reasonable control alternatives that correspond to the different ranges specified in Section II.C.4. This should include an analysis to determine where the increment of pollution reduction achieved in the receiving water diminishes compared to the increased costs. This analysis, often known as knee of the curve, should be among the considerations used to help guide selection of controls.

6. Operational Plan

After agreement between the permittee and NPDES authority on the necessary CSO controls to be implemented under the long-term CSO control plan, the permittee should revise the operation and maintenance program developed as part of the nine minimum controls to include the agreed-upon long-term CSO controls. The revised operation and maintenance program should maximize the removal of pollutants during and after each precipitation event using all available facilities within the collection and treatment system. For any flows in excess of the criteria specified at II.C.4.a.i., ii. or iii and not receiving the treatment specified in II.C.4.a, the operational plan should ensure that such flows receive treatment to the greatest extent practicable.

7. Maximizing Treatment at the Existing POTW Treatment Plant

In some communities, POTW treatment plants may have primary treatment capacity in excess of their secondary treatment capacity. One effective strategy to abate pollution resulting from CSOs is to maximize the delivery of flows during wet weather to the POTW treatment plant for treatment. Delivering these flows can have two significant water quality benefits: First, increased flows during wet weather to the POTW treatment plant may enable the permittee to eliminate or minimize overflows to sensitive areas; second, this would maximize the use of available POTW facilities for wet weather flows and would ensure that combined sewer flows receive at least primary treatment prior to discharge.

Under EPA regulations, the intentional diversion of waste streams from any portion of a treatment facility, including secondary treatment, is a bypass. EPA bypass regulations at 40 CFR 122.41(m) allow for a facility to bypass some or all the flow from its treatment process under specified limited circumstances. Under the regulation, the permittee must show that the bypass was unavoidable to prevent loss of life, personal injury or severe property damage, that there was no feasible alternative to the bypass and that the permittee submitted the required notices. In addition, the regulation provides that a bypass may be approved only after consideration of adverse effects.

Normally, it is the responsibility of the permittee to document, on a case-by-base basis, compliance with 40 CFR 122.41(m) in order to bypass flows legally. For some CSO-related permits, the study of feasible alternatives in the control plan may provide sufficient support for the permit record and for approval of a CSO-related bypass in the permit itself, and to define the specific parameters under which a bypass can legally occur. For approval of a CSO-related bypass, the long-term CSO control plan, at a minimum, should provide justification for the cut-off point at which the flow will be diverted from the secondary treatment portion of the treatment plant, and provide a benefit-cost analysis demonstrating that conveyance of wet weather flow to the POTW for primary treatment is more beneficial than other CSO abatement alternatives such as storage and pump back for secondary treatment, sewer separation, or satellite treatment. Such a permit must define under what specific wet weather conditions a CSO-related bypass is allowed and also specify what treatment or what monitoring, and effluent limitations and requirements apply to the bypass flow. The permit should also provide that approval for the CSO-related bypass will be reviewed and may be modified or terminated if there is a substantial increase in the volume or character of pollutants being introduced to the POTW. The CSO-related bypass provision in the permit should also make it clear that all wet weather flows passing the headworks of the POTW treatment plant will receive at least primary clarification and solids and floatables removal and disposal, and disinfection, where necessary, and any other treatment that can reasonably be provided.

Under this approach, EPA would allow a permit to authorize a CSO-related bypass of the secondary treatment portion of the POTW treatment plant for combined sewer flows in certain identified circumstances. This provision would apply only to those situations where the POTW would ordinarily meet the requirements of 40 CFR 122.41(m) as evaluated on a case-by-case basis. Therefore, there must be sufficient data in the administrative record (reflected in the permit fact sheet or statement of basis) supporting all the requirements in 40 CFR 122.41(m)(4) for approval of an anticipated bypass.

For the purposes of applying this regulation to CSO permittees, "severe property damage" could include

situations where flows above a certain level wash out the POTW's secondary treatment system. EPA further believes that the feasible alternatives requirement of the regulation can be met if the record shows that the secondary treatment system is properly operated and maintained, that the system has been designed to meet secondary limits for flows greater than the peak dry weather flow, plus an appropriate quantity of wet weather flow, and that it is either technically or financially infeasible to provide secondary treatment at the existing facilities for greater amounts of wet weather flow. The feasible alternative analysis should include, for example, consideration of enhanced primary treatment (e.g., chemical addition) and non-biological secondary treatment. Other bases supporting a finding of no feasible alternative may also be available on a case-by-case basis. As part of its consideration of possible adverse effects resulting from the bypass, the permitting authority should also ensure that the bypass will not cause exceedances of WQS.

This Policy does not address the appropriateness of approving anticipated bypasses through NPDES permits in advance outside the CSO context.

8. Implementation Schedule

The permittee should include all pertinent information in the long term control plan necessary to develop the construction and financing schedule for implementation of CSO controls. Schedules for implementation of the CSO controls may be phased based on the relative importance of adverse impacts upon WQS and designated uses, priority projects identified in the long-term plan, and on a permittee's financial capability.

Construction phasing should consider:

a. Eliminating overflows that discharge to sensitive areas as the highest priority;

b. Use impairment;

c. The permittee's financial capability including consideration of such factors as:

i. Median household income;

ii. Total annual wastewater and CSO control costs per household as a percent of median household income;

iii. Overall net debt as a percent of full market property value;

iv. Property tax revenues as a percent of full market property value;

v. Property tax collection rate;

vi. Unemployment; and

vii. Bond rating;

d. Grant and loan availability;

e. Previous and current residential, commercial and industrial sewer user fees and rate structures; and

f. Other viable funding mechanisms and sources of financing.

9. Post-Construction Compliance Monitoring Program

The selected CSO controls should include a post-construction water quality monitoring program adequate to verify compliance with water quality standards and protection of designated uses as well as to ascertain the effectiveness of CSO controls. This water quality compliance monitoring program should include a plan to be approved by the NPDES authority that details the monitoring protocols to be followed, including the necessary effluent and ambient monitoring and, where appropriate, other monitoring protocols such as biological assessments, whole effluent toxicity testing, and sediment sampling.

III. Coordination With State Water Quality Standards

A. Overview

WQS are State adopted, or Federally promulgated rules which serve as the goals for the water body and the legal basis for the water quality-based NPDES permit requirements under the CWA. WQS consist of uses which States designate for their water bodies, criteria to protect the uses, an anti-degradation policy to protect the water quality improvements gained and other policies affecting the implementation of the standards. A primary objective of the long-term CSO control plan is to meet WQS, including the designated uses through reducing risks to human health and the environment by eliminating, relocating or controlling CSOs to the affected waters.

State WQS authorities, NPDES authorities, EPA regional offices, permittees, and the public should meet early and frequently throughout the long-term CSO control planning process. Development of the long-term plan should be coordinated with the review and appropriate revision of WQS and implementation procedures on CSO-impacted waters to ensure that the long-term controls will be sufficient to meet water quality standards. As part of these meetings, participants should agree on the data, information and analyses needed to support the development of the long-term CSO control plan and the review of applicable WQS, and implementation procedures, if appropriate. Agreements should be reached on the monitoring protocols and models that will be used to evaluate the water quality impacts of the overflows, to analyze the attainability of the WQS and to determine the water quality-based requirements for the permit. Many opportunities exist for permittees and States to share information as control programs are developed and as WQS are reviewed. Such information should assist States in determining the need for revisions to WQS and implementation procedures to better reflect the site-specific wet weather impacts of CSOs. Coordinating the development of the long-term CSO control plan and the review of the WQS and implementation procedures provides greater assurance that the long-term control plan selected and the limits and requirements included in the NPDES permit will be sufficient to meet WQS and to comply with sections 301(b)(1)(C) and 402(a)(2) of the CWA.

EPA encourages States and permittees jointly to sponsor workshops for the affected public in the development of the long-term CSO control plan and during the development of appropriate revisions to WQS for CSO-impacted waters. Workshops provide a forum for including the public in discussions of the implications of the proposed long-term CSO control plan on the water quality and uses for the receiving water.

B. Water Quality Standards Reviews

The CWA requires States to periodically, but at least once every three years, hold public hearings for the purpose of reviewing applicable water quality standards and, as appropriate, modifying and adopting standards. States must provide the public an opportunity to comment on any proposed revision to water quality standards and all revisions must be submitted to EPA for review and approval.

EPA regulations and guidance provide States with the flexibility to adapt their WQS, and implementation procedures to reflect site-specific conditions including those related to CSOs. For example, a State may adopt site-specific criteria for a particular pollutant if the State determines that the site-specific criteria fully protects the designated use (40 CFR 131.11). In addition, the regulations at 40 CFR 131.10(g), (h), and (j) specify when and how a designated use may be modified. A State may remove a designated use from its water quality standards only if the designated use is not an existing use. An existing use is a use actually attained in the water body on or after November 28, 1975. Furthermore, a State may not remove a designated use that will be attained by implementing the

technology-based effluent limits required under sections 301(b) and 306 of the CWA and by implementing cost-effective and reasonable best management practices for nonpoint source controls. Thus, if a State has a reasonable basis to determine that the current designated use could be attained after implementation of the technology-based controls of the CWA, then the use could not be removed.

In determining whether a use is attainable and prior to removing a designated use, States must conduct and submit to EPA a use attainability analysis. A use attainability analysis is a structured scientific assessment of the factors affecting the use, including the physical, chemical, biological, and economic factors described in 40 CFR 131.10(g). As part of the analysis, States should evaluate whether the designated use could be attained if CSO controls were implemented. For example, States should examine if sediment loadings from CSOs could be reduced so as not to bury spawning beds, or if biochemical oxygen demanding material in the effluent or the toxicity of the effluent could be corrected so as to reduce the acute or chronic physiological stress on or bioaccumulation potential of aquatic organisms.

In reviewing the attainability of their WQS and the applicability of their implementation procedures to CSO-impacted waters, States are encouraged to define more explicitly their recreational and aquatic life uses and then, if appropriate, modify the criteria accordingly to protect the designated uses.

Another option is for States to adopt partial uses by defining when primary contact recreation such as swimming does not exist, such as during certain seasons of the year in northern climates or during a particular type of storm event. In making such adjustments to their uses, States must ensure that downstream uses are protected, and that during other seasons or after the storm event has passed, the use is fully protected.

In addition to defining recreational uses with greater specificity, States are also encouraged to define the aquatic uses more precisely. Rather than "aquatic life use protection," States should consider defining the type of fishery to be protected such as a cold water fishery (e.g., trout or salmon) or a warm weather fishery (e.g., bluegill or large mouth bass). Explicitly defining the type of fishery to be protected may assist the permittee in enlisting the support of citizens for a CSO control plan.

A water quality standard variance may be appropriate, in limited circumstances on CSO-impacted waters, where the State is uncertain as to whether a standard can be attained and time is needed for the State to conduct additional analyses on the attainability of the standard. Variances are short-term modifications in water quality standards. Subject to EPA approval, States, with their own statutory authority, may grant a variance to a specific discharger for a specific pollutant. The justification for a variance is similar to that required for a permanent change in the standard, although the showings needed are less rigorous. Variances are also subject to public participation requirements of the water quality standards and permits programs and are reviewable generally every three years. A variance allows the CSO permit to be written to meet the "modified" water quality standard as analyses are conducted and as progress is made to improve water quality.

Justifications for variances are the same as those identified in 40 CFR 131.10(g) for modifications in uses. States must provide an opportunity for public review and comment on all variances. If States use the permit as the vehicle to grant the variance, notice of the permit must clearly state that the variance modifies the State's water quality standards. If the variance is approved, the State appends the variance to the State's standards and reviews the variance every three years.

IV. Expectations for Permitting Authorities

A. Overview

CSOs are point sources subject to NPDES permit requirements including both technology-based and water quality-based requirements of the CWA. CSOs are not subject to secondary treatment regulations applicable to publicly owned treatment works (*Montgomery Environmental Coalition vs. Costle*, 646 F.2d 568 (D.C. Cir. 1980)).

All permits for CSOs should require the nine minimum controls as a minimum best available technology economically achievable and best conventional technology (BAT/BCT) established on a best professional judgment (BPJ) basis by the permitting authority (40 CFR 125.3). Water quality-based requirements are to be established based on applicable water quality standards.

This policy establishes a uniform, nationally consistent approach to developing and issuing NPDES permits to permittees with CSOs. Permits for CSOs should be developed and issued expeditiously. A single, system-wide permit generally should be issued for all discharges, including CSOs, from a CSS operated by a single authority. When different parts of a single CSS are operated by more than one authority, permits issued to each authority should generally require joint preparation and implementation of the elements of this Policy and should specifically define the responsibilities and duties of each authority. Permittees should be required to coordinate system-wide implementation of the nine minimum controls and the development and implementation of the long-term CSO control plan.

The individual authorities are responsible for their own discharges and should cooperate with the permittee for the POTW receiving the flows from the CSS. When a CSO is permitted separately from the POTW, both permits should be cross-referenced for informational purposes.

EPA Regions and States should review the CSO permitting priorities established in the State CSO Permitting Strategies developed in response to the 1989 Strategy. Regions and States may elect to revise these previous priorities. In setting permitting priorities, Regions and States should not just focus on those permittees that have initiated monitoring programs. When setting priorities, Regions and States should consider, for example, the known or potential impact of CSOs on sensitive areas, and the extent of upstream industrial user discharges to the CSS.

During the permittee's development of the long-term CSO control plan, the permit writer should promote coordination between the permittee and State WQS authority in connection with possible WQS revisions. Once the permittee has completed development of the long-term CSO control plan and has coordinated with the permitting authority the selection of the controls necessary to meet the requirements of the CWA, the permitting authority should include in an appropriate enforceable mechanism, requirements for implementation of the long-term CSO control plan, including conditions for water quality monitoring and operation and maintenance.

B. NPDES Permit Requirements

Following are the major elements of NPDES permits to implement this Policy and ensure protection of water quality.

1. Phase I Permits—Requirements for Demonstration of Implementation of the Nine Minimum Controls and Development of the Long-Term CSO Control Plan

In the Phase I permit issued/modified to reflect this Policy, the NPDES authority should at least require permittees to:

a. Immediately implement BAT/BCT, which at a minimum includes the nine minimum controls, as determined on a BPJ basis by the permitting authority;

b. Develop and submit a report documenting the implementation of the nine minimum controls within two years of permit issuance/modification;

c. Comply with applicable WQS, no later than the date allowed under the State's WQS, expressed in the form of a narrative limitation; and

d. develop and submit, consistent with this Policy and based on a schedule in an appropriate enforceable mechanism, a long-term CSO control plan as soon as practicable, but generally within two years after the effective date of the permit issuance/modification. However, permitting authorities may establish a longer timetable for completion of the long-term CSO control plan on a case-by-case basis to account for site-specific factors that may influence the complexity of the planning process.

The NPDES authority should include compliance dates on the fastest practicable schedule for each of the nine minimum controls in an appropriate enforceable mechanism issued in conjunction with the Phase I permit. The use of enforceable orders is necessary unless Congress amends the CWA. All orders should require compliance with the nine minimum controls no later than January 1, 1997.

2. Phase II Permits—Requirements for Implementation of a Long-Term CSO Control Plan

Once the permittee has completed development of the long-term CSO control plan and the selection of the controls necessary to meet CWA requirements has been coordinated with the permitting and WQS authorities, the permitting authority should include, in an appropriate enforceable mechanism, requirements for implementation of the long-term CSO control plan as soon as practicable. Where the permittee has selected controls based on the "presumption" approach described in Section II.C.4, the permitting authority must have determined that the presumption that such level of treatment will achieve water quality standards is reasonable in light of the data and analysis conducted under this Policy. The Phase II permit should contain:

a. Requirements to implement the technology-based controls including the nine minimum controls determined on a BPJ basis;

b. Narrative requirements which insure that the selected CSO controls are implemented, operated and maintained as described in the long-term CSO control plan;

c. Water quality-based effluent limits under 40 CFR 122.44(d)(1) and 122.44(k), requiring, at a minimum, compliance with, no later than the date allowed under the State's WQS, the numeric performance standards for the selected CSO controls, based on average design conditions specifying at least one of the following:

i. A maximum number of overflow events per year for specified design conditions consistent with II.C.4.a.i; or

ii. A minimum percentage capture of combined sewage by volume for treatment under specified design conditions consistent with II.C.4.a.ii; or

iii. A minimum removal of the mass of pollutants discharged for specified design conditions consistent with II.C.4.a.iii; or

iv. performance standards and requirements that are consistent with II.C.4.b. of the Policy.

d. A requirement to implement, with an established schedule, the approved post-construction water quality assessment program including requirements to monitor and collect sufficient information to demonstrate compliance with WQS and protection of designated uses as well as to determine the effectiveness of CSO controls.

e. A requirement to reassess overflows to sensitive areas in those cases where elimination or relocation of the overflows is not physically possible and economically achievable. The reassessment should be based on consideration of new or improved techniques to eliminate or relocate overflows or changed circumstances that influence economic achievability;

f. Conditions establishing requirements for maximizing the treatment of wet weather flows at the POTW treatment plant, as appropriate, consistent with Section II.C.7. of this Policy;

g. A reopener clause authorizing the NPDES authority to reopen and modify the permit upon determination that the CSO controls fail to meet WQS or protect designated uses. Upon such determination, the NPDES authority should promptly notify the permittee and proceed to modify or reissue the permit. The permittee should be required to develop, submit and implement, as soon as practicable, a revised CSO control plan which contains additional controls to meet WQS and designated uses. If the initial CSO control plan was approved under the demonstration provision of Section II.C.4.b., the revised plan, at a minimum, should provide for controls that satisfy one of the criteria in Section II.C.4.a. unless the permittee demonstrates that the revised plan is clearly adequate to meet WQS at a lower cost and it is shown that the additional controls resulting from the criteria in Section II.C.4.a. will not result in a greater overall improvement in water quality.

Unless the permittee can comply with all of the requirements of the Phase II permit, the NPDES authority should include, in an enforceable mechanism, compliance dates on the fastest practicable schedule for those activities directly related to meeting the requirements of the CWA. For major permittees, the compliance schedule should be placed in a judicial order. Proper compliance with the schedule for implementing the controls recommended in the long-term CSO control plan constitutes compliance with the elements of this Policy concerning planning and implementation of a long term CSO remedy.

3. Phasing Considerations

Implementation of CSO controls may be phased based on the relative importance of and adverse impacts upon WQS and designated uses, as well as the permittee's financial capability and its previous *efforts to control* CSOs. The NPDES authority should evaluate the proposed implementation schedule and construction phasing discussed in Section II.C.8. of this Policy. The permit should require compliance with the controls proposed in the long-term CSO control plan no later than the applicable deadline(s) under the CWA or State law. If compliance with the Phase II permit is not possible, an enforceable schedule, consistent with the Enforcement and Compliance Section of this Policy, should be issued in conjunction with the Phase II permit which specifies the schedule and milestones for implementation of the long-term CSO control plan.

V. Enforcement and Compliance

A. Overview

It is important that permittees act immediately to take the necessary steps to comply with the CWA. The CSO enforcement effort will commence with

an initiative to address CSOs that discharge during dry weather, followed by an enforcement effort in conjunction with permitting CSOs discussed earlier in this Policy. Success of the enforcement effort will depend in large part upon expeditious action by NPDES authorities in issuing enforceable permits that include requirements both for the nine minimum controls and for compliance with all other requirements of the CWA. Priority for enforcement actions should be set based on environmental impacts or sensitive areas affected by CSOs.

As a further inducement for permittees to cooperate with this process, EPA is prepared to exercise its enforcement discretion in determining whether or not to seek civil penalties for past CSO violations if permittees meet the objectives and schedules of this Policy and do not have CSOs during dry weather.

B. Enforcement of CSO Dry Weather Discharge Prohibition

EPA intends to commence immediately an enforcement initiative against CSO permittees which have CWA violations due to CSOs during dry weather. Discharges during dry weather have always been prohibited by the NPDES program. Such discharges can create serious public health and water quality problems. EPA will use its CWA Section 308 monitoring, reporting, and inspection authorities, together with NPDES State authorities, to locate these violations, and to determine their causes. Appropriate remedies and penalties will be sought for CSOs during dry weather. EPA will provide NPDES authorities more specific guidance on this enforcement initiative separately.

C. Enforcement of Wet Weather CSO Requirements

Under the CWA, EPA can use several enforcement options to address permittees with CSOs. Those options directly applicable to this Policy are section 308 Information Requests, section 309(a) Administrative Orders, section 309(g) Administrative Penalty Orders, section 309 (b) and (d) Civil Judicial Actions, and section 504 Emergency Powers. NPDES States should use comparable means.

NPDES authorities should set priorities for enforcement based on environmental impacts or sensitive areas affected by CSOs. Permittees that have voluntarily initiated monitoring and are progressing expeditiously toward appropriate CSO controls should be given due consideration for their efforts.

1. Enforcement for Compliance With Phase I Permits

Enforcement for compliance with Phase I permits will focus on requirements to implement at least the nine minimum controls, and develop the long-term CSO control plan leading to compliance with the requirements of the CWA. Where immediate compliance with the Phase I permit is infeasible, the NPDES authority should issue an enforceable schedule, in concert with the Phase I permit, requiring compliance with the CWA and imposing compliance schedules with dates for each of the nine minimum controls as soon as practicable. All enforcement authorities should require compliance with the nine minimum controls no later than January 1, 1997. Where the NPDES authority is issuing an order with a compliance schedule for the nine minimum controls, this order should also include a schedule for development of the long-term CSO control plan.

If a CSO permittee fails to meet the final compliance date of the schedule, the NPDES authority should initiate appropriate judicial action.

2. Enforcement for Compliance With Phase II Permits

The main focus for enforcing compliance with Phase II permits will be to incorporate the long-term CSO control plan through a civil judicial action, an administrative order, or other enforceable mechanism requiring compliance with the CWA and imposing a compliance schedule with appropriate milestone dates necessary to implement the plan.

In general, a judicial order is the appropriate mechanism for incorporating the above provisions for Phase II. Administrative orders, however, may be appropriate for permittees whose long-term control plans will take less then five years to complete, and for minors that have complied with the final date of the enforceable order for compliance with their Phase I permit. If necessary, any of the nine minimum controls that have not been implemented by this time should be included in the terms of the judicial order.

D. Penalties

EPA is prepared not to seek civil penalties for past CSO violations, if permittees have no discharges during dry weather and meet the objectives and schedules of this Policy. Notwithstanding this, where a permittee has other significant CWA violations for which EPA or the State is taking judicial action, penalties may be considered as part of that action for the following:

1. CSOs during dry weather;
2. Violations of CSO-related requirements in NPDES permits; consent decrees or court orders which predate this policy; or
3. Other CWA violations.

EPA will not seek penalties for past CSO violations from permittees that fully comply with the Phase I permit or enforceable order requiring compliance with the Phase I permit. For permittees that fail to comply, EPA will exercise its enforcement discretion in determining whether to seek penalties for the time period for which the compliance schedule was violated. If the milestone dates of the enforceable schedule are not achieved and penalties are sought, penalties should be calculated from the last milestone date that was met.

At the time of the judicial settlement imposing a compliance schedule implementing the Phase II permit requirements, EPA will not seek penalties for past CSO violations from permittees that fully comply with the enforceable order requiring compliance with the Phase I permit and if the terms of the judicial order are expeditiously agreed to on consent. However, stipulated penalties for violation of the judicial order generally should be included in the order, consistent with existing Agency policies. Additional guidance on stipulated penalties concerning long-term CSO controls and attainment of WQS will be issued.

Paperwork Reduction Act

The information collection requirements in this policy have been approved by the Office of Management and Budget (OMB) under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq* and have been assigned OMB control number 2040–0170.

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[FR Doc. 94–9295 Filed 4–18–94; 8:45 am]

BILLING CODE 6560–50–P

Appendix D

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

State of Connecticut
Combine Sewer Overflow Strategy
May 1990

The Connecticut DEP has developed this combined sewer overflow strategy as a guidance document for municipalities facing the task of controlling combined sewer overflows. It is to be utilized by the municipalities and their respective planning consultants in the development of individual municipal CSO control strategies and by the Ct. DEP as a measurement document to achieve a consistent and balanced review of each municipality's strategy for compliance with the stated goals. While establishing goals and timetables for action, this strategy is not a workplan commitment between DEP and EPA.

The strategy has been developed with a statement of the long term goal and long term objectives followed by immediate, intermediate and long term corrective actions which should approach the long term goals and objectives.

PREAMBLE

LONG TERM GOAL:

Protect public health and the environment from the impacts of combined sewer overflows.

INTERIM OBJECTIVE:

Eliminate the discharge of untreated sewage from combined sewer overflows. Achieve fishable/swimmable water quality (Connecticut Water Quality Standards; Federal Clean Water Act, Section 101). Construct, maintain and operate sewerage systems to achieve the long term goal, provide for monitoring and maintenance programs to minimize the accidental discharge of raw sewage and efficiently locate and correct sewerage system infrastructure defects.

LONG TERM OBJECTIVE:

Eliminate the discharge of combined sewer overflows.

Discussion: The DEP recognizes that eliminating all raw sewage discharges from Connecticut's combined sewer overflows will be very expensive and will take many years to accomplish. However, DEP also believes that the "fishable swimmable" objective should not be abandoned due to these realities. The Connecticut Clean Water Fund was designed in 1986 to correct combined sewer overflow problems by the year 2010. Furthermore, "Environment 2000: Connecticut's Environmental Plan", also endorses complete elimination of combined sewer overflows.

In working towards the achievement of this goal, it is important to also establish interim and long term objectives, and a detailed management strategy as well. It will be these interim objectives which the public must live with for up to several decades.

Numerous short term combined sewer overflow abatement strategies presently being developed and pursued, representing substantial commitments of private, municipal and State monies, will greatly reduce the impacts of combined sewer overflows. The projects represent the first and perhaps most important steps towards achieving the long term goal, however in most cases there will be needs for additional commitments if Connecticut's long term goal is to be realized.

Periodically each municipality will update its CSO facilities plan to effectively coordinate local, State or Federal redevelopment or transportation projects which require modification of sewerage system infrastructure.

The DEP will not actively seek to downgrade the Water Quality Standards in areas impacted by CSO. However, the DEP is required to consider proposals from municipalities for downgrading after the development of detailed facility plans and compliance with the requirements of the Federal Clean Water Act and the Connecticut Water Quality Standards. Most likely the current standard of C/B will be maintained through the lengthy period of time required for CSO control. This will require the development of esource management strategies such as swimming advisories.

CURRENT STATUS

The following municipalities have combined sewers and the resultant combined sewer overflows:

(1) Bridgeport	(2) Middletown	(1) Norwich	(3)Portland
(3) Enfield	(2) New Haven	(0) Waterbury	
(1) Hartford	(3) Norwalk	(3) Derby	
(2) Jewett City	(3) Westport	(3) Shelton	

(0) - Facility planning not initiated
(1) - Facility planning active
(2) - Phased construction started; design on-going
(3) - Construction completed; new evaluation needed

Appendix A includes a listing of the combined sewer overflows for each municipality. This listing is based upon current knowledge of the sewer systems including existing NPDES permits, facilities plans and DEP surveys where conducted (Bridgeport, New Haven and Norwich).

A municipality is listed as having combined sewers only when the sewerage system was intentionally constructed years ago to serve the needs of both sanitary sewage and storm water runoff in a single conveyance system. Overflows of sewage from sanitary sewers caused by inflow conditions are not considered as CSO's. DEP will take administrative actions against municipalities with overflows of this nature requiring the elimination of the overflows through inflow removal. The DEP will be reviewing all NPDES permits as the permits are being renewed for overflows that are currently permitted and caused by infiltration and inflow conditions. Once identified the renewed permit will not give official recognition to the overflow as a permitted discharge. Concurrently, the municipality will be issued an Abatement Order requiring the elimination of the overflow on a defined schedule. Any discharge from an unpermitted overflow is considered as a bypass of the system and must be reported as such to the DEP in accordance with the applicable regulations. (Section 22a-430-3(k).)

ADMINISTRATIVE ACTIONS AVAILABLE TO ADDRESS CSO PROBLEMS

It is the intent of DEP to issue a separate NPDES permit for combined sewer overflows at the same time the municipality POTW permit is reissued. Similar to POTW permits, the CSO permit will contain restrictions and operating requirements but not include schedules for reports, design and construction. Coupled with the NPDES permit for the CSO's will be the issuance of or modification of an Administrative Order requiring facility planning, design and construction as needed with a defined schedule. Implementation of corrective action will be controlled by the Administrative Order issued under the Connecticut General Statutes. Enforcement of the Administrative Orders through a referral to the Attorney General's office will be utilized as necessary to achieve compliance.

Where dry weather overflows are determined to be the result of poor operation and maintenance of the sewerage system, DEP will recommend legal action through the Attorney General's office. Forfeitures, schedules of corrective action and future stipulated penalties are available for inclusion in the legal action and will be determined case by case.

INTERIM MEASURES

Recognizing the time that will be required in the larger municipalities to achieve the long-term goal of eliminating untreated combined sewage overflows, there is a need to develop corrective action plans for the immediate, intermediate and long term time periods.

1) Immediate Corrective Action

a) Eliminate dry weather overflows -

The DEP has surveyed Bridgeport, New Haven and Norwich to date for the purpose of verifying CSO locations and to clarify and resolve discrepancies between permits, facilities plans, and other records. Each field survey has resulted in a detailed report developed by the DEP field inspectors which identifies overflow locations, their current status and a map of each overflow location. This field work has also identified dry weather overflows. The DEP will issue Administrative Orders to any municipality requiring corrective action when a dry weather overflow is identified. The time table for corrective action will not be tied to a long-term phased CSO correction plan. In addition to the Administrative Action, a referral to the Attorney Generals office for a forfeiture will also be initiated.

b) Permitting requirements -

The DEP will prepare NPDES permits for the CSO's at the time the POTW permit for the municipality is to be renewed. The CSO permit will be prepared as a separate permit for the POTW permit.

Coupled with the final CSO permit will be the issuance of or modification of an Administrative Order requiring facility planning, design and construction as needed with a defined schedule.

c) Inventory - The DEP will continue its field survey of CSOs with the Hartford (MDC) system. It is felt that it might not be necessary to conduct a similar effort in the smaller systems such as in Enfield, Derby, Shelton, Portland, Westport, Jewett City, Middletown, Norwalk and Waterbury. Each of these projects will be reviewed with the area engineer after reviewing all available information to determine if a survey is warranted.

It is the intent of the Department at this time to conduct re-inspections of the CSO systems on a five year cycle.

d) Included as a key measure to maximize benefits with smaller capital investment is the requirement for each municipality to develop and implement a CSO inspection and maintenance program. Each municipality should develop an appropriate inspection program for each outfall and system overflow structure including tide gates at a reasonable frequency to verify proper operation during both wet weather and dry weather. Routine maintenance shall be performed on the appropriate facilities to assure continuous proper operation. Sewer inspection and cleaning of large interceptors shall be accomplished to provide maximum storage within the conveyance system. Maximization of flow to the treatment plant for treatment shall be required. Unnecessary overflow locations which are not utilized shall be permanently abandoned. Proper sewer system personnel shall be hired and retained for this inspection and maintenance program.

These requirements stated above will be analyzed on a case by case need and will be included as enforceable conditions in the CSO NPDES permit.

e) Removal of private inflow sources. In those small CSO communities which have achieved the reduction of CSOs from public sources (Derby, Shelton, Enfield, Portland, Westport) new Abatement Orders shall be issued requiring the verification during wet weather that CSOs are effectively eliminated and the overflow structure sealed or abandoned.

Where CSO's continue to occur (Derby, Enfield) due to private inflow sources, the municipalities must develop a short term program (up to 3 yrs.) to eliminate private inflow sources.

f) Prevention of new CSO sources - It shall be the policy of the DEP that no new CSO's be permitted nor shall combined sewer systems be extended. In addition, municipalities shall be required to adopt ordinances which prevent the additional contribution of storm waters to existing combined sewer systems. This ordinance must address both new development (requirement to construct separate sewer systems), in-filling in already developed areas with combined sewers and rehabilitation of structures in areas with combined sewers (requirement to separate storm water and sanitary sewage system on private property).

g) Field identification of overflow structures - Within the NPDES permit to be issued for CSO discharges, it is intended to requires of the permittee that actual discharge locations be marked to identify the discharge as a CSO discharge. Further discussion will be required on the issue to determine the benefits to be derived, the costs to implement and the practicality of implementing before this intent becomes a requirement.

h) Monitoring and assessment of CSO structures

Local system monitoring - Until CSOs are eliminated, municipalities must develop inspection programs as appropriate to monitor the overflows and system bypasses during both wet and dry periods.

State monitoring - The DEP has completed system inspections in Bridgeport, New Haven and Norwich. Hartford MDC should be completed in early 1990. Other systems may be inspected by DEP if deemed necessary. DEP will periodically, consistent with demands on manpower, conduct inspections of any CSO system for dry weather overflows.

2) <u>Intermediate Corrective Action</u> -

Depending upon the current status of each municipality, the immediate and intermediate corrective actions may be consecutive and concurrent actions.

a) Facilities planning - The development and adoption of this document(s) is the initial step for the intermediate corrective action. Facilities planning shall include:

i. Establishment of priority waterbodies with consideration given to existing and potential uses including:

- shellfishing (commercial and recreational)
- swimming
- aesthetics
- access to water and recreational potential
- water quality impacts
- habitat

ii. Evaluation of abatement alternatives, while guided by municipality-wide alternatives, must take into account individual priority waterbodies which may result in multiple alternatives being recommended for each municipality. This approach will create distinct projects and allow for phasing of individual projects.

iii. In all projects the priority for phasing will be case by case for each municipality. The priority evaluation shall include water quality impacts, use impairment and resource value.

iv. Alternatives include separation, maximization of flow to the plant for treatment, maximum use of existing facilities including system storage, consolidation of overflows, treatment at overflows, treatment at STP's;

v. Alternatives must minimize or eliminate impacts on environmentally significant areas and where treatment at POTWs is recommended evaluate the effect the proposal has on nutrient removal requirements associated with the Long Island Sound Management Plan;

vi. Alternatives must evaluate and be consistent with the goals of the Water Quality Standards including dissolved oxygen, coliform bacteria, and aesthetics;

vii. Design a management plan/CSO warning system to inform commercial and recreational users of periods when water bodies do not meet adopted goals. Where significant recreational uses of waterbodies are impacted by combined sewer overflow, the DEP will encourage the local water pollution control authority to develop a resource management use plan in conjunction with the local Director of Health.

viii. Evaluation of the benefits of long term water quality monitoring of the water body resources impacted by combined sewer overflows.

The facilities plan, as adopted by the municipality through a public process and approved by DEP, will identify discrete projects and their individual priority such that the overall correction strategy will be reflected by individual projects on the Clean Water Fund Priority List for financial assistance.

The facilities plan becomes the "master plan" for correction activities which will ultimately attain the goal of the elimination of untreated sewage from CSOs and the attainment of fishable/swimmable water quality. Municipalities should be guided by this "master plan" in all of their sewerage construction activities including stormwater systems regardless of the funding source (i.e. private development, block grants, transportation projects, HUD grants or others).

b) Appropriation of local financing - The facilities planning shall develop a phased implementation schedule which can range from three years up to twenty years. The schedule shall be determined after careful review of construction sequencing, local fiscal impact and Clean Water Fund fiscal impact while recognizing the priority waterbodies established in the facility plan. Local financing may also be phased but should not be an annual event.

3) Long Term Corrective Action

The long term corrective action shall be the continual implementation of the CSO abatement program after periodic reviews until the long term goal of CSO abatement has been attained.

Review of facilities planning recommendations - At reasonable intervals in the implementation program the municipality shall review with the DEP the CSO program for that municipality to assure that the goals of CSO abatement are being attained and that the program is still appropriate. Mid-course modifications may be desirable for a number of reasons including new technology, changes in fiscal status, revisions to priority waterbodies, and assessment of previous phases impacts.

PRIORITIES OF CSO PROJECTS

Projects which are in facility planning or phased construction are identified and rated on the priority point score sstem contained in the State of Connecticut Financial Assistance Program. The primary CSO communities of Bridgeport, Middletown, MDC (Hartford), Norwich, Norwalk and New Haven rate between 29 and 35 points on the priority list. These ratings indicate that the projects are essentially the same with little difference in water quality impacts between these projects. Therefore, DEP is pursuing these now concurrently and will continue to pursue each project concurrently. The project schedule will be determined by the recommendations of the individual facility plans coupled with consideration of the ability to finance the project through the Clean Water Fund and the municipality. It is the intent of DEP to secure a long term commitment from each municipality to implement the project over a defined period of time. The period of time may range from five years up to twenty years. The Clean Water Fund is anticipated to be able to finance these high rated projects as various phases are ready to proceed to construction.

Secondary CSO projects are identified as Enfield, Jewett City, Westport, Waterbury, Derby, Shelton and Portland. These secondary projects are all in various stages of project completion. Because the number of projects is small and because completion of each project can be accomplished in five years or less, DEP will pursue all of them concurrently. In the case of Westport, Enfield, Derby, Shelton, Portland and Waterbury new Administrative Orders will be required. These will be issued prior to October, 1991.

Minimum Technology - Based Limits

All CSO facility planning shall recognize that CSO discharges are required to meet the following minimum technology - based requirements;

1) Proper operation and maintenance for the sewer system and overflow structures.

2) Maximum use of the sewer system/or storage.

3) Maximization of flow to the treatment plant for treatment.

4) Prohibition of dry weather overflows

5) Control of solid and floatable materials.

Water Quality Standards/Use Attainability

The DEP will only consider a proposal from a municipality to lower the designated use goal after the municipality has completed its detailed facilities planning efforts. The municipality shall be required to comply with state requirements (Water Quality Standards, Section II Surface Water Standards, paragraph 3 - use attainability and paragraph 4 - changing water quality goal) and federal requirements (40.CFR 131.10(g) - Criteria for modifying state water quality standards and 40 CFR 131.20(b) - notice and opportunity for public hearing). Modifications to the standards may address the impacts of CSO's during and shortly after the CSO event.

Consistency of Facility Planning With the Long Island Sound Study (LISS)

The DEP will continue to monitor the development of the LISS and will assure that CSO facility planning is consistent with the management plan to be developed as part of the LISS. The Comprehensive Management Plan is anticipated to be completed by November, 1991. When issued, this CSO strategy will be reviewed to assure consistency between the two document.

Annual Report - An annual status report will be prepared by DEP for use by the Department, the Legislature and the public. Its purpose will be to provide a concise overview of the development of CSO projects and will include contacts for further information and details. Please refer to Appendix B for a format for this report.

WRH:jrs

Appendix E

REPORT

CSO CONTROL PLANNING BASELINE CONDITIONS REPORT

NORWICH PUBLIC UTILITIES
NORWICH, CONNECTICUT

MARCH 2018

CDM Smith

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Appendix G CT DEEP Water Quality Standards (included on provided disc)

Appendix H 2012 LTCP – Water Quality Studies (included on provided disc)

References

Black and Veatch, 2012. CSO Long Term Control Plan Volume 1 of 2 Final Report. Prepared for Norwich Public Utilities.

CDM Smith, 2004. CSO Control Planning, Baseline Conditions Report. Prepared for the Metropolitan District, Hartford, Connecticut.

The Chartered Institution of Water and Environmental Management (CIWEM), 2017. Code of Practice for the Hydraulic Modelling of Urban Drainage Systems.

Heineman, M.C., 2004. "NetSTORM - A Computer Program for Rainfall-Runoff Simulation and Precipitation Analysis" in Critical Transitions in Water and Environmental Resources Management, Proceedings of World Water and Environmental Resources Congress 2004. DOI:10.1061/40737(2004)395

Hershfield, D.M., 1961: Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. Weather Bureau Technical Paper No. 40, U.S. Weather Bureau, Washington, D.C., 115 pp.

Kunkel, K.E., *et al.*, 2013: Monitoring and Understanding Trends in Extreme Storms: State of Knowledge. Bull. Amer. Meteor. Soc., 94, 499–514, DOI:10.1175/BAMS-D-11-00262.1

Maidment, 1993. Handbook of Hydrology. New York: McGraw-Hill, Inc.

NOAA, 2018. Data Tools: 1981-2010 Normals. Website accessed at www.ncdc.noaa.gov/cdo-web/datatools/normals

Northeast Regional Climate Center, 2011. Extreme Precipitation in New York & New England. Website accessed at http://precip.eas.cornell.edu

Ormsbee, L., 1989. "Rainfall Disaggregation Model for Continuous Hydrologic Modeling." Journal of Hydraulic Engineering, 115(4). DOI:10.1061/(ASCE)0733-9429(1989)115:4(507)

Perica, S. *et al.*, 2015. NOAA Atlas 14: Precipitation-Frequency Atlas of the United States, Volume 10 Version 2.0. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Silver Spring, Maryland. www.nws.noaa.gov/oh/hdsc/PF_documents/Atlas14_Volume10.pdf

Executive Summary

ES.1 Purpose

On July 10, 2007, the Connecticut Department of Environmental Protection (CT DEEP) issued Consent Order WC-5445 to Norwich Public Utilities (NPU). This order required NPU to submit an updated Long-Term CSO Control Plan (LTCP) by October 30, 2009. An updated LTCP was submitted in August 2012 recommending public sewer separation in all remaining combined sewer areas, and CT DEEP approved the plan on May 26, 2016. NPU requested permission to update the 2012 LTCP due to several changed conditions. On July 3, 2017, CT DEEP issued Consent Order WRMU17001 to NPU. This order allows 500 days for the development of a revised LTCP. This Baseline Conditions Report characterizes combined sewer system performance in Norwich to establish a benchmark for alternatives development in the revised LTCP.

The goals of this report are to:

- Summarize sewer system features and characterize performance under existing conditions;
- Describe the sewer system model developed to characterize the sewer system and its wet weather response;
- Present frequency of CSO structure activation and quantify CSO based on design storm and representative year simulations;
- Summarize applicable water quality standards and uses of existing receiving water bodies, and;
- Summarize baseline CSO impacts to receiving waters.

ES.2 Sewer System Characteristics

NPU's combined sewer system dates back to the 19th century. It is located primarily in Norwich, with some tributary flow from neighboring communities including Franklin, Lisbon, Preston, and Sprague. All collected flows are conveyed to the Norwich Water Pollution Control Facility (WPCF) on Hollyhock Island for treatment. Currently, the average daily flow at the Norwich WPCF is roughly 5 mgd. The WPCF is permitted for 8.5 mgd under NPDES. The designed peak flow of the facility is 17.0 mgd. Wet weather flows at the plant often reach design peak hydraulic capacity.

Key characteristics of the sewer system include:

- 16 CSO regulator structures
- 14 CSO outfalls
- 5 major interceptors; Laurel Hill, Thamesville, Salem Turnpike, Shetucket, and Yantic

- 116.5 miles of gravity sewer up to 42-inch diameter in Norwich and 3.3 miles outside of Norwich
- 10.5 miles of force main in Norwich and 4.4 miles outside of Norwich
- 39 NPU Maintained Wastewater Pumping Stations, 6 Private Pumping Stations, 1 State of CT owned Pumping Station

To facilitate a better understanding of flows in the sewer system, short-term and long-term flow metering programs were established. During the short-term metering program, 25 temporary meters were installed in interceptors and other key areas of the sewer system for approximately six weeks. The long-term metering program is currently ongoing, with 16 meters installed within the regulator structures to quantify and characterize CSO occurrences. Throughout both metering programs, three rain gauges have been installed in Norwich to record precipitation data.

ES.3 Sewer System Model

The LTCP developed for Norwich and approved by CT DEEP in 2012 used a model of the Norwich collection system built in InfoWorks ICM (Integrated Catchment Modeling). InfoWorks is a proprietary modeling software by Innovyze that incorporates both hydrology and hydraulics, including above- and below-ground features, into a single model. The previous model incorporated;

- A skeleton of the collection system from GIS mapping, which included pipes with diameters of 10 inches or greater.
- Sewershed and watershed boundaries.
- Sanitary flows based on an average per capita rate.
- Flows from large industrial customers.
- Survey information verifying locations and elevations of key hydraulic features.
- Pump curves for major pump stations.
- Information regarding operations at the Rose Alley pump station.

CDM Smith utilized data from a variety of sources to update the model pipe network, regulator structures, and hydrology. Some of the key updates to the model included;

- New survey at key points of interest detailing information on flow splits, sediment depths, pipe sizes, and critical interceptors.
- New survey of all regulator structures detailing weir elevations, weir dimensions, pipe sizes, and pipe inverts.
- Refined subcatchment area delineations considering topography, sewer connectivity, and town parcels.

- Updated characteristics for each catchment including soil properties, slopes, and land use.
- Refined dry weather flow disaggregation between sanitary flow and groundwater infiltration.
- A simple model of the receiving rivers to simulate tail water influence on the system.

The updated sewer model was calibrated to dry weather and wet weather based on data collected during the 2017 metering program. The model was adjusted to minimize differences between observed and simulated timing of peak flows, peak flow rate, volume, velocity, and depth at each metered location. Once the model was calibrated, it was applied to project flows for design storm events and for a three-year representative period. Both design storms and the representative period were developed to analyze the existing collection system under a variety of wet weather conditions.

ES.4 Design Storm and Representative Period Selection

Previous CSO control plan modeling for Norwich used a synthetic 2-year design storm, three smaller historic storms recorded at Mansfield, 17 miles northwest of Norwich, and a representative year composited from eight discrete months of historic data at Mansfield and four months at Bradley Airport in Windsor Locks (Black and Veatch, 2012). The selection of representative precipitation was re-examined in this baseline report, considering updated precipitation statistics and additional sources of precipitation data.

Norwich has greater average annual precipitation than most communities in southern New England, and the best source of long-term precipitation data and design storm hyetographs for Norwich was determined to be Providence, RI data with consideration for climatic differences between the locations. The 54.8 inch estimated annual precipitation used for Norwich in this report is much greater than the 40.3 inches used in the 2012 Facilities Plan or the 42 inches used in Norwich's 1994 plan. This is primarily due to the earlier plans using hourly data from neighboring towns (Mansfield, Jewett City, Windsor Locks) that receive significantly less rainfall than Norwich, CT.

Design storms were selected from Providence long-term hourly and sub-hourly data to align with the Norwich precipitation frequency estimates. Historic events were chosen instead of synthetic hyetographs to ensure realistic distribution of rainfall over the duration of a storm event. **Table ES-1** presents 15-minute through 24-hour maximum depths for the selected design storms in the original data, along with adjusted 15-minute through 1-hour maxima in the final 15-minute hyetographs.

Table ES-1 Design Storms from Providence Hourly Data

Event	Date	15-Minute Hyetograph Maxima (inches)								Hourly Data Peak Hour (inches)
		15-min	30-min	60-min	2-hr	3-hr	6-hr	12-hr	24-hr	
1-month	April 20, 2015	0.20	0.27	0.35	0.50	0.61	0.82	0.95	1.03	0.30
3-month	September 6, 1974	0.37	0.47	0.58	0.82	0.99	1.41	1.82	1.89	0.46
6-month	September 26, 2008	0.51	0.70	0.77	0.98	1.17	1.68	2.40	2.53	0.52
1-year	September 19, 1972	0.56	0.79	1.00	1.38	1.62	1.99	2.66	2.86	0.74
2-year	August 30, 1985	0.67	0.95	1.22	1.83	2.01	2.23	3.17	3.43	1.01
5-year	August 9, 1954	0.85	1.20	1.54	2.15	2.29	2.88	3.27	4.17	1.34

The representative period of 2009-2011 was chosen to represent three consecutive years with average annual rainfall totals and average seasonal distributions of rainfall. For each year in this period, the number of three-month through one-year events at durations from 1 to 24 hours were close to the long-term expected values. The selection of the typical period is further described in Section 4. Over an average three-year period, a system with two-year performance would be expected to experience no more than one overflow. A continuous simulation of these three years will be completed to verify that a two-year performance level is achieved by the final Long Term CSO Control Plan.

ES.5 Wet Weather Flows

The hydrologic and hydraulic InfoWorks model was used to simulate wet weather flow at 14 CSO outfalls for six design storms and for a three-year representative period. Simulations of each design storm will be used in identifying the costs and benefits of CSO remediation. The representative period is used to generate annual CSO statistics and will later be used to assess how well the 2-year control is met.

The 1-month, 3-month, 6-month, 1-year, 2-year, and 5-year design storms were applied to the InfoWorks model. Peak flows and total volumes for each design storm are summarized by CSO outfall in **Table ES-2** and **Table ES-3**. System-wide CSO volume ranges from 0.93 Million Gallons (MGal) for the 1-month storm to 6.33 MGal for the 5-year storm. Approximately half of the total CSO volume for each storm occurs at CSO 017, upstream of Rose Alley pump station, with the percentage of total flow increasing for smaller design storms. Relatively large CSO discharges also occur at 024, 023, and 019, which are all on the Shetucket interceptor.

Table ES-2 Baseline Conditions Design Storm CSO Peak Flow Summary

	Peak Flow (mgd)					
CSO	1-month	3-month	6-month	1-year	2-year	5-year
004	1	4	7	8	19	12
005	<1	<1	<1	1	1	1
017	14	16	31	34	35	43
018	3	5	7	8	10	14
019	3	6	9	10	12	19
021	<1	2	2	2	2	8
022	2	4	6	7	8	10
023	5	9	13	14	16	21
024	4	8	14	15	19	26
025	1	2	4	5	5	8
029	0	<1	<1	<1	1	2
031	<1	2	4	6	6	8
032	0	1	3	4	5	9
040	0	0	0	<1	<1	1
Total	**32**	**61**	**102**	**116**	**140**	**183**

Table ES-3 Baseline Condition Design Storm CSO Volume Summary

	CSO Volume (US Mgal)					
CSO	1-month	3-month	6-month	1-year	2-year	5-year
004	0.01	0.04	0.11	0.12	0.28	0.27
005	<0.01	0.01	0.02	0.03	0.04	0.05
017	0.67	1.19	1.82	2.25	2.72	2.86
018	0.03	0.09	0.16	0.21	0.34	0.37
019	0.03	0.08	0.17	0.22	0.36	0.45
021	<0.01	0.01	0.02	0.01	0.02	0.12
022	0.01	0.04	0.09	0.12	0.21	0.25
023	0.07	0.18	0.32	0.42	0.66	0.72
024	0.06	0.14	0.27	0.34	0.53	0.62
025	0.04	0.08	0.14	0.17	0.23	0.26
029	0	<0.01	<0.01	<0.01	0.01	0.02
031	<0.01	0.02	0.06	0.09	0.17	0.21
032	0	<0.01	0.03	0.04	0.07	0.12
040	0	0	0	<0.01	<0.01	<0.01
Total	**0.93**	**1.89**	**3.19**	**4.02**	**5.65**	**6.33**

The three-year representative simulation from 2009 to 2011 was run to generate annual CSO statistics. Annual CSO volumes for each year ranged from 40.12 MGal in 2009 to 48.63 Mgal in 2010, with an average annual CSO volume of 43.31 Mgal (**Table ES-4**). The updated model estimates 42% less total CSO volume than the 2012 LTCP update. Differences in estimated CSO discharge between the 2012 model and updated model are due to the model updates described in Section 3.4 and the updated calibration with 2017 flow data (Section 3.5 and 3.6).

Table ES-4 Representative Period Summary

Year	Volume (Mgal)	Event Count	Duration (hrs)	Precipitation (in)
2009	40.12	57	359	54.9
2010	48.68	52	340	53.5
2011	41.13	71	367	56.7
Average	43.31	60	355	55.0
2012 LTCP	103.3	90	NA	40.28

The three-year baseline simulation was also analyzed to compute percent capture for the existing sewer system. Percent capture was characterized by the following equation:

Percent Capture = 1 - (CSO Discharged Flow/ Total Wet Weather Flow)

Annual average WPCF wet weather flow was calculated as 249 Mgal (average flow to the WPCF during wet weather of 7.8 mgd), yielding 85 percent average wet weather capture. Percent capture was not reported in the 2012 LTCP report for comparison.

ES.6 Receiving Water Quality and Impact Analysis

The water quality assessment of CSO discharges on the Shetucket River and the Thames River Estuary consisted of the following measures:

- Evaluation of existing water quality classification and its definition;
- Identification of current water uses and impairments of these uses;
- Determination of impacts of CSO discharges on water quality.

By identifying river classifications, current uses and future goals, it is possible to assess CSO impacts on water quality.

The Shetucket River in Norwich is affected by tidal waters and was determined by CT DEEP not to support recreation due to high Escherichia coli (E. coli) in the water. The potential sources of E. coli include stormwater, illicit discharges, and combined sewer overflows. The quality of aquatic life in this section of the river has not been assessed and there are no total maximum daily loads (TMDL).

The Thames River Estuary in Norwich is tidally influenced marine waterbody that was determined by CT DEEP not to supporting aquatic life, recreation, and shellfish harvesting. A summary of the Thames River Impairments:

- Recreation impairment caused by Enterococci bacteria that is potentially from stormwater, municipal discharges, landfills, illicit discharges, insufficient on-site treatment/ septic systems, and/or combined sewer overflow
- Commercial Shellfish Harvesting (where authorized) impairment caused by fecal coliform that is potentially from stormwater, municipal discharges, landfills, illicit discharges, insufficient on-site treatment/ septic systems, and/or combined sewer overflow

- Habitat for Marine Fish, other Aquatic Life and Wildlife impairment caused by dissolved oxygen saturation, estuarine bioassessments, nutrient/eutrophication biological indicators, and dissolved oxygen that is potentially from stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems, and/or combined sewer overflow

In the 2012 LTCP, a water quality monitoring program was conducted to assess the impact of Norwich CSOs on water quality and set baseline conditions for the receiving waterbodies in 2008. The comprehensive program included dry weather and wet weather sampling; land-based and boat-based sampling; and sampling upstream and downstream of the CSO outfalls. NPU followed a CT DEEP approved work plan to delineated mixing zones and conduct a zone of influence analysis. The programs focused on assessing the extent of bacterial contamination downstream of the CSO outfalls on the Thames River and the length of time the bacterial concentrations were elevated following wet weather events with CSO overflows.

Some of the key findings of the water quality monitoring program included

- pH and dissolved oxygen in the saline portion of the Thames River were below water quality standards, but the cause does not appear to be CSO-related because the problems also occurred during dry weather.
- Bacteria levels in the rivers upstream of Norwich CSOs can exceed water quality criteria for days after a storm. This was primarily attributed to nonpoint source runoff. During wet weather, CSOs contributed less than half the bacteria loading in the receiving waters. Even if all CSOs in Norwich were eliminated, the Shetucket and Thames Rivers would not meet bacteria water quality standards.
- Norwich CSOs contribute significantly to bacteria levels in the receiving waters during storms. However, bacteria levels recede relatively quickly after wet weather events. In the Thames River, bacteria counts downstream of CSOs returned to background levels within one to three days after storms.
- The only water quality parameter that Norwich CSOs were found to significantly influence was bacteria. The CSOs are not significant sources of nitrogen or phosphorus in the Shetucket and Thames Rivers.
- Mixing zone modeling indicates a CSO plume discharge will be about 50 feet wide and extend 1,100 yards below the outfall. Although the dissolved oxygen level in the CSO discharges is low, the area with depressed dissolved oxygen will be small because of the high dilution factor and relatively low volume of CSO discharge. The narrow band of CSO influence should not block passage of fish or free-floating organisms in the Thames.

ES.7 Conclusion

Norwich Public Utilities has implemented sewer separation projects from the 1970's onward and reduced the number of CSO discharge outfalls from 43 to 14 by 2005. Design of sewer separation in the Eastside Area of Norwich is being developed concurrently with this CSO LTCP. The revised sewer system model estimates 42% less total CSO volume than was estimated in the 2012 LTCP.

Approximately half of all CSO volume during all design storms originated at CSO 017 at the Rose Alley Pump Station. The outfalls at CSOs 019, 023, and 024 on the Shetucket Interceptor were also large contributors to total CSO volumes.

Information presented in this Baseline Conditions Report will be used to develop CSO abatement alternatives, in addition to those already implemented or planned, to arrive at a cost-effective revised Long-Term CSO Control Plan that further mitigates water quality impacts and is acceptable to CT DEEP.

Section 1
Introduction

1.1 General

On April 11, 1994, the United States Environmental Protection Agency (USEPA) issued the final Combined Sewer Overflow (CSO) Control Policy. The policy establishes a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities, and the public engage in a coordinated planning effort to develop and implement cost-effective CSO controls that ultimately meet appropriate environmental and health objectives. The policy is implemented through the National Pollution Discharge Elimination System (NPDES) permit program under the provisions of the Clean Water Act (CWA).

On July 10, 2007, the Connecticut Department of Environmental Protection (CT DEEP) issued Consent Order WC-5445 to Norwich Public Utilities (NPU). This order required NPU to submit an updated Long-Term Control Plan (LTCP) by October 30, 2009. The deadline was extended and the draft LTCP was submitted in October 2010 and recommended a sewer separation program for most of the combined sewers in Norwich. An updated LTCP was submitted in August 2012 recommending public sewer separation in all remaining combined sewer areas, and CT DEEP approved the plan on May 26, 2016. Due to a number of conditions that changed, NPU requested permission to update the 2012 LTCP.

On July 3, 2017, CT DEEP issued Consent Order WRMU17001 to NPU. This order allows 500 days for development of a revised LTCP. Work necessary to develop a revised LTCP includes system-wide flow metering data; updating and improving the Norwich sewer model, development of this Baseline Conditions Report; re-evaluation of alternatives to achieve the 2-year level of CSO control; development of a refined affordability analysis; development of additional alternatives; public outreach; and a list of recommended projects with a recommended implementation schedule. This Baseline Conditions Report characterizes combined sewer system performance in Norwich to establish a benchmark for alternatives development in the revised LTCP.

1.2 Purpose

The purpose of the Baseline Conditions Report is to describe the Norwich collection system, describe model improvements, characterize and select design storms, provide a summary of CSO discharges and impacts to receiving water discharges, for use in prioritizing and quantifying improvements associated with CSO control measures evaluated in alternatives analysis. Selected design storms and resultant frequency of CSO activation, volumes, and analysis of the estimated pollutant loading to receiving waters are presented.

This report characterizes combined sewer system performance under existing conditions and presents “the problem to be solved” by the revised LTCP. The revised LTCP will document and incorporate a projected “future baseline” that accounts population, commercial, and industrial changes over the next 20 years as part of alternatives analysis.

1.3 Background

Norwich is a small city that is home to 40,000 residents in southeastern Connecticut. Norwich was founded in 1659 and incorporated in 1784 as one of the first five Connecticut cities. The Shetucket, Yantic, and Quinebaug Rivers combine in Norwich to become the Thames River, which flows to Long Island Sound. The abundant river power provided an ideal place to build textile factories, along with other mills, which established the early economy of Norwich.

NPU owns and operates the combined sewer system primarily located in the City of Norwich. NPU is a municipally-owned utility that provides sewer, water, electric, and gas services to customers in Norwich and surrounding communities. The waste water collection system consists of approximately 135 miles of sewers, 45 pump stations, 11 miles of force mains in Norwich; force mains and sewers from neighboring communities; and the Norwich Water Pollution Control Facility (WPCF). The combined sewers in Norwich date back to the late 1800's and early 1900's. The combined sewer pipes were originally sized to carry both sewage and stormwater, intense storm events have historically taxed the capacity of the interceptors and WPCF, which cannot handle the large wet weather flows from the combined sewer system. The City of Norwich owns and operates the stormwater system and is a separate entity from NPU.

In 1972, there were 43 active CSO discharge outfalls in the City of Norwich. In the 1970's and 80's, NPU completed partial sewer separation projects that removed the public stormwater sources from the combined sewer system in the Downtown and the Westside areas of the city and reduced the number of CSO outfalls from 43 to 27.

In 1994, USEPA published the *Combined Sewer Overflow Control Policy* that requires compliance with the Nine Minimum Controls and development of a Long Term Combined Sewer Overflow Control Plan. NPU submitted the *Norwich, CT Modified Facilities Plan* in August 1994 to meet consent order requirements and through partial sewer separation projects reduced the number of CSO outfalls from 27 to 14 by 2005.

Today, the combined sewer system has 16 CSO regulator structures contributing to 14 NPDES permitted CSO outfalls to the Shetucket and Thames Rivers. NPU has contracted with CDM Smith to update the sewer system model and prepare a revised LTCP, address changed conditions since the 2012 LTCP update. CDM Smith is working concurrently on the design of the East Side Area Sewer Separation Project.

1.4 CSO Locations

As mentioned above, there currently are 16 CSO regulators in NPU's sewer system. Overflows occurring at these regulators either flow directly to receiving water bodies or are consolidated with other regulator overflows for discharge to receiving waters through the 14 CSO outfalls. The consolidated regulators overflow directly to the Shetucket and Thames Rivers. See **Figure 1-1** for an overview of NPU's sewer system showing key features including CSO regulators and outfalls, pumping stations, interceptors, sewershed area, and receiving waters.

1.5 Project Approach

Data collection and analysis was an important part of this study and included both field investigations and research. Field work involved flow monitoring, precipitation monitoring, and survey of key structures. Research was done on the existing sewer system, water quality classifications, previous water quality sampling, and water body uses. Data collection provided critical information to perform several analyses, including: CSO characterization analysis and receiving water impact analysis. NPU's existing sewer system hydraulic model was updated and all information is summarized in this Baseline Conditions Report. The following is a summary of how this report was developed.

The first step in determining the system's baseline conditions was to review the existing sewer system, to gain an understanding of how the system operates. The next critical step was to quantify sewer system performance, under both dry and wet weather conditions. This was accomplished by conducting simultaneous flow metering and precipitation monitoring. A short-term flow metering program was completed in spring 2017 and a long-term flow metering program is underway and expected to occur from spring 2017 to spring 2018. In spring 2018, NPU will evaluate options for the long-term monitoring of CSO regulators.

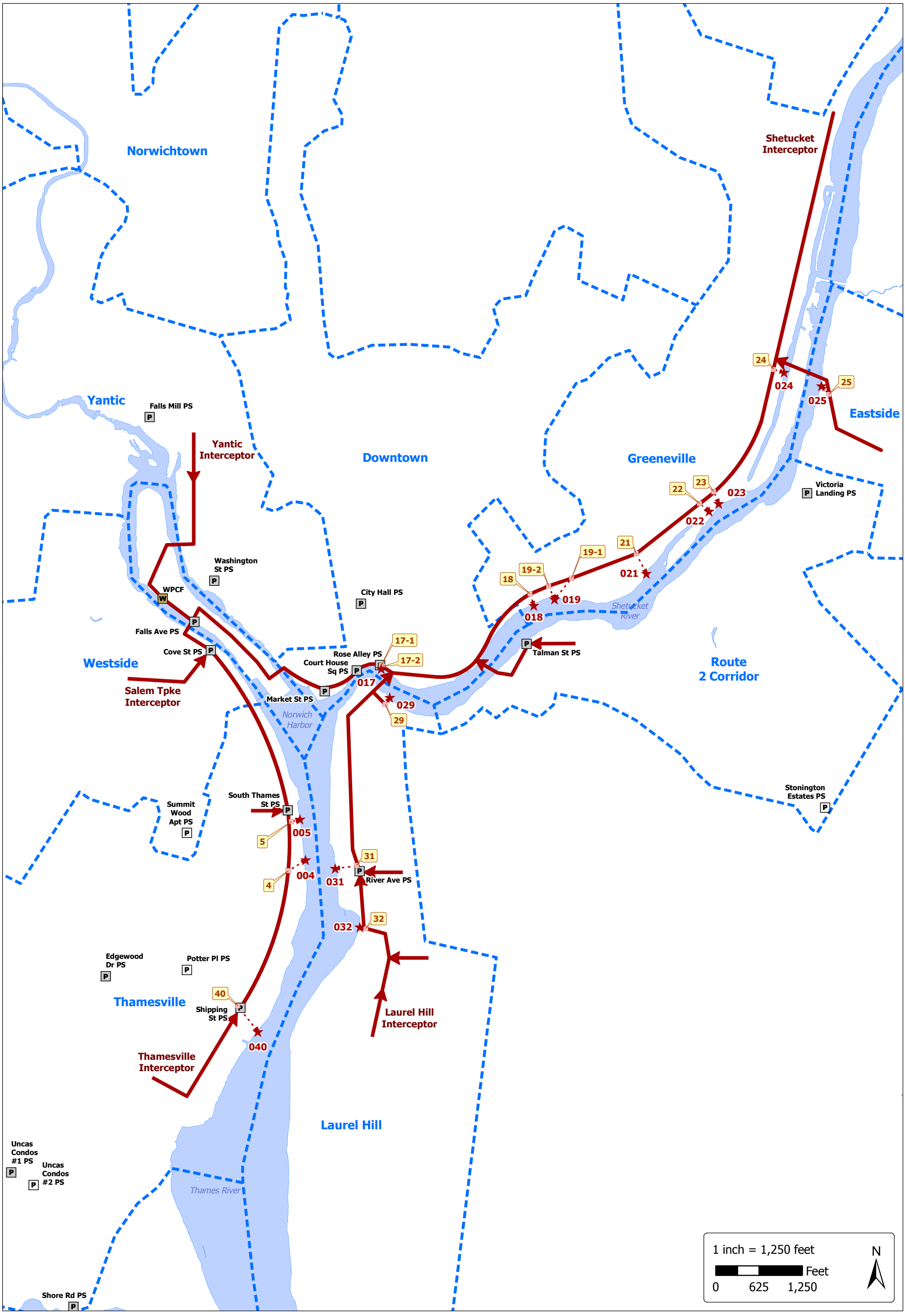
Flow meter data was used to update and calibrate NPU's sewer system hydraulic model. NPU's InfoWorks model was originally developed for the 2012 LTCP based on NPU's geographic information system (GIS) mapping of the collection system. The model includes the entire wastewater system with the combined and separated sewer pipes represented.

Another step required to establish baseline conditions was identification of current receiving water body uses and water quality classifications. Once uses were established, an analysis was done to determine whether CSO discharges impair these uses. The state's 2016 Integrated Water Quality Report, Water Quality Classification maps, and 303(d) List (discussed in Section 6 of this report) were used for this study to determine the classification of Norwich's CSO receiving water bodies and analyze CSO impacts on the water bodies.

The findings and conclusions of this report are based upon information gathered from previous studies, flow metering, water quality information, and survey. The information gathered was used to update the collection system model, which in turn provided valuable information for this study. In summary, this Baseline Conditions Report is a product of data collection efforts, several analyses of this data, and output from the updated InfoWorks model.

1.6 Report Organization

This report is divided into six sections, and provides a characterization of the sewer system, a summary of the hydraulic model, precipitation records and design storms, a summary of wet weather flows and loads, an analysis of the receiving waters, and a summary of impacts to the receiving waters from CSO discharges.



Legend

- CSO Overflow Regulator
- CSO Outfall
- Sewershed Boundary
- Pump Stations (Norwich Public Utilities)
- Pump Stations (Private)
- Water Pollution Control Facility

CDM Smith

Baseline Conditions Report
Norwich Public Utilities
Figure 1-1
Summary of Norwich's Combined Sewer System

Section 2

Sewer System Characterization

2.1 General

Norwich developed as a city surrounded by water. The Shetucket, Yantic, Quinebaug, and Thames are the major rivers; the city also contains many ponds and brooks. The Thames River connects Norwich to Long Island Sound, which provided a pathway for commerce as the city grew but made development and maintenance of the sewer collection system an ongoing challenge. Norwich's existing combined sewer system dates to the 19th century.

A significant portion of the work completed to establish baseline conditions was dedicated to understanding, monitoring and surveillance of the sewer system. This was accomplished through flow metering, data collected through NPU's long-term overflow monitoring system, existing GIS mapping, and interviews with NPU staff.

2.2 Description of the Sewer System

In the 1800s, a combined sewer system with multiple sewage discharge points to the rivers developed in Norwich. By the 1890s, nine and one-half miles of sewer were present. Most of the sewers were existing streams that had been piped under roads and discharged a combination of streamflow and sewage to the principal rivers. Well into the 20th century, combined sewer systems were the nationally accepted engineering standard for design in the United States, especially in the Northeast. Efficient use of pipes for sewage and storm water conveyance was cost effective and more readily managed.

The City of Norwich Sewer Authority owns and operates Norwich's Water Pollution Control Facility (WPCF) that is located on Hollyhock Island off Falls Avenue in Norwich. The first WPCF was constructed in 1936, but was replaced with a larger facility at the same location in 1957. Both early plants provided primary treatment. In the early 1970s, the plant was expanded and upgraded as a larger, secondary treatment plant, put into operation in 1976. The current WPCF provides secondary treatment for all flow that reaches the plant.

Limited mechanical replacements have occurred since the 1970s. Aside from in-kind pump replacements and digester cover modifications, there have been no major process improvements and many of the existing systems are over 40 years old. The plant was designed to treat an average flow of 8.5 million gallons per day (mgd) and a peak flow of 17 mgd. The current NPDES permit matches these flow rates.

Beginning in the 1970s, partial sewer separation projects were constructed to remove stormwater flow from the combined sewer system. These partial sewer separation projects typically included installing a new storm drain pipe in the road, connecting catch basins to the storm drain, and establishing a stormwater outfall. In most cases, private sources of stormwater to the sewer system were not removed; connections such as roof leaders, yard drains, foundation drains, and sump pumps remained connected to the sewer. The partial separation projects

reduced stormwater flows in the sewer system and were integral to the closure of 27 combined sewer overflows (CSOs). These separation projects focused on separation in the Downtown and Westside areas of Norwich.

The Norwich sewer system collects flow from nine major sewer drainage areas. For the purposes of this report, these areas are named Downtown, Eastside, Greeneville, Laurel Hill, Norwichtown, Thamesville, Route 2 Corridor, Westside, and Yantic. Many residences in the north and west sections of Norwich do not connect to the NPU sewer system, owners there have private septic systems to treat wastewater flow. **Figure 2-1** shows the sewer system in Norwich including the sewershed boundaries.

Topographically, The City of Norwich has highly varied terrain, with many hills, and an abundance of rock ledge that makes installation and rehabilitation of sewer segments difficult. Sewer flows ultimately reach the WPCF via the Rose Alley pump station (PS) from the east, the Cove Street PS from the south, or by gravity via the Yantic Interceptor from the northwest. Critical components of NPU's sewer system include:

- 16 CSO regulators discharging to 14 CSO outfalls
- five major interceptors: Laurel Hill, Thamesville, Salem Turnpike, Shetucket, and Yantic
- 116.5 miles of gravity sewer up to 42-inch diameter in Norwich, 3.3 miles outside Norwich
- 10.5 miles of force main in Norwich, 4.4 miles outside Norwich
- 39 NPU-maintained wastewater pump stations, 6 private pump stations, 1 state-owned pump station

2.2.1 Flow from Norwich

Sewer flows from the NPU collection system are treated at the WPCF prior to discharge through two permitted outfalls, Outfall 001 to the Thames River and Outfall 002 to the Yantic River. NPU uses the Thames River outfall as the primary discharge point. During periods of high flow or river flooding, both outfalls are utilized. The WPCF processes an average daily flow of 5 mgd, with wet weather peaks often exceeding the design peak capacity of 17 mgd. Wastewater flows in Norwich are predominantly residential, with some commercial and industrial wastewater.

Infiltration and inflow and (I/I) contributes a significant amount of flow to the sewer system. Significant sources of inflow include street drainage, as well as private roof leaders and sump pumps that could be connected to the sewer. Infiltration, or groundwater that seeps into the sewers, commonly occurs where there are loose joints, broken pipe sections, or root intrusion. Infiltration adds a considerable amount of flow to the collection system, especially in areas with high groundwater tables. It is desirable to remove I/I sources from any sewer collection and treatment system, to maximize the system's hydraulic capacity and to eliminate the expense of treating stormwater. The Downtown, Eastside, Greeneville, Laurel Hill, and Thamesville sewersheds contain combined sewers. Remaining areas are partially separated as described in Section 2.2.

Town of Sprague

Town of Franklin

Town of Lisbon

Town of Bozrah

Town of Montville

Town of Preston

Yantic

Downtown

Greeneville

Route 2 Corridor

Laurel Hill

Norwichtown

Westside

Thamesville

Eastside

Shetucket Interceptor

Yantic Interceptor

Laurel Hill Interceptor

Thamesville Interceptor

6" Stony Brook Water Treatment Plant Waste Sludge and Backwash Line

10" Force Main from Old State Hospital Site

Neighborhood	Discharge Number	Regulator Number	Regulator Location	Receiving Water
Thamesville	004	4	Backyard of 76 Thames Street	Thames River Estuary
Thamesvile	005	5	South Thames Street	Thames River Estuary
Downtown	017	17-1	Rose Alley near Pump Station	Thames River Estuary
		17-2	Rose Alley near Pump Station	Thames River Estuary
Greeneville	018	18	North Main Street	Shetucket River/Thames River Estuary
Greeneville	019	19-1	North Main Street near Barron Street	Shetucket River/Thames River Estuary
		19-2	North Main Street at Roath Street	Shetucket River/Thames River Estuary
Greeneville	021	21	Erin Street	Shetucket River/Thames River Estuary
Greeneville	022	22	North Main Street	Shetucket River/Thames River Estuary
Greeneville	023	23	North Main Street	Shetucket River/Thames River Estuary
Greeneville	024	24	8th Street at Route 12	Shetucket River/Thames River Estuary
Eastside	025	25	Roosevelt Avenue at 8th Street	Shetucket River/Thames River Estuary
Laurel Hill	029	29	Talman Street	Thames River Estuary
Laurel Hill	031	31	River Avenue Extension near Pump Station	Thames River Estuary
Laurel Hill	032	32	Near Railroad Tracks off Crown Street	Thames River Estuary
Thamesvile	040	40	Shipping Street at Terminal Way	Thames River Estuary

Legend

- Pump Stations (Norwich Public Utilities)
- Pump Stations (Private)
- Pump Stations (State)
- Water Pollution Control Facility
- CSO Outfall
- WPCF Outfall
- CSO Overflow

Norwich Public Utilities

Separated Sanitary Sewers

- Other/Unknown Diameter
- Diameter < 24"
- Diameter >= 24"

Private Separated Sanitary Sewers

- Other/Unknown Diameter
- Diameter < 24"
- Diameter >= 24"

- Sewer Manhole
- Storm Drain Manhole
- Force Main
- Sewershed Boundary

City of Norwich Storm Drains

- Storm Drain Pipe

Norwich Public Utilities

Combined Sanitary Sewers

- Other/Unknown Diameter
- Diameter < 24"
- Diameter >= 24"

Private Combined Sanitary Sewers

- Other/Unknown Diameter
- Diameter < 24"
- Diameter >= 24"

1 inch = 800 feet

0 800 1,600 2,400 Feet

N

CDM Smith

Baseline Conditions Report
Norwich Public Utilities

Figure 2-1
Combined Sewer Overlow Regulators and Outfall Locations

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2.2.2 Flow from Neighboring Communities

The Hollyhock Island WPCF receives flow from the City of Norwich, as well as the neighboring towns of Franklin, Sprague, Lisbon, and Preston. Flow from neighboring communities are shown in **Figure 2-2**. These neighboring communities have separated sewage and storm water collection systems. However, since these communities can contribute I/I, they can also use wet weather capacity and indirectly contribute to CSO in Norwich.

Wastewater from Franklin enters the system through a 36-inch line from the southernmost point of Franklin via gravity. Flow enters Norwich near CT-32 and drains to the Yantic interceptor. A small area of NPU's sewer system discharges to Franklin and then to Norwich through the 36-inch pipe. Wastewater inputs from Franklin are limited to a small amount of gravity sewer around the New Park Avenue commercial area. CDM Smith estimates that Franklin contributes 1,100 gpd of sanitary flow to NPU's system.

Wastewater from Lisbon enters NPU's system by gravity through a 10-inch pipe in Route 169. This sewer drains to the Shetucket Interceptor and the Rose Alley PS. Gravity sewers collect flow from an area of Riverview Drive, which crosses the Shetucket River via Newent Road (Route 169). This pipe serves a waste-to-energy incinerator facility at the north end of Riverview Drive. Flows for this facility were determined to be negligible for the hydraulic modeling assessment based on information obtained from NPU.

Wastewater from Preston enters the system through a force main from a waste-to-energy incinerator. NPU also determined that flow from this facility is insignificant. Flow could also enter from Preston through a dormant force main from an inactive state hospital complex. For this Baseline Conditions Report, this force main was modeled with no flow. The Mohegan Tribal Gaming Authority has plans to redevelop this site with amenities that could include an indoor water park, a senior living center, and a sports complex. This new development could add as much as 500,000 gpd. Redevelopment of this site will be considered in the LTCP. The force mains enter the Norwich system from the south via Route 12, from where the system drains by gravity to the Laurel Hill Interceptor.

Wastewater from Sprague enters the north end of the Shetucket Interceptor via a 10-inch gravity line. This flow is collected by a small area of gravity sewer near the Main Street/Papermill Road area in Sprague, and then pumped over the Main Street bridge via Taftville-Occum Road. This area of Sprague is estimated to contribute 15,500 gpd of sanitary flow to NPU's sewer system.

NPU operates the Stony Brook Water Treatment Plant in Montville. Although Montville produces no other wastewater inputs to the NPU system, the Stony Brook plant has a discharge flow that is tributary the Hollyhock WPCF. This flow contains waste sludge, backwash, and other waste waters. A 6-inch force main from the plant enters NPU's sewer system via Montville Road near Maplewood Cemetery. Average flow is estimated at 60,000 gpd.

Collectively, flows from outside Norwich contribute less than three percent of the sanitary baseflow conveyed to the WPCF.

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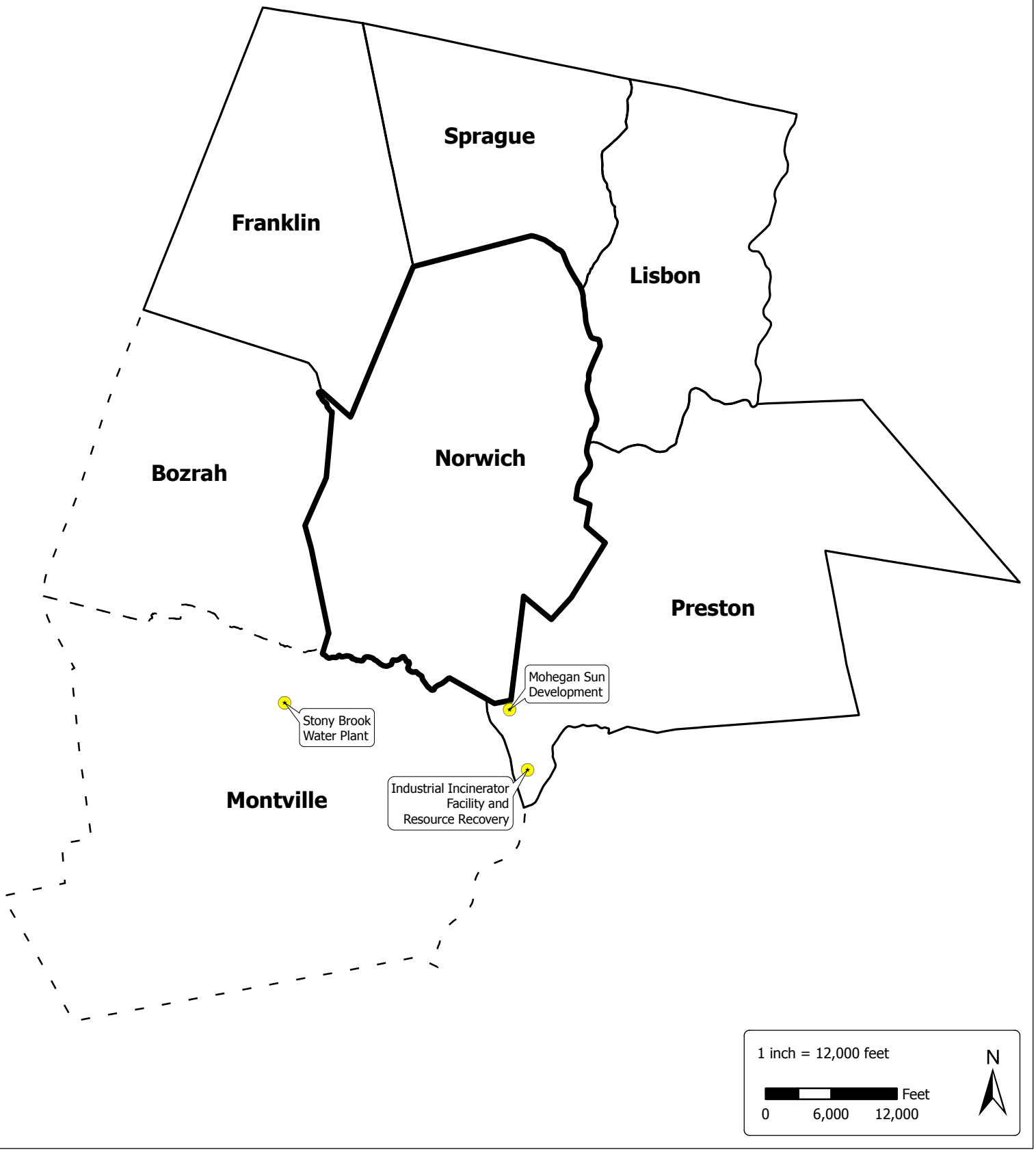

Legend

Town Contributing Sewer Flow to Norwich Public Utilities Sewer System

Town Not Contributing Sewer Flow to Norwich Public Utilities Sewer System

Baseline Conditions Report
Norwich Public Utilities

Figure 2-2
Sewer Service Area

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2.2.3 Description of Tributary Areas in the Sewer System

As discussed above, five of the City's nine drainage districts include combined sewers: Downtown, Eastside, Greeneville, Laurel Hill, and Thamesville.

Downtown is an area to the north of Norwich Harbor. Wastewater in this area drains by gravity to the Rose Alley PS, where it is pumped to the WPCF. A Cipoletti weir and a "pipe cutout" regulator before the pump station relieve excess flow for Downtown and the Shetucket Interceptor.

Greeneville is northeast of Downtown and west of the Shetucket River. This area drains southwest through the Shetucket Interceptor to the Rose Alley PS by gravity flow. This area has the most CSO outfalls, with six providing relief for the Shetucket Interceptor.

Eastside is south of Greeneville, on the eastern side of the Shetucket River, this area flows by gravity north across the river to the Shetucket Interceptor and down to the Rose Alley PS. CDM Smith is currently designing a sewer separation project in the East Side neighborhood. One CSO outfall is tributary to the Eastside Area.

The Laurel Hill Area is south of the Shetucket River and East of the Thames River. Sewer from this area flows north across the Shetucket River, and eventually flows into the Rose Alley PS. Sewer flow from Laurel Hill combines with the Shetucket Interceptor, which carries flow from Greeneville and Eastside, before flowing into the pump station. The Laurel Hill area is served by three CSO outfalls before flow crosses the river to the Rose Alley PS.

The final combined area Thamesville is located on the west side of the Thames River, this area drains to the Cove Street PS which pumps to the treatment plant on Hollyhock Island. The combined sewer system in Thamesville is served by three CSO outfalls before flow reaches the Cove Street PS.

2.2.4 Major Interceptors in Norwich

The NPU sewer system has five major interceptors with multiple tributary lines converging into each. These interceptors, as well as their collection areas, discharge locations, and overflow receiving waters, are listed on **Table 2-1** and shown graphically on **Figure 1-1**. Three of these main interceptors are located in the combined portions of the sewer system. They are the Shetucket Interceptor, Laurel Hill Interceptor, and Thamesville Interceptor.

The Laurel Hill Interceptor originates in the south-east corner of Norwich on Laurel Hill Road. This interceptor takes flow from a forcemain from the south in Preston, as well as the Laurel Hill sewershed area as it works its way north towards CSO regulator 21 on Talman Street. The Laurel Hill sewershed area contains combined sewer lines, including three CSO regulator structures (21, 31, and 32). Flow from this area ultimately flows by gravity across the Shetucket River and combines into the Shetucket Interceptor.

The Salem Turnpike Interceptor collects flow from Westside sewershed in the southwest corner of Norwich. The interceptor runs along Route 82 or the Salem Turnpike and flows northeast towards the Cove Street PS. The Cove Street PS pumps flow directly to the WPCF. No CSO regulators or outfalls are associated with this interceptor. The tributary pipes associated with this

interceptor are "partially separated". Public inflow sources have been removed, private inflow sources such as roof leaders, drains, and sump pumps may still be connected.

The Shetucket Interceptor collects flow from the north-east area of Norwich. This interceptor drains south from the northern border of Norwich, following the path of the Shetucket River. As this interceptor runs through Greeneville, it also collects flow from the Downtown, Eastside, Laurel Hill, and Route 2 Corridor sewersheds. Thirteen CSO regulators (32, 31, 29, 25, 24, 23, 22, 21, 19-1, 19-2, 18, 17-1, and 17-2) fall within these five sewersheds. The interceptor discharges to the Rose Alley PS, which conveys flow to the WPCF.

The Yantic Interceptor passes through Norwich in the northwest area of the city, and drains south to the WPCF. This interceptor collects flow from the Norwichtown and Yantic sewersheds. This Interceptor's flow path follows the course of the Yantic River. There are no CSO regulators associated this interceptor, and the tributary sewers are considered partially separated. This "partial separation" describes areas where public inflow sources have been removed, but there is a possibility for private property inflow sources.

The Thamesville Interceptor collects flow from the south-western portions of Norwich. The Thamesville Interceptor follows the path of the Thames River, and flows north along the west bank. It collects flow from the Thamesville combined sewershed area. This interceptor flows past three CSO regulators (40, 4, and 5) on its way north to the WPCF. This interceptor is pumped along via the Shipping Street and South Thames Street pump stations.

Table 2-1 Major Interceptors, Discharge Locations, & Receiving Waters

Name	Tributary Area	Discharge Location	Receiving Waterbody
Laurel Hill Interceptor	Laurel Hill sewershed area south of River Avenue PS	Shetucket Interceptor	Thames River Estuary (CSO 29, CSO 31 & CSO 32)
Salem Turnpike Interceptor	Area tributary to Route 82 from the west of the Thames River	Cove Street PS/ WPCF	No CSOs
Shetucket Interceptor	Greeneville area tributary to the Shetucket Interceptor. Parallels Shetucket River from northern Norwich border south to Rose Alley PS	Rose Alley PS / WPCF	Shetucket River and Thames River Estuary (CSO 18, 19, 21, 22, 23, and 24), Thames River Estuary only (CSO 017),
Thamesville Interceptor	Thamesville sewershed area parallel to Thames River from southern Norwich border north via Shipping Street & South Thames Street PS	Cove Street PS/ WPCF	Thames River Estuary (CSO 4, 5, and 40)
Yantic Interceptor	Collects flow from along the Yantic River. Drains south to WPCF by gravity	WPCF	No CSOs

2.2.5 Overflow Regulators

NPU has sixteen hydraulic equalization structures, commonly called CSOs. The purpose of these structures is to regulate internal system flow (or head) and relieve excess flow in order to avoid manhole surcharge or flooding in the system. NPU's sewer system has CSO regulators, which allow flow from a combined pipe to enter another sewer pipe, storm drain, or receiving water.

Historically, CSOs were installed to protect areas prone to sewer backups or flooding. In Norwich, the combined sewer areas were originally sized to carry both sewage and stormwater, but intense storm events have historically taxed the capacity of the system and the WPCF. The majority of the CSO structures in Norwich are typical manholes with a weir structure that flow spills over in the event of an excessive depth of flow.

Currently the 16 CSO regulator structures in NPU's system drain to 14 CSO river outfalls, including two locations where regulators structures discharge to a shared outfall pipe. NPU has a regular maintenance and inspection program for all collection system regulators. Regular maintenance and inspection is an excellent tool for monitoring operation of the sewer system and helping to diagnose problems such as sewer backups.

2.2.6 CSO Receiving Waters

NPU's CSO outfalls discharge to the Shetucket River and the Thames River during wet weather conditions. The Shetucket River flows into the Thames River at Norwich Harbor and the Thames River flows south to the Long Island Sound. It should be noted that the Thames River Estuary overlaps the Yantic and Shetucket Rivers, which will be discussed in Section 6. **Table 2-2** shows the CSO outfall numbers, the regulator numbers, the receiving waterbody.

Table 2-2 Table of CSO Locations

Neighborhood	Outfall Number	Regulator Number	Regulator Location	Receiving Water
Thamesville	004	4	Backyard of 76 Thames Street	Thames River Estuary
Thamesville	005	5	South Thames Street	Thames River Estuary
Downtown	017	17-1	Rose Alley near PS	Thames River Estuary
		17-2	Rose Alley near PS	Thames River Estuary
Greeneville	018	18	North Main Street	Shetucket River/Thames River Estuary
Greeneville	019	19-1	North Main Street near Barron Street	Shetucket River/Thames River Estuary
		19-2	North Main Street at Roath Street	Shetucket River/Thames River Estuary
Greeneville	021	21	Erin Street	Shetucket River/Thames River Estuary
Greeneville	022	22	North Main Street	Shetucket River/Thames River Estuary
Greeneville	023	23	North Main Street	Shetucket River/Thames River Estuary
Greeneville	024	24	8th Street at Route 12	Shetucket River/Thames River Estuary
Eastside	025	25	Roosevelt Avenue at 8th Street	Shetucket River/Thames River Estuary
Laurel Hill	029	29	Talman Street	Thames River Estuary
Laurel Hill	031	31	River Avenue Extension near PS	Thames River Estuary
Laurel Hill	032	32	Near Railroad Tracks off Crown Street	Thames River Estuary
Thamesville	040	40	Shipping Street at Terminal Way	Thames River Estuary

2.2.7 Operational Considerations

2.2.7.1 Pump Stations

There are 45 wastewater pump stations throughout Norwich's service area, many of which are tributary to the combined portion of the system areas in Norwich. The major pump stations within the combined portion of the sewer system are at Cove Street, Rose Alley, River Avenue, Shipping Street, South Thames Street, and Talman Street. **Table 2-3** lists Norwich's pump stations.

All pump stations located within NPU's sewer system tributary area have emergency power connections, and most major pump stations have on-site emergency generators. In the event of a power outage, stations without an on-site emergency generator have wet well capacities ranging from one to three hours, which allows crews adequate time to respond with mobile generators.

One of the major pump stations of concern is the Rose Alley PS. Rose Alley is the largest pump station that handles most flow to the WPCF. During wet weather, attempting to accept combined sewer flows over the design capacity of the WPCF could cause damage to the treatment systems. Additionally, excessive flows from the force mains during these conditions can cause the Yantic Interceptor to back up and potentially overtop manholes or flood basements upstream. NPU employees monitor flow at the WPCF and regulate flows at Rose Alley PS to prevent flooding at the WPCF or surcharge in the Yantic Interceptor. Flow pacing at Rose Alley forces overflow at CSO 017 but prevents problems elsewhere in the system and at the WPCF.

2.2.7.2 Water Pollution Control Facility Wet Weather Capacity

By 1973, a large secondary treatment plant was constructed and commenced full service in 1976. Minor unit process upgrades have occurred since 1976, including biosolids upgrades in 2012. The current WPCF is operating essentially as the plant that was built in 1976.

Currently, the average daily flow at the Norwich WPCF is roughly 5 mgd. The plant is currently permitted for 8.5 mgd under NPDES. The designed peak flow of the facility is 17.0 mgd. Wet weather flows at the plant often reach the design peak capacity. When wet weather flows exceed the sewer system's peak hydraulic capacity, the WPCF influent junction box becomes a constraint on the sewer system. When the facility cannot handle additional flow, the interceptors surcharge and release upstream overflows. To help control overflows and protect the WPCF, NPU paces flows from the Rose Alley PS as described in Section 2.2.7.1.

2.3 Flow Monitoring Program

To facilitate better understanding of flows in the sewer system, several types of information have been compiled. These include temporary flow metering in NPU's interceptors, temporary flow metering on other critical system flows, continuous long–term level monitoring at all the active overflow regulators, and development of a precipitation record as described below.

Prior to CDM Smith's metering program for the revised LTCP, flow was permanently metered at three main locations. These include the influent and effluent flow at the WPCF, and a permanent meter that was installed on the Cipoletti Weir at the Rose Alley CSO.

Table 2-3 List of Pumping Stations

Number	GIS ID #	Pumping Station (PS) Name	Location Description	Owner	In Model?
1	1	Rose Alley PS	Located at the end of Rose Alley	NPU	Yes
2	2	Market St PS	Located near the intersection of Market St & Chelsea Harbor Dr	NPU	Yes
3	3	River Ave PS	Located at the end of River Ave Extension	NPU	Yes
4	4	Shipping St PS	Shipping St at Terminal Way	NPU	Yes
5	5	South Thames St PS	South Thames St near West Thames St intersection	NPU	Yes
6	6	Cove St PS	Located at the end of Cove St across the Yantic River from the WPCF	NPU	Yes
7	7	Talman St PS	Talman St Extension	NPU	Yes
8	8	Salem Turnpike #1 PS	Located near 66 Salem Turnpike	NPU	Yes
9	9	Salem Turnpike #2 PS	Located between Maplewood Court and Salem Turnpike	NPU	Yes
10	10	Marcus Plaza PS	Norman Road at Rose Hill Estates	NPU	No
11	11	Phelps Dodge PS	Located at Wawecus St & the Yantic River	NPU	Yes
12	12	Occum Road PS	Occum Road near Pilling St	NPU	Yes
13	13	Shore Road PS	Located at the end of Shore Road	NPU	Yes
14	14	Washington St PS	Near Washington St & Route 32 Intersection	NPU	No
15	16	Falls Mill PS	Located at the Falls Mills Condominiums	NPU	No
16	17	Falls Ave PS	Located on Holly Hock Island at the WPCF	NPU	No
17	18	Bolduc Lane PS	Located Adjacent to 39 Buldoc Lane	NPU	No
18	19	New London Turnpike #1 PS	Intersection of New London Turnpike and Nordon Ave	NPU	No
19	20	Dodd Stadium PS	Located in the Parking lot of Dodd Stadium	NPU	No
20	21	Great Plain Road PS	Located at the intersection of Great Plain Road & Elk Dr	NPU	No
21	22	Sunnyside St PS	Near the Sunnyside and Sunnyside East Streets intersection	NPU	No
22	23	Old Salem Road	Located at Old Salem Road and Gifford St Intersection	NPU	Yes
23	24	Salem Turnpike #3 PS	Salem Turnpike near intersection with Arrowhead Dr	NPU	Yes
24	25	Edgewood Dr PS	Located at the end of Edgewood Dr	NPU	No
25	26	Mallon Chevrolet PS	Located at 774 West Thames St	NPU	No
26	27	Dunham St PS	Located across from 222 Dunham St	NPU	No
27	28	Uncas Condominiums PS	Located at the Uncas Condominiums off of West Thames St	NPU	No
28	29	Parkwood Condominium PS	Located at the Condominiums on Parkwood Dr	NPU	No
29	30	Victoria Landing PS	Located at the Victoria Landing condominium complex, 296 Hamilton Ave	NPU	No
30	31	Yantic Landing Condominiums PS	Located at the Yantic Landing Condominiums, 86 Otrobando Ave	NPU	No
31	32	Forestview Dr PS	Located on Forestview Dr in the Forest View Estates development	NPU	No
32	46	New London Turnpike #2 PS	Grounds of Norwich Regional Technical Vocational High School	NPU	No
33	47	Potter Place PS	Located at the end of Potter Place	Private	No
34	n/a	Lambert Dr PS	Located near 78 Lambert Dr	NPU	No
35	n/a	Court House Square PS	Behind 34 Court House Square on the bank of the Thames	NPU	No
36	n/a	Newton St Sewer Extension PS	Located at the end of Ash St	NPU	No
37	n/a	Uncas Condominiums #2 PS	Located at the intersection of West Thames St and Uncas Condominiums	Private	No
38	n/a	Stonington Estates PS	Located at the Stonington Estates Apartments	Private	No
39	n/a	Old State Hospital Site PS	Located at the old state hospital site on Laurel Hill Road	Town of Preston - NPU Maintained	No
40	n/a	Comfort Suites PS	Located at the Comfort Suites on Otrobando Ave	Private	No
41	n/a	City Hall PS	Located at Norwich City Hall	City of Norwich - NPU Maintained	No
42	n/a	Summit Wood Apartment PS	Located at Summitwood Apartment Complex	Private	No
43	n/a	DOT PS	Located at the DOT Site off of Laura Boulevard	State of CT	No
44	n/a	New Concord Dr PS	Located on New Concord Dr in the New Concord Green Development	NPU	No
45	n/a	Old Pond Lane PS	Located in the Private Development on Old Pond Road	Private	No
46	n/a	Water Pollution Control	WPCF	NPU	No

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2.3.1 Flow Metering

CDM Smith developed short-term and long-term flow metering programs to help define baseline conditions and inform alternatives development for the revised LTCP. The metering program was developed through review of Norwich's GIS, the existing sewer model developed for the 2012 LTCP, and best available system schematics and drawings. NPU staff assisted with the program through their knowledge of the collection system and how best to access the system.

Twenty-five temporary flow meters were deployed in the 2017 short-term metering program, conducted as part of this study. Meters were installed in key interceptors and upstream of the WPCF, as shown schematically in **Figure 2-3**, and on a map in **Figure 2-5** (both at the end of Section 2). Locations were selected based on pipe size, connectivity with other areas of the system, availability of historical flow data, local coverage from other sources, accessibility, likelihood of reliable meter installation, number of regulators associated, cost, and expected importance to model accuracy. Information recorded during the metering program was used to update and calibrate the collection system model.

Subcontractors installed 25 temporary meters between April 10th and April 21st, and monitored them on a regular basis until the completion of the metering program. The primary intent of these initial installations was to collect data for sewer model calibration. CDM Smith planned for this program to extend for up to twelve weeks from the time that the meter network was operational. However, it was understood that the program may need to extend longer if there were not sufficient rain events. Conversely, the program could be terminated early if sufficient rain occurred early in the program. A wet spring allowed completion of the temporary metering program on May 26, 2017.

Following the completion of the short-term meter installation, a long-term metering program with 16 meters has been implemented to gather data on overflow frequency and duration for the CSO Long Term Control Plan. A schematic of the long-term meter installations can be seen in **Figure 2-4**, and meter locations are show on a map in **Figure 2-6**. The figures are located at the end of Section 2.

NPU collected data from the long-term level sensors installed in the active CSO regulators throughout Norwich (overflow alarm and monitoring system). These long-term meters will be installed for approximately ten months. After the 10-month period, NPU plans to keep flow meters installed in the CSO regulators for permanent CSO Metering.

There are 14 active combined sewer outfall pipes within NPU's combined sewer collection system. CDM Smith has implemented a program where these 14 overflows are monitored at the 16 CSO regulators. Specific installation locations, and other information on the short and long-term metering programs can be seen in more detail in the memoranda attached as Appendices A and B.

The long-term level sensors installed in each CSO regulator structure currently relay information in real time to a subcontractor's website, where CDM Smith and NPU can view the information on CSO overflows. A system of live updates is also currently in effect, where CDM Smith and NPU staff are alerted if an overflow event takes place. This includes a text message and email alert when an overflow event begins to occur at a regulator and when the overflow stops at each regulator structure.

2.3.2 Permanent CSO Monitoring

Following the conclusion of the 10-month long term metering program NPU plans to establish a permanent CSO metering program. This more permanent CSO metering installation is planned to be bid in the Spring of 2018. It is anticipated that this permanent program will be put in place for one to three years before it is reevaluated. It is expected that this program will also include live updates and overflow alerting.

2.3.3 Precipitation Record

Three rain gauges were installed on South Golden Street at the NPU Headquarters, at the WPCF, and at the Forestview Drive PS at the start of the spring monitoring program. The locations are shown in Attachment B to Appendix A. **Figure 2-7** plots cumulative precipitation at the project rain gages, as well as NPU's long-term daily gauge which is reported to the National Weather Service (see discussion in Section 4). The figure shows that the three project gages tracked within an inch of one another throughout the year, while the NWS gage trailed the others by about an inch beginning in July.

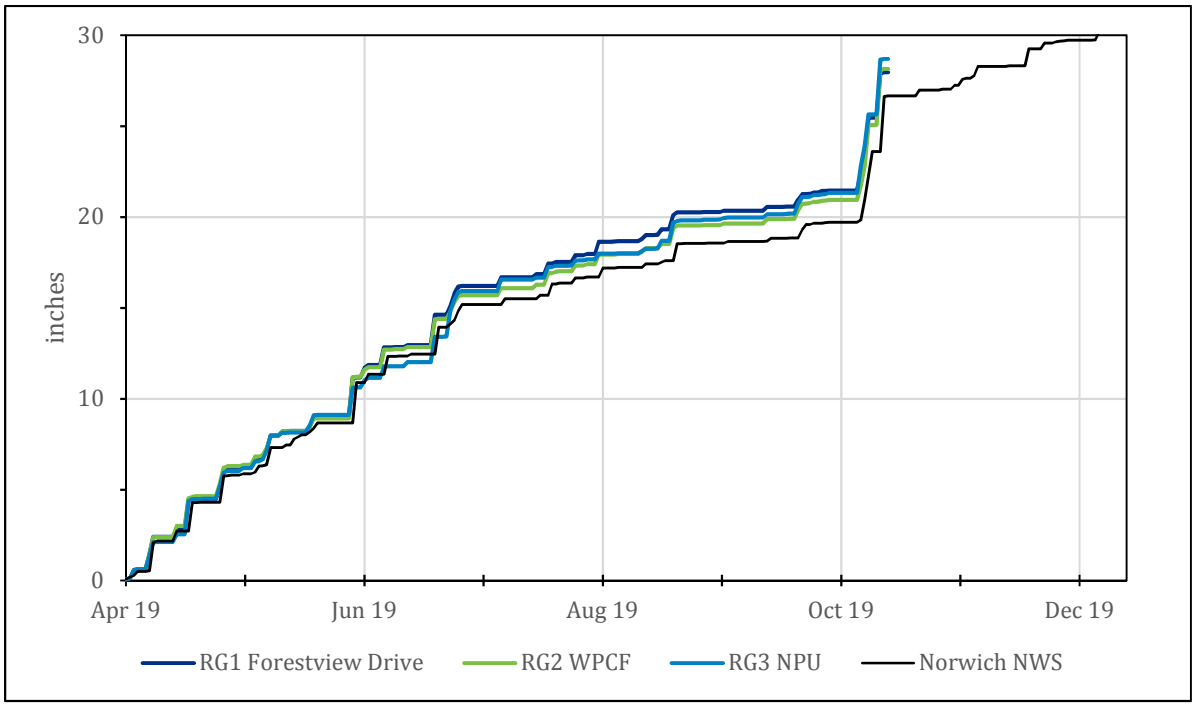


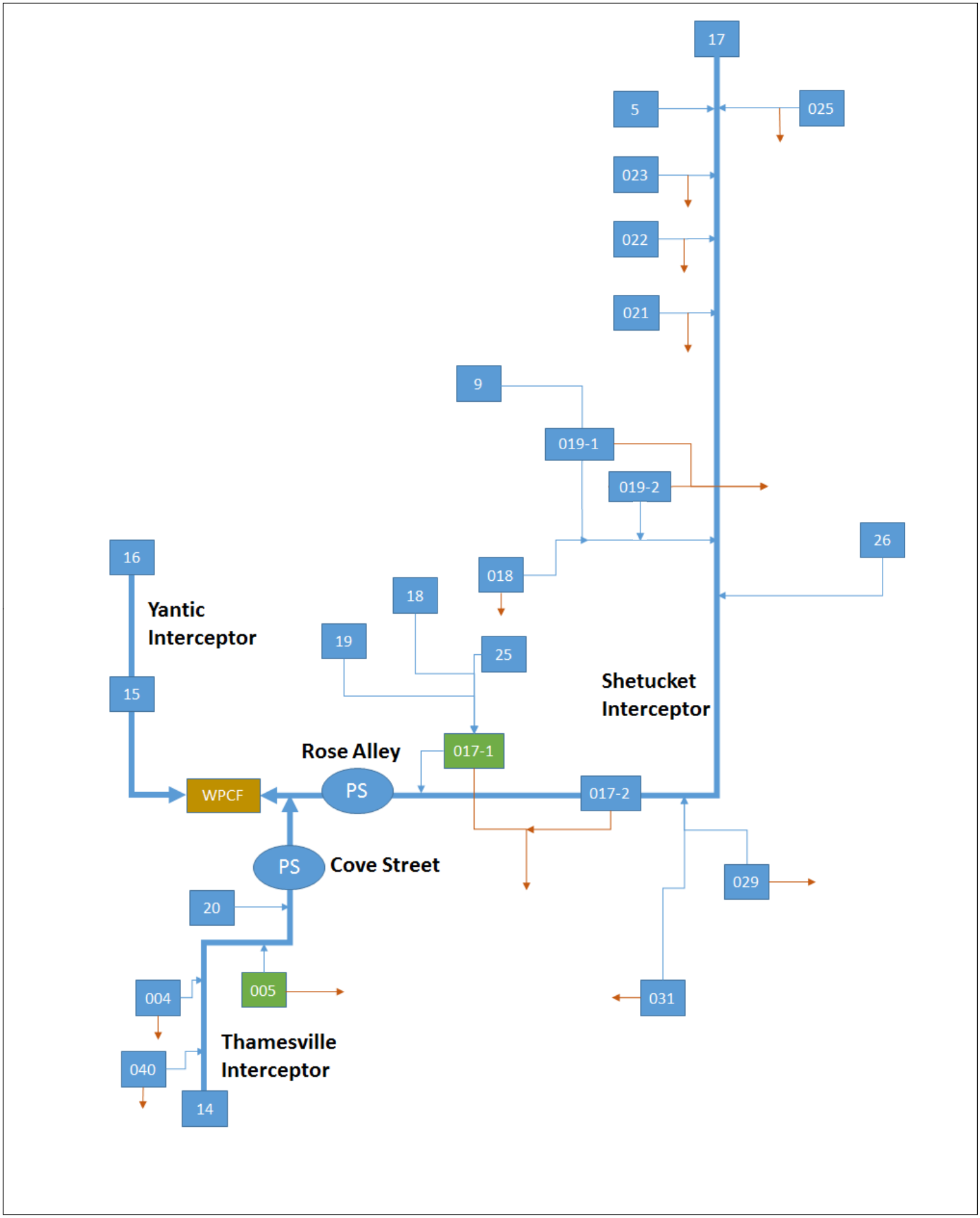
Figure 2-7: Cumulative Precipitation at Project Rain Gages

Table 2-4 lists 24-hour precipitation at the project gages for dates when any of the gages recorded at least 0.75 inches of rain. The table is color-coded according to the average recurrence interval of the 24-hour rainfall. Four storms exceeded a 3-month recurrence: The May 5 storm was a 3-month event at RG3, the June 16 event was a 3-month event at RG1 and RG2, the October 25 storm was a 6-month event at RG1 and RG2, and the October 29 storm was a 2-year event at RG2 and RG3. Additional discussion of the October events is presented in Section 3.

Table 2-4: Largest 24-Hour Rainfall Events April to December 2017

Date	24-hour depth (inches)		
	RG1	RG2	RG3
April 25	1.72	1.72	1.38
May 5	1.62	1.61	1.92
May 13	1.55	1.56	1.45
May 25	1.26	1.07	1.27
June 5	0.65	0.62	0.88
June 16	2.21	2.29	1.51
June 24	0.97	0.98	0.63
July 7	1.67	1.54	1.38
July 10	0	0	1.43
July 12	1.06	0.84	1.04
September 6	0.92	1.02	1.10
October 25	2.67	2.81	2.33
October 29	2.45	3.04	3.04
1-month	1.08		
3-month	1.89		
6-month	2.39		
1-year	2.90		

More information on precipitation data and design storm selection is presented in Section 4.



Legend

- Sewer
- CSO
- Depth-only meter
- Area-velocity meter
- WPCF — Water Pollution Control Facility
- PS — Pump Station

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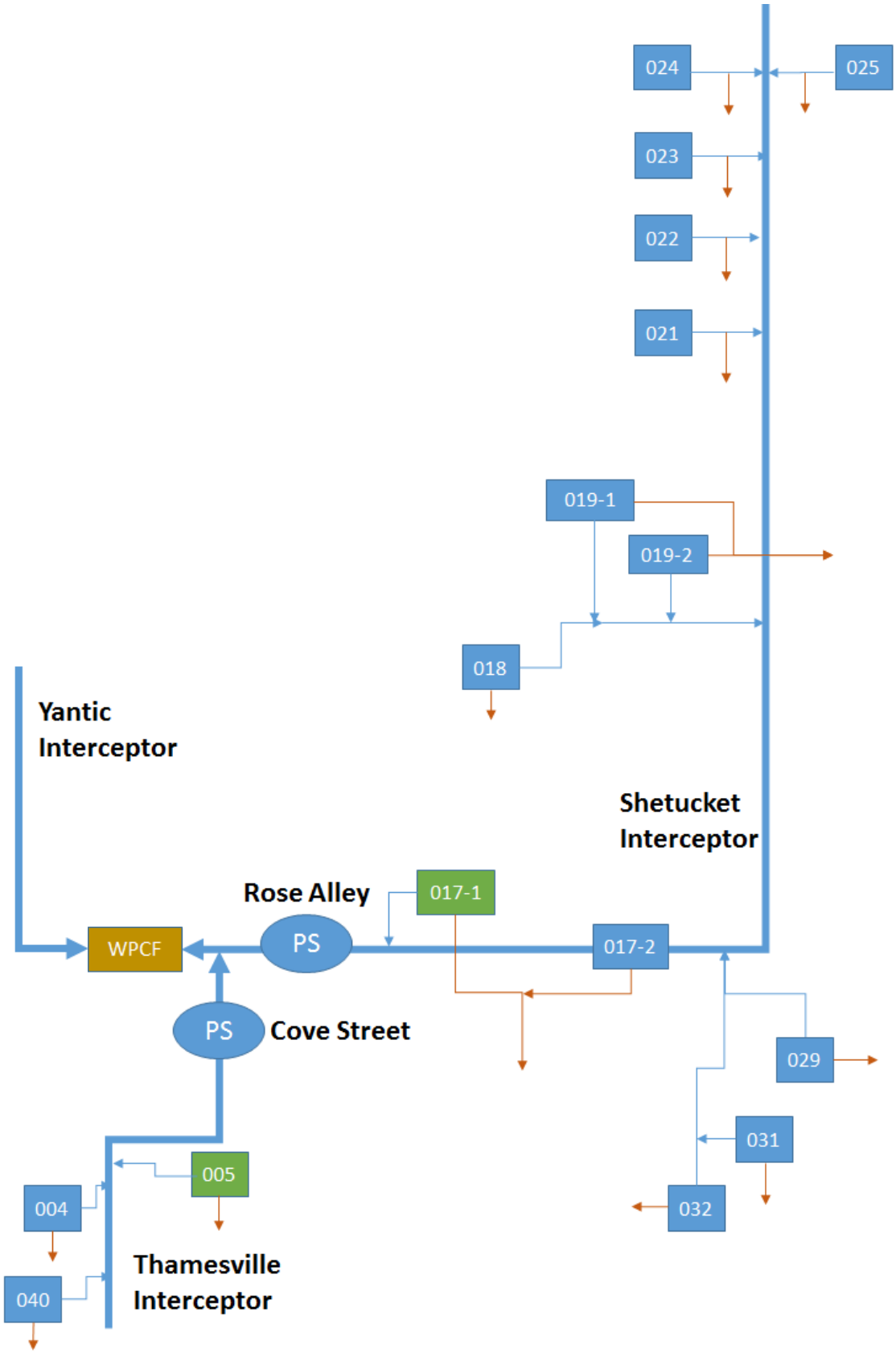
Figure 2-3
Schematic of Interceptors and Short-Term Meter Connectivity



Legend

- Sewer
- CSO
- Depth-only meter
- Area-velocity meter
- WPCF — Water Pollution Control Facility
- PS — Pump Station

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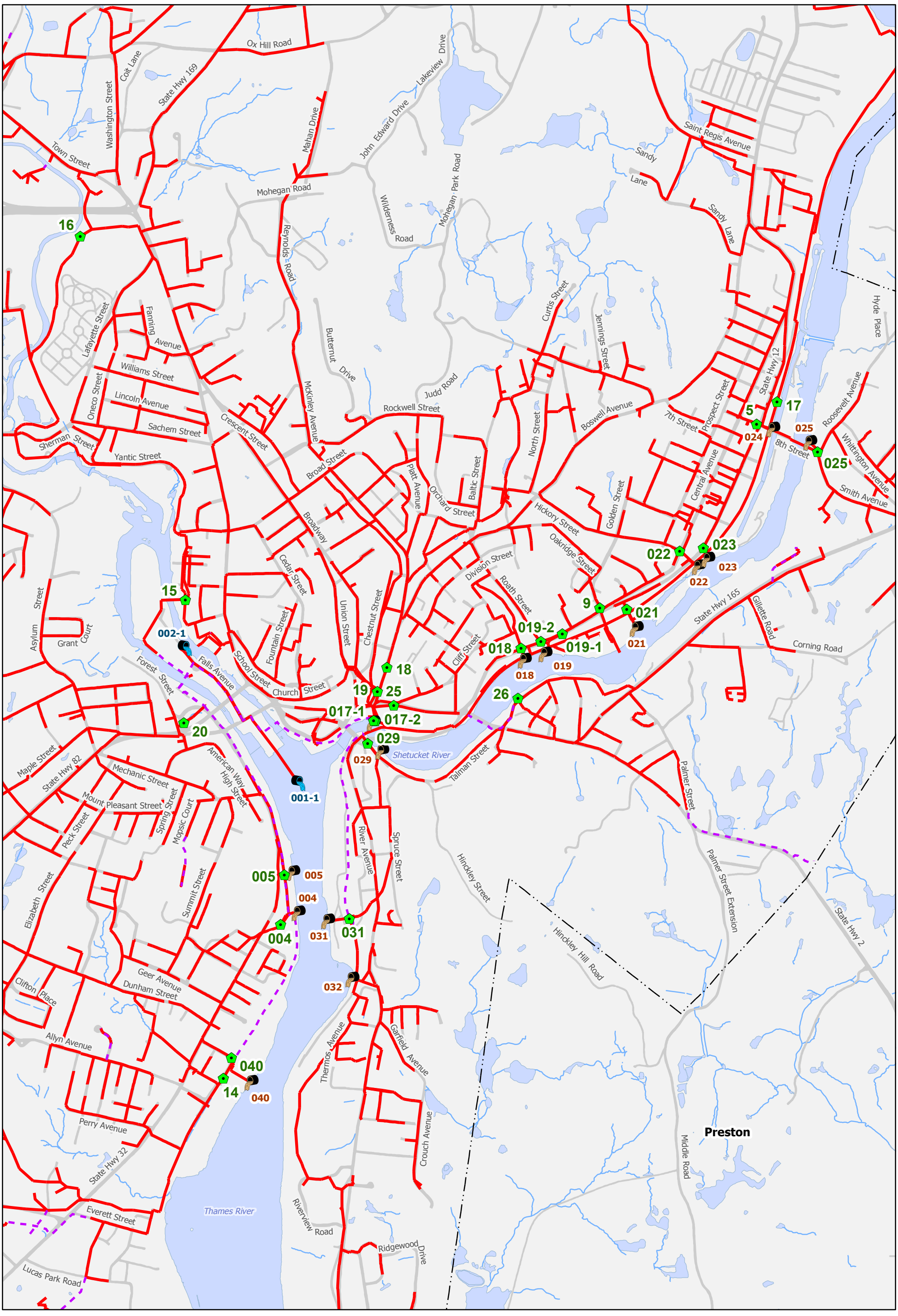
Figure 2-4
Schematic of Interceptors and Long-Term Meter Connectivity



Legend

CSO Outfall

WPCF Outfall

Sewer

Force Main

Scale

N

Feet

0 625 1,250

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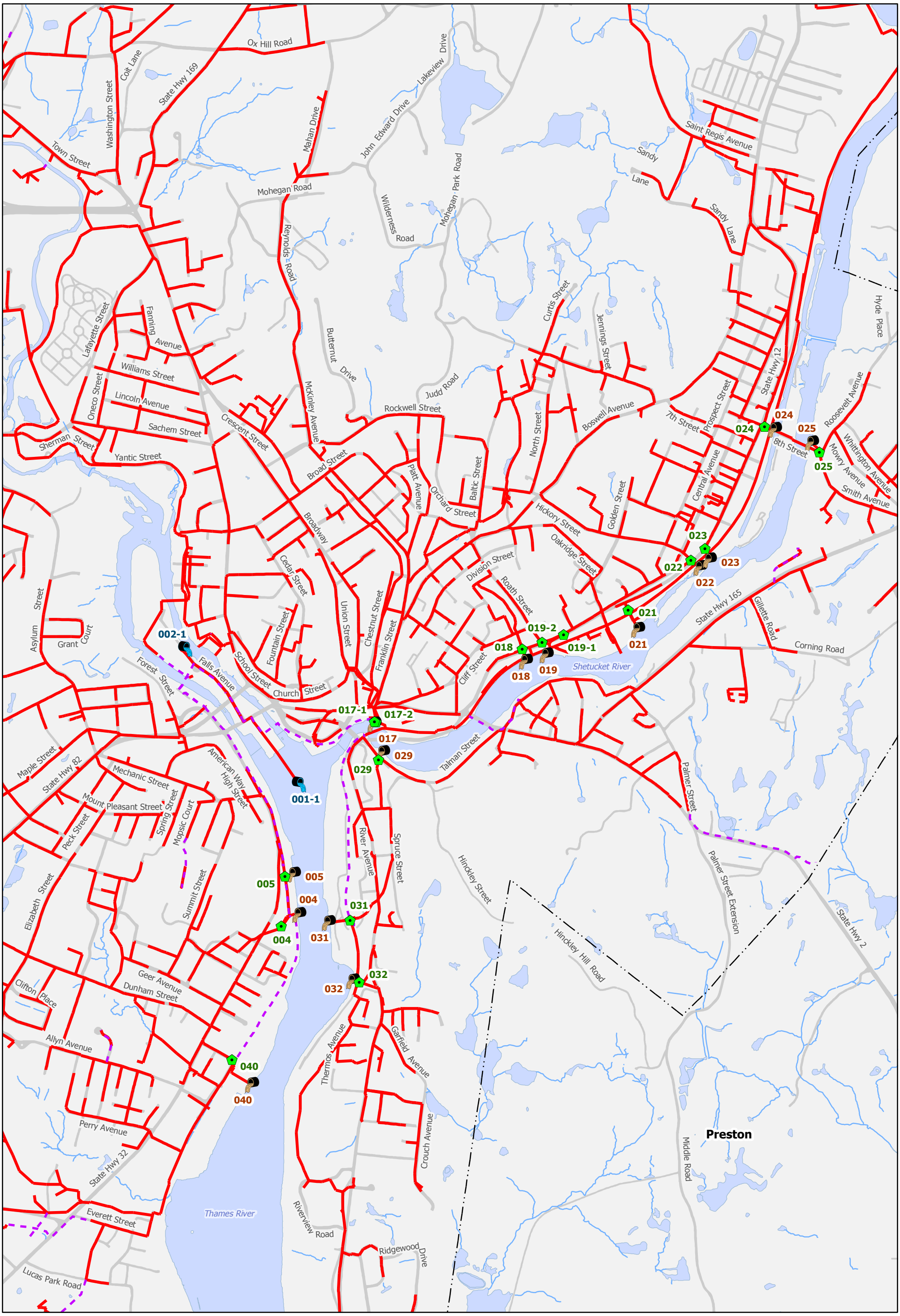
Figure 2-5
Short Term Meter Map



Legend

- Meter
- CSO Outfall
- WPCF Outfall
- Sewer
- Force Main

Scale

N

Feet

0 625 1,250

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Figure 2-6
Long Term Meter Map

Section 3

Sewer System Model

3.1 Previous Work

The Long-Term Control Plan (LTCP) developed for Norwich Public Utilities (NPU) and submitted to Connecticut Department of Environmental Protection (CT DEEP) in 2012 used a model of the Norwich wastewater collection system developed using Innovyze Software's InfoWorks. The model incorporated 1,700 pipes and 1,700 subcatchments. Asset characteristics were primarily obtained from geographic information system (GIS) mapping, including most pipes with diameters of 10 inches or greater. The model also included pump curves for 11 pump stations including operations at Rose Alley pump station. Subcatchments were not spatially represented; rather, contributing areas were assigned to each modeled manhole without corresponding polygons identifying contributing areas. Flow meters were deployed at 21 sites for three months in spring 2008 to support model calibration. Modeled flow was calibrated to a single storm. Calibration plots presented in the 2012 LTCP report show limited correspondence between observed and simulated flows at 13 sites; no effort was made to calibrate hydraulic grade lines.

3.2 Methodology

For the present study, the model was updated and improved to develop baseline conditions for the existing system. The updated model incorporates additional survey data and field checks at key locations, revised hydrology, revised dry weather flow estimates, and represents the receiving rivers. A comprehensive metering program was conducted in April and May 2017. A CSO metering program began in June 2017 (see Section 2.3). The metering programs provide rainfall and flow data to inform model calibration over an extended period. The calibrated model is used to simulate design flow conditions and will aid development and evaluation of alternatives to meet the goals of the revised LTCP.

3.3 Vertical Datum

NPU has historically used two elevation datums. The National Geodetic Vertical Datum of 1929 (NGVD 29) and the North American Vertical Datum of 1988 (NAVD 88) are used by surveyors and engineers for relating ground elevations. NGVD 29 was used for most of the twentieth century, but in recent years has been superseded by NAVD 88. Various NPU documents have been produced using both datums. Sewer separation planning drawings from the 1970s as well as Water Pollution Control Facility (WPCF) upgrades in 2015 were designed in NGVD 29. NPU's sewer GIS was produced using NAVD 88. The hydraulic model of NPU's system for this project was also developed in NAVD 88. In Norwich, NAVD 88 is 0.96 feet above NGVD 29 (i.e. elevations at the same location specified in NAVD 88 are smaller than those specified in NGVD 29). NAVD 88 will be used for the collection system model, alternatives development, and the current Eastside sewer separation design.

3.4 Model Update

Data from a variety of sources was incorporated to refine the model configuration and extend the calibration period, with a focus on high priority areas of the system. Hydraulics were updated to include:

- New survey at all regulators detailing weir elevations, weir dimensions, pipe sizes, and pipe inverts.
- New survey at key points detailing information on flow splits, sediment depths, pipe sizes, and critical interceptors.
- Observations during meter installation including photographs and sketches of regulators detailing pipe sizes, meter orientation, and sediment depths.
- As-builts of Rose Alley Pumping Station (PS) and set points for station operations. NPU manually throttles flow from the pump station during extreme wet weather events as needed to maximize flow to the WPCF while not exceeding plant hydraulic capacity. When the storm is over and flows trend down, the pumps are returned to automatic control. These operations were approximated in the model.
- 1979 design plans for the sewer system by CE Maguire, Inc. The planned designs were never constructed, but information on the existing system in the plans was used to validate pipe sizes where there were discrepancies between data sources (survey meter sketches, and GIS pipes).

Hydrology was updated to include:

- Refined subcatchment area delineations considering topography, sewer connectivity, and city parcels.
- Refined slopes for each subcatchment calculated using a digital elevation model. Slope was calculated as the contour interval times the total length of contours divided by the drainage area (Maidment, 1993).
- Updated soil properties for each subcatchment area.
- Refined estimates of percentages of impervious and pervious area for each subcatchment based on the 2011 National Land Cover Database.
- Drainage sketches from NPU, identifying areas as combined or separated.
- Partitioning of dry weather flow into sanitary and infiltration components.
- Wastewater from the neighboring communities of Franklin (1,100 gallons per day (gpd)) and Sprague (15,500 gpd) and from NPU's Stony Brook water treatment plant (60,000 gpd).

- Representation of the receiving rivers to simulate tail water influence on the system (see below).

The receiving rivers are represented in the collection system model to simulate tail water influence on the system. The rivers are modeled with flow hydrographs at the model's upstream limits and bounded downstream by observed tides at New London (National Ocean Service site 8461490). The model uses flow data for the Shetucket (USGS 011236095), Quinebaug (USGS 01127000), and Yantic (USGS 01127500) rivers. Channel geometry was estimated from USGS topography and NOAA nautical charts. Flap gates were included on all outlets to the river. Weir elevations of all 16 regulator structures are above typical river stages. CSO 040 is likely affected by high tide approximately once per month, and CSOs 017, 018, and 019 may be affected by river stage a few times per year (**Table 3-1**).

Table 3-1 River Boundary Impacts on Regulators

CSO Regulator	Weir Crest (ft NAVD88)	Tidal Impact
004	47.1	No
005	8.8	No
017-2	6.5	High river
017-1	4.7	High river
018	14.9	High river
019-1	15.6	High river
019-2	17.4	Extreme conditions
021	20.6	Extreme conditions
022	35.1	No
023	28.4	No
024	41.3	No
024	31.0	No
025	34.4	No
029	34.8	No
032	8.2	No
040	2.8	High spring tide

During the short-term metering period, 25 meters were installed to monitor flow in key locations throughout the system and upstream of regulators. These 25 meters were used to calibrate the model and ensure that modeled flows matched observed flows entering regulators. At the end of May, the meters upstream of regulators were relocated downstream to monitor the wet weather overflow pipes and the other meters were removed. Data from the remaining 16 meters was collected beginning June 2017. Data from this long-term metering program was used to calibrate CSO volume, frequency, and duration. Rain gauges were also installed at three locations in Norwich throughout the metering periods.

The updated model includes 1,700 conduits and 1,900 subcatchments. The pipe network is shown in **Figure 3-1**, along with meter locations. Meters are labeled in green; meters with a leading zero in the name are installed on regulators; meters without a leading zero are the spring 2017 sites.

The subcatchments comprise 580 acres of combined sewer area and 5,200 acres of separated sewer area. Combined areas include parts of Greeneville, Downtown, Eastside, northern Thamesville, and northern Laurel Hill (**Figure 3-2**). The 14 CSO outfalls and flows from outside the city are also shown.

Shetucket Interceptor

Yantic Interceptor

Salem Tpke Interceptor

Laurel Hill Interceptor

Thamesville Interceptor

Rose Alley PS

WPCF

16 15 20 18 19 25 017-1 017-2 029 005 004 031 032 040 14 17 024 5 025 023 022 021 9 019-2 018 019-1 26

1 inch = 3,000 feet

0 1,500 3,000 Feet

N

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Legend

- Meter
- Pump Stations (Norwich Public Utilities)
- Water Pollution Control Facility
- Subcatchment

Model Pipe

- 4" - 12"
- 13" - 24"
- 25" - 36"
- 37" - 84"
- River

Baseline Conditions Report
Norwich Public Utilities
Figure 3-1
Model Pipe Network
Combined Sewer System

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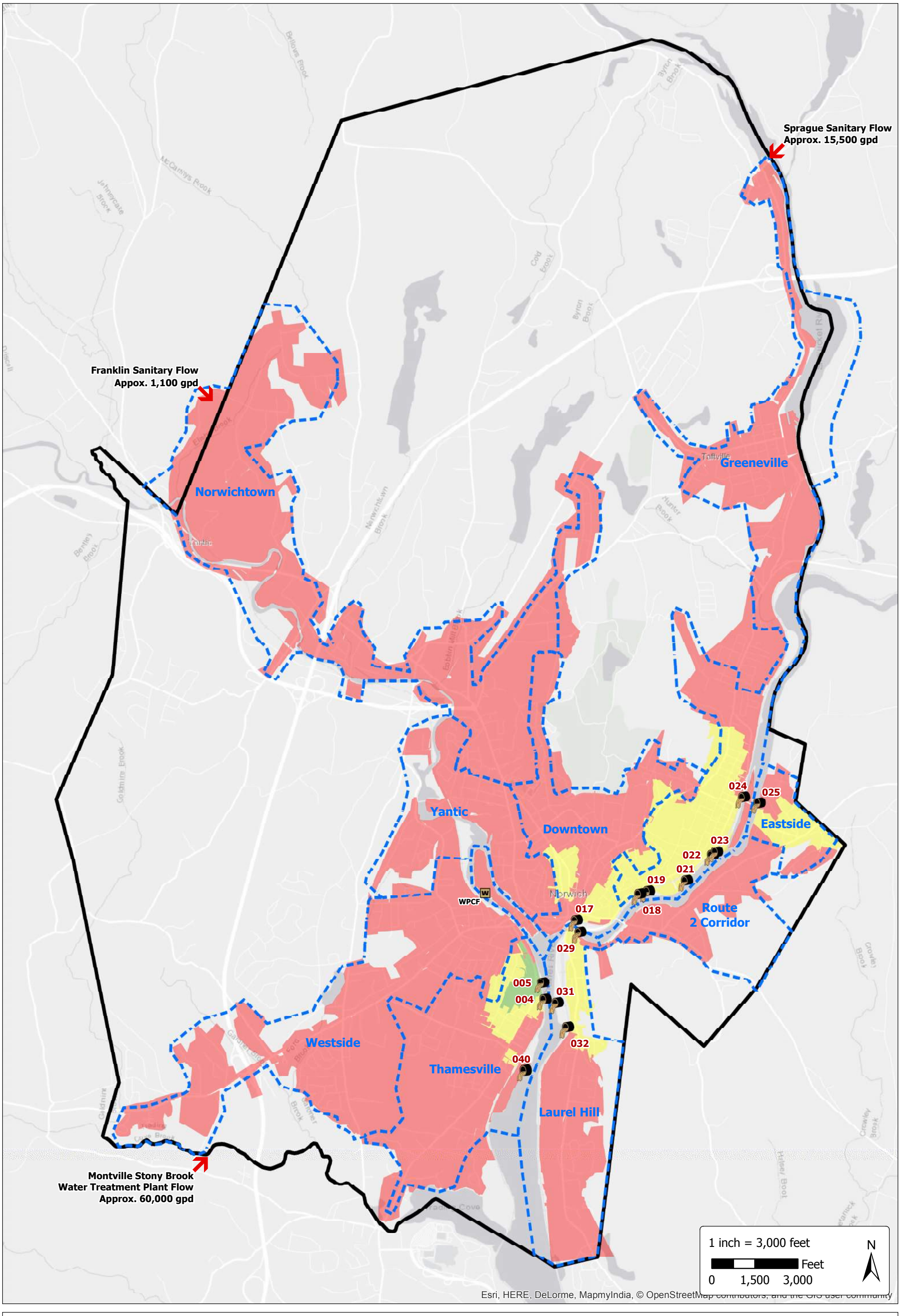

CDM Smith

Legend

- CSO Outfall
- Water Pollution Control Facility
- Sewershed Boundary

Subcatchment

- Sanitary
- Combined
- Non-Contributing

Baseline Conditions Report
Norwich Public Utilities
Figure 3-2
Model Subcatchments
Combined Sewer System

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3.5 Calibration Methodology

The updated sewer model was calibrated to data collected during the 2017 metering programs. This section refers to two calibration periods: the spring calibration period for the meters installed April to May and the CSO calibration period for the meters installed in June. The model was calibrated following best practices, building on those identified in the CIWEM (UK Chartered Institution of Water and Environmental Management; formerly WaPUG) 2017 Code of Practice for the Hydraulic Modelling of Urban Drainage Systems. It has been calibrated to accurately represent depth, velocity, and discharge during dry weather and principal storms in the spring calibration period. CSO volume was calibrated during the CSO calibration period.

3.5.1 Dry Weather

Dry weather flow includes diurnally varied sanitary flow along with infiltration from groundwater. Modeled sanitary flows were allocated according to flow metering data and New London County's 2010 census block population data. Population density was calculated by allocating the population for a census block among the buildings within that block and dividing the population by building area. Population for each sewershed was calculated using this derived population density.

Sanitary flows for each sewershed were defined by flow per capita. These factors ranged from 60 to 130 gallons per capita per day (gpcd) throughout the city, with typical rates between 70 and 90 gpcd. The total system serves a population of 31,800 people and, with an average modeled per capita rate of 85 gpcd, has a modeled total sanitary flow of 2.7 mgd. Sanitary flows from each subcatchment were scaled according to hour-of-day factors estimated from the metering data.

Average dry weather groundwater infiltration rates for each meter area were approximated by subtracting sanitary flow from total flow during dry weather observed during the spring calibration period. Initial dry weather flow estimates were adjusted to match measured discharge data at the spring 2017 meter locations. Systemwide groundwater infiltration calibrated for May 2017 was 3.9 mgd.

A year-round monthly groundwater infiltration pattern was developed based on flow recorded at the WPCF. To coincide with the metering period to which the model was calibrated, the groundwater infiltration pattern was developed based on 2017 WPCF inflow. Daily average flows to the WPCF were filtered to eliminate inflow, and average sanitary flow was subtracted from daily flow to yield average daily groundwater infiltration. From the daily averages, monthly average groundwater infiltration rates were calculated for 2017. A monthly pattern was developed and scaled to maintain the 3.9 mgd groundwater infiltration rate calibrated for May.

The model is later used to analyze flows under design storm conditions and a representative period. For these simulations a typical groundwater infiltration pattern was developed based on WPCF inflow from 2014 to 2016. Monthly dry weather groundwater infiltration for 2017 conditions and 2014-2016 average conditions are summarized in **Table 3-2**.

Table 3-2 Simulated Groundwater Infiltration

Month	2017 Groundwater Infiltration (mgd)	Average 2014-2016 Groundwater Infiltration (mgd)
January	2.30	1.41
February	2.90	1.25
March	2.65	1.54
April	3.09	2.24
May	3.88	1.84
June	2.56	0.90
July	1.31	0.42
August	0.70	0.11
September	0.00	0.00
October	0.86	0.09
November	2.28	0.21
December	1.14	0.74
Average	**1.97**	**0.89**

To calibrate depth and velocity during dry weather, Manning's N for conduits was initially set to 0.014 and adjusted between 0.012 and 0.017. Higher calibrated Manning's coefficients may be due to combined effects of pipe age, unknown obstructions, and sediment accumulation. Sediment was explicitly added to pipes to improve depth and velocity calibration where sediment accumulation seemed likely based on metering data and pipe configuration. Form loss coefficients were applied at some conduits to account for head losses due to pipe bends and other obstructions.

3.5.2 Wet Weather

The model accounts for wet weather flow contributions to the sewer system, including drainage from combined areas and infiltration and inflow (I/I) from separated and combined areas. Model hydrology was calibrated using the metering data from the spring 2017 meters that were installed throughout the system and upstream of CSO regulators. Calibrating total upstream flow ensures that the proper quantity of inflow reaches each regulator. Calibration focused on four principal storms in this period. Hydraulics were then calibrated to match observed depths and velocities. Once the spring 2017 meters were calibrated, the model was run from June to October 2017 to validate CSO volume against the CSO metering data. Minor adjustments were made at some CSOs to improve calibration.

Hydrology calibration to match observed flows involved:

- Adjusting effective imperviousness of each subcatchment to calibrate hydrograph volume. A percentage of the impervious area is routed to the pervious area for each subcatchment, simulating natural processes such as roof runoff flowing from gutters to lawns.
- Adjusting the width factor of each subcatchment to calibrate hydrograph shape.

The hydraulics of the model were calibrated to match observed depth and velocity. Hydraulic calibration involved adjustment of pipe slopes, additional adjustment of Manning's N, and the addition of sediment where accumulation seemed likely based on metering data and pipe

configuration. While pipe slopes are typically not a calibration parameter, for this project, many pipe inverts were carried over from the prior work and not verified by survey. Since the validity of these inverts was unknown, some were adjusted to improve meter calibration.

3.6 Calibration Results

The model was calibrated by comparing simulated and observed flow, depth, and velocity for select storm events and for the full spring survey period. Hydrographs from the entire spring survey period were also examined to identify any poor event predictions. The model was validated by comparing simulated and observed CSO volumes and WPCF inflow over a long-term simulation.

3.6.1 Dry Weather

Figure 3-3 shows an example of dry weather calibration at meter 15, which measures a separated area (shown in **Figure 3-2**) on the Yantic interceptor. The blue lines represent modeled flow, depth, and velocity and the red lines indicate observed meter flow, depth, and velocity. The good match for flow, depth, and velocity at this meter shows the hydrology and hydraulics are well calibrated for the area upstream of meter 15, which also includes the area tributary to meter 16. **Figure 3-4** shows a good dry weather flow calibration entering the CSO 017-2 regulator on the Shetucket interceptor. This meter is immediately upstream of Rose Alley PS and has a large tributary area. The figure illustrates that the model fits observed data well at this meter location, indicating good dry weather flow calibration for the entire Shetucket Interceptor. Primary emphasis was placed on matching dry weather flow; depth and velocity calibration is emphasized during wet weather calibration since the Manning's N at the bottom of the pipe may not be representative of full flow during wet weather conditions.

Dry weather calibration plots for all meters deployed in spring 2017 are included in Appendix C. Overall, good dry weather calibration was achieved.

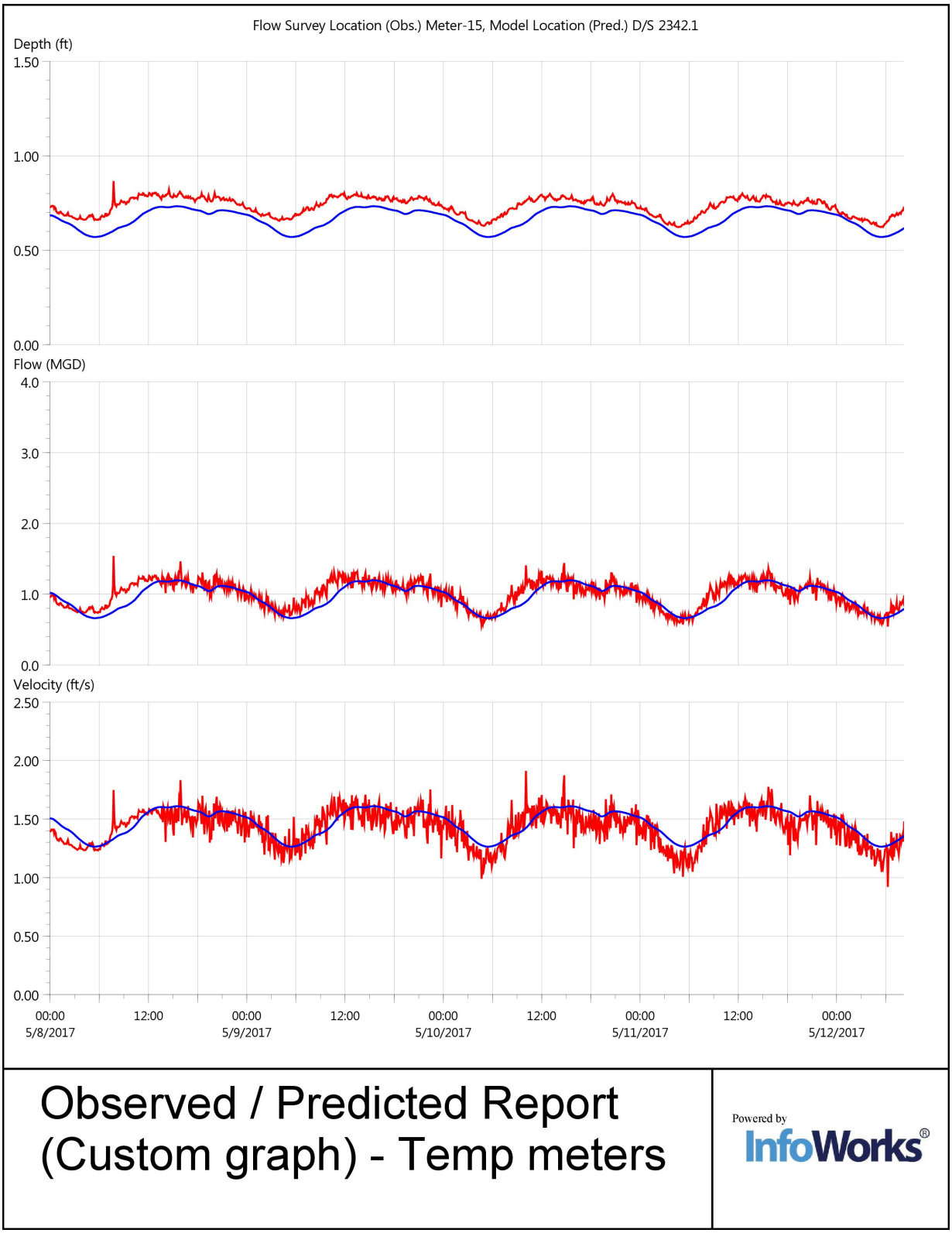


Figure 3-3 Dry Weather Flow Calibration at Meter 15 (Sturtevant Avenue Right of Way)

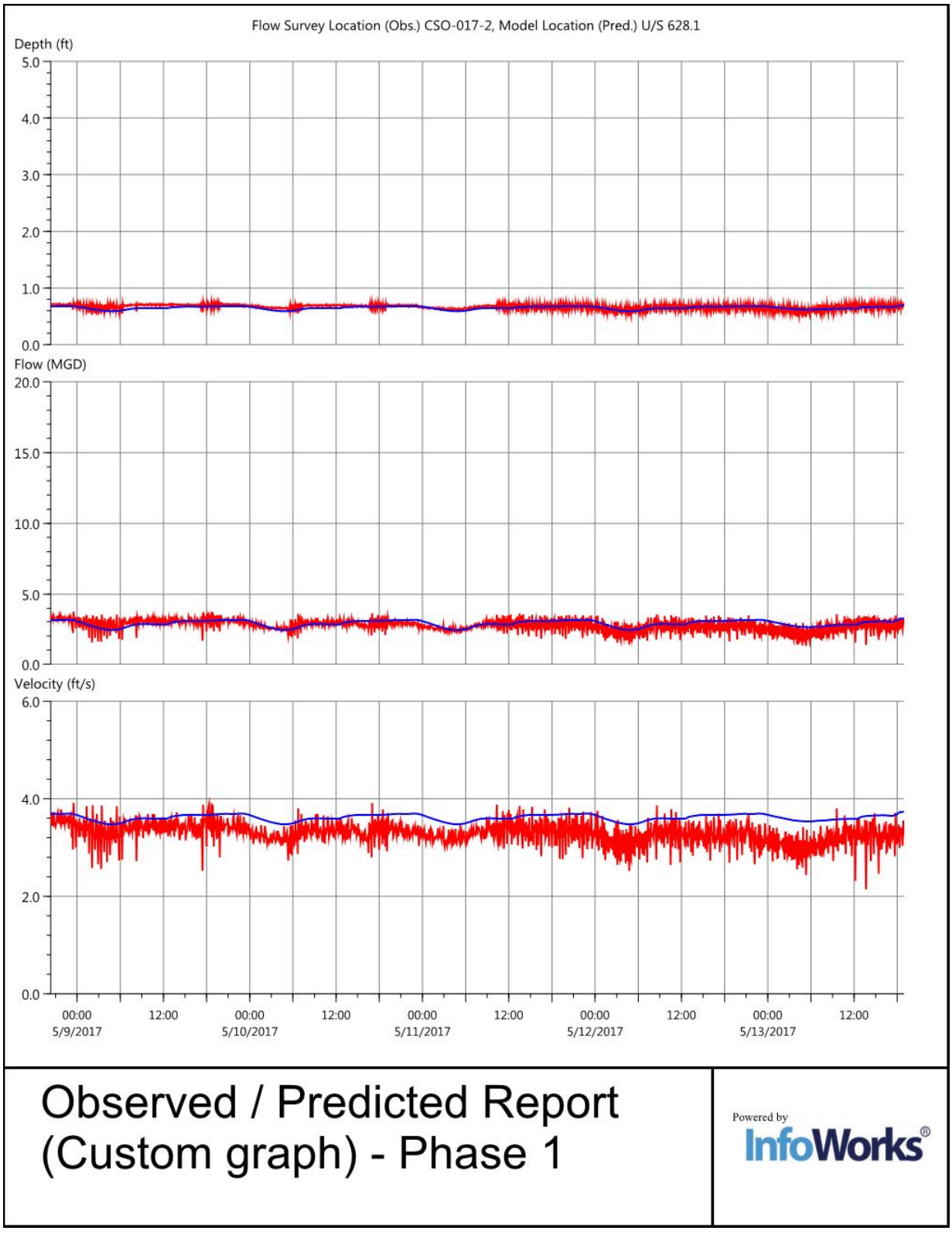


Figure 3-4 Dry Weather Flow Calibration Entering the 017-2 Regulator on the Shetucket Interceptor

3.6.2 Principal Storms Spring 2017

Four principal storms occurring on April 25, May 5, May 13, and May 25, 2017 were selected for detailed wet weather calibration. Statistics for these events are provided in **Table 3-3**. Storm depths at the other project rain gages are presented in Section 2.

Table 3-3 Principal Storms Characteristics

Date	RG1 at WPCF	
	Characteristic ARI	Inches
April 25	3-month 24-hour	1.72
May 5	6-month 6-hour	1.56
May 13	3-month 12-hour	1.52
May 25	1-month 24-hour	1.26

To assess calibration, CIWEM (2017) recommends that peak flows be within +25% to -15% of observed flows, peak depths be within ±4 inches or ±10% (whichever is greater) of observed depths, and flow volumes be within +20% to -10% of observed volumes.

At most locations, the largest flows occurred in response to the May 5th storm. The meter upstream of the regulator 017-2 on the Shetucket Interceptor had the largest flow volume during this storm. **Figure 3-5** shows simulated and observed flow, depth, and velocity for this location for the May 5. The model shows good calibration with respect to CIWEM criteria; total simulated storm volume is within 20% of observed volume and simulated peak flow is within 25% of observed peak flow. The discrepancies in depth and velocity are likely due to the differences in modeled and actual operations at Rose Alley PS. The model controls the pump in real time based on design storm conditions, while in practice NPU modifies the pump speeds manually to maximize flow to the WPCF while not exceeding plant capacity. Simulated and observed flows for the full spring calibration period are shown in **Figure 3-6**. **Figure 3-7** summarizes the spring calibration period results with scatter plots of peak flow, peak depth, and flow volume for all storms in the spring calibration period at this location. The black line shows a 1:1 ratio of observed and simulated values and the blue lines show the acceptable boundaries based on best practices and CIWEM criteria. The scatter plots demonstrate good calibration for volume and peak flow and discrepancies in depth, due to the reasons discussed above.

Wet weather calibration plots for all the spring 2017 meters are included in Appendix D. Scatter plots of observed and modeled peak flow, peak depth, and flow volume for all spring calibration events for each meter location are shown in Appendix E.

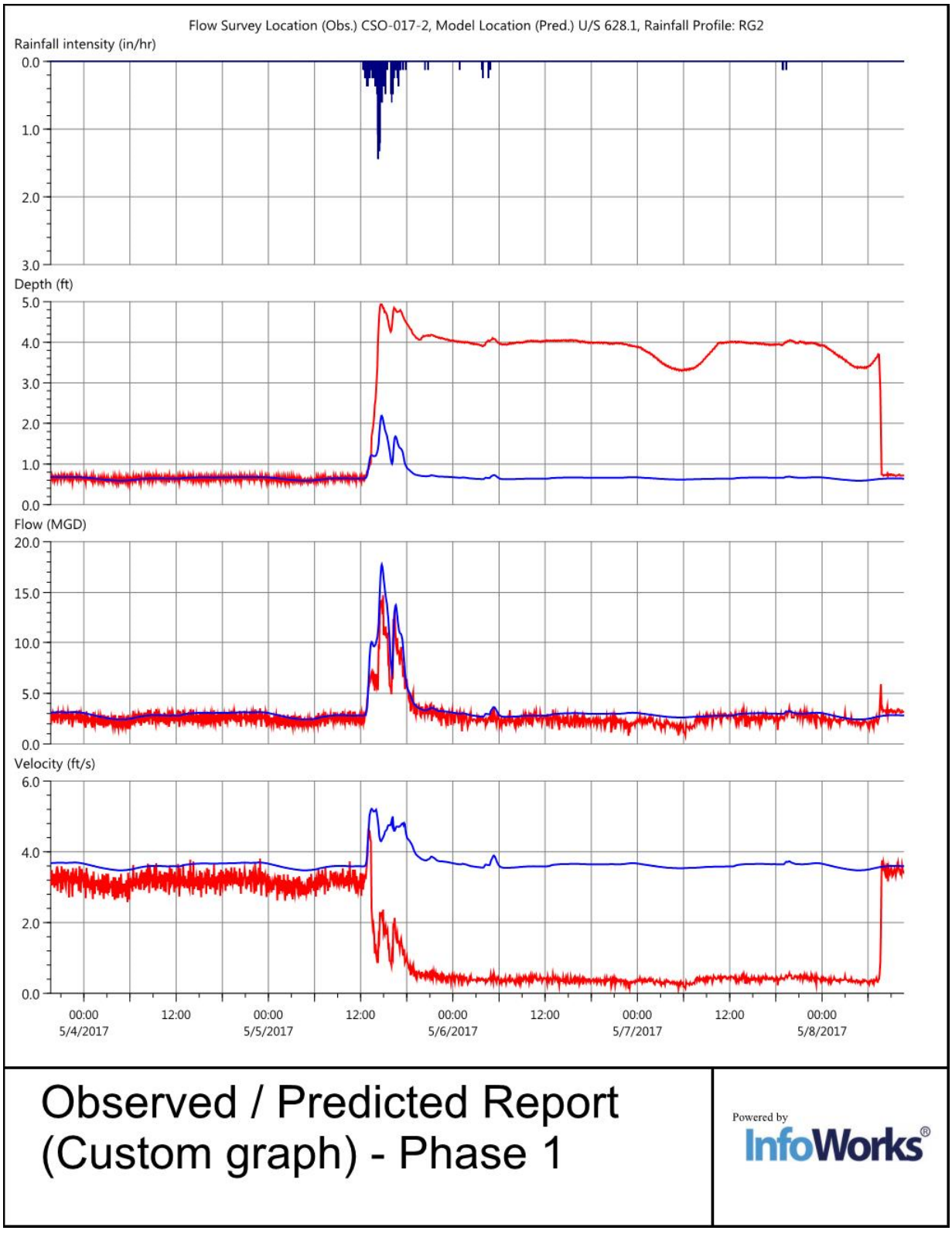


Figure 3-5 Modeled and Observed Flow Upstream of Regulator 017-2 on the Shetucket Interceptor (May 5, 2017 Storm)

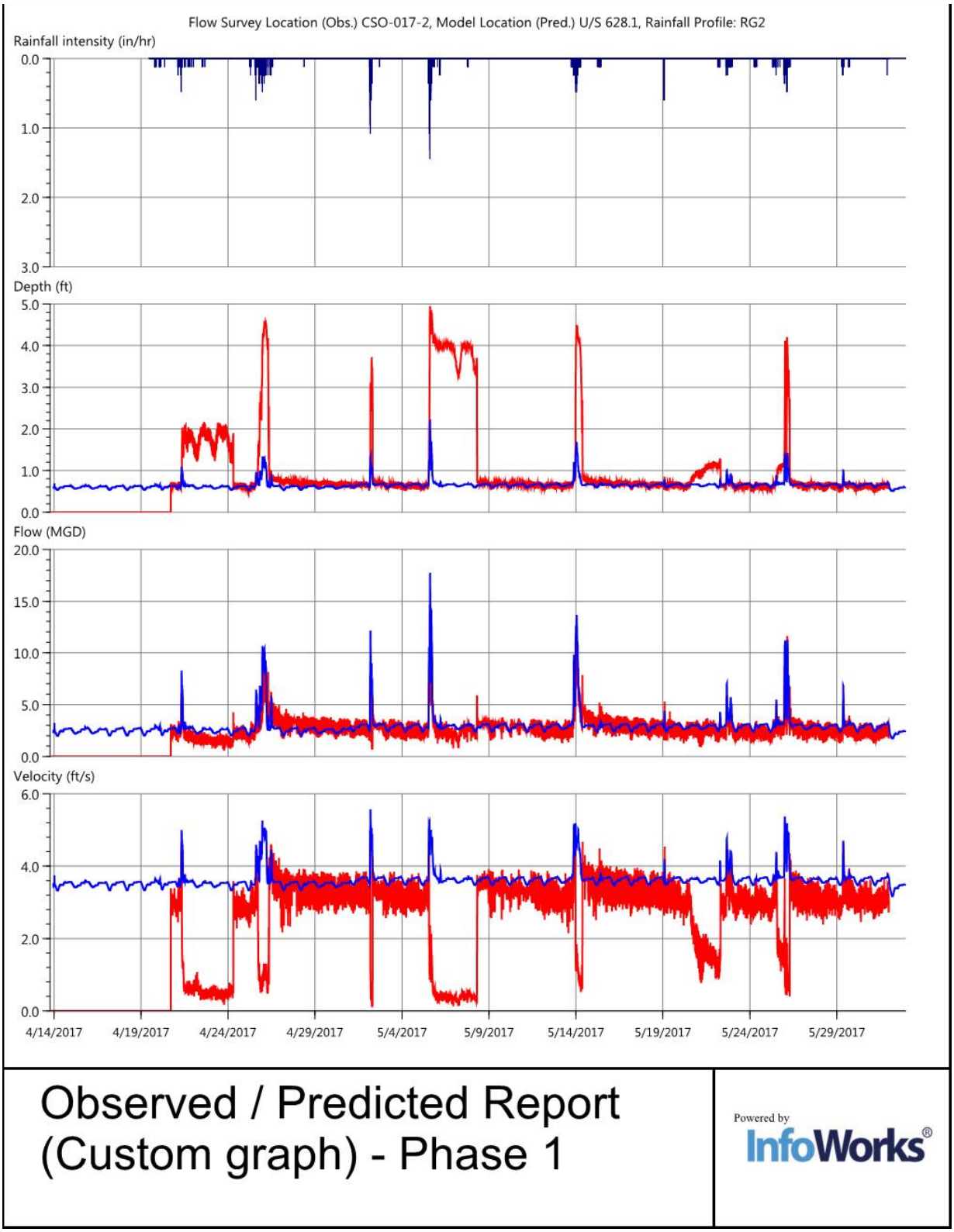
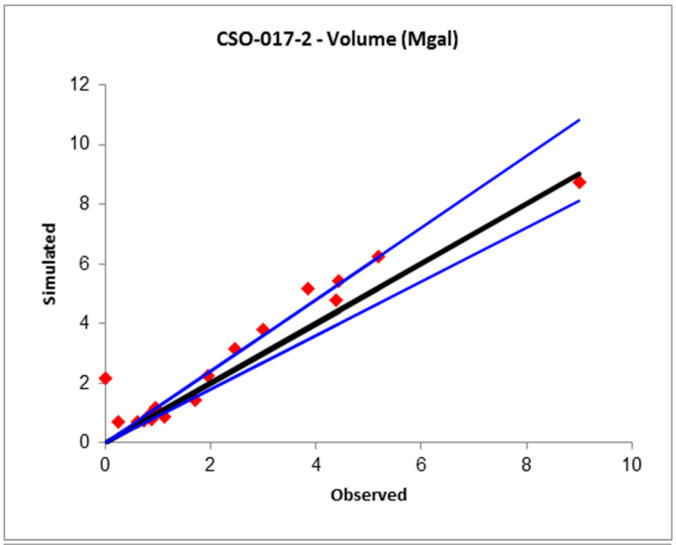
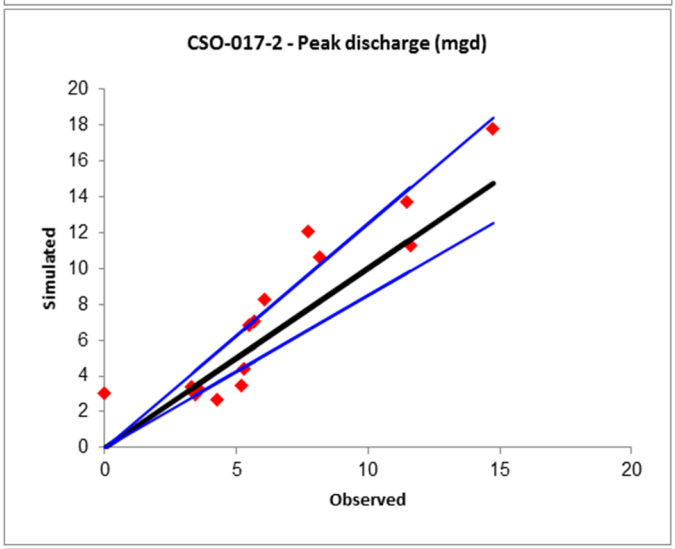


Figure 3-6 Modeled and Observed Flow Upstream of Regulator 017-2 on the Shetucket Interceptor (Spring Calibration Period)





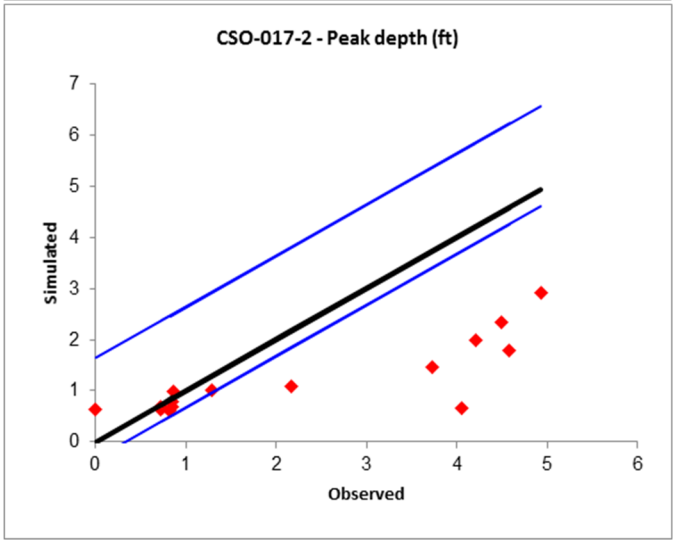


Figure 3-7 Scatter Plots of Observed and Simulated Volume, Peak Discharge, and Peak Depth (Storms from April 13, 2017 to May 31, 2017) at Regulator CSO 017-2

3.6.3 Long-Term Simulation

A long-term simulation was run from June 6 through October 31, 2017 to validate CSO and identify any additional calibration needs. Storms on June 16, October 24, and October 29 provided the most valuable data, but overflow characteristics for all storms also informed the work.

Overflow from CSO 017 (regulators CSO 017-1 and 017-2 discharge to a common outfall) constitutes half the total CSO volume for the system. Observed and simulated flows in the two overflow pipes to CSO 017 are shown for the June 16, 2017 storm in **Figure 3-8** and **Figure 3-9**. Depth and velocity are not shown because flowrate is the only parameter of concern for these overflow pipes. The most important calibration parameter for an overflow pipe is overflow duration. The overall calibration is good. The duration of overflow is slightly longer than observed at CSO 017-2 and shorter than observed at CSO 017-1. Similarly, flow volume is slightly higher than observed at 017-2 and lower than observed at 017-1. The total simulation volumes from the two meters is 25% higher than the observed total volume.

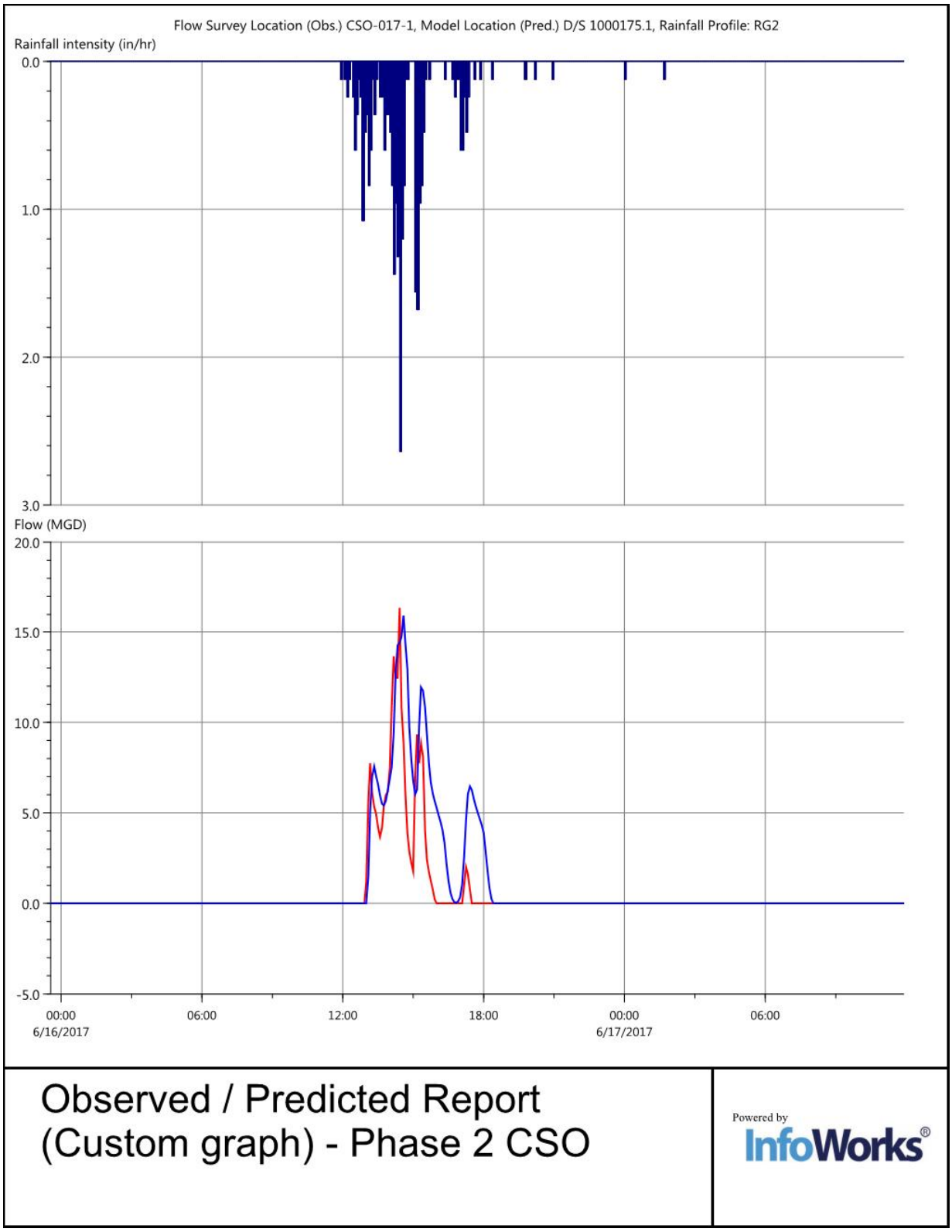


Figure 3-8 Modeled and Observed Flow at CSO 017-1 (June 16, 2017 Storm)

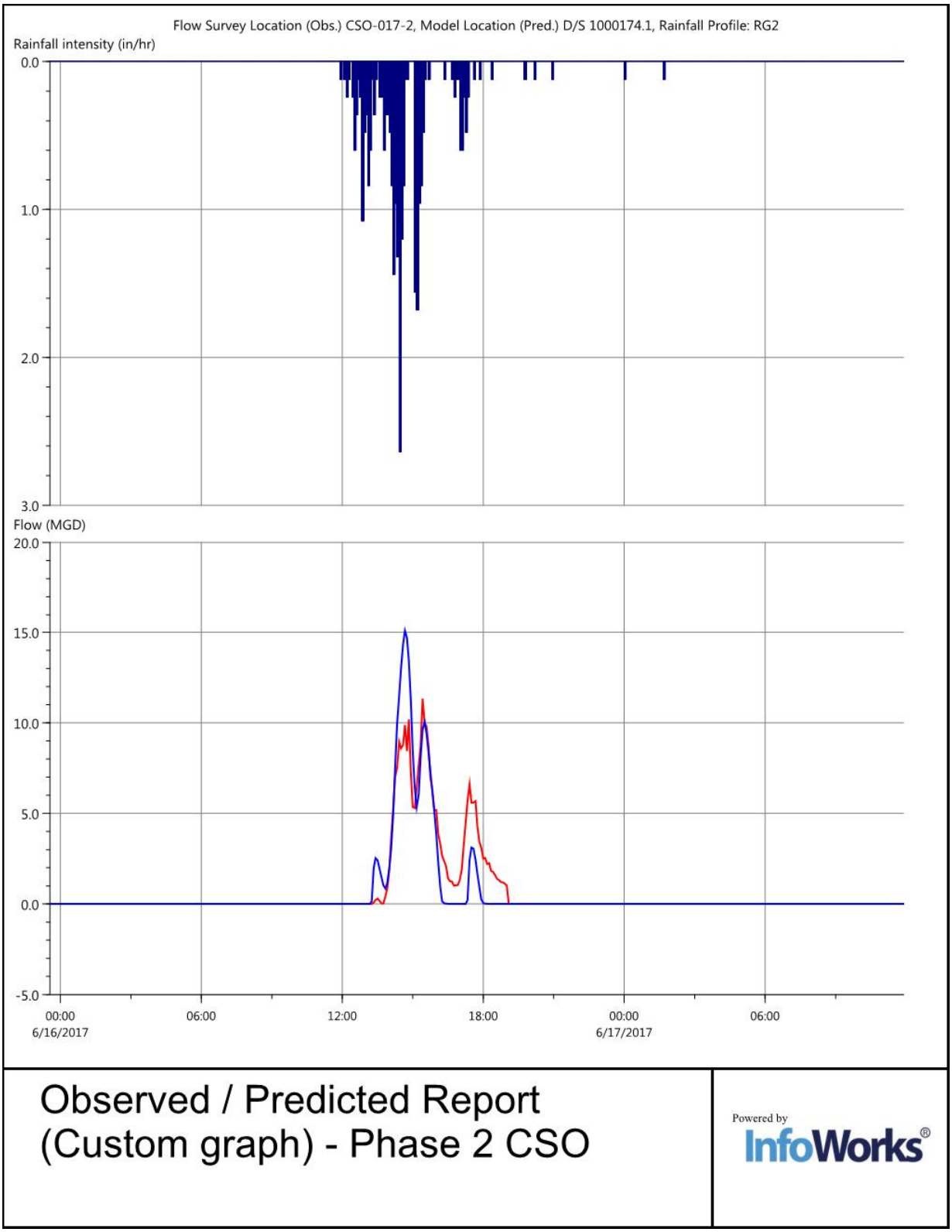


Figure 3-9 Modeled and Observed Flow at CSO 017-2 (June 16, 2017 Storm)

At the end of October 2017, Norwich received heavy precipitation, amounting to a 7-year storm at a 7-day duration **(Table 3-4)**. These storms helped refinement of calibration at some regulators. Observed and simulated flows for the October events at CSO 017-1 and 017-2 are shown in **Figure 3-10** and **Figure 3-11**. The meters perform well for these storms with respect to CIWEM peak flow and total volume criteria. Peak flows for the two meters are within -15% and +25% of observed peak flows. Total flow at 017-2 is within +20% of observed total flow, but total flow at 017-1 is slightly higher than +20% observed total flow (+28% observed total flow). Observed and simulated peak discharges and volumes, and overflow duration for each CSO during these events are shown in **Table 3-5**. Total duration shown is the maximum duration at any CSO. This assumes that CSO at other locations overlapped with the CSO at the most active locations.

Table 3-4 October 2017 Storms Characteristics

Duration	RG2 Precipitation (in)		Average Recurrence Interval	
	24-Oct	29-Oct	24-Oct	29-Oct
15 min	0.2	0.2	2-mo	2-mo
1 hour	0.7	0.7	4-mo	5-mo
3 hours	1.6	1.9	1-yr	2-yr
6 hours	1.9	2.7	1-yr	4-yr
1 day	2.8	3.0	11-mo	1-yr
2 days	4.0	3.1	2-yr	11-mo
4 days	5.2		4-yr	
7 days	7.2		7-yr	

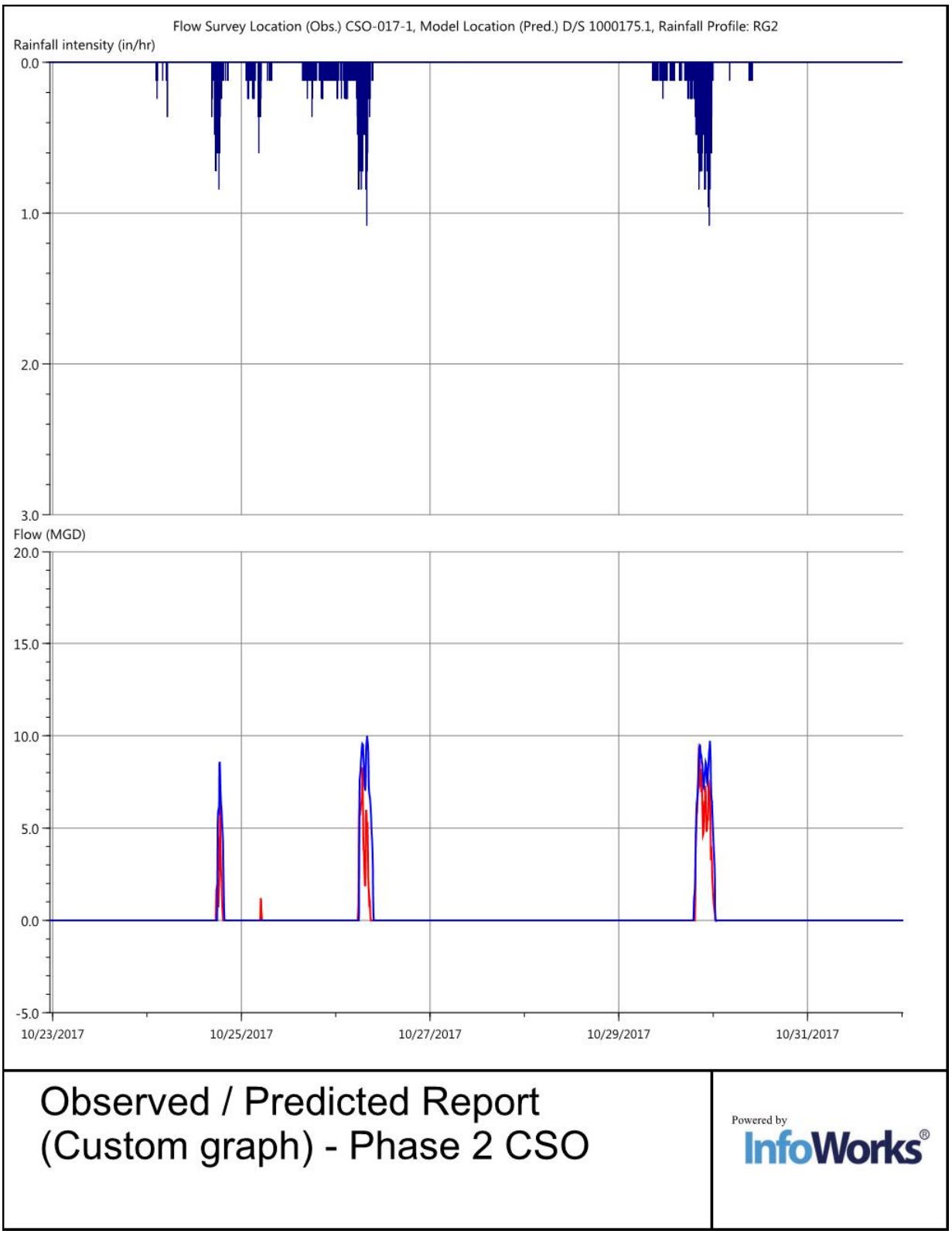


Figure 3-10 Modeled and Observed Flow at CSO 017-1 (October 24 and 29, 2017 Storms)

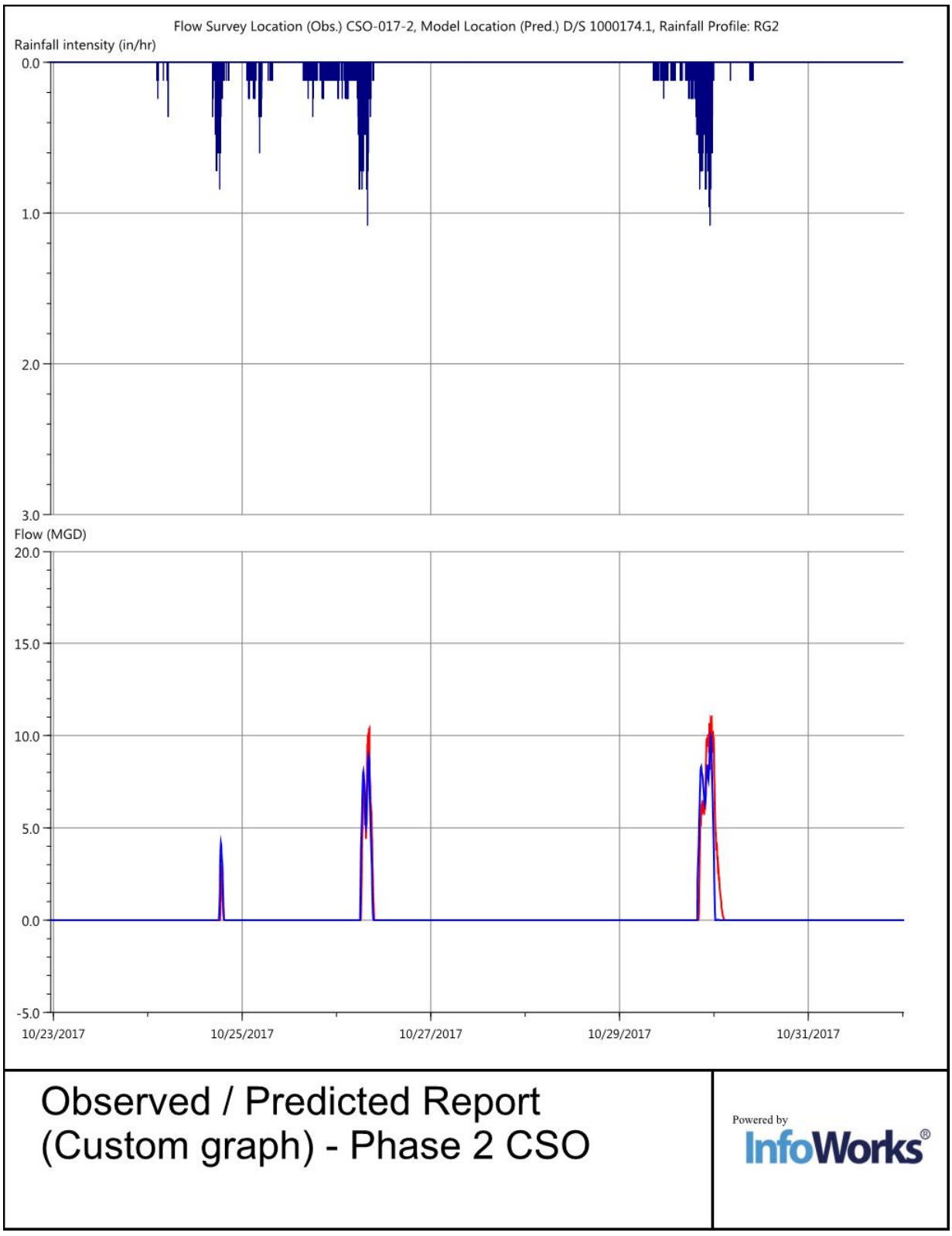


Figure 3-11 Modeled and Observed Flow at CSO 017-2 (October 24 and 29, 2017 Storms)

Table 3-5 October 24 - 29, 2017 CSO Validation

CSO Regulators	Volume (Mgal)		Peak Discharge (mgd)		Duration (hrs)	
	Observed	Simulated	Observed	Simulated	Observed	Simulated
004	0.08	0.18	1	3	18	7
005	0.27	0.06	2	<1	11	7
017-1	2.4	3.08	11	10	11	11
017-2	1.87	2.17	9	10	11	11
018	0.45	0.51	5	3	8	42
019-1	1.24	0.51	3	3	47	29
019-2	0.02	0.01	<1	<1	7	6
021	0	0.01	0	<1	0	5
022	0.3	0.26	2	2	15	19
023	0.41	1.08	4	6	15	30
024	2.32	0.77	10	5	68	45
025	0.67	0.4	4	2	22	59
029	0.09	0	<1	0	84	0
031	0.2	0.11	2	1	7	14
032	0.22	0	3	0	6	0
040	0	<0.01	0	<1	0	<1
Total	**10.55**	**9.14**	**11**	**10**	**84**	**59**

The modeled number of CSO events, event duration, and CSO volume over the long-term simulation period are compared to observed values in **Table 3-6**. Total event duration and counts shown are the maximum duration and count at any CSO. Model results match well with the observed values. Calibration plots of flow for each CSO from June through October are included in Appendix F. It is challenging to collect accurate velocity data on overflow pipes due to the very small flow depths that may occur; resulting flowrate calculations can have limited accuracy. CSO metering is more accurate in measuring the duration and frequency of overflows.

As described previously, discrepancies at CSO 017 are partly due to the challenges of replicating the manual operations that control flow at Rose Alley PS during high flows. The model approximates current operations, but is more indicative of optimal operation of the pump system, where pumps can be adjusted in real time rather than manual adjustment by NPU staff.

Table 3-6 Observed and Simulated CSO (June 6 - October 31, 2017)

	Volume (Mgal)		Number of Events		Duration (hrs)	
CSO Regulators	Observed	Simulated	Observed	Simulated	Observed	Simulated
4	0.24	0.63	22	16	46	25
5	0.35	0.14	8	11	14	14
17-1	3.96	7.15	8	15	23	31
17-2	4.63	3.85	14	12	27	38
18	1.12	1.25	16	17	16	87
19-1	2.63	1.26	22	16	83	62
19-2	0.06	0.06	17	14	17	16
21	0	0.05	0	10	0	10
22	0.55	0.68	20	14	35	46
23	0.85	2.58	20	17	35	70
24	4.27	1.98	24	19	122	109
25	1.22	0.93	21	18	50	129
29	0.14	0.01	19	4	96	2
31	0.29	0.31	16	11	12	27
32	0.4	0.06	13	6	9	4
40	0.01	<0.01	2	1	1	<1
Total	**20.72**	**20.94**	**24**	**19**	**122**	**129**

3.6.4 WPCF Flow

Comparison of observed and simulated flow to the WPCF from June through October 2017 validates the model calibration. **Figure 3-12** shows the average daily flows in the model are higher than the average observed flows, but lower than the maximum observed flows at the WPCF for 99 out of 103 days with data (modeled flows exceed maximum observed flows June 12-14, 2017 and October 6, 2017). Modeled daily average flows range from 2.7 to 7.7 mgd, whereas observed daily average flows range from 2.3 to 5.7 mgd. The model was calibrated to the data deployed in the spring metering program; reported flow at the WPCF appears to under-report flow by 20% in comparison with these data. While comparison of modeled and observed flows at the WPCF validates calibration, calibration at the metered locations is a stronger indicator of good calibration.

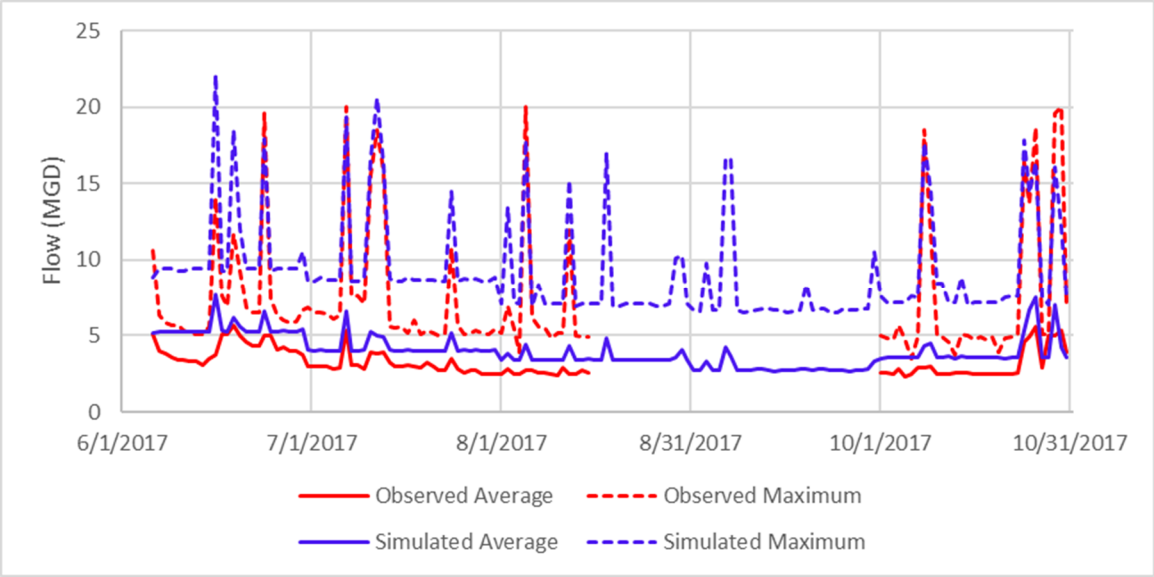


Figure 3-12 Observed and Modeled Daily Flows at the WPCF

3.6.5 Summary of Calibration Results

The model is well-calibrated to dry and wet weather. It accurately represents flows in the interceptors, discharge via CSOs, and flow to the WPCF. Based on the overall calibration and validation simulations performed, the model is a valuable tool for assessing the existing state of the system and analyzing the impacts of planned and potential improvements.

3.7 Baseline Conditions

The calibrated model was applied to characterize CSO for design storms and a representative period. New design storms and a new representative period were established, replacing the datasets used in the 2012 LTCP, as discussed in Section 4.

3.7.1 Design Storms

Design storms with average recurrence intervals of one month, three months, six months, one year, two years, and five years were developed for this study. Design storms were selected from Providence long-term data to align with the Norwich precipitation frequency estimates from NOAA Atlas 14 Volume 10 for New York and New England (2015). Development of these design storms is further detailed in Section 4. Simulations of each of these events will be used in identifying the costs and benefits of CSO remediation. Design storm CSO characteristics are presented in Section 5.

3.7.2 Representative Period

Selection of a three-year representative period is described in Section 4. Continuous simulation of these three years will establish average annual CSO statistics and verify the performance levels identified through design storm analyses. Section 5 presents annual CSO statistics based on simulation of the representative period.

Section 4

Design Storm and Representative Period Selection

4.1 Data Sources

Previous CSO control plan modeling for Norwich used a synthetic 2-year design storm, three smaller historic storms recorded at Mansfield, 17 miles northwest of Norwich, and a representative year composited from eight discrete months of historic data at Mansfield and four months at Bradley Airport in Windsor Locks (Black and Veatch, 2012). The selection of representative precipitation is re-examined here, considering updated precipitation statistics and additional sources of precipitation data. Statistics presented in this report were obtained from National Centers for Environmental Information 1981-2010 precipitation normals (NOAA, 2018), NOAA Atlas 14 Volume 10 for New York and New England (2015), and analysis of monthly, daily, hourly, and 1-minute long-term precipitation datasets listed in **Table 4-1**:

Table 4-1 Precipitation Datasets

Location	COOP ID	Monthly USHCN	Daily GHCN	Hourly COOP	1-Minute ASOS
Norwich	069510	NA	1957	NA	NA
Kingston	374266	1889	1893	NA	NA
Providence	376698	1832	1948	1948	2000

Year shown is start of record; all continue through the present
USHCN: U.S. Historical Climatology Network
GHCN: Global Historical Climatology Network
COOP: Cooperative Observer Program
ASOS: Automated Surface Observing System

Norwich Public Utilities has measured daily precipitation since 1957. Regionally, Storrs, Groton/New London, and other stations have measured daily precipitation over long periods, but only Kingston, 26 miles to the east, has a complete record and annual precipitation similar to Norwich. While hourly precipitation data has been collected nearby at Willimantic and Groton since 1999, these stations have limited quality control. The nearest stations with robust long-term hourly data are Providence's TF Green Airport, 35 miles to the northeast, and Bradley Airport, 43 miles to the northwest. As discussed below, Norwich has greater average annual precipitation than most communities in southern New England, so the best source of long-term precipitation data and design storm hyetographs for Norwich is Providence data with consideration for climatic differences between the locations.

Other datasets are available for the Norwich area, although none match those listed above for length or quality of record. These include 5-minute data collected in Lisbon at station EW7857 for NOAA's Citizens Weather Observer Program, 5-minute data collected at Norwich Free Academy (KCTNORWI12) and other participants in the private Wunderground network, 15-minute data collected at the USGS Yantic River gage in Norwich (USGS 01127500), and Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) daily precipitation station CT-NL-28 in Lisbon.

4.2 Annual Precipitation

Annual "normal" precipitation for Norwich based on the period 1981-2010 is 54.8 inches. Precipitation normals for Norwich and nearby locations are listed in **Table 4-2** and mapped in **Figure 4-1**.

Table 4-2 1981-2010 Regional Precipitation Normals

ID	Location	Inches	Distance (mi)	Elevation (ft)
COOP 065910	Norwich	54.8	---	20
COOP 063207	Groton	49.7	12 S	40
COOP 063857	Jewett City	48.6	12 NE	400
COOP 064488	Mansfield Hollow	52.1	17 NW	250
COOP 063420	Hampton	51.2	17 N	490
WBAN 14794	Westerly RI	47.4	19 SE	80
COOP 064767	Middletown	51.2	24 W	135
COOP 374266	Kingston RI	52.9	28 E	120
WBAN 14765	Providence RI	47.2	36 NE	60

Source: National Weather Service

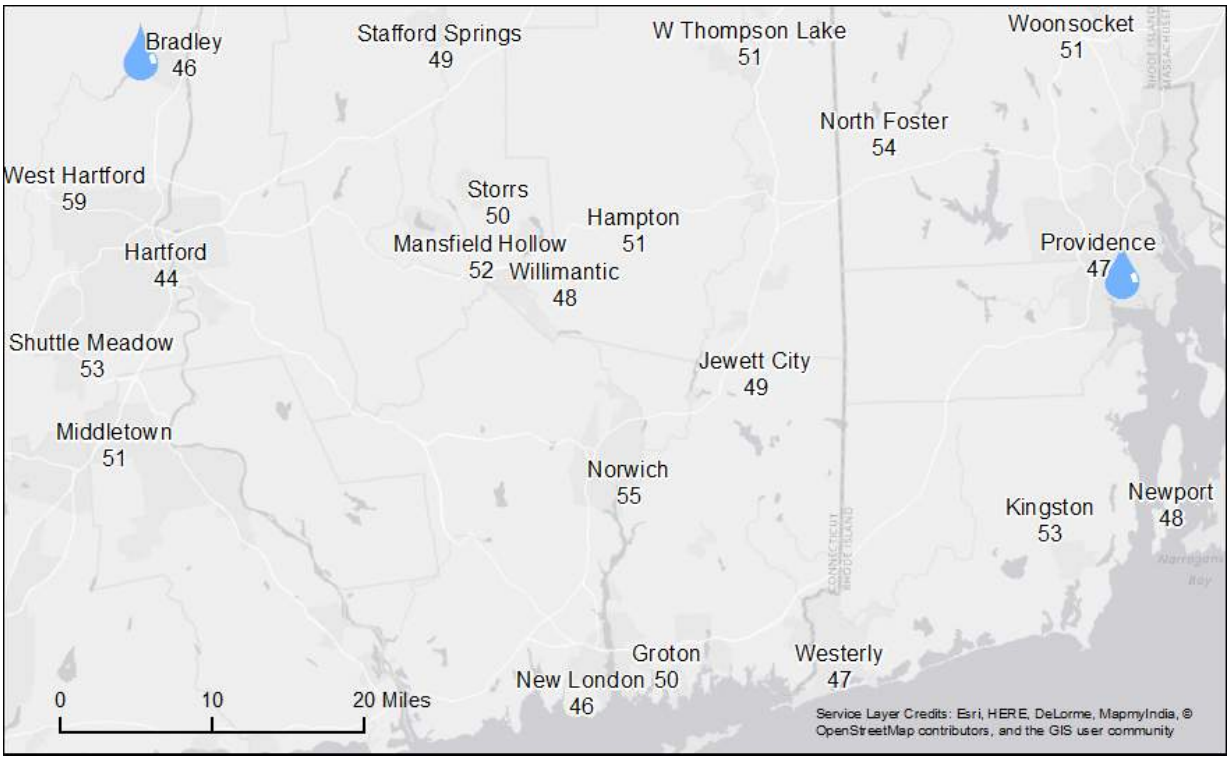


Figure 4-1 1981-2010 Regional Precipitation Normals

Norwich has higher average annual precipitation than almost every other station shown in the figure. Its total is slightly higher than Kingston, which has a similar geographic location relative to the coast, and which, as noted above, has a long historical record that can be compared with Norwich.

Figure 4-2 plots annual precipitation at Norwich and Kingston since 1957. Kingston and Norwich track close to one another most years, although Norwich recorded extremely high totals in 2008 and 2009, and has fallen consistently below Kingston since 2012. As the Kingston station is very reliable, the key conclusions that can be drawn from this figure are that the 55-inch normal reported for Norwich is reasonable, while the recent Norwich record appears questionable. Statistics calculated with the most recent data would yield similar results; annual precipitation at Kingston from 2008-2017 averaged 51.9 inches.

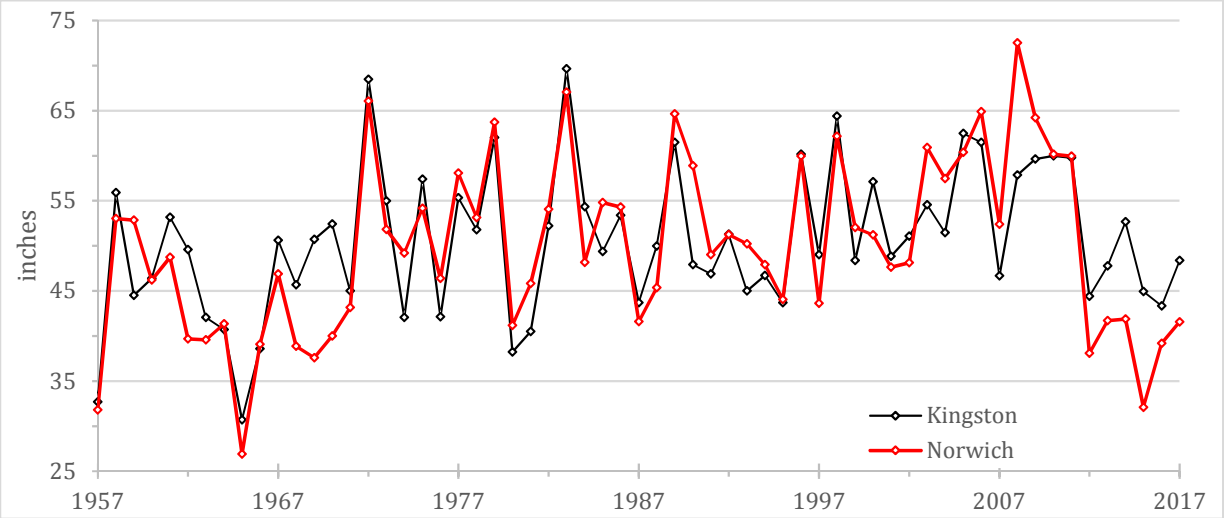


Figure 4-2 Annual Precipitation Since 1957 at Norwich and Kingston

Figure 4-3 shows annual precipitation for Providence and Kingston beginning 1850, and a 30-year running average for Kingston. No long-term trend is evident in average annual precipitation; while 30-year average annual precipitation at Kingston has varied over time, it was 51 inches as of 1920, and is 52 inches today. However, there have recently been more very wet years, with five years exceeding 60 inches precipitation since 1986 at Kingston versus six from 1889-1985, and six years at Providence exceeding 54 inches during each of those periods. The two datasets do not correlate well from 1905-1935, perhaps because, while the Kingston site has remained at the University of Rhode Island campus since inception, Providence data was collected downtown in its early years, but have been obtained at the airport since the 1930s.

Figures 4-2 and **4-3** show differences and similarities among Norwich, Kingston, and Providence. Kingston is the only one of the three with a century of consistent annual totals, as some older Providence data and recent Norwich appear anomalous. While NOAA normals indicate that Providence is drier than Norwich, the high quality long-term hourly data available for Providence are the best source for representative design storm hyetographs and continuous simulation data for Norwich, provided that the selected data conforms with pertinent statistical measures for Norwich. While there have been wetter and drier periods over the decades, there is no evidence of a significant trend in average annual precipitation, and, as discussed below, no significant trend in storm sizes. The entire Providence hourly dataset since 1948 is thus appropriate for selection of representative period precipitation and design storm hyetographs, although more recent data have been favored in the selections presented below wherever possible.

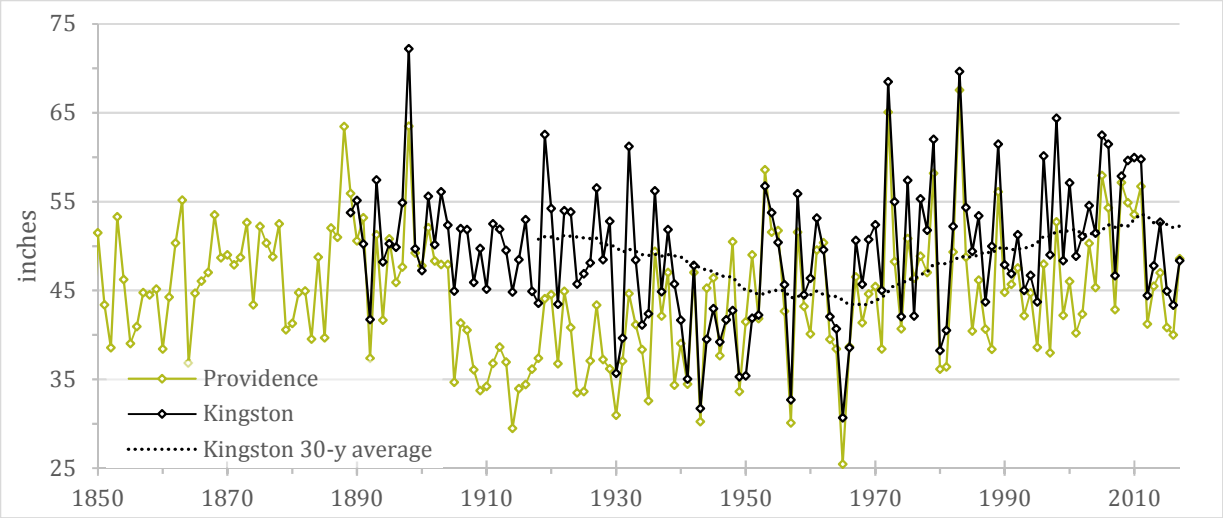


Figure 4-3 Annual Precipitation Since 1850 at Providence and Kingston

The 54.8 inch normal estimated for Norwich is much greater than the 40.3 inches used in the 2012 Facilities Plan or the 42 inches used in Norwich's 1994 plan. The older estimates differ primarily because they were based on hourly data from Mansfield Hollow, Jewett City, and Windsor Locks; all these locations have lower average annual precipitation than Norwich, and hourly data are often deficient when compared with daily data, even at highly reliable locations such as principal airports.

4.3 Precipitation Frequency Estimates

NOAA's Atlas 14 precipitation frequency estimates for New England, published in 2015, supersede previous NOAA estimates for the eastern US (Hershfield, 1961), and estimates published by Cornell University researchers in 2010 (Northeast Regional Climate Center, 2011). Atlas 14 is based on analysis of thousands of daily, hourly, and sub-hourly precipitation datasets across the country. Atlas 14 is the definitive recent report on current rainfall extremes for the region, so its precipitation frequency estimates are used as the basis for design storm selection.

Table 4-3 presents average recurrence interval (ARI) estimates of rainfall depths at durations from 5 minutes to two days at ARIs from 1 month to 10 years. The 1-year and greater estimates are obtained from Atlas 14 for Norwich. As NOAA does not publish sub-annual precipitation frequency estimates, values were estimated through frequency analysis of hourly Providence data since 1948 and 1-minute Providence data since 2011, scaled to match Norwich atlas values at a 1-year ARI.

The estimates presented in **Table 4-3** are slightly larger than corresponding design storms depths in the 2012 Facilities Plan. The Atlas 14 2-year 24-hour rainfall depth is 3.45 inches, while the 2-year storm used in the 2012 plan totaled 3.3 inches in 24 hours. The 1-year storm simulated for that study was a 3-hour, 1.42 inches event. Atlas 14's 1-year, 24-hour depth is 2.90 inches, although its 3-hour total is 1.55 inches, modestly larger than the previous design event.

Table 4-3 Norwich Precipitation Frequency Estimates by Duration and ARI

	1-month	3-month	6-month	1-year	2-year	5-year	10-year
5-minute	0.13	0.22	0.25	0.34	0.40	0.51	0.60
10-minute	0.18	0.31	0.39	0.48	0.57	0.72	0.85
15-minute	0.20	0.37	0.48	0.57	0.67	0.85	1.00
30-minute	0.27	0.46	0.63	0.79	0.95	1.20	1.40
60-minute	0.37	0.60	0.81	1.02	1.22	1.54	1.81
2-hour	0.53	0.84	1.07	1.34	1.59	2.01	2.35
3-hour	0.62	1.01	1.25	1.55	1.84	2.32	2.72
6-hour	0.81	1.34	1.71	1.98	2.34	2.94	3.43
12-hour	0.96	1.62	2.03	2.46	2.91	3.64	4.25
24-hour	1.08	1.89	2.39	2.90	3.45	4.34	5.08
2-day	1.23	2.14	2.69	3.26	3.91	4.98	5.87

4.4 Climate Change Estimates

USEPA promulgates guidance for estimating changes in annual and extreme rainfall through its CREAT (Climate Resilience Evaluation and Awareness Tool) and SWMM-CAT (Storm Water Management Model Climate Adjustment Tool) software; the programs use identical methodology.

Table 4-4 shows projected changes in monthly precipitation for the median climate change scenario in the World Climate Research Programme Coupled Model Intercomparison Project Phase 3 archive obtained from SWMM-CAT.

Table 4-4 Norwich Near-Term Precipitation (inches) for Predicted Median Climate Change Scenario

Month	1981-2010 Normal	Change	2020-2049 Estimate
Jan	4.15	1.5%	4.21
Feb	4.08	9.1%	4.45
Mar	5.48	9.2%	5.98
Apr	5.00	-0.1%	5.00
May	3.92	-2.3%	3.83
Jun	4.21	0.6%	4.24
Jul	3.97	0.6%	3.99
Aug	4.86	2.4%	4.98
Sep	4.58	1.1%	4.63
Oct	4.82	1.2%	4.88
Nov	4.89	4.6%	5.11
Dec	4.85	5.0%	5.09
Year	54.81	2.9%	56.39

As CSO is driven by large rain events, the incidence of days with precipitation exceeding one inch and two inches is presented in **Figure 4-4** to assess the presence of trends in the data. Kingston

data are presented, as it has a reliable long-term record, and is reasonably representative of, although slightly drier than, Norwich. The figure shows that the number of days per year with at least one inch of precipitation averaged over 30 years was 15 in 1930, and is 14 today, while the number of days per year with at least two inches was 3.4 as of 1930, and is 3.5 today. This analysis demonstrates that there has been minimal trend in the number of days with heavy rainfall in the area over the last century. However, long-term trends in extreme precipitation in the region have been identified by Kunkel et al. (2013) and others.

SWMM-CAT presents estimated increases in 24-hour design rainfall depths for 5-year through 100-year events. The near-term (2020-2049) estimate for the median climate change scenario indicates a 4.5 percent increase in the magnitude, so the 5-year 24-hour storm is projected to increase from 4.34 inches to 4.54 inches.

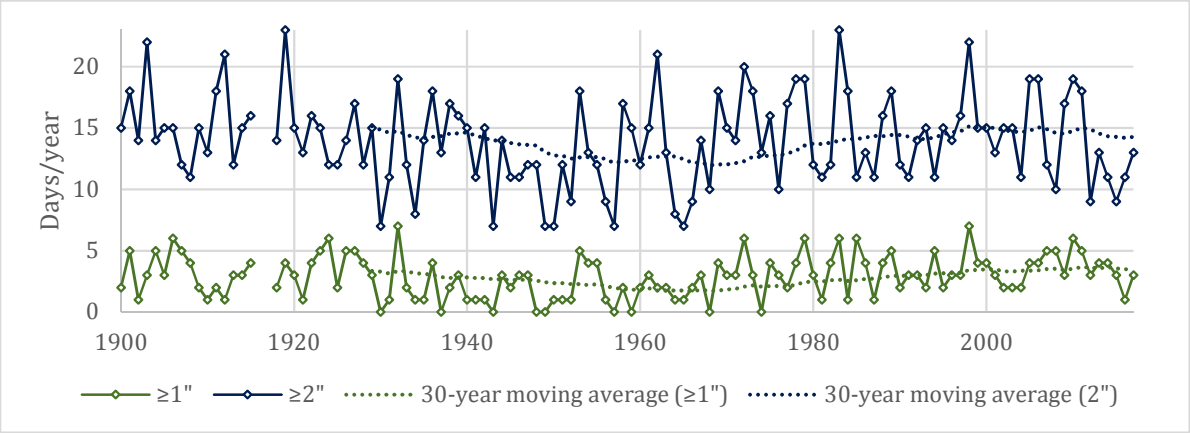


Figure 4-4 Days per Year with Rain above Thresholds

As CSO control plan guidelines are based on current climate conditions, and the historic data show little trend in intense rainfall, projected change in precipitation frequency estimates was not incorporated into design storm development. However, acknowledgement of changing climate can bolster the public credibility of engineering studies. Both the current and projected annual precipitation are thus considered later in this section for selection of representative period annual precipitation.

4.5 Design Storm Selection

Design storms were selected from Providence long-term hourly and sub-hourly data to align with the Norwich precipitation frequency estimates presented in **Table 4-3**. Historic events were chosen instead of synthetic hyetographs to ensure realistic distribution of rainfall over the duration of a storm event. As Providence has 70 years of complete hourly data, it is feasible to identify a suite of storms that produce successively larger CSO volumes and peak discharge rates while ensuring realistic results. The varying hyetograph shapes yield slightly different runoff characteristics from event to event that ensure realistic frequency-volume and frequency-discharge curves for use in identifying costs and benefits of CSO remediation. Storms were identified from the hourly data, and 15-minute hyetographs were developed using 1-minute ASOS data for post-2000 dates, or by synthetic disaggregation using a method described by Ormsbee (1989) and adapted into CDM Smith's NetSTORM software (Heineman, 2004).

The Providence hourly precipitation record was analyzed to identify 1000 storms with at least 1 inch over 24 hours from 1948 through 2017 based on a 12-hour interevent time (i.e. 12 hours with no measurable precipitation was used to separate storms). Each storm was characterized to identify its maximum 1-, 2-, 3-, 6-, 12-, and 24-hour precipitation depth and associated ARI at each duration. The list was ordered according to 24-hour precipitation total, and candidate design storms were then identified from the list that best matched the ARI depths in **Table 4-3** at each duration. For instance, the ideal 6-month event would match the 6-month ARI estimates in the table at 2-hour through 24-hour durations. A storm's 1-hour depth was not critical to the analysis, as the hourly data does not necessarily capture the peak 60 minutes of a storm.

Events were selected based on their 2-hour through 24-hour precipitation depths. The 1-month and 6-month storms have 1-minute ASOS data (this data is available for most post-2000 dates), so 15-minute hyetographs for these events were developed from the 1-minute data. The other storms were synthetically disaggregated to 15-minute intervals. The 15-minute increments within each storm's peak two hours were adjusted to maintain the recorded total while also fitting the 15-minute, 30-minute, and 60-minute ARIs presented in **Table 4-3**.

Table 4-5 presents 15-minute through 24-hour maximum depths for the selected design storms in the original data, along with adjusted 15-minute through 1-hour maxima in the final 15-minute hyetographs. The 1-month storm is in April; all the others occurred in August or September. The 6-month storm on September 26, 2008 was the first wave of rain from Hurricane Kyle, which totaled five inches of rain at Providence from the 26th through the 28th. **Figure 4-5** plots depth-duration curves for each design storm along with the depth-frequency estimates presented in **Table 4-3**. The figure shows that the design storms closely follow the depth-duration curves except at 12 hours, where the 3-month through 2-year storms each exceed the corresponding ARI curves, and where the 5-year storm is only slightly larger than the 2-year storm.

Table 4-5 Design Storms from Providence Hourly Data

Event	Date	15-Minute Hyetograph Maxima (inches)								Hourly Data Peak Hour (inches)
		15-min	30-min	60-min	2-hr	3-hr	6-hr	12-hr	24-hr	
1-month	April 20, 2015	0.20	0.27	0.35	0.50	0.61	0.82	0.95	1.03	0.30
3-month	September 6, 1974	0.37	0.47	0.58	0.82	0.99	1.41	1.82	1.89	0.46
6-month	September 26, 2008	0.51	0.70	0.77	0.98	1.17	1.68	2.40	2.53	0.52
1-year	September 19, 1972	0.56	0.79	1.00	1.38	1.62	1.99	2.66	2.86	0.74
2-year	August 30, 1985	0.67	0.95	1.22	1.83	2.01	2.23	3.17	3.43	1.01
5-year	August 9, 1954	0.85	1.20	1.54	2.15	2.29	2.88	3.27	4.17	1.34

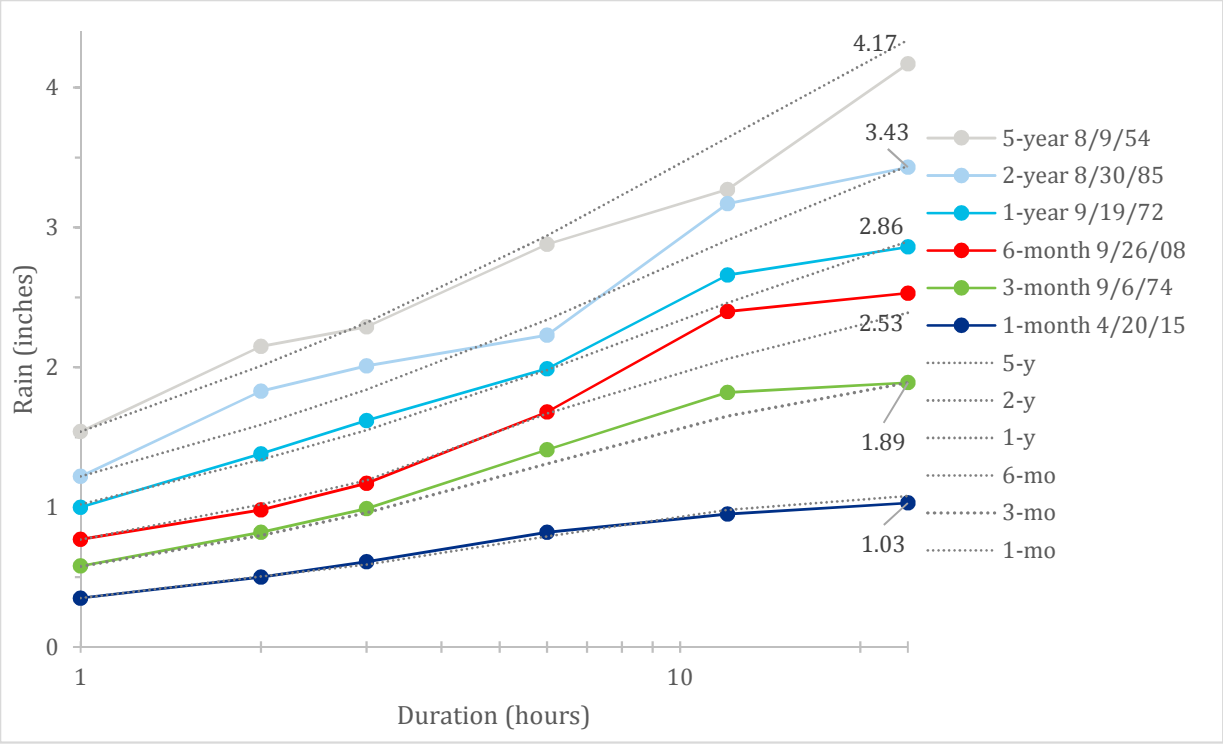


Figure 4-5 Design Storm Depth-Duration Curves

Figure 4-6 presents hourly hyetographs for each design storm. Peak rainfall in most of the storms occurs near the sixth hour. The 5-year storm maximum occurs in its 22nd hour, although this storm also had a lesser maximum in its sixth hour, with a five-hour respite on the evening of August 9th before the more intense rain fell overnight.

These design storms are intended to offer first estimates of CSO at the identified storm frequency; system performance can be subsequently confirmed using representative period simulation, which provides a more realistic assessment of the actual performance level of the collection system.

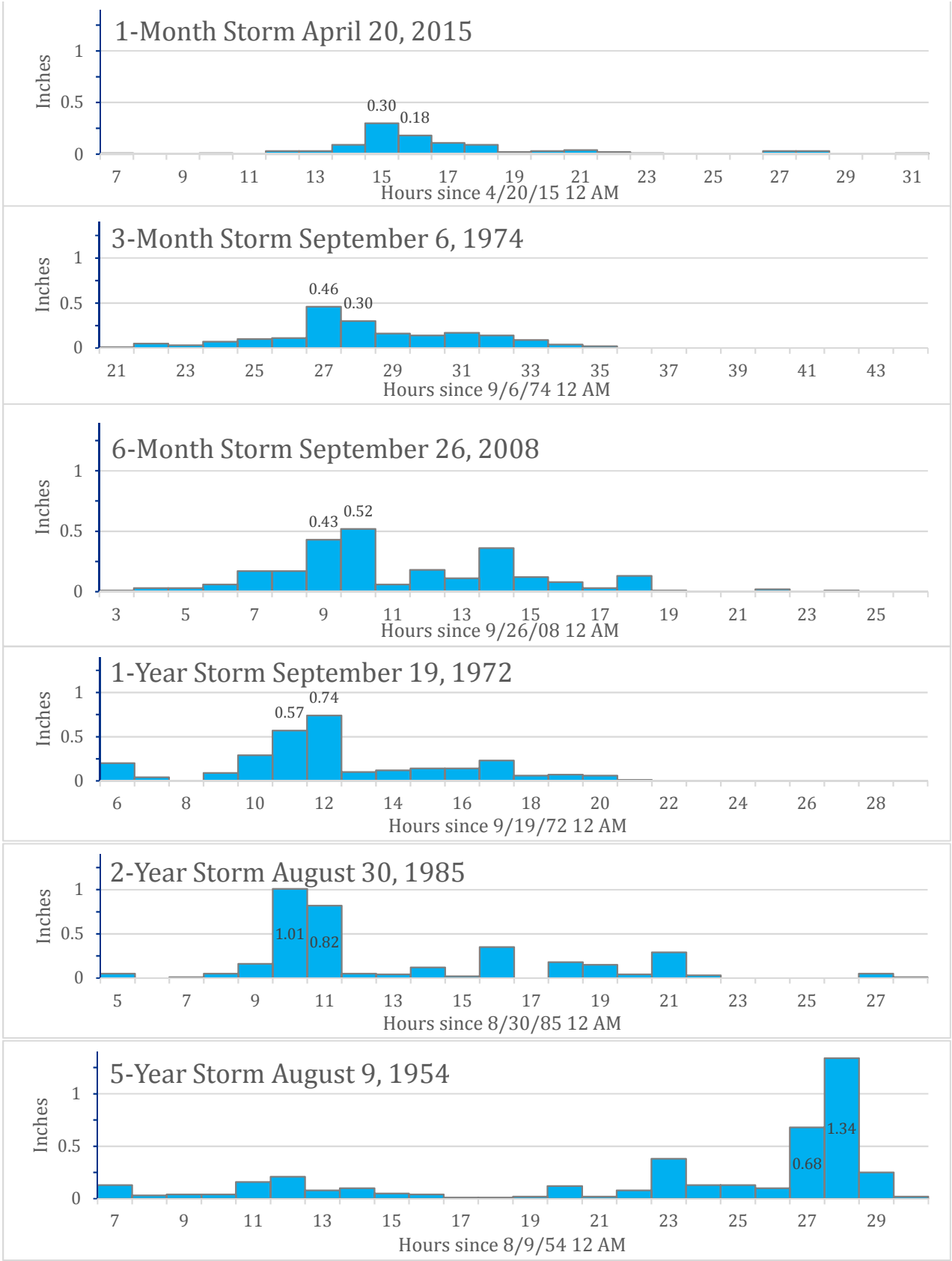


Figure 4-6 Design Storm Hourly Hyetographs

4.6 Representative Period Selection

Candidate representative periods for the updated analyses were screened from Providence data. As discussed above, Providence is the location nearest Norwich with high quality long-term hourly data. Periods were screened according to the following criteria:

- a year or several consecutive years in recent decades with close to 54.8 inches average annual precipitation
- the number of three-month through one-year events at durations from 1 to 24 hours close to long-term expected values
- seasonal precipitation totals close to long-term averages

As the Long Term CSO Control Plan targets a two-year performance level, it is preferable to use a representative period of three years or longer so that the system's performance can be best assessed. For example, over an average three-year evaluation period, a system with two-year performance would be expected to experience no more than one overflow. When a single representative year is simulated, it is not possible to assess whether the absence of CSO indicates a one-year performance level, or some much higher level of service. While simulating multiple years yields greater statistical validity in the results, it comes at the cost of increased effort to obtain results. A three-year period was thus selected to best balance robustness of results with labor.

Figure 4-7 compares annual precipitation at Providence with the Norwich normal. Prior to 2000, only 1953, 1989, and 1998 had annual precipitation totals within five percent (from 52.1 to 57.6 inches) of Norwich's 54.8 inch normal. Since 2000, five years have met that criterion: 2006, and 2008 through 2011.

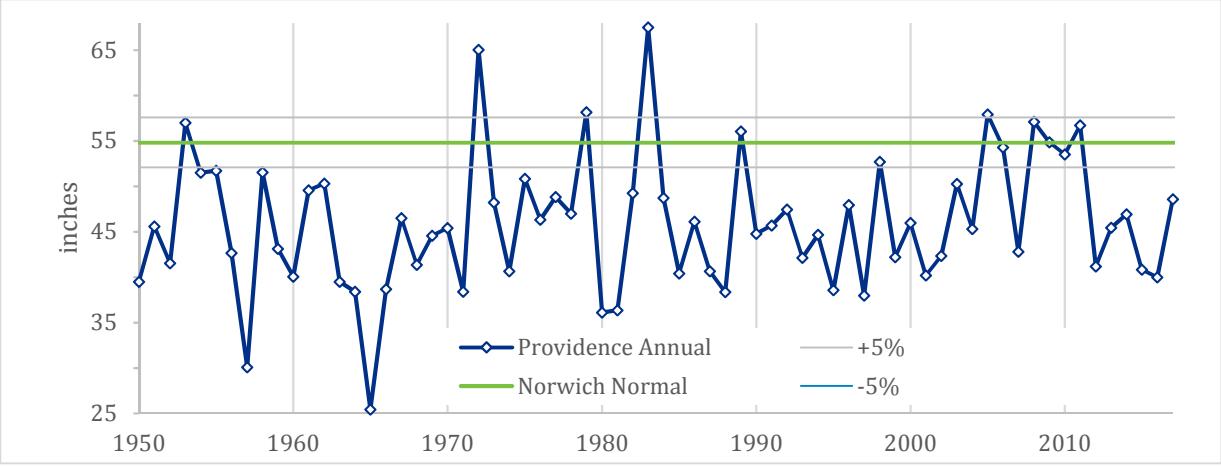


Figure 4-7 Providence Annual Precipitation Since 1950

Table 4-6 lists quarterly and annual precipitation at Providence for the eight years with total precipitation closest to Norwich's normal, as well as 2006 and 2012. No single year had quarterly precipitation within 25 percent of the Norwich normal over the entire year, with only 2009 and 2011 meeting that criterion in at least three quarters. Furthermore, only the three-year periods

ending in 2010 and 2011 have average annual precipitation close to Norwich's normal. The four years from 2008 through 2011 were thus the only ones further screened as representative year candidates.

Table 4-6 Providence Quarterly Precipitation in Candidate Representative Years

Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year	3-Year Mean
1953	19.1	9.8	11.4	16.7	57.0	53.4
1989	8.0	17.2	16.5	14.4	56.1	48.8
1998	18.3	20.6	6.1	7.8	52.7	47.0
2006	8.4	19.7	9.0	17.2	54.3	52.5
2007	12.3	13.6	7.6	9.3	42.8	51.7
2008	16.4	8.5	18.1	14.1	57.1	51.4
2009	8.8	12.8	15.6	17.7	54.9	51.6
2010	24.2	8.9	8.5	12.0	53.5	55.2
2011	11.1	12.4	18.0	15.2	56.7	55.0
2012	6.2	12.8	12.1	10.1	41.2	50.5
Normal	13.7	13.1	13.4	14.6	54.8	

Highlighted values fall within 25% of normal

3-year means for pre-2000 dates are for period beginning; post-2000 means are for period ending

Table 4-7 lists 1-year and larger storms at durations from 1 to 24 hours during each candidate year. During 2008, there were four 1-year and larger events at a 24-hour duration (i.e. exceeding 2.90 inches), with 3.0 inches on February 12, 3.3 inches on March 7, 4.1 inches on September 6, and 3.8 inches on December 11. The September and December events both exceeded the 2-year, 24-hour depth (3.45 inches), rendering this year a weak candidate for inclusion in a one or three-year representative period. The largest 24-hour accumulations from 2009 through 2011 were 2.92 inches on July 1, 2009, 6.56 inches on March 29, 2010, and 2.40 inches on July 8, 2011. The March 2010 storm exceeded a 25-year event on a one-day basis, and its 8.8-inch two-day total has a 90-year ARI. While this very large storm renders 2010 inappropriate for use as an individual representative year, its overall statistics in combination with 2009 and 2011 make these three consecutive years otherwise ideal for simulating representative precipitation at Norwich. The period from 2009 to 2011 has three 1-year events at durations of 1, 2, 6, and 24 hours, has average precipitation nearly matching the normal (55.0 vs. 54.8 inches), and includes 2009, which has annual precipitation very close to the normal (54.9 inches). A supplementary benefit of including 2011 in the representative period is that its 56.72 inches total precipitation matches EPA's 56.39 inch projected mid-century estimate for the median climate change scenario, so that its results may be compared with 2009 results to assess potential climate change impacts on CSO.

The period 2009-2011 was further screened to assess the number of 3-month through 2-year events. **Table 4-8** shows that the three-year period had close to the ideal number of storms at each duration at 6-month, 1-year, and 2-year ARIs. There were more 3-month 24-hour events, and fewer 3-month 1-hour events than the ideal, but these deficiencies are judged minor.

Table 4-7 1-Year Events during Candidate Years

Year	Number of 1-y events at duration (h)					
	1	2	3	6	12	24
2008	1	1	1	3	2	4
2009	0	1	0	0	0	1
2010	2	1	0	2	2	2
2011	1	1	1	1	0	0
Threshold (inches)	1.02	1.34	1.55	1.98	2.46	2.90

Table 4-8 Number of Events Exceeding Specified ARIs at Select Durations, 2009-2011

ARI	Number of events at duration (h)						Ideal
	1	2	3	6	12	24	
3-month	8	13	15	14	16	18	12
6-month	5	6	7	7	7	8	6
1-year	3	3	1	3	2	3	3
2-year	1	1	1	1	1	1	1.5

Inclusion of the March 2010 storm likely generates excessive CSO for 2010. While it would be feasible to adjust the hyetograph for that event to obtain a better fit to Norwich's representative period statistics, the Providence data was left as-is, with the consideration that the overall annual statistics probably exceed Norwich's true average conditions. As a final check of the period, the second largest event at select durations was assessed; each depth would ideally correspond with a 1.5-year ARI. **Table 4-9** shows that the second largest depths occurred across all seasons, and are all within 10 percent of the 1.5-year ARI depth.

Table 4-9 Second Largest Rainfall Depths in 2009-2011 Providence Record at Select Durations

Duration	Date	Rain (inches)	1.5-Year Depth (inches)
1 hour	12/12/2010	1.15	1.13
2 hours	7/1/2009	1.37	1.48
3 hours	7/1/2009	1.54	1.71
6 hours	7/8/2011	2.06	2.18
12 hours	12/12/2010	2.54	2.71
1 day	3/23/2010	3.31	3.21
2 days	9/6/2011	3.46	3.63
4 days	7/1/2009	4.33	4.22
7 days	7/1/2009	5.17	5.01

Peak flows in an urban sewer system and resultant CSO are driven by intense short-duration precipitation. Since CSO regulators in Norwich's system can serve drainage areas with times of concentration as short as 15 minutes, more realistic simulation results are obtained when short-duration precipitation is represented in the input data. A 15-minute record for Providence was thus constructed through combination of 1-minute ASOS data, hourly data disaggregated to 15-minute intervals using NetSTORM, and the daily dataset. The 1-minute data on its own is adequate for use much of the time, but there are occasional periods when the ASOS data is incomplete. For example, 47.1 inches of precipitation are recorded in the 2010 ASOS, while the hourly data recorded 53.0 inches and the daily measurements totaled 53.5 inches.

In summary, while TF Green Airport records less average annual precipitation than is measured in Norwich, the overall pattern of storms in Providence is comparable with Norwich, and TF Green has the most reliable long-term data in the region. A consecutive three-year period from 2009-2011 at Providence was selected to represent average conditions in Norwich. The 54.85-inch precipitation total for 2009 at Providence matches Norwich's 54.81 inch 1981-2010 normal, and the 56.72-inch total for 2011 is close to EPA's 56.39 inch projected mid-century estimate for a median climate change scenario. The middle year of the three, 2010, had 53.54 inches of precipitation, slightly below Norwich's normal, but includes an extremely large storm that can be expected to produce CSO even in most remediation scenarios.

Section 5
Wet Weather Flows

5.1 General

This section characterizes combined sewer overflow (CSO) discharges under various wet weather conditions. The model described in Section 3 was used to simulate wet weather flow at 14 CSO locations for the six design storms and the three-year representative period described in Section 4. Further design storm simulations will be used to identify the costs and benefits of CSO mitigation in the updated Long-Term Control Plan (LTCP). The representative period is used to generate annual CSO statistics and will be used to confirm control level conformance.

5.2 Modeling Approach

As described in Section 3, a model of the Norwich collection system was developed and calibrated. River boundary conditions were not included in the design storm assessment since the river does affect CSO under average conditions. River boundary conditions were included in the representative period assessment to reflect actual conditions during the three-year period. The current conditions sanitary flow used for calibration is also used for the baseline conditions assessment. The baseline conditions assessment uses average monthly groundwater infiltration based on water pollution control facility (WPCF) flows from 2014-2016.

5.3 CSO Discharge

5.3.1 Design Condition CSO Flows

The 1-month, 3-month, 6-month, 1-year, 2-year, and 5-year design storms were applied to the collection system model. Peak flows and total volumes for each design storm are summarized by CSO outfall in **Table 5-1**. System-wide CSO volume ranges from 0.93 million gallons (Mgal) for the 1-month storm to 6.33 Mgal for the 5-year storm.

Figure 5-1 and **Figure 5-2** respectively show peak flows and volumes at each CSO. Approximately half of the total CSO discharges at CSO 017, upstream of Rose Alley pumping station, with the percentage of total flow increasing for smaller design storms. Relatively large CSOs also occur at 024, 023, 019, and 018 on the Shetucket interceptor. The trends in CSO peak flows and volumes are similar; the CSOs with the five largest volumes also exhibit the highest peak flows.

The total peak flow in **Table 5-1** sums the peak flows from each CSO; this is an approximation, as peak flows do not occur concurrently for each CSO. However, the peaks for each CSO typically occurred within 15 minutes of each other for each storm, so the total shown in **Table 5-1** is close to the actual peak.

Table 5-1 Baseline Conditions Design Storm CSO Summary

	Peak Flow (mgd)						Volume (Mgal)					
CSO	1-mo.	3-mo.	6-mo.	1-year	2-year	5-year	1-mo.	3-mo.	6-mo.	1-year	2-year	5-year
004	1	4	7	8	19	12	0.01	0.04	0.11	0.12	0.28	0.27
005	<1	<1	<1	1	1	1	<0.01	0.01	0.02	0.03	0.04	0.05
017	14	16	31	34	35	43	0.67	1.19	1.82	2.25	2.72	2.86
018	3	5	7	8	10	14	0.03	0.09	0.16	0.21	0.34	0.37
019	3	6	9	10	12	19	0.03	0.08	0.17	0.22	0.36	0.45
021	<1	2	2	2	2	8	<0.01	0.01	0.02	0.01	0.02	0.12
022	2	4	6	7	8	10	0.01	0.04	0.09	0.12	0.21	0.25
023	5	9	13	14	16	21	0.07	0.18	0.32	0.42	0.66	0.72
024	4	8	14	15	19	26	0.06	0.14	0.27	0.34	0.53	0.62
025	1	2	4	5	5	8	0.04	0.08	0.14	0.17	0.23	0.26
029	0	<1	<1	<1	1	2	0	<0.01	<0.01	<0.01	0.01	0.02
031	<1	2	4	6	6	8	<0.01	0.02	0.06	0.09	0.17	0.21
032	0	1	3	4	5	9	0	<0.01	0.03	0.04	0.07	0.12
040	0	0	0	<1	<1	1	0	0	0	<0.01	<0.01	<0.01
Total	**32**	**61**	**102**	**116**	**140**	**183**	**0.93**	**1.89**	**3.19**	**4.02**	**5.65**	**6.33**

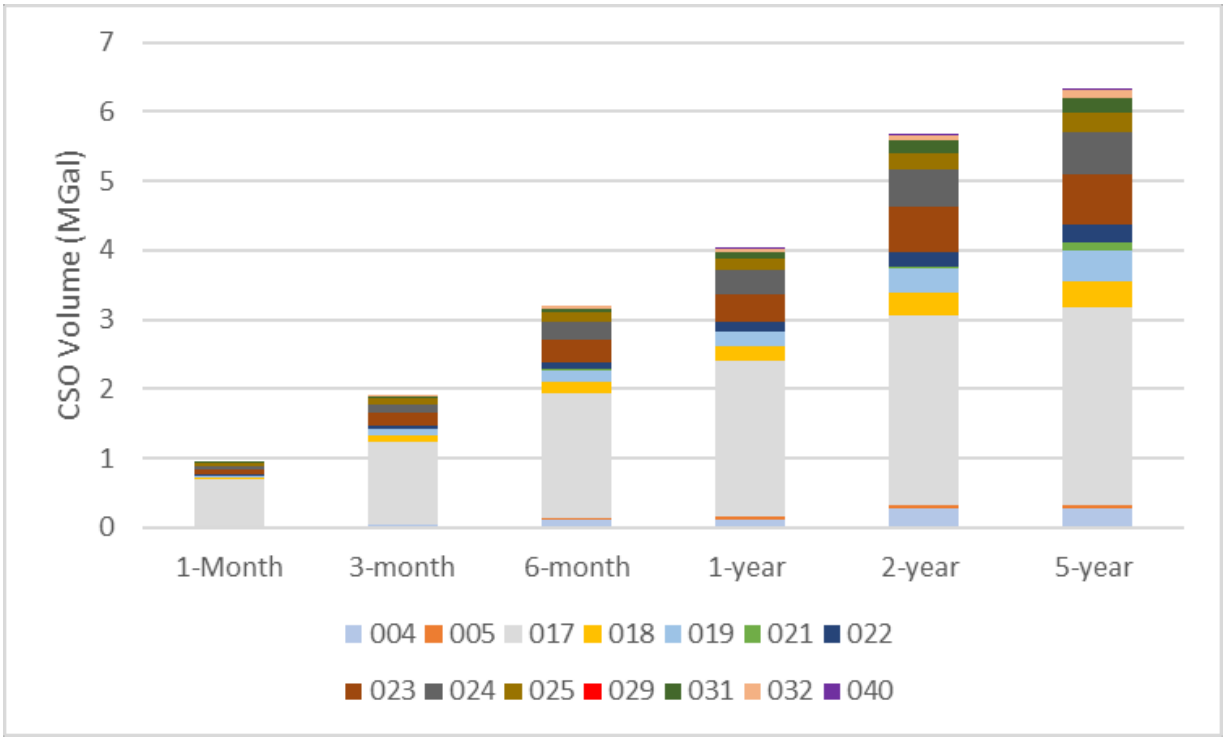


Figure 5-1 Baseline Conditions Design Storm CSO Volume

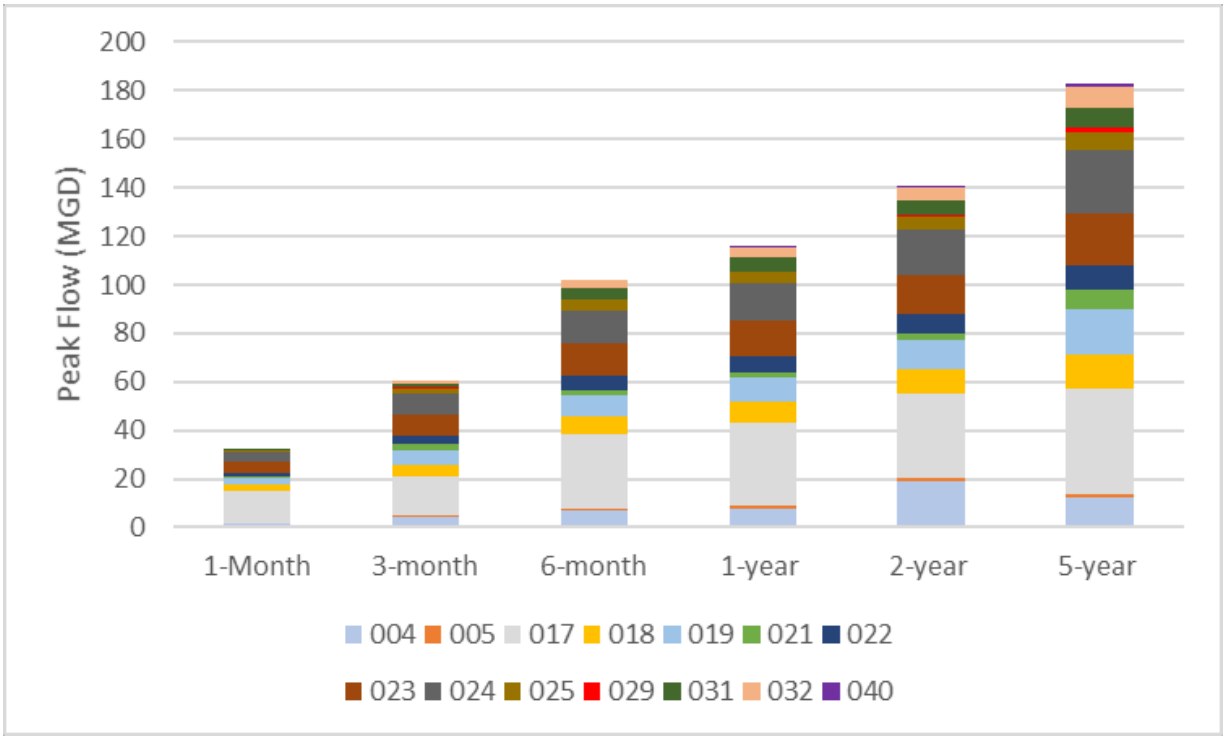


Figure 5-2 Baseline Conditions Design Storm Peak Flows

5.3.2 Annual CSO Statistics

This section summarizes CSO over the 2009 to 2011 representative period. Annual CSO volume ranged from 40.1 Mgal in 2009 to 48.7 Mgal in 2010, with an average annual CSO volume of 43.3 Mgal (**Table 5-2**). CSO was highest for 2010, despite that year having the lowest total precipitation and event count; 2010 results were influenced by the extreme event on March 29-30, 2010, during which 27% of the annual CSO occurred (13.2 Mgal).

Table 5-2 Representative Period Summary

Year	Volume (Mgal)	Number of Events	Duration (hrs)	Precipitation (in)
2009	40.1	57	359	54.9
2010	48.7	52	340	53.5
2011	41.1	71	367	56.7
Average	43.3	60	355	55.0

CSO volumes, event counts, and total event durations are summarized by CSO in **Table 5-3** for each year in the representative period and for the average of this period. Total event duration and counts shown are the maximum duration and count at any CSO. This assumes that CSO at other locations overlapped with the CSO at the most active locations.

Table 5-3 Representative Period CSO

	Volume (Mgal)				Number of Events				Duration (hrs)			
CSO	2009	2010	2011	**Average**	2009	2010	2011	**Average**	2009	2010	2011	**Average**
004	0.93	0.88	0.98	**0.93**	25	22	28	**25**	55	42	64	**53**
005	0.15	0.18	0.15	**0.16**	17	13	14	**15**	21	31	32	**28**
017	23.34	30.7	23.72	**25.92**	36	42	71	**50**	169	228	259	**218**
018	2.21	2.36	2.24	**2.27**	44	39	53	**45**	188	207	204	**200**
019	2.16	2.36	2.28	**2.27**	42	37	48	**42**	135	169	153	**153**
021	0.22	0.16	0.15	**0.18**	12	13	13	**13**	11	10	17	**12**
022	1.01	1.04	1.04	**1.03**	36	33	38	**36**	94	136	105	**112**
023	4.11	4.45	4.06	**4.2**	46	40	51	**46**	182	231	216	**210**
024	3.5	3.83	3.71	**3.68**	51	46	55	**51**	234	262	270	**255**
025	1.88	2.12	2	**2**	57	52	60	**56**	359	340	367	**355**
029	0.02	0.01	0.04	**0.02**	5	5	5	**5**	3	4	2	**3**
031	0.43	0.44	0.49	**0.45**	14	15	13	**14**	17	41	33	**30**
032	0.17	0.15	0.25	**0.19**	6	6	11	**8**	6	4	6	**5**
040	<0.01	<0.01	0.02	**0.01**	1	1	1	**1**	<1	<1	<1	**0**
Total	**40.12**	**48.68**	**41.13**	**43.31**	**57**	**52**	**71**	**56**	**359**	**340**	**367**	**355**

Table 5-4 compares CSO estimates using the updated model with estimates from the 2012 LTCP. The updated model estimates 42% less total CSO than the 2012 LTCP update. While the updated representative period averages 55.0 inches of precipitation annually, 36% more than the 40.28 inches of precipitation in the 2012 LTCP typical year (**Table 5-2**), CSO volume is significantly lower due to the updated model's improved representation of system hydrology.

In addition to the differences in the formulation of the typical year, differences in estimated CSO discharge between the updated and previous model are due to the model updates described in Section 3.4 and the updated calibration with 2017 flow data. The updated model incorporates additional survey and field verification of key information at regulators and significant points in the system such as flow splits. The updated model also is calibrated to metering data from spring, summer, and fall, whereas the previous model was primarily calibrated to a single storm.

Table 5-4 Annual CSO Statistics for LTCP Update and 2012 LTCP

	Volume (Mgal)		Number of Events	Overflow Days
NPDES	Update	2012 LTCP	Update	2012 LTCP
004	0.93	5.1	25	25
005	0.16	3.3	15	24
017	25.9	52.5	50	58
018	2.3	0.1	45	1
019	2.3	4.4	42	78
021	0.18	1[1]	13	57
022	1.0	0	36	0
023	4.2	26.3	46	90
024	3.7	1.5	51	23
025	2.0	8[1]	56	23
029	0.02	0.3	5	2
031	0.45	0.4	14	2
032	0.19	0.3	8	2
040	<0.01	0.2	1	1
Total	**43.3**	**103.3**	**60**	**90**

[1] Volume reported to the nearest integer value in the 2012 LTCP.

5.4 Percent Capture

The three-year baseline simulation was analyzed to compute wet weather percent capture. Capture was characterized according to the following equation:

$$\text{Capture} = 1 - \text{CSO} / (\text{WPCF Wet Weather Flow} + \text{CSO})$$

Timeseries of precipitation, WPCF flow, CSO, and system runoff were reviewed to ensure a good definition of wet weather. From 2009 to 2011, storms at Providence occurred for 1,040 hours per year (based on a 12-hour interevent time); 815 of these hours were during storms with at least one-quarter inch of precipitation. Since not all precipitation produces runoff, runoff was compared with WPCF flow, and a runoff threshold of 0.1 mgd was identified to define wet weather. Using this definition yields an average annual wet weather duration of 771 hours (32 days). All CSO occurred during the defined wet weather period.

Annual average WPCF wet weather flow was calculated as 249 Mgal (average flow to the WPCF during wet weather of 7.8 mgd), yielding 85 percent average wet weather capture.

Section 6

Receiving Water Quality and Impact Analysis

6.1 Introduction

To assess water quality impacts of combined sewer overflow (CSO) discharges from Norwich on the Shetucket River and Thames River Estuary, it is first necessary to understand existing water quality conditions and identify how the river system is being used. The water quality assessment consists of the following measures:

- Evaluate existing water quality classification and its definition;
- Identify current water uses and impairments of these uses;
- Determine impacts of CSO discharges on water quality.

By identifying river classifications, current uses and future goals, it is possible to assess CSO impacts on water quality.

6.2 Water Quality Classification of Receiving Waters

This Baseline Conditions Report summarizes CSO discharges and impacts to receiving waters for prioritizing and quantifying sewer system improvements. The water quality classification information is based on the *2016 Integrated Water Quality Report* (IWQR) published by Connecticut Department of Environmental Protection (CT DEEP) in April 2017. The report is included as Appendix G.

CT DEEP assesses water quality for each waterbody based on designated uses and whether or not its waters are suitable for those uses. The levels of support used in the assessment as defined in the IWQR are:

- Fully Supporting: The designated use is fully achieved in the waterbody
- Not Supporting: The designated use is not supported in the waterbody
- Insufficient Information: Insufficient data/information available to support an evaluation of attainment of designated uses in the waterbody
- Not Assessed: No current readily available information is available to assess use support

Waterbodies are evaluated for recreation; habitat for fish and other aquatic life and wildlife; fish consumption; shellfish harvesting for direct human consumption; commercial shellfish harvesting; existing or proposed drinking water supplies; potential drinking water supplies; navigation; water supply for industry; and agriculture. Waterbodies are categorized as AA, A, B, SA, and SB waters. The following list summarizes the classifications:

Class AA - Inland water source of uniform good to excellent quality. These waters are very close to natural quality with designated uses that include drinking water supply, fish and wildlife habitat, recreational use (may be restricted), agricultural and industrial supply.

Class A - Inland water source of uniform good to excellent quality. Inland Surface water is known or presumed to meet Water Quality Criteria which support designated uses, which may include potential drinking water supply; fish and wildlife habitat; recreational use; agricultural, industrial supply and other legitimate uses, including navigation.

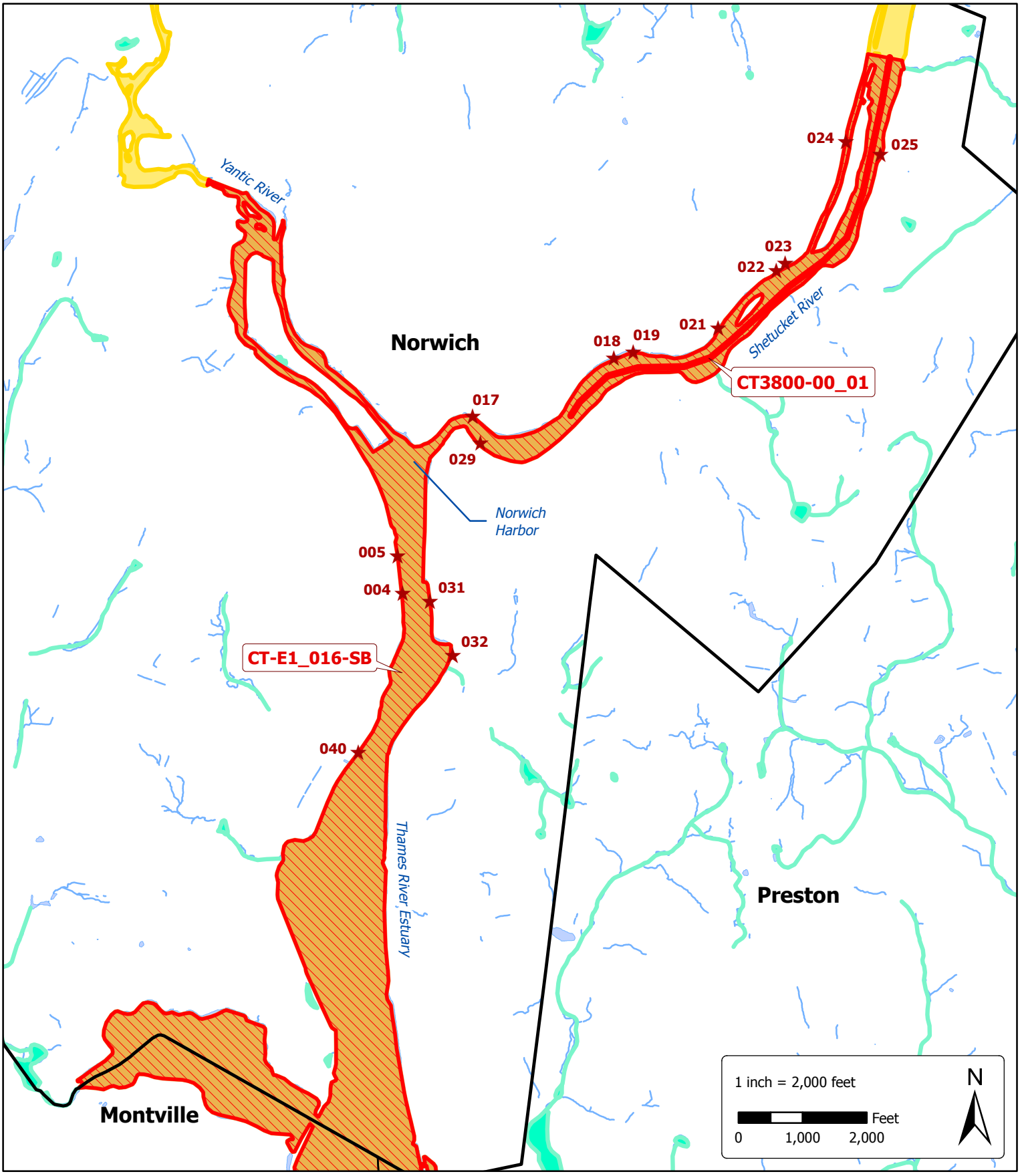
Class B - Inland surface water source that may be of good to excellent quality. Uses include fishing, swimming, and recreation, industrial supply, and agricultural use. These waters generally have a healthy aquatic habitat, are generally rivers or large streams, and may have point source wastewater discharge.

Class SA - Coastal or marine surface water of uniform good to excellent quality. These waters are very close to natural quality. Uses include fishing, swimming, and recreation. These waters are a healthy marine habitat, and direct shellfish consumption is possible. These waters usually do not accept treated wastewater.

Class SB - Coastal or marine surface water of uniform good quality. Uses include fishing, swimming, and recreation, industrial supply, commercial shellfish harvesting (may require purification). These waters generally have a healthy marine habitat, and may have point source wastewater discharges.

Norwich CSOs discharge to the Shetucket River and the Thames River Estuary. The Thames River from Norwich to the confluence with Long Island Sound is the major receiving water for this study. Connecticut Water Quality Classifications in the vicinity of the study area are shown in **Figure 6-1**. This figure was produced using GIS data provided by CT DEEP. According to the map, the water bodies are classified as follows and the Thames River Estuary overlaps the Shetucket River. Both the Shetucket River and the Thames River (Upper) Estuary are designated Class SB.

The IWQR classifies Norwich's receiving waters as impaired because they are not meeting their intended use. The next section summarizes the impaired uses and the potential cause and/or source of the impairment.



Water Quality Classifications and Impaired Waters

- A
- B, B*
- SB
- Impaired River (2016)
- Impaired Estuary (2016)
- CSO Outfall

CDM Smith

Baseline Conditions Report
Norwich Public Utilities

Figure 6-1
CT Water Quality Classifications and Impaired Waters

6.3 Receiving Water Uses

Typically, a waterbody's usage depends on its current classification, which dictates the quality of the water to support such uses. Classification goals are assigned based on desired future uses. Current uses of the Shetucket River and the Thames River Estuary are listed below.

6.3.1 Shetucket River

The Shetucket River drains southwesterly through the City of Norwich to its confluence with the Yantic River in Norwich Harbor. The section of the Shetucket River from the Route 2 (Main St) bridge crossing upstream to the Greeneville Dam is identified as CT3800-00_01. Downstream of the Route 2 bridge, it is known as the Thames River.

In Norwich, the Shetucket River is affected by tidal waters and was determined by CT DEEP not to support recreation due to high Escherichia coli (E. coli) counts. Potential sources of E. coli include stormwater, illicit discharges, and CSO. The quality of aquatic life in this section of the river has not been assessed and there is no assigned total maximum daily load (TMDL). Since the river is not meeting the intended use, it is an impaired water. In the IWQR, CT DEEP identifies the Shetucket in Norwich as a waterbody that will have an action plan developed by 2022. The primary indicator of river impairment to be addressed in the action plan is E. coli. However, additional causes or pollutants may be added based on available information and resources.

Seven active Norwich CSOs discharge to the Shetucket River (CSOs 018, 019, 021, 022, 023, 024 and 025) based on CT DEEP GIS mapping, as shown in **Figure 6-1**. The National Pollutant Discharge Elimination System permit identifies two additional CSOs as discharging to the Shetucket River, which are CSOs 017 and 029, current mapping shows those outfalls discharging to the Thames River Estuary.

6.3.2 Thames River and Estuary

The Thames River discharges southerly from the confluence of the Yantic and Shetucket Rivers in Norwich Harbor to Long Island Sound. Based on the IWQR river descriptions, the upper portion of the Thames River in Norwich starts at the first dams upstream of the confluence; the boundary between the Yantic and the Thames River is located at the Route 82 (West Main Street) bridge, and the boundary between the Shetucket River and the Thames River is located at the Route 2 (Main Street) bridge. The Thames River in Norwich is identified as estuarine segment CT-E1_016-SB. Based on the CT DEEP GIS mapping, the Thames River Estuary overlaps a portion of the Shetucket and the Yantic Rivers in Norwich, as shown in **Figure 6-1**.

The Thames River Estuary is a tidally influenced marine waterbody classified as "SB" determined by CT DEEP not to be supporting aquatic life, recreation, and shellfish harvesting. Thames River impairments are listed below.

- Recreation impairment caused by Enterococci bacteria that is potentially from stormwater, municipal discharges, landfills, illicit discharges, insufficient on-site treatment/ septic systems, and/or CSO.

- Commercial Shellfish Harvesting (where authorized) impairment caused by fecal coliform that is potentially from stormwater, municipal discharges, landfills, illicit discharges, insufficient on-site treatment/ septic systems, and/or CSO.
- Habitat for Marine Fish, other Aquatic Life and Wildlife impairment caused by dissolved oxygen saturation, estuarine bioassessments, nutrient/eutrophication biological indicators, and dissolved oxygen that is potentially from stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems, and/or CSO.

In the IWQR, CT DEEP lists the Thames River Estuary in Norwich on its priority list of waters for action plan development, including TMDL development. Expected plan completion was 2017; CT DEEP currently anticipates that a draft TMDL for the Thames River Estuary will be issued in 2018. The TMDL will be reviewed as part of future CSO LTCP updates.

Based on the CT DEEP delineation of the Thames River Estuary overlapping the Shetucket River in Norwich, all of Norwich's CSO outfalls and the permitted outfalls from the WPCF discharge to the Thames River Estuary. Since the impairments to the estuary are more severe than those for the Shetucket River, it is expected that the water quality requirements for the estuary will govern. The locations of the outfalls and extents of the Thames River Estuary are shown in **Figure 6-1**.

6.4 Status of Water Bodies

Section 303(d) of the Federal Clean Water Act requires each state to identify waterbodies that are not expected to meet surface water quality standards after implementation of technology-based controls or best management practices. Those water bodies are listed on the 303(d) list. TMDLs are to be developed to identify daily pollutant loading limits to enable these waterbodies to meet standards in the future through appropriate load allocation and reduction. This list is to be updated every two years. The most recent update was produced by CT DEEP in 2016 as part of the IWQR and approved by EPA on June 8, 2017. The EPA approval letter and IWQR are included in Appendix G.

The two most important elements to be considered when developing the list are designated uses of the water body and specific water quality criteria necessary to support these designated uses. The assessment is made by comparing physical, chemical, and biological data to numeric and written criteria specified in the Connecticut Water Quality Standards.

The Shetucket River and Thames River Estuary are on the state 303(d) list and are "Category 5" waterbodies. Category 5 is defined as an assessed waterbody where "available data and/or information indicate that one or more designated uses are not being supported and a TMDL or Action Plan is needed" (IWQR, Table 3-4: Connecticut Impaired Waters List).

6.5 2012 LTCP Shetucket and Thames River Water Quality Impact Analysis

The 2012 LTCP evaluated CSO impact on the receiving waters. Field work for water quality analysis was performed in 2007 and 2008 to meet the original 2009 LTCP deadline. That analysis and its conclusions are summarized below.

6.5.1 Receiving Waterbodies Description

The Shetucket River is a fast-moving fresh water river that discharges to the Thames River at Norwich Harbor. The Thames River is a deep tidal river that has a fresh water layer over a saline water wedge.

6.5.2 Aquatic Life Assessment

In 2007, sediment, benthic invertebrates, and 394 fish were collected in the vicinity of the CSO outfalls and analyzed. It was found that quality of aquatic life varied across the samples; variations were attributed to habitat based on water depth and sediment type. The study concluded that aquatic life quality in the Shetucket and Thames Rivers was not related to proximity to the CSO outfalls.

6.5.3 Water Quality Assessment

A water quality monitoring program assessed the impact of Norwich CSOs on water quality and set baseline conditions for the receiving waterbodies in 2008. The comprehensive program included dry and wet weather sampling, land-based and boat-based sampling, and sampling upstream and downstream of CSO outfalls. NPU followed a CT DEEP-approved work plan to delineate mixing zones and conduct a zone of influence analysis. The programs focused on assessing the areal extent of bacterial contamination downstream of the CSOs on the Thames River and the length of time bacterial concentrations were elevated following CSO events.

Wet weather sampling was performed during three storms in 2008 at 11 locations upstream and downstream of Norwich CSOs. Samples were analyzed in the field for dissolved oxygen, conductivity, temperature, and pH. Lab testing analyzed samples for fecal coliform, E. coli, Enterococci, total suspended solids, 5-day BOD, orthophosphate, nitrite, nitrate, total Kjeldahl nitrogen (TKN), and ammonia-N. Samples were taken at the same locations during one dry weather period.

During the wet weather sampling program, samples were also collected at select CSO outfalls and stormwater discharges. This information was used to project the pollutant loadings to the river. Twenty-two flow meters and seven automatic samplers collected flow information at CSO outfalls along with grab samples for bacteria.

In the 2012 LTCP, a mass balance approach was used to track inputs and removal of bacteria from the three rivers and the CSO outfalls. For the three monitored storms, it was estimated that CSOs contributed 40% of the E. coli., 25% of fecal coliform bacteria, and were a minor component of Enterococci loading to the Thames River Estuary.

6.5.4 Plume Modeling

A plume analysis was performed as part of the 2012 LTCP to define the extent and duration of CSO plumes in the Thames River. The CORMIX mixing zone model was used to simulate Norwich CSO discharges. The inputs to the model included physical characteristics of the outfall, effluent data, receiving water data, measured concentrations of parameters of concern in the receiving water, salinity and temperature data near the outfall, flow data, and cross-section profiles. The modeling was used to determine the zone of influence of the CSO plumes.

Modeling indicated that the zone of impact for Norwich CSO discharges on the Thames River is approximately 50 feet wide and extends 1,100 yards below the outfalls. In general, 10-20 % of the width of the Thames River is affected near the outfalls.

6.5.5 Water Quality Impact Conclusions from 2012 LTCP

This section summarizes the water quality conclusions from the 2012 LTCP as approved by CT DEEP. A complete summary of the water quality program is included in Appendix H:

- A water quality monitoring program was conducted in 2008 to establish baseline conditions and assess the impact on water quality from CSOs in Norwich.
- The transition between fresh and brackish water is normally about 10 feet below the water surface in Norwich Harbor. During wet weather, stormwater causes the fresh water layer to increase to up to 20 feet in depth.
- pH and dissolved oxygen in the saline portion of the Thames River were below water quality standards, but the cause does not appear to be CSO-related because the problems also occurred during dry weather.
- Bacteria levels in the rivers upstream of Norwich CSOs can exceed water quality criteria for days after a storm. This was primarily attributed to nonpoint source runoff. During wet weather, CSOs contributed less than half the bacteria loading in the receiving waters. Even if all CSOs in Norwich were eliminated, the Shetucket and Thames Rivers would not meet bacteria water quality standards.
- Norwich CSOs contribute significantly to bacteria levels in the receiving waters during storms. However, bacteria levels recede relatively quickly after wet weather events. In the Thames River, bacteria counts downstream of CSOs returned to background levels within one to three days after storms.
- The only water quality parameter that Norwich CSOs were found to significantly influence was bacteria. The CSOs are not significant sources of nitrogen or phosphorus in the Shetucket and Thames Rivers.
- Mixing zone modeling indicates a CSO plume discharge will be about 50 feet wide and extend 1,100 yards below the outfall. Although the dissolved oxygen level in the CSO discharges is low, the area with depressed dissolved oxygen will be small because of the high dilution factor and relatively low volume of CSO discharge. The narrow band of CSO influence should not block passage of fish or free-floating organisms in the Thames.

Appendix A

Short-term Flow Metering Program Memorandum

Memorandum

To: *Mr. Larry Sullivan P.E*
Norwich Public Utilities

From: *Craig Wagner P.E., BCEE, CDM Smith*

Date: *November 2017*

Subject: *Norwich Metering Program – Final Metering Locations, Short-Term Program*

Background

CDM Smith developed a temporary flow metering program to support data collection and sewer model calibration for the ongoing Revised Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) effort. The metering program was developed through review of the Norwich Public Utilities (NPU) GIS data, the existing sewer model (developed by a previous engineer), and the best available system schematics and drawings. NPU staff also assisted with the program through their real-world knowledge of the collection system.

The final locations of the sewer flow meters varied slightly from the original plan due to differences between the GIS mapping and actual field conditions and because some sewer manholes were not hydraulically conducive to accurate flow measurement. Flow meter locations were moved upstream or downstream to find a reliable data collection points, as needed. In some cases, multiple probes were connected to a single meter. In other cases, only depth could be measured. Ultimately 25 flow meters were installed, and we have high confidence that this configuration provided useful data to be used for sewer model calibration and LTCP alternatives evaluation.

Short-Term Meter Installation

After a few days of field exploration and on-site planning, Flow Assessment Services, LLC installed the 25 meters between April 10 and April 21, 2017. Eleven flow meters measure sewer flow in key interceptors, and fourteen meters measure sewer flow in the CSO regulator chambers in the dry weather pipes. Three rain gauges were installed throughout the city to collect rainfall data.

Sewer flow was metered in the Shetucket Interceptor north of 8th Street, upstream of the Rose Alley Pumping Station. Flow from the Yantic Interceptor was measured near Backus Hospital, and again near Hollyhock Island. The Thamesville Interceptor was monitored near the pumping station on Terminal Way. Flow to the Tallman Street Pumping Station was monitored in the wet well, and flow in the Laurel Hill interceptor was characterized after it combines with the Shetucket Interceptor at Rose Alley. In addition to these six major interceptor locations, in-system flow was measured at five

other locations within the system. These included meters that monitored flow at 8th Street, Bath Street, Franklin Street, Golden Street, and Main Street. Fourteen additional meters characterize events at or near the overflow regulator chambers. The sewer meter locations are shown on the map provided as Attachment A.

Rain gauges were installed at three locations in Norwich to monitor the rainfall volumes which provided local rain data to be incorporated into the model. The first site was the Solids Processing Building at the Norwich Water Pollution Control Facility (WPCF). This gauge was placed on the northeastern side of the roof of the building. The second site was the roof of the Norwich Public Utilities headquarters on South Golden Street. This gauge was place on the highest point on the eastern half of the building. The third site was the pumping station on Forestview Drive. The rain gauge was placed on top of the pumping station control panel, within the locked fence. The three gauges were spread across the city and show a cohesive picture of storm activity within city limits. The rain gauge locations are shown on Attachment B.

The primary intent of short-term flow metering program was to collect data for sewer model update and calibration. Initially, we intended that this early program could extend for twelve weeks from the time that the meter network was operational. It was understood that the program may need to extend longer if we didn't get sufficient rain events. Conversely, the program could be shortened if sufficient rain events occurred early in the program. Typically, we look to have a minimum of three storms of at least one-inch of rain in the metering period. Four storms would increase confidence, and potentially help offset any bad data points from a given storm. It is understood that capturing five or more significant storms (one-inch of rain or more) is deemed unnecessary.

Sufficient rainfall was achieved shortly after the short-term meters were installed. It was determined that enough quality data was recorded to calibrate the meter from these storms. The short-term metering program was therefore reduced to a five-week program and concluded on May 26th, 2017. After completion of this program, meter orientation was adjusted for the long-term metering program. Sixteen sewer flow meters were installed for the long-term program, this is described in a separate memorandum.

The final meter installation locations are presented in the table in Attachment C, which describes the final placement of all the meters and what type of data we can expect from each meter. Individual GIS location diagrams for each installation can also be seen in Attachment D. Flow Assessment Services provided a set of field installations sketches of the flow meter and rain gauge installations that are included as Attachment E. Green Site Design LLC provided survey sketches of the CSO regulator chambers which are included as Attachment F.

Long-Term Overflow Monitoring

At the conclusion of the short-term metering program, the focus of metering shifted to monitoring the occurrence and duration of combined sewer overflows at each of the 14 permitted overflow outfall locations in the Norwich collection system. Selected meters were moved to directly monitor the outfall pipe. Other meters remained in service in their current location because they were already able to monitor overflows effectively. It is intended that overflows would be monitored for the remainder of the intended 12-month period.

At two locations, there are two CSO regulators contributing to a single outfall. These are at Rose Alley (CSO 017) and CSO 019. As a result, 16 meters were needed for the long-term monitoring period. CDM Smith coordinated with Flow Assessment Services on long-term metering locations.

Attachments

Attachment A: Meter Location Map

Attachment B: Rain Gauge Map

Attachment C: Meter Placement Table

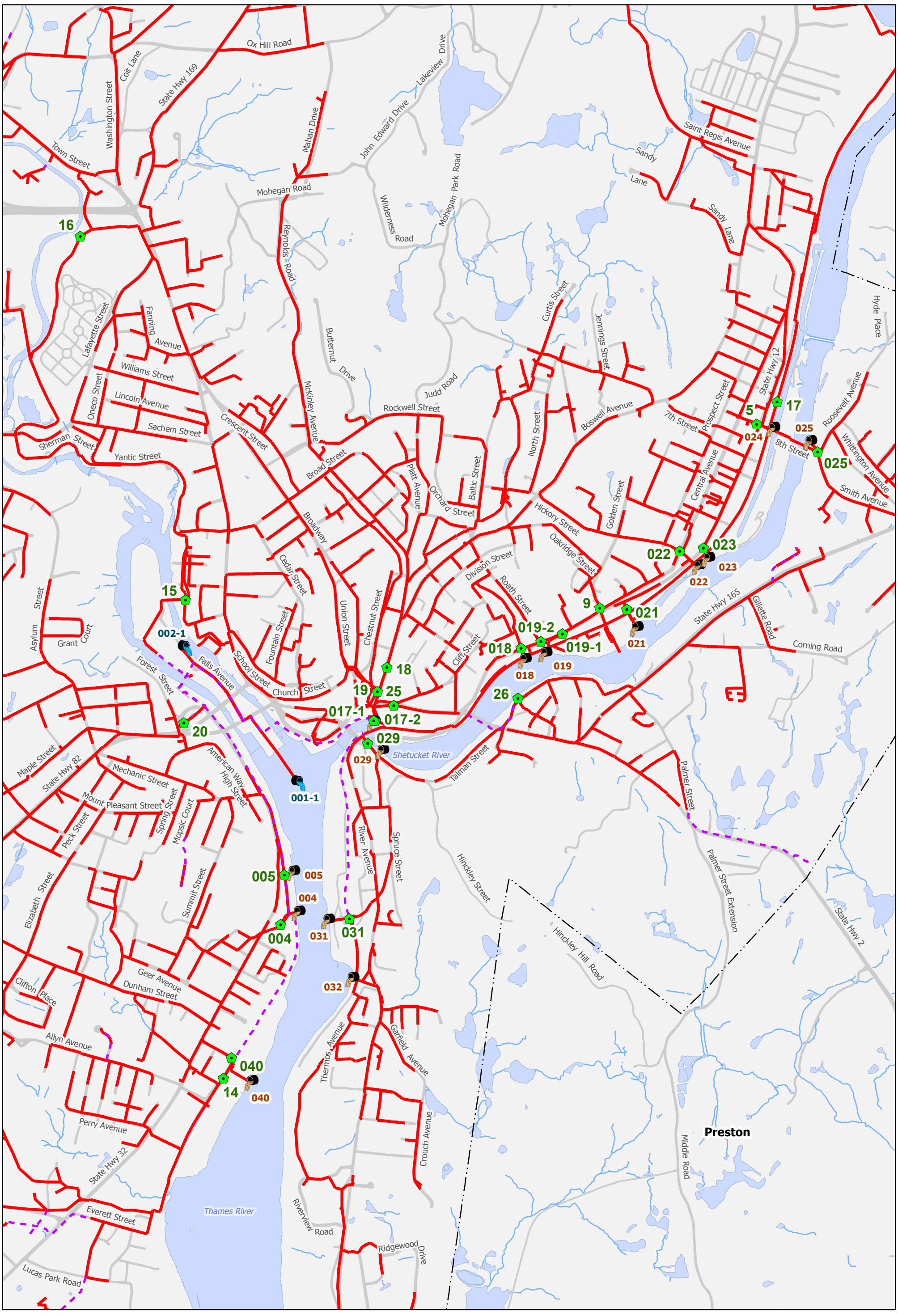
Attachment D: Individual Meter Maps

Attachment E: Flow Meter Installation Diagrams

Attachment F: CSO Regulator Survey Sketches

Attachment A

Meter Location Map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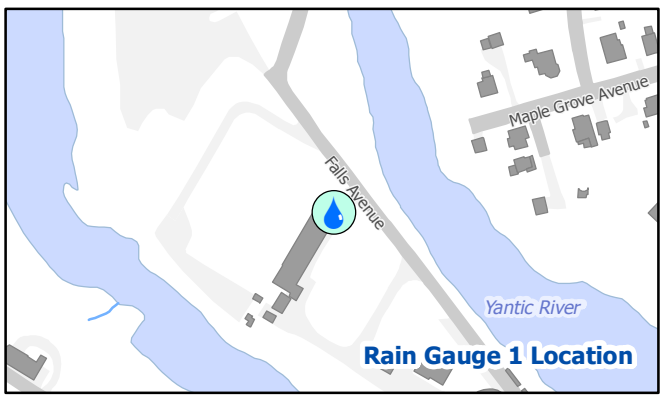
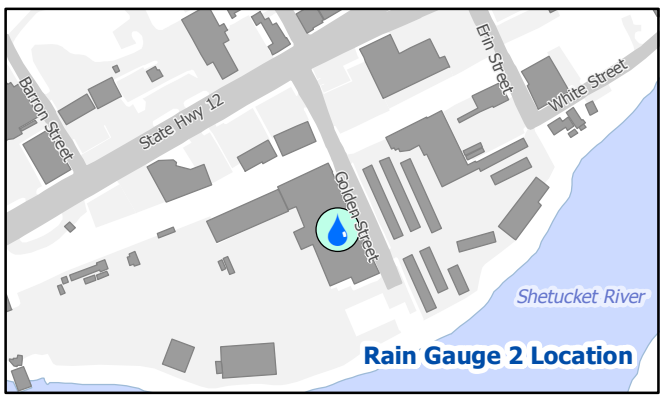
Coit Lane
State Hwy 169
Washington Street
Town Street
Mahan Drive
John Edward Drive
Lakeview Drive
Mohegan Road
Wilderness Road
Mohegan Park Road
Saint Regis Avenue
Sandy Lane
Sandy Lane
Reynolds Road
Butternut Drive
Curtis Street
Jennings Street
Hyde Place
Lafayette Street
Fanning Avenue
Williams Street
Lincoln Avenue
Sachem Street
Yantic Street
Oneco Street
Sherman Street
Crescent Street
McKinley Avenue
Judd Road
Rockwell Street
Broad Street
North Street
Boswell Avenue
7th Street
Prospect Street
State Hwy 12
8th Street
Roosevelt Avenue
Whittington Avenue
Smith Avenue
Central Avenue
Platt Avenue
Orchard Street
Baltic Street
Hickory Street
Golden Street
Oakridge Street
Division Street
Roath Street
Cliff Street
Chestnut Street
Union Street
Cedar Street
Fountain Street
Broadway
Asylum Street
Grant Court
Forest Street
Falls Avenue
School Street
Church Street
American Way
High Street
Mechanic Street
Mount Pleasant Street
Spring Street
Mopsic Court
Peck Street
Maple Street
State Hwy 82
Elizabeth Street
Summit Street
River Avenue
Spruce Street
Talman Street
Palmer Street
Palmer Street Extension
Hinckley Street
Hinckley Hill Road
State Hwy 2
State Hwy 165
Gillette Road
Corning Road
Middle Road
Preston
Geer Avenue
Dunham Street
Clifton Place
Allyn Avenue
Perry Avenue
State Hwy 32
Everett Street
Lucas Park Road
Thames River
Shetucket River
Riverview Road
Ridgewood Drive
Thermos Avenue
Garfield Avenue
Crouch Avenue
16
15
002-1
20
001-1
005
004
031
032
040
14
18
19
25
017-1
017-2
029
026
018
019-2
019-1
019
021
9
022
023
5
024
025
17
Legend
CSO Outfall
WPCF Outfall
Sewer
Force Main
Scale
N
Feet
0
625
1,250
Norwich, Connecticut
Metering Program
Meter Map
Attachment A
CDM Smith

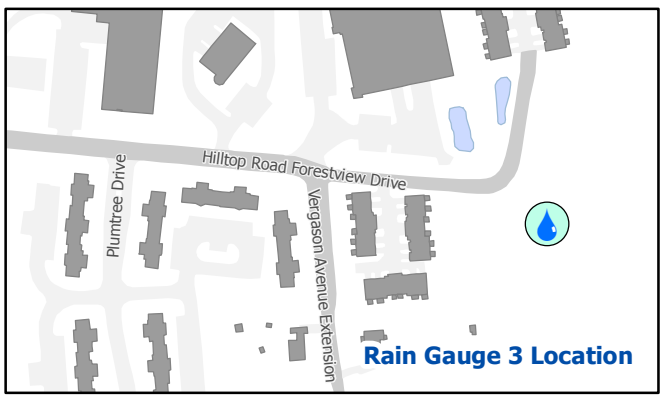
Attachment B

Rain Gauge Map

Rain Gauge 3
Stott Avenue
Lefty Dugas Drive
Vergason Avenue Extension
Plain Hill Road
Bog Meadow Road
Meadowbrook Road
Adams Drive
Caribou Drive
Lawler Lane
Old Canterbury Turnpike
School Street
Sheas Lane
Connecticut Avenue
Brookside Drive
Vergason Avenue
Huntington Avenue
Tanglewood Drive
Royal Oaks Drive
I 395
Case Street
Scotland Road
Canterbury Turnpike
Flyers Drive
Lambert Drive
Wayne Street
Hunters Road
Reservoir Road
State Hwy 169
Oakland Drive
Oakland Heights
Wightman Avenue
Mediterranean Lane
Gulliver Circle
Clinton Avenue
Wawecus Street
Town Street
Sturtevant Street
Otrobando Avenue
Ox Hill Road
Lakeview Drive
Washington Street
Mahan Drive
John Edward Drive
Mohegan Park Road
Sandy Lane
Exit 28S
Exit 81
Exit 81E
Mohegan Road
Wilderness Road
Reynolds Road
McClellan Avenue
Cranberry Pond Road
Dudley Street
Lafayette Street
Oneco Street
Williams Street
Lincoln Avenue
Sachem Street
Sherman Street
Yantic Street
New London Turnpike
State Hwy 2
Crescent Street
Butternut Drive
Rockwell Street
Judd Road
Boswell Avenue
Baltic Street
North Street
McKinley Avenue
Platt Avenue
Orchard Street
Broad Street
Broadway
Hickory Street
Oakridge Street
Golden Street
Prospect Street
Central Avenue
Division Street
Roath Street
Cedar Street
Union Street
Chestnut Street
Franklin Street
Cliff Street
State Hwy 12
State Hwy 165
Shetucket River
Starr Street
Western Avenue
Asylum Street
Grant Court
Tyler Lane
Green Briar Road
Weber Farm Road
Gifford Street
Newton Street
Alice Street
State Hwy 32
Falls Avenue
Rain Gauge 1
Rain Gauge 2







CDM Smith

Legend

Rain Gauge

Scale

N

Feet

0 750 1,500

Norwich, Connecticut
Metering Program

Attachment B

Rain Gauge Map

Attachment C

Meter Placement Table

Attachment C
Meter Location Table

Meter	Street	Flow Meter Location	Duration	Meter Type	Additional Comments
5	8th St. & North Main Street	36" Shetucket Interceptor	3 months	Flow & Depth	Installed in manhole 2461. This meter measures flow in the upstream 36" pipe, as well as flow over a cascade weir down to the 24" pipe that crosses Main Street.
9	S. Golden St. at NPU Bldg.	15" pipe upstream of regulator	3 months	Flow & Depth	Installed in regulator chamber on the upstream pipe. Overflow pipe is sealed. All flow goes to MH 2656.
14	Terminal Way bet. Shipping and South Sts.	24" Thamesville Interceptor	3 months	Flow & Depth	Installed in manhole 0582 on upstream pipe.
15	Across the river from WWTF	28" Yantic Interceptor	3 months	Flow & Depth	Installed in manhole 0229, on upstream pipe segment from MH 0299.
16	Behind Backus Hosp.	27" Yantic Interceptor	3 months	Flow & Depth	Installed in manhole 2563 on the upstream pipe.
17	North Main Street	36" Shetucket Interceptor	3 months	Flow & Depth	Installed in manhole 2033 on the upstream pipe.
18	Franklin St. north of Willow	18" pipe downstream of MH	3 months	Flow & Depth	Installed in manhole 0180.
19	Bath St. near AT&T Bldg.	30" pipe	3 months	Flow & Depth	Installed in manhole 0750 on the upstream pipe.
20	West Main St.	24" Salem Tpk. Interceptor	3 months	Flow & Depth	Installed in manhole 0971 in the upstream pipe.
25	Main Street	14" pipe downstream of MH 0286	3 months	Flow & Depth	Installed on downstream pipe in MH 0286.
26	Talman St. Ext., bet. Rock and E Main Sts.	18"	3 months	Flow & Depth	Installed on inlet pipe to pump station wet well.
CSO 004	Behind 76 West Thames St.	upstream of regulator	12 months	Flow & Depth	Installed at the regulator chamber on upstream side. Meter will be able to provide flow in the upstream pipe and depth to overflow.
CSO 005	South Thames Street	10" pipe upstream of regulator	12 months	Depth Only	Installed at the regulator chamber. Due to backup from the pump station, flow could not be accurately measured. This meter is only a depth meter to measure flow over the weir.
CSO 017-1	Rose Alley at Cipoletti Weir	Cipoletti Weir upstream of Pump station	12 months	Depth Only	Installed at Cipoletti weir upstream of Rose Alley pump station. An ultrasonic depth sensor was installed above the flow path, and a pressure sensor was installed on the weir wall.
CSO 017-2	North of Rose Alley	42" Shetucket Interceptor	12 months	Flow & Depth	Installed at the end of the 42" interceptor, before it drops down into the box culvet. Depth to flow also measured to determine overflow to the "cut out" overflow in the box culvert.
CSO 018	104-106 North Main St.	24" pipe upstream of regulator	12 months	Flow & Depth	Installed at the regulator chamber from the incoming brick pipe from manhole 1808. Depth sensor installed to measure depth to overflow.
CSO 019-1	North Main St., bet. Barron & Roath Sts.	32" pipe upstream of regulator	12 months	Flow & Depth	Installed at the regulator chamber from the incoming pipe from manhole 3481. Depth sensor installed to measure depth to overflow.
CSO 019-2	Roath St. & North Main St.	24" Overflow Pipe	12 months	Flow & Depth	Installed in the overflow pipe at the Regulator Chamber. Flow conditions were not good enough fo in system flow. This meter should only read a flow value when there is an overflow cresting the weir.
CSO 021	Erin St., north of RR tracks	12" pipe upstream of regulator	12 months	Flow & Depth	Installed at the regulator chamber, on the upstream pipe. Depth metered to measure depth to overflow.
CSO 022	North Main St. (1)	24" pipe upstream of regulator	3 months	Flow & Depth	Installed in manhole 1959 on Central Avenue. The flow at the regulator chamber wasn't conducive to flow monitoring. This meter was moved upstream. This will need to be moved for the long term program.
CSO 023	352 North Main St.	36" pipe upstream of regulator	12 months	Flow & Depth	Installed in regulator chamber on the upstream pipe. Depth to flow measured to determine overflow intervals.
CSO 025	8th St., at Roosevelt & Smith Sts.	24" pipe upstream of regulator	12 months	Flow & Depth	Installed in the regulator chamber. The incoming 24 inch pipe was metered for flow, and a depth meter was installed to measure depth for overflow over weir.
CSO 029	Talman St., bet. Spruce St. and Viaduct Rd.	15"	3 months	Flow & Depth	Installed in MH 1607 downstream of regulator. Flow was not meterable in the regulator chamber. This is only metering In-system flow. This will need to be moved for the long term metering program.
CSO 031	Rte. 12 Bus Station Parking Lot (2)	15" pipe upstream of regulator	12 months	Flow & Depth	Installed within the regulator chamber. The upstream pipe was metered for flow, and a depth meter was installed to determine depth to overflow the weir.
CSO 040	Shipping St. & Terminal Way	12" pipe upstream of regulator	12 months	Flow & Depth	Installed within the regulator chamber. The upstream pipe was metered for flow, and a depth meter was installed to determine depth to overflow the weir.

Attachment D

Individual Meter Maps

CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

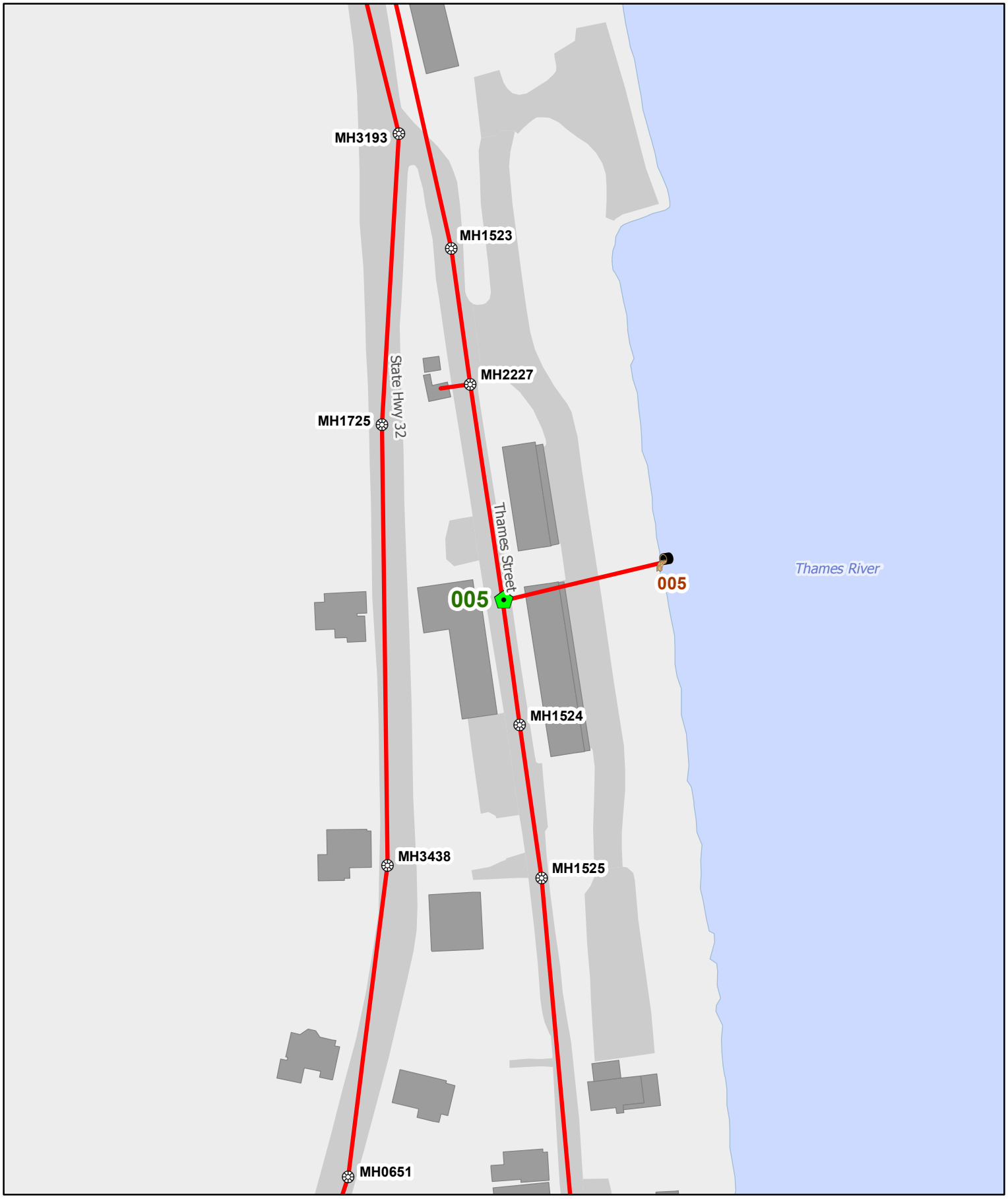
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 004
Attachment D



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

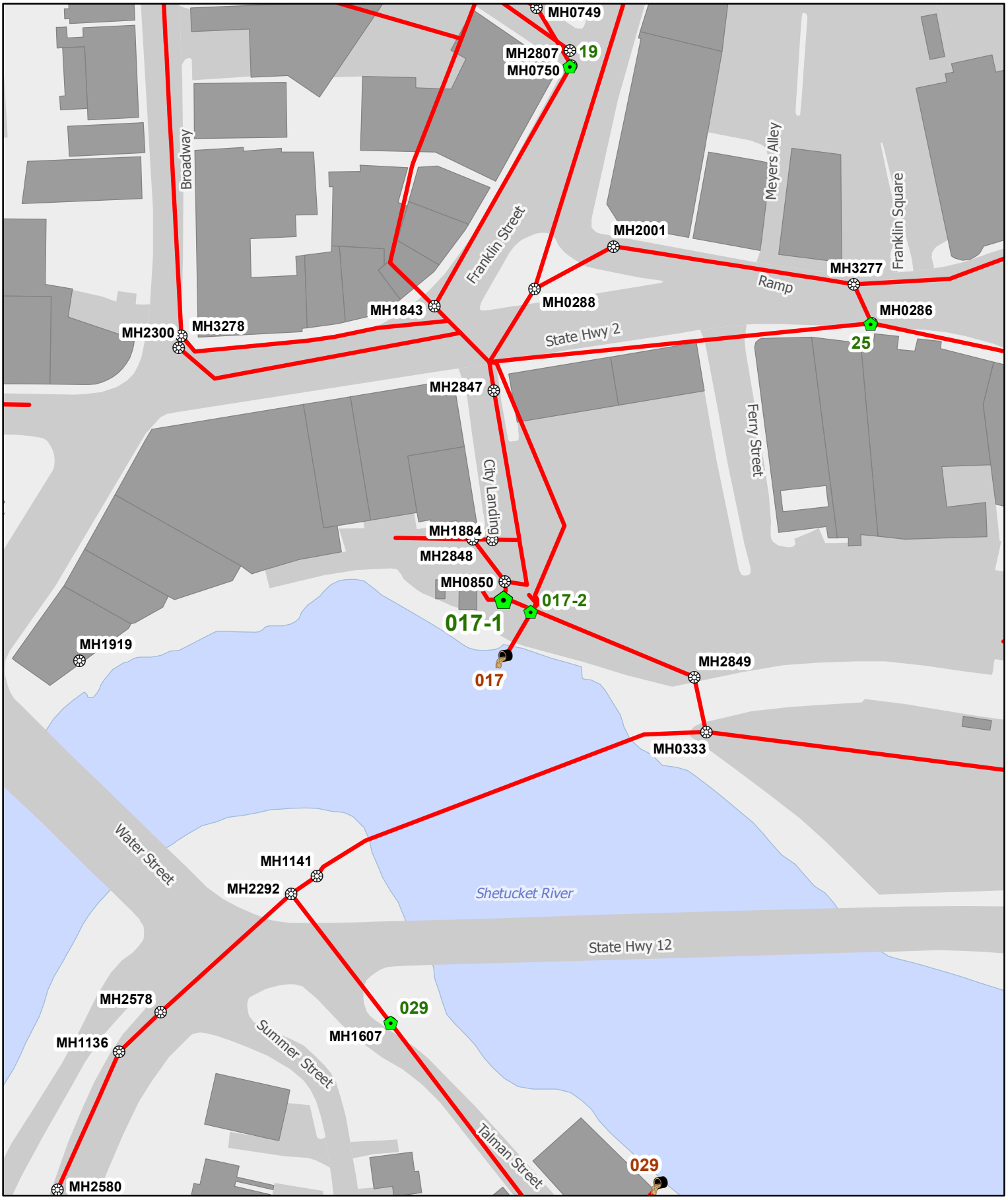
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 005
Attachment D



CDM Smith

Legend

Meter · Manhole · CSO · Pipe

Scale

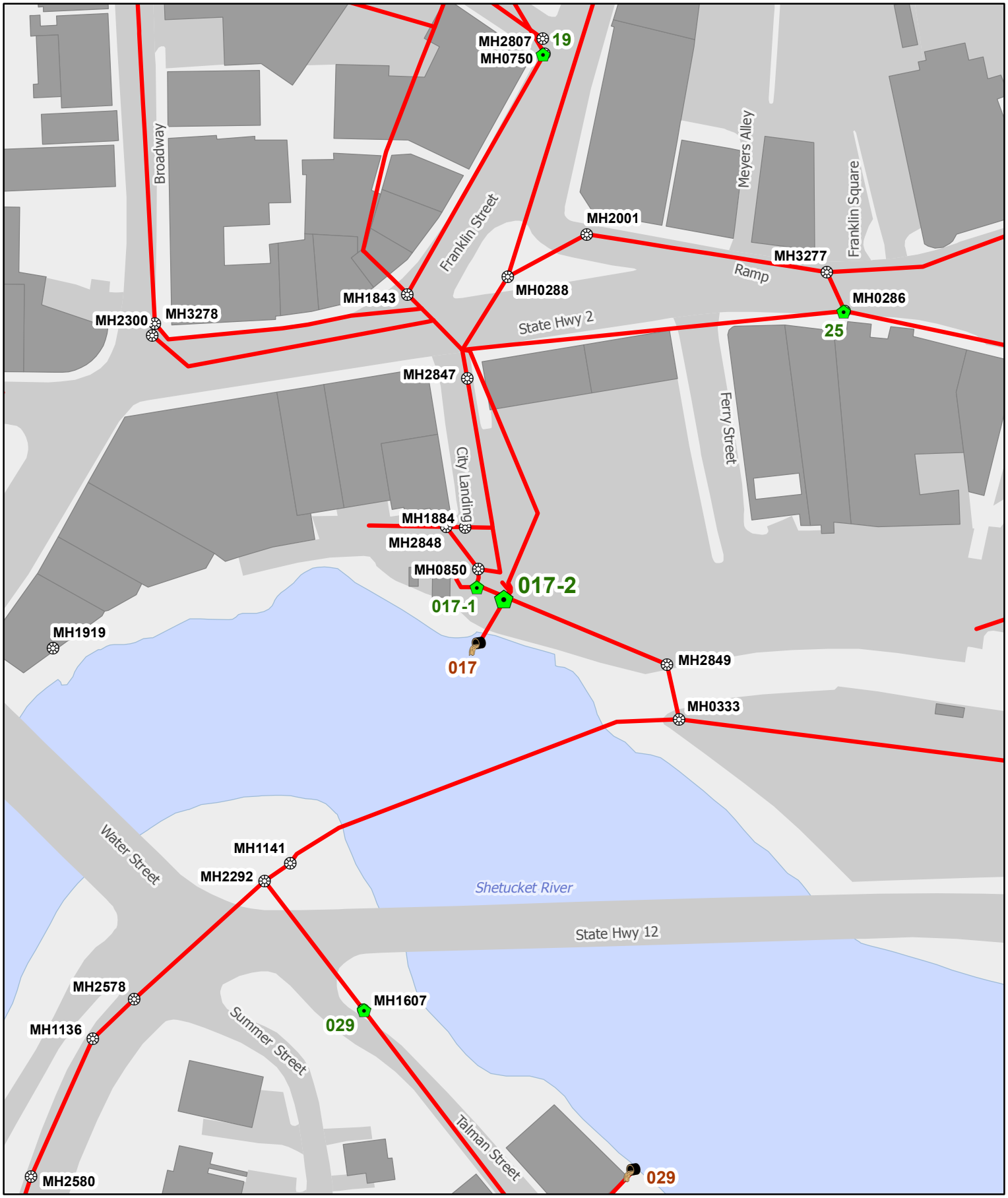
1 inch = 100 feet

0 50 100 Feet

N

Norwich, Connecticut
Metering Program

Meter 017-1
Attachment D



CDM Smith

Legend

Meter | Manhole | CSO | Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 017-2
Attachment D

CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 018
Attachment D

CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

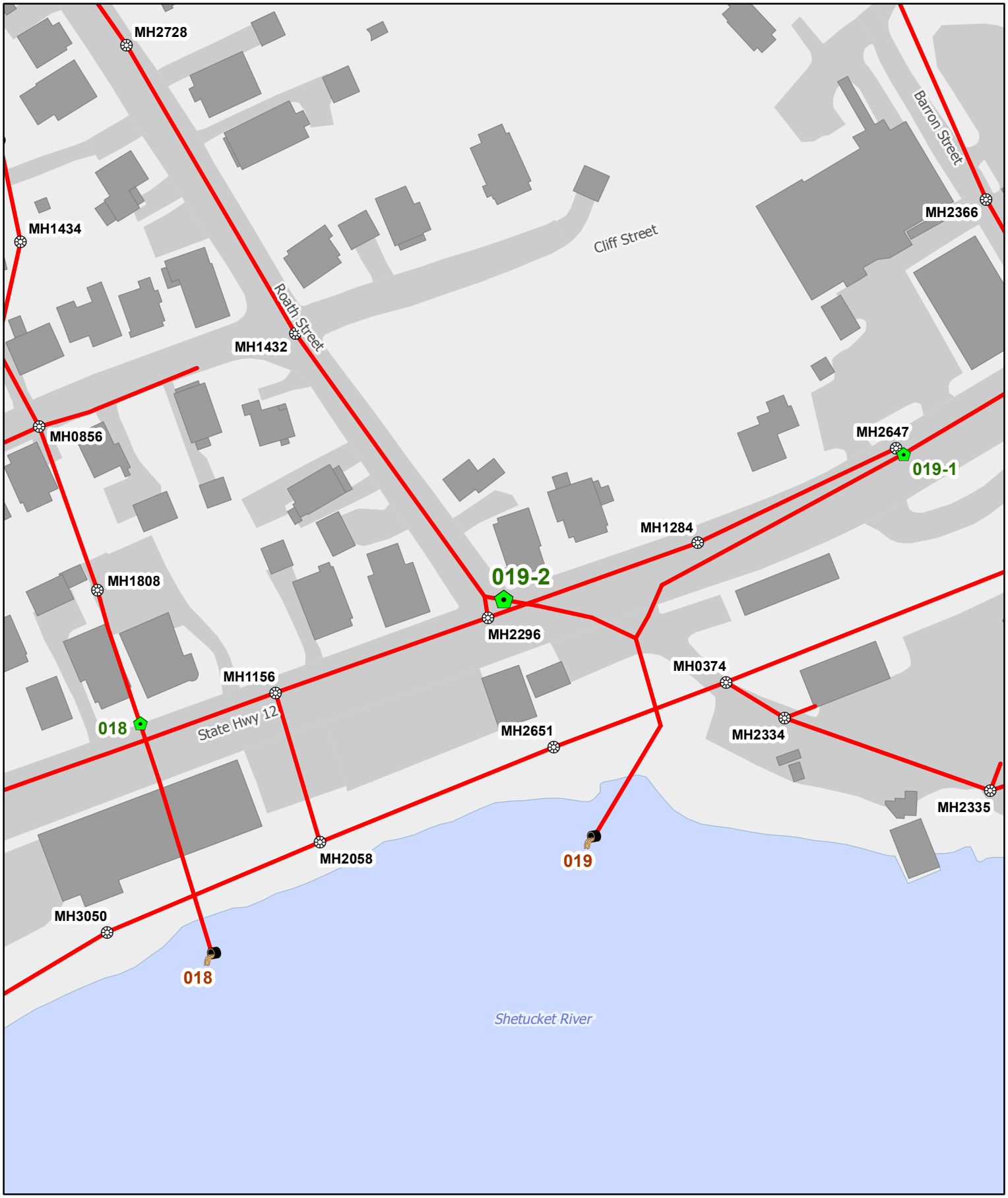
1 inch = 100 feet

N

Feet
0 50 100

Norwich, Connecticut
Metering Program

Meter 019-1
Attachment D



Legend

Meter · Manhole · CSO · Pipe

Scale

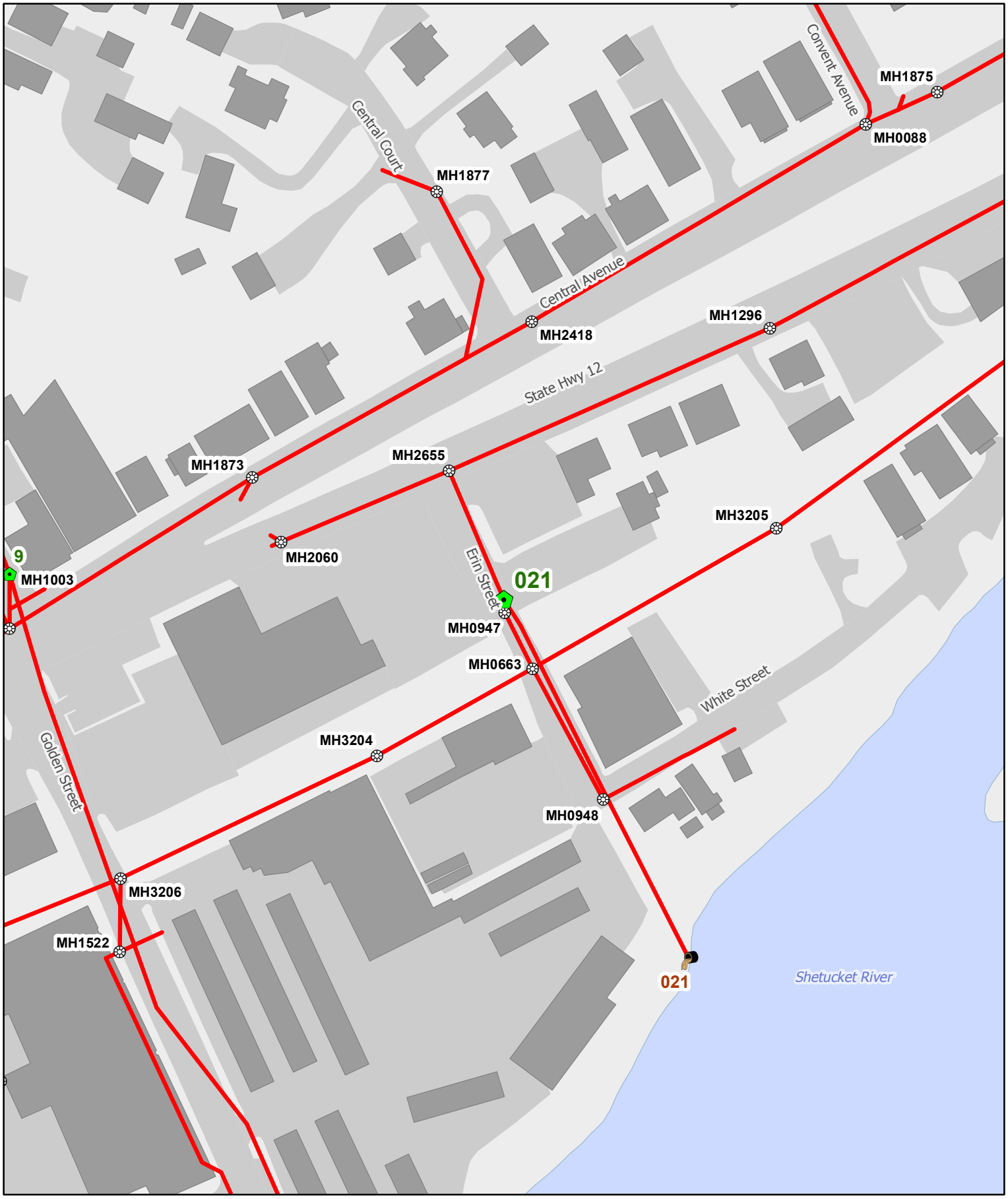
1 inch = 100 feet

0 50 100 Feet

N

Norwich, Connecticut
Metering Program

Meter 019-2
Attachment D



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 021
Attachment D

CDM Smith

Legend

Meter | Manhole | CSO | Pipe

Scale

1 inch = 100 feet

0 50 100 Feet

N

Norwich, Connecticut
Metering Program

Meter 022
Attachment D

CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

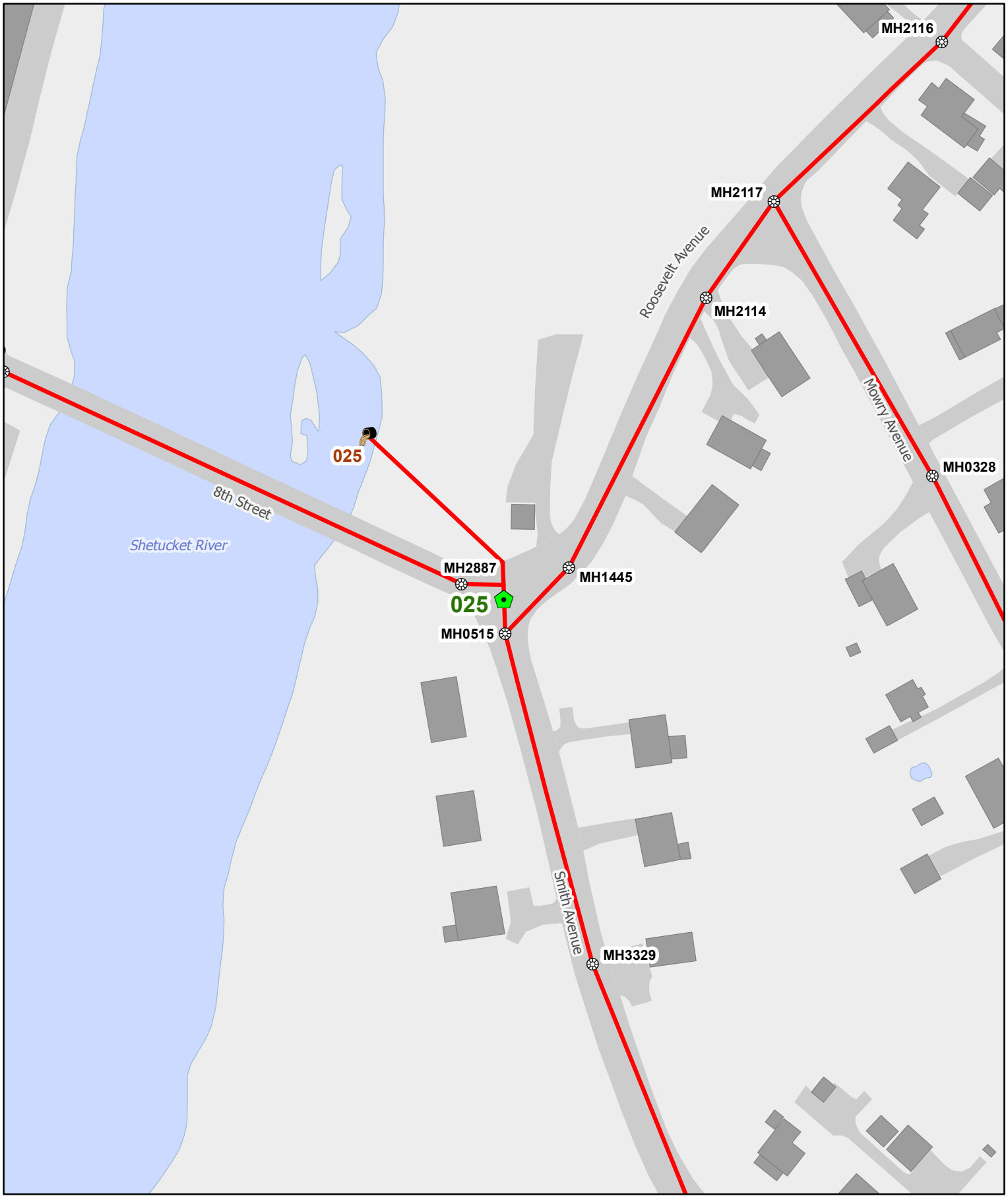
N

Feet

0 50 100

Norwich, Connecticut
Metering Program

Meter 023
Attachment D



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

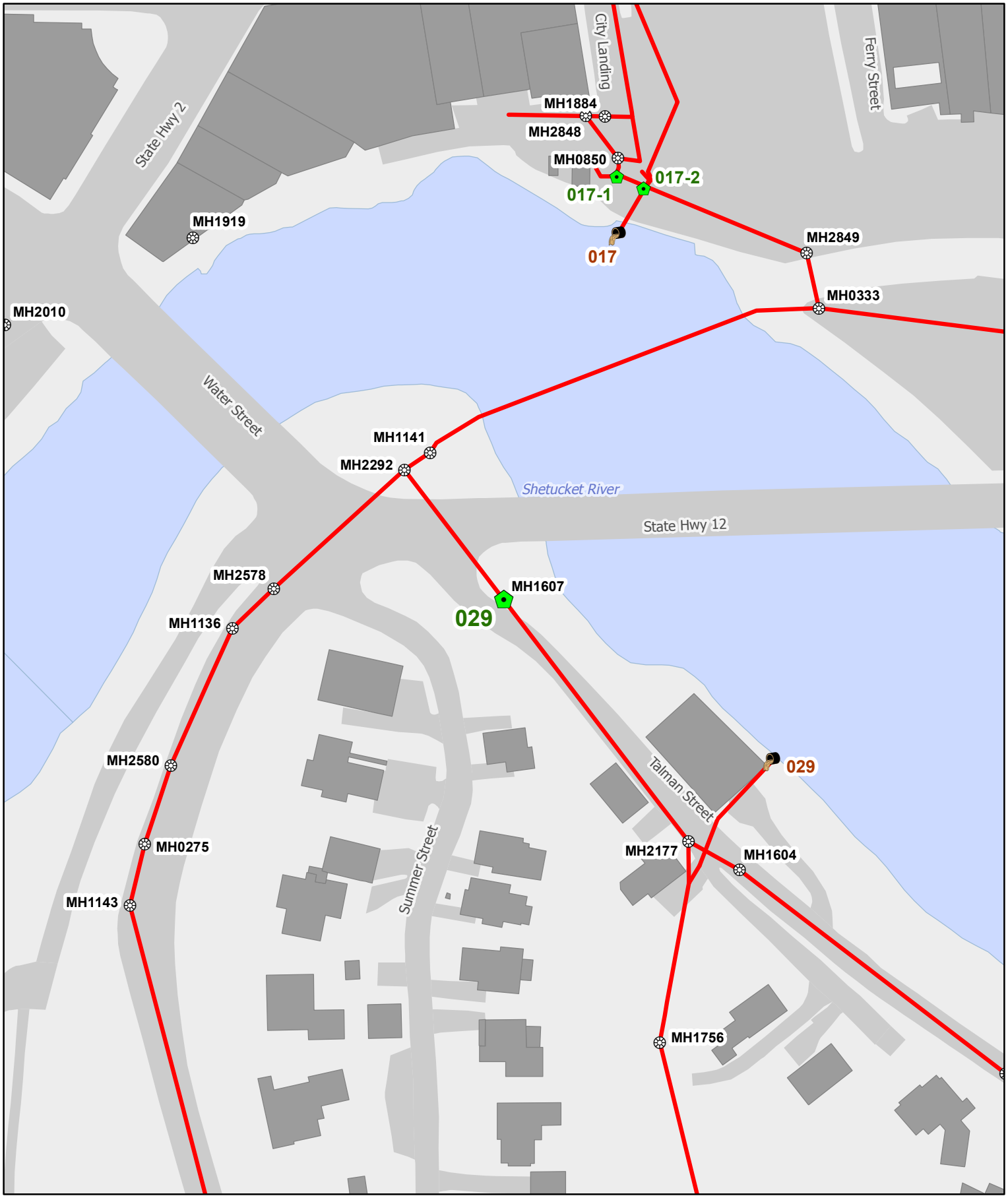
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 025
Attachment D



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

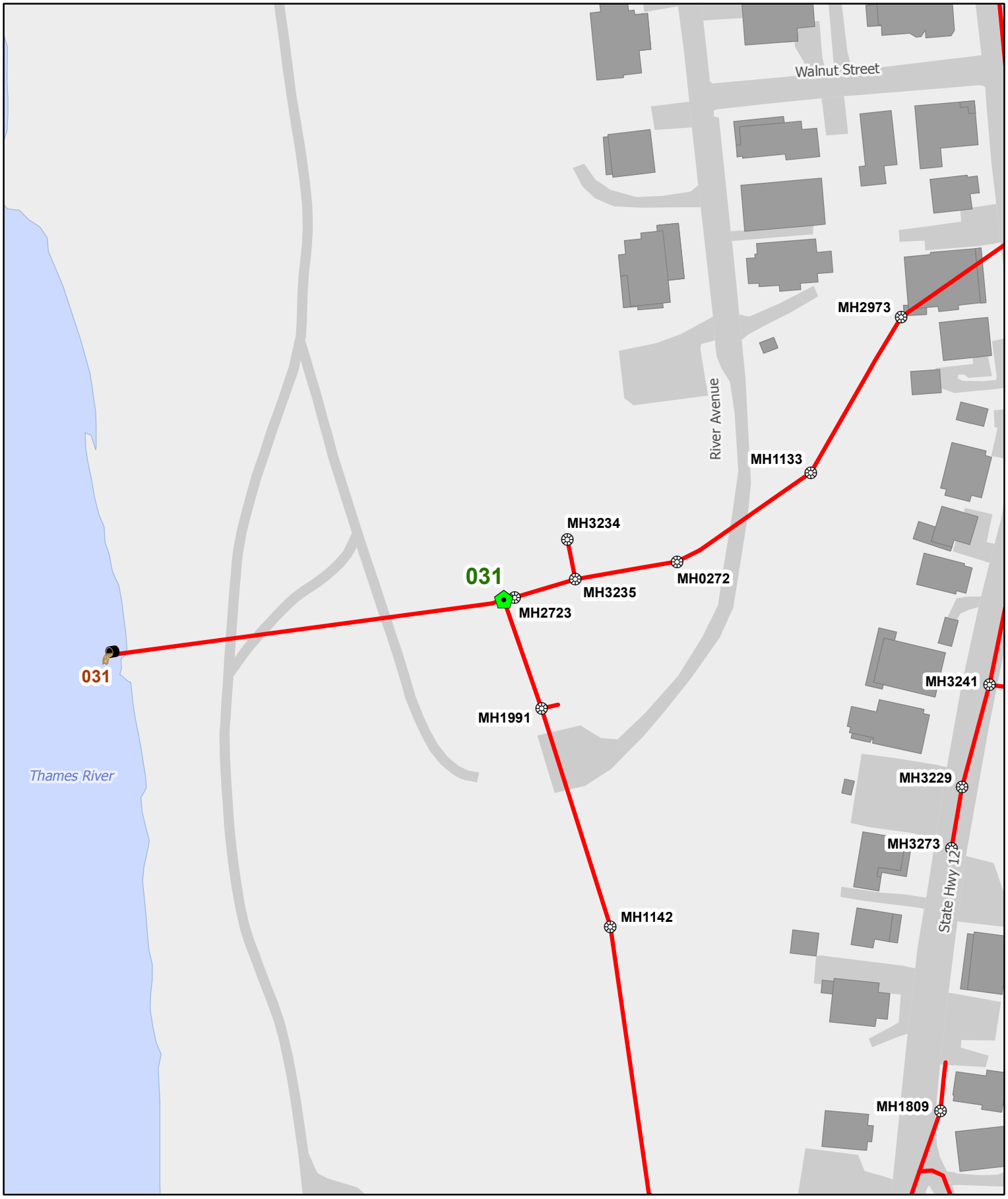
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 029
Attachment D



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

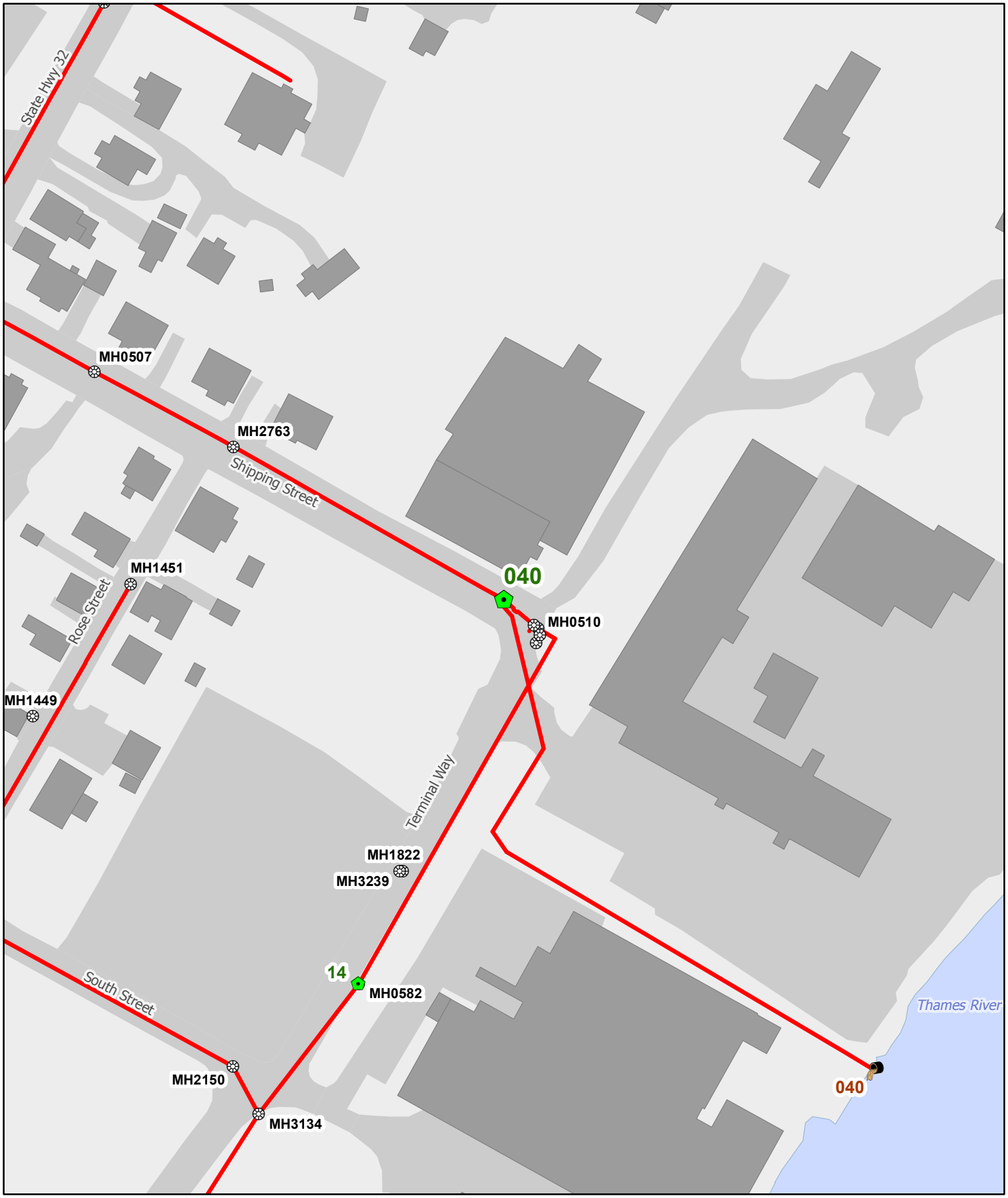
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 031
Attachment D



CDM Smith

Legend

Meter | Manhole | CSO | Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 040
Attachment D

CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

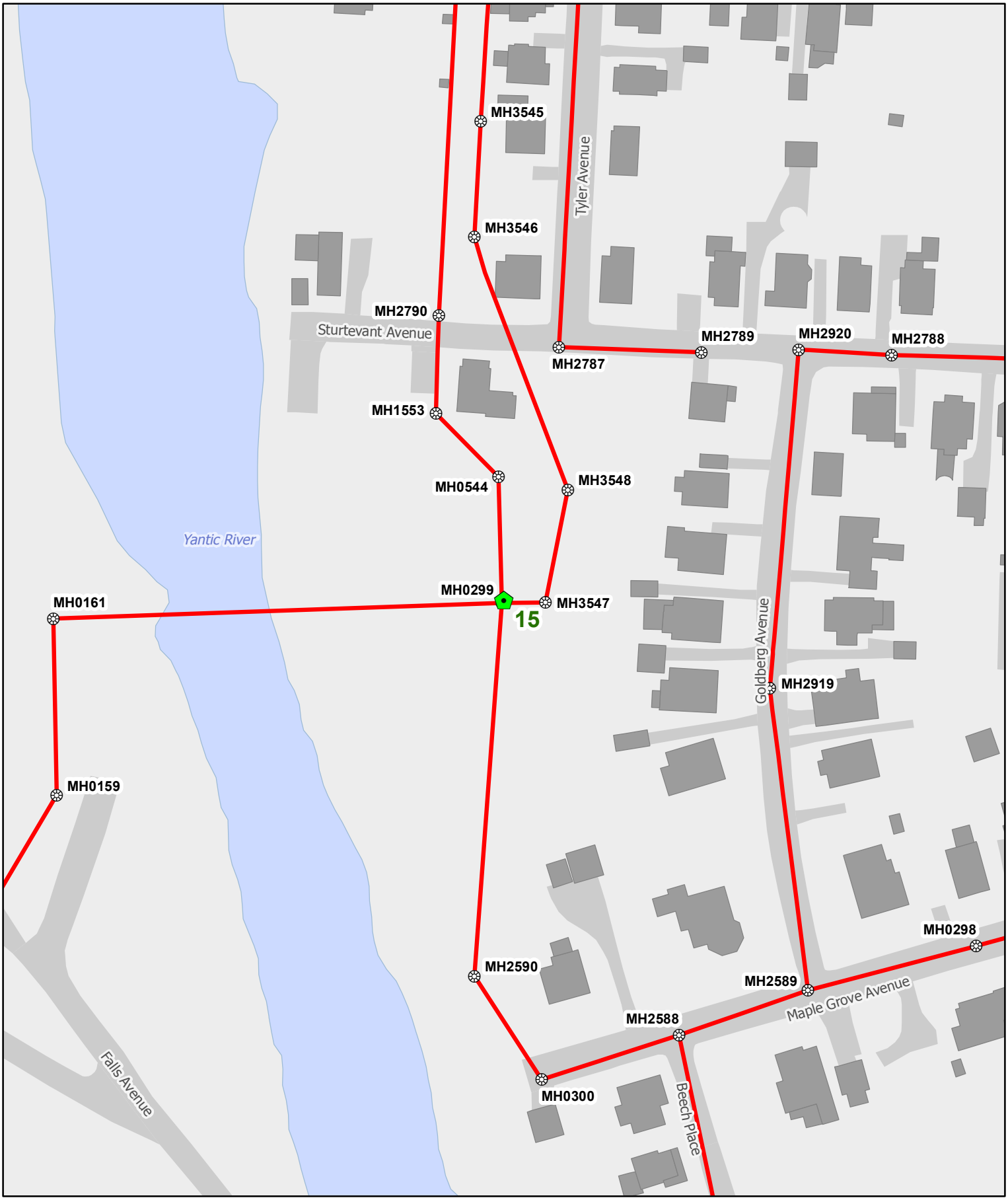
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 14
Attachment D



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

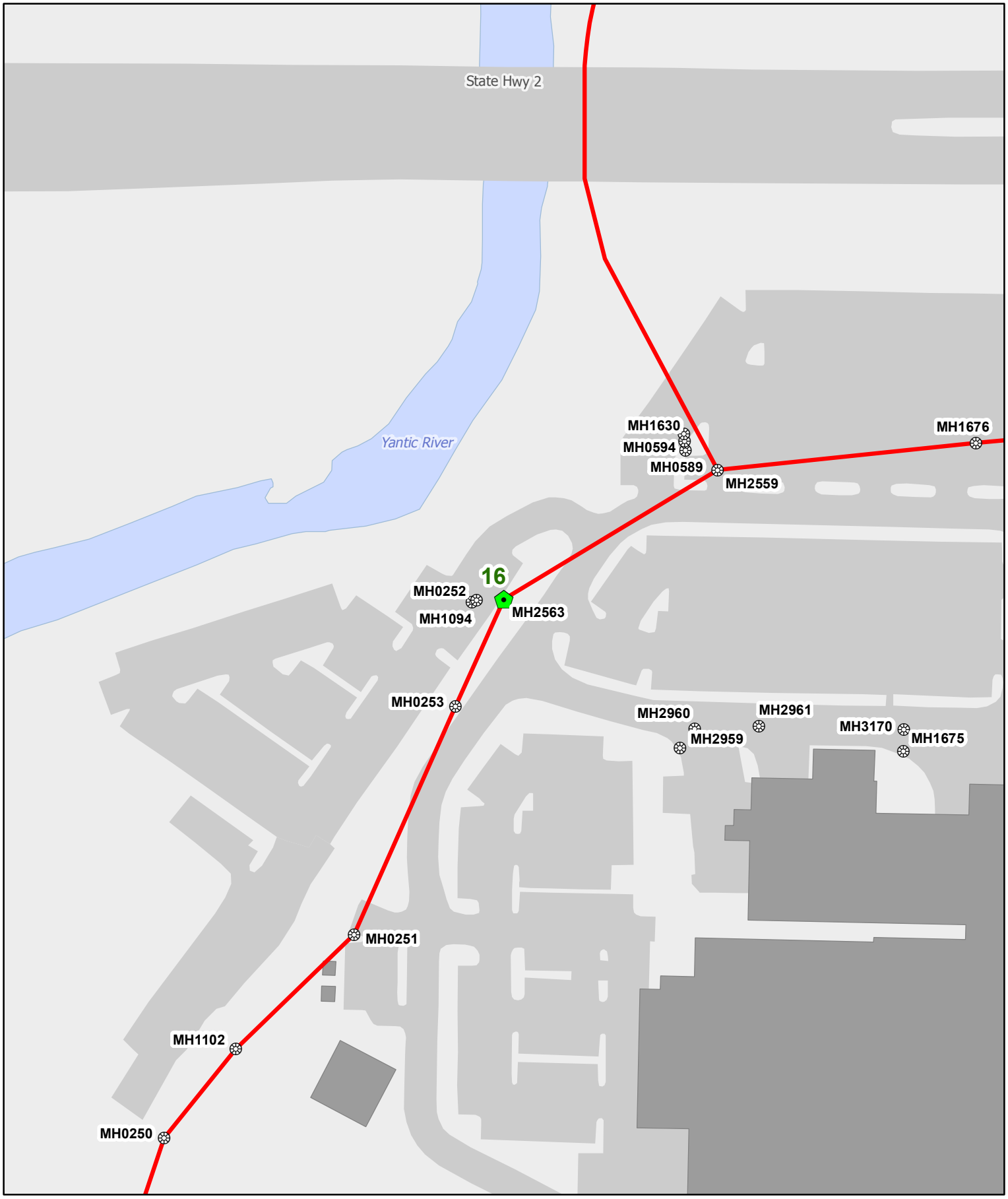
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 15
Attachment D



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 16
Attachment D

CDM Smith

Legend

Meter · Manhole · CSO · Pipe

Scale

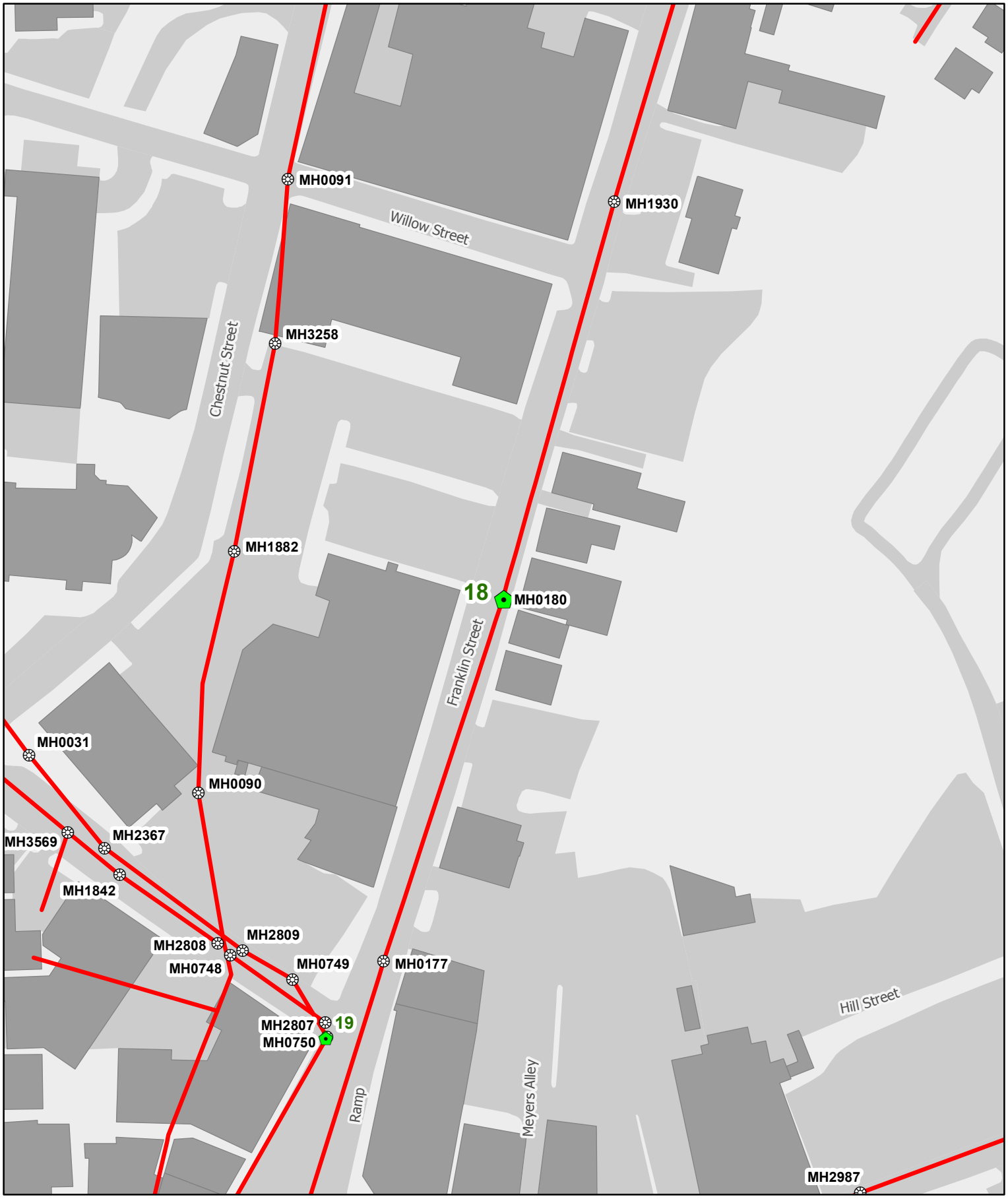
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 17
Attachment D



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 18
Attachment D

CDM Smith

Legend

Meter · Manhole · CSO · Pipe

Scale

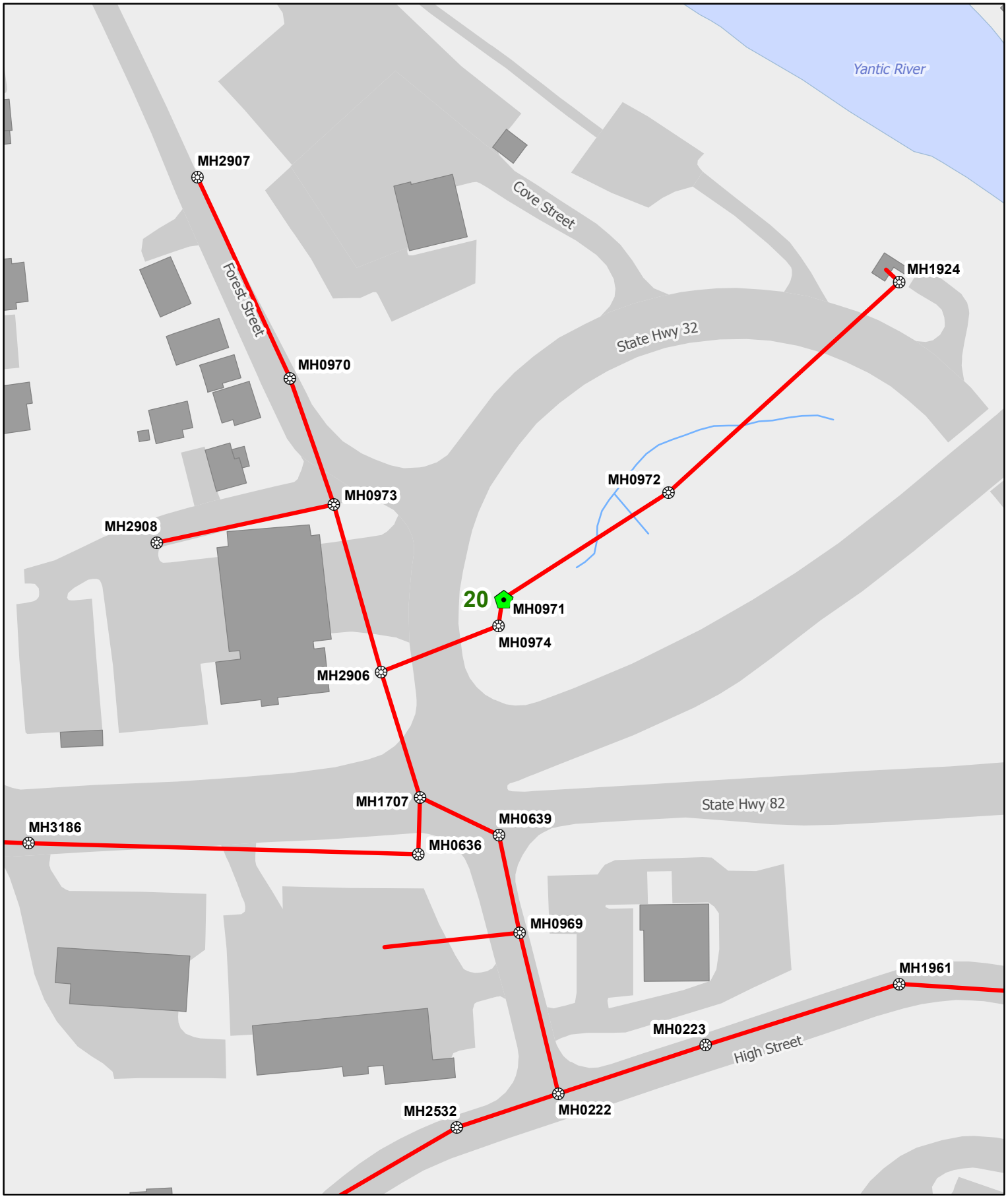
1 inch = 100 feet

0 50 100 Feet

N

Norwich, Connecticut
Metering Program

Meter 19
Attachment D



CDM Smith

Legend

Meter · Manhole · CSO · Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 20
Attachment D

CDM Smith

Legend

Meter | Manhole | CSO | Pipe

Scale

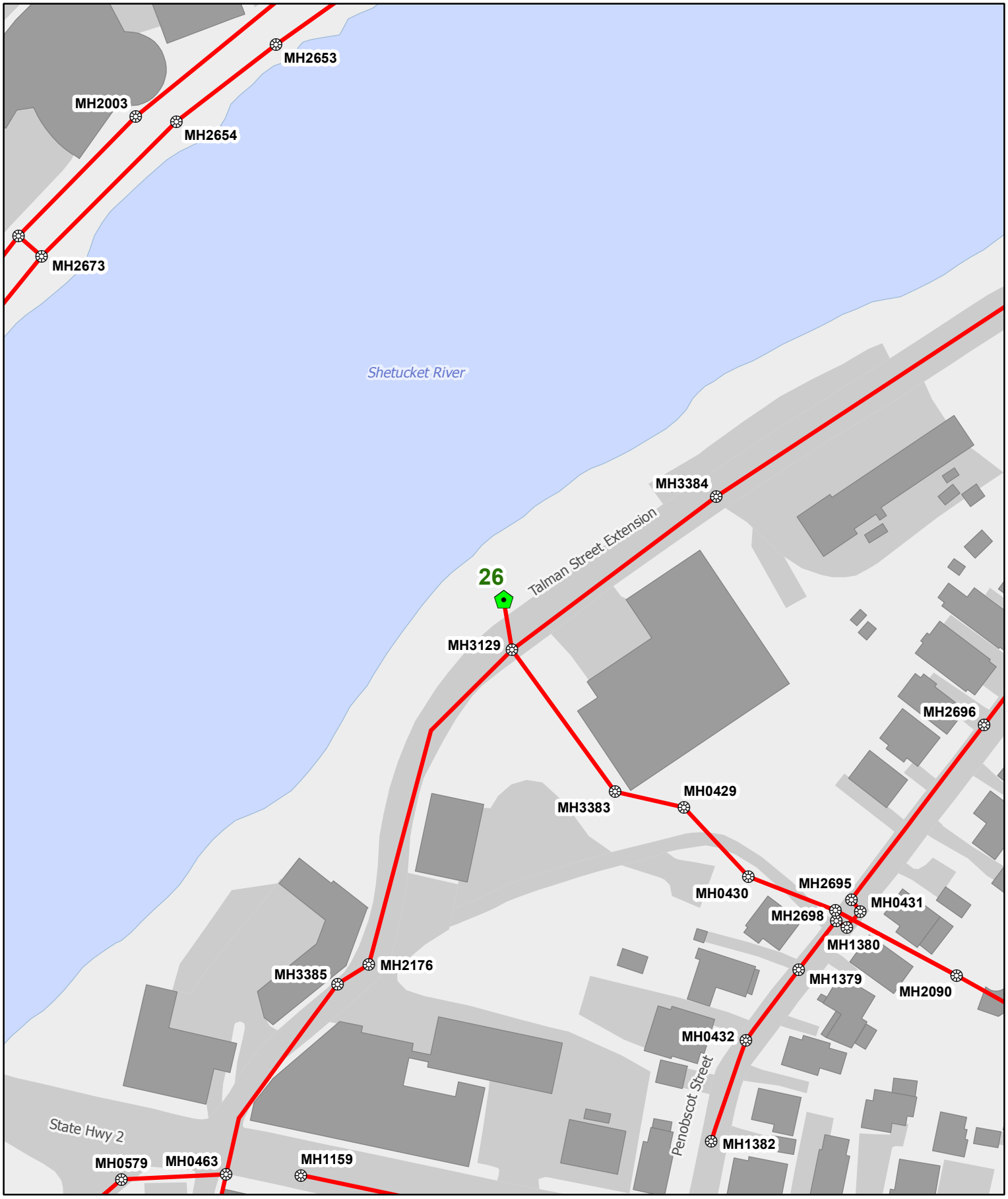
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 25
Attachment D



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

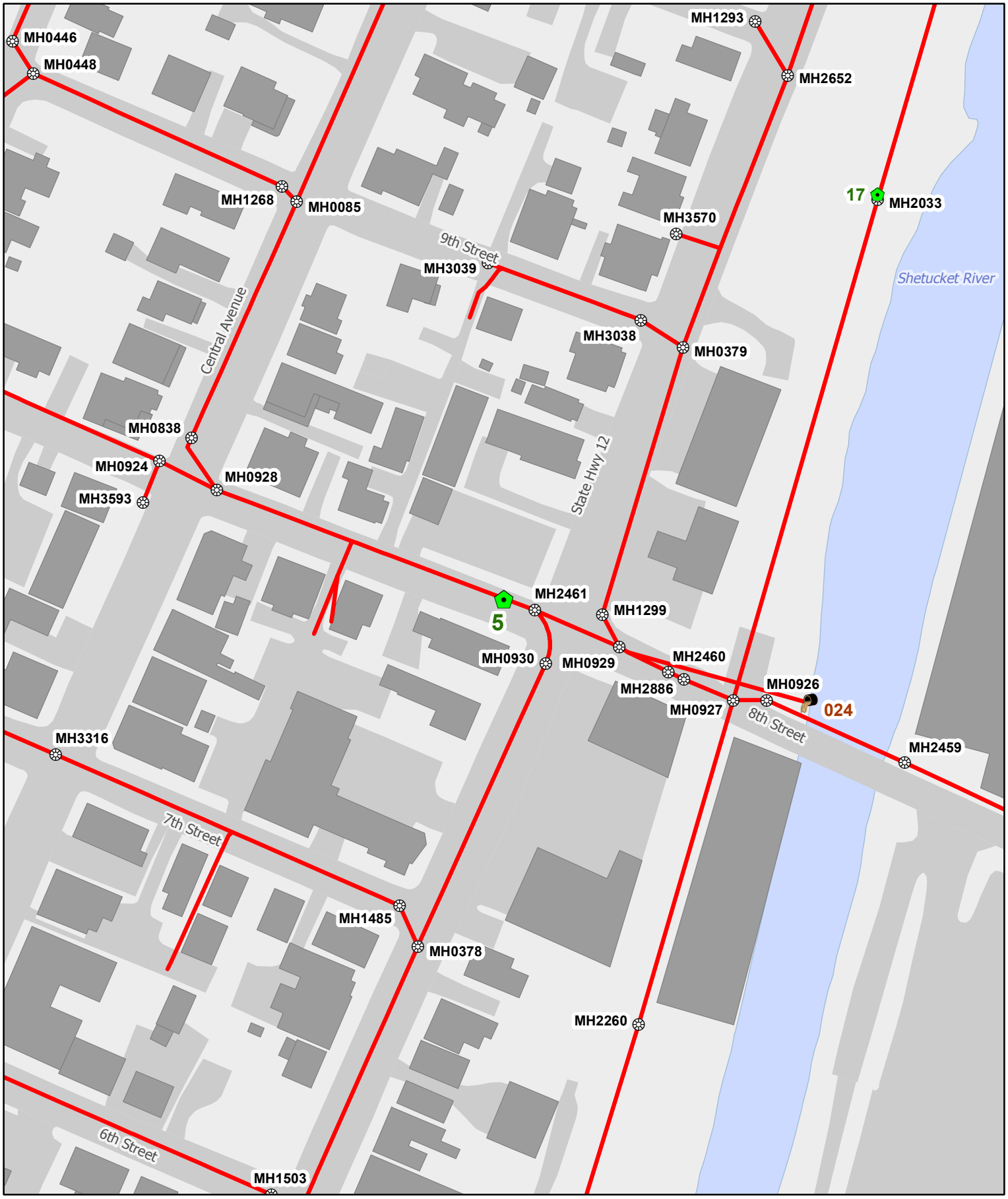
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 26
Attachment D



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

Feet
0 50 100

Norwich, Connecticut
Metering Program

Meter 5
Attachment D

CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 9
Attachment D

Attachment E

Flow Meter Installation Diagrams

RAIN GAUGE SITE INFORMATION FIELD LOG

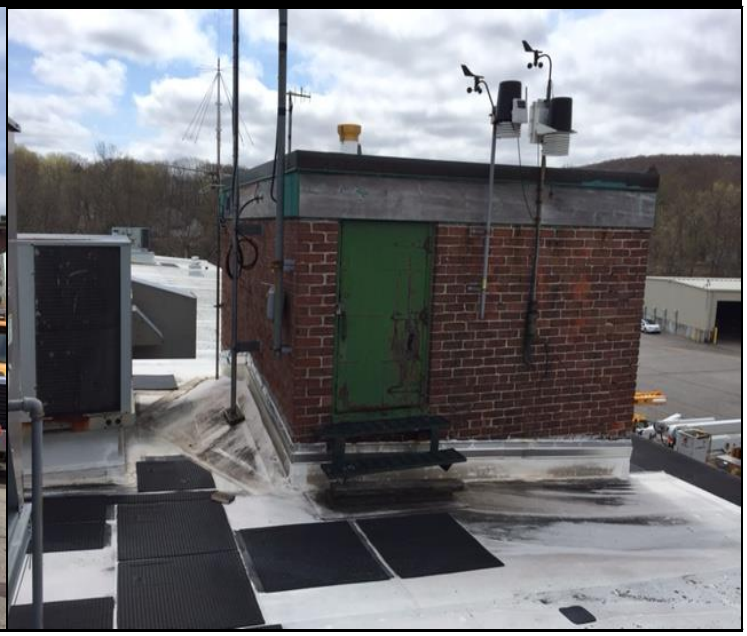
PROJECT: Norwich, CT	**DATE:** April 19, 2017	**PROJECT #:** 17039
LOCATION: WWTP Falls Avenue Sludge Building Roof		**SITE:** Rain Gauge 1
COMMENTS: 41.527290, -72.085725		

LOCATION

RAIN GAUGE SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 19, 2017	**PROJECT #:** 17039
LOCATION: 16 South Golden Street (DPW roof)		**SITE:** Rain Gauge 2
COMMENTS: 41.527239, -72.062486		

LOCATION



RAIN GAUGE SITE INFORMATION FIELD LOG

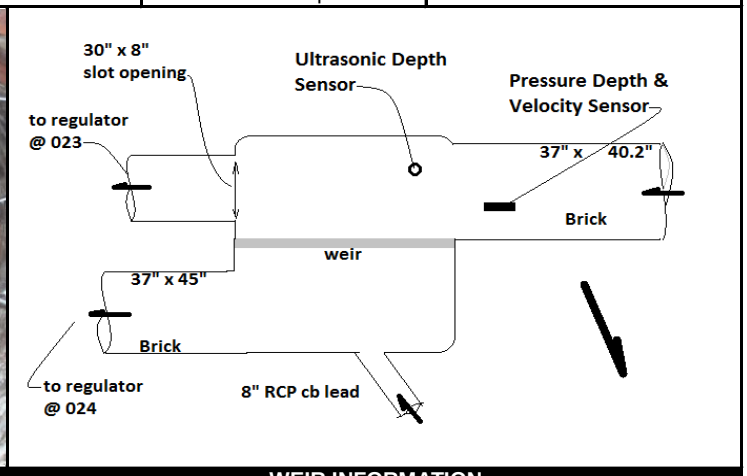
PROJECT: Norwich, CT	**DATE:** April 19, 2017	**PROJECT #:** 17039
LOCATION: 100 Forestview Drive		**SITE:** Rain Gauge 3
COMMENTS: 41.572574, -72.0110686		

LOCATION

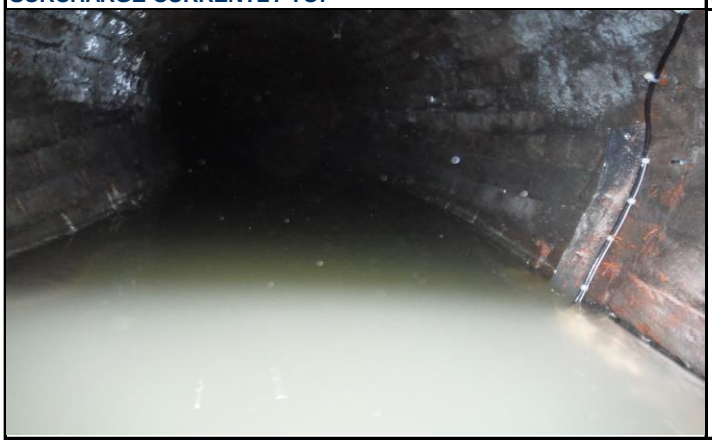
METER SITE INFORMATION FIELD LOG

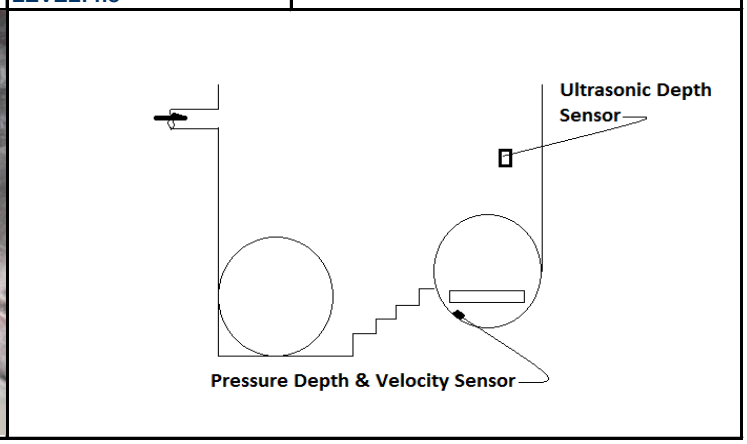
PROJECT: Norwich, CT	**DATE:** April 17, 2017	**JOB#:** 17039
LOCATION: North Main Street at 8th Street	**MH#:** 2461	**METER SITE:** 024
GPS/COMMENTS: 41.535600, -72.054269		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	37 x 40.2	Brick	13.3	0	Oval	11' 11"
Incoming	8	ACP	0	0	Circular	3' 7"
Outgoing	30 x 8	Brick	1	7	Rectangular	11' 6"
Outgoing	37 x 45	Brick	3	0	Arch Top	14' 5"



SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH: 82.5**	**HEIGHT ABOVE WEIR: 128**
SURCHARGED MARKS TO:	**BREADTH: 4.5**	**OVERFLOW OCCURS AT: 12.1**
SURCHARGE CURRENTLY TO:	**LEVEL: no**	

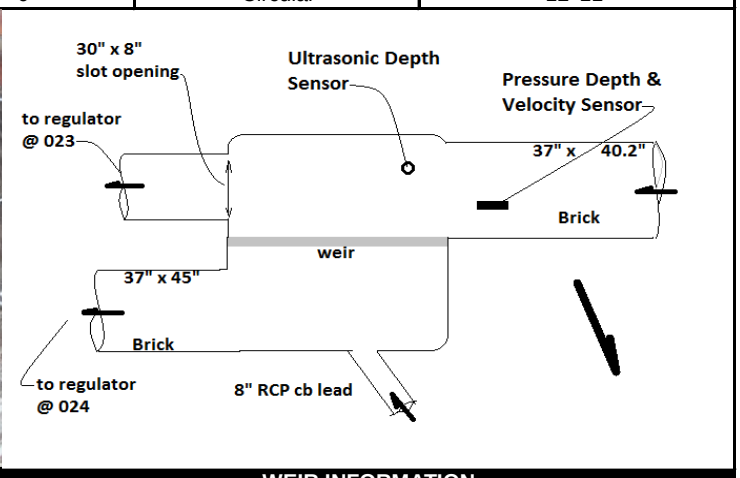




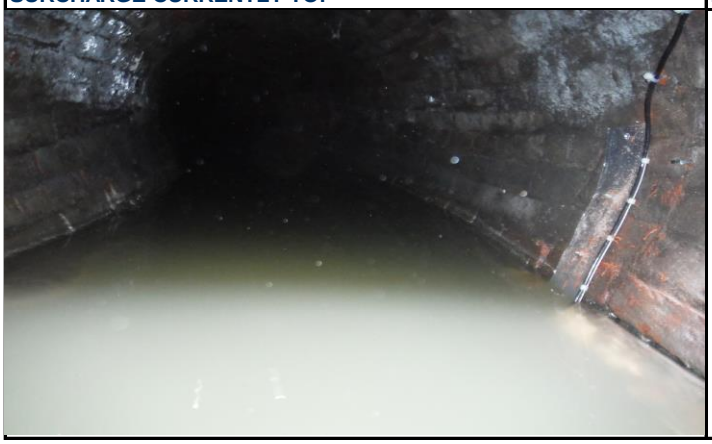
METER SITE INFORMATION FIELD LOG

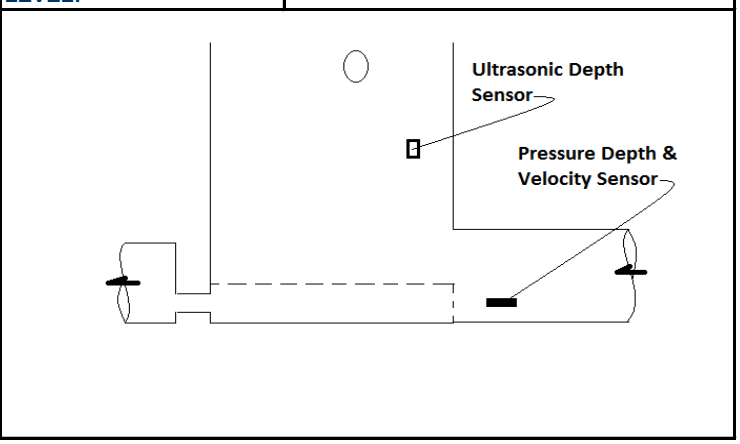
PROJECT: Norwich, CT	**DATE:** April 17, 2017	**JOB#:** 17039
LOCATION: North Main Street at 8th Street	**MH#:**	**METER SITE:** Temp 5
GPS/COMMENTS: 41.535600, -72.054269		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	37 x 40.2	Brick	13.3	0	Oval	11' 11"
Incoming	8	ACP	0	0	Circular	3' 7"
Incoming	30 x 8	Brick	1	7	Circular	11' 6"
Outgoing	37 x 45	Brick	3	0	Circular	12' 11"



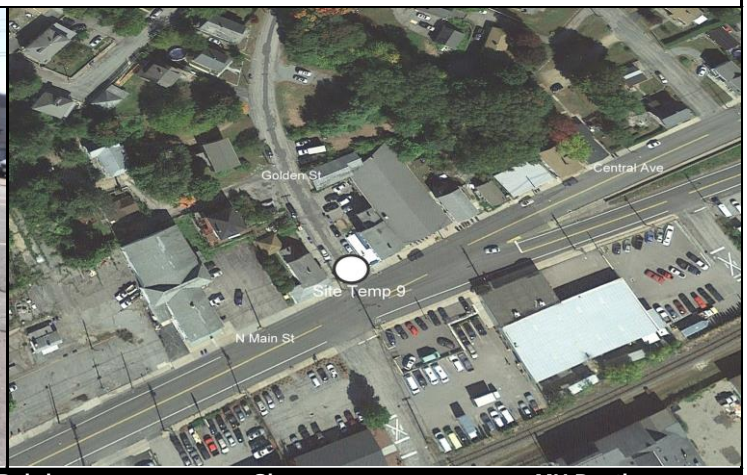
SURCHARGE INFORMATION		WEIR INFORMATION
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



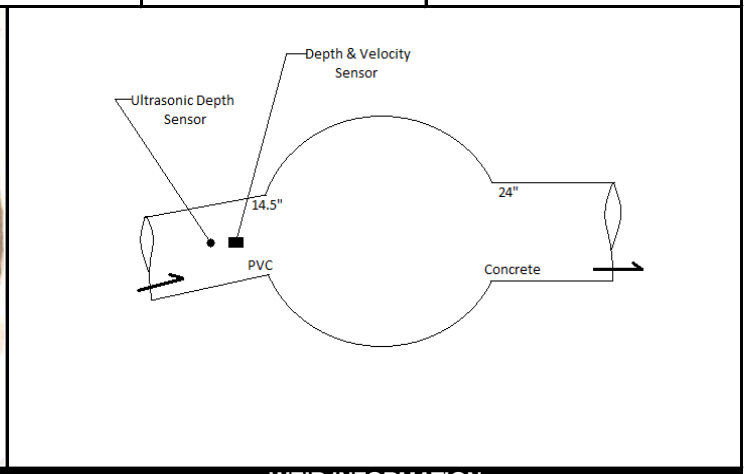


METER SITE INFORMATION FIELD LOG

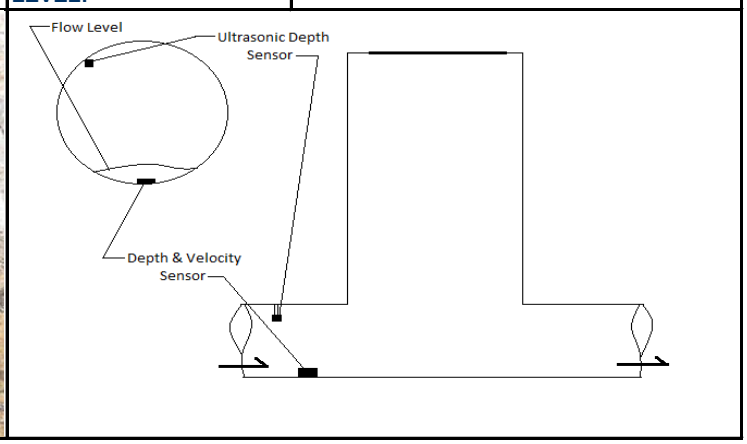
PROJECT: Norwich, CT	**DATE:** April 14, 2017	**JOB#:** 17039
LOCATION: 3 Golden Street	**MH#:**	**METER SITE:** Temp 9
GPS/COMMENTS: 41.528313, -72.062766		



	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	14.5	PVC	1	0	Circular	03' 06"
Incoming						
Incoming						
Outgoing	24	Concrete	1	0	Circular	03' 10"



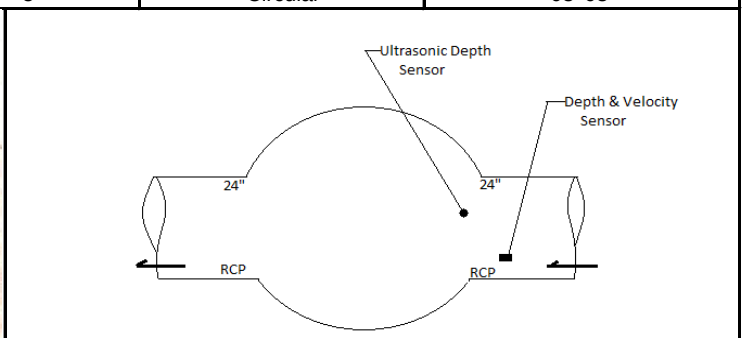
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



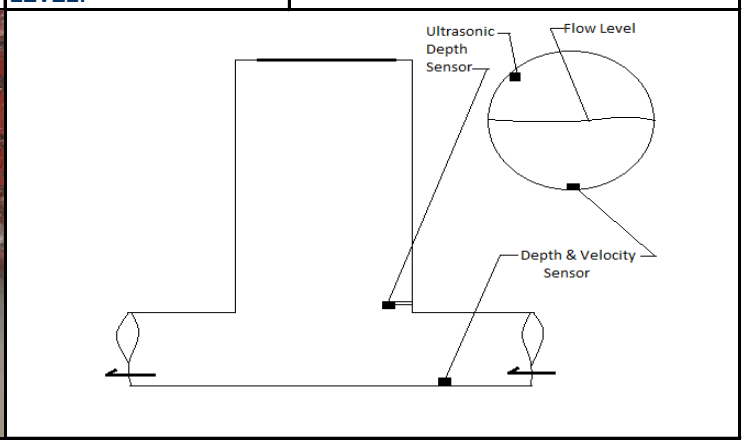
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 13, 2017	**JOB#:** 17039
LOCATION: Terminal Way	**MH#:**	**METER SITE:** Temp 14
GPS/COMMENTS: 41.509607, -72.083009		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24	RCP	13	5	Circular	08' 08'
Incoming						
Incoming						
Outgoing	24	RCP	13	5	Circular	08' 08"



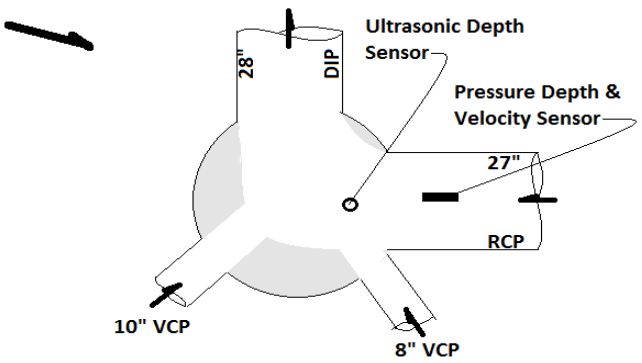
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT:	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO: 08"	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



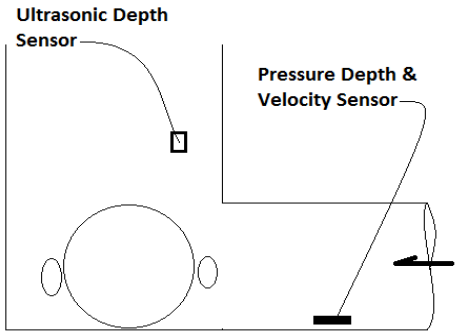
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 19, 2017	**JOB#:** 17039
LOCATION: Sturtevant Avenue R.O.W.	**MH#:** 0299	**METER SITE:** Temp 15
GPS/COMMENTS: 41.528984, -72.084873		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	27	RCP	9.5	1	Circular	4' 7"
Incoming	8	VCP	0.5	0	Circular	3' 3"
Incoming	10	VCP	1	0	Circular	3' 6"
Outgoing	28	DIP	9.5	0	Circular	4' 8"



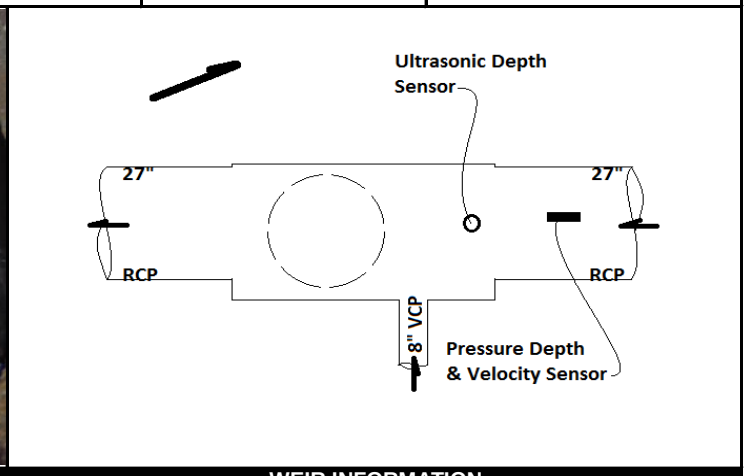
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT:	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO: 3.5'	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



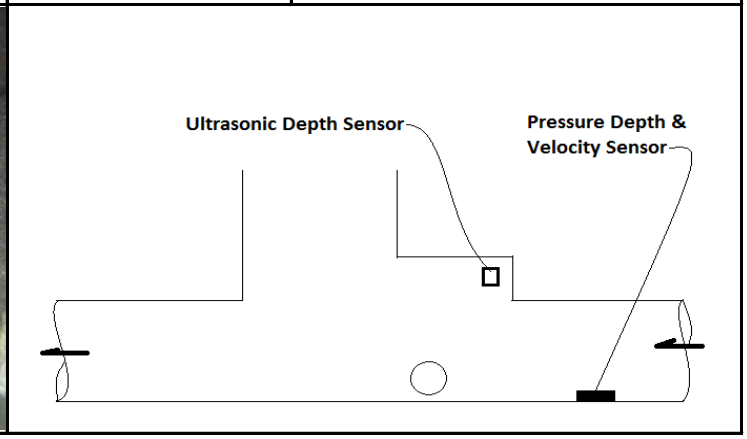
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 10, 2017	**JOB#:** 17039
LOCATION: 326 Washington Street (rear)	**MH#:**	**METER SITE:** Temp 16
GPS/COMMENTS: 41.543213, -72.090369		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	27	RCP	10	0	Circular	4' 10"
Incoming	8	VCP	1	0	Circular	4' 8"
Incoming						
Outgoing	27	RCP	6	0	Circular	4' 11"



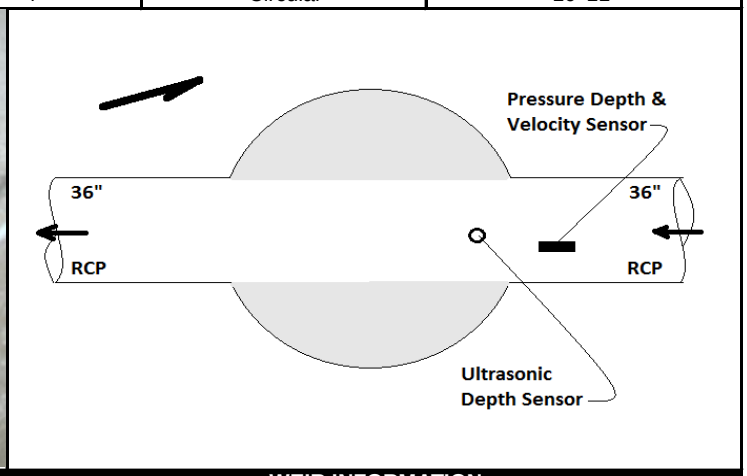
SURCHARGE INFORMATION		WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X		**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:		**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:		**LEVEL:**	



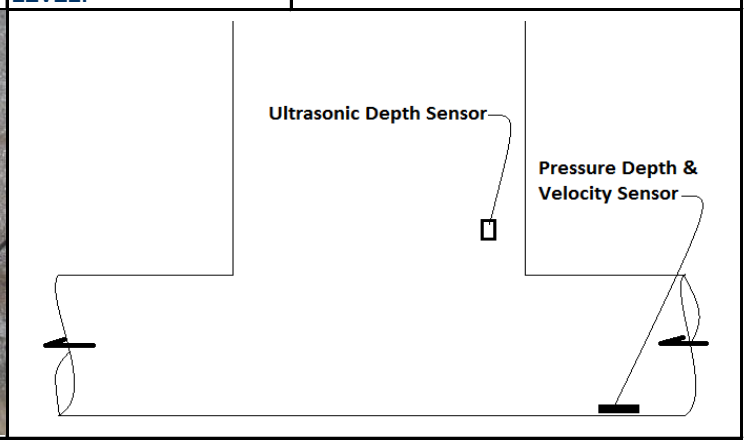
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 17, 2017	**JOB#:** 17039
LOCATION: ROW opposite 526 North Main Street	**MH#:** 2033	**METER SITE:** Temp 17
GPS/COMMENTS: 41.536490, -72.053294		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	36	RCP	9	4	Circular	10' 11"
Incoming						
Incoming						
Outgoing	36	RCP	9	4	Circular	10' 11"



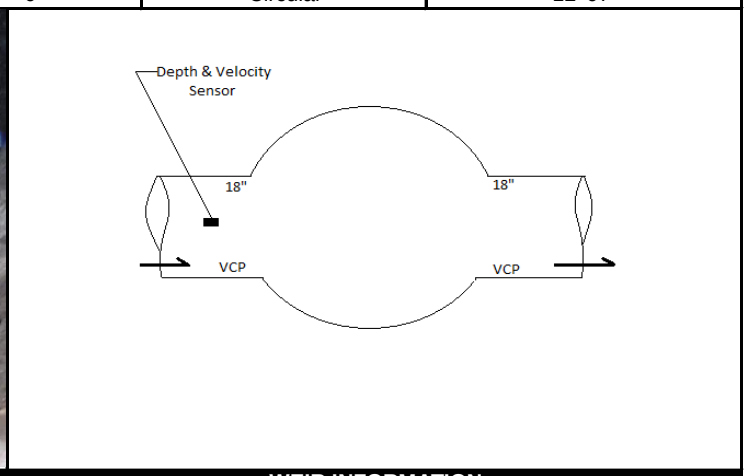
SURCHARGE INFORMATION		WEIR INFORMATION
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



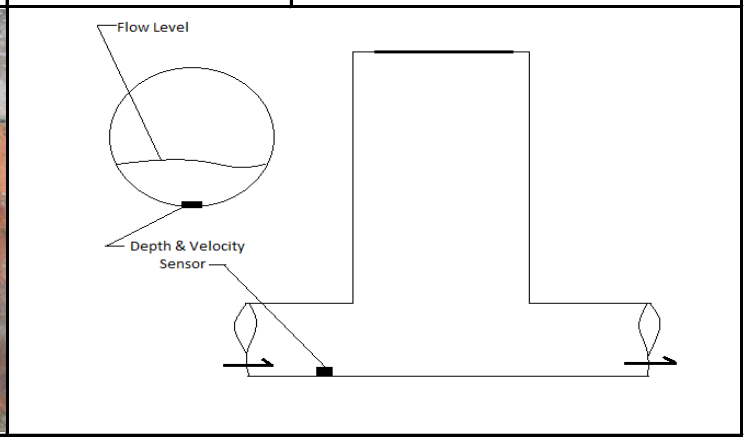
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 13, 2017	**JOB#:** 17039
LOCATION: 87 Franklin Street	**MH#:**	**METER SITE:** Temp 18
GPS/COMMENTS: 41.526005 -72.074107		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	18	VCP	5.6	0	Circular	12' 05"
Incoming						
Incoming						
Outgoing	18	VCP	5.6	0	Circular	12' 07"

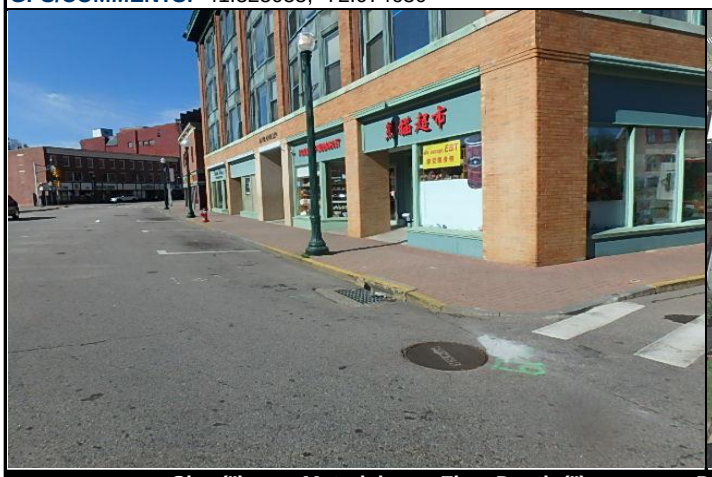


SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT:	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO: 08'	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	

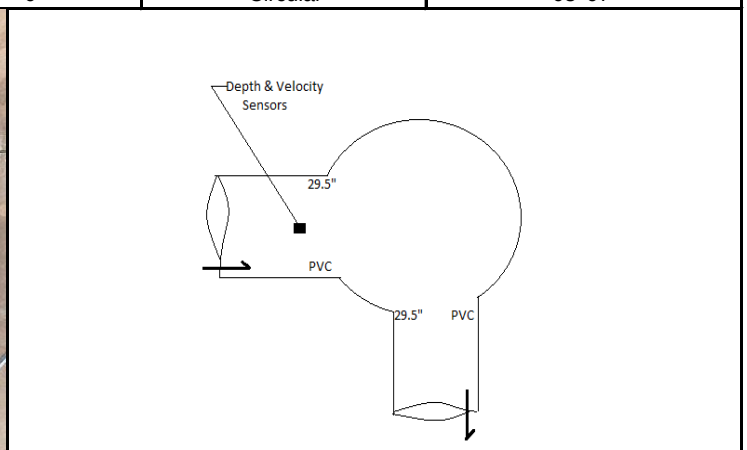


METER SITE INFORMATION FIELD LOG

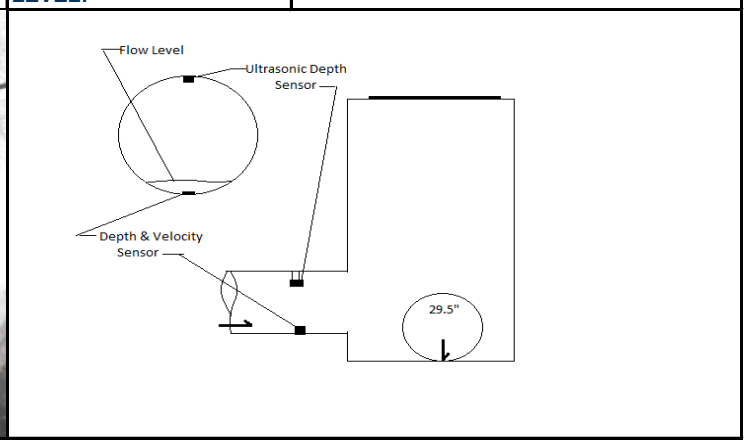
PROJECT: Norwich, CT	**DATE:** April 14, 2017	**JOB#:** 17039
LOCATION: Bath Street at Franklin Street	**MH#:**	**METER SITE:** Temp 19
GPS/COMMENTS: 41.525055, -72.074630		



	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	29.5	PVC	1.5	0	Circular	07' 04"
Incoming						
Incoming						
Outgoing	29.5	PVC	1.5	0	Circular	08' 07"

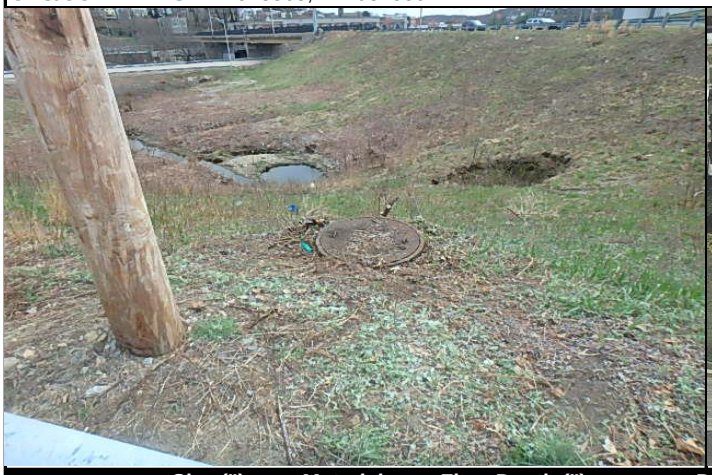


SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	

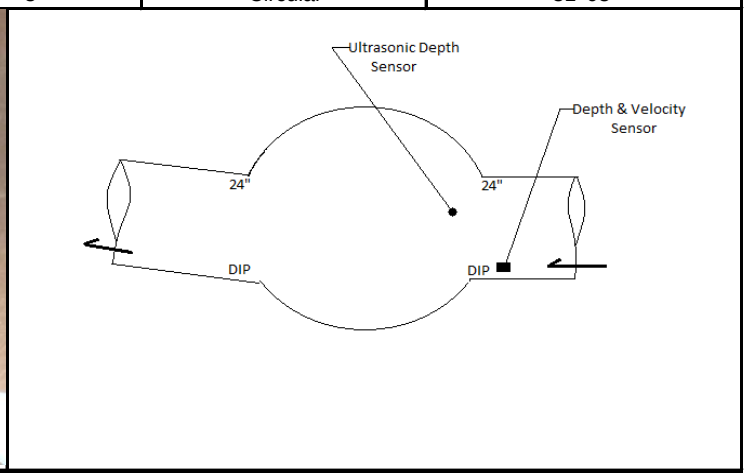


METER SITE INFORMATION FIELD LOG

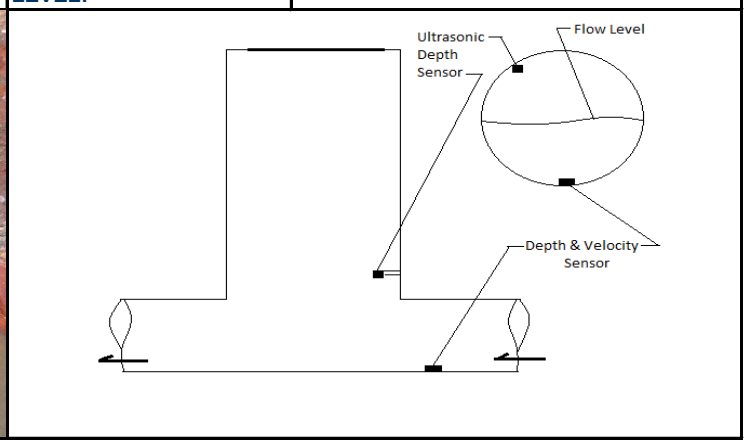
PROJECT: Norwich, CT	**DATE:** April 13, 2017	**JOB#:** 17039
LOCATION: N Thames Street, across from Fire Station	**MH#:**	**METER SITE:** Temp 20
GPS/COMMENTS: 41.523863, -72.084959		



	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24	DIP	12	3	Circular	31' 08"
Incoming						
Incoming						
Outgoing	24	DIP	12	3	Circular	31' 08"



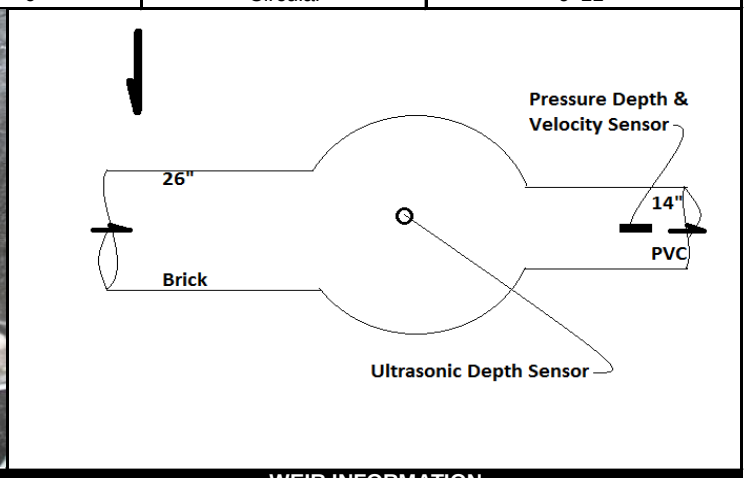
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT:	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO: 05'	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



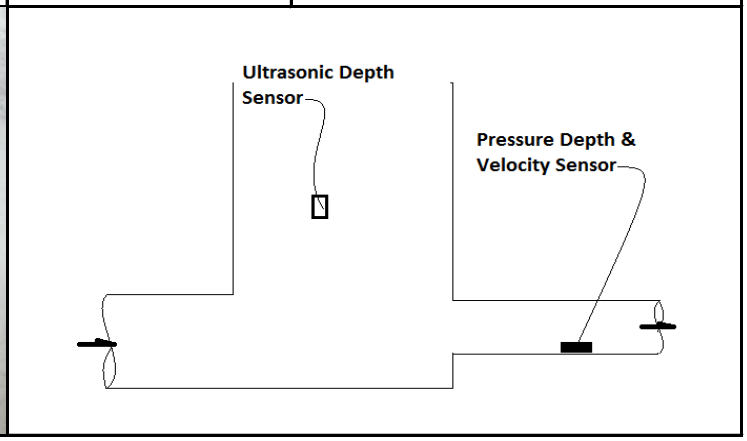
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 20, 2017	**JOB#:** 17039
LOCATION: 26 Main Street	**MH#:**	**METER SITE:** Temp 25
GPS/COMMENTS: 41.524509, -72.073759		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	26	Brick	11	0	Circular	10' 9"
Incoming						
Incoming						
Outgoing	14	PVC	1.1	0	Circular	9' 11"



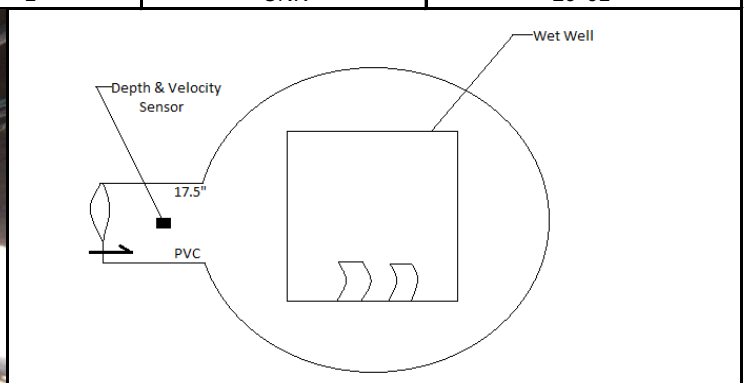
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



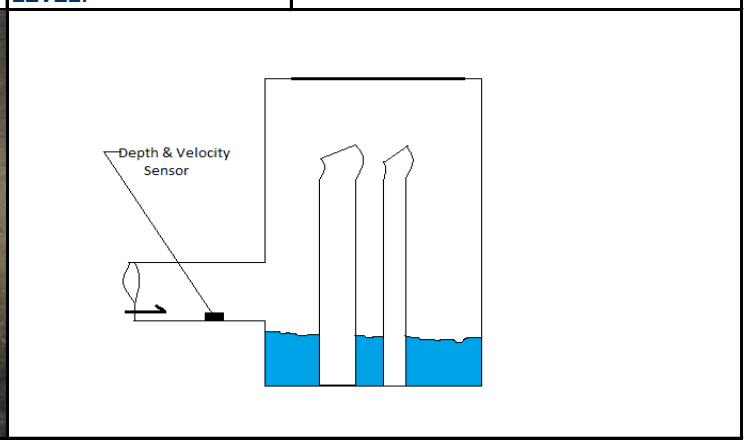
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 13, 2017	**JOB#:** 17039
LOCATION: 220 Talman Street Extension	**MH#:**	**METER SITE:** Temp 26
GPS/COMMENTS: 41.524717, -72.067206		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	17.5	PVC	1.6	0	Circular	12' 02"
Incoming						
Incoming						
Outgoing	UNK	UNK	4	1	UNK	20' 01"



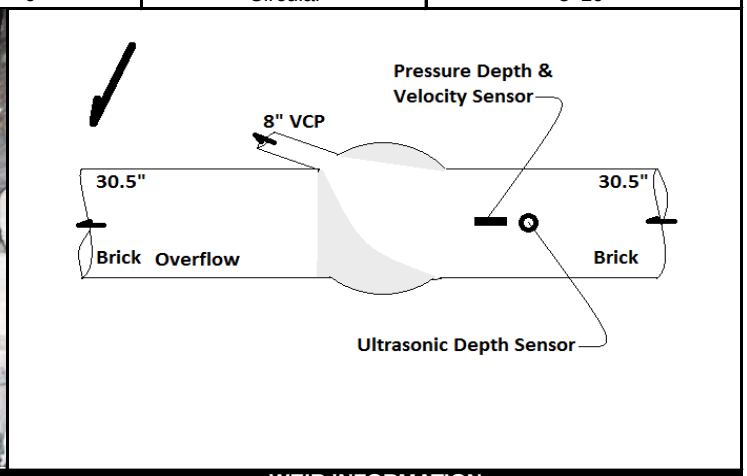
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



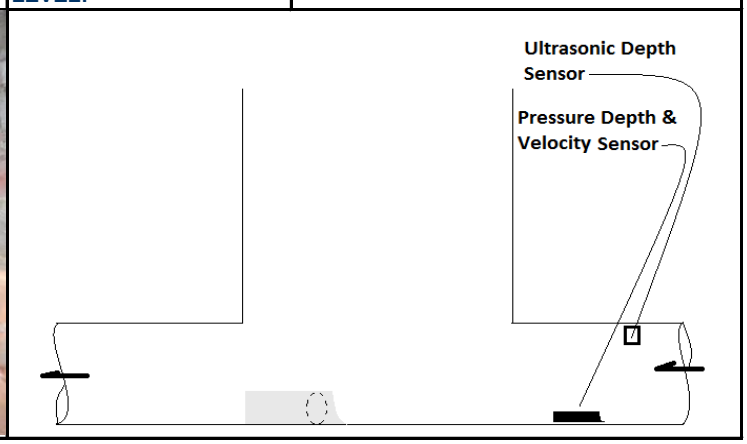
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 12, 2017	**JOB#:** 17039
LOCATION: 76 Thames Street (rear)	**MH#:**	**METER SITE:** 004
GPS/COMMENTS: 41.515727, -72.080033. 6.5" measured depth to o/f. Site charactaristics suggest it will be less.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	30.5	Brick	1.5	0	Circular	5' 7"
Incoming						
Overflow	30.5	Brick	0	0	Circular	5' 8"
Outgoing	8	VCP	3	0	Circular	5' 10"



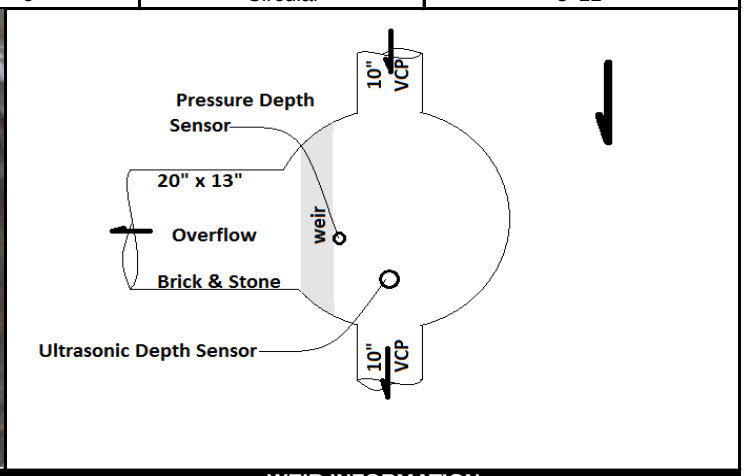
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT: 6.5"**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



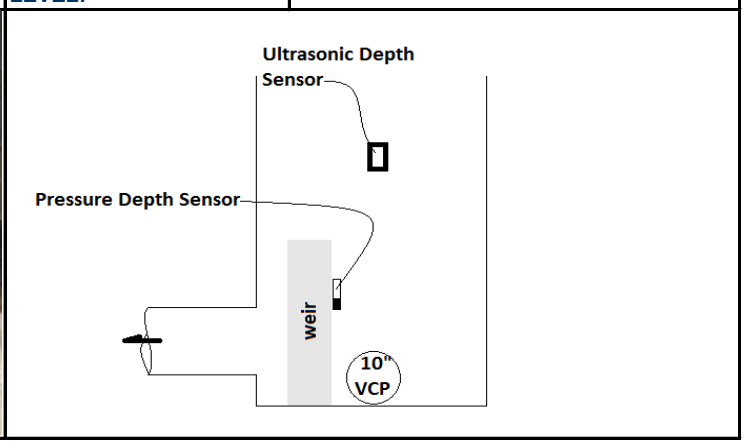
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 12, 2017	**JOB#:** 17039
LOCATION: 17 South Thames Street	**MH#:**	**METER SITE:** 005
GPS/COMMENTS: 41.517828, -72.079675. This site is for duration of overflow event only. Not to quantify.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	10	VCP	1.5	0	Circular	5' 10"
Incoming	6	PVC	0	0	Circular	5' 7"
Overflow	20 x 13	Stone, BRK	0	0	Rectangular	5' 5"
Outgoing	10	VCP	1.5	0	Circular	5' 11"



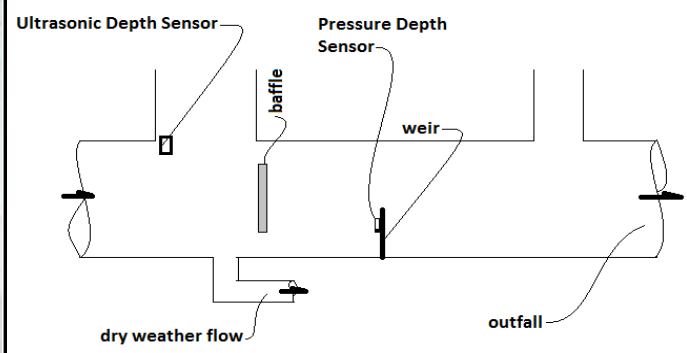
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR: 40"**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



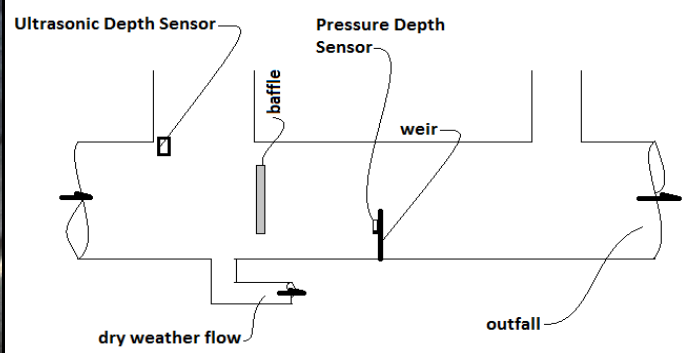
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 19, 2017	**JOB#:** 17039
LOCATION: Rose Alley	**MH#:**	**METER SITE:** 017-2
GPS/COMMENTS: 41.523928, -70.074732		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	88 x 84	Conc.	7	3	Circular	11' 6"
Incoming						
Overflow	88 x 84	Conc.	0	3	Circular	11' 6"
Outgoing	unknown	unknown	unknown	unknown	unknown	unknown



SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 20, 2017	**JOB#:** 1709
LOCATION: Rose Alley	**MH#:**	**METER SITE:** 017
GPS/COMMENTS: 41.523877, -72.074760		

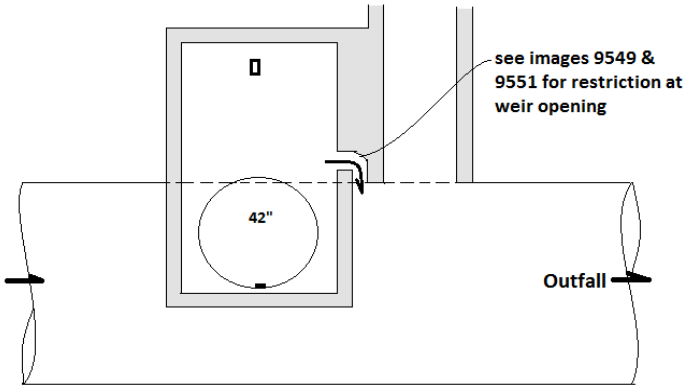
	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	42	RCP	7.3	0	Circular	7' 10"
Incoming						
Incoming						
Outgoing	48.5 x 86.5	PIP	3	0	Rectangular	8' 1"

SURCHARGE INFORMATION

SURCHARGE NONE EVIDENT:

SURCHARGED MARKS TO: 0.5 above weir crest

SURCHARGE CURRENTLY TO:



WEIR INFORMATION

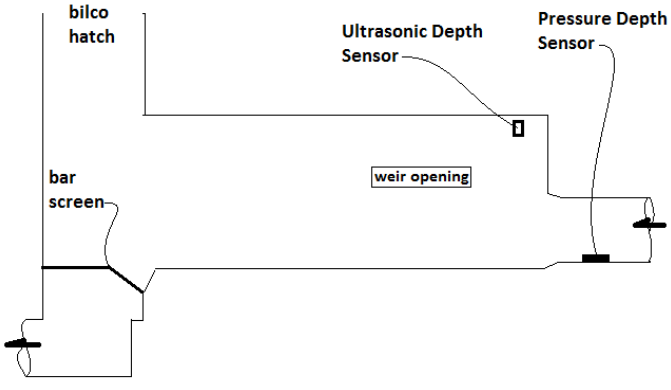
LENGTH: 44.5

BREADTH: 8.1

LEVEL: yes

HEIGHT ABOVE WEIR: 14.9

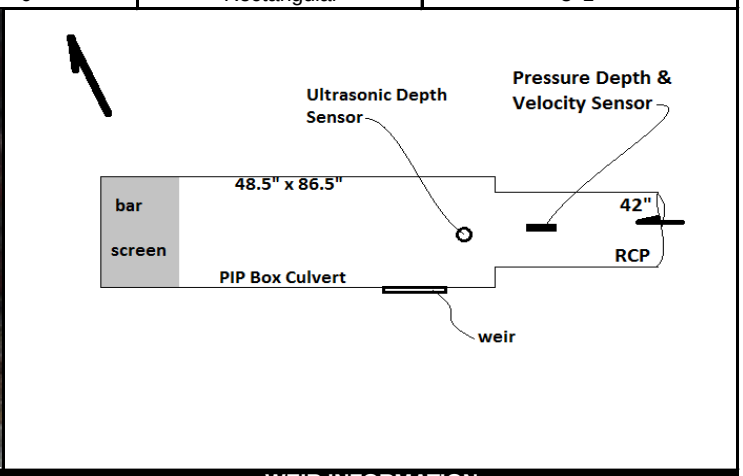
OVERFLOW OCCURS AT:



METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 20, 2017	**JOB#:** 17039
LOCATION: Rose Alley	**MH#:**	**METER SITE:** 017
GPS/COMMENTS: 41.523877, -72.074760		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	42	RCP	7.3	0	Circular	7' 10"
Incoming						
Incoming						
Outgoing	48.5 x 86.5	PIP	3	0	Rectangular	8' 1"



SURCHARGE INFORMATION

SURCHARGE NONE EVIDENT:

SURCHARGED MARKS TO: 0.5' above weir crest

SURCHARGE CURRENTLY TO:

WEIR INFORMATION

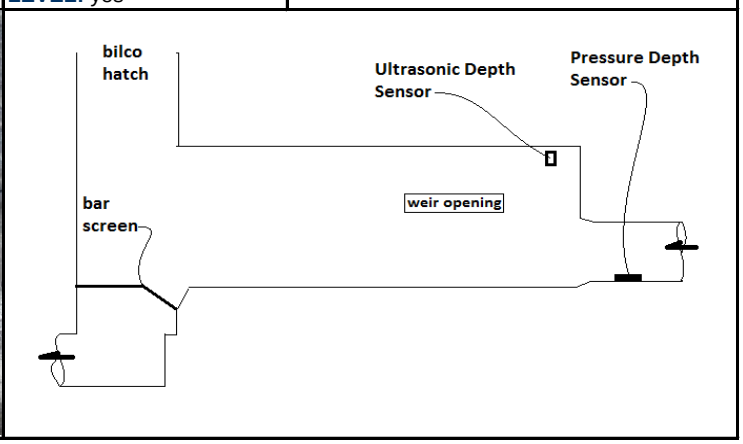
LENGTH: 44.5

BREADTH: 8.1

LEVEL: yes

HEIGHT ABOVE WEIR: 14.9

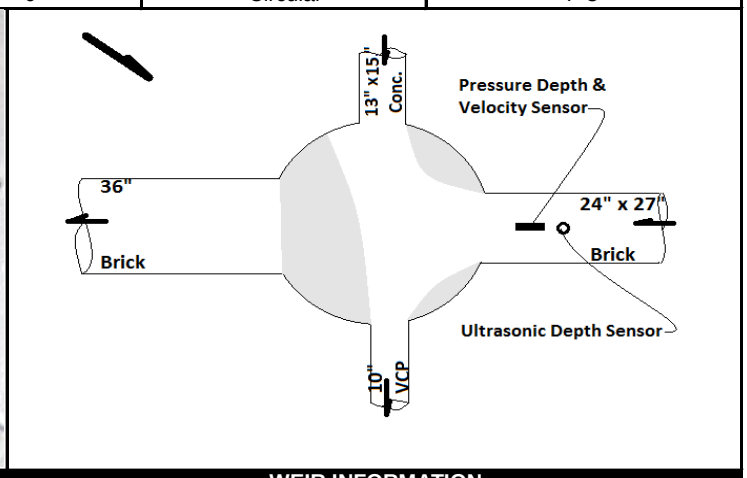
OVERFLOW OCCURS AT:



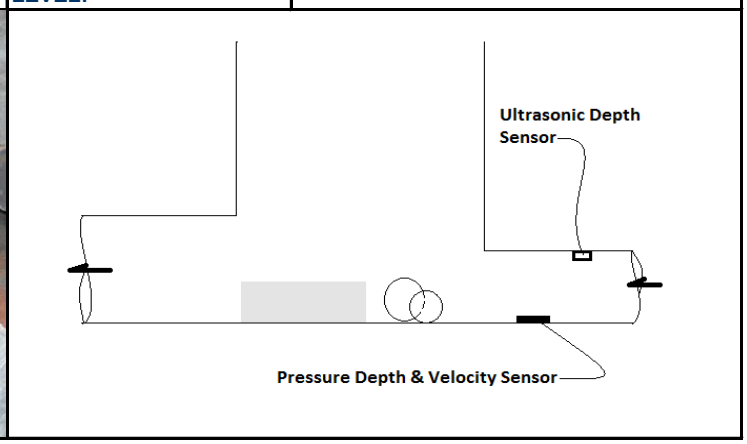
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 18, 2017	**JOB#:** 17039
LOCATION: 104 North Main Street	**MH#:**	**METER SITE:** 018
GPS/COMMENTS: 41.526710, -72.066926		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24 x 27	Brick	2.5	0	Oval	7' 2"
Incoming	13 x 15	Conc.	2	0	Oval	7' 1"
Overflow	36	Brick	0	18	Circular	7' 2"
Outgoing	10	VCP	2	0	Circular	7' 3"



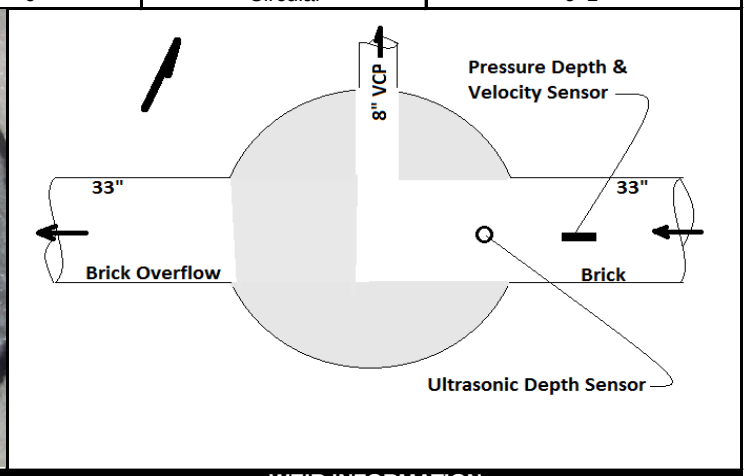
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



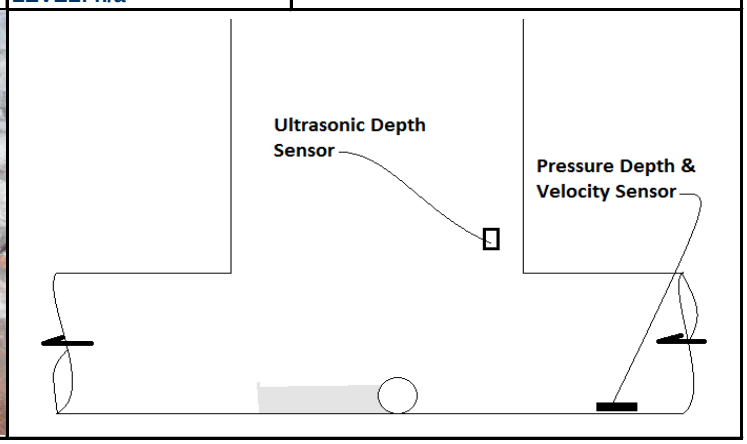
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 18, 2017	**JOB#:** 17039
LOCATION: 154 North Main Street	**MH#:** 2647	**METER SITE:** 019-1
GPS/COMMENTS: 41.527287, -72.064815		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	33	Brick	4.8	0.25	Circular	9' 8.7"
Incoming						
Overflow	33	Brick	0	0	Circular	9' 10"
Outgoing	8	VCP	4	0	Circular	9' 1"



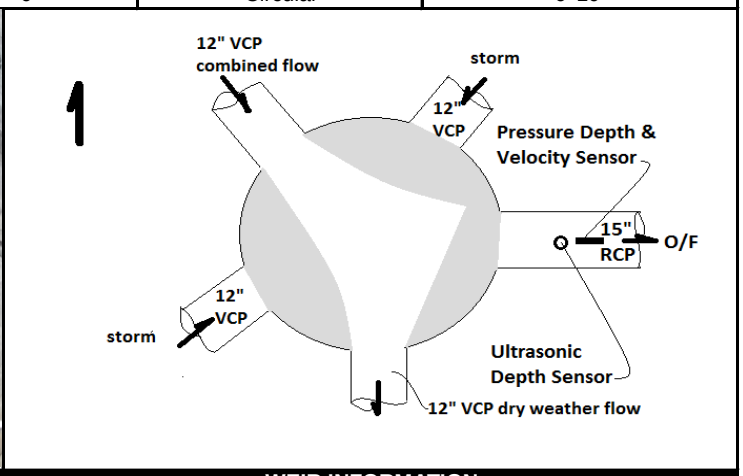
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH: n/a**	**HEIGHT ABOVE WEIR: n/a**
SURCHARGED MARKS TO:	**BREADTH: n/a**	**OVERFLOW OCCURS AT: 6.9**
SURCHARGE CURRENTLY TO:	**LEVEL: n/a**	



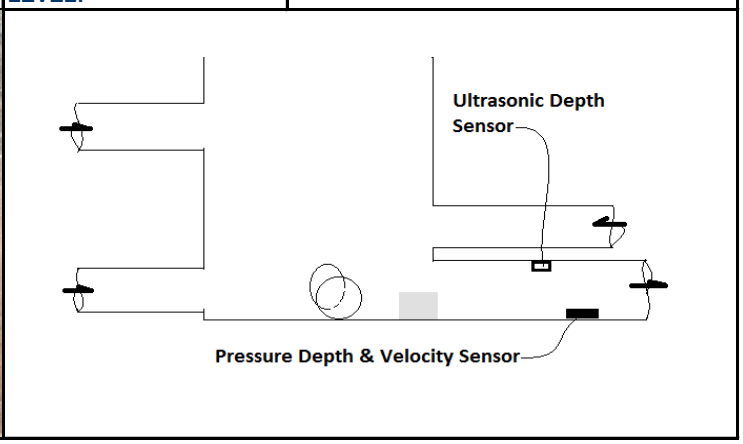
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 18, 2017	**JOB#:** 17039
LOCATION: Roath Street at North Main Street	**MH#:**	**METER SITE:** 019-2
GPS/COMMENTS: 41.527012, -72.065984		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	12	VCP	0.7	0	Circular	6' 7"
Incoming	12	VCP	0	0	Circular	3' 8"
Overflow	15	RCP	0	0	Circular	6' 9"
Outgoing	12	VCP	1.5	0	Circular	6' 10"



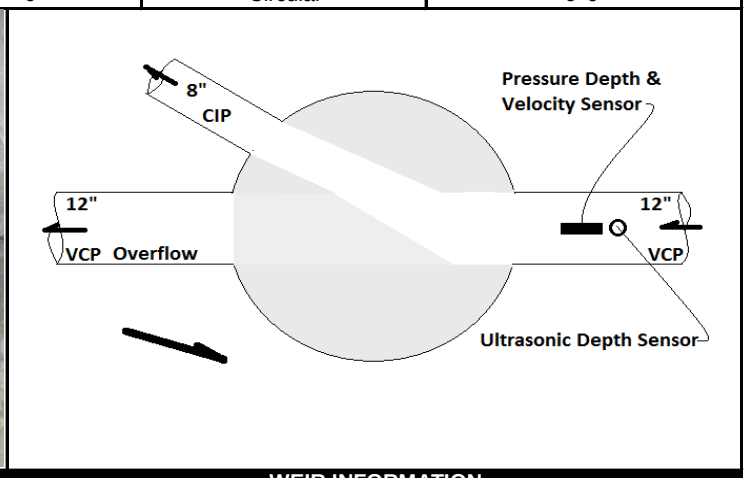
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



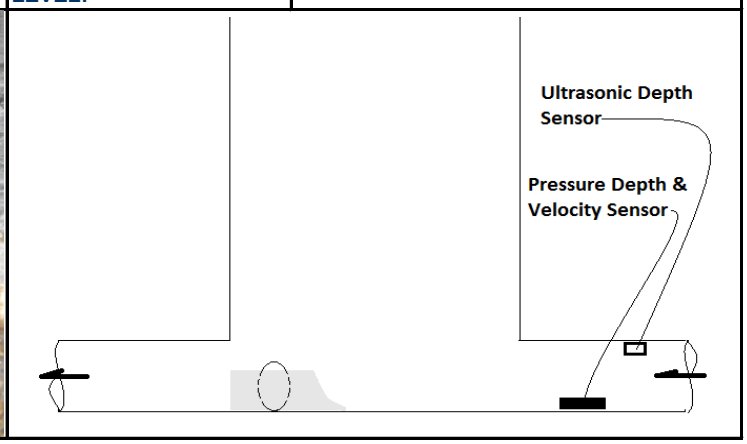
METER SITE INFORMATION FIELD LOG

PROJECT: NORWICH CT	**DATE:** April 12, 2017	**JOB#:** 17039
LOCATION: Erin Street north of tracks	**MH#:**	**METER SITE:** 021
GPS/COMMENTS: 41.528243, -72.061323. O/F measures @ 5" but likely to be less due to site charactaristics.		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	12	VCP	1.5	0	Circular	6' 4"
Incoming						
Overflow	12	VCP	0	6	Circular	6' 4"
Outgoing	8	CIP	2	0	Circular	6' 6"



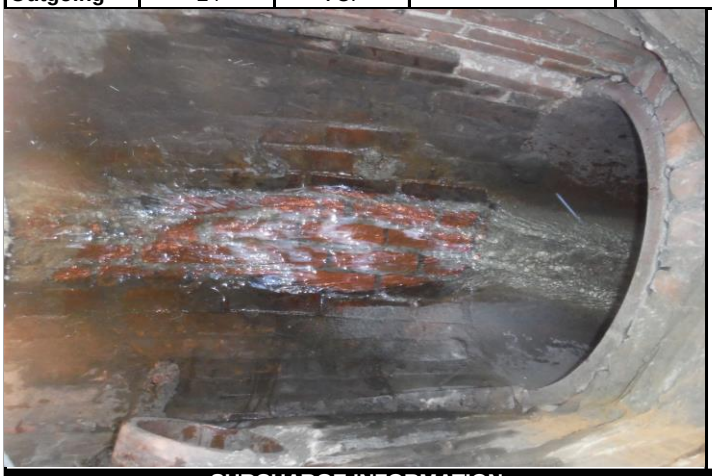
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	

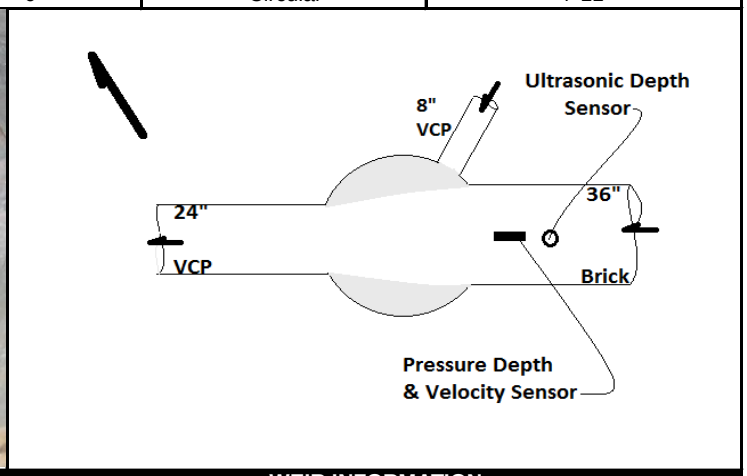


METER SITE INFORMATION FIELD LOG

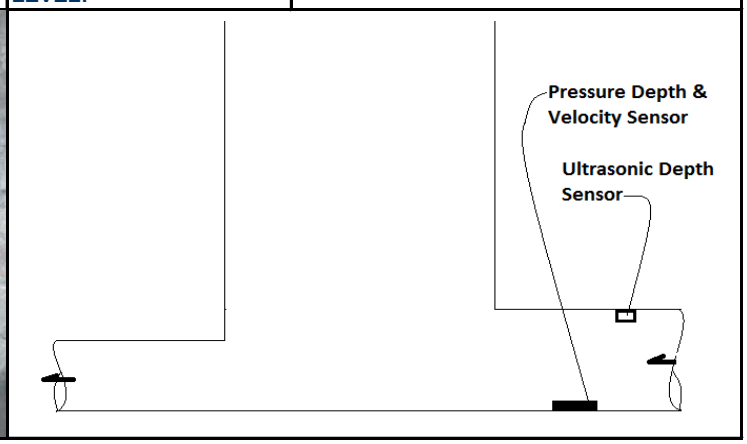
PROJECT: Norwich, CT	**DATE:** April 14, 2017	**JOB#:** 17039
LOCATION: Central Avenue at Hickory Street	**MH#:**	**METER SITE:** 022
GPS/COMMENTS: 41.530580, -72.058504		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	36	Brick		0	Circular	4' 9"
Incoming	8	VCP		0	Circular	3' 6"
Incoming						
Outgoing	24	VCP		0	Circular	4' 11"



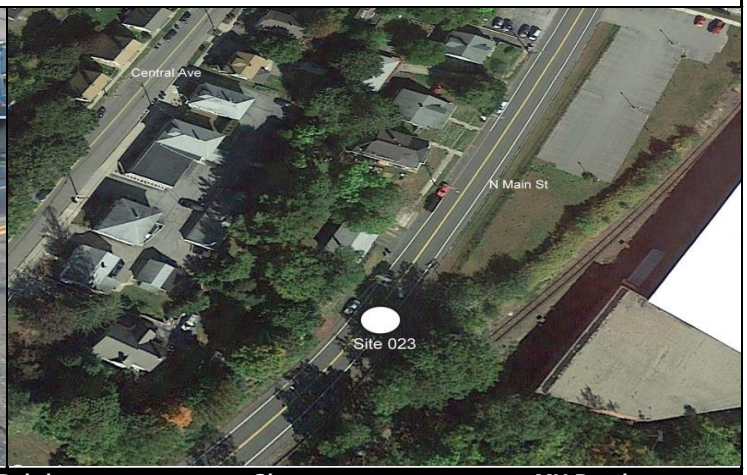


SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	

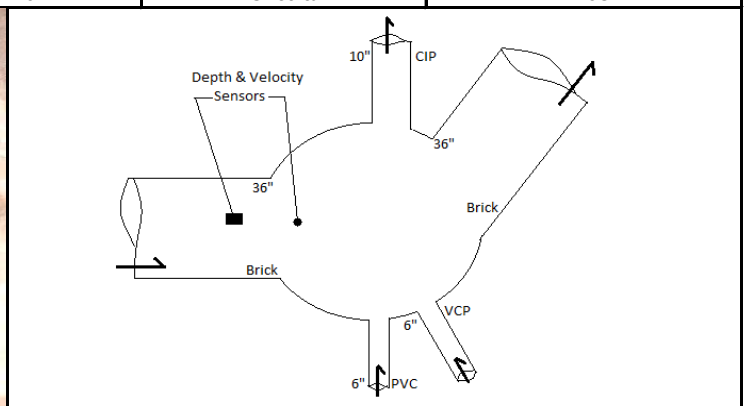


METER SITE INFORMATION FIELD LOG

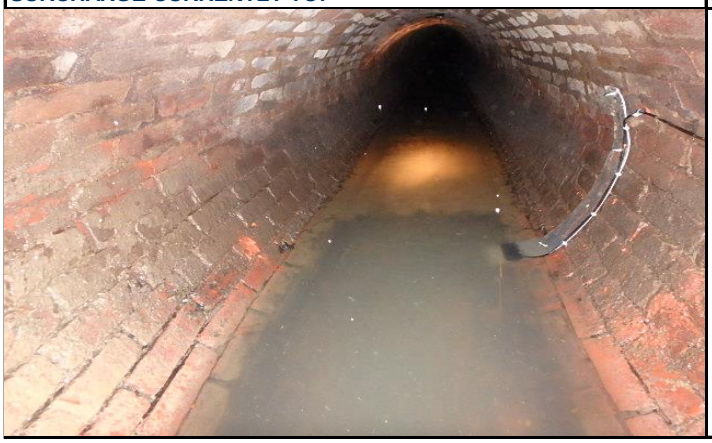
PROJECT: Norwich, CT	**DATE:** April 13, 2017	**JOB#:** 17039
LOCATION: 352 North Main Street	**MH#:**	**METER SITE:** 023
GPS/COMMENTS: 41.530703, -72.057248		

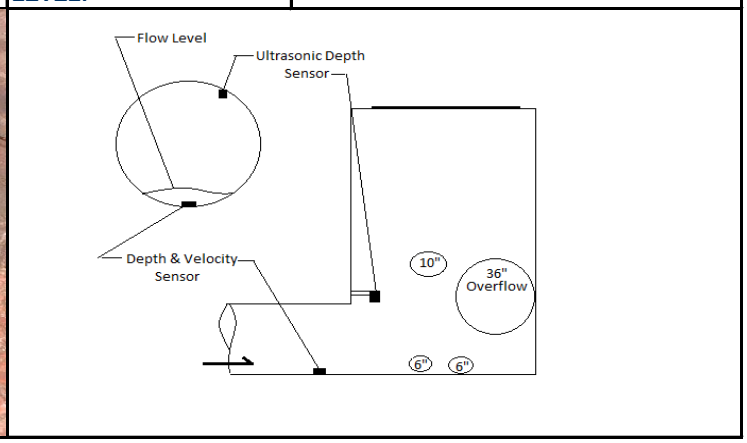


	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	36	Brick	6	5.25	Circular	14' 09"
Incoming	6	VCP	0	0	Circular	13' 01"
Incoming	6	PVC	0	0	Circular	05' 00"
Incoming	10	CIP	0	0	Circular	14' 07"
Overflow	36	Brick	0	0	Circular	14' 08"



SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:** 20.8	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:** 10.75"
SURCHARGE CURRENTLY TO:	**LEVEL:**	

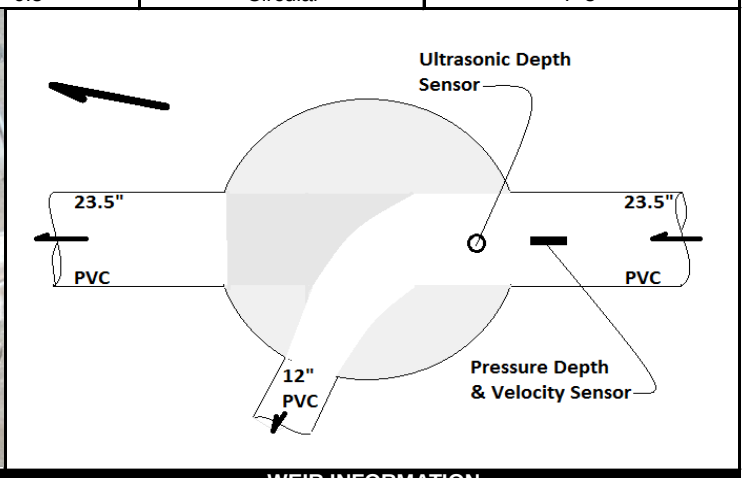




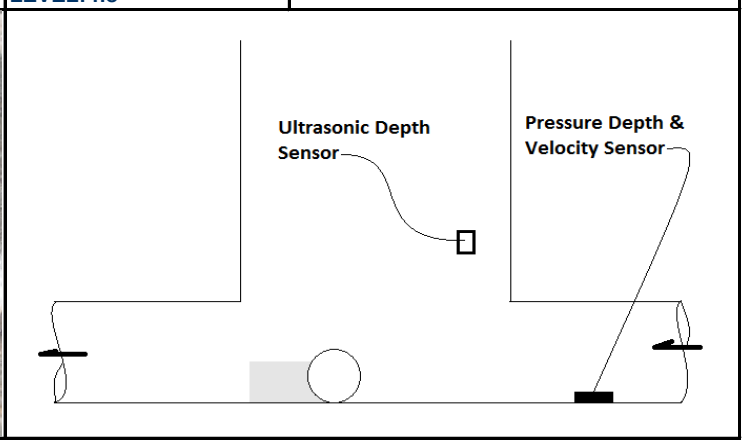
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 17, 2017	**JOB#:** 17039
LOCATION: 8th Street at Smith Avenue	**MH#:**	**METER SITE:** 025
GPS/COMMENTS: 41.534515, -72.051136		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	23.5	PVC	4.75	0.5	Circular	7' 3"
Incoming						
Overflow	23.5	PVC	0	0	Circular	7' 4"
Outgoing	12	PVC	5	0.5	Circular	7' 5"



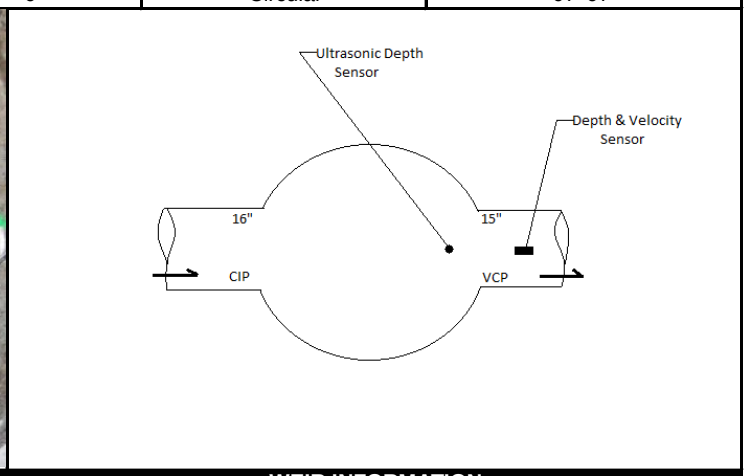
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH: 22.6**	**HEIGHT ABOVE WEIR: 22.6"**
SURCHARGED MARKS TO:	**BREADTH: 4.5**	**OVERFLOW OCCURS AT: 6.5"**
SURCHARGE CURRENTLY TO:	**LEVEL: no**	



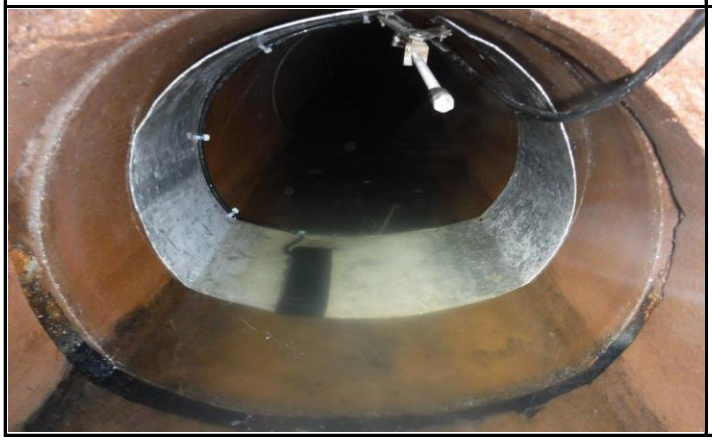
METER SITE INFORMATION FIELD LOG

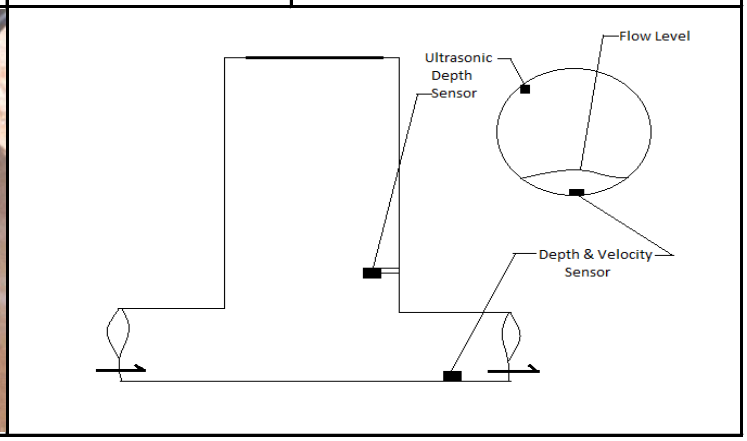
PROJECT: Norwich, CT	**DATE:** April 13, 2017	**JOB#:** 17039
LOCATION: Talman Street at Route 2	**MH#:**	**METER SITE:** 029
GPS/COMMENTS: 41.523010, -72.075132		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	16	CIP	1	2	Circular	07' 06"
Incoming						
Incoming						
Outgoing	15	VCP	3.3	0	Circular	07' 07"



SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT:	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO: 03'	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	

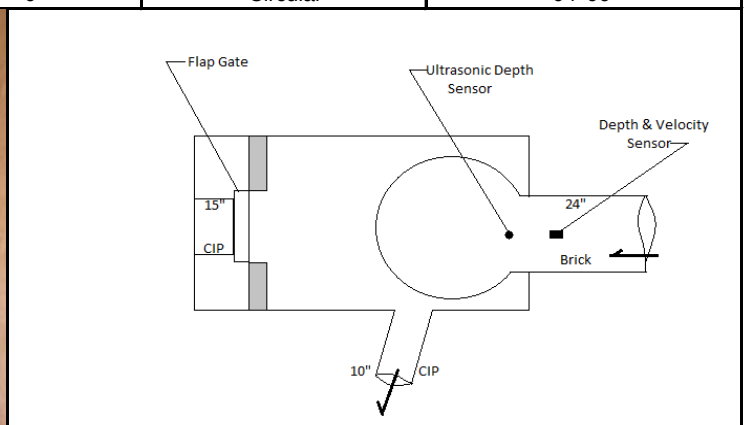




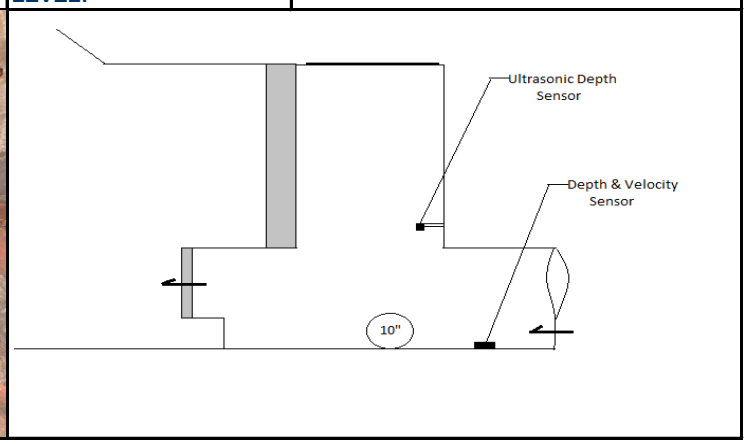
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 13, 2017	**JOB#:** 17039
LOCATION: R.O.W. off of River Avenue	**MH#:**	**METER SITE:** 031
GPS/COMMENTS: 41.515954, -72.076205		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24	Brick	2	0	Circular	05' 02"
Incoming						
Outgoing	10	CIP	2	0	Circular	05' 02"
Overflow	15	CIP	0	0	Circular	04' 06"



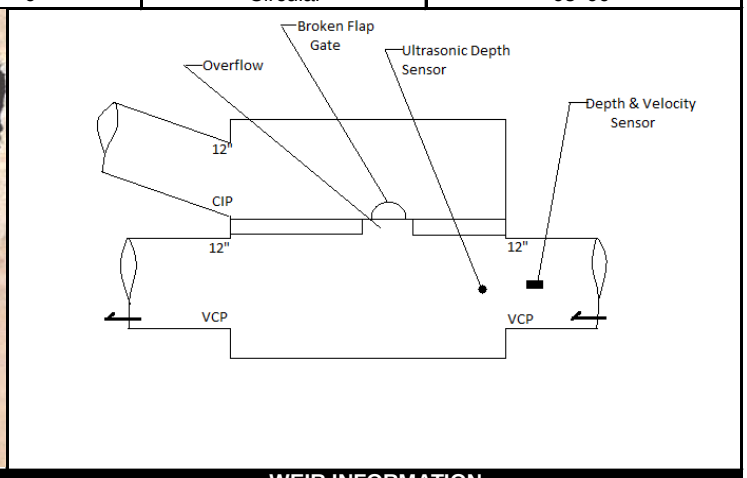
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



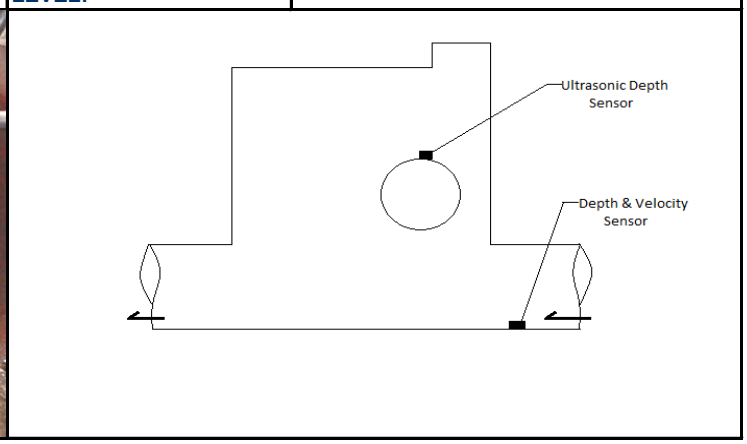
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 12, 2017	**JOB#:** 17039
LOCATION: Shipping Street and Terminal Way	**MH#:**	**METER SITE:** CSO 040
GPS/COMMENTS: 41.510458, -72.082556		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	12	VCP	1.5	0	Circular	05' 09"
Incoming						
Outgoing	12	VCP	2.5	0	Circular	05' 10"
Overfow	12	CIP	0	0	Circular	05' 00"

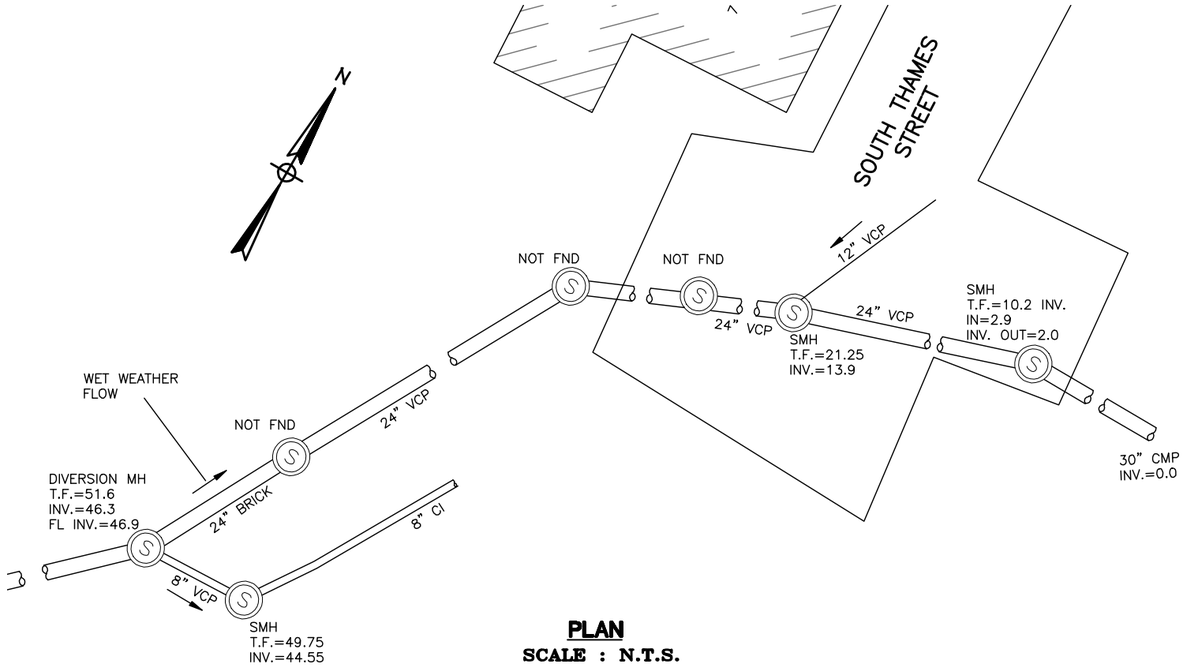


SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	

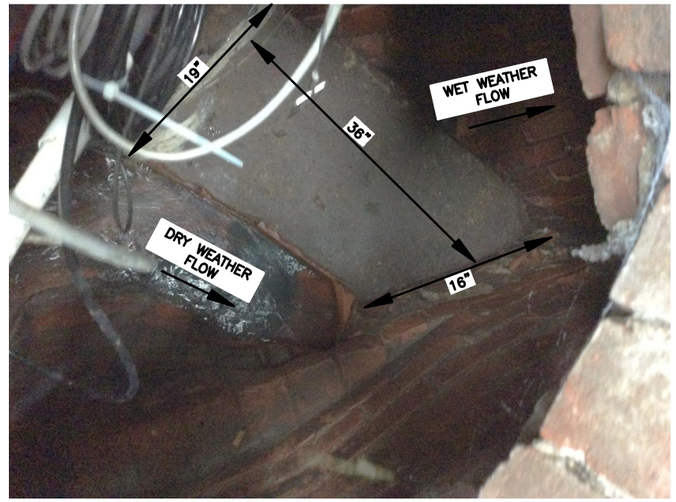


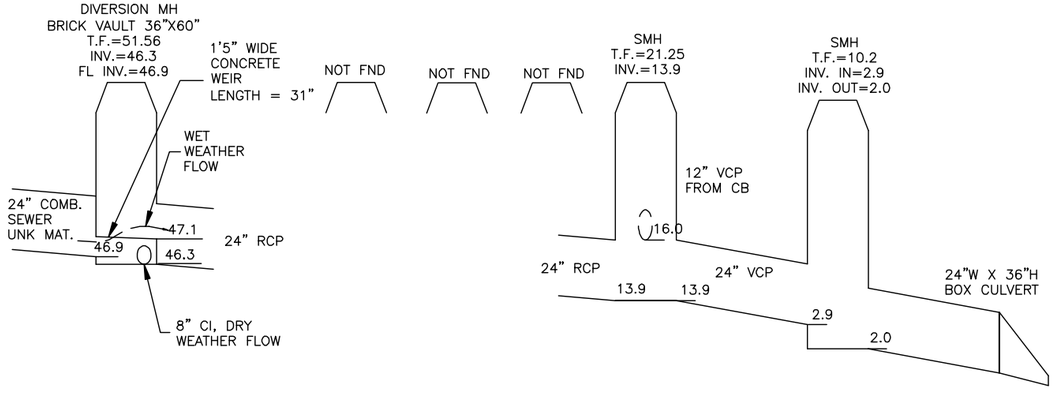
Attachment F

CSO Regulator Survey Sketches



PLAN
SCALE : N.T.S.





PROFILE
SCALE : N.T.S.

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88

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GREEN SITE DESIGN LLC
317 Main Street Norwich, Connecticut
(860) 892-1380 Fax (860) 886-9165

REV. NO.	DATE	DRWN	CHKD	REMARKS

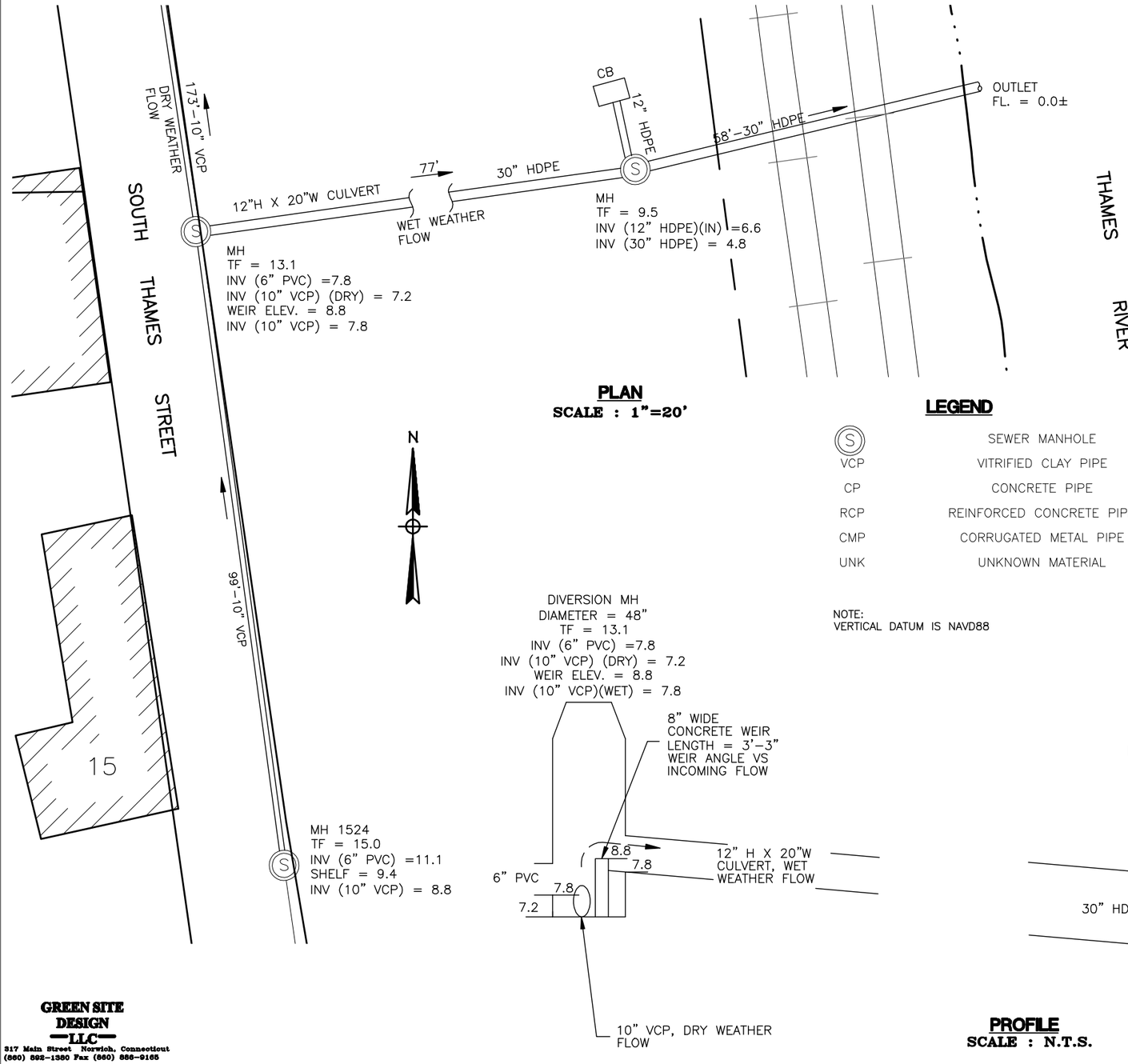
DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1500
East Hartford, Connecticut 06108
Tel: (860) 528-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-4
South Thames Street

96538-

SHEET NO.
1



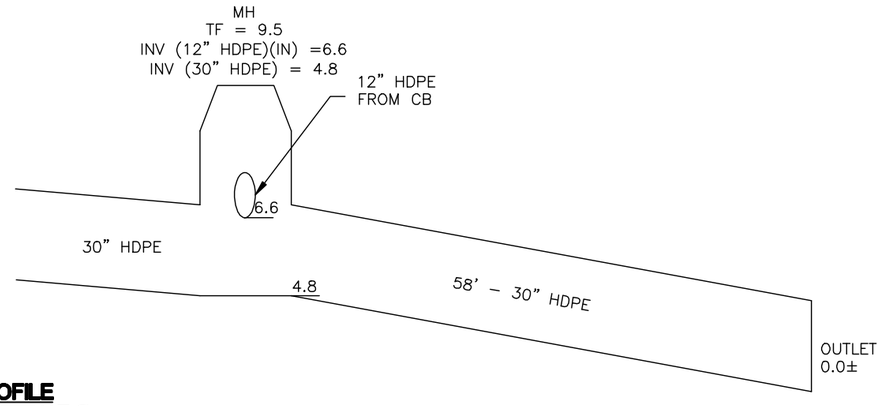
PLAN
SCALE : 1"=20'

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88

DIVERSION MH
DIAMETER = 48"
TF = 13.1
INV (6" PVC) =7.8
INV (10" VCP) (DRY) = 7.2
WEIR ELEV. = 8.8
INV (10" VCP)(WET) = 7.8



PROFILE
SCALE : N.T.S.

GREEN SITE DESIGN LLC
317 Main Street Norwich, Connecticut
(860) 892-1350 Fax (860) 886-9165

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1500
East Hartford, Connecticut 06108
Tel: (860) 529-7015

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-5
South Thames Street

96538-

SHEET NO.
2

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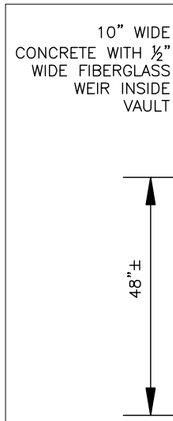
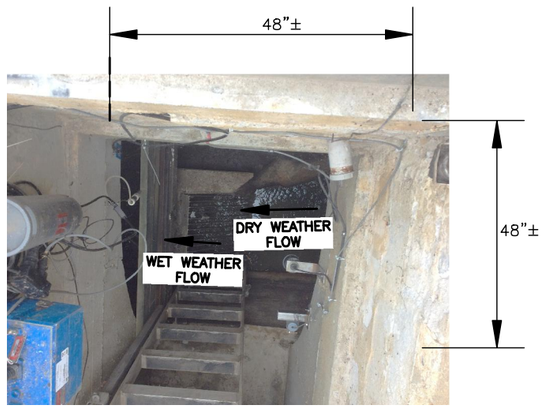
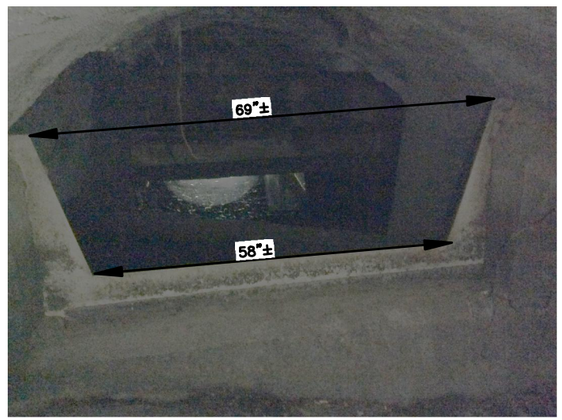
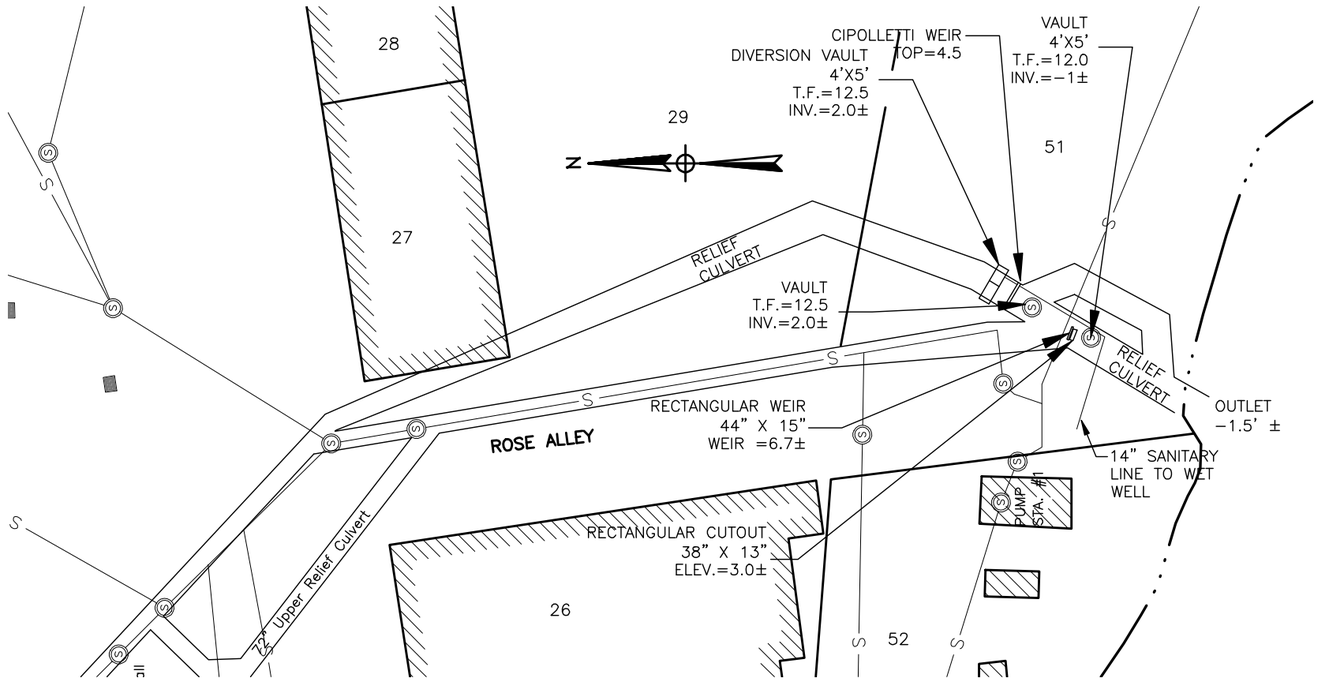
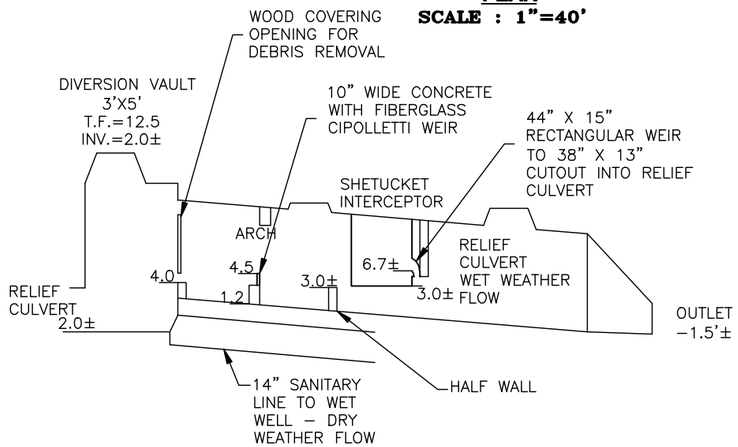








PLAN
SCALE : 1"=40'



PROFILE
SCALE : N.T.S.

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTES:
1. MEASUREMENTS AND ELEVATIONS ARE TAKEN FROM BEST AVAILABLE DATA; INCLUDING PLANS, SKETCHES, AND NPU STAFF.

2. VERTICAL DATUM IS NAVD88

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317 Main Street Norwich, Connecticut
(860) 892-1380 Fax (860) 886-9165

REV. NO.	DATE	DRWN	CHKD	REMARKS

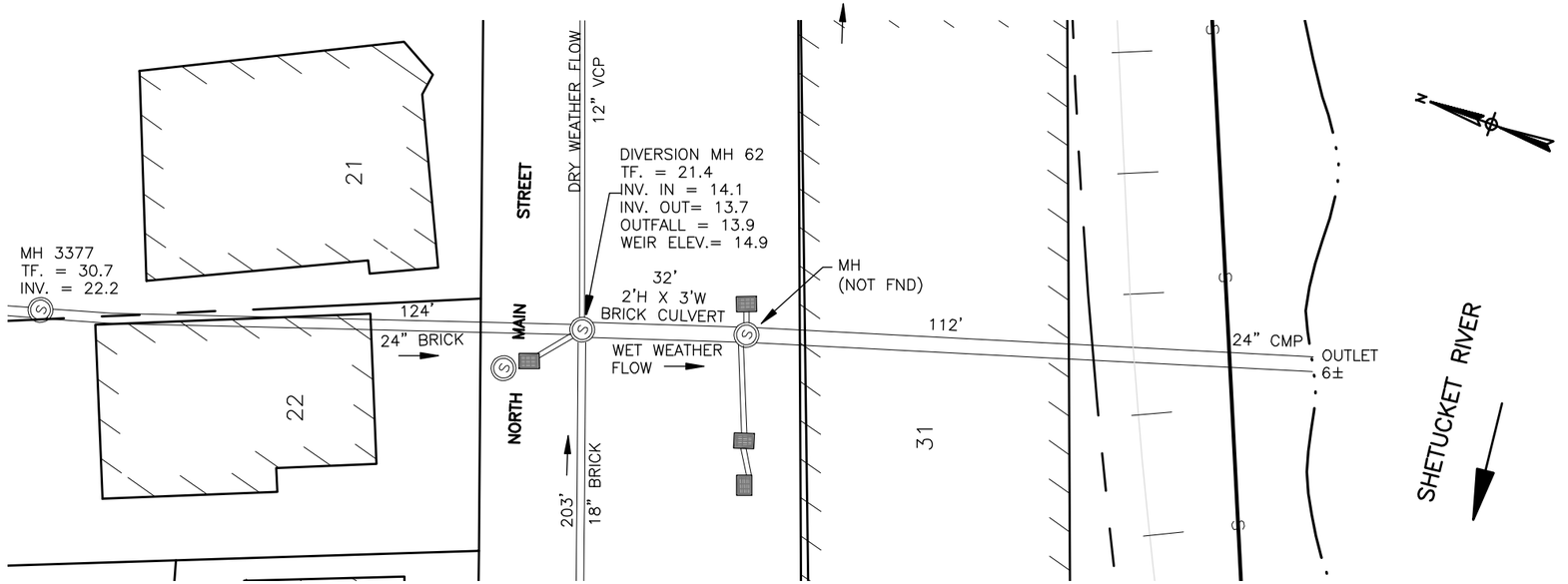
DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1600
East Hartford, Connecticut 06108
Tel: (860) 529-7615

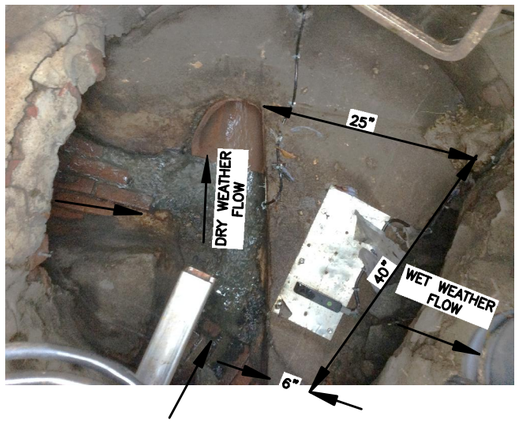
CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-17
Rose Alley

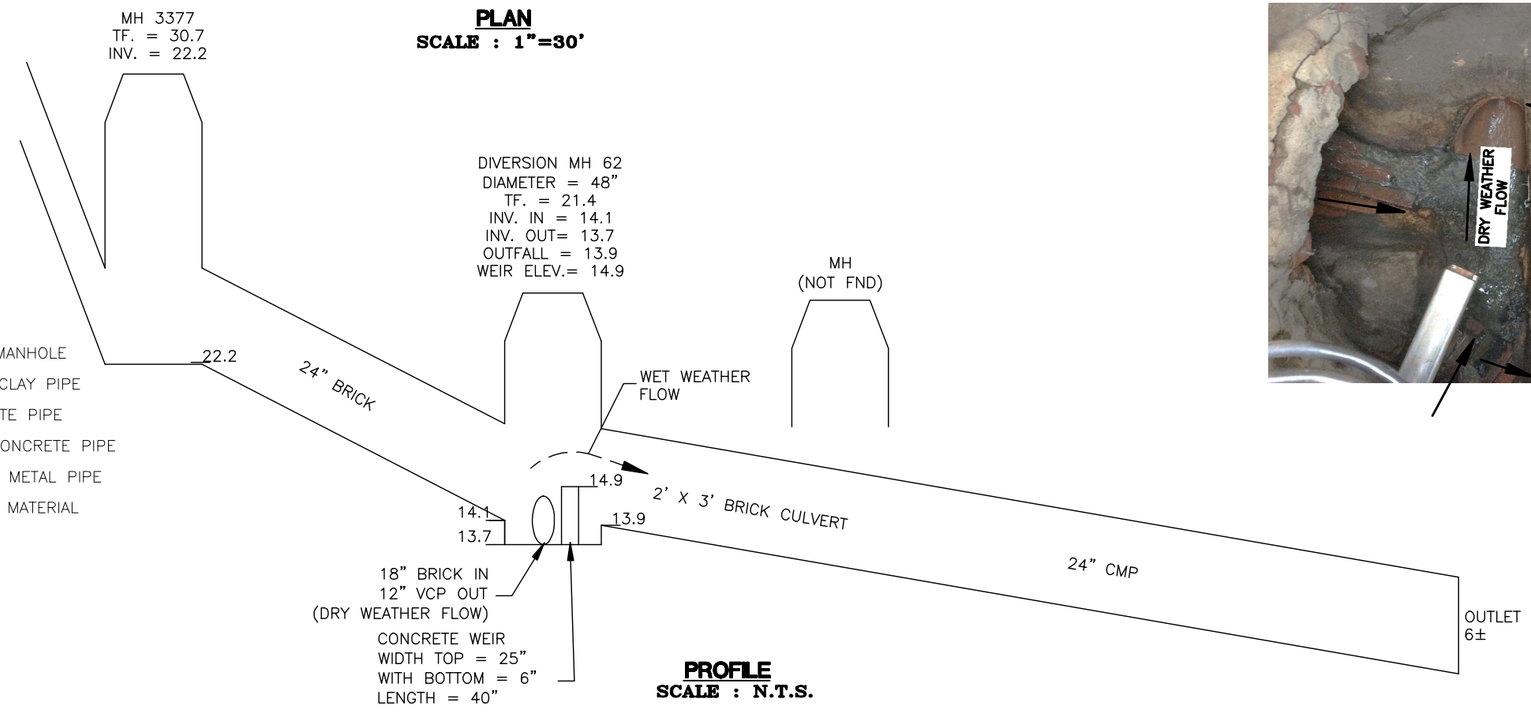
96538-

SHEET NO.
3



PLAN
SCALE : 1"=30'





PROFILE
SCALE : N.T.S.

LEGEND

S	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88

GREEN SITE DESIGN LLC
317 Main Street Norwich, Connecticut
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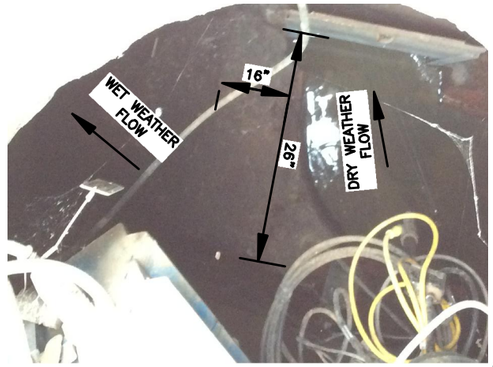
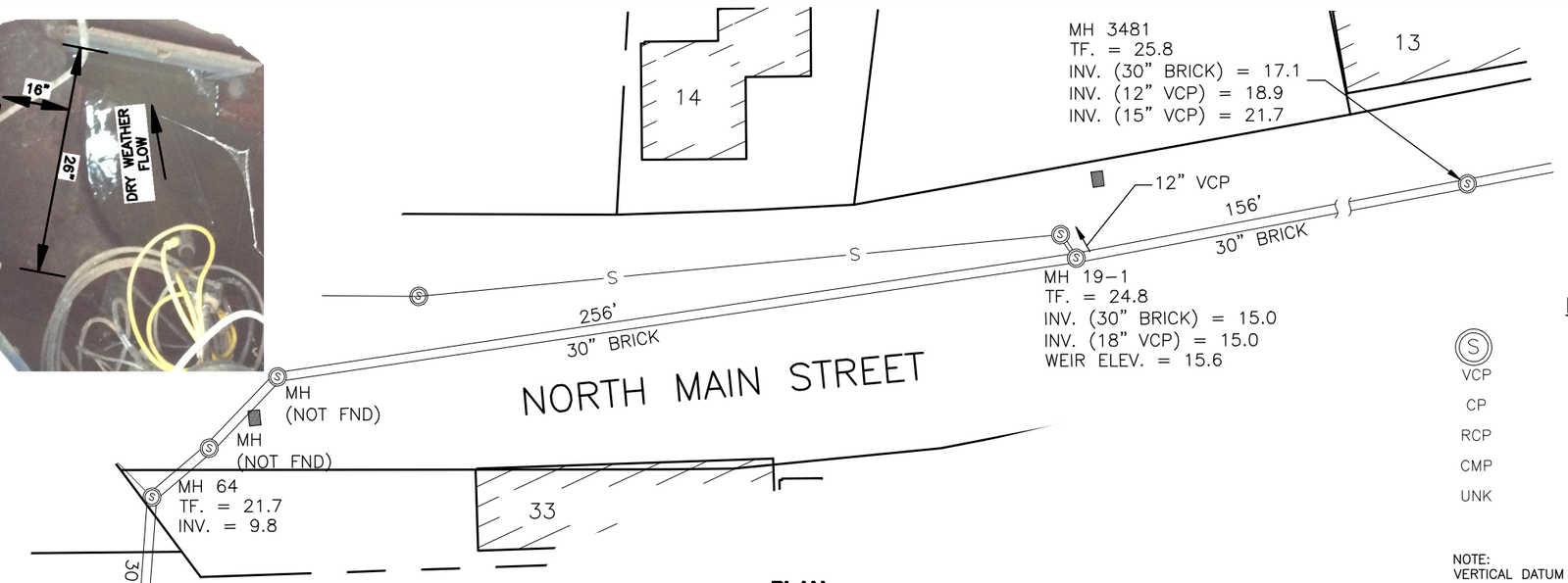
CDM Smith
111 Founders Plaza, Suite 1606
East Hartford, Connecticut 06108
Tel: (860) 528-7616

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-16
North Main Sreet & Trade School

96538-

SHEET NO.
4



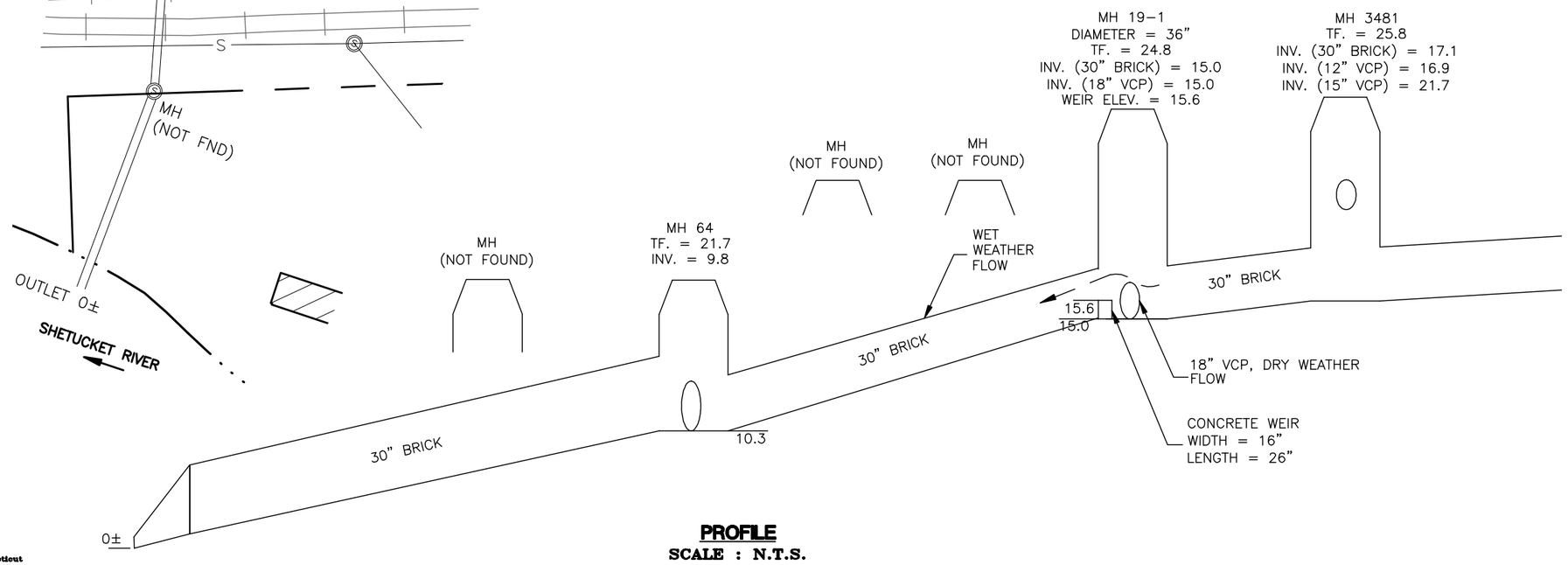


PLAN
SCALE : 1"=40'

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



PROFILE
SCALE : N.T.S.

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REV. NO.	DATE	DRWN	CHKD	REMARKS

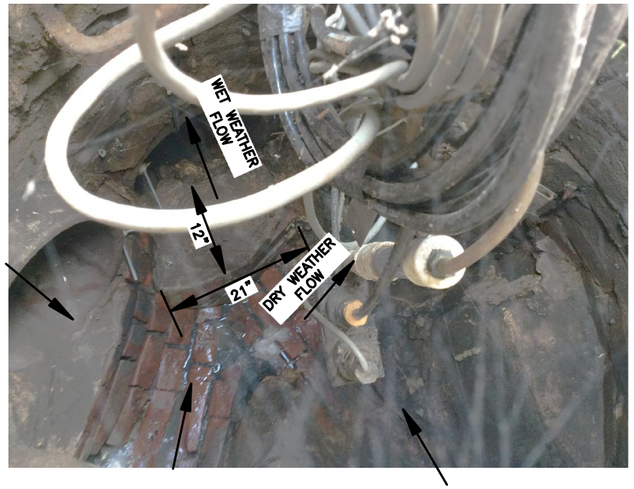
DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

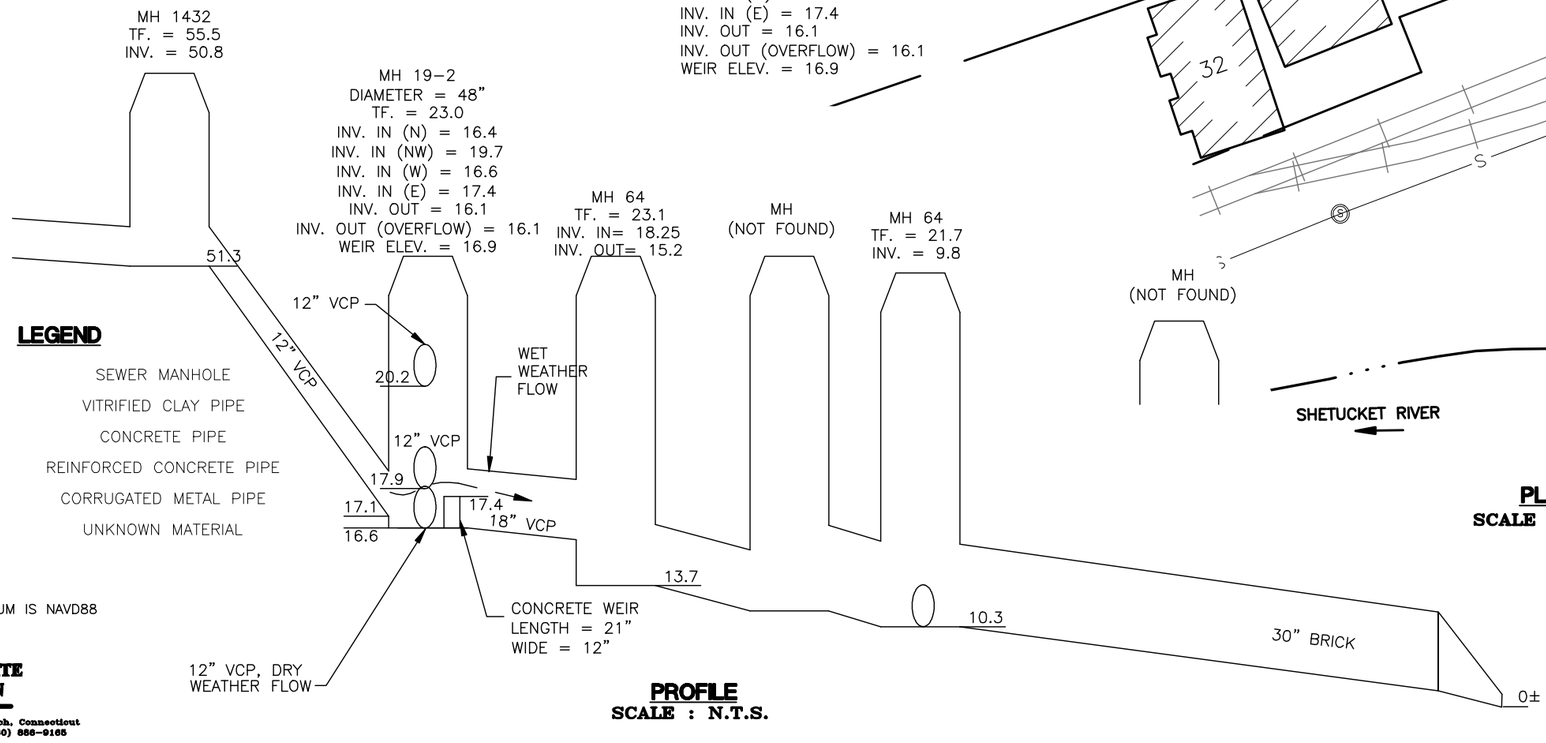
CDM Smith
111 Founders Plaza, Suite 1600
East Hartford, Connecticut 06108
Tel: (860) 529-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-19-1
North Main Sreet

96538-

SHEET NO.
5



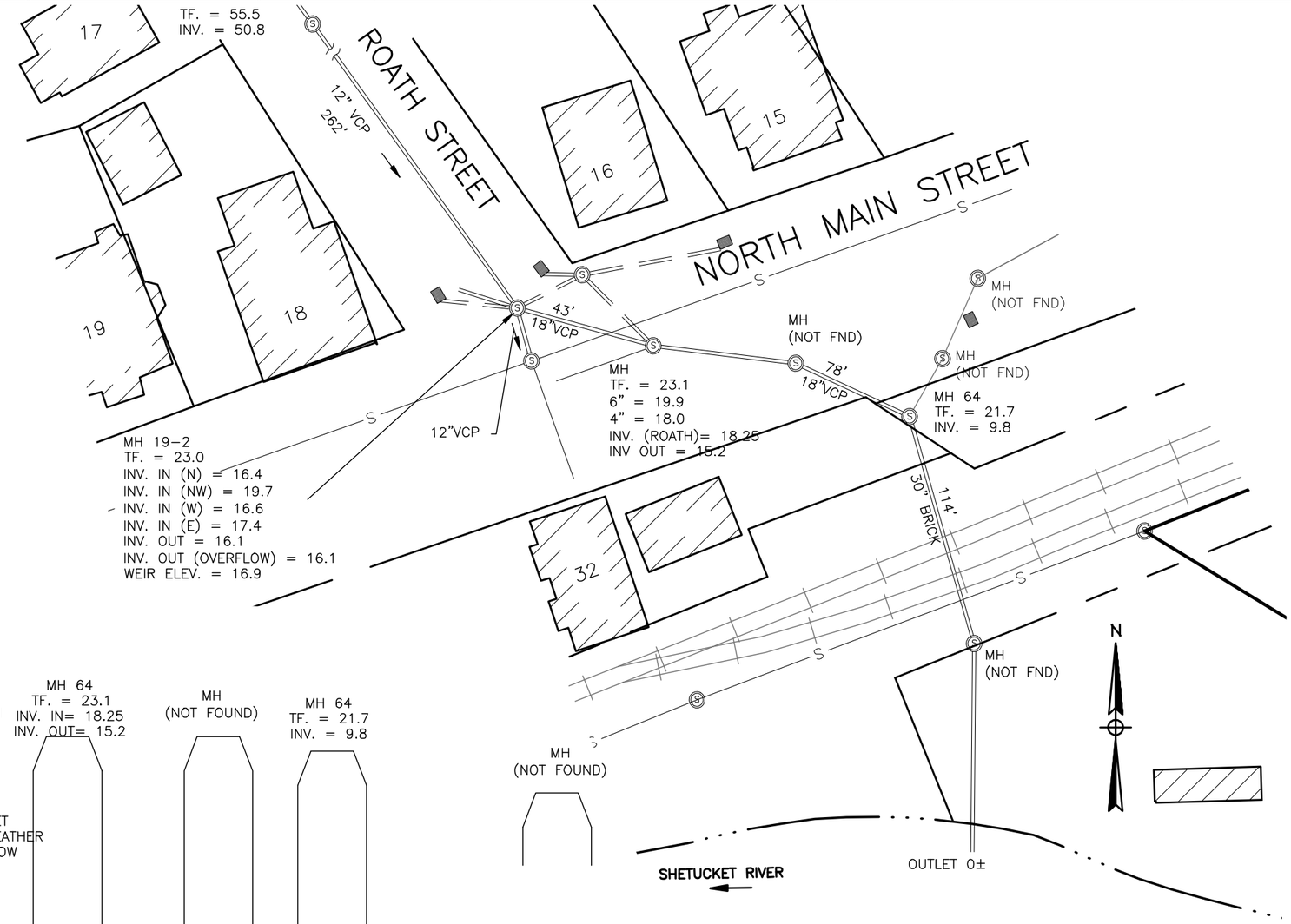


PROFILE
SCALE : N.T.S.

LEGEND

S	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



PLAN
SCALE : 1"=40'

GREEN SITE DESIGN LLC
317 Main Street Norwich, Connecticut
(860) 892-1380 Fax (860) 886-9165

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1800
East Hartford, Connecticut 06108
Tel: (860) 528-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-19-2
North Main Sreet

96538-

SHEET NO.
6

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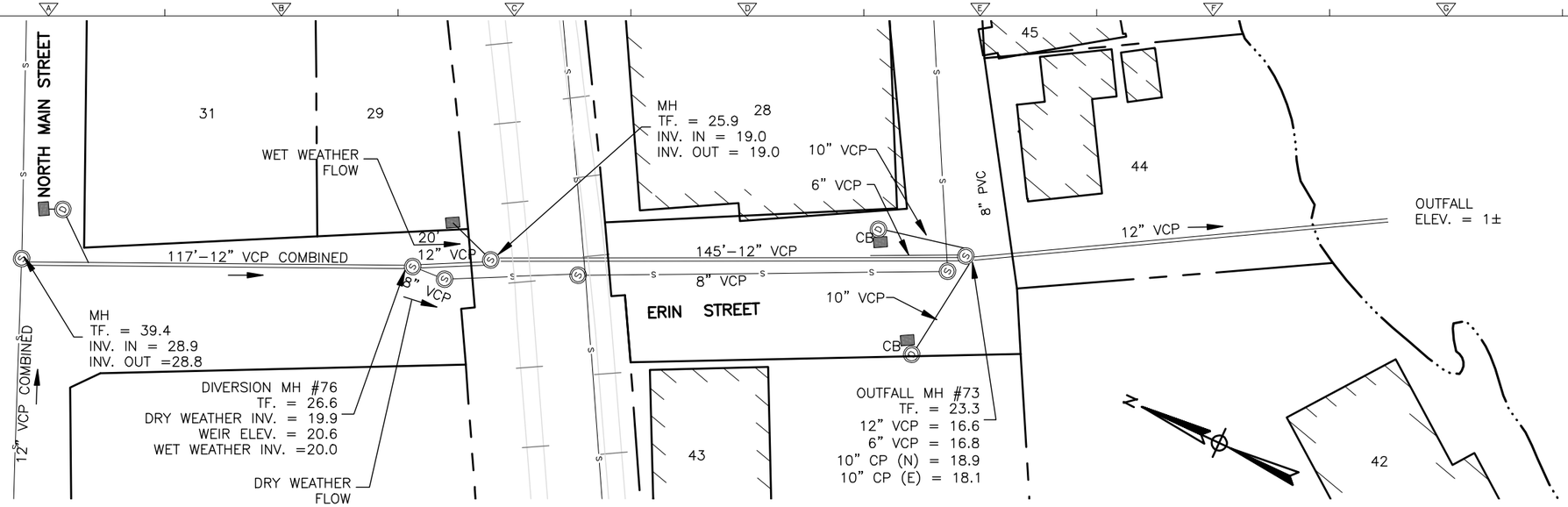
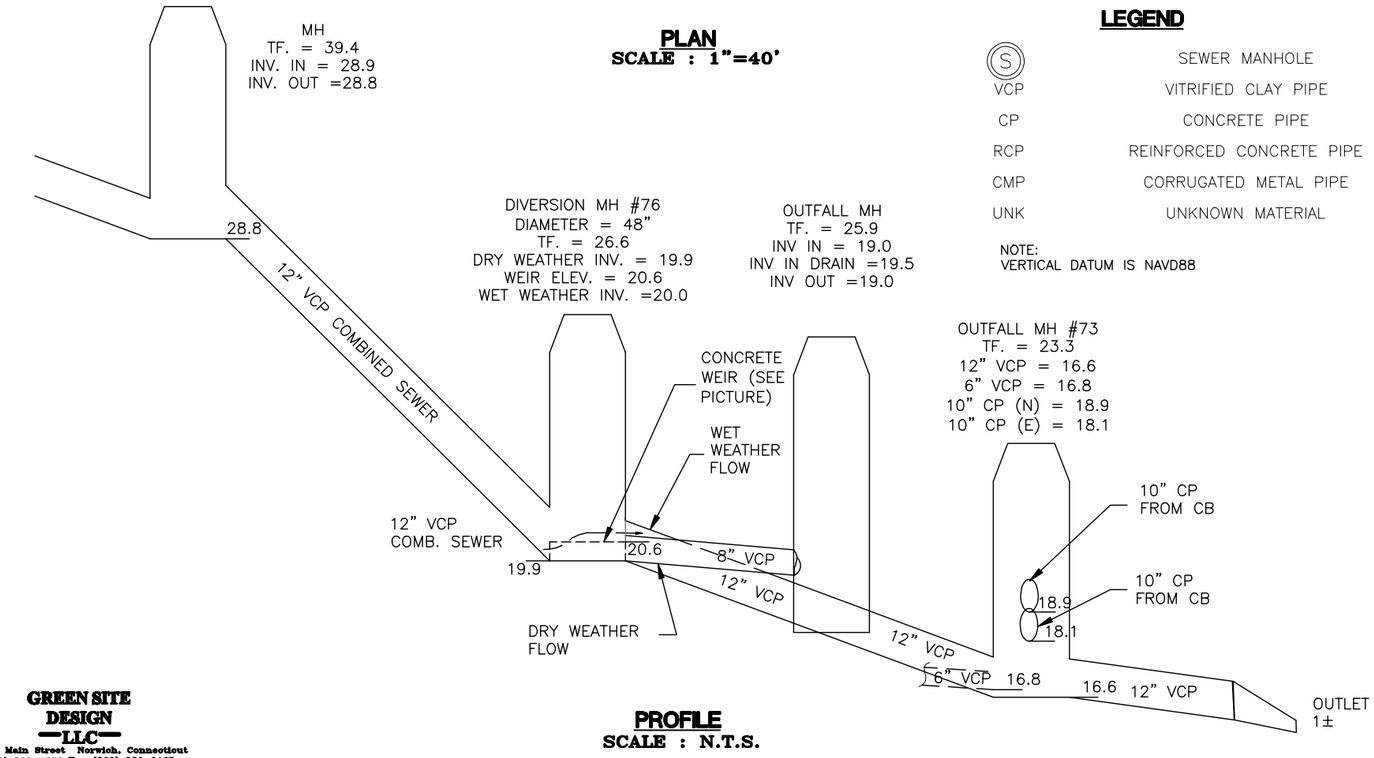


PLAN
SCALE : 1"=40'

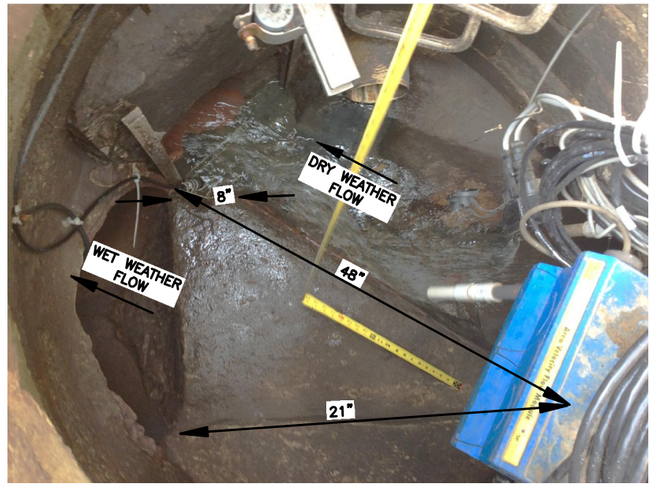


PROFILE
SCALE : N.T.S.

LEGEND

S	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



GREEN SITE DESIGN LLC
317 Main Street Norwich, Connecticut
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REV. NO.	DATE	DRWN	CHKD	REMARKS

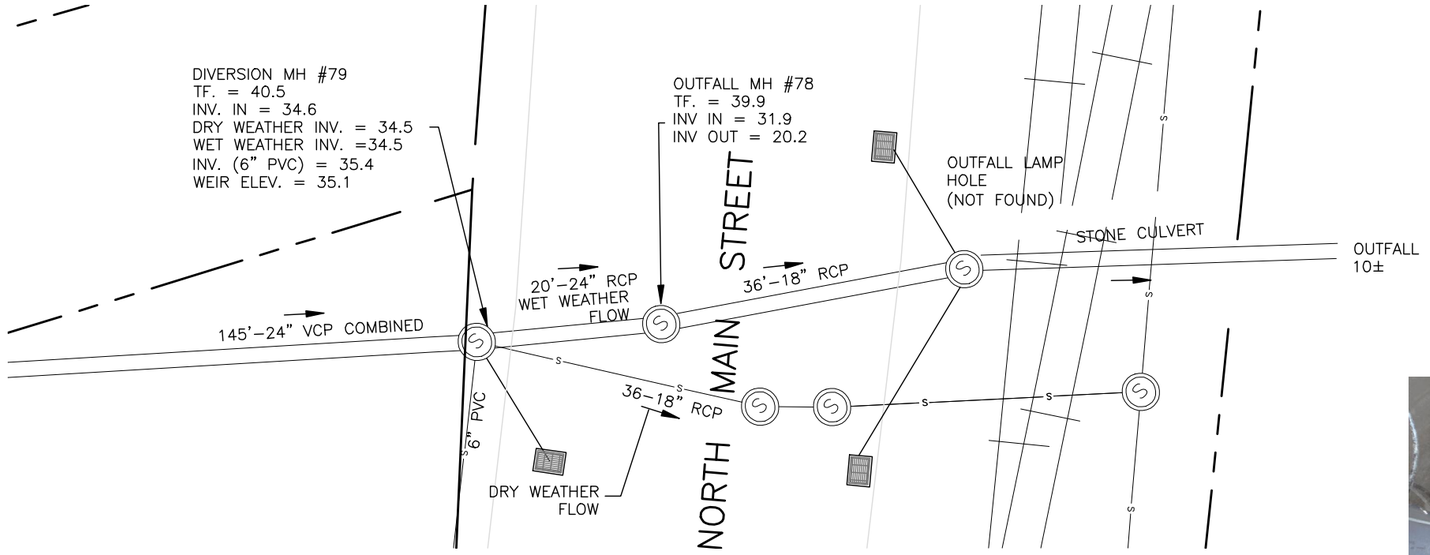
DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1600
East Hartford, Connecticut 06108
Tel: (860) 528-7615

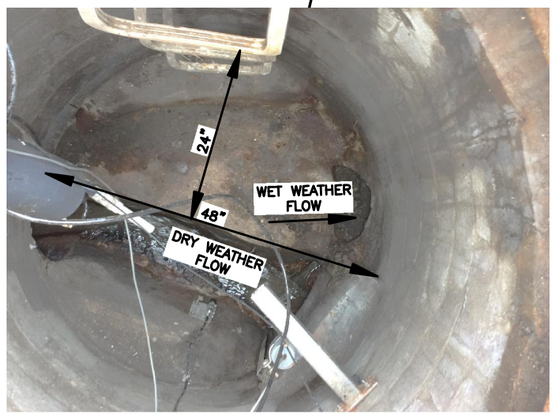
CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-21
Erin Street

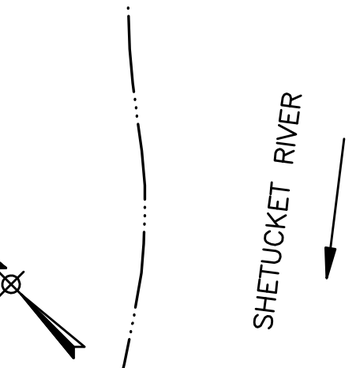
96538-

SHEET NO.
7



PLAN
SCALE : 1"=20'

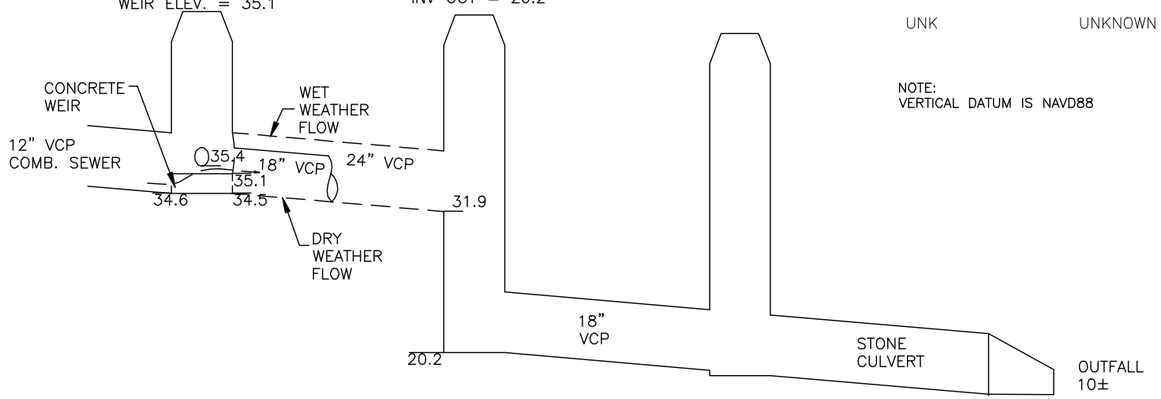




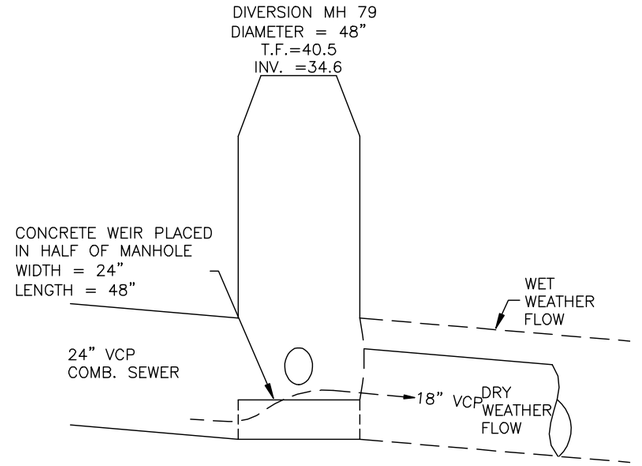
LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



PROFILE
SCALE : N.T.S.



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REV. NO.	DATE	DRWN	CHKD	REMARKS

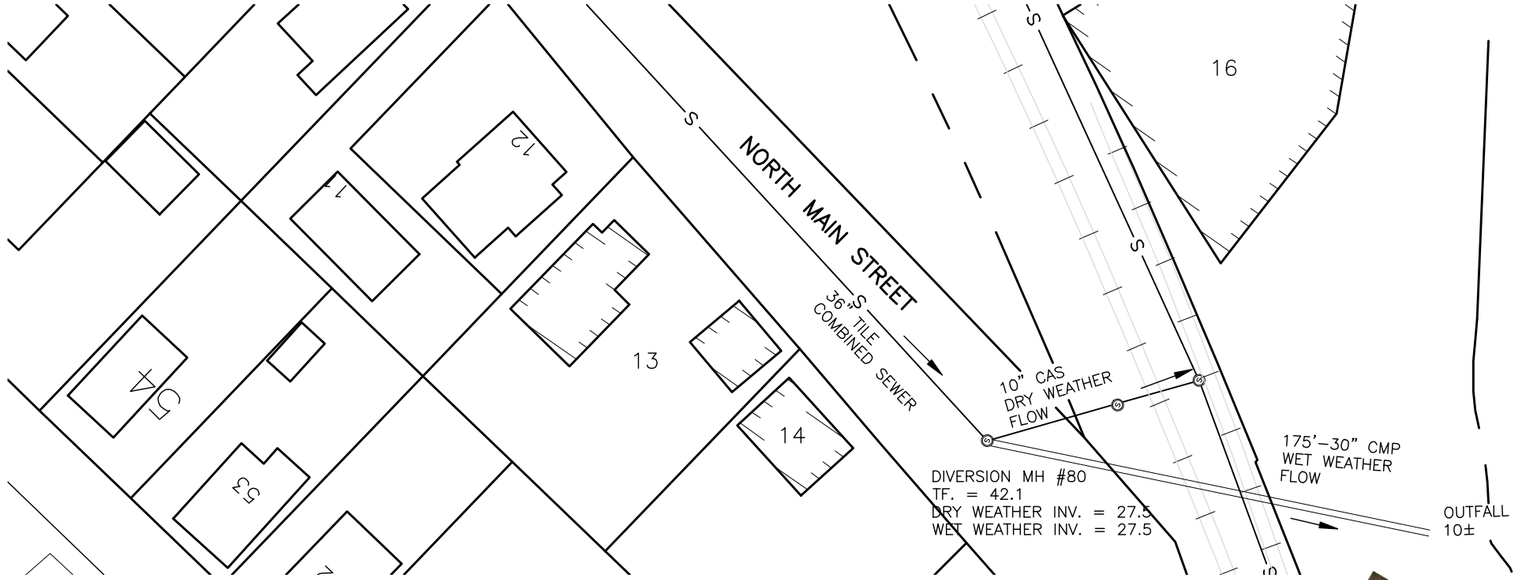
DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1800
East Hartford, Connecticut 06108
Tel: (860) 828-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-22
North Main Street off Hickory Street

96538-

SHEET NO.
8

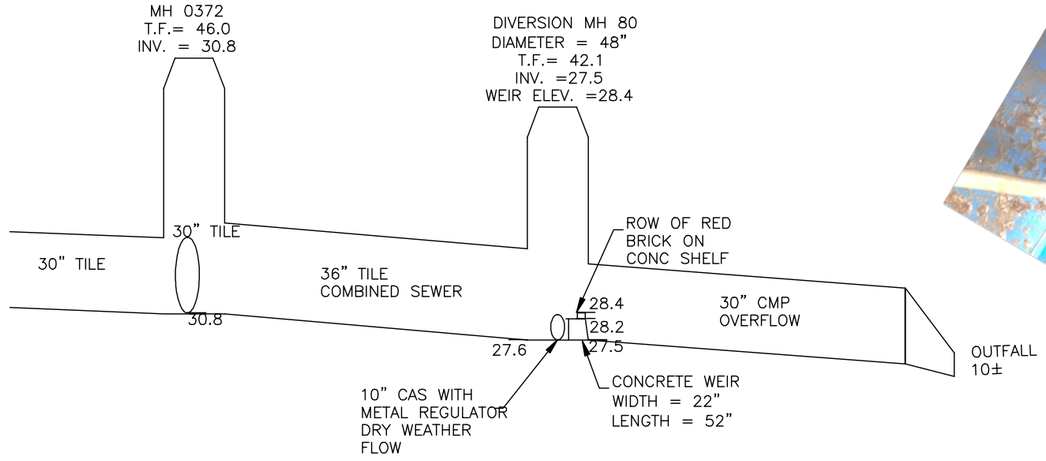


PLAN
SCALE : 1"=60'

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



PROFILE
SCALE : N.T.S.

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REV. NO.	DATE	DRWN	CHKD	REMARKS

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DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1500
East Hartford, Connecticut 06108
Tel: (860) 528-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-23
North Main Sreet near Atlantic Carton

96538-

SHEET NO.
9

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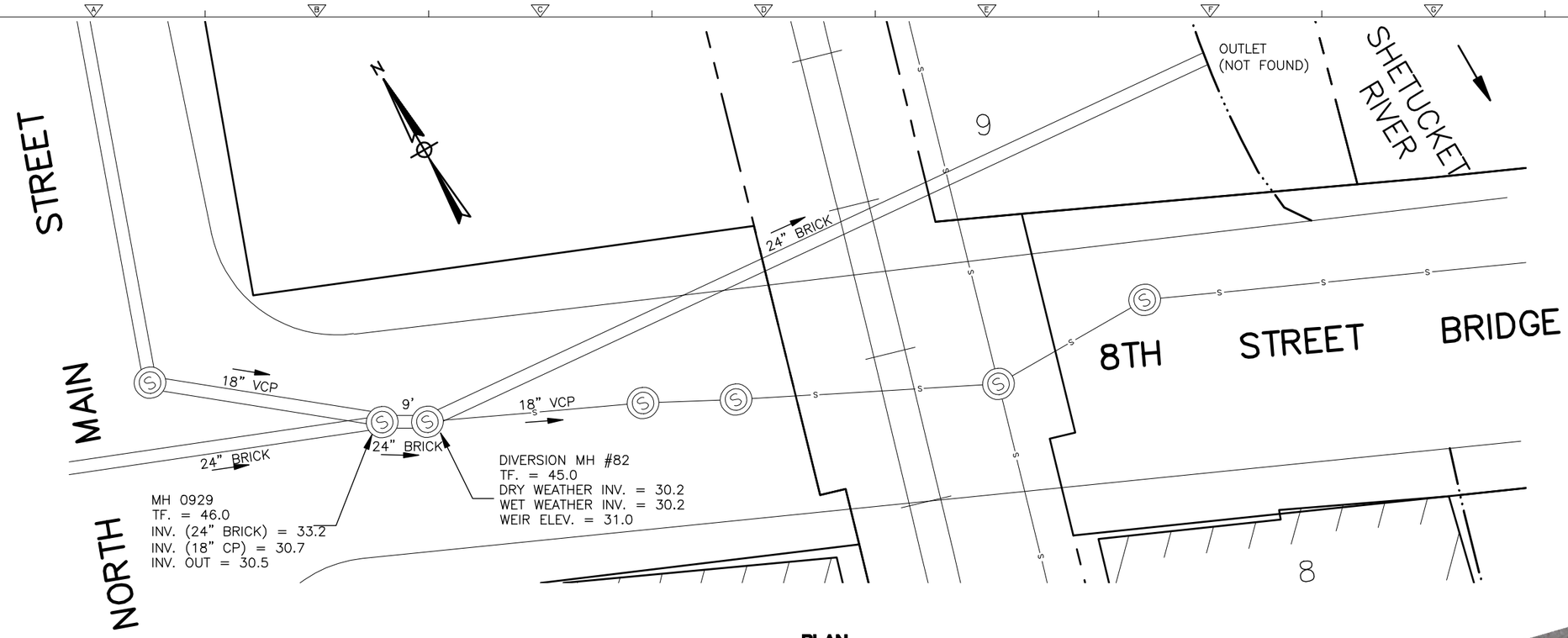
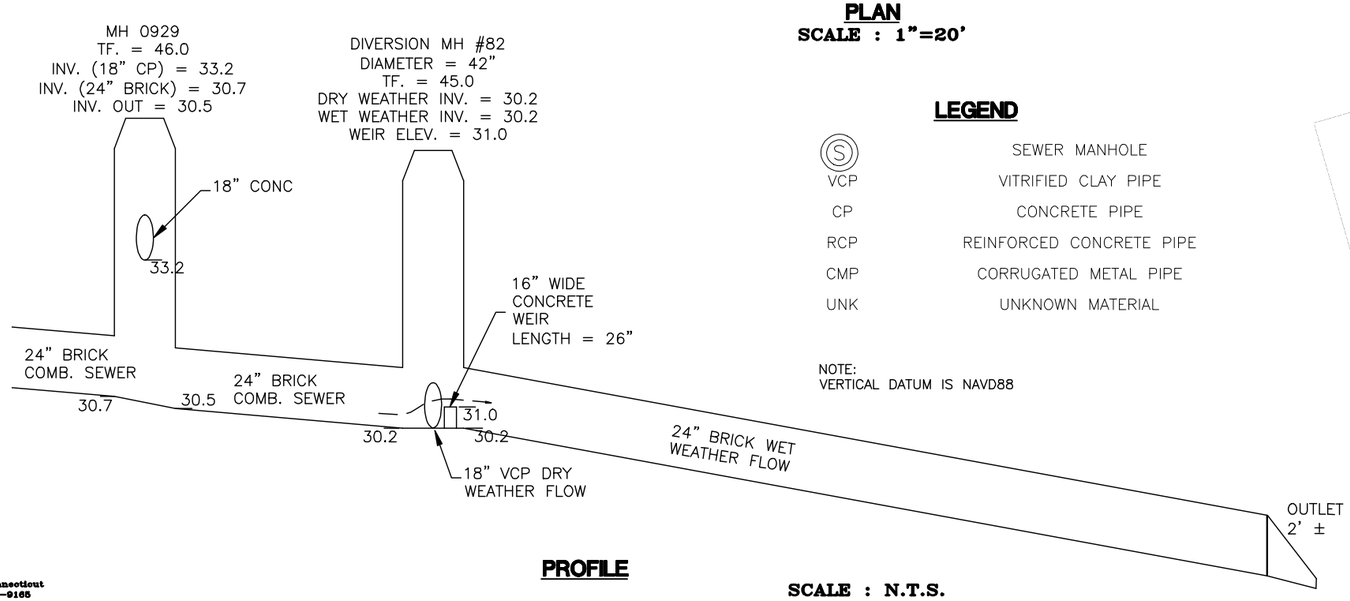


PLAN
SCALE : 1"=20'

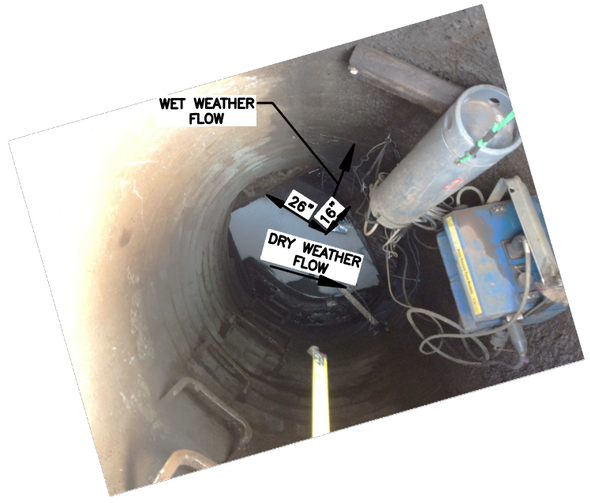


PROFILE
SCALE : N.T.S.

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



GREEN SITE DESIGN LLC
317 Main Street Norwich, Connecticut
(860) 892-1380 Fax (860) 886-0165

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1600
East Hartford, Connecticut 06108
Tel: (860) 528-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-24
Eighth Street

96538-

SHEET NO.
10

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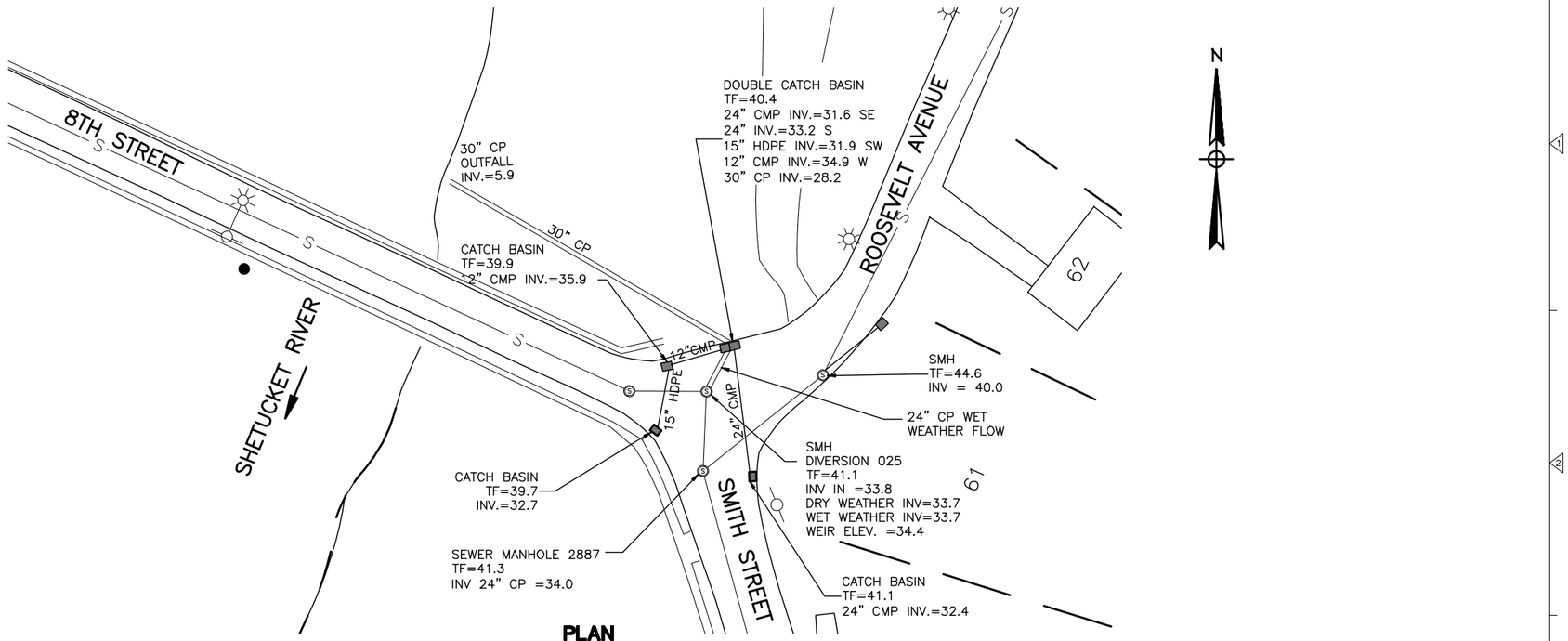
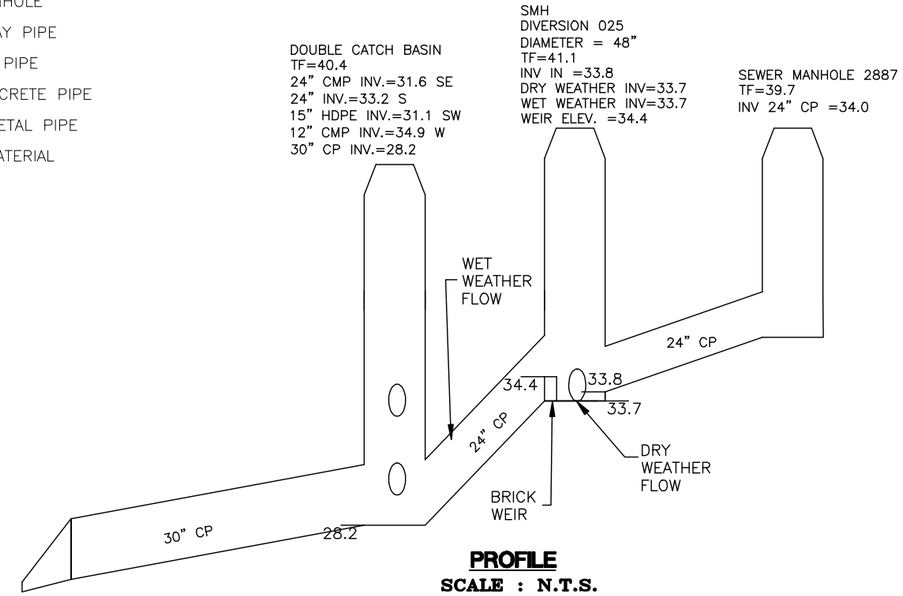


PLAN
SCALE : 1"=40'

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



PROFILE
SCALE : N.T.S.

GREEN SITE DESIGN LLC
317 Main Street Norwich, Connecticut
(860) 892-1360 Fax (860) 886-9165

REV. NO.	DATE	DRWN	CHKD	REMARKS

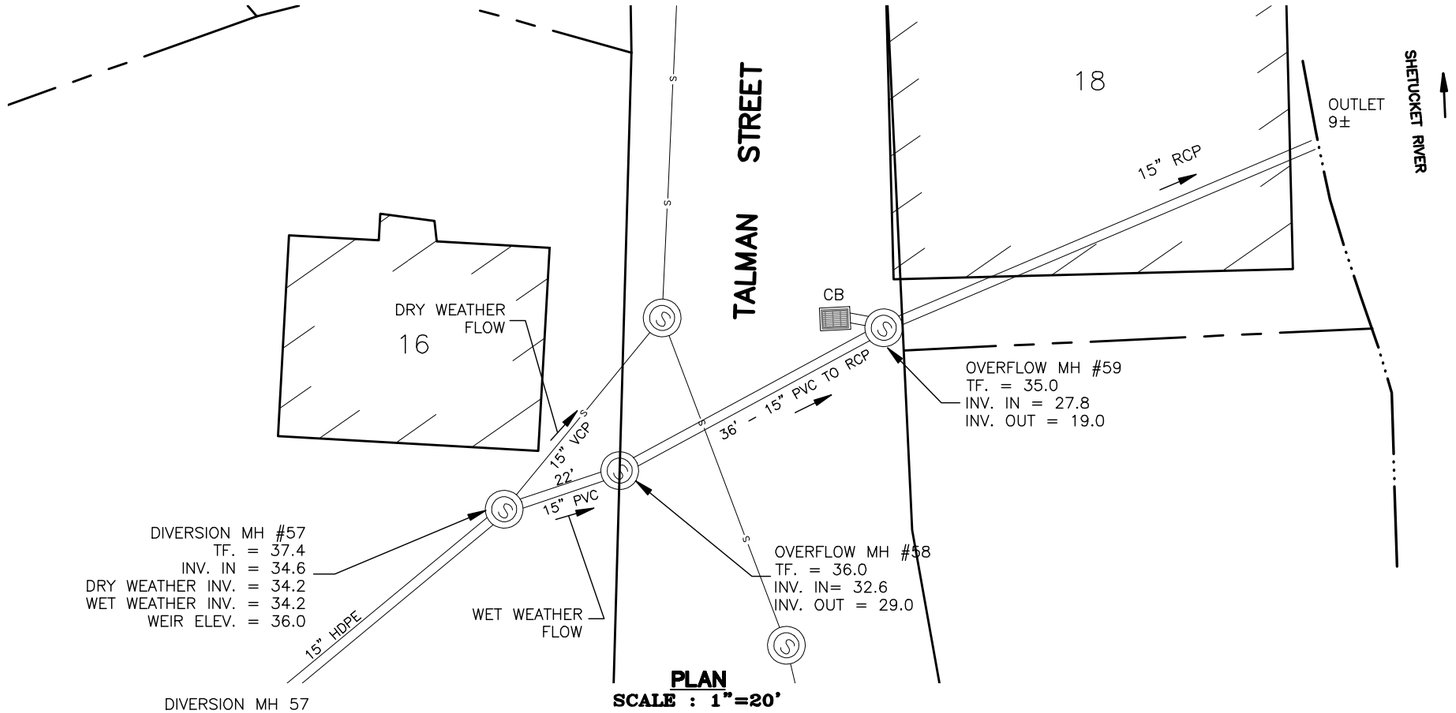
DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1800
East Hartford, Connecticut 06108
Tel: (860) 528-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-25
Smith Avenue

96538-

SHEET NO.
11



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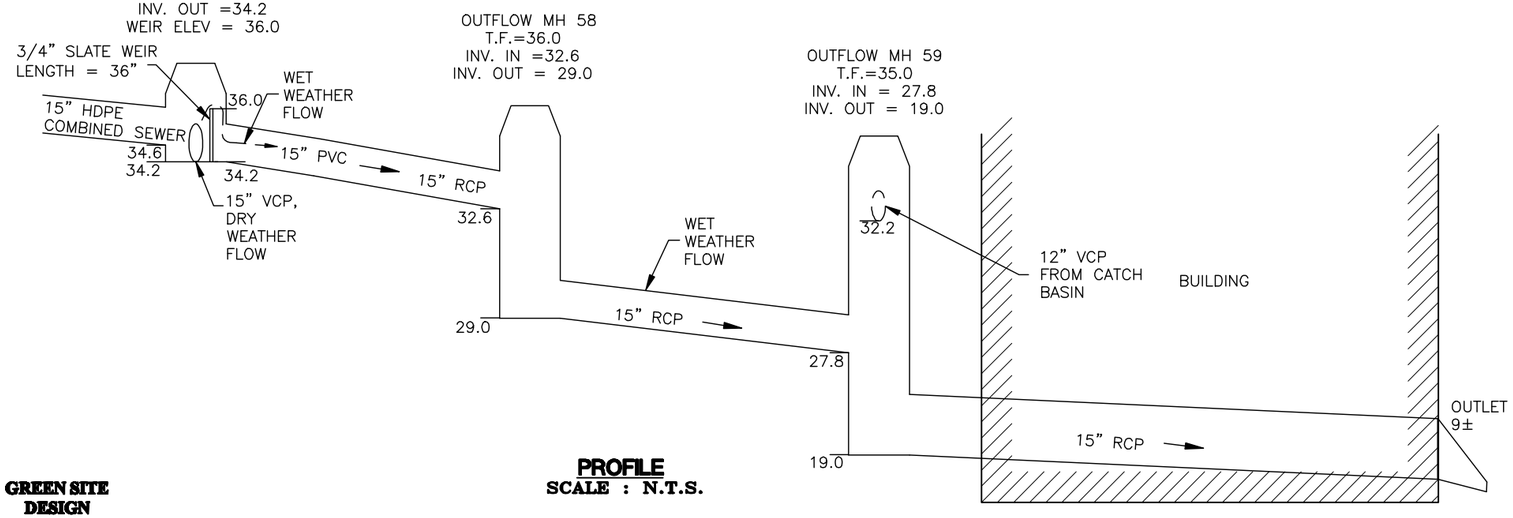

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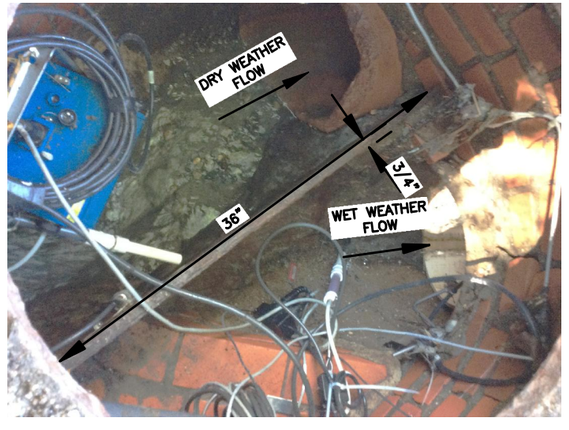
SCALE : N.T.S.



LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88

GREEN SITE DESIGN LLC
317 Main Street Norwich, Connecticut
(860) 892-1380 Fax (860) 886-9165

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CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1500
East Hartford, Connecticut 06108
Tel: (860) 528-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-29
Talman Street

96538-

SHEET NO.
12

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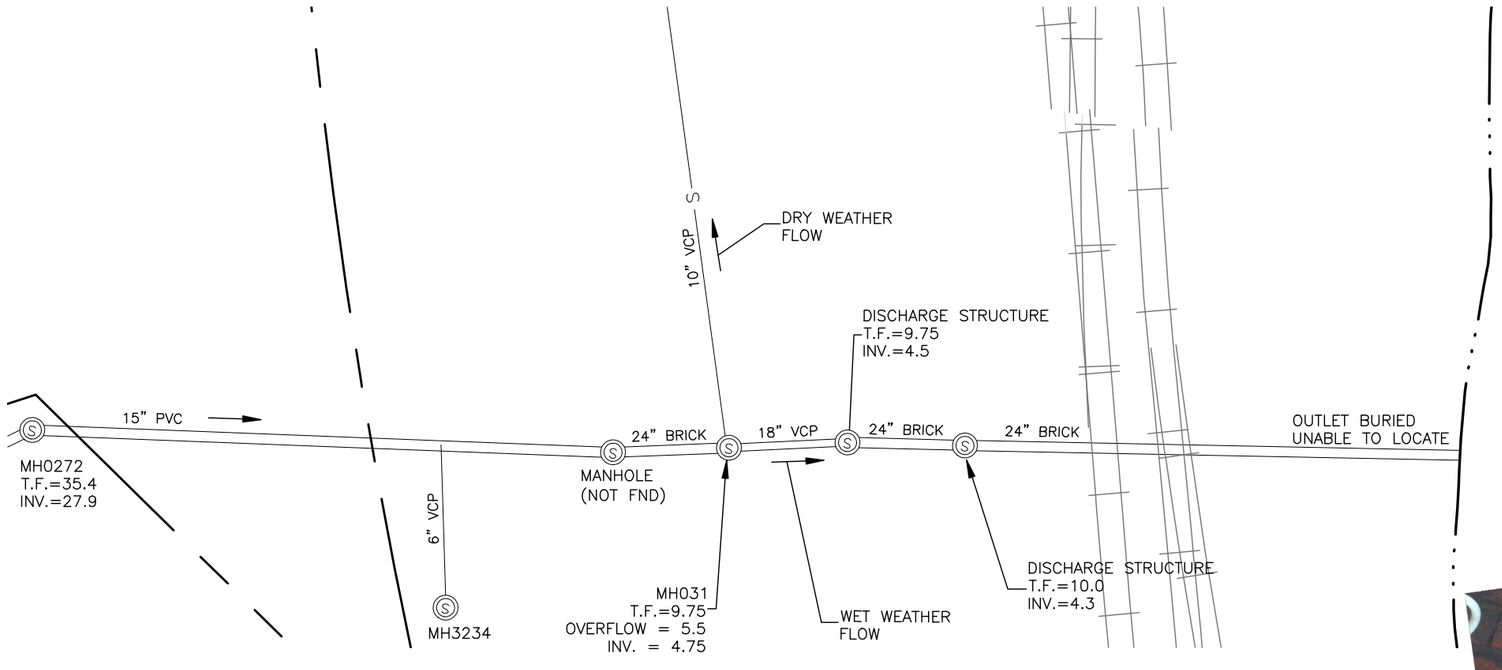
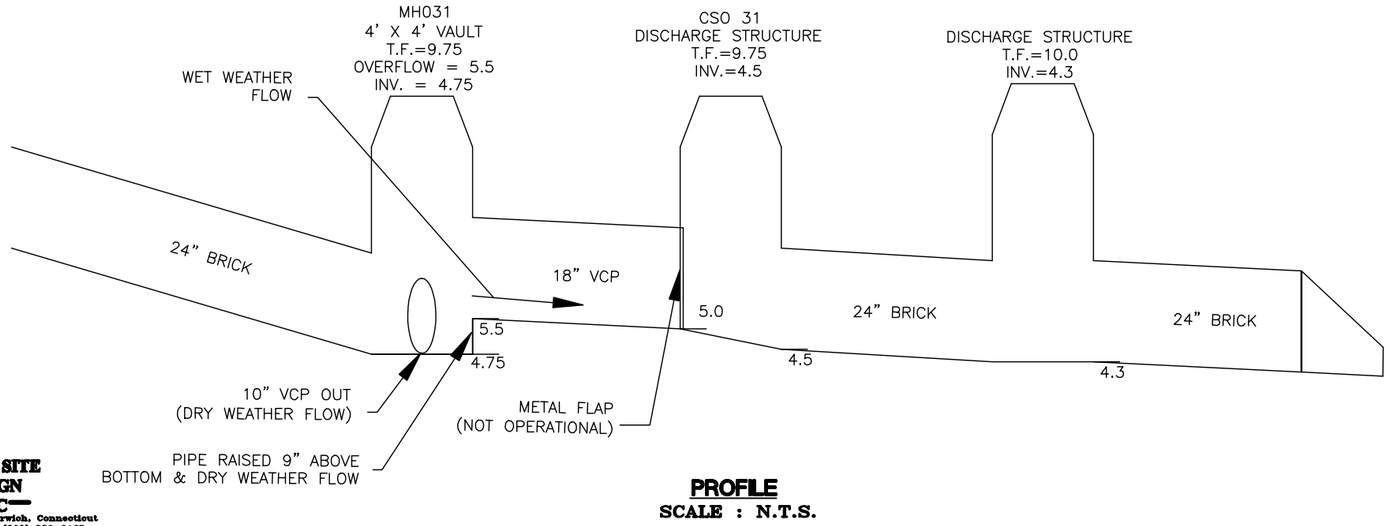


PLAN
SCALE : 1"=20'



PROFILE
SCALE : N.T.S.

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REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY:
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APPROVED BY:
DATE: AUGUST 2017

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East Hartford, Connecticut 06108
Tel: (860) 528-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-31
River Avenue Extension

96538-

SHEET NO.
13

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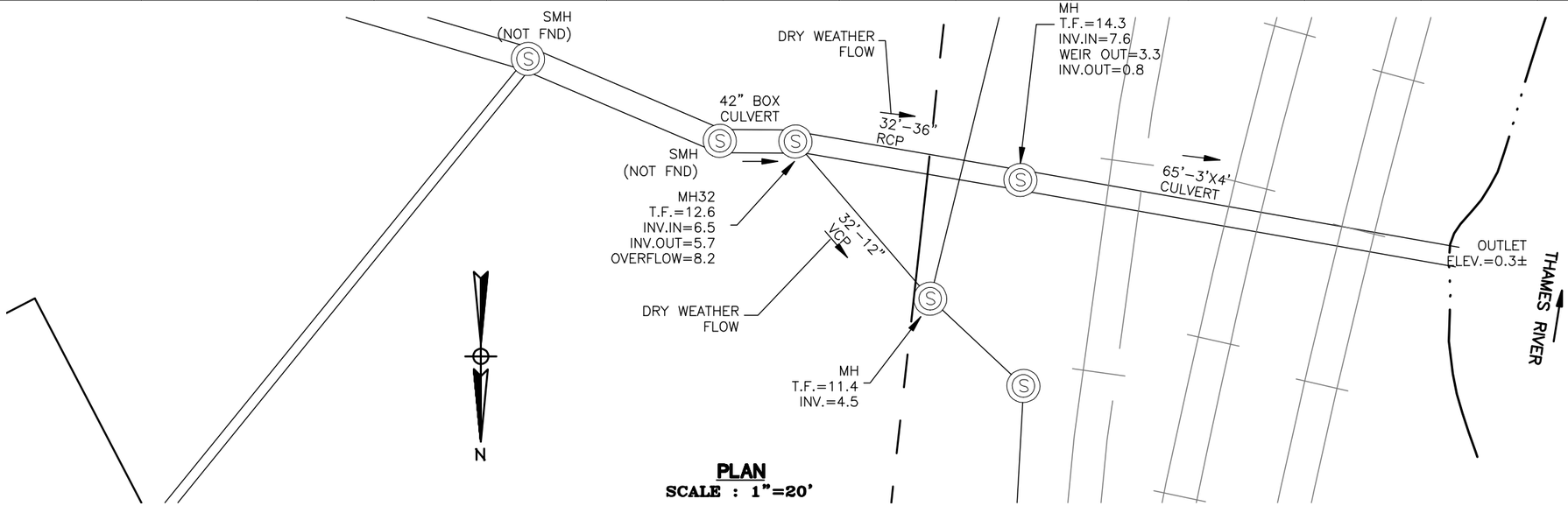
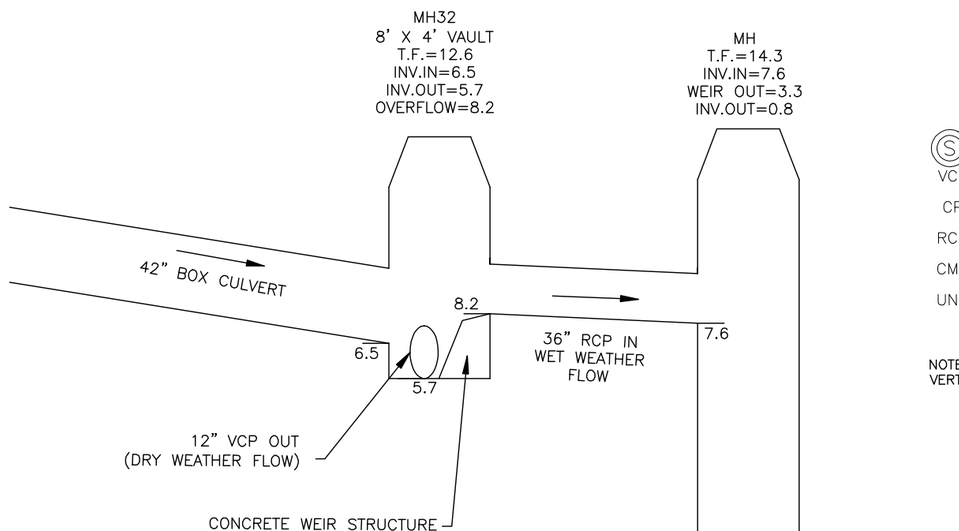


PLAN
SCALE : 1"=20'

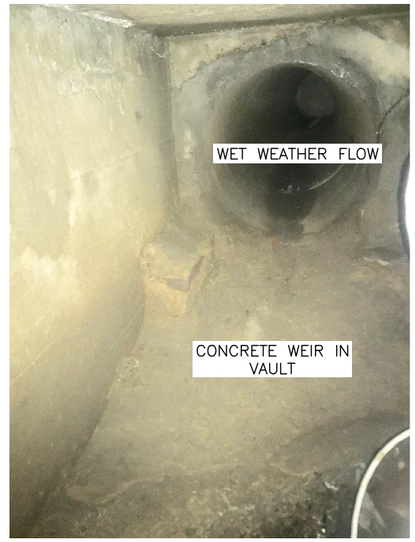


PROFILE
SCALE : N.T.S.

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



NOTE:
REMAINING MEASUREMENTS
NOT ACCESSIBLE

DRY WEATHER FLOW

GREEN SITE DESIGN LLC
317 Main Street Norwich, Connecticut
(860) 892-1380 Fax (860) 886-9165

REV. NO.	DATE	DRWN	CHKD	REMARKS

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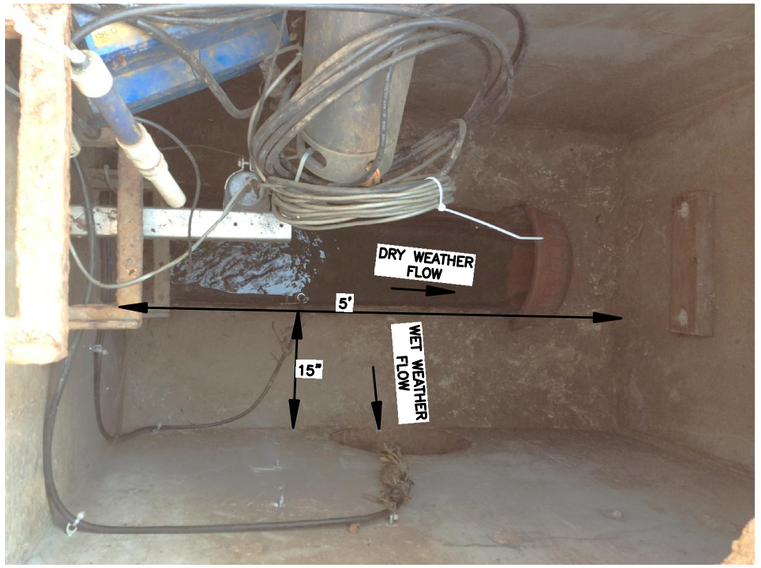
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1020
East Hartford, Connecticut 06108
Tel: (860) 529-7015

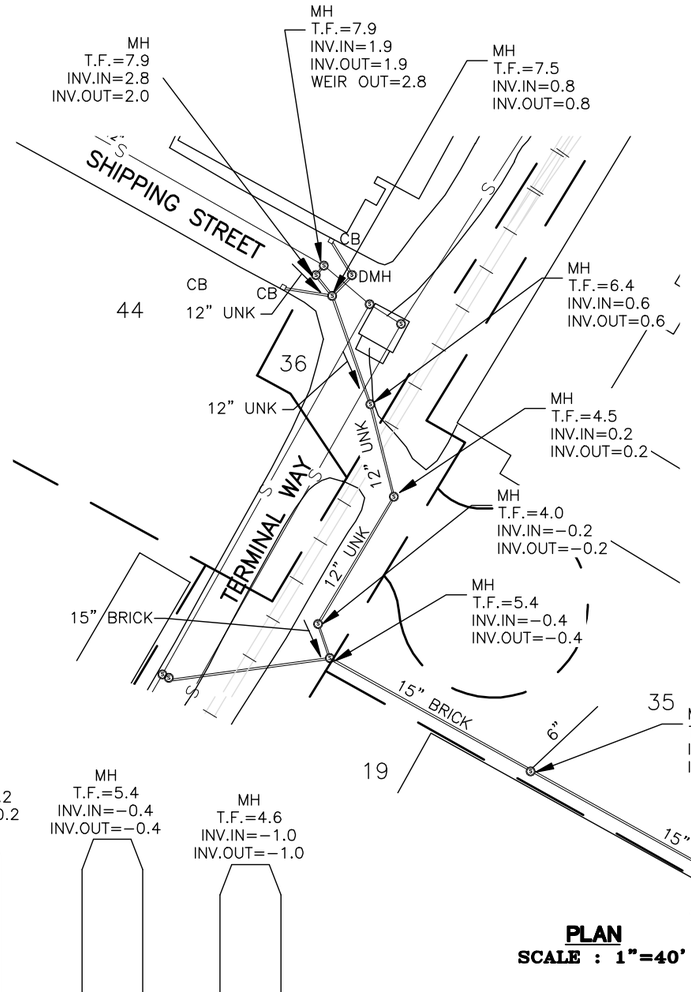
CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-32
Crown Street

96538-

SHEET NO.
14



DIVERSION MH
5'X3'
T.F.=7.9
INV.IN=1.9
INV.OUT=1.9
WIER ELEV. = 2.8



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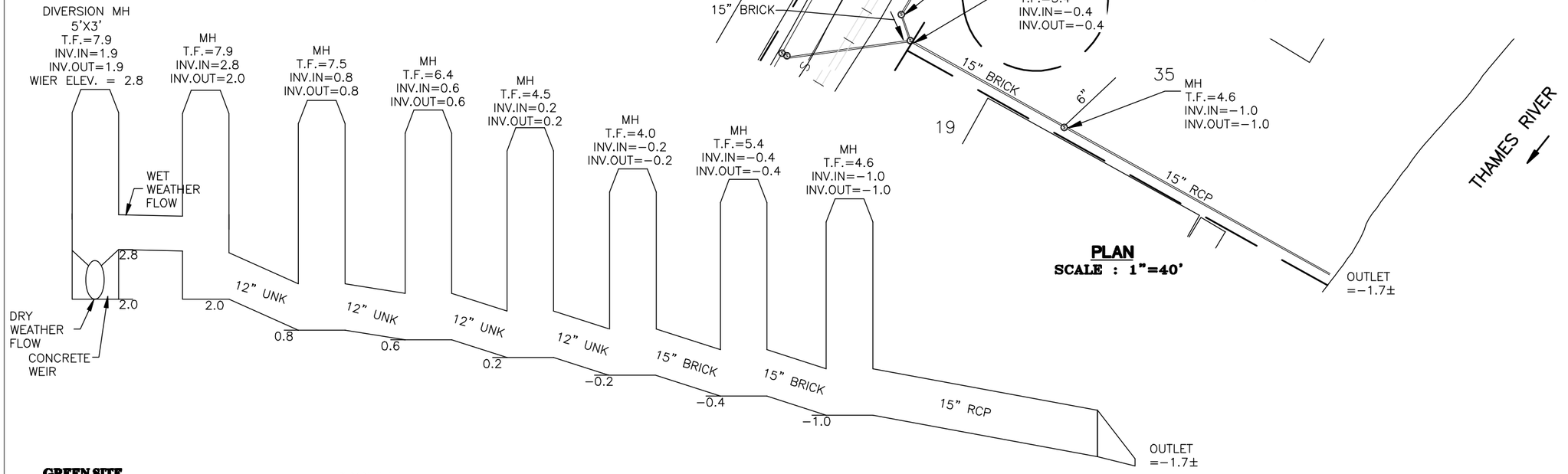
SCALE : 1"=40'



PROFILE
SCALE : N.T.S.

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88

N

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DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1500
East Hartford, Connecticut 06108
Tel: (860) 528-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-40
Shipping Street

96538-

SHEET NO.
15

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Appendix B

Long-term Flow Metering Program Memorandum

Memorandum

To: *Mr. Larry Sullivan P.E.*
Norwich Public Utilities

From: *Craig Wagner P.E., BCEE, CDM Smith*

Date: *November 2017*

Subject: *Norwich Metering Program – Final Meter Location, Long Term Program*

Background

CDM Smith developed a temporary metering program to support data collection and sewer model calibration for the revised Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) being updated for Norwich Public Utilities (NPU). The temporary metering program was completed on May 26th, 2017. The purpose of the initial program was to monitor in-system sewer flows, as well as monitoring the CSO regulators to calibrate the hydraulic model of the collection system. Following completion of the short-term meter installation, a long-term metering program was implemented to gather data on CSO frequency and duration during wet weather for the LTCP and for reporting.

The long-term meters will be installed for approximately ten months. There are fourteen CSO outfalls in NPU's combined sewer collection system. CDM Smith has implemented a program where these fourteen CSO outfalls be monitored with sixteen meter sites. This memo describes the completed installation of the long-term program. CDM Smith has confidence that this layout will be adequate to monitor and characterize the overflow events at NPU's fourteen CSO outfalls for model comparison and regulatory reporting needs.

Long-Term Meter Installation

Sixteen meters were installed to remain in the system long term. The final meter placement for the long-term program can be seen in Attachment A.

Overflow sites 004, 005, 017-1, 017-2, 018, 019-1, 019-2, 021, 023, 025, 031, and 040 were located within regulator chambers for the short-term metering program. Adjustments of the probes were needed at most of the sites to properly characterize the overflow events (in lieu of in-system monitoring). CSO outfalls 017 and 019 have two separate overflow regulator points for each outfall pipe to the river. This is why sixteen meters were needed to monitor the fourteen CSO outfall pipes.

Two of the original meters that remained installed essentially "as-is" from the short-term meter program, these were meters CSO 005, and CSO 017-1. These two sites had depth meters already installed to obtain information on overflows. The other ten metering sites needed to have probes

reconfigured within the original metering (regulator) site. Rain gauge locations from the short-term metering program remained installed and can be seen on the figure included as Attachment B.

The remaining four overflow meters (022, 024, 029, and 032) were meters that were not originally conducive to flow metering within the regulator chamber. These four meters were moved from other sites back into the regulator chambers and the downstream overflow pipes. The remaining meters from the short-term program were removed. The final placement of all the meters, and what type of data we can expect from each meter is shown in the table included as Attachment C.

Meter Location Movement/Re-Installation

CSO 022 was originally not a good candidate for in-system flow metering within the regulator chamber. During the short-term meter program, this meter was moved to Central Avenue for better flow data. This meter was moved back into the regulator chamber for the long-term metering program. A velocity flow band was installed directly into the overflow CSO discharge pipe. Depth sensors were also installed to help characterize overflow events.

The CSO 024 regulator chamber was investigated for flow conditions, and it was determined that this was not a good site for the short-term metering. This meter was eventually moved up the Shetucket Interceptor to manhole 2033. This meter was moved back to the regulator chamber for the long-term metering program. A velocity flow band was installed directly into the overflow CSO discharge pipe. Depth sensors were also installed to help characterize overflow events.

CSO 029 was not originally metered in the regulator chamber. Flow came in at a large downward angle, and was not suitable for metering. This meter site was moved downstream to manhole 1607. For the long-term metering program, this meter was moved to the regulator chamber. A velocity flow band was installed directly into the overflow CSO discharge pipe. Depth sensors were also installed to help characterize overflow events.

CSO 032 was not originally installed during the short-term metering program. Flow conditions at this regulator chamber were not conducive to in-system flow metering for the short-term program. It was determined that this flow point was not critical to the development of the flow model, so the meter was excluded. For the long-term program, a meter was installed directly into the CSO overflow pipe at this CSO regulator to monitor overflow events. A velocity flow band was installed directly into the overflow CSO discharge pipe. Depth sensors were also installed to help characterize overflow events.

Summary

Site-specific GIS meter location maps of the sixteen long-term flow meters can be seen in Attachment D. Flow Assessment Services provided a set of field installations sketches of the sixteen meters and three rain gauge installations that are included as Attachment E. Green Site Design LLC provided survey sketches of the CSO regulator chambers which are included as Attachment F.

In summary, twelve meters from the short-term program were left in the system with minor adjustments (004, 005, 017-1, 017-2, 018, 019-1, 019-2, 021, 023, 025, 031, and 040). These flow meters capture and characterize overflow events, and the meters include telemetry to report overflow events to NPU as they occur.

Four meters were moved or installed. Meter CSO 022 was moved into the regulator chamber, Meter 17 was moved into the regulator chamber for CSO 024, Meter 029 was moved from Central Avenue back into the regulator chamber, and finally a meter was installed at the regulator chamber at CSO 032. Meters from the short-term program that were no longer needed were removed.

Flow meters capture and characterize overflow events, and all the meters include telemetry to report overflow events as they occur. CDM Smith worked with Flow Assessment Services to establish a system for live overflow alerting at all the CSOs. This system includes live email and text alerts when a regulator chamber overtops a wet weather weir. Live alerting will help both CDM Smith and NPU better understand under what conditions overflows occur. This long-term metering program will provide accurate data that will result in more effective preventative solutions in the future Long-Term Control Plan.

Attachments

Attachment A: Meter Location Map

Attachment B: Rain Gauge Map

Attachment C: Meter Placement Table

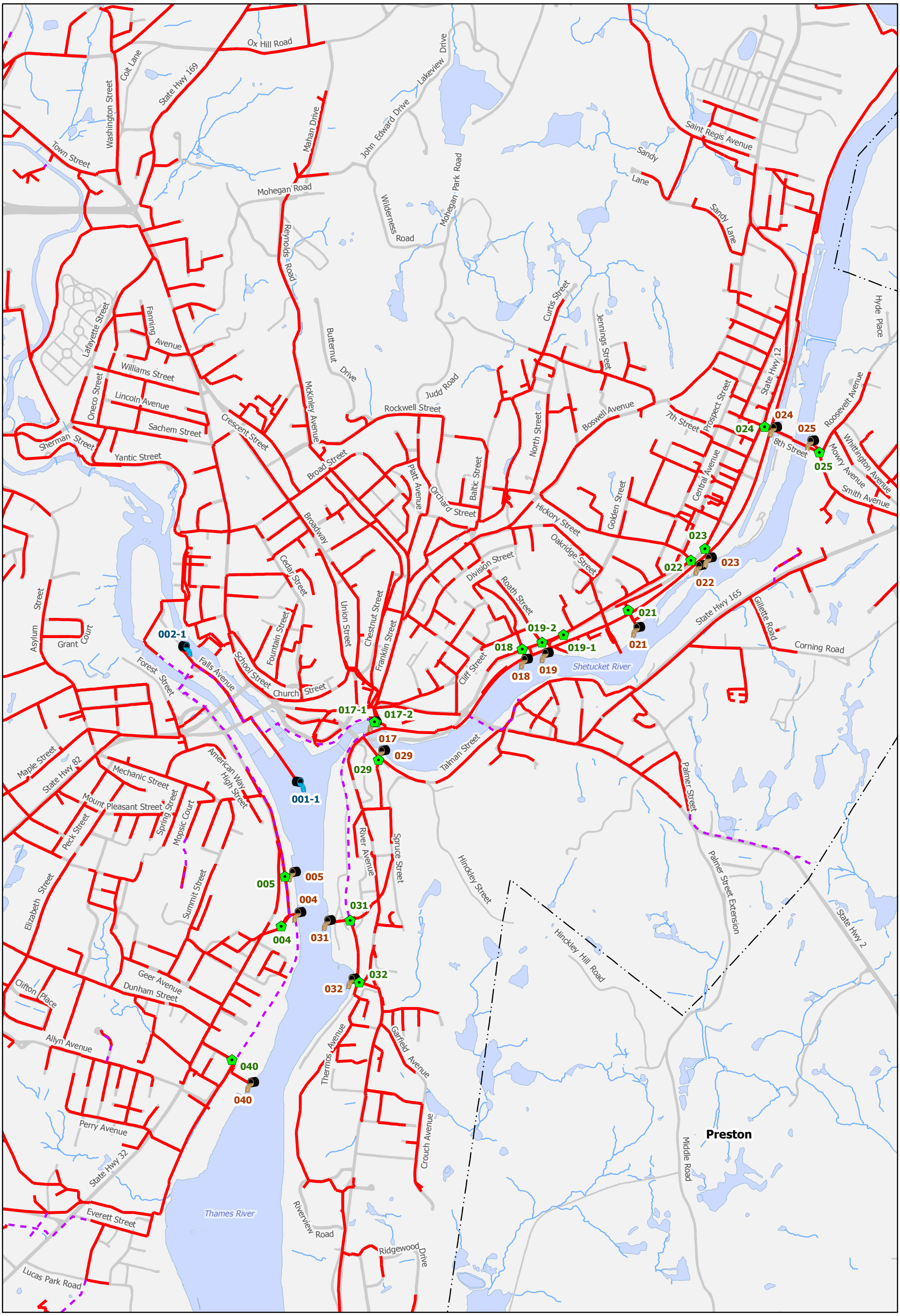
Attachment D: Individual Meter Maps

Attachment E: Flow Meter Installation Diagrams

Attachment F: CSO Regulator Survey Sketches

Attachment A

Meter Location Map



Legend

- Meter
- CSO Outfall
- WPCF Outfall
- Sewer
- Force Main

Scale

0 625 1,250 Feet

N

Norwich, Connecticut
Metering Program

Meter Map
Attachment A

Attachment B

Rain Gauge Map

Rain Gauge 3
Rain Gauge 1
Rain Gauge 2
Stott Avenue
Lefty Dugas Drive
Vergason Avenue Extension
Plain Hill Road
Bog Meadow Road
Meadowbrook Road
Adams Drive
Caribou Drive
Lawler Lane
Old Canterbury Turnpike
School Street
Sheas Lane
Connecticut Avenue
Brookside Drive
Vergason Avenue
Huntington Avenue
Tanglewood Drive
Royal Oaks Drive
I 395
Case Street
Scotland Road
Canterbury Turnpike
Flyers Drive
Lambert Drive
Wayne Street
Hunters Road
Oakland Drive
Oakland Heights
Wightman Avenue
Mediterranean Lane
Gulliver Circle
Reservoir Road
State Hwy 169
Clinton Avenue
Wawecus Street
Town Street
Sturtevant Street
Otrobando Avenue
Ox Hill Road
Lakeview Drive
Washington Street
Mahan Drive
John Edward Drive
Mohegan Park Road
Sandy Lane
Exit 28S
Exit 81
Exit 81E
Mohegan Road
Wilderness Road
Reynolds Road
McClellan Avenue
Cranberry Pond Road
Dudley Street
Lafayette Street
Oneco Street
Williams Street
Lincoln Avenue
Sachem Street
Sherman Street
Yantic Street
New London Turnpike
State Hwy 2
Crescent Street
Butternut Drive
Rockwell Street
Judd Road
Boswell Avenue
Baltic Street
North Street
McKinley Avenue
Platt Avenue
Orchard Street
Broad Street
Broadway
Hickory Street
Oakridge Street
Golden Street
Prospect Street
Central Avenue
Division Street
Roath Street
Cedar Street
Union Street
Chestnut Street
Franklin Street
Cliff Street
State Hwy 12
State Hwy 165
Shetucket River
Starr Street
Western Avenue
Asylum Street
Grant Court
Newton Street
Alice Street
State Hwy 32
Falls Avenue
Tyler Lane
Green Briar Road
Weber Farm Road
Gifford Street

Rain Gauge 1 Location
Maple Grove Avenue
Falls Avenue
Yantic River

Rain Gauge 2 Location
Barron Street
State Hwy 12
Erin Street
White Street
Golden Street
Shetucket River

Rain Gauge 3 Location
Hilltop Road Forestview Drive
Plumtree Drive
Vergason Avenue Extension

CDM Smith

Legend

Rain Gauge

Scale

N

Feet

0 750 1,500

Norwich, Connecticut
Metering Program

Attachment B

Rain Gauge Map

Attachment C

Meter Placement Table

Attachment C

Meter Location Table

CSO Number	Meter	Street	Location	Meter Type	Additional Comments
CSO 004	004	Behind 76 West Thames St.	30.5" Overflow pipe in regulator manhole	Flow & Depth	Installed on the 30.5" overflow pipe in the regulator chamber. Depth meters were also installed in the regulator to characterize overflow events.
CSO 005	005	South Thames Street	Overflow weir in regulator manhole	Depth Only	Installed at the regulator chamber. Due to backup from the pump station, flow could not be accurately measured. This meter is only a depth meter to measure flow over the weir. This install remained the same for the long term metering.
CSO 017	017-1	North of Rose Alley	"Cutout Weir" on 42" Shetucket Interceptor Upstrem of Pump Station	Flow & Depth	Installed at the end of the 42" interceptor, before it drops down into the box culvet. Velocity plate was installed on the "cut out" overflow. Depth meters were also installed to characterize the overflow events. Per Flow Assessment Services, this is a rough cutout, and may not provide perfect flow data.
CSO 017	017-2	Rose Alley at Cipoletti Weir	Cipoletti Weir upstream of Pump station	Depth Only	Installed at Cipoletti weir upstream of Rose Alley pump station. An ultrasonic depth sensor was installed above the flow path, and a pressure sensor was installed on the weir wall. This install remained the same for long term metering.
CSO 018	018	104-106 North Main St.	36" Overflow pipe in regulator manhole	Flow & Depth	Installed in regulator chamber on the 36" overflow pipe. Depth meters were also installed in the regulator to characterize overflow events.
CSO 019	019-1	North Main St., bet. Barron & Roath Sts.	33" Overflow pipe in regulator manhole	Flow & Depth	Installed at the 33" overflow pipe in the regulator chamber. Depth meters were also installed in the regulator to characterize overflow events.
CSO 019	019-2	Roath St. & North Main St.	24" Overflow pipe in regulator manhole	Flow & Depth	Installed in the overflow pipe at the Regulator Chamber. Flow conditions were not good enough for in system flow. This meter is registering overflows during dry conditions. NPU investigated this site and saw some missing bricks, which will be repaired. Unclear where the water is coming from, but downstream MHs are dry. This meter may need to be reconfigured for the long term metering program to avoid misleading alarms.
CSO 021	021	Erin St., north of RR tracks	12" Overflow pipe in regulator manhole	Flow & Depth	Installed at the 12" overflow pipe in the regulator chamber. on the upstream pipe. Depth meters were also installed in the regulator to characterize overflow events.
CSO 022	022	North Main St. (1)	Overflow pipe in regulator manhole	Flow & Depth	Originally installed in manhole 1959 on Central Avenue. The flow at the regulator chamber wasn't conducive to flow monitoring. This meter was moved upstream. For Phase 2, this meter was moved back down to the regulator chamber, and flow was metered in the overflow pipe. Depth meters were also installed in the regulator to characterize overflow events.
CSO 023	023	352 North Main St.	36" Overflow pipe in regulator manhole	Flow & Depth	Installed in regulator chamber on the 36" overflow pipe. Depth meters were also installed in the regulator to characterize overflow events.
CS0 024	024	8th St. & North Main St.	Overflow pipe in regulator manhole	Flow & Depth	Short term metering was installed on the Shetucket Interceptor. The Long term meter location was within the CSO 024 regulator chamber on the overflow pipe. Depth meters were also installed in the regulator to characterize overflow events. A slight trickle was observed entering the overflow pipe during dry conditions.
CSO 025	025	8th St., at Roosevelt & Smith Sts.	23.5" Overflow pipe in regulator manhole	Flow & Depth	Installed in the regulator chamber. The outgoing 23.5 inch pipe was metered for flow. Depth meters were also installed in the regulator to characterize overflow events. Per Flow Assessment Services, this regulator has a high water level and a potential for frequent alarms. Water was observed cresting the bench during dry conditions.
CSO 029	029	Talman St., bet. Spruce St. and Viaduct Rd.	Overflow pipe in regulator manhole	Flow & Depth	Short term meter was installed in MH 1607 downstream of regulator. Flow was not meterable in the regulator chamber. Long term meter was installed within the regulator chamber on the overflow pipe. Depth meters were also installed in the regulator to characterize overflow events. Installed during a rainy day, and some flow was seen entering the overflow pipe.
CSO 031	031	Rte. 12 Bus Station Parking Lot (2)	15" Overflow pipe in regulator manhole	Flow & Depth	Installed at the 15" overflow pipe in the regulator chamber. Depth meters were also installed in the regulator to characterize overflow events.
CSO 032	032	Behind 285 Laurel Hill Ave, East of RR tracks	Overflow pipe in regulator manhole	Flow & Depth	Short term meter was not installed due to poor hydraulics. Long term meter was installed within the regulator chamber on the overflow pipe. Depth meters were also installed in the regulator to characterize overflow events.
CSO 040	040	Shipping St. & Terminal Way	12" CSO pipe in CSO structure beyond overflow	Flow & Depth	Installed on the 12" CSO pipe in the CSO structure, just beyond the regulator chamber. Depth sensors were installed in the regulator chamber to characterize overflow events.

Attachment D

Individual Meter Maps

CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

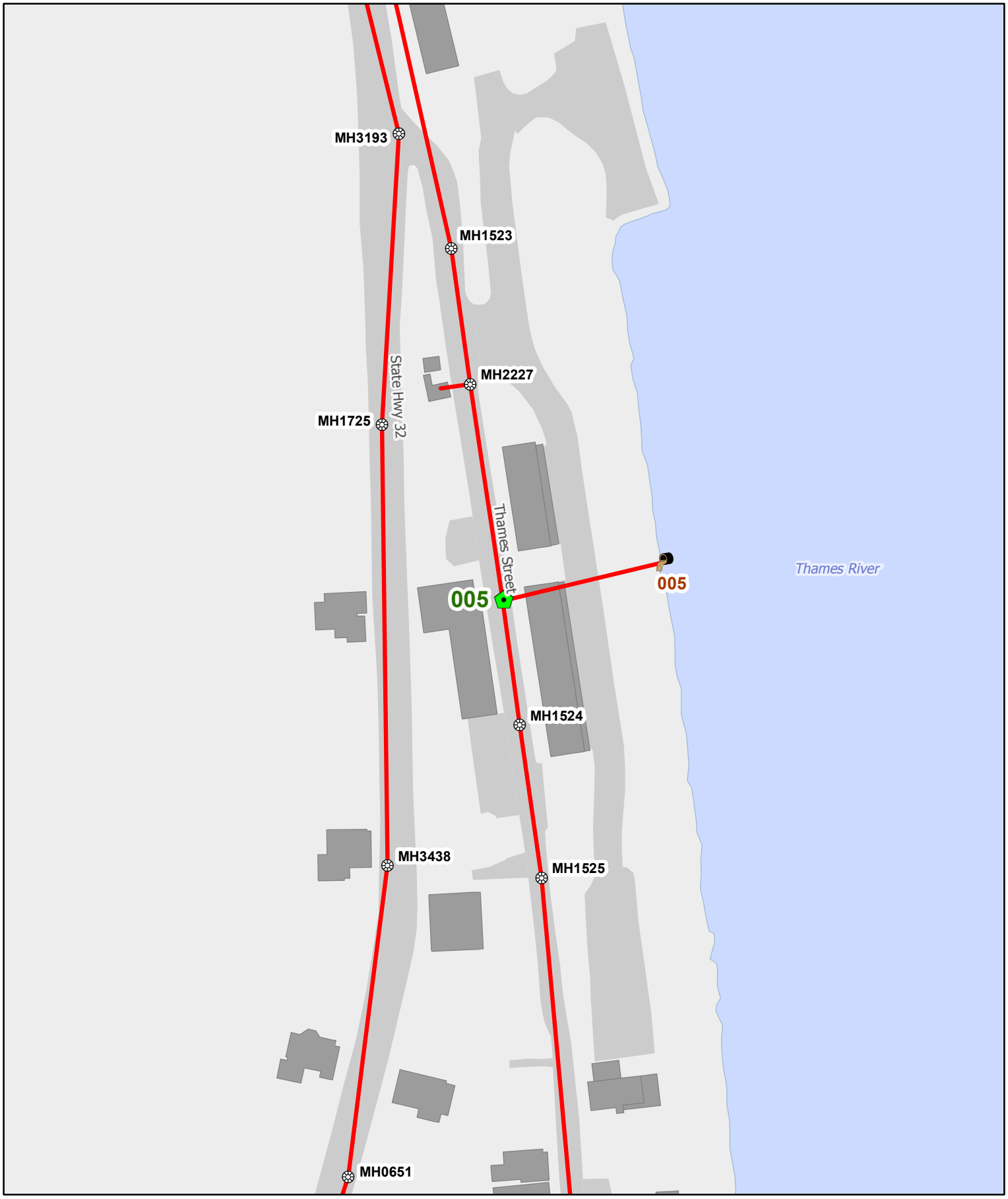
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 004
Attachment C



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

Feet

0 50 100

Norwich, Connecticut
Metering Program

Meter 005
Attachment C

Legend

Meter · Manhole · CSO · Pipe

Scale

1 inch = 100 feet

0 50 100 Feet

N

Norwich, Connecticut
Metering Program

Meter 017-1
Attachment C

CDM Smith

Legend

Meter · Manhole · CSO · Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 017-2
Attachment C

CDM Smith

Legend

Meter · Manhole · CSO · Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 018
Attachment C

CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 019-1
Attachment C

CDM Smith

Legend

Meter | Manhole | CSO | Pipe

Scale

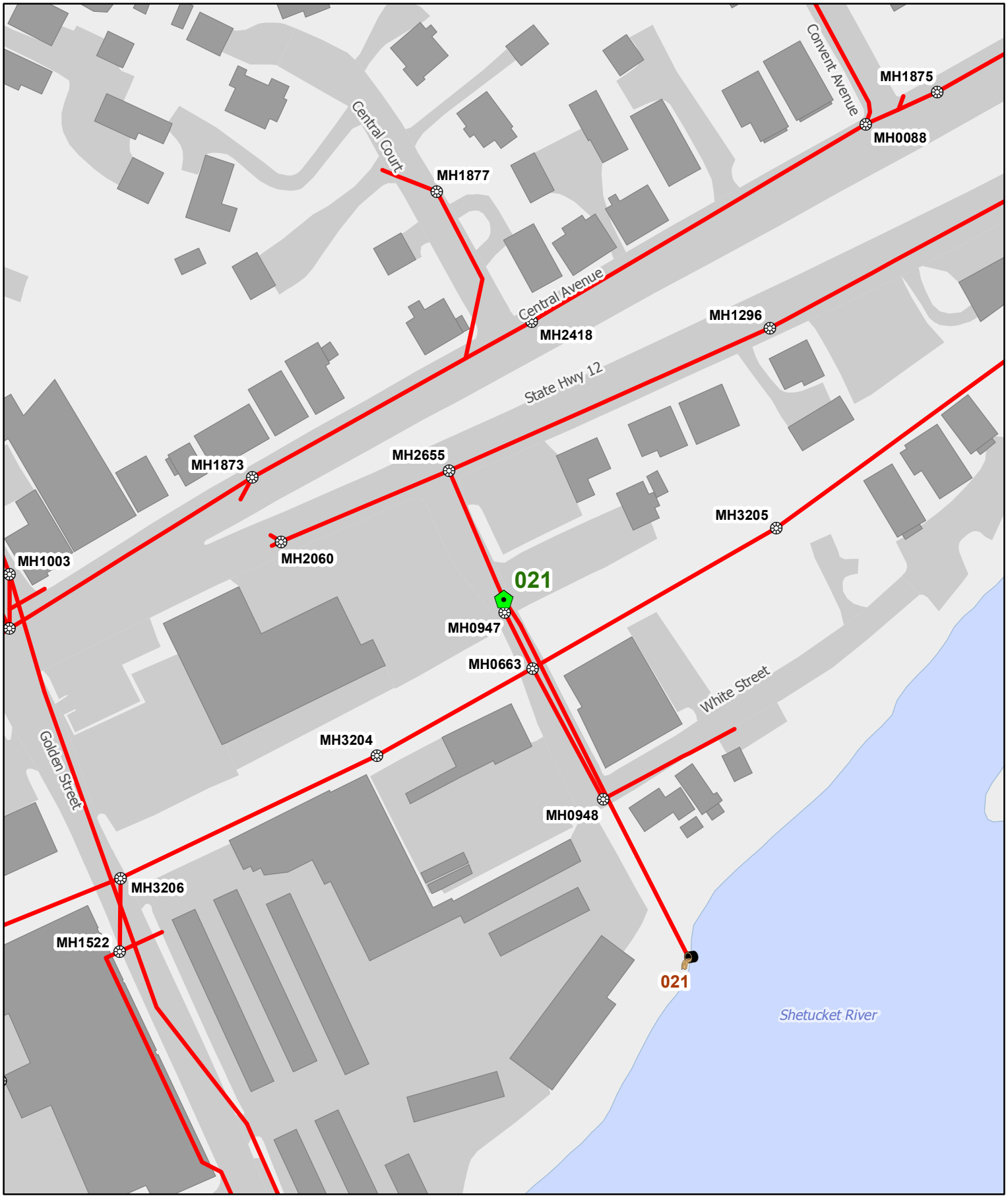
1 inch = 100 feet

0 50 100 Feet

N

Norwich, Connecticut
Metering Program

Meter 019-2
Attachment C



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 021
Attachment C

CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

Feet

0 50 100

Norwich, Connecticut
Metering Program

Meter 022
Attachment C

CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 023
Attachment C

Legend

Meter
Manhole
CSO
Pipe

Scale

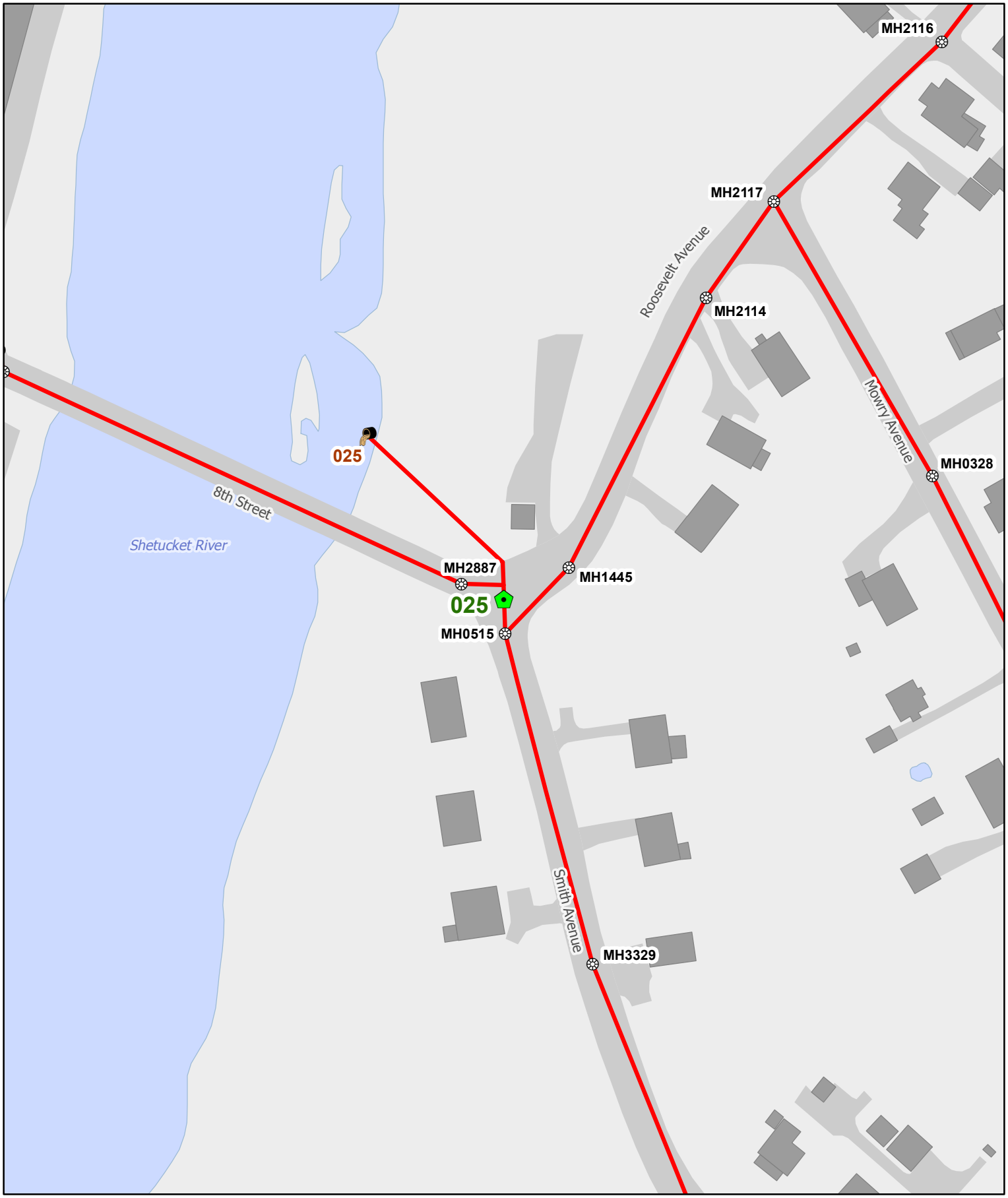
1 inch = 100 feet

0 50 100 Feet

N

Norwich, Connecticut
Metering Program

Meter 024
Attachment C



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 025
Attachment C

CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

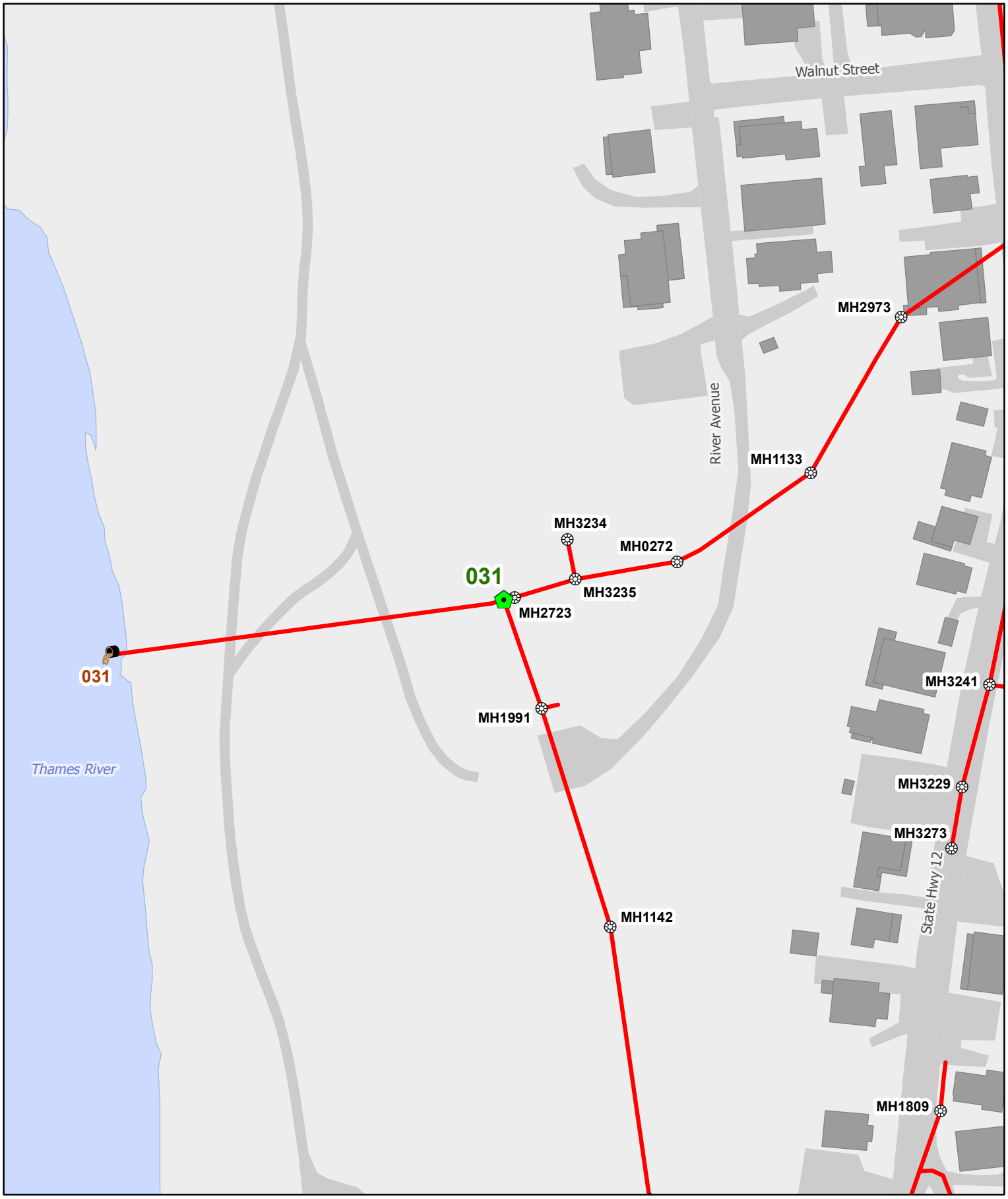
N

Feet

0 50 100

Norwich, Connecticut
Metering Program

Meter 029
Attachment C



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

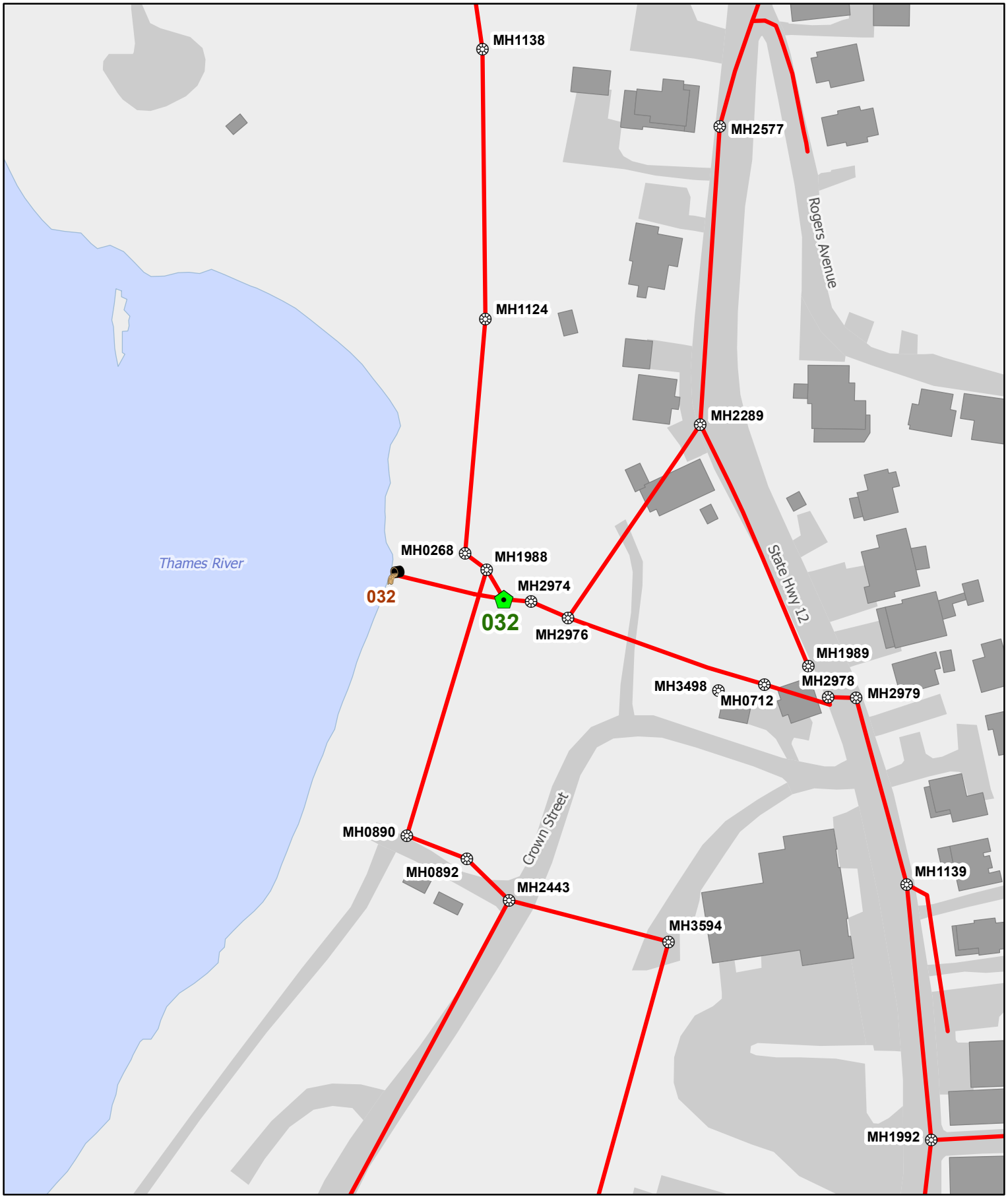
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 031
Attachment C



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

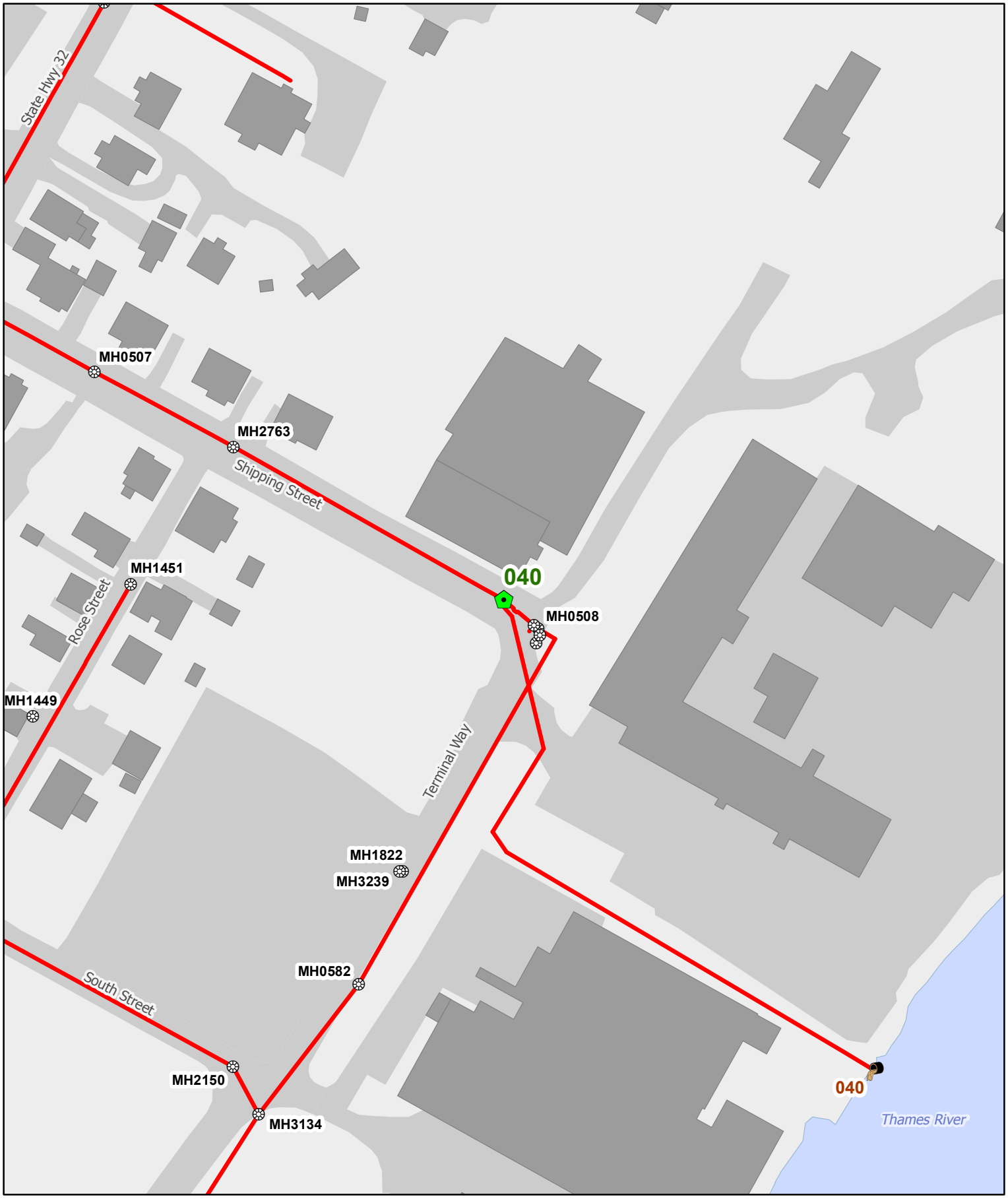
1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 032
Attachment C



CDM Smith

Legend

Meter
Manhole
CSO
Pipe

Scale

1 inch = 100 feet

N

0 50 100 Feet

Norwich, Connecticut
Metering Program

Meter 040
Attachment C

Attachment E

Flow Meter Installation Diagrams

RAIN GAUGE SITE INFORMATION FIELD LOG

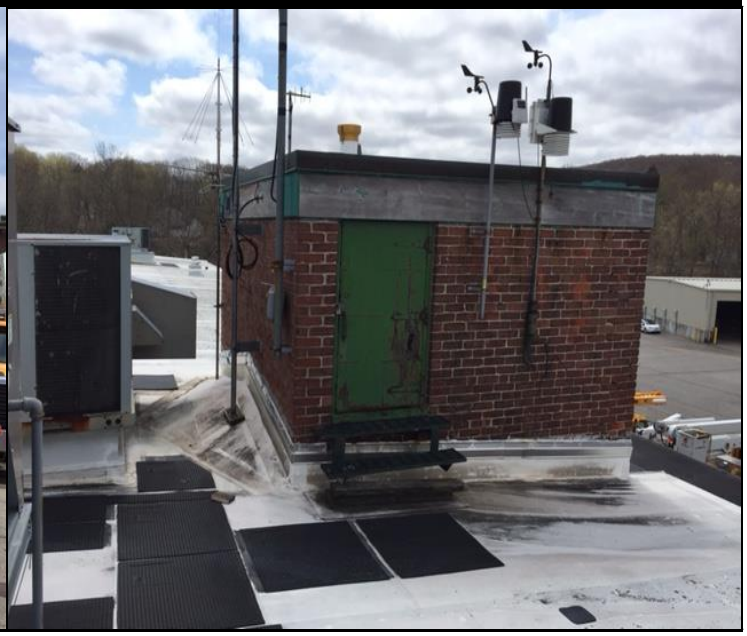
PROJECT: Norwich, CT	**DATE:** April 19, 2017	**PROJECT #:** 17039
LOCATION: WWTP Falls Avenue Sludge Building Roof		**SITE:** Rain Gauge 1
COMMENTS: 41.527290, -72.085725		

LOCATION

RAIN GAUGE SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** April 19, 2017	**PROJECT #:** 17039
LOCATION: 16 South Golden Street (DPW roof)		**SITE:** Rain Gauge 2
COMMENTS: 41.527239, -72.062486		

LOCATION



RAIN GAUGE SITE INFORMATION FIELD LOG

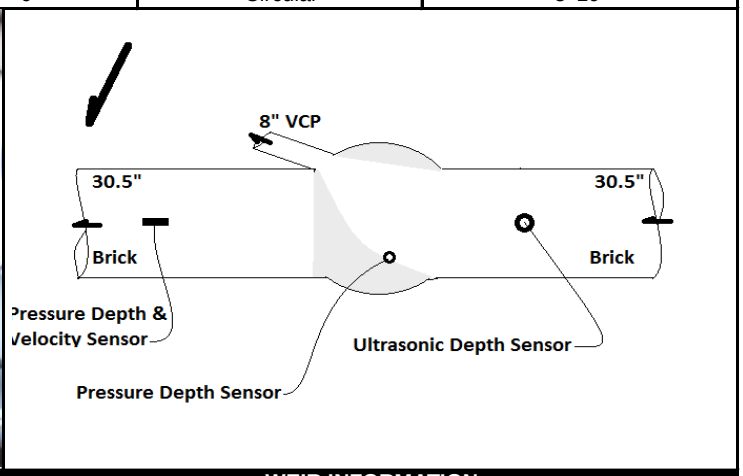
PROJECT: Norwich, CT	**DATE:** April 19, 2017	**PROJECT #:** 17039
LOCATION: 100 Forestview Drive		**SITE:** Rain Gauge 3
COMMENTS: 41.572574, -72.0110686		

LOCATION

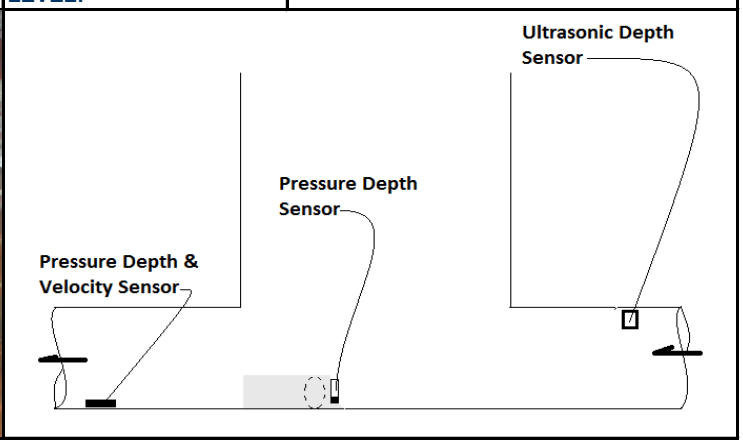
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 6, 2017	**JOB#:** 17063
LOCATION: 76 Thames Street (rear)	**MH#:**	**METER SITE:** 004
GPS/COMMENTS: 41.515727, -72.080033		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	30.5	Brick	1.5	0	Circular	5' 7"
Incoming						
Overflow	30.5	Brick	0	0	Circular	5' 8"
Outgoing	8	VCP	3	0	Circular	5' 10"



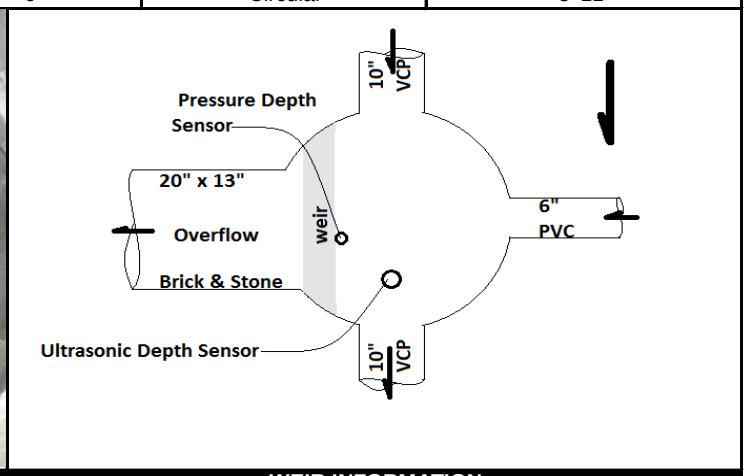
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT: 5.4"**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



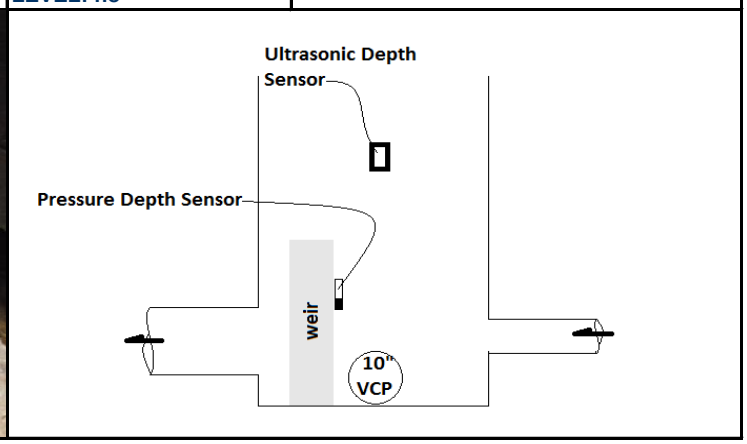
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 5, 2017	**JOB#:** 17063
LOCATION: 17 South Thames Street	**MH#:**	**METER SITE:** 005
GPS/COMMENTS: 41.517828, -72.079675		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	10	VCP	1.5	0	Circular	5' 10"
Incoming	6	PVC	0	0	Circular	5' 7"
Overflow	20 x 13	Stone, BRK	0	0	Rectangular	5' 5"
Outgoing	10	VCP	1.5	0	Circular	5' 11"



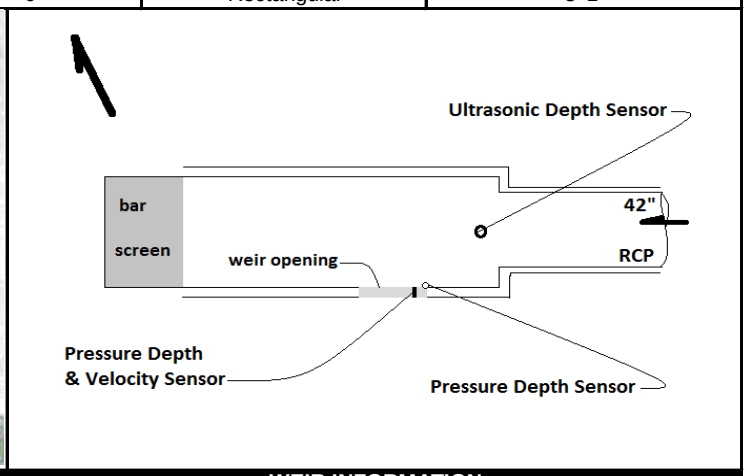
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH: 36.3"**	**HEIGHT ABOVE WEIR: 40"**
SURCHARGED MARKS TO:	**BREADTH: 8"**	**OVERFLOW OCCURS AT: 9.75"**
SURCHARGE CURRENTLY TO:	**LEVEL: no**	



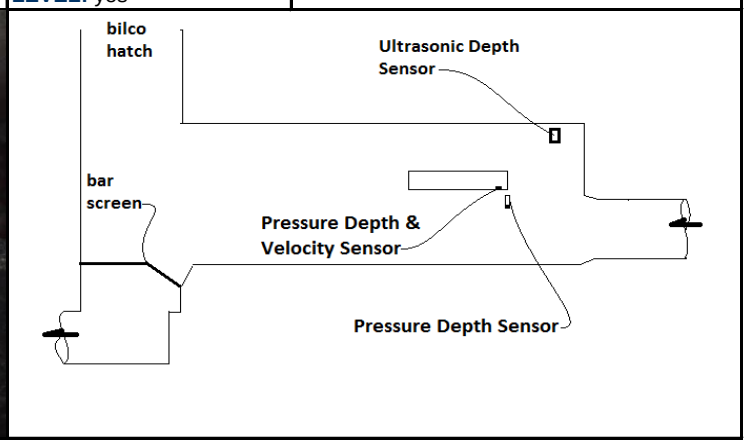
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 9, 2017	**JOB#:** 17063
LOCATION: Rose Alley	**MH#:**	**METER SITE:** 017
GPS/COMMENTS: 41.523877, -72.074760		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	42	RCP	7.3	0	Circular	7' 10"
Incoming						
Incoming						
Outgoing	48.5 x 86.5	PIP	3	0	Rectangular	8' 1"



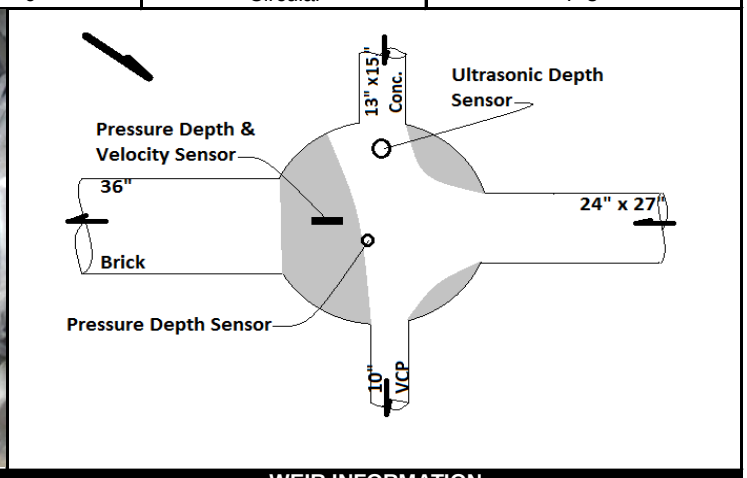
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT:	**LENGTH:** 44.5	**HEIGHT ABOVE WEIR:** 14.9
SURCHARGED MARKS TO: 0.5' above weir crest	**BREADTH:** 8.1	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:** yes	



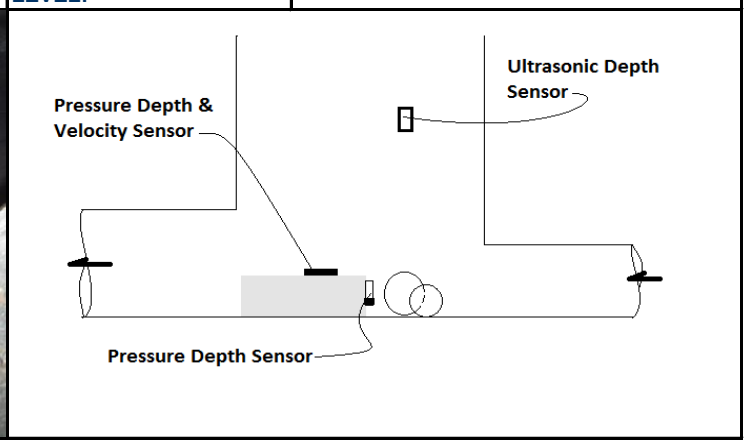
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 8, 2017	**JOB#:** 17063
LOCATION: 104 North Main Street	**MH#:**	**METER SITE:** 018
GPS/COMMENTS: 41.526710, -72.066926		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24 x 27	Brick	2.1	0	Oval	7' 2"
Incoming	13 x 15	Conc.	1.5	0	Oval	7' 1"
Overflow	36	Brick	0	18	Circular	7' 2"
Outgoing	10	VCP	2	0	Circular	7' 3"



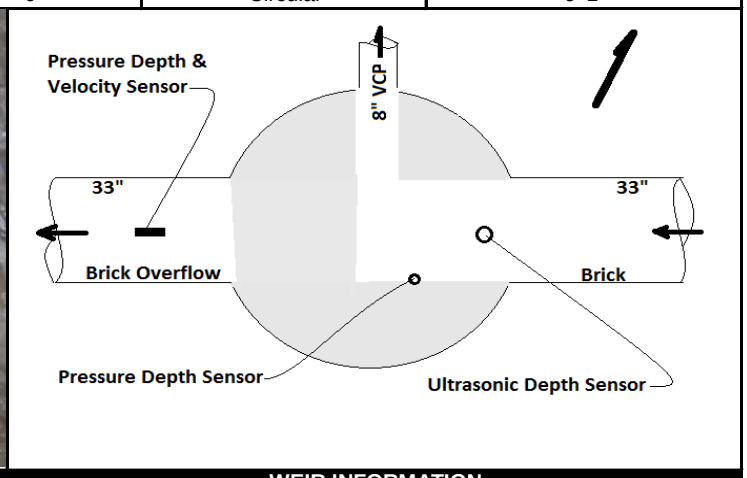
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



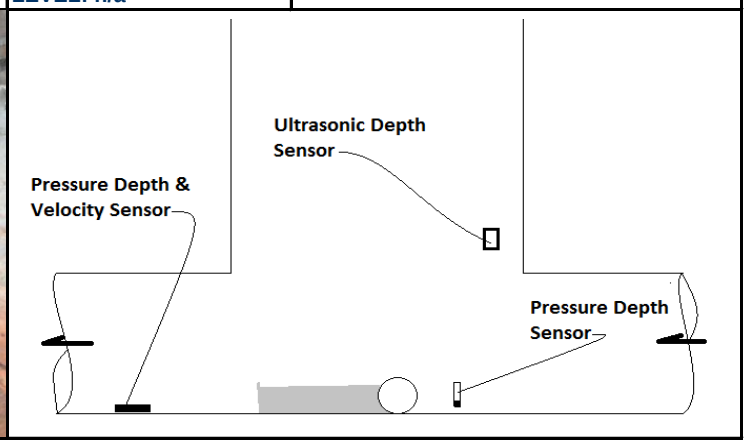
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 8, 2017	**JOB#:** 17063
LOCATION: 154 North Main Street	**MH#:** 2647	**METER SITE:** 019-1
GPS/COMMENTS: 41.527287, -72.064815		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	33	Brick	4.3	0.25	Circular	9' 8.7"
Incoming						
Overflow	33	Brick	0	0	Circular	9' 10"
Outgoing	8	VCP	4	0	Circular	9' 1"



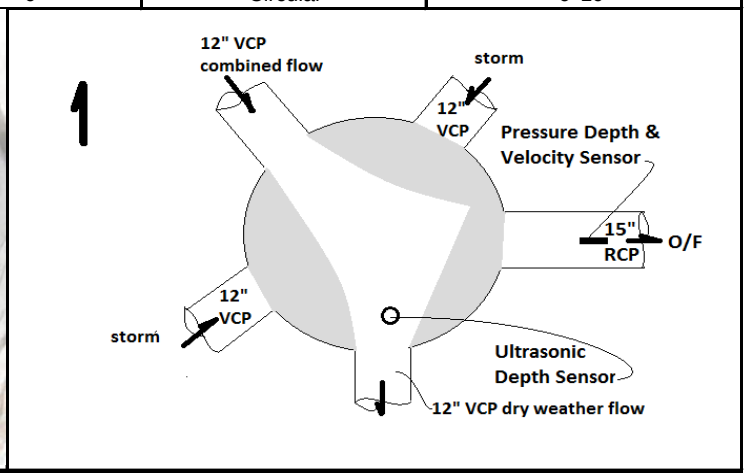
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH: n/a**	**HEIGHT ABOVE WEIR: n/a**
SURCHARGED MARKS TO:	**BREADTH: n/a**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL: n/a**	



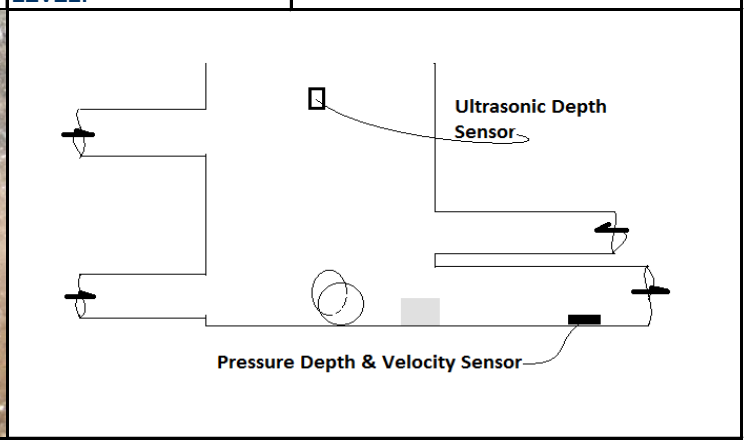
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 15, 2017	**JOB#:** 17063
LOCATION: Roath Street at North Main Street	**MH#:**	**METER SITE:** 019-2
GPS/COMMENTS: 41.527012, -72.065984		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	12	VCP	0.5	0	Circular	6' 7"
Incoming	12	VCP	0	0	Circular	3' 8"
Overflow	15	RCP	0	0	Circular	6' 9"
Outgoing	12	VCP	1.1	0	Circular	6' 10"



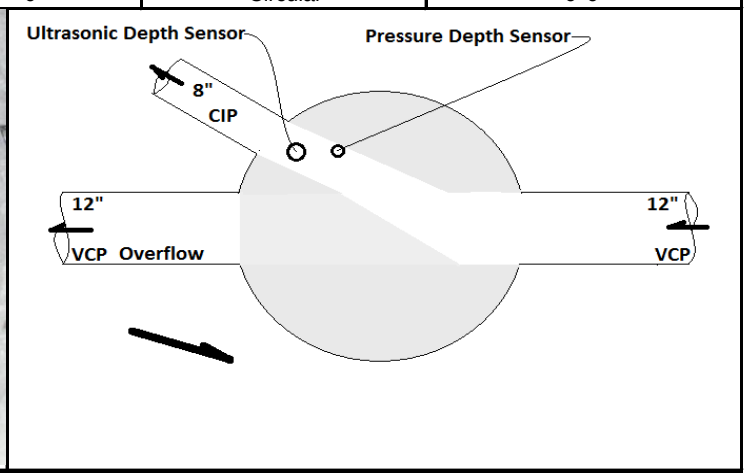
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



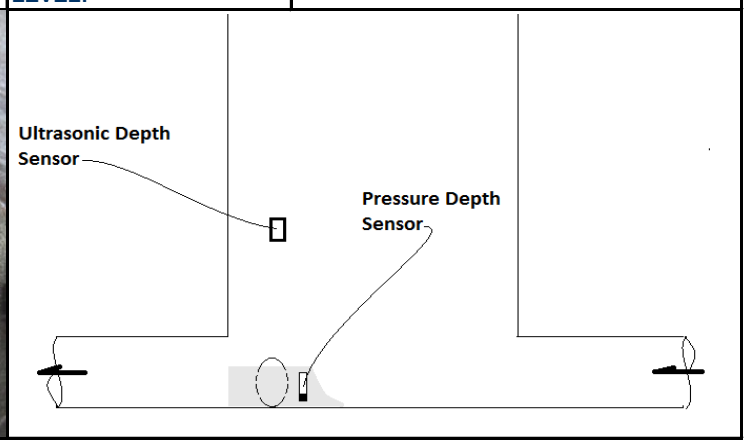
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 6, 2017	**JOB#:** 17063
LOCATION: Erin Street north of tracks	**MH#:**	**METER SITE:** 021
GPS/COMMENTS: 41.528243, -72.061323		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	12	VCP	1.5	0	Circular	6' 4"
Incoming						
Overflow	12	VCP	2	6	Circular	6' 4"
Outgoing	8	CIP	2	0	Circular	6' 6"



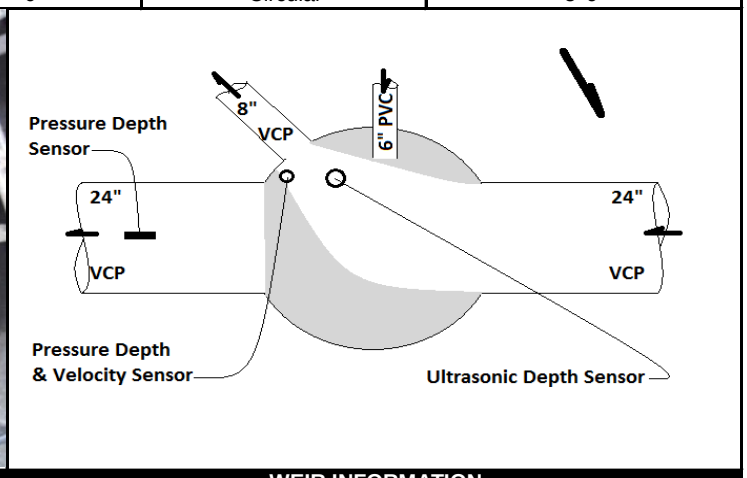
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT: 2.5"**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



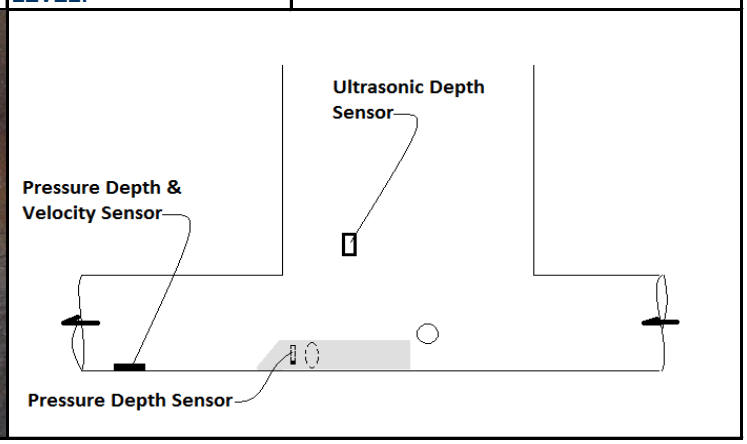
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 7, 2017	**JOB#:** 17063
LOCATION: 328 West Main Street	**MH#:**	**METER SITE:** 022
GPS/COMMENTS: 41.530229, -72.057994		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24	VCP	1.5	0	Circular	5' 9"
Incoming	6	PVC	0.25	0	Circular	5' 1"
Overflow	24	VCP	0	0	Circular	5' 11"
Outgoing	8	VCP	4	0	Circular	5' 9"



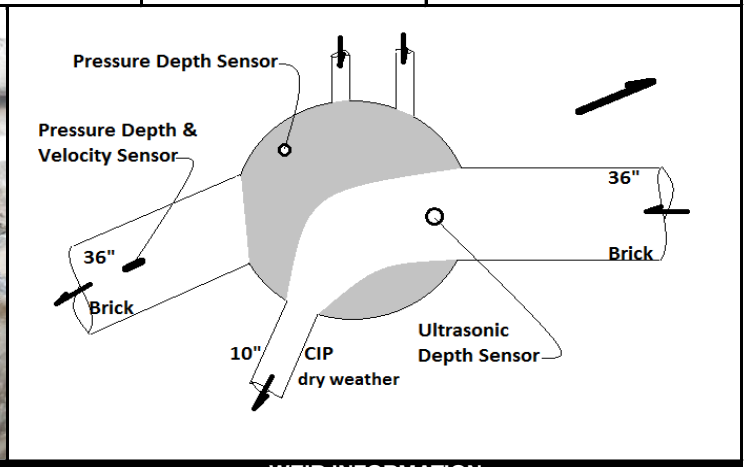
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



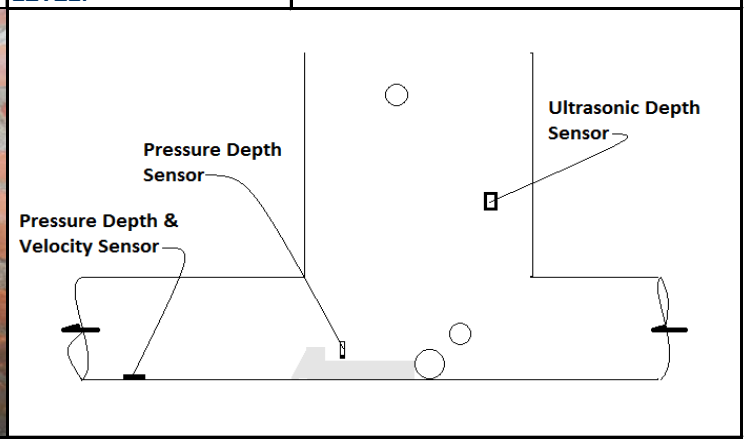
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 7, 2017	**JOB#:** 17063
LOCATION: 352 North Main Street	**MH#:**	**METER SITE:** 023
GPS/COMMENTS: 41.530703, -72.057248		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	36	Brick	6	3	Circular	14' 09"
Incoming	6	VCP	0	0	Circular	13' 01"
Incoming	6	PVC	0	0	Circular	05' 00"
Outgoing	10	CIP	4	0	Circular	14' 07"
Overflow	36	Brick	0	0	Circular	14' 08"



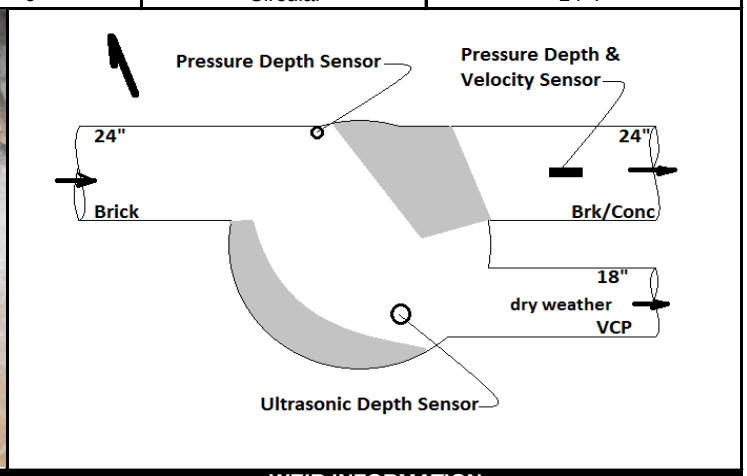
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:** 20.8	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



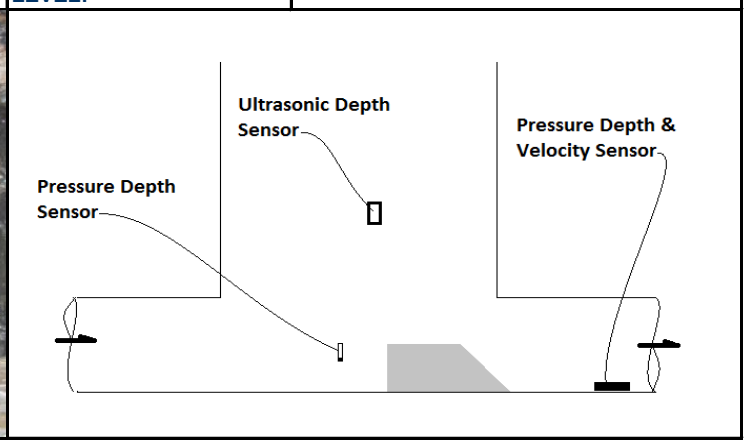
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 7, 2017	**JOB#:** 17063
LOCATION: Eighth Street at railroad tracks	**MH#:**	**METER SITE:** 024
GPS/COMMENTS: 41.535523, -72.053981		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24	Brick	7	0	Circular	14' 8"
Incoming						
Overflow	24	Brick/Conc.	0.1	0	Circular	14' 10"
Outgoing	18	VCP	8	0	Circular	14' 7"



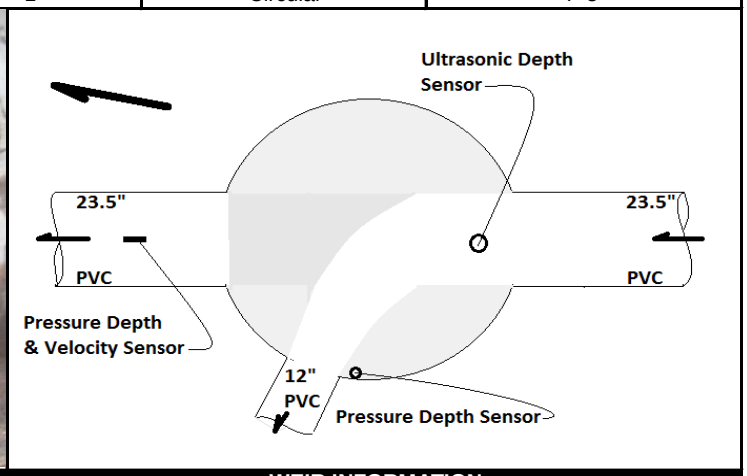
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT:	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO: 5'	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



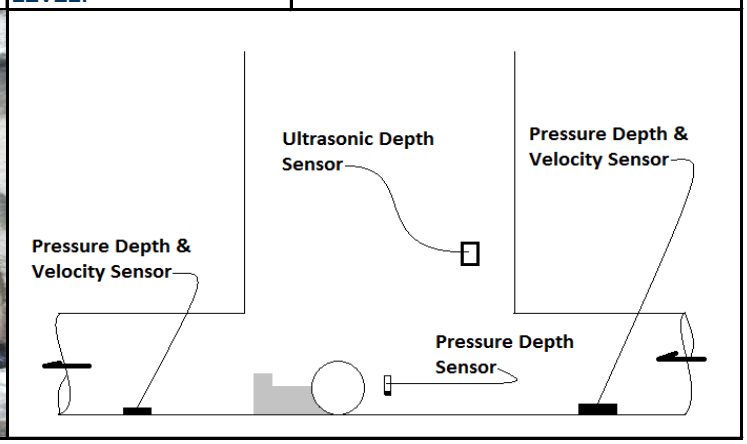
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 12, 2017	**JOB#:** 17063
LOCATION: 8th Street at Smith Avenue	**MH#:**	**METER SITE:** 025
GPS/COMMENTS: 41.534515, -72.051136		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	23.5	PVC	5.1	0.75	Circular	7' 3"
Incoming						
Overflow	23.5	PVC	0	0	Circular	7' 4"
Outgoing	12	PVC	5	1	Circular	7' 5"



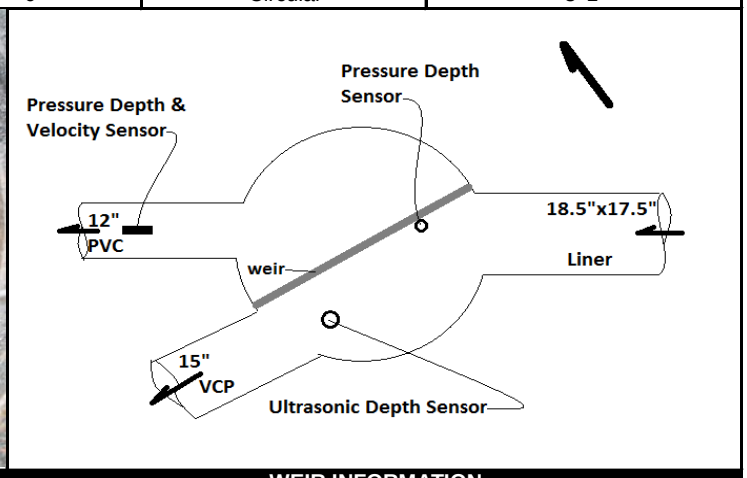
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



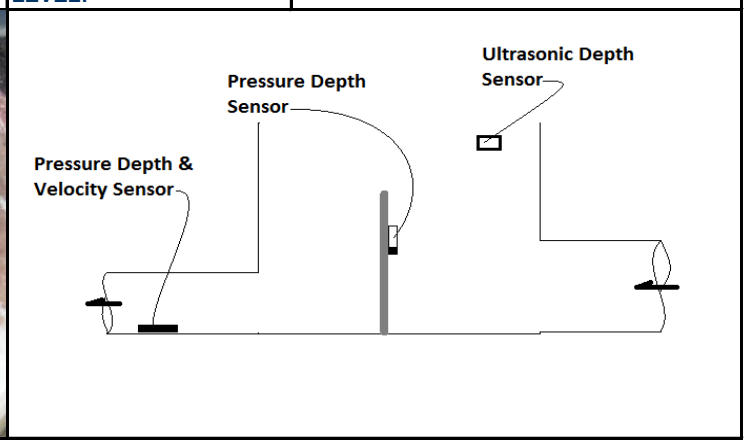
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 6, 2017	**JOB#:** 17063
LOCATION: 76 Tallman Street	**MH#:**	**METER SITE:** 029
GPS/COMMENTS: 41.522366, -72.074627		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	18.5 x 17.5	Liner	1.3	0	Oval	2' 10"
Incoming						
Overflow	12	PVC	0	0	Circular	3' 1"
Outgoing	15	VCP	1.5	0	Circular	3' 1"



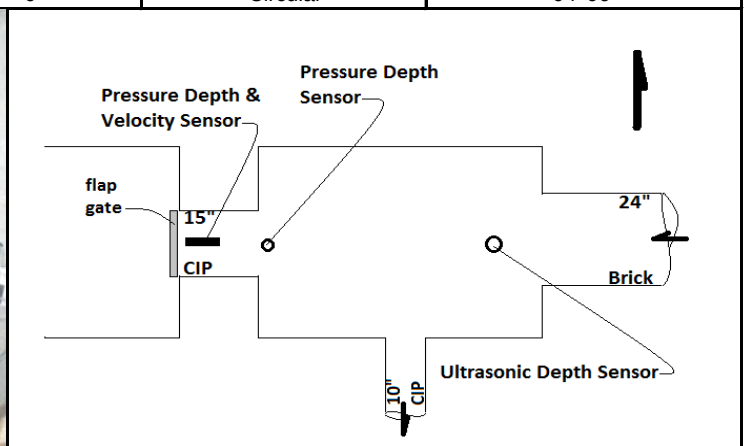
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT: 5.75"**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



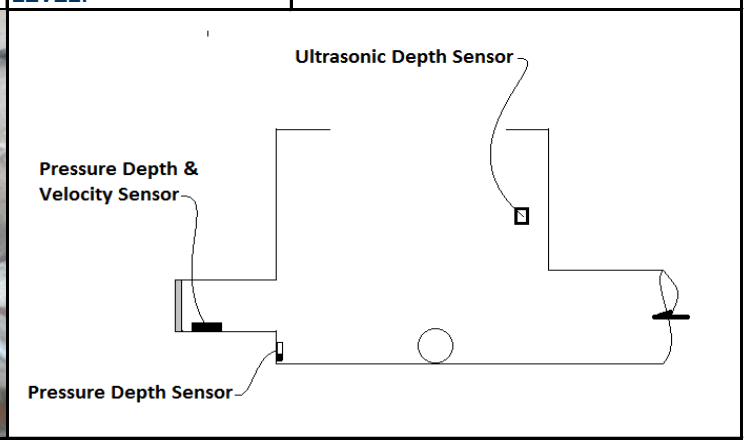
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 6, 2017	**JOB#:** 17063
LOCATION: R.O.W. off of River Avenue	**MH#:**	**METER SITE:** 031
GPS/COMMENTS: 41.515954, -72.076205		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24	Brick	2	0	Circular	05' 02"
Incoming						
Outgoing	10	CIP	2	0	Circular	05' 02"
Overflow	15	CIP	0	0	Circular	04' 06"



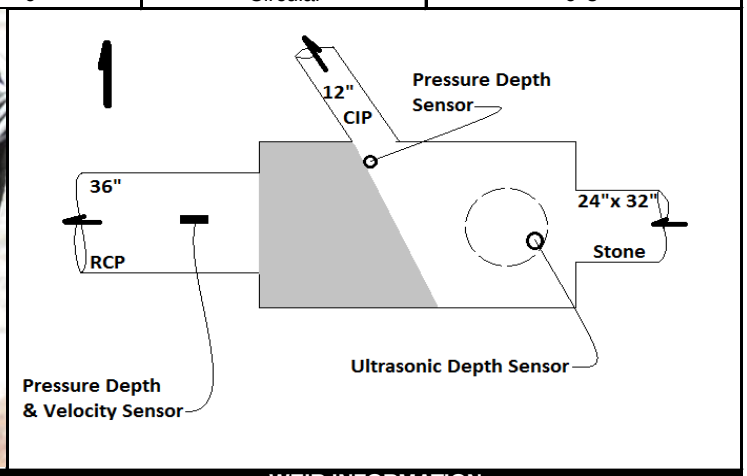
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT: 4.9"**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



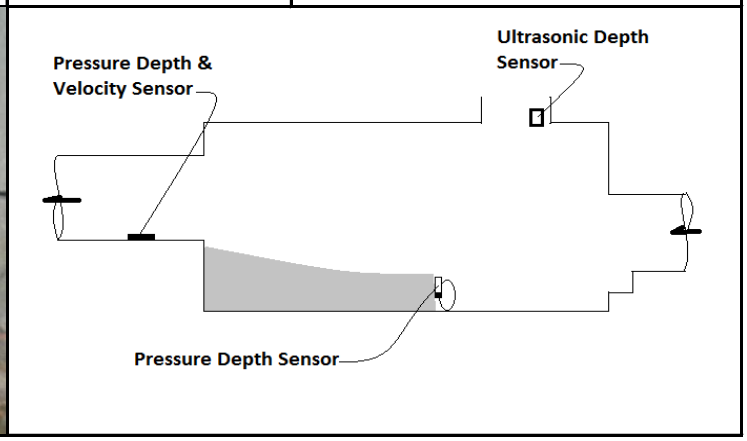
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 8, 2017	**JOB#:** 17063
LOCATION: Crown Street R.O.W.	**MH#:**	**METER SITE:** 032
GPS/COMMENTS: 41.513440, -72.075760		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	24 x 32	Stone	2	0	Irregular	5' 5"
Incoming						
Overflow	36	RCP	0	0	Circular	4' 5"
Outgoing	12	CIP	4	0	Circular	6' 8"



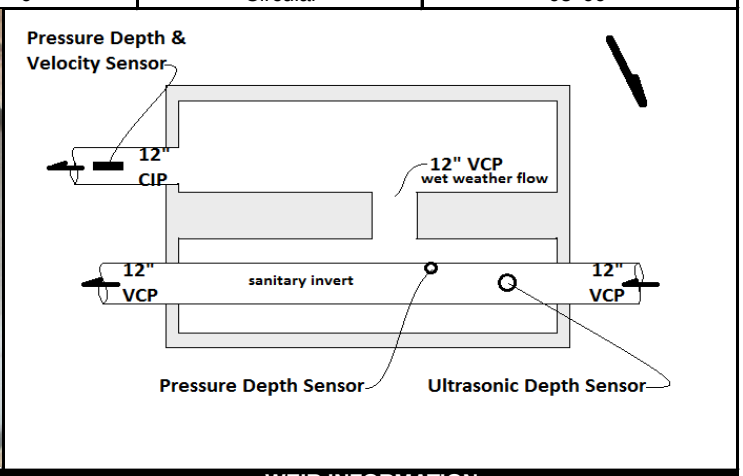
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



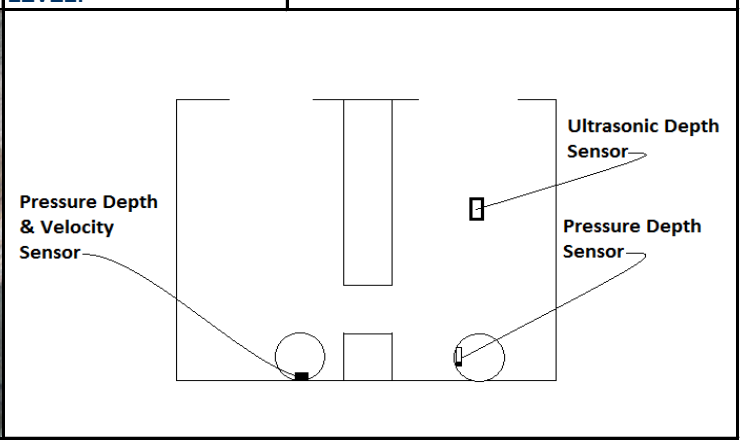
METER SITE INFORMATION FIELD LOG

PROJECT: Norwich, CT	**DATE:** June 5, 2017	**JOB#:** 17063
LOCATION: Shipping Street and Terminal Way	**MH#:**	**METER SITE:** 040
GPS/COMMENTS: 41.510458, -72.082556		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	12	VCP	1.5	0	Circular	05' 09"
Incoming						
Outgoing	12	VCP	2.5	0	Circular	05' 10"
Overfow	12	CIP	0	0	Circular	05' 00"

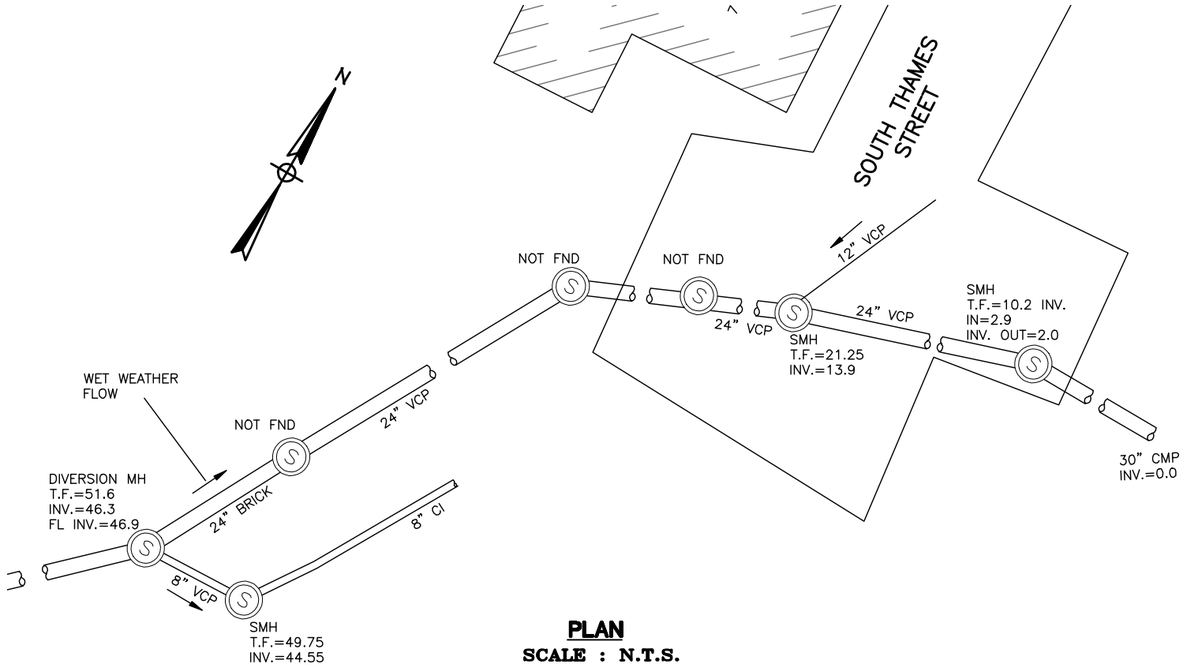


SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	

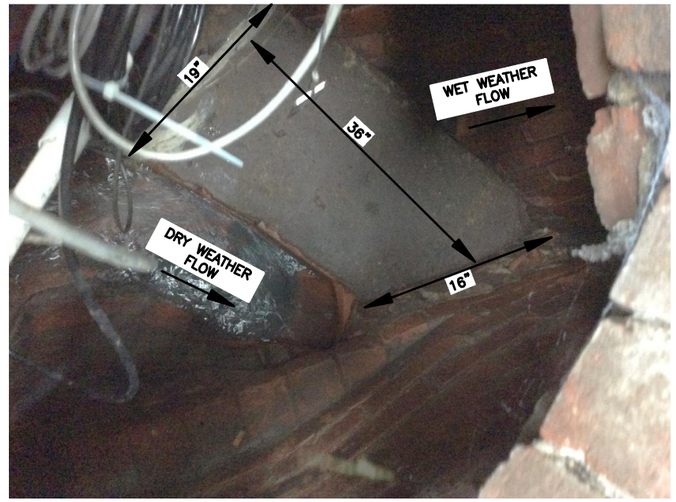


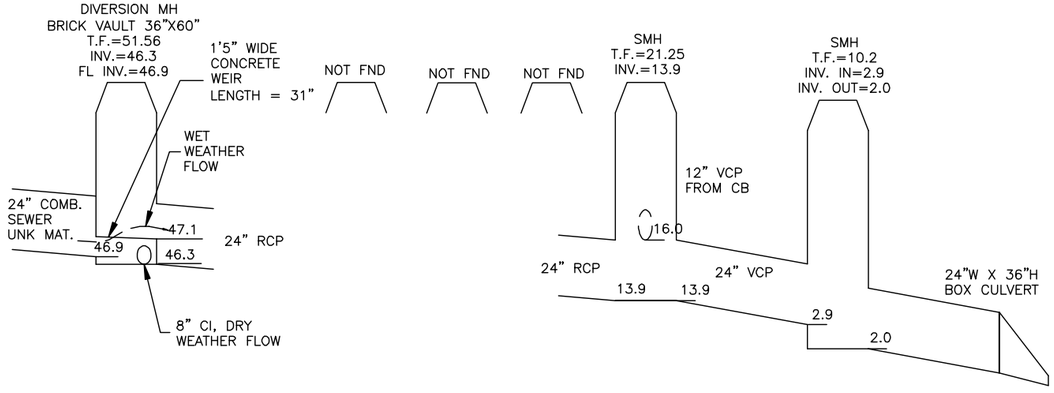
Attachment F

CSO Regulator Survey Sketches



PLAN
SCALE : N.T.S.





PROFILE
SCALE : N.T.S.

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88

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317 Main Street Norwich, Connecticut
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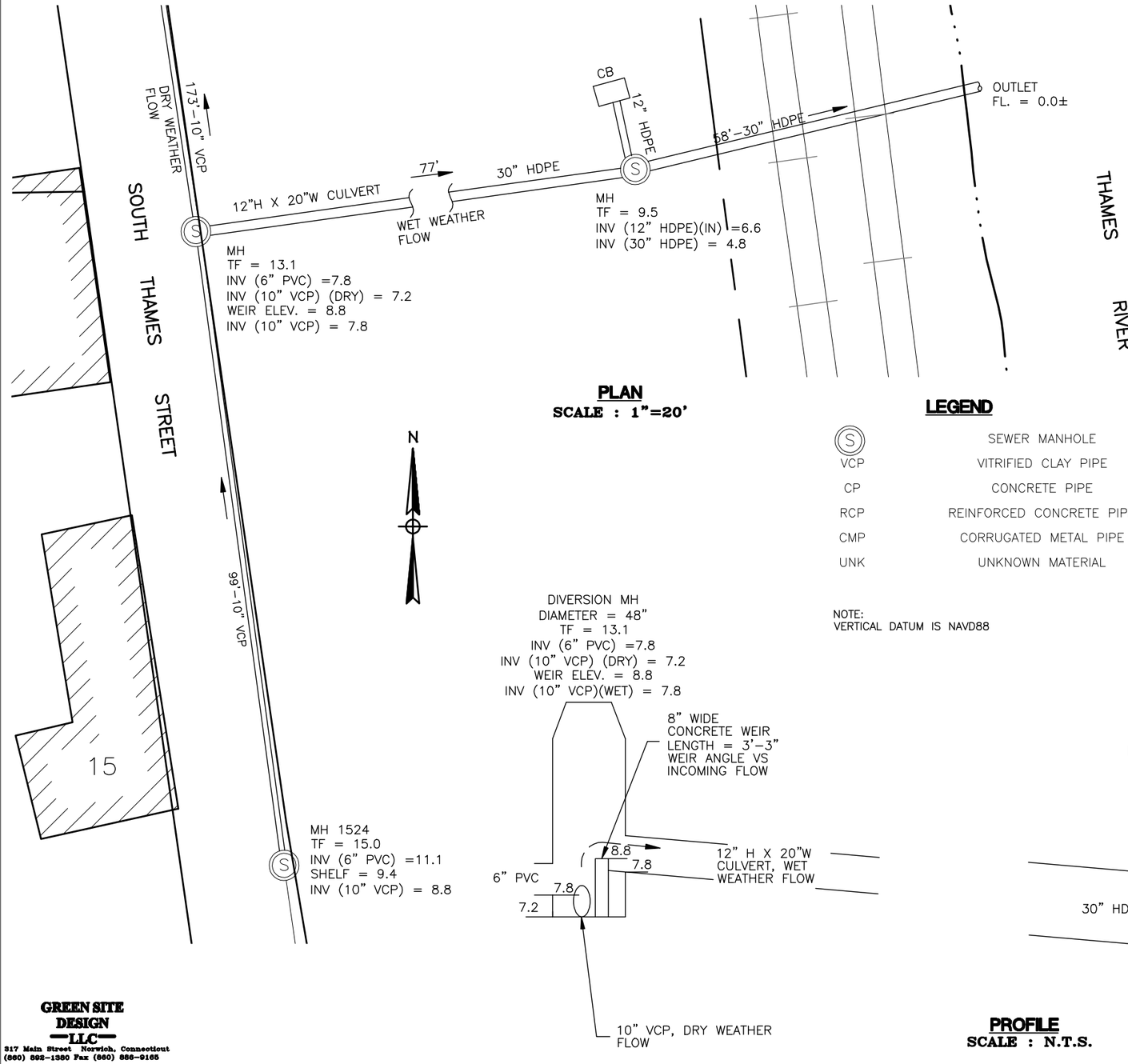
DESIGNED BY:
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1500
East Hartford, Connecticut 06108
Tel: (860) 528-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-4
South Thames Street

96538-

SHEET NO.
1



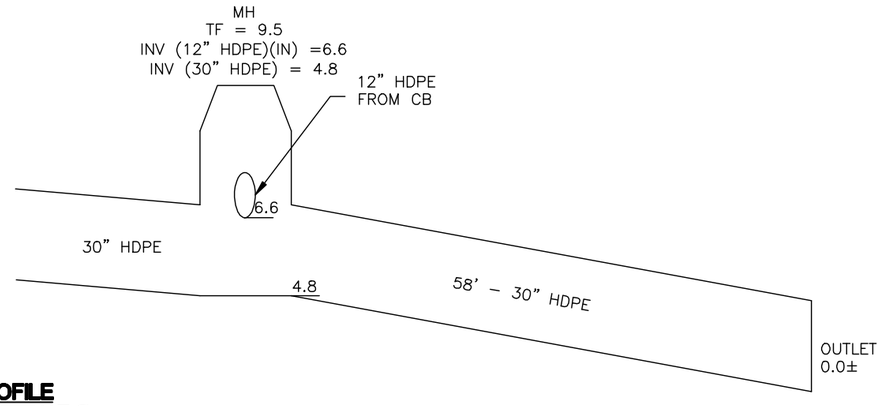
PLAN
SCALE : 1"=20'

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88

DIVERSION MH
DIAMETER = 48"
TF = 13.1
INV (6" PVC) =7.8
INV (10" VCP) (DRY) = 7.2
WEIR ELEV. = 8.8
INV (10" VCP)(WET) = 7.8



PROFILE
SCALE : N.T.S.

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APPROVED BY:
DATE: AUGUST 2017

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East Hartford, Connecticut 06108
Tel: (860) 529-7015

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COMBINED SEWER OUTLET
CSO-5
South Thames Street

96538-

SHEET NO.
2

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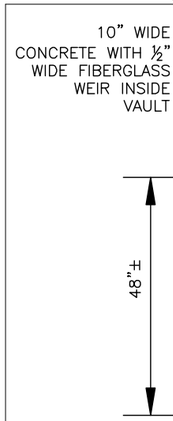
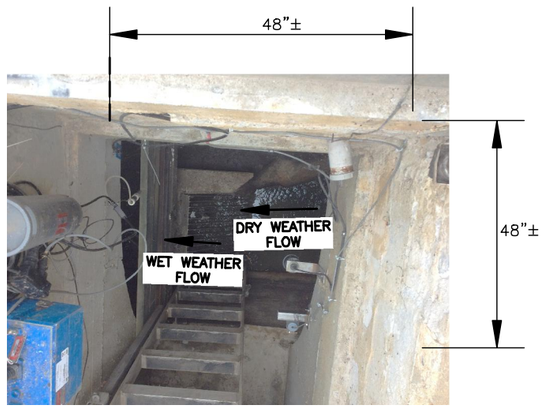
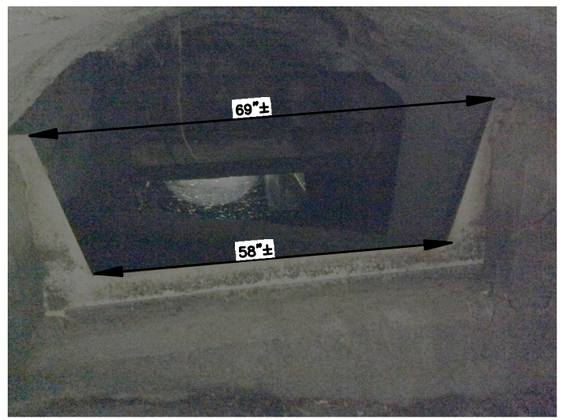
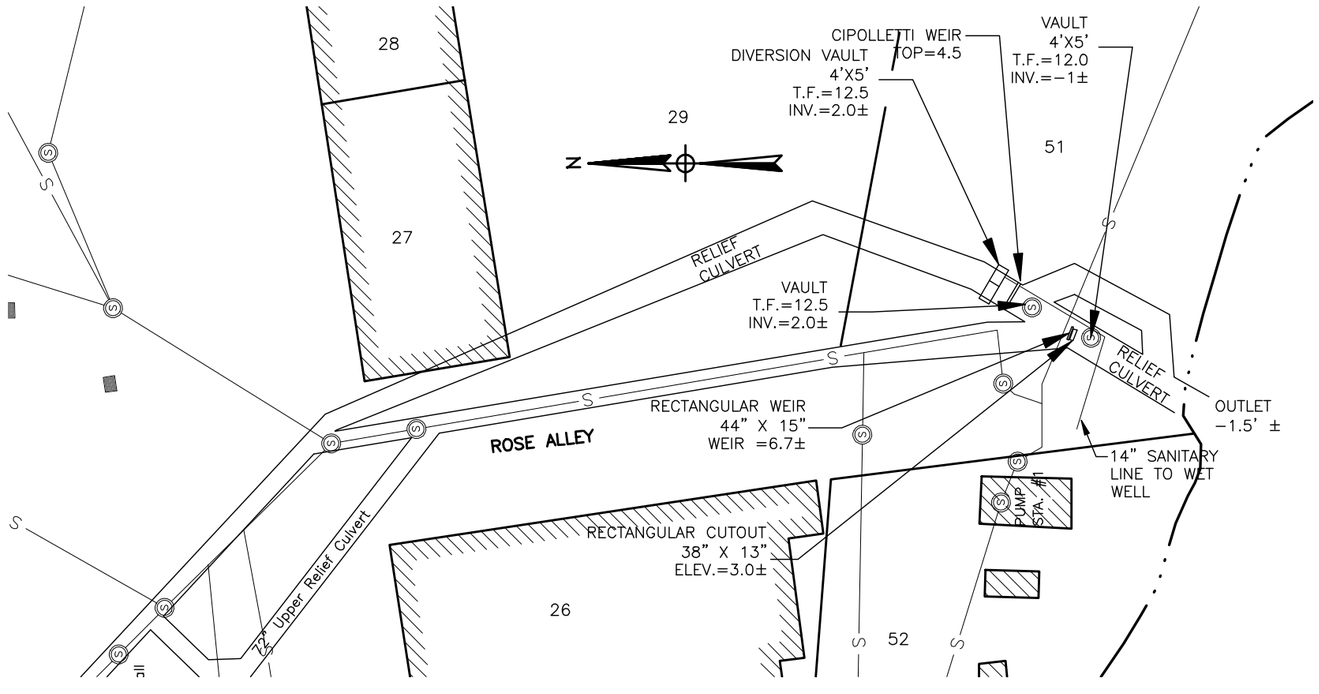
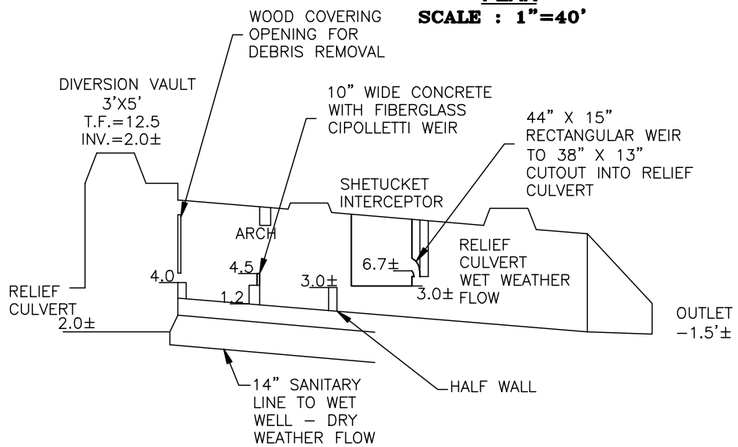








PLAN
SCALE : 1"=40'



PROFILE
SCALE : N.T.S.

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTES:
1. MEASUREMENTS AND ELEVATIONS ARE TAKEN FROM BEST AVAILABLE DATA; INCLUDING PLANS, SKETCHES, AND NPU STAFF.

2. VERTICAL DATUM IS NAVD88

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CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

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111 Founders Plaza, Suite 1600
East Hartford, Connecticut 06108
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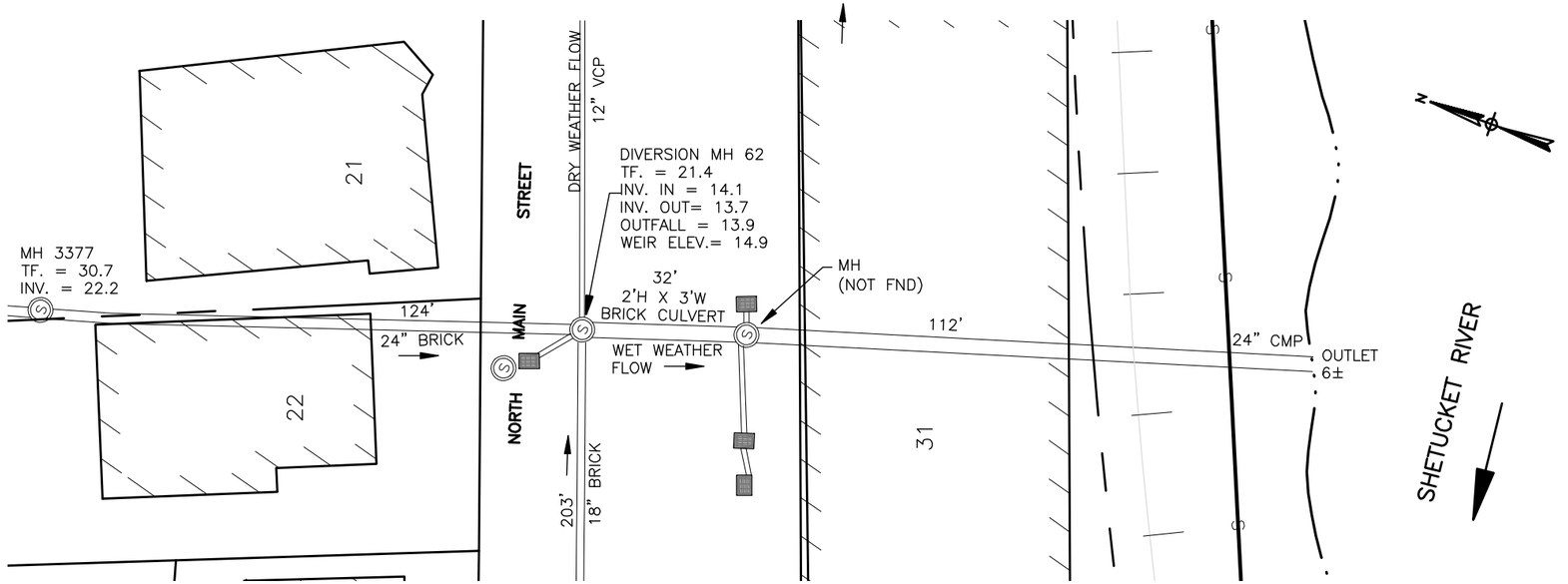
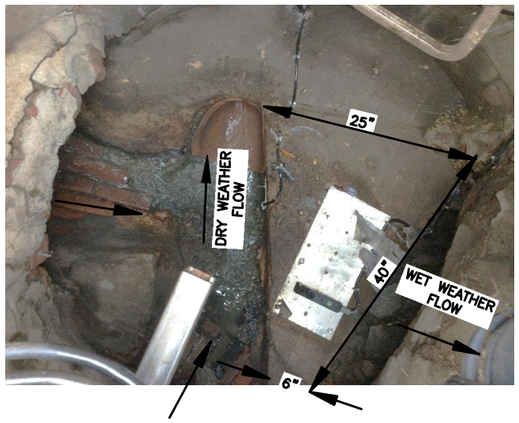
CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-17
Rose Alley

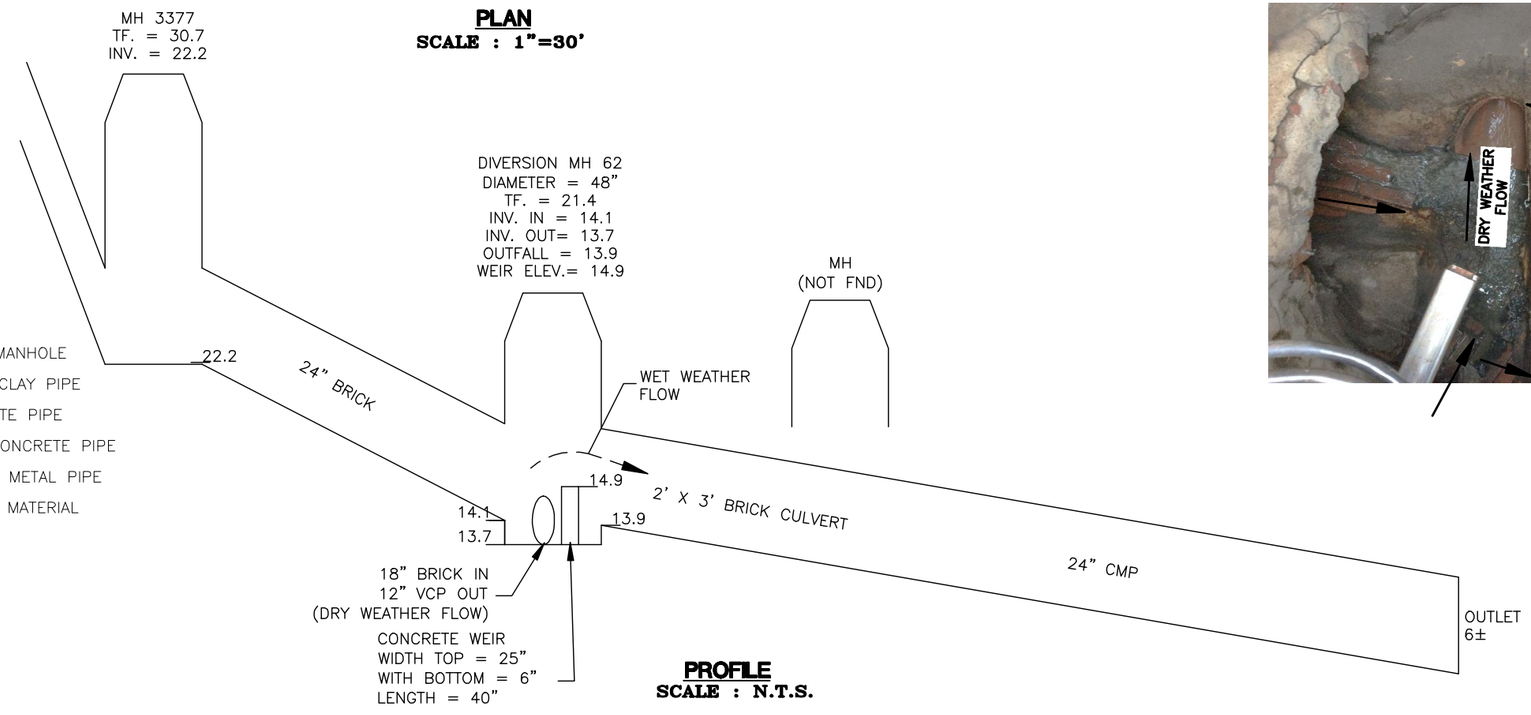
96538-

SHEET NO.
3



PLAN
SCALE : 1"=30'





PROFILE
SCALE : N.T.S.

LEGEND

S	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88

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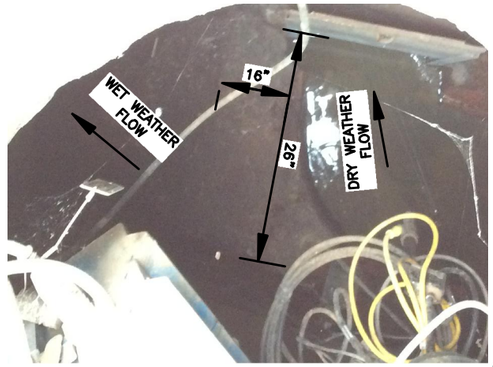
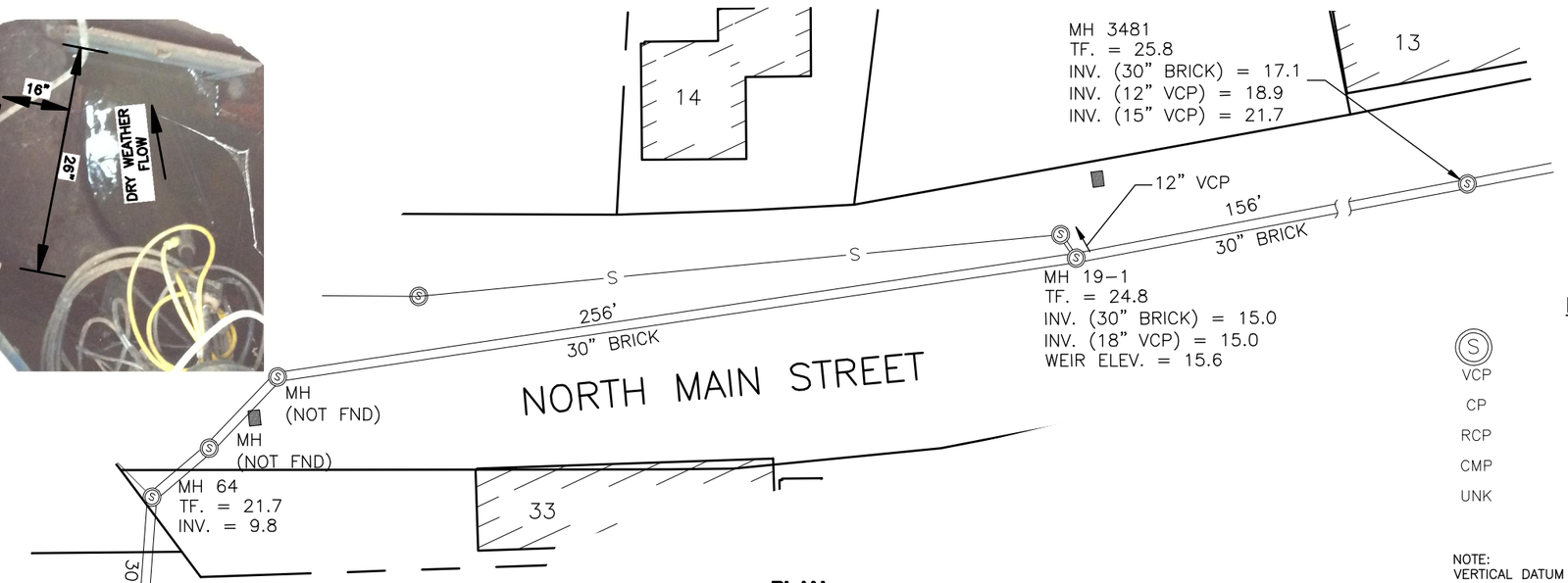
CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-16
North Main Sreet & Trade School

96538-

SHEET NO.
4



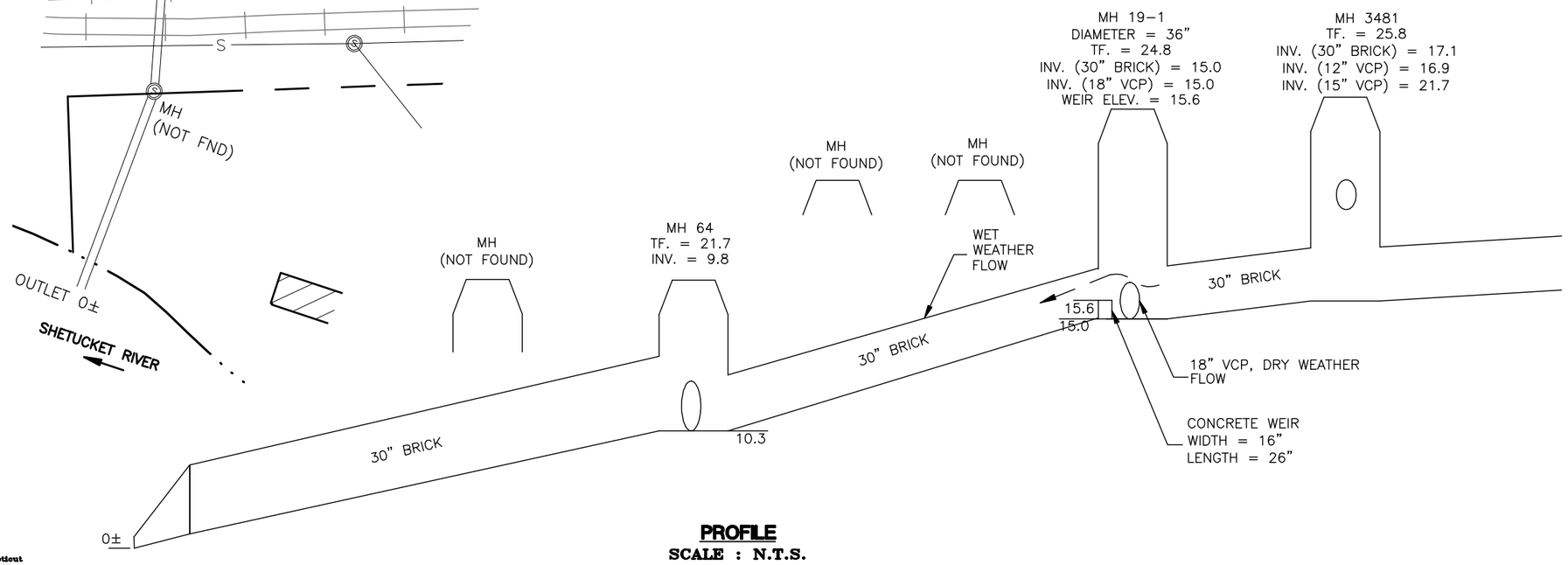


PLAN
SCALE : 1"=40'

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



PROFILE
SCALE : N.T.S.

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DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

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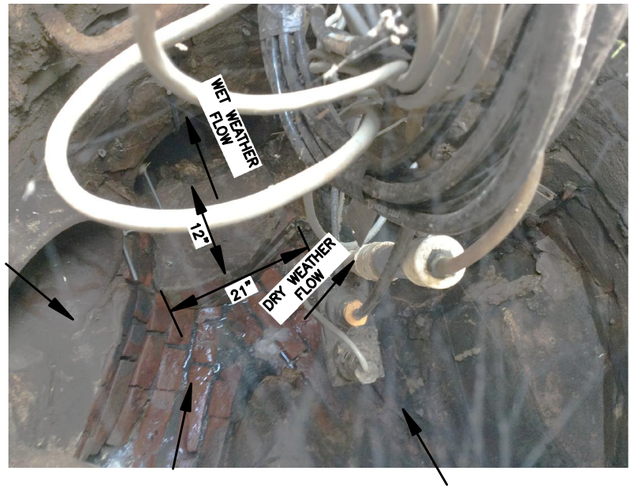
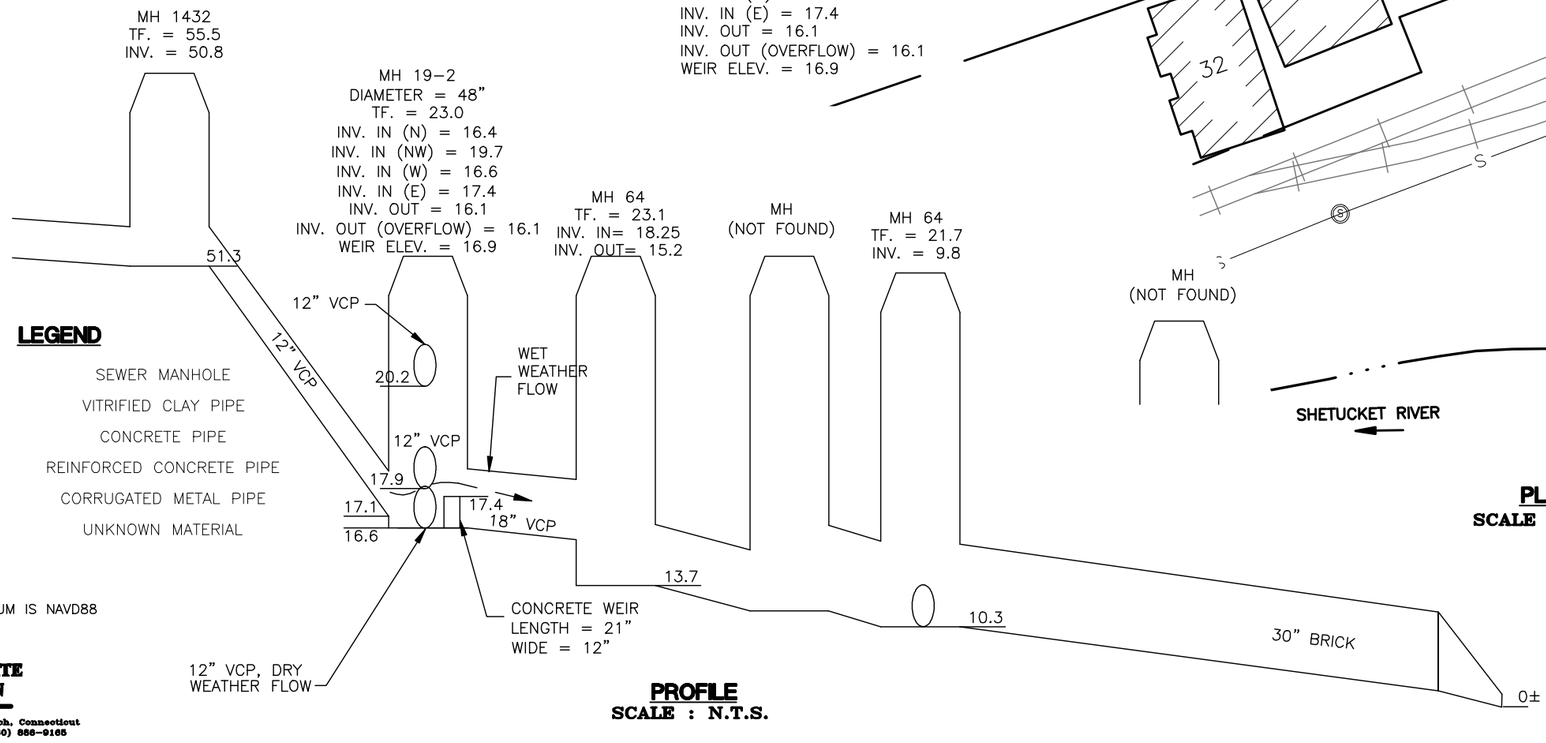
111 Founders Plaza, Suite 1600
East Hartford, Connecticut 06108
Tel: (860) 529-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-19-1
North Main Sreet

96538-

SHEET NO.
5



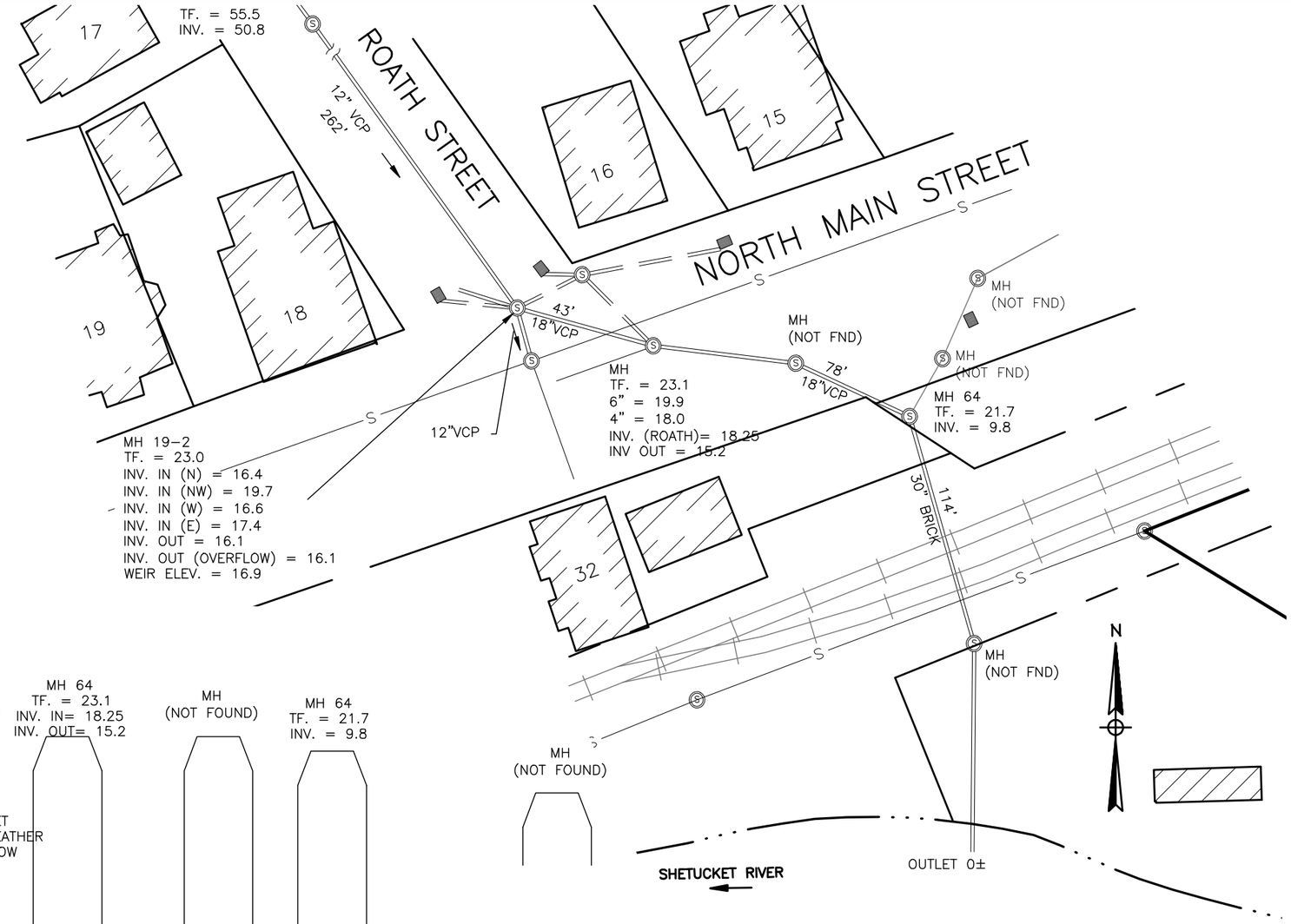


PROFILE
SCALE : N.T.S.

LEGEND

S	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



PLAN
SCALE : 1"=40'

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317 Main Street Norwich, Connecticut
(860) 892-1380 Fax (860) 886-9165

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY:
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SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1800
East Hartford, Connecticut 06108
Tel: (860) 528-7615

CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-19-2
North Main Sreet

96538-

SHEET NO.
6

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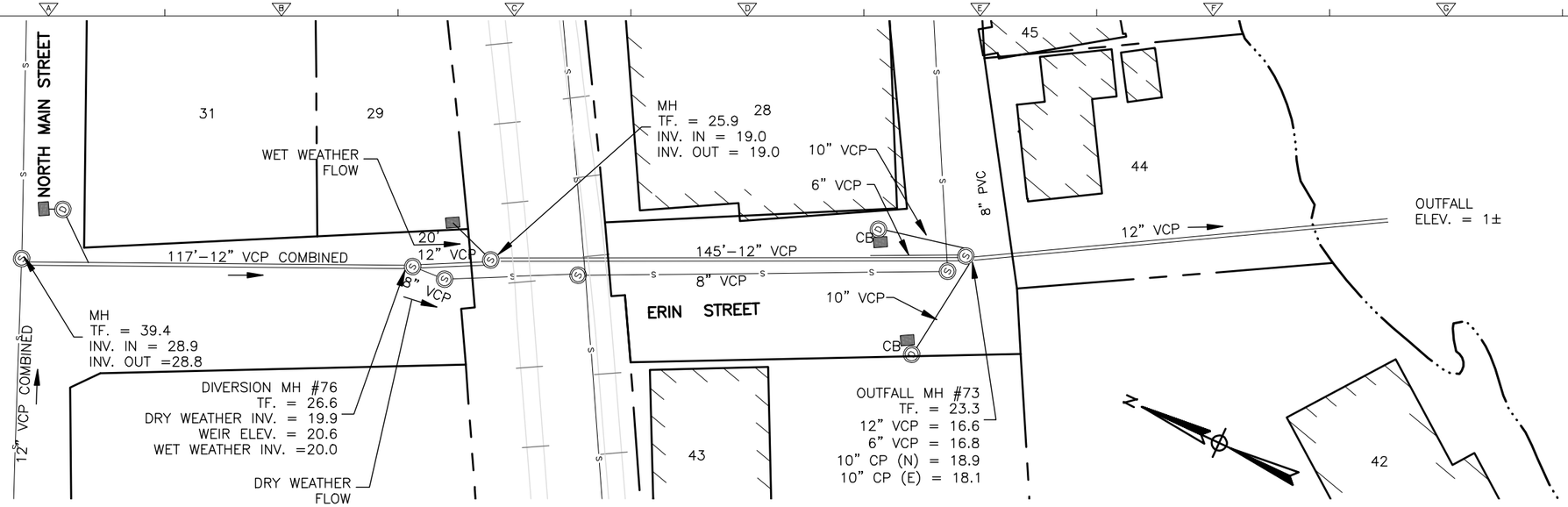
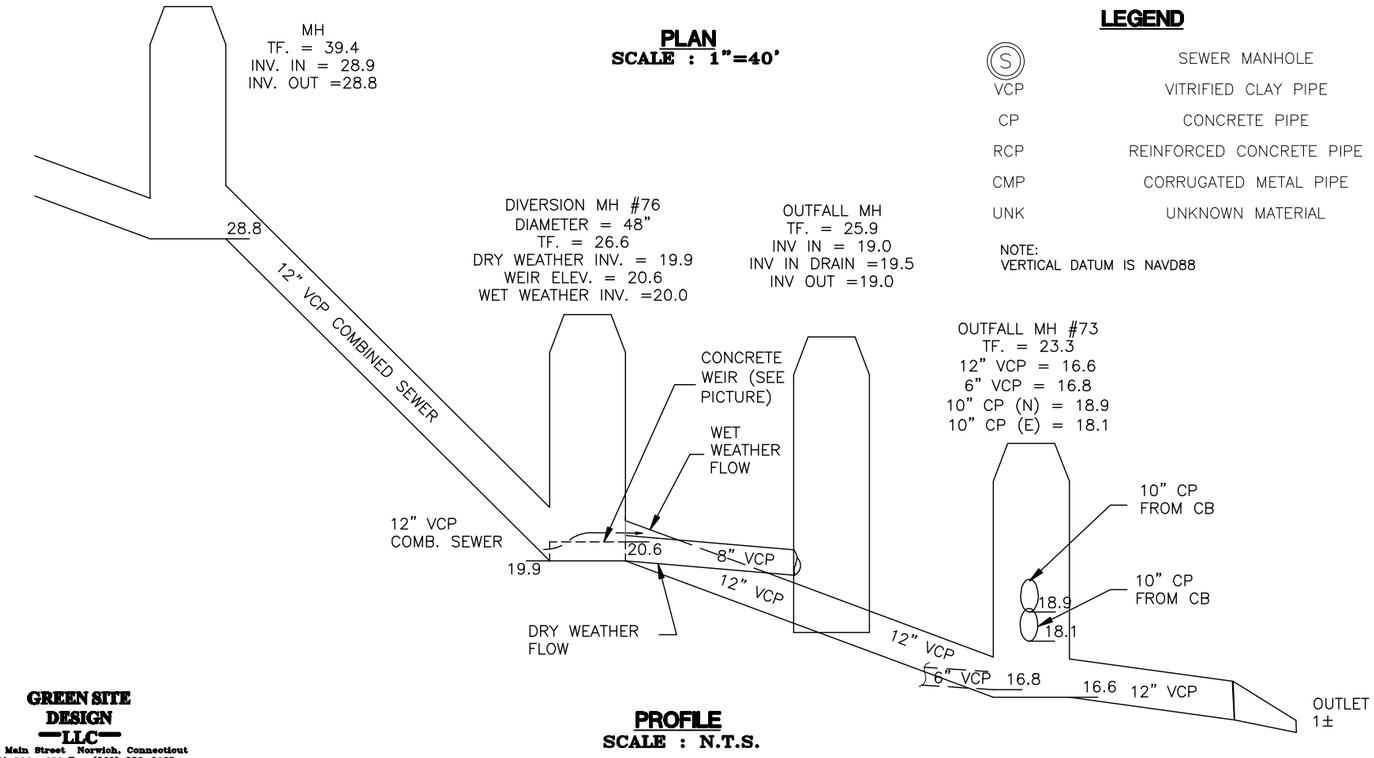


PLAN
SCALE : 1"=40'

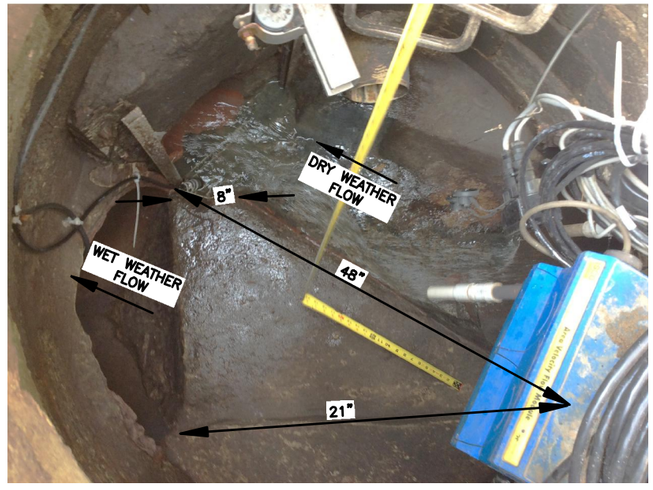


PROFILE
SCALE : N.T.S.

LEGEND

S	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



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REV. NO.	DATE	DRWN	CHKD	REMARKS

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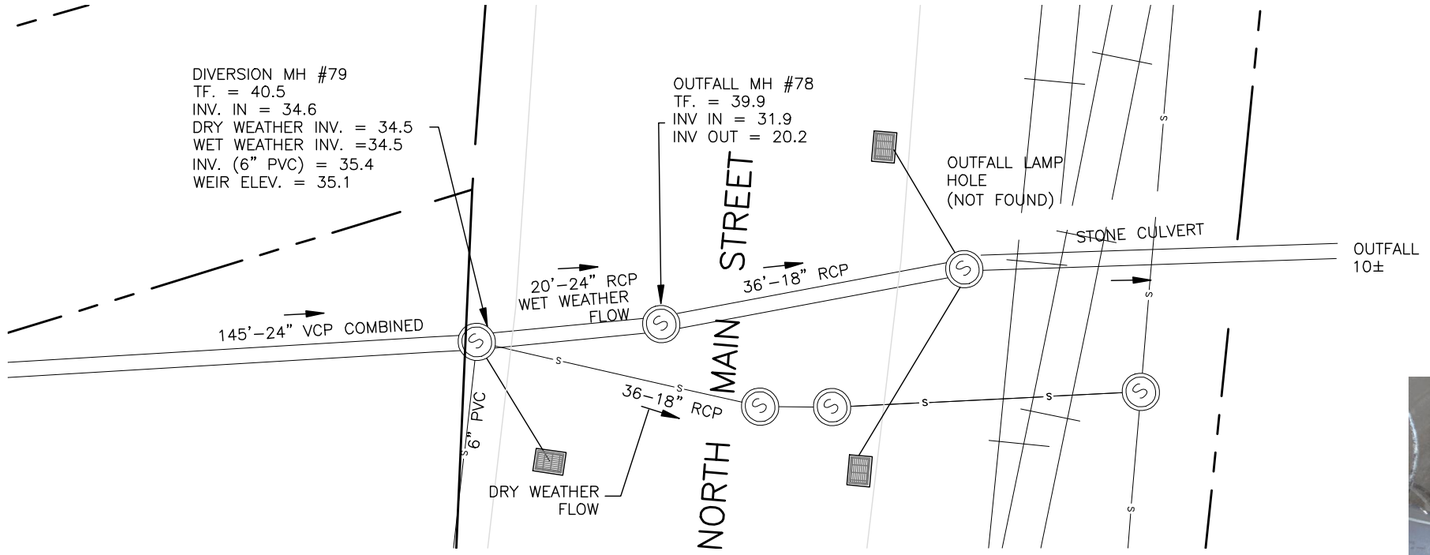
DRAWN BY:
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: AUGUST 2017

CDM Smith
111 Founders Plaza, Suite 1600
East Hartford, Connecticut 06108
Tel: (860) 528-7615

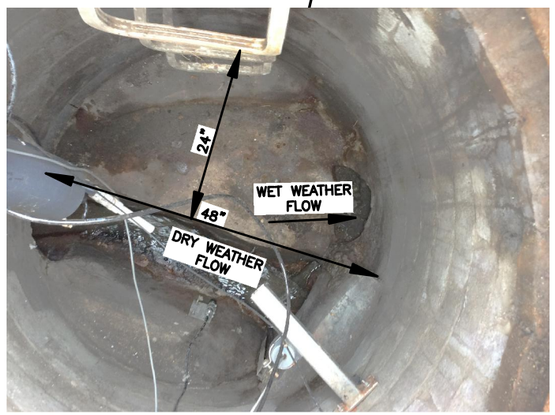
CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-21
Erin Street

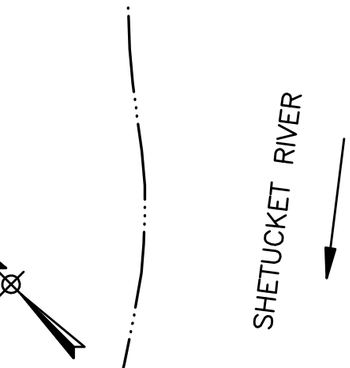
96538-

SHEET NO.
7



PLAN
SCALE : 1"=20'

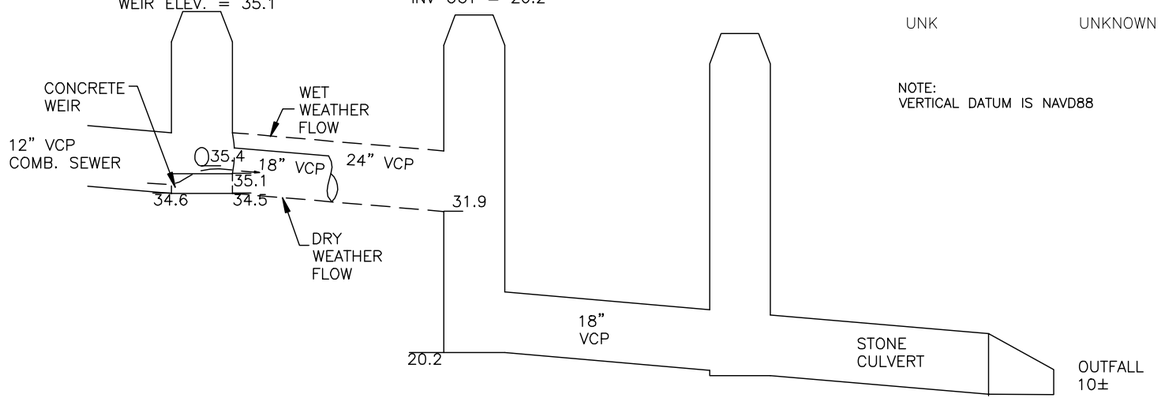




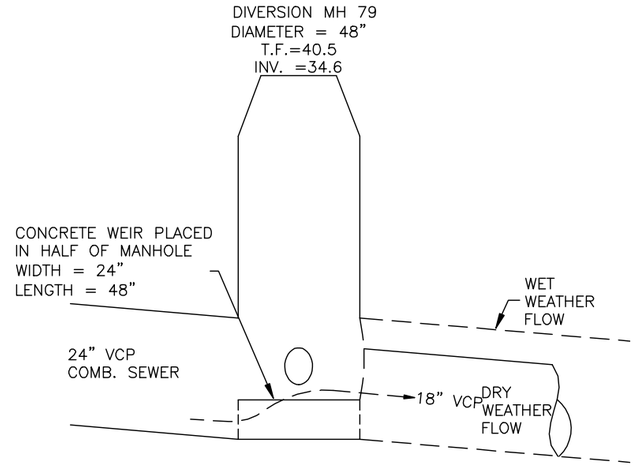
LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



PROFILE
SCALE : N.T.S.



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DATE: AUGUST 2017

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East Hartford, Connecticut 06108
Tel: (860) 828-7615

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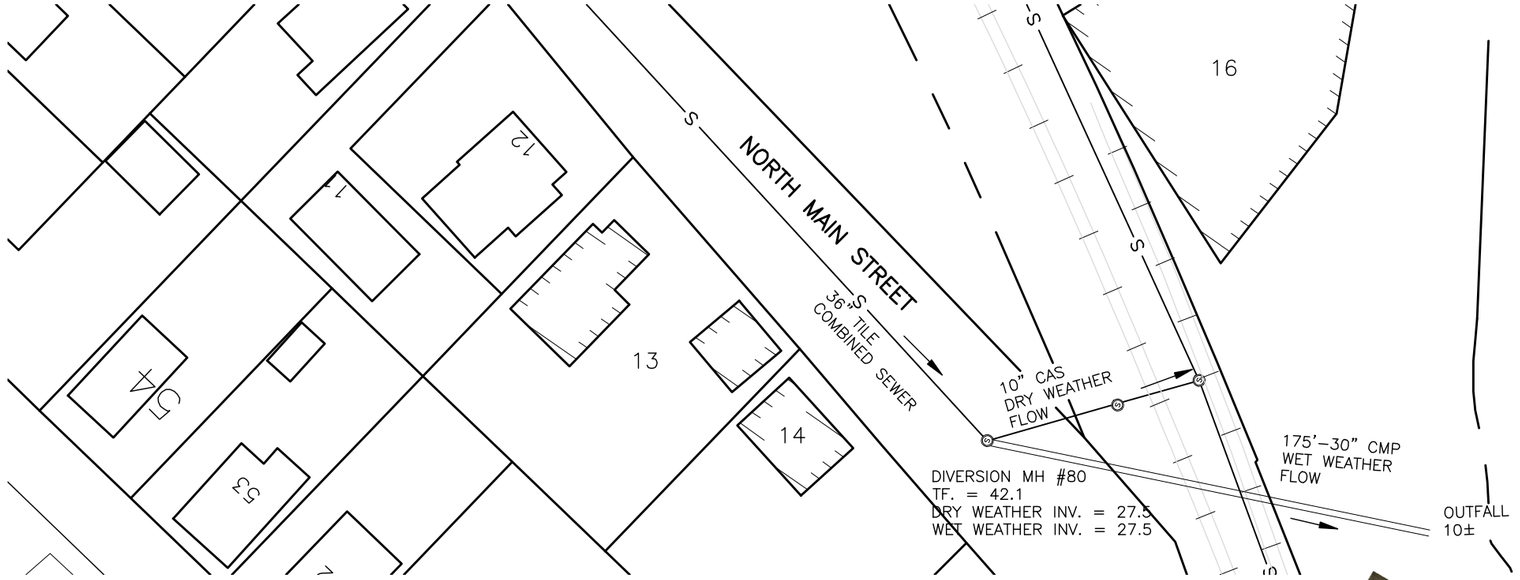
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-22
North Main Street off Hickory Street

96538-

SHEET NO.
8

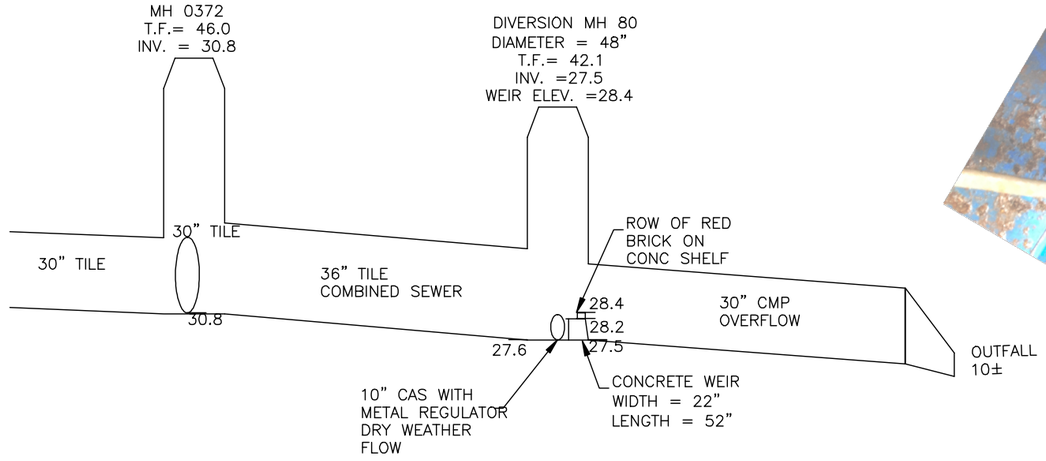


PLAN
SCALE : 1"=60'

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



PROFILE
SCALE : N.T.S.

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COMBINED SEWER OUTLET
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SHEET NO.
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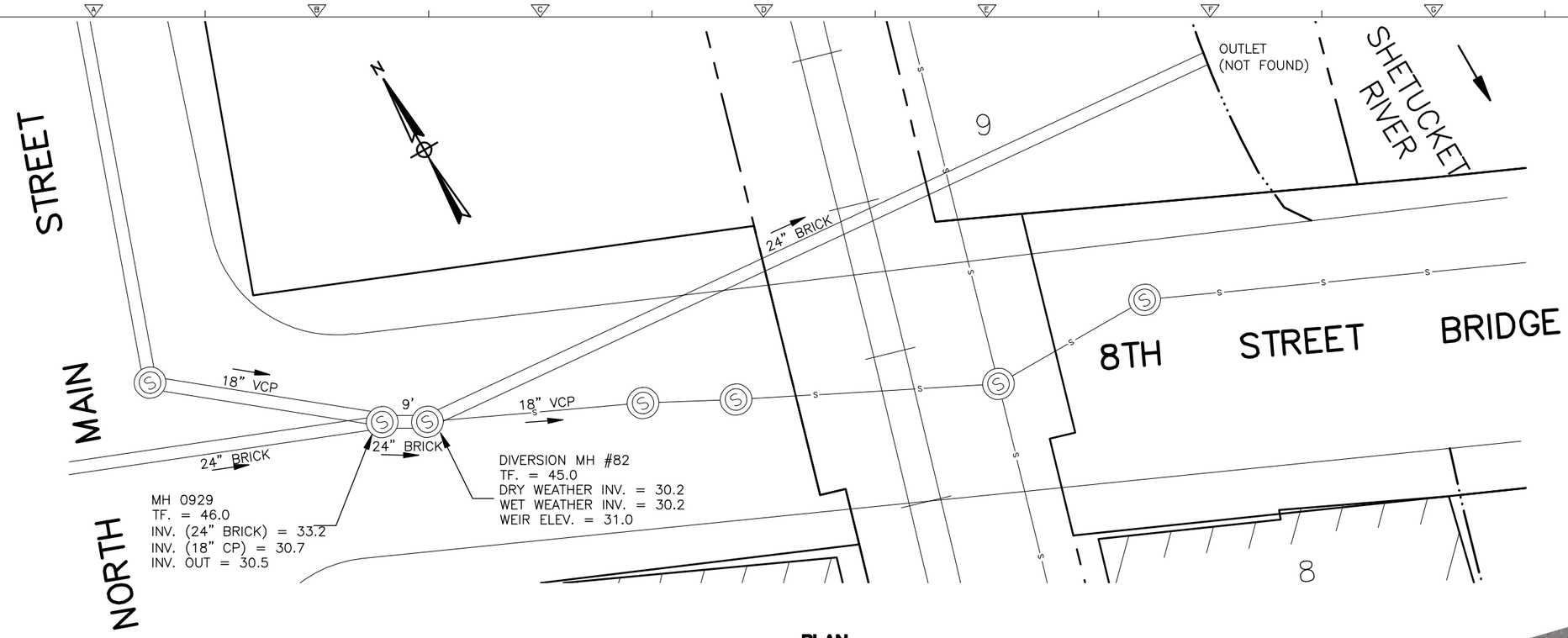
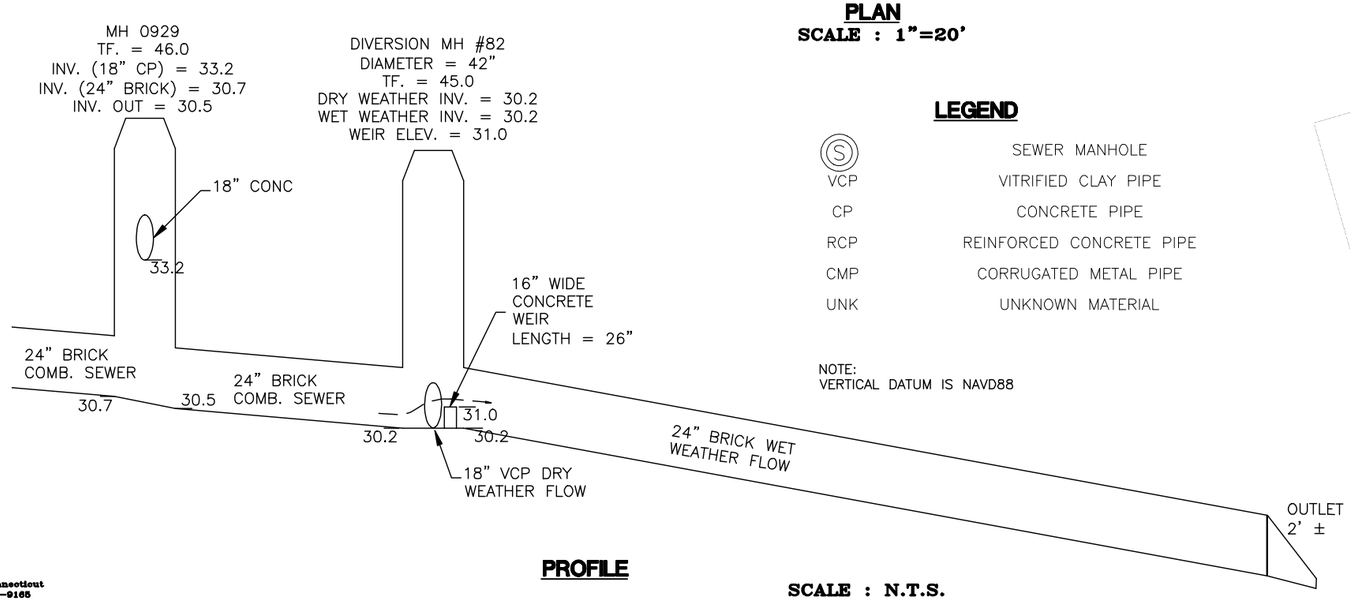


PLAN
SCALE : 1"=20'

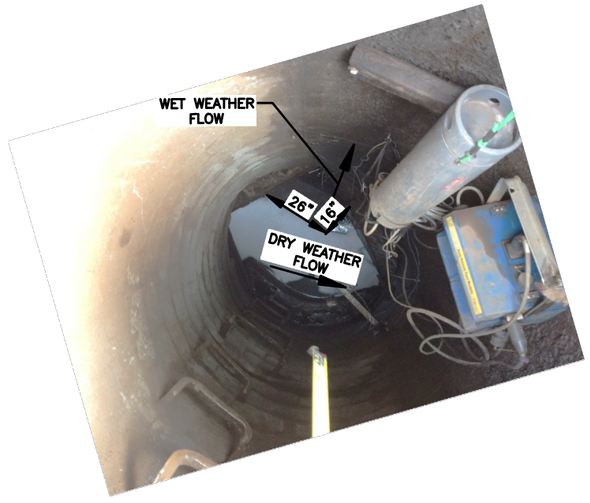


PROFILE
SCALE : N.T.S.

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



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APPROVED BY:
DATE: AUGUST 2017

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CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-24
Eighth Street

96538-

SHEET NO.
10

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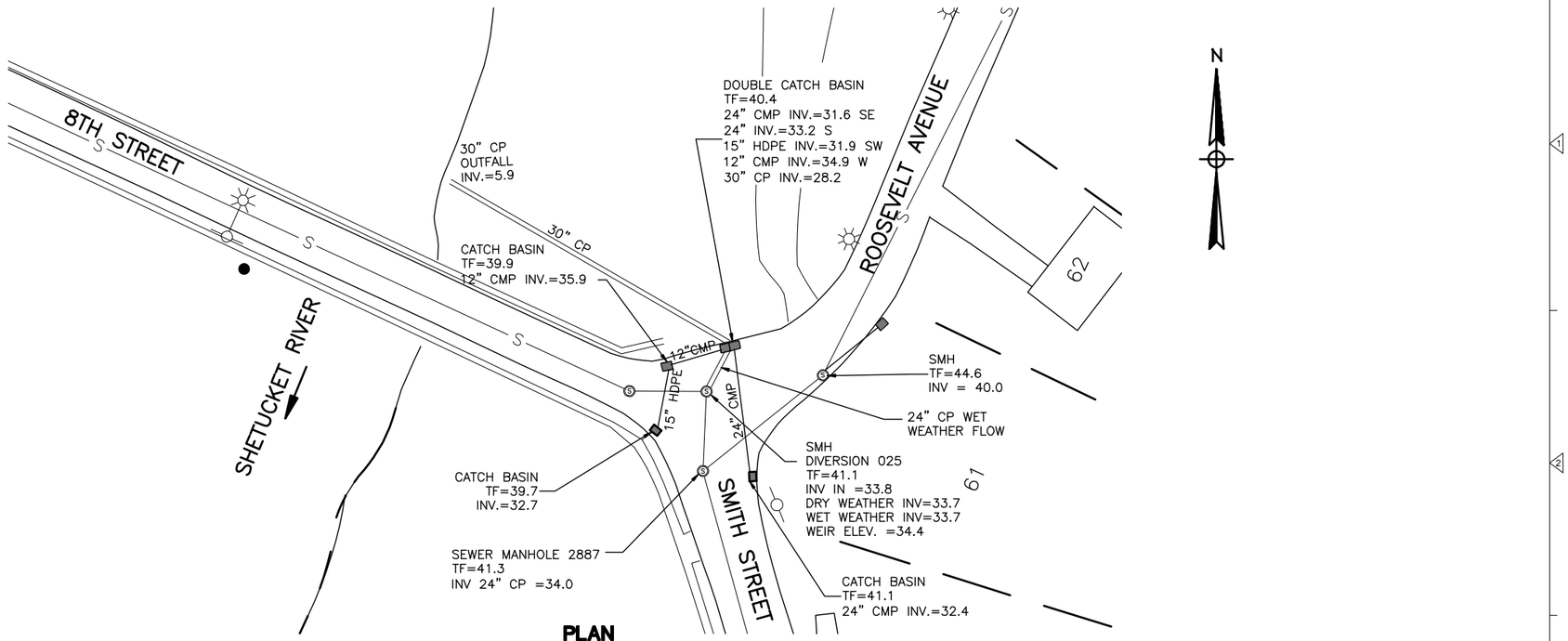
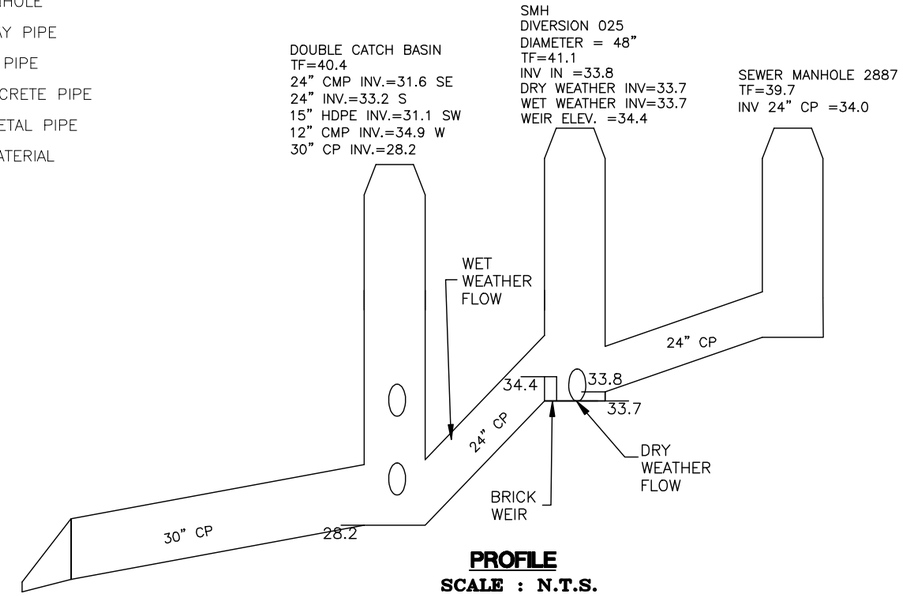


PLAN
SCALE : 1"=40'

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



PROFILE
SCALE : N.T.S.

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APPROVED BY:
DATE: AUGUST 2017

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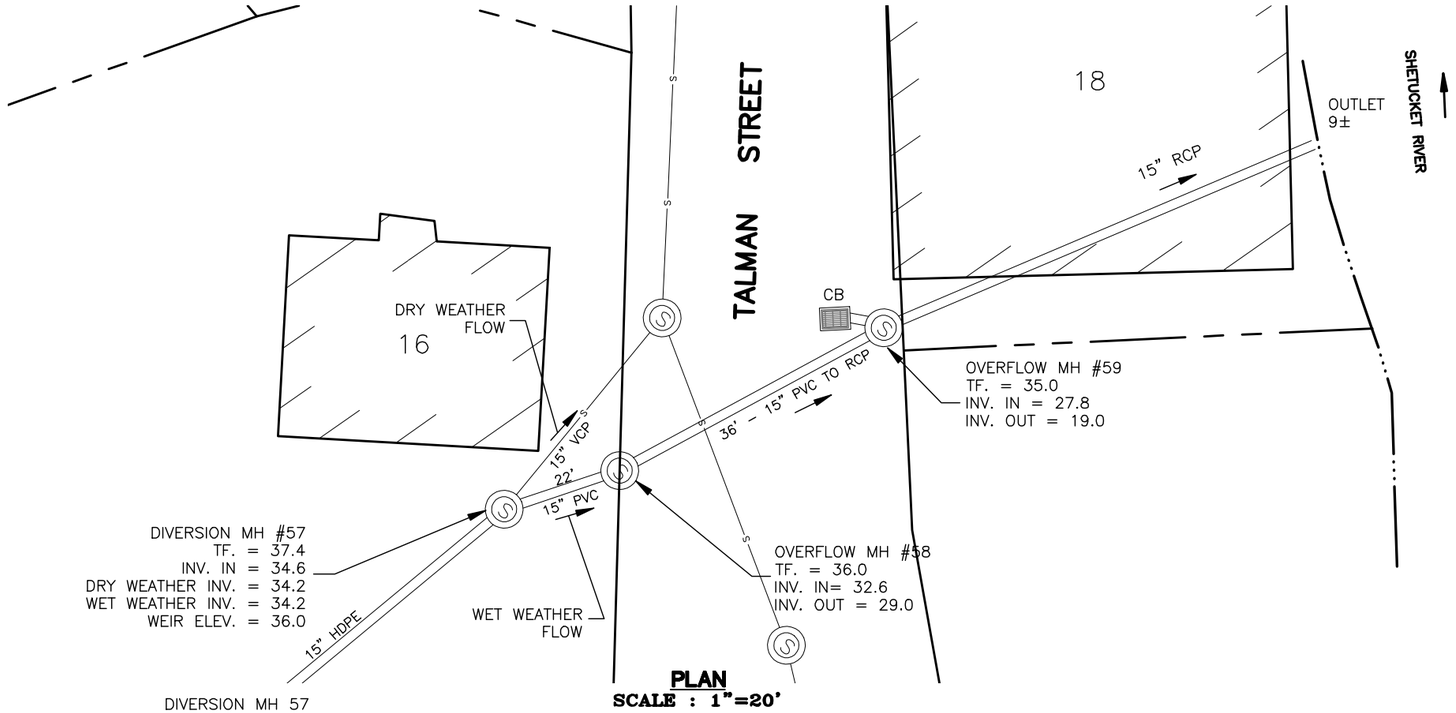
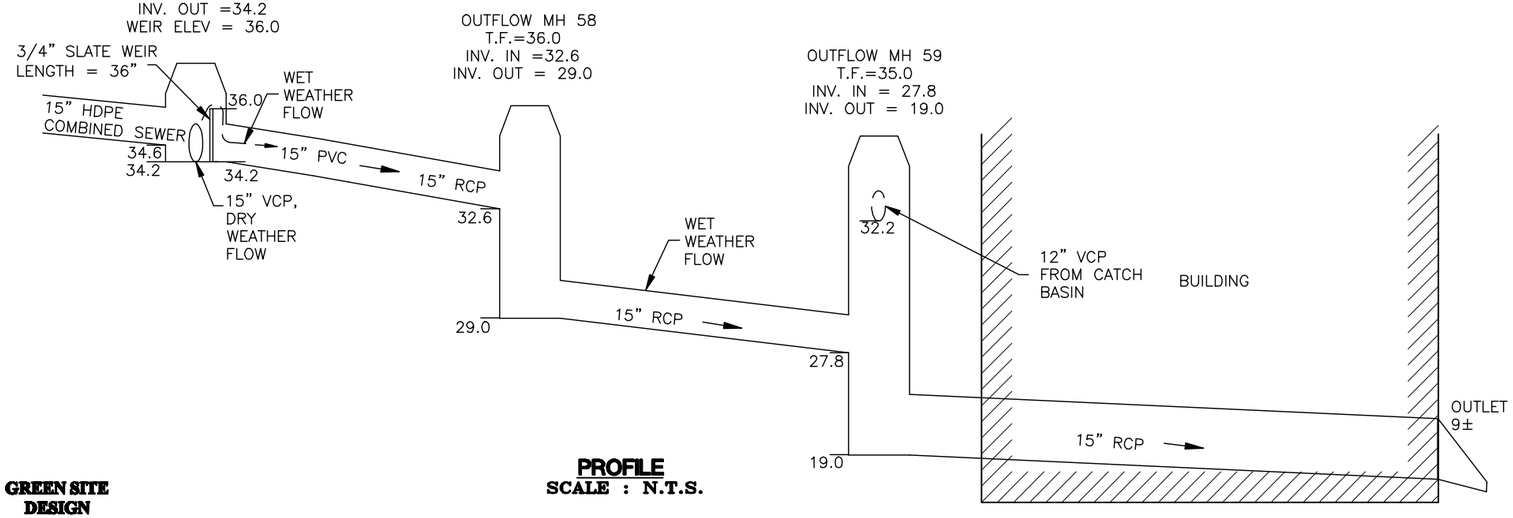
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-25
Smith Avenue

96538-

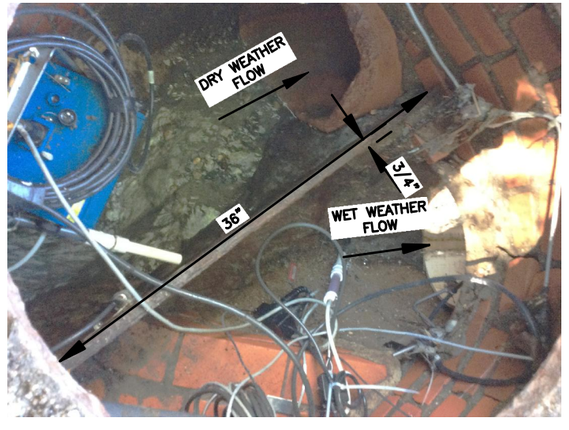
SHEET NO.
11



PLAN
SCALE : 1"=20'



PROFILE
SCALE : N.T.S.



LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88

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COMBINED SEWER OUTLET
CSO-29
Talman Street

96538-

SHEET NO.
12

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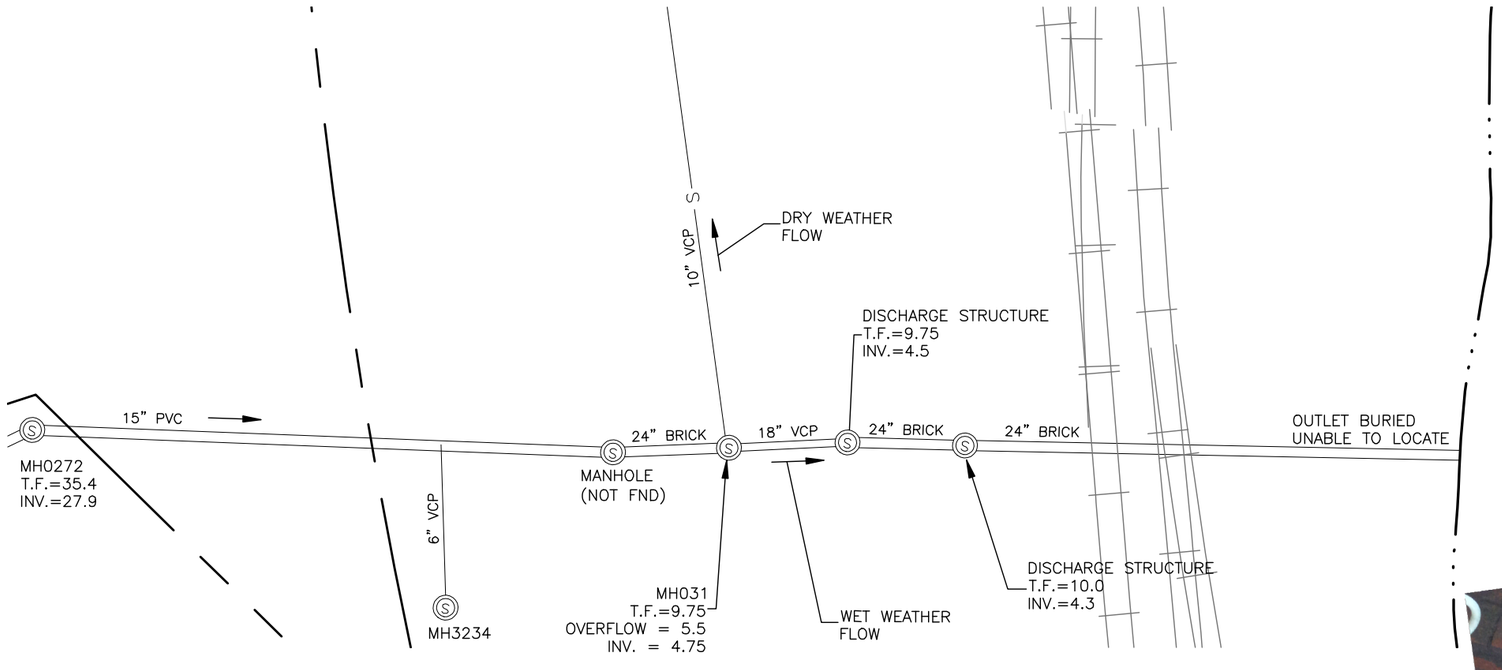
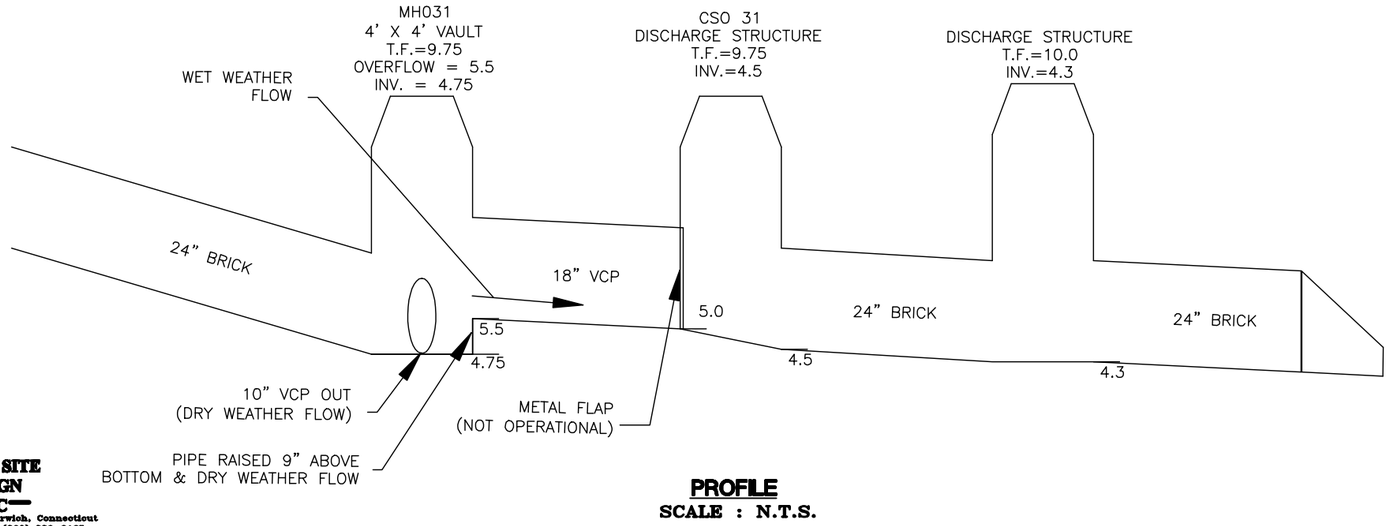


PLAN
SCALE : 1"=20'



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COMBINED SEWER OUTLET
CSO-31
River Avenue Extension

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SHEET NO.
13

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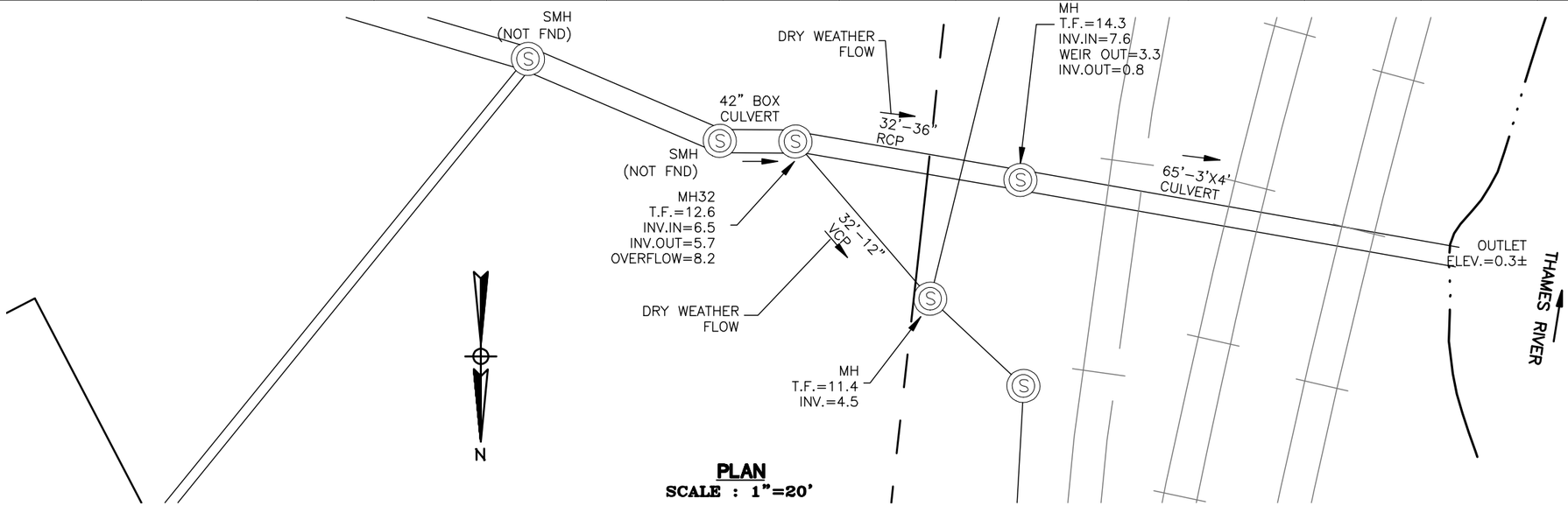
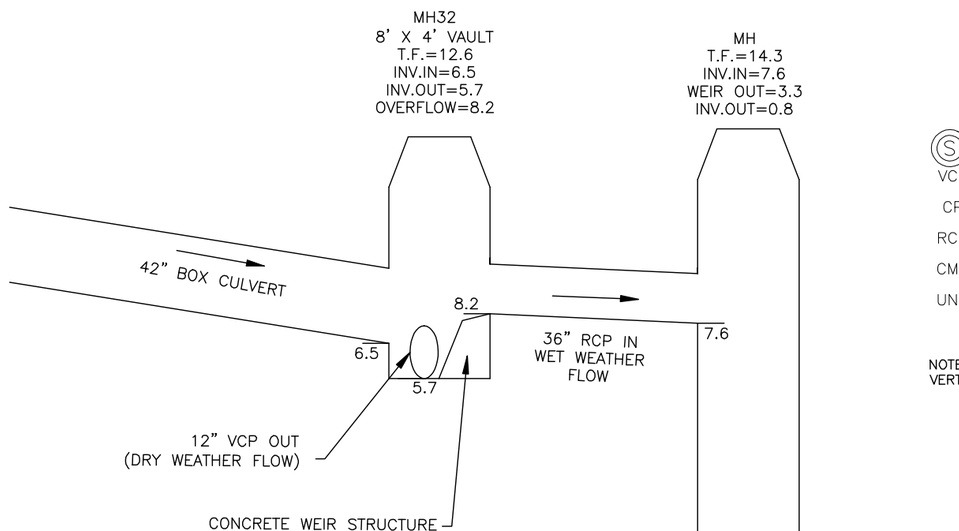


PLAN
SCALE : 1"=20'

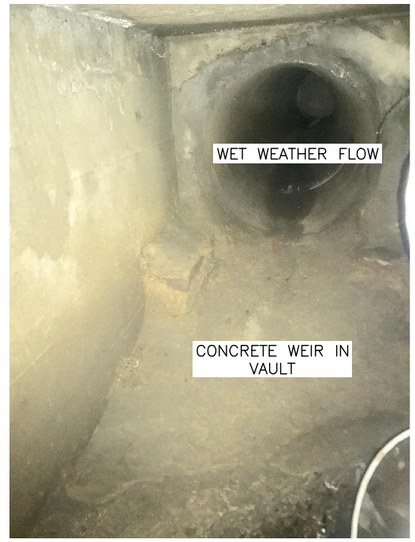


PROFILE
SCALE : N.T.S.

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88



NOTE:
REMAINING MEASUREMENTS
NOT ACCESSIBLE

DRY WEATHER FLOW

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DATE: AUGUST 2017

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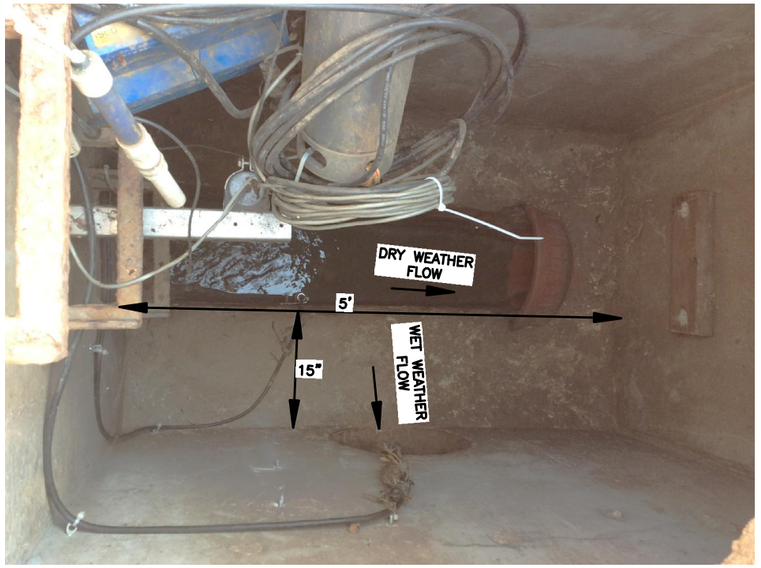
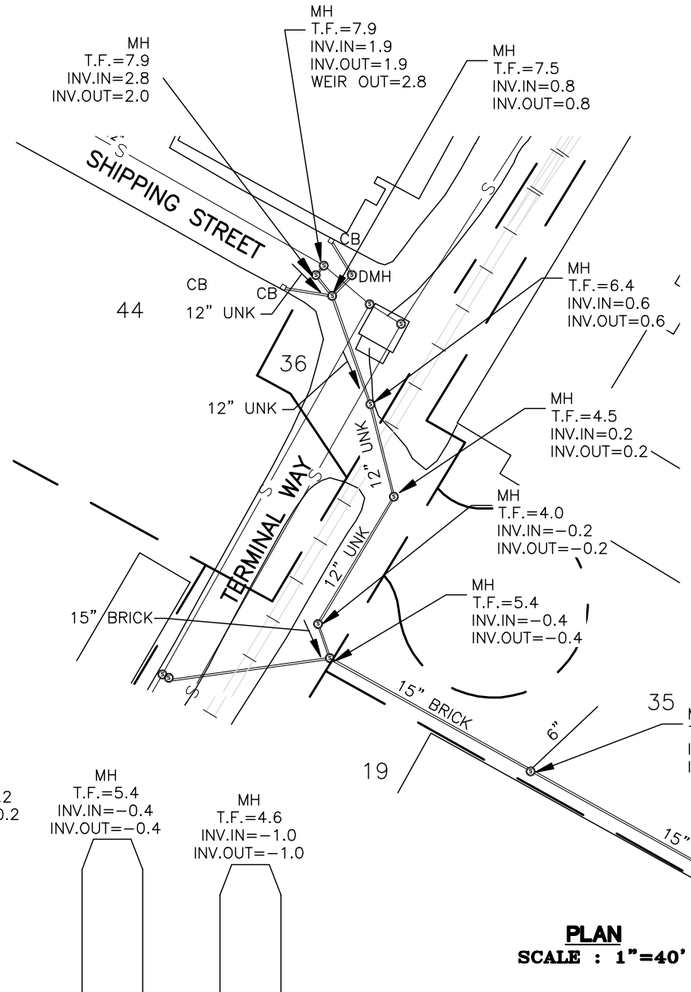
CITY OF NORWICH, CONNECTICUT
CONTRACT NO.
COMBINED SEWER OUTLET
CSO-32
Crown Street

96538-

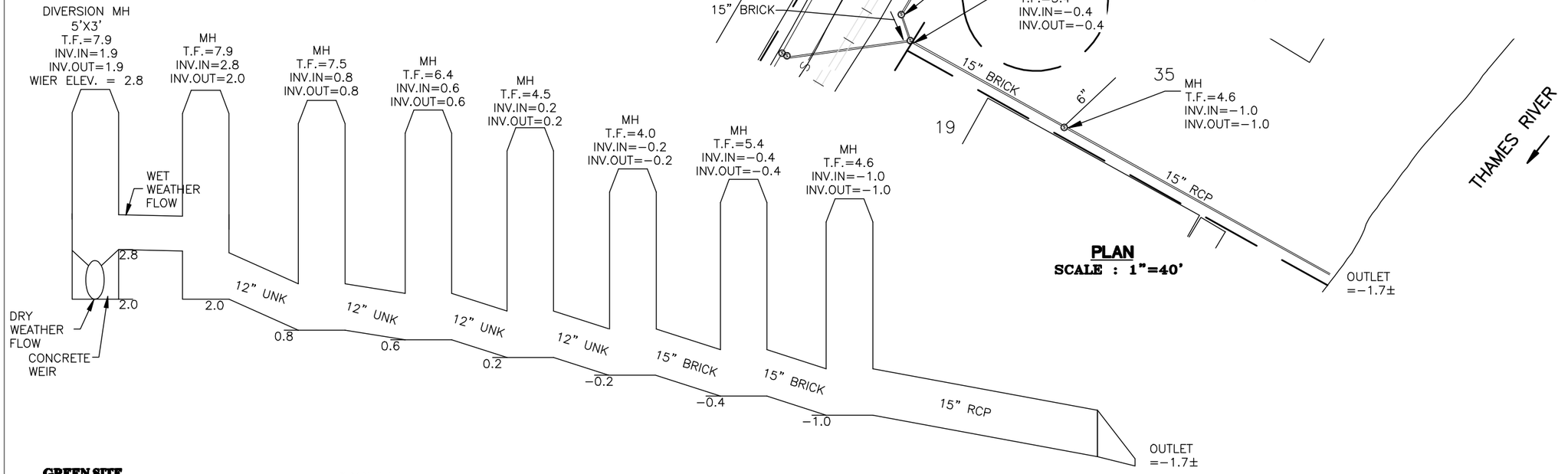
SHEET NO.
14



DIVERSION MH
5'X3'
T.F.=7.9
INV.IN=1.9
INV.OUT=1.9
WIER ELEV. = 2.8



PLAN
SCALE : 1"=40'



PROFILE
SCALE : N.T.S.

LEGEND

(S)	SEWER MANHOLE
VCP	VITRIFIED CLAY PIPE
CP	CONCRETE PIPE
RCP	REINFORCED CONCRETE PIPE
CMP	CORRUGATED METAL PIPE
UNK	UNKNOWN MATERIAL

NOTE:
VERTICAL DATUM IS NAVD88

N

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APPROVED BY:
DATE: AUGUST 2017

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East Hartford, Connecticut 06108
Tel: (860) 528-7615

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COMBINED SEWER OUTLET
CSO-40
Shipping Street

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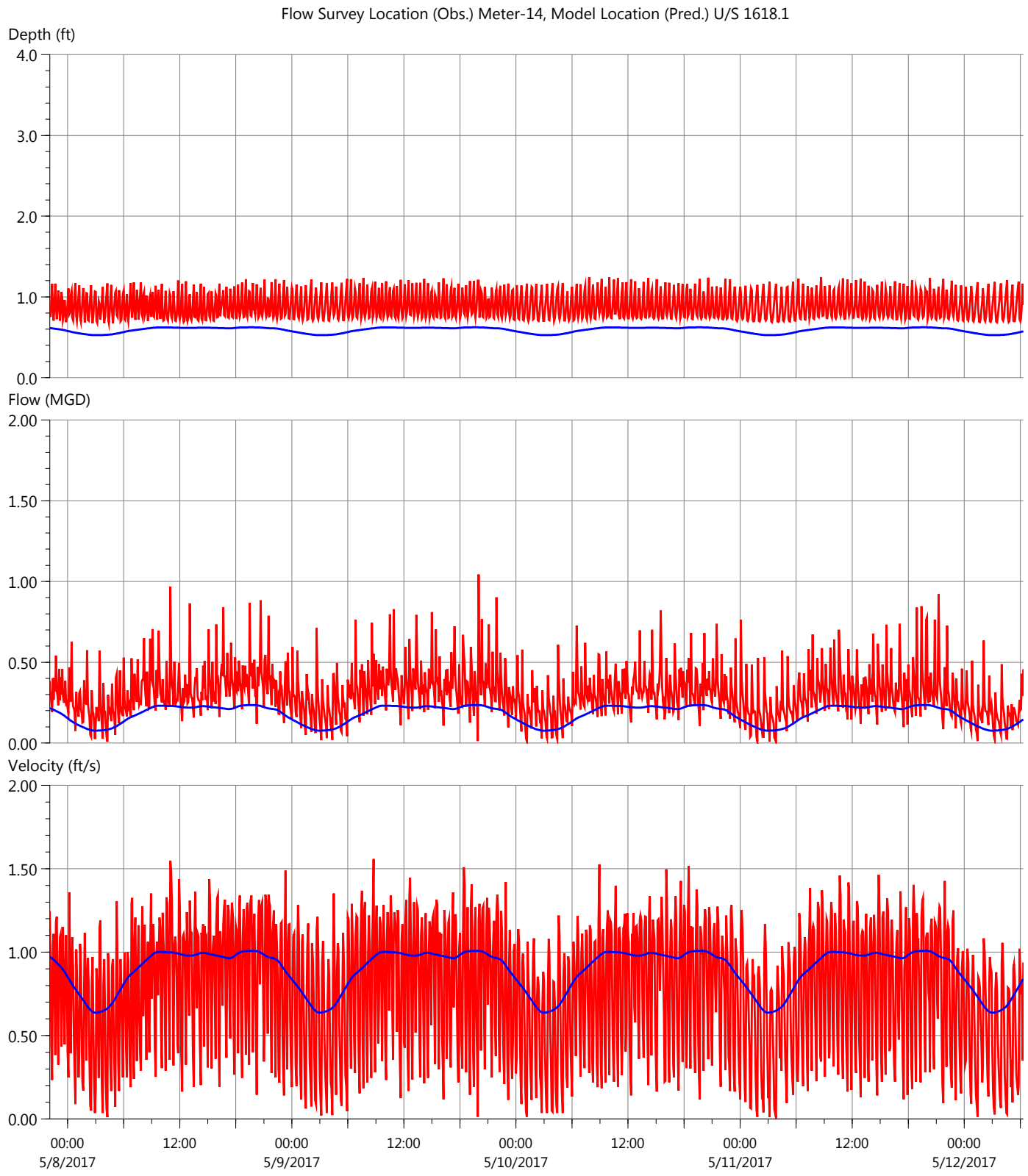
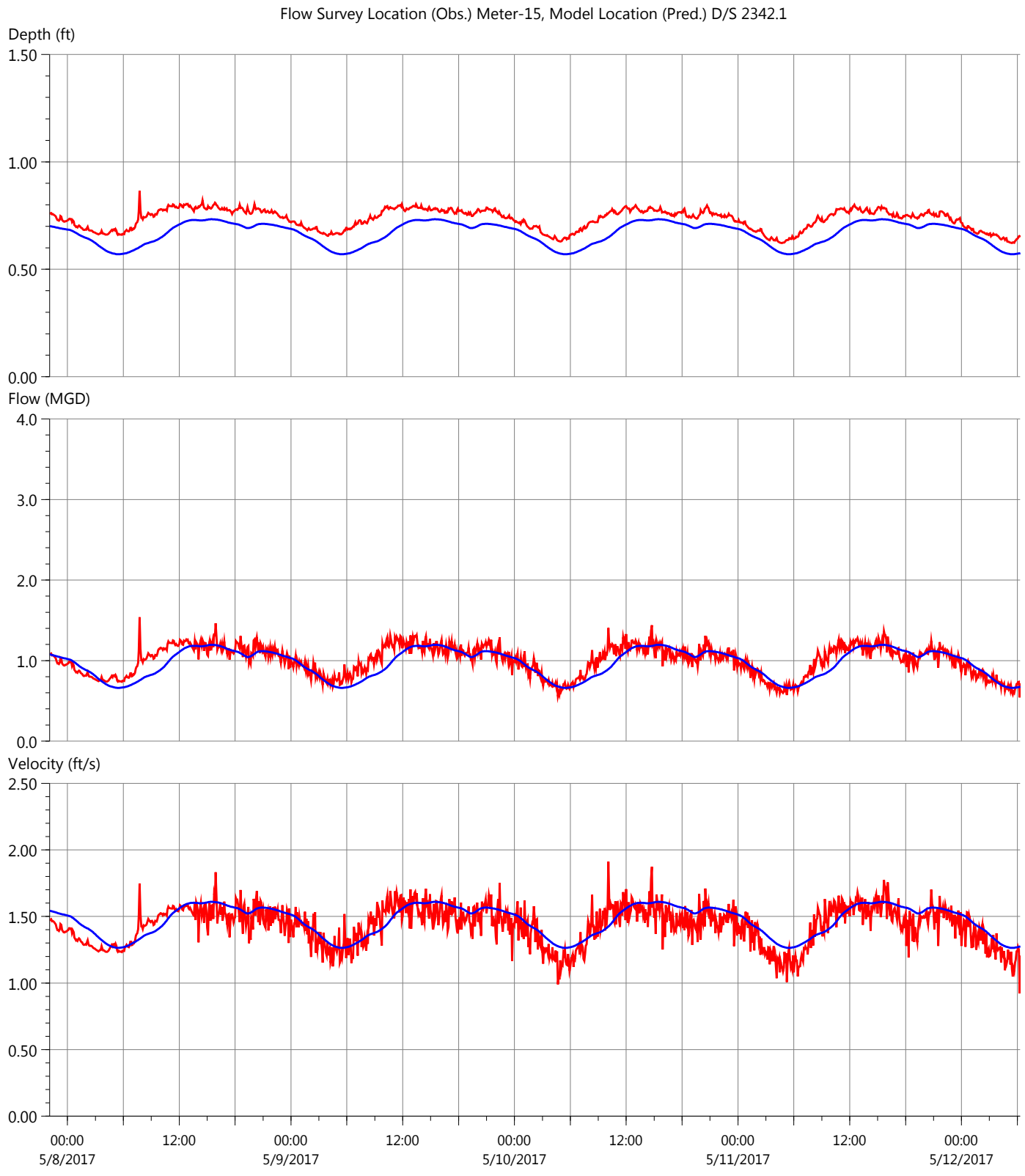
Appendix C

Dry Weather Calibration Plots



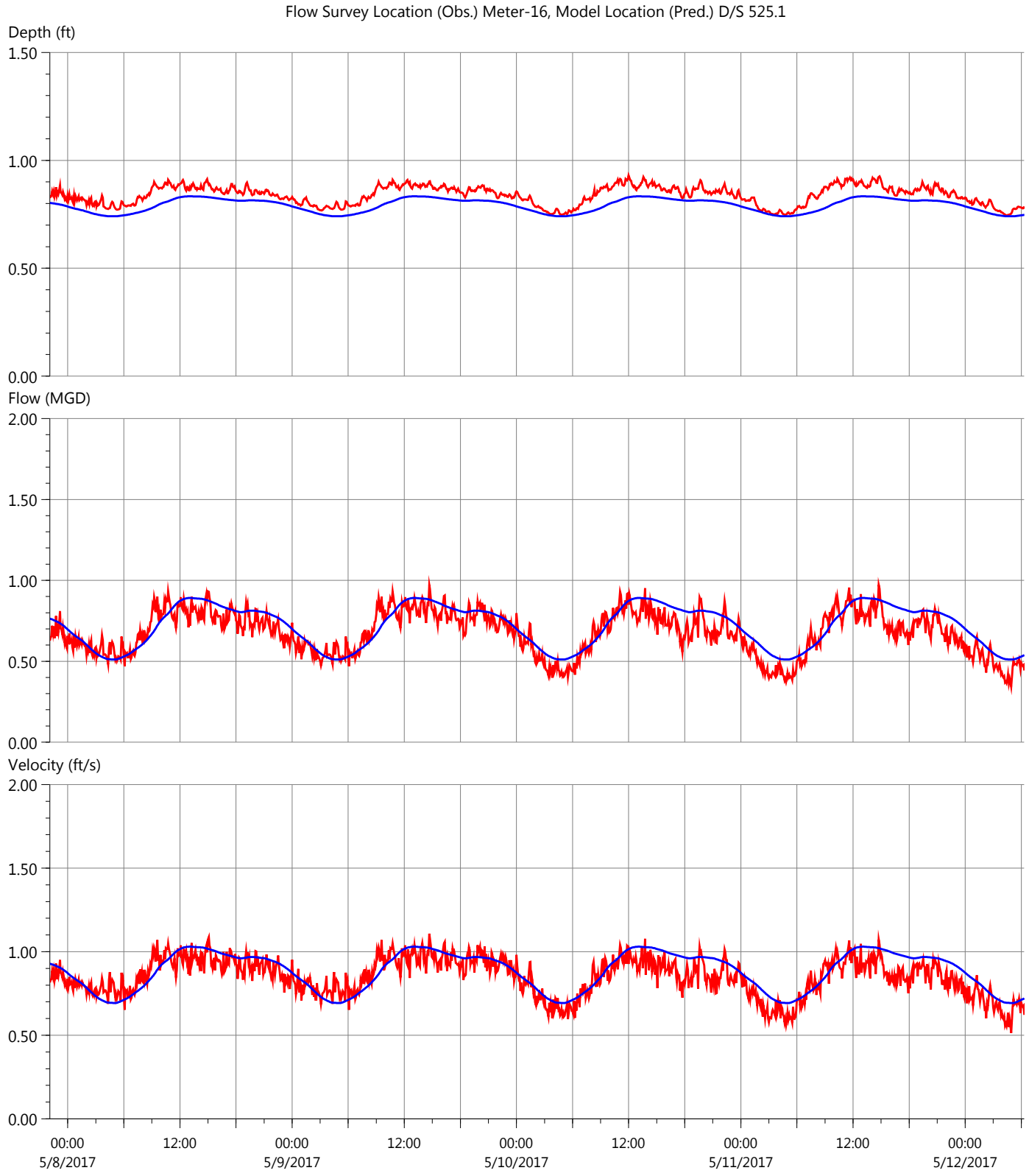
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



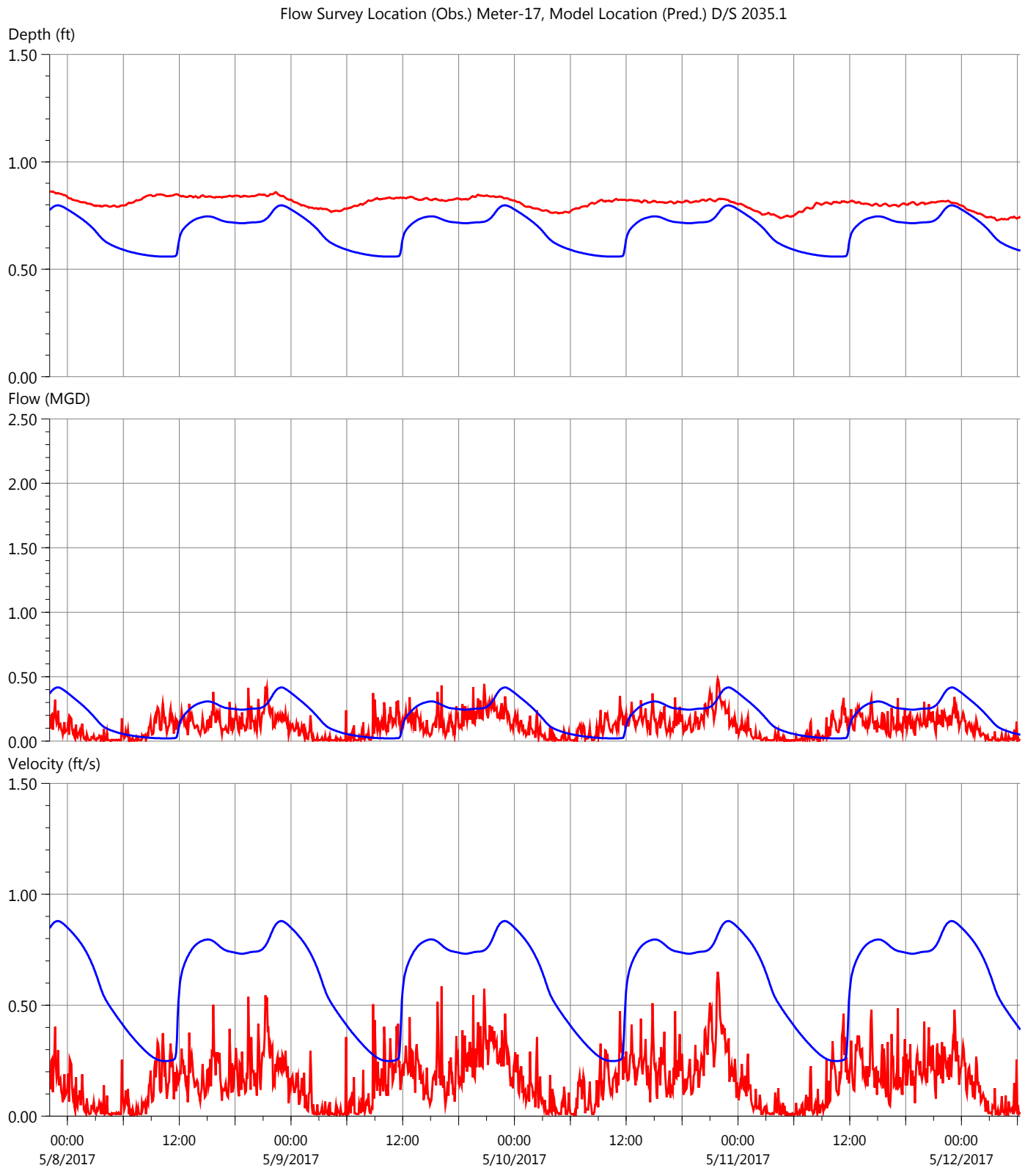
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



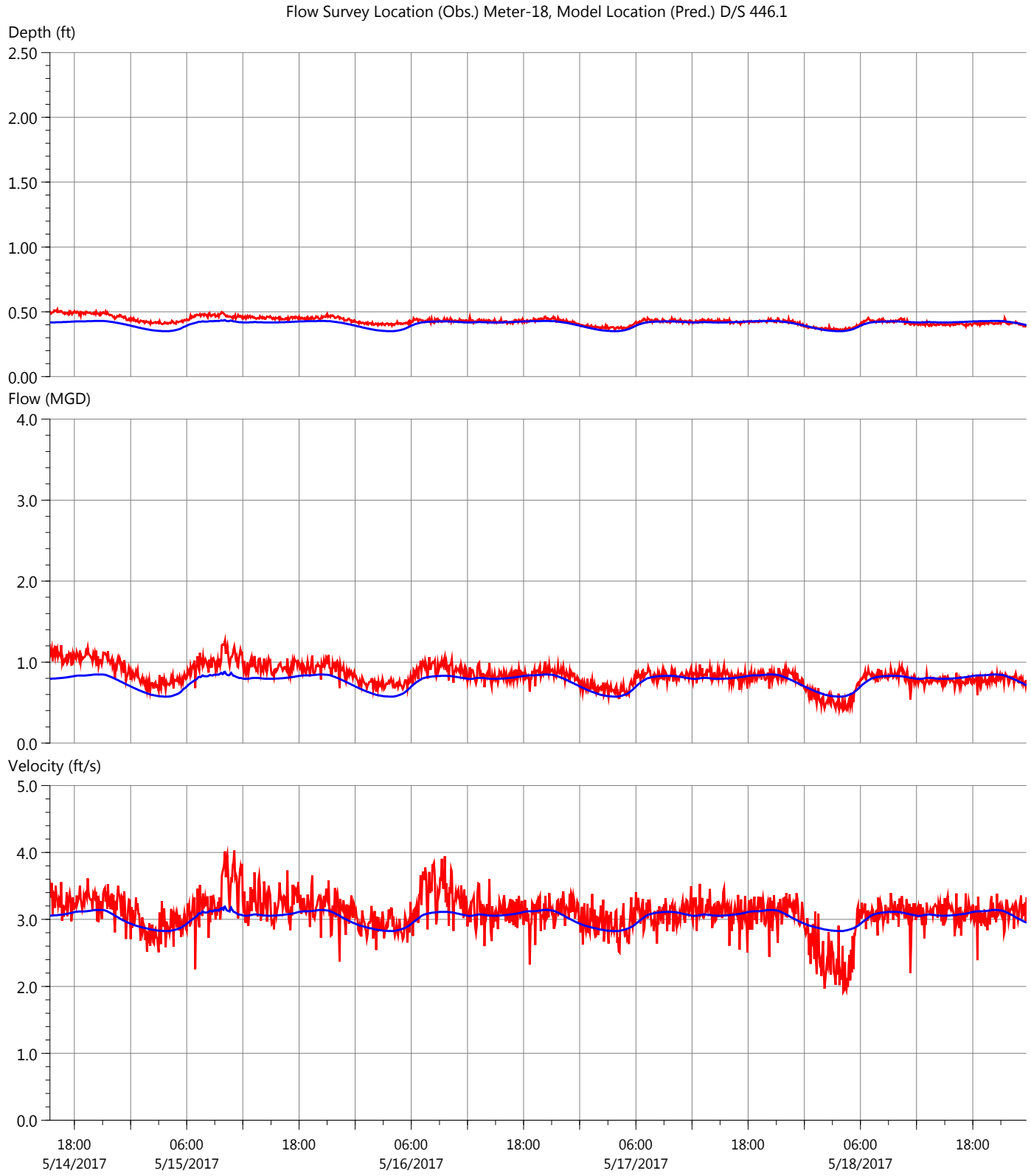
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



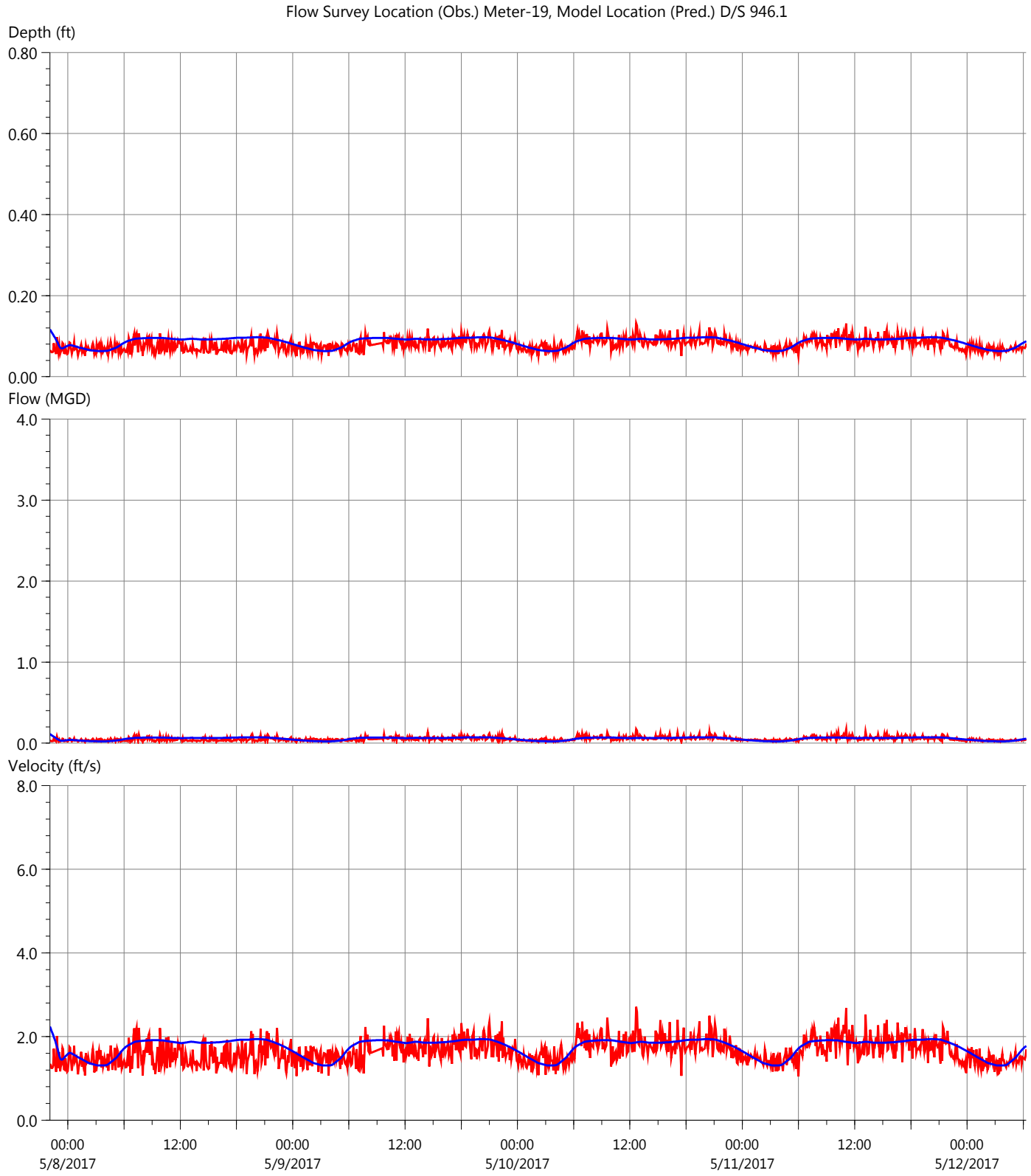
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



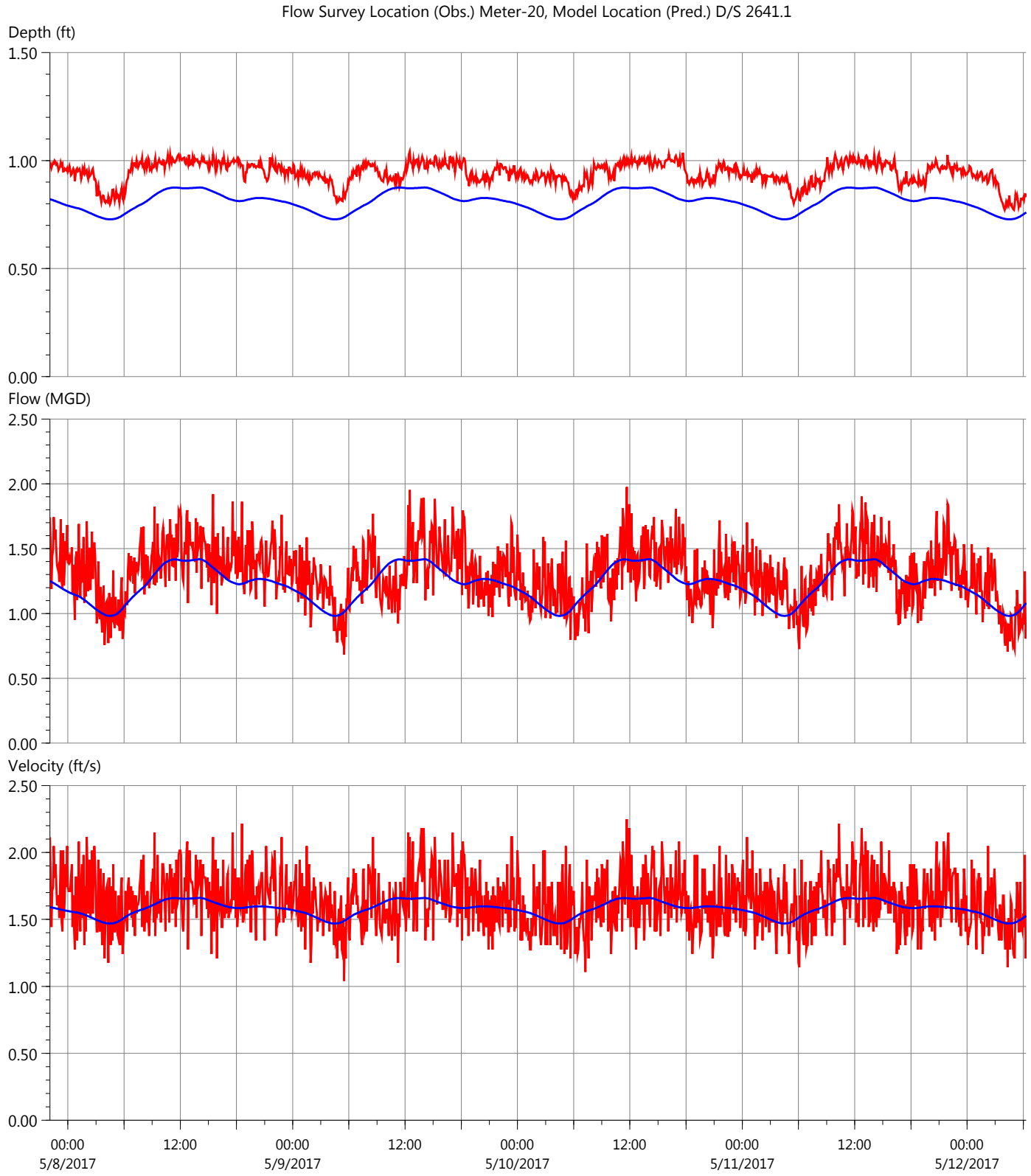
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



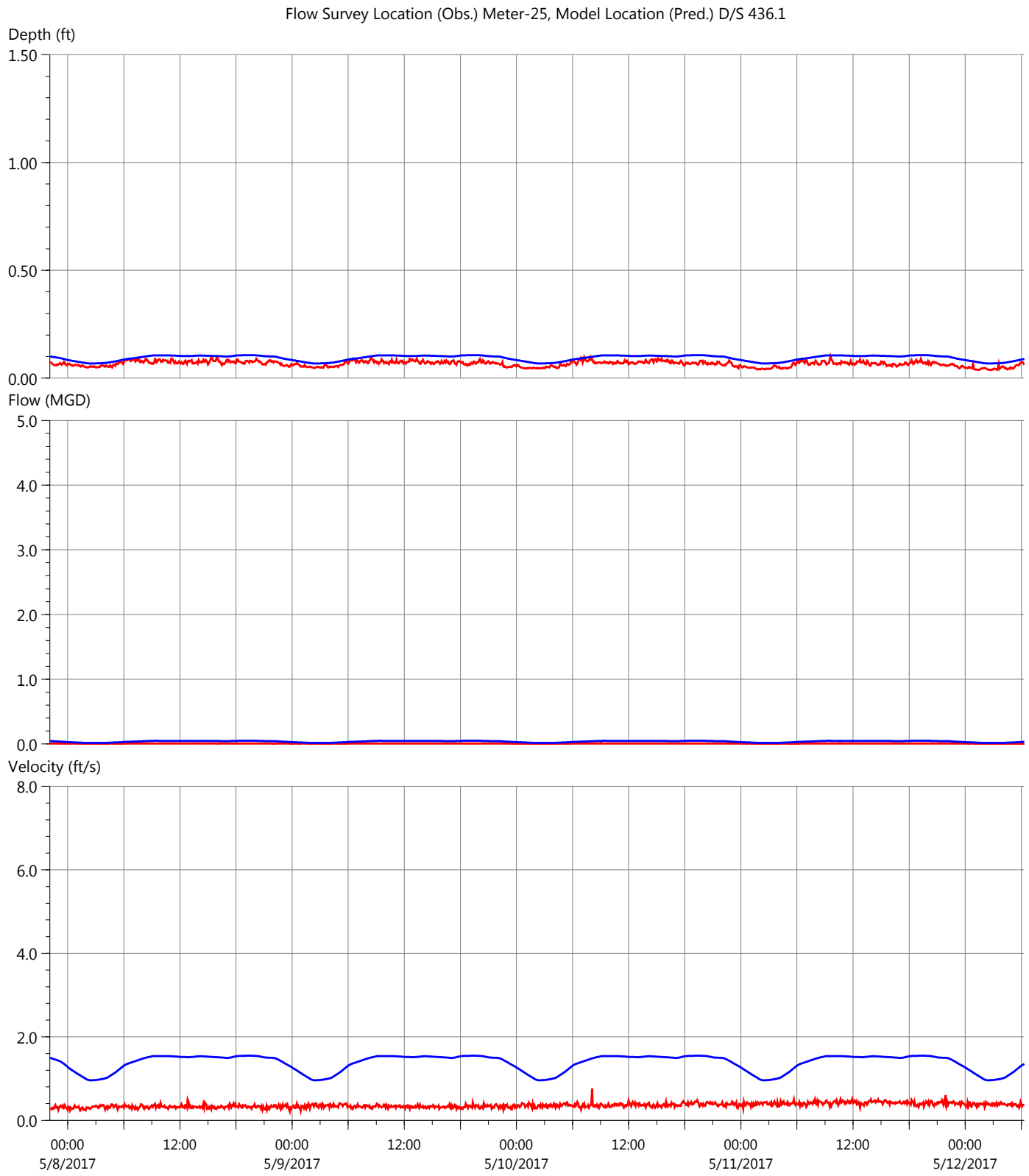
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



Observed / Predicted Report (Custom graph) - Temp meters

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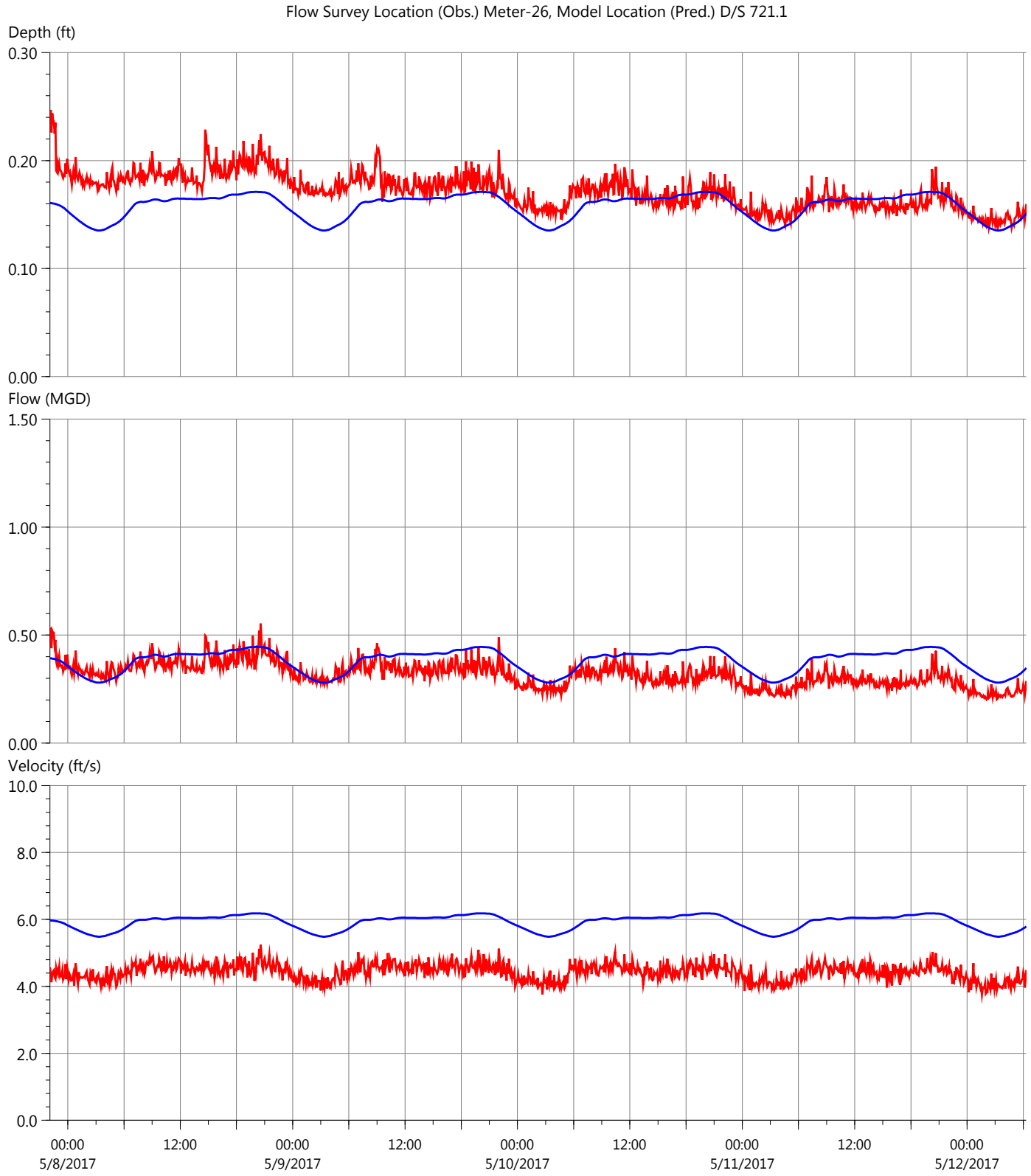

Observed / Predicted Report (Custom graph) - Temp meters

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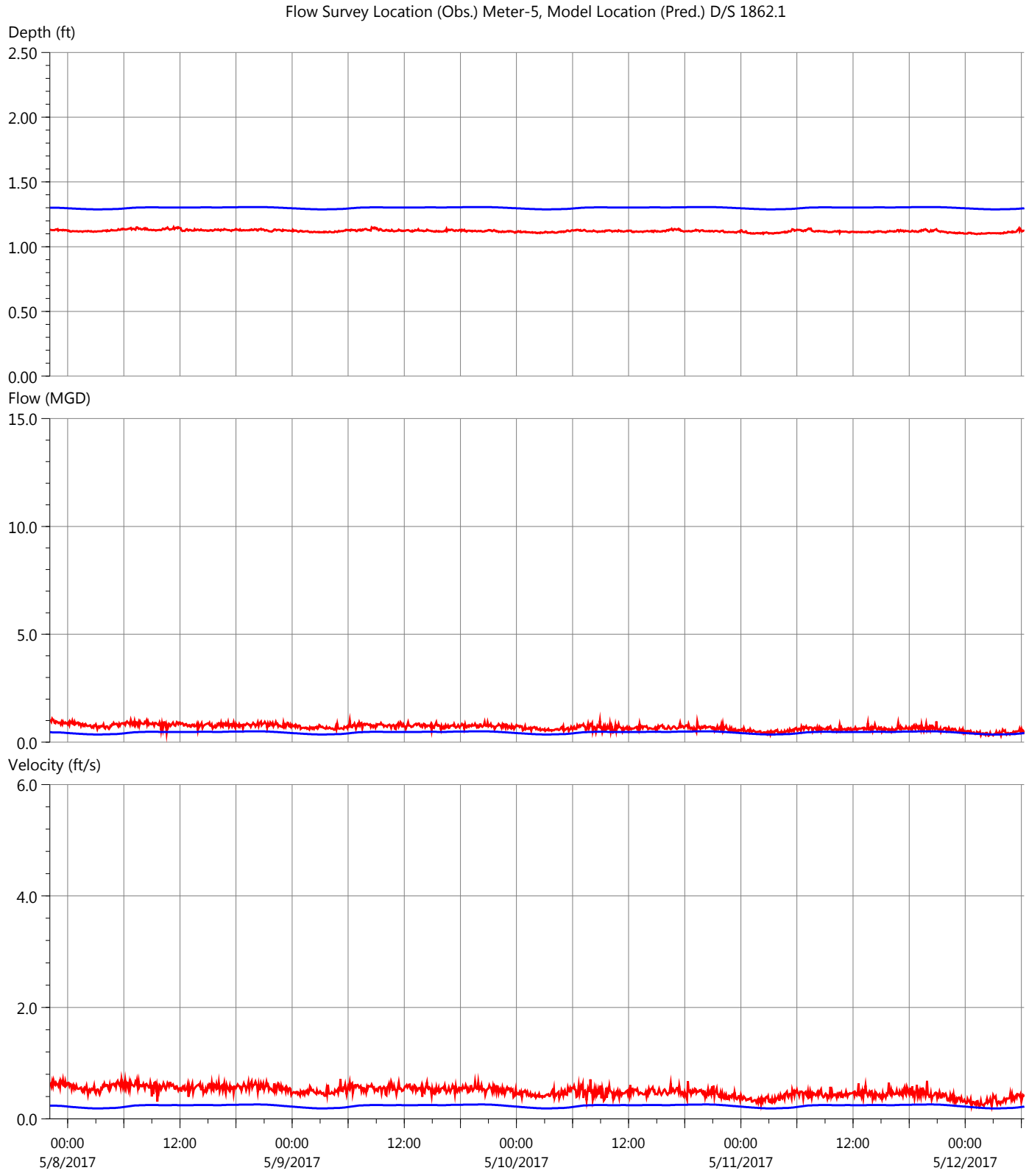

Observed / Predicted Report (Custom graph) - Temp meters

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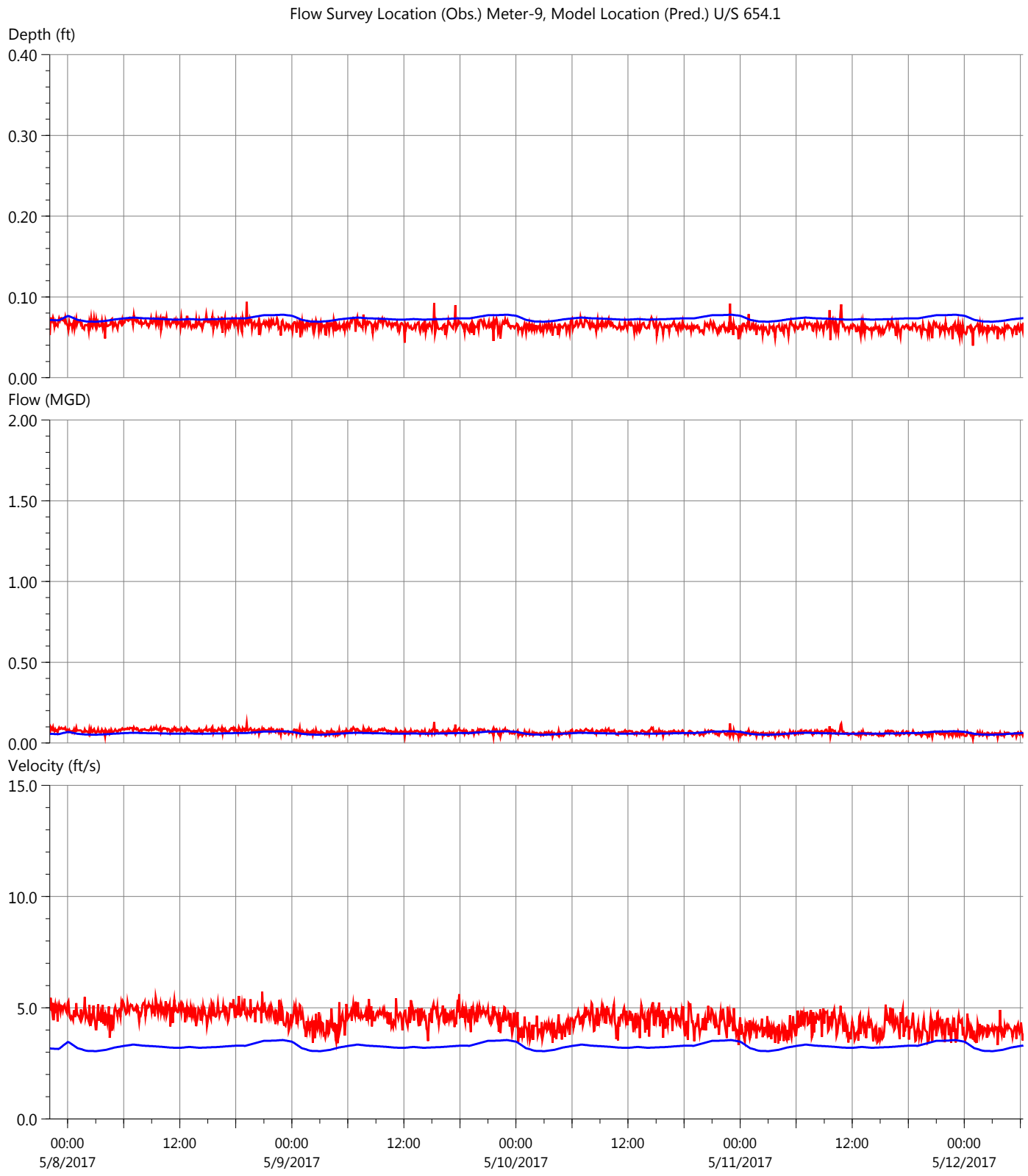
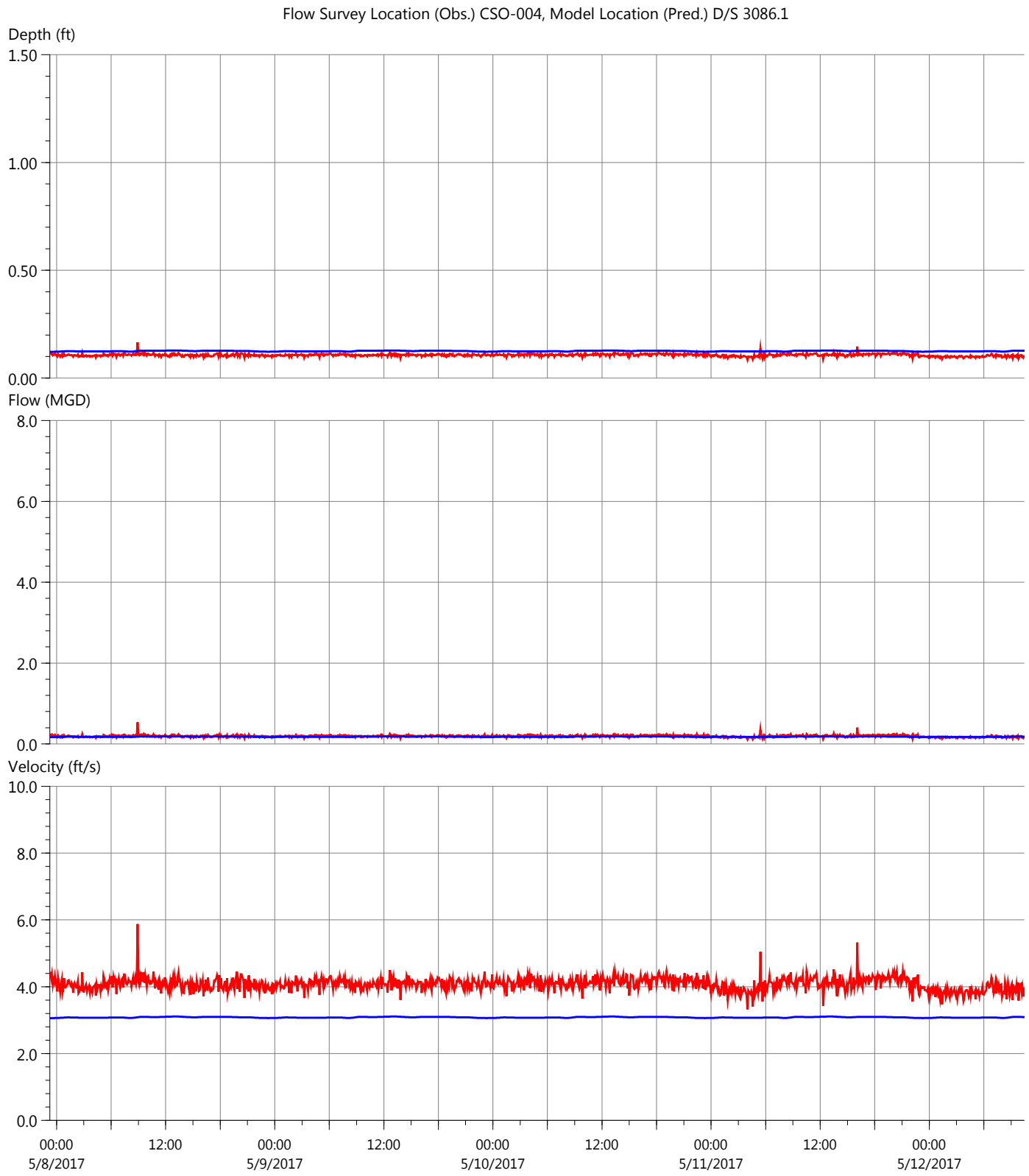


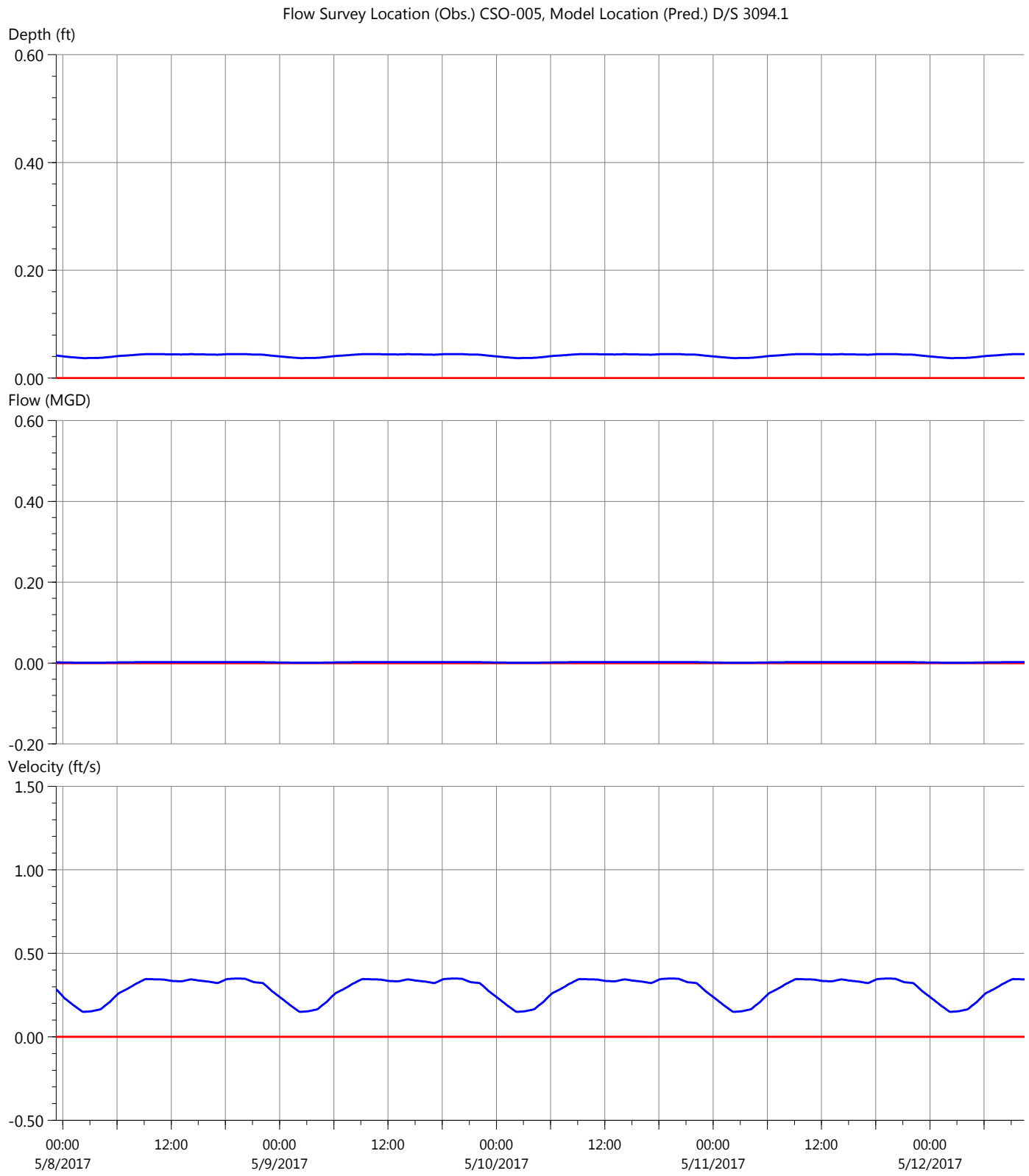
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



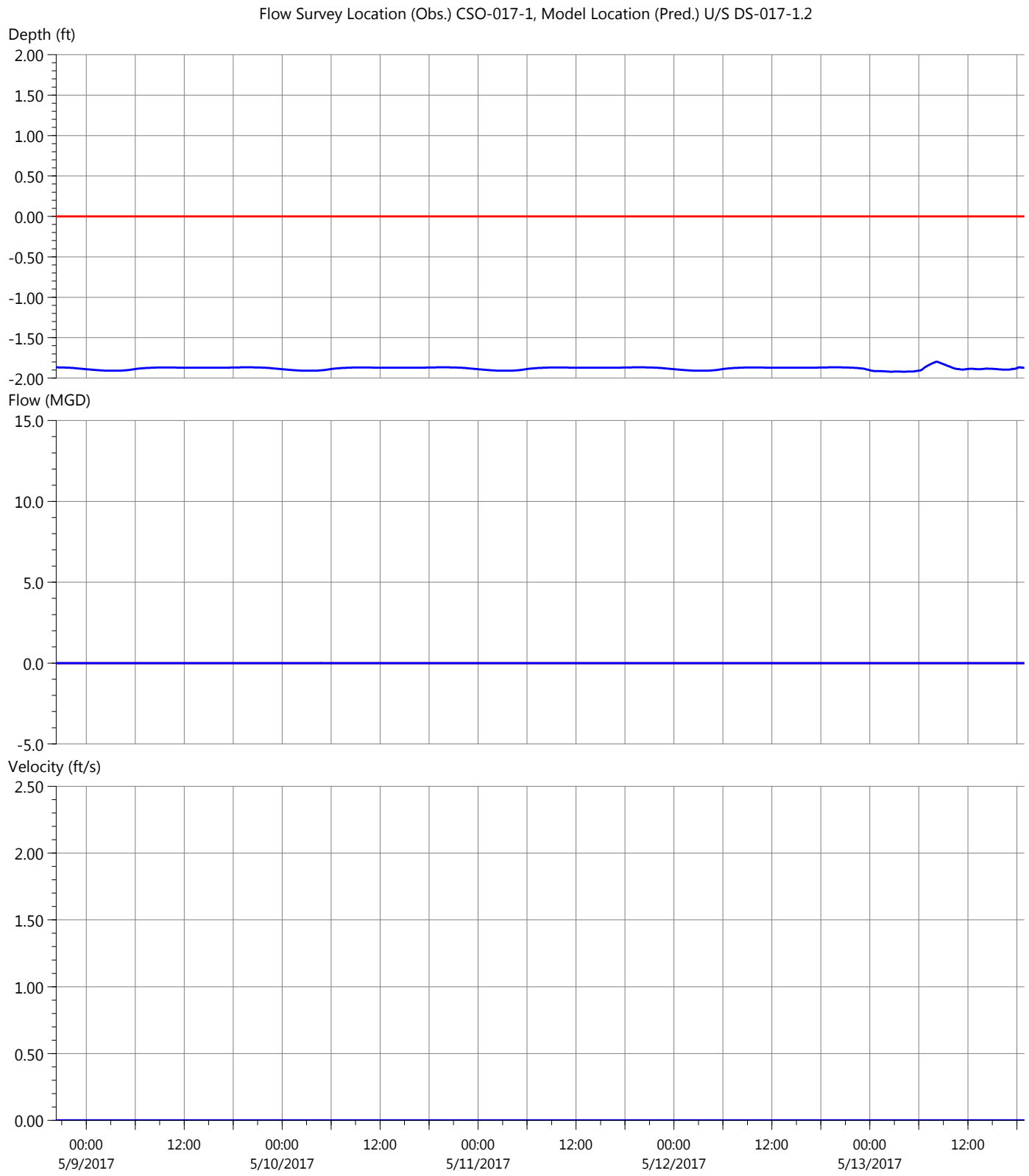
Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



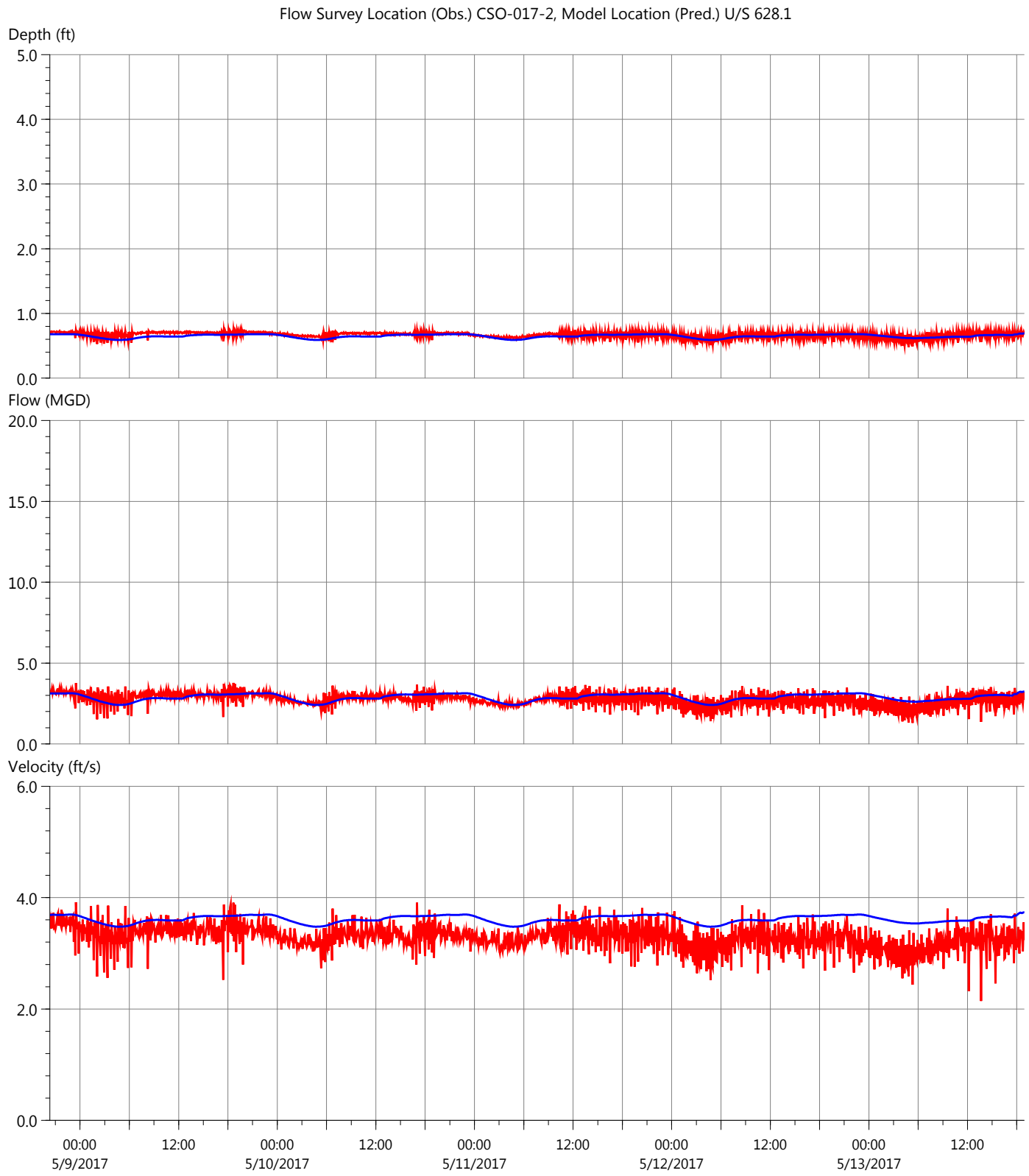
Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



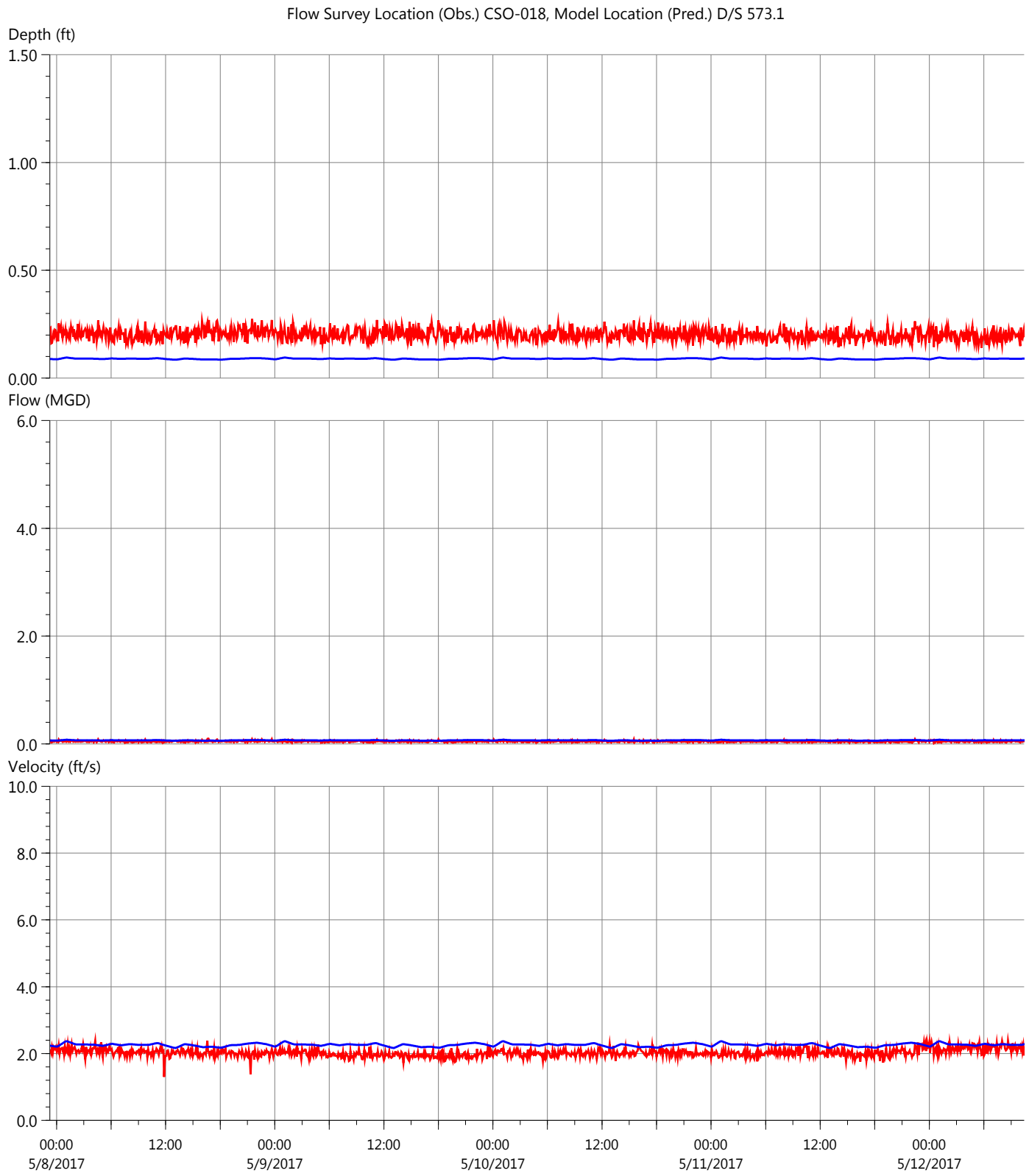
Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



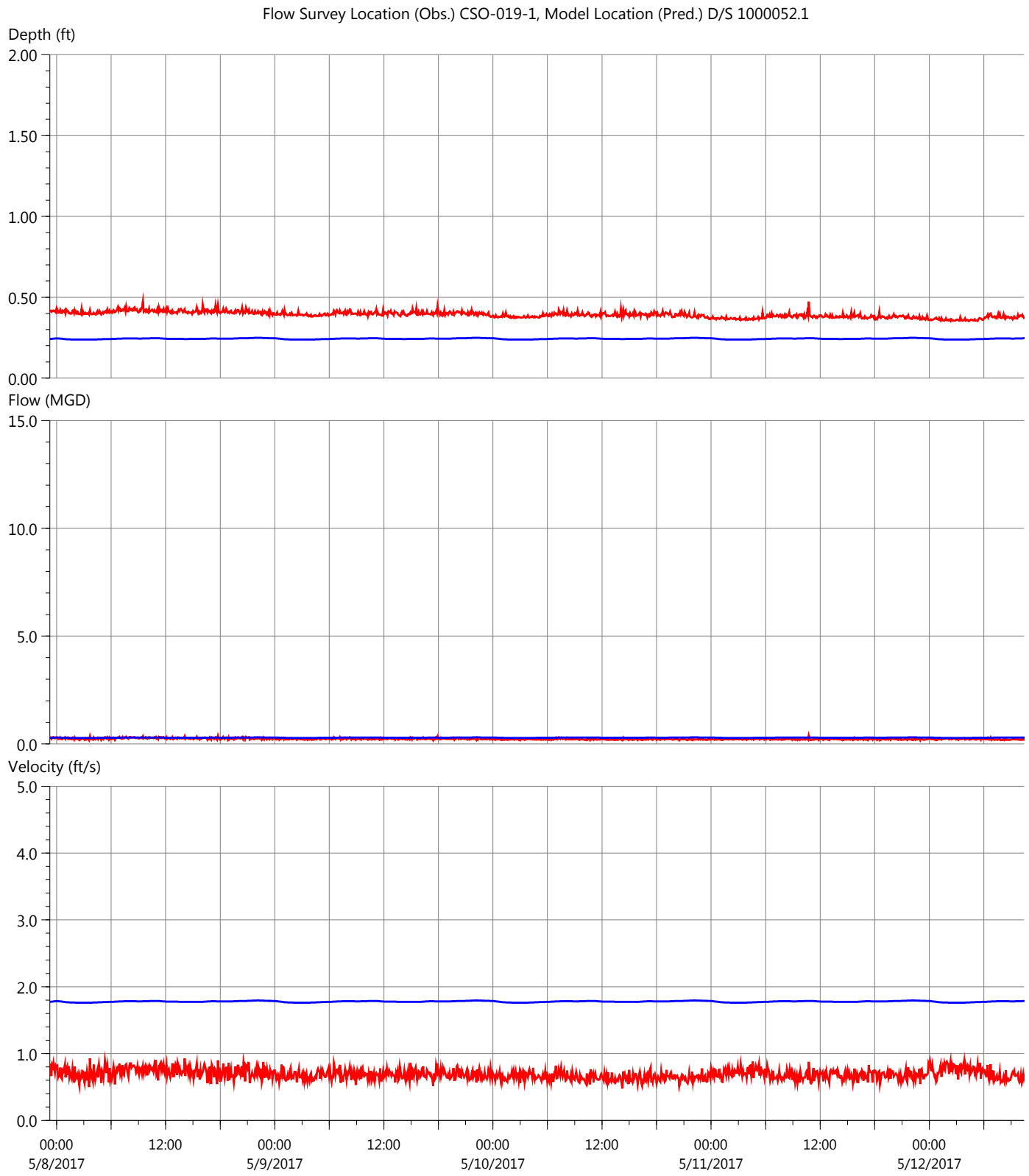
Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



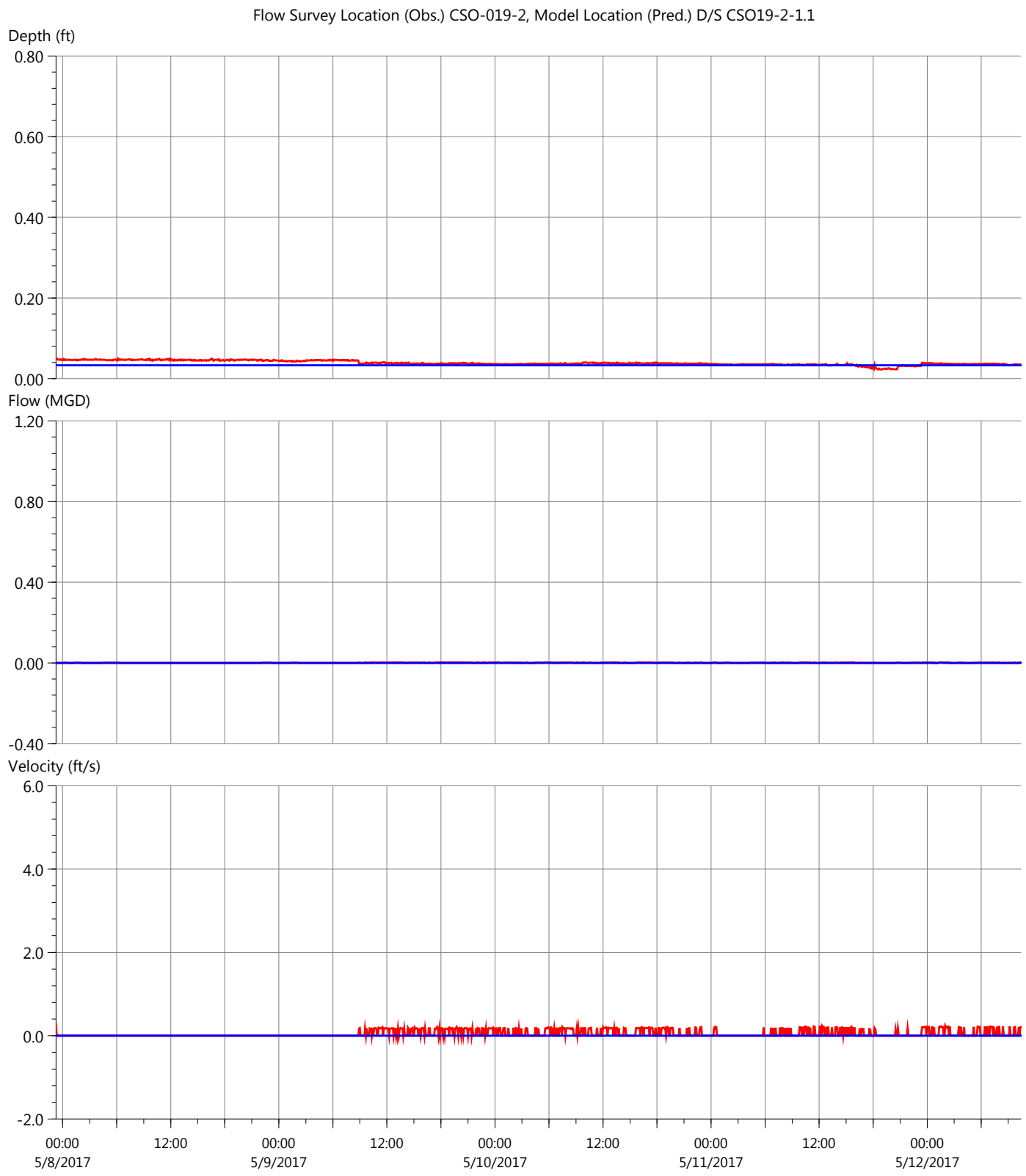
Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



Observed / Predicted Report (Custom graph) - Phase 1

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Observed / Predicted Report (Custom graph) - Phase 1

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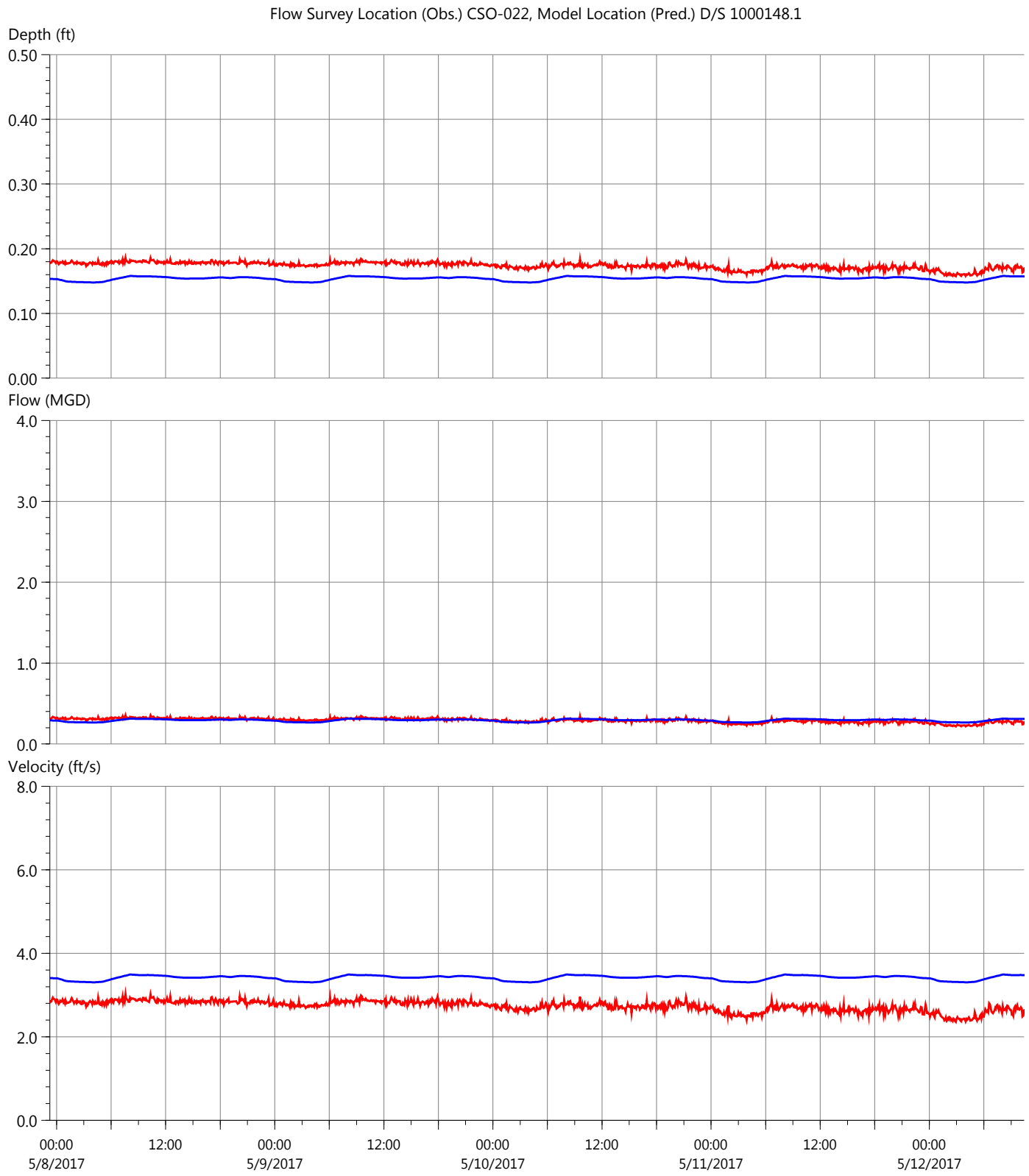
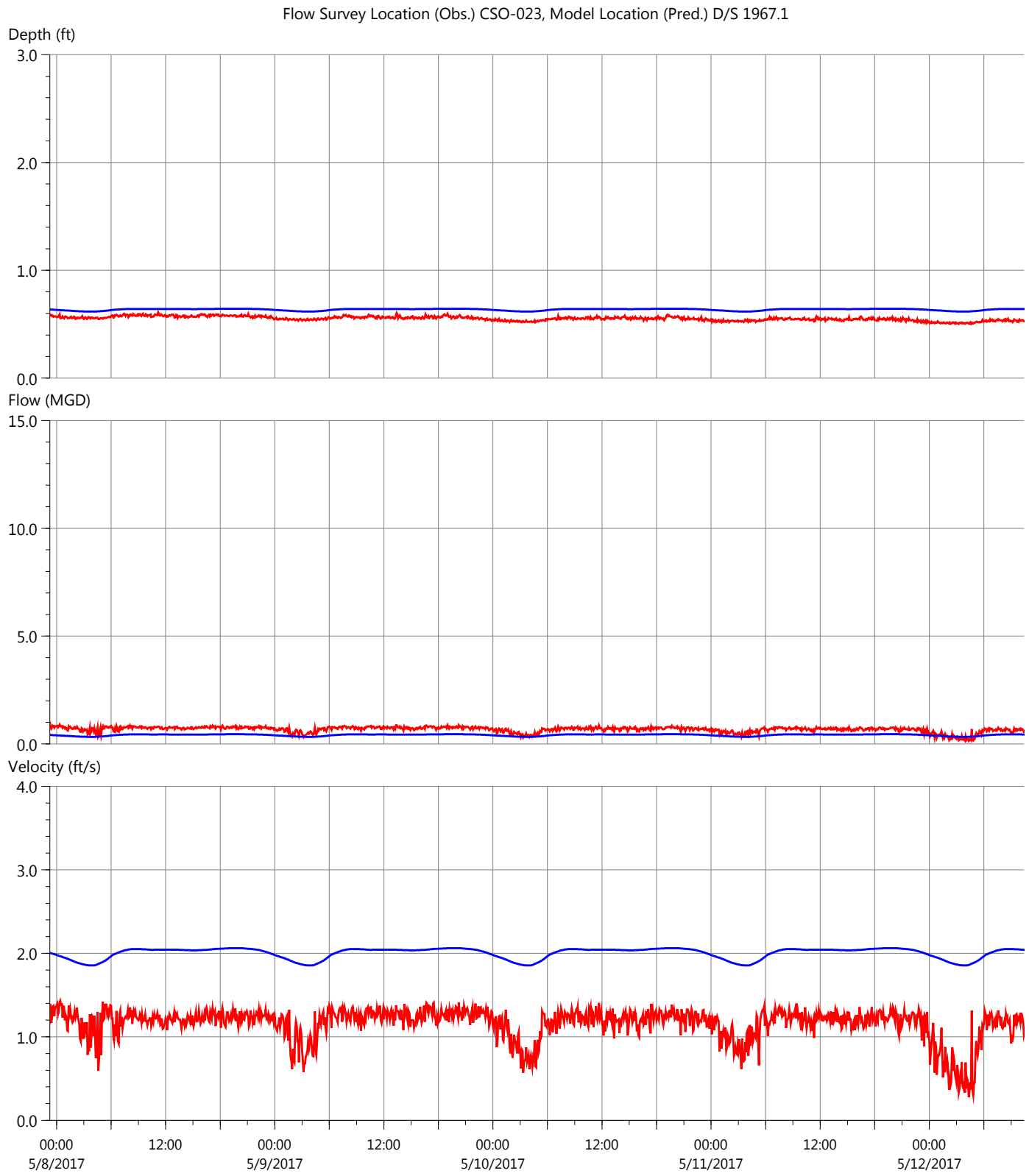


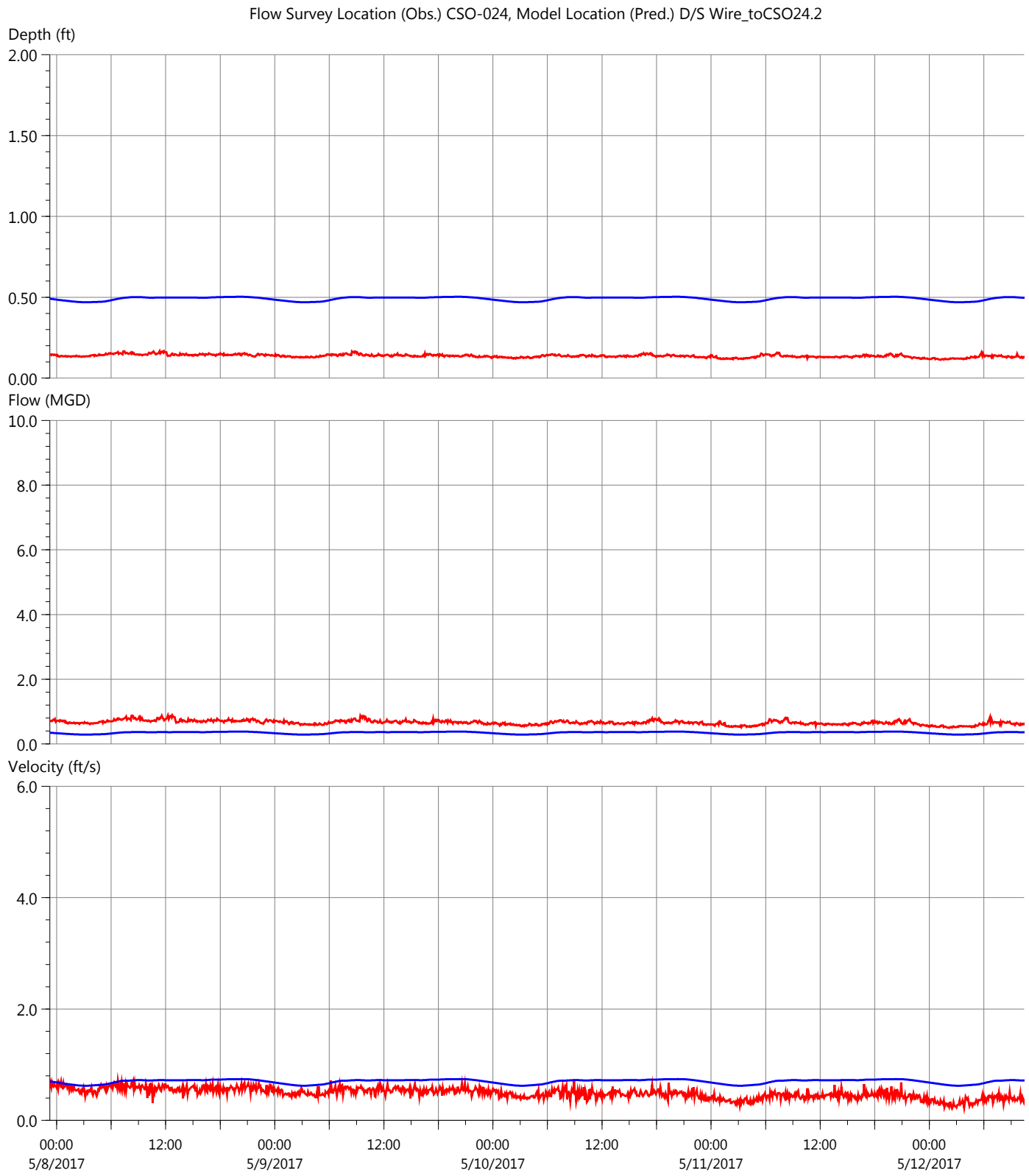
Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



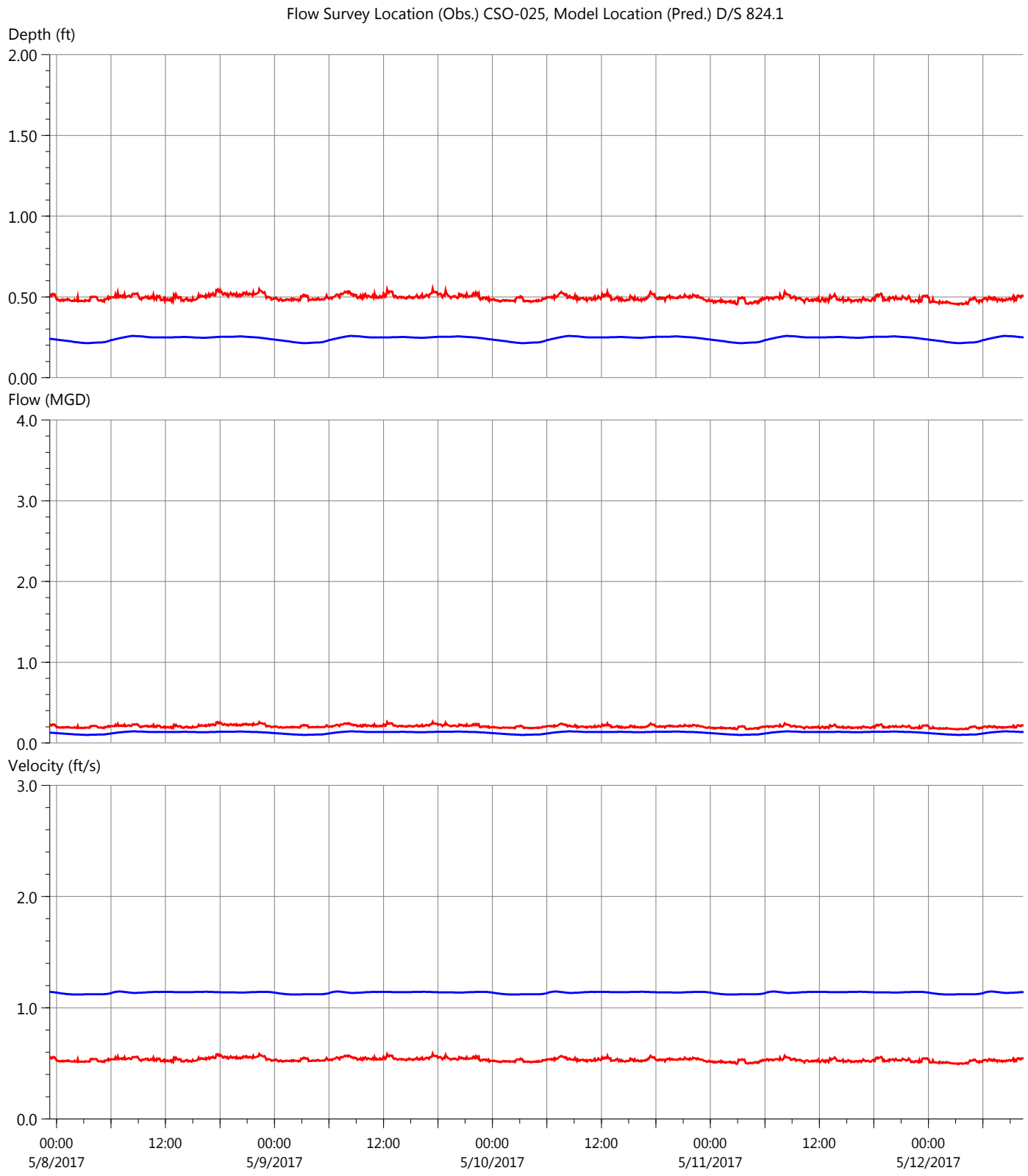
Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



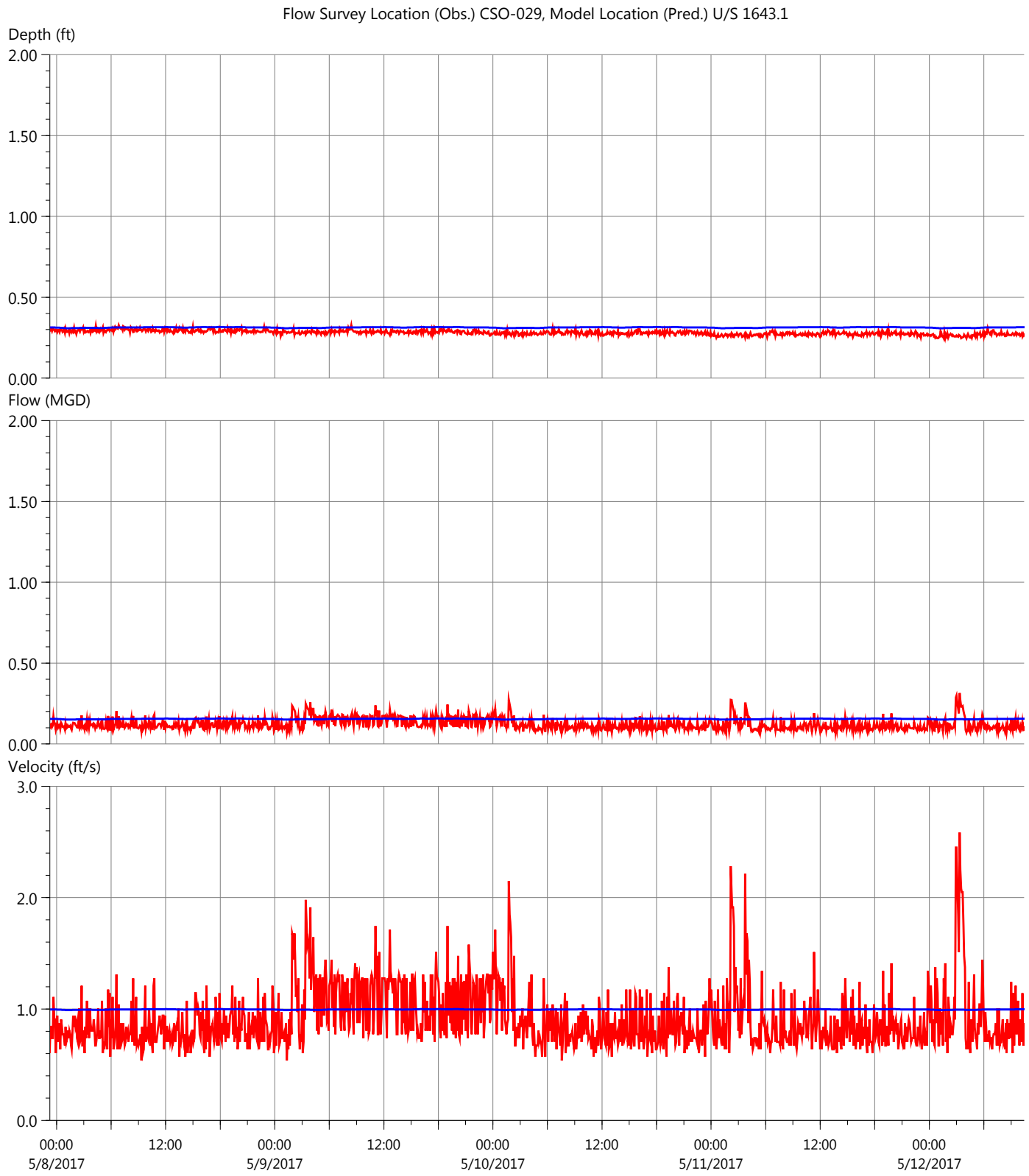
Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



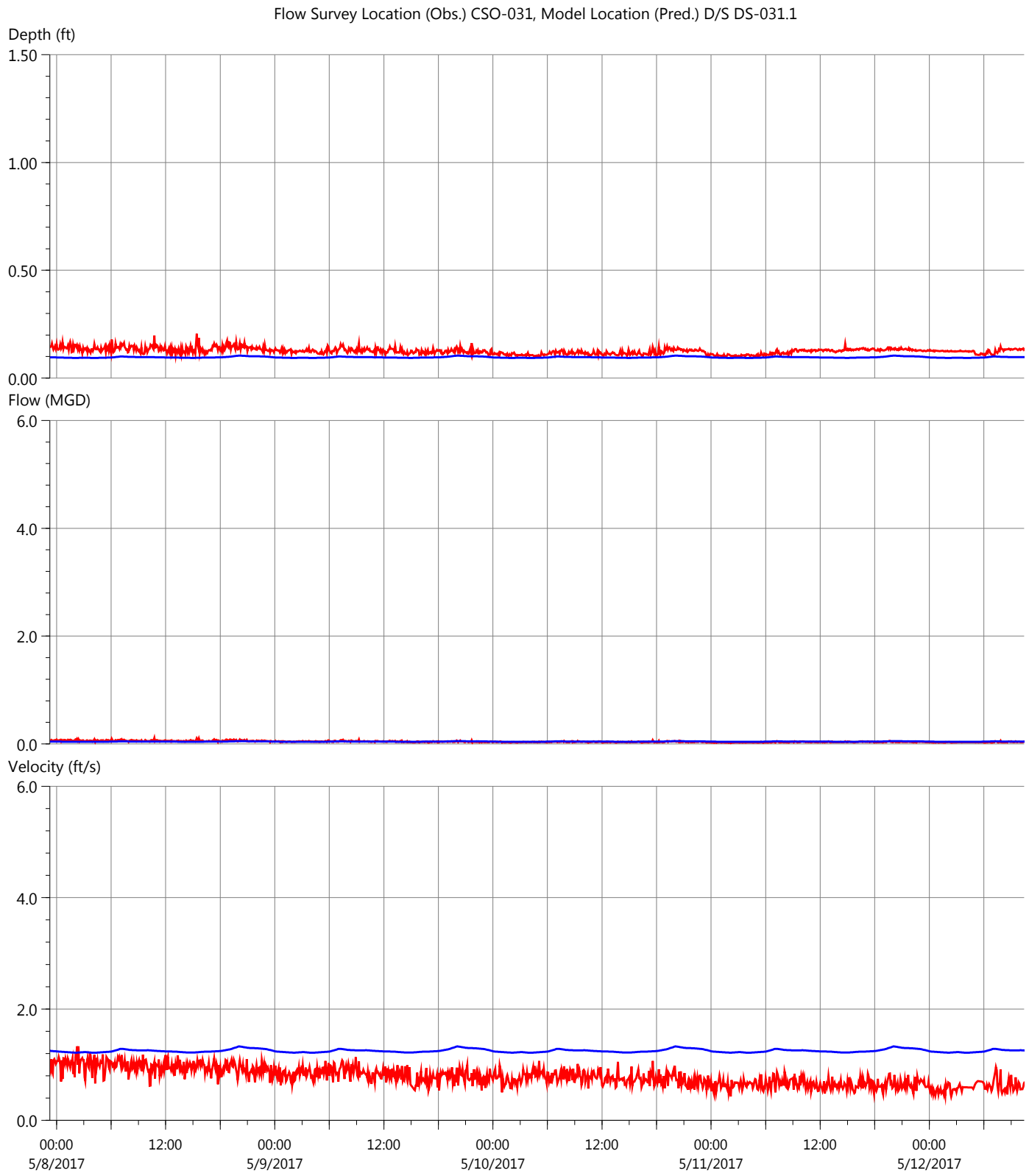
Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



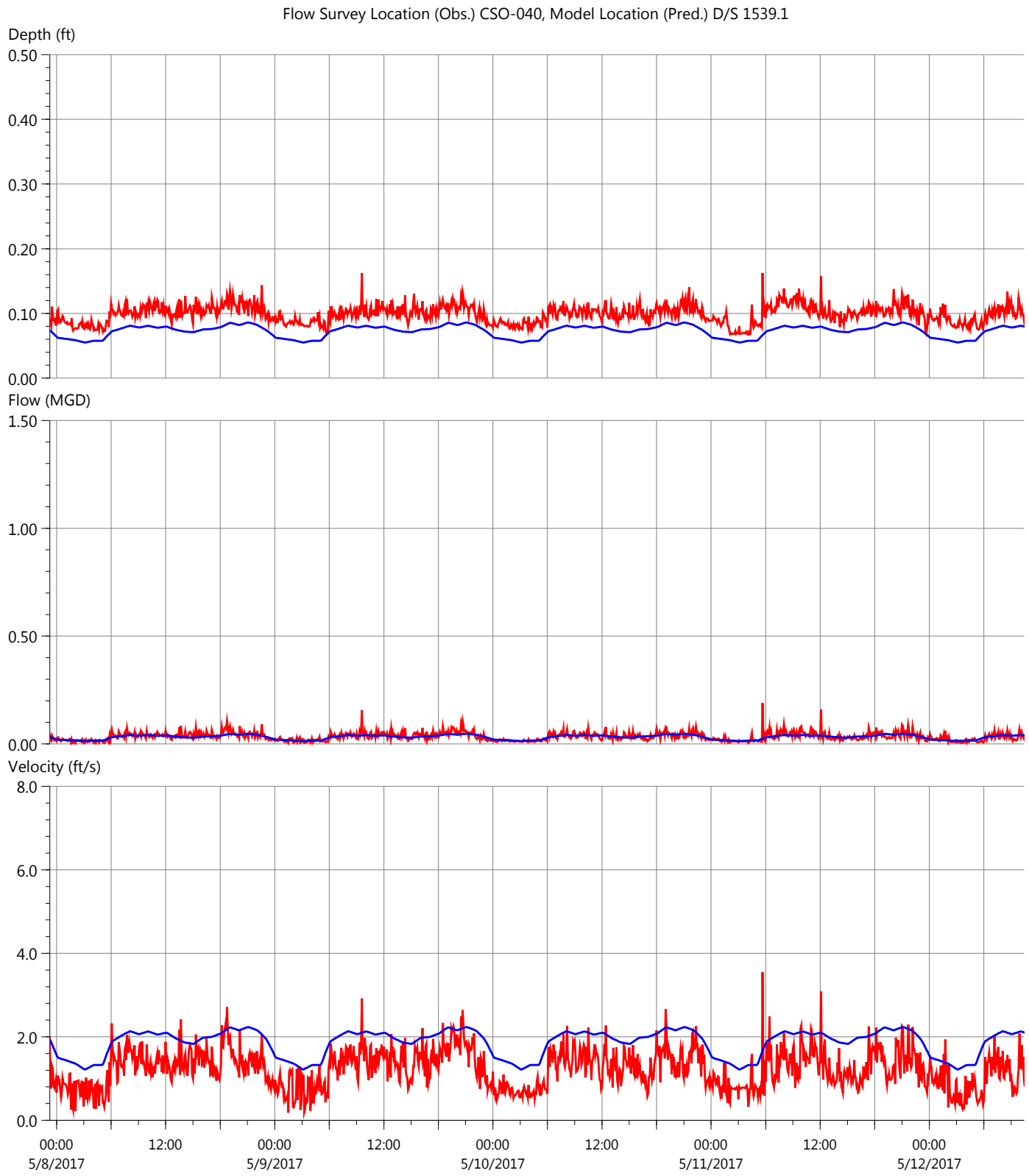
Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



Observed / Predicted Report (Custom graph) - Phase 1

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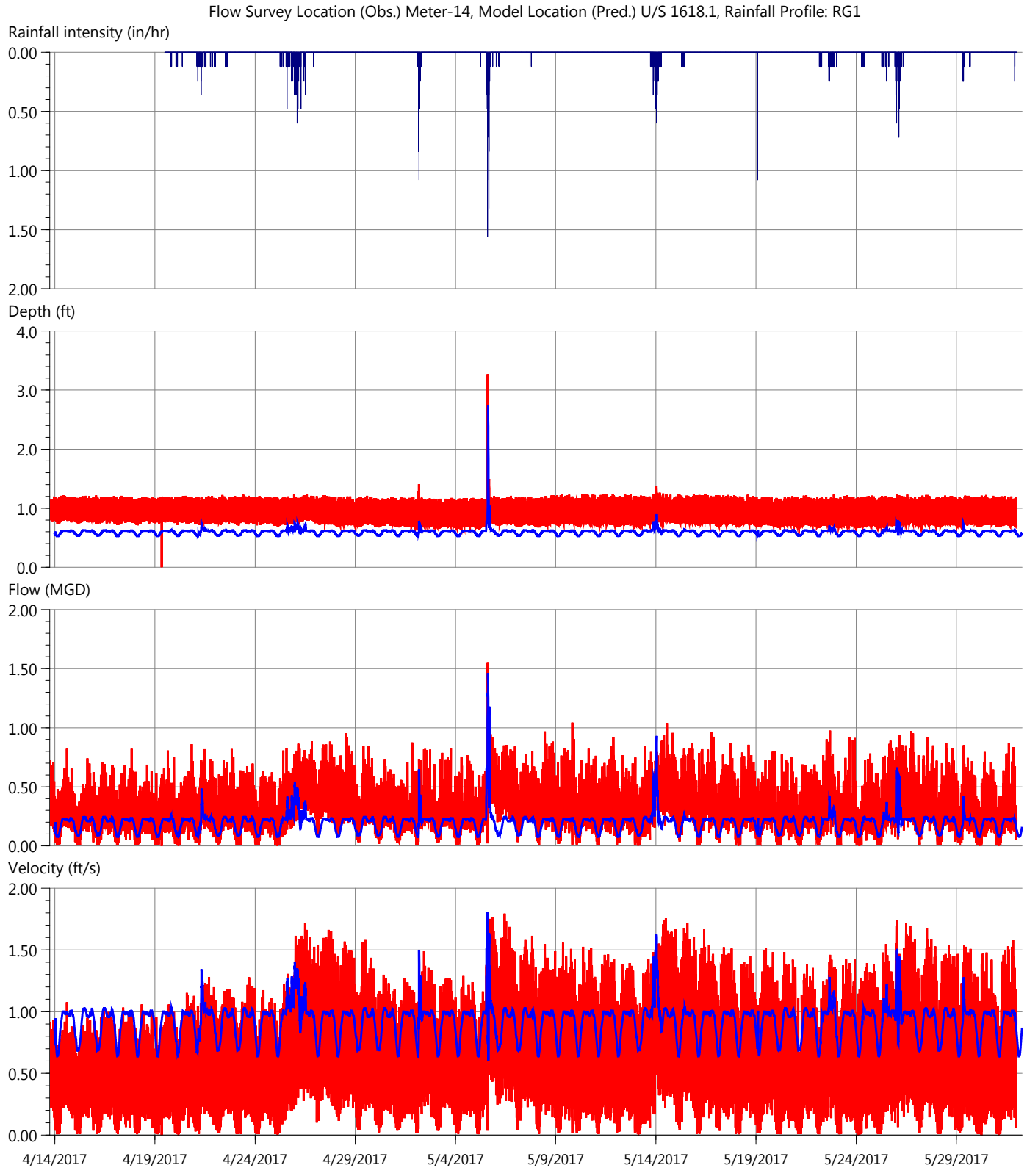
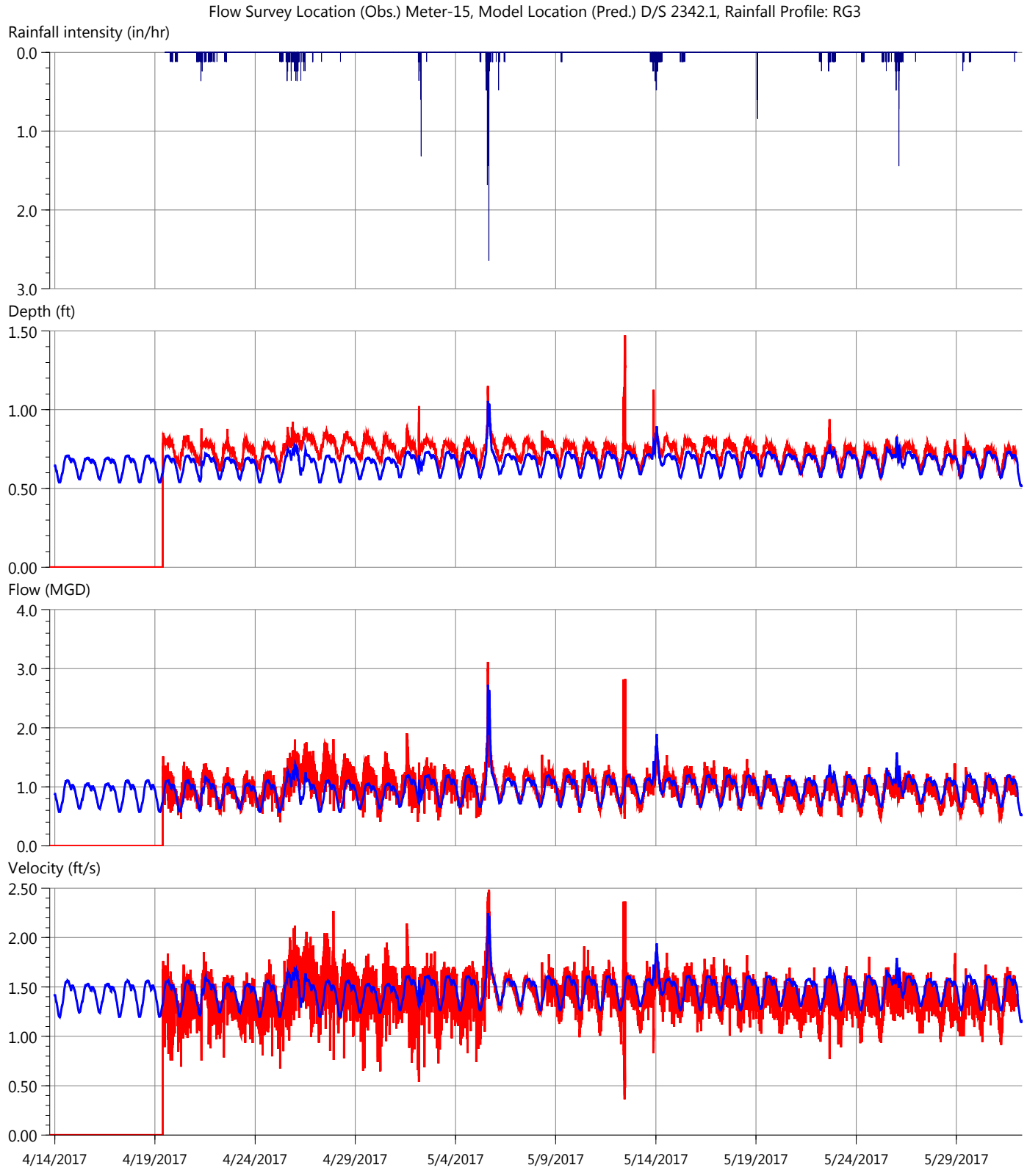
Appendix D

Wet Weather Calibration Plots – Spring 2017



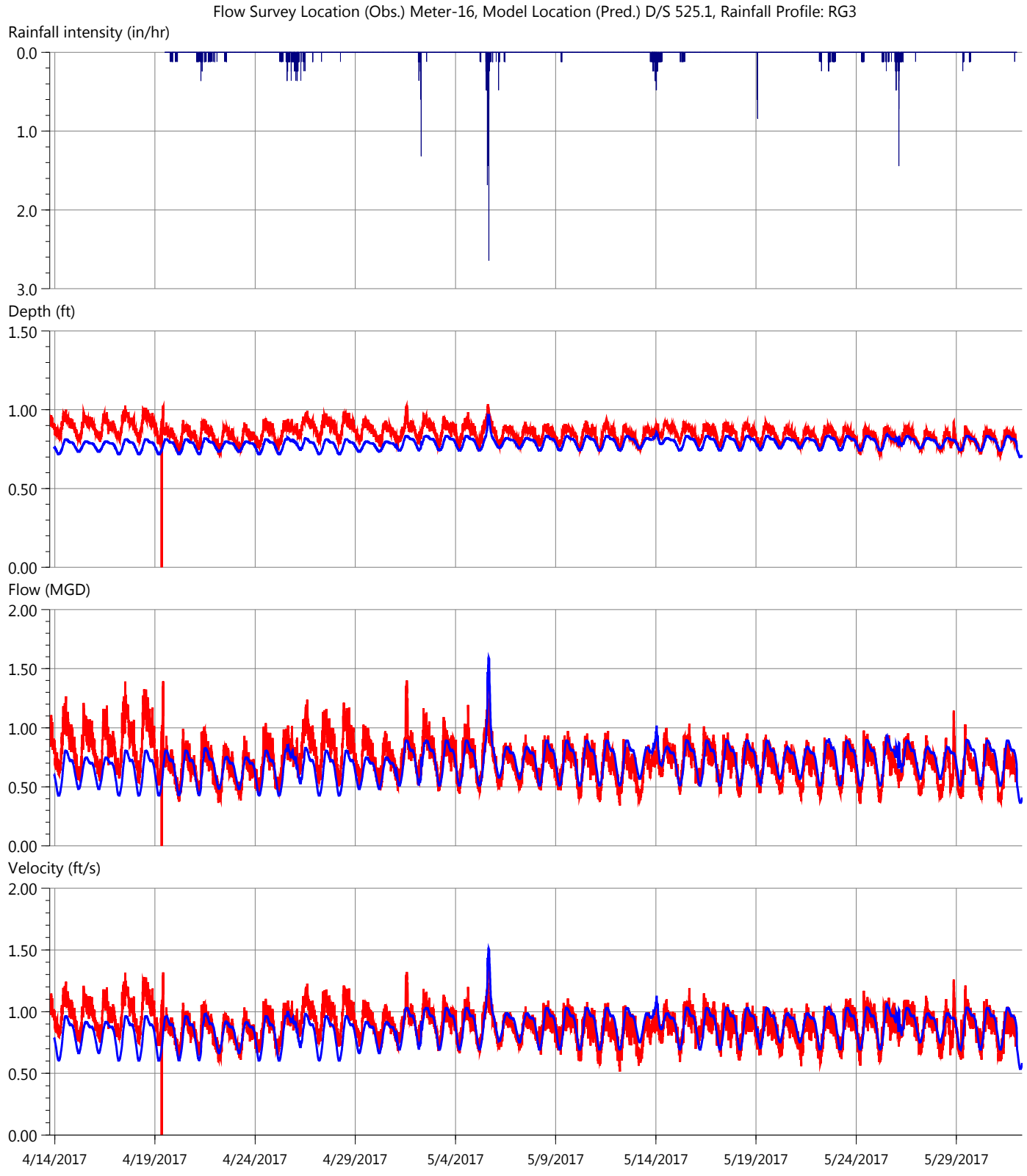
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



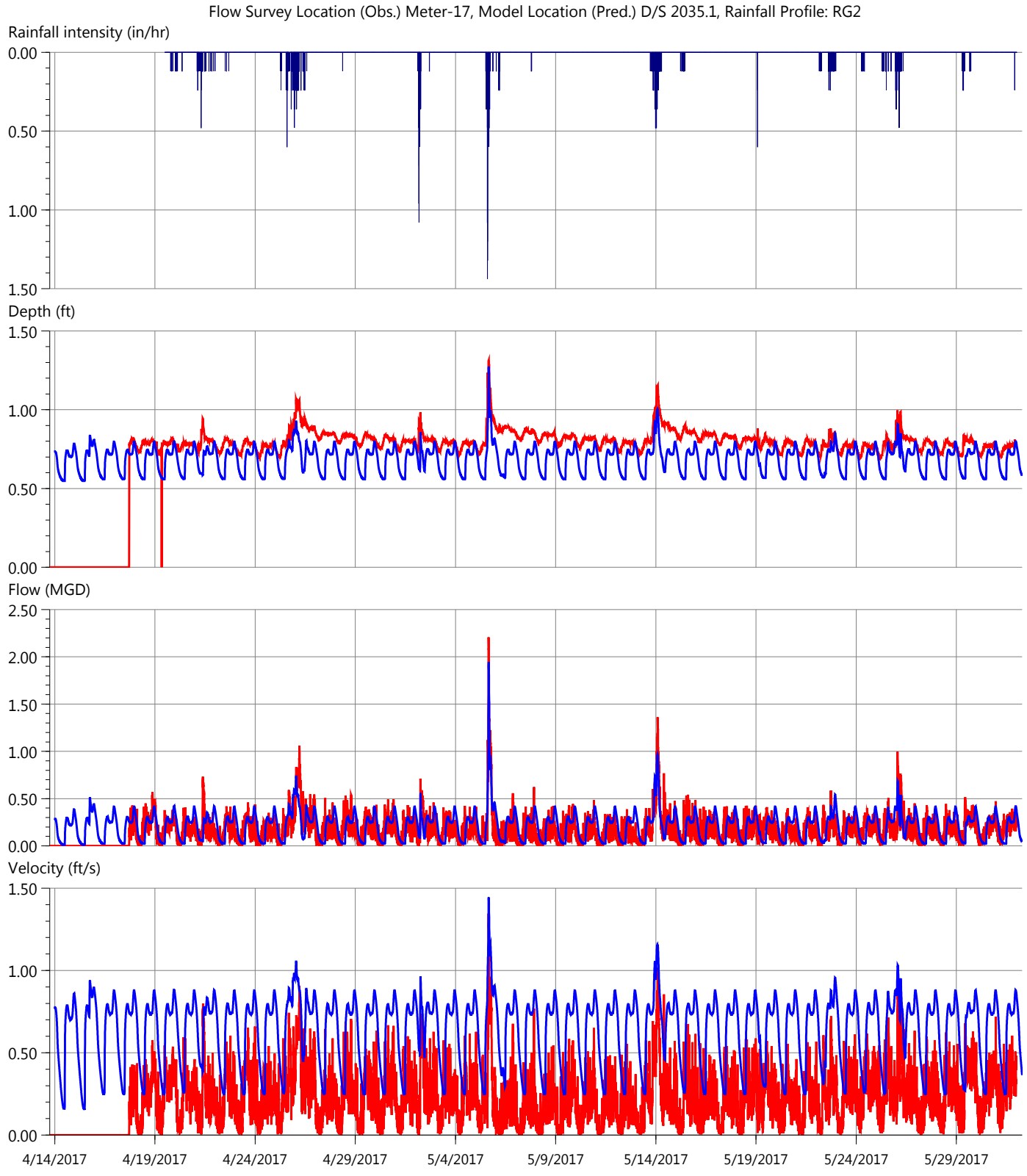
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



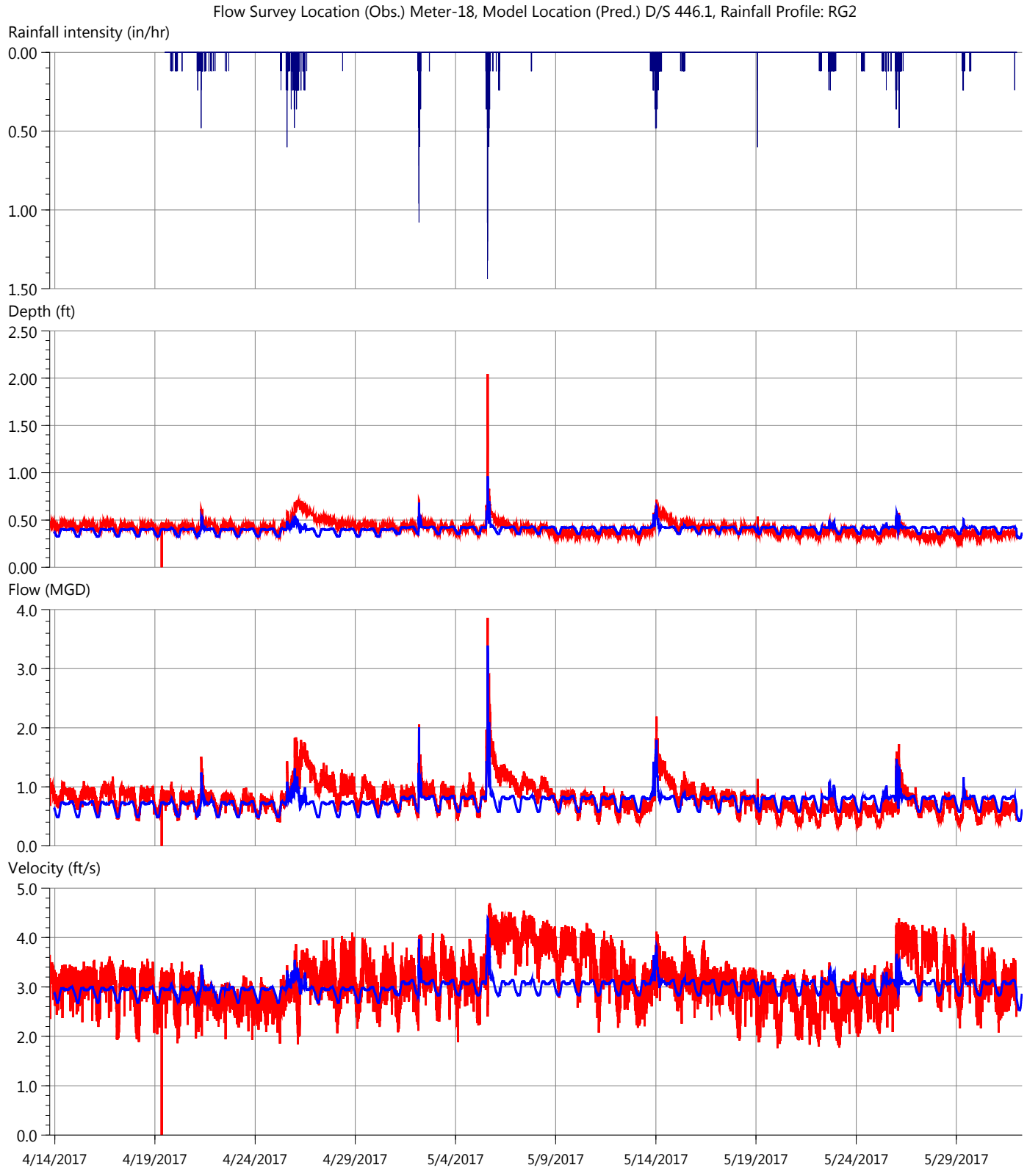
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



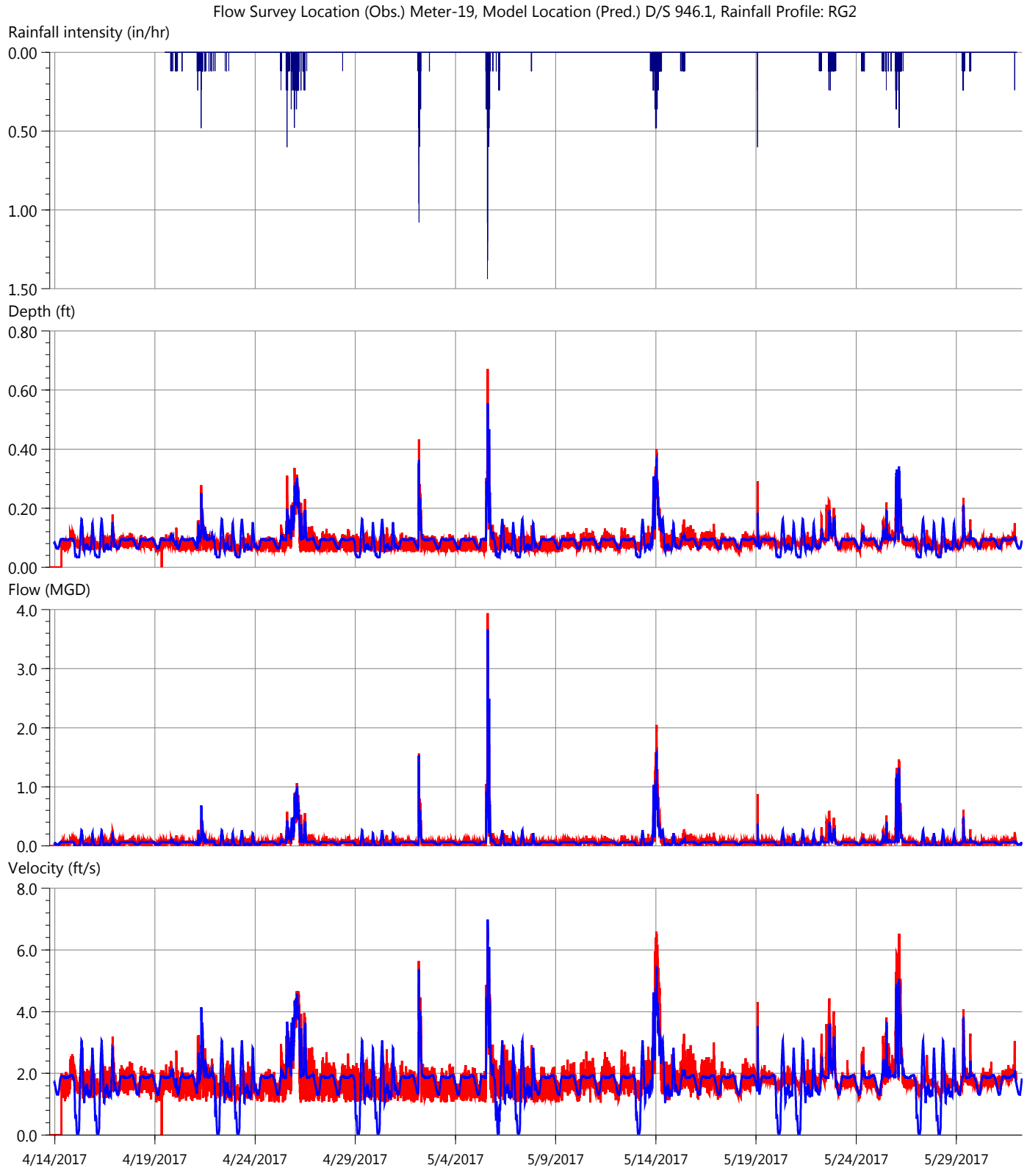
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



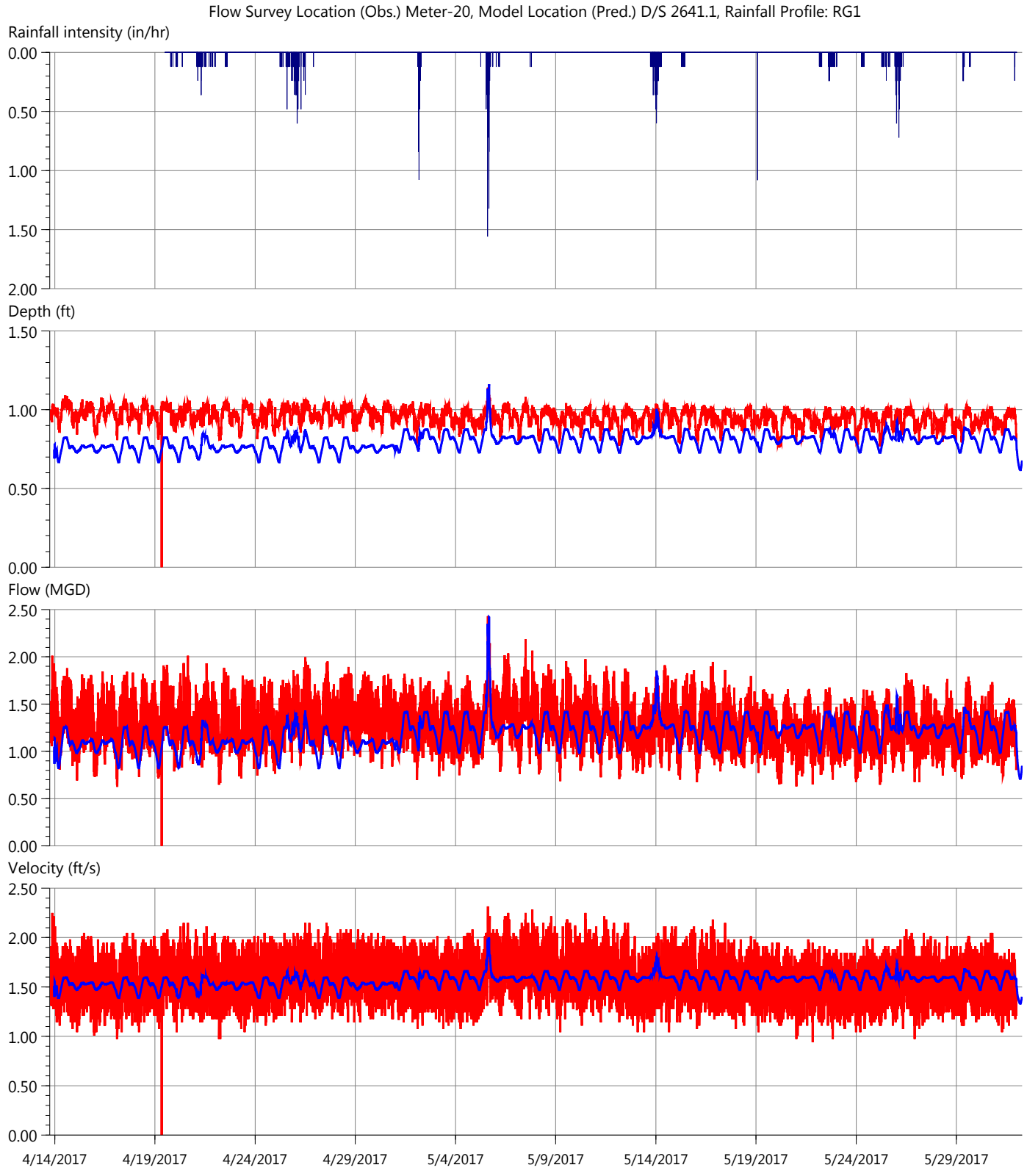
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



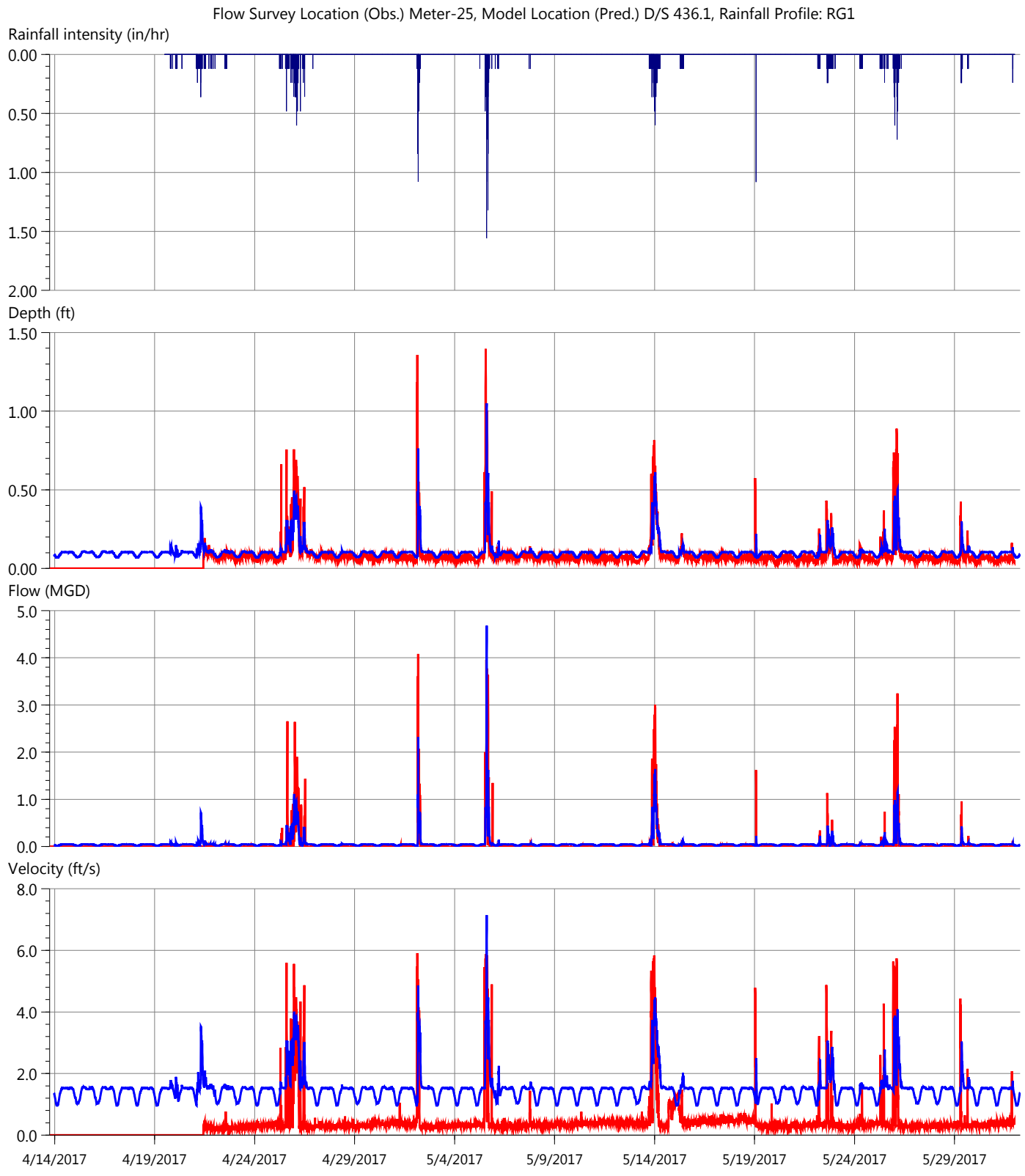
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



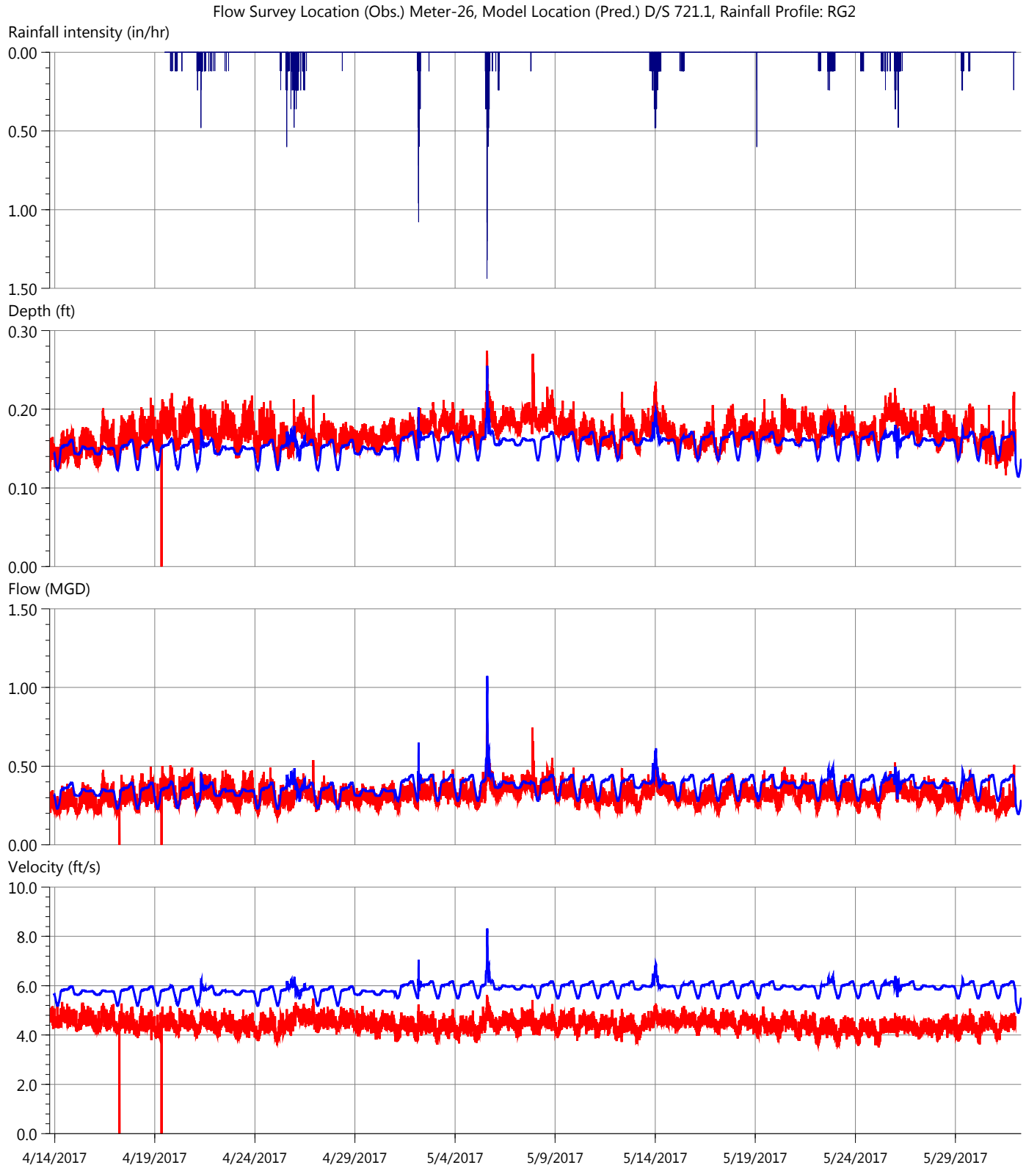
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



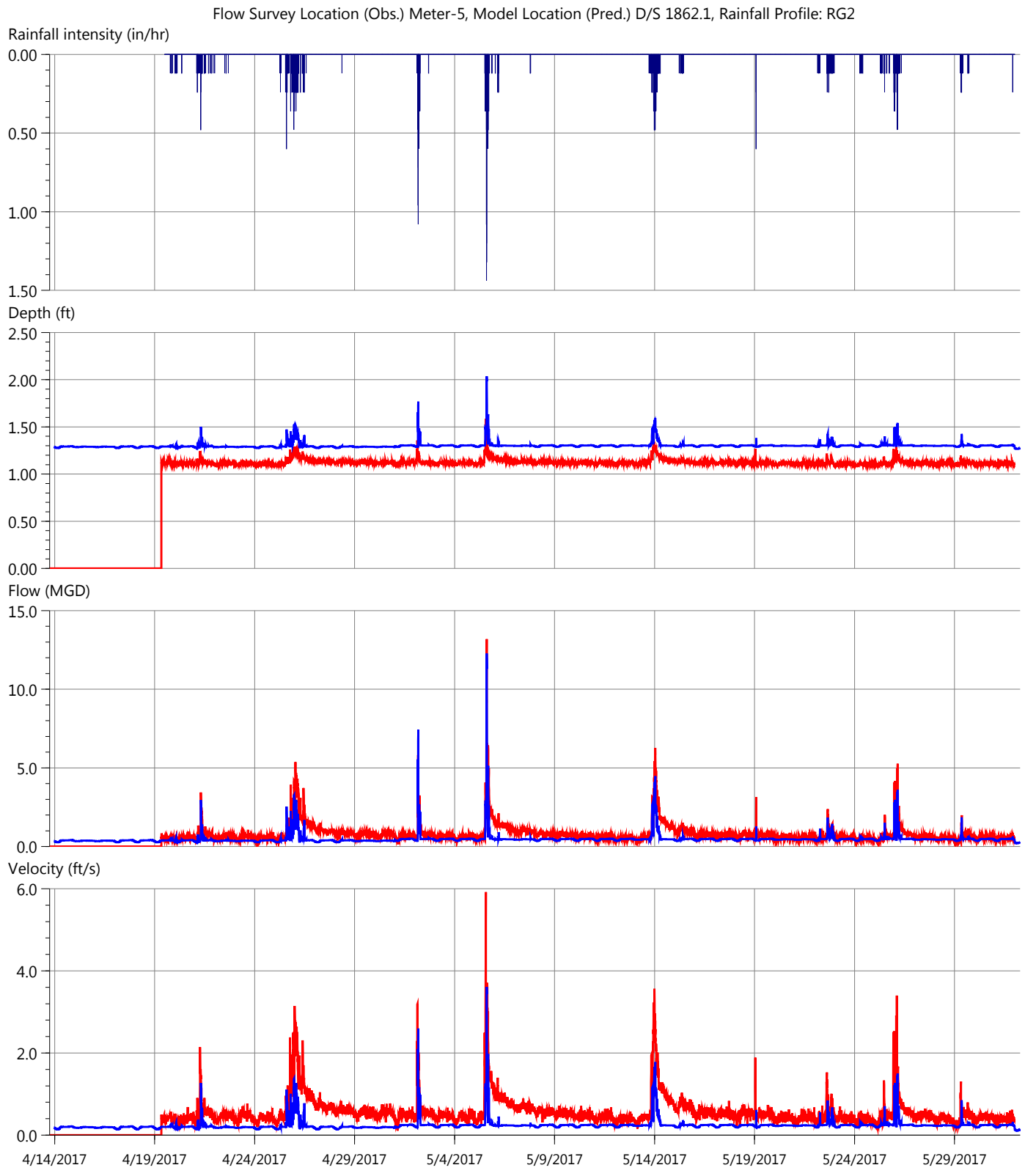
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



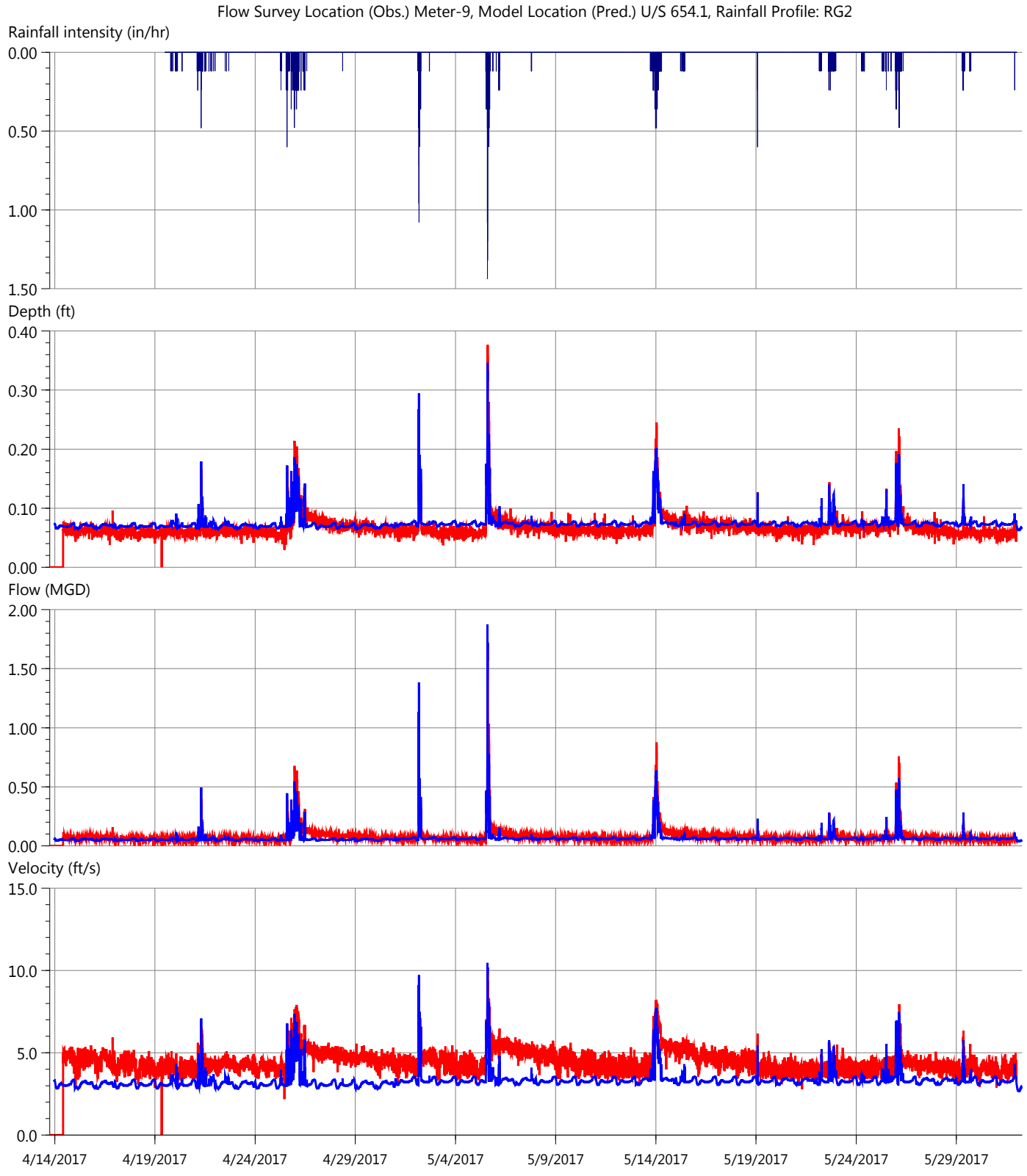
Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



Observed / Predicted Report (Custom graph) - Temp meters

Powered by InfoWorks®



Observed / Predicted Report (Custom graph) - Temp meters

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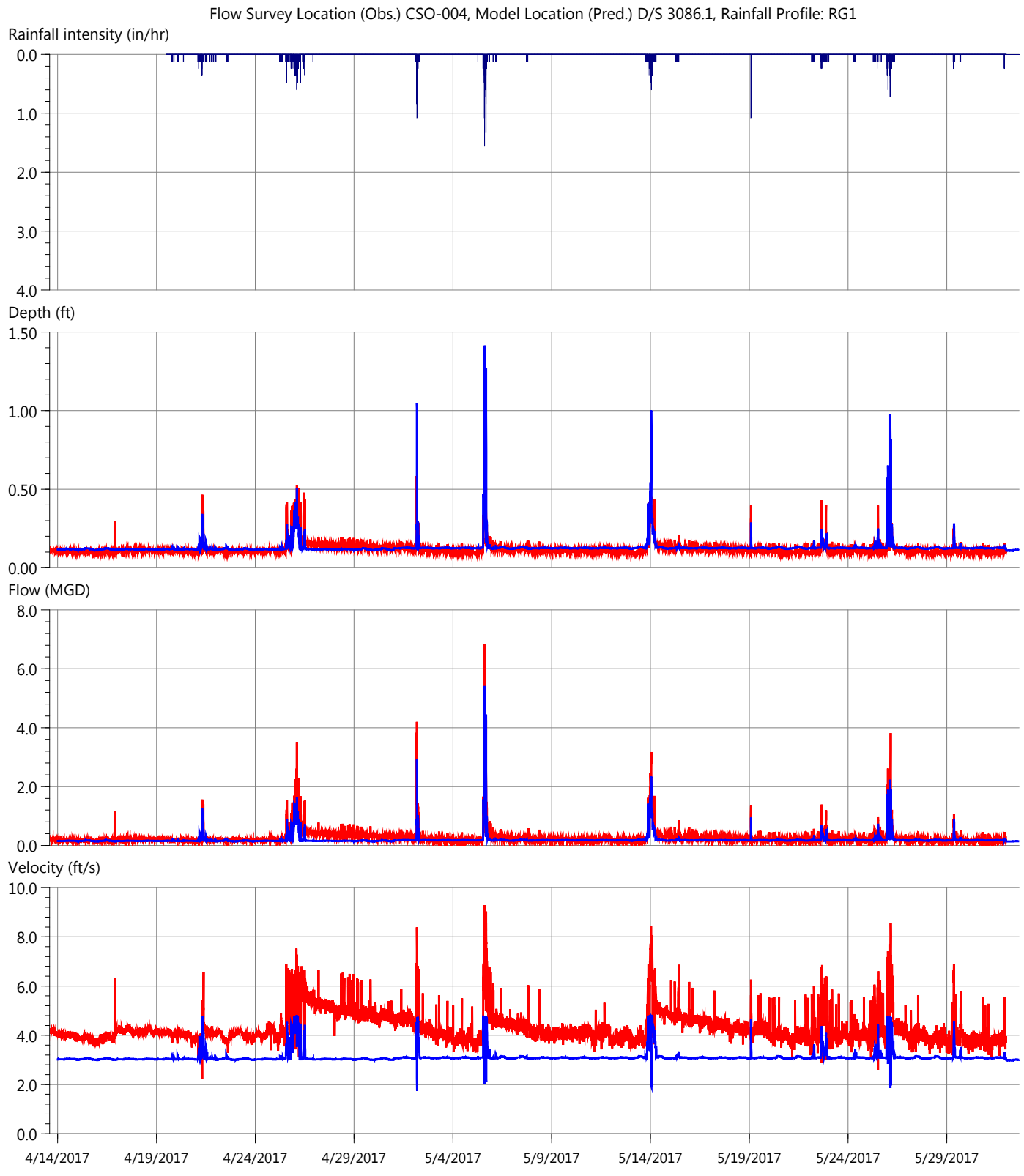
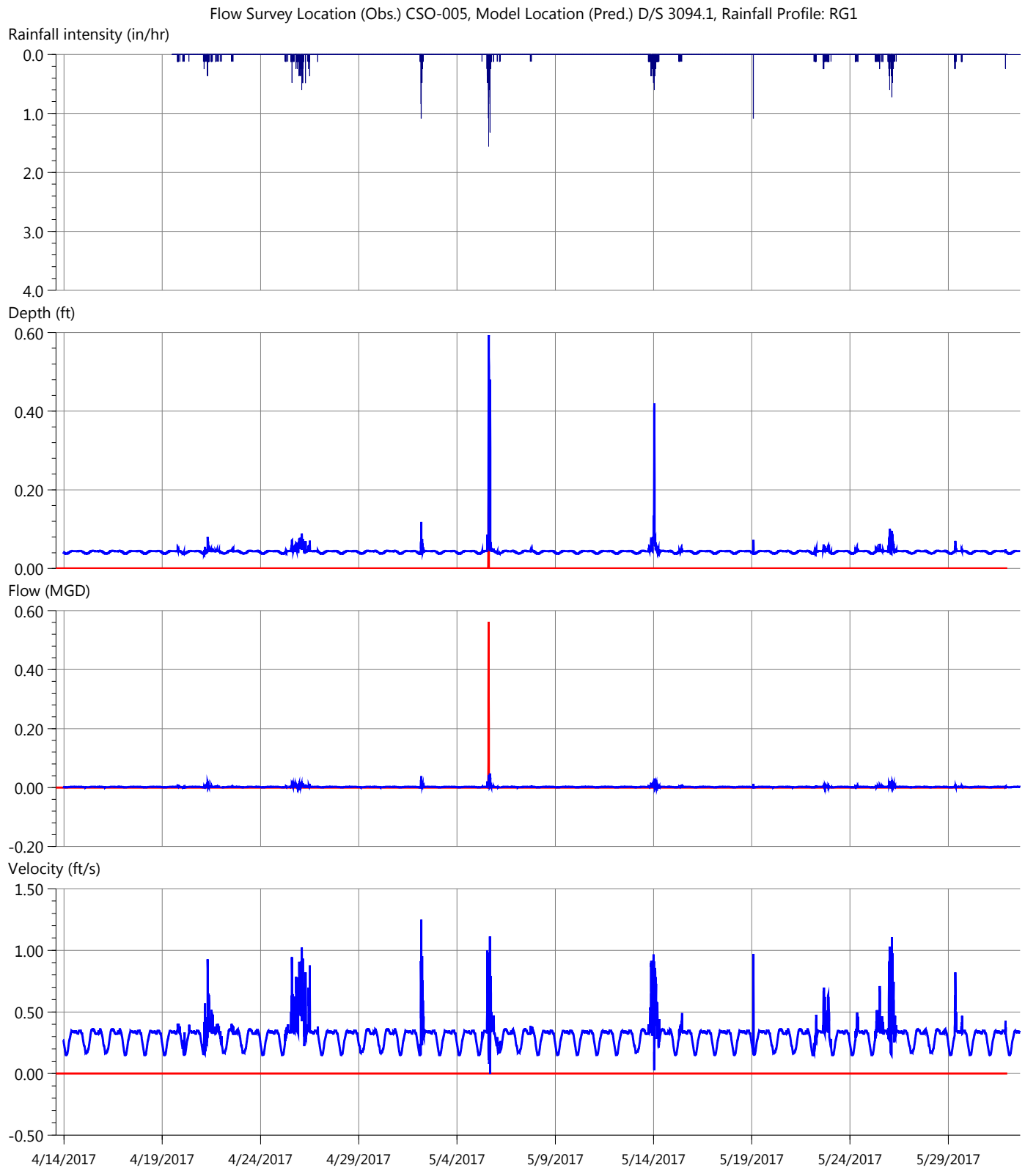


Observed / Predicted Report (Custom graph) - Phase 1

Powered by InfoWorks®



Observed / Predicted Report (Custom graph) - Phase 1

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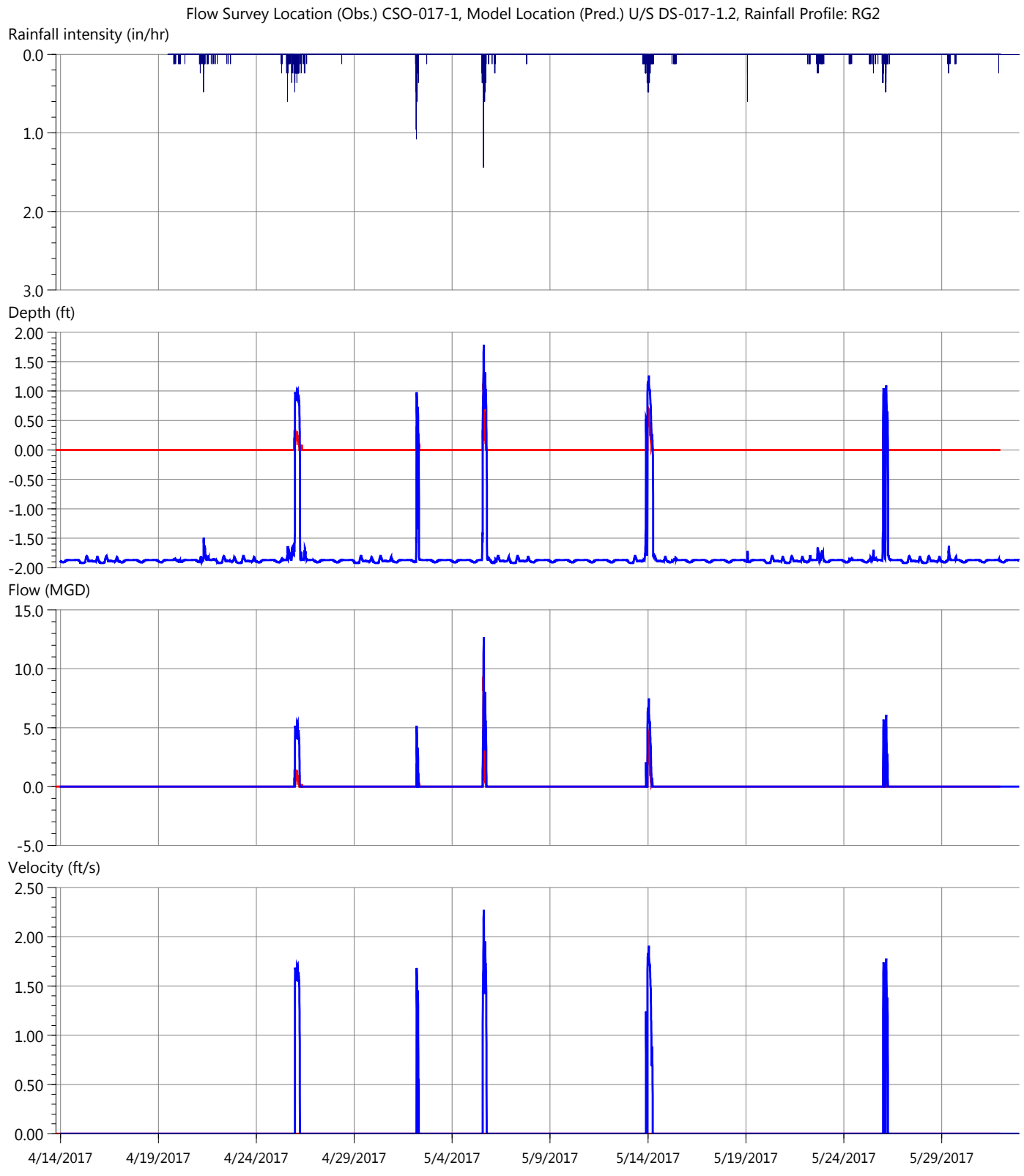

Observed / Predicted Report (Custom graph) - Phase 1

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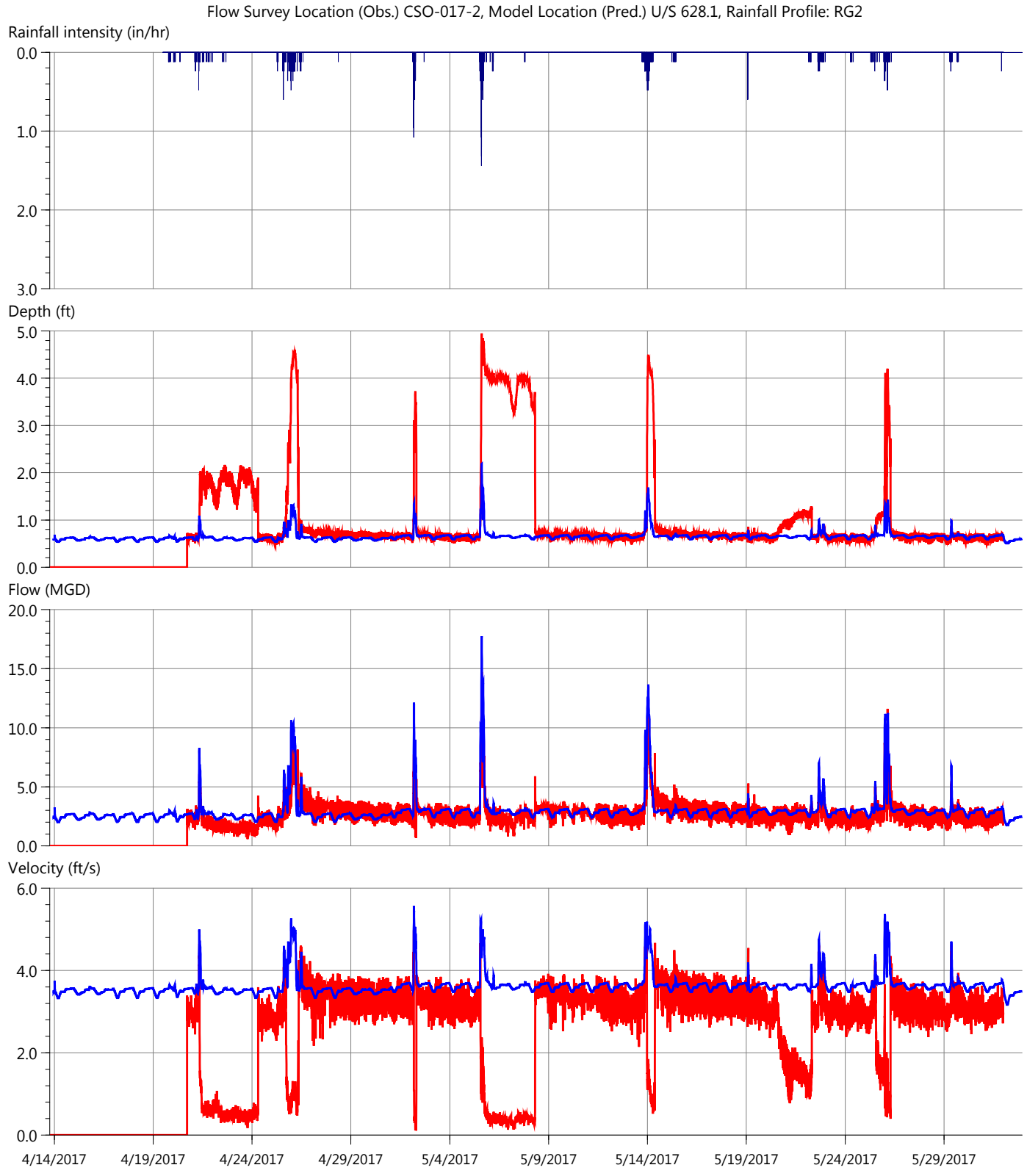

Observed / Predicted Report (Custom graph) - Phase 1

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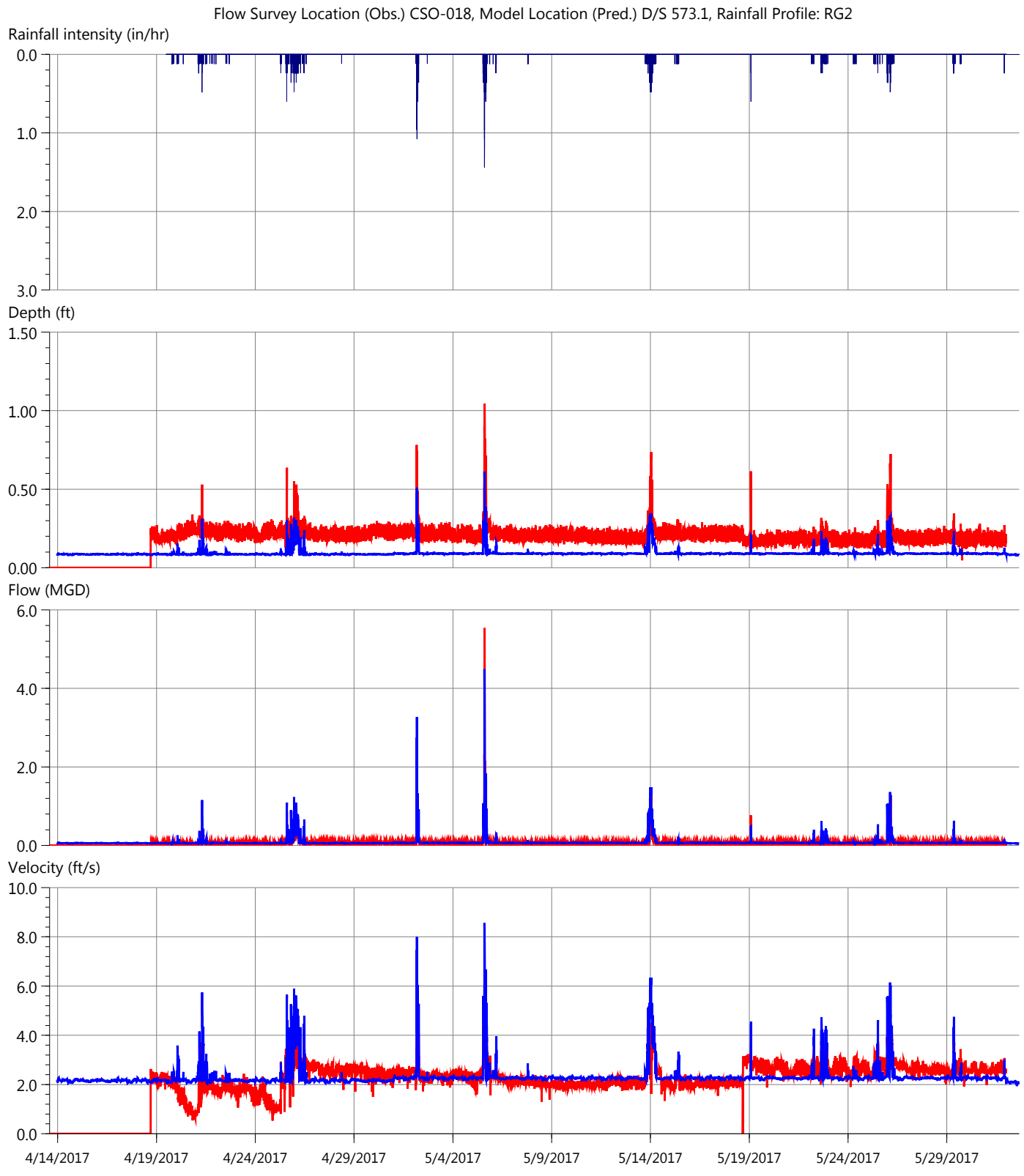

Observed / Predicted Report (Custom graph) - Phase 1

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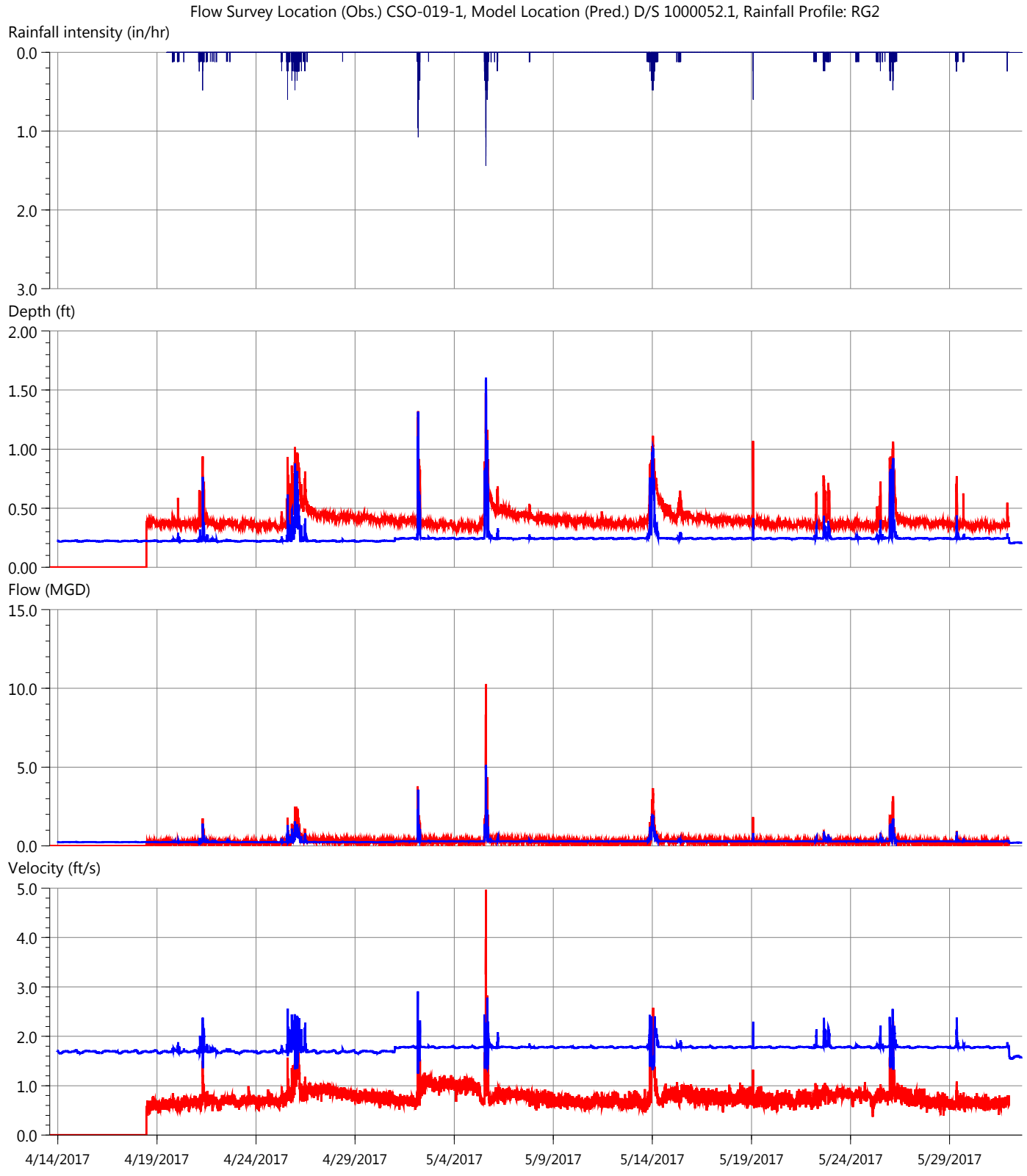

Observed / Predicted Report (Custom graph) - Phase 1

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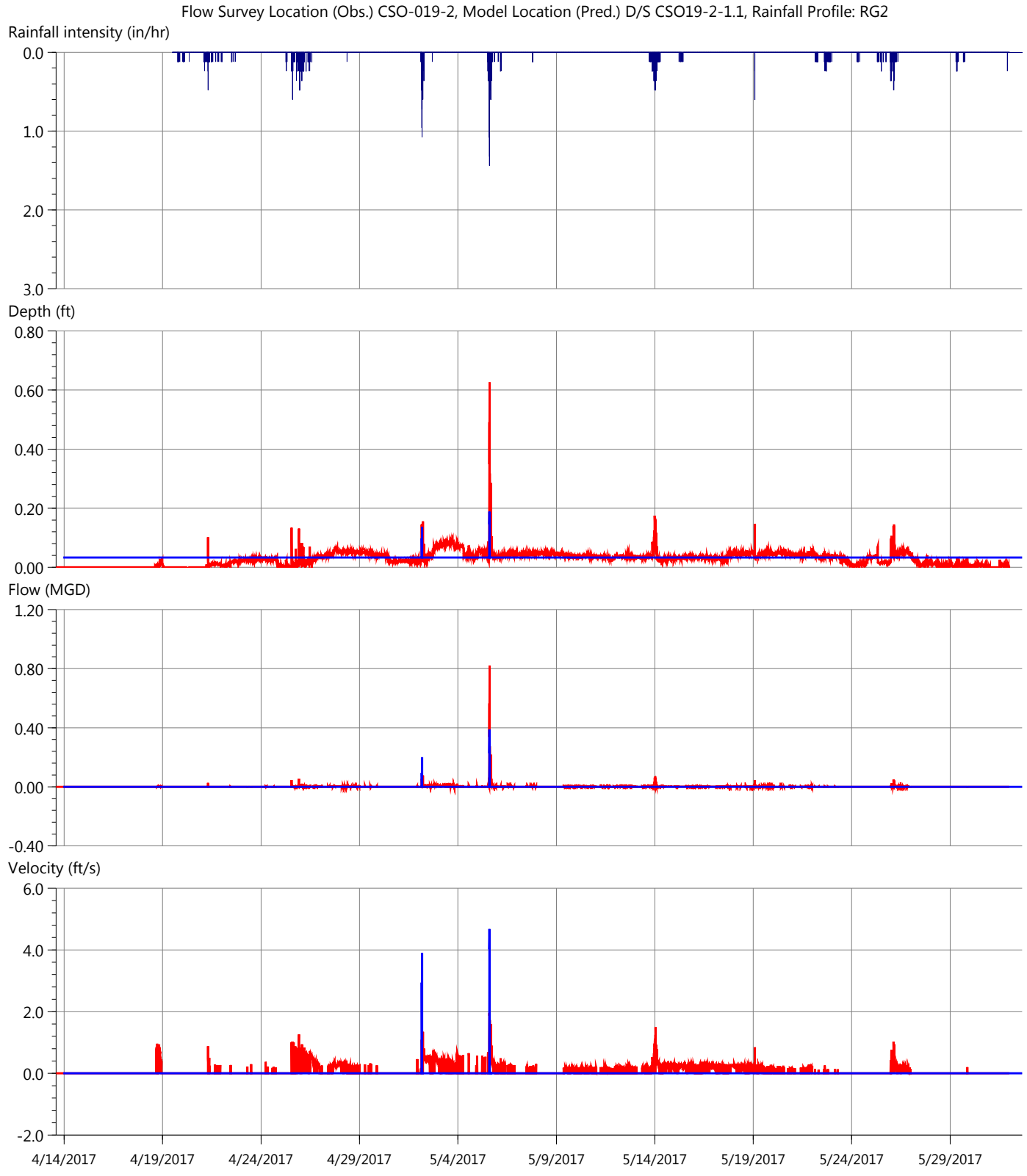

Observed / Predicted Report (Custom graph) - Phase 1

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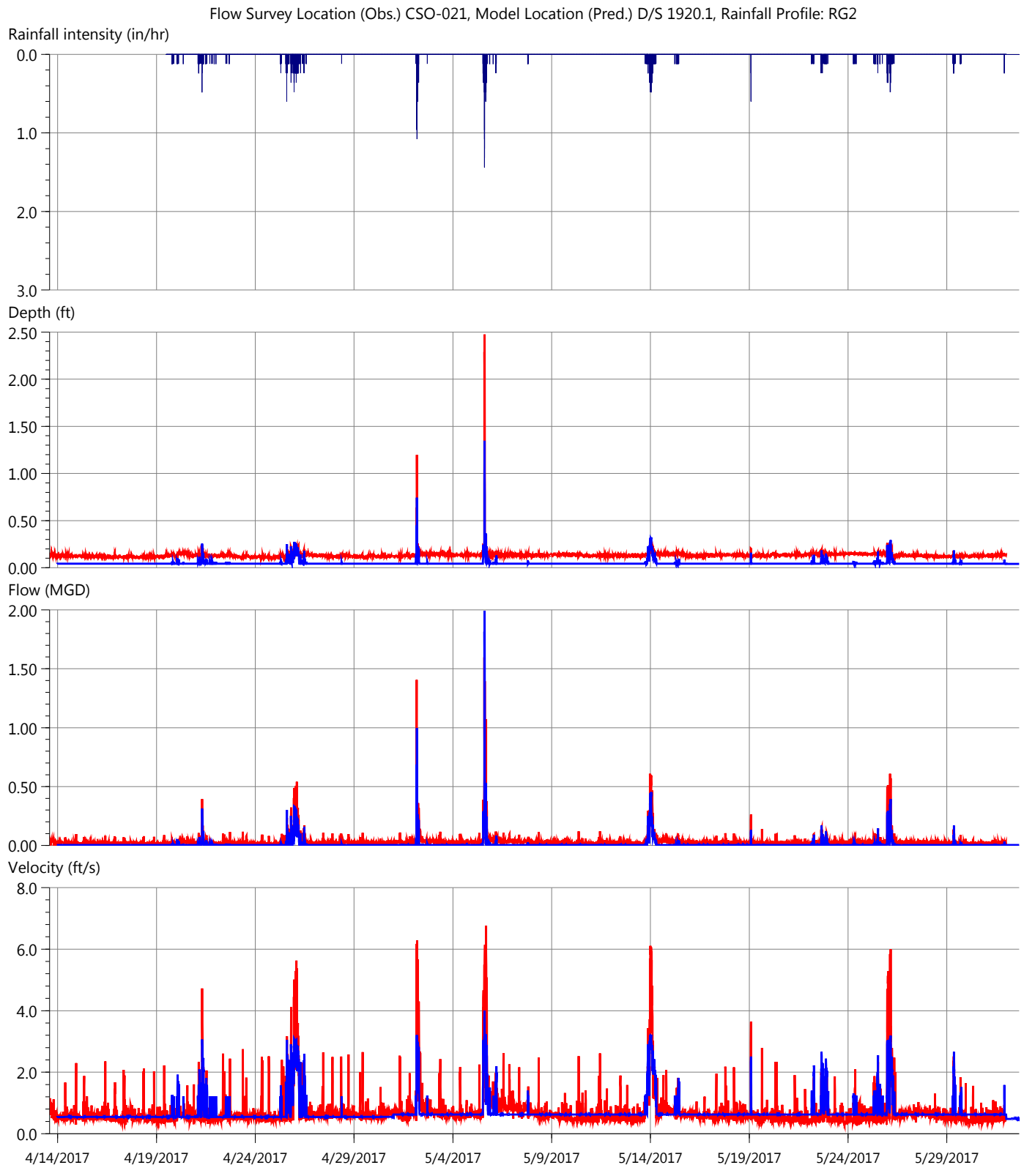

Observed / Predicted Report (Custom graph) - Phase 1

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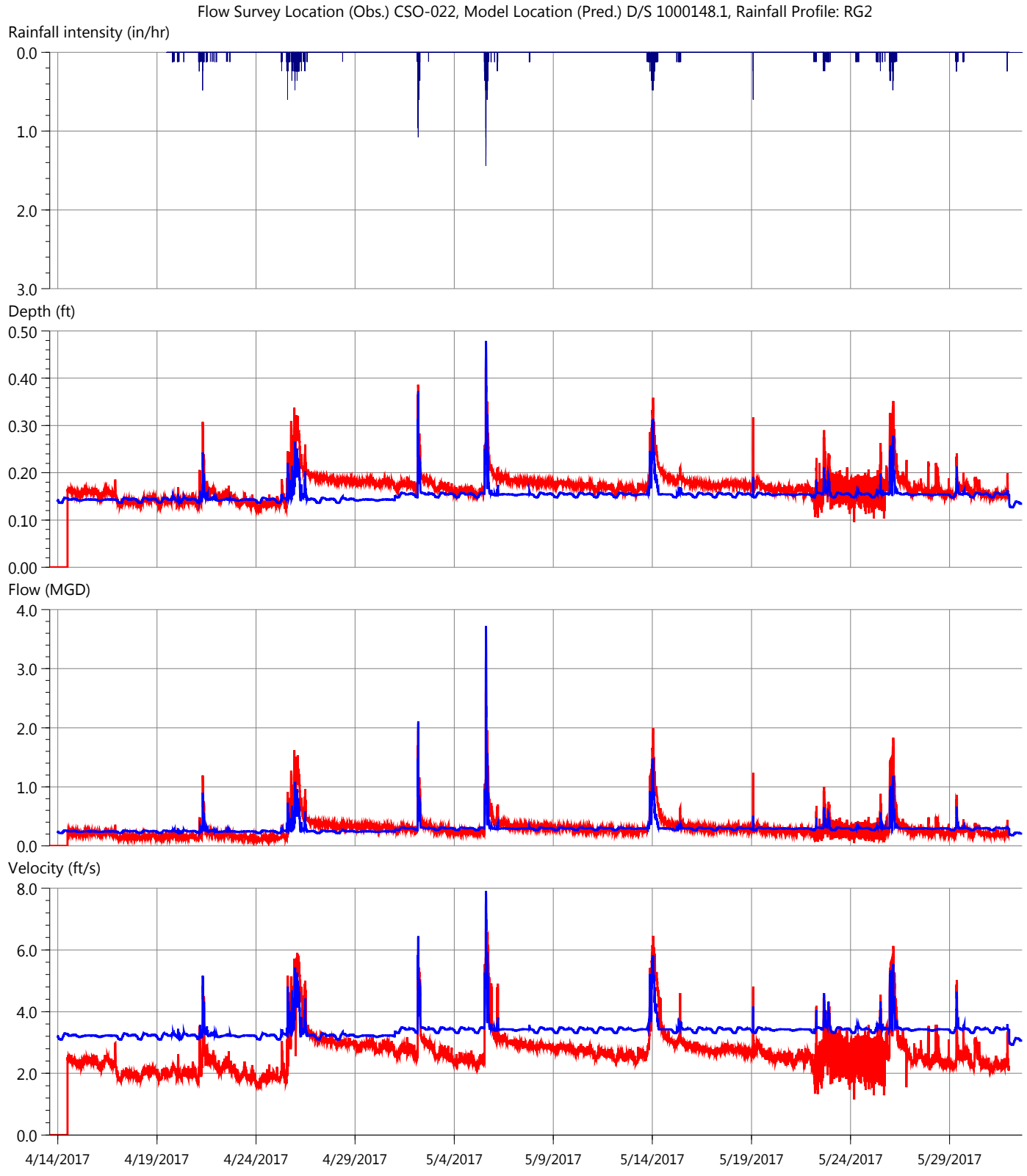

Observed / Predicted Report (Custom graph) - Phase 1

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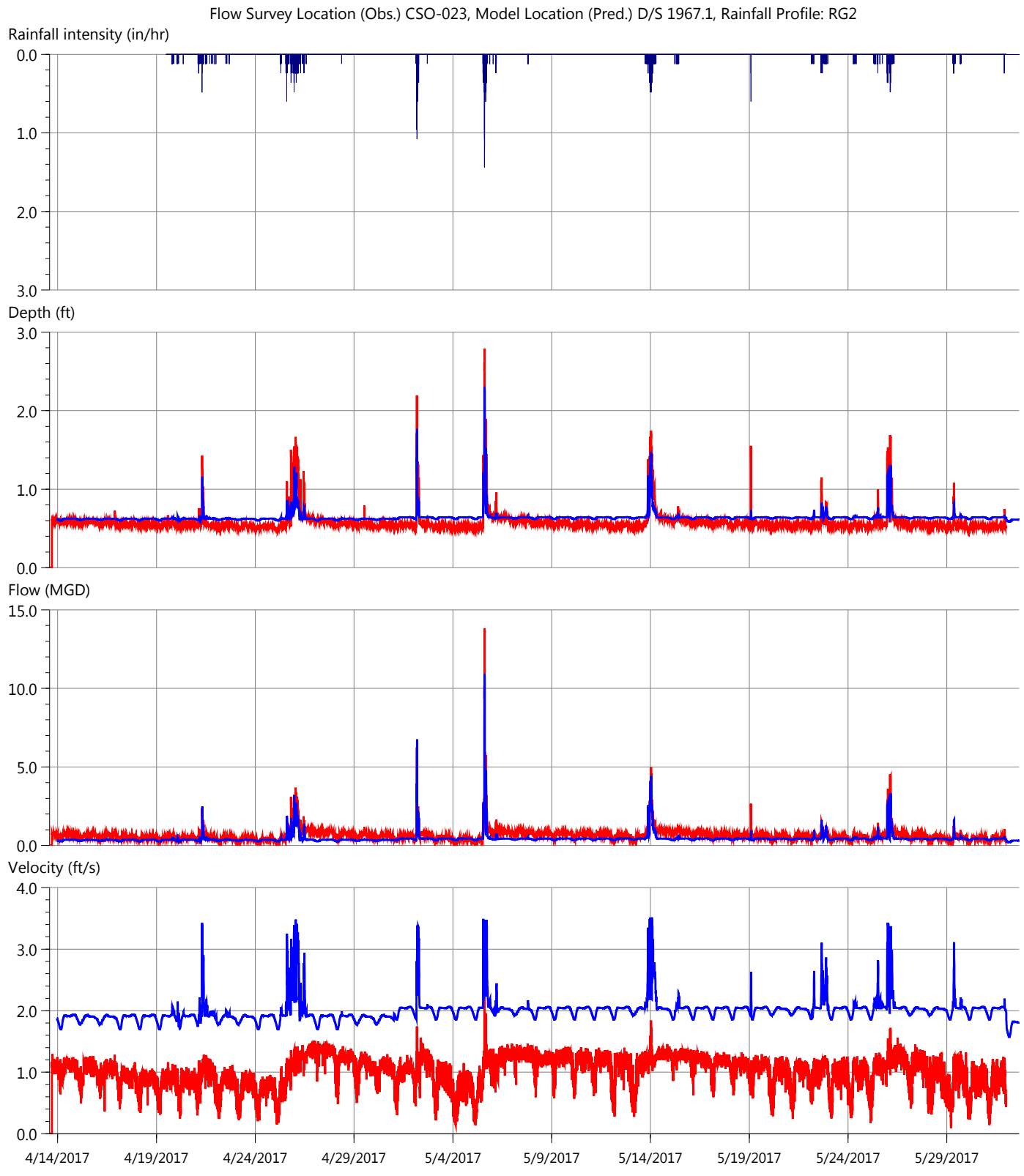

Observed / Predicted Report (Custom graph) - Phase 1

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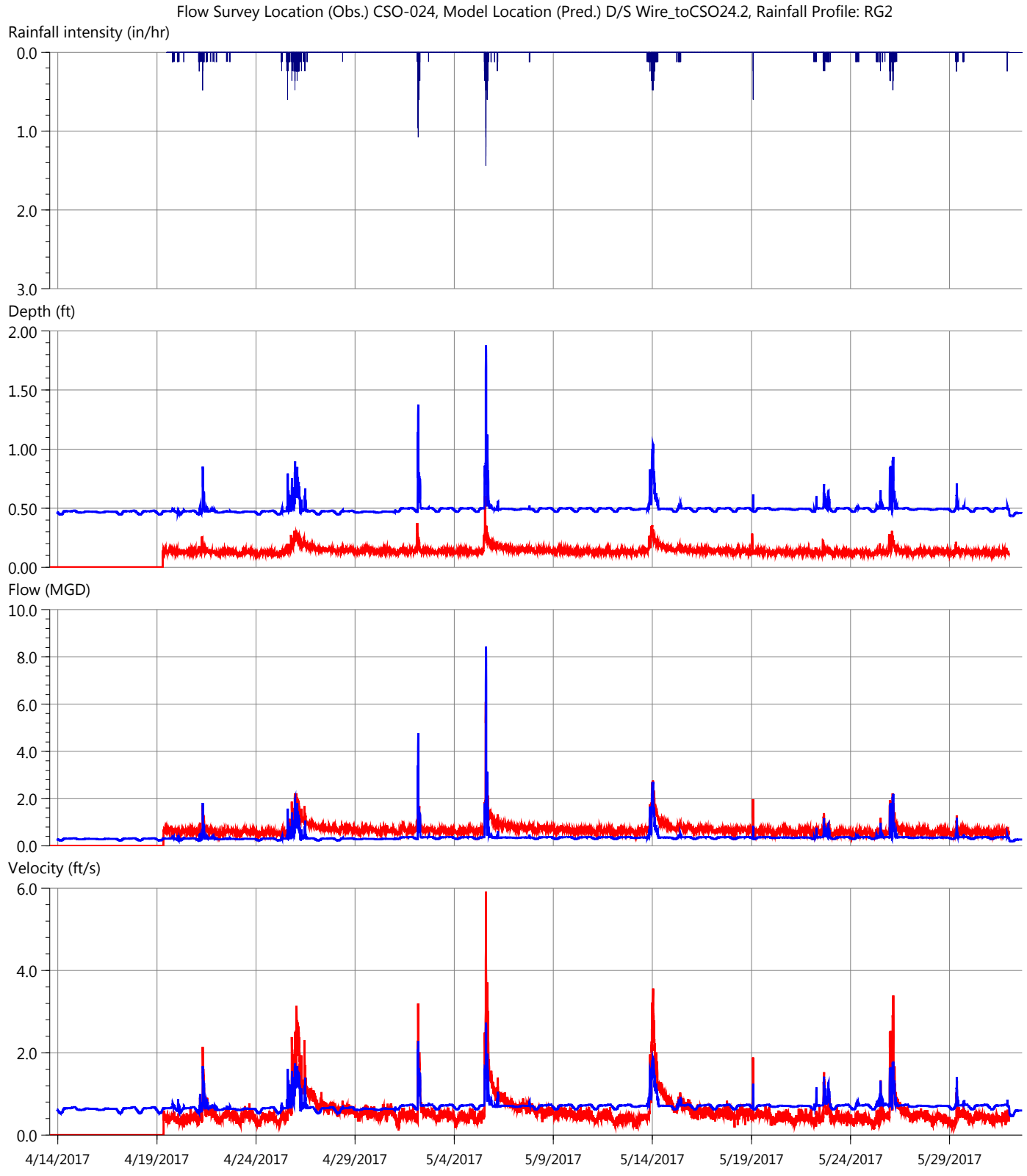

Observed / Predicted Report (Custom graph) - Phase 1

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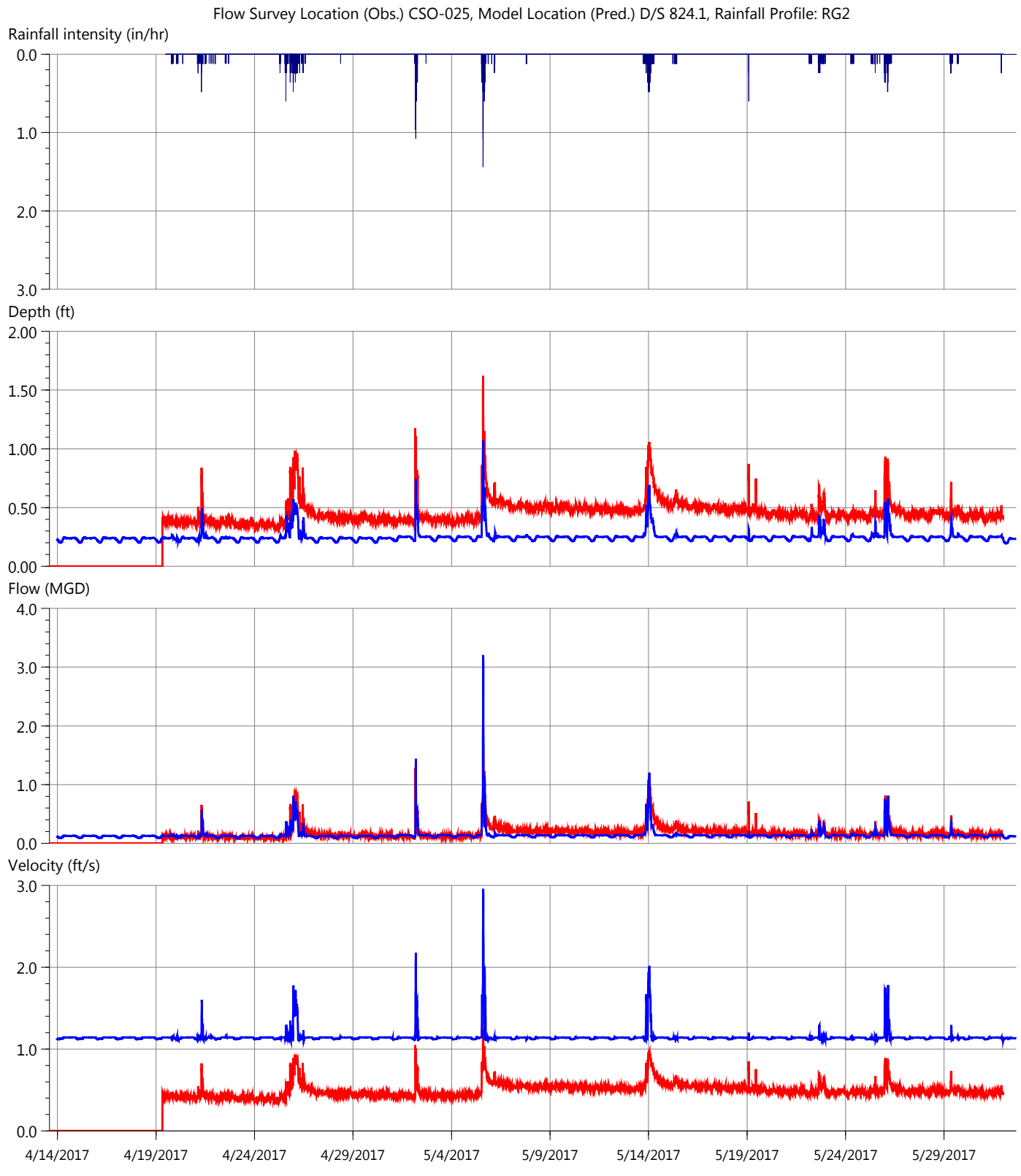

Observed / Predicted Report (Custom graph) - Phase 1

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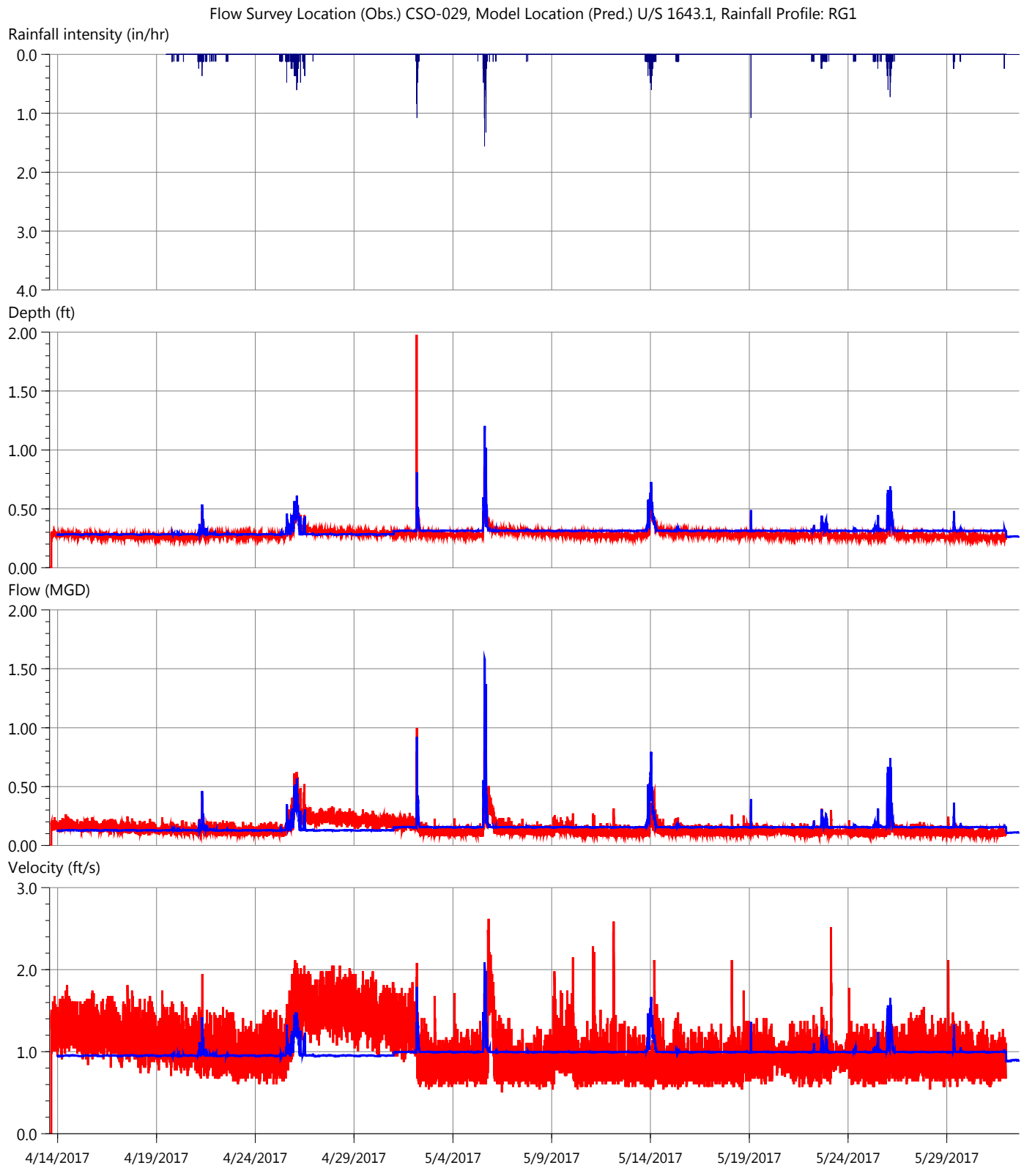

Observed / Predicted Report (Custom graph) - Phase 1

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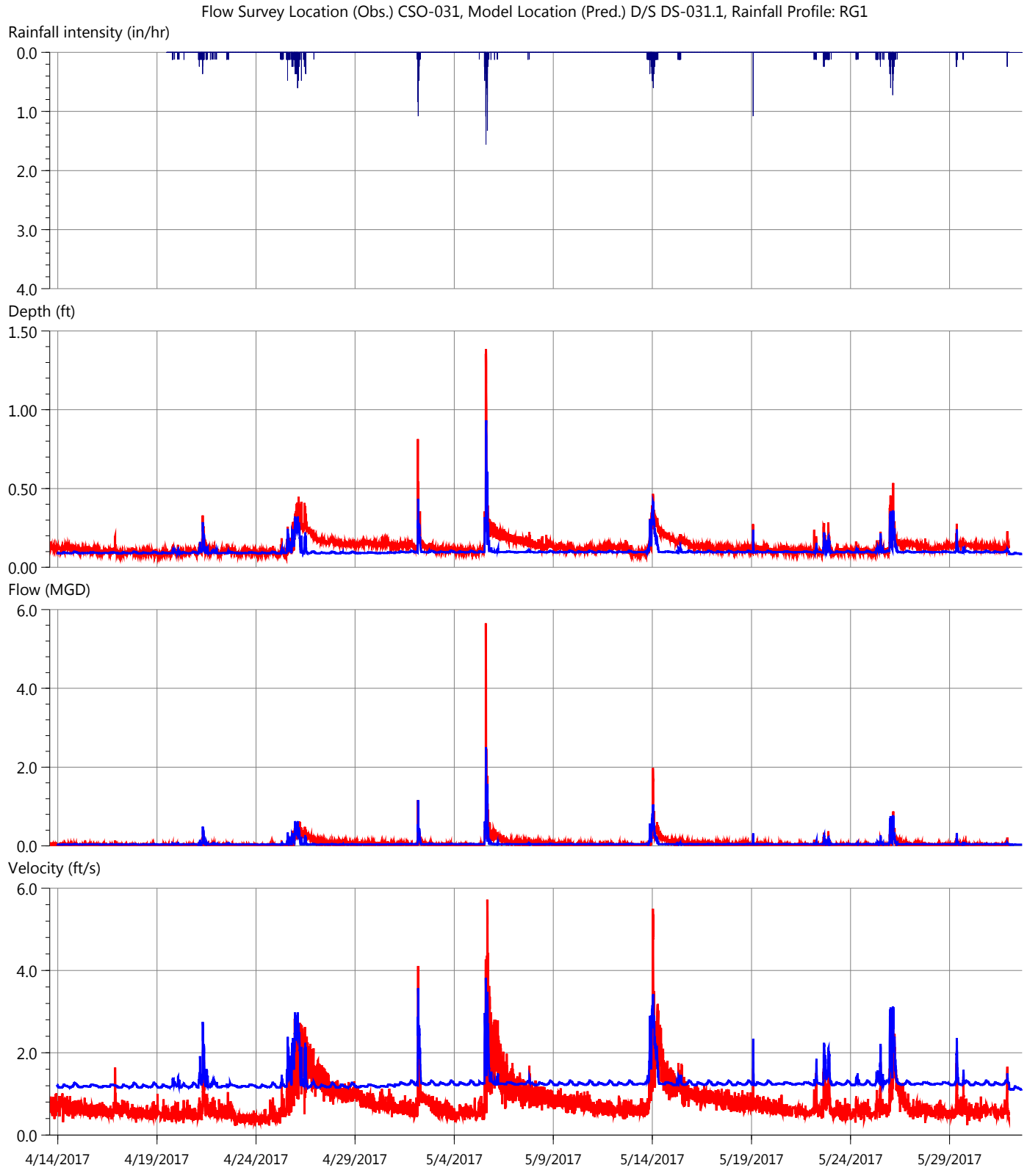

Observed / Predicted Report (Custom graph) - Phase 1

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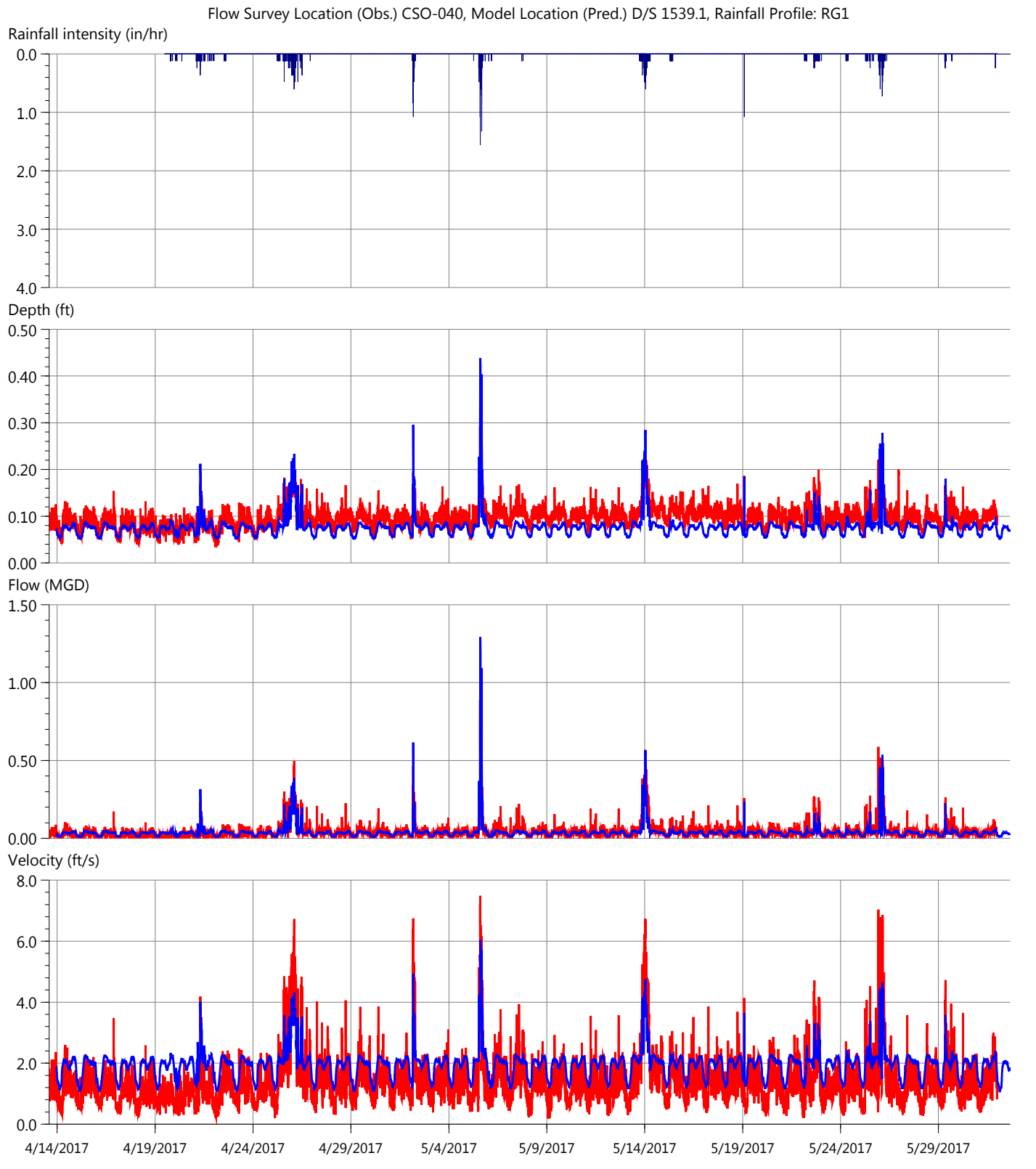

Observed / Predicted Report (Custom graph) - Phase 1

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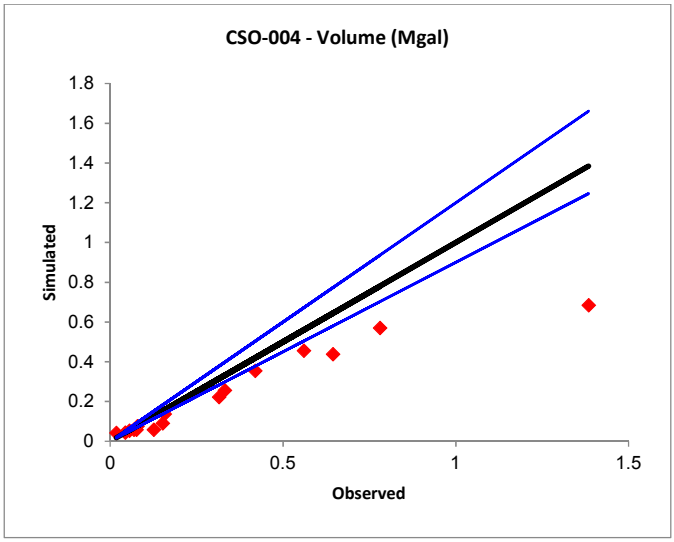
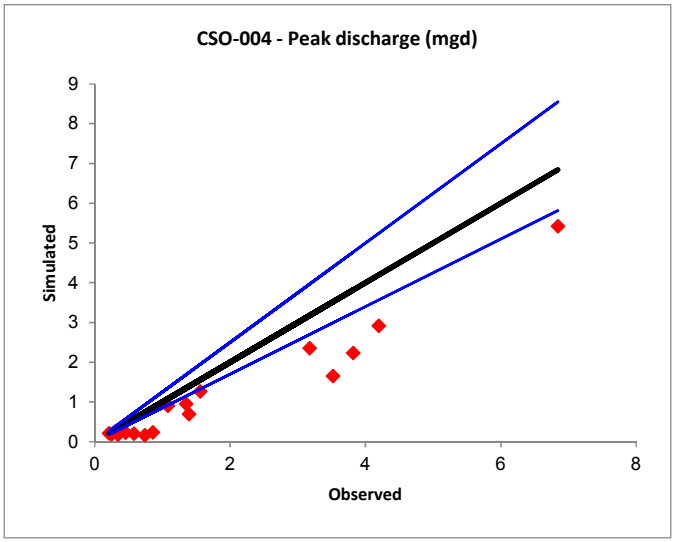
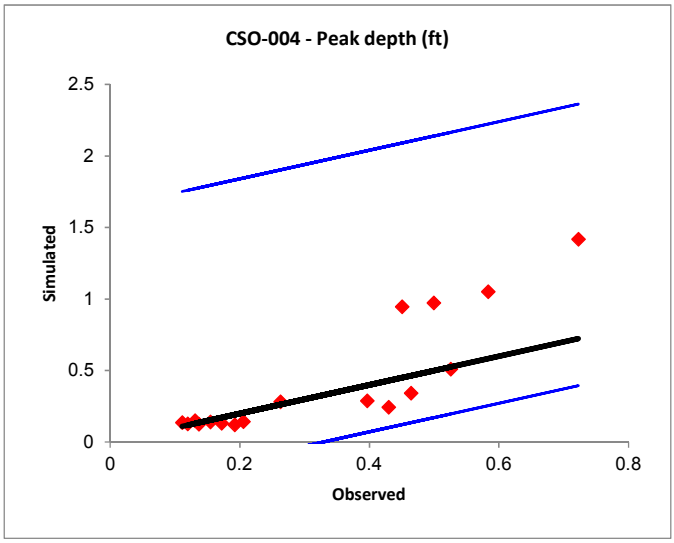
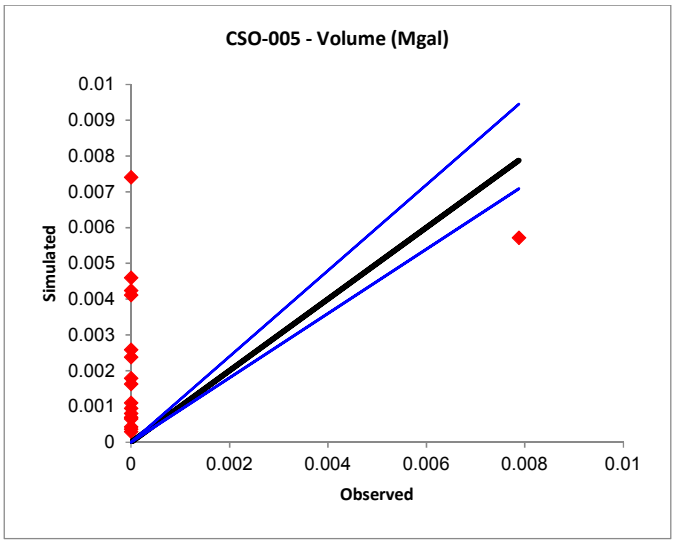
Appendix E

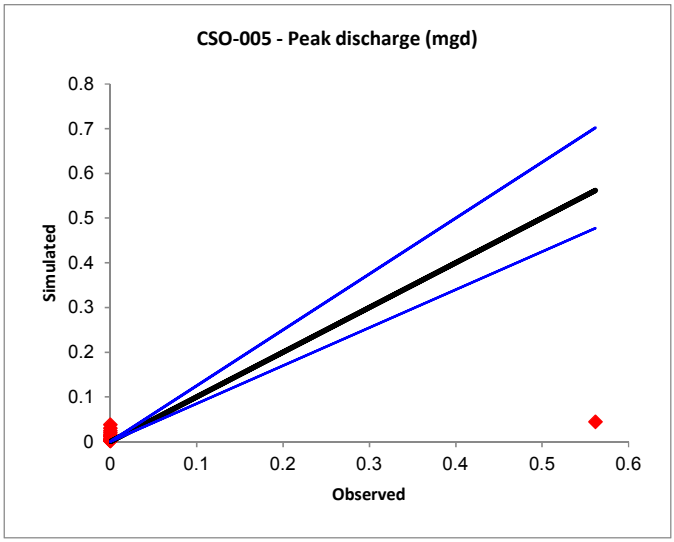
Wet Weather Calibration Scatter Plots – Spring 2017

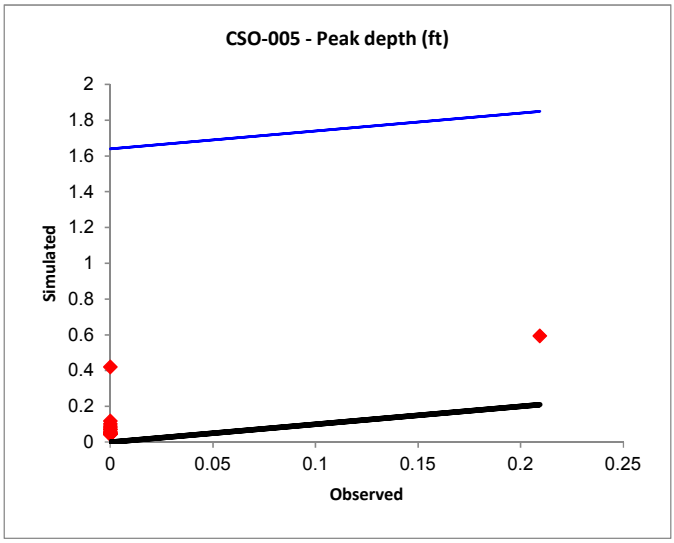

CSO-004 - Volume (Mgal)
Simulated
Observed
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
0
0.5
1
1.5

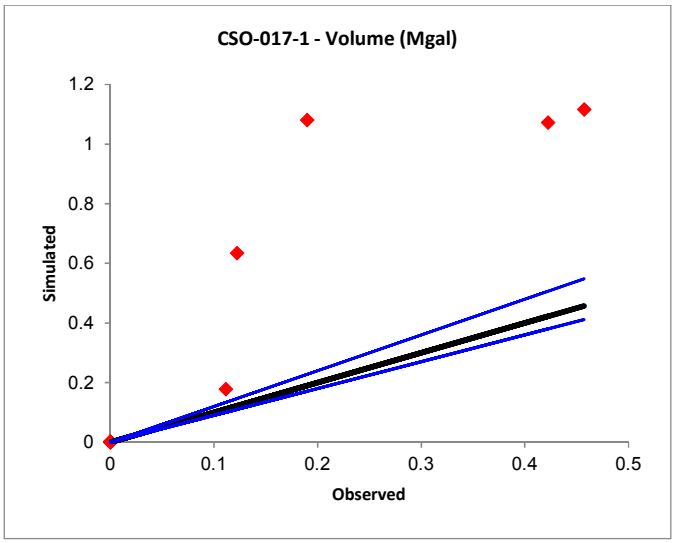

CSO-004 - Peak discharge (mgd)
Simulated
Observed
0
1
2
3
4
5
6
7
8
9
0
2
4
6
8

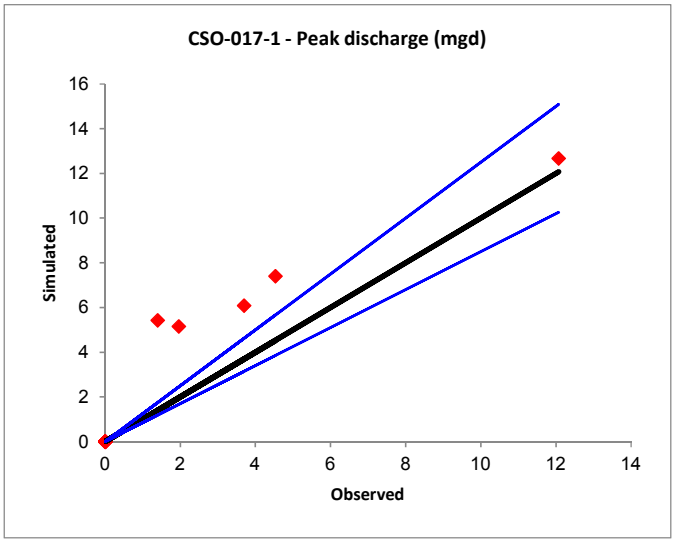

CSO-004 - Peak depth (ft)
Simulated
Observed
0
0.5
1
1.5
2
2.5
0
0.2
0.4
0.6
0.8

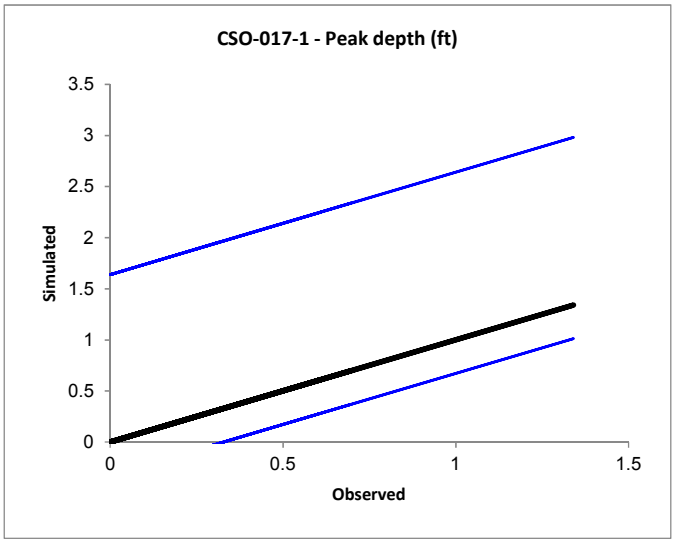

CSO-005 - Volume (Mgal)
Simulated
Observed
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
0.002
0.004
0.006
0.008
0.01

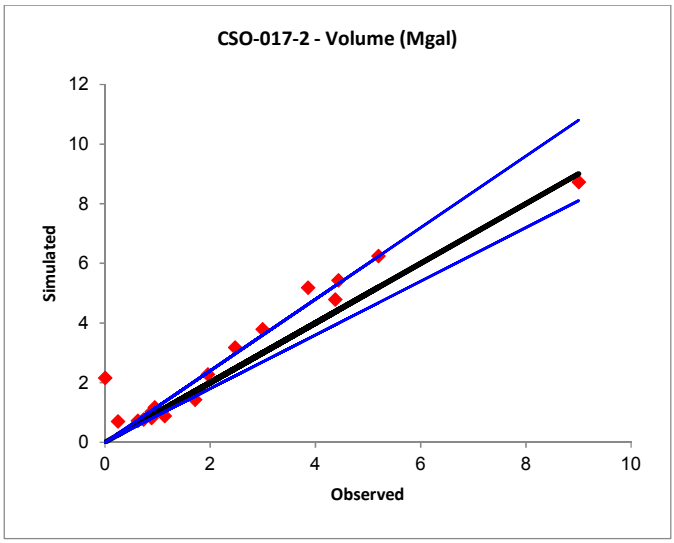

CSO-005 - Peak discharge (mgd)
Simulated
Observed
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6

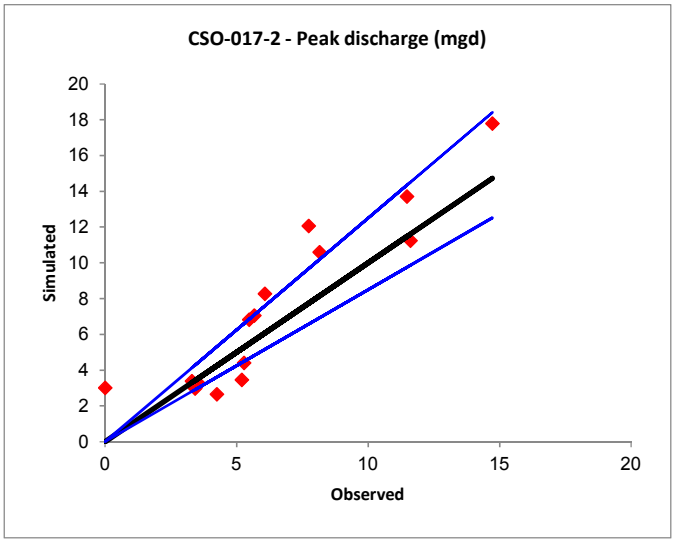

CSO-005 - Peak depth (ft)
Simulated
Observed
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.05
0.1
0.15
0.2
0.25

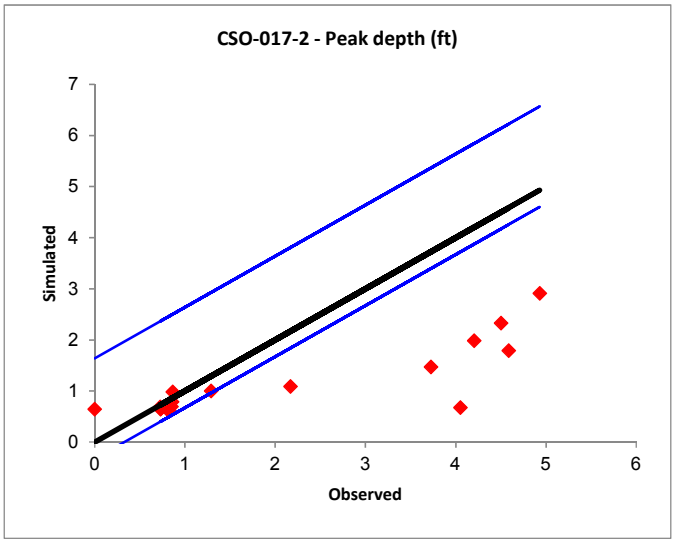

CSO-017-1 - Volume (Mgal)
Simulated
Observed
0
0.2
0.4
0.6
0.8
1
1.2
0.1
0.3
0.5

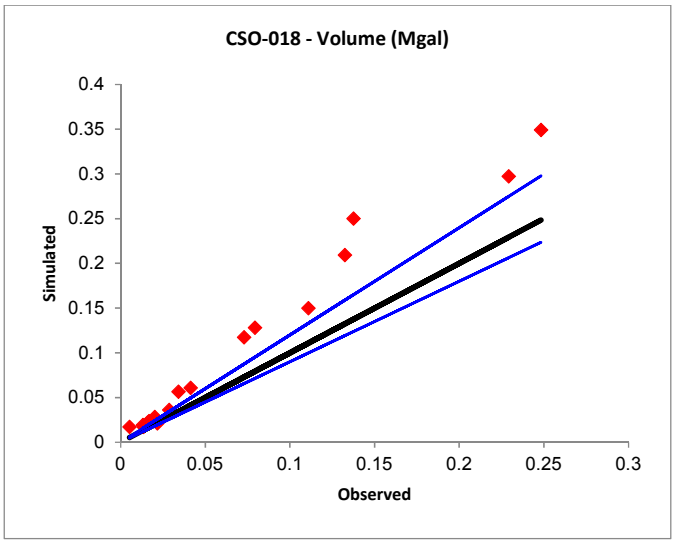

CSO-017-1 - Peak discharge (mgd)
Simulated
Observed
0
2
4
6
8
10
12
14
16

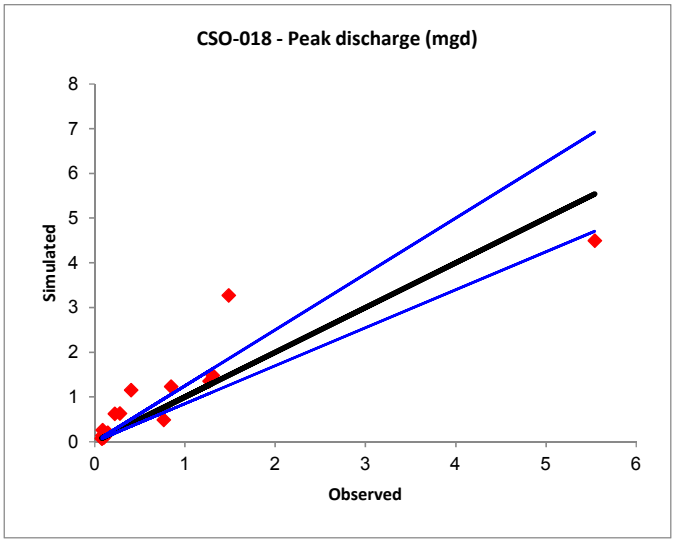

CSO-017-1 - Peak depth (ft)
Simulated
Observed
0
0.5
1
1.5
2
2.5
3
3.5

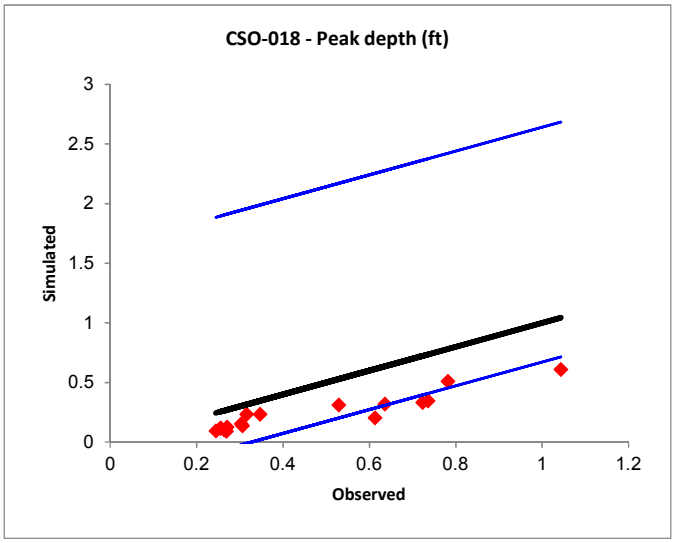

CSO-017-2 - Volume (Mgal)
Simulated
Observed
0
2
4
6
8
10
12

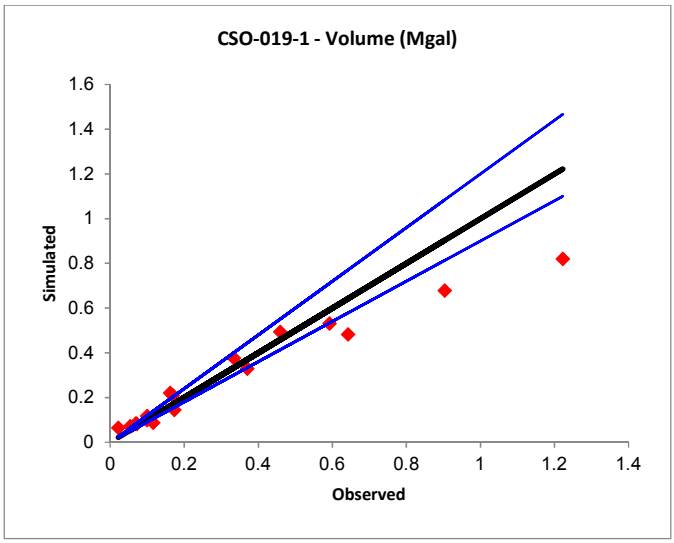

CSO-017-2 - Peak discharge (mgd)
Simulated
Observed
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20

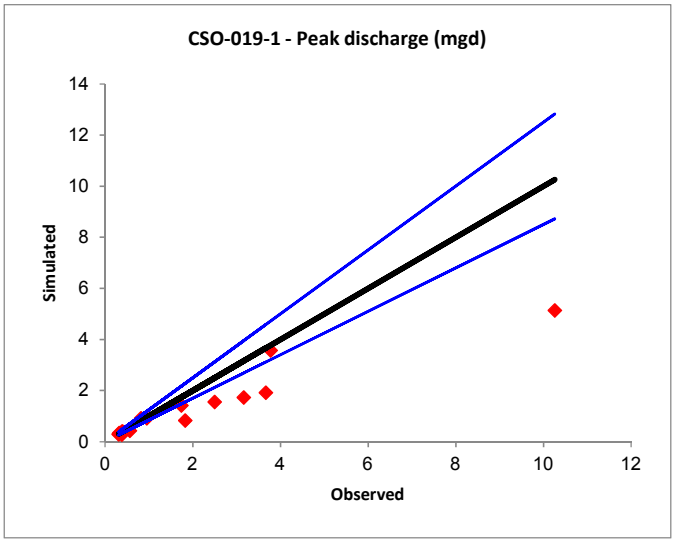

CSO-017-2 - Peak depth (ft)
Simulated
Observed
0
1
2
3
4
5
6
7
0
1
2
3
4
5
6

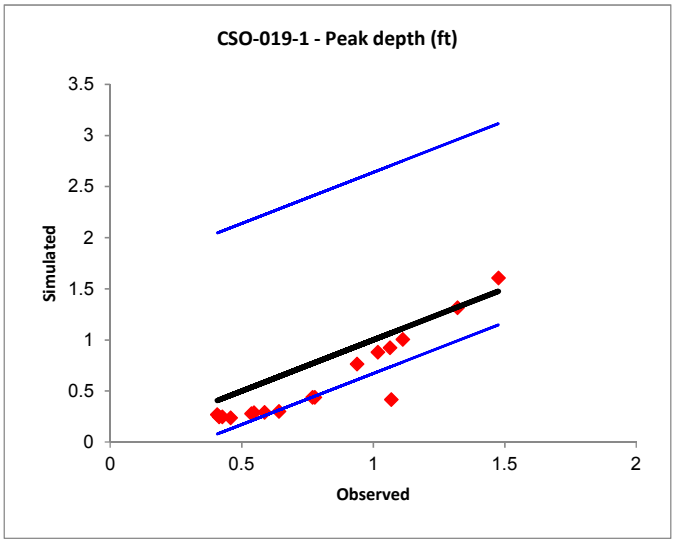

CSO-018 - Volume (Mgal)
Simulated
Observed
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4

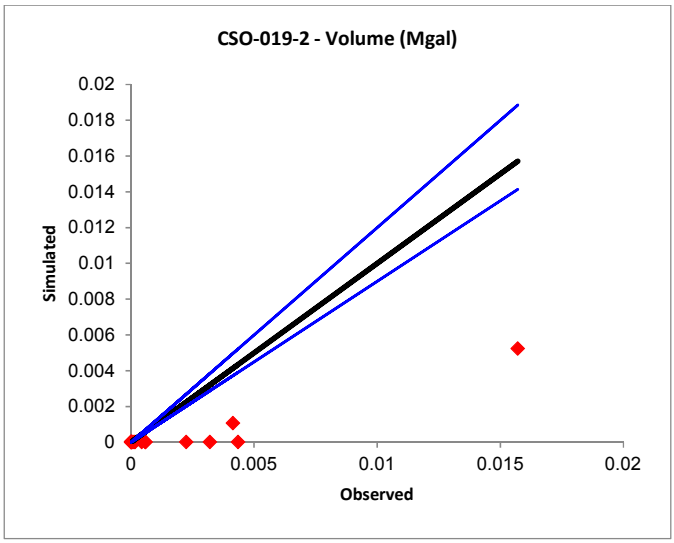

CSO-018 - Peak discharge (mgd)
Simulated
Observed
0
1
2
3
4
5
6
7
8

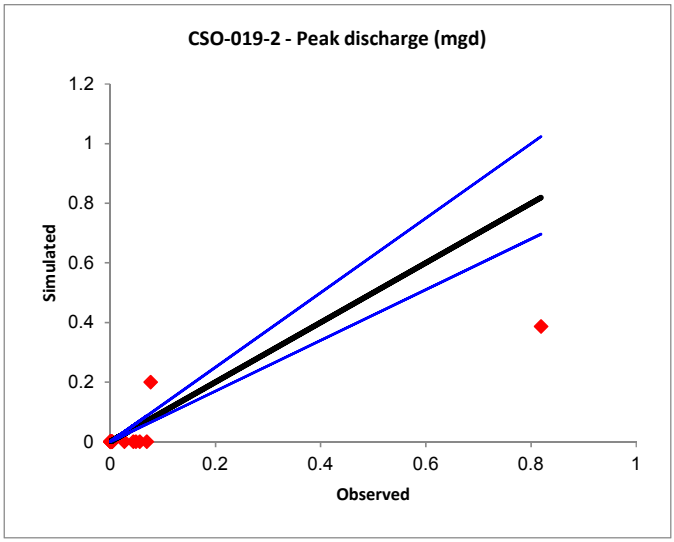

CSO-018 - Peak depth (ft)
Simulated
Observed
0
0.2
0.4
0.6
0.8
1
1.2
0.5
1.5
2
2.5
3

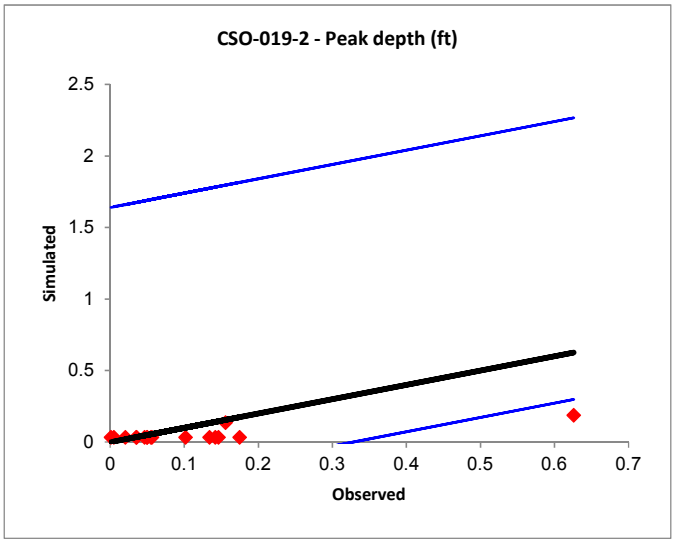

CSO-019-1 - Volume (Mgal)
Simulated
Observed
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6

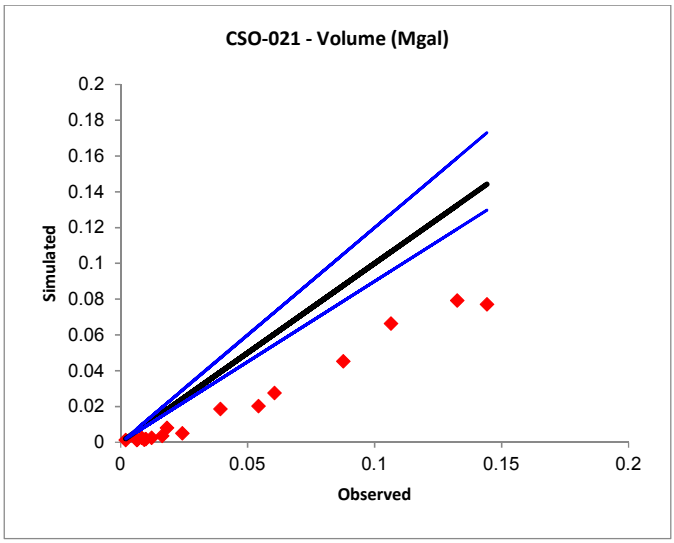

CSO-019-1 - Peak discharge (mgd)
Simulated
Observed
0
2
4
6
8
10
12
14

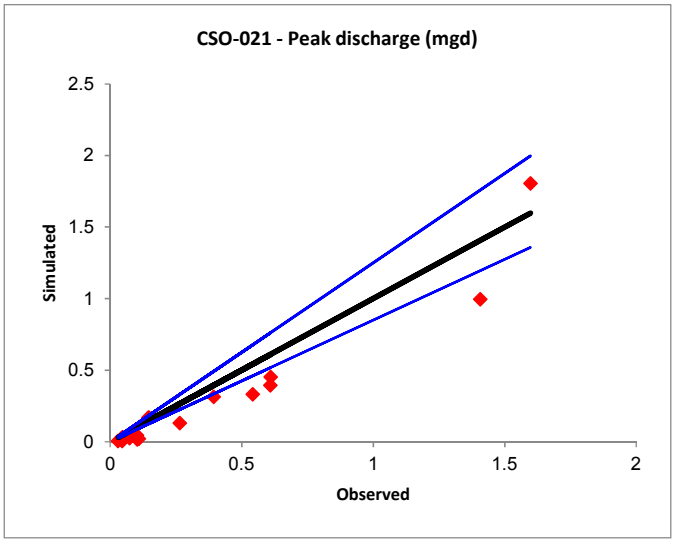

CSO-019-1 - Peak depth (ft)
Simulated
Observed
0
0.5
1
1.5
2
2.5
3
3.5

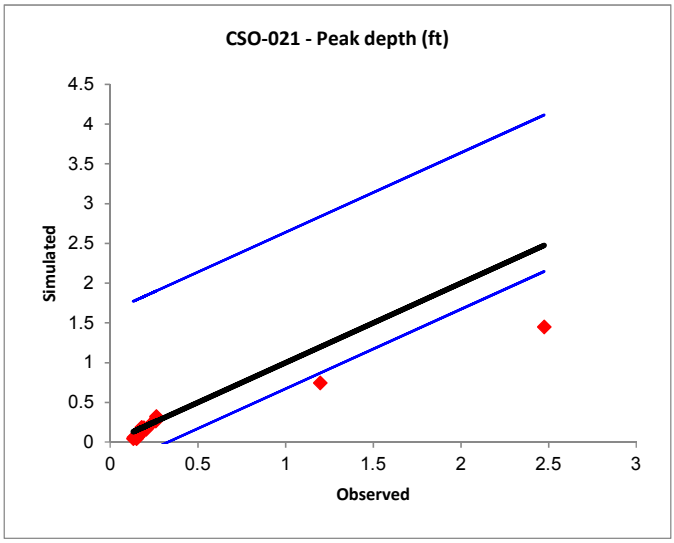

CSO-019-2 - Volume (Mgal)
Simulated
Observed
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
0.005
0.01
0.015
0.02

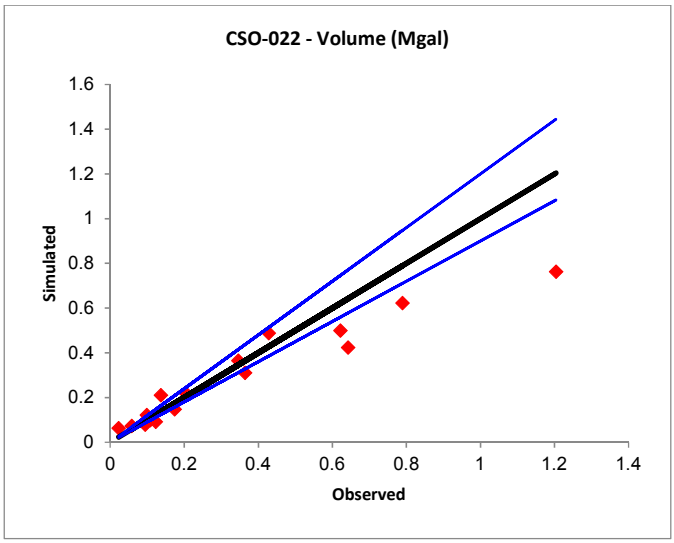

CSO-019-2 - Peak discharge (mgd)
Simulated
Observed
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1

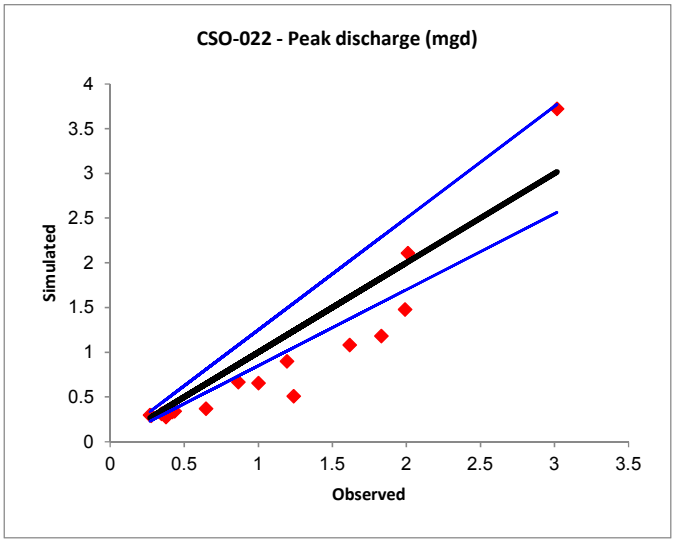

CSO-019-2 - Peak depth (ft)
Simulated
Observed
2.5
2
1.5
1
0.5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

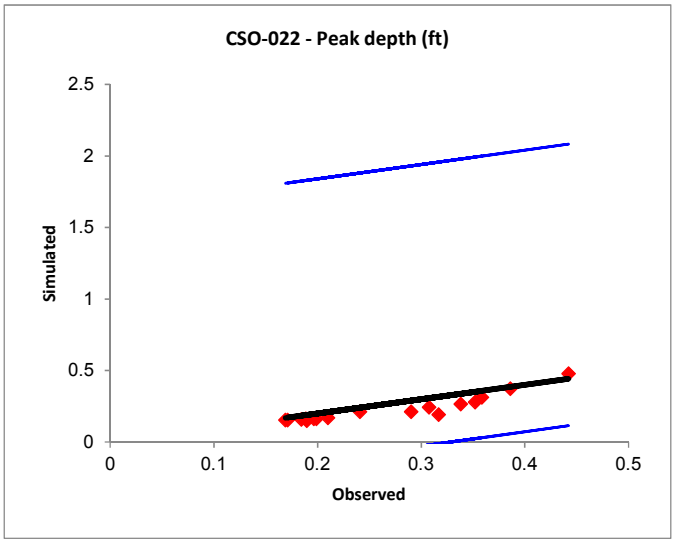

CSO-021 - Volume (Mgal)
Simulated
Observed
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.05
0.15

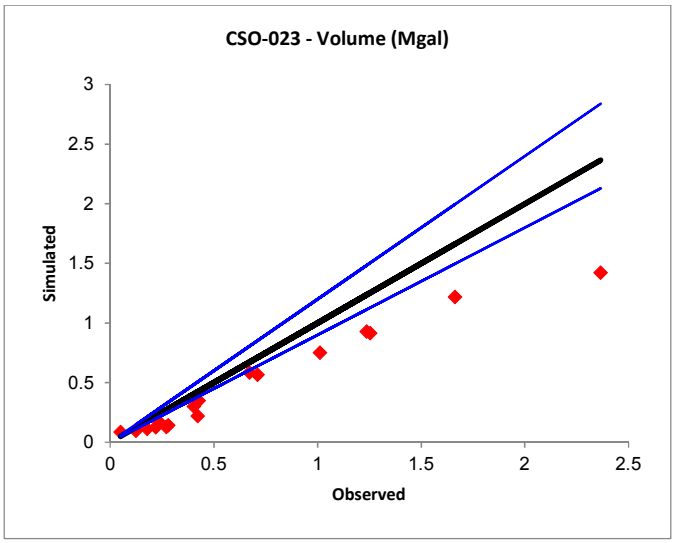

CSO-021 - Peak discharge (mgd)
Simulated
Observed
0
0.5
1
1.5
2
2.5

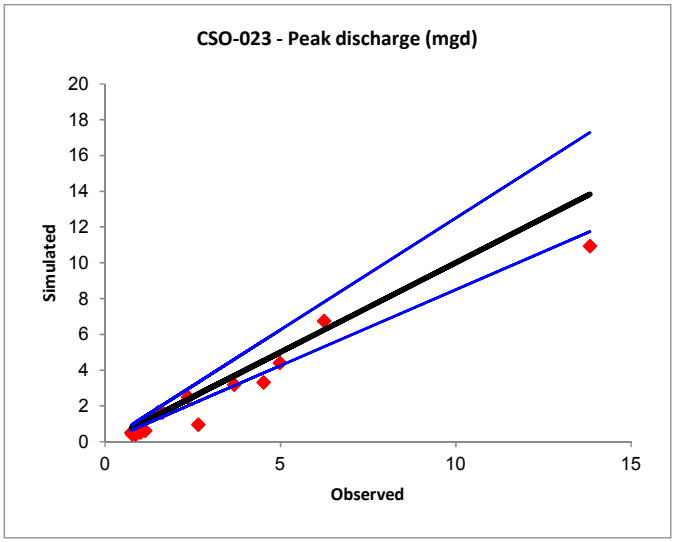

CSO-021 - Peak depth (ft)
Simulated
Observed
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

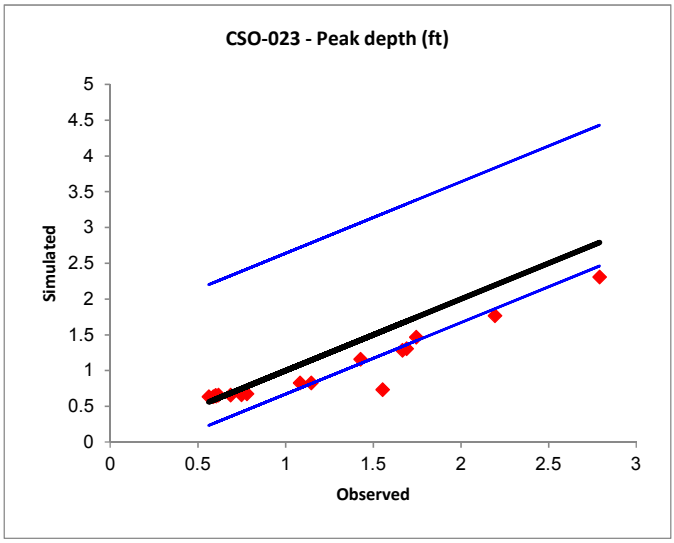

CSO-022 - Volume (Mgal)
Simulated
Observed
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6

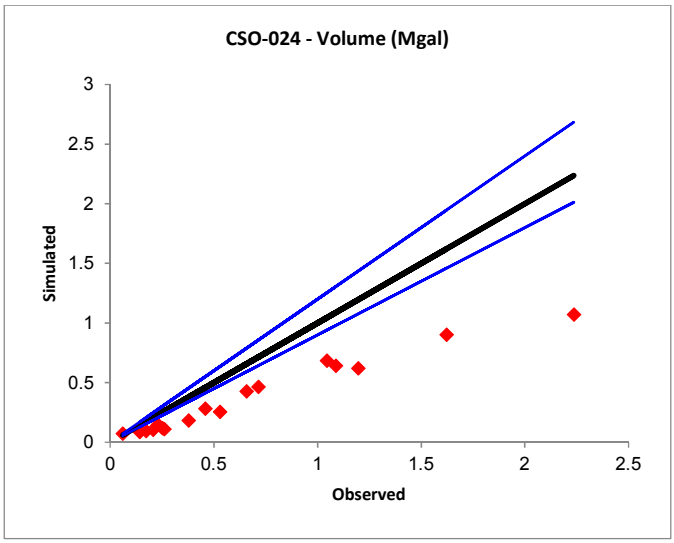

CSO-022 - Peak discharge (mgd)
Simulated
Observed
0
0.5
1
1.5
2
2.5
3
3.5
4

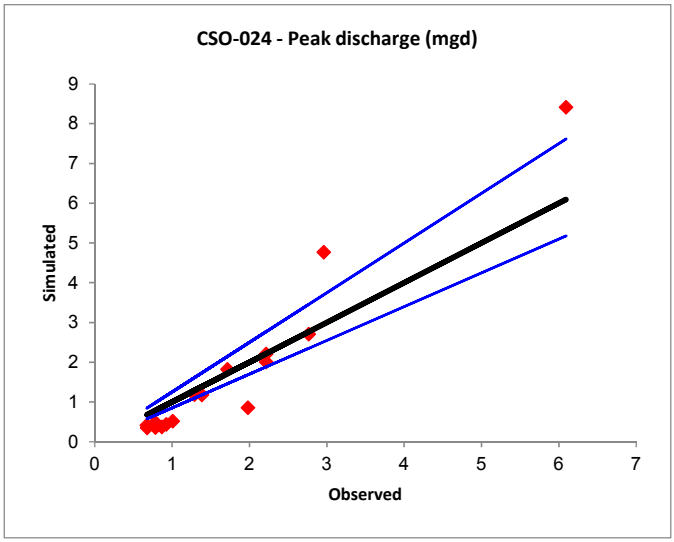

CSO-022 - Peak depth (ft)
Simulated
Observed
0
0.5
1
1.5
2
2.5
0.1
0.2
0.3
0.4
0.5

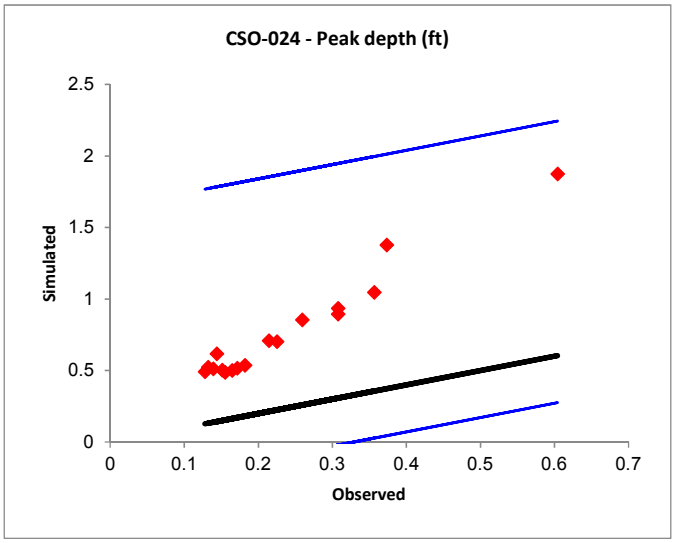

CSO-023 - Volume (Mgal)
Simulated
Observed
0
0.5
1
1.5
2
2.5
3

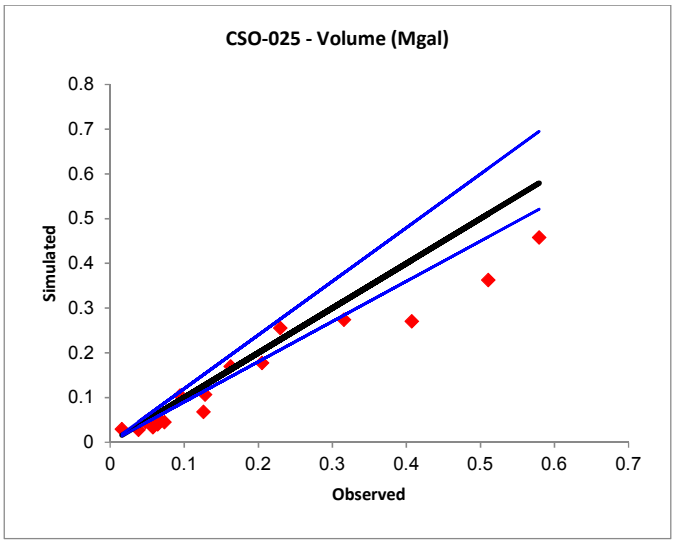

CSO-023 - Peak discharge (mgd)
Simulated
Observed
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15

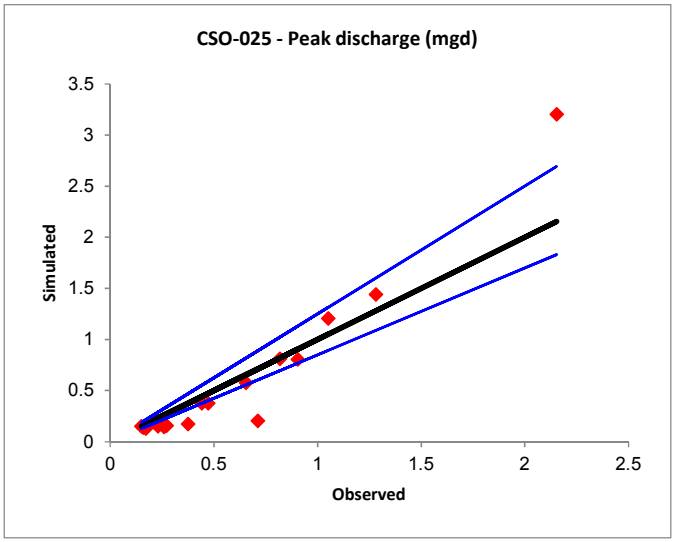

CSO-023 - Peak depth (ft)
Simulated
Observed
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
0.5
1
1.5
2
2.5
3

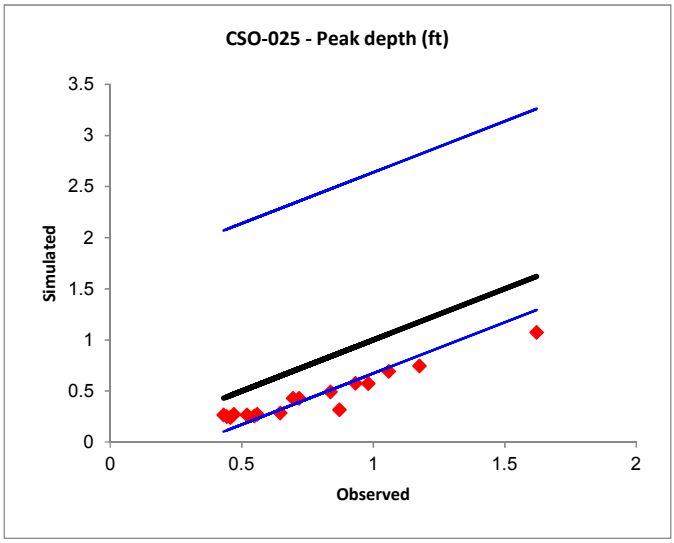

CSO-024 - Volume (Mgal)
Simulated
Observed
0
0.5
1
1.5
2
2.5
3

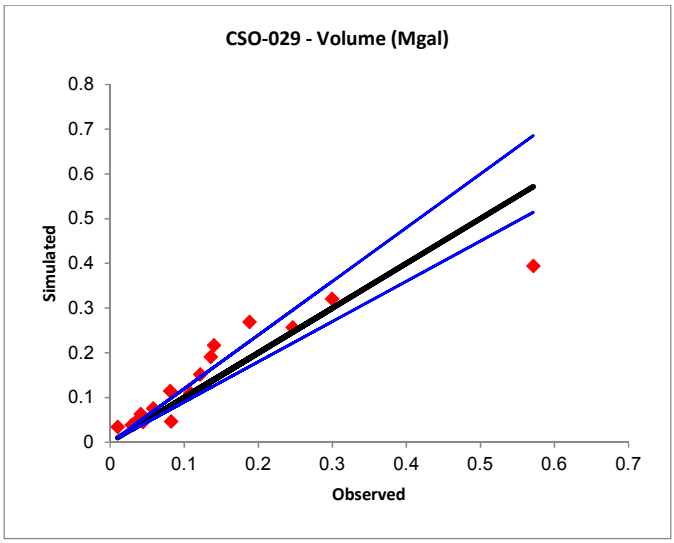

CSO-024 - Peak discharge (mgd)
Simulated
Observed
0
1
2
3
4
5
6
7
8
9

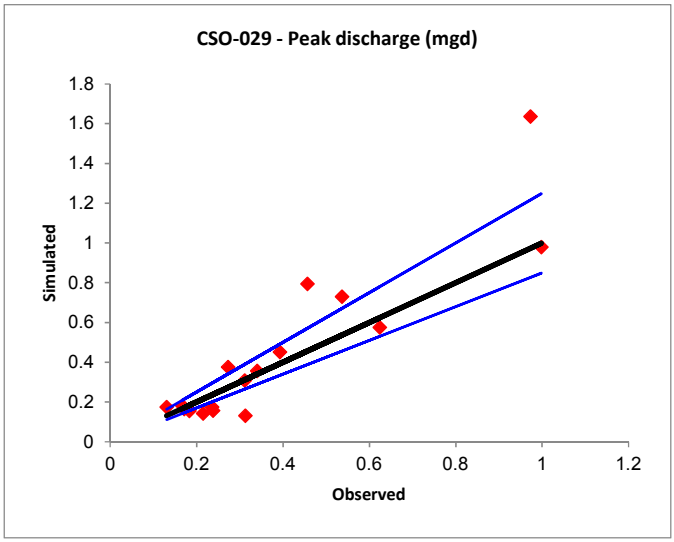

CSO-024 - Peak depth (ft)
Simulated
Observed
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1
1.5
2
2.5

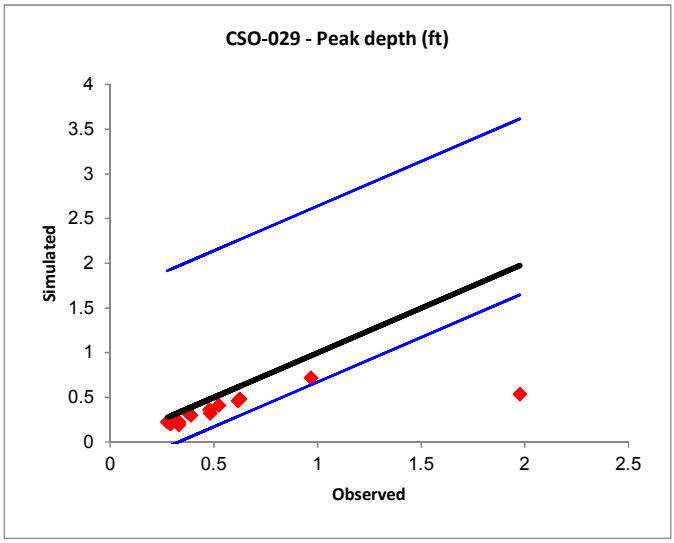

CSO-025 - Volume (Mgal)
Simulated
Observed
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8

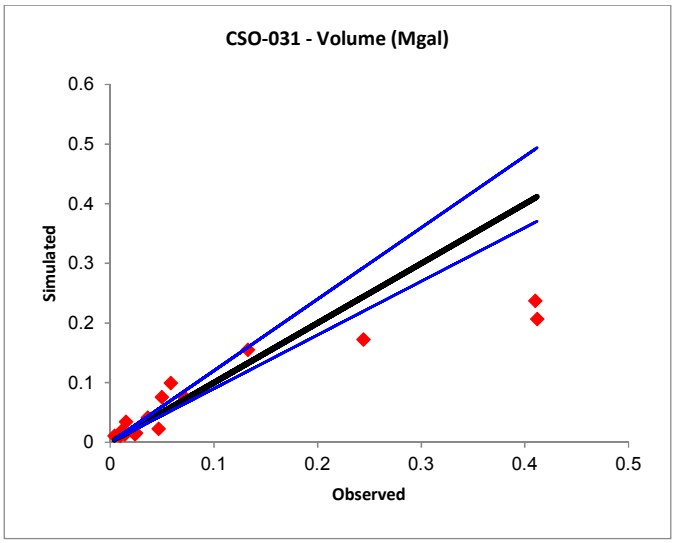

CSO-025 - Peak discharge (mgd)
Simulated
Observed
0
0.5
1
1.5
2
2.5
3
3.5

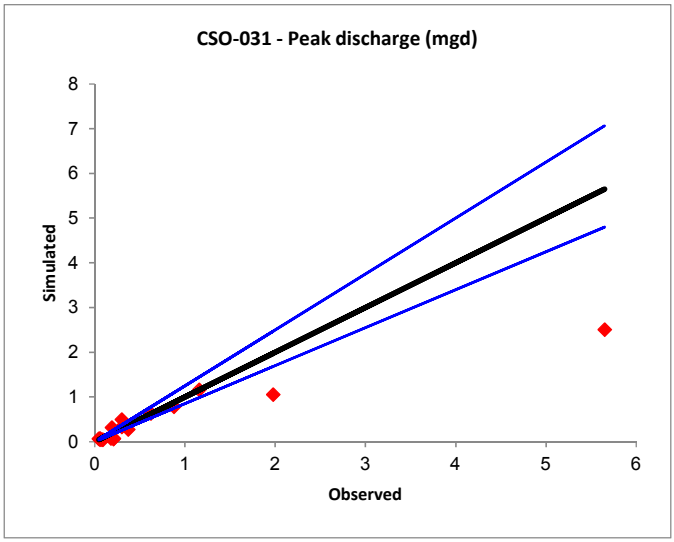

CSO-025 - Peak depth (ft)
Simulated
Observed
0
0.5
1
1.5
2
2.5
3
3.5

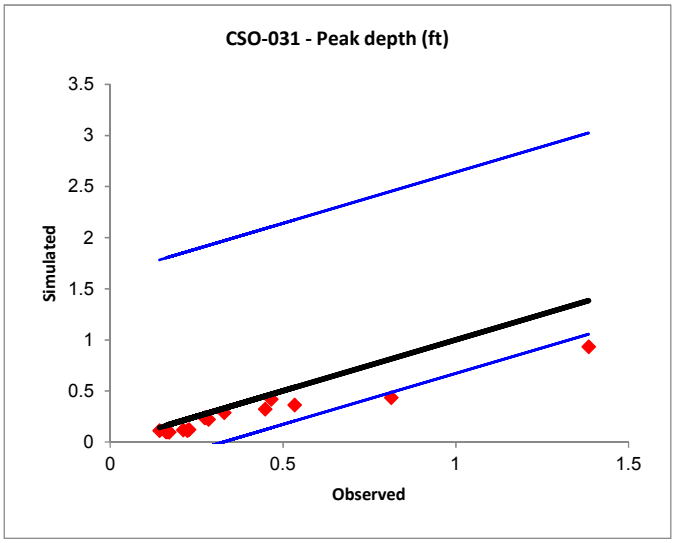

CSO-029 - Volume (Mgal)
Simulated
Observed
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8

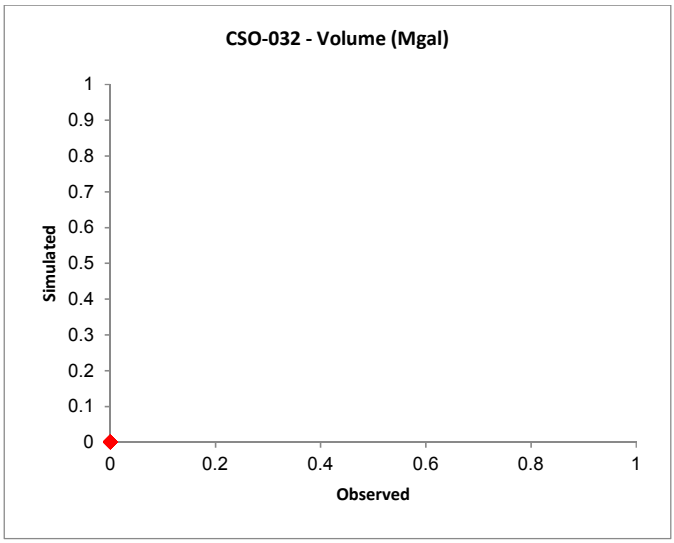

CSO-029 - Peak discharge (mgd)
Simulated
Observed
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8

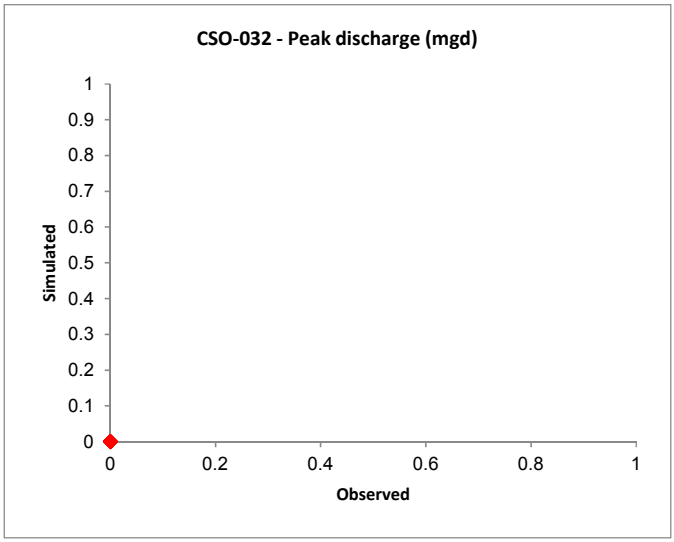

CSO-029 - Peak depth (ft)
Simulated
Observed
0
0.5
1
1.5
2
2.5
3
3.5
4

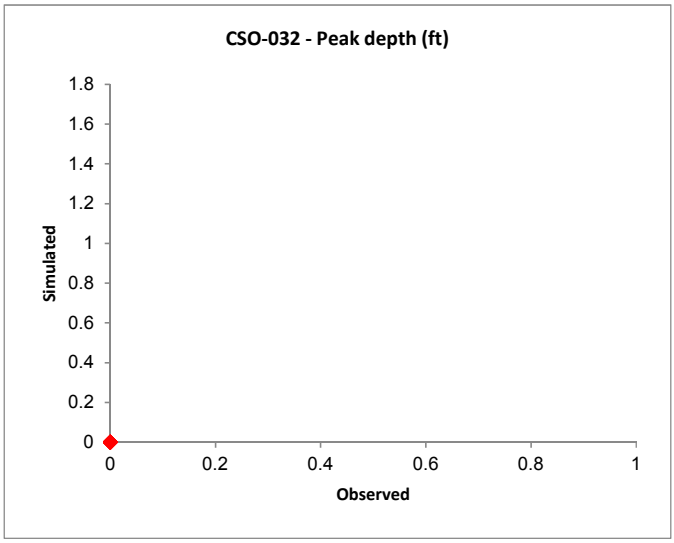

CSO-031 - Volume (Mgal)
Simulated
Observed
0
0.1
0.2
0.3
0.4
0.5
0.6


CSO-031 - Peak discharge (mgd)
Simulated
Observed
0
1
2
3
4
5
6
7
8


CSO-031 - Peak depth (ft)
Simulated
Observed
0
0.5
1
1.5
2
2.5
3
3.5


CSO-032 - Volume (Mgal)
Simulated
Observed
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.2
0.4
0.6
0.8
1


CSO-032 - Peak discharge (mgd)
Simulated
Observed
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.2
0.4
0.6
0.8
1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Simulated
Observed
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1.8
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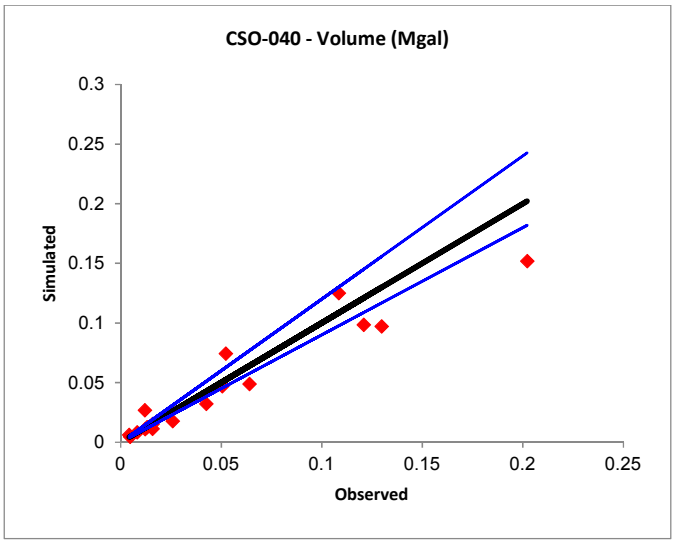
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Observed
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0.2
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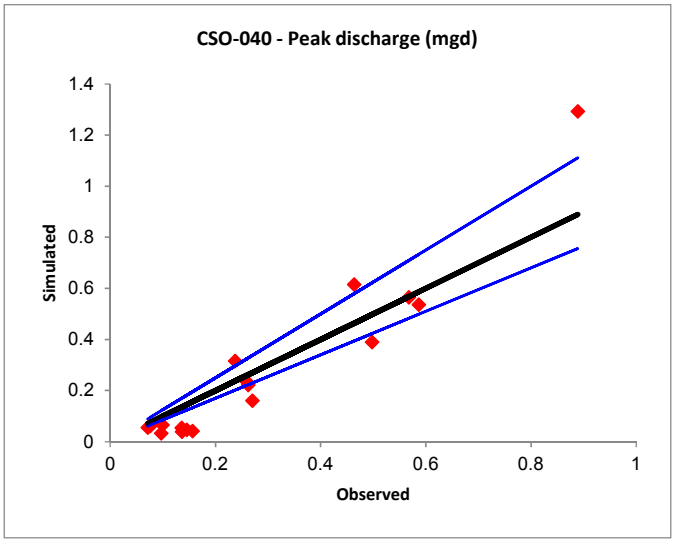
0.3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Observed
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0.4
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1
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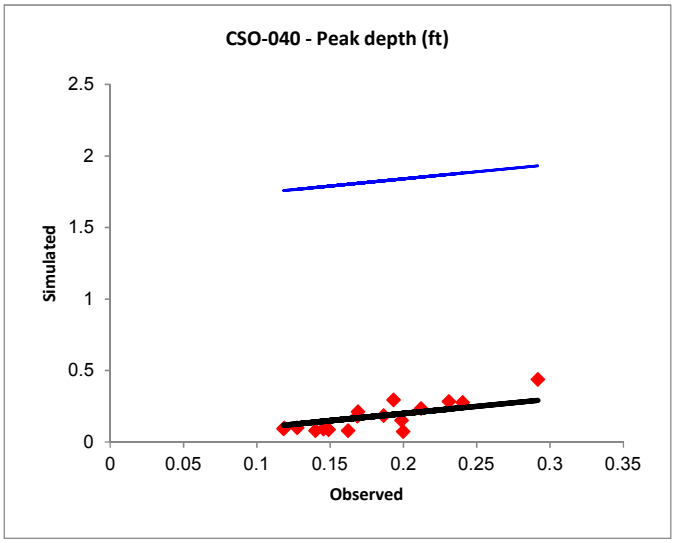
1.4


CSO-040 - Peak depth (ft)
Simulated
Observed
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0.5
1
1.5
2
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0.05
0.1
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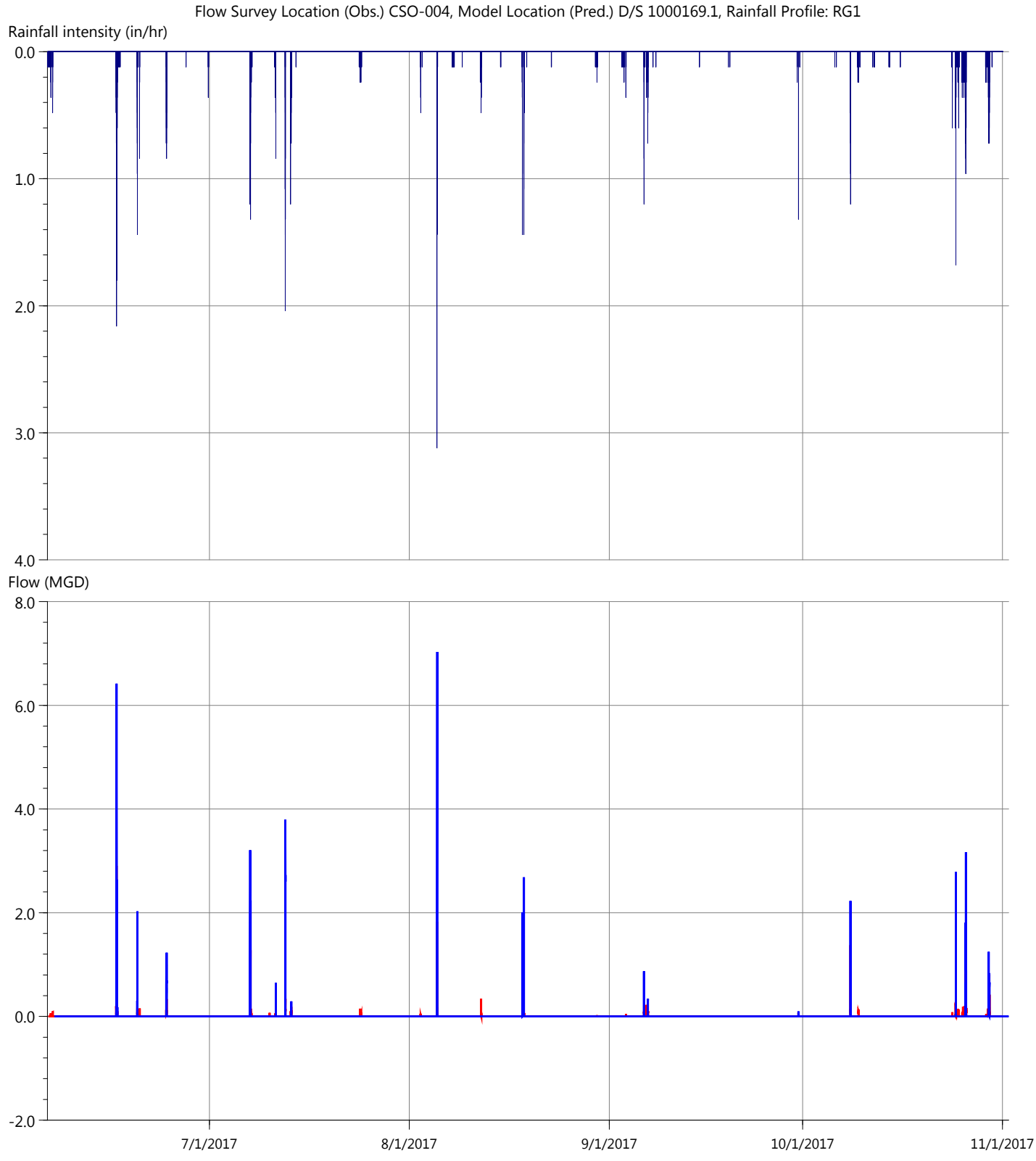
0.2
0.25
0.3
0.35

Appendix F

CSO Validation Plots – June-October 2017



Observed / Predicted Report (Custom graph) - Phase 2 CSO

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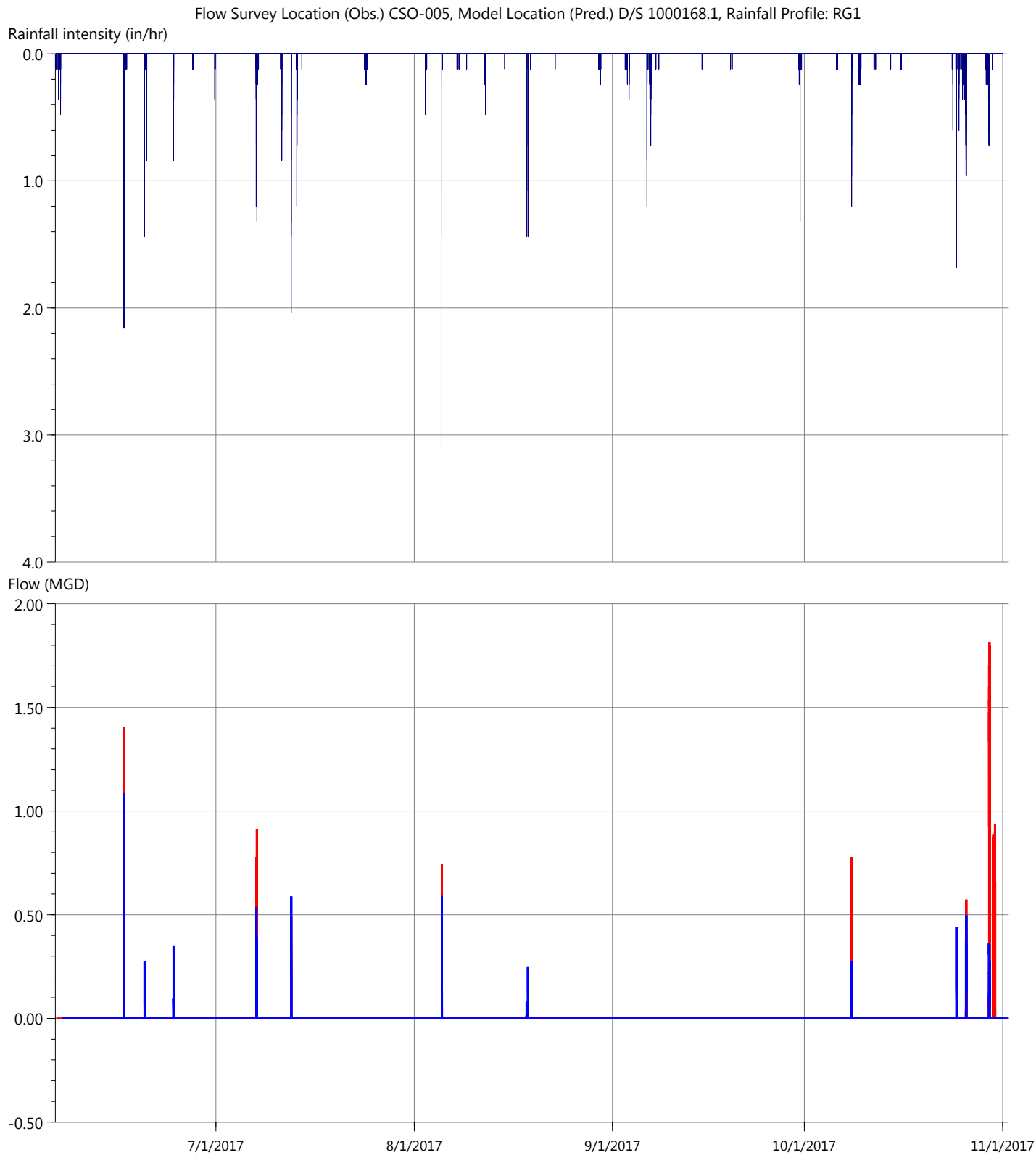

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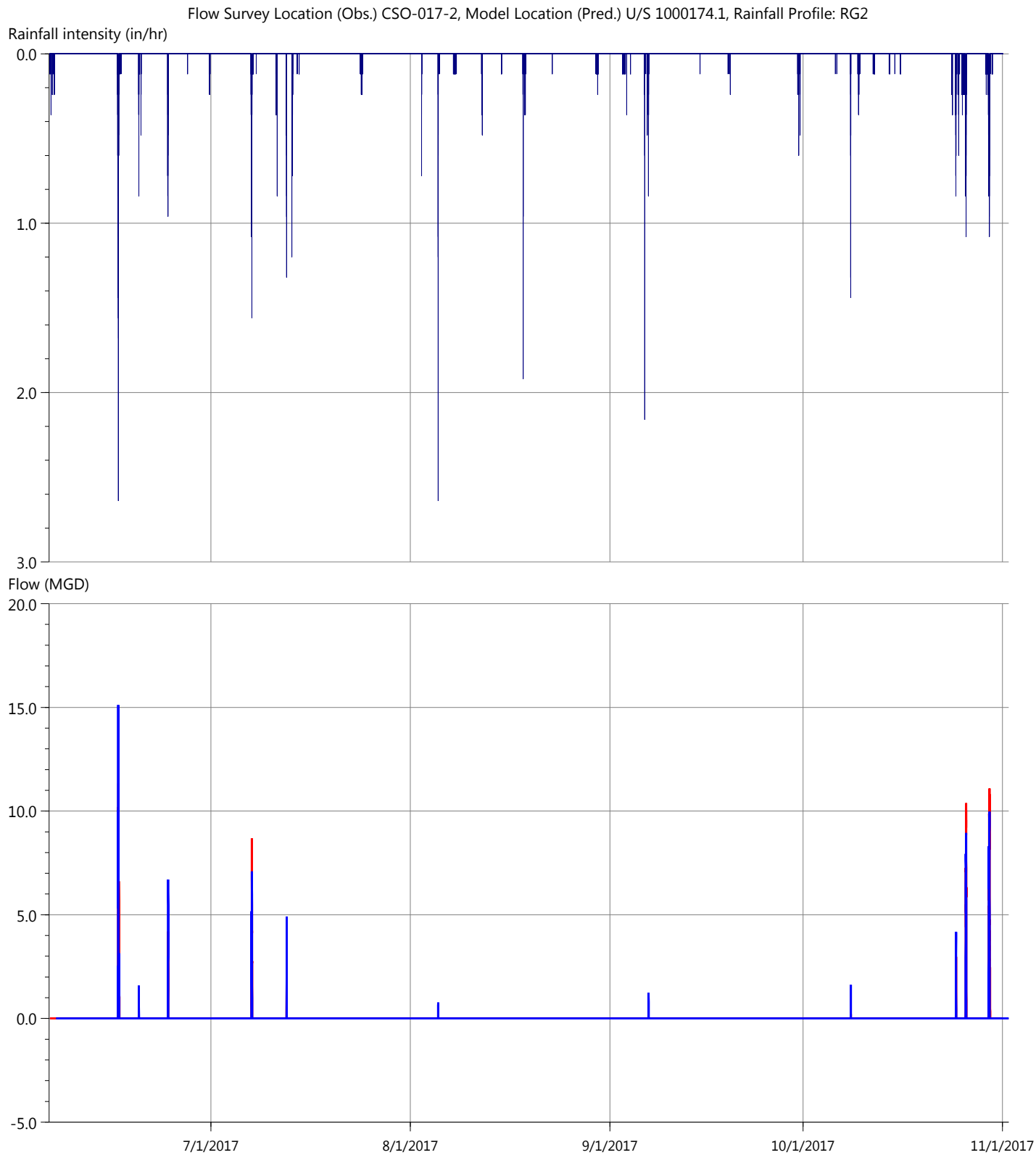

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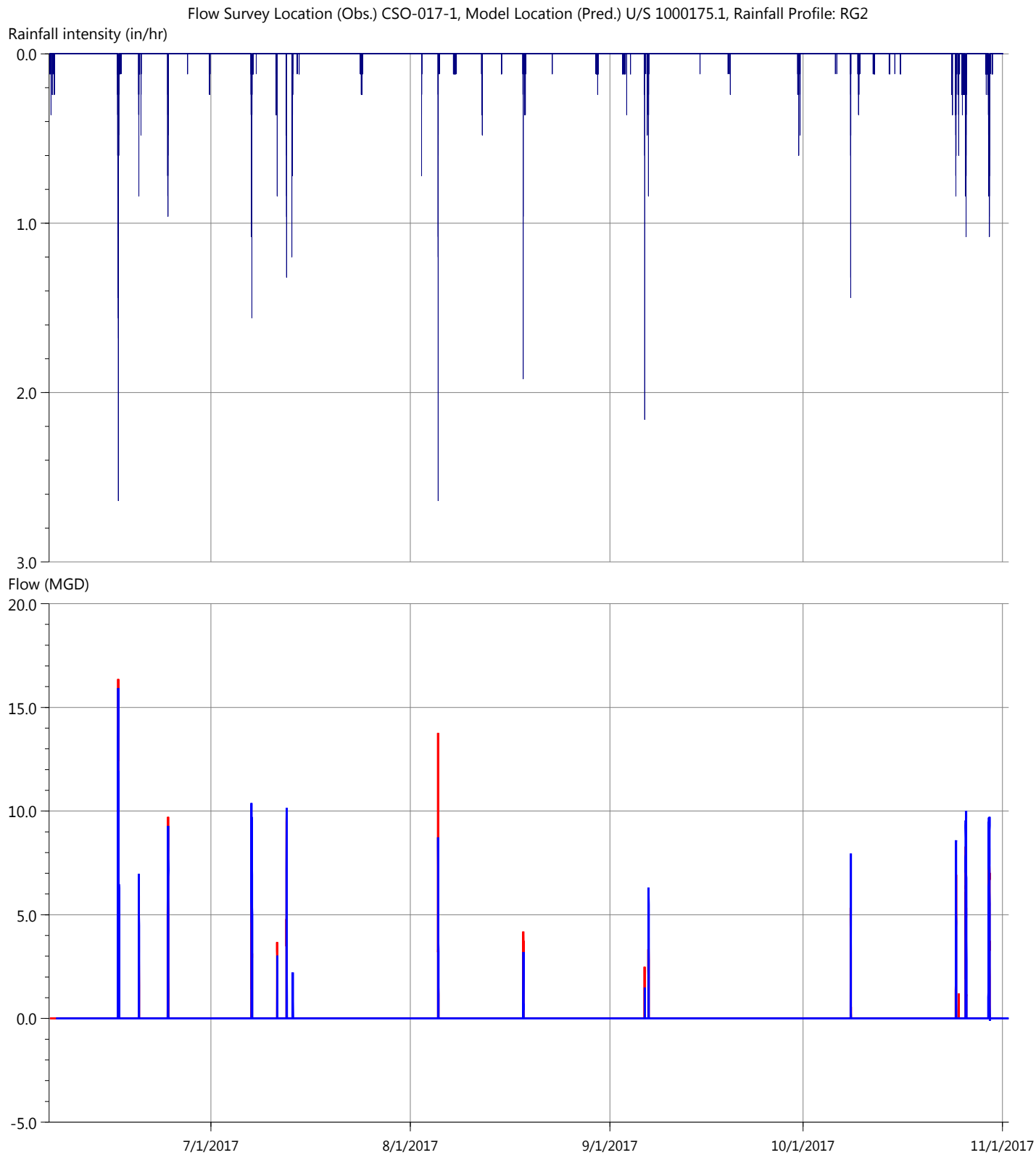

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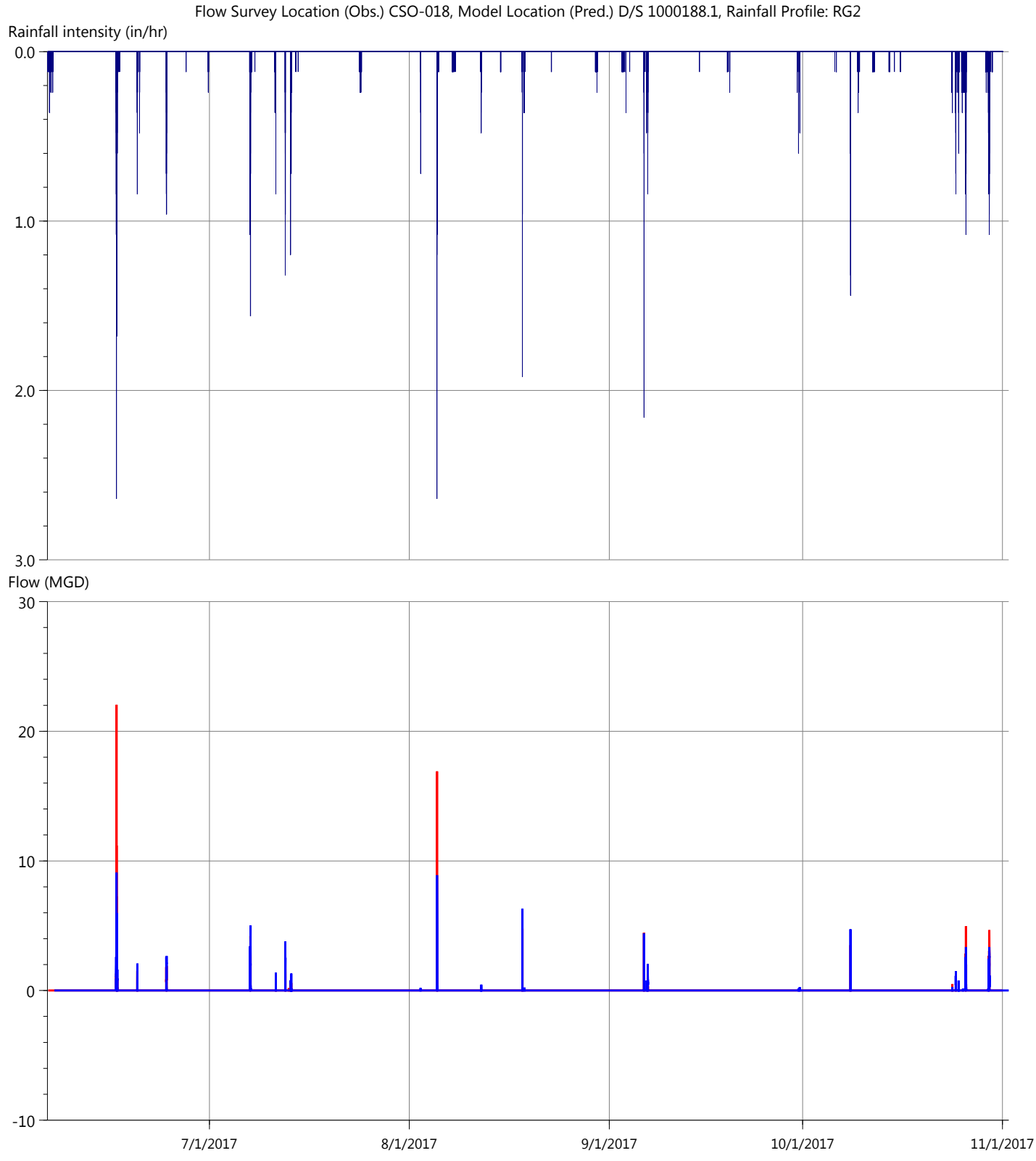

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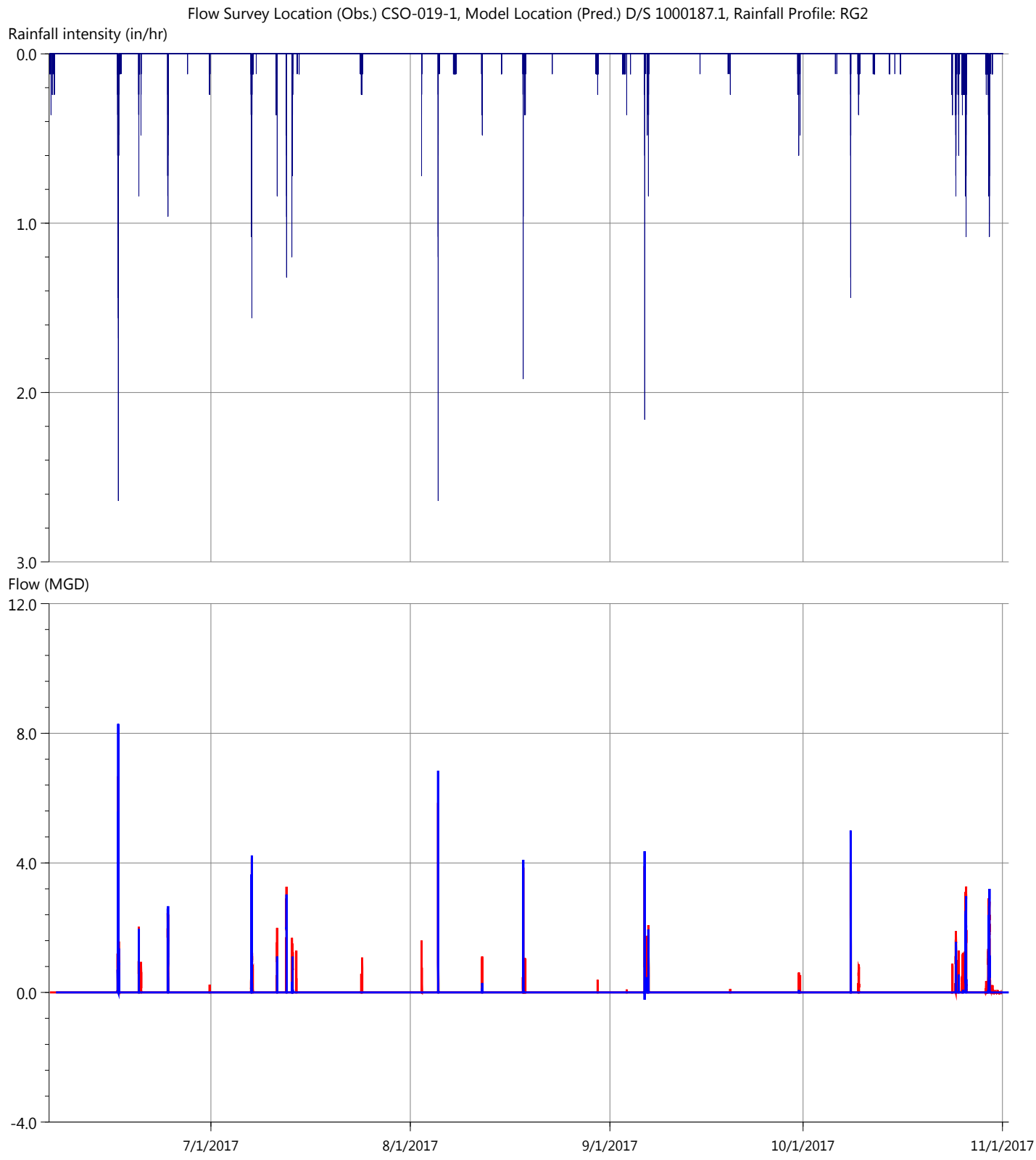

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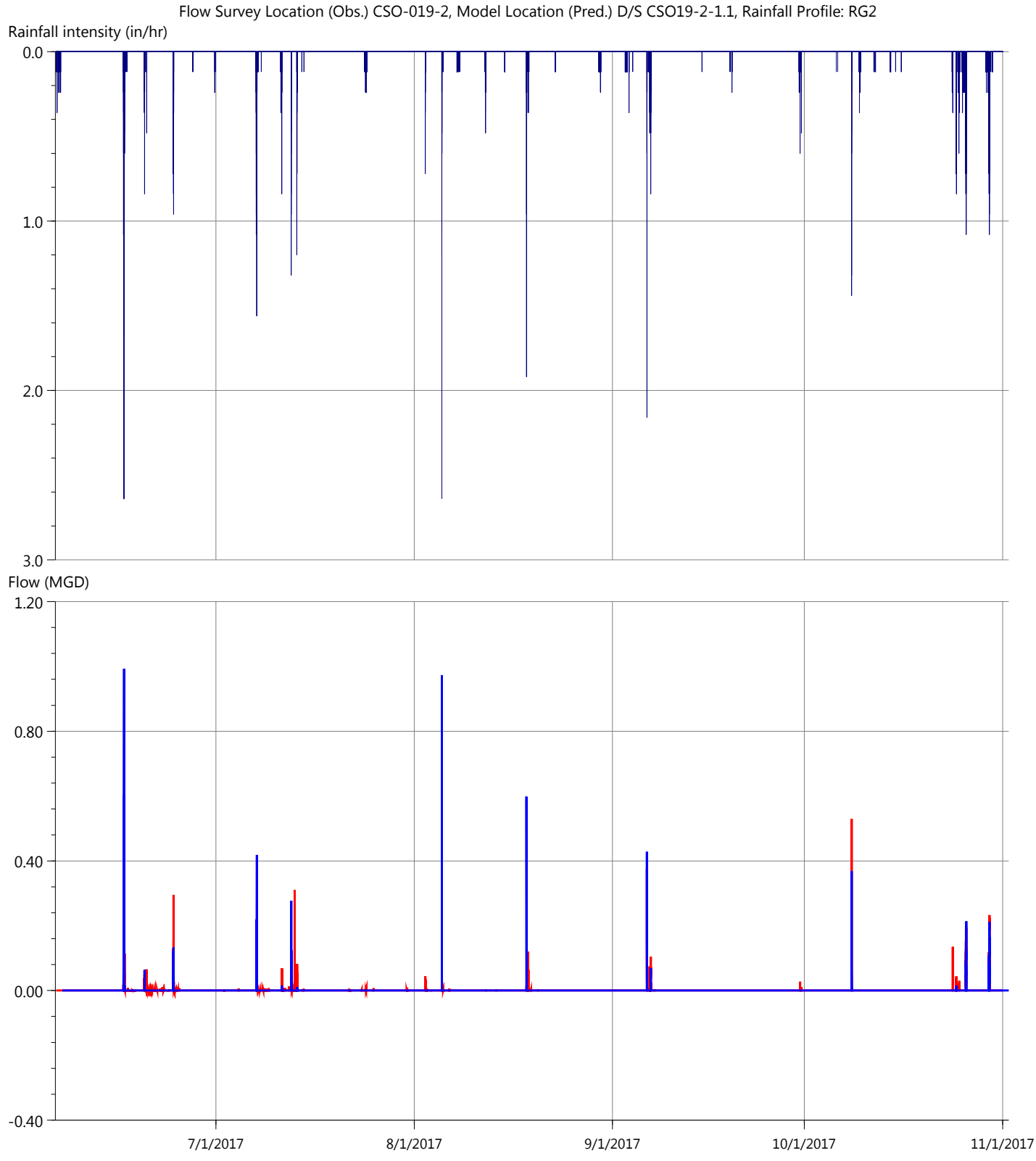

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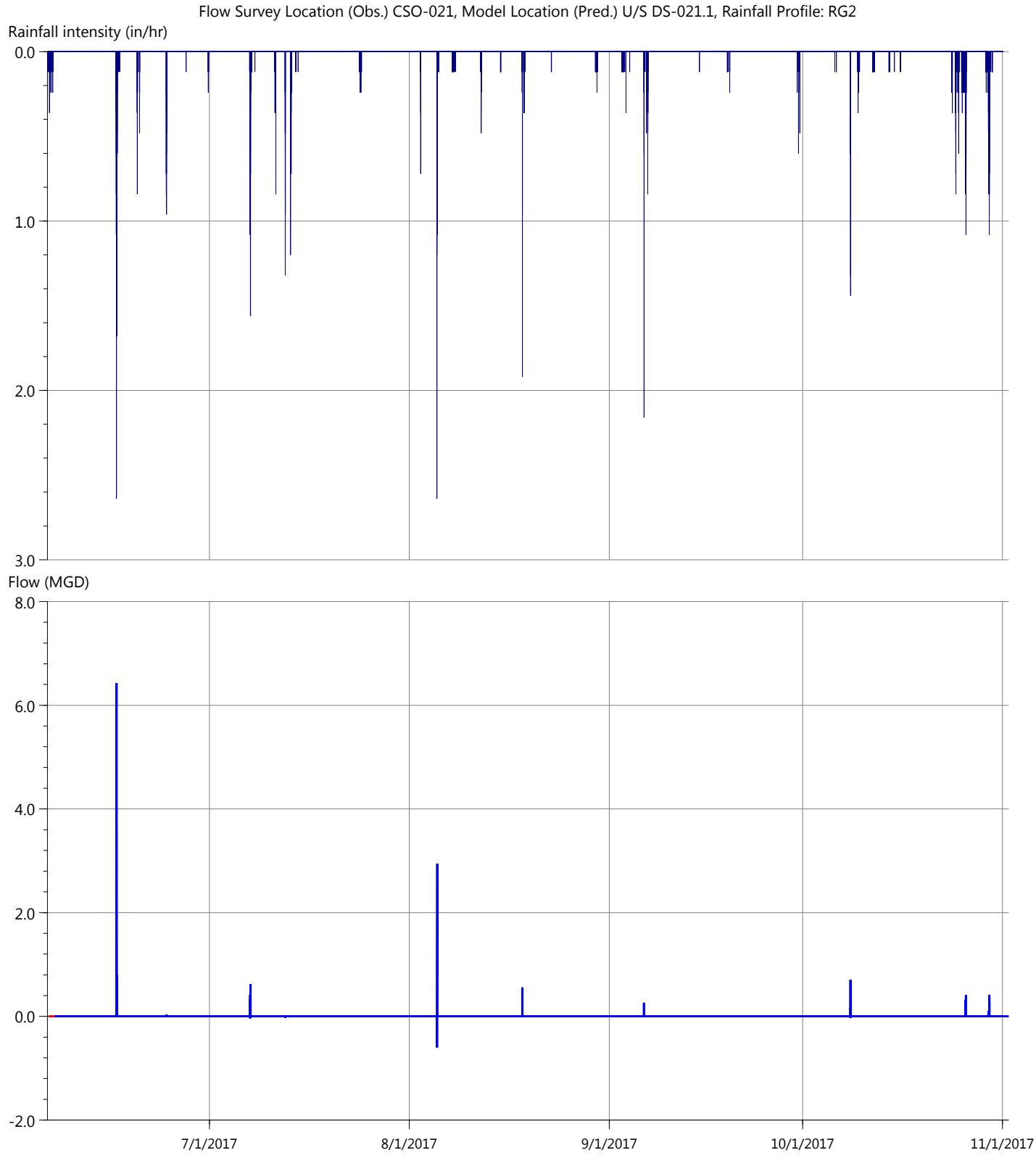

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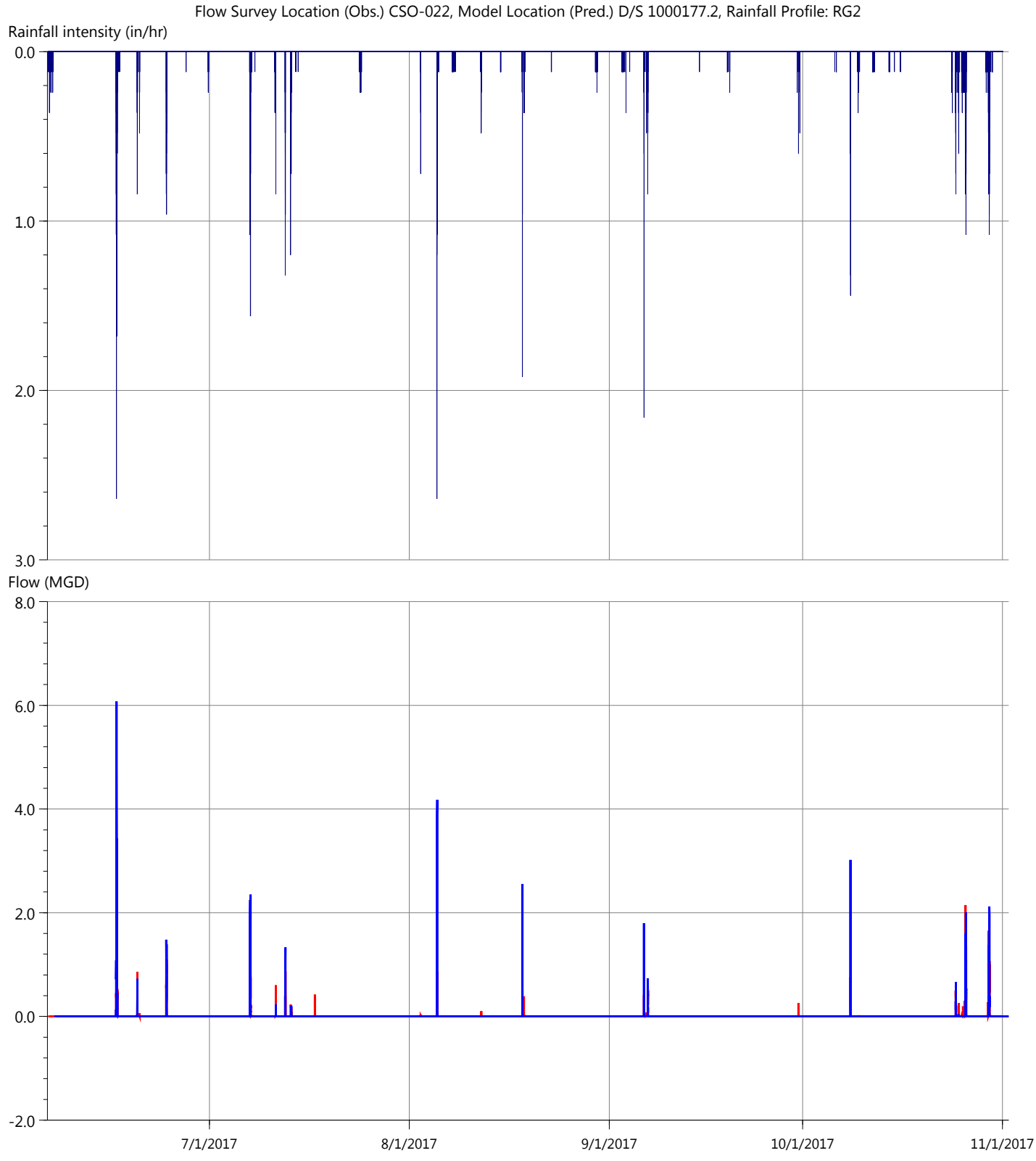

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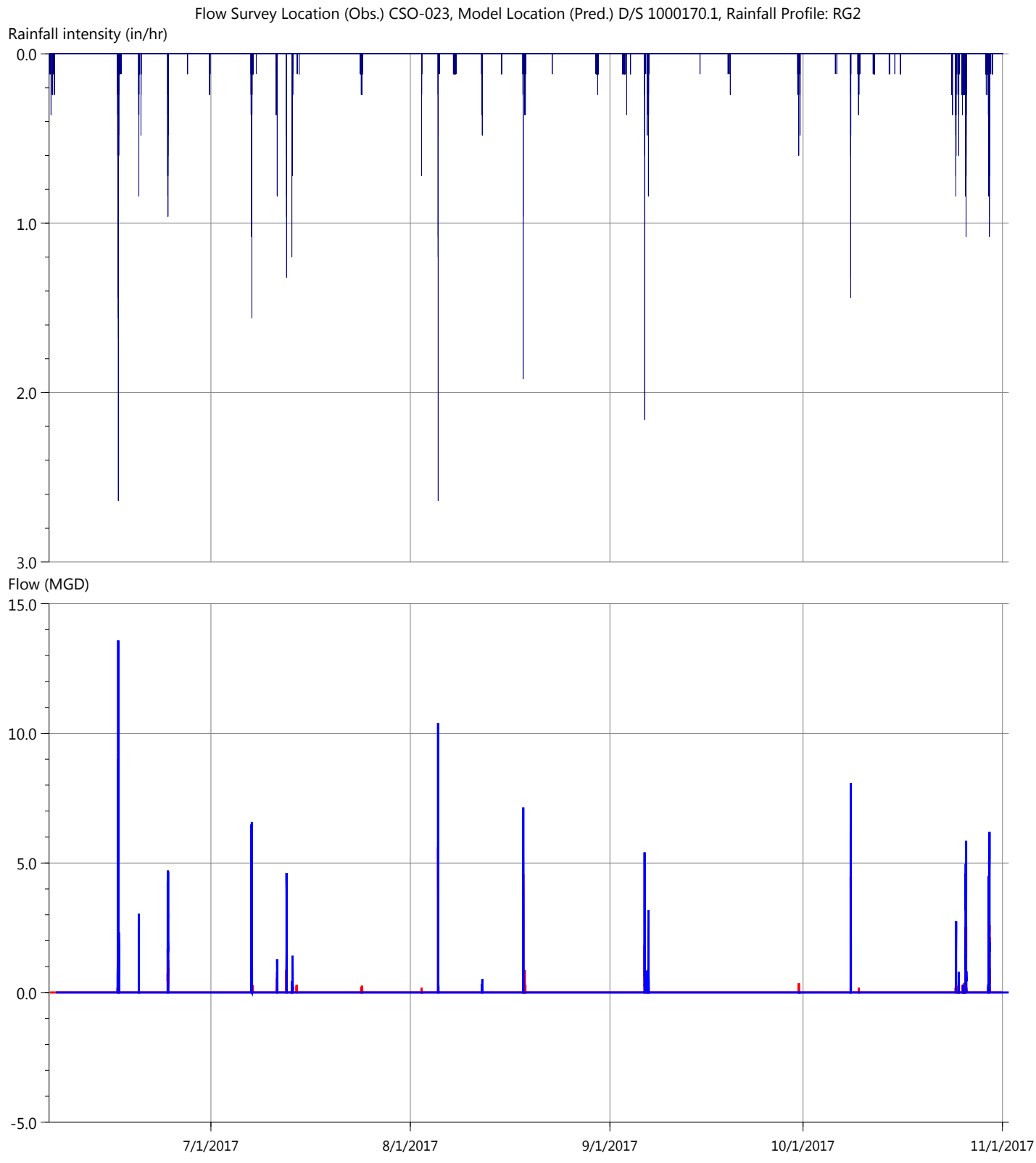

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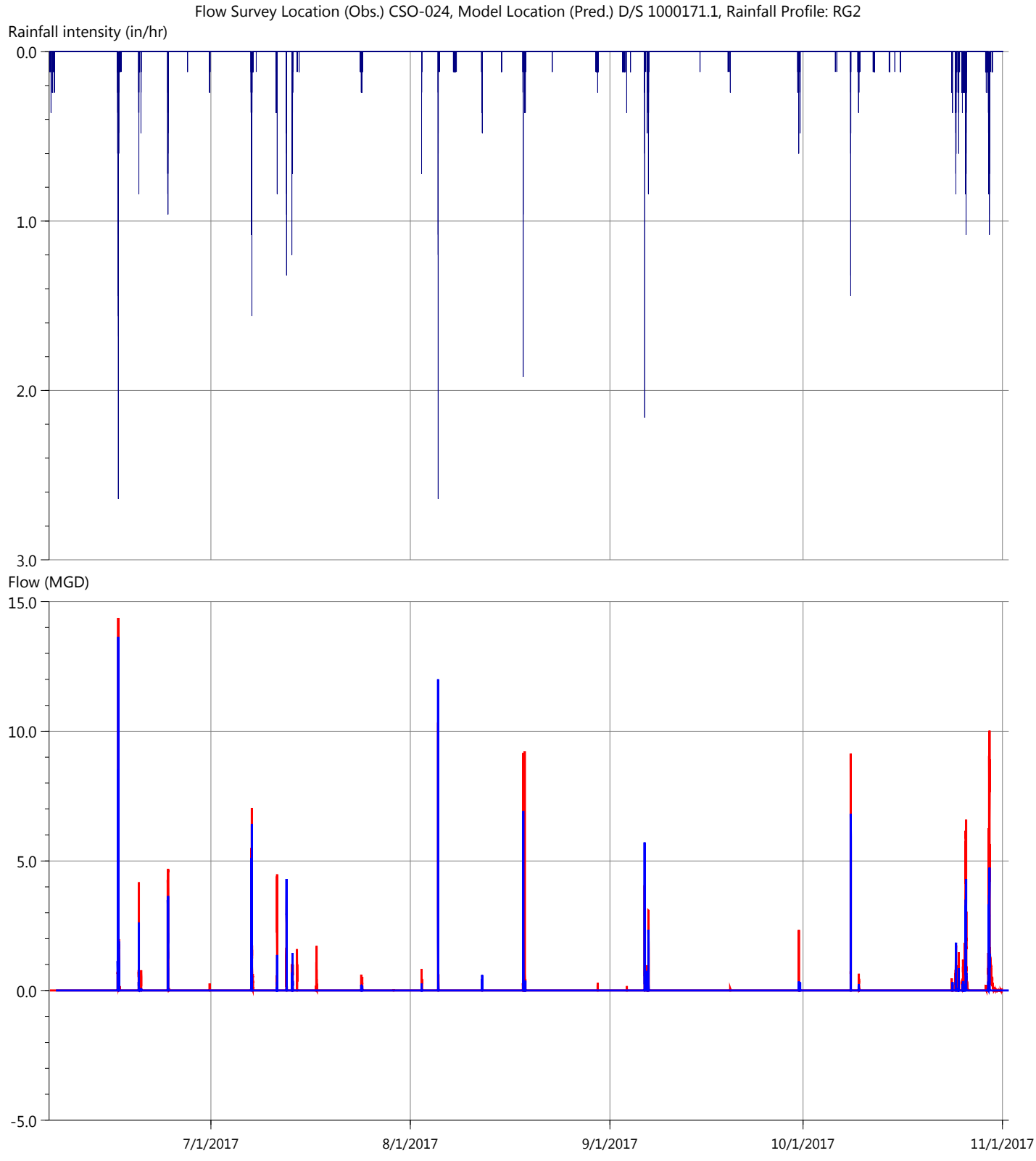

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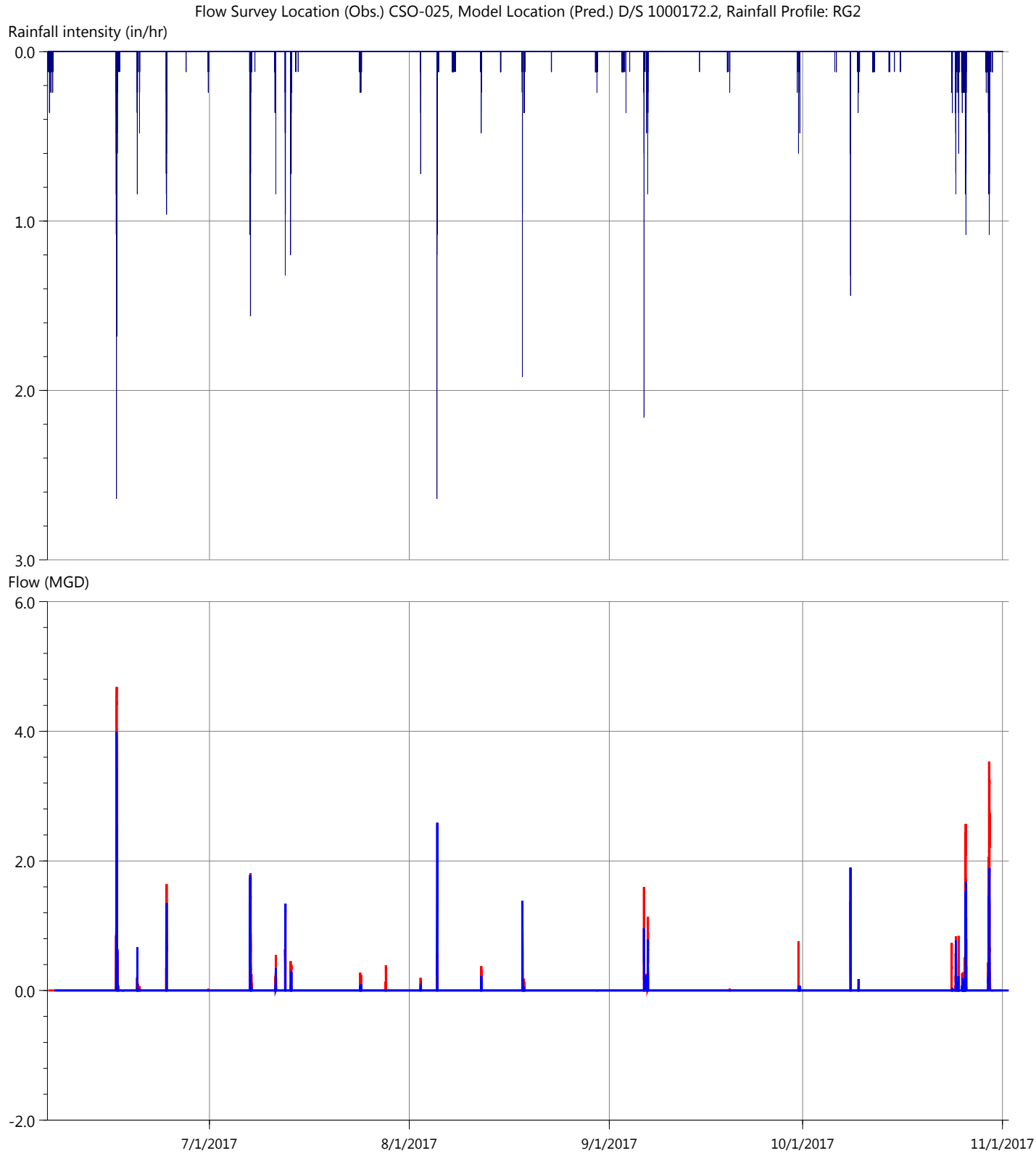

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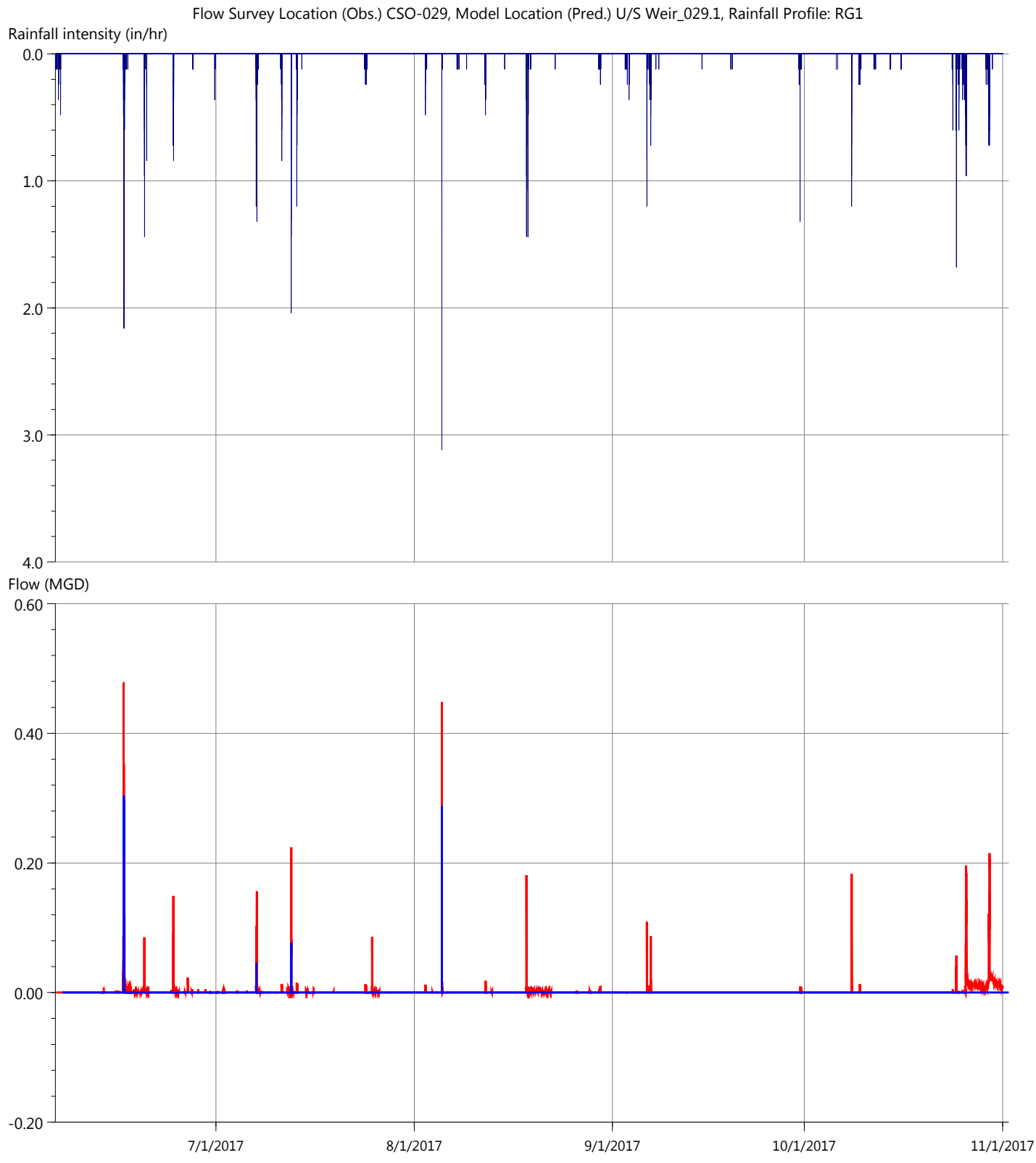

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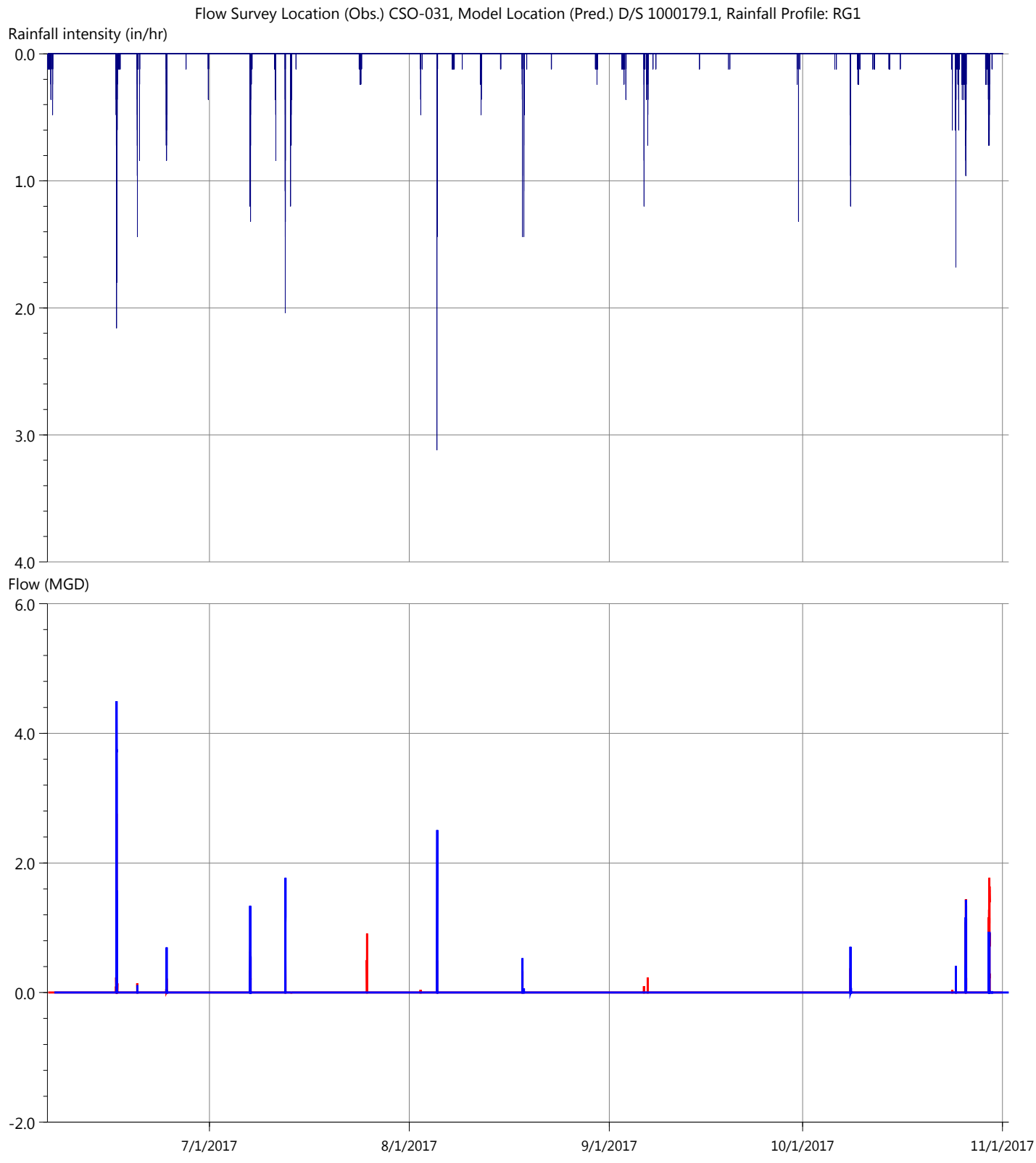

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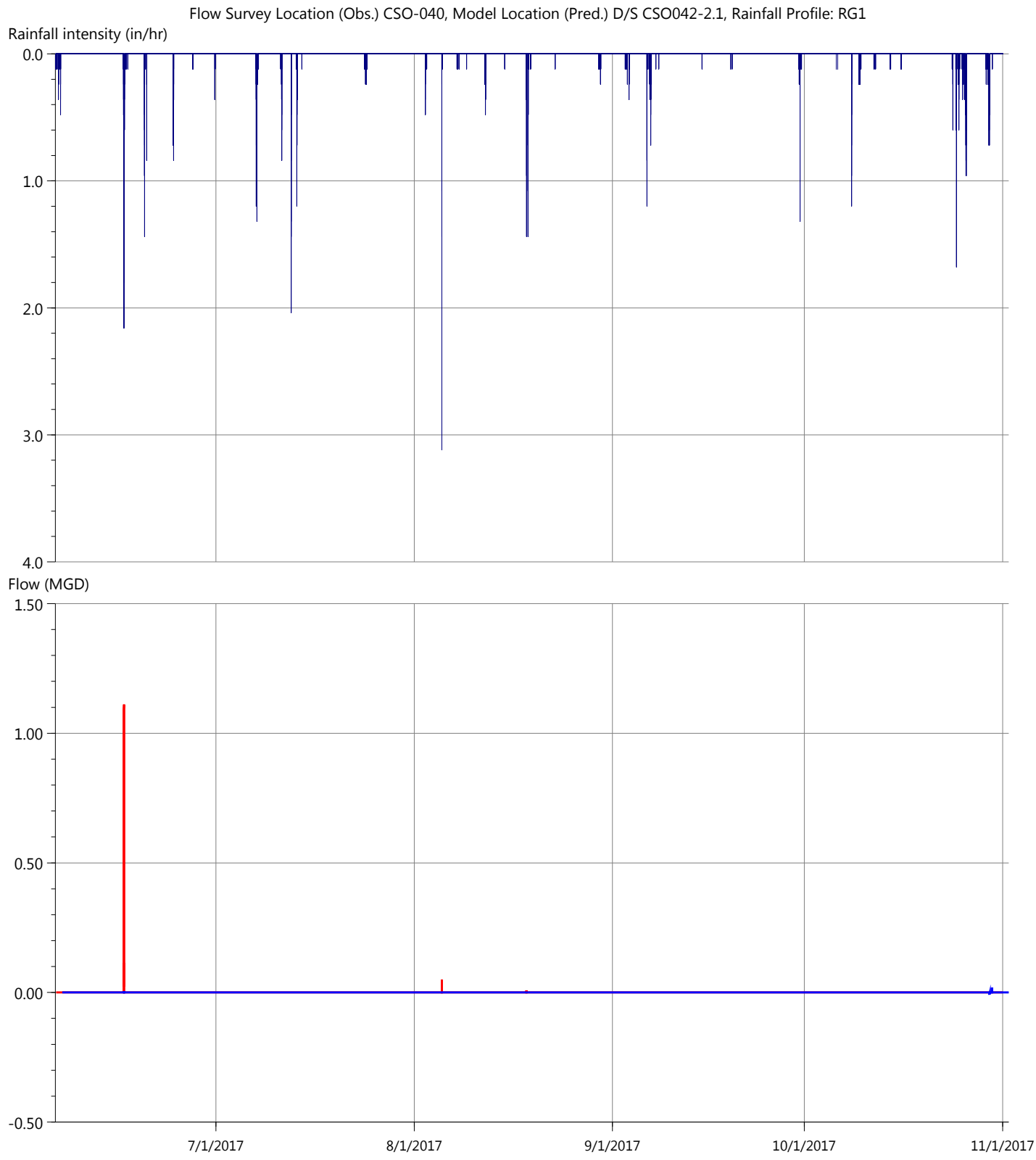

Observed / Predicted Report (Custom graph) - Phase 2 CSO

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Appendix G

CT DEEP Water Quality Standards

STATE OF CONNECTICUT

DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION

2016 INTEGRATED WATER QUALITY REPORT

Final - April 2017

This document has been established pursuant
to the requirements of Sections 305(b) and 303(d)
of the Federal Clean Water Act

/s/ Betsey Wingfield _____ 4/25/17 _____

Betsey Wingfield, Chief
Bureau of Water Protection and Land Reuse

Date

Robert J. Klee, Commissioner

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Table of Acronyms

303(d)	Section 303(d) of the Federal Clean Water Act, which requires States to employ corrective actions to address waters impaired by one or more pollutants (also referred to the 303(d) list)
305(b)	Section 305(b) of the Federal Clean Water Act, which requires States to assess and report on the status of their waters every two years
319(a)	Section 319(a) of the Federal Clean Water Act, which requires States to prepare a report that identifies waters impaired by nonpoint source pollution, its sources and programs to reduce such pollution
ADB	Assessment Database
ALUS	Aquatic Life Use Support
AU	Assessment Unit; a section of a waterbody for which water quality is determined
CFU	Colony Forming Unit for bacteria enumeration
CSO	Combined Sewer Overflow
CT CALM	Connecticut Consolidated Assessment and Listing Methodology
CT DA/BA	Connecticut Department of Agriculture, Bureau of Aquaculture
CT DEP	Connecticut Department of Environmental Protection (previous name of Connecticut Department of Energy and Environmental Protection)
CT DPH	Connecticut Department of Public Health
CT WQS	Connecticut Water Quality Standards
CWA	(Federal) Clean Water Act
CWF	Connecticut Clean Water Fund
DEEP	Connecticut Department of Energy and Environmental Protection formally known as Connecticut Department of Environmental Protection
IWQR	Integrated Water Quality Report
IWL	Impaired Waters List; more formally known as the List of Connecticut Waterbodies Not Meeting Water Quality Standards
MMI	Multimetric Index; used to assess the biological communities for Aquatic Life Use Support (ALUS)
NHD	National Hydrography Dataset
NSSP-MO	National Shellfish Sanitation Program Model Ordinance
QAPP	Quality Assurance Project Plan
RBP	Rapid Bioassessment Protocols
RBV	River Bioassessment for Volunteers
SDWA	(Federal) Safe Drinking Water Act
TMDL	Total Maximum Daily Load
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WQS	Water Quality Standards
WQX	EPA's National Data Water Quality Data Exchange

Introduction

This report was prepared to satisfy statutory reporting requirements pursuant to Sections 305(b) and 303(d) of the federal Clean Water Act (CWA). CWA Section 305(b) requires each State to monitor, assess and report on the quality of its waters relative to attainment of designated uses established by the State's Water Quality Standards (CT WQS). In Connecticut, the Department of Energy and Environmental Protection (DEEP) is the agency with primary responsibilities to report on these CWA activities. Section 303(d) of the CWA requires each State identify and prioritize water quality limited waterbodies and develop Total Maximum Daily Loads (TMDLs) or other management actions consistent with Water Quality Standards. These reports are brought together in the Integrated Water Quality Report (IWQR) which is submitted to the United States Environmental Protection Agency (US EPA) every two years for review and, in the case of waters identified pursuant to Section 303(d), US EPA approval.

Water quality in Connecticut has improved over the last few decades as a result of protective laws, remediation efforts and a substantial investment in improved wastewater treatment. For example, the latest statewide assessment showed that 77% of the wadeable streams in Connecticut are healthy and meet aquatic life use support goals. Although difficult to compare with historic data because statistical surveys were not completed in the early years, it is appropriate to point out that the percentage of streams meeting aquatic life goals during the late 1970's and early 1980's was much lower.

In spite of tremendous progress in water quality, there are still gains to be made particularly in the area of nonpoint source (NPS) stormwater management, and infrastructure maintenance and improvements. Many of the remaining causes of impairment of Connecticut surface waters are difficult to identify (e.g., "cause unknown") and/or correct (e.g., Combined Sewer Overflows, urban stormwater runoff). Initiatives to maintain and improve water quality will require input and cooperation between from the numerous public and private interests that regulate, oversee and land use management and environmental policy, especially at the local level.

Water Pollution Control Programs

Maintenance and Improvements of Infrastructure

Public funding for improved sewage system infrastructure in Connecticut is substantial. The Connecticut Clean Water Fund (CWF) is the state's environmental infrastructure assistance program. The CWF program is defined by Sections 22a-475 through 22a-483 of the Connecticut General Statutes (CGS) and by regulations adopted February 19, 1992 pursuant to CGS 22a-482. The CWF is a nationally recognized program administered by the Office of the Treasurer and DEEP that provides grants and low interest loans to municipalities for wastewater infrastructure improvement projects.

Since its inception in 1986 through FY 2002, the CWF program was supported with an average annual authorization of $48 million in General Obligation bonds, which support the grants. This investment has reaped great benefits to public health, water quality, economic development, and the beginning of restoring an oxygen depleted area in western Long Island Sound.

At no time in the history of the CWF has the demand for construction funding been higher. DEEP estimates wastewater infrastructure needs of nearly 5 billion dollars over the next twenty years. The projects include combined sewer overflow (CSO) correction projects to eliminate the discharge of nearly 2 billion gallons of combined sewage into Connecticut's waterways each year, denitrification projects necessary to restore the health of Long Island Sound, emerging water quality issues such as phosphorus removal, the need for

increased treatment capacity for the state's growth and economic development and the continued maintenance of existing wastewater infrastructure.

The priority list typically funds projects to support wastewater infrastructure projects whose implementation is considered significant to reduce serious negative impacts on water quality in our state. These projects include nitrogen removal projects in order to meet the TMDL for the Long Island Sound; phosphorus removal projects in order to comply with effluent limits that are being incorporated into NPDES permit renewals; and CSO improvement projects in our state's largest cities. Details of fundable project and program detail can be found in the Clean Water Fund Priority List.

Prediction of the economic costs to meet the goals of the Clean Water Act is accomplished through the federally sponsored Clean Watersheds Needs Survey .The survey, which is a joint venture among the individual states and the US EPA, results in a report to the United States Congress delineating the level of economic needs necessary to address water quality problems related to municipal wastewater conveyance and treatment, municipal stormwater management, combined sewer overflow correction, and non-point source pollution control.

Major gains in water quality have been achieved through these public investments, their analogs in the private sector, and protective legislation. Further maintenance and improvement of the quality of water resources will require continued public and private financial support. Essentially all aspects of Connecticut's clean water programs create long and short-term jobs. Upgrading of sewage treatment facilities, the extension of sewer lines, installation of industrial treatment facilities and ground water remediation all generate jobs in the design, engineering and construction industries. Operation and maintenance of these facilities creates long-term employment.

Nonpoint Source Pollution

Most nonpoint source pollution (NPS) is the result of human activities that generate diffuse pollutants over a wide geographic area. Precipitation washes these pollutants off of the landscape, creating polluted runoff that impacts the waterbodies into which it flows. However, NPS pollution may also be associated with non-precipitation events such as: malfunctioning septic systems, hydromodifications, atmospheric deposition, eroding streambanks and mine drainage. DEEP's NPS efforts work to abate known water quality impairments and prevent significant threats to water quality from nonpoint source pollution.

Connecticut's NPS efforts includes all the components required under the CWA Section 319(h) (Nonpoint Source Pollution Management Programs). DEEP has developed a watershed management strategy that establishes a framework to work through a networked approach with federal, state, and municipal governments and non-government agencies and organizations to conduct watershed management and strengthen the state's ability to control nonpoint source pollution. DEEP has organized and focused base program staff, establishing three "major basin" managers, and continues to target grant funds based on watershed priorities. Consistent with this approach, DEEP offers competitive annual Section 319 NPS grants to watershed initiatives for the priority watersheds, and to statewide nonpoint source initiatives.

DEEP NPS efforts are supported by both federal and state funds. CWA Section 319 funds support staff involved in NPS efforts as wells as grants for planning and implementation of environmental programs and projects with the goal of improving water quality. DEEP State and federal funds support staff in other units that are involved in various aspects of NPS management. State bond and other special legislative acts provide funds for projects and grant programs targeting specific resources that address NPS pollution. Coastal Zone Management Act funds, awarded by the National Oceanic and Atmospheric Administration, support CT DEEP Office of Long Island Sound Programs NPS efforts in the coastal area. Numerous other funding sources, from other federal and state agencies, and private foundations, are utilized when available.

Unlike wastewater infrastructure initiatives, the costs and benefits accrued from NPS pollution management measures are not as easily measured. This is due to several factors: projects are often funded by contributions from a combination of state, federal and local agencies as well as from landowners, volunteer groups, foundations, businesses which may include monetary support as well as in-kind services; NPS controls take many shapes and forms and can be applied as structural or non-structural measures; projects can span several years; and many NPS efforts are focused on education, as a way to encourage adoption of recommended practices.

Educational components of NPS Programs often focus on preventative measures to keep high quality waters healthy. For example, maintenance of high quality potable water supplies is critical to the health and economic well-being of every resident. Likewise, clean water for swimming, fishing, and boating is extremely important to quality of life issues such as commercial fishing, marine industries and recreation all of which have associated economic benefits to citizens and generate tax revenues. DEEP has initiated research (http://www.ct.gov/deep/imperviouscoverstudies) to collect information on high quality watersheds in Connecticut and these studies can begin to identify high quality water resources to the attention of Connecticut's citizens.

DEEP has focused on increasing awareness of Low Impact Development (LID) techniques for reducing stormwater and NPS runoff by working with our partners at the federal, state and local levels to provide information, educational materials and technical assistance in the application of LID techniques, building on existing programs such as the Governor's Responsible Growth Initiative, the University of Connecticut's Nonpoint Education for Municipal Officials (NEMO) program and US EPA's Smart Growth Program. The goal is to build better relationships and promote LID management practices with local land use agencies, academic institutions, nonprofit groups, the building industry and the public. Incorporating LID into land use plans can decrease impervious surfaces and limit runoff, leading to improved water quality and recharge of our rivers, streams and groundwater supplies.

IWQR Report Overview

Chapter 1, *Consolidated Assessment and Listing Methodology* (CT CALM) describes the procedure used by the DEEP to assess the quality of the State's waters relative to attainment of Connecticut Water Quality Standards (CT WQS). The CT CALM serves to document the protocols used by DEEP to assess water quality data as well as establishing minimum standards for data acceptability to insure that only credible data are used to perform the assessments. Although DEEP relies primarily on data collected as part of our Ambient Monitoring and Assessment Program, data from other state and federal agencies, local governments, drinking water utilities, volunteer organizations, and academic sources are also solicited and considered when making assessments.

Chapter 2, Clean Water Act Section *305(b) Assessment Results* provides a series of tables presenting the results of DEEP's assessment of all readily available data relating to designated use attainment in Connecticut waters. Designated uses include "habitat for fish and aquatic life", also referred to as Aquatic Life Use Support (ALUS), "recreation", and "fish consumption", reflecting the principal designated uses assigned to all waters. The tables in Chapter 2 are organized in ascending order by waterbody ID number. Inland waters (rivers, streams, and lakes) are presented first, followed by estuarine waterbody segments.

Chapter 3, *Waterbodies Identified for Restoration and Protection Strategies Pursuant to Section 303 of the Clean Water Act,* provides additional information concerning water quality limited waterbodies, such as those assessed waters that do not currently meet water quality standards, commonly referred to as "impaired waters". This Chapter also provides information on the identification of stressors which impact water quality and the development of TMDLs or other appropriate management actions to restore or protect surface waters in Connecticut.

Chapter 1 -Connecticut Consolidated Assessment and Listing Methodology (CT CALM)

Introduction

DEEP submits an IWQR to the US EPA to fulfill the reporting requirements of CWA Sections 305(b) and 303(d). The CT CALM documents the decision-making process for assessing and reporting in the IWQR on the quality of surface waters of the state. The assessments conducted during this report cycle are based on the CT WQS established on October 10, 2013 and approved by EPA on December 11, 2013. CT WQS are adopted as regulations and are contained in Sections 22a-426-1 through 22a-426-9 of the Regulations of Connecticut State Agencies.

The assessment and listing process outlined here should be viewed in context of the CWA and CT WQS. The CWA is the primary federal law that protects our nation's surface waters, including lakes, rivers, wetlands, estuaries and ocean waters. In authorizing the Act, Congress declared as a national goal the attainment, wherever possible, of "water quality, which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water". This goal is popularly referred to as the "fishable / swimmable" requirement of the CWA. In 1967, predating the CWA, the State of Connecticut adopted Water Quality Standards as required under Section 22a-426 of the Connecticut General Statutes to accomplish this and other water quality goals.

The CT WQS contains policy statements addressing the protection of water quality and a classification of state waters. Described for each class are: 1) water quality classifications; 2) numeric or narrative criteria for various parameters or conditions to maintain water quality; and 3) designated uses that should be supported. For example, the designated uses for Class A waters are: habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreational use; and water supply for industry and agriculture. DEEP assesses whether the state waters meet the designated uses by categorizing them into levels of support. Table 1-1 identifies the designated uses for which waterbodies are assessed and associates these uses with the appropriate water quality classification.

Level of Support of Designated Uses

In making water quality assessments, each designated use of a waterbody is assigned a level of support (i.e., either fully supporting, not supporting, insufficient information, not assessed), which characterizes whether or not the water is suitable for that use. The level of use support attainment is based upon available data and other reliable information. The following use support categories are currently used for reporting in the IWQR. These are general definitions. Refer to the section in this report entitled *Assessment Methodology* for specific information regarding the criteria for determining levels of support for each designated use.

Fully Supporting: The designated use is fully achieved in the waterbody.

Not Supporting: The designated use is not supported in the waterbody

Insufficient Information: Insufficient data/information available to support an evaluation of attainment of designated uses in the waterbody.

Not Assessed: No current readily available information is available to assess use support.

Table 1-1. Designated uses for surface waters as described in CT WQS and the IWQR.

Designated Use	Applicable Class of Water or Class Goal	Functional Definition
Recreation	AA, A, B, SA, SB	Swimming, water skiing, surfing or other full body contact activities (primary contact), as well as boating, canoeing, kayaking, fishing, aesthetic appreciation or other activities that do not require full body contact (secondary contact).
Habitat for fish and other aquatic life and wildlife.	AA, A, B, SA, SB	Waters suitable for the protection, maintenance and propagation of a viable community of aquatic life and associated wildlife.
Fish Consumption is not specified independently as a use, but implicit in "Habitat for fish and other..."[a] CT will continue to report on Fish Consumption for 305(b)/303(d)	AA, A, B, SA, SB	Waters supporting fish populations that are free of contaminants at concentrations that would limit human consumption.
Shellfish harvesting for direct human consumption where authorized.	SA	Waters from which shellfish can be harvested both recreationally and commercially and consumed directly without depuration or relay. Waters may be conditionally approved.
Commercial shellfish harvesting where authorized.	SB	Waters supporting commercial shellfish harvesting for transfer to a depuration plant or relay (transplant) to approved areas for purification prior to human consumption (may be conditionally approved); also support seed oyster harvesting
Existing or proposed[b] drinking water supplies.	AA	Waters presently used for public drinking water supply or officially proposed for future public water supply.
Potential drinking water supplies.	A	Waters that have not been identified, officially, but may be considered for public drinking water supply in the future.
Navigation	AA, A, B, SA, SB	Waters capable of being used for shipping, travel or other transportation by private, military or commercial vessels.
Water Supply for Industry	AA, A, B, SA, SB	Waters suitable for industrial supply.
Agriculture	AA, A, B	Waters suitable for general agricultural purposes.

[a] Also addressed in CT WQS policy statement #14: "Surface waters… shall be free of chemical constituents in concentrations or combinations which will… bioconcentrate or bioaccumulate in tissues of fish, shellfish and other aquatic organisms at levels which will impair the health of aquatic organisms or wildlife or result in unacceptable tastes, odors or health risks to human consumers…"

[b] Surface waters identified as potential drinking water supplies as specified in Section 22a-426-4(b) of the Regulations of Connecticut State Agencies.

Information Used to Assess Use Support

Depending on the waterbody and data availability, any one or combination of several types of data may be used to assess water quality and use support: ambient physical and chemical; benthic macroinvertebrate and fish community; indicator bacteria; indicators of productivity and enrichment/eutrophication; aquatic toxicity; tissue contaminant; sediment chemistry/toxicity; and effluent analysis. Following guidance from US EPA (2005), the following sources of data and information are considered in conducting assessments:

- Results from recent ambient monitoring;
- Recent Section 305(b) reports, 303(d) lists, and 319(a) nonpoint assessments;
- Reports of water quality problems provided by local, state, territorial or federal agencies, volunteer monitoring networks, members of the public or academic institutions;
- Fish and shellfish advisories, restrictions on water sports or recreational contact;
- Reports of fish kills;
- Safe Drinking Water Act source water assessments;
- Superfund and Resource Conservation and Recovery Act reports;
- Results from predictive modeling, dilution calculations or landscape analysis; and
- Results from analysis of water quantity impacting aquatic life and other designated uses.

The primary sources of assessment information for rivers are ambient monitoring data collected by DEEP Planning and Standards staff, and physical, chemical and bacteria data collected at fixed sites by the United States Geological Survey (USGS). Lake assessments and trophic status are generally determined from studies conducted by DEEP, the Connecticut Agricultural Experiment Station, USGS and Connecticut College since 1979 (Frink and Norvell, 1984; Canavan and Siver, 1995; Healy and Kulp, 1995; CT DEP, 1998) as well as recent studies by professional contractors. For estuaries, use assessments are based primarily on physical, chemical and biological monitoring by the DEEP Long Island Sound Study and National Coastal Assessment (Strobel, 2000), bacterial monitoring for shellfish sanitation by the Connecticut Department of Agriculture, Bureau of Aquaculture (CT DA/BA), and bathing beach monitoring by state and local authorities.

Reasonable efforts are also made to incorporate data from other state and federal agencies, municipalities, utilities, consultants, academia, and volunteer monitoring groups. DEEP directs a monitoring program for volunteers from which monitoring information is obtained. The details of this program, A Tiered Approach to Citizen – Based Monitoring of Wadeable Streams and Rivers, can be obtained from the DEEP website.

Other types of information that may be used for assessments include water quality surveys conducted by municipalities and discharge monitoring data from municipal sewage treatment plants, industries and remediation projects. DEEP staff may conduct effluent or ambient toxicity tests as a follow-up to investigate suspected problems. Knowledge of a condition known to cause water quality impairment is also considered valid information for determining use support. For example, the presence of a CSO in a stream segment may automatically preclude recreational use support.

Schedule and Degree of Confidence in Assessment Information

DEEP will consider information for assessments up to November 1 prior to the year when the IWQR is due to US EPA. Data and information submitted after November 1st will be considered for the next IWQR reporting cycle and data quality will be evaluated for use in assessments using a three-tiered system (Table1-2).

Table 1-2. Timeline for submitting data to DEEP and tiered data quality considerations for assessments of the State's waters.

IWQR Reporting Year	Deadline for Data Submission
2016	11/1/2015
2018	11/1/2017
2020	11/1/2019
2022	11/1/2021
2024	11/1/2023
2026	11/1/2025
2028	11/1/2027
2030	11/1/2029

Tier 1- Data typically are in the form of digital photos or written descriptions of observations. These data can be helpful as a record of an episodic event. Tier 1 data are not likely to provide sufficient information to formalize an assessment, but can provide supporting information when other data exists for a waterbody.

Tier 2- Data collected may not have been collected under a formal Quality Assurance Project Plan (QAPP). Tier 2 data are not likely to be enough information to formalize an assessment, but can provide supporting information when other data exists for waterbody.

Tier 3- Data are collected under a formal monitoring plan which follows a QAPP approved by DEEP or US EPA. QAPPs shall include laboratory tests to be used and data quality objectives. Standard Operating Procedures for field procedures and lab techniques should be explained as well as a plan for data management. Chemistry results should be provided from a state-certified laboratory. Taxonomic identifications should be from a taxonomist with sufficient experience to provide reliable taxonomic identifications, preferably with certifications by the Society for Freshwater Science and American Fisheries Society. Project objectives should be consistent with DEEP's use of data for waterbody assessment purposes. Tier 3 data may be used to support use assessments.

Geographic and Temporal Extent of Assessment Coverage

Assessment Units

Waterbodies, such as streams, lakes or estuaries are divided into water quality assessment units (AUs). Each unit is considered to have homogenous water quality (*i.e.*, use support is uniform throughout the unit). Generally, streams units are delimited by features that may cause a change in water quality or habitat, such as a confluence with a tributary, a point source discharge, an impoundment or a significant change in land use. Lakes are generally assessed as one segment. Long Island Sound, including its embayments and river-mouth estuaries, was divided into 211 AUs based primarily on designated uses such as shellfishing and recreation and physical features such as depth and distance from shore.

All AUs are organized by a unique identification number (ID305b), which tracks assessment information stored in the Assessment Database Version Two (ADB V2) through each assessment cycle. Both river and lake AUs are derived from basin numbers (Figure 1-1) explained and cataloged in the *Gazetteer of Drainage Areas of Connecticut* (Nosal, 1997). Stream and river segments are indexed to the National Hydrography Dataset (NHD) at a scale of 1:24,000, and lakes are geographically indexed to the CT DEEP lakes data layer. Estuary segments were completely reorganized following the 2006 reporting cycle (Figure 1-2) to better consider bathymetry, water quality, shellfish classification maps, and geographic extent as described in a report titled *Summary Report & Users Guide Connecticut Coastal Assessment And Segmentation Project Final – May 11, 2006 Amended – October 3, 2007* (Streich, 2007). All AUs are created and geographically indexed using ArcGIS software.

Management of Assessment Information

Assessment data (*e.g.*, AU descriptions, assessment methods, use support, causes and sources of impairment) are stored electronically in an Assessment Database (ADB) provided by the US EPA. Data from the ADB are submitted to US EPA annually in electronic format in addition to the written biennial report.

Raw monitoring data are stored and managed in an electronic database that contains sampling results and meta-data collected by Planning and Standards Division staff since 1997. While DEEP uses this in-house database for monitoring and assessment purposes, US EPA's National Data Warehouse (WQX) will be the ultimate repository for all monitoring results. DEEP is in the final stages of a long-term project that will provide seamless transfer of all water related data to the EPA's WQX.

Data used for Rivers and Stream Assessments

There are 5,830 river miles in the State of Connecticut. DEEP has developed an Ambient Water Quality Monitoring Program Strategy (CT DEEP, 2015) that incorporates a combination of targeted and probabilistic sampling designs for an ALUS assessment of rivers and streams. This strategy is intended to provide sufficient targeted data to answer questions about the effectiveness of specific water pollution control activities and also support a statewide probabilistic ALUS assessment at the end of a five-year rotation. Sampling includes annual evaluations of benthic and fish community reference sites, focused monitoring (physical, chemical and/or biological) for TMDL development or other management actions, and follow-up to reported problems.

Physical, chemical and bacteria data from the cooperative DEEP/USGS long-term fixed-network were also reviewed for this report. This network of approximately thirty sites provides data for up to eight sampling events at each site per year on several major rivers and streams throughout the State.

For this reporting cycle, a Generalized Random Tessellation Stratified (GRTS) survey design (Stevens and Olsen 2004) was provided to DEEP from EPA and implemented with a target population of streams based on the National Hydrography Dataset at the 1:24,000 scale. No stratification was included in the survey design. A

total of 100 wadeable stream sites were sampled from 2006-2010 to obtain a statewide estimate of aquatic life use attainment.

Data Used for Lake Assessments

There are 64,973 acres of lakes in the State of Connecticut. Historically, Connecticut has assessed between 105 and 115 "significant public" lakes statewide for 305(b) reporting. Significance was based on a lake having state or federal public access, or providing unique or otherwise important habitats. DEEP reviewed recent data from the above projects along with surveys and data from DEEP administered grants to local entities. Also considered for this report were macrophyte data from the Connecticut Agricultural Experiment Station and DEEP Natural History Survey staff. Beach closure data from DEEP's State beach program, from the State Department of Public Health (CT DPH) and local municipalities from the summers of 2011 and 2012 were evaluated to determine recreation use support.

During the summer of 2007 and 2012, DEEP participated in an US EPA sponsored project called the National Lakes Assessment (NLA). This project was based on a probabilistic sampling design that randomly selected lakes from across the United States for the purpose of producing a comprehensive assessment of trophic status of the nation's lakes. DEEP has committed to participating in the NLA in 2017. More detail is provided on these lakes on pages 38-42 under Probabilistic Monitoring of Lakes.

Connecticut Water Basin Drainage Areas

Connecticut Water Basin Drainage as explained in the CT DEEP Gazetteer of Drainage Areas of Connecticut

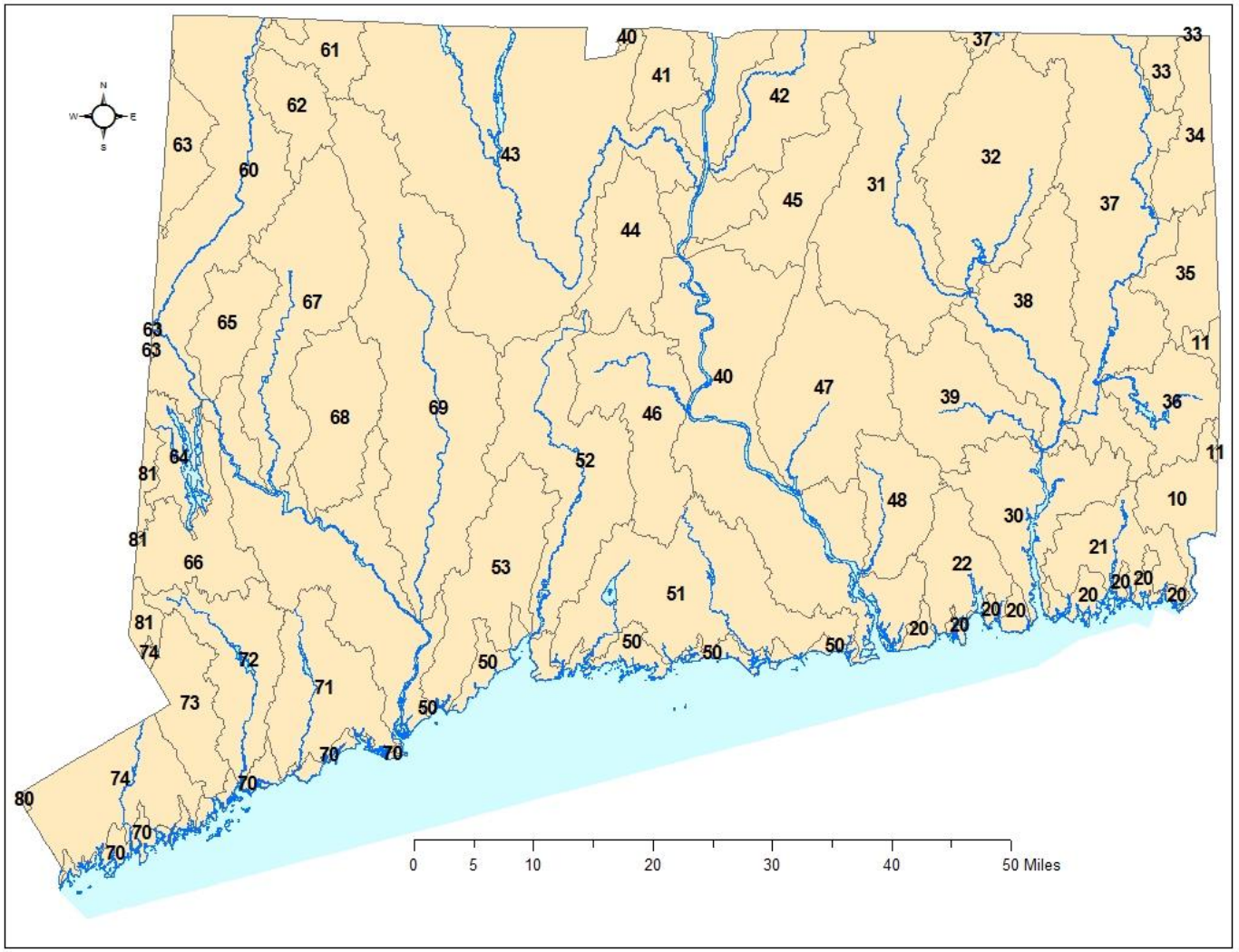

Figure 1-1. Connecticut Rivers and Lake Basins Index

Number	Regional Name
10	Pawcatuck Main Stem
11	Wood
20	Southeast Shoreline
21	Southeast Eastern Complex
22	Southeast Western Complex
30	Thames Main Stem
31	Willimantic
32	Natchaug
33	French
34	Fivemile
35	Moosup
36	Pachaug
37	Quinebaug
38	Shetucket
39	Yantic
40	Connecticut Main Stem
41	Stony Brook
42	Scantic
43	Farmington
44	Park
45	Hockanum
46	Mattabesset
47	Salmon
48	Eightmile
50	South Central Shoreline
51	South Central Eastern Complex
52	Quinnipiac
53	South Central Western Complex
60	Housatonic Main Stem
61	Blackberry
62	Hollenbeck
63	Tenmile
64	Candlewood
65	Aspetuck
66	Still
67	Shepaug
68	Pomperaug
69	Naugatuck
70	Southwest Shoreline
71	Southwest Eastern
72	Saugatuck
73	Norwalk
74	Southwest Western Complex
81	Croton

Connecticut Estuarine Segmentation

Connecticut Estuarine Segmentation Basins as explained in CT DEEP *Summary Report & Users Guide Connecticut Coastal Assessment and Segmentation Project Final – May 11, 2006 amended – October 3, 2007* (Streich, 2007).

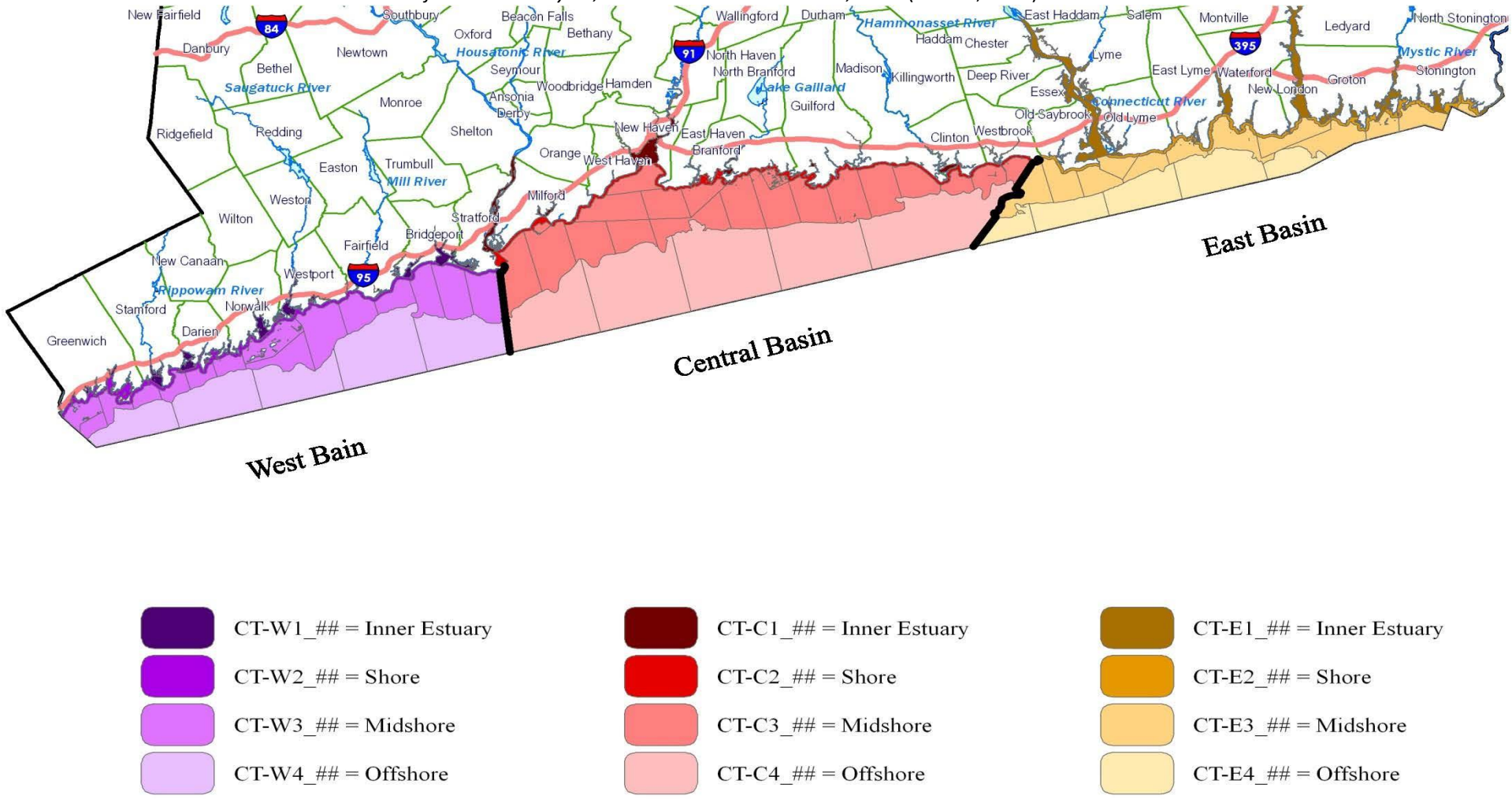

Figure 1-2. Connecticut Estuary Basins Index.

Data Used for Estuary Assessments

There are 611.91 square miles of estuarine waters in the State of Connecticut, all of which are tracked for 305(b) reporting.

Long Island Sound (LIS) is monitored by DEEP on a monthly schedule for dissolved oxygen and nutrients at 17 fixed stations. In addition, 25-30 stations are added to the core 17 stations and monitored bi-weekly monitoring during summer months for dissolved oxygen. This monitoring is funded by the US EPA Long Island Sound Study. From 2000-2006 and in 2010 concurrent with this effort, DEEP collected water quality, sediment, biological community and tissue data at as many as 40 offshore and harbor sites for a US EPA probabilistic monitoring program, the National Coastal Condition Assessment (NCCA; Strobel, 2000). For the NCCA, representative stations in coastal harbors and offshore waters are chosen randomly to represent conditions of the entire Sound. Data from the LIS monitoring program and the NCCA provide the basis for aquatic life use assessments.

Ocean acidification is a topic of recent concern as a consequence of rising atmospheric carbon dioxide. Scientific research indicates that the oceans have a large capacity to absorb carbon dioxide from the atmosphere which can potentially lower pH levels in the ocean and coastal waters. Recently, the Center for Biological Diversity (San Francisco, CA) has asked coastal states to list their coastal waters as threatened or impaired, in Category 5, due to information the Center gathered indicating that, in general, marine ecosystems may already be experiencing declines in ocean pH.

The US EPA issued a memorandum on November 15, 2010, describing how states can move forward, where ocean acidification information exists, to address ocean acidification during the 2012 listing cycle. At the same time, this memorandum acknowledged that in the case of ocean acidification, information is largely absent or limited at this point in time to support the listing of waters for ocean acidification in many states. The EPA Integrated Reporting and Listing Decisions Related to Ocean Acidification includes a copy of the signed memorandum.

LIS is not open ocean water, but rather an estuary with two connections to the Atlantic Ocean from the Race to the east and East River to the west and, is routinely monitored and assessed by DEEP for the IWQR. In August 2010, DEEP added pH to routine LIS Monitoring which involves monthly sampling including 17 monitoring stations and biweekly sampling from June-September at 48 stations. In addition to pH, the sampling plan includes many other parameters and a more detailed description can be found on the DEEP LIS monitoring website. For this report, DEEP reviewed its routine pH data collected in LIS and found no evidence of non-attainment of Connecticut's marine pH criteria (i.e. values were within allowable pH range of 6.8 to 8.5).

DEEP is committed to gathering data to establish baseline conditions and will continue to evaluate ocean acidification. DEEP participated in the Northeast Coastal Acidification Network (NE-CAN) webinar series in late 2013-early 2014. NE-CAN is made up of university researchers, federal and state agency representatives, resource managers, and industry partners that are working towards synthesizing key data and information to develop an implementation plan. NE-CAN focuses on waters from Long Island Sound to the Scotian Shelf.

In addition to routine ambient sampling, DEEP has a keen interest in quantifying changes in LIS brought about by climate change. The Sentinel Monitoring for Climate Change in Long Island Sound Program is a multidisciplinary scientific team interested in climate change impacts to Long Island Sound ecosystems. A work group has been formed in partnership with EPA Long Island Sound Office, National Oceanic and Atmospheric Administration, New York Department of Environmental Conservation, Connecticut Department of Energy and Environmental Protection, New York Sea Grant and Connecticut Sea Grant. There are formal

cooperative agreements/contracts pertaining to funding between these agencies. The two state technical advisory groups include over 60 federal, state, NGO, and university partners who have contributed to all stages of the strategic plan development. This project has a work plan and dedicated funding to study important aspects of climate change in LIS. More information can be found in Sentinel Monitoring for Climate Change in the Long Island Sound Ecosystem.

Annual shellfish bed monitoring and sanitary surveys conducted by the CT Department of Agriculture/Bureau of Aquaculture (DA/BA) provide assessment information for shellfish use support. Beach closure information and data from volunteer organizations as well as known sources of pollution, such as CSOs, are used to determine recreation use support.

All estuarine waters were re-assessed for this reporting cycle using the most recent available information. Dissolved oxygen data collected during the summers of 2014-2015 were used for this reporting cycle assessments. Beach closure information obtained from CT DPH for the 2013-2014 beach seasons was used for the assessment cycle. The Growing Area Classification data layer supplied by CT DA/BA, and annual, triennial and 12 year reports were evaluated for this assessment. Volunteer monitoring data from (CUSH, Save the Bay- Westerly, Earthplace, and Save the Sound), data from local university researchers (University of Connecticut, Yale University, and Southern Connecticut State University), Harbor Watch/River Watch, and data collected by the Millstone Environmental Laboratory were also reviewed for the 2016 assessments.

Assessment Methodology

DEEP's assessment methodology is listed in this section by designated use. Assessment procedures generally follow guidance provided by US EPA (1997) using a variety of information and data types. DEEP applies a "weight of evidence" approach when using multiple types of data. A waterbody is generally considered impaired when one or more sources of data or information indicate a water quality standard is not attained, providing that information is considered sufficient and credible. In resolving discrepancies in conflicting information, consideration is given to data quality, age, frequency and site-specific environmental factors. If reconciliation of conflicting data is not possible or the data are determined to be insufficient, the assessment unit is flagged for further monitoring.

Aquatic Life Use - River and Streams

Because the biological community of a stream integrates the effects of pollutants and other conditions over time, biological community assessment is the best and most direct measure of Aquatic Life Use Support (ALUS), or as stated in the CT WQS "Habitat for fish and other aquatic life and wildlife". DEEP often uses a combination of information on the benthic macroinvertebrate community, fish community, physical/chemical data, toxicity, and records of water quantity to make use support determination for wadeable rivers and streams (Table 1-3).

Table 1-3. Aquatic Life Use Support (ALUS) categories and contributing decision criteria for wadeable streams.

Aquatic Life Use	Criteria / Indicators
Fully Supporting	Biological community with ecological attributes consistent with Biological Condition Gradient Tiers 1-4 as adopted in Connecticut Water Quality Standards Section 22a-426-5 of the Regulations of Connecticut State Agencies. Benthic community: benthic MMI, value >48 (Gerritsen and Jessup, 2007) and meets narrative criteria in CT WQS*. Screening Approach data with 6 or more "Screening Taxa" RBV data submitted to DEEP listed 4 or more pollution sensitive "Most Wanted" invertebrates (see http://www.ct.gov/deep/rbv) Fish community: species composition, trophic structure, and age class distribution as expected for an unimpaired stream of similar watershed size. Conventional physical/chemical criteria are not exceeded. Measured toxicants do not exceed chronic toxicity criteria. Biological communities show no evidence of impact from anthropogenic manipulations to stream flow. No evidence of chronic toxicity in ambient waters.
Not Supporting	Biological community with ecological attributes consistent with Biological Condition Gradient Tiers 5-6 as adopted in Connecticut Water Quality Standards Section 22a-426-5 of the Regulations of Connecticut State Agencies Benthic community: benthic MMI < 43 (Gerritsen and Jessup, 2007), and does not meet narrative criteria in CT WQS*. Screening Approach data with 2 or less "Screening Taxa" Fish community: species composition, trophic structure and age class distribution significantly less than expected for a non-impacted stream of similar watershed size; diversity and abundance of intolerant species reduced or eliminated; top carnivores rare or absent; trophic structure skewed toward omnivory. Physical/chemical or toxicant criteria exceeded in $\geq$ 10% of samples. Biological communities show evidence of impact from anthropogenic manipulations to stream flow. Stream completely enclosed in conduit or cleared concrete trough.
Insufficient Information	Some community data exist, but sampling was very limited and/or the results are ambiguous or conflicting, requiring follow-up monitoring.

* When a bioassessment falls on the border between two use support categories, use support is determined by staff biologists giving consideration to site conditions, certain sensitive taxa present, and other available data. Occasionally, where habitat conditions are not optimal, a non-quantitative sample may be used to infer ALUS as a best professional judgment assessment.

Volunteer monitoring data from the DEEP-sponsored River Bioassessment for Volunteers were incorporated into assessments. The presence of four or more pollution sensitive "most wanted" invertebrate taxa reported at a given site can be considered for an assessment category of "pass".

DEEP has a benthic macroinvertebrate MMI and BCG Assessment Model to assist with stream aquatic life assessments. It is important to note that while DEEP employs the assessment methods described in Gerritsen and Jessup (2007), the actual criteria for benthic invertebrates in the CT WQS are narrative community descriptions, rather than numeric values.

Fish community sampling is evaluated using one of two multimetric indices based upon upstream watershed area (Kanno *et al.* 2010), A Fish BCG Assessment Model and best professional judgment of fisheries and water quality monitoring staff biologists. Methods for fish monitoring are described in CT DEEP (2013), Plafkin *et al*. (1989) and Barbour *et al*. (1999).

In the 2014 Assessment Cycle, DEEP began using a model that predicts macroinvertebrate MMI (Bellucci et al, 2013) as a line of evidence for assessing ALUS in wadeable rivers and streams. The model uses GIS derived landscape variables (percent impervious land cover, percent wetlands, and stream slope) in the upstream watershed to provide a model MMI calculation for any monitored wadeable stream location (Figure1-3). The MMI model is not used on its own for assessment purposes, but rather always in conjunction with other available data. In particular, when sampling a stream reach for the first time without the benefit of an existing data for comparison, the model results can provide another line of evidence to support stream assessments or highlight stream segments that warrant further investigation before a formal assessment can be completed.

Nutrient enrichment has also been identified as one of the most pressing water quality issues facing the nation as a whole. As a result, US EPA has directed states to take aggressive action to limit the quantity of phosphorus being discharged to surface waters. In Region 1, EPA has mandated that all New England states establish limitations on phosphorus in all wastewater discharge permits where the potential exists for the discharge to contribute to eutrophication and impair designated uses in downstream waters.

DEEP is working on developing an assessment methodology for nutrients. As part of ongoing nutrient management efforts, DEEP is currently studying the impacts to aquatic life by nutrients, including the development of effects-based numeric nutrient criteria to protect aquatic life in freshwater wadeable rivers and streams (Becker 2012). In addition, a Coordinating Committee and three Workgroups have been established to meet the legislative requirements of Public Act 12-155, *An Act Concerning Phosphorus Reduction in State Waters* . It is expected that work produced by this legislation will provide guidance toward developing a more formal assessment process for nutrient related biological impacts.

DEEP has a significant effort underway to balance human and ecological needs relative to water quantity. Stream flow classes have been adopted under the Connecticut Stream Flow Standards and Regulations for the Thames River, Pawcatuck River, Southeast Coastal, and South Central Coastal Basins and work is continuing to complete the rest of the state within the next five years. These stream flow classes can be useful to determine potential impacts due to hydrologic alteration since stream flow classes are scaled based on the natural flow paradigm (Poff et al 1997) and can provide a line of evidence to support biological community assessments that may be impacted by hydrologic alteration. Stream flow classes have narrative standards that represent a range of flow conditions (Table 1-4), and these classification can be considered when making judgments on flow altered streams.

DEEP staff have developed a GIS application to help with documenting low flow conditions throughout the state to assist with aquatic life assessments. Flow condition that limit habitat to fish and other aquatic life that occur from non-natural causes are documented and listed as under Category 4C .The following information is considered when making these assessments:

- Biological metrics such as MMIs and BCGs for fish and macroinvertebrates;
- Surficial geology in the watershed;
- Location of diversions and dams;
- Statistical summaries of streamflow or flow measurements in the field that indicate a deviation from the natural hydrograph that results in habitat alteration that can impact aquatic life;
- Stream flow classification adopted under the Connecticut Stream Flow Standards and Regulations;
- Dry or nearly dry streams with severely limited aquatic habitat documented by digital photos influenced by water diversions or registrations that alter the natural hydrologic regime.

Table 1-4. Stream flow classes adopted under the Connecticut Stream Flow Standards and Regulations

Stream flow Class	Narrative Standard
Class 1	River or stream segment shall exhibit, at all times, the depth, volume, velocity and variation of stream flow and water levels necessary to support and maintain habitat conditions supportive of an aquatic, biological community characteristic of that typically present in free-flowing river or stream systems of similar size and geomorphic characteristics under the prevailing climatic conditions.
Class 2	River or stream segment shall exhibit, at all times, the depth, volume, velocity and variation of stream flow and water levels necessary to support and maintain habitat conditions supportive of an aquatic, biological community minimally altered from that typically present in free-flowing river or stream systems of similar size and geomorphic characteristics under the prevailing climatic conditions.
Class 3	River or stream segment shall exhibit, at all times, the depth, volume, velocity and variation of stream flow and water levels necessary to support and maintain habitat conditions supportive of an aquatic, biological community moderately altered from that typically present in free-flowing river or stream systems of similar size and geomorphic characteristics under the prevailing climatic conditions.
Class 4	River or stream segment may exhibit substantially altered stream flow conditions caused by human activity to provide for the needs and requirements of public health and safety, flood control, industry, public utilities, water supply, agriculture and other lawful uses; and shall, while giving consideration to societal needs, economic costs, and environmental impacts, exhibit to the maximum extent practicable the depth, volume, velocity and variation of stream flow and water levels consistent with the narrative standard for Class 3 river and stream segments.

Indirect measurements of ALUS such as ambient physical/chemical data, discharge monitoring reports, aquatic toxicity monitoring reports, and sediment chemistry data are also evaluated against water quality criteria established in CT WQS. These data may be used independently or supplement the weight of evidence for AUs with benthic invertebrate or fish community data.

Connecticut Macroinvertebrate Multimetric Index (MMI) Model

Connecticut stream health condition as predicted by CT DEEP MMI model.

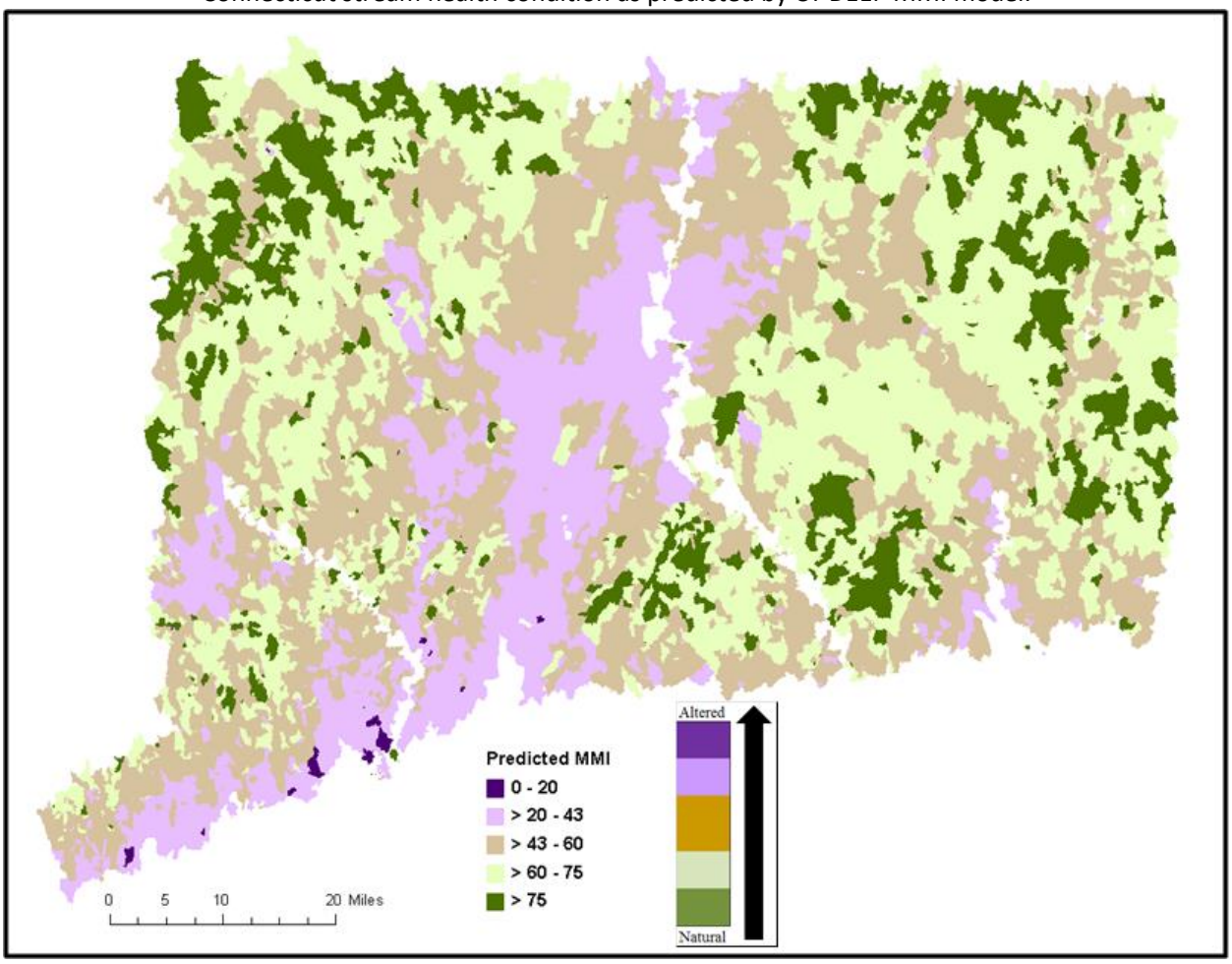

Figure 1-3. Macroinvertebrate Multimetric Index (MMI) model results showing the predicted stream health condition.

CT DEEP Macroinvertebrate Multimetric Index (MMI) model is used to predict stream health across Connecticut. The results shown in Figure 1-3 above predicts, that 76% of stream miles pass aquatic life goals and 24% of stream miles fail aquatic life goals using modeled MMI values. Percent values were obtained by summing the stream miles with an MMI >48 (pass) and MMI < 48 (fail) and dividing by total stream miles.

Aquatic Life Use – Lakes

The most recent available information from DEEP Monitoring Program, government agencies and/or reliable contractors and lake associations are used to determine levels of support for aquatic life use in lakes. Factors taken into consideration are known problems, such as chronic algal blooms, the extent of coverage by exotic invasive plants, severe sedimentation, and results of surveys by fisheries biologists.

Lake trophic classifications, as listed in the CT WQS are based on ambient measurements of four parameters: total phosphorus, total nitrogen, chlorophyll a, and Secchi disc transparency in specified seasons. Lakes are classified as either oligotrophic, mesotrophic, eutrophic, or highly eutrophic based on the range of values for these four parameters. Macrophyte coverage and density are used to adjust the trophic classification based on water column data described above. While trophic status is not a direct measure of aquatic community

health, highly eutrophic conditions, beyond what is naturally expected (given the relative size of the lake/pond and watershed, the origin of the lake/pond, and other physiographic parameters), or a documented trend toward cultural eutrophy may indicate impairment or a threat to aquatic life. A naturally eutrophic lake, having nutrient concentrations that support high levels of biological activity without any significant anthropogenic source, would not be considered impaired.

Lake trophic classifications were determined for all of the lakes that had new data since the previous reporting cycle. DEEP staff then used the data and lake trophic classifications to determine attainment of ALUS using best professional judgment.

Aquatic Life Use – Estuaries

Aquatic life use assessments for estuaries are based primarily on dissolved oxygen and nutrient data (eutrophication assessments) collected by DEEP's Long Island Sound monitoring staff as part of the US EPA Long Island Sound Study. Evaluations are supplemented by special studies, intensive surveys, fish trawl surveys and National Coastal Assessment (NCA) samples, when available. Dissolved oxygen data used for the assessments included data from the University of Connecticut/NERACOOS MySound Western and ARTG buoys (bottom water data); and the USGS/UConn gaging station on the Connecticut River at Essex (01194750). In reviewing available data, measured values for a specific parameter are compared to water quality criteria as defined in the CT WQS. Low dissolved oxygen (Table 1-5), or hypoxia (Figure 1-4) in offshore waters and some embayments is the most frequently cited impairment of aquatic life. DEEP revised its dissolved oxygen criteria in 2011 for marine waters. Benthic community analyses conducted as part of the NCA (Strobel, 2000) are being used to support other findings on ALUS, but the coverage of LIS is not yet spatially or temporally adequate to support assessments on its own. DEEP Marine Fisheries trawl data are also used to support low dissolved oxygen findings with respect to ALUS. Other information sources include tissue analyses, sediment analyses, irregular sampling (*e.g.*, for spills, site assessments or research projects), and professional judgment evaluations of pollutant sources and water quality conditions. Tier 3 quality assured dissolved oxygen data collected by volunteer researchers (CUSH, Harbor Watch/River Watch, and Save the Bay-Westerly) in nearshore waters are also used to assess the Aquatic Life Use.

In nearshore waters, assessment units are evaluated against the dissolved oxygen criteria where data/measurements are available. Generally, nearshore waters are defined as waters landward of the 5 meter depth contour and include assessment units in the inner estuary and shore categories (See Streich (2007) for details). Occasionally AUs in the midshore category are also included as nearshore waters. Data are reviewed for the summer period from May-September/October. First, the total number of samples collected during the index period is determined. Then the number of instances where the value/concentration is below the criterion is determined. Then number of criterion exceedances is divided by the total number of samples and multiplied by 100 to yield a percentage. ALUS is assessed as impaired if >10% of the samples exceed the criterion. The 10% exceedance allowance is based on US EPA assessment guidance (US EPA, 1997).

For AUs in offshore waters containing DEEP LIS sampling stations, dissolved oxygen data are used to determine the ALUS status. If less than 10% of the measurements show dissolved oxygen concentrations below standards the AUs is assessed as Fully Supporting the Aquatic Life Use. If greater than 10% of the samples violate standards the AU is assessed as not supporting. Data from the summer/hypoxia season (May-October) were reviewed.

Table 1-5. Aquatic Life Use Support (ALUS) in estuaries as determined by dissolved oxygen levels.

Aquatic Life Use Assessment	Criteria
Fully Supporting	ACUTE: Measured dissolved oxygen concentrations of 3.0 mg/L and greater in 90% or more of samples Map interpolations indicate at least 90% of AU area with dissolved oxygen concentrations of 3.0 mg/L and higher CHRONIC: Cumulative periods of dissolved oxygen in the 3.0 – 4.8 mg/L range resulting in a decimal fraction of less than 1.0. Benthic or fish communities are not impacted. No violations of water quality criteria or excessive levels of sediment contamination.
Not Supporting	ACUTE: Measured dissolved oxygen concentrations less than 3.0 mg/L in more than 10% of the samples Map interpolations indicate dissolved oxygen concentrations <3.0 mg/L for more than 10% of assessment unit area on multiple cruises over the assessment period CHRONIC: Cumulative periods of dissolved oxygen in the 3.0 – 4.8 mg/L range resulting in a decimal fraction of greater than 1.0. Benthic or fish communities are impacted. Exceedances of water quality criteria or excessive levels of sediment contamination.

Near bottom is defined as 1 m up from the sediment/water interface. Data were compiled by station. A total number of data points (n) were determined. The number of data points that were $\leq$ 3.0 mg/L (acute criterion) was determined. That number was divided by the total number of samples and multiplied by 100 to give a percentage. If this percentage was >10% the ALUS was assessed as impaired. In segments with multiple stations, percentages from each station were reviewed. If conflicts arose (i.e., one station >10% measurements exceeded, other station <10%) the assessment was listed as impaired to be conservative. The 10% exceedance allowance is based on US EPA assessment guidance (US EPA, 1997).

Hypoxia map interpolations are used to determine the ALUS status in those offshore AUs that do not contain LIS sampling stations. Using ArcGIS software, DEEP LIS Monitoring Program staff creates maps that depict the extent of low dissolved oxygen in the bottom waters of Long Island Sound based upon the data collected during the LISS bi-weekly hypoxia surveys from June through September. Maps are only created when concentrations fall below 4.8 mg/L. Concentrations between sampling stations are interpolated using the Spatial Analyst Tool from ESRI, Inc.(Inverse Distance Weighted Average Method, see http://www.esri.com/) Maps are available on the DEEP website at http://www.ct.gov/deep.

Additional details related to map production can be found in the Standard Operating Procedure document *Preparation of Hypoxia Maps and Summaries.* The GIS raster data files are incorporated into a GIS map document created for assessment purposes. The files are overlain on a layer file of AUs to determine the location of sampling stations relative to AUs and to determine the frequency of excursions below the dissolved oxygen criterion (Figure 1-4). Using the zonal histogram tool in ArcGIS, the area of each segment that falls within the defined dissolved oxygen concentration classification scheme for each survey/cruise is calculated. For LIS, the classifications are: 0-0.99 mg/L, 1-1.99 mg/L, 2-2.99 mg/L, 3-3.49 mg/L, 3.5-4.79 mg/L, and >4.8 mg/L. If >10% of the assessment unit area falls below 3.0 mg/L, ALUS is assessed as impaired. The frequency of low dissolved oxygen events is determined based on the number of times the maps indicate dissolved oxygen concentrations fell below the criterion (i.e., X number of cruises < criterion/total number of cruises * 100).

Historic impairments based on dissolved oxygen data are carried forward. Historic impairments associated with sediment contamination are carried forward through the assessment cycle. Many of these impairments were documented in old Water Quality Reports to Congress and date back to the late 1980s/early 1990s. Impairments were based on interviews with staff engineers and reports that indicated elevated levels of sediment contaminants (Stacey, 2007). Additional historic sources of data included the National Oceanic and Atmospheric Administration's Benthic Surveillance Program and Mussel Watch Program, a project developed to analyze chemical and biological contaminant trends in sediment and bivalve tissue from over 280 coastal sites based on data collected from 1986 to the present (see https://products.coastalscience.noaa.gov/collections/ltmonitoring/nsandt/default.aspx for more details.) Data collected for the NCA program (Strobel 2000), data compiled into a sediment dredge geodatabase by the DEEP Office of Long Island Sound Program (O'Brien, undated), and data provided by the DEEP TMDL program (Bellucci, undated) were also used as supplemental sources.

Connecticut Long Island Sound Hypoxia Map

Connecticut DEEP estuarine segments with station locations and Hypoxia interpolations

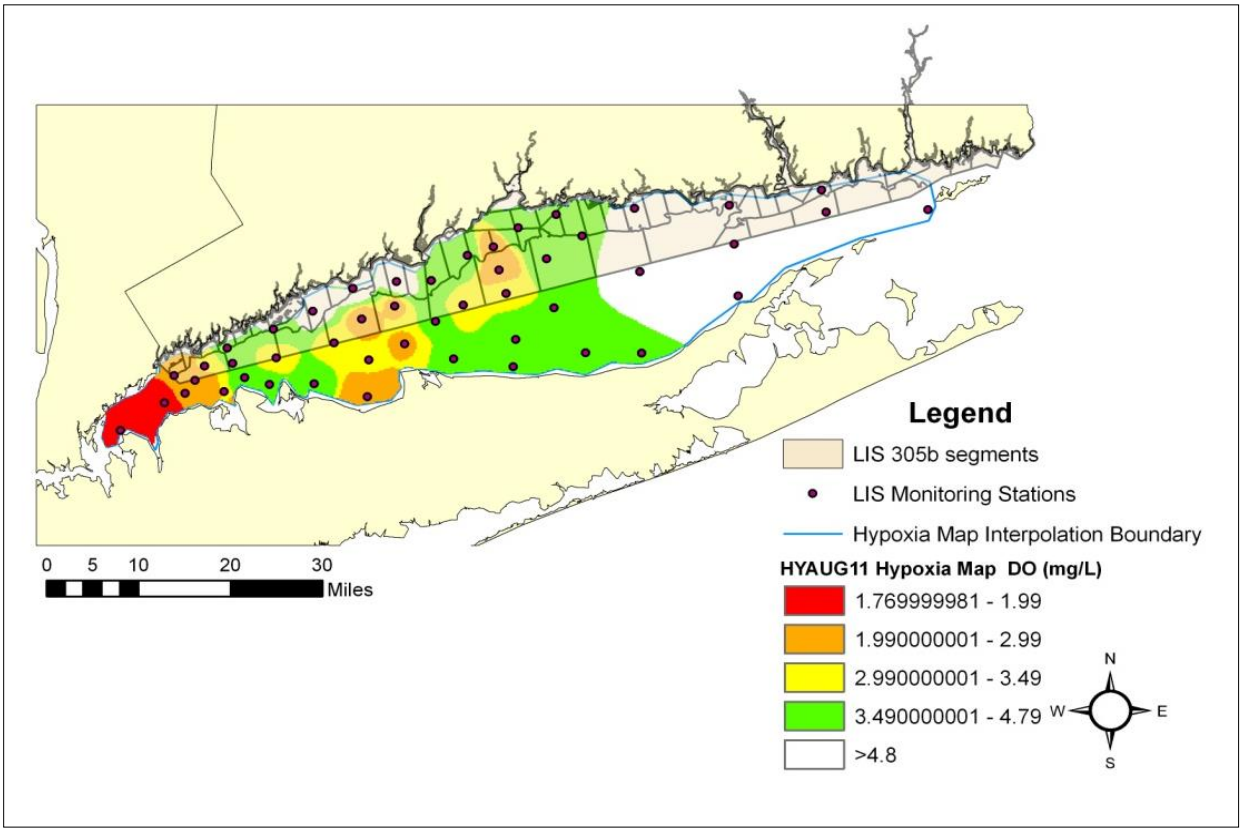

Figure 1-4. Hypoxia map interpolations are overlain on a map of sampling station locations and assessment units to assist with evaluating excursions below the dissolved oxygen criterion.

Fish Consumption

Fish consumption advisories are issued by the Connecticut Department of Public Health (CT DPH, 2010). The advisories are based on risk assessments conducted by CT DPH using fish tissue contaminant data. A statewide fish consumption advisory was issued for all species except trout < 15 inches in length in the mid-1990s due to mercury contamination. This advisory was based on statewide surveys of mercury contamination in fish from lakes (Neumann et. al., 1996) and rivers (CT DEP, unpublished). A follow up study was completed in 2008 (Vokoun and Perkins, 2008) and the statewide fish consumption advisory was continued based on these data

Therefore, in addition to fish consumption use support as determined by the criteria below (Table 1-6), all freshwaters of the State have a fish consumption advisory due to mercury contamination. Likewise, all estuarine waters have fish consumption advisories due to a statewide advisory for PCB contamination in migratory striped bass and bluefish. Refer to DEEP Angler's Guide or CT DPH Connecticut's Fish Consumption Advisory and the Safe Eating of Fish Caught in Connecticut for more information about fish consumption advisories. Waterbodies listed in this report in Table 2-7 have site specific fish consumption advisories in addition to the statewide consumption advisories.

Table 1-6. Fish consumption use support and criteria.

Fish Consumption Assessment	Criteria
Fully Supporting	No site specific consumption advisory for any fish species or any consumer group.
Not Supporting	A site specific consumption advisory exists for all or some fish species or for all or certain consumer groups.

Shellfish Harvesting (in Estuaries)

Starting with the 2006 reporting cycle, shellfish harvesting has been divided into two designated uses as specified in the CT WQS: shellfish harvesting suitable for direct human consumption (SA waters), and shellfish harvesting suitable for commercial operations requiring depuration or relay (SB waters).

The CT DA/BA is responsible for regulating shellfish harvesting. A shellfish growing area is defined by CT DA/BA as any area that supports or could support the growth and/or propagation of molluscan shellstock. Shellfish are defined by CT DA/BA as oysters, clams, mussels, and scallops, either shucked or in the shell, fresh or frozen, whole or roe-on. All shellfish growing areas are classified by CT DA/BA in accordance with the Interstate Shellfish Sanitation Conference (ISSC) National Shellfish Sanitation Program Model Ordinance (NSSP-MO) and CT General Statutes Chapter 491, Sec 26-192e. These classifications, summarized below, are established to minimize health risks and may restrict the taking and use of shellfish from some areas. They are based on fecal coliform bacteria standards as provided in the NSSP-MO (Interstate Shellfish Sanitation Conference, 2007).

APPROVED- Open for harvest of shellfish for direct human consumption

CONDITIONALLY APPROVED- A shellfishing area classification that predictably does not conform to "Approved" area criteria due to the occurrence of specified hydrologic or meteorological events or conditions, but will predictably return to the "Approved" area criteria.

RESTRICTED-RELAY/DEPURATION: A shellfishing area classification that conforms to NSSP-MO criteria that allows the area to be used by CT DA/BA licensed operations for the relaying of shellfish to a depuration plant for controlled purification, to designated beds in Approved or Conditionally Approved areas for natural cleansing, or to areas satisfactory to the CT DA/BA, excluding Prohibited, Conditionally Restricted-Relay, and Restricted-Relay areas. These shellfish may not be directly harvested for market nor consumed prior to the purification process involving relay or depuration.

RESTRICTED-RELAY: A shellfishing area classification where CT DA/BA allows aquaculture, relay or transplant activities in conformance to NSSP-MO criteria. Operations may be licensed to relay shellfish to designated beds in Approved or Conditionally Approved areas for natural cleansing. These shellfish may not be directly harvested for market or consumed prior to a minimum purification period of 14 consecutive days after being relayed to Approved or Conditionally Approved "open" areas with a water temperature of 50 degrees Fahrenheit (10 degrees Celsius) or greater. CT DA/BA may require the shellfish purification time to be longer than 14 consecutive days, based upon shellfish purification verification studies.

CONDITIONALLY RESTRICTED-RELAY: A shellfishing area classification that predictably does not conform to Restricted-Relay area criteria due to the occurrence of specified events or conditions, but predictably returns to the Restricted-Relay area criteria.

PROHIBITED: A shellfishing area classification that prohibits the harvesting of shellfish for any purpose except depletion or aquaculture operations (such as seed oystering) licensed by the CT DA/BA.

US EPA guidance (Grubbs and Wayland, 2000 and US EPA, 2002) identifies that areas closed to shellfish harvesting due to administrative closures, and not based on monitoring data that indicated a water quality impairment, should not be assessed as Not Supporting. These updates are incorporated into the CT CALM and were utilized for this reporting cycle. To determine attainment of water quality standards and for integrated reporting purposes, DEEP utilizes CT DA/BA shellfish growing area classifications as listed in Table 1-7.

Administrative closures are established in areas around potential pollution sources, such as sewage outfalls and marinas/mooring fields, as a preventative measure to safeguard human health and preclude the harvest of possibly contaminated shellfish. A marina is defined in the NSSP-MO as "any water area with a structure (docks, basin, floating docks, etc.) which is used for docking or otherwise mooring vessels, and constructed to provide temporary or permanent docking space for more than ten boats.

Areas may also be classified as prohibited due to incomplete sanitary surveys, lack of water quality data, or insufficient resources/interest. Areas classified as prohibited for administrative reasons (i.e., around outfalls, marinas, no resources/interest) will not be considered as violating water quality standards and will be listed in the Integrated Water Quality Report as Not Assessed. Areas classified as prohibited due to incomplete sanitary surveys will also not be considered as violating water quality standards but will be listed in the Integrated Water Quality Report as Insufficient Information. This approach is consistent with US EPA guidance published in 2000 (Grubbs and Wayland, 2000) and in Chapter 3 of the 2002 US EPA document *Consolidated Assessment and Listing Methodology Toward a Compendium of Best Practices*. Additionally other coastal states within US EPA Regions 1 and 2 have adopted this approach.

In a number of towns, the CT DA/BA has placed restrictions on direct harvest of shellfish from the shoreline out to the mid-Sound state boundary. However, beyond a depth of 50 feet, there is essentially no shellfishing conducted at this time, and these waters are not regularly monitored. Therefore, for Integrated Reporting purposes, shellfish harvesting is not evaluated as a use in waters between the 50-foot depth contour and the state line. The lack of monitoring should not be construed to mean these deeper offshore waters do not achieve applicable water quality criteria for indicator bacteria.

It should be noted that CT DA/BA shellfish growing areas do not necessarily coincide with DEEP waterbody segments (Figure 1-5). To determine use support, GIS is utilized. All DEEP segments from the various geographic areas (i.e., inner estuary, shore, midshore, and offshore) are merged into a single layer file. Then the shellfish area classifications are "unioned" with the merged layer file. The attribute table from this new layer is exported as a .dbf file. Using Microsoft Excel, pivot tables are created that list each classification present per segment along with size of the area falling completely within the segment (Figure1-6). A total area is calculated for each class. The segment is then assessed based on the guidelines above. Sources of impairment are based on shellfish reports compiled by CT DA/BA on an annual, triennial or twelve year basis

Table 1-7. Shellfish harvesting use support as determined by shellfish growing area classifications.

Class SA waters: Shellfish harvesting for direct human consumption where authorized.	Criteria
Fully Supporting	Waters classified by CT DA/BA as Approved.
Not Supporting	>10% of segment area classified by CT DA/BA as Prohibited, Conditionally Approved, Conditionally Restricted-relay, Restricted-relay, or Restricted-relay/depuration
Not Assessed	Waters closed administratively due to a safety management zone around wastewater treatment plants or marinas, no water quality data available, or lack of resources.
Insufficient Information	Waters closed administratively due to a lack of a current sanitary survey or insufficient monitoring data.
Class SB waters: Shellfish harvesting with depuration or relay where authorized.	Criteria
Fully Supporting	Waters classified by CT DA/BA as Approved, Conditionally Approved, Conditionally restricted-relay, Restricted-relay/depuration.
Not Supporting	>10% of segment area classified by CT DA/BA as Prohibited
Not Assessed	Waters closed administratively due to a safety management zone around wastewater treatment plants or marinas, no water quality data available, or lack of resources.
Insufficient Information	Waters closed administratively due to a lack of a current sanitary survey or insufficient monitoring data.

In a number of towns, the CT DA/BA has placed restrictions on direct harvest of shellfish from the shoreline out to the mid-Sound state boundary. However, beyond a depth of 50 feet, there is essentially no shellfishing conducted at this time, and these waters are not regularly monitored. Therefore, for Integrated Reporting purposes, shellfish harvesting is not evaluated as a use in waters between the 50-foot depth contour and the state line. The lack of monitoring should not be construed to mean these deeper offshore waters do not achieve applicable water quality criteria for indicator bacteria.

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Connecticut Long Island Sound Segment and Shellfish Map

Connecticut DEEP estuarine segments with shellfish growing area classifications in Long Island Sound

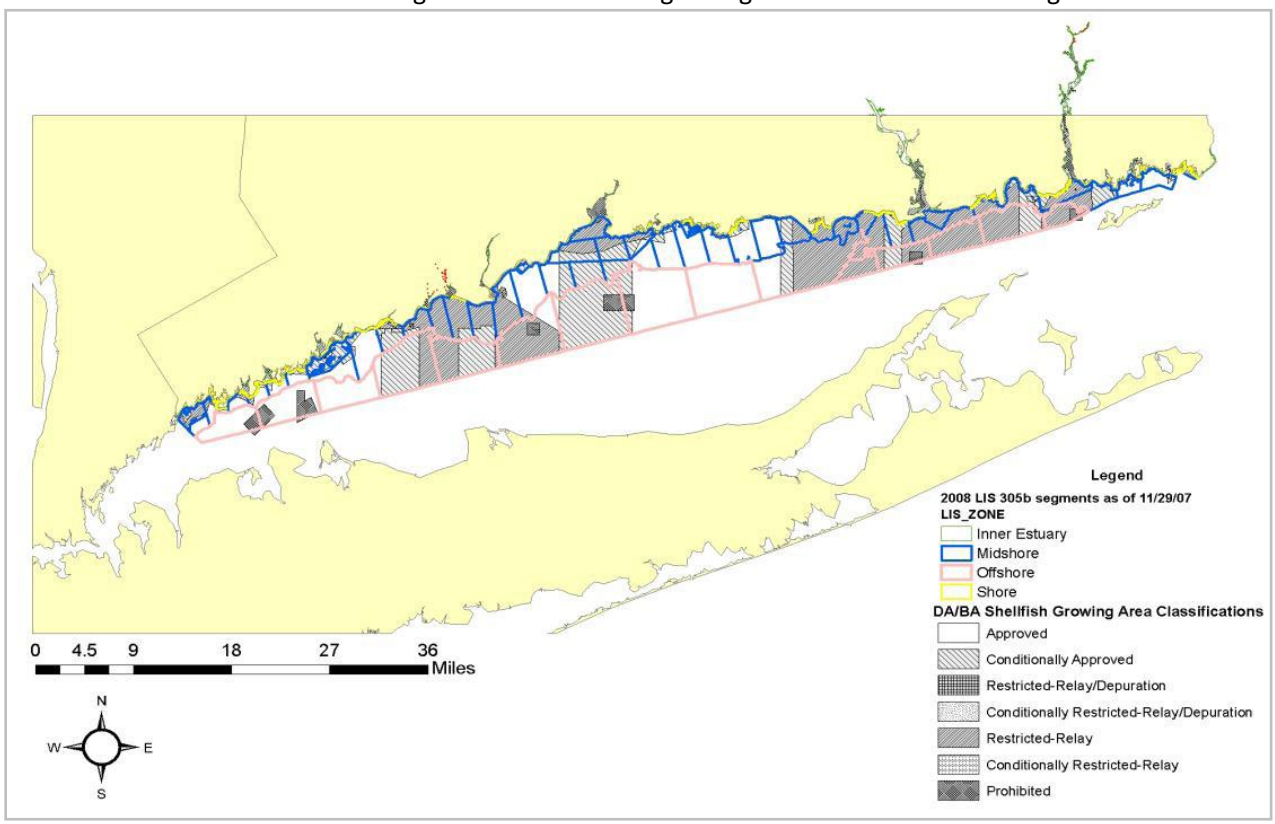


Figure 1-5. Assessment units overlain on shellfish growing area classifications in Long Island Sound.

Connecticut DEEP Long Island Sound Segments and DA/BA Shellfish Classification

Connecticut DEEP estuarine segments with DA/BA shellfish classification area percentages in LIS

Segment ID	Approved	Conditionally Approved	Conditionally Restricted-Relay	Conditionally Restricted-Relay/ Depuration	Prohibited	Restricted-Relay	Restricted-Relay/ Depuration	Grand Total
CT-C2_005	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%
CT-C2_006	12.53%	66.60%	0.00%	0.00%	0.00%	20.87%	0.00%	100.00%
CT-C2_007	53.57%	26.95%	0.00%	0.00%	0.00%	19.48%	0.00%	100.00%
CT-C2_008	0.00%	46.29%	0.04%	23.56%	0.38%	29.73%	0.00%	100.00%
CT-C2_009	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
CT-C2_010	32.61%	66.04%	0.00%	0.00%	0.00%	1.34%	0.00%	100.00%
CT-C2_011	50.39%	42.53%	0.42%	0.00%	0.54%	6.12%	0.00%	100.00%
CT-C2_012	9.11%	4.01%	29.20%	0.00%	6.34%	51.34%	0.00%	100.00%
CT-C2_013	18.04%	81.15%	0.00%	0.00%	0.79%	0.02%	0.00%	100.00%

Figure 1-6. Example of pivot table report showing percentage of segment area falling under each CT DA/BA classifications.

Recreation

Recreation assessments are based on sanitary/safety considerations and aesthetic/practical usability. Sanitary condition is determined from indicator bacteria data provided by DEEP, USGS, volunteer, or municipal monitoring, along with sanitary surveys where appropriate (see Table 1-8 Decision criteria). For lakes, aesthetic and practical usability is considered based on algae and/or macrophyte surveys.

Enterococci group bacteria are used as the primary sanitary indicator organism in estuarine water, and *Escherichia coli* in fresh water per the most current version of Connecticut's WQS. For salt water, 104 Colony Forming Units (CFU)/100 ml of e*nterococci* is the single sample criterion for designated bathing areas, 500 CFU/100 ml for other recreational uses, and 35 CFU/100 ml is the geometric mean criterion for any recreational use. In fresh water, 235 Colony Forming Units or CFU/100 ml of *Escherichia coli* is the single sample criterion for designated bathing areas, 410 CFU/100 ml for non-designated swimming areas, 576 CFU/100 ml for other recreational uses, and 126 CFU/100 ml is the geometric mean criterion for any recreational use.

For AUs with designated bathing areas, beach closure information is generally used to determine use support. Closures of public bathing areas are, for the most part, based on the results of weekly sampling for indicator bacteria during the swimming season. A complete discussion of Connecticut's practices related to beach monitoring and closure may be found in "Guidelines for Monitoring Bathing Waters and Closure Protocol" developed jointly by CT DEEP, the Connecticut Department of Health, the Connecticut Environmental Health Association, and the Connecticut Association of Directors of Health (CT DPH and CT DEP, 2003).

Additionally, beach personnel conduct daily inspections of shoreline bathing areas for evidence of contamination. State and local officials also utilize sanitary surveys of shorelines and watersheds as a primary tool to determine sanitary quality. Evidence of waste materials indicative of untreated sewage or human fecal contamination can be sufficient justification to support a beach closure decision by local or state authorities. Small quantities of temporary and/or transient sources of human fecal contamination transported to a site (*e.g.,* diapers, tampons, medical items) would likely result in a beach closure. Significant sources of contamination from a fixed location within the AU, such as a CSO, would automatically result in an assessment of impairment.

In some lakes, recreation may also be impaired by excessive growth of aquatic invasive plants or algae, which hampers use by physical means (*e.g.*, dense weeds prevent boat mobility) or creates aesthetically offensive conditions. Lakes for which no bacteria data exist may be considered Fully Supporting of recreation if the lake is situated completely within an undeveloped area or if there have been no complaints of illness or excessive aquatic plant growth, or, as in the case of some urban ponds, swimming is not allowed but other recreation activities are supported.

Table 1-8. Decision criteria for various categories of recreational use support.

Recreation Assessment	**Criteria / Indicators for designated public bathing areas**
Fully Supporting	Designated bathing area closed 10 % of swimming seasons[a] or less for a reporting cycle, and sanitary survey indicates no significant source [b] of human fecal contamination. Recreational use is not hindered by weed or algal growth.
Not Supporting	Designated bathing area closed more than 10% of swimming seasons[a] for a reporting cycle, or sanitary survey indicates potential for significant source of human fecal contamination. Algal or exotic weed growth precludes normal recreational use.
	Criteria / Indicators for areas not designated as public bathing areas
Fully Supporting	Sanitary survey indicates no significant source of human fecal contamination, and There are a minimum of 8 samples for the assessment period, and no more than 15% of samples exceed the single sample criterion for *Escherichia coli* (410 CFU [c]/ 100 ml for non-designated swimming areas, 576 CFU/100 ml for all other areas), and there is no exceedance of the geometric mean criterion (126 CFU/100 ml.) Recreational use is not hindered by excessive weed or algal growth.
Not Supporting	Sanitary survey indicates potential for significant source of human fecal contamination; or There are a minimum of 8 samples for the assessment period, and more than 15% of samples exceed the single sample criterion for *Escherichia coli* (410 CFU [c]/ 100 ml for non-designated swimming areas, 576 CFU/100 ml for all other areas), and there is an exceedance of the geometric mean criterion (126 CFU/100 ml) or Algal or exotic weed growth precludes normal recreational use.
Insufficient Information	Less than 8 samples in the assessment period [d].

[a] Swimming season is from Memorial Day to Labor Day

[b] A significant source of human fecal contamination is one that originates from a fixed location and is transported to or within the waterbody (*e.g.*, an untreated sewage discharge or a community with failing septic systems).

[c] CFU refers to colony-forming-unit, which is the unit of measure for indicator bacteria. It is the general equivalent of one bacterium (one bacterium will grow into one colony when incubated on a plate of growth medium.)

[d] In certain cases, best professional judgment can result in an assessment when there are fewer than 8 samples.

Drinking Water Supply

Unless there is evidence to the contrary, DEEP presumes that the drinking water use is fully supporting for Class AA drinking water reservoirs and Class AA tributaries when filtration and disinfection is reliably maintained in accordance with State Public Drinking Water Standards (Regulations of Connecticut State Agencies Section 19-13-B102). These waters are regulated by programs at CT DPH that coordinate, manage, and ensure treatment and source protection through oversight of existing treatment and source protection laws and regulations, coupled with water supply planning, education of local land use officials, and involvement with stakeholders on a continuous basis.

CT DPH implements the federal Safe Drinking Water Act (SDWA) in Connecticut and DEEP cooperates with those efforts. The 1996 amendments to the SDWA enhanced the existing law by recognizing source water protection and striving to optimize and maintain source water quality as an integral component of safe drinking water, including a requirement to complete Source Water Assessments by 2003. This approach ensures the quality of drinking water by protecting it from source to tap. The presumption of full support for the AA designation due to conventional treatment reflects the source to tap approach, and includes efforts and programs by water utilities, CT DPH, DEEP and municipalities to optimize source water quality as an integral component of providing safe and adequate drinking water.

The CT DPH tracks and reports on the water quality of public drinking water supplies within the context of the SDWA. DEEP periodically surveys water utilities for information concerning closures, trophic status, and potential causes and sources of pollution. A number of Class AA tributaries to drinking water reservoirs are tracked and assessed in the ADB for 305(b) reporting. Assessment of these streams is based on standard measures of water quality (physical/chemical parameters, macroinvertebrate community, fish community, etc. where available), plus consideration of the potential causes and sources of pollution noted on water utility surveys.

Navigation

Navigation is assumed to be fully supported for all waters suitable for navigation.

Agriculture, Industry

Agricultural uses are assumed to be fully supported for all AA, A, and B waters. Industrial use is assumed to be fully supported for all AA, A, B, SA and SB waters.

Chapter 2 – 305(b) Assessment Results

DEEP's assessment results by waterbody type and designated use are summarized in Table 2-1. Not all waterbodies are assessed for all designated uses and some waterbodies that were previously assessed as Fully Supporting may have been assessed as Not Assessed in this reporting cycle due to data age limitations on assessment information. Any waterbody assessed as Not Supporting in a prior report retains that assessment until new monitoring data confirm that use is supported.

Assessment results are provided in more detail in Table 2-2. Waterbody assessment results are provided in ascending order by waterbody ID number. Inland water (rivers, streams, and lakes) are presented first, followed by estuarine waterbody segments. Figures 1-1 and 1-2 will assist readers in spatial overview of segments that correspond with Table 2-2. An interactive GIS of assessment results is available on the Connecticut Environmental Conditions online website. Figure 2-1 below displays all waterbody type segments assessed for any use over the entire state of Connecticut, and Figures 2-2 and 2-3 display assessment support for Aquatic Life and Recreational uses respectively.

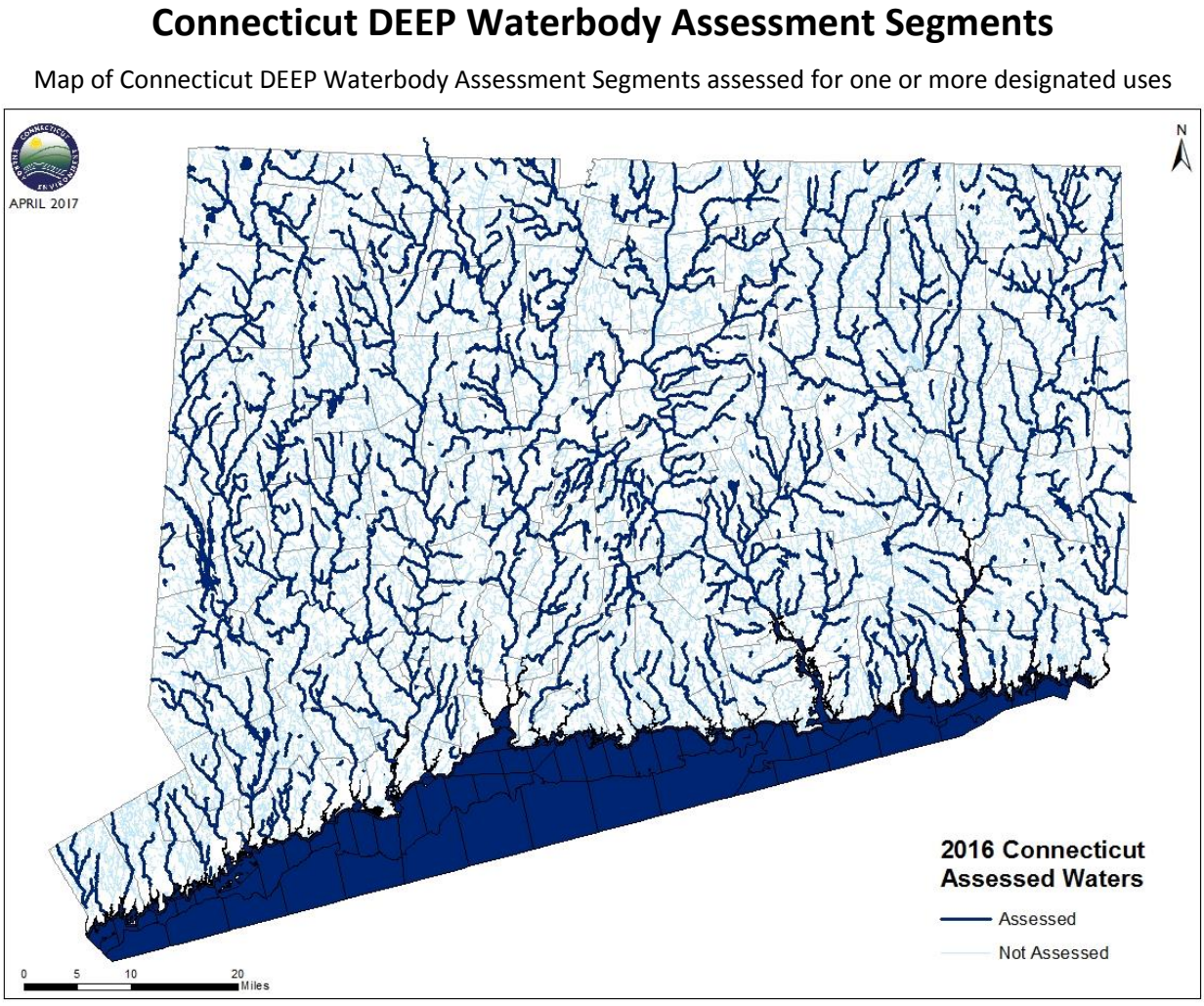


Figure 2-1. Waterbody segments assessed for one or more designated uses

Table 2-1. Designated Use support summaries for rivers, lakes, and estuaries

USE SUPPORT 2016		FULLY SUPPORTING	NOT SUPPORTING	INSUFFICIENT INFORMATION	TOTAL ASSESSED	NOT ASSESSED	TOTAL TRACKED[a]
Rivers							
	Segments	464	194	91	749	302	1051
Aquatic Life	Miles	1619.85	544.33	262.77	2426.95	555.77	2982.72
	Segments	108	255	36	399	652	1051
Recreation	Miles	397.74	828.76	88.61	1315.11	1667.62	2982.72
	Segments	1032	14	0	1046	5	1051
Fish Consumption [b]	Miles	2870.05	110.72	0	2980.77	1.95	2982.72
Lakes							
	Segments	102	17		119	63	182
Aquatic Life	Acres	24173.13	1158.90		25332.03	5105.43	30437.46
	Segments	80	31		111	71	182
Recreation	Acres	14832.24	6711.70		21543.94	8893.52	30437.46
	Segments	168	13		181	1	182
Fish Consumption [b]	Acres	26797.08	3639.01		30436.09	1.37	30437.46
Estuaries							
	Segments	29	76	0	105	106	211
Marine Aquatic Life	Mi^2	236.75	316.75	0	553.50	58.40	611.91
	Segments	55	25	1	81	130	211
Recreation	Mi^2	28.41	15.29	0.02	43.72	568.19	611.91
	Segments	207	4		211	0	211
Fish Consumption [b]	Mi^2	603.28	8.63		611.91	0	611.91
	Segments	7	117		124	10	134
Shellfish Harvesting, Class SA Waters	Mi^2	39.19	206.47		245.66	0.76	246.42
	Segments	22	27		49	11	60
Shellfish Harvesting, Class SB Waters	Mi^2	38.27	20.65		58.92	6.19	65.11

[a] "Total Tracked" refers to the waterbody sizes tracked in the Assessment Database (ADB V2). The total size of estuaries in the State is accounted for, but only a fraction of river miles and lake acres are tracked in the ADB V2. The total number of river miles estimated for Connecticut is 5,830 and the total number of lake acres is 64,973.

[b] All freshwaters of the State have a fish consumption advisory and addressed by a statewide limited consumption advisory for all freshwater fish, except trout, due to atmospheric deposition of mercury. Similarly, all estuarine waters have a fish consumption advisory and addressed by a statewide advisory on striped bass and bluefish due to PCB contamination. The waters summarized in these tables contain fish consumption advisories beyond the statewide advisories.

Connecticut DEEP Waterbody Assessments, Aquatic Life Use Support

Map of Connecticut DEEP Waterbody Assessment Segments showing Aquatic Life Use Support

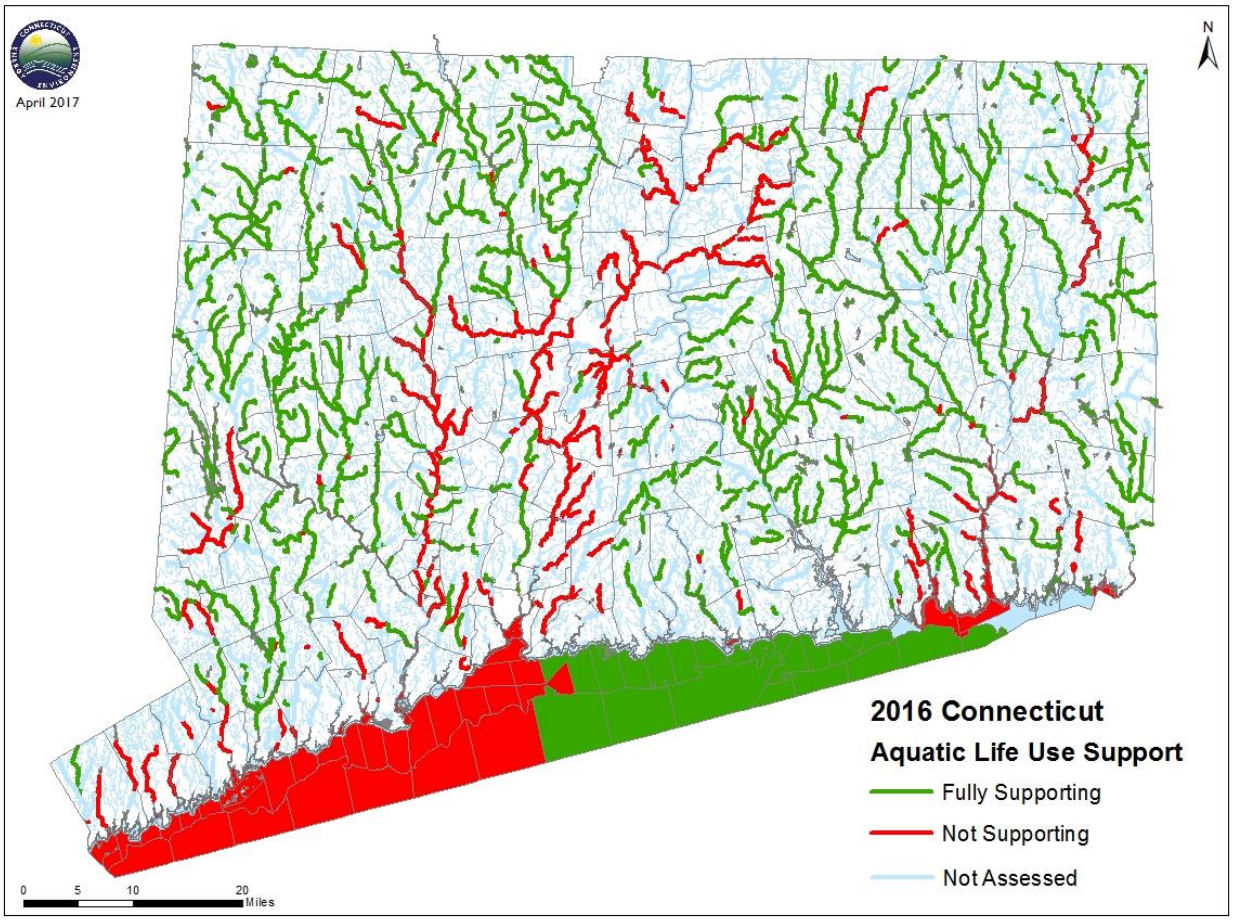


Figure 2-2. Waterbody segments assessed for Aquatic Life Use Support (ALUS)

Connecticut DEEP Waterbody Assessments, Recreational Use Support

Map of Connecticut DEEP Waterbody Assessment Segments showing Recreational Use Support

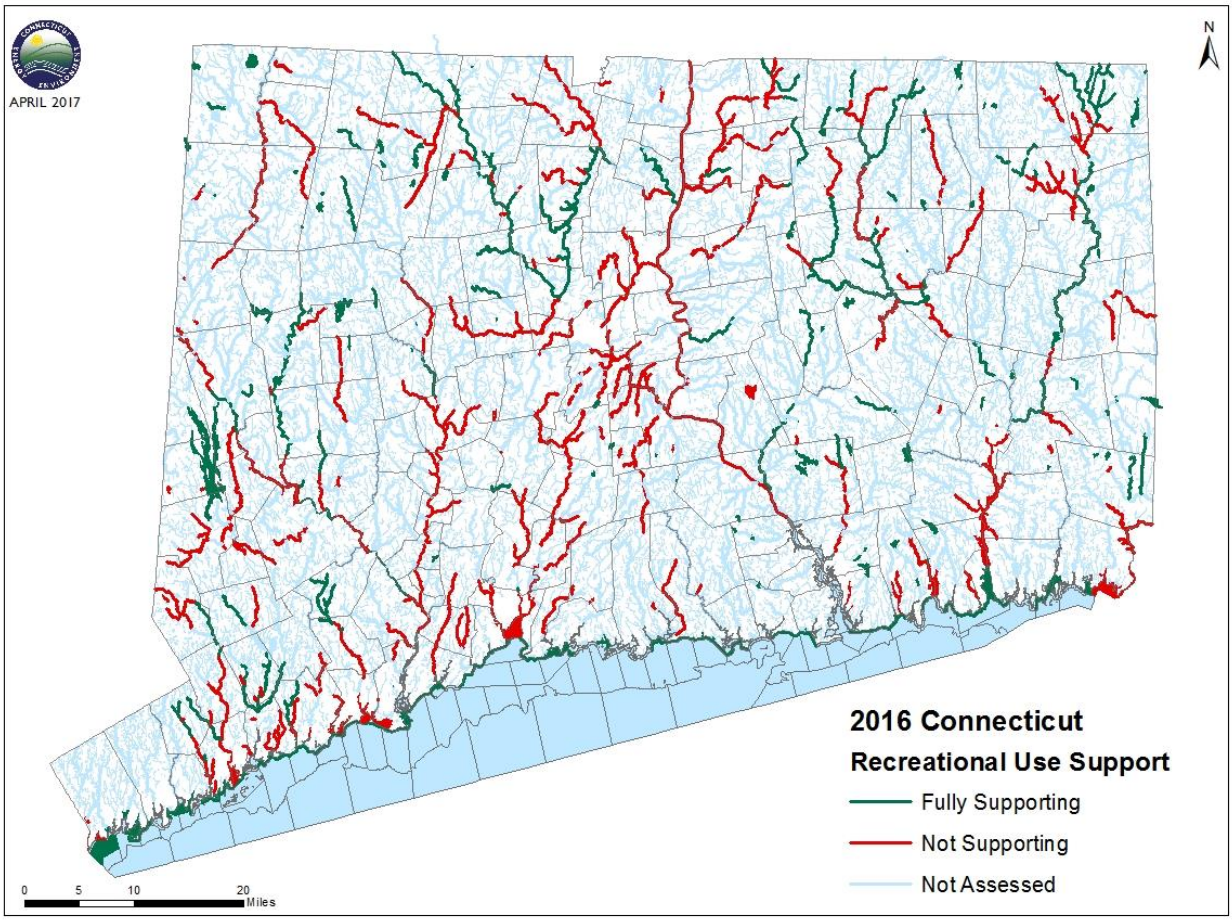


Figure 2-3. Waterbody segments assessed for Recreational Use Support (REC)

Connecticut Estuary Square Miles Assessed for Shellfish Use

Connecticut estuaries evaluated by CT DEEP for support of Shellfishing Use.

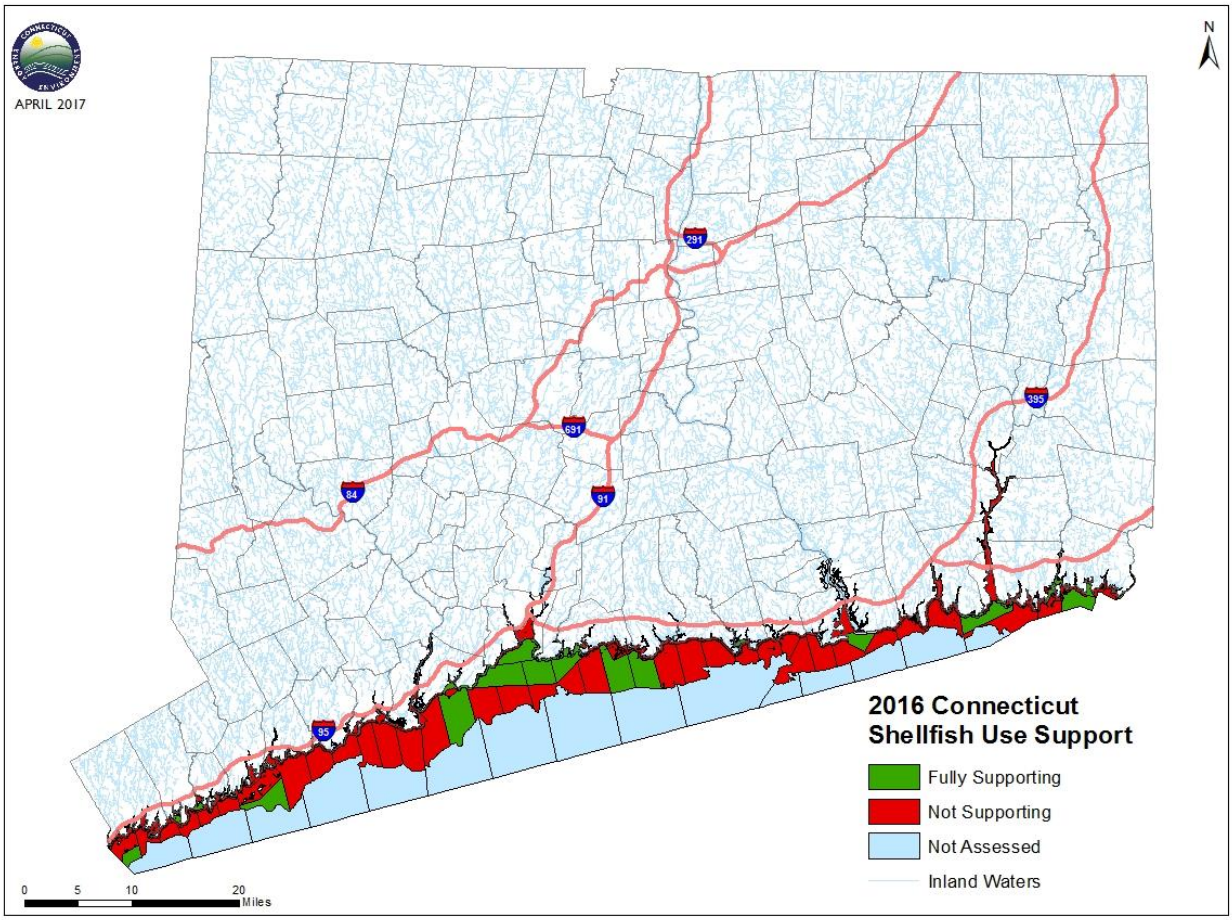


Figure 2-4. Waterbody segments assessed for Shellfishing Use Support.

CT DEEP evaluated current and available monitoring data to assess Shellfishing Use Support for 312 square miles of estuary in Connecticut (Figure 2-4). An important note for shellfish in estuarine waters is assessment criteria are only applied to inner, shore, and midshore waters where growth is viable, which is approximately 50% of Connecticut's estuarine waters. Percentages are based upon the area viable for shellfish use and not the total estuarine waters in Connecticut.

Statewide Assessments using a Probabilistic Sampling Design

Probabilistic Monitoring of Rivers and Streams

Statistical surveys were implemented in accordance with Connecticut's Ambient Water Quality Monitoring Strategy (CTDEEP 2015) to characterize use support in wadeable streams for aquatic life and recreation on a statewide basis. A Generalized Random Tessellation Stratified (GRTS) survey design (Stevens and Olsen 2004) was provided to DEEP from EPA and implemented with a target population of streams based on the National Hydrography Dataset at the 1:24,000 scale. No stratification was included in the survey design.

A total of 100 wadeable stream sites were sampled from 2006-2010 to obtain a statewide estimate of aquatic life use attainment. This was achieved by sampling 20 streams per year over the five year rotating basin cycle. In 2011, these stream samples were evaluated and summarized for Aquatic Life Use support assessment (Table 2-2) resulting in 77% Fully Supporting, 22% Not Supporting, and 1% Insufficient Information Statewide statistical assessment for aquatic life in wadeable streams in Connecticut. Samples (n=100) were collected from 2006-2010 using a Generalized Random-Tessellation Stratified Design.

Table 2-2. CT DEEP Probabilistic Monitoring Aquatic Life Use Support 2006-2010 Summary

Use Support Category	Percent of Target	Standard Error	Upper and Lower 95% Confidence Intervals
Fully Supporting	77	2.7	71.7-82.3
Not Supporting	22	2.6	16.9-27.1
Insufficient Information	1	0.8	0.0-2.7

The probabilistic assessments for aquatic life use in streams was repeated in 2011-2015 and results of this survey will be available in the 2018 IWQR.

Spatially, the 100 streams assessed for aquatic life use support follow patterns observed in past work in Connecticut. That is, land cover, specifically impervious land cover, is an important consideration when determining aquatic life use support in wadeable streams in Connecticut (Figure 2-5). For example, more than 90% of the randomly selected stream sites that were not supporting aquatic life use were located in watersheds that had more than 12% impervious cover in the watershed. Further, no sites that were Fully Supporting aquatic life use were contained in watersheds with more than 12 % impervious cover.

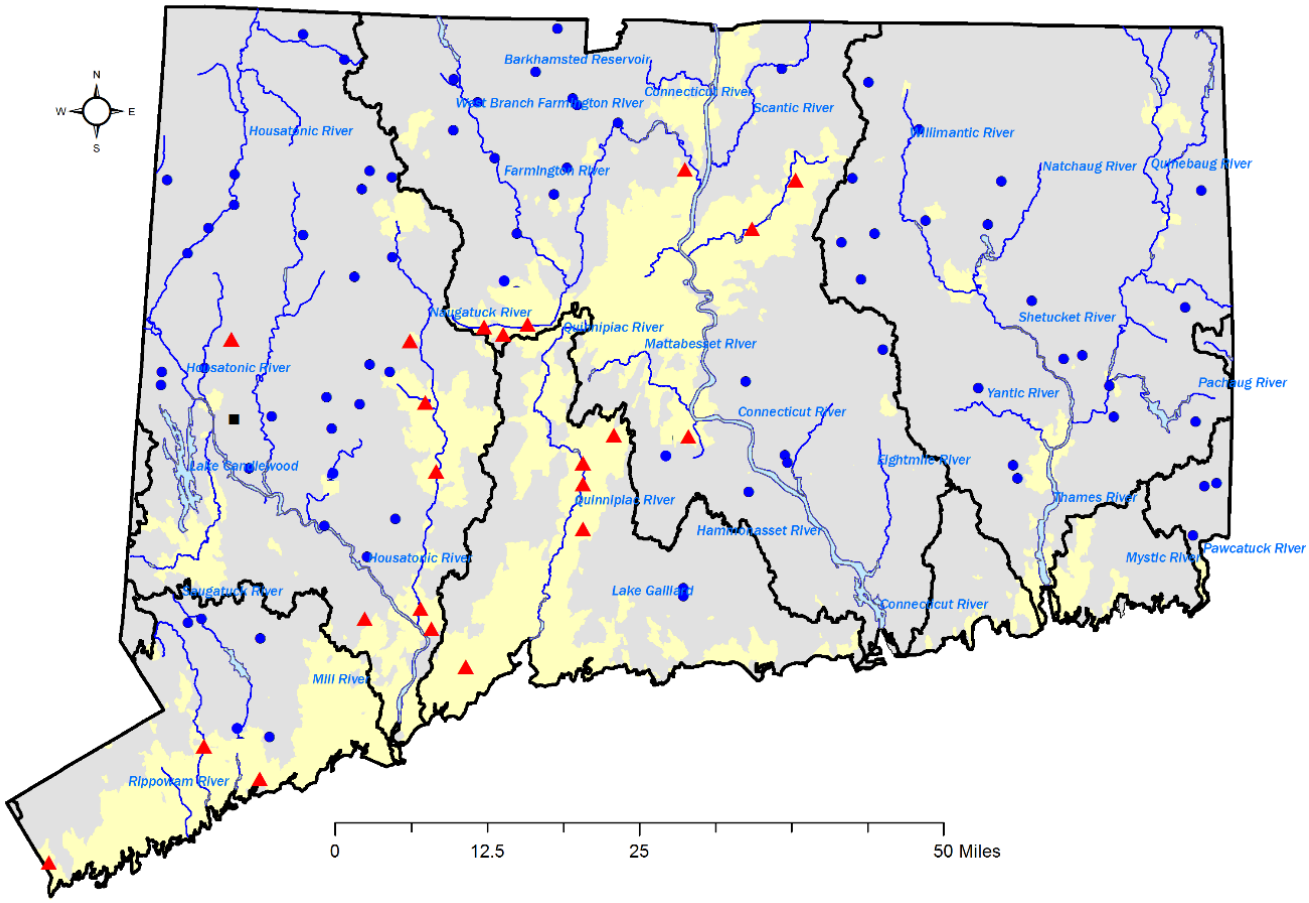


Figure 2-5. Statewide statistical assessment for aquatic life in wadeable streams in Connecticut.

Samples (n=100) were collected from 2006-2010 using a Generalized Random-Tessellation Stratified design. Blue circles are fully supporting, red triangles are not supporting, and black squares have insufficient information to make an assessment of aquatic life. Yellow shaded polygons are all basins that have >12 % impervious cover and grey shaded basins have <12 % impervious cover.

Probabilistic Monitoring of Lakes

We evaluated data collected from 14 lakes included in the 2007 National Lake Assessment (NLA). These included Beardsley Pond, Bissonnette Pond, Groton Reservoir, Knowlton Pond, Lake Kenosia, Lake Waramaug, Lake Zoar, Morris Reservoir, Pachaug Pond, Riga Lake, Roseland Lake, Union Pond, West Hill Pond and Wononpakook Lake.

For this assessment cycle, we evaluated data collected from our participation in the 2012 National Lakes Assessment from Beardsley Pond, Bissonette Pond, Columbia Lake, Halls Pond, Roseland Lake, Long Meadow Pond, Messerschmidt Pond, Morris Reservoir, Peat Swamp Reservoir, Quinebaug Pond (Wauregan Reservoir), Shetucket River Reservoir (Blissville Pond) , and West Hill Pond.

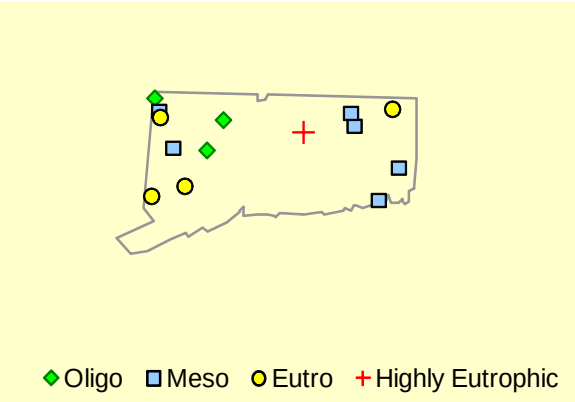
Lake trophic classifications, as listed in the CT WQS (www.ct.gov/deep/wqsc) are based on ambient measurements of four parameters: total nitrogen, total phosphorus, chlorophyll a, and Secchi disc transparency in specified seasons. In general, the range of indicators in Connecticut's Trophic Category System for the 14 lakes based on total nitrogen (Fig. 2-6) , total phosphorus (Fig. 2-7), chlorophyll a (Fig. 2-8), and Secchi depth (Fig. 2-9) fell in between what was measured in the New England States (n=69) and those lake sampled throughout the Nation (n= 1,028). These evaluations are based on a single trip following standard sampling protocols for the 2007 NLA study and are not conclusive assessments of trophic status. Rather they are presented to show how Connecticut's lakes sampled in the NLA compared to lakes regionally and across the United States.

Drinking Water Use

Currently, a 1.24 mile section of the Farm River - CT5112-00_02, Farm River (North Branford)-02 (From confluence with Burrs Brook (DS of Route 80 crossing), upstream to Pages Mill Pond outlet dam, Upstream side of Mill Road crossing, North Branford) is the only waterbody assessed as not supporting drinking water use.

Connecticut Lakes Total Nitrogen in 2007 NLA

14 Connecticut Lakes evaluated for Total Nitrogen in 2007 NLA.



Map of total nitrogen ranges for 14 lakes in Connecticut that were surveyed in 2007 for the National Lakes Assessment.

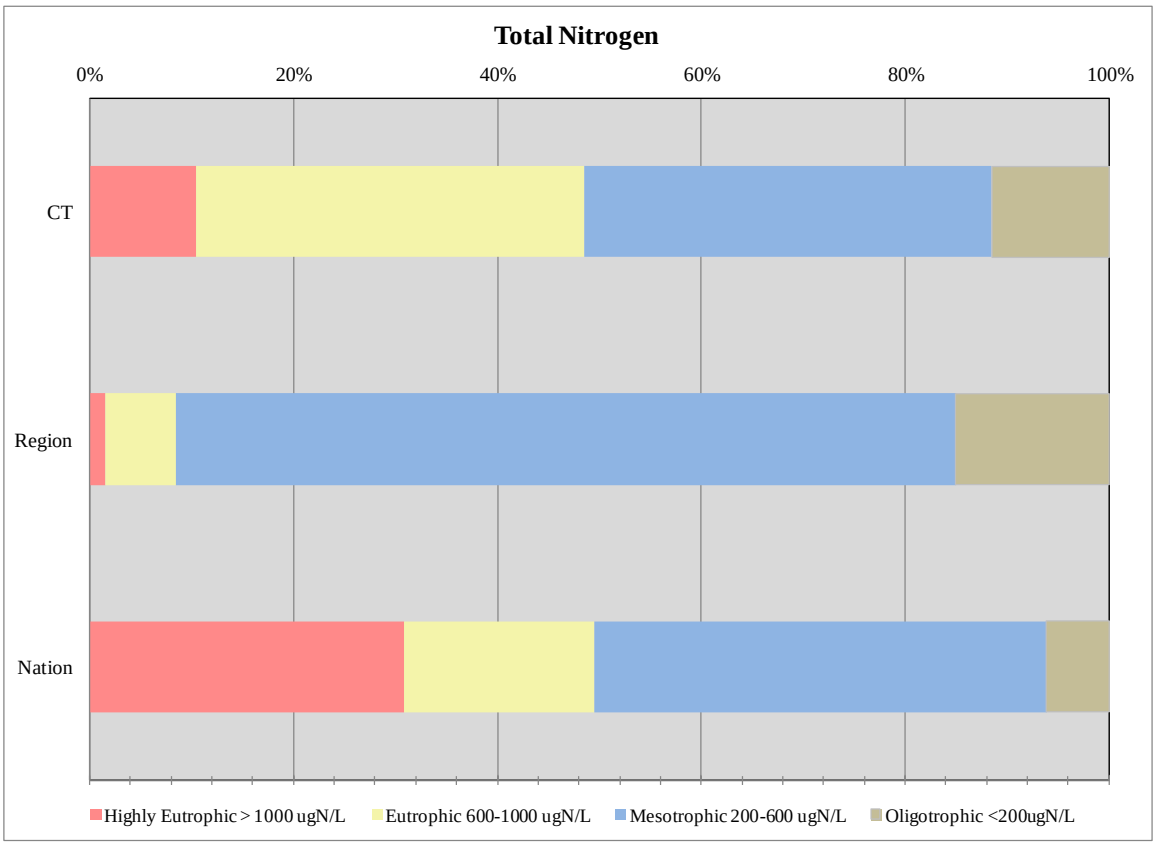
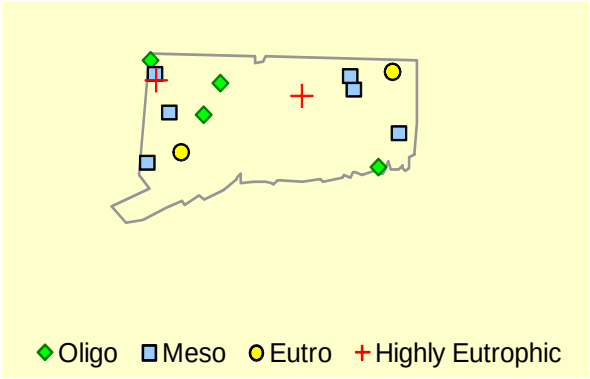


Figure 2-6. Comparing Connecticut lakes to the Nation based on Total Nitrogen from the 2007 National Lakes Assessment in Connecticut (CT, n=14) New England Region (Region; n=69), and Nationally (Nation; n=1,028) that were in the highly eutrophic, eutrophic, mesotrophic, and oligotrophic range for total nitrogen (TN) based on Connecticut's Trophic Category System.

Connecticut Lakes Total Phosphorus in 2007 NLA

14 Connecticut Lakes evaluated for Total Phosphorus in 2007 NLA



Map of total phosphorus ranges for 14 lakes in Connecticut that were surveyed in 2007 for the National Lakes Assessment.

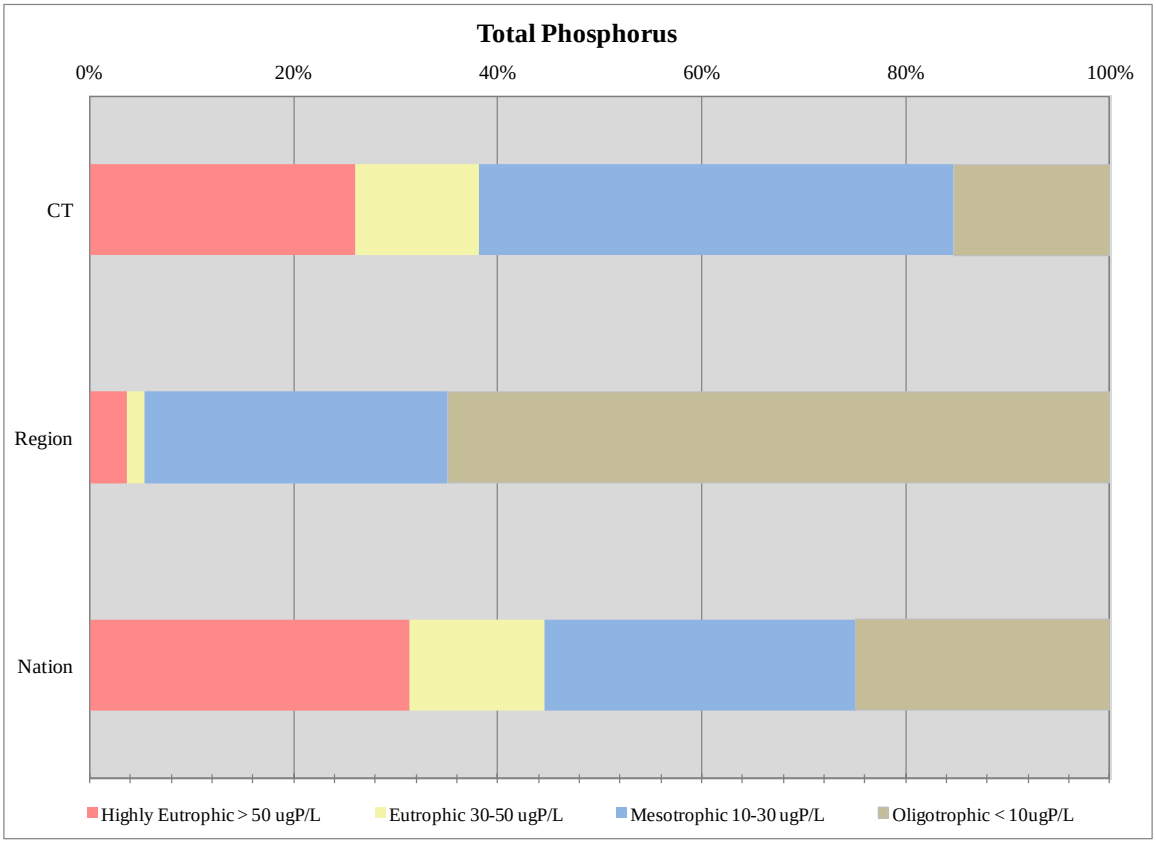
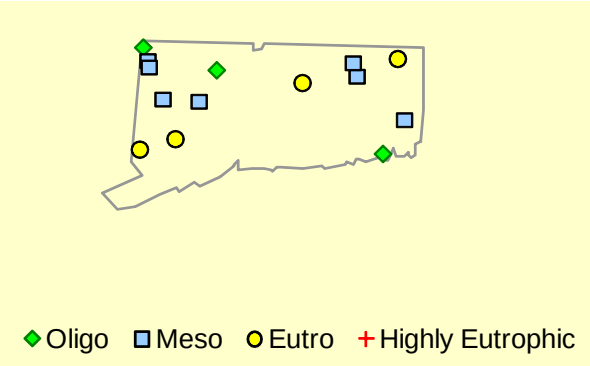


Figure 2-7. Comparing Connecticut lakes to the Nation based on Total Phosphorus from the 2007 National Lakes Assessment in Connecticut (CT; n=14), New England Region (Region; n=69), and Nationally (Nation; n=1,028) that were in the highly eutrophic, eutrophic, mesotrophic, and oligotrophic range for total phosphorus (TP) based on Connecticut's Trophic Category System.

Connecticut Lakes Chlorophyll-a in 2007 NLA

14 Connecticut Lakes evaluated for Total Phosphorus in 2007 NLA



Map of chlorophyll-a ranges for 14 lakes in Connecticut that were surveyed in 2007 for the National Lakes Assessment.

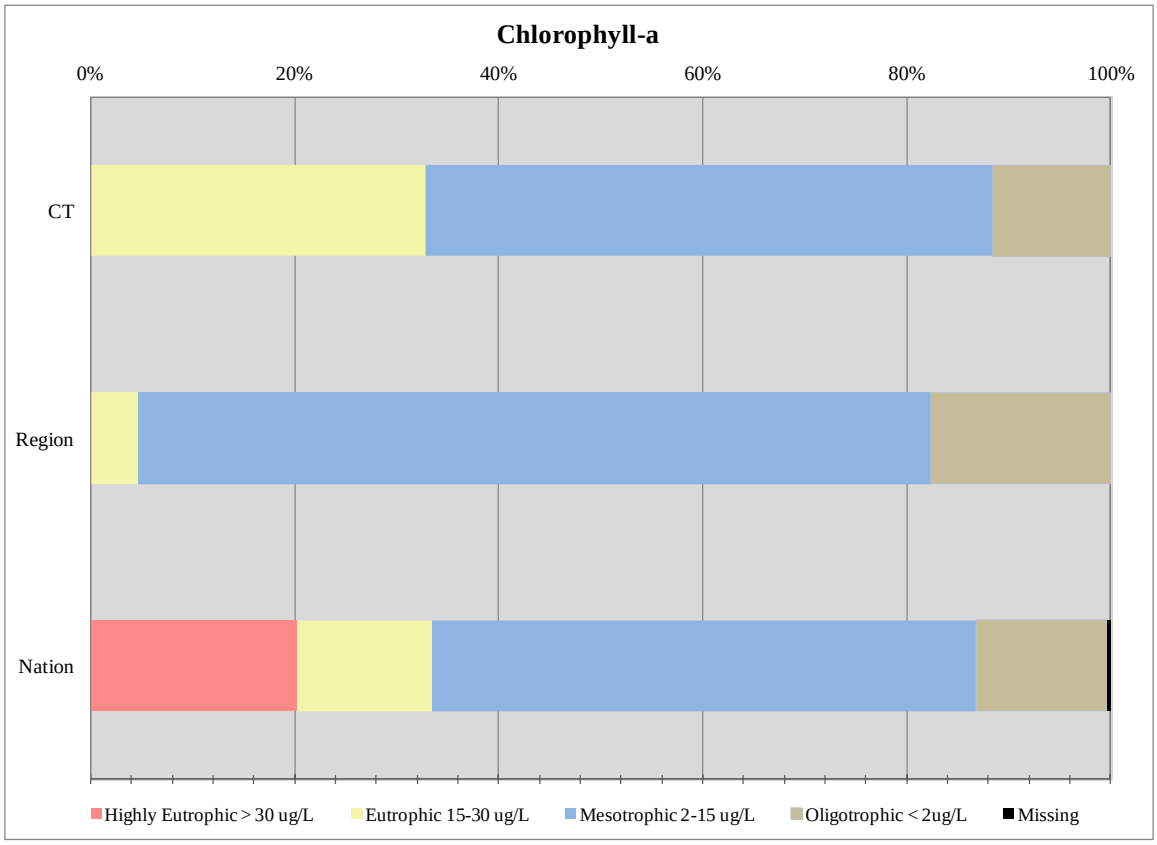
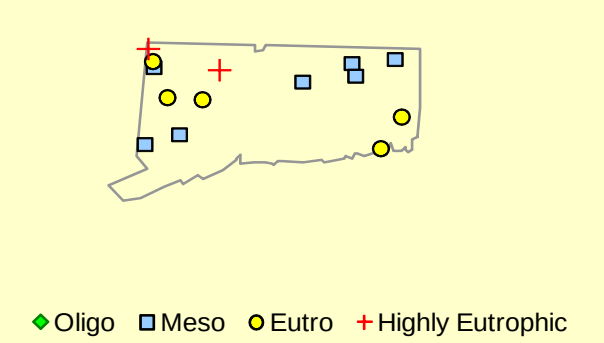


Figure 2-8. Comparing Connecticut lakes to the Nation based on Chlorophyll-a from the 2007 National Lakes Assessment in Connecticut (CT; n=14), New England Region (Region; n=69), and Nationally (Nation; n=1,028) that were in the highly eutrophic, eutrophic, mesotrophic, and oligotrophic range for chlorophyll-a based on Connecticut's Trophic Category System.

Connecticut Lakes Secchi Depth in 2007 NLA

14 Connecticut Lakes evaluated for Secchi Depth in 2007 NLA



Map of Secchi depth ranges for 14 lakes in Connecticut that were surveyed in 2007 for the National Lakes Assessment.

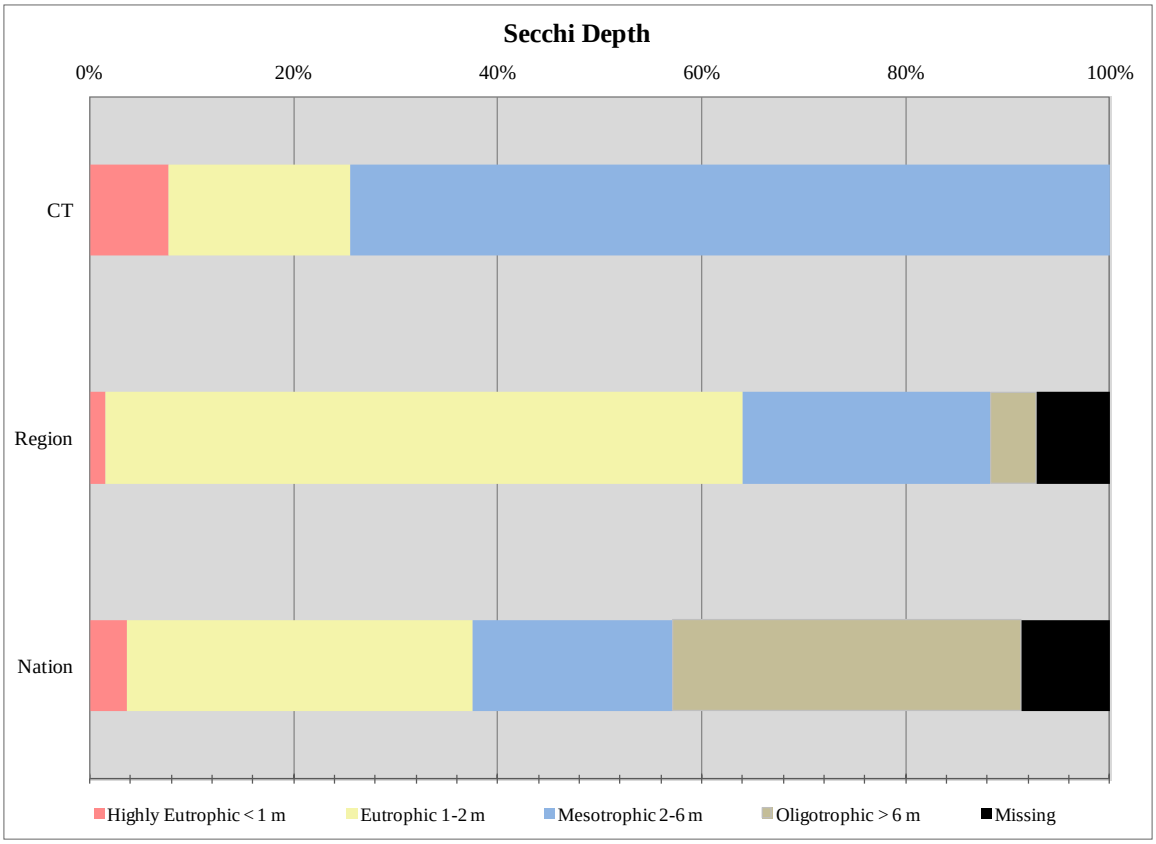


Figure 2-9. Comparing Connecticut lakes to the Nation based on Secchi Depth from the 2007 National Lakes Assessment in Connecticut (CT; n=14), New England Region (Region; n=69), and Nationally (Nation; n=1,028) that were in the highly eutrophic, eutrophic, mesotrophic, and oligotrophic range for Secchi depth based on Connecticut's Trophic Category System.

Table 2-3. Connecticut 305b Assessment Results for Rivers and Streams

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT1000-00_01	Pawcatuck River (Stonington/North Stonington)-01	Head of tide at Route 1 crossing Stonington to Pawcatuck-Westerly RI, US along CT/RI border until river enters RI, lower portion North Stonington.	5.38	Fully Supporting	Not Supporting
CT1000-00_trib_01	Unnamed tributary Pawcatuck River 1000-00 (Stonington)-01	Mouth at confluence Pawcatuck River (Little Narragansett Bay portion) just DS of Route 49 crossing, US to HW at unnamed pond outlet just US of Route 49 crossing, very close to Town border, Stonington. Statewide bacteria TMDL	0.18	Not Assessed	Not Supporting
CT1000-01_01	Unnamed tributary Pawcatuck River 1000-01 (N. Stonington)-01	Mouth at confluence Pawcatuck River, US to Lewis Pond OUTLET, just US of Boom Bridge Road crossing, North Stonington. Statewide bacteria TMDL	0.14	Not Assessed	Not Supporting
CT1000-03_01	Unnamed tributary Pawcatuck River 1000-03 (Stonington)-01	Mouth at confluence Pawcatuck River, just DS of Route 2/78 crossing, US to HW at unnamed pond OUTLET just US of Elm Ridge Road crossing, Stonington.	0.88	Not Assessed	Not Supporting
CT1000-04_01	Unnamed tributary Pawcatuck River 1000-04 (Stonington)-01	Mouth at confluence Pawcatuck River, US to HW, US of Route 2/78 crossing and above Kelly Street and North Road access points, Stonington. Statewide bacteria TMDL	0.72	Not Assessed	Not Supporting
CT1000-05_01	Unnamed tributary Pawcatuck River 1000-05 (Stonington)-01	Mouth at confluence Pawcatuck River, US to HW at unnamed pond OUTLET just US of Arch Street crossing, Stonington. Statewide bacteria TMDL	0.55	Not Assessed	Not Supporting
CT1001-00_01	Wyassup Brook (North Stonington)-01	Mouth at confluence Green Fall River (on North side and parallel to Route 216 (Clarks Falls Road)), US to Wyassup Lake outlet (just US of Wyassup Road crossing), North Stonington.	5.27	Fully Supporting	Not Assessed
CT1001-02_01	Pendleton Hill Brook (North Stonington)-01	Mouth at Spalding Pond portion of Wyassup brook, just DS of Route 49 crossing, US to HW, adjacent to route 49 at Wyassup Road intersection, North Stonington.	5.13	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT1002-00_01	Green Fall River (North Stonington)-01	Rhode Island border (very close to mouth), US to confluence Wyassup Brook (just US of Clarks Falls Road crossing), North Stonington.	1.47	Fully Supporting	Not Assessed
CT1002-00_02	Green Fall River (North Stonington/Voluntown)-02	Confluence Wyassup Brook (just US of Clarks Falls Road crossing), North Stonington, US to Green Fall Pond (Reservoir) outlet dam, Voluntown.	5.18	Fully Supporting	Fully Supporting
CT1004-00_01	Shunock River (North Stonington)-01	Mouth at Pawcatuck River, US to Side Pond dam at outlet of Ripley Parks Pond (just south of Babcock Road), North Stonington Center.	4.37	Fully Supporting	Not Supporting
CT2000-30_01	Fenger Brook (Waterford)-01	Mouth at head of tide, Alewife Cove (just DS of Niles Hill Road (Route 213) crossing), US to HW (southeast of Clark Lane and Chester Street intersection), Waterford.	3.47	Not Supporting	Not Supporting
CT2102-00_01	Copps Brook (Stonington)-01	Mouth at Quiambog Cove (parallel to Cove Road), US to Palmer (Mystic) Reservoir outlet dam (just US of Jerry Brown Road crossing), Stonington.	0.77	Not Supporting	Not Assessed
CT2102-00_02	Copps Brook (Stonington/North Stonington)-02	Inlet to Palmer (Deans/Mystic) Reservoir (just DS of Pequot Trail (Route 234) road crossing), Stonington, US to HW (just US of Mystic Road (Route 201) crossing, North Stonington.	4.32	Not Supporting	Not Assessed
CT2102-00-trib_01	Unnamed tributary Copps Brook (Stonington)-01	Mouth at confluence Copps Brook just US of Quiambog Cove (parallel to Cove Road), US to HW near Jerry Brown Road, Stonington (intermittent).	0.66	Not Supporting	Not Assessed
CT2103-00_03	Seth Williams Brook-03	From Highlands POTW (DS of Town Farm Road crossing, parallel to Shewville Road), US to headwaters (US of Shewville Road crossing, south of Route 214 intersection), Ledyard.	2.1	Not Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT2104-00_01	Whitford Brook-01	From mouth at head of Mystic River Estuary (at confluence with Haleys Brook, above Mystic River, DS of Route 27 crossing), Stonington/Groton town line, US to area east of the Shewville Road and Gallup Hill Road intersection, Ledyard/Stonington town line.	1.63	Fully Supporting	Not Assessed
CT2104-00_02a	Whitford Brook-02a	From area east of the Shewville Road and Gallup Hill Road intersection, Ledyard/Stonington town line, US to entrance of "Lantern Hill" wellfield (west of Lantern Hill Road, in marsh parallel with Stony Pond), Ledyard/Stonington town line.	0.74	Not Supporting	Not Assessed
CT2105-00_01	Haleys Brook (Groton/Ledyard)-01	Mouth at confluence with Whitford Brook above Mystic river just DS of the River Road crossing, parallel to Main Street (Route 27), Groton, US to HW parallel to Fox Hollow off of Sable Drive (off Route 117), Ledyard.	5.86	Fully Supporting	Not Assessed
CT2107-05_01	Hempstead Brook (Groton)-01	Mouth at inlet to Buddington Pond (above Groton Reservoir), just DS of Route 184 (Gold Star hwy) crossing, US to HW at YMCA Pond outlet (just US of Gungywamp Rd crossing), Groton.	1.8	Fully Supporting	Not Assessed
CT2201-00_01	Jordan Brook (Waterford)-01	Saltwater limit at INLET to Jordan Mill Pond, .18 miles DS of Route 156 (Rope Ferry Road) crossing, US to US side of Waterford Pkwy (just US of I95 crossing), Waterford.	2.52	Fully Supporting	Not Assessed
CT2201-00_02	Jordan Brook (Waterford)-02	US side of Waterford Pkwy (just US of I95 crossing), US to HW 1.23 mile US (north) of I395 crossing (parallel with Vauxhall Street), Waterford.	3.7	Fully Supporting	Not Assessed
CT2202-00_01	Latimer Brook (East Lyme)-01	From mouth at confluence with Niantic River (head of tide at Banning Cove inlet, just DS of Route 1 crossing, south side of I95, east of exit 75), US to confluence with Cranberry Meadow Brook (parallel with Route 161), East Lyme	4.23	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT2202-00_02	Latimer Brook-02	From confluence with Cranberry Meadow Brook (parallel with Route 161), East Lyme, US to Beckwith Pond outlet dam (boundary of drinking water watershed, just US of Route 85 crossing), Montville.	3.43	Not Supporting	Not Assessed
CT2202-08_01	Cranberry Meadow Brook (East Lyme)-01	Mouth at confluence Latimer Brook, parallel to Chesterfield Rd (Route 161) at Ponderosa Park, US to confluence with unnamed trib just US of Nehantic State Forest property boundary and parallel to Walnut Hill Rd & 1 mi DS of Grassy Hill Rd, East Lyme.	2.05	Fully Supporting	Not Assessed
CT2203-00_01	Oil Mill Brook (East Lyme/Waterford)-01	Mouth on Niantic River, parallel to Oil Mill Road, Waterford/East Lyme town line, US to I95 north bound crossing, Waterford.	0.26	Fully Supporting	Fully Supporting
CT2203-00_02	Oil Mill Brook (Waterford)-02	I95 north bound crossing (includes under I95 both lanes), US to confluence with Lakes Pond Brook, above I395 crossing, just US of Way Hill Road crossing, Waterford.	1.73	Fully Supporting	Not Assessed
CT2203-02_01	Willys Meadow Brook (Waterford)-01	Mouth Oil Mill Brook just DS of I395 crossing, US to HW at unnamed pond, Waterford.	1.29	Fully Supporting	Not Assessed
CT2204-03_01	Stony Brook (Waterford)-01	Mouth on Niantic River (saltwater limit), DS of Oswegatchie Road crossing, US to ponded section on US side of Route 1 crossing, Waterford.	0.23	Not Assessed	Not Supporting
CT2204-03_02	Stony Brook (Waterford)-02	US side of Route 1 crossing (including ponded section) US to US side of I95 (includes section under I95 both lanes) and just DS of Waterford Pkwy crossing, Waterford.	0.84	Fully Supporting	Not Assessed
CT2204-03_03	Stony Brook (Waterford)-03	US side of I95 (above section under I95 both lanes) and just DS of Waterford Pkwy crossing, US to HW just US of power line access cut and parallel to Route 85 (north of Cross Road area, in undeveloped land behind businesses), Waterford.	1.39	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT2205-00_01	Pattagansett River-01	From head of tide, just DS of Route 156 crossing, US to Gorton Pond outlet dam (just US of Roxbury Road crossing, east of Route 161 intersection), East Lyme.	1.2	Not Supporting	Not Assessed
CT2205-00_02	Pattagansett River-02	From inlet to Gorton Pond (northern side in marsh, just DS of I95 crossing), US to Pattagansett Lake outlet dam (just US of Route 1 crossing), East Lyme.	1.9	Not Supporting	Not Assessed
CT2206-00_01	Bride Brook (East Lyme)-01	Head of estuary (salt water limit, just DS of Route 156 crossing), US to Bride Lake outlet dam (just US of North Bride Brook Road), East Lyme.	0.7	Not Supporting	Not Supporting
CT2206-00_02	Bride Brook (East Lyme)-02	Inlet to Bride Lake (northwest portion, just DS of North Bride Brook Road crossing), US to headwaters (marsh on south side of Route 1), East Lyme.	2.13	Fully Supporting	Not Supporting
CT2206-03_01	Unnamed tributary to Bride Brook (East Lyme)-01	Mouth at confluence with Bride Brook (DS of Bride Brook crossing Bride Brook Road), US (under I95 near exit 72 ramp, Rocky Neck Connector) to HW near Spring Rock Road and south of Plants Dam Road, East Lyme.	1.71	Not Assessed	Not Supporting
CT2207-00_01	Fourmile River (Old Lyme/East Lyme)-01	Saltwater limit at US side of Route 156 (Shore Road) crossing, US to US side of I95 crossing (includes section under both lanes I95 and Exit 71 North ramp, but Exit 71 South ramp is in seg-02), Old Lyme/East Lyme town line.	0.99	Fully Supporting	Not Assessed
CT3000-02_01	Billings Avery Brook (Ledyard)-01	Mouth at Thames River DS Route 12 crossing, US to AA water boundary US Daniels Lane crossing at outlet Billings Avery Diversion Dam, Ledyard.	1.78	Not Supporting	Not Assessed
CT3000-08_01	Flat Brook (Ledyard)-01	Mouth confluence Thames River (inlet Long Cove, North of Navy Base), Gales Ferry/Ledyard, US to HW at unnamed pond, Groton (Brook runs North).	1.09	Not Assessed	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3001-00_01	Trading Cove Brook-01	Head of tide confluence Thames River (inlet Trading Cove, just DS from Route 32 crossing), Norwich/Montville town line, US to HW (in marsh just US Bozrah Road (Route 163) crossing), Montville.	7.24	Fully Supporting	Not Assessed
CT3003-01_01	Poquetanuck and Hewitt Brooks (Preston)-01	Mouth of Poquetanuck Brook at confluence with Thames River, inlet to Poquetanuck Cove, just DS of Poquetanuck Road (Route 2A) crossing, US to confluence with Hewitt Brook, then CONTINUES US in Hewitt Brook to Hallville Pond outlet dam, Preston.	1.69	Fully Supporting	Not Assessed
CT3003-05_01	Joe Clark Brook (Preston/Ledyard)-01	Mouth at Poquetanuck Cove portion of Thames River, DS of Cider Mill Road crossing on Preston/Ledyard border, US to HW just US of Silas Deane Road crossing, Ledyard.	3.4	Fully Supporting	Not Assessed
CT3004-00_01	Oxoboxo Brook-01	From mouth at head of tide (inlet to Gay Cemetery Pond, Horton Cove, Thames River), US to Wheeler Pond outlet dam, Montville. (Segment includes Rockland Pond)	2.62	Not Supporting	Not Supporting
CT3004-00_02	Oxoboxo Brook-02	From inlet to Wheeler Pond (northwestern portion, DS of Meeting House Lane road crossing), US to Oxoboxo Lake outlet dam. (Includes Scholfield Pond)	2.95	Fully Supporting	Not Assessed
CT3005-01_01	Stony Brook (Montville)-01	Mouth on Horton Cove portion of Thames River, just DS of Route 32 crossing, US to confluence with unnamed tributary (3005-02), DS of Fitch Hill Road crossing, parallel to Gallivan Lane, Montville.	2.97	Fully Supporting	Not Assessed
CT3005-01_02	Stony Brook (Montville)-02	Confluence with unnamed tributary (3005-02), DS of Fitch Hill Road crossing, parallel to Gallivan Lane, US to Stony Brook reservoir outlet, parallel to Noble Hill Road, Montville.	1.56	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3006-00_01	Hunts Brook (Waterford)-01	Saltwater limit at DS side of Old Norwich Road crossing, just south of Quaker Hill Elementary school, US to OUTLET Miller Pond (near power line access) parallel to Old Colchester Road, Waterford.	1.38	Not Supporting	Not Assessed
CT3006-00_03	Hunts Brook (Montville)-03	Confluence with unnamed tributary at AA water quality boundary, .4 miles US of Unger Road crossing and parallel to Fire Street, US to HW US of Fire Street crossing north of Fire Street and Lake Road intersection, Montville.	1.9	Fully Supporting	Not Assessed
CT3100-00_01	Willimantic River-01	From mouth at confluence with Shetucket River, Windham, US to confluence with the Tenmile River (at Columbia/Lebanon/Windham borders, just DS of Route 66 crossing). Entire segment parallels Route 66.	2.69	Not Assessed	Fully Supporting
CT3100-00_02	Willimantic River-02	From confluence with Tenmile River (at Columbia/Lebanon/Windham borders, just DS of Route 66 crossing), US to Eagleville Pond dam outlet (just US of Stonehouse Road crossing).	6.59	Fully Supporting	Fully Supporting
CT3100-00_03	Willimantic River (Willington/Tolland)-03	Inlet to Eagleville Pond (west of Route 32 and Railroad tracks near Ravine Road intersection), Mansfield, US to I84 crossing (includes under highway crossing area), Willington/Tolland.	9.59	Fully Supporting	Not Supporting
CT3100-00_04	Willimantic River-04	From I84 crossing (includes under highway crossing area), Willington/Tolland, US to confluence with Bonemill Brook, Tolland.	3.11	Fully Supporting	Fully Supporting
CT3100-00_05	Willimantic River (Tolland/Willington/Ellington/ Stafford)-05	From confluence with Bonemill Brook (just DS of Route 32 crossing), Willington/Tolland, US to Stafford POTW (east of Route 32 (River Road)), Stafford.	1.65	Not Supporting	Fully Supporting
CT3100-00_06	Willimantic River-06	From Stafford POTW (east of Route 32 (River Road)), US to headwaters at confluence of Middle River and Furnace Brook.	0.4	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3100-03_01	Bonemill Brook-01	From mouth at confluence with Willimantic River, US to Sweetheart Lake outlet dam, Tolland.	0.19	Not Assessed	Fully Supporting
CT3100-03_02	Bonemill Brook-02	From inlet to Sweetheart Lake, Tolland, US to headwaters (US of Tolland Turnpike crossing), Ellington.	1.93	Fully Supporting	Not Assessed
CT3100-17_01	Cedar Swamp Brook (Mansfield)-01	From confluence with Willimantic River (segment03, in Eagleville Pond portion of river) just DS of Route 32 (Stafford Road) and Railroad crossings, US to confluence with Nelson Brook, Mansfield.	1.54	Not Assessed	Fully Supporting
CT3100-17_02	Cedar Swamp Brook (Mansfield)-02	From confluence with Nelson Brook, US to Hunting Lodge Road crossing, Mansfield.	0.59	Fully Supporting	Not Assessed
CT3100-17_03	Cedar Swamp Brook (Mansfield)-03	From Hunting Lodge Road crossing, US to Swamp Brook Pond outlet dam (just US of Route 44 crossing), Mansfield.	0.61	Fully Supporting	Not Supporting
CT3100-19_01	Eagleville Brook (Mansfield)-01	Mouth at Eagleville Pond entrance (lower eastern corner), US to confluence with Kings Brook (east side of North Eagleville Road), Mansfield.	0.68	Fully Supporting	Fully Supporting
CT3100-19_02	Eagleville Brook (Mansfield)-02	Confluence Kings Brook (east side of North Eagleville Road), US to HW near UConn campus (just crossing Stadium Road), Mansfield.	1.67	Not Supporting	Not Supporting
CT3101-00_01	Edison Brook (Stafford)-01	Mouth at confluence with Middle River, East side of Swift Airport property (west of Route 190), US to confluence with Hopyard Brook (short outlet area from pond or wetland), US of Copper Lane crossing, parallel to dirt road, Stafford.	0.86	Not Assessed	Fully Supporting
CT3101-03_01	Crystal Lake Brook (Stafford)-01	From mouth at confluence with Ellis Brook, HW of Edson Brook (DS of West Stafford Road (Route 190) crossing), US to Crystal Lake outlet dam (just US of Conklin Road crossing), Stafford.	2.18	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3101-05_01	Ellis Brook (Stratford)-01	Mouth confluence Crystal Lake Brook above Edson Brook US of Route 190 and Route 30 intersection (parallel Old Spring Road), US to HW at Bruie Pond outlet just US of Hampden Road crossing, Stafford.	2.99	Fully Supporting	Not Assessed
CT3101-07_01	Diamond Ledge Brook (Stafford)-01	Mouth at Edson Brook just DS and parallel with Route 190 crossing, US to HW US of Lake Mark (segment includes Lake Mark), Stafford.	3.25	Fully Supporting	Not Assessed
CT3102-00_01	Middle River (Stafford)-01	From mouth at confluence with Furnace Brook (above Willimantic River), US to 800Ft US of Route 32 crossing, Stafford Springs center.	0.23	Fully Supporting	Not Supporting
CT3102-00_02	Middle River (Stafford)-02	From 800Ft US of Route 32 crossing, Stafford Springs center, US to Orcutts Pond dam outlet (just US of Orcutville Road (Route319) crossing), Stafford.	3.92	Fully Supporting	Not Supporting
CT3102-00_03	Middle River (Stafford)-03	From Orcutts Pond inlet, US to State Line Pond outlet (on southern end, just US of Route 32 crossing), Stafford.	2.78	Not Assessed	Fully Supporting
CT3103-00_01	Furnace Brook (Stafford)-01	From mouth at confluence with Middle River, US through concrete channel, stopping at US end of concrete channel (passes under Railroad tracks and Route 14), Stafford.	0.18	Not Supporting	Not Supporting
CT3103-00_02	Furnace Brook(Stafford)-02	From US end of concrete channel (just US of Route 14 crossing), US to Staffordville Reservoir outlet dam (just US of Upper Road crossing), Stafford.	4.93	Not Supporting	Not Supporting
CT3103-01_01	Delphi Brook (Stafford)-01	Mouth at inlet to Staffordville Reservoir, between Delphi Road and Route 19, US to Connecticut/Massachusetts state line, parallel to Route 19, Stafford.	1.46	Fully Supporting	Not Assessed
CT3103-04_01	Potash Brook (Stafford)-01	Mouth at inlet to Staffordville Reservoir DS of Delphi Road crossing, US to HW just above CT/MA boarder, Stafford.	1.3	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3104-00_01	Roaring Brook (Willington)-01	From mouth at confluence with Willimantic River (just DS from Route 32 crossing), US to Stafford Springs Reservoir No2 outlet (Willington, Stafford).	7.3	Fully Supporting	Fully Supporting
CT3104-00_02	Roaring Brook (Stafford/Union)-02	From Stafford Springs Reservoir No2 inlet (just DS from South Road crossing), US to headwaters at Moore Pond outlet dam (Stafford Springs Reservoir No4).	3.42	Insufficient Information	Fully Supporting
CT3104-00-2-L8_outlet_01	Ruby Lake outlet stream-01	From mouth at Roaring Brook, Willington, US to wetland adjacent to truck stop, Southwest of Exit 71 off I84.	0.12	Not Supporting	Not Assessed
CT3104-01_01	Stickney Hill Brook-01	From mouth at confluence with Roaring Brook (just DS of Old Brown Road crossing), US to headwaters at small unnamed pond (just US of Stickney Hill Road crossing), Union.	2.32	Fully Supporting	Fully Supporting
CT3105-00_01	Mill Brook (Coventry)-01	Mouth at confluence with Willimantic River, DS of Depot Road crossing (Coventry/Mansfield town line), US to exit of underground connector from Wangumbaug Lake, just US of Monument Hill Road crossing, parallel to Route 31, Coventry.	2.49	Not Assessed	Fully Supporting
CT3106-00_01a	Skungamaug River (Andover/Coventry/Tolland)-01a	Mouth at confluence with Hop River, Andover (between Hendee Road and Times Farm Road), US to INLET to Summer Lake (includes lake) above Anderson Road, Tolland.	10.39	Fully Supporting	Fully Supporting
CT3106-00_01b	Skungamaug River-01b	From INLET to Summer Lake (lake in seg-01) above Anderson Road, US to headwaters (US of Old Tolland Road crossing), Tolland.	6.29	Fully Supporting	Not Supporting
CT3106-07_01	Spice Brook (Tolland)-01	From mouth at confluence with Chapins Meadow Brook, HW of Metcalf Brook (US of Grant Hill Road crossing), US to HW (just US of Route 31 crossing), Tolland.	2.32	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3107-00_01	Burnap Brook (Andover)-01	Mouth at confluence with Hop River, .6 miles DS for Route 6 crossing, US to confluence with unnamed tributary .5 miles US of Route 6 crossing, parallel to Burnap Brook Road (unnamed tributary crosses Burnap Brook Road perpendicular), Andover.	1.1	Fully Supporting	Fully Supporting
CT3108-00_01a	Hop River (Columbia/Coventry/Andover) -01a	Mouth at confluence with Willimantic River (between Route 6 connector and Route 66, just DS of Flanders Road crossing), Columbia/Coventry town line, US to Confluence with Skungamaug River, just US of Hendee Road crossing (east of Route 6), Andover.	11.82	Fully Supporting	Fully Supporting
CT3108-00_01b	Hop River (Andover/Coventry/Bolton)-01b	Confluence with Skungamaug River, just US of Hendee Road crossing (east of Route 6), Andover, US to HW behind Munsons Chocolate Company (crosses Route 6 several times, last time is near Stony Hill Road intersection), Bolton.	3.22	Fully Supporting	Not Supporting
CT3108-07_02	Straddle Brook (Andover)-02	Cider Mill Pond inlet, just US of Route 316 crossing, US to confluence with Massinger Brook, US of Townsend Road crossing, Andover.	1.2	Fully Supporting	Not Assessed
CT3110-00_01	Tenmile River (Willimantic)-01	From mouth at confluence with Willimantic River (south of Route 66), Willimantic, US to Stiles Pond outlet dam, Lebanon.	8.67	Fully Supporting	Not Supporting
CT3200-00_01	Natchaug River (Windham/Mansfield)-01	From mouth at confluence with Willimantic River, above Shetucket River (DS of Brick Top Road (Route 14) crossing), Windham, US to Willimantic Reservoir outlet dam (Natchaug River Dam), southwest of Windam Airport, Windham/Mansfield town border.	3.38	Not Assessed	Fully Supporting
CT3200-00_02	Natchaug River (Eastford)-02	Mansfield Hollow Reservoir inlet at Basset Bridge Road crossing (name changes to Station Road between North Windham Road and Route 6), Windham, US to HW (confluence Bigalow Brook and Still River), Eastford.	11.03	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3201-00_01	Bungee Brook-01	From mouth at confluence with Still River, Eastford, US to Bungee Lake (Witches Woods Lake) outlet dam (just US of Route 198 crossing), Woodstock.	5.56	Fully Supporting	Not Assessed
CT3201-07_01	Indian Hut Brook (Eastford/Pomfret)-01	Mouth at confluence with Bungee Brook, just DS of Bungee Brook Road crossing (Old Colony Road), Eastford, US to HW at marsh OUTLET, just US of Route 244 crossing, Pomfret.	1.53	Not Assessed	Fully Supporting
CT3202-00_01	Still River (Eastford)-01	Mouth at confluence with Bigelow Brook, above Natchaug River (on east side of Route 198 (Chaplin Road), US to confluence with Bungee Brook (just US of Brayman Hollow Road (Route 244) crossing), Eastford.	2.57	Fully Supporting	Not Assessed
CT3202-00_02	Still River (Eastford/Woodstock)-02	From confluence with Bungee Brook, Eastford, US to Dickenson Pond outlet dam (just US of Route 171 crossing). Woodstock.	4.01	Fully Supporting	Not Assessed
CT3203-00_01	Bigelow Brook (Eastford/Ashford)-01	Mouth at confluence Still River, above Natchaug River, Eastford, US to Eastford/Westford Road crossing, Ashford/Eastford town line (US confluence Branch Brook).	5.27	Fully Supporting	Not Assessed
CT3203-06_01	Lead Mine Brook (Ashford)-01	Mouth confluence Bigelow Brook (DS Barlow Mill Rd crossing), US to HW at Sustek Pond outlet dam, Ashford.	1.29	Fully Supporting	Not Assessed
CT3203-10_01	Branch Brook (Eastford)-01	Confluence with Bigelow Brook, just DS of Westford Road crossing, US to confluence with unnamed Tributary, parallel to Kozy Corner Road, Eastford.	0.76	Fully Supporting	Not Assessed
CT3204-00_01	Stonehouse Brook (Chaplin)-01	Mouth on Natchaug River, DS of Bedlam Road crossing, US to confluence with East Branch Stonehouse Brook, just over 1 mile US of Tower Hill Road crossing, Chaplin.	3.87	Fully Supporting	Not Assessed
CT3205-00_01	Squaw Hollow Brook-01	From mouth at confluence with Mount Hope River, US to confluence with Knowlton Brook (north side of Varga Road), Ashford.	0.91	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3205-01_02	Knowlton Brook-02	From mouth at confluence with Squaw Hollow Brook, US to confluence with Moritz Brook (outlet river for Moritz Pond), Ashford.	1.47	Fully Supporting	Not Assessed
CT3206-00_01	Mount Hope River (Mansfield/Ashford)-01	Mouth at Mansfield Hollow Reservoir inlet, (DS of Atwoodville Road), Mansfield, US to first Route 89 (Mansfield Road) crossing, near southern Ashford border, Ashford.	5.66	Fully Supporting	Insufficient Information
CT3206-00_02	Mount Hope River (Ashford/Union)-02	From first Route 89 (Mansfield Road) crossing, Ashford, US to headwaters at Morey Pond outlet dam, on Union/Ashford border.	9.99	Fully Supporting	Not Supporting
CT3206-03_01	East Branch Mount Hope River (Ashford)-01	Mouth at confluence Mount Hope River just DS James Rd crossing, US to HW US Boston Hollow Rd crossing and parallel to Nagy Rd, Ashford.	4.43	Fully Supporting	Not Assessed
CT3206-09_01	Gardner Brook (Ashford)-01	Mouth at Mount Hope River, just DS from Route 89 crossing, US to HW, just US of Fitts Road, Ashford.	2.74	Fully Supporting	Not Assessed
CT3206-10_01	Bebbington Brook (Ashford)-01	From mouth at confluence with Mount Hope River (DS of Mansfield Road (Route 89) crossing), US to marsh entrance (adjacent to Bebbington Road at Slade Road intersection), Ashford.	1.86	Fully Supporting	Not Assessed
CT3207-00_01a	Fenton River-01a	From mouth at Mansfield Hollow Reservoir (Route 89/Warnerville Road crossing), US to Gurleyville Road Crossing, Mansfield.	3.82	Fully Supporting	Not Assessed
CT3207-00_01b	Fenton River (Mansfield)-01b	Gurleyville Road crossing, US to confluence with unnamed tributary (1 mile US of Gurleyville road crossing), perpendicular to Horsebarn Hill Road, Mansfield.	1.24	Fully Supporting	Not Assessed
CT3207-00_01c	Fenton River-01c	From confluence with unnamed tributary (~1 mile US of Gurleyville Road crossing), perpendicular to Horsebarn Hill Road, US to Route 44 crossing, Mansfield.	0.95	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3207-00_02	Fenton River-02	From Route 44 crossing, Mansfield, US to headwaters (just US of Buchner Road crossing), Willington.	10.75	Fully Supporting	Not Assessed
CT3207-07_01	Eldredge Brook (Willington)-01	Mouth on Fenton River just DS of Daleville Road crossing, US to OUTLET of Eldridge Pond just US of Clint Eldridge Road crossing, Willington.	1.12	Not Assessed	Fully Supporting
CT3207-12_01	Roberts Brook (Mansfield)-01	Mouth at confluence with Fenton River DS Gurleyville Road crossing, US to HW US of Route 195 crossing at UCONN Mirror Lake outlet.	1.7	Not Supporting	Not Assessed
CT3208-00_01	Sawmill Brook (Mansfield)-01	From mouth at confluence with Natchaug River (DS of Route 6 and Route 195 intersection crossing), Windham, US to Conantville Road crossing, Mansfield.	1.11	Not Assessed	Not Supporting
CT3208-00_02	Sawmill Brook (Mansfield)-02	From Conantville Road crossing, US to headwaters (US of Spring Hill Road crossing), Mansfield.	3.92	Fully Supporting	Not Assessed
CT3208-02_01	Conantville Brook (Mansfield)-01	Mouth at confluence Sawmill Brook, just DS of Conantville Road crossing (parallel to Frontage Road on north side), US to HW at outlet small unnamed pond along south side of Stearns Road (on farm, pond looks enriched), Mansfield.	3.2	Not Assessed	Not Supporting
CT3300-00_01	French River (Thompson)-01	Mouth confluence Quinebaug River (just DS West Thompson Flood Control dam), US to North Grosvenordale Pond outlet dam (just US Buckley Hill Road crossing), Thompson.	4.61	Fully Supporting	Fully Supporting
CT3300-00_02	French River (Thompson)-02	Inlet North Grosvenordale Pond (east of Route 12, just DS of Langers Pond), US to Massachusetts State line. Segment includes Langers Pond, Thompson.	1.08	Fully Supporting	Fully Supporting
CT3300-02_01	Long Branch Brook (Thompson)-01	Mouth at INLET to Langers Pond (part of French River segment 2) parallel to Wilsonville Road, US to confluence with Knowlton Brook, US of Labby Road crossing, Thompson.	0.96	Not Assessed	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3300-02_02	Long Branch Brook (Thompson)-02	Knowlton Brook confluence US Labby Rd crossing, US to CT/MA state boarder, Thompson.	0.76	Not Assessed	Fully Supporting
CT3300-04_01	Knowlton Brook (Thompson)-01	Mouth Long Branch Brook, east of Labby Rd (US of LBB crossing) US to HW US Wilsonville Rd crossing, Thompson.	0.86	Not Assessed	Fully Supporting
CT3300-05_01	Backwater Brook (Thompson)-01	Mouth French River, just DS Main St crossing, US to HW just south of Laporte Rd, Thompson.	2.99	Not Assessed	Fully Supporting
CT3300-06_01	Sunset Hill Brook (Thompson)-01	Mouth French River DS Route 12 crossing, US to HW US Lowell Davis Rd crossing and parallel I395, Thompson.	2.44	Not Assessed	Fully Supporting
CT3300-08_01	Stoud Brook (Thompson)-01	Mouth Inlet Masonville Pond section of Sunset Hill Brook just DS Route 200 road crossing, US to HW, US and parallel Pasay Rd crossing, Thompson.	2.5	Not Assessed	Fully Supporting
CT3300-10_01	Quinatissett Brook (Thompson)-01	Mouth at Mechanicville Pond section of French River just DS of Route 12 crossing, US to Reams Pond outlet dam, US Route 21 crossing, Thompson.	1.97	Not Assessed	Not Supporting
CT3400-00_03	Fivemile River (Killingly-Thompson)-03	From confluence with Attawaugan Brook (just west of Route 395 crossing), US to Quaddick Reservoir outlet dam (just US of Quaddick Road crossing). Segment includes Ballouville and Lower Ponds.	10.06	Fully Supporting	Not Assessed
CT3400-00_04	Fivemile River (Thompson)-04	From inlet to Quaddick Reservoir (northwest portion, also called Stump Pond), US to Little (Schoolhouse) Pond outlet dam (just US of Jezierski Road crossing), Thompson.	4.54	Fully Supporting	Not Assessed
CT3400-15_01	Kelly Brook (Killingly)-01	Mouth confluence Barley Brook east side of Yosemite Valley Rd, US along east side of Yosemite Valley Rd to HW, US of Chestnut Hill Rd crossing, Killingly	2.04	Fully Supporting	Not Assessed
CT3401-00_02	Rocky Brook (Thompson)-02	Confluence unnamed tributary (in marsh, south side of East Thompson Road), US to Massachusetts border, Thompson.	0.24	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3402-00_01	Mary Brown Brook (Putnam)-01	Mouth Five Mile River DS Route 44 crossing, US to Cadyville Pond outlet at CT/RI state line, north side of Rhode Island Line Rd, Putnam.	2.26	Fully Supporting	Not Assessed
CT3403-05_01	Shady Oak Schoolhouse Brook (Putnam/Killingly)-01	Mouth at confluence with Cady Brook US of Cady Brook crossing Chase Road, Putnam, US to HW 0.75 miles US of Tucker District Road crossing, Killingly.	1.73	Fully Supporting	Insufficient Information
CT3404-00_01	Whetstone Brook-01	From mouth at confluence with Fivemile River, US to Bog Meadow Reservoir outlet dam, Killingly.	4.64	Fully Supporting	Not Assessed
CT3404-06_01	Slater Brook (Killingly)-01	Mouth at Mashentuck Brook, just DS of Burlingame Road crossing, US to HW, US of Bailey Hill Road Crossing, Killingly.	2.6	Fully Supporting	Not Assessed
CT3500-00_02	Moosup River-02	From POTW outfall (just DS from Black Hill Road crossing), Central Village, US to Brunswick Mill Dam #1(first impoundment in Almyville, parallel to Route 14), Plainfield.	4.01	Fully Supporting	Not Assessed
CT3500-00_03	Moosup River-03	From Brunswick Mill Dam #1 (first impoundment in Almyville, parallel to Route 14), Plainfield, US to Rhode Island border.	7.36	Fully Supporting	Not Supporting
CT3501-00_01	Quanduck Brook-01	From mouth at confluence with Moosup River, US to Rhode Island border (parallel with Snake Meadow Hill Road).	4.05	Fully Supporting	Not Assessed
CT3502-00_01	Snake Meadow Brook (Plainfield/Killingly)-01	Mouth at Sterling Rd crossing (inlet to Rogers Lake), Plainfield, US to Tetreault Pond outlet, US Halls Hill Rd crossing, Killingly.	5.08	Fully Supporting	Not Assessed
CT3502-06_01	Wood Brook (Plainfield/Sterling)-01	Mouth Snake Meadow Brook at Demers Rd crossing, Plainfield, US to HW near Barber Rd, Sterling.	1.7	Fully Supporting	Not Assessed
CT3503-00_01	Ekonk Brook-01	From mouth at confluence with Moosup River (DS of River Street crossing), US to headwaters at Lockes Meadow Pond outlet dam, Plainfield.	4.5	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3600-00-trib_01	Partridge Brook (Griswold)-01	Mouth at Hopeville Pond just DS Route 201 crossing, US to HW at unnamed pond on farm property, Griswold. Enters Hopeville Pond in cove just US of state park beach. May locally be called Palmer Brook.	0.8	Fully Supporting	Not Assessed
CT3602-01_01	Lowden Brook (Voluntown)-01	Mouth at confluence with Misery Brook DS of Trail 1 Road crossing near Stone Hill Road intersection (and parallel to Trail 2 Rd), US to HW near Plainfield border, parallel to Route 49, on south side of Hell Hollow Road, Voluntown.	3.4	Fully Supporting	Not Assessed
CT3603-00_01	Denison Brook (Voluntown)-01	Mouth on Beachdale Pond at US side of Route 165/138/49 crossing, US to HW (this brook runs north) parallel to Route 49 near Gallup Farm Airport, Voluntown.	3.57	Fully Supporting	Not Assessed
CT3604-00_01	Myron Kinney Brook-01	From mouth at Glasgo Pond inlet (southeast side) near Voluntown/Griswold border, US to headwaters, parallel to Pendleton Hill Road (Route 49), North Stonington.	4.33	Fully Supporting	Not Assessed
CT3604-01_01	Koistenen Brook (Voluntown/North stonington)-01	Mouth at confluence Myron Kinney Brook (0.6 miles DS of route 49 crossing), Voluntown, US to HW 1 mile US of Sand Hill Road crossing, North Stonington.	2	Fully Supporting	Not Assessed
CT3700-00_01	Quinebaug River (Lisbon/Griswold)-01	Mouth confluence Shetucket River, Lisbon/Norwich town border, US to Aspinook Pond outlet dam (US of River Road (Route 12) crossing), Lisbon/Griswold border.	7.46	Not Supporting	Fully Supporting
CT3700-00_02	Quinebaug River (Canterbury)-02	Aspinook Pond INLET (at Butts Bridge Road crossing), US to confluence Mill Brook, Canterbury.	2.98	Not Assessed	Fully Supporting
CT3700-00_03	Quinebaug River (Canterbury/Plainfield)-03	Confluence Mill Brook, near Yaworski Landfill, US to confluence Moosup River (river forms town boundary for Canterbury and Plainfield).	6.3	Not Assessed	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3700-00_04	Quinebaug River (Putnam)-04	Confluence Moosup River (river forms town boundary for Canterbury and Plainfield), US to Putnam POTW (parallel to Kennedy Drive near I-395), Putnam.	17.61	Not Supporting	Fully Supporting
CT3700-00_05	Quinebaug River (Putnam/Thompson)-05	Just US of Putnam POTW (just DS of Railroad crossing), Putnam, US to confluence French River, Thompson.	3.32	Not Supporting	Not Supporting
CT3700-00_07	Quinebaug River (Thompson)-07	INLET West Thompson Lake (Reservoir) just DS of Blain Road crossing, US to Massachusetts border (US of Route 197 crossing), Thompson.	6.4	Fully Supporting	Fully Supporting
CT3700-14_01	Culver Brook (Putnam)-01	Mouth at confluence Quinebaug River, just DS of I395 crossing, US to HW just US Pitkin Road crossing, Putnam.	2.9	Fully Supporting	Not Assessed
CT3700-17_01	Durkee Brook (Pomfret)-01	Mouth at confluence with Quinebaug River DS of River Road crossing, US to confluence with Bark Meadow Brook, just US of Holmes Road crossing, Pomfret.	1.72	Not Assessed	Not Supporting
CT3701-02_01	Browns Brook (MA/Union)-01	Mouth at Hamilton Reservoir in Massachusetts along Maybrook Road, US (flowing south into CT) to west of I84, through Sessions Meadow Marsh Dam to HW .8 mile above Bear Den Road crossing, Union, CT.	3.6	Fully Supporting	Not Assessed
CT3705-00_01	Lebanon Brook (Woodstock)-01	State border (MA) DS of Pole Bridge Rd crossing (Laurel Ridge on east side) US (moving south) to HW at Griggs Pond outlet dam, just US of Route 198 crossing, Woodstock.	3.9	Fully Supporting	Not Assessed
CT3706-00_01	English Neighborhood Brook (Woodstock)-01	Mouth at confluence Muddy Brook parallel along south side of Route 197, US to HW 2 miles US of northern most English Neighborhood Road crossing, Woodstock.	4	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3707-00_02	Mill Brook (Woodstock)-02	Norwich Worchester Tpke (Route 171/Route 169) crossing, US to OUTLET of Cemetery Pond, just US of Quasset Road crossing, Woodstock.	1.48	Fully Supporting	Not Assessed
CT3708-00_01	Little River (Putnam/Woodstock)-01	Mouth Quinebaug River (just DS of Route 44 crossing), Putnam, US to drinking water watershed boundary (outlet of marsh, parallel to Peake Brook Road, DS of Shepherds Pond), Woodstock (southeast corner).	2.64	Not Supporting	Not Supporting
CT3708-01_01	Muddy Brook (Woodstock)-01	From mouth at inlet to Roseland Lake, US to Route 197 crossing, Woodstock.	5.44	Not Assessed	Not Supporting
CT3708-01_02	Muddy Brook (Woodstock)-02	Route 197 crossing, US to confluence with Moss Brook (just DS of Route 169 crossing, Sherman corner area), Woodstock.	1.98	Fully Supporting	Not Assessed
CT3708-06_01	Gravelly Brook (Woodstock)-01	Mouth Muddy Brook DS Cady Lane crossing, US to HW US County Road crossing, Woodstock.	2.05	Fully Supporting	Not Assessed
CT3708-08_01	Peckham Brook (Woodstock)-01	Mouth at confluence with Muddy Brook just DS of Dugg Hill Road crossing, US to confluence with Coman Brook, just US of Morses Pond outlet stream and parallel to Paine District Road, Woodstock.	0.89	Fully Supporting	Not Supporting
CT3708-10_01	North Running Brook (Woodstock)-01	Mouth at confluence Muddy Brook, US to runoff ditch from farm field (300Ft US of farm road crossing) (farm road crossing is 900Ft US of Muddy Brook confluence, farm road is off of Child Hill Road), Woodstock.	0.19	Fully Supporting	Not Assessed
CT3708-18_01	Wheatons Brook (Putnam/Thompson)-01	Mouth Little River DS Wicker St crossing, Putnam, US to HW parallel to Ravenelle Rd, Thompson.	3.27	Not Assessed	Not Supporting
CT3709-00_01	Wappaquoia Brook-01	From mouth at confluence with Mashamoquet Brook (east of Route 169), US to Hollow Pond outlet dam (just US of Brayman Hollow Road (Route 244) crossing), Pomfret.	3.23	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3709-02_01	Day Brook (Pomfret)-01	Mouth at confluence with Mashamoquet Brook, east side of Route 169 (across field to wooded area) about .23 miles south of Day Road intersection, US to confluence with unnamed tributary (near power line cut through), just south of Grosvenor Road, Pomfret.	1.57	Not Assessed	Not Supporting
CT3710-00_01	Mashamoquet Brook-01	From mouth at confluence with Quinebaug River (parallel to Route 101 on north side), US to confluence with Wolf Den Brook (US of Route 101 crossing), Pomfret.	3.06	Fully Supporting	Not Supporting
CT3710-00_02	Mashamoquet Brook (Pomfret)-02	Confluence Wolf Den Brook (just US Route 101 crossing), US to Taft Pond outlet dam (US Taft Pond Road crossing), Pomfret. Includes diversion to swimming pond in Mashamoquet State Park.	4.36	Fully Supporting	Not Supporting
CT3710-01_01	Cemetery Brook (Pomfret)-01	From mouth at confluence with Nightingale Brook (near Taft Pond Road crossing), US to headwaters in marsh (US of Chase Hill Road crossing), Pomfret.	1.14	Not Assessed	Fully Supporting
CT3710-02_01	Angel Brook (Pomfret/Woodstock)-01	Mouth at INLET to Nightingale Pond .7 mile DS of Johnson Road crossing, Pomfret, US to HW, US of Tyott Road crossing, Woodstock.	1.44	Not Assessed	Fully Supporting
CT3710-05_01	Nightingale Brook (Pomfret)-01	Mouth at confluence with Cemetery Brook, above Mashamoquet Brook, just US of Taft Pond Road crossing, US to Nightingale Pond OUTLET, just US of Route 244 crossing, Pomfret.	1.48	Not Assessed	Fully Supporting
CT3710-07_01	Lyon Brook (Pomfret)-01	Mouth at confluence with Mashamoquet Brook (above Taft Pond) US to OUTLET of Eddies Pond No 2, entire segment parallel to Taft Pond Road on south side (Cemetery Brook is on north side), Pomfret.	0.36	Not Assessed	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3710-08_01	unnamed Tributary to Mashamoquet Brook (Pomfret)-01	Mouth at confluence with Mashamoquet Brook, on west side and parallel to North Road (aka. Holbrook Road) just north of intersection with Route 97 (another unnamed trib enters from east), US to OUTLET of Abbotts Dam, Pomfret.	0.71	Not Assessed	Fully Supporting
CT3710-11_01	Abington Brook (Pomfret)-01	Mouth at confluence with Mashamoquet Brook, between Route 97 and Mashamoquet Brook crossing of Covell Road, US to confluence with unnamed tributary, just US of 2nd Route 44 crossing (DS of Abington Pond), Pomfret.	1.75	Not Assessed	Not Supporting
CT3710-13_01	Sap Tree Run (Pomfret)-01	Mouth at confluence with Mashamoquet Brook, just US of Wolf Den Road crossing, US past Route 44 crossing to HW in wooded area east of Blossom Drive, Pomfret.	1.09	Not Assessed	Not Supporting
CT3710-18_01	White Brook (Pomfret/Brooklyn)-01	Mouth at confluence with Mashamoquet Brook just DS of Route 101 crossing (close to confluence with Quinebaug River), Pomfret, US to confluence with unnamed tributary just US of Darby Road crossing, Brooklyn.	3.07	Not Assessed	Not Supporting
CT3711-00_01	Blackwell Brook-01	From mouth at confluence with Quinebaug River in northeast corner of Canterbury, US to headwaters at small pond just US of Fay Road crossing, Pomfret.	13.82	Fully Supporting	Not Assessed
CT3712-00_02	Fry Brook (Plainfield)-02	Just US side of I395 crossing, US to HW US Route 14a crossing, then US confluence Kennedy Brook (continues parallel to east along Route 14a), Plainfield.	1.15	Fully Supporting	Not Assessed
CT3713-00_01	Mill Brook (Plainfield)-01	From mouth at confluence with Quinebaug River (DS of Weston Road crossing), Canterbury, US to Railroad crossing, Plainfield.	1.99	Fully Supporting	Not Assessed
CT3713-00_02	Mill Brook (Plainfield)-02	From Railroad crossing (DS of Route 12 crossing), Plainfield, US to headwaters in large wetland area, north of Rhode Road (east of I395), Griswold.	3.1	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3713-03_01	Lathrop Brook (Plainfield)-01	Mouth Mill Brook just DS of I395 crossing, US to HW, US of Colbridge Road crossing and parallel to Davis Road, Plainfield.	3.44	Fully Supporting	Not Assessed
CT3715-00_01	Cory Brook (Canterbury)-01	Mouth Aspinook Pond portion Quinebaug River DS RR crossing and near Depot Rd, US (includes Burr Smith Pond and Potter Pond) to HW US Water Street crossing, Canterbury.	6.2	Fully Supporting	Not Assessed
CT3716-00_01	Broad Brook (Preston)-01	Mouth at confluence Quinnebaug River (DS of Old Jewett City Road crossing), at the Preston/Lisbon/Griswold borders, US to Lewis Pond outlet dam (north side of Route 165, near intersection with Lewis Road), Preston.	4.73	Fully Supporting	Not Supporting
CT3716-00_02	Miller Brook (Preston/North Stonington)-02	Mouth above Broad Brook Lewis Pond OUTLET (includes Lewis Pond), north side of Route 165, Preston, US to HW, US Miller Rd crossing (includes Shaws Pond), North Stonington. NOTE: Seg1=Broad Brook	5.22	Fully Supporting	Not Assessed
CT3800-00_01	Shetucket River (Norwich)-01	Route 2 crossing, US to Greenville dam, Norwich (tidal affected waters).	1.56	Not Assessed	Not Supporting
CT3800-00_03	Shetucket River-03	From Sprague WPCF (near head of Occum Pond), US to confluence with Merrick Brook at Sprague/Scotland town line (DS of Scotland Dam).	4.7	Fully Supporting	Fully Supporting
CT3800-00_05	Shetucket River (Windham)-05	Confluence Cold Brook (DS Franklin Mushroom Farm STP from unnamed tributary), US to HW confluence Natchaug River and Willimantic River, Windham.	4.99	Fully Supporting	Not Supporting
CT3800-02_01	Obwebetuck Brook (Windham)-01	Mouth at confluence with Shetucket River just DS of Route 32 and Railroad crossing, US to confluence with Jordan Brook, US of Windham Road crossing and parallel to Bush Hill Road, Windham.	0.55	Not Assessed	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3800-10_01	Waldo Brook (Sprague/Scotland)-01	Mouth at confluence with Shetucket River in Mohegan State Forest, Sprague, US to HW parallel to Route 97, Scotland.	1.86	Fully Supporting	Not Assessed
CT3801-01_01	Ballymahack Brook (Windham)-01	mouth at INLET to Marie Lake on Joshuas Trust property (near dirt road off Back Rd just south of Sundale Drive intersection), US to HW just US of Beaver Hill Road crossing (near Nutmeg Lane intersection), Windham.	1.92	Fully Supporting	Not Assessed
CT3802-00_01	Beaver Brook (Scotland)-01	From mouth at confluence with Merrick Brook (just DS of Bass Road), US to Route 14 (Huntington Road) crossing, Scotland.	1.38	Fully Supporting	Not Assessed
CT3802-01_01	Unnamed Tributary to Beaver Brook (Scotland)-01	Mouth on Beaver Brook, just US of Route 14, US to WH parallel to Ziegler Road, Scotland.	3.93	Fully Supporting	Not Assessed
CT3803-00_01	Merrick Brook-01	From mouth at confluence with Shetucket River (just DS of Station Road), Scotland, US to headwaters (just US of Goshen Road crossing), Chaplin.	12	Fully Supporting	Not Assessed
CT3805-00_02	Little River (Sprague)-02	From inlet to Versailles Pond (northwest corner of pond), US to Papermill Pond outlet dam, Sprague.	0.89	Not Supporting	Fully Supporting
CT3805-00_03	Little River (Sprague)-03	Inlet to Paper Mill Pond, Sprague, US to HW at Hampton Reservoir outlet dam (just US of Kenyon Road crossing), Hampton.	1.79	Fully Supporting	Not Assessed
CT3805-00_04	Little River (Canterbury/Scotland/Hampton)-04	From Hanover Reservoir inlet, Canterbury, US to headwaters at Hampton Reservoir outlet dam (just US of Kenyon Road crossing), Hampton.	16.02	Fully Supporting	Not Assessed
CT3805-04_02	Murphy Brook (Hampton)-02	From inlet to small pool (just DS of Robbins Street crossing), US to confluence with unnamed perennial tributary (just DS of Sarah Pearl Road crossing), Hampton.	0.46	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3805-19_01	Old Stone Mill Brook (Sprague/Lisbon/Canterbury)-01	Mouth at confluence on Little River (just DS of Railroad crossing and DS of Versailles Inland Road), Sprague, US to HW at OUTLET of Lisbon Pond, US of Sullivan Road crossing, and parallel with Lisbon Road, Canterbury.	2.6	Fully Supporting	Not Assessed
CT3900-00_01	Yantic River Bozrah)-01	From Vermont Railroad crossing (just US of Falls Mill lower dam), Norwich, US to Fitchville Pond outlet dam (just US of Fitchville Road crossing), Bozrah.	6.46	Fully Supporting	Not Assessed
CT3900-00_02	Yantic River-02	From Fitchville Pond inlet (Haughton Road crossing, north side of Route 2, exit 23), Bozrah, US to headwaters at confluence of Sherman Brook and Deep River, Lebanon.	5.93	Fully Supporting	Not Assessed
CT3900-00_trib_01	Unnamed Trib, Yantic River (Norwich Landfill)-01	From mouth at confluence with Yantic River, just DS of Railroad crossing (100m US of I395 crossing of Yantic River), US to Browning Pond outlet dam, Norwich (influenced by Landfill).	0.57	Not Supporting	Not Assessed
CT3900-07_01	Kahn Brook (Bozrah)-01	From mouth at confluence with Yantic River (just DS of Fitchville Road crossing), US to chicken farm road crossing, Bozrah.	0.61	Not Supporting	Not Supporting
CT3902-00_02	Bartlett Brook (Lebanon)-02	INLET to Savin Lake (between Roger Foot Road and Geer Road just above Savin Lake) US to confluence with Exeter Brook (1 mile US of Taylor Bridge Road crossing), Lebanon.	1.14	Fully Supporting	Not Assessed
CT3903-00_01	Sherman Brook-01	From mouth at confluence with Deep River, above Yantic River, Lebanon, US to headwaters (just US of Lebanon Avenue (Route 16 crossing), Colchester. (Segment includes Sherman Pond).	5.01	Fully Supporting	Fully Supporting
CT3905-00_01a	Pease Brook (Bozrah/Franklin/Lebanon)-01a	From mouth at confluence with Yantic River, Bozrah, US to the US side of Goshen Hill Road crossing (near Smith Road intersection), Lebanon	4.4	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT3905-00_01b	Pease Brook (Lebanon)-01b	From the US side of Goshen Hill Road crossing (near Smith Road intersection), Lebanon US to headwaters (just US of Burnham Road crossing, Lebanon	5.23	Fully Supporting	Not Assessed
CT3906-00_01	Gardner Brook-01	From mouth at confluence with Yantic River (inlet to Fitchville Pond, southeast side parallel to Route 163), US to Gardner Lake outlet dam (just US of Lake Road crossing), Bozrah.	4.84	Fully Supporting	Not Assessed
CT3907-00_01	Susquetonscut Brook-01	From mouth at confluence with Yantic River, Bozrah/Norwich town border (just DS of Railroad crossing), US to headwaters (just US of Bender Road crossing, along south side of Beaumont Highway and Rafferty Road intersection, Lebanon.	13.55	Fully Supporting	Not Assessed
CT4000-00_01	Connecticut River-01	From head of estuary at Chapman Pond outlet, East Haddam, US to northern most boundary of Hurd State Park, East Hampton.	10.27	Not Assessed	Not Supporting
CT4000-00_02	Connecticut River-02	From northern most boundary of Hurd State Park, East Hampton, US to confluence with Reservoir Brook (adjacent to Gildersleeve Island), Portland.	10.49	Insufficient Information	Not Supporting
CT4000-00_03	Connecticut River (Portland/Suffield)-03	Reservoir Brook confluence (adjacent to Gildersleeve Island), Portland, US to Suffield, MA border.	35.26	Insufficient Information	Not Supporting
CT4000-30_02	Grindle Brook (Glastonbury)-02	Great Pond INLET, DS of Great Pond Road crossing, US to HW, 4 miles US of Main Street crossing near the end of Chamberlain Lane off Foote Road, Glastonbury. (HiGate Farm property east above HW)	1.9	Fully Supporting	Not Assessed
CT4000-33_01	Hales Brook (Portland)-01	Mouth at confluence with Connecticut River (enters on corner, cut through abandon channels) 5.5 miles DS of Route 17 (Glastonbury Tpke) crossing, US to HW at Portland/Glastonbury border near Clark Hill Road (8 miles US of Route 17 crossing), Portland.	4.3	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4000-41_01	Mine Brook (East Hampton)-01	Mouth at confluence with Connecticut River just DS of Shipyard Road crossing, US past Route 151, past Cobalt Road crossing, to HW near Gadpouch Road, East Hampton.	3.4	Fully Supporting	Not Assessed
CT4000-43_01	Unnamed tributary Hubbard Brook (Middletown)-01	Mouth at confluence Hubbard Brook DS River Road crossing (in wetland that leads to CT River), US crossing to north side of Aircraft Road and continue to HW parallel to Aircraft Road, Middletown.	1.4	Fully Supporting	Not Assessed
CT4000-50_01	Succor Brook (East Haddam)-01	Mouth at confluence with Connecticut River DS of Lumber Yard Road crossing (Goodspeed Oprah House area), US to HW .1 miles west of Smith Road (near intersection with Laurel Cove Road), East Haddam.	4.5	Fully Supporting	Not Assessed
CT4000-51_01	Roaring Brook (Haddam)-01	Mouth at confluence with Clark Creek, parallel to Ruth Hill Rd (just US of Clark Creek crossing of Ruth Hill), US to HW just US of Plains Rd crossing, Haddam.	1.9	Fully Supporting	Not Assessed
CT4000-53_01	Deep Hollow Brook (Haddam/Chester)-01	Mouth at confluence with Roaring Brook above Clark Creek, just US of Ruth Hill Road crossing of Clark Creek (before powerline crossing), Haddam, US to HW 1.2 miles due south of Route 82 along power line cut, Chester.	1.3	Fully Supporting	Not Assessed
CT4000-54_02	Clark Creek (Haddam)-02	From falls near Route 154 crossing, US to headwaters at confluence of Roaring and Deep Hollow Brooks, Haddam	0.46	Fully Supporting	Not Assessed
CT4006-00_01	Salmon Brook-01 (Glastonbury)	From mouth on Keeney Cove (Connecticut River, near Naubuc Avenue), Glastonbury, US to Addison Pond outlet, Glastonbury.	3.07	Fully Supporting	Not Assessed
CT4006-00_02	Salmon Brook-02 (Glastonbury)	From Addison Pond outlet, US to headwaters at Manchester Country Club Pond Dam, Glastonbury (includes Addison Pond).	4.33	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4008-03_01	Mott Hill Brook (Glastonbury)-01	Mouth at confluence with Dark Hollow Brook, above Cold Brook, US to first Mott Hill Road crossing, Glastonbury.	0.56	Fully Supporting	Not Assessed
CT4009-00_01	Roaring Brook (Glastonbury)-01	From mouth at Connecticut River US to Angus Park Pond dam at outlet (Angus Park Pond NOT included).	6.73	Fully Supporting	Fully Supporting
CT4009-00_02	Roaring Brook (Glastonbury)-02	From Angus Park Pond inlet, East Glastonbury, US to Buckingham Reservoir outlet Dam Buckingham Reservoir NOT included).	2.79	Fully Supporting	Not Assessed
CT4009-05_01	Wintergreen Brook (Glastonbury)-01	Mouth at confluence Roaring Brook US of Roaring Brook Route 83 crossing and between Forest Lane and Staples Lane, US to HW 2.2 miles US of Roaring River confluence in Meshomasic State Forest, Glastonbury.	2.4	Fully Supporting	Not Assessed
CT4011-00_01	Reservoir Brook (Portland)-01	Mouth on Connecticut River, DS Route 17 crossing, US to Portland Reservoir outlet, parallel to Old Marlborough Turnpike, Portland.	2.81	Fully Supporting	Not Assessed
CT4011-02_01	Buck Brook (Portland)-01	Mouth at inlet to Portland Reservoir, just DS of Reservoir Rd crossing, US to HW (near Glastonbury town line) parallel to the east along Clark Hill Rd, Portland.	1.8	Fully Supporting	Not Assessed
CT4012-00_03	Carr Brook (Portland)-03	Kelseys Pond inlet, parallel to Cox Road, Portland, US to HW, East Hampton.	2.64	Fully Supporting	Not Assessed
CT4013-00_02	Sumner Brook (Middletown)-02	Confluence with Long Hill Brook, parallel with Mill Street, US to Russells Pond OUTLET, DS of Russell Street crossing, Middletown.	0.52	Not Supporting	Not Assessed
CT4013-00_04	Sumner Brook (Middletown)-04	Confluence with unnamed tributary, just US of Millbrook Road crossing, at Middletown/Durham/Haddam town lines, US to HW at Millers Pond outlet, Durham.	2.06	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4014-03_02	Ponsett Brook (Haddam)-02	From inlet to Higganum Reservoir, between Route 9 and Route 81, near Nelson Place, US to confluence with Saltpeter Brook, between Route 81 and Dish Mill Road, Haddam.	1.28	Fully Supporting	Not Assessed
CT4014-10_01	Bible Rock Brook (Haddam)-01	Mouth at confluence with Higganum Creek (above Nosal Rd crossing) north side of Depot Rd, US to HW at Stepanski Pond outlet, just US of Oxbow Rd crossing, Haddam.	4.8	Fully Supporting	Not Assessed
CT4015-00_01	Mill Creek (Haddam)-01	Mouth at confluence with Connecticut River, just DS of Route 154 and Railroad crossings, US to confluence with Beaver Meadow Brook and Pole Bridge Brook (parallel in woods to Beaver Meadow Rd), Haddam.	2.5	Fully Supporting	Not Assessed
CT4015-01_01	Pole Bridge Brook (Haddam)-01	Mouth at confluence Beaver Meadow Brook above Mill Creek .3 miles DS of Hubbard Road crossing, US through Cockaponset State Forest and under Route 9 to HW at small pond (runs parallel to Hubbard Street and pond before Morris Road intersection), Haddam.	1.3	Fully Supporting	Not Assessed
CT4015-02_01	Beaver Meadow Brook-01	From mouth at confluence with Pole Bridge Brook (above Mill Creek), US to headwaters, just US of Beaver Meadow Road crossing, Haddam	2.62	Fully Supporting	Not Assessed
CT4016-01_01	Roaring Brook No 2 (Lyme/East Haddam)-01	Mouth at confluence with Hungerford Brook, above Whalebone Creek, just DS of Day Hill Road crossing, Lyme, US to HW at Martin Pond outlet, just US of Mount Parnassus Road crossing, East Haddam.	5.2	Fully Supporting	Not Assessed
CT4016-10_01	Hungerford Brook (East Haddam)-01	Mouth at confluence with Roaring Brook no 2, above Whalebone Creek, near Day Hill Road crossing, US to HW pond between Mill Road and Petticoat Lane, East Haddam.	1.59	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4016-11_01	Hemlock Valley Brook (Lyme/East Haddam)-01	Mouth on CT-E1_031-SB estuary portion of Connecticut River, just DS of Route 148 crossing, Lyme, US to HW, just US of Bogel Road crossing, parallel to Smith Road, East Haddam.	4.9	Fully Supporting	Not Assessed
CT4017-03_01	Pattaconk Brook (Chester)-01	Mouth at confluence with Great Brook (US of head of Chester Creek in marsh), US to Cedar Lake outlet dam, just US of Route 148 crossing, Chester (Cedar Lake NOT included).	4	Fully Supporting	Not Assessed
CT4017-04_01	Great Brook (Chester)-01	Mouth at confluence with Pattaconk Brook (US of head of Chester Creek in marsh), US to Deuces Pond outlet dam (change of water class A to AA), parallel at end of Deep Hollow Road, Chester. (Segment includes flow through bottom of Grist Mill Pond).	1.8	Fully Supporting	Not Assessed
CT4100-00_01	Stony Brook (Suffield)-01	Mouth at OUTLET on canal parallel to Connecticut River, US to confluence with Muddy Brook at railroad crossing, Suffield.	3.47	Not Supporting	Not Assessed
CT4100-00_03	Stony Brook (Suffield)-03	From confluence with DeGrayes Brook (just northwest of airport), US to headwaters (the confluence of Rocky Gutter Brook and Rattlesnake Brook), Suffield.	4.27	Not Supporting	Not Assessed
CT4101-00_01	Muddy Brook (Suffield)-01	From mouth at Stony Brook, Suffield, US to confluence with Philo Brook.	2.23	Not Supporting	Not Supporting
CT4101-00_02	Muddy Brook (Suffield)-02	From confluence with Philo Brook US to headwaters (confluence of Still Brook and Spears Brook).	7.45	Fully Supporting	Not Assessed
CT4200-00_01	Scantic River-01	From mouth at Connecticut River, US to confluence with Broad Brook, East Windsor.	9.38	Not Supporting	Not Supporting
CT4200-00_02	Scantic River-02	From confluence with Broad Brook, East Windsor, US to Somersville Pond outlet, Somers (passes Somers WPCF at upper end below lake).	13.56	Fully Supporting	Not Supporting
CT4200-00_03	Scantic River-03	From Somersville Pond inlet, Somers, US to MA border.	6.05	Not Assessed	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4200-15_01	Thrasher Brook (Somers)-01	Mouth at confluence with Scantic River .25 miles DS of unnamed road crossing that extends from end of Northwest Drive, US to confluence with unnamed tributary .28 miles US of Route 83 crossing, Somers.	1.52	Not Assessed	Not Supporting
CT4200-28_01	Dry Brook (South Windsor/East Windsor)-01	Mouth at confluence with Scantic River .76 miles DS of Rye Street crossing (near intersection with Troy Road), South Windsor, US to HW US of Griffin Road crossing near Vintage Road, South Windsor.	4.7	Not Assessed	Not Supporting
CT4201-00_01	Watchaug Brook (Somers)-01	From mouth at confluence with Scantic River (DS of Watchaug Road crossing), US to CT/MA state border, Somers.	2.1	Not Assessed	Fully Supporting
CT4202-00_01	Gillettes Brook (Somers)-01	Mouth at confluence with Scantic River .2 miles DS of Durkee Road crossing, US to confluence with unnamed tributary just US of Route 83 crossing, Somers.	0.41	Not Assessed	Not Supporting
CT4202-00_02	Gillettes Brook (Somers)-02	Confluence with unnamed tributary just US of Route 83 crossing, US to confluence with unnamed stream that outlets Worthington Pond, along Mountain Road, just DE from intersection with Broadway Road, Somers.	3.69	Not Assessed	Fully Supporting
CT4203-00_01	Gulf Stream (Somers)-01	Mouth at Scantic River, US to Shady Lake outlet, just US of Route 83 crossing, Somers.	1.88	Not Assessed	Not Supporting
CT4203-00_02	Gulf Stream (Somers)-02	Shady Lake outlet, just US of Route 83 crossing, US to confluence with Lievre Brook, just US of Gulf Road crossing, Somers.	1.3	Fully Supporting	Fully Supporting
CT4204-00_01	Abbey Brook (Somers)-01	Mouth at INLET to Somersville Pond 1 mile DS of Billings Road crossing, near Harness Road, US to confluence with unnamed tributary .5 miles US of Billings Road crossing, Somers.	1.63	Not Assessed	Not Supporting
CT4205-00_01	Buckhorn Brook (Enfield)-01	From mouth at confluence with Scantic River, US to marsh (US of Town Farm Road crossing) near inlet from Tobacco Pond No 2, Enfield.	2.02	Not Assessed	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4206-00_01	Broad Brook (East Windsor)-01	Mouth Scantic River, US to Broad Brook Mill Pond outlet dam just US Main Street (Route 191) crossing, East Windsor.	1.01	Not Supporting	Not Supporting
CT4206-00_02	Broad Brook (East Windsor-Ellington)-02	From Broad Brook Mill Pond inlet, East Windsor, US to headwaters, Ellington, just US of Snipsic Forest Road crossing.	9.01	Not Supporting	Not Supporting
CT4206-01_01	Hydes Brook (Ellington)-01	Mouth at confluence Broad Brook just DS of Bridge Street crossing, US to HW at unnamed pond at Porter Road crossing, (DS side of Porter Road stream flows through Shenipsit State Forest), Ellington.	1.9	Fully Supporting	Not Assessed
CT4206-05_01	Muddy Brook (Ellington)-01	Mouth at confluence with Broad Brook DS of Muddy Brook Road crossing, US to HW (parallel to west of Jobs Hill Road and north as far as Wysocki Field Airport), Ellington.	2.3	Fully Supporting	Not Assessed
CT4206-08_01	Creamery Brook (Ellington)-01	Mouth at confluence Broad Brook DS Route 104 crossing, US to HW near Reeves Road and west of Greene Road among farm fields (heavy agriculture watershed), Ellington.	2.1	Fully Supporting	Not Assessed
CT4207-00_01	Ketch Brook (East Windsor)-01	Mouth at confluence with Scantic River .5 miles DS of Rye Street crossing, US to OUTLET of Windsorville Pond at Wapping Road crossing, near intersection with Windsorville Road, East Windsor.	2.93	Not Assessed	Fully Supporting
CT4300-00_01	Farmington River (Windsor)-01	Mouth Connecticut River (DS Route 159 crossing), US to outlet Rainbow Reservoir dam, Windsor.	8.59	Not Supporting	Fully Supporting
CT4300-00_02	Farmington River (Bloomfield/Farmington)-02	INLET to Rainbow Reservoir (at Route 187 crossing), Bloomfield, US (south) to confluence Pequabuck River (US Route 4 crossing), Farmington.	19.38	Fully Supporting	Fully Supporting
CT4300-00_03	Farmington River (Farmington/Burlington)-03	Confluence Pequabuck River, Farmington, US to lower Collinsville dam (Collins Company Lower Dam, along route 179), Burlington.	8.46	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4300-00_04	Farmington River-04	From lower Collinsvile dam (Collins Company Lower Dam near Route 179), Burlington, US to confluence with Still River, Barkhamsted.	15.01	Fully Supporting	Fully Supporting
CT4300-00_05	Farmington River-05	From confluence with Still River, Barkhamsted, US to West Branch Reservoir outlet (Hogback Dam, just US of Durst Road crossing), Hartland.	2.41	Fully Supporting	Fully Supporting
CT4300-05_01	Howells Brook (Hartland)-01	Mouth at confluence with Thorne Brook DS of Pond Hill Rd crossing, US to HW at Howells Pond outlet, just US of Dish Hill Rd crossing, Hartland.	1.7	Fully Supporting	Not Assessed
CT4300-10_01	East Mountain Brook (New Hartford)-01	Confluence with Farmington River, just DS of Route 44 crossing, US to confluence with Hallock Brook, New Hartford.	0.15	Fully Supporting	Not Assessed
CT4300-19_01	Hawley Brook (Avon)-01	Mouth at confluence with Farmington River DS New Road crossing (near Pequot Road intersection), US to HW between Huckleberry Hill Road on west and Northington Drive on east and north about to Saddle Ridge Drive, Avon.	2	Fully Supporting	Not Assessed
CT4300-32_01	Minister Brook (Simsbury)-01	Mouth Farmington River, DS Route 202/10 crossing, US to HW just east Pine Glen Road, Simsbury.	1.82	Not Assessed	Fully Supporting
CT4300-33_01	Russell Brook (Simsbury)-01	Mouth Farmington River, DS Route 10 (202) road crossing, US to HW White Foundation Pond, parallel to Deer Park Road, Simsbury.	1.25	Not Assessed	Fully Supporting
CT4300-39_01	Owens Brook (Simsbury)-01	Mouth on Farmington River, DS of Route 10 (202) road crossing, US to HW parallel to Owens Brook Blvd, between Musket Trail and Winterset Lane intersections with Owens Brook Blvd, Simsbury.	1.05	Not Assessed	Not Supporting
CT4300-44_01	Munnisunk Brook (Simsbury)-01	Mouth confluence Farmington River, US to Lake Basile outlet dam (US Wolcott Road and Railroad crossings), Simsbury.	0.89	Not Assessed	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4300-50_01	Rainbow Brook-01	From mouth at Farmington River (just DS of Island below Rainbow Reservoir Dam), Windsor, US to headwaters, southwest portion of Bradley International Airport, Windsor Locks.	1.74	Not Supporting	Not Assessed
CT4300-51_01	Seymour Hollow Brook-01	From mouth at Farmington River, Windsor (formerly tributary to Rainbow Brook, now channelized to Farmington, Gazetteer # based upon Rainbow Brook), US to headwaters, southest portion of Bradley International Airport, Windsor Locks.	1.36	Not Supporting	Not Assessed
CT4300-54_01	Phelps Brook (Windsor)-01	Mouth Farmington River, near Apple Tree Lane, US to Route 75 crossing, Windsor.	0.39	Insufficient Information	Fully Supporting
CT4300-54_02	Phelps Brook (Windsor)-02	US side of Route 75 crossing, US to HW parallel at end of Marble Faun Lane (subdivision, expecting control changes in hydro), Windsor.	2.22	Fully Supporting	Not Assessed
CT4302-00_01	Mad River (Winchester)-01	Mouth at Still River, US to Mad River Dam outlet, Winchester.	2.24	Fully Supporting	Not Supporting
CT4302-00_02a	Mad River (Winchester)-02a	From Mad River Dam outlet, Wincheter, US to outlet from Rugg Brook Reservoir.	1.77	Not Assessed	Not Supporting
CT4302-00_02b	Mad River (Winchester)-02b	From confluence with Rugg Brook Reservoir outlet, US to diversion entrance for Rugg Brook Reservoir.	0.63	Not Supporting	Not Assessed
CT4302-00_03	Mad River (Winchester)-03	From diversion entrance for Rugg Brook Reservoir (boundary of drinking water watershed), US to headwaters at Spaulding Pond outlet dam, Norfolk.	5.17	Not Supporting	Not Supporting
CT4302-04_01	Rugg Brook (Winchester)-01	Mouth at inlet to Rugg Brook Reservoir, just DS from Old Waterbury Turnpike crossing, US to HW, US of Route 263 crossing, Winchester.	3.29	Fully Supporting	Not Assessed
CT4302-05_01	Mill Brook (Winchester/Norfolk)-01	Mouth at Mad River, just DS of Route 44 crossing, Winchester, US to HW, just US of Green Road crossing, Norfolk.	5.31	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4302-09_01	Indian Meadow Brook-01	From mouth at Mad River (just DS from Route 44/183 crossing), US to confluence with Colebrook Brook, Winchester	0.46	Fully Supporting	Not Assessed
CT4302-10_01	Colebrook Brook (Winchester/Colebrook)-01	Confluence with Indian Meadow Brook, just DS of Route 183 crossing, Winchester, US to HW, Colebrook.	3.58	Fully Supporting	Not Assessed
CT4302-13_01	Taylor Brook (Winchester)-01	Mouth on Highland Lake, just DS of Wakefield Boulevard crossing, US to HW, US of Hollow Hill Road crossing, Winchester.	2.12	Fully Supporting	Not Assessed
CT4303-00_02	Still River (Colebrook)-02	From confluence with Sandy Brook, Colebrook, US to Winchester (Winsted) POTW (east side of Route 8), Winsted.	2.67	Fully Supporting	Not Supporting
CT4303-00_03	Still River (Winsted)-03	From Winchester (Winsted) POTW, US to confluence with Mad River (just US of Route 44/183 crossing).	1.67	Not Supporting	Not Supporting
CT4303-00_04	Still River (Winsted/Torrington)-04	From confluence with Mad River (just US of Route 44/183 crossing), US to headwaters (on west side of Route 8, parallel with Exit 45 offramp), Torrington.	7.56	Not Assessed	Not Supporting
CT4304-00_01	Sandy Brook (Colebrook)-01	From mouth at confluence with Still River (just DS of Old Forge Road crossing), Colebrook (Southeast), US to Massachusetts border, Norfolk (Northeast corner).	8.63	Fully Supporting	Fully Supporting
CT4304-00_01a	Sandy Brook (Barkhamsted/Colebrook)-01a	Mouth confluence Farmington River, Barkhamsted, US to confluence Still River, Colebrook. NOTE Formerly called Still River-01 (CT4303-00_01), see comments.	1.35	Fully Supporting	Not Supporting
CT4304-08_01	Center Brook-01	From mouth at Sandy Brook, US to Route 183 (Colebrook Rd) crossing, Colebrook.	1.28	Fully Supporting	Not Assessed
CT4305-00_01	Morgan Brook-01	From mouth at West Branch Farmington River, US to confluence with tributary 4305-04 (first confluence) on east side of Route 44, Barkhamsted.	0.69	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4305-00_02	Morgan Brook-02	From confluence with tributary 4305-04 (end of seg-01) east side of Route 44, US to East West Hill Road crossing area (50 meters US of East West Hill Road crossing, entrance of 9/12/05 home heating fuel spill), Barkhamsted.	1.41	Fully Supporting	Not Supporting
CT4305-00_04	Morgan Brook-04	From confluence with Mallory Brook, US to West Hill Pond outlet dam, Barkhamsted.	1.52	Fully Supporting	Not Supporting
CT4305-02_01	Mallory Brook-01	From confluence with Morgan Brook, US to Tennessee Gas pipeline crossing (near Barkhamsted and Winchester town line, south of Route 44), Barkhamsted.	1.54	Fully Supporting	Insufficient Information
CT4305-02_02	Mallory Brook-02	From Tennessee Gas Pipeline Crossing (end of segment-01, near Barkhamsted and Winchester town line, south of Route 44), US to headwaters, Winchester.	0.7	Fully Supporting	Insufficient Information
CT4306-00_01	Valley Brook-01	From mouth at northwestern most portion of Barkhamsted Reservoir, Hartland, US (towards northeast) to CT/MA state line.	0.73	Fully Supporting	Not Assessed
CT4307-00_01	Hubbard Brook-01	From mouth at northwestern most portion of Barkhamsted Reservoir, Hartland, US (towards northwest) to CT/MA state line.	0.57	Fully Supporting	Not Assessed
CT4308-00_01	Farmington River, East Branch-01	From mouth at Farmington River mainstem, New Hartford, US to Lake McDonough outlet dam.	1.11	Not Supporting	Not Supporting
CT4308-01_01	Hurricane Brook (Hartland)-01	Mouth on Barkhamsted Reservoir, just DS of Route 20 crossing, US to HW at Emmons Pond, just US of Hurricane Brook Road crossing, Hartland.	2.24	Fully Supporting	Not Assessed
CT4308-02_01	Falls Brook (Hartland)-01	Mouth at confluence East Branch Farmington River in Barkhamsted Reservoir section from west side near Route 20, US to HW in Tunxis State Forest, Hartland.	2.1	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4308-11_01	Roaring Brook (Barkhamsted)-01	Mouth at inlet to Barkhamsted Reservoir, parallel to Kettle Brook, US to HW near Pine Mountain road, Barkhamsted.	2.4	Fully Supporting	Not Assessed
CT4308-13_01	Kettle Brook (Barkhamsted)-01	Mouth at inlet to Barkhamsted Reservoir, just DS of Ratlum Road crossing, US to HW just US of Route 219 crossing, Barkhamsted.	1.95	Fully Supporting	Not Assessed
CT4308-14_01	Storehouse Brook (Barkhamsted)-01	Mouth at confluence with East Branch Farmington River in Barkhamsted Reservoir section DS of Route 219 crossing, along east side of beach near Saville Dam Road, US to HW US of Hillcrest Drive crossing, near intersection with Route 219, Barkhamsted.	1.9	Fully Supporting	Not Assessed
CT4308-15_01	Beaver Brook (Barkhamsted)-01	From mouth at northwestern corner of Lake McDonough (Compensating Reservoir), Barkhamsted, US to headwaters in Peoples State Forest, Hartland.	5.51	Fully Supporting	Not Assessed
CT4308-15-trib_01	Unnamed Tributary, Beaver Brook (Barkhamsted)-01	Mouth on Beaver Brook, just DS of Beaver Brook Road crossing, US to HW, US of Beaver Brook Road crossing, Barkhamsted.	0.38	Fully Supporting	Not Assessed
CT4308-18_01	Ratlum Brook (New Hartford)-01	From mouth at confluence with East Branch Farmington River (just DS of Farmington River Turnpike crossing), US to Sholom Pond outlet dam (parallel to Ratlum Road), New Hartford.	0.28	Fully Supporting	Not Assessed
CT4308-18_02	Ratlum Brook (New Hartford/Canton)-02	Sholom Pond OUTLET dam parallel to Ratlum Road, (segment includes pond), New Hartford, US to HW in forested area US of Ratlum Mountain Road crossing, Canton.	2.7	Fully Supporting	Not Assessed
CT4309-00_01	Cherry Brook (Canton)-01	Mouth confluence Farmington River (just DS Albany Turnpike (Route 44) crossing), US to Barbourtown Road crossing, Canton.	2.05	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4309-00_02	Cherry Brook (Canton)-02	From Barbourtown road crossing (segment-01), US to confluence with unnamed tributary (outlet stream for Linsey Pond), just US of Meadow Road crossing, Canton.	0.66	Not Assessed	Not Supporting
CT4309-00_03	Cherry Brook (Canton/Barkhamsted)-03	Confluence with unnamed tributary, just US of Meadow Road crossing and parallel to Route 179, Canton, US to HW, just US of Route 219 crossing, Barkhamsted.	6.64	Fully Supporting	Insufficient Information
CT4309-02_01	Unnamed Tributary to Cherry Brook (Canton)-01	Mouth on Cherry Brook, just DS from Route 179 crossing, US to outlet of Tiltons Pond, just US of Route 179 crossing, Canton.	0.38	Fully Supporting	Insufficient Information
CT4310-00_01	Nepaug River-01	From mouth at confluence with Farmington River (southwest of Route 202 crossing), US to Nepaug Reservoir outlet dam.	0.9	Not Supporting	Not Supporting
CT4310-00_02	Nepaug River-02	From inlet to Nepaug Reservoir (far western portion), US to headwaters (just above confluence with Cedar Swamp Brook, parallel with Niles Road), New Hartford.	7.73	Fully Supporting	Not Assessed
CT4310-01_01	Bakerville Brook-01	From mouth at Nepaug River, US to confluence with Torringford Brook (west of Cedar Lane crossing, along north side of Route 202), New Hartford.	1.01	Fully Supporting	Not Assessed
CT4310-01_02	Bakerville Brook (New Hartford)-02	Confluence with Torrington Brook, parallel with Route 202, US to HW near Pearl Rd (above Rt 202 crossing), New Hartford.	3.2	Fully Supporting	Not Assessed
CT4310-05_01	North Brook (New Hartford)-01	Mouth on North Nepaug Brook, between Route 219 and Maple Hollow Road, US to HW, between West Hill Road and Stub Hollow Road, New Hartford.	2.51	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4311-00_01	Burlington Brook (Burlington)-01	Mouth Farmington River, US to HW at confluence North and South Branches Bunnell Brook, Burlington. Segment includes Burlington Brook name upto confluence with Bradley brook, then name changes to Bunnell Brook, but number stays constant.	4.78	Fully Supporting	Fully Supporting
CT4311-06_01	Punch Brook (Burlington)-01	Mouth on Burlington Brook at Route 4 crossing, US to Punch Brook Pond outlet, Burlington.	0.65	Fully Supporting	Not Assessed
CT4312-00_01	Roaring Brook (Farmington)-01	Mouth confluence Farmington River (just DS Farmington Avenue (Route 4) crossing), Farmington, US to Paparrazzo Dam outlet (just US Mallard Drive crossing), Avon.	1.17	Not Supporting	Not Supporting
CT4312-01_01	Jim Brook (Canton)-01	Mouth on Roaring Brook between Washburn Road and Lawton Road, US to HW parallel to Sextons Hollow Road, Canton.	2.23	Fully Supporting	Not Assessed
CT4313-00_01	Poland River-01	From mouth at confluence with Pequabuck River, US to confluence with Marsh Brook (seg 2 begins), Plymouth.	0.42	Not Assessed	Not Supporting
CT4313-00_02	Poland River-02	From confluence with Marsh Brook, US to confluence with unnamed brook 4313-03-1, US of Judd Road crossing (parallel with Route 72), Plymouth, CT.	0.71	Fully Supporting	Not Supporting
CT4314-00_01	Coppermine Brook (Bristol)-01	Mouth Pequabuck River, US to New Britain drinking water watershed boundary and water diversion (just US confluence with Polkville Brook), Bristol.	2.43	Not Supporting	Not Supporting
CT4314-00_02	Coppermine Brook (Bristol)-02	From drinking water watershed boundary and water diversion (just US of confluence with Polkville Brook), US to headwaters (confluence of Whigville & Wildcat Brooks).	2.66	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4314-01_01	Whigville Brook (Burlington)-01	Mouth at confluence Wildcat Brook above Coppermine Brook, DS of Prospect Street crossing, US to HW between Route 69 on west and Savarese Lane on east, Burlington.	4.8	Fully Supporting	Not Assessed
CT4314-04_01	Wildcat Brook (Burlington)-01	Mouth at confluence Whigville Brook above Coppermine Brook, DS of Prospect Street crossing, US to HW (flows along eastern boundary of Nassahegon State Forest) US of George Washington Turnpike crossing (just East of Cedar Ridge intersection), Burlington.	2.6	Fully Supporting	Not Assessed
CT4314-06_02	Negro Hill Brook (Burlington)-02	Confluence with unnamed tributary at Bristol/Burlington town line, near Intervale Road, US to HW just US of Gilbert Road crossing, Burlington.	4.08	Fully Supporting	Fully Supporting
CT4314-08_01	Polkville Avenue Brook (Bristol)-01	Mouth coppermine Brook US Farmington Avenue crossing (DS Mix Street crossing and below aqueduct), US to HW at P&B Dam just US Hart Street crossing, Bristol.	3.19	Not Supporting	Not Assessed
CT4315-00_01	Pequabuck River (Plainville)-01	Mouth Farmington River, US to Railroad crossing (US (south) Route 72 crossing), Plainville.	5.37	Not Supporting	Not Supporting
CT4315-00_02	Pequabuck River-02	From Railroad crossing (US (south) of Route 72 crossing), Plainville, US to Bristol POTW outfall (DS of route 229 crossing), Bristol.	3.37	Not Supporting	Not Supporting
CT4315-00_03	Pequabuck River-03	From Bristol POTW outfall (DS of route 229 crossing), US to exit of box culvert, downtown Bristol.	1.23	Not Supporting	Not Supporting
CT4315-00_04	Pequabuck River-04	From exit of box culvert, US to entrance of box culvert (entire segment in culvert), center of Bristol.	0.33	Not Supporting	Not Supporting
CT4315-00_05	Pequabuck River-05	From entrance to box culvert, center Bristol, US to Plymouth POTW (just DS of Canal Street (Route 72) crossing), Plymouth.	2.7	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4315-00_06	Pequabuck River-06	From Plymouth POTW (just DS of Canal Street (Route72) crossing), US to headwaters, South of Rocky Road, Harwinton.	5.46	Not Supporting	Not Supporting
CT4315-08_02	South Mountain Brook (Bristol)-02	Clayton Manufacturing Dam inlet, parallel to Union Street, US to confluence with unnamed tributary, behind South Side School, near Tuttle Road, Bristol.	0.51	Fully Supporting	Not Assessed
CT4316-00_01	Thompson Brook (Avon)-01	Mouth Farmington River (DS Old Farms Road crossing), US to INLET Beaverdam Pond (DS old Railroad crossing, now bike path), Avon.	1.91	Fully Supporting	Fully Supporting
CT4316-00_02	Thompson Brook (Avon)-02	From INLET to Beaverdam Pond (DS of old Railroad crossing which is now a bike path), US to HW at confluence of Big Brook and Chidsey Brook (just US of Thompson Road crossing), Avon.	1.24	Fully Supporting	Not Supporting
CT4316-01_01	Chidsey Brook (Avon)-01	From mouth at confluence with Big Brook, forming HW of Thompson Brook (DS of Scoville Road crossing), US to Lamonica Pond outlet (just US of West Avon Road crossing), Avon	1.34	Not Supporting	Not Assessed
CT4317-00_01	Nod Brook (Avon/Simsbury)-01	Mouth at Farmington River (includes dredge holes, Twin Lakes North and South and outlet to Farmington River in wildlife management area), Avon, US to headwaters (just US of Rocklyn Road crossing), Simsbury.	6.95	Fully Supporting	Fully Supporting
CT4318-00_01	Hop Brook (Simsbury)-01	Mouth Farmington River, US to HW at outlet Tuller Reservoir, Simsbury.	6.74	Fully Supporting	Not Supporting
CT4318-03_01	Stratton Brook-01	From mouth at confluence with Hop Brook (just DS of Farms Village Road (Route 309) crossing), US to headwaters (near Bushy Hill Road (Route 167), Simsbury.	3.89	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4319-00_01a	Salmon Brook, West Branch (Granby)-01a	Mouth at confluence with East Branch Salmon Brook (part of Salmon Brook mainstem), DS of Route 10/202 crossing, just to West of Route 189, Granby, US to Bissell Brook (just US of Route 10/202 crossing), Granby.	1.4	Fully Supporting	Not Supporting
CT4319-00_01b	Salmon Brook, West Branch (Granby/Hartland)-01b	Confluence Bissell Brook US of Route 10/202 crossing, US to HW just US Route 179 (South Road) crossing, Hartland.	11.29	Fully Supporting	Not Supporting
CT4319-03_01	Enders Brook (Granby/Barkhamsted)-01	Confluence with West Branch Salmon River, adjacent to Route 219, Graby, US to HW, just US of Hayes Road crossing, Barkhamsted.	3.75	Fully Supporting	Not Assessed
CT4319-09_01	Unnamed Tributary to Salmon Brook (Granby)-01	Mouth on West Branch Salmon Brook, just DS of Simsbury Road crossing, US to HW, west of Weed Hill Road, Granby.	2.23	Fully Supporting	Not Assessed
CT4320-00_01	Salmon Brook (East Granby/Granby)-01	Mouth Farmington River DS Floydville Road crossing, East Granby, US to Massachusetts border (includes Salmon Brook and East Branch Salmon Brook sections), Granby.	13.55	Fully Supporting	Not Supporting
CT4320-01_01	Unnamed Tributary to East Branch Salmon Brook (Granby)-01	Mouth on East Branch Salmon River, just DS of Route 189 crossing, Granby, US to Connecticut State Border with Massachusetts, parallel with Peck Orchard Road, Hartland.	0.87	Fully Supporting	Not Assessed
CT4320-02_01	Fox Brook (Hartland)-01	From mouth at confluence with East Branch Salmon Brook (just DS of Granville Road (Route 189) crossing), Granby, US to HW (just East of Pell Road, along the CT/MA border), Hartland.	2.55	Fully Supporting	Not Assessed
CT4320-05_01	Belden Brook-01	From mouth at confluence with East Branch Salmon Brook (just DS of Route 189 crossing), Granby, US to headwaters (just US of Granville Road crossing), Hartland	4.08	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4320-08_01	Mountain Brook-01	From mouth at confluence with East Branch Salmon Brook, (just DS of Route 189 (Granville Road) crossing), US to headwaters (East of Silkey Road), Granby.	3.55	Fully Supporting	Not Assessed
CT4320-19_01	Mountain Brook (Suffield)-01	From mouth at confluence with Hungary Brook (just US of Railroad crossing on Hungary Brook), US to confluence with unnamed tributary just US of Copper Hill Road crossing, Suffield.	1.37	Not Assessed	Not Supporting
CT4321-00_01	Mill Brook (Windsor/Bloomfield)-01	Mouth Farmington River DS Palisado Avenue and Railroad crossings, Windsor, US Barber Pond Outlet dam (just US Old Winsor Road (Route 305) crossing), Bloomfield.	4.56	Not Supporting	Not Supporting
CT4400-00_01	Park River (Hartford)-01	Mouth confluence Connecticut River, US to confluence with North Branch Park River, just DS of I84 crossing at opening of conduit (US of Willow Street crossing), Hartford.	2.39	Not Supporting	Not Supporting
CT4400-01_01	South Branch Park River (Hartford)-01	Mouth at confluence Park River, US to entrance of conduit (entire segment in pipe underground), Hartford.	0.32	Not Supporting	Not Supporting
CT4400-01_02	South Branch Park River (Hartford)-02	Entrance of conduit (segment-01), US to confluence with Piper and Trout Brooks, between Railroad and Route 173 (New Britian avenue), Hartford.	2.62	Not Supporting	Not Supporting
CT4402-00_01	Piper Brook (West Hartford)-01	Mouth at confluence Trout Brook, above South Branch Park River, West Hartford, US (under New Britian Avenue), to conduit opening, US side of New Britain Ave (segment completely in conduit).	0.05	Not Supporting	Not Supporting
CT4402-00_02	Piper Brook-02	From conduit entrance (segment-01) US side of New Britain Avenue, West Hartford, US into St. Marys Cemetary (just US of railroad crossing and parallel with Route 9) where pipe emerges from ground, New Britain.	5.81	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4403-00_01	Trout Brook-01	From mouth at confluence with Piper Brook, above South Branch Park River (just DS of railroad crossing, near New Britian Avenue), West Hartford, US under Route 84 exit 42 (Trout Brook Drive) ramp.	1.07	Not Supporting	Not Supporting
CT4403-00_02	Trout Brook-02	From US side of Route 84 Exit 42 (Trout Brook) ramp, West Hartford, US to Park Road crossing (Entire segment flows through concrete channel).	0.88	Not Supporting	Not Supporting
CT4403-00_03	Trout Brook-03	From Park Road crossing (just DS of Boulevard road crossing), US to Woodbridge Lake outlet dam, West Hartford.	5.95	Not Supporting	Not Supporting
CT4404-00_01	North Branch Park River (Hartford)-01	Mouth at confluence with Park River just DS of I84 crossing, US to entrance of conduit (entire segment in pipe) near Farmington Avenue, Hartford.	0.51	Not Supporting	Not Supporting
CT4404-00_02	North Branch Park River-02	From DS side of Farmington Avenue (at entrance of conduit), US to confluence with Wash Brook (just DS of confluence of Wash Brook and Beamans Brook), Bloomfield.	5.39	Not Supporting	Not Supporting
CT4500-00_01	Hockanum River-01	From mouth at Connecticut River, East Hartford, US to Cellu Company Dam, the first dam at Scotland Impoundment (two dams just DS of this dam), includes impounded water behind East Hartford town hall.	4.26	Not Supporting	Insufficient Information
CT4500-00_02	Hockanum River (East Hartford/Manchester)-02	Cellu Company dam (first dam at Scotland Rd Impoundment), East Hartford, US to confluence with South Fork Hockanum (AKA Hop) River, just US of "Laurel Lake", Manchester.	3.6	Not Supporting	Not Supporting
CT4500-00_03	Hockanum River-03	From confluence with South Fork Hockanum (AKA Hop) River (just US of "Laurel Lake"), US to Union Pond outlet dam, Manchester.	3.42	Not Supporting	Not Supporting
CT4500-00_04a	Hockanum River-04a	From inlet to Union Pond, Manchester, US to confluence with Tankerhoosen River, Vernon.	1.44	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4500-00_04b	Hockanum River-04b	From confluence with Tankerhoosen River, Vernon, US to marsh (approximately one mile DS of Dart Hill Road crossing, parallel to Route 83, near Neak Road), Vernon.	1.67	Not Supporting	Not Supporting
CT4500-00_05	Hockanum River-05	From marsh exit (approximately one mile DS of Dart Hill Road crossing, parallel to Route 83, near Neak Road), Vernon, US to Vernon POTW (just DS of Route 74 crossing).	2.48	Not Supporting	Not Supporting
CT4500-00_06a	Hockanum River-06a	From Vernon POTW (just DS of Route 74 crossing), Vernon, US to Windsor Avenue crossing (Route 74), Vernon.	3.03	Not Supporting	Not Supporting
CT4500-00_06b	Hockanum River (Vernon/Rockville)-06b	Windsor Avenue crossing (Route 74), Vernon, US to Vernon Ave, Vernon (Rockville).	0.93	Not Supporting	Not Supporting
CT4500-00_07	Hockanum River-07	From Vernon Ave (outlet of culvert), Rockville, US to Paper Mill Pond outlet dam (inlet to culvert).	0.52	Not Supporting	Not Supporting
CT4500-00_08	Hockanum River-08	From Paper Mill Pond outlet dam, Rockville, US to Shenipsit Lake outlet dam.	0.59	Not Supporting	Fully Supporting
CT4500-01_01	West Brook (Tolland)-01	Mouth Charters Brook DS Eaton Rd crossing (just US Shenipsit Lake inlet), US to HW Poehnerts Pond outlet dam, near Route 74, Tolland.	1.85	Fully Supporting	Not Assessed
CT4500-04_01	Ogden Brook (Vernon)-01	Mouth on Hockanum River, just DS of Thrall Road crossing, US to HW at JR High Pond, near Inland Drive, Vernon.	2.42	Not Supporting	Not Assessed
CT4500-12_02	Lydall Brook (Manchester)-02	Route 83 crossing (end of underground conduit), US to outlet of Salters Pond, parallel to Lydall Street at Coleman Road intersection, Manchester.	1.05	Not Supporting	Not Assessed
CT4500-12_03	Lydall Brook (Manchester)-03	Inlet Salters Pond, parallel to Lydall Street at Ambassador Drive intersection, US to outlet of Lydall Street Reservoir No1, parallel to Lydall Street, Manchester.	1.01	Not Supporting	Insufficient Information

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4500-14_01	Bigelow Brook (Manchester)-01	Confluence with Hockanum River, just DS of Hillard Street crossing, US to Adams Street crossing, Manchester.	0.27	Fully Supporting	Not Assessed
CT4501-00_01	Charters Brook-01	From mouth at Shenipsit Lake Tolland US to headwaters near Webster Rd Ellington	6.22	Fully Supporting	Fully Supporting
CT4503-00_01	Tankerhoosen River-01	From mouth at Hockanum River, Vernon (DS of Route 83/30 crossing near Manchester border), US to Tankerhoosen Lake outlet dam, Vernon.	1.51	Not Supporting	Not Assessed
CT4503-00_02	Tankerhoosen River-02	From Tankerhoosen Lake outlet dam (includes lake), Vernon, US to Walker Reservoir East outlet (headwater).	4.07	Fully Supporting	Not Assessed
CT4503-00-trib_01	Barrows Brook (Vernon/Tolland)-01	Mouth at confluence Tankerhoosen River east of Reservoir Rd and Baker Rd intersection, Vernon, US to HW just over town line, Tolland.	0.92	Fully Supporting	Not Assessed
CT4503-04_01	Railroad Brook (Vernon/Bolton)-01	Mouth at confluence Tankerhoosen River DS Milk and Bread Road crossing (US flows through Valley Falls Pond), Vernon, US to HW at Bolton Notch Pond OUTLET, Bolton. (adjacent to airline trail and I384)	2.8	Fully Supporting	Not Assessed
CT4504-00_01	South Fork Hockanum River (Manchester)-01	Mouth at confluence Hockanum River just DS of Thrall Road crossing, US to HW at confluence of Hop Brook and Folly Brook US Hartford Road crossing and at I384 crossing (Folly Brook goes under I384), Manchester.	1.2	Not Supporting	Not Assessed
CT4504-00_02	Hop Brook (Manchester)-01	Mouth at confluence South Fork Hockanum River DS side of I384, US parallel along north side of I384 to HW at confluence of Porter Brook and Birch Mountain Brook just US of Route 83 crossing, Manchester. NOTE: name of segment changes with river name.	2.24	Not Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4504-01_01	Porter Brook (Manchester)-01	Mouth at confluence Birch Mountain Brook above Hop Brook DS of Charter Oak Street crossing (adjacent to I384 near baseball field), US to Howard Reservoir OUTLET adjacent to I384 (water class changes A to AA), Manchester.	2.2	Not Supporting	Not Assessed
CT4504-03_01	Birch Mountain Brook (Manchester)-01	Mouth at confluence Porter Brook above Hop Brook (near baseball field) DS of Gardner Street crossing (brook runs adjacent on north side of I384), US to HW just US of Birch Mountain Road crossing at Manchester/Bolton border.	3.6	Not Supporting	Not Assessed
CT4600-00_01	Mattabesset River (Cromwell/Middletown)-01	Mouth Connecticut River under Route 9, Cromwell, US to Route 3 crossing (south Route 372 intersection), Cromwell/Middletown line.	3.31	Not Assessed	Not Supporting
CT4600-00_02	Mattabesset River (Cromwell/East Berlin)-02	From Route 3 crossing, Cromwell and Middletown Townline, US to High Pond Dam (just US of Berlin Street crossing), East Berlin.	3.65	Not Supporting	Not Supporting
CT4600-00_03	Mattabesset River-03	From High Pond Dam just US of Berlin Street crossing, East Berlin, US to confluence with Willow Brook.	3.6	Not Supporting	Not Supporting
CT4600-00_04	Mattabesset River-04	From confluence with Willow Brook, US to Kensington Dam at outlet of Railroad Pond (just US of Kensington Road crossing), Berlin.	2.83	Not Supporting	Not Supporting
CT4600-00_05	Mattabesset River-05	From Kensington Dam at outlet of Railroad Pond (just US of Kensington Road crossing), Berlin, US to inlet of Paper Goods Pond (segment includes both ponds).	1.01	Not Supporting	Not Assessed
CT4600-00_06	Mattabesset River-06	From inlet to Paper Goods Pond, US to Lower Hart Pond outlet dam (Both Lower and Upper Hart Ponds are not in segment).	1.32	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4600-00-trib_01	Unnamed tributary Connecticut River (Cromwell)-01	Inlet to conduit at Route 372 crossing, US (through nursery) to HW near Iron Gate Lane, Cromwell. NOTE: lower hydrology manipulated, flow to CT River, but basin consistent with Mattabesset River.	1.06	Not Supporting	Not Assessed
CT4600-01_01	Stocking Brook-01	From mouth at confluence with Mattabesset River (just DS of Lower Hart Pond inlet), US to confluence with John Hall Brook (DS of Southington Road crossing), Berlin.	1.3	Fully Supporting	Not Assessed
CT4600-05_01	John Hall Brook-01	From mouth at confluence with Stocking Brook (DS of Southington Road crossing), US to Kenmere Reservoir OUTLET, Berlin.	1.02	Fully Supporting	Not Supporting
CT4600-05_02	John Hall Brook-02	From Kenmere Reservoir INLET, US to Hallmere Reservoir outlet dam, Berlin.	1	Not Assessed	Not Supporting
CT4600-07_01	Little Brook (Rocky Hill)-01	From mouth at Mattabasset River US to source near Trinity Rd, Rocky Hill.	1.92	Fully Supporting	Not Supporting
CT4600-13_01	Spruce Brook (Berlin)-01	From mouth at Mattabasset River US to headwaters at confluence of East/West Spruce Brooks, above Lamentation Brook (Lamentation Mountain area).	4.17	Insufficient Information	Not Supporting
CT4600-22_01	Coles Brook-01	From mouth at Mattabasset River, US to headwaters above Shunpike Road (Route 3) crossing, Cromwell.	3.1	Not Assessed	Not Supporting
CT4600-26_01	Miner Brook-01	From mouth at confluence with Mattabasset River, Cromwell/Middletown border, US to headwaters (in marsh just US (south) of Westfield Street crossing, parallel with Route 217), Middletown.	2.92	Insufficient Information	Not Supporting
CT4600-27_01	Willow Brook (Cromwell)-01	From mouth at confluence with Mattabasset River (DS of Berlin Road (Route 372) crossing, US to headwaters, just US of Coles Road crossing (near junction of Coles Road and Willow Brook Road), Cromwell.	1.38	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4600-27_trib_01	East Branch Willow Brook-01	From mouth at confluence with Willow brook (DS of Evergreen Road crossing), US to headwaters (in marsh US of Route 9 crossing, along west side of Shunpike Road (Route 3) area), Cromwell.	0.76	Not Assessed	Not Supporting
CT4601-00_01	Belcher Brook-01	From mouth at Mattabasset River US to source at Silver Lake, Berlin.	3.74	Not Supporting	Not Supporting
CT4601-01_01	Crooked Brook (Berlin)-01	From mouth at Belcher Brook (near Norton Road), US to Swede Pond outlet, Berlin.	1.15	Fully Supporting	Not Assessed
CT4601-01_02	Crooked Brook (Berlin)-02	From Swede Pond INLET, US to Elton Rd crossing, Berlin.	0.34	Not Supporting	Not Assessed
CT4601-02_01	Hatchery Brook-01	From mouth at confluence with Belcher Brook, US to area adjacent to Lions Club Pool (just US of Norton Road crossing), Berlin.	1.88	Not Supporting	Not Assessed
CT4602-00_01	Willow Brook (New Britain)-01	From mouth at Mattabasset River, US to outlet of conduit under Buell Street, near intersection with Route 71A (Kensington Ave, east of Hart Park), New Britain.	3.43	Not Supporting	Not Supporting
CT4603-00_01	Webster Brook-01	From mouth at Mattabasset River, US to headwaters between Railroad track and Stamm Road, just US of Route 174 crossing, Newington.	3.42	Not Supporting	Not Supporting
CT4604-00_01	Sawmill Brook (Middletown)-01	From mouth at Mattabasset River, US to headwater above Atkin Street Pond (Highland Pond) Middletown.	4.18	Fully Supporting	Not Supporting
CT4605-01_01	Hersig Brook (Durham)-01	Mouth at INLET of Allyn Millpond at confluence of Fowler Brook in Allyn Brook Park, US to HW US Johson Lane crossing, Durham. (local brook names here may cause confusion, followed basin number 4605-01)	2.7	Fully Supporting	Not Assessed
CT4607-00_02	Coginchaug River-02	From downstream side of Route 3 crossing, US to downstream side of Route 66 crossing (just US of Veterans Memorial Park), Middletown.	0.75	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4607-00_03	Coginchaug River-03	From downstream side of Route 66 crossing (just US of Veterans Memorial Park), US to Starr Mill Pond dam, Middletown.	0.6	Fully Supporting	Not Supporting
CT4607-00_04	Coginchaug River (Middletown/Middlefield)-04	Starr Mill Pond Inlet, Middletown, US (past Wadsworth Falls) to Strictland Road crossing, Middlefield. (Includes diversion for swimming area)	4.19	Fully Supporting	Not Supporting
CT4607-00_05	Coginchaug River (Middlefield/Durham)-05	From Strictland Road crossing, Middlefield, US to Meeting House Hill Road crossing, Durham.	4.95	Not Assessed	Not Supporting
CT4607-00_06	Coginchaug River-06	From Meeting House Hill Road crossing, Durham, US to headwaters (US of Route 72 crossing, between Bluff Head and Broomstick Ledges), North Guilford.	3.59	Fully Supporting	Not Supporting
CT4607-05_01	Parmalee Brook (Durham)-01	Mouth on Coginchaug River, DS of Parmelee Hill Road crossing, US to confluence with unnamed tributary, just US of Saw Mill Road crossing (water class changes from A to AA), Durham.	1.94	Fully Supporting	Insufficient Information
CT4607-05_02	Parmalee Brook (Durham/North Branford)-02	Confluence unnamed tributary, just US of Saw Mill Road crossing (water class changes from A in segment 1 to AA in this segment 2), Durham, US along Route 5 to HW just east of Blue Jay Drive and Skylark Drive, North Branford.	3.64	Fully Supporting	Not Assessed
CT4607-06_01	Cream Pot Brook (Durham)-01	Mouth at confluence Coginchaug River, US of Coginchaug River crossing Route 68 (in Durham Meadows Wildlife Area), US to HW at unnamed pond just US of Dead Hill Road crossing (runs parallel to Route 79 in upper part of segment), Durham.	3.3	Fully Supporting	Not Assessed
CT4607-08_01	Lyman Meadow Brook (Middlefield)-01	Mouth on Coginchaug River, US of Coginchaug River crossing of Miller Road, US to outlet of South Street Pond, US of Railroad crossing, Middlefield.	1.43	Not Assessed	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4607-11_01	Hans Brook (Middlefield)-01	Mouth at confluence Coginchaug River just DS of Route 157 crossing (behind Cahill Construction) US to HW at Jeep Trail Pond (west side of Jackson Hill Road), Middlefield.	1.1	Fully Supporting	Not Assessed
CT4607-13_01	Laurel Brook (Middletown)-01	Mouth on Coginchaug River, in Wadsworth Falls State Park, parallel to swimming area, near Route 157, US to unnamed pond outlet, just US of Red Road crossing, Middletown.	1.17	Insufficient Information	Not Supporting
CT4700-00_01	Salmon River (East Haddam/Colchester)-01	Mouth at Connecticut River, East Haddam, US to headwaters at confluence of Blackledge and Jeremy Rivers, Colchester.	10.41	Fully Supporting	Fully Supporting
CT4700-02_01	Day Pond Brook (Colchester)-01	Confluence with Salmon River, US to Day Pond outlet, Colchester.	1.11	Fully Supporting	Not Assessed
CT4700-03_01	Flat Brook (East Hampton)-01	Mouth at Salmon River, DS of Route 16 crossing, US to HW, US of Daly Road crossing, East Hampton.	3.2	Fully Supporting	Not Assessed
CT4700-07_01	Safstrom Brook (East Hampton)-01	Mouth at confluence Salmon River DS of Wopowog Street crossing in Wopowog Wildlife area (trout management area in Salmon River), US HW at unnamed pond (near Edgerton Street) US of Route 16 crossing, East Hampton.	4.1	Fully Supporting	Not Assessed
CT4700-09_01	Elbow Brook (East Hampton)-01	Confluence with Salmon River, US to HW (runs parallel to Route 196), East Hampton.	2.28	Fully Supporting	Not Assessed
CT4701-00_01	Raymond Brook (Hebron)-01	Mouth on Jeremy River, along Airline Trail, DS of Grayville Road crossing, US to Route 85 crossing, Hebron.	2.81	Fully Supporting	Not Assessed
CT4701-00_02	Raymond Brook (Hebron)-02	Route 85 crossing, Hebron, US to HW, near Basket Shop Road at Hebron/Columbia town line.	4.15	Fully Supporting	Not Assessed
CT4702-00_01	Judd Brook (Colchester/Hebron)-01	Mouth on Jeremy River, just US of Airline Trail crossing, Colchester/Hebron town line, US to crossing, US to confluence with unnamed tributary, just US of Route 85 crossing, Colchester.	2.44	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4703-00_01	Meadow Brook (Colchester)-01	From mouth at confluence with Jeremy River (parallel to Route 2, US of Prospect Hill Road crossing), US to Lincoln Lake outlet dam on Levy Pond (just US of Levy Road crossing), Colchester.	3.07	Fully Supporting	Not Assessed
CT4703-01_01a	Cabin Brook (Colchester)-01	Mouth at confluence with Nelkin Brook above Meadow Brook (in marsh DS of Cabin Road crossing), US to just above storm water discharge form subdivision, near Lynn Lane and Kennedy Drive, Colchester.	0.6	Not Supporting	Not Assessed
CT4703-01_01b	Cabin Brook (Colchester)-01b	Just above storm water discharge form subdivision, near Lynn Lane and Kennedy Drive, US under Route 2/Route 11 interchange to confluence with small tributary near exit 20 ramp, Colchester.	0.93	Fully Supporting	Not Assessed
CT4703-01_02	Cabin Brook-02	From confluence with small tributary near exit 20 ramp (US of Route 2/Route 11 interchange), US to headwaters on south side of Parum Road (Route 354), north of Dutton Swamp (US of McDonald Road crossing), Colchester.	1.02	Fully Supporting	Not Assessed
CT4704-00_01	Pine Brook (Colchester)-01	Mouth at confluence with Jeremy River, before it crosses Route 149 (Pine Brook is parallel Cato Corner Rd), US to Babcock Pond outlet (lower portion on north side of Route 16 parallel to Pinebrook Rd), Colchester.	2.5	Fully Supporting	Not Assessed
CT4705-00_01	Jeremy River (Colchester)-01	Mouth at confluence Blackledge River, above Salmon River, US to Norton Paper Company Dam (just US of Route 149 crossing), Colchester (North Westchester).	1.17	Fully Supporting	Not Assessed
CT4705-00_02	Jeremy River (Colchester/Hebron)-02	Norton Paper Company Dam INLET (just US of Route 149 crossing), Colchester (North Westchester), US to HW at Holbrook Pond outlet dam, just US of Route 85 crossing and in Salmon River State Forest, Hebron.	9.6	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4705-01_01	Hope Valley Brook (Hebron)-01	Mouth at confluence Jeremy River parallel to Hope Valley Road (west of intersection with Reidy Hill Road), US to HW at Holman Pond outlet dam, just US of Route 66 crossing, Hebron. (includes unnamed pond on Burrows Hill Road)	1.9	Fully Supporting	Not Assessed
CT4706-00_01	Fawn Brook (Marlborough)-01	Mouth on Blackledge River, just DS of Main Street crossing, Marlborough, US to confluence with West Branch Fawn Brook, parallel to Paper Mill Road, at Marlborough/Hebron town line.	2.05	Fully Supporting	Not Assessed
CT4706-00_02	Fawn Brook (Marlborough/Hebron)-02	Confluence with West Branch Fawn Brook on Marlborough/Hebron town line, just DS of Paper Mill Road crossing, US to HW at Merrow Swamp OUTLET, just US of East Road crossing, Hebron.	6.88	Fully Supporting	Fully Supporting
CT4707-00_01	Blackledge River (Colchester/Bolton)-01	Mouth confluence Jeremy River above Salmon River (near River Road), Colchester, US to HW (near Converse Road, just off Birch Mountain Road), Bolton. Segment includes river below and above Gay City Pond.	16.35	Fully Supporting	Not Assessed
CT4707-02_01	French Brook (Bolton)-01	From mouth at confluence with Blackledge River (segment-01) DS of French Road crossing, US to Tinker Pond outlet Dam (US of Tinker Pond Road crossing), Bolton.	1	Fully Supporting	Not Assessed
CT4707-12_01	Lyman Brook (Marlborough)-01	Mouth Blackledge River (just US of Blackledge River crossing South Main Street) parallel and DS Route 2 at exit 15 offramp, US to HW parallel to Jones Hollow Rd and near Avalon Lane, Marlborough.	3.82	Not Supporting	Not Assessed
CT4708-00_01	Dickinson Creek (Colchester/Marlborough)-01	Mouth on Salmon River, just DS of Comstock Bridge crossing, Colchester, US to confluence with Fawn Hill Brook, just US of Flood Road crossing, Marlborough.	4.82	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4709-00_01	Pine Brook (Haddam/East Hampton)-01	Mouth at confluence Salmon River DS Route 151 crossing, Haddam, US to confluence Pocotopaug Creek US Upper Pine Brook Road crossing, East Hampton.	3.18	Fully Supporting	Not Assessed
CT4709-00_02	Pine Brook (East Hampton)-02	Confluence Pocotopaug Creek DS Whippoorwill Hollow Road crossing, US past Route 66 crossing to HW just US of Clark Hill Road crossing, East Hampton.	4.51	Fully Supporting	Not Assessed
CT4709-04_01	Pocotopaug Creek (East Hampton)-01	Mouth at confluence Pine Brook (just US of Pine Brook crossing Upper Pine Brook Road AND east of Pine Brook Road), US to Old Chestnut Hill Road crossing, East Hampton.	1.74	Fully Supporting	Not Assessed
CT4709-04_02	Pocotopaug Creek (East Hampton)-02	Old Chestnut Hill Road crossing, US to Pocotopaug Lake outlet dam (just US of Route 66 crossing), East Hampton.	2.66	Not Supporting	Not Assessed
CT4709-05_01	Muddy Gutter Brook (East Hampton)-01	Mouth at confluence Pocotopaug Creek just DS of Route 16 crossing, US to HW near Saffron Lane (west side) and Christopher Road (further away to east), East Hampton.	2.2	Fully Supporting	Not Assessed
CT4710-00_01	Moodus River (East Haddam)-01	Mouth Salmon River DS Johnsonville Rd crossing and parallel to Cove Rd, US to Moodus Reservoir outlet dam just US of Falls Bashan Rd crossing near Route 149 intersection, East Haddam. (See notes)	4.13	Fully Supporting	Not Assessed
CT4710-12_01	Unnamed tributary Moodus River 4710-12 (East Haddam)-01	Mouth at confluence Moodus River DS Leesville Road crossing (through Machimoodus State Park), US to HW at Banner Lodge Dam outlet (west of end of Pinehurst Lane and south of Cherry Swamp Road), East Haddam.	1.7	Fully Supporting	Not Assessed
CT4800-00_01	Eightmile River (Lyme)-01	From mouth at Connecticut River, Hamburg Cove (part of Connecticut River tidal area), US to headwaters at Peck Meadow Pond outlet dam.	12.22	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT4800-01_01	Early Brook (East Haddam/Colchester)-01	Confluence with Eightmile River, near Salem Road, East Haddam, US to HW, just US of Alfred Drive crossing, Colchester	3.55	Fully Supporting	Fully Supporting
CT4800-06_01	Muddy Brook (East Haddam)-01	Mouth on Eightmile River, DS of Devils Hopyard Road crossing, US to outlet of Will Cone Pond, just US of Tater Hill Road crossing, East Haddam.	1.24	Fully Supporting	Not Assessed
CT4800-08_01	Burnhams Brook (East Haddam)-01	Confluence with Eightmile River, near Devils Hopyard Road, US to HW, US of Baker Road crossing, East Haddam.	2.52	Fully Supporting	Not Assessed
CT4800-15_01	Tributary-Eightmile River (Lyme)-01	From mouth at west side of Eightmile River, just US of Macintosh Road crossing, US to headwaters, Lyme.	2.23	Fully Supporting	Not Assessed
CT4801-00_01	Harris Brook (Salem)-01	From mouth at East Branch Eightmile River (just DS of Old Farm Road crossing), US to Salter Farm Pond outlet dam on Byron Clark Pond (just US of Salter Road crossing), Salem.	1.19	Fully Supporting	Not Assessed
CT4802-00_01	Eightmile River, East Branch (Salem)-01	From mouth at Eight Mile River (DS of Route 156 crossing), Lyme, US to headwaters at Major Kennys Pond (just US of Witch Meadow Road crossing), Salem.	8.03	Fully Supporting	Not Assessed
CT4803-00_01	Beaver Brook (Lyme)-01	From mouth at Eightmile River, along west side of Route 156, US to confluence with Cedar Pond Brook, Lyme.	1.86	Fully Supporting	Not Assessed
CT4803-01_01	Cedar Pond Brook (Lyme)-01	Mouth on Beaver Brook, DS of Beaver Brook Road crossing, US to Cedar Lake outlet, US of Beaver Brook Road crossing, Lyme.	1.74	Fully Supporting	Not Assessed
CT5000-55_01	Unnamed trib to Oyster River (Milford)-01	From Merwin Avenue crossing, US to Railroad (Amtrak) crossing (just US of Quirks Pond (included in segment)), Milford.	1.47	Not Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT5000-55_02	Unnamed trib to Oyster River (Milford)-02	From Railroad (Amtrak) crossing (just US of Quirks Pond), US to headwaters (inlet to unnamed swamp), just US of Cascade Boulevard (entrance to Light Sources Inc.), Milford.	0.43	Not Supporting	Not Assessed
CT5102-02_02	Spring Lot Brook (Westbrook)-02	Unnamed dirt access road crossing (off Dewolfe (McVeagh) Road) behind Westbrook High, US to OUTLET of Vincent Pond (1/2 US of Fishing Brook Road crossing) Westbrook.	0.92	Fully Supporting	Not Assessed
CT5103-00_01	Menunketesuck River-01	From inlet to Chapman Pond (just DS of Pleasant Valley Road crossing), Westbrook, US to Lockwood Lake outlet dam on Bushy Pond (just US of Woods Lane crossing), Clinton.	2.03	Fully Supporting	Not Assessed
CT5103-00_02	Menunketesuck River-02	From Bushy Pond inlet (just DS of Kelseytown Road crossing), Clinton, US to Kelseytown Reservoir outlet dam (just US of Kelseytown Bridge Road crossing), Clinton-Killingworth border.	1.78	Not Supporting	Not Assessed
CT5103-00_03	Menunketesuck River-03	From Kelseytown Reservoir inlet (northeast corner), Clinton-Killingworth border, US to North Roast Meat Hill Road crossing (just US of Route 148 crossing), Killingworth.	5.17	Fully Supporting	Not Assessed
CT5103-01_01	Heft Brook (Killingworth/Haddam)-01	Mouth at confluence with Menunketesuck River, just DS of Menunketesuck River Roast Meat Hill Road crossing (near Cockaponset State Forest) Killingworth, US to HW parallel to Perker Hill Road, just over the Haddam town line, Haddam.	4.09	Fully Supporting	Not Assessed
CT5105-00_01	Chatfield Hollow Brook (Killingworth)-01	Mouth at confluence Hammonasset River (DS of River Road crossing), US to Deer Lake outlet Dam, Killingworth.	1.03	Fully Supporting	Not Supporting
CT5105-00_04	Chatfield Hollow Brook (Killingworth)-04	Schreeder Pond inlet, parallel to Buck Road, US to confluence with Pond Meadow Brook (just DS of Old Mill Pond), Killingworth.	0.53	Not Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT5105-01_01	Pond Meadow Brook-01	Mouth at confluence Chatfield Hollow Brook (just DS of Old Mill Pond outlet dam on Chatfield Hollow Brook, in Chatfield Hollow State Park), US to Kroupa Pond outlet dam (just US of Route 148 crossing), Killingworth.	0.7	Fully Supporting	Not Assessed
CT5106-00_01	Hammonasset River-01	From saltwater limit at DS most portion of I95 crossing, Madison/Clinton town border, US to Hammonassett Reservoir outlet dam (just US of Route 80 crossing), Killingworth/Madison town border.	8.07	Fully Supporting	Not Assessed
CT5107-00_01	Neck River-01	From head of tide (marsh exit, parallel to Neck Road, DS of Route 1 crossing), US to headwaters (just northeast of Roure 80 and Route 79 rotary intersection, and south of aqueduct), Madison.	9.49	Not Assessed	Not Supporting
CT5108-00_01	East River (Guilford)-01	From Platner Dam (just US of Foot Bridge Road crossing, head of tide), US to 2nd unnamed tributary (below lakes), Guilford.	0.67	Not Assessed	Not Supporting
CT5108-05_01	Dowd Hollow Brook (Madison)-01	Confluence with Iron Stream, DS of Route 80 crossing, US to Race Hill Road crossing, Madison.	1.13	Fully Supporting	Not Assessed
CT5108-05_02	Dowd Hollow Brook (Madison)-02	Race Hill Road crossing, US to water company diversion pipe, Madison.	1.59	Fully Supporting	Not Assessed
CT5110-00_02	West River (Guilford)-02	From confluence with unnamed tributary from Thirsty Lake outlet (just DS of Flat Meadow Road crossing), US to confluence with Branch Brook (just US of Race Hill Road crossing, parallel with Route 77), DS of lake Quonnipaug outlet dam, Guilford.	5.41	Fully Supporting	Not Assessed
CT5110-01_02	Branch Brook (Guilford)-02	Inlet to Lake Menunatuck DS Great Hill Road crossing, US to HW US Beaver Head Rd crossing and west of unnamed subdivision Rd (includes Bartlett Pond), Guilford.	2.31	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT5111-00_02	Branford River-02	From confluence with Notch Hill Brook (US of School Ground Road crossing), Branford, US to Lake Gaillard outlet dam (southeast portion of lake), North Branford.	3.07	Not Supporting	Not Assessed
CT5112-00_01	Farm River (East Haven)-01	Saltwater limit at marsh, just DS of Main Street Anx. crossing, southwest of Lake Saltonstall outflow, East Haven, US parallel to lake around west side to confluence Burrs Brook parallel along Route 80 and DS of crossing), North Branford.	6.14	Not Supporting	Not Supporting
CT5112-00_02	Farm River (North Branford)-02	Confluence Burrs Brook just DS of Route 80 crossing, US to Pages Mill Pond outlet dam, US side of Mill Road crossing, North Branford.	1.24	Not Supporting	Not Supporting
CT5112-00_03b	Farm River (North Branford)-03b	Gulf Brook to HW just US of Hyla Lane crossing, and parallel to Route 17 (Middletown Avenue), North Branford. (Site15018)	4.87	Not Supporting	Not Assessed
CT5112-05_01	Gulf Brook (North Branford)-01	Mouth at confluence with Farm River, along Route 22 just south of the intersection of Route 22 and Route 17, US to HW just south of Reeds Gap Road (near Guilford town line, and Lanes Pond area), North Branford.	3.42	Not Supporting	Not Assessed
CT5112-10_01	Burrs Brook-01	From mouth at confluence with Farm River (just DS of Totoket Road crossing), US to Vic's Pond (on Tomasso property) outlet (part of hyro missing from NHD). Brook contributes to drinking water supply, Lake Saltonstall.	1.35	Not Supporting	Not Assessed
CT5200-00_01	Quinnipiac River (North Haven/Wallingford)-01	Sackett Point Road crossing (west of I91, and east of Route 15), North Haven, US to Toelles Road crossing (head of tide), Wallingford/North Haven town border.	5.05	Not Supporting	Not Supporting
CT5200-00_02	Quinnipiac River (North Haven/Meriden)-02	Toelles Road crossing (head of tide, just east Route 15), Wallingford/North Haven town border, US to Hanover Pond outlet dam, Meriden. (Segment includes Community Lake portion)	8.5	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT5200-00_03	Quinnipiac River-03	Hanover Pond inlet (at Oregon Road crossing, DS end of Quinnipiac Gorge), Meriden, US (through Gorge) to Waterworks (breached dam), just DS Cheshire/Meriden town border (parallel to River Road (Route 70)).	1.29	Not Supporting	Not Supporting
CT5200-00_04	Quinnipiac River-04	From Waterworks (breached dam), just DS of Cheshire/Meriden town border (parallel to River Road (Route 70)), US to confluence with Tenmile River (US of Route 322 crossing, and US of Southington WPCF).	4.78	Not Supporting	Not Supporting
CT5200-00_05	Quinnipiac River-05	From confluence with Tenmile River (US of Route 322 crossing, and US of Southington WPCF), US to Queen Street (Route 10) crossing (US of Railroad crossing, North of I-84 crossing), Southington.	8.32	Not Supporting	Not Assessed
CT5200-00_06	Quinnipiac River-06	From Queen Street (Route 10) crossing (US of Railroad crossing, North of I-84 crossing), Southington, US to Hamlin Pond outlet dam (US of Pine Street crossing), Plainville.	3	Not Supporting	Not Supporting
CT5200-00_07	Quinnipiac River-07	From Hamlin Pond inlet (northeast corner, just south of Route 72 and I84 connection and Railroad), Plainville, US to headwaters at Dead Wood Swamp (west side of I84, near exit 37, just south of Route 6), Farmington.	3.5	Not Supporting	Not Supporting
CT5200-02_01	Patton Brook-01	From mouth at confluence with Quinnipiac River (just DS of River Road crossing), US to headwaters at unnamed pond (US of confluence with Mill Pond tributary, just US of Malcein Drive crossing), Southington.	2.84	Not Supporting	Not Assessed
CT5200-07_01	Honeypot Brook-01	Mouth at confluence with Quinnipiac River, (US of Blacks Road crossing), US to headwaters, US of Wiese Road crossing (near Route 70), Cheshire.	4.95	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT5200-10_01	Meetinghouse Brook (Wallingford)-01	Mouth on Quinnipiac River, at Route 68 crossing, US to confluence with Spruce Glen Brook, parallel to Route 15, Wallingford.	1.15	Not Supporting	Not Assessed
CT5200-23_01	Hemingway Creek-01	From saltwater limit (200m DS of Quinipiac Avenue crossing, just DS of Railroad crossing), New Haven, US to Golf Pond outlet dam, East Haven.	0.74	Not Supporting	Not Assessed
CT5201-00_01	Eightmile River (Southington)-01	From mouth at confluence with Quinnipiac River (DS of West Main Street crossing and just DS of Railroad crossing), US to Grannis Pond outlet dam (just US of Churchhill Street crossing), Southington.	3.39	Fully Supporting	Insufficient Information
CT5202-00_01	Tenmile River (Southington/Cheshire)-01	From mouth at confluence with Quinnipiac River (DS of Old Turnpike Road crossing), Southington, US to Lake Percivel outlet dam on Moss Farms Pond (just US of Jarvis Street crossing), Cheshire.	4.1	Not Supporting	Not Assessed
CT5202-00_02	Tenmile River (Cheshire)-02	From inlet to Moss Farms Pond (on southwest end), US to headwaters at Mixville Pond outlet dam (just US of Notch Road crossing), Cheshire.	1.42	Fully Supporting	Not Assessed
CT5203-00_01	Misery Brook (Southington)-01	Mouth Quinnipiac River (just DS Meriden Waterbury Turnpike (Route 322) crossing), Cheshire/Southington border, US to Slopers Pond outlet dam (just US East Street crossing), Southington.	4.23	Not Supporting	Not Supporting
CT5205-00_01	Sodom Brook-01	From mouth at confluence with Quinnipiac River (flows into north side of Hanover Pond portion of river), US to headwaters (just US of second Hicks Avenue crossing, due to river changing direction), Meriden.	4.16	Not Supporting	Not Supporting
CT5206-00_01	Harbor Brook (Meriden)-01	From mouth at confluence with Quinnipiac River (flows into north side of Hanover Pond portion of river, DS of Bradley Avenue crossing), US to exit of box culvert (just DS of Railroad and Main Street (Route 71) crossings), Meriden.	2.02	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT5206-00_02	Harbor Brook (Meriden)-02	From exit of box culvert (just DS of Railroad and Main Street (Route 71) crossings), US to culvert entrance (just US of Fire Station, and US of Mill Street crossing), Meriden.	0.4	Not Supporting	Not Supporting
CT5206-00_03	Harbor Brook (Meriden)-03	From culvert entrance (just US of Fire Station, and US of Mill Street crossing), US to Baldwins Pond outlet dam (just US of Westfield Road crossing), Meriden.	1.48	Not Supporting	Not Assessed
CT5206-01_01	Spoon Shop Brook (Meriden)-01	Mouth at confluence with Harbor Brook near Orchid Road and Meadow Brook Road, to east of Route 15, US under I91 and I691 to confluence with North Branch Spoon Shop Brook, US of Tumblebrook Road crossing, near exit 12 off I691, Meriden.	1.49	Not Assessed	Not Supporting
CT5206-02_01	Willow Brook (Meriden)-01	Mouth on Spoon Shop Brook between Route 15 (Wilbur Cross) and Orchid Road, US to HW at OUTLET of Bishops Pond just US of Research Pkwy crossing and parallel to I91, Meriden.	2.87	Not Supporting	Not Assessed
CT5207-00_01	Wharton Brook-01	From mouth at confluence with Quinnipiac River (DS of Route 5 and Railroad crossing), Wallingford/North Haven town borders, US to Simpson Pond outlet dam (US of Center Street (Route 150) crossing), Wallingford.	3.97	Not Supporting	Not Assessed
CT5207-00_02	Wharton Brook-02	From inlet to Simpson Pond, US to North Farms Reservoir outlet dam (just US of Church Street (Route 68) crossing), Wallingford.	2.94	Not Supporting	Not Assessed
CT5207-01_01	Unnamed Tributary to Wharton Brook (Wallingford)-01	Mouth at confluence with Wharton Brook, just DS of Reskin Drive crossing (off of Pond Hill Road), US to confluence with another unnamed trib, just US of Route 150 crossing and between Airline Road and I91, Wallingford.	1.8	Not Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT5207-02_01	Allen Brook (Wallingford/North Haven)-01	Mouth confluence Wharton Brook (east of Route 5, south exit 13 on/off ramp, I91), US to Allen Brook Pond outlet dam, Wallingford/North Haven town line.	0.05	Not Assessed	Not Supporting
CT5207-02_02	Allen Brook (Wallingford)-02	Inlet to Allen Brook Pond in Wharton Brook State Park which includes swimming area (south exit 13 on/off ramp, I91), Wallingford/North Haven town border, US to HW (under I91, parallel along east side of I91 and west side RR track), Wallingford.	1.8	Not Assessed	Not Supporting
CT5208-00_02a	Muddy River (North Haven)-02a	Muddy River Pond inlet (east side of I91), North Haven, US to confluence with unnnamed tributary (outlet for Tamarac Swamp), just DS of Tyler Mill Road crossing, Wallingford.	8.1	Not Supporting	Not Supporting
CT5208-00_02b	Muddy River (Wallingford)-02b	From confluence with unnnamed tributary (outlet for Tamarac Swamp), just DS of Tyler Mill Road crossing, Wallingford, US to MacKenzie Reservoir outlet dam (US of Northford Road crossing), Wallingford.	1.81	Not Supporting	Not Assessed
CT5301-00_01	Willow Brook (Hamden)-01	From mouth at confluence with Mill River (DS of Willow Street crossing), Hamden, US to confluence with Brooksvale Stream (DS of South Brooksvale Road crossing), Cheshire. (River travels along RR track)	1.87	Not Assessed	Not Supporting
CT5301-02_01	Sanford Brook (Cheshire)-01	From mouth at confluence with Willow Brook (DS of South Brooksvale Road crossing), Cheshire, US to HW (just US of Candee Road crossing), Prospect.	2.68	Fully Supporting	Fully Supporting
CT5302-00_01	Mill River (Hamden)-01	From Footbridge off of Park Road (US extent of saltwater influence), US to Lake Whitney outlet dam, Hamden. (Segment is tidally affected, but not saltwater).	0.41	Fully Supporting	Fully Supporting
CT5302-00_02	Mill River (Hamden/Cheshire)-02	From inlet to Lake Whitney (east side of Route 15, just DS of Connolly Parkway crossing), Hamden, US to Cook Hill Road crossing, Cheshire.	9.06	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT5302-00_03	Mill River (Cheshire)-03	From Cook Hill Road crossing, Cheshire, US to headwaters (US of Williamsburg Drive crossing).	3.09	Not Supporting	Insufficient Information
CT5302-06_01	Shepard Brook (Hamden)-01	Mouth at confluence with Mill River just DS of Route 15 crossing, US (includes Turners Pond) to confluence with unnamed tributary behind business park off Sherman Avenue on west and Town Walk Drive on East (above ponded area at Sherman Lane), Hamden.	1.78	Not Assessed	Not Supporting
CT5303-00_01	Sargent River-01	From mouth at confluence with West River (DS of Route 69 crossing) at inlet to Lake Dawson, Woodbridge, US to headwaters at Munson Road Pond outlet dam, Bethany (EXCLUDING Lake Glen and Lake Chamberlain).	3.96	Fully Supporting	Not Assessed
CT5304-00_01	Wintergreen Brook (New Haven)-01	Mouth on West River, DS of Blake Street crossing, US to confluence with Wilmot Brook, US of Wilmot Road crossing, New Haven.	1.42	Not Assessed	Not Supporting
CT5304-00_03	Wintergreen Brook (New Haven)-03	Confluence with Belden Brook, US of Brookside Avenue crossing, New Haven, US to Lake Wintergreen outlet, US of Wintergreen Avenue crossing (near Route 15), Hamden.	1.22	Fully Supporting	Not Assessed
CT5305-00_01	West River (New Haven/Woodbridge)-01	Chapel Street crossing (just DS of Edgewood Park Pond), New Haven, US to Konolds Pond outlet dam (just US of Bradley Road crossing), Woodbridge.	3.23	Not Supporting	Not Supporting
CT5306-00_02	Indian River (Orange)-02	Route 1 crossing, US to HW, just US of Route 34 crossing, Orange.	3.27	Fully Supporting	Not Supporting
CT5306-01_01	Silver Brook (Orange)-01	From mouth at confluence with Indian River (just US of Indian Lake, parallel to Indian River Road), US to confluence with Trout Brook (just US of Smith Farm Road crossing), Orange.	1.6	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT5306-01_02	Silver Brook (Orange)-02	From confluence with Trout Brook (just US of Smith Farm Road crossing), US to HW (west side of Dogburn Road, near Woodbridge town line), Orange.	3.1	Not Assessed	Not Supporting
CT5307-00_01	Wepawaug River-01	From Wepawaug Pond outlet dam (head of tide) at New Haven Avenue (Route 162) crossing, US to Route 1 crossing, Milford. Segment includes Wepawaug Pond and City Pond portions on river.	0.77	Not Assessed	Not Supporting
CT5307-00_02	Wepawaug River-02	From Route 1 crossing, Milford, US to Lake Wepawaug inlet, Orange. Segment includes Lake Wepawaug portion on river.	4.2	Insufficient Information	Not Supporting
CT5307-00_03	Wepawaug River-03	From inlet to Lake Wepawaug, US to inlet to Wepawaug Reservoir (US of Route 34 crossing), Orange. Segment includes Wepawaug Reservoir portion of river.	2.33	Fully Supporting	Not Supporting
CT5307-00_04	Wepawaug River-04	From inlet to Wepawaug Reservoir, Orange, US to area east of Racebrook Road (Route 114), perpendicular to Milan Road, Woodbridge.	3.05	Fully Supporting	Not Supporting
CT5307-00_05	Wepawaug River-05	From area east of Racebrook Road (Route 114), perpendicular to Milan Road, US to headwaters at Center Street Pond outlet dam (on Keenes Ice Pond), just US of Center Road (Route 14) crossing, Woodbridge,	0.99	Not Assessed	Not Supporting
CT5307-04_01	Race Brook-01	From mouth at confluence with Wepawaug River near Mulberry Lane (about .5 miles DS of Route 152 crossing) Orange, US to headwaters, just US of Route 114 crossing, Woodbridge.	5.81	Not Supporting	Insufficient Information
CT6000-00_01	Housatonic River (Orange/Shelton/Derby)-01	From end of saltwater influence, at southern most portion of Wooster Island, Orange, US to confluence with Naugatuck River, Shelton/Derby town border.	3.17	Not Assessed	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6000-00_02	Housatonic River (Shelton/Derby)-02	Confluence with Naugatuck River, US to Lake Housatonic outlet dam (Derby Dam), Shelton/Derby town border (Between segment 02 and 03, are Lake Housatonic, Lake Zoar, and Lake Lillinonah, all independent waterbodies).	1.5	Not Assessed	Not Supporting
CT6000-00_03	Housatonic River (New Milford/Bridgewater)-03	Inlet Lake Lillinonah (Northwestern most portion, DS Lovers Leap Road crossing), confluence Town Farm Brook, New Milford/Bridgewater town border, US to Boardman Road crossing (between Route 7 and Railroad tracks), New Milford.	5.09	Insufficient Information	Fully Supporting
CT6000-00_04	Housatonic River-04	From Boardman Road crossing (between Route 7 and Railroad tracks), New Milford, US to Bull Bridge outlet dam (US of Bulls Bridge Road crossing, west side of Route 7), Kent.	8.05	Fully Supporting	Not Supporting
CT6000-00_06	Housatonic River-06	From confluence with Mauwee Brook (between River Road on west side, and Railroad tracks on east), Kent, US to Great Falls outlet dam, Salisbury/Canaan (Amesville) town border. (Segment follows river channel, not concrete passage from dam).	18.23	Fully Supporting	Not Supporting
CT6000-12_01	Hatch Brook-01	From mouth at confluence with Housatonic River (just DS of Route 7 crossing), US to headwaters (just US of East Street crossing), Sharon.	2.73	Fully Supporting	Not Assessed
CT6000-13_01	Bonney Brook (Cornwall)-01	Mouth at confluence Housatonic River DS Route 7 and RR crossings, US (through Wyantenock State Forest) to HW to east near end of Prichard Road, Cornwall.	2.8	Fully Supporting	Not Assessed
CT6000-14_01	Gunn Brook (Cornwall)-01	Mouth at confluence Housatonic River (DS of RR crossing on north side of Swifts Bridge Road), Sharon/Cornwall town border, US to headwaters (marsh US of Prichard Road crossing, above Spruce dam), Cornwall.	3.58	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6000-16-trib_01	Unnamed tributary to Deep Brook (Kent)-01	Mouth confluence Deep Brook DS Dungan Rd crossing, US to HW US Dugan Rd crossing, Kent.	0.64	Fully Supporting	Not Assessed
CT6000-17_01	Stony Brook (Kent)-01	Mouth on Housatonic River, Kent, US to HW just US of Modley Road crossing, Sharon.	2.57	Fully Supporting	Not Assessed
CT6000-35_01	Cross Brook (New Milford)-01	Mouth at confluence with Great Brook, just DS of Crossbrook Road crossing near Weatinock Drive, US (includes New Milford Res#3) to HW near Heritage Drive and Round Table Road, New Milford.	2.36	Not Assessed	Fully Supporting
CT6000-37_01	Town Farm Brook (New Milford)-01	From mouth at confluence with Housatonic River (Lake Lillinonah, segment CT6000-00+L1_01) just DS of Lake Lillinonah Road crossing, US to HW above New Milford Reservoir Number 4, New Milford.	4.57	Fully Supporting	Not Assessed
CT6000-38_01	Clapboard Oak Brook (Bridgewater)-01	Mouth at confluence with Lake Lillinonah (Housatonic River) just DS of Lake Lillinonah Rd crossing, US to HW at marsh outlet just US of Route 133 (Main St) crossing, Bridgewater.	2.3	Fully Supporting	Not Assessed
CT6000-41_01	Hitchcock Mill Brook (Bridgewater)-01	Mouth at confluence with Lake Lillinonah portion of Housatonic River near end of Benson Road, US through Sunny Valley Foundation land to HW at Shurick Dam outlet, US of Christian Street crossing (in South Cemetery), Bridgewater.	1.5	Fully Supporting	Not Assessed
CT6000-42_01	Hop Brook (Brookfield)-01	From mouth at confluence with Housatonic River (Lake Lillinonah), US to Long Meadow Hill Road crossing, Brookfield.	1.49	Fully Supporting	Not Assessed
CT6000-45_01	Wewaka Brook (Bridgewater)-01	Mouth at confluence with Housatonic River (Lake Lillinonah) just DS of Route 133 crossing, US along Route 133 to outlet of Cider Millpond (dam washed out), Bridgewater.	0.64	Fully Supporting	Not Assessed
CT6000-45_02	Wewaka Brook (Bridgewater)-02	Along Route 133 where outlet of Cider Millpond was (dam washed out), US to HW between Millvoe Drive and Canfield Drive (runs parallel to Hut Hill Road), Bridgewater.	3.14	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6000-48_01	Purchase Brook (Southbury)-01	Mouth at INLET to Lake Lillinonah portion of Housatonic River, DS of Purchase Brook Road crossing and parallel to Little York Road, US (includes Housatonic Farm Pond) to confluence with first unnamed tributary at Flat Road crossing, Southbury.	0.85	Insufficient Information	Fully Supporting
CT6000-56_01	Lee Brook-01	From mouth at confluence with Housatonic River (Lake Zoar portion, near Lee Farm Drive), US to headwaters (US of Georges Hill Road crossing), Southbury.	1.91	Fully Supporting	Not Assessed
CT6000-62_01a	Fivemile Brook (Oxford)-01a	From mouth at confluence with Housatonic River (Lake Housatonic portion, DS of Route 34 crossing), US to confluence with unnamed tributary (parallel to Old Country Road and DS of Route 188 crossing), Oxford.	1.43	Fully Supporting	Not Assessed
CT6000-64_01	Fourmile River (Seymour)-01	From mouth at Housatonic River (Lake Housatonic) DS of Route 34 crossing, US to Great Hill Reservoir outlet dam (parallel with Route 188), Seymour.	1	Fully Supporting	Not Assessed
CT6000-73_01	Curtiss Brook (Shelton)-01	Mouth at confluence with Housatonic River, DS Route 110 and Railroad crossings, US to OUTLET of Shelton Res #2, parallel to Route 108, Shelton.	0.8	Not Assessed	Not Supporting
CT6000-77_01	Twomile Brook (Derby/Orange)-01	Mouth on Housatonic River, DS of Derby Milford Road crossing, Derby/Orange town line, US to HW near Osborne Lane, Ansonia.	5.67	Not Supporting	Not Assessed
CT6001-00_01	Sages Ravine Brook-01	from mouth at confluence with Schenob Brook, US to Under Mountain Road (Route 41) crossing, Salisbury.	0.66	Fully Supporting	Not Assessed
CT6001-00_02	Sages Ravine Brook-02	From Under Mountain Road (Route 41) crossing, Salisbury, US to Massachusetts state border, Salisbury.	0.68	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6005-00_01	Factory Brook-01	From mouth at confluence with Spruce Swamp Creek (headwaters of Salmon Creek), US to Salisbury WPCF discharge (just DS of confluence with Burton Brook), Salisbury.	1.7	Fully Supporting	Not Assessed
CT6005-00_02	Factory Brook-02	From Salisbury WPCF discharge (just DS of confluence with Burton Brook), US to headwaters at Wonoskopomuc Lake outlet dam (just US of Ethan Allen Street crossing, US of Factory Pond, included in segment), Salisbury.	1.1	Fully Supporting	Insufficient Information
CT6005-01_01	Burton Brook (Salisbury)-01	Mouth at confluence with Factory Brook, .3 miles DS of Walton Street crossing, US to confluence with McDuffee Brook, US of Covered Bridge Road in wood area between Moore Road and Upland Meadow Road, Salisbury.	2.09	Not Supporting	Fully Supporting
CT6005-04_01	Wachocastinook Creek (Salisbury)-01	Mouth at confluence Factory Brook DS Route 41 crossing, US to HW South Pond outlet dam, just US Mount Rd crossing (runs parallel along Mount Riga Rd), Salisbury.	4.5	Fully Supporting	Not Assessed
CT6006-00_01	Spruce Swamp Creek-01	From mouth at confluence with Factory Brook (headwaters of Salmon Creek), US to headwaters at confluence of Garnett Brook and Moore Brook (US of Route 44 crossing, parallel with Railroad tracks), Salisbury.	1.93	Fully Supporting	Not Assessed
CT6007-00_01	Salmon Creek (Salisbury)-01	From mouth at confluence with Housatonic River (DS of Lime Rock Road (Route 112) crossing), Canaan/Salisbury town border, US to headwaters, at the confluence of Factory Brook and Spruce Swamp Creek, Salisbury.	6.95	Fully Supporting	Not Assessed
CT6008-00_01	Mill Brook (Cornwall)-01	From mouth at confluence with Housatonic River (just DS of Lower River Road crossing), Sharon/Cornwall town border, US to confluence with Heffers Brook (just US of Sharon Goshen Turnpike (Route 128) crossing), Cornwall.	1.63	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6008-00_02a	Mill Brook (Cornwall)-02a	From confluence with Heffers Brook (just US of Sharon Goshen Turnpike (Route 128) crossing), US to Rattlesnake Road crossing, Cornwall.	1.21	Fully Supporting	Not Assessed
CT6008-00_02b	Mill Brook (Cornwall)-02b	From Rattlesnake Road crossing, US to Headwaters at Cream Hill Lake outlet dam (US of Town Street crossing), Cornwall.	1.01	Not Supporting	Not Assessed
CT6009-00_01	Carse Brook (Sharon)-01	From mouth at confluence with Housatonic River (DS Route 7 crossing), US to headwaters (US of West Cornwall Road crossing), Sharon.	4.67	Fully Supporting	Not Assessed
CT6010-00_01	Furnace Brook (Cornwall)-01	From mouth at confluence with Housatonic River (just DS of Popple Swamp Road crossing) Sharon/Cornwall town border, US to headwaters at confluence of Valley Brook and Birdseye Brook (parallel to Valley Road), Cornwall.	3.98	Fully Supporting	Not Assessed
CT6011-00_01	Guinea Brook (Sharon)-01	Mouth at confluence Housatonic River (DS of River Road crossing), Cornwall/Sharon town border, US to headwaters (US of Westwood 2 Road crossing), Sharon.	5.04	Fully Supporting	Not Assessed
CT6011-00-trib_01	Unnamed tributary Guinea Brook (Sharon)-01	Mouth at confluence Guinea Brook DS crossing West Woods Road 2, US to HW US West Woods Road 2 (brook past pond inflow), Sharon.	0.9	Fully Supporting	Not Assessed
CT6012-00_01	Kent Falls Brook (Kent)-01	Mouth at confluence Housatonic River (just DS of Route 7 crossing), US to Carter Road crossing, Kent.	1.16	Fully Supporting	Not Assessed
CT6013-00_01	Cobble Brook-01	From mouth at confluence with Housatonic River (east bank, just DS of Railroad crossing), US to headwaters (US of Segar Mountain Road (Route 341) crossing), Kent.	3.71	Fully Supporting	Not Assessed
CT6014-00_01	Bog Hollow Brook (Kent)-01	Mouth at confluence with Macedonia Brook just DS of Route 341 crossing, US to confluence with first unnamed tributary .13 miles US of Route 341 crossing, Kent.	0.27	Not Assessed	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6015-00_02	Macedonia Brook-02	From Macedonia Road (Route 341) crossing, US to confluence with Pond Mountain Brook (US of Fuller Mountain Road crossing, along east side of Macedonia Brook Road), Kent.	2.31	Fully Supporting	Not Assessed
CT6015-00_03	Macedonia Brook-03	From confluence with Pond Mountain Brook (US of Fuller Mountain Road crossing, along east side of Macedonia Brook Road), US to confluence with unnamed tributary, outlet stream for Hilltop Pond (near Appalachian Trail), Kent.	2.62	Fully Supporting	Not Assessed
CT6015-01_01	Pond Mountain Brook (Kent)-01	Mouth confluence Macedonia Brook DS Fuller Mountain Rd crossing, US to HW US Skiff Mountain Rd crossing (west of Marvelwood School), Kent.	4.04	Fully Supporting	Not Assessed
CT6016-00_03	Womenshenuck Brook (Kent)-03	Lenard Pond inlet just DS Lenard Pond Rd crossing, US to HW at Kent Reservoir outlet dam (east side Route 341), Kent.	1.13	Fully Supporting	Not Assessed
CT6016-03_02	Bull Mountain Brook-02	From Mud Pond inlet (northeastern portion, DS of Camps Flat Road crossing), New Milford, US to headwaters at Geer Mountain Pond outlet dam (just US of Richard Road crossing, segment includes Irving Pond), Kent.	2.97	Fully Supporting	Not Assessed
CT6017-00_02	Morrissey Brook (New Milford)-02	Gaylord Road crossing, New Milford, US to Route 39 crossing, Sherman.	3.03	Fully Supporting	Not Assessed
CT6018-00_01	Pond Brook (Newtown)-01	From mouth at confluence with Lake Lillononah (just DS of Pond Brook Road crossing), US to confluence with Dingle Brook, Newtown.	0.17	Fully Supporting	Not Assessed
CT6018-00_02	Pond Brook (Newtown)-02	Confluence with Dingle Brook (near Lake Lillinonah and parallel to Pond Brook Road), US to HW at OUTLET of Taunton Lake, just US of Taunton Lake Road crossing, Newtown.	6.13	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6019-00_01	Deep Brook (Newtown)-01	Mouth at confluence Pootatuck River (south side of I84, near exit 10), US to HW at Deep Brook Pond outlet dam (parallel to Head of Meadow Road), Newtown.	5.25	Fully Supporting	Not Supporting
CT6019-00-trib_01	Unnamed tributary Deep Brook (Newtown)-01	Mouth at Deep Brook US to HW near Old Farm Rd, Newtown. Locally called Oil Creek, between Town salt storage lot and old mill.	0.07	Not Supporting	Not Assessed
CT6019-02_01	Unnamed tributary Deep Brook 6019-02 (Newtown)-01	Mouth at confluence Deep Brook DS (north) Head Of Meadow Road crossing, US (south) to HW past Head Of Meadow School, parallel to east along Shepard Hill Road (north of Sugar Hill Road intersection), Newtown.	1.6	Fully Supporting	Not Assessed
CT6020-00_01	Pootatuck River-01	From mouth at confluence with Housatonic River (west bank, DS of Walnut Tree Hill Road crossing), US to confluence with Newtown WPCF outflow (just DS of confluence with Deep Brook, US of I84 crossing), Newtown.	2.44	Fully Supporting	Not Assessed
CT6020-00_02	Pootatuck River-02	From confluence with Newtown WPCF outflow (just DS of confluence with Deep Brook, US of I84 crossing), Newtown, US to headwaters at unnamed pond (parallel to Judd Road), Easton.	8.39	Fully Supporting	Not Assessed
CT6021-00_01	Kettletown Brook (Southbury)-01	From mouth at confluence with Housatonic River (Lake Zoar), US to confluence with unnamed tributary (just US of Kettletown State Park beach access road), Southbury.	0.39	Fully Supporting	Not Assessed
CT6022-00_01	Halfway River (Newtown/Monroe)-01	Mouth on Lake Zoar portion of Housatonic River, just DS of Route 34 crossing, Newtown/Monroe town line, US to confluence with Copper Mill Brook, parallel to RR track and Hammertown Road, along Newtown/Monroe town line.	2.9	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6023-00_01	Eightmile Brook (Oxford-Middlebury)-01	From mouth at confluence with Housatonic River (Lake Housatonic portion, just DS of Roosevelt Road (Route 34) crossing), Oxford, US to headwaters at Lake Quassapaug outlet dam (US of Route 64 crossing), Middlebury.	11.78	Fully Supporting	Not Assessed
CT6024-00_02	Means Brook (Shelton)-02	From inlet to Means Brook Reservoir (just DS of Saw Mill City Road crossing), US to East Village Road crossing (NOTE: Aqueduct connects HW to Hurds Brook), Shelton.	3.2	Fully Supporting	Not Assessed
CT6025-00_02	Farmill River-02	From River Road (Route 110) crossing (Wilson Gardens Dog Pond outlet dam), Shelton/Stratford town border, US to confluence with Means Brook (US of Sycamore Drive crossing), Shelton.	3.99	Fully Supporting	Not Supporting
CT6025-00_03	Farmill River-03	From confluence with Means Brook (just DS of Huntington Street crossing), US to Far Mill (Isinglass) Reservoir outlet dam, just US of Farmill Street crossing (beginning of drinking water watershed), Shelton.	3.33	Not Supporting	Not Assessed
CT6026-03_01	Cemetery Pond Brook (Stratford/Shelton)-01	Mouth at confluence with Pumpkin Ground Brook at Circle Drive crossing, Stratford, US to HW at OUTLET of Cranberry Pond, just US of James Farm Road crossing, Shelton.	2.15	Not Assessed	Not Supporting
CT6100-00_01	Blackberry River (North Canaan)-01	From mouth at confluence with Housatonic River (at loop in river around island), US to confluence with North Canaan WPCF (near old Railroad grade, currently trail), North Canaan.	0.78	Fully Supporting	Not Assessed
CT6100-00_02a	Blackberry River (North Canaan)-02a	From confluence with North Canaan WPCF (near old Railroad grade, currently trail, DS of Route 44 crossing), US to drainage ditch at southwest boundary of Lime Quarry (parallel to Lower Road), North Canaan.	2.75	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6100-00_02b	Blackberry River (North Canaan)-02b	From drainage ditch at southwest boundary of Lime Quarry (parallel to Lower Road), US to Blast Furnace (Historical Park) at Lower Pond dam outlet on Iron Furnace Pond (perpendicular to Furnace Hill Road), North Canaan.	1.18	Fully Supporting	Not Assessed
CT6100-00_03	Blackberry River (Norfolk)-03	From Blast Furnace (Historical Park) at Lower Pond dam outlet on Iron Furnace Pond (perpendicular to Furnace Hill Road), North Canaan, US to confluence with North Brook (DS of Norfolk WPCF, south side of Route 44 at Ashpohtag Road intersection), Norfolk.	4.19	Fully Supporting	Not Assessed
CT6100-00_04	Blackberry River (Norfolk)-04	From confluence with North Brook (DS of Norfolk WPCF, south side of Route 44 at Ashpohtag Road intersection), US to Norfolk WPCF outfall (US end of site), Norfolk.	0.46	Fully Supporting	Not Assessed
CT6100-00_05	Blackberry River-05	From Norfolk WPCF outfall (DS end of site), US to headwaters at confluence of Wood Creek and Spaulding Brook (US of Blackberry Street crossing, parallel to Route 44), Norfolk.	1.03	Fully Supporting	Not Assessed
CT6100-03_01	Norfolk Brook (Norfolk)-01	Mouth at confluence with Spaulding brook DS of Mountain Road crossing (near intersection with Route 272), US to HW at OUTLET Pond Hill Pond just US of Route 44 crossing, Norfolk.	2.23	Fully Supporting	Not Assessed
CT6100-06_01	North Brook (Norfolk)-01	Mouth at confluence Blackberry River DS of Route 44 crossing, US through Haystack Mountain State Park to HW US Buckley Pond (included) to north west parallel to Bald Mountain Road, Norfolk.	2	Fully Supporting	Not Assessed
CT6101-00_01	Whiting River-01	From mouth at confluence with Blackberry River (just DS of Canaan Road (Route 44) crossing), US to College Hill Road crossing, North Canaan.	1.66	Fully Supporting	Not Assessed
CT6101-00_02	Whiting River (North Canaan)-02	From College Hill Road crossing, US to Whiting River Dam outlet, near CT state border with MA, US of Toby Hill Road crossing, North Canaan.	1.38	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6200-00_01	Hollenbeck River-01	From mouth at confluence with Housatonic River (DS of Point of Rock Road (Route 126) crossing), Canaan, US to headwaters (US of Cornwall Hollow Road (Route 43) crossing), Cornwall.	18.32	Fully Supporting	Not Supporting
CT6200-02_01	Ocain Brook (Cornwall/Goshen)-01	Mouth at confluence Hollenbeck River DS Route 63 crossing (farm area, low gradient), Cornwall, US to HW at Ocain Pond outlet dam (pond is DS Wildcat Pond on south west side of Goshen Road), Goshen.	2.8	Fully Supporting	Not Assessed
CT6200-05_01	Flat Brook (Canaan)-01	Mouth at Hollenbeck River, DS of Route 126 crossing, US to Music Mountain Road crossing, Canaan.	2.18	Fully Supporting	Not Assessed
CT6200-06_01	Whiting Brook (Canaan)-01	Mouth on Hollenbeck River, DS of Route 7 crossing, US to HW, US of Under Mountain Road crossing, Canaan.	3.62	Fully Supporting	Not Assessed
CT6201-00_01	Brown Brook (Canaan)-01	Confluence with Hollenbeck River, just DS of Route 63 crossing, US to confluence with North Branch Brown Brook, Canaan.	0.77	Fully Supporting	Not Assessed
CT6300-00_01	Tenmile River (Sherman)-01	From mouth at confluence with Housatonic River, US to New York state border, Sherman/Kent town borders.	0.62	Fully Supporting	Not Assessed
CT6302-00_02	Mill Brook (Sharon)-02	From confluence with Bebee Brook (just DS of Woods 1 road crossing), US to Hatch Pond outlet dam (just US of Mitchelltown Road crossing and confluence with Bog Meadow Brook), Sharon.	1.66	Not Assessed	Not Supporting
CT6302-01_01	Bog Meadow Brook (Sharon)-01	From mouth at confluence with Mill Brook (at Mitchell Town Road crossing), US to Ford Pond outlet dam (parallel to Route 4), Sharon.	1.13	Fully Supporting	Not Assessed
CT6302-03_01	Beebe Brook (Sharon)-01	Mouth at confluence with Mill Brook among farm fields between Route 41 and Woods Road, US parallel with Woods Road to HW at OUTLET Eastmen Pond, Sharon.	1.09	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6303-00_01	Webatuck Creek (Sharon)-01	NY border near Sharon Valley Road to NY border US Sharon Station Rd crossing (river runs into CT from NY, then back into NY), Sharon.	1.52	Fully Supporting	Not Assessed
CT6401-00_01	Sawmill Brook (Sherman)-01	From mouth at inlet to Candlewood Lake (northwest portion of lake, DS of Sawmill Road crossing), US to New York state border, Sherman.	2.38	Fully Supporting	Not Assessed
CT6402-00_01	Ball Pond Brook (New Fairfield)-01	Mouth at Lake Candlewood .2 miles DS of Bear Mountain Road crossing, US to confluence with Deep Hollow Brook, .2 miles US of Bear Hollow Road crossing, New Fairfield.	0.39	Insufficient Information	Not Supporting
CT6500-00_01	Aspetuck River (New Milford)-01	From mouth at confluence with Housatonic River (DS of Housatonic Avenue crossing), New Milford, US to headwaters at North Spectacle Pond outlet (US of Segar Mountain Road (Route 341) crossing), Kent. (Includes West Branch portion above East Branch)	15.04	Fully Supporting	Not Assessed
CT6501-00_01	Merryall Brook (New Milford/Kent)-01	Mouth at confluence Aspetuck River DS Chinmoy Lane crossing, New Milford, US to HW US Ore Hill Road crossing and close to Treasure Hill Road, Kent.	7.2	Fully Supporting	Not Assessed
CT6502-00_02	East Aspetuck River-02	From Wellsville Avenue crossing, US to Wheaton Road Crossing (near Route 202, parallel to Old Mill Road), New Milford.	5.07	Fully Supporting	Not Assessed
CT6502-01_01	Lake Waramaug Brook (Warren)-01	Mouth at Lake Waramaug (northeast portion, DS of Hopkins Road crossing), US to HW at Eel Pond outlet dam (US of Route 45 crossing and parallel to Kent Road), Warren.	5.17	Fully Supporting	Not Assessed
CT6600-00_01	Still River (New Milford/Brookfield)-01	From mouth at confluence with Housatonic River (DS of Railroad crossing), New Milford, US to Silvermine Road crossing (USGS station), Brookfield (just DS of Route 7 crossing, and DS of confluence with Charles Pickneys Brook), Brookfield.	8.48	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6600-00_02	Still River (Brookfield/Danbury)-02	Silvermine Road crossing (USGS station), Brookfield (just DS Route 7 crossing, DS confluence Charles Pickneys Brook), US to confluence Limekiln Brook (just US I84 crossing), Danbury.	6.21	Not Supporting	Not Supporting
CT6600-00_03	Still River (Danbury)-03	From confluence with Limekiln Brook (just US of I84 crossing), US to confluence with Sympaug Brook (just US of Cross Street crossing), Danbury.	2.19	Not Supporting	Not Supporting
CT6600-00_04	Still River (Danbury)-04	From confluence with Sympaug Brook (just US of Cross Street crossing), US to confluence with Padanaram Brook (just US of White Street crossing, river runs between Railroad tracks), Danbury.	1.56	Not Supporting	Not Assessed
CT6600-00_05	Still River (Danbury)-05	From confluence with Padanaram Brook (just US of White Street crossing, river runs between Railroad tracks), US to Lake Kenosia outlet (just US of Kenosia Avenue crossing), Danbury.	3.87	Not Supporting	Not Supporting
CT6600-07_01	West Brook (Brookfield/Danbury)-01	Mouth at confluence Still River DS Federal Road crossing (and west side of White Turkey Road), Brookfield, US to HW at unnamed waterbody near end of Lily Drive, Danbury. (US end passes south of a mobile home park to get to HW)	1.4	Fully Supporting	Not Assessed
CT6601-00_01	Miry Brook (Danbury)-01	From mouth at confluence with Still River (just DS of Backus Avenue crossing), Danbury, US to HW at North Ridgebury Pond outlet dam (just US of Aarons Court crossing), Ridgefield.	3.42	Not Assessed	Not Supporting
CT6602-00_01	Kohanza Brook (Danbury)-01	From mouth at confluence with Padanaram Brook (DS of North Street crossing), US to Ridgewood Country Club Pond outlet dam (adjacent to Franklin Street), Danbury.	1.14	Not Assessed	Not Supporting
CT6603-00_01	Padanaram Brook-01	From mouth at confluence with Still River (just DS of Crosby Street crossing), US to headwaters at Padanaram Reservoir outlet dam (parallel to Padanaram Road), Danbury.	3.71	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6604-00_01	Sympaug Brook-01	From mouth at confluence with Still River (DS of Shelter Rock Road crossing, parallel to Cross Street), US to Greatpasture Road (Wooster Street) crossing, Danbury.	0.6	Not Supporting	Not Supporting
CT6605-00_01	East Swamp Brook (Bethel)-01	From mouth at confluence with Limekiln Brook (DS of Shelter Rock Road crossing), US to confluence with Wolf Pit Brook (DS of Taylor Road crossing), Bethel.	2.34	Not Assessed	Not Supporting
CT6606-00_01	Limekiln Brook-01	From mouth at confluence with Still River (just US of I84 crossing), US to confluence with Danbury WPCF outfall channel (US of Newtown Road (Route 6) crossing, behind shopping plaza at pump station), Danbury.	0.45	Not Supporting	Not Supporting
CT6606-00_03	Limekiln Brook-03	From Shelter Rock Road crossing (first road crossing, above landfill), Bethel, US to headwaters (just US of Poverty Hollow Road crossing), Newtown.	6.04	Not Assessed	Not Supporting
CT6606-03_01	Dibbles Brook (Bethel)-01	Mouth at confluence with Limekiln Brook, just DS of Rockwell Road crossing (parallel to Plumtrees Road and near intersection), US to HW at unnamed pond, just US of Stony Hill Road (Route 6) crossing (runs through and above 4H center property), Bethel.	2.13	Fully Supporting	Not Assessed
CT6606-04_01	Stony Hill Brook (Danbury/Bethel)-01	Mouth at confluence Limekiln Brook .4 Mile DS of Old Sherman Turnpike crossing (south side of business area), Danbury, US under I84 Exit 8 ramp area to unnamed pond behind business off Berkshire Industrial Park Blvd, Bethel.	0.9	Fully Supporting	Not Assessed
CT6700-00_01	Shepaug River (Roxbury/Washington)-01	Mouth Housatonic River (northeast branch of Lake Lillinonah portion, just DS of Minor Bridge Road crossing), Roxbury, US to confluence Bantam River (parallel to Whittlesey Road), Washington.	17.67	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6700-00_02	Shepaug River (Washington/Litchfield/Warren)-02	Confluence Bantam River (just DS of Whittlesey Road crossing), Washington, US to Shepaug Reservoir outlet dam (US of Valley Road crossing), along Litchfield/Warren town border.	3.51	Fully Supporting	Fully Supporting
CT6700-01_01	East Branch Shepaug River (Litchfield/Goshen/Cornwall)-01	Mouth at inlet to Shepaug Reservoir (open space) 2 Miles west of intersection Headquarters Road and Dugway Road (Dugway Road is dirt road along river), Litchfield, US through Mowhawk State Forest, Goshen, US to HW near Route 4 in MSF, Cornwall.	10.4	Fully Supporting	Not Assessed
CT6700-11_01	Bee Brook (Washington)-01	From mouth at confluence with Shepaug River (near Bee Brook Road (Route 47) crossing of Shepaug River), US to Litchfield Turnpike (Route 202) crossing (near intersection of Route 47 and Route 202), Washington.	2.21	Fully Supporting	Not Assessed
CT6700-13_01	Unnamed tributary Shepaug River 6700-13 (Washington)-01	Mouth at confluence Shepaug River (west, along Route 109 Route 47 area), US to HW at small unnamed pond (near farm road to fields) on US side of Calhoun Street crossing, Washington.	2.13	Fully Supporting	Not Assessed
CT6700-14_01	Mallory Brook (Washington)-01	Mouth at confluence with Shepaug River just DS of Wyant Rd crossing (near Route 109 and Route 47 intersection), US along Route 109 to HW at Rainer Pond outlet, just US of Nettleton Hollow Rd crossing, Washington.	3.4	Fully Supporting	Not Assessed
CT6700-15_01	Unnamed tributary Shepaug River 6700-15 (Washington)-01	Mouth at confluence Shepaug River just DS of River Road crossing, US to HW in farm fields along east side of Popple Swamp Road, Washington.	2.18	Fully Supporting	Not Assessed
CT6700-17_01	Kirby Brook (Washington)-01	Mouth at confluence with Shepaug River, just DS of Tunnel Rd crossing, US to HW at outlet of Miller Pond, US of Route 47 crossing, Washington.	1.6	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6700-20_01	Walker Brook (Roxbury/Washington)-01	Mouth at confluence with Shepaug River .4 miles DS from intersection of Hartwell Road, Shinar Mountain Road and Walker Brook Road crossing, US to confluence with first unnamed tributary (from west side) along and parallel to Walker Brook Road, Washington.	0.64	Not Assessed	Not Supporting
CT6700-20_02	Walker Brook (Washington/New Milford)-02	Confluence with first unnamed tributary (from west side) along and parallel to lower portion Walker Brook Road, Washington, US to HW along and parallel to Walker Brook Road, US of Route 109 crossing, New Milford.	2.98	Fully Supporting	Not Assessed
CT6700-25_01	Battle Swamp Brook Roxbury/Washington)-01	Mouth confluence Shepaug River DS Judds Bridge Rd crossing, Roxbury, US to HW US Nichols Hill Rd crossing, Washington.	3.96	Fully Supporting	Not Assessed
CT6700-27_01	Fenn Brook (Roxbury)-01	From mouth at confluence with Shepaug River (just DS of Route 67 crossing), US to HW (parallel to Painter Hill Road), Roxbury.	2.6	Fully Supporting	Not Assessed
CT6701-00_01	Marshepaug River (Litchfield)-01	Mouth on East Branch Shepaug River, parallel to Blue Swamp Road, Litchfield, US to outlet of Woodbridge Lake, US of Milton Road crossing, Goshen.	3.19	Fully Supporting	Not Assessed
CT6703-00_01	West Branch Bantam River (Litchfield/Goshen)-01	Mouth at confluence with Bantam River on west side of Route 202 (north of baseball/soccer fields), Litchfield, US to outlet of Dog Pond, just US of Town Hill Rd crossing, Goshen.	6.4	Not Supporting	Not Assessed
CT6705-00_01	Bantam River-01	From mouth at confluence with Shepaug River (parallel with Whittlesey Road), Washington, US to confluence with Bizell Brook (just US of West Morris Road crossing), Morris.	4.53	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6705-00_04	Bantam River (Litchfield/Goshen)-04	From inlet to Bantam Lake (northeast portion, in marsh, DS of Whitehall Road crossing), Litchfield, US to headwaters (marsh US of Litchfield Reservoir, south side of Pie Hill Road, east of Route 63 intersection), Goshen.	12.02	Fully Supporting	Not Assessed
CT6705-01_01	Ivy Mountain Brook (Goshen)-01	Mouth at confluence with Bantam River at intersection of Reservoir Road and East Street, US to HW at marsh outlet US side of Hageman Shean Road crossing, Goshen.	6.35	Insufficient Information	Fully Supporting
CT6706-00_01	Jacks Brook (Roxbury)-01	Mouth at confluence with Shepaug River, DS of River Rd crossing, US to HW just US of Booth Rd crossing, Roxbury.	6	Fully Supporting	Not Assessed
CT6800-00_01	Pomperaug River-01	From mouth at confluence with Housatonic River (DS of River Road crossing, near west side of I84, exit 13), US to confluence with Transylvania Brook (south side of East Flat Hill Road), Southbury.	2.74	Fully Supporting	Not Supporting
CT6800-00_02	Pomperaug River-02	From confluence with Transylvania Brook (south side of East Flat Hill Road), US to Flood Bridge Road crossing, Southbury.	1.97	Fully Supporting	Not Assessed
CT6800-00_03	Pomperaug River-03	From Flood Bridge Road crossing, US to confluence with Bullet Hill Brook (just DS of Heritage Road crossing), Southbury. (Segment includes Heritage Village POTW discharge)	1.31	Fully Supporting	Not Supporting
CT6800-00_04	Pomperaug River-04	From confluence with Bullet Hill Brook (just DS of Heritage Road crossing), Southbury, US to headwaters at confluence of Nonewaug River and Weekeepeemee River (just DS of Washington Road (Route 47) crossing), Woodbury.	7.38	Fully Supporting	Not Assessed
CT6800-02_01	South Brook (Woodbury)-01	Confluence with Pomperaug River, US to Main Street (Route 6) crossing, Woodbury.	0.37	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6800-03_01	Stiles Brook-01	From mouth at confluence with Pomperaug River, US to Anna Stiles Pond outlet Dam (just US of Route 6 crossing), Southbury.	0.25	Not Supporting	Not Assessed
CT6800-05_01	Bullet Hill Brook (Southbury)-01	Mouth at Pomperaug River, just DS of Old Field Road crossing, US (along and under I84) to HW in Hidden Pond Park, US of Bucks Hill Road crossing, Southbury.	3.56	Fully Supporting	Not Assessed
CT6800-08_01	Unnamed tributary Pomperaug River 6800-08 (Southbury)-01	Mouth at confluence Pomperaug River DS Main Street crossing (near Flood Bridge Road intersection), US under I84 to HW between Eagle View Drive on west and near Gray Rock Road to east, Southbury.	1	Fully Supporting	Not Assessed
CT6801-00_01	East Spring Brook (Woodbury/Bethlehem)-01	Mouth at Nonnewaug River (DS Nonnewaug Road crossing), Woodbury, US to HW at Watertown Reservoir outlet (start of AA water just US of Route 132 crossing), Bethlehem.	3.4	Fully Supporting	Not Assessed
CT6802-00_01	Nonewaug River-01	From mouth at confluence with Weekeepeemee River, above Pomperaug River (just DS of Washington Road (Route 47) crossing), US to confluence with Harvey Brook (parallel with Oldtown Farm Road), Woodbury.	4.45	Fully Supporting	Not Assessed
CT6802-00_02	Nonewaug River-02	From confluence with Harvey Brook (parallel with Oldtown Farm Road), Woodbury, US to Big Meadow Pond (Judd Pond) Reservoir outlet dam (just US of Guernseytown Road crossing), Watertown.	4.3	Fully Supporting	Not Assessed
CT6803-00_01	Sprain Brook (Woodbury/Washington)-01	Mouth at confluence with Weekeepeemee River just DS of Washington Road (Route 47) crossing (south of Papermill Road and north of Westwood Road) Woodbury, US to HW at OUTLET of Washington Game Pond, just US of Wykeham Road crossing, Washington.	6.77	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6803-03_01	Unnamed tributary Sprain Brook (Woodbury/Roxbury)-01	Mouth at confluence Sprain Brook .5 mile DS Route 47 crossing, Woodbury, US through Roxbury and parallel to Route 47 to HW at wetland on south side of Nichols Hill Road, Washington.	2	Fully Supporting	Not Assessed
CT6804-00_01	Weekeepeemee River-01	From mouth at confluence with Nonewaug River, above Pomeraug River (DS of Jacks Bridge Road crossing), Woodbury, US to headwaters in marsh (just US of Bergman Hill Road crossing, east of intersection with Todd Hill Road), Morris.	9.61	Fully Supporting	Not Supporting
CT6804-04_01	Wood Creek (Bethlehem)-01	From mouth at confluence with Weekeepeemee River (just DS of Guilds Hollow Road (Route132) crossing), US to headwaters at Zieglers Pond outlet dam (just US of Carmel Hill Road crossing), Bethlehem.	3.27	Fully Supporting	Not Assessed
CT6805-02_01	Good Hill Brook (Woodbury)-01	Mouth at outlet into Hesseky Meadow Pond (Hesseky Brook) DS Old Grassy Hill Rd crossing, US to HW US Route 317 crossing and parallel Tophet Rd, Woodbury.	2.98	Fully Supporting	Not Assessed
CT6806-00_01	Transylvania Brook (Southbury)-01	From mouth at confluence with Pomperaug River (just DS of East Flat Hill Road crossing), US to confluence with Spruce Brook (just US side of Southbury Training School STP), Southbury.	1.6	Not Supporting	Not Supporting
CT6806-00_02	Transylvania Brook (Southbury)-02	Confluence Spruce Brook (just US side of Southbury Training School STP), US to Gravel Pit Pond outlet dam (US of South Britian Road (Route 172) crossing), Southbury.	0.32	Not Assessed	Fully Supporting
CT6806-00_03	Transylvania Brook (Southbury/Woodbury/Roxbury)-03	From inlet to Gravel Pit Pond (northern side), Southbury, US to headwaters, Roxbury (near Woodbury town border).	3.81	Fully Supporting	Fully Supporting
CT6900-00_01	Naugatuck River (Derby/Seymour)-01	Mouth Housatonic River (DS Railroad crossing), Derby, US Rimmon (Tingue) outlet dam (US Broad Street crossing, and just DS Route 8 crossing), Seymour.	6.15	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6900-00_02	Naugatuck River (Seymour/Waterbury)-02	From Rimmon (Tingue) outlet dam (just DS of Route 8 crossing), Seymour, US to confluence with Hopeville Pond Brook, just US of Waterbury WPCF. (Segment includes Wtby, Naug & Beacon Falls WPCFs, & dredge holes in river between Rts 42 & 67 in Beacon Falls)	11.26	Not Supporting	Not Supporting
CT6900-00_03	Naugatuck River-03	From confluence with Hopeville Pond Brook, just US of Waterbury WPCF, US to confluence with Steele Brook (west side of Route 8, at Route 73 connection), Waterbury.	3.52	Not Supporting	Not Supporting
CT6900-00_04	Naugatuck River-04	From confluence with Steele Brook (west side of Route 8, at Route 73 connection), Waterbury, US to sewage leak from pipe under river (near old bridge abutment) along Chase River Road, Watertown/Waterbury town border.	1.65	Not Supporting	Not Supporting
CT6900-00_05	Naugatuck River (Waterbury/Thomaston)-05	US side sewage leak from pipe under river (near old bridge abutment) along Chase River Road, Watertown/Waterbury town border, US to confluence Thomaston WPCF outfall (just US confluence Branch Brook), Thomaston.	4.46	Not Supporting	Fully Supporting
CT6900-00_06	Naugatuck River-06	From confluence with Thomaston WPCF outfall (just US of confluence with Branch Brook), Thomaston, US to confluence with Spruce Brook (west side of Route 8), Litchfield/Harwinton town border.	9	Not Supporting	Not Supporting
CT6900-00_07	Naugatuck River-07	From confluence with Spruce Brook (west side of Route 8), Litchfield/Harwinton town border, US to confluence with Torrington WPCF (just US of bend north of plant), Harwinton/Torrington town border.	2.71	Not Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6900-00_08	Naugatuck River-08	From confluence with Torrington WPCF (just US of bend, north of plant), Harwinton/Torrington town border, US to headwaters at confluence of East and West Branches of Naugatuck River (just US of East Albert Street crossing), Torrington.	1.36	Not Supporting	Not Assessed
CT6900-01_01	Gulf Stream (Torrington/Litchfield)-01	Mouth at confluence Naugatuck River DS Park Avenue crossing, Torrington, US along Route 202 through Litchfield to HW at unnamed pond US Highland Avenue crossing, Torrington.	5.1	Fully Supporting	Not Assessed
CT6900-22_01	Great Brook (Waterbury)-01	From mouth at confluence with Naugatuck River (east bank, DS of West Liberty Street crossing), US to Great Brook Reservoir at Belleview Lake outlet dam (Reservoir in 2 sections, split bt Lakewood Drive), Waterbury. Most of segment in culvert under city.	1.98	Not Supporting	Not Supporting
CT6900-27_01	Spruce Brook (Beacon Falls)-01	From mouth at confluence with Naugatuck River (DS of Cold Springs Road crossing), Naugatuck/Beacon Falls town border, US to headwaters (south of Andrew Mountain Road), Naugatuck.	2.82	Fully Supporting	Not Assessed
CT6900-28_01	Hockanum Brook (Beacon Falls)-01	From mouth at confluence with Naugatuck River (just DS of Main Street (Route 42) crossing), Beacon Falls, US to headwaters at Simpson Lake outlet dam (parallel to Beacon Road (Route 42)), Bethany.	3.17	Fully Supporting	Not Supporting
CT6900-31_01	Hemp Swamp Brook (Beacon Falls/Oxford)-01	Mouth at confluence Naugatuck River DS Lopus Road and RR crossings parallel to Route 42 bridge crossing, Beacon Falls, US through Matthies Park to HW at unnamed pond southeast of Route 42 at Chestnut Tree Hill Road intersection, Oxford.	1.8	Fully Supporting	Not Assessed
CT6900-40_01	Beaver Brook (Ansonia)-01	Confluence with Naugatuck River, just DS of Route 115 crossing, US to Quillinian Reservoir outlet, Ansonia.	1.23	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6900-40_02	Beaver Brook (Ansonia)-02	Inlet of Quillinian Reservoir, Ansonia, US to Middle Reservoir outlet, just US of Route 313 crossing, Seymour.	1.1	Not Supporting	Not Assessed
CT6901-00_02	Hall Meadow Brook (Torrington)-02	Hall Meadow Brook Reservoir inlet (parallel to Route 272), Torrington, US to Goshen/Norfolk town line (parallel to Route 272).	3.16	Fully Supporting	Not Assessed
CT6901-00_03	Hall Meadow Brook (Norfolk)-03	Goshen/Norfolk town line (parallel to Route 272), US to HW, US of Meekertown Road crossing, Norfolk.	3.65	Fully Supporting	Fully Supporting
CT6901-03_01	Unnamed tributary Hall Meadow Brook (Goshen/Norfolk)-01	Mouth at confluence Hall Meadow Brook DS Route 272 crossing through farm fields ditch, Goshen, US to HW in forested area US of Bruey Road crossing, Norfolk.	2.8	Fully Supporting	Not Assessed
CT6902-00_01	Hart Brook-01	From mouth at confluence with Hall Meadow Brook, above West Branch Naugatuck River (just US of Norfolk Road (Route 272) crossing), US to Reuben Hart Reservoir outlet dam, Torrington.	0.64	Not Supporting	Not Assessed
CT6902-02_01	Jakes Brook (Torrington)-01	Mouth on Hart Brook, just DS of Route 272 crossing, US to HW near East Street, Goshen.	3.05	Fully Supporting	Not Assessed
CT6903-00_01	Nickelmine Brook (Torrington)-01	From mouth at confluence with West Branch Naugatuck River-03 (just DS of Norfolk Road crossing, US to Allen Dam Reservoir INLET (US of University Drive crossing), Torrington.	1.13	Fully Supporting	Not Assessed
CT6903-00_02	Nickelmine Brook (Torrington)-02	From Allen Dam Reservoir INLET (end of segment-01), Torrington, US to Hatchaluchi Reservoir INLET (beginning of segment-03), Goshen.	2.61	Fully Supporting	Not Assessed
CT6904-00_01	West Branch Naugatuck River-01	From mouth at confluence with East Branch Naugatuck River, above Naugatuck River (US of East Albert Street crossing), US to Old Brass Mill Pond outlet dam (1st impoundment on river), just US of Church Street crossing, Torrington.	0.97	Not Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6904-00_03	West Branch Naugatuck River-03	From inlet to impoundment at Wolcott Avenue crossing (head of Old Brass Mill Pond), US to Stillwater Pond outlet dam (just US of Brass Mill Dam Road crossing), Torrington.	2.1	Fully Supporting	Not Assessed
CT6904-00_04	West Branch Naugatuck River-04	From inlet to Stillwater Pond (DS of Norfolk Road (Route 272) crossing, pond is on east side of road), US to headwaters at confluence of Hart Brook and Hall Meadow Brook (US of Norfolk Road (Route 272) crossing), Torrington.	1.15	Fully Supporting	Not Assessed
CT6905-00_01	East Branch Naugatuck River-01	From mouth at confluence with West Branch Naugatuck River, above Naugatuck River (just DS of Franklin Drive crossing), US to North Elm Street Road (Route 4) crossing, Torrington.	1.33	Not Supporting	Insufficient Information
CT6905-00_02	East Branch Naugatuck River-02	From North Elm Street Road (Route 4) crossing, Torrington, US to headwaters at Lake Winchester outlet dam (just US of West Road crossing), Winchester.	7.67	Fully Supporting	Not Assessed
CT6906-00_01	Spruce Brook-01	From mouth at confluence with Naugatuck River (DS from Railroad crossing, on west bank), US to confluence with Jefferson Hill Brook, Litchfield.	0.27	Fully Supporting	Not Assessed
CT6906-00_02	Spruce Brook-02	From confluence with Jefferson Hill Brook, US to East Litchfield Road crossing, Litchfield.	1.31	Fully Supporting	Not Assessed
CT6907-00_01	Rock Brook (Harwinton)-01	Mouth on Leadmine Brook, just DS from Hollow Road crossing, Harwinton, US to HW, near Cotton Hill Road, New Hartford.	6.29	Fully Supporting	Not Assessed
CT6908-00_01	Leadmine Brook-01	Mouth at Naugatuck River (US from railroad crossing of Naugatuck River), Thomaston, US to confluence Rock Brook (just US from South Road crossing), Harwinton.	2.76	Fully Supporting	Insufficient Information

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6909-00_01	Northfield Brook (Thomaston)-01	Mouth at confluence Naugatuck River DS Main Street crossing, US along Route 254 to outlet of Northfield Brook Lake (flood control ACOE) below dam between Route 254 on west and Litchfield Street on east (just above confluence with NNT), Thomaston.	1.5	Fully Supporting	Not Assessed
CT6910-00_01	Branch Brook-01	From mouth at confluence with Naugatuck River (DS of Route 8 crossing), US to Black Rock Dam outlet (along south side of Route 109), Watertown-Thomaston.	2.06	Not Supporting	Not Assessed
CT6910-00_02	Branch Brook-02	From Black Rock Dam outlet (along south side of Route 109), US to Wigwam Reservoir outlet dam, Watertown-Thomaston.	1.91	Not Supporting	Not Assessed
CT6910-03_01	Pitch Brook (Morris/Litchfield)-01	Mouth at INLET to Pitch Reservoir just DS of Chestnut Hill Road crossing, Morris, US to HW between Chestnut Hill and East Chestnut Hill Roads, above Highmark Road intersection, Litchfield.	1.92	Not Assessed	Fully Supporting
CT6911-00_01	Hancock Brook (Waterbury)-01	From mouth at confluence with Naugatuck River (segment-04) DS of Huntingdon Avenue and Railroad crossings, US to Hancock Pond outlet dam (between Sheffield Street and Railroad), Waterbury.	1.06	Not Supporting	Not Assessed
CT6912-00_01	Steele Brook-01	From mouth at confluence with Naugatuck River (just DS of Route 8 crossing), US to Sherwood Medical (American Home Products) area (site is behind Municipal Stadium parking lot on northend of stadium property), Waterbury.	1.18	Not Supporting	Not Supporting
CT6912-00_02	Steele Brook-02	From Sherwood Medical (American Home Products) area (site is behind Municipal Stadium parking lot on northend of stadium property), Waterbury, US to INLET of Heminway Pond (DS of Route 6 crossing, pond included in segment), Watertown.	3.78	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6912-00_03	Steele Brook-03	From INLET of Heminway Pond (DS of Route 6 crossing), Watertown, US to headwaters (in marsh US of Killorin Road and Litchfield Road (Route 63) crossing area).	3.59	Fully Supporting	Insufficient Information
CT6914-00_01	Mad River (Waterbury)-01	From mouth at confluence with Naugatuck River (behind Roller Magic, off of Harvester Road), US to Route 69 crossing (US of I84 crossing, exit 22 area, and just US of Brass City Mall), Waterbury.	1.77	Not Supporting	Not Supporting
CT6914-00_02	Mad River (Waterbury)-02	From Route 69 crossing (US of I84 crossing, exit 22 area, and just US of Brass City Mall), US to confluence with Beaver Pond Brook, just US of I84 crossing (Scovill Pond no longer exists), Waterbury.	1.01	Not Supporting	Not Supporting
CT6914-00_03a	Mad River (Waterbury)-03a	From confluence with Beaver Pond Brook, (just US of I84 crossing and DS of Plank Road crossing, in former Scovill Ponds section), Waterbury, US to confluence with Lily Brook (CT6914-06 Gazetteer, and called Finch Brook in NHD), Wolcott.	3.46	Not Supporting	Not Supporting
CT6914-06_01	Lily Brook (Wolcott)-01	Mouth at confluence with Mad River DS of Woodtick Road crossing, US to confluence with unnamed tributary US of Todd Road crossing, parallel to Frisbie Circle, Wolcott.	0.74	Not Assessed	Not Supporting
CT6915-00_01	Fulling Mill Brook (Naugatuck)-01	From mouth at confluence with Naugatuck River (segment-02) DS of Route 8 crossing, US to Maple Hill Road crossing, Naugatuck.	1.51	Fully Supporting	Not Assessed
CT6916-00_01	Hop Brook (Naugatuck)-01	Mouth at confluence Naugatuck River (DS of Bridge Street (Route 68) crossing and Railroad crossing), Naugatuck, US to Hop Brook Lake outlet dam (flood control area along eastern side of Church Street (Route 63)), Naugatuck/Waterbury town line.	1.44	Not Supporting	Not Supporting
CT6916-00_02	Hop Brook (Waterbury/Middlebury/Watertown)-02	INLET to Hop Brook Lake (ACOE flood control area, entrance on Route 63), Waterbury, US to west under Route 63 and under I84 continuing to HW US of Old Watertown Road crossing, Middlebury.	7.97	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT6916-05_01	Goat Brook (Middlebury)-01	Mouth at confluence Hop Brook DS Tucker Hill Road crossing near intersection Chase Road, US along Route 64 then Charcoal Avenue to HW at wetland on southwest side of Charcoal Avenue at Breakneck Hill Road intersection, Middlebury.	1.8	Fully Supporting	Not Assessed
CT6917-00_01	Long Meadow Pond Brook-01	From mouth at confluence with Naugatuck River (DS of Elm Street crossing and Railroad crossing), US to outlet of Naugatuck Ice Company Pond Dam (just US of Rubber Avenue crossing), Naugatuck.	0.94	Not Supporting	Not Supporting
CT6918-00_01	Beacon Hill Brook (Naugatuck)-01	From mouth at confluence with Naugatuck River, just DS of Route 8 crossing, US to confluence with Marks Brook, parallel with Margaret Circle, Naugatuck.	2.45	Fully Supporting	Insufficient Information
CT6919-00_01	Bladens River (Seymour)-01	Mouth Naugatuck River (just DS New Haven Avenue (Route 8) and Derby Avenue (Route 67) crossings), US to North Street crossing (upper end industrial area), Seymour.	0.68	Not Supporting	Not Supporting
CT6919-00_02	Bladens River-02	From North Street crossing, DS of Paper Mill Pond (upper end of industrial area), Seymour, US to headwaters at Round Hill Pond outlet dam (US of Round Hill Road crossing), Bethany.	3.85	Fully Supporting	Not Assessed
CT6920-00_02	Little River (Seymour)-02	From Swans Pond INLET (segment 1 includes Swans Pond), US to confluence with Riggs Street Brook (just US of Oxford Road (Route 67) crossing), Oxford.	2.96	Fully Supporting	Not Assessed
CT6920-03_02	Jacks Brook (Oxford)-02	Confluence with Riggs Street Brook, parallel to Riggs Street at Cedar Lane intersection, US to Little Valley Road crossing, Oxford.	1.56	Fully Supporting	Not Assessed
CT7000-16_01	Muddy Brook (Westport)-01	Mouth Mill Creek (LIS Estuary segment) on DS side I95 Exit 18 ramp, US to HW (just US Route 15 crossing), Westport.	4.17	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT7000-16-trib_01	Unnamed tributary, Muddy Brook (Westport)-01	Mouth Muddy Brook near Center Street, US to HW at small unnamed pond east side Colony Road, Westport. (Includes underground portion industrial area)	1.32	Not Assessed	Not Supporting
CT7000-17_01	Unnamed tributary, Muddy Brook (Westport)-01	Mouth Muddy Brook DS Route 1 crossing, US to HW US North Ave crossing near Staples High School, Westport.	1.13	Not Assessed	Not Supporting
CT7000-18_01	Unnamed tributary, Sherwood Millpond LIS (Westport)-01	Mouth Sherwood Millpond (LIS) near Grove Point and along I95 and RR crossings, US to HW US Route 1 and Cresent Road crossings, Westport.	2.33	Not Assessed	Not Supporting
CT7000-22_01	Indian River (Westport)-01	Mouth Saugatuck River (head Burritt Cove, Saugatuck River Estuary, just DS Saugatuck Avenue (Route 136) crossing), US to I95 crossing, Westport.	0.53	Not Assessed	Not Supporting
CT7000-22_02	Indian River (Westport)-02	I95 crossing, Westport, US to HW (river portions in concrete channels and pipes), Norwalk. (Segment made from site map, actual hydro must be mapped to confirm underground portions).	0.94	Not Assessed	Not Supporting
CT7000-29_01	Unnamed tributary to Farm Creek LIS (Norwalk)-01	Mouth Farm River (LIS) DS Route 136 crossing, US to HW at unnamed pond US Roton Middle School and RR crossing, Norwalk.	1.07	Not Assessed	Not Supporting
CT7102-00_02	Bruce Brook (Bridgeport/Stratford)-02	Inlet to Bruce Pond, US to Barnum Avenue crossing, Bridgeport/Stratford town line.	0.22	Not Supporting	Not Supporting
CT7105-00_02	Pequonnock River (Bridgeport/Trumbull)-02	INLET Bunnells (Beardsley Park) Pond (east side Route 8, exit 6 area), Bridgeport, US to Daniels Farm Road crossing (US Route 25 crossing), Trumbull.	2.92	Not Supporting	Not Supporting
CT7105-00_03	Pequonnock River (Trumbull)-03	Daniels Farm Road crossing (US Route 25 crossing), US to Monroe Turnpike (Route 111) crossing (near intersection Route 25), Trumbull.	4.19	Not Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT7105-00_04	Pequonnock River (Trumbull/Monroe)-04	Monroe Turnpike (Route 111) crossing (near intersection Route 25), Trumbull, US to outlet unnamed impoundment (US Purdy Hill Road crossing, and US Harsh Pond) Monroe.	1.83	Not Assessed	Fully Supporting
CT7105-00_05	Pequonnock River (Monroe)-05	INLET unnamed impoundment (northeastern portion of pond), US to HW Stepney Pond outlet dam (just US West Maiden Lane crossing), Monroe.	2.35	Fully Supporting	Fully Supporting
CT7105-00-trib_01	Unnamed trib, Pequonnock River (Monroe)-01	Mouth Great Hollow Lake (part of Pequonnock River system), US to HW near Great Oak Farm Rd, Monroe.	0.67	Not Assessed	Fully Supporting
CT7105-01_01	West Branch Pequonnock River (Monroe)-01	Mouth Pequonnock River, DS Maple Drive crossing, on Jewish Community Center property, US to outlet West Poquonnock Reservoir, parallel to Route 25, Monroe.	1.51	Insufficient Information	Fully Supporting
CT7105-01_02	West Branch Pequonock River (Monroe)-02	OUTLET dam West Pequonnock Reservoir parallel near Route 25, US to HW at unnamed pond US Pastors Walk crossing (all AA watershed), Monroe.	4.01	Not Assessed	Fully Supporting
CT7105-02_01	Unnamed trib, West Branch Pequonock River (Monroe)-01	Mouth West Branch Pequonnock River DS Pepper St crossing, US to HW (AA watershed), Monroe	1.25	Not Assessed	Fully Supporting
CT7105-04_01	North Farrars Brook (Trumbull)-01	Mouth Pequonnock River DS Route 25 crossing (parallel to Spring Hill Rd), US to HW US Red Barn Rd crossing, Trumbull.	1.15	Not Assessed	Fully Supporting
CT7105-06_01	Kaatz Ice Pond Brook (Trumbull)-01	Mouth Pequonnock River DS Indian Ledge Park Rd, US to Kaatz Pond outlet (US Route 25 and Whitney Ave crossings), Trumbull.	0.29	Not Assessed	Fully Supporting
CT7106-00_01	Rooster River (Fairfield)-01	Mouth at confluence with Ash Creek (US of I95 crossing, in area near end of Fairchild Avenue), Fairfield/Bridgeport town border, US to headwaters at confluence of Londons Brook and Horse Tavern Brook (US of Cornell Road crossing), Fairfield.	2.69	Not Assessed	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT7107-00_01	Cricker Brook (Fairfield)-01	From mouth at confluence with Swamp Mortar Reservoir (Mill River) parallel to Route 58 (Black Rock Turnpike), US to Hemlock Reservoir outlet dam, Fairfield.	1.69	Not Assessed	Not Supporting
CT7108-00_02a	Mill River (Fairfield/Easton)-02a	From INLET to Samp Mortar Reservoir, Fairfield, US to confluence with unnamed tributary (US of South Park Avenue crossing, DS of Easton Reservoir and Canoe Brook confluence), Easton. (Segment does NOT include Lake Mohegan).	3.57	Insufficient Information	Not Supporting
CT7108-00_02b	Mill River (Fairfield/Easton)-02b	From confluence with unnamed tributary (US of South Park Avenue crossing, DS of Easton Reservoir and Canoe Brook confluence), US to Easton Reservoir outlet dam (Lakeview Drive crossing on dam), Easton.	0.54	Fully Supporting	Not Supporting
CT7108-00_03	Mill River (Easton/Monroe)-03	From INLET to Easton Reservoir, Easton/Trumbull town border, US to headwaters at marsh (just US of Hattertown Road crossing), Monroe.	3.43	Fully Supporting	Not Assessed
CT7108-05_02	Unnamed tributary, Easton Reservoir (Snow Farm)-02	From confluence with unnamed tributary to Easton Reservoir (east of Sport Hill Road (Route 59)), US to outlet of pond on Phil Snow's farm, Easton. (Unnamed tributary flows into Easton Reservoir from western side)	0.3	Not Supporting	Not Assessed
CT7109-00_01	Sasco Brook (Westport/Fairfield)-01	Bulkely Pond OUTLET dam (US Post Road East (Route 1) crossing), Westport/Fairfield town border, US to Hulls Farm Road crossing (just DS Great Brook confluence), Westport/Fairfield town border. (Segment includes Buckley Pond).	1.42	Not Supporting	Not Supporting
CT7109-00_02	Sasco Brook (Westport/Fairfield)-02	Hulls Farm Road crossing (just DS of Great Brook confluence), Westport/Fairfield town border, US to headwaters at marsh (US of Burr Street crossing), Fairfield.	5.2	Not Assessed	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT7109-00-trib_01	Unnamed tributary, Sasco Brook (Westport)-01	Mouth Sasco Brook (US Old Road crossing), Westport/Fairfield town border, US to HW (US Bulkley Avenue crossing), Westport.	0.34	Not Assessed	Not Supporting
CT7109-02_01	Unnamed Tributary, Sasco Brook (Fairfield)-01	Confluence with Sasco Brook (DS Route 15 crossing), US to confluence with unnamed tributary, just DS of Merwins Lane crossing, Fairfield.	0.61	Fully Supporting	Fully Supporting
CT7109-06_01	Great Brook (Fairfield)-01	Mouth at confluence with Sasco Brook (just US of Hulls Farm Road crossing of Sasco Brook, east bank), US to first confluence with unnamed brook (just US of Morehouse Lane crossing, DS of marsh), Fairfield.	0.72	Not Assessed	Not Supporting
CT7109-06_02	Great Brook (Fairfield)-02	First confluence with unnamed brook (just US of Morehouse Lane crossing, DS of marsh), US to headwaters at marsh (US of Congress Street crossing, southwest of Cross highway and Hillside road intersection), Fairfield.	2.2	Not Assessed	Not Supporting
CT7200-00_01	Saugatuck River-01	From Hydraulic Pond OUTLET dam (head of estuary, saltwater limit), US (through Hydraulic Pond and lower end of Lee Pond) to confluence with West Branch Saugatuck River (parallel with Ford Road), Westport.	1.74	Fully Supporting	Insufficient Information
CT7200-00_02	Saugatuck River-02	From confluence with West Branch Saugatuck River (parallel with Ford Road), Westport, US (through upper end of Lee Pond) to Samuel Senior dam at Saugatuck Reservoir outlet, Weston.	6.46	Fully Supporting	Fully Supporting
CT7200-00_03	Saugatuck River (Redding)-03	INLET Saugatuck Reservoir, Newtown Turnpike (Route 53) crossing, US to confluence Bogus Mountain Brook (US Redding Road (Route 53) crossing, and parallel Station Road), Redding.	4.36	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT7200-00_04	Saugatuck River-04	From confluence with Bogus Mountain Brook (US of Redding Road (Route 53) crossing, and parallel to Station Road), Redding, US to headwaters, at Wataba Lake outlet dam (just US of Mountain Road crossing), Ridgefield.	5.53	Fully Supporting	Insufficient Information
CT7200-03_01	Umpawaug Pond Brook (Redding)-01	Mouth on Saugatuck River, DS of Simpaug Turnpike crossing, US to HW above Steichens Ponds, just US of Old Redding Road crossing, Redding.	2.98	Fully Supporting	Insufficient Information
CT7200-19_01	Hawleys Brook (Weston/Easton)-01	Mouth at confluence Saugatuck River in Devils Glen Park DS Valley Forge Road crossing, Weston, US into Trout Brook Valley (DEEP property) Trout management area to HW (no roads or access points), Easton. (Between Saugatuck Reservoir and Route 58)	2.1	Fully Supporting	Not Assessed
CT7200-20_01	Unnamed tributary Hawleys Brook 7200-20 (Easton)-01	Mouth at confluence Hawleys Brook in Trout Brook Valley (DEEP property) Trout management area, US out of property and across Connecticut Golf Club property to HW (no roads or access points), Easton. (Between Saugatuck Reservoir and Route 58)	1.5	Fully Supporting	Not Assessed
CT7200-20-trib_02	Unnamed tributary Hawleys Brook 7200-20-trib (Easton)-02	Confluence with main unnamed tributary 7200-20 to Hawleys Brook, US into private property (Golf course), Easton. (Entire segment is west of Blackrock Turnpike (Route 58), AND southwest out of golf course property)	0.56	Not Supporting	Not Assessed
CT7200-21_01	Jennings Brook (Weston)-01	From mouth at confluence with Saugatuck River (DS Davis Hill Road crossing), US to 1st confluence with unnamed tributary adjacent to Treadwell Lane, Weston.	0.73	Not Assessed	Fully Supporting
CT7200-22_01	Beaver Brook (Weston)-01	From mouth at confluence with Saugatuck River (DS Slumber Lane crossing), US to confluence with Davidge Brook (adjacent to Glenwood Road), Weston.	1.02	Not Assessed	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT7200-24_01	Kettle Creek (Weston)-01	From mouth at confluence with Saugatuck River (DS of Good Hill Road crossing), US to confluence with unnamed tributary (DS of Kettle Creek Road crossing), Weston.	0.62	Not Assessed	Not Supporting
CT7200-26_01	Poplar Plains Brook (Westport)-01	From mouth at confluence with Saugatuck River (Lee Pond section, just DS of Route 15 crossing), US to confluence with unnamed tributary US of Route 33 (Wilton Road) crossing (outlet for Keenes Pond), Westport.	0.5	Not Assessed	Not Supporting
CT7201-00_01	Little River (Redding)-01	Mouth at inlet to Saugatuck Reservoir, parallel to Newtown Turnpike, US to outlet of Lower Park Pond, parallel to Route 58, Redding.	4.43	Fully Supporting	Not Supporting
CT7202-00_01	Aspetuck River (Westport-Easton)-01	From confluence with Saugatuck River (DS of Weston Road (ROUTE 57) crossing), Westport, US to Aspetuck Reservoir outlet dam (US of Black Rock Turnpike (Route 58) crossing), Easton. (Segment passes through Pfeiffer Pond, Weston/Easton town border)	5.93	Fully Supporting	Fully Supporting
CT7202-00_02	Aspetuck River (Easton-Newtown)-02	From INLET to Aspetuck Reservoir (northwestern side, parallel with Black Rock Turnpike (Route 58)), Easton, US to headwaters at unnamed pond (US of Poverty Hollow Road crossing), Newtown.	9.54	Fully Supporting	Not Assessed
CT7203-00_01	West Branch Saugatuck River-01	From mouth at confluence with Saugatuck River (DS of Pan Handle Lane crossing), Westport, US to Godfrey Road West crossing (just east of Old Orchard Drive intersection), Weston.	6.12	Fully Supporting	Fully Supporting
CT7203-04_01	Cobbs Mill Brook (Weston)-01	Mouth at confluence with West Branch Saugatuck River just DS of Cobb Mill Road crossing, US to confluence with unnamed tributary parallel to Route 57 (on west side behind houses) at Hillside Road intersection, Weston.	0.89	Not Assessed	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT7300-00_01	Norwalk River (Norwalk/Wilton)-01	Wall Street (Commerce Street) crossing (head of estuary/saltwater limit), Norwalk, US to confluence Bryant Brook (DS Wolfpit Road crossing), Wilton. (Segment includes Winnipauk Mill Pond, Deering Pond)	5.63	Not Supporting	Not Supporting
CT7300-00_02	Norwalk River (Wilton)-02	Confluence Bryant Brook (DS Wolfpit Road crossing), US to Old Mill Road crossing (between Danbury Road (Route 7) and Railroad tracks southeast, Georgetown), Wilton.	5.61	Fully Supporting	Not Supporting
CT7300-00_03a	Norwalk River (Wilton/Redding)-03a	Old Mill Road crossing (between Danbury Road (Route 7) and Railroad track, southeast, Georgetown), Wilton, US to confluence Georgetown POTW outfall, Redding.	0.84	Fully Supporting	Fully Supporting
CT7300-00_03b	Norwalk River (Redding)-03b	From confluence with Georgetown POTW outfall, US to EXIT of underground (pipe) section (just US of Railroad crossing), Redding.	0.2	Insufficient Information	Not Supporting
CT7300-00_04	Norwalk River (Wilton/Ridgefield)-04	INLET Factory Pond (just DS Danbury Road (Route 7) crossing), Wilton, US to confluence Cooper Pond Brook (DS Branchville Road, east intersection Route 7), Ridgefield.	0.7	Fully Supporting	Fully Supporting
CT7300-00_05	Norwalk River (Ridgefield)-05	Confluence Cooper Pond Brook (DS Branchville Road, east of intersection Route 7), US to HW at Little Pond outlet dam (US confluence Ridgefield Brook, west, on west side parallel to Route 7), Ridgefield.	4.85	Not Supporting	Fully Supporting
CT7300-02_01	Ridgefield Brook (Ridgefield)-01	From confluence with Norwalk River (DS of headwaters at Little Pond outlet dam, west side of Route 7), US to Taylors Pond outlet dam (US of Limestone Road crossing), Ridgefield.	1.05	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT7300-02_02	Ridgefield Brook (Ridgefield)-02	INLET Taylor Pond (southwest portion pond, east Barrow Mountain), US (south) to HW at outlet Lounsebury Pond in southwest portion Great Swamp, Ridgefield. (Segment includes outfall Ridgefield POTW, upper Great Swamp area)	3.22	Not Supporting	Not Supporting
CT7301-00_01	Comstock Brook (Wilton)-01	From mouth at confluence with Norwalk River (segment-02, just DS of Lovers Lane crossing), US to confluence with Barretts Brook (outlet for Popes Pond, parallel to Route 33, at intersection with Signal Hill Road), Wilton.	2.02	Not Supporting	Not Supporting
CT7301-00_02	Comstock Brook (Wilton)-02	From confluence with Barretts Brook (outlet for Popes Pond, parallel to Route 33, at intersection with Signal Hill Road), US to HW (just west and parallel with Grey Rocks Road), Wilton.	2.29	Fully Supporting	Not Assessed
CT7302-00_01	Silvermine River (Norwalk)-01	Mouth Norwalk River (northwest INLET Deering Pond portion of river), US to Merritt Parkway (Route 15) crossing, Norwalk. (Segment includes Davis Pond).	0.98	Insufficient Information	Fully Supporting
CT7302-00_02	Silvermine River (Norwalk/New Canaan)-02	From Merritt Parkway (Route 15) crossing), Norwalk, US to Grupes Reservoir outlet dam (US of Valley Road crossing), New Canaan.	5.49	Insufficient Information	Fully Supporting
CT7302-13_01	Belden Hill Brook (Wilton)-01	Mouth Perry Pond section of Silvermine River, Wilton/Norwalk town line, US to OUTLET City Lake (South Norwalk Res) US of Route 106 crossing, Wilton.	1.47	Not Assessed	Not Supporting
CT7302-13_trib_01	Unnamed tributary Belden Hill Brook-01	From mouth at confluence with Beldon Hill Brook (DS of Belden Hill Brook crossing of New Canaan Road (Route 106), DS of South Norwalk Reservoir), US to discharge source at Sisters of Notre Dame (discharge of private STPl), Wilton.	0.4	Not Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT7401-00_01	Fivemile River (New Canaan)-01	INLET Jacob Pond (DS Amtrack crossing and Carolyn Court crossing), Norwalk/Darien town border, US to Old Norwalk Road crossing (0.2 Mi DS POTW), New Canaan.	5.62	Not Assessed	Not Supporting
CT7401-00_02	Fivemile River (New Canaan)-02	Old Norwalk Road crossing (0.2 Mi DS POTW), US to confluence New Canaan POTW outfall, New Canaan.	0.23	Not Supporting	Not Supporting
CT7401-00_03	Fivemile River (New Canaan)-03	From confluence with New Canaan POTW outfall, US to confluence with unnamed tributary (US of New Norwalk Road (Route 123) crossing, on northeastern side of Parade Hill Road, near Cemetery), New Canaan.	1.82	Not Supporting	Fully Supporting
CT7401-00_04	Fivemile River (New Canaan)-04	Confluence unnamed tributary (US New Norwalk Road (Route 123) crossing, on northeastern side Parade Hill Road, near Cemetery), US to HW at New Canaan Reservoir dam outlet (US Country Club Road crossing), New Canaan.	1.69	Not Assessed	Fully Supporting
CT7401-01_01	Unnamed Tributary, Fivemile River (New Canaan)-01	Mouth Fivemile River, just DS Indian Rock Road crossing (near Fivemile River Country Club Road crossing), US to HW just US Smith Ridge Road (Route 123) crossing, New Canaan. Segment goes through golf course.	1.47	Not Assessed	Fully Supporting
CT7401-02_01	Unnamed tributary to Fivemile River (New Canaan)-01	Mouth at confluence with Five Mile river, DS of Glen Drive crossing, US to OUTLET of Taeger Pond, just US of Route 123 crossing, New Canaan. (includes Field Club Pond)	0.2	Not Assessed	Not Supporting
CT7401-05_01	Holy Ghost Fathers Brook (Norwalk)-01	Mouth Fivemile River (Cedar Pond section) DS Bonnybrook Road crossing, US to confluence unnamed tributary DS Fillow Street crossing, Norwalk. (Includes Land and Bethmarlea Ponds)	0.61	Not Assessed	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT7401-06_01	Keelers Brook (Norwalk)-01	Mouth Fivemile River Darien/Norwalk town line, just DS Rowayton Avenue crossing (Woodchuck Lane intersection) US to unnamed tributary, .3 miles US Flax Hill Road crossing and just DS I95, Norwalk.	1.08	Not Assessed	Not Supporting
CT7401-07_01	Unnamed tributary, Keelers Brook (Norwalk)-01	Mouth Keelers Brook .3 miles US Flax Hill Road crossing and just DS I95, US to OUTLET Scribner Pond just US Gillys Lane crossing, Norwalk.	1.03	Not Assessed	Not Supporting
CT7403-00_01	Noroton River-01	From Post Road (Route 1) crossing (saltwater limit at head of Holly Pond), US to southwestern corner of St. John's Cemetery (river bend to west), Stamford/Darien town border.	2.3	Not Supporting	Not Assessed
CT7403-00_02	Noroton River-02	From southwestern corner of St. John's Cemetery (river bend to west), Stamford/Darien town border, US to Merritt Parkway (Route 15) crossing (US of Raymonds Pond), New Canaan.	2.61	Not Supporting	Not Assessed
CT7405-00_01	Rippowam River-01	From Rippowam River West Branch dam (head of tide, US of Route 1 and Main Street crossings), US to Merritt Parkway (Route 15) crossing (mid-way between exit 34 and exit 35), Stamford.	5.22	Not Supporting	Not Assessed
CT7405-00_02	Rippowam River-02	From Merritt Parkway (Route 15) crossing (mid-way between exit 34 and exit 35), US to North Stamford Reservoir dam outlet (US of Interlaken Road crossing), Stamford.	2.09	Not Supporting	Not Assessed
CT7407-00_02	Mianus River-02	From Mianus Filtration Plant dam outlet (impoundment at filtration plant), Greenwich, US to Sam Bargh Reservoir (Mianus Reservoir on topo) dam outlet (US of Farms Road crossing, near New York border), Stamford.	6.1	Not Supporting	Not Assessed
CT7409-00_01	Horseneck Brook-01	From mouth at Greenwich Harbor (just DS of I95 crossing, at exit 3 offramp), US to Putnam Lake Reservoir outlet dam (just US of Dewart Road crossing), Greenwich.	5.78	Not Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation
CT7410-00_01	East Branch Byram River-01	From confluence with Byram River (northeast portion of Toll Gate Pond section of river, between Route 15 and Riversville Road), US to Old Pond outlet dam (just US of Old Mill Road crossing, first impoundment DS of John Street site), Greenwich.	2.79	Fully Supporting	Insufficient Information
CT7410-00_02	East Branch Byram River-02	From Old Pond INLET (first impoundment DS of John Street site), US to New York state border (US of Chitwick Pond Road crossing), Greenwich. (Segment includes Lake Mead	2.61	Fully Supporting	Not Assessed
CT7411-00_01	Byram River-01	From head of tide (US of Route 1 crossing, at INLET to ponded portion of river, just DS of Upland Street East area), US to Pemberwick outlet dam (US of Comly Avenue crossing, and US of confluence with Pemberwick Brook, Greenwich.	0.49	Not Supporting	Not Supporting
CT8101-00_01	Quaker Brook-01	From New York state border (DS of Merritts Pond, parallel to Route 37, north of intersection with Haviland Hollow Road), New Fairfield, US to New York state border (along south side of Chapel Hill Road), Sherman. (Segment includes 6 ponds/lakes)	4.78	Fully Supporting	Not Assessed
CT8103-01_01	Gerow Brook (New Fairfield)-01	Mouth at confluence Quaker Brook above Haviland Hollow Brook in NY at CT state line, .5 mile DS Quaker Road crossing (on Wesleyan University property), US to HW at unnamed pond US of Cloverleaf Drive crossing, New Fairfield.	2.5	Fully Supporting	Not Assessed
CT8104-00_01	Titicus River-01	From New York state border (in large marsh along north side of North Salem Road (Route 116)), US to headwaters (at unnamed marsh, US of Old West Mountain Road crossing), Ridgefield. (Segment includes several ponds and marshes)	6.34	Fully Supporting	Not Supporting

Table 2-4. Connecticut 305b Assessment Results for Lakes

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT1001-00-1-L1_01	Wyassup Lake (North Stonington)	North central North Stonington, east of Rte 49. Headwaters of Wyassup Brook.	98.94	Fully Supporting	Not Supporting
CT1002-00-1-L1_01	Green Falls Reservoir (Voluntown)	SE Voluntown, east of Route 49, south of Route 138. Includes CT DEEP swimming area in Pachaug State Forest camping area.	46.15	Fully Supporting	Fully Supporting
CT1100-00-1-L1_01	Porter Pond (Sterling)	Headwaters of Wood River near Rhode Island border, Sterling.	10.4	Fully Supporting	Not Assessed
CT2107-00-1-L1_01	Morgan Pond (Ledyard)	South side of Sandy Hollow Road, West of Route 117 intersection, Ledyard.	146.22	Fully Supporting	Not Assessed
CT2107-00-1-L6_01	Groton (Poquonnock) Reservoir (Groton)	Groton	194.68	Fully Supporting	Not Assessed
CT2203-00-1-L2_01	Konomoc, Lake (Waterford/Montville)	Waterford	288.66	Fully Supporting	Fully Supporting
CT2205-00-1-L1_01	Powers Lake (East Lyme)	East Lyme, Headwaters of Pataganset River.	146.5	Fully Supporting	Fully Supporting
CT2205-00-1-L3_01	Gorton Pond (East Lyme)	East Lyme. Impoundment of Pataganset River.	52.41	Fully Supporting	Fully Supporting
CT3002-02-1-L2_01	Amos Lake (Preston)	East of Rte 164, Preston.	112.42	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT3002-04-1-L1_01	Avery Pond (Preston)	East of Rte 164, north of Rte 2, Preston.	45.62	Fully Supporting	Fully Supporting
CT3100-00-3-L1_01	Eagleville Pond (Coventry/Mansfield)	Impoundment of Willimantic River, just south of Mansfield Depot, along Mansfield/ Coventry border.	79.49	Fully Supporting	Fully Supporting
CT3101-03-1-L1_01	Crystal Lake (Ellington/Stafford)	Northeast section of Ellington, small part in southwestern section of Stafford.	187.38	Fully Supporting	Fully Supporting
CT3106-06-1-L2_01	Crandall Pond (Cider Mill Pond) (Tolland)	Cider Mill Road, Tolland (just north of I84, in Crandall Park) formerly CT3106-00-2-L2_01 (wrong waterbody)	2.63	Not Assessed	Not Supporting
CT3108-02-1-L2_01	Bolton Lake, Middle (Vernon)	Southeast section of Vernon.	117.2	Fully Supporting	Fully Supporting
CT3108-02-1-L3_01	Bolton Lake, Lower (Bolton/Vernon)	Mostly in NE corner of Bolton, continues into SE corner of Vernon.	176.46	Fully Supporting	Fully Supporting
CT3108-13-1-L1_01	Columbia Lake (Columbia)	NW Columbia	277.28	Fully Supporting	Fully Supporting
CT3200-01-1-L1_01	Halls Pond (Eastford/Ashford)	SW corner of Eastford.	83.16	Fully Supporting	Fully Supporting
CT3201-01-1-L1_01	Black Pond (Woodstock)	Eastern Woodstock, south of Rte 197.	71.88	Fully Supporting	Fully Supporting
CT3202-00-1-L1_01	Keach Pond (Woodstock)	Woodstock	29.69	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT3203-00-1-L1_01	Mashapaug Lake (Union)	Northeastern Union near MA border.	297.92	Fully Supporting	Fully Supporting
CT3203-00-1-L2_01	Bigelow Pond (Union)	DS of Mashapaug Lake in northern Union.	25.8	Fully Supporting	Fully Supporting
CT3206-00-1-L1_01	Morey Pond (Union/Ashford)	Straddles Ashford - Union line and is split by Rte 84.	47.22	Not Assessed	Fully Supporting
CT3206-00-1-L2_01	Chaffee, Lake (Ashford)	Ashford	52.15	Fully Supporting	Fully Supporting
CT3206-12-1-L1_01	Knowlton Pond (Ashford)	Ashford	110.95	Fully Supporting	Fully Supporting
CT3207-16-1-L1_01	Bicentennial Pond (Mansfield)	Impoundment of Schoolhouse Brook, Spring Hill area of Mansfield	6.05	Not Assessed	Fully Supporting
CT3300-00-3+L3_01	North Grosvenordale Pond Impoundment (Thompson)	Impoundment of French River in north central Thompson, near MA border.	58.66	Fully Supporting	Fully Supporting
CT3400-00-2-L11_01	Quaddick Reservoir (Thompson)	Impoundment of Fivemile River in Southeast corner of Thompson. Includes CT DEEP State swimming area in Quaddick State Park.	391.3	Fully Supporting	Fully Supporting
CT3502-07-1-L1_01	Moosup Pond (Plainfield)	Northeast section of Plainfield.	89.27	Fully Supporting	Not Assessed
CT3600-00-1-L1_01	Beach Pond (Voluntown/Rhode Island)	Eastern border of Voluntown with RI.	407.6	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT3600-00-3-L3_01	Beachdale Pond (Voluntown)	Impoundment of Pachaug River, Voluntown; US of Glasgo and DS of Beach Ponds.	37.32	Fully Supporting	Fully Supporting
CT3600-00-3-L5_01	Doaneville Pond (Griswold/Voluntown)	Eastern border of Griswold just overlapping Voluntown border, north of Rte 165 and east of Sheldon Rd. Pond formerly considered part of Glasgo Pond; separated from Glasgo Pond by Sheldon Rd.	68.36	Fully Supporting	Fully Supporting
CT3600-00-3-L7_01	Pachaug Pond (Griswold)	Impoundment of Pachaug River, eastern Griswold.	836.92	Fully Supporting	Not Assessed
CT3600-00-3-L8_01	Hopeville Pond (Griswold)	CT DEEP Hopeville Pond State Park. Impoundment of Pachaug River (DS of Pachaug Pond), Griswold.	106.6	Not Assessed	Fully Supporting
CT3605-00-1-L1_01	Billings Lake (North Stonington)	North central North Stonington.	94.88	Fully Supporting	Fully Supporting
CT3605-01-1-L1_01	Anderson Pond (North Stonington)	North central North Stonington	49.18	Not Assessed	Fully Supporting
CT3700-00-2+L1_01	West Thompson Lake (Thompson)	Impoundment of Quinebaug River in Thompson.	189.28	Not Supporting	Not Supporting
CT3700-00-5+L4_01	Aspinook Pond (Canterbury/Griswold/Lisbon)	Impoundment of Quinebaug River, parts in Canterbury, Griswold, & Lisbon (DS of Segment 02 in Quinebaug River)	308.86	Fully Supporting	Not Supporting
CT3700-23-1-L1_01	Alexander Lake (Killingly)	Dayville section of Killingly.	189.55	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT3700-28-1-L1_01	Wauregan (Quinebaug) Pond (Killingly)	Southwestern corner of Killingly.	71.06	Fully Supporting	Fully Supporting
CT3708-00-1-L1_01	Roseland Lake (Woodstock)	Southeast section of Woodstock.	96.38	Fully Supporting	Not Supporting
CT3800-00-6+L3_01	Spaulding Pond (Norwich)	Mohegan Park, Norwich (Mohegan Park Rd)	14.3	Not Assessed	Not Supporting
CT3800-05-1-L4_01	Big Pond (Lebanon/Windham)	Lebanon	38.55	Fully Supporting	Not Assessed
CT3805-00-3-L5_01	Hanover Reservoir (Sprague/Canterbury)	Sprague	22.85	Fully Supporting	Fully Supporting
CT3805-00-3-L7_01	Versailles Pond (Sprague)	Impoundment of Little River, southeast corner of Sprague.	57.2	Not Supporting	Not Assessed
CT3900-00-UL_pond_01	Browning Pond (Norwich Landfill)-01	Located southwest of Route 2/32, near exit 27 offramp, along Browning Road (rivers entering and exiting pond are intermittent), Norwich (influenced by Landfill).	0.58	Not Supporting	Not Assessed
CT3900-11-1-L1_01	Bog Meadow Reservoir (Norwich)	Norwich	91.15	Fully Supporting	Fully Supporting
CT3902-00-1-L1_01	Williams Pond (Lebanon)	Lebanon	250.3	Fully Supporting	Not Assessed
CT3906-00-1-L1_01	Gardner Lake (Salem/Montville/Bozrah)	CT DEEP Gardner Lake State Park. At junction of Salem, Montville and Bozrah.	527.29	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT4009-00-2-L4_01	Angus Park Pond (Glastonbury)	Impoundment of Roaring Brook, east of Rte 83 Glastonbury.	9.35	Not Assessed	Not Supporting
CT4013-00-1-L1_01	Millers Pond (Durham)	Durham	29.87	Fully Supporting	Fully Supporting
CT4013-05-1-L1_01	Crystal Lake (Middletown)	South of Randolph Road, Middletown.	30.96	Fully Supporting	Not Supporting
CT4013-08-1-L1_01	Dooley Pond (Middletown)	East of Rt 17, Middletown, 1.5 miles South of Randolph Rd.	15.24	Fully Supporting	Fully Supporting
CT4017-03-1-L3_01	Pattaconk Reservoir (Chester)	1.25 miles north of Rt 148, In Cockaponset State Forest and includes CT DEEP swimming area, Chester.	52.25	Not Assessed	Fully Supporting
CT4017-03-1-L4_01	Cedar Lake (Chester)	North of Rt. 148, Chester.	70.65	Not Assessed	Fully Supporting
CT4017-04-1-L1_01	Turkey Hill Reservoir (Haddam/Chester)	Straddles southern border of Haddam with Chester. Located within Cockaponset State Forest, bounded by Cedar Lake Road and Filley Road.	75.9	Fully Supporting	Fully Supporting
CT4019-00-1-L3_01	Messerschmidt Pond (Westbrook/Deep River)	Rt 145 Westbrook; straddles Westbrook/Deep River border.	81.67	Fully Supporting	Fully Supporting
CT4020-06-1-L1_01	Rogers Lake (Lyme/Old Lyme)	Lyme - Old Lyme border.	275.37	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT4200-00-4-L2_01	Somersville Pond (Somers)	Near eastern border of Somers with Enfield; pond is south of intersection of Rte 190 and Rte 186.	40.9	Fully Supporting	Not Assessed
CT4300-00-1+L2_01	West Branch Reservoir (Colebrook/Hartland)	Colebrook	201.82	Fully Supporting	Fully Supporting
CT4300-00-5+L5_01	Rainbow Reservoir (Windsor/Bloomfield/East Granby)	Northwest corner of Windsor. Impoundment of the Farmington River.	214.44	Not Supporting	Not Assessed
CT4300-05-1-L2_01	Howells Pond (Hartland)	Northwest corner of Hartland, Dish Mill Road.	14.32	Fully Supporting	Fully Supporting
CT4302-16-1-L1_01	Highland Lake (Winchester)	Southeast corner of Winchester.	448.18	Fully Supporting	Fully Supporting
CT4303-02-1-L1_01	Burr Pond (Torrington)	CT DEEP Burr Pond State Park. South of Burr Mountain Rd, Northeast corner of Torrington.	83.39	Fully Supporting	Fully Supporting
CT4304-05-2-L2_01	Triangle, Lake (Colebrook)	Northwest corner of Colebrook (North Colebrook area); lake is east of Rte 183, access by Prock Hill Road on YMCA Camp Jewell property.	49.2	Fully Supporting	Not Assessed
CT4305-00-1-L1_01	West Hill Pond (New Hartford/Barkhamsted)	Northwest corner of New Hartford.	245.54	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT4308-00-1-L2_01	Compensating Res. (L. McDonough) (Barkhamsted/New Hartford)	Southeast Barkhamsted - northeast New Hartford.	385.75	Fully Supporting	Fully Supporting
CT4315-05-1-L1_01	Birge Pond (Bristol)	West of Rt 69 and Pond Street, Bristol	11.84	Fully Supporting	Fully Supporting
CT4318-03-1-L1_01	Stratton Brook Park Pond (Simsbury)	Small impoundment of Stratton Brook, South of Rt 309. Includes CT DEEP State swimming area in Stratton Brook State Park, Simsbury.	2.35	Not Assessed	Fully Supporting
CT4401-00-1-L1_01	Batterson Park Pond (Farmington/New Britain)	Southeast Farmington - northeastern border of New Britain.	145.49	Fully Supporting	Not Supporting
CT4500-00-3-L3_01	Union Pond (Manchester)	Impoundment of Hockanum River in Manchester at Union Street.	49.9	Not Supporting	Fully Supporting
CT4601-00-1-L2_01	Silver Lake (Berlin/Meriden)	Southeast corner of Berlin, extending slightly into northeast Meriden.	140.58	Not Supporting	Fully Supporting
CT4607-00-UL_pond_01	Wadsworth Falls State Park Pond (Middletown)	Small pond within Wadsworth Falls State Park (filled and drained with connection to Coginchaug River), on Route 157 between confluence of Laurel Brook to Coginchaug River and Wadsworth Brook confluence with Coginchaug River, Middletown.	1.37	Not Assessed	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT4607-10-1-L1_01	Beseck Lake (Middlefield)	East central Middlefield.	112.83	Not Supporting	Not Supporting
CT4700-02-1-L1_01	Day Pond (Colchester)	CT DEEP Day Pond State Park. Impoundment and headwaters of Day Pond Brook. Day Pond Road (east of Rt 149), Colchester.	7.35	Not Assessed	Fully Supporting
CT4705-00-1-L1_01	Holbrook Pond (Hebron)	Northeast corner of Hebron; northeast of Rt 85.	68.67	Fully Supporting	Fully Supporting
CT4707-00-2-L2_01	Gay City Pond (Hebron)	CT DEEP Gay City State Park. Impoundment of Black Ledge River. NW corner of Hebron.	5.14	Not Assessed	Not Supporting
CT4709-04-1-L1_01	Pocotopaug Lake (East Hampton)	North of Rt 66, East Hampton.	502.28	Fully Supporting	Not Supporting
CT4710-00-1-L1_01	Bashan Lake (East Haddam)	North Central East Haddam, drains to Moodus Reservoir.	265.54	Fully Supporting	Fully Supporting
CT4710-00-1-L2_01	Moodus Reservoir (East Haddam)	Northeast East Haddam.	440.74	Fully Supporting	Fully Supporting
CT4710-06-1-L1_01	Pickerel Lake (Colchester/East Haddam)	Southeast corner of Colchester, extending slightly into E. Haddam. Drains to Moodus Reservoir	82.11	Fully Supporting	Not Supporting
CT4800-04-1-L1_01	Hayward, Lake (East Haddam)	Northeast corner of East Haddam.	172.41	Fully Supporting	Fully Supporting
CT4800-10-1-L1_01	Norwich Pond (Lyme)	Southeast corner of Lyme, located within Nehantic State Forest. Drains to Uncas Lake.	29.4	Not Assessed	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT4800-16-1-L2_01	Uncas Pond (Lyme)	Southeast Lyme, located within Nehantic State Forest.	69.03	Fully Supporting	Fully Supporting
CT5105-00-2-L1_01	Schreeder Pond (Killingworth)	CT DEEP Chatfield Hollow State Park. Impoundment of Chatfield Hollow Brook, US of Rte 80 crossing, Killingworth.	3.94	Not Assessed	Fully Supporting
CT5110-04-1-L1_01	Quonnipaug Lake (Guilford)	Guilford just east of Rt 77, 2 miles north of Rt 80.	96.1	Fully Supporting	Not Assessed
CT5111-09-1-L1_01	Cedar Pond (North Branford)	South of Lake Gaillard, North Branford, just upstream of Linsley Pond along Pisgah Brook (trib to Branford River).	21.58	Not Supporting	Not Supporting
CT5111-09-1-L2_01	Linsley Pond (Branford/North Branford)	South of Lake Gaillard, North Branford, just downstream of Cedar Pond along Pisgah Brook (trib to Branford River). Linsley Pond straddles Branford-North Branford town line.	22.92	Not Supporting	Not Supporting
CT5111-09-2-L3_01	Branford Supply Pond, Northwest (Branford)	Northwest Branford Supply Pond receives water from Pisgah Brook and Pine Gutter Brook (Int trib to Pisgah Brook). Discharges to Southeast Branford Supply Pond. Ponds located on north side of I95 (east of Lake Saltonstall area).	9.39	Not Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT5200-00-4-L2_01	Hanover Pond (Meriden)	Southwest corner of Meriden, impoundment along Quinnipiac River below Gorge.	70.53	Not Supporting	Not Supporting
CT5202-00-1-L3_01	Mixville Pond (Cheshire)	Mixville Road, Cheshire. Impoundment at head of Tenmile River	10.68	Not Assessed	Not Supporting
CT5206-01-1-L2_01	Black Pond (Meriden/Middlefield)	On Meriden/Middlefield town border, south side of Meriden Road (Route 66).	69.89	Fully Supporting	Fully Supporting
CT5207-00-1-L1_01	North Farms Reservoir (Wallingford)	0.5 miles west of Rt. 91, north side of Rt. 68, Wallingford. Headwaters of Wharton Brook.	66.07	Not Assessed	Fully Supporting
CT5207-02-1-L1_01	Allen Brook Pond (North Haven/Wallingford)	Impoundment of Allen Brook, just US mouth at confluence Wharton Brook. Includes CT DEEP State swimming area and Trout Park within Wharton Brook State Park. Between Route 5 and I91 (exit 13), Wallingford/North Haven town lines.	4.79	Not Assessed	Fully Supporting
CT5305-00-3-L1_01	Edgewood Park Pond (New Haven)	Along eastern bank of West River, just US of Chapel St, New Haven.	2.72	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT6000-00-5+L1_01	Lillinonah, Lake (Newtown/Southbury/Bridgewater/Brookfield)	Impoundment of Housatonic River, from Shepaug Dam US to top of impoundment, south side of Lovers Leap Road; Southbury and Bridgewater along east bank, Newtown, Brookfield, and New Milford along west bank.	1594.85	Fully Supporting	Not Supporting
CT6000-00-5+L2_01	Zoar, Lake (Monroe/Newtown/Oxford/Southbury)	Stevenson Dam, Oxford/Monroe, US to a line drawn between DEEP Lake Zoar wildlife area boat launch on northeast shore in Southbury, across to just DS of confluence with Gelding Brook on southwest shore in Newtown (Riverside). Includes Kettletown State Park.	580.57	Fully Supporting	Not Supporting
CT6000-00-5+L2_02	Zoar, Lake (Newtown/Southbury)	From a line drawn between DEEP Lake Zoar wildlife area boat launch on northeast shore in Southbury, across to just DS of confluence with Gelding Brook on southwest shore in Newtown (Riverside), US approximately 5 miles to Shepaug dam (L. Lillinonah).	339.25	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT6000-00-5+L4_01	Housatonic Lake (Shelton/Derby/Seymour/Oxford/Monroe)	Lake Housatonic Dam (Derby Dam), US to Stevenson Dam (division lower Lake Zoar and upper Lake Housatonic), segment includes Indian Well State Park Beach, Oxford/Monroe. First major impoundment of Housatonic River.	346.29	Fully Supporting	Not Supporting
CT6000-88-1-L1_01	Brewsters Pond (Stratford)	Stratford, east of Main Street (Rte 113).	4.02	Not Supporting	Fully Supporting
CT6002-00-1-L1_01	Washining Lake (Twin Lakes, Eastern) (Salisbury)	Northeastern Salisbury	565.31	Fully Supporting	Fully Supporting
CT6005-00-1-L1_01	Wononscopomuc (Lakeville) Lake (Salisbury)	South central Salisbury.	348.14	Fully Supporting	Not Assessed
CT6005-04-1-L1_01	Riga Lake (Salisbury)	Northwestern Salisbury, small portion over border in New York.	155.9	Fully Supporting	Fully Supporting
CT6005-04-1-L2_01	South Pond (Salisbury)	Northwest corner of Salisbury, at the end of Mt. Riga Road (western most lobe of lake in New York). Downstream of Riga Lake, on private property managed by Mt. Riga, Inc.	123	Fully Supporting	Not Assessed
CT6008-00-1-L1_01	Cream Hill Lake (Cornwall)	Northeastern Cornwall.	67.31	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT6015-00-1-L1_01	Peck Pond (Sharon)	Sharon	27.33	Fully Supporting	Not Assessed
CT6016-00-1-L3_01	Hatch Pond (Kent)	South central Kent, DS of Leonard Pond along Womenshenuck Brook, Kent.	65.66	Not Supporting	Not Supporting
CT6202-00-1-L1_01	Wangum, Lake (Canaan)	Canaan	177.88	Fully Supporting	Not Assessed
CT6301-00-1-L1_01	Wononpakook, Lake (Salisbury)	Located west of Route 41, Southwestern Salisbury (also known as Long Pond).	167.5	Fully Supporting	Not Assessed
CT6301-00-2-L2_01	Mudge Pond (Sharon)	Northwest Sharon.	211.17	Fully Supporting	Not Assessed
CT6301-08-1-L1_01	Indian Lake (Sharon/NY State Line)	Sharon	195.81	Fully Supporting	Fully Supporting
CT6302-00-1-L1_01	Hatch Pond (Sharon)	Sharon	19.82	Fully Supporting	Fully Supporting
CT6302-01-1-L2_01	Ford Pond (Sharon)	Sharon	22.9	Fully Supporting	Fully Supporting
CT6400-00-1-L5_01	Candlewood, Lake (New Fairfield/Danbury/Sherman/ New Milford)	Parts of Brookfield, Danbury, New Milford, New Fairfield, & Sherman.	5085.67	Fully Supporting	Fully Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT6400-03-1-L1_01	Squantz Pond (New Fairfield/Sherman)	Northeast corner of New Fairfield and into Sherman. Large cove of Candlewood Lake contained by Squantz Pond Dam at Route 39 crossing. Includes CT DEEP State swimming area at Squantz Pond State Park.	266.81	Fully Supporting	Fully Supporting
CT6402-00-1-L1_01	Ball Pond (New Fairfield)	New Fairfield	80.7	Fully Supporting	Not Supporting
CT6502-00-1-L2_01	Waramaug, Lake (Kent/Warren/Washington)	Southwest corner of Warren, Northwest corner of Washington. Headwaters of East Aspetuck River. Includes Lake Waramaug State Park.	640.81	Fully Supporting	Not Supporting
CT6600-01-1-L3_01	Kenosia, Lake (Danbury)	Impoundment of Still River, Danbury.	56.75	Fully Supporting	Not Supporting
CT6700-03-1-L2_01	Mohawk Pond (Goshen/Cornwall)	Goshen - Cornwall boundary within Mohawk State Forest.	16.34	Not Assessed	Fully Supporting
CT6701-00-1-L1_01	Tyler Lake (Goshen)	West central Goshen; headwaters of Marshepaug River.	187.22	Fully Supporting	Fully Supporting
CT6701-01-1-L1_01	West Side Pond (Goshen)	West central Goshen; drains to West Side Pond Brook to Tyler Lake	40.37	Fully Supporting	Fully Supporting
CT6703-00-2-L1_01	Dog Pond (Goshen)	South central Goshen; along West Branch of Bantam River	65.77	Fully Supporting	Not Assessed
CT6705-00-3-L3_01	Bantam Lake (Litchfield/Morris)	Litchfield, Morris	955.45	Fully Supporting	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT6705-14-1-L1_01	Mount Tom Pond (Litchfield/Morris/ Washington)	Northwest corner of Morris, southwest corner of Litchfield, within Mount Tom State Park.	55.14	Fully Supporting	Fully Supporting
CT6802-12-1-L1_01	Cat Swamp Pond (Woodbury)	Woodbury	28.57	Fully Supporting	Not Assessed
CT6804-02-1-L1_01	Long Meadow Pond (Bethlehem/Morris)	North central Bethlehem, borders Morris.	101.41	Fully Supporting	Fully Supporting
CT6900-40-1-L1_01	Beaver Lake (Seymour)	Seymour	68.82	Fully Supporting	Fully Supporting
CT6900-42-1-L1_01	Upper Derby Hill Reservoir (Derby)	Derby	29.93	Fully Supporting	Not Assessed
CT6905-00-1-L3_01	Winchester, Lake (Winchester)	Winchester	248.07	Fully Supporting	Fully Supporting
CT6905-00-1-L4_01	Park Pond (Winchester)	Southwest corner of Winchester; drains to East Branch of Naugatuck River	74.95	Not Assessed	Fully Supporting
CT6909-00-2-L1_01	Northfield (Reservoir) Brook Lake (Thomaston)	Impoundment of Northfield Brook, northeast corner of Thomaston.	5.3	Not Assessed	Fully Supporting
CT6910-14-1-L3_01	Black Rock Lake (Watertown)	CT DEEP Black Rock State Park. Impoundment of Purgatory Brook (trib to Branch Brook), west of Rte 6, Watertown.	9.48	Not Assessed	Fully Supporting
CT6911-07-1-L1_01	Plymouth Lake (Plymouth)	Plymouth	44.85	Fully Supporting	Not Assessed
CT6914-06-1-L1_01	Hitchcock Lake (Wolcott)	Southeast corner of Wolcott, near Cheshire border.	100.3	Not Assessed	Not Supporting

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT6914-09-1-L2_01	Chestnut Hill Reservoir (Wolcott)	Near western border of Wolcott, north side of Lyman Road, west of Route 69.	65.19	Fully Supporting	Not Assessed
CT6916-00-3-L4_01	Hop Brook Lake (Waterbury/Middlebury)	Impoundment of Hop Brook, Waterbury/Naugatuck/Middlebury.	25.77	Not Assessed	Not Supporting
CT7103-00-2-L3_01	Success Lake (Bridgeport)	US of Stillman Pond, Pembroke Lakes & Yellowmill Channel, Bridgeport.	15.79	Not Supporting	Not Assessed
CT7103-00-2-L4_01	Stillman Pond (Bridgeport)	Upstream of Yellow Mill Channel, Bridgeport. Downstream of Success Lake.	4.97	Fully Supporting	Not Assessed
CT7103-00-2-L5_01	Pembroke Lakes (Bridgeport)	Just upstream of Yellow Mill Channel, US side of Railroad crossing, and DS of Stillman Pond and Route 1 crossing, Bridgeport. (Includes Arms Pond, Remington Arms Company Pond, and Barnum Avenue Pond)	2.74	Not Supporting	Not Assessed
CT7200-00-3-L5_01	Saugatuck Reservoir (Weston/Easton/Redding)	Weston	823.11	Fully Supporting	Not Assessed
CT7301-04-1-L2_01	Popes Pond (Wilton)	Wilton	82.47	Fully Supporting	Not Assessed
CT7407-00-3-L14_01	Bargh (Mianus) Reservoir (Stamford)	Impoundment of the Mianus River in the NW corner of Stamford.	161.43	Fully Supporting	Not Assessed

Waterbody Segment ID	Waterbody Name	Location	Acres	Aquatic Life	Recreation
CT7409-00-1-L3_01	Putnam Lake Reservoir (Greenwich)	Impoundment of Horseneck Brook, just south of Rt. 15, Greenwich.	95.56	Not Supporting	Not Assessed
CT8104-00-2-L5_01	Mamanasco Lake (Ridgefield)	Northwest Ridgefield.	85.9	Not Supporting	Not Supporting

Table 2-5. Connecticut 305b Assessment Results for Estuaries

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-C1_001	LIS CB Inner - Patchogue And Menunketesuck Rivers	See Map for Boundaries. Central portion of LIS, Inner Estuary, Patchogue and Menunketesuck Rivers from mouths at Grove Beach Point, US to saltwater limits just above I95 crossing, and at I95 crossing respectively, Westbrook.	0.182	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-C1_002-SB	LIS CB Inner - Inner Clinton Harbor, Clinton	See Map for Boundaries. Central portion of LIS, Inner Estuary, SB water of inner Clinton Harbor, including mouths of Hammonasset, Indian, Hammock Rivers, and Dudley Creek (includes Esposito Beach), Clinton.	0.372	Not Supporting	Not Assessed	Fully Supporting	Commercial Harvesting
CT-C1_003-SB	LIS CB Inner - Hammonasset River, Clinton	See Map for Boundaries. Central portion of LIS, Inner Estuary, Hammonasset River SB water from mouth at inner Clinton Harbor, US to SA/SB water quality line between Currycross Road and RR track, Clinton.	0.072	Not Assessed	Not Assessed	Not Supporting	Commercial Harvesting
CT-C1_004-SB	LIS CB Inner - Hayden Creek, Clinton	See Map for Boundaries. Central portion of LIS, Inner Estuary, Hayden Creek SB water from mouth at Hammonasset River (parallel with Pratt Road), US to saltwater limit near Maple Avenue (off Route 1), Clinton.	0.009	Not Assessed	Not Assessed	Not Supporting	Commercial Harvesting
CT-C1_005	LIS CB Inner - Clinton Harbor (SA Inputs), Clinton	See Map for Boundaries. Central portion of LIS, Inner Estuary, (DISCONTINUOUS SEGMENT) SA water of upper Hammonasset, Indian, Hammock Rivers, Dudley Creek and other small tributaries, from SA/SB water quality line, US to saltwater limits, Clinton.	0.138	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-C1_006	LIS CB Inner - East and Neck Rivers, Guilford	See Map for Boundaries. Central portion of LIS, Inner Estuary, from mouth of East River at outlet into Guilford Harbor, US to saltwater limit at Planter Pond outlet (includes Neck River from mouth to above River Edge Farms Road, Guilford.	0.151	Not Assessed	Not Assessed	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-C1_007	LIS CB Inner - West River, Guilford	See Map for Boundaries. Central portion of LIS, Inner Estuary, from mouth of West River at outlet into Guilford Harbor, US to saltwater limit at Route 1 crossing, Guilford.	0.047	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-C1_009-SB	LIS CB Inner - Inner Branford Harbor, Branford	See Map for Boundaries. Central portion of LIS, Inner Estuary, from Branford Point, US to SA/SB water quality line at RR crossing above Route 146 crossing, Branford.	0.314	Not Assessed	Not Assessed	Not Supporting	Commercial Harvesting
CT-C1_012	LIS CB Inner - Morris Creek, East Haven	See Map for Boundaries. Central portion of LIS, Inner Estuary, SA water from SA/SB water quality line at New Haven Harbor (near Lighthouse Point Beach) to, US to saltwater limit above Route 337, East Haven/New Haven.	0.016	Not Supporting	Not Assessed	Not Assessed	Direct Consumption
CT-C1_013-SB	LIS CB Inner - New Haven Harbor, New Haven	See Map for Boundaries. Central portion of LIS, Inner Estuary, Inner New Haven Harbor from Sandy Point to I95 crossing (mouth of Quinnipiac and Mill Rivers, and mouth of West River), New Haven/West Haven.	2.343	Not Supporting	Not Supporting	Not Supporting	Commercial Harvesting
CT-C1_014-SB	LIS CB Inner - Quinnipiac River (mouth), New Haven	See Map for Boundaries. Central portion of LIS, Inner Estuary, from mouth at I95 crossing, US Quinnipiac River to Sackett Point Road (includes Mill River mouth BELOW Chapel Street crossing), North Haven.	0.626	Not Supporting	Not Supporting	Not Assessed	Commercial Harvesting
CT-C1_015-SB	LIS CB Inner - West River (Lower), West Haven	See Map for Boundaries. Central portion of LIS, Inner Estuary, from mouth just DS of I95 crossing (City Point, New Haven Harbor), US to SA/SB water quality line at Route 1 crossing, West Haven.	0.065	Not Supporting	Not Supporting	Not Assessed	Commercial Harvesting

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-C1_016	LIS CB Inner - Cove River, West Haven	See Map for Boundaries. Central portion of LIS, Inner Estuary, from mouth at West Haven West Beach (just DS of Ocean Avenue crossing), US to saltwater limit near Riverview Terrace, West Haven.	0.008	Not Supporting	Not Assessed	Not Assessed	Direct Consumption
CT-C1_017	LIS CB Inner - Oyster River, Milford	See Map for Boundaries. Central portion of LIS, Inner Estuary, from mouth at Oyster River Beach (just DS of New Haven Avenue crossing), US to saltwater limit near Woodmont Road, Milford.	0.012	Not Supporting	Not Assessed	Not Assessed	Direct Consumption
CT-C1_018-SB	LIS CB Inner - Milford Harbor & Gulf Pond, Milford	See Map for Boundaries. Central portion of LIS, Inner Estuary, from mouth at Burns Point, The Gulf, US Milford Harbor to New Haven Avenue crossing (saltwater limit), and US Indian River (through Gulf Pond) to saltwater limit US of I95 crossing, Milford.	0.272	Not Assessed	Not Assessed	Not Supporting	Commercial Harvesting
CT-C1_019-SB	LIS CB Inner - Housatonic River (mouth), Milford	See Map for Boundaries. Central portion of LIS, Inner Estuary, from mouth between Sniffens Point and Milford Point, US to Route 1 crossing (includes Nells Island area, lower Beaver Brook to saltwater limit, Goose Island, Crimbo Point), Milford/Stratford.	0.805	Not Supporting	Not Assessed	Not Supporting	Commercial Harvesting
CT-C1_021-SB	LIS CB Inner - Housatonic River (Upper), Orange	See Map for Boundaries. Central portion of LIS, Inner Estuary, from Route 15 crossing, US to just below Wooster Island (includes Great Flats, and mouth of Farmill River) Orange/Shelton.	0.402	Not Supporting	Not Assessed	Not Assessed	Commercial Harvesting
CT-C1_022	LIS CB Inner - West River (Upper), West Haven	See Map for Boundaries. Central portion of LIS, Inner Estuary, from SA/SB water quality line at Route 1 crossing, US past Route 34 crossing to southside of Edgewood Avenue (near Edgewood Park Pond), West Haven.	0.063	Not Supporting	Not Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-C1_023-SB	LIS CB Inner - Mill River (mouth), New Haven/Hamden	See Map for Boundaries. Central portion of LIS, Inner Estuary, from mouth at confluence with Quinnipiac River (Chapel Street crossing), New Haven, US to Footbridge crossing (just US of East Rock Road crossing), Hamden.	0.068	Not Supporting	Not Supporting	Not Supporting	Commercial Harvesting
CT-C2_001	LIS CB Shore - Westbrook Harbor (East), Westbrook	See Map for Boundaries. Central portion of LIS from Fiske Lane to Old Saltworks Road (includes Middle Beach), out approximately 1000 ft offshore, Westbrook.	0.244	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-C2_002	LIS CB Shore - Westbrook Harbor (West), Westbrook	See Map for Boundaries. Central portion of LIS from Portside Drive near Patchogue River outlet to Fiske Lane (includes Westbrook Town Beach), out approximately 1000 ft offshore, Westbrook.	0.231	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-C2_003	LIS CB Shore - Clinton Beach, Clinton	See Map for Boundaries. Central portion of LIS from Kelsey Point to Grove Beach Point area (to Portside Drive, includes Patchogue River outlet), out approximately 1000 ft offshore, Clinton/Westbrook.	0.516	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-C2_004	LIS CB Shore - Outer Clinton Harbor, Clinton	See Map for Boundaries. Central portion of LIS from West Rock to Kelsey Point area (outer Clinton Harbor SA water includes Hammonasset, Indian, and Hammock River outlets, and Town Beach), out approximately 1000 ft offshore, Clinton.	0.505	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-C2_005	LIS CB Shore - Hammonasset Beach, Madison	See Map for Boundaries. Central portion of LIS from Webster Point to West Rock area (includes Hammonasset State Park Beach), out approximately 1000 ft offshore, Madison.	0.583	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-C2_006	LIS CB Shore - Madison Beaches (East), Madison	See Map for Boundaries. Central portion of LIS from West Warf to Webster Point area (includes West Wharf and East Wharf Beaches, Tuxis Island, and tidal Fence Creek), out approximately 1000 ft offshore, Madison.	0.399	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-C2_007	LIS CB Shore - Madison Beaches (West), Madison	See Map for Boundaries. Central portion of LIS from Hogshead Point to West Wharf area (includes Surf Club Beach, Chipman Point), out approximately 1000 ft offshore, Madison.	0.482	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-C2_008	LIS CB Shore - Guilford Harbor, Guilford	See Map for Boundaries. Central portion of LIS from Mulberry Point to Hogshead Point area (includes Jacobs Beach, Guilford Point), out approximately 1000 ft offshore, Guilford.	0.481	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-C2_009	LIS CB Shore - Indian Cove, Guilford	See Map for Boundaries. Central portion of LIS from Sachem Head to Mulberry Point area (includes Vineyard Point), out approximately 1000 ft offshore, Guilford.	0.431	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-C2_010	LIS CB Shore - Joshua Cove & Island Bay, Guilford	See Map for Boundaries. Central portion of LIS from Clark Point to Sachem Head area (includes Horse and Foskett Islands), out approximately 1000 ft offshore, Guilford.	0.738	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-C2_011	LIS CB Shore - Stony Creek (East), Branford	See Map for Boundaries. Central portion of LIS from Flying Point to Clark Point area (includes Hoadley Neck, Narrows Island), out approximately 1000 ft offshore, Branford/Guilford.	0.546	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-C2_012	LIS CB Shore - Stony Creek (West), Branford	See Map for Boundaries. Central portion of LIS from Brown Point to Flying Point area (includes Stony Creek Beach, Saint Helena Island, Juniper Point, Pleasant Point), out approximately 1000 ft offshore, Branford.	0.379	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-C2_013	LIS CB Shore - Indian Neck, Branford	See Map for Boundaries. Central portion of LIS from Clam Island to Brown Point area (includes Haycock Point), out approximately 1000 ft offshore, Branford.	0.567	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-C2_014-SB	LIS CB Shore - Branford Harbor, Branford	See Map for Boundaries. Central portion of LIS from Johnson Point to Clam Island area (includes Branford Point Beach, Lovers Island, Indian Neck Point, Linden Point), out approximately 1000 ft offshore, Branford.	0.648	Not Assessed	Fully Supporting	Fully Supporting	Commercial Harvesting
CT-C2_015-SB	LIS CB Shore - Pages Cove, Branford	See Map for Boundaries. Central portion of LIS from Mansfield Point to Johnson Point area (includes Clark Avenue Beach, Farm River Gut, Kelsey Island, Gull Rocks), out approximately 1000 ft offshore, Branford.	0.731	Not Assessed	Fully Supporting	Fully Supporting	Commercial Harvesting
CT-C2_016-SB	LIS CB Shore - New Haven Harbor (East), East Haven	See Map for Boundaries. Central portion of LIS from Morgan Point to Mansfield Point area (includes East Haven Beach, South End Point, Momauguin), out approximately 1000 ft offshore, East Haven.	0.371	Not Assessed	Fully Supporting	Fully Supporting	Commercial Harvesting
CT-C2_017-SB	LIS CB Shore - Morris Cove, New Haven	See Map for Boundaries. Central portion of LIS from Black Rock to Morgan Point area (includes Lighthouse Point Beach, Lighthouse Point, South End), out approximately 1000 ft offshore, New Haven.	0.586	Not Supporting	Fully Supporting	Fully Supporting	Commercial Harvesting
CT-C2_018-SB	LIS CB Shore - New Haven Harbor (West), West Haven	See Map for Boundaries. Central portion of LIS from Oyster River Point to Sandy Point area (includes West Haven West Beach, West Haven East Beach, West Shore, Sandy Point), out approximately 1000 ft offshore, West Haven.	0.789	Not Supporting	Fully Supporting	Not Supporting	Commercial Harvesting

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-C2_019-SB	LIS CB Shore - New Haven Harbor (West), Milford	See Map for Boundaries. Central portion of LIS from Merwin Point to Oyster River Point area (includes Woodmont Beach, Oyster River outlet), out approximately 1000 ft offshore, Milford.	0.295	Not Assessed	Fully Supporting	Fully Supporting	Commercial Harvesting
CT-C2_020-SB	LIS CB Shore - New Haven Harbor (SWest), Milford	See Map for Boundaries. Central portion of LIS from SA/SB water quality line at Pond Point to Merwin Point area (includes Anchor Beach #1, Anchor Beach #2, Morningside), out approximately 1000 ft offshore, Milford.	0.385	Not Assessed	Fully Supporting	Fully Supporting	Commercial Harvesting
CT-C2_021	LIS CB Shore - Bayview, Milford	See Map for Boundaries. Central portion of LIS from SA/SB water quality line at Welches Point to SA/SB water quality line at Pond Point area (includes only SA water between New Haven Harbor and Gulf), out approximately 1000 ft offshore, Milford.	0.331	Not Assessed	Not Assessed	Fully Supporting	Direct Consumption
CT-C2_022-SB	LIS CB Shore - The Gulf, Milford	See Map for Boundaries. Central portion of LIS from SA/SB WQ line at Western end of Silver Sands State Park Beach to SA/SB WQ line at Welches Point area (includes Silver Sands and Gulf Beaches) all SB water in The Gulf out to Charles Island, Milford.	0.593	Not Assessed	Fully Supporting	Fully Supporting	Commercial Harvesting
CT-C2_023	LIS CB Shore - Walnut Beach, Milford	See Map for Boundaries. Central portion of LIS from SA/SB WQ line at Milford Point to SA/SB WQ line at Silver Sands State Park Beach area (includes Walnut Beach, all SA, Housatonic River mouth to The Gulf), out approximately 1000 ft offshore, Milford.	0.577	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-C2_024-SB	LIS CB Shore - Housatonic River mouth, Stratford	See Map for Boundaries. Central portion of LIS from SA/SB WQ line at Stratford Point to SA/SB WQ line at Milford Point area (includes Short Beach, entire mouth of Housatonic River) all SB waters out approximately 1000-4000 ft offshore, Stratford.	0.64	Not Supporting	Fully Supporting	Not Supporting	Commercial Harvesting
CT-C3_001	LIS CB Midshore - Westbrook Harbor, Westbrook	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Westbrook Harbor), out to 50 ft contour and basin boundary separating Eastern/Central.	2.692	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-C3_002	LIS CB Midshore - Duck Island area, Clinton	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Clinton Beach, includes Duck Island and Menunketesuck Island areas), out to 50 ft contour, Clinton.	3.619	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-C3_003	LIS CB Midshore - Outer Clinton Harbor, Clinton	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Clinton Harbor), out to 50 ft contour, Clinton.	2.524	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-C3_004	LIS CB Midshore - Hammonasset Beach area, Madison	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Madison Beaches, including area nearshore Hammonasset Beach State Park), out to 50 ft contour, Madison.	5.554	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-C3_005	LIS CB Midshore - Madison	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Hogshead Point), out to 50 ft contour, Madison.	8.348	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-C3_006	LIS CB Midshore - Outer Guilford Harbor, Guilford	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Guilford Harbor), out to 50 ft contour, Guilford.	8.364	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-C3_007	LIS CB Midshore - Sachem Head Harbor, Guilford	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Sachem Head), out to 50 ft contour, Guilford.	7.089	Fully Supporting	Not Assessed	Fully Supporting	Direct Consumption
CT-C3_008	LIS CB Midshore - Branford	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Haycock Point to Smith Island), out to 50 ft contour, Branford.	8.379	Fully Supporting	Not Assessed	Fully Supporting	Direct Consumption
CT-C3_009-I	LIS CB Midshore - Thimble Islands, Branford	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Thimble Islands), out to 50 ft contour, Branford.	1.457	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-C3_010	LIS CB Midshore - Indian Neck, Branford	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Indian Neck, Little Point), out to 50 ft contour, Branford.	8.554	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-C3_011	LIS CB Midshore - East Haven	See Map for Boundaries. Central portion of LIS, SA water from SA/SB water boundary along outer New Haven and Branford Harbors out to 50 ft contour, East Haven.	8.152	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-C3_012-SB	LIS CB Midshore - Outer Branford Harbor, Branford	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (East Haven Town Beach to Clam Island), out to extent of SB water at SA/SB water quality line for outer Branford Harbor, Branford.	3.83	Fully Supporting	Not Assessed	Fully Supporting	Commercial Harvesting
CT-C3_013-SB	LIS CB Midshore - New Haven Harbor, East Haven	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (South End, Morgan Point), out to extent of SB water at SA/SB water quality line for outer New Haven Harbor, East Haven.	6.051	Not Supporting	Not Assessed	Fully Supporting	Commercial Harvesting

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-C3_014-SB	LIS CB Midshore - New Haven Harbor, West Haven	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Morningside to West Shore), out to extent of SB water at SA/SB water quality line for outer New Haven Harbor, Milford/West Haven.	7.961	Not Supporting	Not Assessed	Fully Supporting	Commercial Harvesting
CT-C3_015-SB	LIS CB Midshore - New Haven Harbor, New Haven	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (West Shore to Morgan Point), from Sandy Point out to segments CT-C3_013/014, outer New Haven Harbor, West Haven/New Haven.	4.561	Not Supporting	Not Assessed	Fully Supporting	Commercial Harvesting
CT-C3_016	LIS CB Midshore - West Haven	See Map for Boundaries. Central portion of LIS, SA water from SA/SB water boundary along outer New Haven Harbor, out to 50 ft contour, West Haven.	6.121	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-C3_017	LIS CB Midshore - Milford	See Map for Boundaries. Central portion of LIS, SA water from SA/SB water boundary along outer New Haven Harbor, out to 50 ft contour, Milford.	8.095	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-C3_018	LIS CB Midshore - Fort Trumbull, Milford	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (Silver Sands State Park area, water beyond Island), out to 50 ft contour, Milford.	11.311	Not Supporting	Not Assessed	Fully Supporting	Direct Consumption
CT-C3_019-I	LIS CB Midshore - Outer Silver Sand Beach, Milford	See Map for Boundaries. Central portion of LIS from SA/SB water quality line along beach, out to Island (THE GULF SA water inside of Island at Silver Sands State Park Beach), Milford.	0.573	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-C3_020	LIS CB Midshore - Milford Point, Milford	See Map for Boundaries. Central portion of LIS from approximately 1000 ft offshore (SA water surrounding SB water, outer mouth of Housatonic River), out to 50 ft contour, Milford.	10.663	Not Supporting	Not Assessed	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-C4_001	LIS CB Offshore - Madison	See Map for Boundaries. Central portion of LIS from 50ft contour to CT/NY State line.	37.978	Fully Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-C4_002	LIS CB Offshore - Guilford	See Map for Boundaries. Central portion of LIS from 50ft contour to CT/NY State line.	27.166	Fully Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-C4_003	LIS CB Offshore - East Haven	See Map for Boundaries. Central portion of LIS from 50ft contour to CT/NY State line.	35.333	Fully Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-C4_004	LIS CB Offshore - West Haven	See Map for Boundaries. Central portion of LIS from 50ft contour to CT/NY State line.	34.332	Not Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-C4_005	LIS CB Offshore - Milford	See Map for Boundaries. Central portion of LIS from 50ft contour to CT/NY State line.	24.248	Not Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-E1_001-SB	LIS EB Inner - Pawcatuck River (01), Stonington	See Map for Boundaries. Eastern portion of LIS, Inner Estuary in Pawcatuck River from Stanton Weir Point US to Saltwater limit, parallel to RR and Mechanic Street, Clarks Village, (Stonington).	0.103	Not Supporting	Not Supporting	Not Supporting	Commercial Harvesting
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	See Map for Boundaries. Eastern portion of LIS, Inner Estuary in Pawcatuck River from mouth at Pawcatuck Point, US to Stanton Weir Point.	0.313	Not Supporting	Not Supporting	Fully Supporting	Commercial Harvesting
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Inner Wequetequock Cove from RR crossing US to saltwater limit, adjacent to Route 1, Stonington.	0.094	Not Supporting	Not Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-E1_004-SB	LIS EB Inner - Outer Stonington Harbor, Stonington	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Outer Stonington Harbor from SB/SA water quality boundary near Wamphassuc Point to offshore Stonington Point, US to RR crossing, Stonington.	0.638	Fully Supporting	Fully Supporting	Fully Supporting	Commercial Harvesting
CT-E1_005	LIS EB Inner - Inner Stonington Harbor, Stonington	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Inner Stonington Harbor from SB/SA water quality boundary at RR crossing, US to Saltwater limit near Route 1 crossing, Stonington.	0.226	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-E1_006	LIS EB Inner - Inner Quiambaug Cove, Stonington	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Inner Quiambaug Cove from RR crossing, US to Saltwater limit, above Route 1 crossing, adjacent to Cove Road, Stonington.	0.114	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E1_007-SB	LIS EB Inner - Mystic River (Mouth), Stonington	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Mouth of Mystic River Estuary from RR crossing, US to Saltwater limit, above Route 95 crossing, adjacent to Mill Street, Stonington (Old Mystic).	0.453	Fully Supporting	Not Assessed	Fully Supporting	Commercial Harvesting
CT-E1_008-SB	LIS EB Inner - Mystic Harbor, Groton/Stonington	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Mystic Harbor Morgan Point to RR crossing mouth of Mystic River near Murphy Point and RR crossing mouth Pequotsepos Cove on Northeast of Mason Island, Groton/Stonington.	0.954	Fully Supporting	Fully Supporting	Fully Supporting	Commercial Harvesting
CT-E1_009	LIS EB Inner - Beebe Cove (Mystic Harbor), Groton	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Beebe Cove (Mystic Harbor) waters west of two RR crossings along shore, Groton.	0.207	Not Assessed	Not Assessed	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-E1_010	LIS EB Inner - Palmer Cove (Inner), Groton	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Inner Palmer Cove waters from North side of Groton Long Point Road crossing, past RR crossings to saltwater limit, Groton.	0.113	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E1_011-SB	LIS EB Inner - Mumford Cove (Inner), Groton	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Inner Mumford Cove along east side of Bluff Point State Park shore, and North of Groton Long Point to saltwater limit near RR crossing, Groton.	0.219	Not Assessed	Not Assessed	Not Supporting	Commercial Harvesting
CT-E1_012	LIS EB Inner - Poquonuck River (Mouth), Groton	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Poquonuck River from mouth at Baker Cove (along East of Groton-New London Airport), US to saltwater limit just US of RR crossing, Groton.	0.367	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E1_013	LIS EB Inner - Baker Cove, Groton	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Baker cove from Avery Point and tip of Pine Island, to mouth of Poquonuck River (South of Groton-New London Airport), Groton.	0.314	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E1_014-SB	LIS EB Inner - Thames River (Mouth), New London	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, mouth of Thames River from Eastern Point (North of Avery Point), US to I95 crossing (Includes Inner New London Harbor), Groton.	1.994	Not Supporting	Fully Supporting	Not Supporting	Commercial Harvesting
CT-E1_015-SB	LIS EB Inner - Thames River (middle), Ledyard	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Thames River from I95 crossing, US to just below outlet of Poquetanuck Cove (near Walden Island), and adjacent to Route 12 at Cardinal Lane intersection, Ledyard.	3.316	Not Supporting	Not Supporting	Not Supporting	Commercial Harvesting

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-E1_016-SB	LIS EB Inner - Thames River (Upper), Norwich	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Thames River from just below outlet of Poquetanuck Cove (near Walden Island), adjacent to Route 12 at Cardinal Lane intersection, US to first dams in Yantic and Shetucket Rivers, Norwich.	1.555	Not Supporting	Not Supporting	Not Supporting	Commercial Harvesting
CT-E1_017	LIS EB Inner - Alewife Cove, Waterford/New London	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Alewife Cove from outlet at Waterford Beach Park Picnic Area, US to Saltwater limit at Niles Hill Road crossing, Waterford.	0.063	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-E1_019	LIS EB Inner - Jordan Cove, Waterford	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Jordan Cove from outlet at Pleasure Beach, US past RR crossing, to Saltwater limit at outlet dam of Jordan Mill Pond, adjacent to Route 156, Waterford.	0.191	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E1_020	LIS EB Inner - Niantic River (mouth), Niantic	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Niantic River (Inner Niantic Bay) from outlet at Route 156 and RR crossing, US to saltwater limit in Banning Cove (between Route 1 crossing and I95/I395), East Lyme/Waterford.	1.305	Not Supporting	Not Supporting	Not Supporting	Direct Consumption
CT-E1_021	LIS EB Inner - Pattagansett Rvr (mouth), East Lyme	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Pattagansett River from outlet at RR crossing, US to saltwater limit at Route 156 crossing, East Lyme.	0.048	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E1_022	LIS EB Inner - Bride Brook, East Lyme	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Bride Brook from outlet at RR crossing, Eastern end of Rocky Neck State Park Beach, US to saltwater limit at Route 156 crossing, East Lyme.	0.029	Not Assessed	Not Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-E1_023	LIS EB Inner - Fourmile River (mouth), Old Lyme	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Fourmile River from outlet at RR crossing, Western end of Rocky Neck State Park Beach, US to saltwater limit at Route 156 crossing, Old Lyme.	0.031	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E1_024-SB	LIS EB Inner - Connecticut River (mouth), Old Lyme	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Connecticut River from outlet at Griswold Point, US to I 95 crossing (Includes North and South Coves, lower Lieutenant River and waters around Great Island upto RR crossings), Old Lyme.	3.284	Not Assessed	Not Assessed	Not Supporting	Commercial Harvesting
CT-E1_026-SB	LIS EB Inner - Black Hall River (upper), Old Lyme	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Black Hall River from Route 156 crossing, US to saltwater limit at Mile Creek Road crossing, Old Lyme.	0.041	Not Assessed	Not Assessed	Not Supporting	Commercial Harvesting
CT-E1_027-SB	LIS EB Inner - Duck River, Old Lyme	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Duck River from RR crossing near Route 156 crossing, US to saltwater limit at Elm Street, Old Lyme.	0.007	Not Assessed	Not Supporting	Not Supporting	Commercial Harvesting
CT-E1_028-SB	LIS EB Inner - Lieutenant River, Old Lyme	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Lieutenant River from Route 156 crossing, US to saltwater limit adjacent to Longacre Lane, Old Lyme.	0.105	Not Assessed	Not Supporting	Not Assessed	Commercial Harvesting
CT-E1_032	LIS EB Inner - Oyster River Area, Old Saybrook	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Oyster River, Plum Bank Creek, and Back River from mouths on Indian Harbor, US to saltwater limits (Oyster River is to RR crossing above Route 1), Old Saybrook.	0.098	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E1_033	LIS EB Inner - Pequotsepos Cove, Stonington	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Pequotsepos Cove. From outlet into Mystic Harbor at RR crossing to inlet of Pequotsepos Brook, Stonington.	0.024	Not Supporting	Insufficient Information	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	See Map for Boundaries. Eastern portion of LIS from RR crossing on east side of Wequetequock Cove to mouth of Pawcatuck River, out approximately 1000 ft offshore (Little Narragansett Bay).	0.619	Not Supporting	Not Supporting	Not Supporting	Direct Consumption
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	See Map for Boundaries. Eastern portion of LIS from Stonington Point to RR crossing on west side of Wequetequock Cove, out approximately 1000 ft offshore.	0.668	Not Supporting	Not Supporting	Not Supporting	Direct Consumption
CT-E2_003	LIS EB Shore - Outer Quiambaug Cove, Stonington	See Map for Boundaries. Eastern portion of LIS from Mouth of inner Quiambaug Cove at RR crossing to SB/SA water quality boundary at mouth of Stonington Harbor, out approximately 1000 ft offshore.	0.388	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E2_004	LIS EB Shore - Wilcox Cove (Mason Is.), Stonington	See Map for Boundaries. Eastern portion of LIS from tip of Mason Island to Mouth of inner Quiambaug Cove, out approximately 1000 ft offshore.	0.694	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E2_005	LIS EB Shore - Mouth Mystic River, Stonington	See Map for Boundaries. Eastern portion of LIS from western most tip of Mason Island along SB/SA water quality boundary to eastern most tip of Mason Island, out approximately 1000 ft offshore.	0.35	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E2_006	LIS EB Shore - West Cove (Groton Long Pt), Groton	See Map for Boundaries. Eastern portion of LIS from tip of Groton Long Point to Morgan Point at SB/SA water quality boundary for Mystic River mouth, out approximately 1000 ft offshore.	0.422	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-E2_007	LIS EB Shore - Outer Mumford Cove, Groton	See Map for Boundaries. Eastern portion of LIS from Mumford Point to eastern most tip of Groton Long Point (includes outer Mumford Cove and all of Venetian Harbor), out approximately 1000 ft offshore.	0.555	Not Assessed	Not Assessed	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-E2_008	LIS EB Shore - Bluff Point, Groton	See Map for Boundaries. Eastern portion of LIS from SB/SA water quality boundary at Bushy Point Beach to Mumford Point, out approximately 1000 ft offshore.	0.235	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E2_009-SB	LIS EB Shore - Thames River Mouth (East), Groton	See Map for Boundaries. Eastern portion of LIS from Eastern Point in mouth of Thames River to SB/SA water quality boundary at Bushy Point Beach, out approximately 1000 ft offshore.	0.4	Not Supporting	Fully Supporting	Fully Supporting	Commercial Harvesting
CT-E2_010-SB	LIS EB Shore - Thames Rvr Mouth (West), New London	See Map for Boundaries. Eastern portion of LIS from mouth of Alewife Cove to Quinnipeag Rocks along western shore of Thames River mouth, out approximately 1000 ft offshore (SB Water Quality).	0.299	Not Supporting	Fully Supporting	Not Supporting	Commercial Harvesting
CT-E2_011-SB	LIS EB Shore - Thames Rvr Mouth (West), Waterford	See Map for Boundaries. Eastern portion of LIS from Magonk Point to mouth of Alewife Cove, out approximately 1000 ft offshore (SB Water Quality).	0.486	Not Supporting	Fully Supporting	Fully Supporting	Commercial Harvesting
CT-E2_012	LIS EB Shore - Outer Jordan Cove, Waterford	See Map for Boundaries. Eastern portion of LIS from Millstone Point to SB/SA water quality boundary at Magonk Point, out approximately 1000 ft offshore. Waters adjacent to Millstone Power Plant.	0.465	Fully Supporting	Fully Supporting	Not Supporting	Direct Consumption
CT-E2_013	LIS EB Shore - Niantic Bay (East), Waterford	See Map for Boundaries. Eastern portion of LIS from Smith Avenue at junction with Route 156 to Millstone Point, out approximately 1000 ft offshore. Waters adjacent to Millstone Power Plant.	0.444	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-E2_014	LIS EB Shore - Niantic Bay (West), East Lyme	See Map for Boundaries. Eastern portion of LIS from Pond Point to Smith Avenue at junction with Route 156, out approximately 1000 ft offshore. Waters adjacent to Millstone Power Plant.	0.302	Not Supporting	Fully Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-E2_015	LIS EB Shore - Niantic Bay (Black Pt), East Lyme	See Map for Boundaries. Eastern portion of LIS from Point East of Griswald Island, past Black Point to Pond Point in Niantic Bay, out approximately 1000 ft offshore.	0.554	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-E2_016	LIS EB Shore - Pattagansett River Mouth, East Lyme	See Map for Boundaries. Eastern portion of LIS from Seal Rock (Great Neck) to Point East of Griswold Island (entire mouth of Pattagansett River, including area around Watts Island), out approximately 1000 ft offshore.	0.322	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E2_017	LIS EB Shore - Rocky Neck (Fourmile Rvr), Old Lyme	See Map for Boundaries. Eastern portion of LIS from Hatchett Point to Seal Rock (Great Neck) Includes Rocky Neck State Park Beach, out approximately 1000 ft offshore.	0.531	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-E2_018	LIS EB Shore - Soundview Beach, Old Lyme	See Map for Boundaries. Eastern portion of LIS from SB/SA water quality boundary at Hawks Nest Beach area to Hatchett Point (Includes Soundview Beach), out approximately 1000 ft offshore.	0.332	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-E2_019-SB	LIS EB Shore - CT River Mouth (East), Old Lyme	See Map for Boundaries. Eastern portion of LIS from Griswold Point to SB/SA water quality boundary at Hawks Nest Beach area (Includes White Sands Beach), out approximately 1000 ft offshore. (SB water)	0.423	Not Assessed	Fully Supporting	Not Assessed	Commercial Harvesting
CT-E2_020	LIS EB Shore - Willard Bay, Old Saybrook	See Map for Boundaries. Eastern portion of LIS from Cornfield Point to SB/SA water quality boundary at Lynde Point, out approximately 1000 ft offshore. (SB water)	0.5	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E2_021	LIS EB Shore - Plum Bank, Old Saybrook	See Map for Boundaries. Eastern portion of LIS from Plum Bank Creek to Cornfield Point (includes Town Beach), out approximately 1000 ft offshore.	0.182	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-E2_022	LIS EB Shore - Indiantown Harbor, Old Saybrook	See Map for Boundaries. Eastern portion of LIS from Long Rock to Plum Bank Creek (includes the mouth of Oyster River and Back River, and Plum Bank Creek), out approximately 1000 ft offshore.	0.389	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-E3_001	LIS EB Midshore - Stonington	See Map for Boundaries. Eastern portion of LIS from approximately 1000 ft offshore (Little Narragansett Bay), out to CT/NY State line.	0.585	Not Supporting	Not Supporting	Not Supporting	Direct Consumption
CT-E3_002	LIS EB Midshore - Stonington Harbor	See Map for Boundaries. Eastern portion of LIS from approximately 1000 ft offshore, Enders Island to Stonington Point, out to CT/NY State line.	4.414	Not Assessed	Not Assessed	Fully Supporting	Direct Consumption
CT-E3_003	LIS EB Midshore - Groton, Mystic River	See Map for Boundaries. Eastern portion of LIS from approximately 1000 ft offshore, Groton Long Point to Enders Island, out to CT/NY State line.	2.853	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E3_004	LIS EB Midshore - Groton, Thames River	See Map for Boundaries. Eastern portion of LIS from SB/SA water quality boundary out to 50 ft contour offshore of Goshen Point, Waterford, to approximately 1000 ft offshore, Groton Long Point, out to CT/NY State line.	6.738	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E3_005-SB	LIS EB Midshore - Waterford, Thames River	See Map for Boundaries. Eastern portion of LIS from SB/SA water quality boundary, approximately 1000 ft offshore of Magonk Point, Waterford to Bushy Point, Groton, out to SB/SA water quality boundary (Thames River mouth).	5.256	Not Supporting	Not Assessed	Fully Supporting	Commercial Harvesting
CT-E3_006	LIS EB Midshore - Niantic Bay	See Map for Boundaries. Eastern portion of LIS from approximately 1000 ft offshore Black Point, East Lyme to Magonk Point (SB/SA water quality boundary) Waterford, out to 50 ft contour (Niantic Bay).	6.179	Not Supporting	Not Assessed	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-E3_007	LIS EB Midshore - East Lyme, Rocky Neck	See Map for Boundaries. Eastern portion of LIS from approximately 1000 ft offshore Hatchett Point to Black Point, East Lyme, out to 50 ft contour (offshore of mouths of Fourmile and Pattagasett Rivers).	2.93	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-E3_008	LIS EB Midshore - Old Lyme, CT River	See Map for Boundaries. Eastern portion of LIS from SB/SA water quality boundary near CT River mouth to approximately 1000 ft offshore Hatchett Point, Old Lyme, out to 50 ft contour (offshore of Connecticut River).	3.517	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-E3_009-SB	LIS EB Midshore - Old Saybrook, CT River	See Map for Boundaries. Eastern portion of LIS from SB/SA water quality boundary, Lynde Point in CT river mouth Old Saybrook, to approximately 1000 ft offshore East of White Sands Beach, Old Lyme (Mouth of Connecticut River).	2.89	Fully Supporting	Not Assessed	Fully Supporting	Commercial Harvesting
CT-E3_010	LIS EB Midshore - Old Saybrook	See Map for Boundaries. Eastern portion of LIS from approximately 1000 ft offshore Guardhouse Point, to SB/SA water quality boundary, Old Saybrook (Mouth of Connecticut River), out to 50 ft contour.	4.409	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-E3_011	LIS EB Midshore - Old Saybrook, Indian Harbor	See Map for Boundaries. Eastern portion of LIS from approximately 1000 ft offshore Old Kelsey Point, to Guardhouse Point, Old Saybrook, (outer Indiantown Harbor and Plum Bank), out to 50 ft contour.	5.639	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-E3_012	LIS EB Midshore - Westbrook	See Map for Boundaries. Eastern portion of LIS from approximately 1000 ft offshore Old Kelsey Point (outer Westbrook Harbor), out to 50 ft contour. Odd shape due to 50 ft contour.	7.407	Fully Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-E4_001	LIS EB Offshore - Waterford	See Map for Boundaries. Eastern portion of LIS from 50ft contour to CT/NY State line.	5.935	Fully Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-E4_002	LIS EB Offshore - East Lyme	See Map for Boundaries. Eastern portion of LIS from 50ft contour to CT/NY State line.	15.984	Fully Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-E4_003	LIS EB Offshore - Old Lyme	See Map for Boundaries. Eastern portion of LIS from 50ft contour to CT/NY State line.	11.837	Fully Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-E4_004	LIS EB Offshore - Old Saybrook	See Map for Boundaries. Eastern portion of LIS from 50ft contour to CT/NY State line.	9.44	Fully Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-E4_005	LIS EB Offshore - Westbrook	See Map for Boundaries. Eastern portion of LIS from 50ft contour to CT/NY State line.	6.07	Fully Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-W1_001-SB	LIS WB Inner - Bridgeport Harbor, Bridgeport	See Map for Boundaries. Western portion of LIS from SA/SB water quality line at mouth at Pleasure Beach area, US to saltwater limit in Pequonnock River and Lewis Gut (includes Yellow Mill Channel, Johnsons Creek, all SB water of Harbor area), Bridgeport.	1.434	Not Supporting	Not Supporting	Not Supporting	Commercial Harvesting
CT-W1_002-SB	LIS WB Inner - Black Rock Harbor, Bridgeport	See Map for Boundaries. Western portion of LIS, Inner Estuary, from SA/SB water quality line at mouth at Fayerweather Island area, US to saltwater limit at I95 (includes Burr Creek, Cedar Creek, all SB water of Harbor area), Bridgeport.	0.442	Not Supporting	Not Supporting	Not Supporting	Commercial Harvesting
CT-W1_003-SB	LIS WB Inner - Ash Creek, Fairfield	See Map for Boundaries. Western portion of LIS, Inner Estuary, from SA/SB water quality line at mouth near South Benson Road, US to saltwater limit at I95, Fairfield/Bridgeport.	0.157	Not Supporting	Not Supporting	Not Supporting	Commercial Harvesting

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-W1_004	LIS WB Inner - Pine Creek, Fairfield	See Map for Boundaries. Western portion of LIS, Inner Estuary, from mouth at Pine Creek Point, US to saltwater limit at Oldfield Road crossing, Fairfield.	0.06	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-W1_005	LIS WB Inner - Southport Harbor, Fairfield	See Map for Boundaries. Western portion of LIS, Inner Estuary, from mouth parallel to Willow Street, US to Harbor Road crossing, Fairfield.	0.072	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-W1_006	LIS WB Inner - Mill River, Fairfield	See Map for Boundaries. Western portion of LIS, Inner Estuary, from Harbor Road crossing, US to saltwater limit at Sturges Road crossing (includes Mill Pond section of Mill River), Fairfield.	0.033	Not Supporting	Not Supporting	Not Supporting	Direct Consumption
CT-W1_007	LIS WB Inner - Sasco Brook, Westport	See Map for Boundaries. Western portion of LIS, Inner Estuary, from mouth DS of Pequot Avenue crossing, US to saltwater limit at Route 1 crossing, Westport/Fairfield.	0.022	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W1_008	LIS WB Inner - Sherwood Millpond, Westport	See Map for Boundaries. Western portion of LIS, Inner Estuary, from mouth at Compo Cove, US to saltwater limit south of RR and I95 (includes Mill Creek, Grove Point, and all of Greens Farm Brook surrounding Sherwood Island State Park), Westport.	0.168	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-W1_009	LIS WB Inner - Grays Creek, Westport	See Map for Boundaries. Western portion of LIS, Inner Estuary, from SA/SB water quality line at mouth on Saugatuck River Estuary, US to saltwater limit at Compo Road, Westport.	0.036	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-W1_010-SB	LIS WB Inner - Saugatuck River (mouth), Westport	See Map for Boundaries. Western portion of LIS, Inner Estuary, from SA/SB water quality line at mouth of Saugatuck River Estuary (at Bluff Point across to Owenoke), US to RR crossing, DS of I95 crossing (includes Kitts Island, Burritt Cove), Westport.	0.645	Not Assessed	Not Assessed	Not Supporting	Commercial Harvesting

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	See Map for Boundaries. Western portion of LIS, Inner Estuary, from SA/SB water quality line at mouth of Norwalk Harbor (Calf Pasture Point), US to saltwater limit at Wall Street Crossing (EXCLUDES eastern cove of Marvin Beach), Norwalk.	0.942	Not Supporting	Not Supporting	Not Supporting	Commercial Harvesting
CT-W1_013-SB	LIS WB Inner - Norwalk Hrbr (MarvinBeach), Norwalk	See Map for Boundaries. Western portion of LIS, Inner Estuary, eastern embayment of Norwalk Harbor, from Gregory Point to Fitch Point into shore (includes Marvin Beach), Norwalk.	0.044	Not Supporting	Not Supporting	Fully Supporting	Commercial Harvesting
CT-W1_014-SB	LIS WB Inner - Fivemile River (mouth), Norwalk	See Map for Boundaries. Western portion of LIS, Inner Estuary, from SA/SB water quality line at mouth of Harbor (Butlers Island to Roton Point), US to saltwater limit at Cudlipp Street Crossing (Route 136), Norwalk.	0.164	Not Assessed	Not Assessed	Not Assessed	Commercial Harvesting
CT-W1_015-SB	LIS WB Inner - Cove Harbor, Stamford	See Map for Boundaries. Western portion of LIS, Inner Estuary, from SA/SB water quality line at mouth (Greenway Island to Pratt Island Two), to Holly Pond outlet at Brush Island (includes Quigley, East (Cove Island), and Weed Beaches), Stamford/Darien.	0.466	Not Assessed	Fully Supporting	Not Assessed	Commercial Harvesting
CT-W1_016-SB	LIS WB Inner - Holly Pond, Stamford	See Map for Boundaries. Western portion of LIS, Inner Estuary, from Holly Pond outlet at Brush Island (flows into Cove Harbor), US to saltwater limit at Route 1 crossing (just DS of I95 crossing), Stamford/Darien.	0.31	Not Assessed	Not Assessed	Not Supporting	Commercial Harvesting
CT-W1_017-SB	LIS WB Inner - Stamford Harbor (mouth), Stamford	See Map for Boundaries. Western portion of LIS, Inner Estuary, from SA/SB water quality line at mouth of Harbor (Davenport Point to Shippan Point), up to Cook Road and across to Yacht Club, Stamford.	0.436	Not Assessed	Not Assessed	Fully Supporting	Commercial Harvesting

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-W1_018-SB	LIS WB Inner - Stamford Harbor (Inner), Stamford	See Map for Boundaries. Western portion of LIS, Inner Estuary, from Cook Road and across to Yacht Club, US to saltwater limit in both the West (Route 137 crossing above I95 crossing) and East (Jefferson Street) Branches of Harbor, Stamford.	0.318	Not Supporting	Not Assessed	Not Assessed	Commercial Harvesting
CT-W1_019	LIS WB Inner - Cos Cob Harbor (upper), Greenwich	See Map for Boundaries. Western portion of LIS, Inner Estuary, from RR crossing, US to saltwater limit at Mianus River Dam, Route 1 crossing (includes I95 bridge crossing), Greenwich.	0.132	Not Assessed	Fully Supporting	Not Assessed	Direct Consumption
CT-W1_020	LIS WB Inner - Indian Harbor (upper), Greenwich	See Map for Boundaries. Western portion of LIS, Inner Estuary, upper Indian Harbor (lower portion of Greenwich Creek) from Davis Avenue crossing, US to saltwater limit at West Brother Drive crossing (includes I95 crossing), Greenwich.	0.025	Not Supporting	Not Assessed	Not Assessed	Direct Consumption
CT-W1_021-SB	LIS WB Inner - Greenwich Harbor, Greenwich	See Map for Boundaries. Western portion of LIS, Inner Estuary, from SA/SB water quality line at mouth of Greenwich Harbor (Round Island to Smith Cove), US to saltwater limit just below I95 (mouth of Horseneck Brook), Greenwich.	0.104	Not Supporting	Fully Supporting	Not Supporting	Commercial Harvesting
CT-W1_022-SB	LIS WB Inner - Byram River (CT), Greenwich	See Map for Boundaries. Western portion of LIS, Inner Estuary, from SA/SB water quality line at mouth of Byram River, US to saltwater limit just above Route 1 crossing, out to CT/NY border (includes CT half of River), I95 crosses river in segment, Greenwich.	0.037	Not Assessed	Not Supporting	Not Supporting	Commercial Harvesting

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-W2_001	LIS WB Shore - Lordship, Stratford	See Map for Boundaries. Western portion of LIS from Point No Point area to SA/SB WQ line at Stratford Point (includes Long Beach (Marnick's), SB water is at mouth of Housatonic River) out approximately 1000 ft offshore, Stratford.	0.409	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_002	LIS WB Shore - Long Beach, Stratford	See Map for Boundaries. Western portion of LIS from SA/SB WQ line at Pleasure Beach to Point No Point area (includes Long Beach (Proper), SB water is Bridgeport Harbor) out approximately 1000 ft offshore, Stratford.	0.458	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_003	LIS WB Shore - Seaside Park Beach, Bridgeport	See Map for Boundaries. Western portion of LIS from tip of Fayerweather Island to SA/SB WQ line at Bridgeport Harbor area (includes Seaside Park Beach, SB water is Bridgeport Harbor) out approximately 1000 ft offshore, Bridgeport.	0.492	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_004	LIS WB Shore - Outer Bridgeport Harbor, Fairfield	See Map for Boundaries. Western portion of LIS from Shoal Point to tip of Fayerweather Island (includes Penfield Beach, Jennings Beach, Ash Creek outlet) out approximately 1000 ft offshore, Fairfield.	0.407	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_005	LIS WB Shore - Pine Creek Point, Fairfield	See Map for Boundaries. Western portion of LIS from Pine Creek Point area to Shoal Point (includes South Pine Creek Beach, Pine Creek outlet) out approximately 1000 ft offshore, Fairfield.	0.37	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_006	LIS WB Shore - Southport Harbor (East), Fairfield	See Map for Boundaries. Western portion of LIS from inner Southport Harbor outlet to Pine Creek Point area (includes Sasco Beach, Kense Point) out approximately 1000 ft offshore, Fairfield.	0.183	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-W2_007	LIS WB Shore - Southport Harbor (West), Fairfield	See Map for Boundaries. Western portion of LIS from Beachside Lane area to inner Southport Harbor outlet area (includes Southport Beach, Sasco Brook outlet) out approximately 1000 ft offshore, Fairfield.	0.188	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_008	LIS WB Shore - Green Farms, Westport	See Map for Boundaries. Western portion of LIS from Burying Hill Road to Beachside Lane area (includes Burying Hill Beach, Frost Point) out approximately 1000 ft offshore, Westport.	0.237	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_009	LIS WB Shore - Compo Cove, SISP, Westport	See Map for Boundaries. Western portion of LIS from Compo Cove to Burying Hill Road area (includes Sherwood Island State Park Beach, Sherwood Point, Sherwood Millpond outlet, Greens Farms Brook outlet) out approximately 1000 ft offshore, Westport.	0.324	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_010	LIS WB Shore - Compo Beach, Cedar Point, Westport	See Map for Boundaries. Western portion of LIS from Saugatuck Shores area to Compo Cove (includes Compo Beach, Cedar Point, Saugatuck River outlet, Owenoke) out approximately 1000 ft offshore, Westport.	0.419	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_011	LIS WB Shore - Canfield Island, Westport	See Map for Boundaries. Western portion of LIS from just west of Canfield Island to Saugatuck Shores area (includes Canfiled Island, Saugatuck Shores, Seymour Point) out approximately 1000 ft offshore, Westport.	0.43	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-W2_012	LIS WB Shore - Outer Norwalk Harbor(East), Norwalk	See Map for Boundaries. Western portion of LIS from midpoint of outer Norwalk Harbor to just west of Canfield Island area (includes Calf Pasture Beach, Shady Beach, Calf Pasture Point) out approximately 1000 ft offshore, Norwalk.	0.258	Not Supporting	Fully Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-W2_013	LIS WB Shore - Outer Norwalk Harbor(West), Norwalk	See Map for Boundaries. Western portion of LIS from just west of Hoyt Island to midpoint of outer Norwalk Harbor (includes Hickory Bluff Beach, Hoyt Island, Keyser Point) out approximately 1000 ft offshore, Norwalk.	0.365	Not Supporting	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_014	LIS WB Shore - Wilson Cove, Farm Creek, Norwalk	See Map for Boundaries. Western portion of LIS from Norton Point to just west of Hoyt Island (includes Rowayton Beach, Bell Island, Wilson Point) out approximately 1000 ft offshore, Norwalk.	0.424	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_015	LIS WB Shore - Fivemile River Estuary, Darien	See Map for Boundaries. Western portion of LIS from Fish Islands to Norton Point (includes Bell Island Beach, Fish Islands, Contentment Island, Butlers Island, Fivemile River mouth, Roton Point) out approximately 1000 ft offshore, Darien.	0.342	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_016	LIS WB Shore - Scott Cove, Darien	See Map for Boundaries. Western portion of LIS from Long Neck Point to Fish Islands (includes Hay Island, Great Island) out approximately 1000 ft offshore, Darien.	0.718	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-W2_017	LIS WB Shore - Darien Cove, Darien	See Map for Boundaries. Western portion of LIS from Greenway Island area of outer Cove Harbor to Long Neck Point (includes Pear Tree Point Beach, Nash Island, Darien River mouth) out approximately 1000 ft offshore, Darien.	0.498	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_018	LIS WB Shore - Westcott Cove, Stamford	See Map for Boundaries. Western portion of LIS from near intersection of Hobson Street and Sea Beach Drive to Greenway Island area of outer Cove Harbor (includes West Beach, Cummings Beach, Vincent Island) out approximately 1000 ft offshore, Stamford.	0.366	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-W2_019	LIS WB Shore - Stamford Harbor, Stamford	See Map for Boundaries. Western portion of LIS from Peck Point to near intersection of Hobson Street and Sea Beach Drive (includes Flathead Rocks, Davenport Point, Shippan Point, outer Stamford Harbor) out approximately 1000 ft offshore, Stamford.	0.524	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-W2_020	LIS WB Shore - Stamford Harbor (West), Greenwich	See Map for Boundaries. Western portion of LIS from Greenwich Point to Peck Point (includes Greenwich Point Beach, western portion of Stamford Harbor) out approximately 1000 ft offshore, Greenwich.	0.54	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_021	LIS WB Shore - Greenwich Cove, Greenwich	See Map for Boundaries. Western portion of LIS from Todd Point to Greenwich Point (includes Elias Point, Greenwich Island, Pelican Island, Flat Neck Point, Greenwich Cove) out approximately 1000 ft offshore, Greenwich.	1.244	Not Assessed	Fully Supporting	Not Supporting	Direct Consumption
CT-W2_022	LIS WB Shore - Cos Cob Harbor, Greenwich	See Map for Boundaries. Western portion of LIS from Tweed Island to Todd Point (includes Horse Island, Goose Island, Cos Cob Cove) out approximately 1000 ft offshore, Greenwich.	0.704	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-W2_023	LIS WB Shore - Smith Cove, Indian Hrbr, Greenwich	See Map for Boundaries. Western portion of LIS from Field Point to Tweed Island (includes Round Island, Tweed Island, Smith Cove, Indian Harbor) out approximately 1000 ft offshore, Greenwich.	0.374	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-W2_024	LIS WB Shore - Byram Harbor, Greenwich	See Map for Boundaries. Western portion of LIS from just west of Shore Island to Field Point (includes Shore Island, Rich Island, Farwells Island, Game Cock Island, Byram Harbor) out approximately 1000 ft offshore, Greenwich.	0.34	Not Assessed	Not Supporting	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-W2_025	LIS WB Shore - Byram Harbor (West), Greenwich	See Map for Boundaries. Western portion of LIS from NY/CT border at Byram River to just west of Shore Island (includes mouth of Byram River, Byram Point) out approximately 1000 ft offshore, Greenwich.	0.244	Not Assessed	Not Assessed	Not Supporting	Direct Consumption
CT-W3_001	LIS WB Midshore - Lordship, Stratford	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (Point No Point, Lordship), out to 50 ft contour, Stratford. Odd shape due to 50 ft contour.	7.916	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-W3_002	LIS WB Midshore - Bridgeport Hbr, East, Bridgeport	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (Inner Bridgeport Harbor, Lewis Gut, Pleasure Beach area), out to 50 ft contour, Bridgeport.	8.083	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-W3_003	LIS WB Midshore - Bridgeport Hbr, West, Bridgeport	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (Grover Hill, Fayerweather Island, Seaside Beach area), out to 50 ft contour, Bridgeport. Odd shape due to 50 ft contour.	6.059	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-W3_004	LIS WB Midshore - Shoal Point, Fairfield	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (Shoal Point and outer Black Rock Harbor area), out to 50 ft contour, Fairfield.	4.155	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-W3_005	LIS WB Midshore - Southport Harbor, Fairfield	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (Frost Point to Pine creek Point area), out to 50 ft contour, Fairfield.	5.275	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-W3_006	LIS WB Midshore - Sherwood Point, Westport	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (Saugatuck River mouth, Compo Cove, Sherwood Island State Park area), out to 50 ft contour, Westport.	9.69	Not Supporting	Not Assessed	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-W3_007	LIS WB Midshore - Offshore Norwalk Islands, Norwalk	See Map for Boundaries. Western portion of LIS from line just beyond cluster of Norwalk Islands (Sheffield Island to Cockenoe Island area), out to 50 ft contour, Norwalk.	5.663	Not Supporting	Not Assessed	Fully Supporting	Direct Consumption
CT-W3_008-I	LIS WB Midshore - Norwalk Islands, Norwalk	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (Norton Point to Seymour Point, includes all Norwalk Islands area), out to line just beyond Sheffield Island to Cockenoe Island, Norwalk.	5.94	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-W3_009	LIS WB Midshore - Outer Fivemile R Estuary, Darien	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (outer Scott Cove near Fish Islands to Norton Point area), out to 50 ft contour, Darien.	2.453	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-W3_010	LIS WB Midshore - Outer Cove Harbor, Darien	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (off of Long neck Point, outer Cove Harbor, Darien Cove, Scott Cove area), out to 50 ft contour, Darien.	2.113	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-W3_011	LIS WB Midshore - Outer Westcott Cove, Stamford	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (Shippan Point to Greenway Island, outer Westcott Cove, Cove Harbor, Darien Cove, Scott Cove areas), out to 50 ft contour, Stamford.	2.404	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-W3_012	LIS WB Midshore - Outer Stamford Harbor, Greenwich	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (Greenwich Point to Shippan Point area), out to 50 ft contour, Greenwich/Stamford.	2.101	Not Supporting	Not Assessed	Not Supporting	Direct Consumption

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-W3_013	LIS WB Midshore - Outer Cos Cob Harbor, Greenwich	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (Bush Island to Greenwich Point area), out to 50 ft contour, Greenwich.	2.378	Not Supporting	Not Assessed	Not Supporting	Direct Consumption
CT-W3_014	LIS WB Midshore - Outer Captain Harbor, Greenwich	See Map for Boundaries. Western portion of LIS from Connecticut New York state line just beyond Great Captain Island to east of Wee Captain Island, out to 50 ft contour, Greenwich.	2.007	Not Supporting	Not Assessed	Fully Supporting	Direct Consumption
CT-W3_015-I	LIS WB Midshore - Captain Harbor, Greenwich	See Map for Boundaries. Western portion of LIS from approximately 1000 ft offshore (Byrant Point at Connecticut/New York state line, to Brush Island, Captain Harbor area), out to just beyond Great Captain Island to Wee Captain Island, Greenwich.	3.422	Not Supporting	Fully Supporting	Not Supporting	Direct Consumption
CT-W4_001	LIS WB Offshore - Bridgeport	See Map for Boundaries. Western portion of LIS from 50ft contour to CT/NY State line.	19.767	Not Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-W4_002	LIS WB Offshore - Fairfield	See Map for Boundaries. Western portion of LIS from 50ft contour to CT/NY State line.	26.403	Not Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-W4_003	LIS WB Offshore - Norwalk	See Map for Boundaries. Western portion of LIS from 50ft contour to CT/NY State line.	15.06	Not Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable
CT-W4_004	LIS WB Offshore - Darien	See Map for Boundaries. Western portion of LIS from 50ft contour to CT/NY State line.	16.767	Not Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable

Waterbody Segment ID	Waterbody Name	Location	Square Miles	Aquatic Life	Recreation	Shellfish A	Shellfish Class
CT-W4_005	LIS WB Offshore - Greenwich	See Map for Boundaries. Western portion of LIS from 50ft contour to CT/NY State line.	11.753	Not Supporting	Not Assessed	Not Evaluated	Natural Conditions Not Viable

Table 2-6. Site Specific Fish Consumption Advisories. (Refer to DEEP Angler's Guide http://www.ct.gov/dep/anglersguide or CT DPH website online at http://www.ct.gov/dph/ for more information about fish consumption advisories.)

Waterbody Segment ID	Waterbody Name	Location	Water Size	Fish Consumption	Water Type
CT1001-00-1-L1_01	Wyassup Lake (North Stonington)	North central North Stonington, east of Rte 49. Headwaters of Wyassup Brook.	98.94	Not Supporting	Freshwater Lake
CT2205-02-1-L1_01	Dodge Pond (East Lyme)	East Lyme; near Niantic village center, east of Rte 161, north of Rte 156.	29.59	Not Supporting	Freshwater Lake
CT3805-00_02	Little River (Sprague)-02	From inlet to Versailles Pond (northwest corner of pond), US to Papermill Pond outlet dam, Sprague.	0.89	Not Supporting	River
CT3805-00-3-L6_01	Papermill Pond (Sprague)	Impoundment of Little River, Sprague.	77.15	Not Supporting	Freshwater Lake
CT3805-00-3-L7_01	Versailles Pond (Sprague)	Impoundment of Little River, southeast corner of Sprague.	57.2	Not Supporting	Freshwater Lake
CT4000-00_01	Connecticut River-01	From head of estuary at Chapman Pond outlet, East Haddam, US to northern most boundary of Hurd State Park, East Hampton.	10.27	Not Supporting	River
CT4000-00_02	Connecticut River-02	From northern most boundary of Hurd State Park, East Hampton, US to confluence with Reservoir Brook (adjacent to Gildersleeve Island), Portland.	10.49	Not Supporting	River
CT4000-00_03	Connecticut River (Portland/Suffield)-03	Reservoir Brook confluence (adjacent to Gildersleeve Island), Portland, US to Suffield, MA border.	35.26	Not Supporting	River
CT4308-00-1-L2_01	Compensating Res. (L. McDonough) (Barkhamsted/New Hartford)	Southeast Barkhamsted - northeast New Hartford.	385.75	Not Supporting	Freshwater Lake
CT4500-00-3-L3_01	Union Pond (Manchester)	Impoundment of Hockanum River in Manchester at Union Street.	49.9	Not Supporting	Freshwater Lake

Waterbody Segment ID	Waterbody Name	Location	Water Size	Fish Consumption	Water Type
CT5200-00_03	Quinnipiac River-03	Hanover Pond inlet (at Oregon Road crossing, DS end of Quinnipiac Gorge), Meriden, US (through Gorge) to Waterworks (breached dam), just DS Cheshire/Meriden town border (parallel to River Road (Route 70)).	1.29	Not Supporting	River
CT5200-00-4-L2_01	Hanover Pond (Meriden)	Southwest corner of Meriden, impoundment along Quinnipiac River below Gorge.	70.53	Not Supporting	Freshwater Lake
CT6000-00_03	Housatonic River (New Milford/Bridgewater)-03	Inlet Lake Lillinonah (Northwestern most portion, DS Lovers Leap Road crossing), confluence Town Farm Brook, New Milford/Bridgewater town border, US to Boardman Road crossing (between Route 7 and Railroad tracks), New Milford.	5.09	Not Supporting	River
CT6000-00_04	Housatonic River-04	From Boardman Road crossing (between Route 7 and Railroad tracks), New Milford, US to Bull Bridge outlet dam (US of Bulls Bridge Road crossing, west side of Route 7), Kent.	8.05	Not Supporting	River
CT6000-00_05	Housatonic River-05	From Bull Bridge OUTLET dam (US of Bulls Bridge Road crossing, west side of Route 7), US to confluence with Mauwee Brook (between River Road on west side, and Railroad tracks on east), Kent.	6.66	Not Supporting	River
CT6000-00_06	Housatonic River-06	From confluence with Mauwee Brook (between River Road on west side, and Railroad tracks on east), Kent, US to Great Falls outlet dam, Salisbury/Canaan (Amesville) town border. (Segment follows river channel, not concrete passage from dam).	18.23	Not Supporting	River
CT6000-00_07	Housatonic River (Salisbury/North Canaan at MA border)-07	From Great Falls outlet dam, Salisbury/Canaan (Amesville) town border (river channel, not concrete passage from dam), US along Salisbury/North Canaan town border to Massachusetts border.	7.34	Not Supporting	River

Waterbody Segment ID	Waterbody Name	Location	Water Size	Fish Consumption	Water Type
CT6000-00-5+L1_01	Lillinonah, Lake (Newtown/Southbury/Bridgewater/Brookfield)	Impoundment of Housatonic River, from Shepaug Dam US to top of impoundment, south side of Lovers Leap Road; Southbury and Bridgewater along east bank, Newtown, Brookfield, and New Milford along west bank.	1594.85	Not Supporting	Freshwater Lake
CT6000-00-5+L2_01	Zoar, Lake (Monroe/Newtown/Oxford/Southbury)	Stevenson Dam, Oxford/Monroe, US to a line drawn between DEP Lake Zoar wildlife area boat launch on northeast shore in Southbury, across to just DS of confluence with Gelding Brook on southwest shore in Newtown (Riverside). Includes Kettletown State Park.	580.57	Not Supporting	Freshwater Lake
CT6000-00-5+L2_02	Zoar, Lake (Newtown/Southbury)	From a line drawn between DEEP Lake Zoar wildlife area boat launch on northeast shore in Southbury, across to just DS of confluence with Gelding Brook on southwest shore in Newtown (Riverside), US approximately 5 miles to Shepaug dam (L. Lillinonah).	339.25	Not Supporting	Freshwater Lake
CT6000-00-5+L4_01	Housatonic Lake (Shelton/Derby/Seymour/Oxford/Monroe)	Lake Housatonic Dam (Derby Dam), US to Stevenson Dam (division lower Lake Zoar and upper Lake Housatonic), segment includes Indian Well State Park Beach, Oxford/Monroe. First major impoundment of Housatonic River.	346.29	Not Supporting	Freshwater Lake
CT6000-88-1-L1_01	Brewsters Pond (Stratford)	Stratford, east of Main Street (Rte 113).	4.02	Not Supporting	Freshwater Lake
CT6004-00_01	Konkapot River-01	From Massachusetts state border (DS of Clayton Road crossing), US to Massachusetts state border (US of Old Turnpike Road crossing), North Canaan. (Small loop through northern Connecticut).	2.44	Not Supporting	River
CT6100-00_01	Blackberry River (North Canaan)-01	From mouth at confluence with Housatonic River (at loop in river around island), US to confluence with North Canaan WPCF (near old Railroad grade, currently trail), North Canaan.	0.78	Not Supporting	River

Waterbody Segment ID	Waterbody Name	Location	Water Size	Fish Consumption	Water Type
CT6100-00_02a	Blackberry River (North Canaan)-02a	From confluence with North Canaan WPCF (near old Railroad grade, currently trail, DS of Route 44 crossing), US to drainage ditch at southwest boundary of Lime Quarry (parallel to Lower Road), North Canaan.	2.75	Not Supporting	River
CT6100-00_02b	Blackberry River (North Canaan)-02b	From drainage ditch at southwest boundary of Lime Quarry (parallel to Lower Road), US to Blast Furnace (Historical Park) at Lower Pond dam outlet on Iron Furnace Pond (perpendicular to Furnace Hill Road), North Canaan.	1.18	Not Supporting	River
CT7103-00-2-L4_01	Stillman Pond (Bridgeport)	Upstream of Yellow Mill Channel, Bridgeport. Downstream of Success Lake.	4.97	Not Supporting	Freshwater Lake
CT-E1_024-SB	LIS EB Inner - Connecticut River (mouth), Old Lyme	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Connecticut River from outlet at Griswold Point, US to I 95 crossing (Includes North and South Coves, lower Lieutenant River and waters around Great Island upto RR crossings), Old Lyme.	3.284	Not Supporting	Estuary
CT-E1_029-SB	LIS EB Inner - Connecticut River (Lower), Essex	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Connecticut River from I95 crossing, US to area just above Brockway Island, Essex.	3.182	Not Supporting	Estuary
CT-E1_031-SB	LIS EB Inner - Connecticut River (upper), Chester	See Map for Boundaries. Eastern portion of LIS, Inner Estuary, Connecticut River from area just above Brockway Island, US to saltwater limit just above Chapman Pond inlet (adjacent to Gillette Castle State Park), East Haddam.	2.13	Not Supporting	Estuary
CT-W1_006	LIS WB Inner - Mill River, Fairfield	See Map for Boundaries. Western portion of LIS, Inner Estuary, from Harbor Road crossing, US to saltwater limit at Sturges Road crossing (includes Mill Pond section of Mill River), Fairfield.	0.033	Not Supporting	Estuary

Chapter 3 - Waterbodies Identified for Restoration and Protection Strategies Pursuant to Section 303 of the Clean Water Act

Background Information

Using information provided by the statewide assessment of water quality described in Chapters 1 and 2 of this document, the Department conducts an evaluation of the State's surface water bodies for the development of restoration and protection strategies in accordance with the requirements of Section 303 of the federal Clean Water Act (CWA). The CWA is the primary federal law that protects our nation's surface waters, including lakes, rivers, and coastal areas. Through passage of the CWA, the United States Congress established a national goal of restoring and maintaining the chemical, physical and biological integrity of the Nation's waters by achieving and maintaining "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water wherever attainable" and preventing the discharge of toxic substances in toxic amounts (CWA Section 101).

Development of restoration and protection strategies is part of a broad effort to achieve these goals. This effort includes: 1) adoption of Connecticut Water Quality Standards (CT WQS); 2) monitoring and assessment of surface waters to evaluate consistency with those standards; 3) evaluating and prioritizing those waters for development of action plans, such as Total Maximum Daily Load (TMDL) analyses or other management plans to restore or protect water quality consistent with CT WQS; and (4) implementation of those TMDLs or action plans, achieving consistency with the CT WQS.

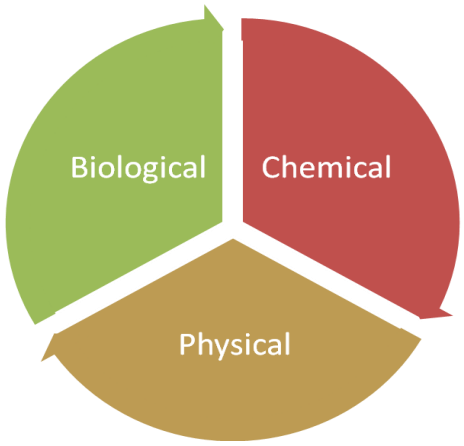


Figure 3-1 Key Components of Water Quality

Figure 3-2: Water Quality Planning and Implementation Process

Connecticut has adopted CT WQS as required under Section 22a-426 of the Connecticut General Statutes and CWA Section 303. The CT WQS contains policy statements concerning the protection of water quality and describe the system used by Connecticut to classify all waters in the State based on use of the waterbodies. Two elements of the CT WQS critical to the development of restoration or protection strategies are the establishment of waterbody designated uses (Table 3-1) and the specified narrative and numeric Water Quality Criteria and Standards to protect and support those uses. Physical, chemical, and biological monitoring data or other applicable information is compared to the Water Quality Criteria and Standards to assess whether or not a waterbody is meeting the attainment of designated uses.

Table 3-1: Designated Uses for Surface Waters in Connecticut

Designated Uses → / Classifications ↓	Existing or Proposed Drinking Water Supply	Potential Drinking Water Supply	Habitat for Fish, Other Aquatic Life and Wildlife	Shellfish Harvesting for Direct Human Consumption	Commercial Shellfish Harvesting	Recreation	Industrial and / or Agricultural Supply	Navigation
AA	■		■			■	■	■
A		■	■			■	■	■
B			■			■	■	■
SA			■	■		■	■	■
SB			■		■	■	■	■

■ Established Use

The Connecticut Consolidated Assessment and Listing Methodology (CT CALM, found in Chapter 1 of this report) for 305(b) and 303(d) reporting was used as a guidance document for the assessment of surface waters in accordance with the CT WQS. Assessments of individual waterbody segments (i.e. Assessment Units, AUs) were conducted using relevant data that met requirements specified by the CT CALM.

Integrated Water Resource Management

In order to improve the effectiveness of the Department's water quality restoration and protection actions, Connecticut has undertaken a new effort called Integrated Water Resource Management. This effort is an outgrowth of a national collaboration between the States and EPA. The States and EPA have been working together to develop enhancements to the 303d Program, within the current framework of the Federal Clean Water Act, to improve protection and restoration efforts of water quality in our nation's waters. EPA calls this updated approach the "Long-Term Vision for Assessment, Restoration and Protection under the Clean Water Act Section 303(d) Program" or the 303d Vision in short. Connecticut has taken this updated approach and used it as the basis to enhance our efforts in restoring and protecting Connecticut's waters through Integrated Water Resource Management. This approach will help focus state resources through a comprehensive review of ecological, pollution stressors and social use information and by building on new partnerships to protect and restore water quality.

These new actions to improve water quality include:

- Reviewing information to choose waterbodies with the most likely successful restoration potential
- Focusing on certain water resource areas while maintaining statewide water quality efforts

- Identifying alternative action plans that will lead to effective water quality improvement
- Enhancing protection of high quality water resources from pollution impacts
- Building on existing partnerships

Integrated Water Resource Management includes identifying waterbodies (and their watersheds) for focused water quality efforts. CT DEEP is focusing on landscape features and pollutants that influence water quality. Additional focus is placed on aquatic resources and features of important value to the public.

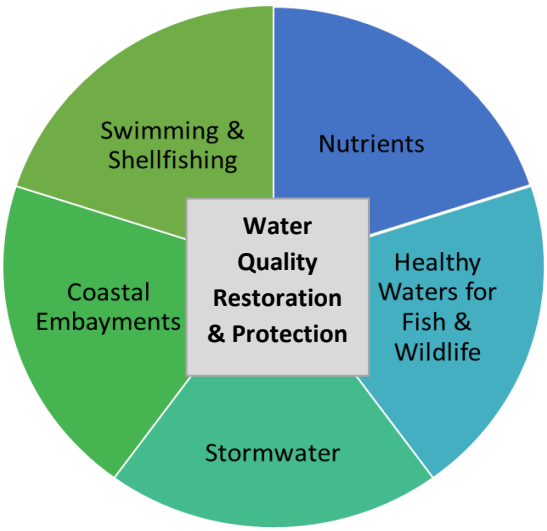


Figure 3-3. CT DEEP Water Quality Concerns

CT DEEP used a practical approach to screen waterbodies using ecological, stressor, social and partnership data. This approach resulted in a list of waterbodies with a high likelihood of restoring or protecting water quality. For each waterbody selected through this process, an action plan (which could be a TMDL) will be developed by 2022 to restore or protect water quality, consistent with the timeframes outlined by EPA in the 303d Vision.

During the selection process many groups within CT DEEP worked together to review ecological conditions, social values, and existing management efforts. Priority data used to select waterbodies for focused efforts included:

- Ecological information showing the health of fish and other aquatic life
- Social values such as fishing, swimming, other recreation, and drinking water sources
- Sources of potential pollution such as industrial discharges and sewage treatment plants
- Land use conditions, amount of hard surfaces, and stormwater runoff
- Existing planning efforts within the watershed
- Existing and potential partnerships

States, with support from EPA, are encouraged to consider the best type of plans to make in order to restore or protect waters. States can develop traditional TMDL plans or use other innovative approaches. CTDEEP has typically developed traditional TMDL plans to address impaired water quality for specific waters. However, under Integrated Water Resource Management other types of Actions Plans may be selected to achieve water quality restoration or protection goals.

More information on the Integrated Water Resources Management approach can be found on the CT DEEP website: http://www.ct.gov/deep/iwrm

Identification of Waters for Action Plan Development

Integrated Water Resource Management is a longer term planning effort identifying waters for action plan development through 2022 (*Table 3-10. List of Waters for Action Plan Development by 2022 Identified in Integrated Water Resource Management Reports*). The 2016 IWQR builds on that effort, providing a refinement of that list to highlight waters from that list which are selected for action plan development in 2016-2018.

For this reporting cycle, CTDEEP is proposing waters for action plan development based on continuing work in support of key statewide TMDL initiatives including the Long Island Sound TMDL, Statewide Bacteria TMDL and New England Regional Mercury TMDL as well as supporting the cleanup of the Housatonic River as a result of PCB contamination. These waters were selected because they were either part of long-standing projects or sufficient data, information and resources were available to develop action plans during the next two years. Water quality program efforts for all waters of Connecticut continues, even without placement on the selected waters lists through Integrated Water Resource Management or this 2016 report. Not all efforts require the development of a new plan under Section 303d of the Clean Water Act. This includes other program work in CT DEEP, assistance from Department staff and sharing resources with non-government organizations and municipalities, as they are available. Projects already underway will continue. In addition to the waters identified in the *List of Waters for Action Plan Development* (Table 3-9), CT DEEP also support various implementation programs such as the Watershed Management Program, as well as State NPDES permitting and Remediation Programs through development of risk-based approaches to water quality restoration and protection.

Connecticut's Impaired Waterbodies

In addition to requiring states to provide a list of waters for action plan development within the next two years, the CWA requires states to track attainment of water quality goals for each waterbody using a five-category approach (Categories 1,2,3,4, and 5) developed by the US EPA. Categories 1, 2 and 3 do not pertain to impaired waters, but may include water bodies prioritized for action plans based on water quality protection or for which TMDLs have been developed to identify pollutant loadings to either have restored the water quality or ensure continued attainment of water quality. Waterbodies that have been identified as impaired are assigned to Categories 4 and 5 under the reporting requirements of CWA Section 303(d). Category 4 has been assigned to waterbodies where the planning and implementation of pollution control and management measures have been initiated with the expectation to achieve CT WQS attainment in future assessments. Category 5 waters are those for which a TMDL or equivalent plan is required. Information regarding Categories 4 and 5 has been summarized in Table 3-2 as applicable to waterbodies in Connecticut.

Table 3-2. Definitions of US EPA Categories 4 and 5 for Assessed Waterbodies in Connecticut

Category	Definition	Number of Waterbodies	Location of Information
4a	Waterbodies impaired for one or more designated uses that have an established TMDL and where a pollutant has been identified as the cause of the impairment.	373	Table 3-5 *Waterbodies with Adopted TMDLs*
4b	Waterbodies impaired for one or more designated uses by a pollutant that is being addressed by pollution control requirements other than a TMDL which are expected to address the impairment.	12	Table 3-6 *Pollution Control Measures for Waterbody Segments*
4c	Waterbodies impaired for one or more designated uses which is the result of pollution but is not caused by a pollutant.	85	Table 3-7 *Nonpollutant Impairments*
5	Available data and/or information indicate that one or more designated uses are not being supported and a TMDL or action plan is needed.	284	Table 3-4 *Connecticut Impaired Waters List*

US EPA reviews the rationale and supporting assessment information for inclusion of any waterbody segment impairment in Category 4 to ensure that these waters are appropriately categorized. However, formal approval of waterbodies in Category 4 is not required under Section 303(d) of the CWA. Waterbody impairments listed in Category 5 constitute the regulatory 303(d) list of impaired waterbodies which is subject to US EPA review and approval pursuant to federal regulation 40 CFR 130.7.

As with the IWQR, the Impaired Waters List is updated by CT DEEP and approved by US EPA every two years as required under the CWA. Updates to impaired waterbodies may include changes to waterbody assessments in Category 5, and also revisions to segments in Category 4a, 4b, and 4c. Totals for impaired waterbodies that were identified within Categories 4 and 5 have been compiled in Figure 3-3.

It is expected that the biannual review of surface waters for 305(b) and 303(d) reporting may result in a change in the US EPA category for any given waterbody as new information is obtained. For example, a waterbody listed in Category 5 may be reassigned to Category 4b if other pollution control requirements, such as a consent order for remedial action, are determined to be the most effective option for attaining water quality standards in place of a TMDL. Thus, the 305(b) and 303(d) reporting is an iterative process that may result in the re-classification of waterbodies to different categories based on new assessment data or changes in US EPA regulations or guidance relating to the assessment and listing process.

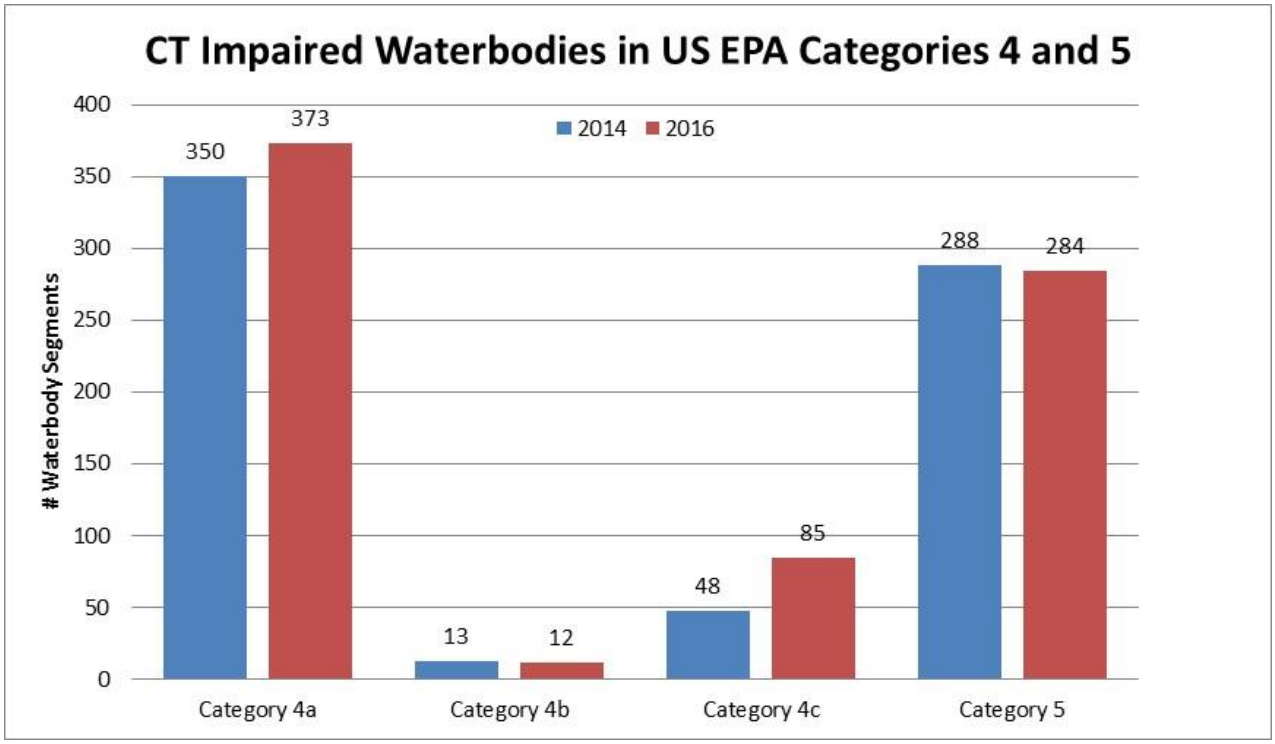


Figure 3-4. Total segments in US EPA Category 4 and 5

Impaired Waters in Category 5

The Impaired Waters List (IWL) is an account of Connecticut's waterbody segments that do not support at least one designated use (Table 3-4 – *Connecticut Impaired Waters List, US EPA Category 5*). The table identifies the waterbody impairment information for the designated use(s) and impairment cause(s) as required under CWA Section 303(d). A total of 288 segments were identified in the Impaired Waters List (US EPA Category 5) for this reporting cycle.

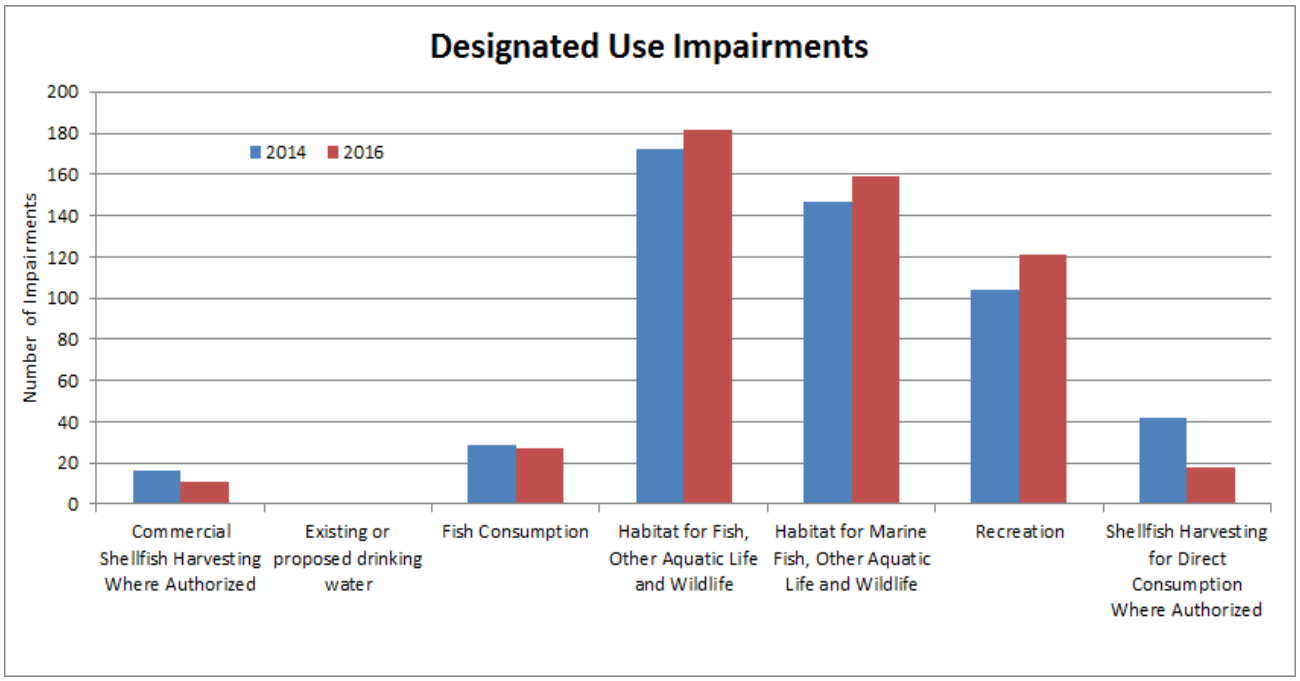


Figure 3-5. Total segments by Designated Use that require a TMDL or equivalent plan

Pollution Control Plans and Implementation for Impaired Waterbodies

Water quality for many Connecticut waterbodies is being addressed in various pollution control and management programs within CT DEEP. Information about waters for which TMDLs have been established and approved by USEPA is provided in Table 3-5. This includes impaired segments in EPA Category 4a (*Impaired waters with adopted TMDLs)* for which a TMDL has been established but water quality has not yet been restored. A TMDL can be specific to a designated use and impairment cause, so segments can have a number of TMDLs for each use and/or cause.

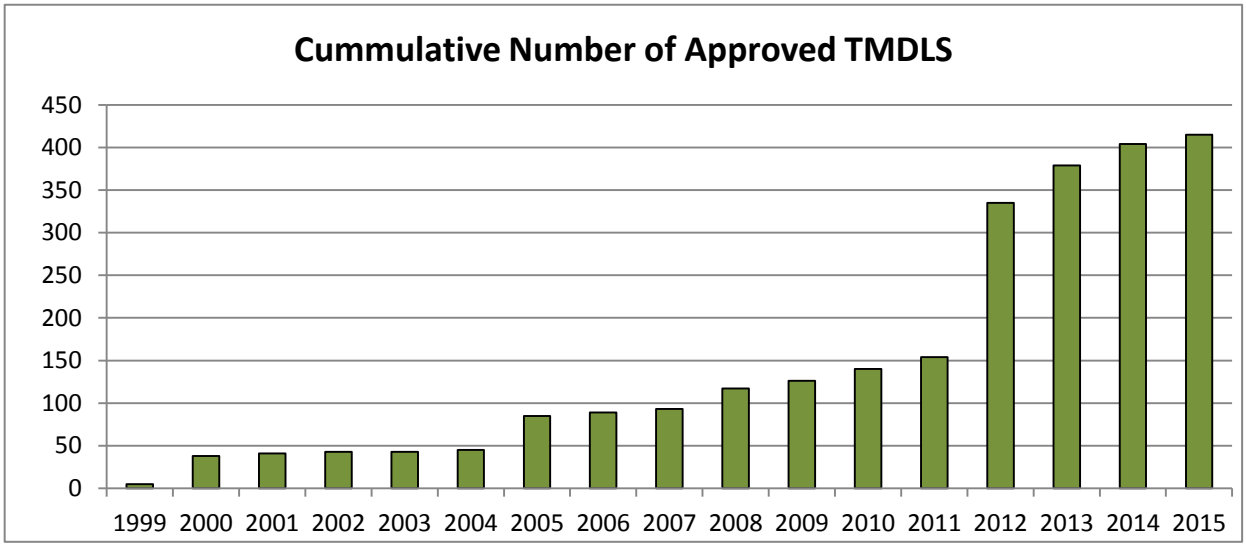


Figure 3-6 Cumulative Number of Approved TMDLs in Connecticut

Segments assigned to US EPA Category 4b (*Pollution Control Measures for Waterbody Segments)* are provided in Table 3-6 and includes a description of the non TMDL-based pollution control requirements expected to result in full attainment of CT WQS. Examples of other pollution control requirements include Consent Orders, Combined Sewer Overflow Control Plans, Remedial Action Plans, Restoration Plans, other plans or studies where activities in progress are expected to result in attainment of the applicable water quality standards and designated uses. Waters are not assigned to this category unless there is reasonable assurance that compliance with the requirements will result in attainment of uses and there are provisions for follow-up monitoring to track progress. In the event that follow-up monitoring indicates that the other pollution control requirements will fall short of achieving the goal of attaining standards, segments will be reassigned to Category 5 for TMDL development. There are many other waters, not listed under Category 4b, for which water quality based pollution control measures have been established. There are a variety of these alternative measures, such as water quality based permitting or ecological risk assessment activities. These efforts are designed to support restoration or protection of water quality but may not be selected for inclusion in Category 4b.

Information on the segments identified in US EPA Category 4c with impairment not due to a pollutant is provided in Table 3-7. The Clean Water Act defines pollution as "the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water". In this case, the pollution is not from a chemical contaminant, but it is from a human impact. While a TMDL is not typically prepared for 4c waters, this type of pollution does require management measures to meet the applicable water quality standards. Some examples of this pollution include flow alterations, stream channelization, and invasive species.

Category 4c for nonpollutant causes includes waterbodies that are impacted by flow alterations. CT DEEP has developed a new methodology for assessing flow impairments when sufficient information is available. In this report cycle, the combination of a newly established methodology and new available information resulted in a number of waters being identified in Category 4c as impaired for aquatic life use due to flow (see Chapter 1). CT DEEP has historically reported the cause of these types of flow impaired waters as “other flow regimes” based on the reporting structure that was available at the time. However, the term “other flow regimes” does not accurately reflect the impairments which are predominantly due to flow alterations that serve public needs and safety. While the historical assessments remain the same, CT DEEP and US EPA reached agreement that all flow impaired waters identified in the IWQR will be reported as “flow alterations”.

The table of Category 4c segments is not to be considered a comprehensive listing of all known impaired segments in this category. Current assessment protocols have not covered the entirety of waterbodies across the State of Connecticut to determine all impairments due to nonpollutant sources.

Alternative Approaches to Restoring and Protecting Water Quality

Through the EPA 303d Vision and Connecticut Integrated Water Resource Management approaches, States have the flexibility to take alternative actions to restore or protect water quality, separate from establishing a traditional TMDL. CT DEEP is actively using alternative approaches to restore water quality in several watersheds. While these alternative actions are pursued, the waters have continued to be designated as part of Category 5, if impaired.

One instance in which CT DEEP may advocate the use of alternative approaches to water quality restoration is for waterbodies that are impaired due to historical pollution from site activities. At these locations, CT DEEP works within various remediation programs such as the EPA Superfund Program (https://www.epa.gov/superfund) or Connecticut Remediation Programs (www.ct.gov/deep/remediation) to work with responsible parties to develop strategies to address and remediate the contamination in order to ensure protection of the environment and attainment of water quality goals. Planning and implementation of remedial strategies are very complex and

often takes several years to achieve. In the end, the remedial action strategies at these sites are anticipated to 1) address the impairment of the waterbody and 2) provide the conditions that fully support the designated uses within the waterbody. Table 3-11 provides examples of alternative approaches and actions which are being developed the address water quality impairments in Connecticut.

Determining Causes and Sources of Impairment

Monitoring and assessment data used to determine the attainment of CT WQS and designated uses are generally insufficient to provide specific indication of causes or sources of impairment or potential sources of stress to a water body. The causes and sources contributing to waterbody impairments or stress can best be determined through a stressor identification study conducted in support of development of TMDLs or alternative approaches. Once a segment is designated for development of a TMDL or alternative, an investigative study is conducted to identify causes and sources of impairment. These investigations may include more intensive ambient water quality sampling, aquatic toxicity studies, sediment or fish tissue analysis and/or dilution calculations of known discharges.

One water quality concern which is receiving attention on a national level as a cause and/or source of impairments is nutrients. Nutrients, such as phosphorus and nitrogen, are naturally occurring elements and are essential to support plant growth. However, when present in excessive amounts, nutrients contribute to a process called “cultural eutrophication” that can impair aquatic life, water supply and recreational use of Connecticut’s water resources. Cultural eutrophication, or nutrient enrichment, is a serious threat to water quality in Connecticut. Excessive loading of nutrients to surface waters as a result of discharges from industrial and municipal water pollution control facilities (WPCF), stormwater or nonpoint sources such as runoff from urban and agricultural lands, or other sources, can lead to algal blooms, including blooms of noxious blue green algae, reduction in water clarity, habitat modification, aquatic life impairments and in extreme cases depletion of oxygen and fish kills. Understanding the impacts of nutrients on attainment of designated uses as well as potential sources of nutrient inputs to the environment informs both TMDL and other implementation plans to address the effects that excess nutrients can have on water quality. Nutrient reductions have been targeted for discharges of both phosphorus and nitrogen in order to address water quality concerns associated with nutrients. CT DEEP is also actively involved in the interstate effort to update and enhance the implementation activities for the Long Island Sound TMDL which focuses on nitrogen impacts and associated hypoxia, as well as efforts under Connecticut Public Act 12-155 to evaluate the impact and control of phosphorus in freshwater non-tidal streams.

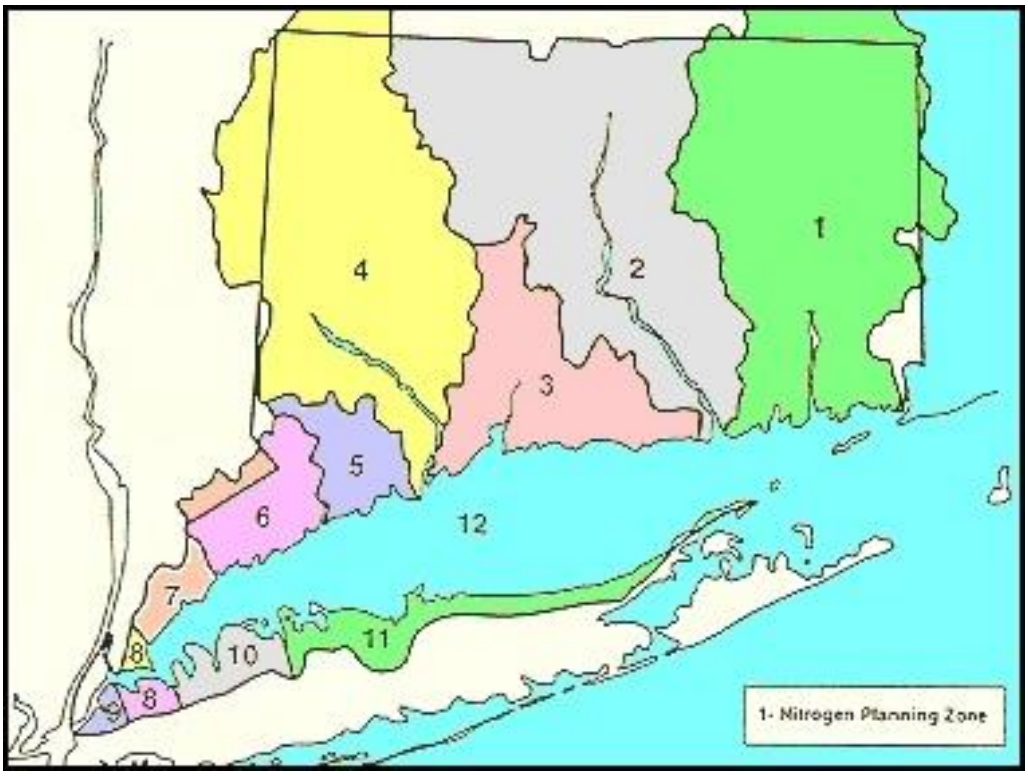


Figure 3-7. In-state Areas Targeted for Nitrogen Reductions

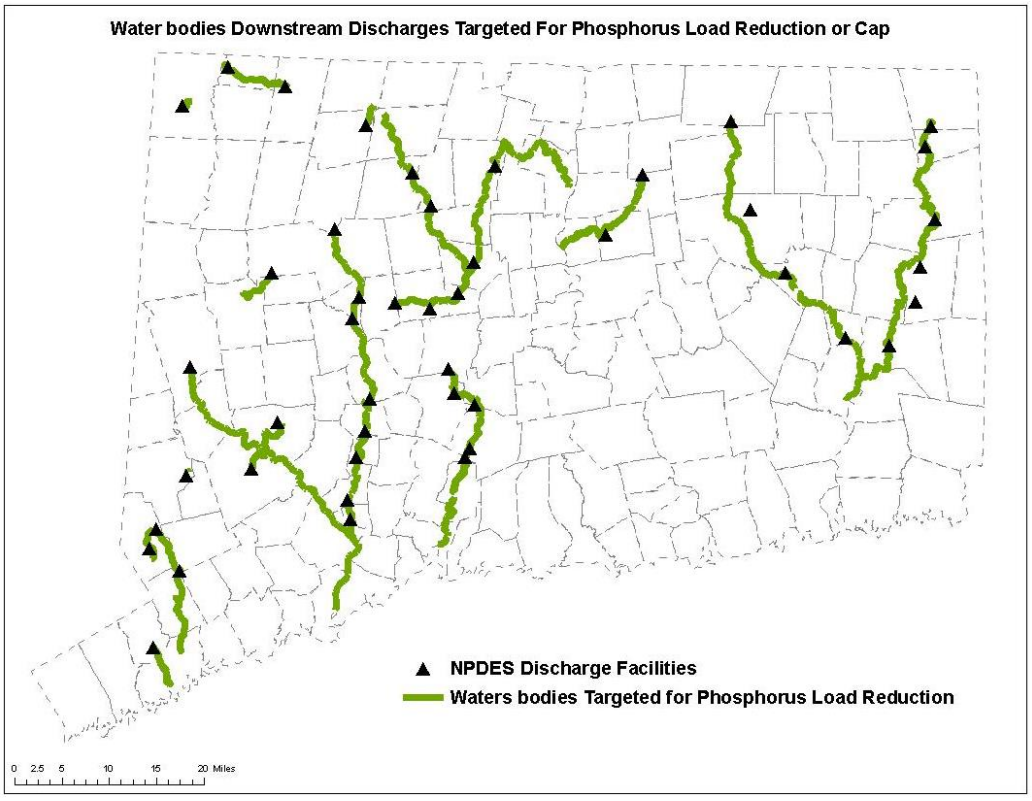


Figure 3-8. Freshwaters Targeted for Management Measures of Cultural Eutrophication

General information, where available, can help to identify sources potentially contributing to the observed impairment. For example, there are circumstances that are generally prone to contribute pollutants to waterbodies which may have an impact on designated uses. Some examples include:

- Bacterial contamination that poses a risk to human health can originate from waterfowl, wildlife, domestic animals (dogs, horses, poultry, swine and cattle) and human waste from malfunctioning septic systems, private/public sewers, and sewage discharges from watercraft. Potential sources of bacteria are recognized by US EPA as Non-Point Source Pollution, Urban Stormwater, Sources Outside State Jurisdiction or Borders, Illicit Connections/Hook-ups to Storm Sewers, Combined Sewer Overflows, and Municipal Point Source Discharges.
- Land uses can contribute pollutants that vary depending on the type of land cover or activity. Developed areas whether industrial, commercial, residential or urban can contribute pollutants through stormwater runoff. These pollutants originate from human activities that generally include heavy metals, nutrients, and petroleum based products. Impervious cover, stormwater drainage systems and over land flow are primary factors in the transport of these pollutants to surface waters. Small and large agricultural operations can contribute nutrients, pesticides, bacteria and sediment to surface waters.
- Point Source Discharges are regulated by the State through applicable wastewater discharge permits. Industrial and municipal permittees may generate wastewater that is treated and discharged to a waterbody which has been determined to have a specific discharge assimilative capacity. However short term discharge violations of the permit limits can occur due to equipment malfunction, changes to wastewater processes and human error. The pollutants contributed to surface waters vary depending on the type of wastewater generated.
- Industrial contamination is persistent in Connecticut which has had a long history of industrial activities such as textiles, firearms, glassware, metal finishing, and much more. Unfortunately, historical contamination from many industrial activities contributed pollutants directly to surface waters and sediments as well as groundwater which eventually discharge to surface water. Many sites have been remediated by eliminating the contaminant source, but others remain or need further investigation to determine the contaminant(s) that may be present and may be contributing to impairments.

Some of the more common sources of stressors associated with the various use impairments are identified in Table 3-3.

Reporting the sources of impairment is not a requirement of Section 303(d), and is not subject to US EPA review and approval. As stated above, identifying sources is most appropriately done within a TMDL or similar evaluation. For the purposes of this report, general information on potentially contributing sources is provided the "Comment" column of the Impaired Waters List (Table 3-4) to allow for a general understanding of potential sources or stressors which might impact the waterbody. This information is either based on a GIS evaluation to determine the potential presence of regulatory discharges, contaminated sites or land uses which might contribute to the observed impairment or site-specific knowledge. The identification of potential sources is not comprehensive nor in most cases based on an analysis of data. Source contributions will be refined within the stressor identification and TMDL/Action Plan development process.

Table 3-3. Summary of Designated Uses with Common Stressors

Impaired Use	Potential Stressors Types			Examples of Common Stressors	Examples of Common Sources
	Physical	Chemical	Biological		
Existing or Proposed Drinking Water		X	X	Bacteria	Stormwater, illicit discharges, agricultural runoff
Fish Consumption		X		Mercury, PCBs, Pesticides	Atmospheric deposition, industrial discharges, municipal wastewater treatment discharges hazardous waste sites, oil and chemical spills, land use
Habitat for Fish, Other Aquatic Life and Wildlife	X	X	X	Habitat alterations, flow regime changes, Toxics, Nutrients, Interactions between multiple pollutants, Low Dissolved Oxygen	Industrial discharges, municipal wastewater treatment discharges hazardous waste sites, oil and chemical spills, land use, stormwater
Habitat for Marine Fish, Other Aquatic Life and Wildlife	X	X	X	Habitat alterations, flow regime changes, Toxics, Nutrients, Interactions between multiple pollutants, Low dissolved oxygen	Industrial discharges, municipal wastewater treatment discharges hazardous waste sites, oil and chemical spills, land use, stormwater
Recreation	X	X	X	Bacteria	Stormwater, illicit discharges, agricultural runoff
Shellfish Harvesting for Direct Consumption Where Authorized		X	X	Bacteria	Stormwater, illicit discharges, agricultural runoff
Commercial Shellfish Harvesting Where Authorized		X	X	Bacteria	Stormwater, illicit discharges, agricultural runoff

Reconciliation List of 303(d) Delistings and Listings

The assessment of surface waters is an on-going process that will result in the removal of some waterbodies from the 303(d) reporting, and the addition of others. A waterbody is no longer impaired when an assessment of relevant data conducted in accordance with the CT CALM confirms attainment of water quality standards. Additionally, waterbodies may be delisted when:

- An error was made in the initial listing causing an incorrect listing. These listings include those based on anecdotal information (information, often transmitted orally and undocumented, which cannot be confirmed through direct observation or measurement using generally accepted, reproducible analytical methods). In these circumstances, the waterbody usually was moved into US EPA Category 2 (supporting for some uses, other uses not assessed) or more often Category 3 (no or insufficient data available to make any assessment).
- Quality controlled data, which are acceptable to CT DEEP, demonstrate that designated uses are being met for the waterbody (with or without implementation of a TMDL).
- Revisions in Water Quality Standards and Criteria and/or assessment methodologies result in a change in assessment from non-attainment to attainment.
- The waterbody meets conditions described in Categories 4a, 4b, 4c as described above, however it will continue to be considered Not Supporting for one or more designated uses until water quality standards and designated uses are met, although the regulatory requirement to adopt a TMDL will no longer apply.

Based on the waterbody assessments where data were available for this reporting cycle, these changes include all segments that were proposed for the listing and delisting of impaired waterbodies. Table 3-8 *Reconciliation List of Impaired Waters (Delistings and Listings)* was compiled where a change in an assessment affected the status of the impaired waterbodies (US EPA Categories 4 or 5). A total of 38 segments have been delisted from the Impaired Waters List and 37 of those segments were delisted due to completed TMDLs. A total of 64 waterbodies segments were listed for impairments while 38 segments were added to Category 4c.

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT1001-00-1-L1_01	Wyassup Lake (North Stonington)	Fish Consumption	Mercury	Potential sources include atmospheric deposition
CT2000-30_01	Fenger Brook (Waterford)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, remediation sites, landfills, groundwater impacts
CT2102-00_01	Copps Brook (Stonington)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, upstream sources, Hydromodification/ impoundments
CT2202-00_01	Latimer Brook (East Lyme)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems, agricultural activities
CT2204-03_01	Stony Brook (Waterford)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems, agricultural activities
CT2205-02-1-L1_01	Dodge Pond (East Lyme)	Fish Consumption	Mercury	Point sources include remediation sites
CT3002-02-1-L2_01	Amos Lake (Preston)	Recreation	Chlorophyll-a	Potential sources include stormwater, upstream sources, agricultural activities
CT3002-02-1-L2_01	Amos Lake (Preston)	Recreation	Excess Algal Growth	Potential sources include stormwater, upstream sources, agricultural activities
CT3002-02-1-L2_01	Amos Lake (Preston)	Recreation	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, upstream sources, agricultural activities
CT3004-00_01	Oxoboxo Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, remediation sites, landfills, groundwater impacts
CT3006-00_01	Hunts Brook (Waterford)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT3100-00_03	Willimantic River (Willington/ Tolland)-03	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems, agricultural activities
CT3100-00_05	Willimantic River (Tolland/ Willington/ Ellington/ Stafford)-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT3200-00_02	Natchaug River (Eastford)-02	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities, upstream sources
CT3207-12_01	Roberts Brook (Mansfield)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT3208-00_01	Sawmill Brook (Mansfield)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT3208-02_01	Conantville Brook (Mansfield)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT3300-10_01	Quinatissett Brook (Thompson)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT3700-00_01	Quinebaug River (Lisbon/ Griswold)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities
CT3700-00_04	Quinebaug River (Putnam)-04	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, remediation sites, groundwater impacts, salt storage facilities, industrial discharges, municipal discharges

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT3700-00_05	Quinebaug River (Putnam/ Thompson)-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, remediation sites, groundwater impacts, landfills, salt storage facilities, municipal discharges, industrial discharges
CT3700-00_05	Quinebaug River (Putnam/ Thompson)-05	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems, agricultural activities
CT3700-00-2+L1_01	West Thompson Lake (Thompson)	Habitat for Fish, Other Aquatic Life and Wildlife	Chlorophyll-a	Potential sources include stormwater, upstream sources, agricultural activities
CT3700-00-2+L1_01	West Thompson Lake (Thompson)	Habitat for Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Potential sources include stormwater, upstream sources, agricultural activities
CT3700-00-2+L1_01	West Thompson Lake (Thompson)	Habitat for Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, upstream sources, agricultural activities
CT3700-00-2+L1_01	West Thompson Lake (Thompson)	Recreation	Chlorophyll-a	Potential sources include stormwater, upstream sources, agricultural activities
CT3700-00-2+L1_01	West Thompson Lake (Thompson)	Recreation	Excess Algal Growth	Potential sources include stormwater, upstream sources, agricultural activities
CT3700-00-2+L1_01	West Thompson Lake (Thompson)	Recreation	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, upstream sources, agricultural activities
CT3700-00-5+L4_01	Aspinook Pond (Canterbury/ Griswold/ Lisbon)	Recreation	Chlorophyll-a	Potential sources include stormwater, upstream sources, agricultural activities
CT3700-00-5+L4_01	Aspinook Pond (Canterbury/ Griswold/ Lisbon)	Recreation	Excess Algal Growth	Potential sources include stormwater, upstream sources, agricultural activities
CT3700-00-5+L4_01	Aspinook Pond (Canterbury/ Griswold/ Lisbon)	Recreation	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, upstream sources, agricultural activities

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT3700-17_01	Durkee Brook (Pomfret)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems, agricultural activities
CT3708-00_01	Little River (Putnam/ Woodstock)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems, agricultural activities
CT3708-00-1-L1_01	Roseland Lake (Woodstock)	Recreation	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, upstream sources, agricultural activities
CT3708-18_01	Wheatons Brook (Putnam/Thompson)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT3709-00_01	Wappaquoia Brook-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems, agricultural activities
CT3709-02_01	Day Brook (Pomfret)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems, agricultural activities
CT3800-00_01	Shetucket River (Norwich)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, combined sewer overflows
CT3800-00-6+L3_01	Spaulding Pond (Norwich)	Recreation	Escherichia coli	Potential sources include stormwater
CT3805-00_02	Little River (Sprague)-02	Fish Consumption	Mercury	Point sources include industrial discharges, releases, spills
CT3805-00_02	Little River (Sprague)-02	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, releases, spills
CT3805-00_02	Little River (Sprague)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, releases, spills

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT3805-00_02	Little River (Sprague)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Whole Effluent Toxicity (WET)	Point sources include industrial discharges, releases, spills
CT3805-00-3-L6_01	Papermill Pond (Sprague)	Fish Consumption	Mercury	Point sources include industrial discharges, releases, spills
CT3805-00-3-L6_01	Papermill Pond (Sprague)	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, releases, spills
CT3805-00-3-L7_01	Versailles Pond (Sprague)	Fish Consumption	Mercury	Point sources include industrial discharges, releases, spills
CT3805-00-3-L7_01	Versailles Pond (Sprague)	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, releases, spills
CT3805-00-3-L7_01	Versailles Pond (Sprague)	Habitat for Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include industrial discharges, releases, spills
CT3900-00_trib_01	Unnamed Tributary, Yantic River (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Ammonia (Un-ionized)	Point sources include outdoor shooting range, remediation sites, groundwater impacts, municipal sewage disposal, landfills, industrial discharges
CT3900-00_trib_01	Unnamed Tributary, Yantic River (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Copper	Point sources include outdoor shooting range, remediation sites, groundwater impacts, municipal sewage disposal, landfills, industrial discharges
CT3900-00_trib_01	Unnamed Tributary, Yantic River (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater, outdoor shooting range, remediation sites, groundwater impacts, municipal sewage disposal, landfills, industrial discharges
CT3900-00_trib_01	Unnamed Tributary, Yantic River (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Lead	Point sources include outdoor shooting range, remediation sites, groundwater impacts, municipal sewage disposal, landfills, industrial discharges

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT3900-00_trib_01	Unnamed Tributary, Yantic River (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, outdoor shooting range, remediation sites, groundwater impacts, municipal sewage disposal, landfills, industrial discharges
CT3900-00_trib_01	Unnamed Tributary, Yantic River (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Organic Enrichment (Sewage) Biological Indicators	Potential sources include stormwater, outdoor shooting range, remediation sites, groundwater impacts, municipal sewage disposal, landfills, industrial discharges
CT3900-00-UL_pond_01	Browning Pond (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Ammonia (Un-ionized)	Point sources include remediation sites, groundwater impacts, municipal sewage disposal, landfills
CT3900-00-UL_pond_01	Browning Pond (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Copper	Point sources include remediation sites, groundwater impacts, municipal sewage disposal, landfills
CT3900-00-UL_pond_01	Browning Pond (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Point sources include remediation sites, groundwater impacts, municipal sewage disposal, landfills
CT3900-00-UL_pond_01	Browning Pond (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Lead	Point sources include remediation sites, groundwater impacts, municipal sewage disposal, landfills
CT3900-00-UL_pond_01	Browning Pond (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Point sources include remediation sites, groundwater impacts, municipal sewage disposal, landfills
CT3900-00-UL_pond_01	Browning Pond (Norwich Landfill)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Organic Enrichment (Sewage) Biological Indicators	Point sources include remediation sites, groundwater impacts, municipal sewage disposal, landfills
CT3900-07_01	Kahn Brook (Bozrah)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, septage lagoons, agricultural activities

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT3900-07_01	Kahn Brook (Bozrah)-01	Recreation	Escherichia coli	Potential sources include stormwater, septage lagoons, agricultural activities
CT4000-00_01	Connecticut River-01	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT4000-00_02	Connecticut River-02	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT4000-00_02	Connecticut River-02	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, combined sewer overflows, insufficient on-site treatment/ septic systems, agricultural activities
CT4000-00_03	Connecticut River (Portland/ Suffield)-03	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT4000-00_03	Connecticut River-03	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, combined sewer overflows, insufficient on-site treatment/ septic systems, agricultural activities
CT4013-00_02	Sumner Brook (Middletown)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, remediation sites, groundwater impacts, industrial discharges, spills
CT4013-05-1-L1_01	Crystal Lake (Middletown)	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems, agricultural activities
CT4100-00_01	Stony Brook (Suffield)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, remediation sites, groundwater impacts, industrial discharges, municipal discharges, spills

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT4100-00_03	Stony Brook (Suffield)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, agricultural activities
CT4101-00_01	Muddy Brook (Suffield)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, agricultural activities, remediation sites, groundwater impacts, salt storage facilities
CT4200-00_01	Scantic River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, salt storage facilities, remediation sites, groundwater impacts
CT4200-00_01	Scantic River-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT4200-00_02	Scantic River-02	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT4200-00_03	Scantic River-03	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT4200-15_01	Thrasher Brook (Somers)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT4200-28_01	Dry Brook (South Windsor/ East Windsor)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT4202-00_01	Gillettes Brook (Somers)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT4203-00_01	Gulf Stream (Somers)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT4204-00_01	Abbey Brook (Somers)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT4206-00_01	Broad Brook (East Windsor)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, remediation sites, groundwater impacts
CT4206-00_02	Broad Brook (East Windsor-Ellington)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, remediation sites, groundwater impacts, agricultural activities, landfills
CT4303-00_03	Still River (Winsted)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, landfills, groundwater impacts
CT4308-00-1-L2_01	Compensating Res. (L. McDonough) (Barkhamsted/ New Hartford)	Fish Consumption	Mercury	Potential sources include atmospheric deposition
CT4312-00_01	Roaring Brook (Farmington)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, remediation sites, groundwater impacts
CT4312-00_01	Roaring Brook (Farmington)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, upstream sources
CT4314-00_01	Coppermine Brook (Bristol)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges
CT4315-00_01	Pequabuck River (Plainville)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharge
CT4315-00_02	Pequabuck River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, remediation sites, groundwater impacts

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT4315-00_03	Pequabuck River-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, illicit discharges, landfills, groundwater impacts
CT4315-00_03	Pequabuck River-03	Habitat for Fish, Other Aquatic Life and Wildlife	Zinc	Potential sources include industrial discharges, landfills, remediation sites, groundwater impacts
CT4315-00_05	Pequabuck River-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT4315-00_06	Pequabuck River-06	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT4321-00_01	Mill Brook (Windsor/ Bloomfield)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, remediation sites, groundwater impacts
CT4400-00_01	Park River-01	Recreation	Escherichia coli	Potential sources include stormwater, industrial discharges, illicit discharges, combined sewer overflows
CT4400-01_01	South Branch Park River (Hartford)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, combined sewer overflow, upstream sources
CT4400-01_02	South Branch Park River (Hartford)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT4402-00_02	Piper Brook-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT4403-00_01	Trout Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, illicit discharges, remediation sites, groundwater impacts, stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT4403-00_02	Trout Brook-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, illicit discharges, remediation sites, groundwater impacts, stormwater
CT4403-00_03	Trout Brook-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, illicit discharges, remediation sites, groundwater impacts, stormwater
CT4404-00_02	North Branch Park River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, illicit discharges, remediation sites, groundwater impacts, combined sewer overflows, agricultural activities, stormwater
CT4500-00_01	Hockanum River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT4500-00_02	Hockanum River (East Hartford/ Manchester)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharge
CT4500-00_03	Hockanum River-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, municipal discharges, remediation sites, groundwater impacts
CT4500-00_04a	Hockanum River-04a	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts
CT4500-00_04b	Hockanum River-04b	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts
CT4500-00_05	Hockanum River-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, municipal discharges

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT4500-00_06a	Hockanum River-06a	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges
CT4500-00_06b	Hockanum River (Vernon/ Rockville)-06b	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, remediation sites, groundwater impacts
CT4500-00_08	Hockanum River-08	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, remediation sites, groundwater impacts
CT4500-00-3-L3_01	Union Pond (Manchester)	Fish Consumption	Chlordane	Potential sources include remediation sites, groundwater impacts
CT4500-00-3-L3_01	Union Pond (Manchester)	Habitat for Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Potential sources include stormwater, illicit discharges
CT4500-00-3-L3_01	Union Pond (Manchester)	Habitat for Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, illicit discharges
CT4500-00-3-L3_01	Union Pond (Manchester)	Habitat for Fish, Other Aquatic Life and Wildlife	Sedimentation/ Siltation	Potential sources include stormwater, illicit discharges
CT4500-04_01	Ogden Brook (Vernon)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, landfills, illicit discharge
CT4500-12_02	Lydall Brook (Manchester)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, illicit discharge
CT4503-00_01	Tankerhoosen River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, illicit discharge

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Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT4504-00_01	South Fork Hockanum River (Manchester)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT4600-00_02	Mattabesset River (Cromwell/ East Berlin)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT4600-00_03	Mattabesset River-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, landfills, illicit discharge
CT4600-00_04	Mattabesset River-04	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT4600-00_05	Mattabesset River-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, remediation sites, upstream sources
CT4600-00_06	Mattabesset River-06	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, agricultural activities, upstream sources
CT4600-00-trib_01	Unnamed tributary Connecticut River (Cromwell)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, upstream sources
CT4601-00_01	Belcher Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, remediation sites
CT4601-00-1-L2_01	Silver Lake (Berlin/ Meriden)	Habitat for Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT4601-00-1-L2_01	Silver Lake (Berlin/ Meriden)	Habitat for Fish, Other Aquatic Life and Wildlife	Turbidity	Potential sources include stormwater
CT4601-02_01	Hatchery Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT4602-00_01	Willow Brook (New Britain)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include discharges, landfills, illicit discharges, remediation sites, remediation sites, groundwater impacts, combined sewer overflow
CT4603-00_01	Webster Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT4607-10-1-L1_01	Beseck Lake (Middlefield)	Habitat for Fish, Other Aquatic Life and Wildlife	Chlorophyll-a	Potential sources include stormwater, hydromodifications/ impoundments
CT4607-10-1-L1_01	Beseck Lake (Middlefield)	Habitat for Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Potential sources include stormwater, hydromodifications/ impoundments
CT4607-10-1-L1_01	Beseck Lake (Middlefield)	Habitat for Fish, Other Aquatic Life and Wildlife	Phosphorus (Total)	Potential sources include stormwater, hydromodifications/ impoundments
CT4607-10-1-L1_01	Beseck Lake (Middlefield)	Recreation	Chlorophyll-a	Potential sources include stormwater, hydromodifications/ impoundments
CT4607-10-1-L1_01	Beseck Lake (Middlefield)	Recreation	Excess Algal Growth	Potential sources include stormwater, hydromodifications/ impoundments
CT4607-10-1-L1_01	Beseck Lake (Middlefield)	Recreation	Phosphorus (Total)	Potential sources include stormwater, hydromodifications/ impoundments

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT4703-01_01a	Cabin Brook (Colchester)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, illicit discharges
CT4707-12_01	Lyman Brook (Marlborough)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT4709-04_02	Pocotopaug Creek (East Hampton)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, insufficient on-site treatment/ septic systems
CT4709-04-1-L1_01	Pocotopaug Lake (East Hampton)	Recreation	Chlorophyll-a	Potential sources include stormwater, industrial discharges
CT4709-04-1-L1_01	Pocotopaug Lake (East Hampton)	Recreation	Excess Algal Growth	Potential sources include stormwater, industrial discharges
CT4709-04-1-L1_01	Pocotopaug Lake (East Hampton)	Recreation	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, industrial discharges
CT5000-55_01	Unnamed tributary to Oyster River (Milford)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT5105-00_04	Chatfield Hollow Brook (Killingworth)-04	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT5111-00_02	Branford River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, landfills, remediation sites
CT5111-09-2-L3_01	Branford Supply Pond, Northwest (Branford)	Habitat for Fish, Other Aquatic Life and Wildlife	Sedimentation/ Siltation	Potential sources include stormwater, streambank erosion
CT5111-09-2-L3_01	Branford Supply Pond, Northwest (Branford)	Habitat for Fish, Other Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Potential sources include stormwater, streambank erosion

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT5111-09-2-L3_01	Branford Supply Pond, Northwest (Branford)	Habitat for Fish, Other Aquatic Life and Wildlife	Turbidity	Potential sources include stormwater, streambank erosion
CT5112-00_01	Farm River (East Haven)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, illicit discharges, remediation sites, groundwater impacts
CT5112-00_02	Farm River (North Branford)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, illicit discharges, remediation sites, remediation sites, groundwater impacts, agricultural activities
CT5112-00_02	Farm River (North Branford)-02	Existing or Proposed Drinking Water	Escherichia coli	Potential sources include stormwater, illicit discharges, agricultural activities
CT5112-10_01	Burrs Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Sodium	Potential sources include industrial discharges, groundwater impacts
CT5112-10_01	Burrs Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Turbidity	Potential sources include stormwater, industrial discharges
CT5200-00_01	Quinnipiac River (North Haven/ Wallingford)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT5200-00_02	Quinnipiac River (North Haven/ Meriden)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts,
CT5200-00_03	Quinnipiac River-03	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT5200-00_03	Quinnipiac River-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT5200-00_04	Quinnipiac River-04	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT5200-00_05	Quinnipiac River-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT5200-00_06	Quinnipiac River-06	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT5200-00_07	Quinnipiac River-07	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT5200-00-4-L2_01	Hanover Pond (Meriden)	Fish Consumption	Polychlorinated biphenyls	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT5200-00-4-L2_01	Hanover Pond (Meriden)	Habitat for Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT5200-00-4-L2_01	Hanover Pond (Meriden)	Habitat for Fish, Other Aquatic Life and Wildlife	Sedimentation/ Siltation	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, stormwater
CT5200-00-4-L2_01	Hanover Pond (Meriden)	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, municipal discharges
CT5200-02_01	Patton Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT5200-10_01	Meetinghouse Brook (Wallingford)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT5200-23_01	Hemingway Creek-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include combined sewer overflow
CT5202-00_01	Tenmile River (Southington/ Cheshire)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial point sources discharges, illicit discharges, remediation sites, groundwater impacts
CT5203-00_01	Misery Brook (Southington)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, insufficient on-site treatment/ septic systems
CT5205-00_01	Sodom Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT5206-00_01	Harbor Brook (Meriden)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, remediation sites, groundwater impacts
CT5206-00_03	Harbor Brook (Meriden)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, remediation sites, groundwater impacts

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT5206-01_01	Spoon Shop Brook (Meriden)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, upstream sources
CT5206-02_01	Willow Brook (Meriden)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, illicit discharges, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems
CT5207-00_01	Wharton Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, landfills, illicit discharge
CT5207-00_02	Wharton Brook-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT5207-01_01	Unnamed Tributary to Wharton Brook (Wallingford)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT5208-00_02a	Muddy River (North Haven)-02a	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, landfills
CT5208-00_02a	Muddy River (North Haven)-02a	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, upstream sources
CT5301-00_01	Willow Brook (Hamden)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems, agricultural activities
CT5302-00_03	Mill River (Cheshire)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT5304-00_01	Wintergreen Brook (New Haven)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, agricultural activities, upstream sources

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT5305-00_01	West River (New Haven/ Woodbridge)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, landfills, illicit discharges, combined sewer overflow
CT5306-00_02	Indian River (Orange)-02	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, upstream sources
CT5306-01_01	Silver Brook (Orange)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, landfills, illicit discharge
CT5306-01_01	Silver Brook (Orange)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, upstream sources
CT5306-01_02	Silver Brook (Orange)-02	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, upstream sources
CT6000-00_01	Housatonic River (Orange/ Shelton/ Derby)-01	Recreation	Escherichia coli	Potential sources include stormwater, industrial discharges, illicit discharges, upstream sources
CT6000-00_02	Housatonic River (Shelton/ Derby)-02	Recreation	Escherichia coli	Potential sources include stormwater, industrial discharges, illicit discharges, upstream sources
CT6000-00_04	Housatonic River-04	Recreation	Escherichia coli	Potential sources include stormwater, industrial discharges, illicit discharges, upstream sources
CT6000-00-5+L1_01	Lillinonah, Lake (Newtown/ Southbury/ Bridgewater/ Brookfield)	Recreation	Chlorophyll-a	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources
CT6000-00-5+L1_01	Lillinonah, Lake (Newtown/ Southbury/ Bridgewater/ Brookfield)	Recreation	Debris/ Floatables/ Trash	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT6000-00-5+L1_01	Lillinonah, Lake (Newtown/ Southbury/ Bridgewater/ Brookfield)	Recreation	Excess Algal Growth	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources
CT6000-00-5+L1_01	Lillinonah, Lake (Newtown/ Southbury/ Bridgewater/ Brookfield)	Recreation	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources
CT6000-00-5+L1_01	Lillinonah, Lake (Newtown/ Southbury/ Bridgewater/ Brookfield)	Recreation	Taste and Odor	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources
CT6000-00-5+L2_01	Zoar, Lake	Recreation	Chlorophyll-a	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources
CT6000-00-5+L2_01	Zoar, Lake	Recreation	Excess Algal Growth	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources
CT6000-00-5+L2_01	Zoar, Lake	Recreation	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT6000-00-5+L2_02	Zoar, Lake	Recreation	Chlorophyll-a	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources
CT6000-00-5+L2_02	Zoar, Lake	Recreation	Excess Algal Growth	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources
CT6000-00-5+L2_02	Zoar, Lake	Recreation	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources
CT6000-00-5+L4_01	Housatonic Lake	Recreation	Chlorophyll-a	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources
CT6000-00-5+L4_01	Housatonic Lake	Recreation	Excess Algal Growth	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources
CT6000-00-5+L4_01	Housatonic Lake	Recreation	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, municipal discharges, insufficient on-site treatment/ septic systems, agricultural activities, hydromodifications/ impoundments, upstream sources

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Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT6000-77_01	Twomile Brook (Derby/ Orange)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, landfills, illicit discharge
CT6000-88-1-L1_01	Brewsters Pond (Stratford)	Fish Consumption	Chlordane	Potential sources include stormwater, industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT6000-88-1-L1_01	Brewsters Pond (Stratford)	Habitat for Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Potential sources include stormwater, industrial discharges, illicit discharges
CT6000-88-1-L1_01	Brewsters Pond (Stratford)	Habitat for Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, industrial discharges, illicit discharges
CT6000-88-1-L1_01	Brewsters Pond (Stratford)	Habitat for Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT6004-00_01	Konkapot River-01	Fish Consumption	Mercury	Potential sources include illicit dump site, spills, upstream sources
CT6008-00_02b	Mill Brook (Cornwall)-02b	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT6014-00_01	Bog Hollow Brook (Kent)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems, agricultural activities
CT6016-00-1-L3_01	Hatch Pond (Kent)	Habitat for Fish, Other Aquatic Life and Wildlife	Chlorophyll-a	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT6016-00-1-L3_01	Hatch Pond (Kent)	Habitat for Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status
CT6016-00-1-L3_01	Hatch Pond (Kent)	Habitat for Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status
CT6016-00-1-L3_01	Hatch Pond (Kent)	Habitat for Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status
CT6016-00-1-L3_01	Hatch Pond (Kent)	Habitat for Fish, Other Aquatic Life and Wildlife	Sedimentation/ Siltation	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status
CT6016-00-1-L3_01	Hatch Pond (Kent)	Recreation	Chlorophyll-a	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status
CT6016-00-1-L3_01	Hatch Pond (Kent)	Recreation	Excess Algal Growth	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status
CT6016-00-1-L3_01	Hatch Pond (Kent)	Recreation	Nutrient/ Eutrophication Biological Indicators	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT6016-00-1-L3_01	Hatch Pond (Kent)	Recreation	Sedimentation/ Siltation	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status
CT6019-00-trib_01	Unnamed trib Deep Brook (Newtown)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, illicit discharges
CT6026-03_01	Cemetery Pond Brook (Stratford/ Shelton)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, upstream sources
CT6100-00_01	Blackberry River (North Canaan)-01	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, remediation sites, groundwater impacts
CT6100-00_02a	Blackberry River (North Canaan)-02a	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, remediation sites, groundwater impacts
CT6100-00_02b	Blackberry River (North Canaan)-02b	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, remediation sites, groundwater impacts
CT6200-00_01	Hollenbeck River-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities
CT6402-00_01	Ball Pond Brook (New Fairfield)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT6402-00-1-L1_01	Ball Pond (New Fairfield)	Recreation	Chlorophyll-a	Potential sources include stormwater, illicit discharges
CT6402-00-1-L1_01	Ball Pond (New Fairfield)	Recreation	Excess Algal Growth	Potential sources include stormwater, illicit discharges
CT6402-00-1-L1_01	Ball Pond (New Fairfield)	Recreation	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, illicit discharges

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Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT6502-00-1-L2_01	Waramaug, Lake	Recreation	Chlorophyll-a	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status
CT6502-00-1-L2_01	Waramaug, Lake	Recreation	Excess Algal Growth	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status
CT6502-00-1-L2_01	Waramaug, Lake	Recreation	Nutrient/ Eutrophication Biological Indicators	Point sources include historic agricultural activities - Note: activities have been discontinued, monitoring is ongoing to determine status
CT6600-00_01	Still River (New Milford/ Brookfield)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, landfills, remediation sites, groundwater impacts
CT6600-00_02	Still River (Brookfield/ Danbury)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, landfills, remediation sites, groundwater impacts
CT6600-00_03	Still River (Danbury)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, landfills, remediation sites, groundwater impacts
CT6600-00_04	Still River (Danbury)-04	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, landfills, remediation sites, groundwater impacts
CT6600-00_05	Still River (Danbury)-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, landfills, remediation sites, groundwater impacts

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Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT6603-00_01	Padanaram Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, landfills, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems
CT6604-00_01	Sympaug Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, landfills, remediation sites, groundwater impacts
CT6703-00_01	West Branch Bantam River (Litchfield/ Goshen)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, municipal discharge, groundwater impacts
CT6705-00-3-L3_01	Bantam Lake	Recreation	Chlorophyll-a	Potential sources include stormwater
CT6705-00-3-L3_01	Bantam Lake	Recreation	Excess Algal Growth	Potential sources include stormwater
CT6705-00-3-L3_01	Bantam Lake	Recreation	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater
CT6806-00_01	Transylvania Brook (Southbury)-01	Recreation	Escherichia coli	Point sources include insufficient on-site treatment system - Note: improvements have been made to upgrade the system, additional monitoring data is needed to determine status
CT6900-00_01	Naugatuck River (Derby/ Seymour)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT6900-00_02	Naugatuck River (Seymour/ Waterbury)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, combined sewer overflows

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT6900-00_03	Naugatuck River-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT6900-00_04	Naugatuck River-04	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT6900-00_06	Naugatuck River-06	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT6900-00_07	Naugatuck River-07	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT6900-00_08	Naugatuck River-08	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges
CT6904-00_01	West Branch Naugatuck River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT6905-00_01	East Branch Naugatuck River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT6910-00_01	Branch Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT6911-00_01	Hancock Brook (Waterbury)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT6912-00_02	Steele Brook-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT6912-00_02	Steele Brook-02	Habitat for Fish, Other Aquatic Life and Wildlife	Iron	Potential sources include industrial discharges, municipal discharges, landfills, remediation sites, groundwater impacts
CT6914-00_01	Mad River (Waterbury)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT6914-00_02	Mad River (Waterbury)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT6914-00_03a	Mad River (Waterbury)-03a	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT6916-00_01	Hop Brook (Naugatuck)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, remediation sites, upstream sources
CT6916-00-3-L4_01	Hop Brook Lake (Waterbury/ Middlebury)	Recreation	Escherichia coli	Potential sources include stormwater, upstream sources
CT6917-00_01	Long Meadow Pond Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT6919-00_01	Bladens River (Seymour)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, remediation sites, groundwater impacts

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT6919-00_01	Bladens River (Seymour)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, upstream sources
CT7000-16_01	Muddy Brook (Westport)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, illicit discharge, remediation sites, groundwater impacts
CT7000-16_01	Muddy Brook (Westport)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges
CT7000-22_01	Indian River (Westport)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, upstream sources
CT7000-22_01	Indian River (Westport)-01	Recreation	Iron	Potential sources include stormwater, illicit discharges, remediation sites, upstream sources, groundwater impacts
CT7000-22_02	Indian River (Westport)-02	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, upstream sources
CT7000-22_02	Indian River (Westport)-02	Recreation	Iron	Potential sources include stormwater, illicit discharges, remediation sites, upstream sources, groundwater impacts
CT7102-00_02	Bruce Brook (Bridgeport/ Stratford)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, remediation sites, groundwater impacts
CT7103-00-2-L3_01	Success Lake (Bridgeport)	Habitat for Fish, Other Aquatic Life and Wildlife	Lead	Point sources include industrial discharges, remediation sites, groundwater impacts
CT7103-00-2-L3_01	Success Lake (Bridgeport)	Habitat for Fish, Other Aquatic Life and Wildlife	Mercury	Point sources include industrial discharges, remediation sites, groundwater impacts
CT7103-00-2-L4_01	Stillman Pond (Bridgeport)	Fish Consumption	Cadmium	Point sources include industrial discharges, remediation sites, groundwater impacts
CT7103-00-2-L4_01	Stillman Pond (Bridgeport)	Fish Consumption	Lead	Point sources include industrial discharges, remediation sites, groundwater impacts

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT7103-00-2-L4_01	Stillman Pond (Bridgeport)	Fish Consumption	Mercury	Point sources include industrial discharges, remediation sites, groundwater impacts
CT7103-00-2-L4_01	Stillman Pond (Bridgeport)	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, remediation sites, groundwater impacts
CT7103-00-2-L5_01	Pembroke Lakes (Bridgeport)	Habitat for Fish, Other Aquatic Life and Wildlife	Lead	Point sources include industrial discharges, remediation sites, groundwater impacts
CT7103-00-2-L5_01	Pembroke Lakes (Bridgeport)	Habitat for Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Point sources include industrial discharges, remediation sites, groundwater impacts
CT7105-00_02	Pequonnock River (Bridgeport/ Trumbull)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, municipal discharges, illicit discharges, remediation sites, groundwater impacts
CT7105-00_03	Pequonnock River (Trumbull)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, stormwater, municipal discharges illicit discharges, remediation sites, groundwater impacts
CT7107-00_01	Cricker Brook (Fairfield)-01	Recreation	Escherichia coli	Potential sources include stormwater, illicit discharges, upstream sources
CT7108-05_02	Unnamed tributary, Easton Reservoir (Snow Farm)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT7109-00_01	Sasco Brook (Westport/ Fairfield)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, landfills, remediation sites, groundwater impacts
CT7201-00_01	Little River (Redding)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, agricultural activities

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Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT7300-00_01	Norwalk River (Norwalk/ Wilton)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT7300-00_01	Norwalk River (Norwalk/ Wilton)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Sedimentation/ Siltation	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharge
CT7300-00_05	Norwalk River (Ridgefield)-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, municipal discharges, industrial discharges, remediation sites, spills
CT7300-02_02	Ridgefield Brook (Ridgefield)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts
CT7301-00_01	Comstock Brook (Wilton)-01	Recreation	Escherichia coli	Potential sources include stormwater, insufficient on-site treatment/ septic systems, upstream sources
CT7401-00_02	Fivemile River (New Canaan)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT7401-00_03	Fivemile River (New Canaan)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, remediation sites, groundwater impacts
CT7403-00_01	Noroton River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT7403-00_02	Noroton River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, remediation sites, groundwater impacts

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT7405-00_01	Rippowam River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT7405-00_02	Rippowam River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, groundwater impacts
CT7407-00_02	Mianus River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, spills
CT7409-00_01	Horseneck Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT7411-00_01	Byram River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, groundwater impacts
CT8104-00-2-L5_01	Mamanasco Lake (Ridgefield)	Habitat for Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Potential sources include stormwater, hydromodifications/ impoundments
CT8104-00-2-L5_01	Mamanasco Lake (Ridgefield)	Recreation	Excess Algal Growth	Potential sources include stormwater, hydromodifications/ impoundments
CT-C1_001	LIS CB Inner - Patchogue And Menunketesuck Rivers	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, illicit discharges
CT-C1_002-SB	LIS CB Inner - Inner Clinton Harbor, Clinton	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include municipal discharges
CT-C1_002-SB	LIS CB Inner - Inner Clinton Harbor, Clinton	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include municipal discharges

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-C1_002-SB	LIS CB Inner - Inner Clinton Harbor, Clinton	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include municipal discharges
CT-C1_012	LIS CB Inner - Morris Creek, East Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater, landfills, municipal discharges, remediation sites, groundwater impacts
CT-C1_012	LIS CB Inner - Morris Creek, East Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, landfills, municipal discharges, remediation sites, groundwater impacts
CT-C1_012	LIS CB Inner - Morris Creek, East Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oil and Grease	Potential sources include stormwater, landfills, municipal discharges, remediation sites, groundwater impacts
CT-C1_012	LIS CB Inner - Morris Creek, East Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, landfills, municipal discharges, remediation sites, groundwater impacts
CT-C1_012	LIS CB Inner - Morris Creek, East Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Potential sources include landfills, municipal discharges, remediation sites, groundwater impacts
CT-C1_013-SB	LIS CB Inner - New Haven Harbor, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include industrial discharges, municipal discharges, stormwater, landfills, illicit discharges, remediation sites, groundwater impacts, combine sewer overflow
CT-C1_013-SB	LIS CB Inner - New Haven Harbor, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include industrial discharges, municipal discharges, stormwater, landfills, illicit discharges, remediation sites, groundwater impacts, combine sewer overflow
CT-C1_013-SB	LIS CB Inner - New Haven Harbor, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oil and Grease	Potential sources include industrial discharges, municipal discharges, stormwater, landfills, illicit discharges, remediation sites, groundwater impacts, combine sewer overflow

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-C1_013-SB	LIS CB Inner - New Haven Harbor, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include industrial discharges, municipal discharges, stormwater, landfills, illicit discharges, remediation sites, groundwater impacts, combine sewer overflow
CT-C1_013-SB	LIS CB Inner - New Haven Harbor, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Potential sources include industrial discharges, municipal discharges, stormwater, landfills, illicit discharges, remediation sites, groundwater impacts
CT-C1_013-SB	LIS CB Inner - New Haven Harbor, New Haven	Recreation	Enterococcus	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, combine sewer overflow
CT-C1_014-SB	LIS CB Inner - Quinnipiac River (mouth), New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, combined sewer overflow
CT-C1_014-SB	LIS CB Inner - Quinnipiac River (mouth), New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, combine sewer overflow
CT-C1_014-SB	LIS CB Inner - Quinnipiac River (mouth), New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oil and Grease	Potential sources include stormwater, industrial discharges, municipal discharges, remediation sites, groundwater impacts, landfills, illicit discharges, combine sewer overflow
CT-C1_014-SB	LIS CB Inner - Quinnipiac River (mouth), New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, combine sewer overflow
CT-C1_014-SB	LIS CB Inner - Quinnipiac River (mouth), New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, combine sewer overflow

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-C1_014-SB	LIS CB Inner - Quinnipiac River (mouth), New Haven	Recreation	Enterococcus	Potential sources include stormwater, municipal discharges, illicit discharges, combine sewer overflow
CT-C1_015-SB	LIS CB Inner - West River (Lower), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater, industrial discharges, municipal discharges, remediation sites, groundwater impacts, landfills, illicit discharges, combine sewer overflow
CT-C1_015-SB	LIS CB Inner - West River (Lower), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, industrial discharges, municipal discharges, illicit discharges, combine sewer overflow
CT-C1_015-SB	LIS CB Inner - West River (Lower), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oil and Grease	Potential sources include stormwater, industrial discharges, municipal discharges, remediation sites, groundwater impacts, landfills, illicit discharges, combine sewer overflow
CT-C1_015-SB	LIS CB Inner - West River (Lower), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, industrial discharges, municipal discharges, remediation sites, groundwater impacts, landfills, illicit discharges, combine sewer overflow
CT-C1_015-SB	LIS CB Inner - West River (Lower), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Potential sources include stormwater, industrial discharges, municipal discharges, remediation sites, groundwater impacts, landfills, illicit discharges, combine sewer overflow
CT-C1_015-SB	LIS CB Inner - West River (Lower), West Haven	Recreation	Enterococcus	Potential sources include municipal discharges
CT-C1_016	LIS CB Inner - Cove River, West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include municipal discharges
CT-C1_016	LIS CB Inner - Cove River, West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include municipal discharges

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Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-C1_016	LIS CB Inner - Cove River, West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include municipal discharges
CT-C1_016	LIS CB Inner - Cove River, West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Potential sources include municipal discharges
CT-C1_017	LIS CB Inner - Oyster River, Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include municipal discharges
CT-C1_017	LIS CB Inner - Oyster River, Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include municipal discharges
CT-C1_017	LIS CB Inner - Oyster River, Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include municipal discharges
CT-C1_017	LIS CB Inner - Oyster River, Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Potential sources include municipal discharges
CT-C1_019-SB	LIS CB Inner - Housatonic River (mouth), Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Copper	Potential sources include industrial stormwater, industrial discharges, landfills, remediation sites
CT-C1_019-SB	LIS CB Inner - Housatonic River (mouth), Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dioxin (including 2,3,7,8-TCDD)	Potential sources include industrial stormwater, industrial discharges, landfills, remediation sites
CT-C1_019-SB	LIS CB Inner - Housatonic River (mouth), Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Potential sources include industrial stormwater, industrial discharges, landfills, remediation sites
CT-C1_019-SB	LIS CB Inner - Housatonic River (mouth), Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Zinc	Potential sources include industrial stormwater, industrial discharges, landfills, remediation sites

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-C1_021-SB	LIS CB Inner - Housatonic River (Upper), Orange	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include industrial stormwater, industrial discharges, landfills, remediation sites
CT-C1_021-SB	LIS CB Inner - Housatonic River (Upper), Orange	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include industrial stormwater, industrial discharges, landfills, remediation sites
CT-C1_021-SB	LIS CB Inner - Housatonic River (Upper), Orange	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include industrial stormwater, industrial discharges, landfills, remediation sites
CT-C1_022	LIS CB Inner - West River (Upper), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater, industrial discharges, landfills
CT-C1_022	LIS CB Inner - West River (Upper), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, industrial discharges, landfills
CT-C1_022	LIS CB Inner - West River (Upper), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oil and Grease	Potential sources include stormwater, industrial discharges, landfills
CT-C1_022	LIS CB Inner - West River (Upper), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, industrial discharges, landfills
CT-C1_022	LIS CB Inner - West River (Upper), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Potential sources include stormwater, industrial discharges, landfills
CT-C1_022	LIS CB Inner - West River (Upper), West Haven	Recreation	Enterococcus	Potential sources include stormwater, industrial discharges, landfills
CT-C1_022	LIS CB Inner - West River (Upper), West Haven	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, illicit discharges

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-C1_023-SB	LIS CB Inner - Mill River (mouth), New Haven/ Hamden	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Potential sources include stormwater, illicit discharges
CT-C1_023-SB	LIS CB Inner - Mill River (mouth), New Haven/ Hamden	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater, industrial discharges, illicit discharges
CT-C1_023-SB	LIS CB Inner - Mill River (mouth), New Haven/ Hamden	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, industrial discharges, illicit discharges
CT-C1_023-SB	LIS CB Inner - Mill River (mouth), New Haven/ Hamden	Recreation	Enterococcus	Potential sources include stormwater, illicit discharges
CT-C2_001	LIS CB Shore - Westbrook Harbor (East), Westbrook	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, illicit discharges
CT-C2_002	LIS CB Shore - Westbrook Harbor (West), Westbrook	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, illicit discharges
CT-C2_017-SB	LIS CB Shore - Morris Cove, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-C2_017-SB	LIS CB Shore - Morris Cove, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-C2_017-SB	LIS CB Shore - Morris Cove, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oil and Grease	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-C2_017-SB	LIS CB Shore - Morris Cove, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-C2_017-SB	LIS CB Shore - Morris Cove, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Point sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT-C2_018-SB	LIS CB Shore - New Haven Harbor (West), West Haven	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Potential sources include industrial discharges, municipal discharges, marinas, stormwater
CT-C2_018-SB	LIS CB Shore - New Haven Harbor (West), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-C2_018-SB	LIS CB Shore - New Haven Harbor (West), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-C2_018-SB	LIS CB Shore - New Haven Harbor (West), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oil and Grease	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-C2_018-SB	LIS CB Shore - New Haven Harbor (West), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-C2_018-SB	LIS CB Shore - New Haven Harbor (West), West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Point sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-C2_024-SB	LIS CB Shore - Housatonic River mouth, Stratford	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Potential sources include stormwater, industrial discharges, landfills
CT-C2_024-SB	LIS CB Shore - Housatonic River mouth, Stratford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Copper	Point sources include industrial stormwater, industrial discharges, landfills, remediation sites
CT-C2_024-SB	LIS CB Shore - Housatonic River mouth, Stratford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dioxin (including 2,3,7,8-TCDD)	Point sources include industrial stormwater, industrial discharges, landfills, remediation sites
CT-C2_024-SB	LIS CB Shore - Housatonic River mouth, Stratford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Lead	Point sources include industrial stormwater, industrial discharges, landfills, remediation sites
CT-C2_024-SB	LIS CB Shore - Housatonic River mouth, Stratford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Point sources include industrial stormwater, industrial discharges, landfills, remediation sites
CT-C2_024-SB	LIS CB Shore - Housatonic River mouth, Stratford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Zinc	Point sources include industrial stormwater, industrial discharges, landfills, remediation sites
CT-C3_001	LIS CB Midshore - Westbrook Harbor, Westbrook	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include industrial discharges, municipal discharges, marinas, stormwater
CT-C3_005	LIS CB Midshore - Madison	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include industrial discharges, municipal discharges, marinas, stormwater
CT-C3_015-SB	LIS CB Midshore - New Haven Harbor, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-C3_015-SB	LIS CB Midshore - New Haven Harbor, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-C3_015-SB	LIS CB Midshore - New Haven Harbor, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oil and Grease	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-C3_015-SB	LIS CB Midshore - New Haven Harbor, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-C3_015-SB	LIS CB Midshore - New Haven Harbor, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Point sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT-C3_016	LIS CB Midshore - West Haven	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include industrial discharges, municipal discharges, marinas, stormwater
CT-E1_001-SB	LIS EB Inner - Pawcatuck River (01), Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include industrial discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts, stormwater
CT-E1_001-SB	LIS EB Inner - Pawcatuck River (01), Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include industrial discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts, stormwater
CT-E1_001-SB	LIS EB Inner - Pawcatuck River (01), Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include industrial discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts, stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Potential sources include stormwater, agricultural activities, upstream sources
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, agricultural activities, upstream sources
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Recreation	Estuarine Bioassessments	Potential sources include stormwater, agricultural activities, upstream sources
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Recreation	Excess Algal Growth	Potential sources include stormwater, agricultural activities, upstream sources
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include stormwater, agricultural activities, upstream sources
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Potential sources include stormwater, agricultural activities, upstream sources
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Recreation	Estuarine Bioassessments	Potential sources include stormwater, agricultural activities, upstream sources
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Recreation	Excess Algal Growth	Potential sources include stormwater, agricultural activities, upstream sources
CT-E1_007-SB	LIS EB Inner - Mystic River (Mouth), Stonington	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Potential sources include industrial discharges, municipal discharges, marinas, stormwater
CT-E1_014-SB	LIS EB Inner - Thames River (Mouth), New London	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include industrial point discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts, stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-E1_014-SB	LIS EB Inner - Thames River (Mouth), New London	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include industrial point discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts, stormwater
CT-E1_014-SB	LIS EB Inner - Thames River (Mouth), New London	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include industrial point discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts, stormwater
CT-E1_015-SB	LIS EB Inner - Thames River (middle), Ledyard	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Potential sources include industrial discharges, municipal discharges, marinas, stormwater
CT-E1_015-SB	LIS EB Inner - Thames River (middle), Ledyard	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, stormwater
CT-E1_015-SB	LIS EB Inner - Thames River (middle), Ledyard	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, stormwater
CT-E1_015-SB	LIS EB Inner - Thames River (middle), Ledyard	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, stormwater
CT-E1_015-SB	LIS EB Inner - Thames River (middle), Ledyard	Recreation	Enterococcus	Potential sources include municipal discharges, landfills, illicit discharges, stormwater
CT-E1_016-SB	LIS EB Inner - Thames River (Upper), Norwich	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Potential sources include stormwater, municipal discharges, landfills, illicit discharges, insufficient on-site treatment/ septic systems, combined sewer overflow

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-E1_016-SB	LIS EB Inner - Thames River (Upper), Norwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems, combined sewer overflow
CT-E1_016-SB	LIS EB Inner - Thames River (Upper), Norwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems, combined sewer overflow
CT-E1_016-SB	LIS EB Inner - Thames River (Upper), Norwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems, combined sewer overflow
CT-E1_016-SB	LIS EB Inner - Thames River (Upper), Norwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems, combined sewer overflow
CT-E1_016-SB	LIS EB Inner - Thames River (Upper), Norwich	Recreation	Enterococcus	Potential sources include stormwater, municipal discharges, landfills, illicit discharges, insufficient on-site treatment/ septic systems, combined sewer overflow
CT-E1_017	LIS EB Inner - Alewife Cove, Waterford/ New London	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater
CT-E1_017	LIS EB Inner - Alewife Cove, Waterford/ New London	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-E1_017	LIS EB Inner - Alewife Cove, Waterford/ New London	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater
CT-E1_020	LIS EB Inner - Niantic River (mouth), Niantic	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater, industrial discharges, illicit discharges, remediation sites, groundwater impacts
CT-E1_020	LIS EB Inner - Niantic River (mouth), Niantic	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include industrial discharges, illicit discharges, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems, stormwater
CT-E1_020	LIS EB Inner - Niantic River (mouth), Niantic	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater
CT-E1_022	LIS EB Inner - Bride Brook, East Lyme	Recreation	Enterococcus	Potential sources include stormwater
CT-E1_024-SB	LIS EB Inner - Connecticut River (mouth), Old Lyme	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT-E1_028-SB	LIS EB Inner - Lieutenant River, Old Lyme	Recreation	Enterococcus	Potential sources include stormwater, illicit discharges
CT-E1_029-SB	LIS EB Inner - Connecticut River (Lower), Essex	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT-E1_031-SB	LIS EB Inner - Connecticut River (upper), Chester	Fish Consumption	Polychlorinated biphenyls	Point sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT-E1_033	LIS EB Inner - Pequotsepos Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-E1_033	LIS EB Inner - Pequotsepos Cove, Stonington	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, agricultural activities
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include stormwater
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Potential sources include stormwater
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Recreation	Estuarine Bioassessments	Potential sources include stormwater
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Recreation	Excess Algal Growth	Potential sources include stormwater
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include stormwater
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Potential sources include stormwater
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Recreation	Estuarine Bioassessments	Potential sources include stormwater
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Recreation	Excess Algal Growth	Potential sources include stormwater
CT-E2_009-SB	LIS EB Shore - Thames River Mouth (East), Groton	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include industrial discharges, remediation sites, groundwater impacts, stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-E2_009-SB	LIS EB Shore - Thames River Mouth (East), Groton	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include industrial discharges, remediation sites, groundwater impacts, stormwater
CT-E2_009-SB	LIS EB Shore - Thames River Mouth (East), Groton	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include industrial discharges, remediation sites, groundwater impacts, stormwater
CT-E2_010-SB	LIS EB Shore - Thames River Mouth (West), New London	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Potential sources include industrial discharges, municipal discharges, marinas, stormwater
CT-E2_010-SB	LIS EB Shore - Thames River Mouth (West), New London	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include groundwater impacts
CT-E2_010-SB	LIS EB Shore - Thames River Mouth (West), New London	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include groundwater impacts
CT-E2_010-SB	LIS EB Shore - Thames River Mouth (West), New London	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include groundwater impacts
CT-E2_011-SB	LIS EB Shore - Thames River Mouth (West), Waterford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include industrial discharges, groundwater impacts, stormwater
CT-E2_011-SB	LIS EB Shore - Thames River Mouth (West), Waterford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include industrial discharges, groundwater impacts, stormwater
CT-E2_011-SB	LIS EB Shore - Thames River Mouth (West), Waterford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include industrial discharges, groundwater impacts, stormwater
CT-E2_013	LIS EB Shore - Niantic Bay (East), Waterford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include groundwater impacts

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-E2_014	LIS EB Shore - Niantic Bay (West), East Lyme	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include industrial discharges, stormwater
CT-E2_015	LIS EB Shore - Niantic Bay (Black Pt), East Lyme	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater
CT-E3_001	LIS EB Midshore - Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include stormwater
CT-E3_001	LIS EB Midshore - Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Potential sources include stormwater
CT-E3_001	LIS EB Midshore - Stonington	Recreation	Estuarine Bioassessments	Potential sources include stormwater
CT-E3_001	LIS EB Midshore - Stonington	Recreation	Excess Algal Growth	Potential sources include stormwater
CT-E3_005-SB	LIS EB Midshore - Waterford, Thames River	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater
CT-E3_005-SB	LIS EB Midshore - Waterford, Thames River	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include stormwater
CT-E3_005-SB	LIS EB Midshore - Waterford, Thames River	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater
CT-E3_006	LIS EB Midshore - Niantic Bay	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Cause Unknown	Potential sources include stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-E3_012	LIS EB Midshore - Westbrook	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, insufficient on-site treatment/ septic systems, combined sewer overflows, stormwater
CT-W1_001-SB	LIS WB Inner - Bridgeport Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems, combined sewer overflow, stormwater
CT-W1_001-SB	LIS WB Inner - Bridgeport Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems, combined sewer overflow, stormwater
CT-W1_001-SB	LIS WB Inner - Bridgeport Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, illicit discharges, combined sewer overflows, marinas, insufficient on-site treatment/ septic systems
CT-W1_001-SB	LIS WB Inner - Bridgeport Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Potential sources include industrial discharges, remediation sites, illicit discharges, groundwater impacts
CT-W1_001-SB	LIS WB Inner - Bridgeport Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polycyclic Aromatic Hydrocarbons (PAHs) (Aquatic Ecosystems)	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, combined sewer overflow, stormwater
CT-W1_001-SB	LIS WB Inner - Bridgeport Harbor, Bridgeport	Recreation	Enterococcus	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, insufficient on-site treatment/ septic systems, combined sewer overflows, stormwater

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-W1_002-SB	LIS WB Inner - Black Rock Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts, combined sewer overflow
CT-W1_002-SB	LIS WB Inner - Black Rock Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Potential sources include industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts, combined sewer overflow
CT-W1_002-SB	LIS WB Inner - Black Rock Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts, combined sewer overflow
CT-W1_002-SB	LIS WB Inner - Black Rock Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oil and Grease	Potential sources include industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts, combined sewer overflow
CT-W1_002-SB	LIS WB Inner - Black Rock Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts, insufficient on-site treatment/ septic systems, combined sewer overflow, stormwater
CT-W1_002-SB	LIS WB Inner - Black Rock Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polychlorinated biphenyls	Potential sources include industrial discharges, remediation sites, illicit discharges, groundwater impacts
CT-W1_002-SB	LIS WB Inner - Black Rock Harbor, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Polycyclic Aromatic Hydrocarbons (PAHs) (Aquatic Ecosystems)	Potential sources include industrial discharges, landfills, illicit discharges, remediation sites, groundwater impacts, combined sewer overflow
CT-W1_003-SB	LIS WB Inner - Ash Creek, Fairfield	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Potential sources include industrial discharges, remediation sites, groundwater impacts
CT-W1_003-SB	LIS WB Inner - Ash Creek, Fairfield	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Gold	Point sources include industrial discharges, remediation sites, groundwater impacts

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-W1_003-SB	LIS WB Inner - Ash Creek, Fairfield	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Silver	Point sources include industrial discharges, remediation sites, groundwater impacts
CT-W1_003-SB	LIS WB Inner - Ash Creek, Fairfield	Recreation	Enterococcus	Potential sources include stormwater, illicit discharges
CT-W1_004	LIS WB Inner - Pine Creek, Fairfield	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include industrial discharges, remediation sites, groundwater impacts
CT-W1_006	LIS WB Inner - Mill River, Fairfield	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT-W1_007	LIS WB Inner - Sasco Brook, Westport	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, illicit discharges
CT-W1_009	LIS WB Inner - Grays Creek, Westport	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, insufficient on-site treatment/ septic systems, combined sewer overflows, stormwater
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Lead	Potential sources include industrial discharges, remediation sites, illicit discharges, groundwater impacts

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Mercury	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nitrogen (Total)	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, remediation sites, groundwater impacts
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include remediation sites, spills, groundwater impacts, industrial discharges, landfills, municipal discharges, salt storage facilities, marinas, stormwater
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	Recreation	Enterococcus	Potential sources include industrial discharges, municipal discharges, landfills, illicit discharges, insufficient on-site treatment/ septic systems, combined sewer overflows, stormwater
CT-W1_013-SB	LIS WB Inner - Norwalk Harbor (MarvinBeach), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT-W1_013-SB	LIS WB Inner - Norwalk Harbor (MarvinBeach), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nitrogen (Total)	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT-W1_013-SB	LIS WB Inner - Norwalk Harbor (MarvinBeach), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT-W1_013-SB	LIS WB Inner - Norwalk Harbor (MarvinBeach), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-W1_016-SB	LIS WB Inner - Holly Pond, Stamford	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Potential sources include stormwater, groundwater impacts
CT-W1_018-SB	LIS WB Inner - Stamford Harbor (Inner), Stamford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include groundwater impacts
CT-W1_018-SB	LIS WB Inner - Stamford Harbor (Inner), Stamford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include industrial discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts
CT-W1_018-SB	LIS WB Inner - Stamford Harbor (Inner), Stamford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include groundwater impacts
CT-W1_020	LIS WB Inner - Indian Harbor (upper), Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include industrial discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts
CT-W1_020	LIS WB Inner - Indian Harbor (upper), Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include industrial discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts
CT-W1_020	LIS WB Inner - Indian Harbor (upper), Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include industrial discharges, municipal discharges, illicit discharges, remediation sites, groundwater impacts
CT-W1_021-SB	LIS WB Inner - Greenwich Harbor, Greenwich	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT-W1_021-SB	LIS WB Inner - Greenwich Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT-W1_021-SB	LIS WB Inner - Greenwich Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-W1_021-SB	LIS WB Inner - Greenwich Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT-W2_001	LIS WB Shore - Lordship, Stratford	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, illicit discharges
CT-W2_002	LIS WB Shore - Long Beach, Stratford	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, insufficient on-site treatment/ septic systems
CT-W2_003	LIS WB Shore - Seaside Park Beach, Bridgeport	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, insufficient on-site treatment/ septic systems
CT-W2_005	LIS WB Shore - Pine Creek Point, Fairfield	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, illicit discharges
CT-W2_012	LIS WB Shore - Outer Norwalk Harbor(East), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include industrial discharges, landfill
CT-W2_012	LIS WB Shore - Outer Norwalk Harbor(East), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nitrogen (Total)	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT-W2_012	LIS WB Shore - Outer Norwalk Harbor(East), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include industrial discharges, landfills, remediation sites, groundwater impacts
CT-W2_012	LIS WB Shore - Outer Norwalk Harbor(East), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include industrial discharges, landfill
CT-W2_013	LIS WB Shore - Outer Norwalk Harbor(West), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-W2_013	LIS WB Shore - Outer Norwalk Harbor(West), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nitrogen (Total)	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT-W2_013	LIS WB Shore - Outer Norwalk Harbor(West), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT-W2_013	LIS WB Shore - Outer Norwalk Harbor(West), Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, illicit discharges, insufficient on-site treatment/ septic systems
CT-W2_023	LIS WB Shore - Smith Cove, Indian Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater
CT-W2_023	LIS WB Shore - Smith Cove, Indian Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nutrient/ Eutrophication Biological Indicators	Potential sources include stormwater
CT-W2_023	LIS WB Shore - Smith Cove, Indian Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater
CT-W2_023	LIS WB Shore - Smith Cove, Indian Harbor, Greenwich	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	Potential sources include stormwater, illicit discharges, combined sewer overflows, marinas, insufficient on-site treatment/ septic systems
CT-W3_014	LIS WB Midshore - Outer Captain Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation	Potential sources include stormwater, illicit discharges, municipal discharges
CT-W3_014	LIS WB Midshore - Outer Captain Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Nitrogen (Total)	Potential sources include stormwater, illicit discharges, municipal discharges
CT-W3_014	LIS WB Midshore - Outer Captain Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Organic Enrichment (Sewage) Biological Indicators	Potential sources include stormwater, illicit discharges, municipal discharges

Table 3-4. Connecticut Impaired Waters List (EPA Category 5)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Comment
CT-W3_014	LIS WB Midshore - Outer Captain Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Oxygen, Dissolved	Potential sources include stormwater, illicit discharges, municipal discharges

Table 3-5. Waterbodies with Adopted TMDLs

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT1000-00_01	1000	Pawcatuck River (Stonington/North Stonington)-01	Recreation	Escherichia coli	2015	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pawcatuck_watershed_tmdl_final.pdf
CT Statewide Bacteria TMDL	CT1000-00_trib_01	1000	Unnamed tributary Pawcatuck River 1000-00 (Stonington)-01	Recreation	Escherichia coli	2015	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pawcatuck_watershed_tmdl_final.pdf
CT Statewide Bacteria TMDL	CT1000-01_01	1000	Unnamed tributary Pawcatuck River 1000-01 (N. Stonington)-01	Recreation	Escherichia coli	2015	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pawcatuck_watershed_tmdl_final.pdf
CT Statewide Bacteria TMDL	CT1000-03_01	1000	Unnamed tributary Pawcatuck River 1000-03 (Stonington)-01	Recreation	Escherichia coli	2015	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pawcatuck_watershed_tmdl_final.pdf
CT Statewide Bacteria TMDL	CT1000-04_01	1000	Unnamed tributary Pawcatuck River 1000-04 (Stonington)-01	Recreation	Escherichia coli	2015	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pawcatuck_watershed_tmdl_final.pdf
CT Statewide Bacteria TMDL	CT1000-05_01	1000	Unnamed tributary Pawcatuck River 1000-05 (Stonington)-01	Recreation	Escherichia coli	2015	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pawcatuck_watershed_tmdl_final.pdf
CT Statewide Bacteria TMDL	CT1004-00_01	1004	Shunock River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/shunockriver1004.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT2000-30_01	2000	Fenger Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/southeastshoreline2000.pdf
CT Statewide Bacteria TMDL	CT2206-00_01	2206	Bride Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/bridebrook2206.pdf
CT Statewide Bacteria TMDL	CT2206-00_02	2206	Bride Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/bridebrook2206.pdf
CT Statewide Bacteria TMDL	CT2206-03_01	2206	Bride Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/bridebrook2206.pdf
CT Statewide Bacteria TMDL	CT3000-08_01	3000	Thames River / Flat Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/thamesflatbrook3000.pdf
CT Statewide Bacteria TMDL	CT3004-00_01	3004	Oxoboxo Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/oxoboxobrook3004.pdf
Upper Willimantic River TMDL	CT3100-00_05	3100	Willimantic River-05	Habitat for Fish, Other Aquatic Life and Wildlife	Copper, Lead, Zinc	2001	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/upperwillimanticrivertmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Upper Willimantic River TMDL	CT3100-00_05	3100	Willimantic River-05	Recreation	Copper, Lead, Zinc	2001	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/upperwillimanticrivertmdl.pdf
CT Statewide Bacteria TMDL	CT3100-00_06	3100	Willimantic River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/willimanticriver3100.pdf
CT Statewide Bacteria TMDL	CT3100-17_03	3100	Willimantic River / Cedar Swamp Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/willimanticriver3100.pdf
Eagleville Brook Impervious Cover TMDL	CT3100-19_01	3100	Eagleville Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Impervious Cover	2007	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/eaglevillefinal.pdf
Eagleville Brook Impervious Cover TMDL	CT3100-19_02	3100	Eagleville Brook-02	Habitat for Fish, Other Aquatic Life and Wildlife	Impervious Cover	2007	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/eaglevillefinal.pdf
CT Statewide Bacteria TMDL	CT3100-19_02	3100	Willimantic River / Eagleville Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/willimanticriver3100.pdf
CT Statewide Bacteria TMDL	CT3102-00_01	3102	Middle River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/middleriver3102.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT3102-00_02	3102	Middle River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/middleriver3102.pdf
CT Statewide Bacteria TMDL	CT3103-00_01	3103	Furnace Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/furnacebrook3103.pdf
CT Statewide Bacteria TMDL	CT3103-00_02	3103	Furnace Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/furnacebrook3103.pdf
CT Statewide Bacteria TMDL	CT3106-00_01b	3106	Skungamaug River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/skungamaugriver3106.pdf
CT Statewide Bacteria TMDL	CT3106-06-1-L2_01	3106	Skungamaug River / Crandall Pond	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/skungamaugriver3106.pdf
CT Statewide Bacteria TMDL	CT3108-00_01b	3108	Hop River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/hopriver3108.pdf
CT Statewide Bacteria TMDL	CT3110-00_01	3110	Tenmile River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/tenmileriver3110.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT3200-00_01	3200	Natchaug River / Lauter Park Beach	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/natchaugriver3200.pdf
CT Statewide Bacteria TMDL	CT3206-00_02	3206	Mount Hope River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/mounthoperiver3206.pdf
CT Statewide Bacteria TMDL	CT3207-16-1-L1_01	3207	Fenton River / Bicentennial Pond	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/fentonriver3207.pdf
CT Statewide Bacteria TMDL	CT3300-02_01	3300	French River / Long Branch Brook	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/frenchriver3300.pdf
CT Statewide Bacteria TMDL	CT3500-00_03	3500	Moosup River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/moosupriver3500.pdf
A Total Maximum Daily Load Analysis for Recreational Uses of the Ekonk River Sub-Regional Basin	CT3503-00_01	3503	Ekonk Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/execsums/ekonk_fs.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT3708-01_01	3708	Little River / Muddy Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/littleriver3708.pdf
CT Statewide Bacteria TMDL	CT3708-08_01	3708	Little River / Peckham Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/littleriver3708.pdf
CT Statewide Bacteria TMDL	CT3710-00_01	3710	Mashamoquet Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/mashamoquet3710.pdf
CT Statewide Bacteria TMDL	CT3710-00_02	3710	Mashamoquet Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/mashamoquet3710.pdf
CT Statewide Bacteria TMDL	CT3710-11_01	3710	Mashamoquet Brook / Abington Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/mashamoquet3710.pdf
CT Statewide Bacteria TMDL	CT3710-13_01	3710	Mashamoquet Brook / Sap Tree Run	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/mashamoquet3710.pdf
CT Statewide Bacteria TMDL	CT3710-18_01	3710	Mashamoquet Brook / White Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/mashamoquet3710.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT3716-00_01	3716	Broad Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/broadbrook3716.pdf
CT Statewide Bacteria TMDL	CT3800-00_05	3800	Shetucket River	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/shetucketriver3800.pdf
CT Statewide Bacteria TMDL	CT3800-02_01	3800	Shetucket River / Obwebetuck Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/shetucketriver3800.pdf
CT Statewide Bacteria TMDL	CT4000-00_01	4000	Connecticut River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/connecticutriver4000.pdf
CT Statewide Bacteria TMDL	CT4000-00_03	4000	Connecticut River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/connecticutriver4000.pdf
CT Statewide Bacteria TMDL	CT4009-00-2-L4_01	4009	Roaring Brook / Angus Park Pond	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/roaringbrook4009.pdf
CT Statewide Bacteria TMDL	CT4101-00_01	4101	Muddy Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/muddybrook4101.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT4205-00_01	4205	Buckhorn Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/buckhornbrook4205.pdf
CT Statewide Bacteria TMDL	CT4206-00_01	4206	Broad Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/broadbrook4206.pdf
CT Statewide Bacteria TMDL	CT4206-00_02	4206	Broad Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/broadbrook4206.pdf
CT Statewide Bacteria TMDL	CT4300-00_02	4300	Farmington River	Recreation	Escherichia coli	2012	2	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/farmingtonriver4300.pdf
CT Statewide Bacteria TMDL	CT4300-32_01	4300	Farmington River / Minister Brook	Recreation	Escherichia coli	2012	2	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/farmingtonriver4300.pdf
CT Statewide Bacteria TMDL	CT4300-33_01	4300	Farmington River / Russell Brook	Recreation	Escherichia coli	2012	2	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/farmingtonriver4300.pdf
CT Statewide Bacteria TMDL	CT4300-39_01	4300	Farmington River / Owens Brook	Recreation	Escherichia coli	2012	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/farmingtonriver4300.pdf
CT Statewide Bacteria TMDL	CT4300-44_01	4300	Farmington River / Munnisunk Brook	Recreation	Escherichia coli	2012	2	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/farmingtonriver4300.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Rainbow Brook TMDL	CT4300-50_01	4300	Rainbow Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Ethylene Glycol, Propylene Glycol	1999	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/rainbow_seymour_hollow_tmdl.pdf
Seymour Hollow Brook TMDL	CT4300-51_01	4300	Seymour Hollow Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Ethylene Glycol, Propylene Glycol	1999	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/rainbow_seymour_hollow_tmdl.pdf
CT Statewide Bacteria TMDL	CT4302-00_01	4302	Mad River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/madriver4302.pdf
CT Statewide Bacteria TMDL	CT4302-00_02a	4302	Mad River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/madriver4302.pdf
CT Statewide Bacteria TMDL	CT4302-00_03	4302	Mad River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/madriver4302.pdf
CT Statewide Bacteria TMDL	CT4303-00_02	4303	Still River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/stillriver4303.pdf
CT Statewide Bacteria TMDL	CT4303-00_03	4303	Still River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/stillriver4303.pdf
CT Statewide Bacteria TMDL	CT4303-00_04	4303	Still River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/stillriver4303.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT4304-00_01a	4304	Sandy Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/sandybrook4304.pdf
CT Statewide Bacteria TMDL	CT4305-00_01	4305	Morgan Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/morganbrook4305.pdf
CT Statewide Bacteria TMDL	CT4305-00_02	4305	Morgan Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/morganbrook4305.pdf
CT Statewide Bacteria TMDL	CT4305-00_04	4305	Morgan Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/morganbrook4305.pdf
CT Statewide Bacteria TMDL	CT4309-00_01	4309	Cherry Brook	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/cherrybrook4309.pdf
CT Statewide Bacteria TMDL	CT4309-00_02	4309	Cherry Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/cherrybrook4309.pdf
Pequabuck River Subregional Basin E.coli TMDL	CT4313-00_01	4313	Poland River	Recreation	Escherichia coli	2009	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/pequabucktmdl_final.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Pequabuck River Subregional Basin E.coli TMDL	CT4313-00_02	4313	Poland River	Recreation	Escherichia coli	2009	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/pequabucktmdl_final.pdf
Pequabuck River Subregional Basin E.coli TMDL	CT4314-00_01	4314	Coppermine Brook	Recreation	Escherichia coli	2009	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/pequabucktmdl_final.pdf
Pequabuck River Subregional Basin E.coli TMDL	CT4315-00_01	4315	Pequabuck River	Recreation	Escherichia coli	2009	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/pequabucktmdl_final.pdf
Pequabuck River Subregional Basin E.coli TMDL	CT4315-00_02	4315	Pequabuck River	Recreation	Escherichia coli	2009	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/pequabucktmdl_final.pdf
Pequabuck River Subregional Basin E.coli TMDL	CT4315-00_03	4315	Pequabuck River	Recreation	Escherichia coli	2009	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/pequabucktmdl_final.pdf
Pequabuck River Subregional Basin E.coli TMDL	CT4315-00_04	4315	Pequabuck River	Recreation	Escherichia coli	2009	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/pequabucktmdl_final.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Pequabuck River Subregional Basin E.coli TMDL	CT4315-00_05	4315	Pequabuck River	Recreation	Escherichia coli	2009	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/pequabucktmdl_final.pdf
Pequabuck River Subregional Basin E.coli TMDL	CT4315-00_06	4315	Pequabuck River	Recreation	Escherichia coli	2009	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/pequabucktmdl_final.pdf
CT Statewide Bacteria TMDL	CT4316-00_02	4316	Thompson Brook	Recreation	Escherichia coli	2012	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/thompsonbrook4316.pdf
CT Statewide Bacteria TMDL	CT4317-00_01	4317	Nod Brook	Recreation	Escherichia coli	2012	2	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/nodbrook4317.pdf
CT Statewide Bacteria TMDL	CT4318-00_01	4318	Hop Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/hopbrook4318.pdf
CT Statewide Bacteria TMDL	CT4319-00_01a	4319	West Branch Salmon Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/westbranchsalmonbrook4319.pdf
CT Statewide Bacteria TMDL	CT4319-00_01b	4319	West Branch Salmon Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/westbranchsalmonbrook4319.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
East Branch Salmon Brook and Mountain Brook E. coli TMDL	CT4320-00_01	4320	Salmon Brook (East Granby)-01	Recreation	Escherichia coli	2011	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/salmonmtn9_10.pdf
East Branch Salmon Brook and Mountain Brook E. coli TMDL	CT4320-19_01	4320	Mountain Brook (Suffield)-01	Recreation	Escherichia coli	2011	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/salmonmtn9_10.pdf
CT Statewide Bacteria TMDL	CT4321-00_01	4321	Mill Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/millbrook4321.pdf
CT Statewide Bacteria TMDL	CT4400-00_01	4400	Park River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/parkriver4400.pdf
CT Statewide Bacteria TMDL	CT4400-01_01	4400	S Branch Park River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/parkriver4400.pdf
CT Statewide Bacteria TMDL	CT4400-01_02	4400	S Branch Park River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/parkriver4400.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Batterson Park Pond TMDL	CT4401-00-1-L1_01	4401	Batterson Park Pond (Farmington / New Britain)	Recreation	Chlorophyll-a, Excess Algal Growth, Nutrient / Eutrophication, Biological Indicators	2004	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/battersonparkpondtmdl.pdf
CT Statewide Bacteria TMDL	CT4402-00_01	4402	Piper Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/piperbrook4402.pdf
CT Statewide Bacteria TMDL	CT4402-00_02	4402	Piper Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/piperbrook4402.pdf
CT Statewide Bacteria TMDL	CT4403-00_01	4403	Trout Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/troutbrook4403.pdf
CT Statewide Bacteria TMDL	CT4403-00_02	4403	Trout Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/troutbrook4403.pdf
CT Statewide Bacteria TMDL	CT4403-00_03	4403	Trout Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/troutbrook4403.pdf
CT Statewide Bacteria TMDL	CT4404-00_01	4404	N Branch Park River	Recreation	Escherichia coli	2012	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/nbranchparkriver4404.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT4404-00_02	4404	N Branch Park River	Recreation	Escherichia coli	2012	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/nbranchparkriver4404.pdf
Hockanum River Regional Basin E. coli TMDL	CT4500-00_01	4500	Hockanum River-01	Recreation	Escherichia coli	2011	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hockanum_final.pdf
Hockanum River Regional Basin E. coli TMDL	CT4500-00_02	4500	Hockanum River-02	Recreation	Escherichia coli	2011	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hockanum_final.pdf
Hockanum River Regional Basin E. coli TMDL	CT4500-00_03	4500	Hockanum River-03	Recreation	Escherichia coli	2011	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hockanum_final.pdf
Hockanum River Regional Basin E. coli TMDL	CT4500-00_04A	4500	Hockanum River-04A	Recreation	Escherichia coli	2011	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hockanum_final.pdf
Hockanum River Regional Basin E. coli TMDL	CT4500-00_04B	4500	Hockanum River-04B	Recreation	Escherichia coli	2011	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hockanum_final.pdf
Hockanum River Regional Basin E. coli TMDL	CT4500-00_05	4500	Hockanum River-05	Recreation	Escherichia coli	2011	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hockanum_final.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Hockanum River Regional Basin E. coli TMDL	CT4500-00_06A	4500	Hockanum River-06A	Recreation	Escherichia coli	2011	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hockanum_final.pdf
Hockanum River Regional Basin E. coli TMDL	CT4500-00_06B	4500	Hockanum River-06B	Recreation	Escherichia coli	2011	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hockanum_final.pdf
Hockanum River Regional Basin E. coli TMDL	CT4500-00_07	4500	Hockanum River-07	Recreation	Escherichia coli	2011	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hockanum_final.pdf
Hockanum River Regional Basin E. coli TMDL	CT4500-00_08	4500	Hockanum River-08	Recreation	Escherichia coli	2011	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hockanum_final.pdf
Hockanum River Regional Basin E. coli TMDL	CT4501-00_01	4501	Charters Brook-01	Recreation	Escherichia coli	2011	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hockanum_final.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4600-00_01	4600	Mattabesset River-01	Recreation	Escherichia coli	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf w

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Mattabesset River Regional Basin E.coli TMDL	CT4600-00_02	4600	Mattabesset River-02	Recreation	Escherichia coli	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf w
Mattabesset River Regional Basin E.coli TMDL	CT4600-00_03	4600	Mattabesset River-03	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4600-00_04	4600	Mattabesset River-04	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4600-00_06	4600	Mattabesset River-06	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4600-05_01	4600	John Hall Brook-01	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4600-05_02	4600	John Hall Brook-02	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Mattabesset River Regional Basin E.coli TMDL	CT4600-07_01	4600	Little Brook (Rocky Hill)-01	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4600-13_01	4600	Spruce Brook (Berlin)-01	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4600-22_01	4600	Coles Brook-01	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4600-26_01	4600	Miner Brook-01	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4600-27_01	4600	Willow Brook (Cromwell)-01	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
CT Statewide Bacteria TMDL	CT4600-27_trib_01	4600	Mattabesset River/ Willow Brook East Branch	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/mattabessetriver4600.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4601-00_01	4601	Belcher Brook-01	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Mattabesset River Regional Basin E.coli TMDL	CT4602-00_01	4602	Willow Brook (New Britain)-01	Recreation	Escherichia coli	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf w
Mattabesset River Regional Basin E.coli TMDL	CT4603-00_01	4603	Webster Brook-01	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4604-00_01	4604	Sawmill Brook (Middletown)-01	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4607-00_02	4607	Coginchaug River-02	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4607-00_03	4607	Coginchaug River-03	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4607-00_04	4607	Coginchaug River-04	Recreation	Escherichia coli	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf w

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Mattabesset River Regional Basin E.coli TMDL	CT4607-00_05	4607	Coginchaug River-05	Recreation	Escherichia coli	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
Mattabesset River Regional Basin E.coli TMDL	CT4607-00_06	4607	Coginchaug River-06	Recreation	Escherichia coli	2005	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/mattbasintmdlfinal.pdf
CT Statewide Bacteria TMDL	CT4607-00-UL_pond_01	4607	Coginchaug River / Wadsworth Falls SP pond	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/coginchaugriver4607.pdf
CT Statewide Bacteria TMDL	CT4607-08_01	4607	Coginchaug River / Lyman Meadows Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/coginchaugriver4607.pdf
CT Statewide Bacteria TMDL	CT4607-13_01	4607	Coginchaug River / Laurel Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/coginchaugriver4607.pdf
Allen Brook, Allen Brook Pond, Gay City Pond and Schreeder Pond E.coli TMDL	CT4707-00-2-L2_01	4707	Gay City Pond (Hebron)	Recreation	Escherichia coli	2006	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/allenbrookfinal.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT4800-00_01	4800	Eightmile River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/eightmileriver4800.pdf
CT Statewide Bacteria TMDL	CT5105-00_01	5105	Chatfield Hollow Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/chatfieldhollowbrook5105.pdf
Allen Brook, Allen Brook Pond, Gay City Pond and Schreeder Pond E.coli TMDL	CT5105-00-2-L1_01	5105	Schreeder Pond (Killingworth)	Recreation	Escherichia coli	2006	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/allenbrookfinal.pdf
CT Statewide Bacteria TMDL	CT5107-00_01	5107	Neck River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/neckriver5107.pdf
CT Statewide Bacteria TMDL	CT5108-00_01	5108	East River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/eastriver5108.pdf
Cedar Pond TMDL	CT5111-09-1-L1_01	5111	Cedar Pond (North Branford)	Habitat for Fish, Other Aquatic Life and Wildlife	Chlorophyll-a, Excess Algal Growth, Nutrient / Eutrophication Biological Indicators	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/cedarfinaltmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Cedar Pond TMDL	CT5111-09-1-L1_01	5111	Cedar Pond (North Branford)	Recreation	Chlorophyll-a, Excess Algal Growth, Nutrient / Eutrophication Biological Indicators	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/cedarfinaltmdl.pdf
Linsley Pond TMDL	CT5111-09-1-L2_01	5111	Linsley Pond (Branford / North Branford)	Habitat for Fish, Other Aquatic Life and Wildlife	Chlorophyll-a, Excess Algal Growth, Nutrient / Eutrophication Biological Indicators	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/linsleyfinaltmdl.pdf
Linsley Pond TMDL	CT5111-09-1-L2_01	5111	Linsley Pond (Branford / North Branford)	Recreation	Chlorophyll-a, Excess Algal Growth, Nutrient / Eutrophication Biological Indicators	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/linsleyfinaltmdl.pdf
CT Statewide Bacteria TMDL	CT5112-00_01	5112	Farm River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/farmriver5112.pdf
CT Statewide Bacteria TMDL	CT5112-00_02	5112	Farm River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/farmriver5112.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Quinnipiac River Regional Basin E.coli TMDL	CT5200-00_01	5200	Quinnipiac River	Recreation	Escherichia coli	2008	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/quinnipiac_tmdl_final.pdf
Quinnipiac River Regional Basin E.coli TMDL	CT5200-00_02	5200	Quinnipiac River	Recreation	Escherichia coli	2008	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/quinnipiac_tmdl_final.pdf
Quinnipiac River Regional Basin E.coli TMDL	CT5200-00_03	5200	Quinnipiac River	Recreation	Escherichia coli	2008	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/quinnipiac_tmdl_final.pdf
Quinnipiac River Regional Basin E.coli TMDL	CT5200-00_04	5200	Quinnipiac River	Recreation	Escherichia coli	2008	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/quinnipiac_tmdl_final.pdf
Quinnipiac River Regional Basin E.coli TMDL	CT5200-00_06	5200	Quinnipiac River	Recreation	Escherichia coli	2008	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/quinnipiac_tmdl_final.pdf
Quinnipiac River Regional Basin E.coli TMDL	CT5200-00_07	5200	Quinnipiac River	Recreation	Escherichia coli	2008	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/quinnipiac_tmdl_final.pdf
CT Statewide Bacteria TMDL	CT5202-00-1-L3_01	5202	Tenmile River / Mixville Pond	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/tenmileriver5202.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Quinnipiac River Regional Basin E.coli TMDL	CT5203-00_01	5203	Misery Brook	Recreation	Escherichia coli	2008	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/quinnipiac_tmdl_final.pdf
Quinnipiac River Regional Basin E.coli TMDL	CT5205-00_01	5205	Sodom Brook	Recreation	Escherichia coli	2008	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/quinnipiac_tmdl_final.pdf
Quinnipiac River Regional Basin E.coli TMDL	CT5206-00_01	5206	Harbor Brook	Recreation	Escherichia coli	2008	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/quinnipiac_tmdl_final.pdf
Quinnipiac River Regional Basin E.coli TMDL	CT5206-00_02	5206	Harbor Brook	Recreation	Escherichia coli	2008	4a	www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/quinnipiac_tmdl_final.pdf
Allen Brook, Allen Brook Pond, Gay City Pond and Schreeder Pond E.coli TMDL	CT5207-02_01	5207	Allen Brook-01	Recreation	Escherichia coli	2006	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/allenbrookfinal.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Allen Brook, Allen Brook Pond, Gay City Pond and Schreeder Pond E.coli TMDL	CT5207-02_02	5207	Allen Brook-02	Recreation	Escherichia coli	2006	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/allenbrookfinal.pdf
Allen Brook, Allen Brook Pond, Gay City Pond and Schreeder Pond E.coli TMDL	CT5207-02-1-L1_01	5207	Allen Brook Pond (North Haven / Wallingford)	Recreation	Escherichia coli	2006	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/allenbrookfinal.pdf
CT Statewide Bacteria TMDL	CT5302-00_02	5302	Mill River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/millriver5302.pdf
CT Statewide Bacteria TMDL	CT5302-06_01	5302	Mill River / Shepard Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/millriver5302.pdf
CT Statewide Bacteria TMDL	CT5305-00_01	5305	West River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/westriver5305.pdf
CT Statewide Bacteria TMDL	CT5305-00-3-L1_01	5305	Edgewood Park Pond	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/westriver5305.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT5307-00_01	5307	Wepawaug River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/wepawaugriver5307.pdf
CT Statewide Bacteria TMDL	CT5307-00_02	5307	Wepawaug River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/wepawaugriver5307.pdf
CT Statewide Bacteria TMDL	CT5307-00_03	5307	Wepawaug River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/wepawaugriver5307.pdf
CT Statewide Bacteria TMDL	CT5307-00_04	5307	Wepawaug River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/wepawaugriver5307.pdf
CT Statewide Bacteria TMDL	CT5307-00_05	5307	Wepawaug River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/wepawaugriver5307.pdf
CT Statewide Bacteria TMDL	CT6000-00_06	6000	Housatonic River	Recreation	Escherichia coli	2012	4a	http:\\www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/housatonicriver6000.pdf
CT Statewide Bacteria TMDL	CT6000-00-5+L2_01	6000	Housatonic River /Lake Zoar	Recreation	Escherichia coli	2012	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/housatonicriver6000.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT6000-00-5+L4_01	6000	Housatonic River / Lake Housatonic	Recreation	Escherichia coli	2012	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/housatonicriver6000.pdf
CT Statewide Bacteria TMDL	CT6000-73_01	6000	Housatonic River / Curtiss Brook	Recreation	Escherichia coli	2012	4a	http:\\www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/housatonicriver6000.pdf
Factory Brook TMDL	CT6005-00_01	6005	Factory Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Ammonia, Copper, Lead, Zinc, Chlorine	2000	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/factory_brook_tmdl.pdf
Factory Brook TMDL	CT6005-00_01	6005	Factory Brook-01	Recreation	Ammonia, Copper, Lead, Zinc, Chlorine	2000	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/factory_brook_tmdl.pdf
A Total Maximum Daily Load Analysis for Recreational Uses of the Deep Brook Sub-Regional Basin	CT6019-00_01	6019	Deep Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/execsums/deepbrook_fs.pdf
CT Statewide Bacteria TMDL	CT6025-00_02	6025	Far Mill River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/farmillriver6025.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT6100-00_02a	6100	Blackberry River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/blackberryriver6100.pdf
CT Statewide Bacteria TMDL	CT6200-00_01	6200	Hollenbeck River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/hollenbeckriver6200.pdf
CT Statewide Bacteria TMDL	CT6302-00_02	6302	Mill Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/millbrook6302.pdf
Still River Regional Basin E. coli TMDL	CT6600-00_01	6600	Still River (New Milford / Brookfield)-01	Recreation	Escherichia coli	2010	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf
Still River Regional Basin E. coli TMDL	CT6600-00_02	6600	Still River (Brookfield / Danbury)-02	Recreation	Escherichia coli	2010	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf
Still River Regional Basin E. coli TMDL	CT6600-00_03	6600	Still River (Danbury)-03	Recreation	Escherichia coli	2010	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf
Still River Regional Basin E. coli TMDL	CT6600-00_04	6600	Still River (Danbury)-04	Recreation	Escherichia coli	2010	3	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf
Still River Regional Basin E. coli TMDL	CT6600-00_05	6600	Still River (Danbury)-05	Recreation	Escherichia coli	2010	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Kenosia Lake TMDL	CT6600-01-1-L3_01	6600	Kenosia, Lake (Danbury)	Recreation	Chlorophyll-a, Excess Algal Growth, Nutrient / Eutrophication Biological Indicators	2004	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/kenosialaketmdl.pdf
Still River Regional Basin E. coli TMDL	CT6601-00_01	6601	Miry Brook (Danbury)-01	Recreation	Escherichia coli	2010	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf
Still River Regional Basin E. coli TMDL	CT6602-00_01	6602	Kohanza Brook (Danbury)-01	Recreation	Escherichia coli	2010	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf
Still River Regional Basin E. coli TMDL	CT6603-00_01	6603	Padanaram Brook-01	Recreation	Escherichia coli	2010	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf
Still River Regional Basin E. coli TMDL	CT6604-00_01	6604	Sympaug Brook-01	Recreation	Escherichia coli	2010	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf
Still River Regional Basin E. coli TMDL	CT6605-00_01	6605	East Swamp Brook (Bethel)-01	Recreation	Escherichia coli	2010	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf
Limekiln Brook TMDL	CT6606-00_01	6606	Limekiln Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Copper, Zinc, Chlorine and ammonia	2002 (Cu,Zn,Cl); 2003(Nh3	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/limekilnbrooktmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Still River Regional Basin E. coli TMDL	CT6606-00_01	6606	Limekiln Brook-01	Recreation	Escherichia coli	2010	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf
Still River Regional Basin E. coli TMDL	CT6606-00_03	6606	Limekiln Brook-03	Recreation	Escherichia coli	2010	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/still_final.pdf
CT Statewide Bacteria TMDL	CT6700-20_01	6700	Shepaug River / Walker Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/shepaugriver6700.pdf
CT Statewide Bacteria TMDL	CT6705-00_01	6705	Bantam River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/bantamriver6705.pdf
CT Statewide Bacteria TMDL	CT6800-00_03	6800	Pomperaug River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pomperaugriver6800.pdf
CT Statewide Bacteria TMDL	CT6800-01_01	6800	Pomperaug River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pomperaugriver6800.pdf
CT Statewide Bacteria TMDL	CT6804-00_01	6804	Weekeepeemee River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/weekeepeemeeriver6804.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Transylvania Brook TMDL	CT6806-00_01	6806	Transylvania Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Ammonia (Un-ionized), Chlorine, Copper, Zinc	2001	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/transylvaniabrookmdlfinal.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6900-00_01	6900	Naugatuck River	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6900-00_02	6900	Naugatuck River	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6900-00_03	6900	Naugatuck River	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6900-00_04	6900	Naugatuck River	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6900-00_05	6900	Naugatuck River	Recreation	Escherichia coli	2008	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
Upper Naugatuck River TMDL	CT6900-00_05	6900	Naugatuck River-05	Habitat for Fish, Other Aquatic Life and Wildlife	Whole Effluent Toxicity (WET)	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugtmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Naugatuck River Regional Basin E.coli TMDL	CT6900-00_06	6900	Naugatuck River	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6900-22_01	6900	Great Brook	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
CT Statewide Bacteria TMDL	CT6900-28_01	6900	Naugatuck River / Hockanum Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/naugatuckriverhockanumbrook6900.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6912-00_01	6912	Steele Brook	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
Steele Brook TMDL	CT6912-00_01	6912	Steele Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Copper	2001	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/steelebrookfinal.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6912-00_02	6912	Steele Brook	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6914-00_01	6914	Mad River	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Naugatuck River Regional Basin E.coli TMDL	CT6914-00_02	6914	Mad River	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6914-00_03a	6914	Mad River	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
CT Statewide Bacteria TMDL	CT6914-06_01	6914	Mad River / Lilly Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/madriver6914.pdf
CT Statewide Bacteria TMDL	CT6914-06-1-L1_01	6914	Mad River / Hitchcock Lake	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/madriver6914.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6916-00_01	6916	Hop Brook	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
Naugatuck River Regional Basin E.coli TMDL	CT6917-00_01	6917	Long Meadow Pond Brook	Recreation	Escherichia coli	2008	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/naugatucktmdl_final.pdf
CT Statewide Bacteria TMDL	CT7000-22_01	7000	Indian River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/southwestshoreline7000.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT7000-22_02	7000	Indian River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/southwestshoreline7000.pdf
CT Statewide Bacteria TMDL	CT7102-00_02	7102	Bruce Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/brucebrook7102.pdf
CT Statewide Bacteria TMDL	CT7105-00_02	7105	Pequonnock River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pequonnockriver7105.pdf
CT Statewide Bacteria TMDL	CT7105-00_03	7105	Pequonnock River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pequonnockriver7105.pdf
CT Statewide Bacteria TMDL	CT7105-00_04	7105	Pequonnock River	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pequonnockriver7105.pdf
CT Statewide Bacteria TMDL	CT7105-00_05	7105	Pequonnock River	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pequonnockriver7105.pdf
CT Statewide Bacteria TMDL	CT7105-01_01	7105	West Branch Pequonnock River	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pequonnockriver7105.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Mill River, Rooster River and Sasco Brook E.coli TMDL	CT7106-00_01	7106	Rooster River-01	Recreation	Escherichia coli	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/swebasintmdlfinal.pdf
Mill River, Rooster River and Sasco Brook E.coli TMDL	CT7108-00_02a	7108	Mill River (Fairfield / Easton)-02a	Recreation	Escherichia coli	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/swebasintmdlfinal.pdf
Mill River, Rooster River and Sasco Brook E.coli TMDL	CT7108-00_02b	7108	Mill River (Fairfield / Easton)-02b	Recreation	Escherichia coli	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/swebasintmdlfinal.pdf
Sasco Brook TMDL	CT7109-00_01	7109	Sasco Brook	Recreation	Fecal Coliform	2000	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/sascofinal.pdf
Sasco Brook TMDL	CT7109-00_02	7109	Sasco Brook	Recreation	Fecal Coliform	2000	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/sascofinal.pdf
Mill River, Rooster River and Sasco Brook E.coli TMDL	CT7109-00_01	7109	Sasco Brook-01	Recreation	Escherichia coli	2005	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/swebasintmdlfinal.pdf
Mill River, Rooster River and Sasco Brook E.coli TMDL	CT7109-00_02	7109	Sasco Brook-02	Recreation	Escherichia coli	2005	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/swebasintmdlfinal.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT7109-00-trib_01	7109	Sasco Brook / Great Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/sascobrook7109.pdf
CT Statewide Bacteria TMDL	CT7109-02_01	7109	Sasco Brook / Unnamed Tributary	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/sascobrook7109.pdf
CT Statewide Bacteria TMDL	CT7109-06_01	7109	Sasco Brook / Great Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/sascobrook7109.pdf
CT Statewide Bacteria TMDL	CT7109-06_02	7109	Sasco Brook / Great Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/sascobrook7109.pdf
CT Statewide Bacteria TMDL	CT7200-22_01	7200	Saugatuck River / Beaver Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/saugatuck7200.pdf
CT Statewide Bacteria TMDL	CT7200-24_01	7200	Saugatuck River / Kettle Creek	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/saugatuck7200.pdf
CT Statewide Bacteria TMDL	CT7200-26_01	7200	Saugatuck River / Poplar Plain Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/saugatuck7200.pdf
CT Statewide Bacteria TMDL	CT7203-04_01	7203	West Branch Saugatuck River / Cobbs Mill Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/westbranchsaugatuckriver7203.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Norwalk River Regional Basin E. coli TMDL	CT7300-00_01	7300	Norwalk River-01	Recreation	Escherichia coli	2006	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/norwalktmdlfinal.pdf
Norwalk River Regional Basin E. coli TMDL	CT7300-00_02	7300	Norwalk River-02	Recreation	Escherichia coli	2006	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/norwalktmdlfinal.pdf
Norwalk River Regional Basin E. coli TMDL	CT7300-00_03a	7300	Norwalk River-03a	Recreation	Escherichia coli	2006	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/norwalktmdlfinal.pdf
Norwalk River Regional Basin E. coli TMDL	CT7300-00_03b	7300	Norwalk River-03b	Recreation	Escherichia coli	2006	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/norwalktmdlfinal.pdf
Norwalk River Regional Basin E. coli TMDL	CT7300-00_04	7300	Norwalk River-04	Recreation	Escherichia coli	2006	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/norwalktmdlfinal.pdf
Norwalk River Regional Basin E. coli TMDL	CT7300-00_05	7300	Norwalk River-05	Recreation	Escherichia coli	2006	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/norwalktmdlfinal.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Norwalk River Regional Basin E. coli TMDL	CT7300-02_01	7300	Ridgefield Brook-01	Recreation	Escherichia coli	2006	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/norwalktmdlfinal.pdf
Norwalk River Regional Basin E. coli TMDL	CT7300-02_02	7300	Ridgefield Brook-02	Recreation	Escherichia coli	2006	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/norwalktmdlfinal.pdf
Norwalk River Regional Basin E. coli TMDL	CT7302-00_01	7302	Silvermine River-01	Recreation	Escherichia coli	2006	2	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/norwalktmdlfinal.pdf
CT Statewide Bacteria TMDL	CT7302-00_02	7302	Silvermine River-02	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/silvermineriver7302.pdf
Tributary to Belden Hill Brook TMDL	CT7302-13_trib_01	7302	Unnamed tributary Belden Hill Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Chlorine	2000	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/beldenhilltmdlfinal.pdf
CT Statewide Bacteria TMDL	CT7401-00_01	7401	Five Mile River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/fivemileriver7401.pdf
CT Statewide Bacteria TMDL	CT7401-00_02	7401	Five Mile River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/fivemileriver7401.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT7401-00_03	7401	Five Mile River	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/fivemileriver7401.pdf
CT Statewide Bacteria TMDL	CT7401-02_01	7401	Five Mile River / Unnamed Tributary	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/fivemileriver7401.pdf
CT Statewide Bacteria TMDL	CT7401-05_01	7401	Five Mile River / Holy Ghost Father's Brook	Recreation	Escherichia coli	2012	2	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/fivemileriver7401.pdf
CT Statewide Bacteria TMDL	CT7401-06_01	7401	Five Mile River / Keelers Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/fivemileriver7401.pdf
CT Statewide Bacteria TMDL	CT7401-07_01	7401	Five Mile River / Unnamed Tributary to Keelers Brook	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/fivemileriver7401.pdf
CT Statewide Bacteria TMDL	CT7411-00_01	7411	Byram River	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/byramriver7411.pdf
A Total Maximum Daily Load Analysis for Recreational Uses of the Titicus River Sub-Regional Basin	CT8104-00_01	8104	Titicus River Sub-Regional Basin (Ridgefield)	Recreation	Escherichia coli	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/titicusfinal.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-C1_003-SB		LIS CB Inner-Hammonasset River	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary10_clinton.pdf
CT Statewide Bacteria TMDL	CT-C1_004-SB		LIS CB Inner - Hayden Creek, Clinton	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary10_clinton.pdf
Hayden Creek TMDL	CT-C1_004-SB		LIS CB Inner - Hayden Creek, Clinton	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Copper, Lead, Zinc	2002	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/hydencreektmdl.pdf
CT Statewide Bacteria TMDL	CT-C1_005		LIS CB Inner - Clinton Harbor	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary10_clinton.pdf
CT Statewide Bacteria TMDL	CT-C1_006		LIS CB Inner - East and Neck Rivers, Guilford	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary9_guilford_madison.pdf
CT Statewide Bacteria TMDL	CT-C1_007		LIS CB Inner – West River, Guilford	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary9_guilford_madison.pdf
CT Statewide Bacteria TMDL	CT-C1_009-SB		LIS CB Inner - Inner Branford Harbor	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary8_branford_easthaven.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-C1_013-SB		LIS CB Inner - New Haven Harbor	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary6newhaven.pdf
CT Statewide Bacteria TMDL	CT-C1_018-SB		LIS CB Inner - Milford Harbor & Gulf Pond	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary5milford.pdf
CT Statewide Bacteria TMDL	CT-C1_019-SB		LIS CB Inner - Housatonic River Mouth	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
CT Statewide Bacteria TMDL	CT-C2_003		LIS CB Shore - Clinton Beach, Clinton	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary10_clinton.pdf
CT Statewide Bacteria TMDL	CT-C2_004		LIS CB Shore - Outer Clinton Harbor	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary10_clinton.pdf
CT Statewide Bacteria TMDL	CT-C2_005		LIS CB Shore – Hammonasset Beach, Madison	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary9_guilford_madison.pdf
CT Statewide Bacteria TMDL	CT-C2_006		LIS CB Shore - Madison Beaches East, Madison	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary9_guilford_madison.pdf
CT Statewide Bacteria TMDL	CT-C2_007		LIS CB Shore - Madison Beaches West, Madison	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary9_guilford_madison.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-C2_008		LIS CB Shore - Guilford Harbor, Guilford	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary9_guilford_madison.pdf
CT Statewide Bacteria TMDL	CT-C2_009		LIS CB Shore - Indian Cove, Guilford	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary9_guilford_madison.pdf
CT Statewide Bacteria TMDL	CT-C2_010		LIS CB Shore - Joshua Cove & Island Bay, Guilford	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary9_guilford_madison.pdf
CT Statewide Bacteria TMDL	CT-C2_011		LIS CB Shore - Stony Creek East	Shellfish Harvest	Fecal Coliform	2013	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary8_branford_easthaven.pdf
CT Statewide Bacteria TMDL	CT-C2_012		LIS CB Shore - Stony Creek West	Shellfish Harvest	Fecal Coliform	2013	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary8_branford_easthaven.pdf
CT Statewide Bacteria TMDL	CT-C2_013		LIS CB Shore - Indian Neck	Shellfish Harvest	Fecal Coliform	2013	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary8_branford_easthaven.pdf
CT Statewide Bacteria TMDL	CT-C2_023		LIS CB Shore - Walnut Beach	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-C3_002		LIS CB Midshore - Duck Island area	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary10_clinton.pdf
CT Statewide Bacteria TMDL	CT-C3_003		LIS CB Midshore - Outer Clinton Harbor	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary10_clinton.pdf
CT Statewide Bacteria TMDL	CT-C3_004		LIS CB Midshore - Hammonasset Beach area, Madison	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary9_guilford_madison.pdf
CT Statewide Bacteria TMDL	CT-C3_006		LIS CB Midshore - Outer Guilford Harbor, Guilford	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary9_guilford_madison.pdf
CT Statewide Bacteria TMDL	CT-C3_009-I		LIS CB Midshore - Thimble Islands	Shellfish Harvest	Fecal Coliform	2013	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary8_branford_easthaven.pdf
CT Statewide Bacteria TMDL	CT-C3_010		LIS CB Midshore - Indian Neck	Shellfish Harvest	Fecal Coliform	2013	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary8_branford_easthaven.pdf
CT Statewide Bacteria TMDL	CT-C3_011		LIS CB Midshore - East Haven	Shellfish Harvest	Fecal Coliform	2013	4a	www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary8_branford_easthaven.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-C3_011		LIS CB Midshore - East Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
Long Island Sound TMDL	CT-C3_013-SB		LIS CB Midshore - New Haven Harbor, East Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-C3_014-SB		LIS CB Midshore - New Haven Harbor, West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
Long Island Sound TMDL	CT-C3_015-SB		LIS CB Midshore - New Haven Harbor, New Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	2	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-C3_016		LIS CB Midshore - West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	2	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
Long Island Sound TMDL	CT-C3_017		LIS CB Midshore - Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-C3_017		LIS CB Midshore - Milford	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-C3_018		LIS CB Midshore - Fort Trumbull, Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-C3_019-I		LIS CB Midshore - Outer Silver Sand Beach	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
CT Statewide Bacteria TMDL	CT-C3_020		LIS CB Midshore - Milford Point	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
Long Island Sound TMDL	CT-C3_020		LIS CB Midshore - Milford Point, Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-C4_004		LIS CB Offshore - West Haven	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
Long Island Sound TMDL	CT-C4_005		LIS CB Offshore - Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-E1_001-SB		LIS EB Inner - Pawcatuck River (01), Stonington	Shellfish Harvest	Fecal Coliform	2015	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pawcatuck_watershed_tmdl_final.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-E1_001-SB		LIS EB Inner - Pawcatuck River (01), Stonington	Recreation	Enterococcus	2015	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pawcatuck_watershed_tmdl_final.pdf
CT Statewide Bacteria TMDL	CT-E1_002-SB		LIS EB Inner - Pawcatuck River (02), Stonington	Shellfish Harvest	Fecal Coliform	2015	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pawcatuck_watershed_tmdl_final.pdf
CT Statewide Bacteria TMDL	CT-E1_003		LIS EB Inner – Inner Wequetequock Cove	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary12_stonington.pdf
CT Statewide Bacteria TMDL	CT-E1_005		LIS EB Inner – Inner Stonington Harbor	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary12_stonington.pdf
CT Statewide Bacteria TMDL	CT-E1_006		LIS EB Inner- Inner Quiambaug Cove	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary12_stonington.pdf
CT Statewide Bacteria TMDL	CT-E1_009		LIS EB Inner – Beebe Cove Mystic Harbor	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf
CT Statewide Bacteria TMDL	CT-E1_010		LIS EB Inner Palmer Cove Inner	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-E1_011-SB		LIS EB Inner Mumford Cove Inner	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf
CT Statewide Bacteria TMDL	CT-E1_012		LIS EB Inner Poquonuck River Mouth	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf
CT Statewide Bacteria TMDL	CT-E1_013		LIS EB Inner – Baker Cove	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf
CT Statewide Bacteria TMDL	CT-E1_014-SB		LIS EB Inner Thames River Mouth	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf
CT Statewide Bacteria TMDL	CT-E1_017		LIS EB Inner Alewife Cove	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf
CT Statewide Bacteria TMDL	CT-E1_019		LIS EB Inner - Jordan Cove	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E1_020		LIS EB Inner - Niantic River (mouth)	Recreation	Enterococcus	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-E1_020		LIS EB Inner - Niantic River (mouth)	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E1_021		LIS EB Inner - Pattagansett River (mouth)	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E1_022		LIS EB Inner – Bride Brook- East Lyme	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E1_023		LIS EB Inner - Fourmile River	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E1_024-SB		LIS EB Inner - Connecticut River (mouth)	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E1_026-SB		LIS EB Inner - Black Hall River (upper)	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-E1_027-SB		LIS EB Inner - Duck River	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E1_027-SB		LIS EB Inner - Duck River	Recreation	Enterococcus	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E1_032		LIS EB Inner - Oyster River Area	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E2_001		LIS EB Shore - Wequetequock Cove, Stonington	Shellfish Harvest	Fecal Coliform	2015	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pawcatuck_watershed_tmdl_final.pdf
CT Statewide Bacteria TMDL	CT-E2_002		LIS EB Shore - Stonington Point	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary12_stonington.pdf
CT Statewide Bacteria TMDL	CT-E2_004		LIS EB Shore – Wilcox Cove Mason Island	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary12_stonington.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-E2_005		LIS EB Shore – Mouth Mystic River	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary12_stonington.pdf
CT Statewide Bacteria TMDL	CT-E2_006		LIS EB Shore West Cove	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf
CT Statewide Bacteria TMDL	CT-E2_007		LIS EB Shore Outer Mumford Cove	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf
CT Statewide Bacteria TMDL	CT-E2_008		LIS EB Shore- Bluff Point	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf
CT Statewide Bacteria TMDL	CT-E2_012		LIS EB Shore - Outer Jordan Cove	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E2_013		LIS EB Shore - Niantic Bay (East)	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-E2_014		LIS EB Shore - Niantic Bay (West)	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E2_015		LIS EB Shore - Niantic Bay (Black Pt)	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E2_016		LIS EB Shore - Pattagansett River Mouth	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E2_017		LIS EB Shore - Rocky Neck (Fourmile River)	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E2_018		LIS EB Shore - Soundview Beach	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E2_020		LIS EB Shore - Willard Bay	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-E2_022		LIS EB Shore - Indiantown Harbor	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E2-003		LIS EB Shore - Outer Quiambaug Cove, Stonington	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary12_stonington.pdf
CT Statewide Bacteria TMDL	CT-E3_001		LIS EB Midshore - Stonington	Shellfish Harvest	Fecal Coliform	2015	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/pawcatuck_watershed_tmdl_final.pdf
CT Statewide Bacteria TMDL	CT-E3_003		LIS EB Midshore Mystic River	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf
CT Statewide Bacteria TMDL	CT-E3_004		LIS EB Midshore Thames River	Shellfish Harvest	Fecal Coliform	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary11newlondon_groton.pdf
CT Statewide Bacteria TMDL	CT-E3_006		LIS EB Midshore - Niantic Bay	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-E3_007		LIS EB Midshore - East Lyme, Rocky Neck	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_14_-_eastlyme_waterford_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E3_008		LIS EB Midshore - Old Lyme, CT River	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E3_010		LIS EB Midshore - Old Saybrook	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf
CT Statewide Bacteria TMDL	CT-E3_011		LIS EB Midshore - Old Saybrook, Indian Harbor	Shellfish Harvest	Fecal Coliform	2014	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/final_estuary_13-old_saybrook_old_lyme_-_complete.pdf
CT Statewide Bacteria TMDL	CT-W1_001-SB		LIS WB Inner - Bridgeport Harbor	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary7bridgeport.pdf
CT Statewide Bacteria TMDL	CT-W1_002-SB		LIS WB Inner - Black Rock Harbor	Shellfish Harvest, Recreation	Fecal Coliform, Enterococcus	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary7bridgeport.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-W1_005		LIS WB Inner - Southport Harbor	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
CT Statewide Bacteria TMDL	CT-W1_008		LIS WB Inner - Sherwood Millpond	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
CT Statewide Bacteria TMDL	CT-W1_010-SB		LIS WB Inner - Saugatuck River Mouth	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
CT Statewide Bacteria TMDL	CT-W1_013-SB		LIS WB Inner - Norwalk Harbor Marvin Beach	Recreation	Enterococcus	2013	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary1norwalk.pdf
CT Statewide Bacteria TMDL	CT-W1_022-SB		LIS WB Inner - Byram River	Shellfish Harvest, Recreation	Fecal Coliform, Enterococcus	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf
CT Statewide Bacteria TMDL	CT-W2_004		LIS WB Shore - Outer Bridgeport Harbor	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary7bridgeport.pdf
Southport Harbor TMDL	CT-W2_006		LIS WB Shore - Southport Harbor (East), Fairfield	Shellfish Harvest	Fecal Coliform	2007	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/southport_h_final.pdf
CT Statewide Bacteria TMDL	CT-W2_006		LIS WB Shore - Southport Harbor East	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-W2_007		LIS WB Shore - Southport Harbor West	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
Southport Harbor TMDL	CT-W2_008		LIS WB Shore - Green Farms, Westport	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/southport_h_final.pdf
CT Statewide Bacteria TMDL	CT-W2_009		LIS WB Shore - Compo Cove, SISP	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
CT Statewide Bacteria TMDL	CT-W2_010		LIS WB Shore - Compo Beach, Cedar Point	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
CT Statewide Bacteria TMDL	CT-W2_011		LIS WB Shore - Canfield Island	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary1norwalk.pdf
CT Statewide Bacteria TMDL	CT-W2_012		LIS WB Shore - Outer Norwalk Harbor East	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary1norwalk.pdf
CT Statewide Bacteria TMDL	CT-W2_013		LIS WB Shore - Outer Norwalk Harbor West	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary1norwalk.pdf
CT Statewide Bacteria TMDL	CT-W2_014		LIS WB Shore - Wilson Cove, Farm Creek	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary1norwalk.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-W2_015		LIS WB Shore - Fivemile River Estuary	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
CT Statewide Bacteria TMDL	CT-W2_016		LIS WB Shore - Scott Cove	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
CT Statewide Bacteria TMDL	CT-W2_017		LIS WB Shore - Darien Cove	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
CT Statewide Bacteria TMDL	CT-W2_018		LIS WB Shore - Westcott Cove	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf
CT Statewide Bacteria TMDL	CT-W2_019		LIS WB Shore - Stamford Harbor	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf
CT Statewide Bacteria TMDL	CT-W2_020		LIS WB Shore - Stamford Harbor West	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf
CT Statewide Bacteria TMDL	CT-W2_021		LIS WB Shore - Greenwich Cove	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-W2_022		LIS WB Shore - Cos Cob Harbor	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf
CT Statewide Bacteria TMDL	CT-W2_024		LIS WB Shore - Byram Harbor	Shellfish Harvest, Recreation	Fecal Coliform, Enterococcus	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf
CT Statewide Bacteria TMDL	CT-W2_025		LIS WB Shore - Byram Harbor West	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf
CT Statewide Bacteria TMDL	CT-W3_001		LIS WB Midshore - Lordship	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary7bridgeport.pdf
Long Island Sound TMDL	CT-W3_001		LIS WB Midshore - Lordship, Stratford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-W3_002		LIS WB Midshore - Bridgeport Harbor East	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary7bridgeport.pdf
Long Island Sound TMDL	CT-W3_002		LIS WB Midshore - Bridgeport Harbor, East, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-W3_003		LIS WB Midshore - Bridgeport Harbor West	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary7bridgeport.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-W3_003		LIS WB Midshore - Bridgeport Harbor, West, Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-W3_004		LIS WB Midshore - Shoal Point	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary7bridgeport.pdf
Long Island Sound TMDL	CT-W3_004		LIS WB Midshore - Shoal Point, Fairfield	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-W3_005		LIS WB Midshore - Southport Harbor	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-W3_005		LIS WB Midshore - Southport Harbor, Fairfield	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-W3_006		LIS WB Midshore - Sherwood Point	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
Long Island Sound TMDL	CT-W3_006		LIS WB Midshore - Sherwood Point, Westport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-W3_007		LIS WB Midshore - Offshore Norwalk Islands, Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-W3_008-I		LIS WB Midshore - Norwalk Islands	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary1norwalk.pdf
Long Island Sound TMDL	CT-W3_008-I		LIS WB Midshore - Norwalk Islands, Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-W3_009		LIS WB Midshore - Outer Fivemile R Estuary, Darien	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-W3_009		LIS WB Midshore - Outer Fivemile River Estuary	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
CT Statewide Bacteria TMDL	CT-W3_010		LIS WB Midshore - Outer Cove Harbor	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary3darien.pdf
Long Island Sound TMDL	CT-W3_010		LIS WB Midshore - Outer Cove Harbor, Darien	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
CT Statewide Bacteria TMDL	CT-W3_011		LIS WB Midshore - Outer Westcott Cove	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf
Long Island Sound TMDL	CT-W3_011		LIS WB Midshore - Outer Westcott Cove, Stamford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-W3_012		LIS WB Midshore - Outer Stamford Harbor	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-W3_012		LIS WB Midshore - Outer Stamford Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
Long Island Sound TMDL	CT-W3_013		LIS WB Midshore - Outer Cos Cob Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-W3_013		LIS WB Midshore - Outer Cos Cob Harbor, Greenwich	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-W3_014		LIS WB Midshore - Outer Captain Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	2	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
CT Statewide Bacteria TMDL	CT-W3_015-I		LIS WB Midshore - Captain Harbor	Shellfish Harvest	Fecal Coliform	2012	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/statewidebacteria/estuary2greenwichstamford.pdf
Long Island Sound TMDL	CT-W3_015-I		LIS WB Midshore - Captain Harbor, Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-W4_001		LIS WB Offshore - Bridgeport	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
Long Island Sound TMDL	CT-W4_002		LIS WB Offshore - Fairfield	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-W4_003		LIS WB Offshore - Norwalk	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
Long Island Sound TMDL	CT-W4_004		LIS WB Offshore - Darien	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf

Table 3-5. Waterbodies with Adopted TMDLs

TMDL	Waterbody Segment ID	Basin Number	Waterbody Name	Impaired Designated Use	Cause	EPA Approved	EPA Category	Web link
Long Island Sound TMDL	CT-W4_005		LIS WB Offshore - Greenwich	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	2001	4a	http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf
Northeast Regional Mercury TMDL			All State fresh waterbodies	Fish Consumption	Mercury	2007	4a	http://www.ct.gov/deep/lib/deep/water/tmdl/tmdl_final/ne_hg_tmdl.pdf

342 Table 3-6. Pollution Control Measures for Waterbody Segments (EPA Category 4b)

Table 3-6. Pollution Control Measures for Waterbody Segments (EPA Category 4b)

Waterbody Segment ID	Waterbody Name	Pollution Control Measures
CT3104-00-2-L8_outlet_01	Ruby Lake outlet stream-01	As a result of a release of diesel fuel in February 2003, TravelCenters of America (TA) entered into Consent Order WC5392 on October 14, 2003. The consent order required a site investigation into the extent and degree of contamination and upgrades to the stormwater collection system. Release investigation activities and improvements to the stormwater management system since 2003 include the following: removal of impacted soils from, and modifications to, the stormwater detention basin; cleaning of the affected portions of the stormwater conveyance system and catch basins; cleaning of, and improvements to, the existing 18,000 gallon oil/water separator that receives most of the site runoff; installation of a diesel UST containment area; replacement of an existing oil/water separator with a dedicated 6,000 gallon spill containment tank to receive spills and leaks from the diesel UST pad and the diesel dispensing area; excavation and removal of impacted soils encountered during site improvement activities; and increased site and equipment inspections. In March 2012, the Department moved to approve a submitted report (Release Investigation & Contamination Extent Determination (RI/CED) Environmental Site Assessment) however specific revisions for monitoring and reporting had yet to be incorporated in the report. In July 2014, DEEP submitted a letter to TA requesting that revisions be completed to the RI/CED report so that DEEP could finalize approval of the report. In November 2016, TA submitted a Screening Level Ecological Risk Assessment of the impacted area which is under review by CT DEEP staff. The NPDES Permit No. CT0029520 was reissued to TA on July 24, 2009 for the discharge of stormwater to a Tributary of Roaring Brook. The permit requires quarterly monitoring for a variety of parameters at the inlet and outlet of the stormwater detention basin, and monthly monitoring for oil and grease and the BTEX components (benzene, toluene, ethylbenzene, and xylene) within the basin. A review of Discharge Monitoring Reports submitted by TA indicates that these parameters are typically not detected in the monthly samples. In addition, the permit required the submittal of an updated Stormwater Pollution Prevention Plan for the review of the commissioner. On March 15, 2010, TA submitted an Integrated Contingency Plan for the review of the commissioner. This document combines the components of the Spill Prevention, Control and Countermeasure Plan required by 40 CFR 112 and the Stormwater Pollution Prevention Plan required by NPDES Permit No. CT0029520. The Integrated Contingency Plan was reviewed by Department staff and a comment letter sent to the permittee on July 20, 2010. In September 2013, DEEP staff performed an inspection of the stormwater system and determined that TA's stormwater maintenance activities likely violated their NPDES Permit No. CT0029520 as well as CT statutes and regulations and issued a Notice of Violation in November 2013. In June 2014, EPA issued a compliance letter to TA under Section 308 of the Clean Water Act (CWA) which requires submittal of any information responsive to EPA’s questions concerning CWA discharges.

Table 3-6. Pollution Control Measures for Waterbody Segments (EPA Category 4b)

Waterbody Segment ID	Waterbody Name	Pollution Control Measures
CT5000-55_02	Unnamed trib to Oyster River (Milford)-02	This waterbody is impaired for Habitat for Fish, Other Aquatic Life and Wildlife use due to mercury detected in the sediment and fish tissue in several studies. Light Sources Inc., a light bulb manufacturer, was determined to be the source of the mercury in the waterbody. A court-issued clarification (12/04/03) of the court's Memorandum of Decision (05/27/03) requires the manufacturer to remediate the waterbody and achieve a level of 0.2 mg/kg for mercury in the sediment. This level is based on toxicity to environmental receptors as well as the potential for mercury to bioaccumulate and once achieved, it is expected that uses will be maintained. The instream cleanup level for mercury in the sediments must be protective of both human health and the environment and consistent with CT WQS #14. In October 2008, the company submitted a report detailing additional sampling to define the nature and extent of mercury contamination within the wetlands. The report also included proposals for the remedial activities in certain areas as well as an ecological risk assessment. All submitted reports have been reviewed by CT DEEP and comments provided to Light Sources, Inc. As of June 2014, the company is updating and revising the remedial action plan required by the permanent injunction order and/or otherwise approved by CT DEEP. Additionally, follow-up monitoring to determine the effectiveness of any remedial actions will be required for the site. The Department has requested a revised workplan to address areas still requiring investigation and remediation of the wooded "wetland" and the larger wetland. Light Sources, Inc. has not submitted a revised work plan, but Light Sources, Inc. has been challenging the appropriateness of the 0.2 mg/kg clean up criteria, stating that the cleanup criteria should be a higher concentration which would be less restrictive.

Table 3-6. Pollution Control Measures for Waterbody Segments (EPA Category 4b)

Waterbody Segment ID	Waterbody Name	Pollution Control Measures
CT6000-00_03 CT6000-00_04 CT6000-00_05 CT6000-00_06 CT6000-00_07 CT6000-00-5+L1_01 CT6000-00-5+L2_01 CT6000-00-5+L2_02 CT6000-00-5+L4_01	Housatonic River-03 Housatonic River-04 Housatonic River-05 Housatonic River-06 Housatonic River-07 Lillinonah, Lake (Newtown/ Southbury/ Bridgewater/ Brookfield) Zoar, Lake (Monroe/ Newtown/ Oxford/ Southbury) Zoar, Lake (Newtown/ Southbury) Housatonic, Lake (Shelton/ Derby/ Seymour/ Oxford/ Monroe)	The Housatonic River from the Derby-Shelton Dam to the Massachusetts border, which includes Lake Housatonic, Lake Zoar, and Lake Lillinonah, is listed for a CT DPH fish consumption advisory as a result of the bioaccumulation of polychlorinated biphenyls (PCBs). The PCBs originated in Pittsfield, Massachusetts from transformer manufacturing between 1932 and 1977 by the General Electric Company (GE). PCBs were released into the soil, groundwater, river and other media. In 2000, the U.S. District Court approved a Consent Decree which specified a detailed process for evaluating contamination and addressing areas for cleanup. Three distinct areas have been identified for remediation activities: the ½ mile (immediately adjacent and downstream of the GE facility); the 1 ½ mile (immediately below the ½ mile and ending at the confluence of the East and West Branches); and Rest of River (confluence of the East and West Branches, which form the mainstem of the Housatonic, down through MA and CT to Long Island Sound). Cleanup of contaminated river sediment and bank soil in the ½ mile section and 1 ½ mile section were completed by GE in 2002 and by EPA in 2007, respectively. In 2003, GE completed a RCRA Facility Investigation Report (RFI) which documented all sampling investigations and delineated the nature and extent of constituents in the Rest of River section. By 2006, EPA had finalized the ecological (ERA) and human health (HHRA) risk assessments as well as a modeling study. Also in 2006, GE received approval for Interim Media Protection Goals (IMPGs) for human and ecological receptors found to be at risk in Rest of River. GE received approval in 2007 for a Corrective Measures Study Proposal (CMS-P) that sets forth the work plan for the Corrective Measures Study (CMS), which proposes clean-up alternatives for the Rest of the River. After GE submitted the CMS in 2008, EPA issued a letter of comment that required GE to address several specific points and to revise the CMS. In January 2009, GE requested to study an additional set of remedial alternatives which would be an addendum to the CMS-P. EPA agreed to the request, but required GE to include some specific remedial alternatives. GE submitted the additional remedial alternatives in August 2009 and EPA issued a conditional approval in January that required GE to respond to comments not yet addressed in the 2008 letter of comment for the CMS. After much discussion between GE, EPA, other federal and state agencies, GE invoked a formal dispute resolution with EPA pertaining to the conditional approval. In June 2010, EPA's Office of Site Remediation and Restoration issued a final decision in which EPA and GE agreed to a proposed schedule for submitting a revised CMS. The revised CMS was to include responses to EPA comments with exemptions on specific items as modified by the dispute resolution. In October 2010, GE submitted a Revised CMS which included two additional clean up alternatives. In the informal public comment period that followed, EPA received comments from the Commonwealth of Massachusetts - Executive Office of Energy & Environmental Affairs expressing concern regarding the impact that potential cleanup activities might have on the Housatonic floodplain ecosystem, an area that Massachusetts had designated as an Area of Critical Environmental Concern in 2009. In its comments, the Commonwealth proposed another clean up alternative. Taking into account comments received, EPA moved forward with evaluating the proposed alternatives in the Revised CMS against nine criteria specified in the RCRA Permit, and developing its preferred remedial alternative or set of alternatives. As part of this process, EPA sponsored a series

Table 3-6. Pollution Control Measures for Waterbody Segments (EPA Category 4b)

Waterbody Segment ID	Waterbody Name	Pollution Control Measures
		of mini workshops in April 2011 to provide information on PCBs and share ideas with the public. In a process separate from but related to the Consent Decree, EPA's New England regional office was required, in June 2011, to submit a pre-decisional document on remediation options to and attend a meeting of the EPA National Remedy Review Board which reviews large scale projects across the country for consistency and also provides feedback. Although this meeting was closed to the public, they were invited to submit comments on issues pertinent to the cleanup decision. Following this, between the Fall of 2011 and Spring of 2012, EPA entered into confidential, high level technical meetings with Commonwealth of Massachusetts and State of Connecticut regulatory agencies to discuss potential clean up approaches for Rest of River. A major goal was to try to move towards consensus and strike a balance between the need to address the risks from PCBs to humans, fish, wildlife and other organisms while avoiding, mitigating or minimizing the impacts of the clean up on the unique ecological character of the Housatonic River. In May 2012, EPA and the States released a document entitled: "Status Report of Preliminary Discussions of Potential Remediation Approaches to the GE-Housatonic River Site "Rest of River". Subsequently, in May and June of 2012, EPA, with Connecticut and Massachusetts, hosted four public informational meetings - two in each state - to discuss the status report and receive public feedback. Following this, GE requested further discussion with EPA and the States on technical issues. Discussions ended in 2013. In June 2014, EPA issued the Statement of Basis for their proposed remedial action for "Rest of River" and draft modification to the reissued RCRA permit. As part of this, EPA also hosted public informational meetings in both Massachusetts and Connecticut. A formal public comment period between June through October 2014 ensued, during which time EPA also held a public hearing. In September 2015, EPA issued its Intended Final Decision for cleanup. Shortly thereafter, in October 2015, GE invoked its right to dispute resolution, as allowed under the Consent Decree. Mediation was pursued but an agreement could not be reached. As a result, EPA (in consultation with Massachusetts and Connecticut) and GE each submitted formal Statements of Position for review by an EPA decision maker. In October 2016, the Final Administrative Decision concerning the GE Housatonic Rest of River Remedy Dispute was issued, upholding EPA's cleanup decision. EPA subsequently issued a Final Permit Modification to the Reissued RCRA Permit which would have become effective in thirty days, except for timely petitions for review which were filed with EPA's Environmental Appeals Board (EAB). In February 2017, the EAB granted oral arguments on the permit appeals which have been scheduled for in June 2017. After completion of the EAB process, the EPA cleanup decision may move forward (with a requirement for GE to submit a Statement of Work) or it may be appealed to the U.S. Circuit Court of Appeals. While contested portions of the permit are being reviewed by EAB, un-contested portions of the permit are now in effect. GE must submit a Scope of Work for accomplishing deliverables described in un-contested portions of the permit to EPA by May 12, 2017. The Consent Decree requires EPA to provide Massachusetts and Connecticut with reasonable opportunity to review and comment on all deliverables under the permit. Because of the complexity of the remediation decision process, it is difficult to predict when a Final Cleanup Decision or additional remediation activities would be completed. Until the final clean-up decision is issued, it is difficult to say whether or not the waterbody is likely to meet water quality standards for Fish Consumption in Connecticut upon project completion. Further information about the project can be found on EPA's website at http://www.epa.gov/region01/ge/index.html.

Table 3-6. Pollution Control Measures for Waterbody Segments (EPA Category 4b)

Waterbody Segment ID	Waterbody Name	Pollution Control Measures
CT-W1_006	LIS WB Inner - Mill River, Fairfield	This waterbody segment is impaired for Fish Consumption (blue crabs), Habitat for Fish, Other Aquatic Life and Wildlife, and Contact Recreation due to the presence of sediments contaminated with lead. Investigations conducted by the CT DEP indicated that property formerly owned and operated by Exide Corporation and acquired in 1983 by International Nickel Corporation (INCO) a subsidiary of Exide Group Inc. (Exide), is the source of lead contamination. A unilateral order was issued by the CT DEP to Exide, which requires the implementation of remedial measures necessary to abate contamination of the upland property as well as within these waterbodies. In accordance with the order, remediation of the upland property began in 2005 and CT DEP and INCO are developing remediation goals to restore and maintain Fish Consumption, Habitat for Fish, Other Aquatic Life and Wildlife, and Contact Recreation uses in upper and lower Mill pond. Pursuant to the order, remediation of the upland property was initiated in 2005 and completed in 2013. The remediation goals to restore and maintain Fish Consumption, Habitat for Fish, Other Aquatic Life and Wildlife, and Contact Recreation uses in upper and lower Mill pond were also developed. A sediment remedial action plan (Sed RAP) to achieve the remediation goals for the Mill River and to monitor the effectiveness of cleanup was approved by the CT DEEP in October 2013. Exide obtained the necessary permits to conduct the sediment cleanup and plan to initiate activities during the summer of 2014. Additionally, CT DEEP is in contact with Superior Plating, which has also contributed contaminants to the river. Discussions with Superior Plating focus on activities needed to address their contributions to the contamination in the Mill River. In April 2016, Exide completed the in-river hydraulic dredging of contaminated sediment. The dredged sediment required dewatering which included treating the filtrate before being discharged back to the Mill River. By November 2016, the dewatering process was completed and the dewatered sediment was removed from the site for disposal at an appropriate disposal facility. The filtrate treatment system was dismantled and removed from the site as of February 2017. The project will continue in 2017 with removing of the dewatering liner system, collecting soil samples below the liner, and reestablishing the site. Following completion of Exide's sediment cleanup project, the designated uses are anticipated to be restored and will be assessed by CT DEEP when information becomes available.

Table 3-7. Nonpollutant Impairments (EPA Category 4c)

Table 3-7. Nonpollutant Impairments (EPA Category 4c)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Source
CT1001-00-1-L1_01	Wyassup Lake (North Stonington)	Recreation	Non-Native Aquatic Plants	Source Unknown
CT2102-00_01	Copps Brook (Stonington)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Impacts from Hydrostructure Flow Regulation/modification
CT2102-00_02	Copps Brook (Stonington/North Stonington)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Impacts from Hydrostructure Flow Regulation/modification
CT2102-00-trib_01	Unnamed Trib to Copps Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Impacts from Hydrostructure Flow Regulation/modification
CT2103-00_03	Seth Williams Brook-03	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Flow Alterations from Water Diversions
CT2104-00_02a	Whitford Brook-02a	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals, Flow Alterations from Water Diversions
CT2202-00_01	Latimer Brook (East Lyme)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT2202-00_02	Latimer Brook-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT2205-00_01	Pattagansett River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT2205-00_02	Pattagansett River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Baseflow Depletion from Groundwater Withdrawals

Table 3-7. Nonpollutant Impairments (EPA Category 4c)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Source
CT2206-00_01	Bride Brook (East Lyme)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals
CT3000-02_01	Billings Avery Brook (Ledyard)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Baseflow Depletion from Groundwater Withdrawals
CT3004-00_01	Oxoboxo Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Channelization, Dam or Impoundment
CT3103-00_01	Furnace Brook (Stafford)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT3103-00_01	Furnace Brook (Stafford)-01	Recreation	Physical substrate habitat alterations	Channelization
CT3103-00_02	Furnace Brook (Stafford)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Channelization, Dam or Impoundment
CT3708-00_01	Little River (Putnam/Woodstock)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT4300-00_01	Farmington River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Upstream Impoundments, Impacts from Hydrostructure Flow Regulation/modification
CT4300-00-5+L5_01	Rainbow Reservoir (Windsor/Bloomfield/East Granby)	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Impacts from Hydrostructure Flow Regulation/modification
CT4302-00_02b	Mad River (Winchester)-02b	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT4302-00_03	Mad River (Winchester)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions

Table 3-7. Nonpollutant Impairments (EPA Category 4c)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Source
CT4308-00_01	Farmington River, East Branch-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT4308-00_01	Farmington River, East Branch-01	Recreation	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT4310-00_01	Nepaug River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT4310-00_01	Nepaug River-01	Recreation	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT4314-00_01	Coppermine Brook (Bristol)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals
CT4314-08_01	Polkville Avenue Brook (Bristol)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Channelization, Flow Alterations from Water Diversions
CT4315-00_04	Pequabuck River-04	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT4315-00_04	Pequabuck River-04	Recreation	Physical substrate habitat alterations	Channelization
CT4316-01_01	Chidsey Brook (Avon)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals
CT4400-00_01	Park river-01	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT4400-00_01	Park river-01	Recreation	Physical substrate habitat alterations	Channelization
CT4400-01_01	South Branch Park River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization

Table 3-7. Nonpollutant Impairments (EPA Category 4c)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Source
CT4400-01_01	South Branch Park River-01	Recreation	Physical substrate habitat alterations	Channelization
CT4400-01_02	South Branch Park River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT4400-01_02	South Branch Park River-02	Recreation	Physical substrate habitat alterations	Channelization
CT4402-00_01	Piper Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT4402-00_01	Piper Brook-01	Recreation	Physical substrate habitat alterations	Channelization
CT4403-00_01	Trout Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT4403-00_02	Trout Brook-02	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT4403-00_02	Trout Brook-02	Recreation	Physical substrate habitat alterations	Channelization
CT4403-00_03	Trout Brook-03	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT4403-00_03	Trout Brook-03	Recreation	Physical substrate habitat alterations	Channelization
CT4404-00_01	North Branch Park River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT4404-00_01	North Branch Park River-01	Recreation	Physical substrate habitat alterations	Channelization
CT4500-00_06a	Hockanum River-06a	Recreation	Alterations in wetland habitats	Channelization, Agricultural activities, Stormwater
CT4500-00_06b	Hockanum River-06b	Recreation	Alterations in wetland habitats	Channelization, Agricultural activities, stormwater

Table 3-7. Nonpollutant Impairments (EPA Category 4c)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Source
CT4500-00_07	Hockanum River-07	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT4500-12_03	Lydall Brook (Manchester)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT4504-00_02	Hop Brook (Manchester)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals
CT4504-01_01	Porter Brook (Manchester)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals
CT4504-03_01	Birch Mountain Brook (Manchester)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals
CT4601-01_02	Crooked Brook (Berlin)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals, Flow Alterations from Water Diversions
CT4710-06-1-L1_01	Pickerel Lake (Colchester/East Haddam)	Recreation	Non-Native Aquatic Plants	Source Unknown
CT5103-00_02	Menunketesuck River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT5112-00_03b	Farm River (North Branford)-03b	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Flow Alterations from Water Diversions
CT5112-05_01	Gulf Brook (North Branford)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Flow Alterations from Water Diversions
CT5200-00_02	Quinnipiac River (North Haven/Meriden)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Baseflow Depletion from Groundwater Withdrawals
CT5200-00_04	Quinnipiac River-04	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Baseflow Depletion from Groundwater Withdrawals

Table 3-7. Nonpollutant Impairments (EPA Category 4c)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Source
CT5200-00_05	Quinnipiac River-05	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Baseflow Depletion from Groundwater Withdrawals
CT5200-00_06	Quinnipiac River-06	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Baseflow Depletion from Groundwater Withdrawals
CT5200-00_07	Quinnipiac River-07	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Channelization
CT5200-00_07	Quinnipiac River-07	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Dam or Impoundment, Baseflow Depletion from Groundwater Withdrawals
CT5203-00_01	Misery Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions, Baseflow Depletion from Groundwater Withdrawals
CT5205-00_01	Sodom Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals
CT5206-00_01	Harbor Brook (Meriden)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Channelization
CT5206-00_02	Harbor Brook (Meriden)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT5206-00_02	Harbor Brook (Meriden)-02	Recreation	Physical substrate habitat alterations	Channelization
CT5206-00_03	Harbor Brook (Meriden)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Channelization, Golf Courses
CT5208-00_02a	Muddy River (North Haven)-02a	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions

Table 3-7. Nonpollutant Impairments (EPA Category 4c)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Source
CT5208-00_02b	Muddy River (Wallingford)-02b	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT5208-00_02b	Muddy River (Wallingford)-02b	Habitat for Fish, Other Aquatic Life and Wildlife	Temperature, water	Agricultural Activities, Upstream Impoundments, Flow Alterations from Water Diversions
CT5302-00_02	Mill River	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals, Golf Courses
CT5302-00_03	Mill River	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals, Golf Courses
CT5307-04_01	Race Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Golf Courses
CT6005-01_01	Burton Brook (Salisbury)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals
CT6016-00-1-L3_01	Hatch Pond (Kent)	Habitat for Fish, Other Aquatic Life and Wildlife	Non-Native Aquatic Plants	Source Unknown
CT6016-00-1-L3_01	Hatch Pond (Kent)	Recreation	Non-Native Aquatic Plants	Source Unknown
CT6025-00_03	Farmill River-03	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Upstream Impoundments, Flow Alterations from Water Diversions
CT6600-01-1-L3_01	Kenosia, Lake (Danbury)	Recreation	Non-Native Aquatic Plants	Source Unknown
CT6603-00_01	Padanaram Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT6800-03_01	Stiles Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Flow Alterations from Water Diversions

Table 3-7. Nonpollutant Impairments (EPA Category 4c)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Source
CT6806-00_01	Transylvania Brook (Southbury)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Baseflow Depletion from Groundwater Withdrawals
CT6900-22_01	Great Brook (Waterbury)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT6900-22_01	Great Brook (Waterbury)-01	Recreation	Physical substrate habitat alterations	Channelization
CT6900-40_02	Beaver Brook (Ansonia)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Flow Alterations from Water Diversions
CT6902-00_01	Hart Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT6904-00_01	West Branch Naugatuck River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT6910-00_02	Branch Brook-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Dam or Impoundment, Flow Alterations from Water Diversions
CT6914-00_01	Mad River (Waterbury)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT6914-00_01	Mad River (Waterbury)-01	Recreation	Physical substrate habitat alterations	Channelization
CT6914-00_02	Mad River (Waterbury)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT6914-00_02	Mad River (Waterbury)-02	Recreation	Physical substrate habitat alterations	Channelization
CT6914-00_03a	Mad River (Waterbury)-03a	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	Channelization
CT7000-22_01	Indian River (Westport)-01	Recreation	Alterations in wetland habitats	Habitat Modification

Table 3-7. Nonpollutant Impairments (EPA Category 4c)

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Cause	Source
CT7200-20-trib_02	Unnamed tributary Hawleys Brook-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Golf Courses
CT7301-00_01	Comstock Brook (Wilton)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Baseflow Depletion from Groundwater Withdrawals
CT7403-00_02	Noroton River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Golf Courses
CT7409-00-1-L3_01	Putnam Lake Reservoir (Greenwich)	Habitat for Fish, Other Aquatic Life and Wildlife	Alterations in wetland habitats	Habitat Modification
CT8104-00-2-L5_01	Mamanasco Lake (Ridgefield)	Habitat for Fish, Other Aquatic Life and Wildlife	Non-Native Aquatic Plants	Source Unknown
CT8104-00-2-L5_01	Mamanasco Lake (Ridgefield)	Recreation	Non-Native Aquatic Plants	Source Unknown
CT-C1_021-SB	LIS CB Inner - Housatonic River (Upper), Orange	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Alterations in wetland habitats	Dredge Mining

358 Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT1000-00_01	Pawcatuck River (Stonington/North Stonington)-01	Recreation	Escherichia coli	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT1000-00_trib_01	Unnamed tributary Pawcatuck River 1000-00 (Stonington)-01	Recreation	Escherichia coli	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT1000-01_01	Unnamed tributary Pawcatuck River 1000-01 (N. Stonington)-01	Recreation	Escherichia coli	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT1000-03_01	Unnamed tributary Pawcatuck River 1000-03 (Stonington)-01	Recreation	Escherichia coli	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT1000-04_01	Unnamed tributary Pawcatuck River 1000-04 (Stonington)-01	Recreation	Escherichia coli	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT1000-05_01	Unnamed tributary Pawcatuck River 1000-05 (Stonington)-01	Recreation	Escherichia coli	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT2102-00_02	Copps Brook (Stonington/North Stonington)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT2103-00_03	Seth Williams Brook-03	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT2202-00_01	Latimer Brook (East Lyme)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT2202-00_02	Latimer Brook-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT2205-00_01	Pattagansett River-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT2205-00_02	Pattagansett River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT2206-00_01	Bride Brook (East Lyme)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT3000-02_01	Billings Avery Brook (Ledyard)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT3004-00_01	Oxoboxo Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT3004-00_01	Oxoboxo Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT3103-00_02	Furnace Brook (Stafford)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT3207-12_01	Roberts Brook (Mansfield)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT3207-16-1-L1_01	Bicentennial Pond (Mansfield)	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT3300-02_01	Long Branch Brook (Thompson)-01	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT3300-10_01	Quinatissett Brook (Thompson)-01	Recreation	Escherichia coli	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT3700-00_01	Quinebaug River	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT3708-00_01	Little River (Putnam/Woodstock) -01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT3708-18_01	Wheatons Brook (Putnam/Thompson)-01	Recreation	Escherichia coli	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT3800-00_05	Shetucket River (Windham)-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT4300-32_01	Minister Brook (Simsbury)-01	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT4300-33_01	Russell Brook (Simsbury)-01	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT4302-00_03	Mad River (Winchester)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT4309-00_01	Cherry Brook (Canton)-01	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT4312-00_01	Roaring Brook (Farmington)-01	Recreation	Escherichia coli	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT4314-00_01	Coppermine Brook (Bristol)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT4314-08_01	Polkville Avenue Brook (Bristol)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: New Segment. Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT4316-01_01	Chidsey Brook (Avon)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT4317-00_01	Nod Brook (Avon/Simsbury)-01	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT4319-00_01b	Salmon Brook, West Branch (Granby/Hartland)-01b	Recreation	Escherichia coli	New biological, chemical or physical data determined the Designated Use is Not Supporting; AND TMDL approved or established by EPA (4A)	2016: LIST/DELIST ACTION - Recommend segment for Category 4a - new data/new segment for 2016 Cycle show Not Supporting for the designated use. Bacteria TMDL from 2012 in effect for the segment.	DELISTING - TMDL complete
CT4500-12_03	Lydall Brook (Manchester)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT4504-00_02	Hop Brook (Manchester)	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT4504-00_02	Hop Brook (Manchester)	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT4504-01_01	Porter Brook (Manchester)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT4504-03_01	Birch Mountain Brook (Manchester)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT4600-00-trib_01	Unnamed tributary Connecticut River (Cromwell)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT4601-00_01	Belcher Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT4601-02_01	Hatchery Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT4607-00-UL_pond_01	Wadsworth Falls State Park Pond (Middletown)	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT5111-00_02	Branford River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT5112-00_03a	Farm River (North Branford)-03a	Habitat for Fish, Other Aquatic Life and Wildlife	Segment Split	Segment Split	2016: Segment split as -03a and -03b of Farm River-03 for this cycle. Use retains previous assessment = Insufficient Information for segment -03a	Segment Split
CT5112-00_03b	Farm River (North Branford)-03b	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use. Segment split as -03a and -03b of Farm River-03 for this cycle.	Nonpollutant Cause assigned Category 4c
CT5112-00_03b	Farm River (North Branford)-03b	Habitat for Fish, Other Aquatic Life and Wildlife	Segment Split	Segment Split	2016: Segment split as -03a and -03b of Farm River-03 for this cycle. Use retains previous assessment = Insufficient Information for segment -03a	Segment Split
CT5112-05_01	Gulf Brook (North Branford)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT5200-00_02	Quinnipiac River (North Haven/Meriden)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT5200-00_04	Quinnipiac River-04	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT5200-00_05	Quinnipiac River-05	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT5200-00_06	Quinnipiac River-06	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT5200-00_07	Quinnipiac River-07	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT5200-00-04	Quinnipiac River-04	Fish Consumption	PCBs	Applicable WQS attained; due to restoration activities	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use. The fish consumption impairment was caused by a release of PCBs from nearby storage tanks, and the impacted area was remediated. The fish consumption advisory has been removed by CT DPH as fish tissue analyses indicated that PCBs in fish have decreased to acceptable levels.	Delisting

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT5200-00-05	Quinnipiac River-05	Fish Consumption	PCBs	Applicable WQS attained; due to restoration activities	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use. The fish consumption impairment was caused by a release of PCBs from nearby storage tanks, and the impacted area was remediated. The fish consumption advisory has been removed by CT DPH as fish tissue analyses indicated that PCBs in fish have decreased to acceptable levels.	Delisting
CT5200-00-06	Quinnipiac River-06	Fish Consumption	PCBs	Applicable WQS attained; due to restoration activities	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use. The fish consumption impairment was caused by a release of PCBs from nearby storage tanks, and the impacted area was remediated. The fish consumption advisory has been removed by CT DPH as fish tissue analyses indicated that PCBs in fish have decreased to acceptable levels.	Delisting
CT5201-00_01	Eightmile River (Southington)-01	Fish Consumption	PCBs	Applicable WQS attained; due to restoration activities	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use. The fish consumption impairment was caused by a release of PCBs from nearby storage tanks, and the impacted area was remediated. The fish consumption advisory has been removed by CT DPH as fish tissue analyses indicated	Delisting

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
					that PCBs in fish have decreased to acceptable levels.	
CT5205-00_01	Sodom Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT5206-00_01	Harbor Brook (Meriden)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT5206-00_03	Harbor Brook (Meriden)-03	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT5207-02-1-L1_01	Allen Brook Pond (North Haven/Wallingford)	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT5208-00_02a	Muddy River (North Haven)-02a	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT5208-00_02a	Muddy River (North Haven)-02a	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT5302-00_02	Mill River	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT5302-00_03	Mill River	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT6000-00-5+L2_01	Zoar, Lake	Recreation	Chlorophyll-a	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6000-00-5+L2_01	Zoar, Lake	Recreation	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6000-00-5+L2_01	Zoar, Lake	Recreation	Nutrient/Eutrophication Biological Indicators	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6000-00-5+L2_02	Zoar, Lake	Recreation	Chlorophyll-a	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT6000-00-5+L2_02	Zoar, Lake	Recreation	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6000-00-5+L2_02	Zoar, Lake	Recreation	Nutrient/Eutrophication Biological Indicators	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6000-00-5+L4_01	Housatonic Lake	Recreation	Chlorophyll-a	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6000-00-5+L4_01	Housatonic Lake	Recreation	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6000-00-5+L4_01	Housatonic Lake	Recreation	Nutrient/Eutrophication Biological Indicators	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6005-01_01	Burton Brook (Salisbury)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT6019-00-trib_01	Unnamed trib Deep Brook (Newtown)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT6502-00-1-L2_01	Waramaug, Lake	Recreation	Chlorophyll-a	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6502-00-1-L2_01	Waramaug, Lake	Recreation	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6502-00-1-L2_01	Waramaug, Lake	Recreation	Nutrient/Eutrophication Biological Indicators	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6703-00_01	West Branch Bantam River (Litchfield/Goshen)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6705-00-3-L3_01	Bantam Lake	Recreation	Chlorophyll-a	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6705-00-3-L3_01	Bantam Lake	Recreation	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT6705-00-3-L3_01	Bantam Lake	Recreation	Nutrient/Eutrophication Biological Indicators	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT6806-00_01	Transylvania Brook (Southbury)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT6900-40_02	Beaver Brook (Ansonia)-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT6916-00_01	Hop Brook (Naugatuck)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT7000-16_01	Muddy Brook (Westport)-01	Recreation	Escherichia coli	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT7000-16-trib_01	Unnamed trib to Muddy Brook	Recreation	Escherichia coli	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT7000-17_01	Unnamed trib, Muddy Brook (Westport)-01	Recreation	Escherichia coli	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT7000-18_01	Unnamed trib, Sherwood Millpond LIS (Westport)-01	Recreation	Escherichia coli	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT7000-29_01	Unnamed trib to Farm Creek LIS (Norwalk)-01	Recreation	Escherichia coli	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT7103-00-2-L4_01	Stillman Pond (Bridgeport)	Fish Consumption	Polychlorinated biphenyls	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT7105-01_01	West Branch Pequonnock River (Monroe)-01	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT7300-00_05	Norwalk River (Ridgefield)-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT7301-00_01	Comstock Brook (Wilton)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT7302-00_02	Silvermine River (Norwalk/New Canaan)-02	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT7302-13_01	Belden Hill Brook	Recreation	Escherichia coli	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT7401-00_03	Fivemile River (New Canaan)-03	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT7401-05_01	Holy Ghost Fathers Brook (Norwalk)-01	Recreation	Escherichia coli	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT7403-00_02	Noroton River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Flow Alterations	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Nonpollutant Cause assigned Category 4c
CT7407-00_02	Mianus River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-C1_002-SB	LIS CB Inner - Inner Clinton Harbor, Clinton	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform	Applicable WQS attained; new biological, chemical or physical data determined the Designated Use is Fully Supporting	2016: RECOMMEND DELISTING. New data for 2016 Cycle to show Fully Supporting for the designated use.	Delisting
CT-C2_024	LIS CB Shore - Housatonic River mouth, Stratford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Lead	Applicable WQS not attained; biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend Listing for Lead, segment is currently impaired for other causes. Information based on site-specific data for Lead concentrations in sediment.	Listing
CT-E1_001-SB	LIS EB Inner - Pawcatuck River (01), Stonington	Recreation	Enterococcus	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E1_001-SB	LIS EB Inner - Pawcatuck River (01), Stonington	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Recreation	Estuarine Bioassessments	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Recreation	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Recreation	Estuarine Bioassessments	Applicable WQS not attained; new biological, chemical or physical data determined the	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
				Designated Use is Not Supporting		
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Recreation	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E1_007-SB	LIS EB Inner - Mystic River (Mouth), Stonington	Shellfish Harvesting	Fecal Coliform	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E1_019	LIS EB Inner - Jordan Cove	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E1_020	LIS EB Inner - Niantic River (mouth)	Recreation	Enterococcus	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E1_020	LIS EB Inner - Niantic River (mouth)	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E1_021	LIS EB Inner - Pattagansett River (mouth)	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E1_022	LIS EB Inner – Bride Brook- East Lyme	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E1_023	LIS EB Inner - Fourmile River	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E1_024-SB	LIS EB Inner - Connecticut River (mouth)	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E1_026-SB	LIS EB Inner - Black Hall River (upper)	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E1_027-SB	LIS EB Inner - Duck River	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E1_032	LIS EB Inner - Oyster River Area	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT-E1_033	LIS EB Inner - Pequotsepos Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved Oxygen	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E1_033	LIS EB Inner - Pequotsepos Cove, Stonington	Shellfish Harvesting	Fecal Coliform	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Recreation	Estuarine Bioassessments	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Recreation	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Recreation	Estuarine Bioassessments	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Recreation	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E2_010-SB	LIS EB Shore - Thames River Mouth (West), New London	Shellfish Harvesting	Fecal Coliform	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E2_012	LIS EB Shore - Outer Jordan Cove	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E2_013	LIS EB Shore - Niantic Bay (East)	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E2_014	LIS EB Shore - Niantic Bay (West)	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E2_015	LIS EB Shore - Niantic Bay (Black Pt)	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E2_016	LIS EB Shore - Pattagansett River Mouth	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT-E2_017	LIS EB Shore - Rocky Neck (Fourmile River)	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E2_018	LIS EB Shore - Soundview Beach	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E2_020	LIS EB Shore - Willard Bay	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E2_021	LIS EB Shore - Plum Bank, Old Saybrook	Shellfish Harvesting	Fecal Coliform	Applicable WQS attained; according to new assessment method	2016: RECOMMEND DELISTING. Shellfish areas are classified as Prohibited due to an administrative closure with no data. Listing of the waterbody segment was not based on available data, but instead, compared the CT DEP Water Quality Class to the CT Bureau of Aquaculture Classification (these two categories are not interchangeable). The CT Bureau of Aquaculture is the governing agency for shellfishing in CT and previous administrative actions by the agency had determined the area to be an inadequate use of Shellfish Harvest. The assessment status of the waterbody segment was changed to Not Assessed.	Delisting
CT-E2_022	LIS EB Shore - Indiantown Harbor	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E3_001	LIS EB Midshore - Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT-E3_001	LIS EB Midshore - Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E3_001	LIS EB Midshore - Stonington	Recreation	Estuarine Bioassessments	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E3_001	LIS EB Midshore - Stonington	Recreation	Excess Algal Growth	Applicable WQS not attained; new biological, chemical or physical data determined the Designated Use is Not Supporting	2016: Recommend 303d Listing - new data/new segment for 2016 Cycle show Not Supporting for the designated use.	Listing
CT-E3_001	LIS EB Midshore - Stonington	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E3_006	LIS EB Midshore - Niantic Bay	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E3_007	LIS EB Midshore - East Lyme, Rocky Neck	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E3_008	LIS EB Midshore - Old Lyme, CT River	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E3_010	LIS EB Midshore - Old Saybrook	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete
CT-E3_011	LIS EB Midshore - Old Saybrook, Indian Harbor	Shellfish Harvesting	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2014	DELISTING - TMDL complete

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT-W1_014-SB	LIS WB Inner - Fivemile River (mouth), Norwalk	Shellfish Harvesting	Fecal Coliform	Applicable WQS attained; according to new assessment method	2016: RECOMMEND DELISTING. Shellfish areas are classified as Prohibited due to an administrative closure with no data. Listing of the waterbody segment was not based on available data, but instead, compared the CT DEP Water Quality Class to the CT Bureau of Aquaculture Classification (these two categories are not interchangeable). The CT Bureau of Aquaculture is the governing agency for shellfishing in CT and previous administrative actions by the agency had determined the area to be an inadequate use of Shellfish Harvest. The assessment status of the waterbody segment was changed to Not Assessed.	Delisting
CT-W3_013	LIS WB Midshore - Outer Cos Cob Harbor, Greenwich	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform	TMDL approved or established by EPA (4A)	Established bacteria TMDL 2012	DELISTING - TMDL complete

Table 3-8. Reconciliation List of Impaired Waters (Delistings and Listings)

Waterbody Segment ID	Waterbody Name	Designated Use	Cause	Reason for Category Change	Comment	Activity
CT-E3_005-SB	LIS EB Midshore - Waterford, Thames River	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved oxygen saturation, Nitrogen (Total), Nutrient / Eutrophication Biological Indicators, Oxygen, Dissolved	No category change.	In the 2014 Report, the segment was included in error within the TMDL table as part of the LIS TMDL. The segment was not part of the TMDL nor was the segment within the Category 4a for TMDLs. The segment was removed from the TMDL table and remains impaired in Category 5 for Habitat for Marine Fish, Other Aquatic Life and Wildlife.	Corrected figures and tables

Table 3-9. Priority List of Waters for Action Plan Development (including TMDL development)

Table 3-9. Priority List of Waters for Action Plan Development (including TMDL development)

Impairment Cause	Watersheds Listed	Description	Expected Action Plan Completion	Type of Action Plan
Nutrients/Dissolved Oxygen	Long Island Sound	Long Island Sound TMDL Activities	On-going	Various Activities
Mercury	Statewide Fresh Waters	Regional Mercury TMDL: CT Update	2018	TMDL Update Report
Polychlorinated Biphenyls	Housatonic River Watershed	Various activities in support of Consent Decree activities to address PCB contamination	On-going	Various Activities
Bacteria	CT4013-05-1-L1_01	Crystal Lake (Middletown)	2017	TMDL
	CT4200-00_01	Scantic River-01	2017	TMDL
	CT4200-00_02	Scantic River-02	2017	TMDL
	CT4200-00_03	Scantic River-03	2017	TMDL
	CT4200-15_01	Thrasher Brook (Somers)-01	2017	TMDL
	CT4200-28_01	Dry Brook (South Windsor/East Windsor)-01	2017	TMDL
	CT4202-00_01	Gillettes Brook (Somers)-01	2017	TMDL
	CT4203-00_01	Gulf Stream (Somers)-01	2017	TMDL
	CT4204-00_01	Abbey Brook (Somers)-01	2017	TMDL
	CT4312-00_01	Roaring Brook (Farmington)-01	2017	TMDL
	CT5206-01_01	Spoon Shop Brook (Meriden)-01	2017	TMDL

Table 3-9. Priority List of Waters for Action Plan Development (including TMDL development)

Impairment Cause	Watersheds Listed	Description	Expected Action Plan Completion	Type of Action Plan
	CT5208-00_02a	Muddy River (North Haven)-02a	2017	TMDL
	CT5301-00_01	Willow Brook (Hamden)-01	2017	TMDL
	CT5304-00_01	Wintergreen Brook (New Haven)-01	2017	TMDL
	CT5306-00_02	Indian River (Orange)-02	2017	TMDL
	CT5306-01_01	Silver Brook (Orange)-01	2017	TMDL
	CT5306-01_02	Silver Brook (Orange)-02	2017	TMDL
	CT-C1_001	LIS CB Inner - Patchogue And Menunketesuck Rivers	2017	TMDL
	CT-C2_001	LIS CB Shore - Westbrook Harbor (East), Westbrook	2017	TMDL
	CT-C2_002	LIS CB Shore - Westbrook Harbor (West), Westbrook	2017	TMDL
	CT-C3_001	LIS CB Midshore - Westbrook Harbor, Westbrook	2017	TMDL
	CT-C3_005	LIS CB Midshore - Madison	2017	TMDL
	CT-C3_016	LIS CB Midshore - West Haven	2017	TMDL
	CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	2017	TMDL
	CT-E1_007-SB	LIS EB Inner - Mystic River (Mouth), Stonington	2017	TMDL
	CT-E1_015-SB	LIS EB Inner - Thames River (middle), Ledyard	2017	TMDL

Table 3-9. Priority List of Waters for Action Plan Development (including TMDL development)

Impairment Cause	Watersheds Listed	Description	Expected Action Plan Completion	Type of Action Plan
	CT-E1_016-SB	LIS EB Inner - Thames River (Upper), Norwich	2017	TMDL
	CT-E1_033	LIS EB Inner - Pequotsepos Cove, Stonington	2017	TMDL
	CT-E2_010-SB	LIS EB Shore - Thames River Mouth (West), New London	2017	TMDL
	CT-E3_012	LIS EB Midshore - Westbrook	2017	TMDL
	CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	2017	TMDL
	CT-W1_021-SB	LIS WB Inner - Greenwich Harbor, Greenwich	2017	TMDL
	CT-W2_003	LIS WB Shore - Seaside Park Beach	2017	TMDL
	CT6000-00_01	Housatonic River (Orange/Shelton/Derby)-01	2018	TMDL
	CT6000-00_02	Housatonic River (Shelton/Derby)-02	2018	TMDL
	CT6000-00_04	Housatonic River-04	2018	TMDL
	CT6014-00_01	Bog Hollow Brook (Kent)-01	2018	TMDL
	CT6019-00_01	Deep Brook (Newtown)-01	2018	TMDL
	CT6026-03_01	Cemetery Pond Brook (Stratford/Shelton)-01	2018	TMDL
	CT6402-00_01	Ball Pond Brook (New Fairfield)-01	2018	TMDL
	CT6806-00_01	Transylvania Brook (Southbury)-01	2018	TMDL

Table 3-9. Priority List of Waters for Action Plan Development (including TMDL development)

Impairment Cause	Watersheds Listed	Description	Expected Action Plan Completion	Type of Action Plan
	CT6916-00-3-L4_01	Hop Brook Lake (Waterbury/Middlebury)	2018	TMDL
	CT6919-00_01	Bladens River-01	2018	TMDL
	CT7000-16_01	Muddy Brook (Westport)-01	2018	TMDL
	CT7000-16-trib_01	Unnamed trib to Muddy Brook	2018	TMDL
	CT7000-17_01	Unnamed trib, Muddy Brook (Westport)-01	2018	TMDL
	CT7000-18_01	Unnamed trib, Sherwood Millpond LIS (Westport)-01	2018	TMDL
	CT7000-29_01	Unnamed trib to Farm Creek LIS (Norwalk)-01	2018	TMDL
	CT7107-00_01	Cricker Brook (Fairfield)-01	2018	TMDL
	CT7201-00_01	Little River (Redding)-01	2018	TMDL
	CT7301-00_01	Comstock Brook (Wilton)-01	2018	TMDL
	CT7302-13_01	Belden Hill Brook	2018	TMDL

Table 3-10. List of Waters for Action Plan Development by 2022 Identified in Integrated Water Resource Management Reports

Table 3-10. List of Waters for Action Plan Development by 2022 Identified in Integrated Water Resource Management Reports

Notes:
[1]Waters shaded in blue have been proposed for action plan development in 2017 and those in green, in 2018, as identified in this draft 2016 IWQR.
[2]The primary cause to be addressed in the proposed action plan is identified in this table. Additional causes or pollutants may be added during the course of developing the plan depending on information available at that time and resources.

Watersheds Listed[1]	Description	Cause[2]	Designated Use
Statewide Bacteria TMDL: Additional Waterbodies			
CT-C1_001	LIS CB Inner - Patchogue And Menunketesuck Rivers	Fecal Coliform	Shellfish Harvesting for Direct Consumption where Authorized
CT-C2_001	LIS CB Shore - Westbrook Harbor (East), Westbrook	Fecal Coliform	Shellfish Harvesting for Direct Consumption where Authorized
CT-C2_002	LIS CB Shore - Westbrook Harbor (West), Westbrook	Fecal Coliform	Shellfish Harvesting for Direct Consumption where Authorized
CT-C3_001	LIS CB Midshore - Westbrook Harbor, Westbrook	Fecal Coliform	Shellfish Harvesting for Direct Consumption where Authorized
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Enterococcus	Recreation
CT-E3_012	LIS EB Midshore - Westbrook	Fecal Coliform	Shellfish Harvesting for Direct Consumption where Authorized
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	Fecal Coliform	Commercial Shellfish Harvesting Where Authorized
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	Enterococcus	Recreation
CT-W1_021-SB	LIS WB Inner - Greenwich Harbor, Greenwich	Fecal Coliform	Commercial Shellfish Harvesting Where Authorized
CT-W1_021-SB	LIS WB Inner - Greenwich Harbor, Greenwich	Enterococcus	Recreation
CT-W2_003	LIS WB Shore - Seaside Park Beach	Fecal Coliform	Shellfish Harvesting for Direct Consumption where Authorized

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT-C3_005	LIS CB Midshore - Madison	Fecal Coliform	Shellfish Harvesting for Direct Consumption where Authorized
CT-C3_016	LIS CB Midshore - West Haven	Fecal Coliform	Shellfish Harvesting for Direct Consumption where Authorized
CT-E1_007-SB	LIS EB Inner - Mystic River (Mouth), Stonington	Fecal Coliform	Commercial Shellfish Harvesting Where Authorized
CT-E1_015-SB	LIS EB Inner - Thames River (middle), Ledyard	Fecal Coliform	Commercial Shellfish Harvesting Where Authorized
CT-E1_015-SB	LIS EB Inner - Thames River (middle), Ledyard	Enterococcus	Recreation
CT-E1_016-SB	LIS EB Inner - Thames River (Upper), Norwich	Fecal Coliform	Shellfish Harvesting for Direct Consumption where Authorized
CT-E1_016-SB	LIS EB Inner - Thames River (Upper), Norwich	Enterococcus	Recreation
CT-E1_033	LIS EB Inner - Pequotsepos Cove, Stonington	Fecal Coliform	Shellfish Harvesting for Direct Consumption where Authorized
CT-E2_010-SB	LIS EB Shore - Thames River Mouth (West), New London	Fecal Coliform	Commercial Shellfish Harvesting Where Authorized
CT4013-05-1-L1_01	Crystal Lake (Middletown)	Escherichia coli	Recreation
CT4200-00_01	Scantic River-01	Escherichia coli	Recreation
CT4200-00_02	Scantic River-02	Escherichia coli	Recreation
CT4200-00_03	Scantic River-03	Escherichia coli	Recreation

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT4200-15_01	Thrasher Brook (Somers)-01	Escherichia coli	Recreation
CT4200-28_01	Dry Brook (South Windsor/East Windsor)-01	Escherichia coli	Recreation
CT4202-00_01	Gillettes Brook (Somers)-01	Escherichia coli	Recreation
CT4203-00_01	Gulf Stream (Somers)-01	Escherichia coli	Recreation
CT4204-00_01	Abbey Brook (Somers)-01	Escherichia coli	Recreation
CT4312-00_01	Roaring Brook (Farmington)-01	Escherichia coli	Recreation
CT5206-01_01	Spoon Shop Brook (Meriden)-01	Escherichia coli	Recreation
CT5208-00_02a	Muddy River (North Haven)-02a	Escherichia coli	Recreation
CT5301-00_01	Willow Brook (Hamden)-01	Escherichia coli	Recreation
CT5304-00_01	Wintergreen Brook (New Haven)-01	Escherichia coli	Recreation
CT5306-00_02	Indian River (Orange)-02	Escherichia coli	Recreation
CT5306-01_01	Silver Brook (Orange)-01	Escherichia coli	Recreation
CT5306-01_02	Silver Brook (Orange)-02	Escherichia coli	Recreation
CT6000-00_01	Housatonic River (Orange/Shelton/Derby)-01	Escherichia coli	Recreation
CT6000-00_02	Housatonic River (Shelton/Derby)-02	Escherichia coli	Recreation

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT6000-00_04	Housatonic River-04	Escherichia coli	Recreation
CT6014-00_01	Bog Hollow Brook (Kent)-01	Escherichia coli	Recreation
CT6019-00_01	Deep Brook (Newtown)-01	Escherichia coli	Recreation
CT6026-03_01	Cemetery Pond Brook (Stratford/Shelton)-01	Escherichia coli	Recreation
CT6402-00_01	Ball Pond Brook (New Fairfield)-01	Escherichia coli	Recreation
CT6806-00_01	Transylvania Brook (Southbury)-01	Escherichia coli	Recreation
CT6916-00-3-L4_01	Hop Brook Lake (Waterbury/Middlebury)	Escherichia coli	Recreation
CT6919-00_01	Bladens River-01	Escherichia coli	Recreation
CT7000-16_01	Muddy Brook (Westport)-01	Escherichia coli	Recreation
CT7000-16-trib_01	Unnamed trib to Muddy Brook	Escherichia coli	Recreation
CT7000-17_01	Unnamed trib, Muddy Brook (Westport)-01	Escherichia coli	Recreation
CT7000-18_01	Unnamed trib, Sherwood Millpond LIS (Westport)-01	Escherichia coli	Recreation
CT7000-29_01	Unnamed trib to Farm Creek LIS (Norwalk)-01	Escherichia coli	Recreation
CT7107-00_01	Cricker Brook (Fairfield)-01	Escherichia coli	Recreation
CT7201-00_01	Little River (Redding)-01	Escherichia coli	Recreation

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT7301-00_01	Comstock Brook (Wilton)-01	Escherichia coli	Recreation
CT7302-13_01	Belden Hill Brook	Escherichia coli	Recreation
CT2202-00_01	Latimer Brook (East Lyme)-01	Escherichia coli	Recreation
CT2204-03_01	Stony Brook (Waterford)-01	Escherichia coli	Recreation
CT3100-00_03	Willimantic River (Willington/Tolland)-03	Escherichia coli	Recreation
CT3103-00_02	Furnace Brook (Stafford)-02	Escherichia coli	Recreation
CT3208-00_01	Sawmill Brook (Mansfield)-01	Escherichia coli	Recreation
CT3208-02_01	Conantville Brook (Mansfield)-01	Escherichia coli	Recreation
CT3300-10_01	Quinatissett Brook (Thompson)-01	Escherichia coli	Recreation
CT3700-00_01	Quinebaug River (Lisbon/Griswold)-01	Escherichia coli	Recreation
CT3700-00_05	Quinebaug River-05	Escherichia coli	Recreation
CT3700-17_01	Durkee Brook (Pomfret)-01	Escherichia coli	Recreation
CT3708-00_01	Bittle River (Putnam)-01	Escherichia coli	Recreation
CT3708-18_01	Wheatons Brook (Putnam/Thompson)-01	Escherichia coli	Recreation
CT3709-00_01	Wappaquoia Brook-01	Escherichia coli	Recreation

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT3709-02_01	Day Brook (Pomfret)-01	Escherichia coli	Recreation
CT3800-00_01	Shetucket River (Norwich)-01	Escherichia coli	Recreation
CT3800-00-6+l3_01	Spaulding Pond (Norwich)	Escherichia coli	Recreation
CT3900-07_01	Kahn Brook (Bozrah)-01	Escherichia coli	Recreation
Protection Watersheds			
Upper Pawcatuck Watershed			
CT1000	Pawcatuck River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT1001	Wyassup Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT1002	Green Fall River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT1003	Ashaway River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
Natchaug River and Mount Hope Watershed			
CT3200	Natchaug River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT3201	Bungee Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT3202	Still River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT3203	Bigelow Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT3204	Stonehouse Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT3205	Squaw Hollow Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT3206	Mount Hope River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT3207	Fenton River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
Eightmile River Watershed: Eightmile River and East Branch Eightmile River			
CT4800	Eightmile River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT4801	Harris Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT4802	East Branch Eightmile River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT4803	Beaver Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
Headwaters of the Saugatuck River			
CT7201	Little River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7200	Saugatuck River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
Freshwater Restoration Watersheds			
Scantic River Regional Basin			
CT4200	Scantic River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT4201	Wachaug River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT4202	Gillettes Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT4203	Gulf Stream	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT4204	Abbey Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT4205	Buckhorn Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT4206	Broad Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT4207	Ketch Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
Rainbow Brook / Seymour Hollow Brook			
CT4300-50	Rainbow Brook	Ethylene Glycol, Propylene Glycol	Habitat for Fish, Other Aquatic Life and Wildlife
CT4300-51	Seymour Hollow Brook	Ethylene Glycol, Propylene Glycol	Habitat for Fish, Other Aquatic Life and Wildlife
Quinnipiac River Watershed			
CT5200	Quinnipiac River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT5201	Eightmile River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT5202	Tenmile River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT5203	Misery Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT5204	Broad Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT5205	Sodom Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT5206	Harbor Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT5207	Wharton Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT5208	Muddy River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
Bantam Lake Watershed			
CT6703-00	West Branch Bantam River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT6705-00	Bantam River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT6705-00-3-L3_01	Bantam Lake (Litchfield/Morris)	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT6705-06	Tannery Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT6705-07	Unnamed Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT6705-08	Moulthrop Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
Still River Watershed: Headwaters Still River & Limekiln Brook Still River			
CT6600	Still River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT6601	Miry Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT6602	Kohanza Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT6603	Padanaram Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT6604	Sympaug Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT6605	East Swamp Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT6606	Limekiln Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
Embayments and Associated Upland Watersheds			
Stonington Harbor / Pawcatuck River Embayment			
CT1000	Pawcatuck River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT1001	Wyassup Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT1002	Green Fall River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT1003	Ashaway River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2000-01	Barn Island Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT-E1_001-SB	LIS EB Inner - Pawcatuck River (01), Stonington	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
Stony Brook Frontal			
CT2000-12	Pequotsepos Brook Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2000-13	Pequotsepos Brook Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2000-14	Pequotsepos Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT-E2_002	LIS EB Shore Stonington Point	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT-E3_001	LIS EB Midshore-Stonington	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
Mystic River			
CT2000-15	Mystic Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2000-16	Beebe Cove Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2000-17	Noank Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2101-01	Wheeler Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2101-02	Unnamed Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2103	Williams Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2104	Whitford Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT2105	Haleys Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2106	Mystic Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT-E1_007-SB	LIS EB Inner - Mystic River (Mouth), Stonington	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-E1_008-SB	LIS EB Inner - Mystic Harbor, Groton/Stonington	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-E1_009	LIS EB Inner - Beebe Cove (Mystic Harbor), Groton	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
Niantic River Estuary			
CT2000-38	Millstone Point Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2000-39	Black Point Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2202	Latimer Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2203	Oil Mill Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT2204	Niantic River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT-E1_020	LIS EB Inner - Niantic River (mouth), Niantic	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-E2_013	LIS EB Shore - Niantic Bay (East), Waterford	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT-E2_014	LIS EB Shore - Niantic Bay (West), East Lyme	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
Farm River Embayment			
CT5000-42	Short Beach Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT5000-43	Momaugum Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT5000-44	Momaugum Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT5112	Farm River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT-C1_011	LIS CB Inner – Farm River, East Haven	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-C2_015-SB	LIS CB Shore - Pages Cove, Branford	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-C2_016-SB	LIS CB Shore - New Haven Harbor (East), East Haven	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
Southport Harbor / Sasco Brook Embayment			
CT7000-10	Sasco Hill Beach Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7000-11	Southport Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7000-12	Frost Point Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7107	Cricker Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT7108	Mill River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7109	Sasco Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT-W1_005	LIS WB Inner - Southport Harbor, Fairfield	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-W1_006	LIS WB Inner - Mill River, Fairfield	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-W1_007	LIS WB Inner - Sasco Brook, Westport	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-W2_006	LIS WB Shore - Southport Harbor (East), Fairfield	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-W2_007	LIS WB Shore - Southport Harbor (West), Fairfield	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
Saugatuck River Embayment			
CT7000-20	Compo Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7000-21	Compo Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7000-22	Indian River Coastal Area	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7200	Saugatuck River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7201	Little River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT7203	West Branch Saugatuck River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT-W1_009	LIS WB Inner - Grays Creek, Westport	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-W1_010-SB	LIS WB Inner - Saugatuck River (mouth), Westport	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-W1_011	LIS WB Inner – Saugatuck River, Westport	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-W2_010	LIS WB Shore - Compo Beach, Cedar Point, Westport	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-W2_011	LIS WB Shore - Canfield Island, Westport	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
Norwalk Harbor Embayment			
CT7000-23	Davidge Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7000-24	Kettle Creek	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7000-25	Unnamed Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7000-26	Poplar Blains Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7300	Norwalk River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT7301	Comstock Brook	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife

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Watersheds Listed[1]	Description	Cause[2]	Designated Use
CT7302	Silvermine River	Nutrients	Habitat for Fish, Other Aquatic Life and Wildlife
CT-W1_012-SB	LIS WB Inner - Norwalk Harbor, Norwalk	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-W1_013-SB	LIS WB Inner - Norwalk Harbor (Marvin Beach), Norwalk	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-W2_012	LIS WB Shore - Outer Norwalk Harbor(East), Norwalk	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife
CT-W2_013	LIS WB Shore - Outer Norwalk Harbor(West), Norwalk	Nutrients	Habitat for Marine Fish, Other Aquatic Life and Wildlife

Table 3-11. Alternative Approaches to Restoring and Protecting Water Quality

Table 3-11. Alternative Approaches to Restoring and Protecting Water Quality

Waterbody Segment ID	Waterbody Name	Impaired Designated Use	Description
CT-C1_019-SB	LIS CB Inner - Housatonic River (mouth), Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Raymark Industries, Inc. • Contaminated sediment in Ferry Creek • Action - EPA established Record of Decision to remediate sediment
CT-C1_019-SB	LIS CB Inner - Housatonic River (mouth), Milford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Stratford Army Engine Plant • Contaminated sediment in adjacent tidal flats and tidal ditch • Action – evaluation for the extent of remedial dredging
CT-C2_024	LIS CB Shore - Housatonic River mouth, Stratford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Sporting Goods Properties, Inc. • Contaminated sediment along Lordship Point • Action - evaluation of ecological risk
CT7103-00-2-L3_01	Success Lake (Bridgeport)	Habitat for Fish, Other Aquatic Life and Wildlife	Sporting Goods Properties, Inc. • Contaminated sediment within lake • Action - Planned for remedial dredging
CT7103-00-2-L4_01	Stillman Pond (Bridgeport)	Fish Consumption	GE Bridgeport • Contaminated sediment within pond • Action - Planned for remedial dredging

References

Barbour, M.T., J. Gerritsen, B.D. Snyder and J.B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition*. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington D.C.

Becker, M. 2012. Quality Assurance Project Plan-Aquatic Life Response to Cultural Eutrophication in Connecticut Freshwater Wadeable Rivers and Stream (2012-2015). Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse, Planning and Standards Division Hartford, CT.

Bellucci, C. TMDL information. CT Dept. of Environmental Protection, Bureau of Water Protection and Land Reuse, Planning and Standards Division, Hartford, CT. Personal communication to P. Stacey, CT Dept. of Environmental Protection, Bureau of Water Protection and Land Reuse, Planning and Standards Division Hartford, CT.

Bellucci, C.J., M.E. Becker, M. Beauchene, and L. Dunbar. 2013. Classifying the Health of Connecticut Streams Using Benthic Macroinvertebrates with Implications for Water Management. Environmental Management 51:1274-1283.

Canavan, R.W. IV and P.A. Siver. 1995. *Connecticut Lakes: A Study of Chemical and Physical Properties of Fifty-six Connecticut lakes*. Connecticut College Arboretum, New London, CT.

CT DEEP. *Water Quality Standards.* CT Dept. of Environmental Protection, Bureau of Water Management, Planning Division, Hartford, CT. www.ct.gov/deep/wqsc

CTDEEP. 2015. Ambient Water Quality Monitoring Program Strategy, 2015-2024. Connecticut Department of Energy and Environmental Protection. Hartford, CT 06106.

CT DEP. 1996. *Quality Assurance Project Plan for Ambient Biological Monitoring*. CT Dept. of Environmental Protection, Bureau of Water Management, Planning Division, Hartford, CT.

CT DEP. 1998. *Trophic Classifications of Twelve Connecticut Lakes*. CT Dept. of Environmental Protection, Bureau of Water Management, Lakes Program, Hartford, CT.

CT DEP. 1999. *Ambient Monitoring Strategy for Rivers and Streams: Rotating Basin Approach*. CT Dept. of Environmental Protection, Bureau of Water Management, Planning Division, Hartford, CT.

CTDEEP. 2013. Standard Operating Procedures for the Collection of Fish Community Data from Wadeable Streams for Aquatic Life Assessment. Bureau of Water Protection and Land Reuse, Planning and Standards Division, Hartford, CT.

CT DEP. 2005. *Connecticut Comprehensive Ambient Water Quality Monitoring Strategy.* CT Dept. of Environmental Protection, Bureau of Water Management, Planning Division, Hartford, CT.

CT DEP. Unpublished data. CT Dept. of Environmental Protection, Bureau of Water Management, Planning Division, Hartford, CT

CT DPH and CT DEP. 2003. *State of Connecticut Guidelines for Monitoring Bathing Water and Closure Protocol: revised 2003.* CT Dept. of Health Services, CT Dept. of Environmental Protection, Hartford, CT.

CT DPH. 2016. *If I Catch It, Can I Eat It? A Guide to Eating Fish Safely Connecticut Fish Consumption Advisory*. Connecticut Department of Public Health, Hartford, CT. www.ct.gov/dph/fish

Frink, C.R. and W.A. Norvell. 1984. *Chemical and Physical Properties of Connecticut Lakes*. The Connecticut Agricultural Experiment Station, New Haven, CT.

Gerritsen, J. and B. Jessup. 2007. *Calibration of the Biological Condition Gradient for High Gradient Streams of Connecticut*. Tetra Tech, Inc. Owings Mills, MD. Prepared for US EPA, Office of Science and Technology and the CT DEP.

Grubbs, G. H. and R.H. Wayland. 2000. [Online] *Guidance: Use of Fish and Shellfish Advisories and Classifications in 303(d) and 305(b) Listing Decisions (October 24, 2000) WQSP-00-03* United States Environmental Protection Agency, Office of Water, Washington, DC. Accessed 10/21/09 http://www.epa.gov/waterscience/standards/library/shellfish.pdf website last updated 9/29/09

Healy, D.F. and K.P. Kulp. 1995. *Water Quality Characteristics of Selected Public Recreational Lakes and Ponds in Connecticut.* U.S. Geologic Survey Water-Resources Investigations Report 95-4098, prepared in cooperation with the State of Connecticut Department of Environmental Protection, Hartford, CT.

Interstate Shellfish Sanitation Conference. 2009. [Online] *Guide for the Control of Molluscan Shellfish 2009.* U.S. Department of Health and Human Services, Public Health Service, Food and Drug Administration. http://www.fda.gov/downloads/Food/GuidanceRegulation/FederalStateFoodPrograms/UCM350004.pdf.

Kanno, Y., J.C. Vokoun, and M. Beauchene. 2010. *Development of dual fish multi-metric indices of biological condition for streams with characteristic thermal gradients and low species richness.* Ecol. Indicators.

Neumann, R.M., R.J. Carley, C.P. Perkins, and R. Pirrie. 1996. *Preliminary Assessment of Total Mercury Concentrations in Fishes from Connecticut Water Bodies.* Department of Natural Resource Management and Engineering and Environmental Research Institute. University of Connecticut, Storrs, CT.

Nosal, T. 1997. *Gazetteer of Drainage Areas of Connecticut*. Water Resources Bulletin Number 35. CT Department of Environmental Protection. Available at http://www.cteco.uconn.edu/docs/wrb/WRB45_Gazetteer_of_Drainage_Areas_of_Connecticut.pdf

O'Brien, K. undated. *OLISP sediment geodatabase*. CT Department of Environmental Protection Bureau of Water Protection and Land Reuse, Office of Long Island Sound Programs, Hartford, CT.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989. *Rapid Bioassessment Protocols for use in Streams and Rivers: Benthic Macroinvertebrates and Fish*. EPA/444/4-89-00. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The Natural Flow Regime-A Paradigm for River Conservation and Restoration. Bioscience 47:769-784.

Stacey, P. 2007. *RE: determination of impairment based on sediment contamination- CALM update* State of Connecticut, Department of Environmental Protection, Bureau of Water Protection and Land Reuse, Division Director, Hartford, CT. Email to Katie O'Brien-Clayton, Department of Environmental Protection, Bureau of Water Protection and Land Reuse dated 12/27/2007.

Stevens, D. L., Jr. and A. R. Olsen. 2004. Spatially-balanced sampling of natural resources. Journal of American Statistical Association 99(465): 262-278.

Streich, K. 2007. *Summary Report & Users Guide Connecticut Coastal Assessment And Segmentation Project Final - May 11, 2006 Amended - October 3, 2007* State of Connecticut. Department of Environmental Protection. Hartford, CT

Strobel, C.J. 2000. *Coastal 2000 - Northeast Component: Field Operation Manual*. EPA/620/R-00.002. U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division, Narragansett, RI.

US EPA. Clean Water Act. https://www.epa.gov/laws-regulations/summary-clean-water-act

US EPA. 1997. *Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) Reports) and Electronic Updates: Report Contents.* EPA-841-B-97-002A. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

US EPA. 2000. *Ambient aquatic life water quality criteria for dissolved oxygen (saltwater): Cape Cod to Cape Hatteras.* EPA-822-R-00-012. U.S. Environmental Protection Agency, Office of Water, Washington, DC. 49 p.

US EPA. 2002. [Online] *Consolidated Assessment and Listing Methodology Toward a Compendium of Best Practices*/. First Edition. July 2002. U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, D.C. http://www.epa.gov/owow/monitoring/calm.html

US EPA. 2005. *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act.* U.S. Environmental Protection Agency, Assessment and Watershed Protection Division, Office of Water, United States Protection Agency, Washington, DC.

US EPA. 2013. *Long-Term Vision for Assessment, Restoration and Protection under the Clean Water Act Section 303(d) Program*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. https://www.epa.gov/tmdl/new-vision-cwa-303d-program-updated-framework-implementing-cwa-303d-program-responsibilities

Vokoun, J.C and C.R. Perkins. 2008. *Second Statewide Assessment of Mercury Contamination in Fish Tissue from Connecticut Lakes (2005-2006)* Department of Natural Resource Management and Center for Environmental Sciences and Engineering. University of Connecticut, Storrs, CT.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
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June 8, 2017

Betsey Wingfield, Chief
Bureau of Water Protection and Land Reuse
Connecticut Department of Energy and Environmental Protection
79 Elm Street
Hartford, CT 06106

Dear Ms. Wingfield:

Thank you for your submittal of the 2016 Clean Water Act ("CWA") Section 303(d) list, Connecticut's 2016 list of water bodies not meeting water quality standards. In accordance with Section 303(d) of the CWA and 40 CFR §130.7, the U.S. Environmental Protection Agency, Region 1 (EPA) conducted a complete review of Connecticut's 2016 Section 303(d) list and supporting documentation. Based on this review, EPA has determined that Connecticut's list of water quality limited segments still requiring total maximum daily loads meets the requirements of Section 303(d) of the CWA and EPA's implementing regulations. Therefore, by this letter, EPA hereby approves Connecticut's 2016 Section 303(d) list.

The Section 303(d) list was submitted in Chapter 3 of the Connecticut's 2016 Integrated Water Quality Report. Table 3-4 comprises the list of those waters for which technology based and other required controls for point and nonpoint sources are not stringent enough to attain or maintain compliance with the state's water quality standards. The submittal also presents Connecticut's total maximum daily load strategy which describes the priority setting approach and identifies those waters for which total maximum daily loads will be completed and submitted during the next two years. The statutory and regulatory requirements, and EPA's review of Connecticut's compliance with each requirement, are described in detail in the enclosed approval document.

The Connecticut Department of Energy and Environmental Protection ("CT DEEP") has also successfully completed a public participation process during which the public was given the opportunity to review and comment on the 2016 Section 303(d) list. As a result of this effort, Connecticut has considered public comments in the development of the final list. The public comments and CT DEEP's responses to those comments were included in the state's final submittal.

EPA is pleased with the quality of the state's submittal and appreciates the level of effort that CT DEEP has devoted to preparing the 2016 Integrated Water Quality Report in general and 2016 Section 303(d) list in particular. Your staff has prepared a

comprehensive and informative list, and has also provided EPA with supporting documentation and assistance to aid in our review and approval. The 2016 Integrated Water Quality Report reflects the state's larger vision for addressing impaired and protecting unimpaired waters through CT's Integrated Water Resource Management process. My staff and I look forward to continued cooperation with CT DEEP in implementing the requirements under Section 303(d) of the CWA.

Please feel free to contact Mary Garren at 617-918-1322 if you have any questions about or comments on our review.

Sincerely,

/s/

Arthur Johnson, Acting Director
Office of Ecosystem Protection

Enclosure

cc: Chris Bellucci, CT DEEP
Traci Iott, CT DEEP
Denise Rudzicka, CT DEEP
Ralph Abele, EPA

EPA NEW ENGLAND'S REVIEW OF
CONNECTICUT'S 2016 CWA SECTION 303(d) LIST

I. INTRODUCTION

EPA has conducted a complete review of Connecticut's (CT) 2016 Section 303(d) list and supporting documentation and information and, based on this review, EPA has determined that Connecticut's list of water quality-limited segments (WQLSs) still requiring total maximum daily loads (TMDLs) meets the requirements of Section 303(d) of the Clean Water Act ("CWA" or "the Act") and EPA implementing regulations. Therefore, by this order, EPA hereby approves Connecticut's final 2016 Section 303(d) list, included as part of the *State of Connecticut 2016 Integrated Water Quality Report established pursuant to Sections 305(b) and 303(d) of the Federal Clean Water Act* (IWQR), dated April 25, 2017. The final IWQR was received by EPA on May 2, 2017. The statutory and regulatory requirements, and EPA's review of Connecticut's compliance with each requirement, are described in detail below.

II. STATUTORY AND REGULATORY BACKGROUND

Identification of WQLSs for Inclusion on Section 303(d) List

Section 303(d)(1) of the Act directs states to identify those waters within its jurisdiction for which effluent limitations required by Section 301(b)(1)(A) and (B) are not stringent enough to implement any applicable water quality standard, and to establish a priority ranking for such waters, taking into account the severity of the pollution and the uses to be made of such waters. The Section 303(d) listing requirement applies to waters impaired by point and/or nonpoint sources, pursuant to EPA's long-standing interpretation of Section 303(d).

EPA regulations provide that states do not need to list waters where the following controls are adequate to implement applicable standards: (1) technology-based effluent limitations required by the Act, (2) more stringent effluent limitations required by state or local authority, and (3) other pollution control requirements required by state, local, or federal authority. See 40 CFR Section 130.7(b)(1).

Consideration of Existing and Readily Available Water Quality-Related Data and Information

In developing Section 303(d) lists, states are required to assemble and evaluate all existing and readily available water quality related data and information, including, at a minimum, consideration of existing and readily available data and information about the following categories of waters: (1) waters identified as partially meeting or not meeting designated uses, or as threatened, in the state's most recent Section 305(b) report; (2) waters for which dilution calculations or predictive modeling indicate nonattainment of applicable standards; (3) waters for which water quality problems have been reported by governmental agencies, members of the public, or academic institutions; and (4) waters identified as impaired or threatened in any Section 319 nonpoint assessment submitted to EPA. See 40 CFR §130.7(b)(5). In addition to these minimum categories, states are required to consider any other data and information that is

existing and readily available. EPA's 2006 Integrated Report Guidance describes categories of water quality related data and information that may be existing and readily available. See EPA's August 13, 2015 memorandum on *Information Concerning 2016 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions* which recommends that 2016 integrated water quality reports follow the *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act, issued July 29, 2005,* as supplemented by the October 12, 2006 memorandum and attachments, the May 5, 2009 memorandum and attachments, the November 15, 2010 memorandum, the March 21, 2011 memorandum and attachments, and the September 3, 2013 memorandum and attachments,. All guidance, memoranda, and attachments may be found at https://www.epa.gov/tmdl/integrated-reporting-guidance. While states are required to evaluate all existing and readily available water quality related data and information, states may decide to rely or not rely on particular data or information in determining whether to list particular waters.

In addition to requiring states to assemble and evaluate all existing and readily available water quality related data and information, EPA regulations at 40 CFR §130.7(b)(6) require states to include, as part of their submissions to EPA, documentation to support decisions to rely or not rely on particular data and information and decisions to list or not list waters. Such documentation needs to include, at a minimum, the following information: (1) a description of the methodology used to develop the list; (2) a description of the data and information used to identify waters; and (3) any other reasonable information requested by the Region.

Priority Ranking

EPA regulations also codify and interpret the requirement in Section 303(d)(1)(A) of the Act that states establish a priority ranking for listed waters. The regulations at 40 CFR §130.7(b)(4) require states to prioritize waters on their Section 303(d) lists for TMDL development, and also to identify those WQLSs targeted for TMDL development in the next two years. In prioritizing and targeting waters, states must, at a minimum, take into account the severity of the pollution and the uses to be made of such waters. See Section 303(d)(1)(A). As long as these factors are taken into account, the Act provides that states establish priorities. States may consider other factors relevant to prioritizing waters for TMDL development, including immediate programmatic needs, vulnerability of particular waters as aquatic habitats, recreational, economic, and aesthetic importance of particular waters, degree of public interest and support, and state or national policies and priorities. See 57 FR 33040, 33045 (July 24, 1992), and EPA's 2006 Integrated Report Guidance and the 2006, 2009, 2010, 2011, 2013 and 2015 memoranda and attachments.

III. REVIEW OF CONNECTICUT'S SECTION 303(d) SUBMISSION

The Connecticut Department of Energy and Environmental Protection (CT DEEP) submitted the final 2016 Section 303(d) list to EPA, along with responses to comments, dated April 25, 2017. The integrated listing format (i.e., a combination of the state's Section 305(b) report and the state's Section 303(d) list) allows states to provide the status of all assessed waters in a single multi-part list or document. CT's 2016 IWQR can be found at: http://www.ct.gov/deep/lib/deep/water/water_quality_management/305b/2016_iwqr_final.pdf.

Chapter 1 of the IWQR, *Connecticut Consolidated Assessment and Listing Methodology (CT CALM)*, describes the procedure used by the CT DEEP to assess the quality of the state's waters relative to attainment of Connecticut Water Quality Standards Regulations. Chapter 2, *305(b) Assessment Results,* provides a series of figures and tables presenting the results of CT DEEP's assessment of all readily available data relating to designated use attainment in Connecticut waters. Chapter 3, *Waterbodies identified for restoration and protection strategies pursuant to Section 303 of the Clean Water Act,* provides additional information concerning those assessed waters that do not currently meet water quality standards and includes the state's 2016 Section 303(d) list.

States may include each waterbody or segment thereof into one or more of the following five categories as part of an IWQR; however, only waterbodies or segments placed in Category 5 (impaired by a pollutant and for which a TMDL is needed) constitute a state's Section 303(d) list:

1) All designated uses are supported, no use is threatened;
2) Available data and/or information indicate that some, but not all of the designated uses are supported;
3) There is insufficient available data and/or information to make a use support determination;
4) Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed;
  4-A) A state-developed TMDL has been approved by EPA or a TMDL has been established by EPA for any segment-pollutant combination;
  4-B) Other required control measures are expected to result in the attainment of an applicable water quality standard in a reasonable period of time;
  4-C) The non-attainment of any applicable water quality standard for the segment is the result of pollution and is not caused by a pollutant;
5) Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed; and
  5-Alt) Impaired without a TMDL completed but assigned a low priority for TMDL development because an alternative restoration approach is being pursued.

The 2016 Section 303(d) list under review here is included in Chapter 3 of Connecticut's IWQR. The Section 303(d) list includes all waters that have been assigned to Category 5. Chapter 3 also presents the state's rationale for prioritizing TMDL development for Category 5 waterbody segments and their associated impairments. Waters listed by Connecticut in Table 3-4 of the IWQR represent the state's 2016 Section 303(d) list, which the state is required to submit to EPA for review and approval or disapproval.

1.) Final 2016 State of Connecticut Integrated Water Quality Report

Connecticut's IWQR includes extensive information on all waters assessed in the state. All waters known or suspected not to be meeting water quality standards and in need TMDLs have been included on the Section 303(d) list in the IWQR. Under its current listing approach, Connecticut keeps a water on its impaired waters list until it is shown that water quality

standards are being attained, revision of the water quality standards support a change in assessment status, data indicates that the designated uses of the waterbody are being met, criteria are met for its placement in Category 4, or the initial listing is confirmed as having been incorrect. TMDLs for listed waters will be completed in accordance with the schedule established, which reflects priority rankings and other relevant factors.

The IWQR specifies waters in Category 4. These are waters that are currently not meeting water quality standards but do not need a TMDL completed due to one of three reasons. Waters for which TMDLs have already been approved are listed in Category 4-A. Category 4-B includes waters for which a functionally equivalent control action has been developed, i.e., an impairment caused by a pollutant is being addressed through other pollution control requirements. Waters in Category 4-C are not attaining water quality standards but the cause is not associated with a pollutant. EPA reviews the Category 4 list to insure that the waters are categorized appropriately and do not belong in Category 5.

As noted above, Category 5 contains waters where available data and/or other information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed. Federal Regulations in 40 CFR Section 130.7 require EPA to review and approve or disapprove the Category 5 list of impaired waters.

2.) Response to Public Comments

CT DEEP published a draft *2016 Integrated Water Quality Report* on January 30, 2017. The state's *List of Connecticut Waterbodies Not Meeting Water Quality Standards* was included in Chapter 3 of the draft report. The public notice notifying stakeholders of the opportunity to comment on the draft report was sent to interested parties by email, posted on the CT DEEP website, and published in six newspapers throughout the state. A public informational meeting was held on March 1, 2017. Comments were accepted from the public from February 6 through March 13, 2017. Seven parties submitted comments during the public comment period. The state published a detailed response to comments, including the original comment letters, along with the final IWQR. The text of the response to comments provided a summary of the public comments and the state's responses to each question or issue raised.

CT DEEP received comments during the public comment period from EPA New England, Eastern CT Conservation District, South Central CT Regional Water Authority, Tom Leone, and the Towns of Cromwell, Mansfield, and Thompson. CT DEEP reviewed information provided by the commenters and made certain changes to the final IWQR based on public comment. One waterbody segment/impairment, the recreational use of Bicentennial Pond, was removed from Category 4-A. In addition, some language in the document was changed or refined by the state based upon comments received. The state also agreed to consider certain locations for future sampling efforts. The agency affirmed its commitment to work with outside partners through its Integrated Water Management process. CT DEEP also provided guidance to the public for obtaining other sources of relevant information. Finally, Connecticut provided answers to the questions raised by the public that were responsive and clarified why the state made decisions regarding listing or delisting of certain waterbody segment/impairments.

One commenter asked why two waters, Pumpkin Ground Brook and Pecks Mill Pond in Stratford, were not found in the IWQR. Listing every water in the state is the aim of the Integrated Report, however it is not uncommon for states to be in the process of cataloging many of their smaller waterbodies. CT DEEP committed to assessing Pumpkin Ground Brook during the next listing cycle and to consider Pecks Mill Pond for future monitoring. In response to the interest in these particular waters EPA requests that CT DEEP include Pumpkin Ground Brook and Pecks Mill Pond in the 2018 IWQR.

Bicentennial Pond remained listed on the draft 2016 IWQR as impaired for its recreational use at the designated bathing beach due to the presence of Escherichia coli (E. coli). The Town of Mansfield submitted a comment during the public comment period on Bicentennial Pond (CT3207-16-1-L1_01) requesting that CT DEEP assess the pond as fully supporting its recreational use and that the state remove the pond from Category 4A. The request was accompanied by a report with data showing that since 2012 there have been no levels of E. coli above the single sample maximum and consequently no beach closures. The state agreed with the town's comment on Bicentennial Pond and made the change between the draft and final IWQR.

CT DEEP also responded to questions regarding three brooks raised by the Town of Thompson through direct communication with the town and in its response to comments. In a follow-up letter to CT DEEP the town disagreed with the state's assessment that all 3.27 miles of Wheaton Brook should be listed as impaired for its recreational use based upon the E. coli data used by CT DEEP to make that assessment. CT DEEP's use of the data is consistent with its CALM, CT Water Quality Standards Regulations, and is also consistent with how the state has treated assessments in similar small watersheds. There was no other data to justify delisting Wheatons Brook or splitting the segment at the town line. CT DEEP offered the Town of Thompson assistance on future work in the brooks. EPA agrees with the state's decisions to retain Wheaton Brook on the state's list of impaired waters and not to split the brook into more than one segment.

EPA has reviewed the language within CT DEEP's IWQR addressing areas of public concern as well as CT DEEP's responses to public comments. EPA concludes that Connecticut has appropriately and adequately responded to the public comments and concerns.

IV. IDENTIFICATION OF WATERS AND CONSIDERATION OF EXISTING AND READILY AVAILABLE WATER QUALITY-RELATED DATA AND INFORMATION

EPA has reviewed the state's submission, and has concluded that the state developed its 2016 Section 303(d) list in compliance with Section 303(d) of the Act and 40 CFR Section 130.7. EPA's review is based on its analysis of whether the state reasonably considered existing and readily available water quality related data and information and reasonably identified waters required to be listed.

The State of Connecticut uses sources of data and information consistent with EPA regulations and EPA's 2006 Integrated Report Guidance when conducting the state's water quality assessments. As outlined in the IWQR, these data include:

- Results from recent ambient monitoring;
- Recent Sections 305(b) reports, 303(d) lists, and 319(a) nonpoint assessments;
- Reports of water quality problems provided by local, state, territorial or federal agencies, volunteer monitoring networks, members of the public or academic institutions;
- Fish and shellfish advisories, restrictions on water sports or recreational contact;
- Reports of fish kills;
- Safe Drinking Water Act source water assessments;
- Superfund and Resource Conservation and Recovery Act reports;
- Results from predictive modeling, dilution calculations or landscape analysis; and
- Results from analysis of water quantity impacting aquatic life and other designated uses.

The primary sources of assessment information for rivers are ambient monitoring data collected by CT DEEP monitoring staff, and physical, chemical and bacteria data collected at fixed sites by the United States Geological Survey (USGS). Lake assessments and trophic status are generally determined from studies conducted by CT DEEP, the Connecticut Agricultural Experiment Station, USGS and Connecticut College since 1979 (Frink and Norvell 1984, Canavan and Siver 1995, Healy and Kulp 1995, CT DEEP 1998) as well as recent studies by professional contractors. For estuaries, use assessments are based primarily on physical, chemical and biological monitoring by the CT DEEP for the Long Island Sound Study and National Coastal Assessment (Strobel 2000), bacterial monitoring for shellfish sanitation by the CT Department of Agriculture, Bureau of Aquaculture (CT DA-BA), and beach monitoring by state and local authorities. Reasonable efforts are also made to incorporate data from other state and federal agencies, municipalities, utilities, consultants, academia, and volunteer monitoring groups. (taken from Page 7 of the IWQR)

Connecticut relies upon data and/or other information from many sources to assess whether a water is meeting water quality standards and maintaining the water's designated uses. These sources are outlined above. The types of data used to assess the status of a water may include, but are not limited to: ambient physical and chemical, benthic invertebrate and fish community, indicator bacteria, indicators of productivity and enrichment/eutrophication, aquatic toxicity, tissue contaminant, sediment chemistry/toxicity, and effluent analysis. The data and/or other information that meets CT DEEP's minimum standard for data acceptability is then used to assess the status of the waterbody.

In order to prepare the 2016 Section 303(d) list, the state established a date by which data would be considered for this listing cycle. Data available to CT DEEP as of November 1, 2015 are relied upon for these assessments. Connecticut permits data from catastrophic events, such as fish kills and chemical spills, to be used in the assessment even if collected after November 1st. Assessment data are maintained by the state in the EPA Section 305(b) Assessment Database (ADB) Version 2, as well as a number of databases designed for CT DEEP use.

The state provided its rationale for not relying on particular existing and readily available water quality related data and information as a basis for listing waters. Details as to why certain waters were not listed are provided in CT DEEP's response to comments. Waters included in Category

5 of the 2016 Section 303(d) list were assessed as impaired based upon failure of the water to attain its designated uses and attain water quality standards. Connecticut's waters may be placed in multiple categories to reflect the attainment or non-attainment of different particular designated uses. Table 2-1 of the IWQR summarizes the status of Connecticut's rivers, lakes, and estuarine waters.

EPA has reviewed Connecticut's description of the data and information considered in development of the 2016 Section 303(d) list, including but not limited to the state's methodology for identifying waters, data in ADB, and the CT Water Quality Standards Regulations. EPA concludes that the state properly assembled and evaluated all existing and readily available data and information, including data and information relating to the categories of waters specified in 40 CFR Section 130.7(b)(5).

Waterbody Segment/Impairments newly listed on Connecticut's 2016 Section 303(d) list.

There are 284 waterbody segments on the state's 2016 Section 303(d) list, impaired for one or more designated uses. Additions to the 2016 Section 303(d) list, Category 5, involve a total of 63 water body segment/impairment causes. There are thirty-eight fresh waterbody segment/impairments and twenty-five estuarine segment/impairments. These listings were related to bacteria, nutrient-related impairments, unknown causes, lead, and PCB impairments.

Table 1: New waterbody segment/impairments added to Connecticut's 2016 Section 303(d) list (Category 5 of the IWQR)

Segment ID#	Waterbody name	Impaired use listed	Associated pollutant
CT3004-00_01	Oxoboxo Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT3207-12_01	Roberts Brook (Mansfield)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT3300-10_01	Quinatissett Brook (Thompson)-01	Recreation	E. coli
CT3708-18_01	Wheatons Brook (Putnam/Thompson)-01	Recreation	E. coli
CT4312-00_01	Roaring Brook (Farmington)-01	Recreation	E. coli
CT4504-00_02	Hop Brook (Manchester)	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT4600-00-trib_01	Unnamed tributary Connecticut River (Cromwell)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT4601-00_01	Belcher Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown

CT4601-02_01	Hatchery Brook-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT5111-00_02	Branford River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT5208-00_02a	Muddy River (North Haven)-02a	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT6000-00-5+L2_01	Zoar, Lake	Recreation	Chlorophyll-a
CT6000-00-5+L2_01	Zoar, Lake	Recreation	Excess Algal Growth
CT6000-00-5+L2_01	Zoar, Lake	Recreation	Nutrient/Eutrophication Biological Indicators
CT6000-00-5+L2_02	Zoar, Lake	Recreation	Chlorophyll-a
CT6000-00-5+L2_02	Zoar, Lake	Recreation	Excess Algal Growth
CT6000-00-5+L2_02	Zoar, Lake	Recreation	Nutrient/Eutrophication Biological Indicators
CT6000-00-5+L4_01	Housatonic Lake	Recreation	Chlorophyll-a
CT6000-00-5+L4_01	Housatonic Lake	Recreation	Excess Algal Growth
CT6000-00-5+L4_01	Housatonic Lake	Recreation	Nutrient/Eutrophication Biological Indicators
CT6019-00-trib_01	Unnamed trib Deep Brook (Newtown)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT6502-00-1-L2_01	Waramaug, Lake	Recreation	Chlorophyll-a
CT6502-00-1-L2_01	Waramaug, Lake	Recreation	Excess Algal Growth
CT6502-00-1-L2_01	Waramaug, Lake	Recreation	Nutrient/Eutrophication Biological Indicators
CT6703-00_01	West Branch Bantam River (Litchfield/Goshen)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT6705-00-3-L3_01	Bantam Lake	Recreation	Chlorophyll-a
CT6705-00-3-L3_01	Bantam Lake	Recreation	Excess Algal Growth
CT6705-00-3-L3_01	Bantam Lake	Recreation	Nutrient/Eutrophication Biological Indicators
CT6916-00_01	Hop Brook (Naugatuck)-01	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown

CT7000-16_01	Muddy Brook (Westport)-01	Recreation	E. coli
CT7000-16-trib_01	Unnamed trib to Muddy Brook	Recreation	E. coli
CT7000-17_01	Unnamed trib, Muddy Brook (Westport)-01	Recreation	E. coli
CT7000-18_01	Unnamed trib, Sherwood Millpond LIS (Westport)-01	Recreation	E. coli
CT7000-29_01	Unnamed trib to Farm Creek LIS (Norwalk)-01	Recreation	E. coli
CT7103-00-2-L4_01	Stillman Pond (Bridgeport)	Fish Consumption	Polychlorinated biphenyls
CT7300-00_05	Norwalk River (Ridgefield)-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT7302-13_01	Belden Hill Brook	Recreation	E. coli
CT7407-00_02	Mianus River-02	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT-C2_024	LIS CB Shore - Housatonic River mouth, Stratford	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Lead
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Recreation	Estuarine Bioassessments
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Recreation	Excess Algal Growth
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Recreation	Estuarine Bioassessments
CT-E1_003	LIS EB Inner - Inner Wequetequock Cove, Stonington	Recreation	Excess Algal Growth

CT-E1_007-SB	LIS EB Inner - Mystic River (Mouth), Stonington	Shellfish Harvesting	Fecal Coliform
CT-E1_033	LIS EB Inner - Pequotsepos Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Dissolved Oxygen
CT-E1_033	LIS EB Inner - Pequotsepos Cove, Stonington	Shellfish Harvesting	Fecal Coliform
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Recreation	Estuarine Bioassessments
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Recreation	Excess Algal Growth
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Recreation	Estuarine Bioassessments
CT-E2_002	LIS EB Shore - Stonington Point, Stonington	Recreation	Excess Algal Growth
CT-E2_010-SB	LIS EB Shore - Thames River Mouth (West), New London	Shellfish Harvesting	Fecal Coliform
CT-E3_001	LIS EB Midshore - Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Estuarine Bioassessments
CT-E3_001	LIS EB Midshore - Stonington	Habitat for Marine Fish, Other Aquatic Life and Wildlife	Excess Algal Growth
CT-E3_001	LIS EB Midshore - Stonington	Recreation	Estuarine Bioassessments
CT-E3_001	LIS EB Midshore - Stonington	Recreation	Excess Algal Growth

The waterbody segment/impairments noted above were identified by new assessments during this listing cycle and were thus newly placed in Category 5, the Section 303(d) list.

Additionally, EPA notes that while it is not acting to approve or disapprove Connecticut's listing methodology set forth in its CALM, EPA has reviewed all of the relevant material and concludes that the methodology CT DEEP used to develop the impaired waters list is reasonable and consistent with Connecticut's Water Quality Standards Regulations, the Clean Water Act, and EPA Section 303(d) regulations and guidelines.

Waterbody Segment/Impairments not listed on Connecticut's 2016 Section 303(d) list that were listed on Connecticut's 2014 Section 303(d) list.

EPA requested that Connecticut provide a rationale for its decision not to include on its 2016 Section 303(d) list previously listed waters. As discussed below, the state has demonstrated to EPA's satisfaction good cause for not listing those waters, consistent with 40 C.F.R. §130.7(b)(6)(iv).

Category 5 in 2014 to Category 2 in 2016

For the 2016 Section 303(d) list cycle, the state has delisted eight waterbody segment/impairments that were included on the state's 2014 Section 303(d) list. These waterbody segment/impairments were listed in Category 5 in 2014 and are being placed in Category 2 in 2016. In these waterbody segments either the designated use of the waterbody segment has been restored and the water is now meeting WQS for the pollutant that was causing the impairment or the reason for the original listing was incorrect. CT DEEP supplied to EPA up-to-date information on all the state's waters as part of the 2016 assessment cycle. Summaries of this information can be found in the state's IWQR. Information regarding waters in the IWQR is also available for review at EPA's water quality assessment and TMDL information page for the State of Connecticut at:
https://ofmpub.epa.gov/waters10/attains_state.control?p_state=CT

Table 2: Waterbody segment/impairments on Connecticut's 2014 Section 303(d) list (Category 5 of the IWQR) that are being delisted in 2016.

Segment ID#	Waterbody name	Use restored	Pollutant meeting WQS
CT3700-00_01	Quinebaug River	Recreation	E. coli
CT3800-00_05	Shetucket River (Windham)-05	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown
CT5200-00-04	Quinnipiac River-04	Fish Consumption	PCBs
CT5200-00-05	Quinnipiac River-05	Fish Consumption	PCBs
CT5200-00-06	Quinnipiac River-06	Fish Consumption	PCBs
CT-C1_002-SB	LIS CB Inner - Inner Clinton Harbor, Clinton	Commercial Shellfish Harvesting Where Authorized	Fecal Coliform
CT-E2_021	LIS EB Shore - Plum Bank, Old Saybrook	Shellfish Harvesting	Fecal Coliform
CT-W1_014-SB	LIS WB Inner - Fivemile River (mouth), Norwalk	Shellfish Harvesting	Fecal Coliform

EPA has reviewed the specific bases for the eight waterbody segment/impairments delisted on

the 2016 Section 303(d) list and agrees with CT DEEP that these delistings are appropriate. The details of these changes from the 2014 to the 2016 IWQR are presented below.

The recreational use of the Quinebaug River, CT3700-00_01, was impaired due to E. coli and listed in Category 5 on the state's 2014 list. No designated bathing beach is found on this segment. A robust data set from USGS confirms that the recreational use is no longer impaired and the segment is meeting CT's geomean bacteria criterion for E. coli. Neither were there single sample maximum exceedances. EPA agrees with the state's decision to delist this segment to Category 2.

The Shetucket River (Windham)-05, CT3800-00_05, had an impairment of its habitat for fish, other aquatic life and wildlife. It was listed in Category 5 on the state's 2014 list with the cause unknown. CT DEEP collected extensive data for the 2016 listing cycle on the biological health of the river. Multimetric indices (MMI) were calculated and a biological condition gradient (BCG) assessment for the river conducted to determine the health of macroinvertebrates and fish in the river. Macroinvertebrate and fish population subsamples were used to calculate MMI health scores for each sampling location. Highly sensitive taxa are typically found in least stressed sites and tolerant and exotic/invasive taxa are typically found in severely stressed sites. MMI scores are the arithmetic average of various metrics using different sensitive taxa with higher values representing least stressed sites. The BCG is a conceptual model that describes changes in aquatic communities using ten biological attributes. It allows a water to be assessed on a scale from natural/undisturbed to entirely biologically and ecologically impaired. The 2016 assessment showed that macroinvertebrate and fish MMI scores as well as BCG scores were of passing grades. Macroinvertebrate data from 2009 and 2012 also support the 2016 assessment. EPA agrees with the state's decision to delist this segment to Category 2.

A historic PCB release from storage tanks in Southington lead to Eightmile River (Southington)-01 segment being listed in Category 4B on the state's 2014 list. Three downstream segments of the Quinnipiac River, below the confluence with the Eightmile, were listed in Category 5 on the state's 2014 list, as the result of the same PCB release. The impacted area subsequently was extensively remediated and confirmatory sampling conducted. The Connecticut Department of Public Health (CT DPH) released a 2016 public health evaluation of fish tissue contaminant data in the Quinnipiac and Eightmile Rivers that found that PCBs in fish have decreased to acceptable levels. The fish consumption advisory has thus been lifted as consumption over a long period of time would not be harmful to human health. CT DEEP finds that the three segments of the Quinnipiac River are now meeting their designated use for fish consumption. The same is true for the Eightmile River (Southington)-01 segment which is discussed on page 16 below. EPA agrees with the state's decision to delist these three segments and return them to Category 2. They are Quinnipiac River-04 (CT5200-00-04), Quinnipiac River-05 (CT5200-00-05), and Quinnipiac River-06 (CT5200-00-06).

LIS CB Inner Clinton Harbor Clinton, CT-C1_002-SB, was impaired for its commercial shellfish harvesting in 2014. Fecal coliform was the cause identified for the impairment and the waterbody segment/impairment was listed in Category 5. The Connecticut Department of Agriculture, Bureau of Aquaculture (DA/BA) conducted a detailed assessment of shellfish growing areas in the Town of Clinton, including the Inner Clinton Harbor segment. Sampling data from stations within this segment show that the segment is meeting fecal coliform bacteria

criteria for indirect consumption of shellfish. DA/BA has reopened these waters for commercial shellfish harvesting. EPA agrees with CT DEEP's decision to delist the segment because it is now attaining bacteria criteria and meeting its designated use. This segment will be placed in Category 2 for its commercial shellfishing use.

Two segments were originally listed in Category 5 because CT DPH administratively closed the recreational shellfish harvesting in these waters without any data. CT DEEP listed these waterbody segment/impairments in Category 5 on its 2014 list without any fecal coliform data on which to base an impairment assessment. These delistings from Category 5 to Category 2 are the same as others that EPA has approved during the last two listing cycles. They will be characterized more appropriately as "not assessed." These segments are LIS EB Shore - Plum Bank Old Saybrook (CT-E2_021) and LIS WB Inner - Fivemile River (mouth) Norwalk (CT-W1_014-SB).

As with all of the state's waters, if any designated use is determined to be impaired in the next listing cycle it will be fully or partially returned to Category 5 (the Section 303(d) list).

Category 5 in 2014 to Category 4-A in 2016

As discussed earlier, Category 4 contains segments that remain impaired for one or more designated uses, but do not need a TMDL for one of three reasons specified on page 3 above. Waterbody segment/impairments in Category 4-A have a state-developed TMDL which has been approved by EPA. A waterbody segment/impairment listed in Category 4-A in prior listing cycles remains in Category 4-A until appropriate water quality standards are attained and the designated use is restored, usually through implementation of the TMDL.

Thirty-seven segment/impairments are being delisted from the impaired waters list for bacterial impairments and placed in Category 4-A due to EPA's approval of TMDLs under the Connecticut Statewide Bacteria TMDL. Implementation of the TMDLs is expected to result in full attainment of the water quality standards. Standards attainment will be verified through follow-up monitoring. EPA approves the state's 2016 Section 303(d) list without these waterbody segment-pollutant combinations because the delistings are consistent with EPA regulations and EPA guidance.

Table 3: Waterbody segment/impairments delisted to Category 4-A because of an approved TMDL during this listing cycle

Segment ID#	Waterbody name addressed by the TMDL	Impaired use	Pollutant
CT1000-00_01	Pawcatuck River (Stonington/North Stonington)-01	Recreation	E. coli
CT1000-00_trib_01	Unnamed tributary Pawcatuck River 1000-00 (Stonington)-01	Recreation	E. coli
CT1000-01_01	Unnamed tributary Pawcatuck River 1000-01 (N. Stonington)-01	Recreation	E. coli
CT1000-03_01	Unnamed tributary Pawcatuck River 1000-03 (Stonington)-01	Recreation	E. coli

CT1000-04_01	Unnamed tributary Pawcatuck River 1000-04 (Stonington)-01	Recreation	E. coli
CT1000-05_01	Unnamed tributary Pawcatuck River 1000-05 (Stonington)-01	Recreation	E. coli
CT4319-00_01b	Salmon Brook, West Branch (Granby/Hartland)-01b	Recreation	E. coli
CT-E1_001-SB	LIS EB Inner - Pawcatuck River (01), Stonington	Recreation	Enterococcus
CT-E1_001-SB	LIS EB Inner - Pawcatuck River (01), Stonington	Shellfish Harvesting	Fecal Coliform
CT-E1_002-SB	LIS EB Inner - Pawcatuck River (02), Stonington	Shellfish Harvesting	Fecal Coliform
CT-E1_019	LIS EB Inner - Jordan Cove	Shellfish Harvesting	Fecal Coliform
CT-E1_020	LIS EB Inner - Niantic River (mouth)	Recreation	Enterococcus
CT-E1_020	LIS EB Inner - Niantic River (mouth)	Shellfish Harvesting	Fecal Coliform
CT-E1_021	LIS EB Inner - Pattagansett River (mouth)	Shellfish Harvesting	Fecal Coliform
CT-E1_022	LIS EB Inner – Bride Brook- East Lyme	Shellfish Harvesting	Fecal Coliform
CT-E1_023	LIS EB Inner - Fourmile River	Shellfish Harvesting	Fecal Coliform
CT-E1_024-SB	LIS EB Inner - Connecticut River (mouth)	Shellfish Harvesting	Fecal Coliform
CT-E1_026-SB	LIS EB Inner - Black Hall River (upper)	Shellfish Harvesting	Fecal Coliform
CT-E1_027-SB	LIS EB Inner - Duck River	Shellfish Harvesting	Fecal Coliform
CT-E1_032	LIS EB Inner - Oyster River Area	Shellfish Harvesting	Fecal Coliform
CT-E2_001	LIS EB Shore - Wequetequock Cove, Stonington	Shellfish Harvesting	Fecal Coliform
CT-E2_012	LIS EB Shore - Outer Jordan Cove	Shellfish Harvesting	Fecal Coliform
CT-E2_013	LIS EB Shore - Niantic Bay (East)	Shellfish Harvesting	Fecal Coliform
CT-E2_014	LIS EB Shore - Niantic Bay (West)	Shellfish Harvesting	Fecal Coliform
CT-E2_015	LIS EB Shore - Niantic Bay (Black Pt)	Shellfish Harvesting	Fecal Coliform
CT-E2_016	LIS EB Shore - Pattagansett River Mouth	Shellfish Harvesting	Fecal Coliform
CT-E2_017	LIS EB Shore - Rocky Neck (Fourmile River)	Shellfish Harvesting	Fecal Coliform
CT-E2_018	LIS EB Shore - Soundview Beach	Shellfish Harvesting	Fecal Coliform
CT-E2_020	LIS EB Shore - Willard Bay	Shellfish Harvesting	Fecal Coliform
CT-E2_022	LIS EB Shore - Indiantown Harbor	Shellfish Harvesting	Fecal Coliform
CT-E3_001	LIS EB Midshore - Stonington	Shellfish Harvesting	Fecal Coliform

CT-E3_006	LIS EB Midshore - Niantic Bay	Shellfish Harvesting	Fecal Coliform
CT-E3_007	LIS EB Midshore - East Lyme, Rocky Neck	Shellfish Harvesting	Fecal Coliform
CT-E3_008	LIS EB Midshore - Old Lyme, CT River	Shellfish Harvesting	Fecal Coliform
CT-E3_010	LIS EB Midshore - Old Saybrook	Shellfish Harvesting	Fecal Coliform
CT-E3_011	LIS EB Midshore - Old Saybrook, Indian Harbor	Shellfish Harvesting	Fecal Coliform
CT-W3_013	LIS WB Midshore - Outer Cos Cob Harbor, Greenwich	Shellfish Harvesting for Direct Consumption Where Authorized	Fecal Coliform

In summary, EPA recognizes that Connecticut's delisting in 2016 of these previously listed thirty-seven waterbody segment/impairments has been done in accordance with 40 CFR Section 130.7(b) and EPA guidance referenced above. For each of the waterbody segment/impairments delisted from Category 5 to Category 4-A, EPA agrees that the state has reasonably concluded that the identified impairments no longer need to be on the 2016 Section 303(d) list because the impairment is now the subject of an EPA-approved TMDL.

EPA's conclusion regarding review of the CT DEEP's delistings from Category 5

Table 3-8 of the IWQR provides a full detailed reconciliation of all the changes made between the 2014 and 2016 Section 303(d) lists. For each of the waterbody segment/impairments delisted from Category 5, EPA agrees that the state has reasonably concluded that the identified waterbody segment/impairments no longer need to be on the 2016 Section 303(d) list because the segment is now meeting water quality standards for the identified impairment, the reason for the original listing has been addressed, the impairment did not originally require listing, or a TMDL for the impairment has been approved by EPA.

Other Changes Noted in Connecticut's 2016 IWQR.

Waterbody Segments in Category 4-A

Twelve waterbody segment/impairment causes that were in Category 4A (under the Statewide Bacteria TMDL) are being removed from Category 4A and placed in Category 2. Ten of these changes are based upon data showing that the waters now attain CT's bacteria criterion for E. coli. The ten non-bathing beach waters demonstrated attaining the geomean criterion of 126/100ml for E. coli, each with a sufficiently robust set of samples. The other two segments, Wadsworth Falls State Park Pond (Middletown) and Bicentennial Pond (Mansfield) have designated bathing beaches on them. Monitoring data for Wadsworth Falls State Park Pond show that in nine years the beach has been closed 2.3% of the time due to single sample maximum exceedances, the threshold used for designated beach posting. This is far less than the standard set by CT DEEP of a maximum of 10% closure during swimming season. In fact, in no one year during the nine year monitoring period did the beach reach 10% closure. Data submitted by the Town of Mansfield during the public comment period supports CT DEEP's decision to move Bicentennial Pond (CT3207-16-1-L1_01) from Category 4A to Category 2.

The data show that since 2012 there have been no levels of E. coli above the single sample maximum and consequently no beach closures. These twelve waterbody segments are placed in Category 2 as no longer impaired for recreation.

Table 4: Waterbody segment/impairments being removed from Category 4A and placed in Category 2

Segment ID#	Waterbody name	Use restored	Pollutant meeting WQS
CT3207-16-1-L1_01	Bicentennial Pond (Mansfield)	Recreation	Escherichia coli
CT3300-02_01	Long Branch Brook (Thompson)-01	Recreation	Escherichia coli
CT4300-32_01	Minister Brook (Simsbury)-01	Recreation	Escherichia coli
CT4300-33_01	Russell Brook (Simsbury)-01	Recreation	Escherichia coli
CT4309-00_01	Cherry Brook (Canton)-01	Recreation	Escherichia coli
CT4317-00_01	Nod Brook (Avon/Simsbury)-01	Recreation	Escherichia coli
CT4607-00-UL_pond_01	Wadsworth Falls State Park Pond (Middletown)	Recreation	Escherichia coli
CT5207-02-1-L1_01	Allen Brook Pond (North Haven/Wallingford)	Recreation	Escherichia coli
CT7105-01_01	West Branch Pequonnock River (Monroe)-01	Recreation	Escherichia coli
CT7302-00_02	Silvermine River (Norwalk/New Canaan)-02	Recreation	Escherichia coli
CT7401-00_03	Fivemile River (New Canaan)-03	Recreation	Escherichia coli
CT7401-05_01	Holy Ghost Fathers Brook (Norwalk)-01	Recreation	Escherichia coli

These waterbodies are included in the IWQR and are included here for completeness sake. EPA is taking no action on the waters removed from Category 4-A.

Waterbody Segments in Category 4-B

Segments listed in Category 4-B have other required control measures which are expected to result in attainment of an applicable water quality standard in a reasonable period of time. The 2016 IWQR does not include any waterbody segment/impairments that are being added to Category 4-B. One waterbody segment/impairment, Eightmile River (Southington)-01 (CT5201-00_01), is being removed from Category 4-B and placed in Category 2 during the 2016 listing cycle. This segment of the Eightmile River was listed in Category 4-B since 2002 due to fish contamination resulting from a release of PCBs from storage tanks. The impacted area was extensively remediated and confirmatory sampling conducted. CT DPH released a 2016 public health evaluation of fish tissue contaminant data in the Quinnipiac and Eightmile Rivers that found that PCBs in fish have decreased to acceptable levels. The fish consumption advisory has

been lifted as consumption over a long period of time would not be harmful to human health. The segment is now attaining its designated use for fish consumption.

This waterbody is included in the IWQR and is included here for completeness sake. EPA is taking no action on this water removed from Category 4-B.

Waterbody Segments in Category 4-C

Category 4-C contains water segments for which the state has demonstrated that the failure to meet water quality standards is not caused by a pollutant, but rather by other types of pollution. A number of additions are being made to Category 4C during this listing cycle. The 2011 Connecticut Stream Flow Standards and Regulations and collection of data to identify waters impaired for flow has resulted in 37 waterbody segments being placed in Category 4C in 2016. These waters do not meet their designated use for habitat for fish, other aquatic life, and wildlife and are listed as impaired for flow alterations, a non-pollutant.

Table 5: Waterbody segments being added to Category 4-C due to flow alterations

Segment ID#	**Waterbody name**
CT2102-00_02	Copps Brook (Stonington/North Stonington)-02
CT2103-00_03	Seth Williams Brook-03
CT2202-00_01	Latimer Brook (East Lyme)-01
CT2202-00_02	Latimer Brook-02
CT2205-00_01	Pattagansett River-01
CT2205-00_02	Pattagansett River-02
CT2206-00_01	Bride Brook (East Lyme)-01
CT3000-02_01	Billings Avery Brook (Ledyard)-01
CT3004-00_01	Oxoboxo Brook-01
CT3103-00_02	Furnace Brook (Stafford)-02
CT3708-00_01	Little River (Putnam/Woodstock)-01
CT4302-00_03	Mad River (Winchester)-03
CT4314-00_01	Coppermine Brook (Bristol)-01
CT4314-08_01	Polkville Avenue Brook (Bristol)-01
CT4316-01_01	Chidsey Brook (Avon)-01
CT4500-12_03	Lydall Brook (Manchester)-03
CT4504-00_02	Hop Brook (Manchester)
CT4504-01_01	Porter Brook (Manchester)-01
CT4504-03_01	Birch Mountain Brook (Manchester)-01
CT5112-00_03b	Farm River (North Branford)-03b
CT5112-05_01	Gulf Brook (North Branford)-01
CT5200-00_02	Quinnipiac River (North Haven/Meriden)-02
CT5200-00_04	Quinnipiac River-04
CT5200-00_05	Quinnipiac River-05
CT5200-00_06	Quinnipiac River-06

CT5200-00_07	Quinnipiac River-07
CT5205-00_01	Sodom Brook-01
CT5206-00_01	Harbor Brook (Meriden)-01
CT5206-00_03	Harbor Brook (Meriden)-03
CT5208-00_02a	Muddy River (North Haven)-02a
CT5302-00_02	Mill River
CT5302-00_03	Mill River
CT6005-01_01	Burton Brook (Salisbury)-01
CT6806-00_01	Transylvania Brook (Southbury)-01
CT6900-40_02	Beaver Brook (Ansonia)-02
CT7301-00_01	Comstock Brook (Wilton)-01
CT7403-00_02	Noroton River-02

These waterbodies are included in the IWQR and are included here for completeness sake. EPA is taking no action on the waters added to Category 4-C.

Other Waterbody Segment Changes

Farm River (North Branford)-03 was split into two segments during the 2016 listing cycle. CT5112-00_03 was split into Farm River (North Branford)-03a (CT5112-00_03a) and Farm River (North Branford)-03b (CT5112-00_03b). No change in assessment was made.

One waterbody segment listing was corrected in the IWQR. LIS EB Midshore - Waterford, Thames River (CT-E3_005-SB) was included in error on the Category 4-A table in the 2014 IWQR. The segment was not part of the Long Island Sound TMDL and was incorrectly placed on Table 3-5 of the 2014 IWQR. It was, however, correctly listed in Category 5 as well. In the 2016 IWQR, CT DEEP adjusted figures and tables to correct this error. The segment was removed from Table 3-5 in the 2016 IWQR and remains impaired in Category 5 for habitat for marine fish, other aquatic life and wildlife.

Priority Ranking

EPA reviewed Connecticut's priority ranking of listed waters for TMDL development and concludes that the state properly took into account the severity of pollution and the uses to be made of such water in establishing that ranking. The state has also identified the pollutants causing or expected to cause violations of applicable WQS. 40 C.F.R. §130.7(b)(4) requires that "the priority ranking shall specifically include the identification of waters targeted for TMDL development in the next two years." While the CT DEEP identifies its priority waters for the next two years, EPA and CT DEEP assess yearly the state's plans for TMDL development versus the universe of impaired waters in the state. CT DEEP makes an annual commitment to EPA, as part of its Performance Partnership Agreement, as to the TMDLs the state will submit during the coming year and provides updates on its progress during the year. Table 3-9 of the 2016 IWQR details the priority ranking of waters for TMDL development by the state in the next two years.

After a lengthy public process, CT DEEP released its document entitled *Integrated Water Resource Management, January 2017* (http://www.ct.gov/deep/lib/deep/water/integrated_water_quality_management/official_response_to_comments_documentsignaturefinal.pdf) detailing the state's larger vision for addressing impaired and protecting unimpaired waters in CT. Drawing from that document, the state also included within the IWQR a list of waters selected for action plan development by 2022 (Table 3-10). Such action plans might include TMDLs, alternatives to TMDLs for impaired waters, or protection plans for unimpaired waters. If a water is listed on the 303(d) list as impaired, it remains in Category 5 as a TMDL alternative is being pursued. In establishing its priority ranking for development of TMDLs, as well as other action plans, the state considers factors such as ecological information, the designated use of the water, sources of potential pollution, land use conditions, existing planning efforts, and existing or potential partnerships within the watershed.

EPA concludes that Connecticut's prioritization and identification of waters targeted for TMDL study and/or development during the next two years is reasonable and sufficient for the purposes of 40 C.F.R. §130.7(b)(4). CT DEEP properly examined and considered the severity of pollution and uses of the listed waters, as well as other relevant factors identified in EPA regulations and described above. Further, EPA has determined that CT DEEP's priority ranking ensures reasonable progress in addressing high priority waters with challenging water quality problems (Memo from Geoffrey H. Grubbs, Supplemental Guidance on Section 303(d) Implementation, August 13, 1992).

EPA reviewed the state's identification of WQLSs targeted for TMDL development in the next two years, and concludes that the targeted waters are appropriate for TMDL development in this time frame.

Water bodies on tribal lands

EPA's approval of Connecticut's 2016 Section 303(d) list extends to all waterbodies on the list with the exception of those waters, if any, that are within Indian Country, as defined in 18 U.S.C. Section 1151. EPA is taking no action to approve or disapprove the state's list with respect to waters within Indian country at this time. EPA, or any eligible Indian Tribe, as appropriate, will retain responsibilities under Section 303(d) for those waters. There are two Federally-recognized Indian Tribes in Connecticut. They are the Mashantucket Pequot Tribal Nation and the Mohegan Tribe.

Waters impaired by nonpoint sources of pollution

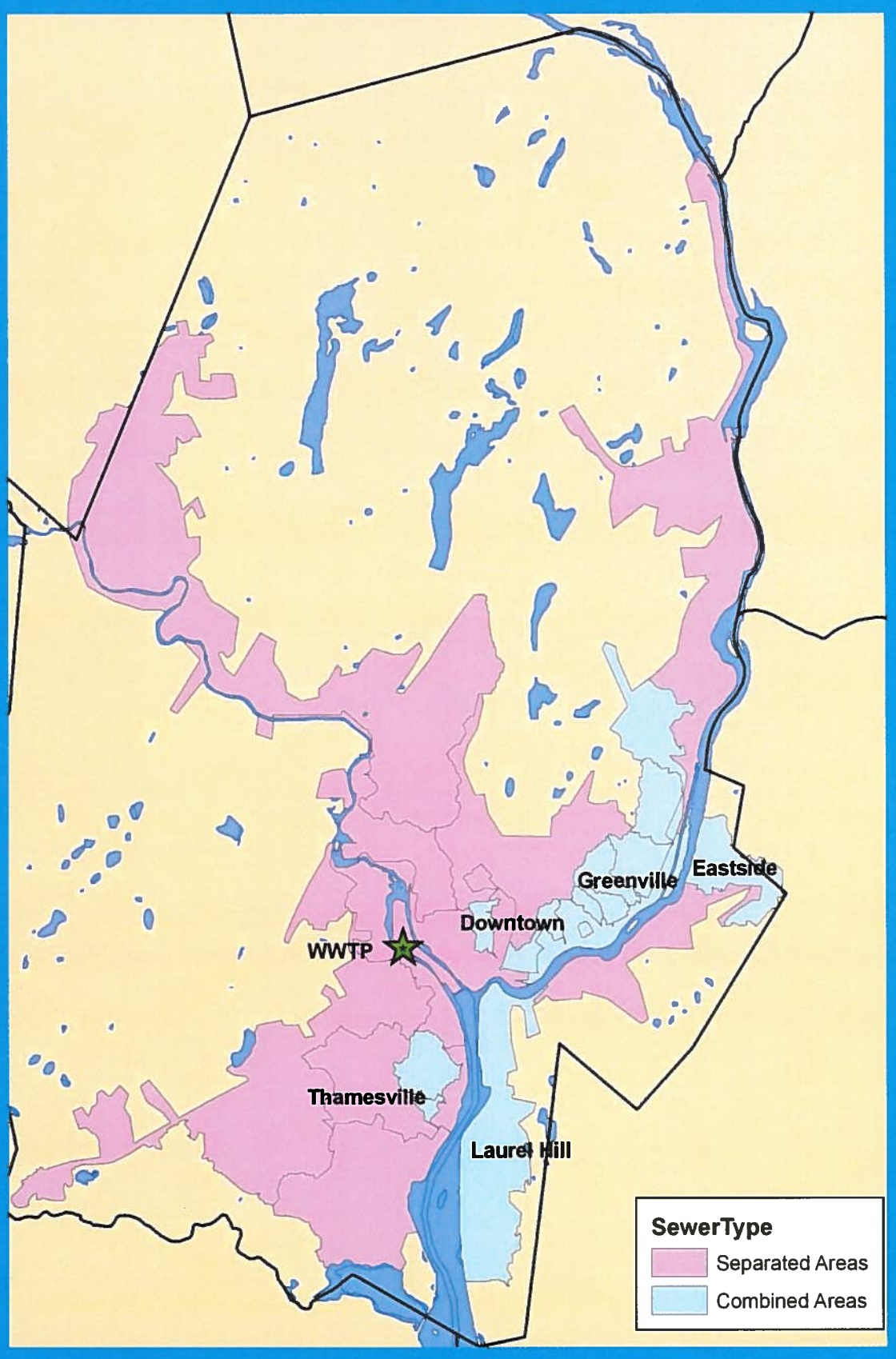
The state properly listed waters with nonpoint sources causing or expected to cause impairment, consistent with Section 303(d) and EPA guidance. Section 303(d) lists are to include all WQLSs still needing TMDLs, regardless of whether the source of the impairment is a point and/or nonpoint source. EPA's long-standing interpretation is that Section 303(d) applies to waters impacted by point and/or nonpoint sources. In 'Pronsolino v. Marcus,' the District Court for Northern District of California held that Section 303(d) of the Clean Water Act authorizes EPA to identify and establish total maximum daily loads for waters impaired by nonpoint sources.

Pronsolino v. Marcus, 91 F. Supp. 2d 1337, 1347 (N.D.CA. 2000). This decision was affirmed by the 9th Circuit court of appeals in Pronsolino v. Nastri, 291 F.3d 1123 (9th Cir. 2002). See also EPA *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Section 303(d), 305(b), and 314 of the Clean Water Act* – EPA Office of Water, July 29, 2005. Waters identified by the state as impaired or threatened by nonpoint sources of pollution (NPS) were appropriately considered for inclusion on Connecticut's 2016 Section 303(d) list. Connecticut properly listed waters with nonpoint sources causing or expected to cause impairment, consistent with Section 303(d) regulations and EPA guidance.

EPA concludes that CT DEEP properly considered waters identified by the state as impaired or threatened in nonpoint assessments under Section 319 of the CWA in the development of the 2016 Section 303(d) list.

Appendix H

2012 LTCP - Water Quality Studies



CSO LONG TERM CONTROL PLAN

VOLUME 1 OF 2

FINAL REPORT

Prepared for

NORWICH PUBLIC UTILITIES

Norwich Public Utilities

AUGUST 17, 2012

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Section 3. Water Quality Impact Evaluation, Mixing Zones and Zones of Influence

3.1 Objective of Water Quality Impact Evaluation

This section assesses the impact of Norwich CSOs on the water quality in the Thames River estuary. The analysis used in that assessment has been based on an extensive water quality monitoring program conducted in the spring and summer of 2008 as part of this study, as well as computer models used to establish the mixing zones and zones of influence for the CSO discharges.

A mixing zone is defined by EPA (1994) as:

> *A limited area or volume of water where initial dilution of a discharge takes place and where numeric water quality criteria can be exceeded but acutely toxic conditions are prevented.*

The CT DEP defines a zone of influence as:

> *An area or volume of surface water or ground water within which some degradation of water quality or inconsistency with water quality criteria is anticipated as a result of a pollutant discharge. The term zone of influence may be used to describe an area impacted by thermal, conventional, or toxic pollutants.*

Mixing zones for CSOs in the Thames River estuary have been delineated using data from the sampling program and results of CORMIX modeling. Properly defining the mixing zone required recognition of the salt wedge that occurs in the Thames River. The wedge inhibits mixing of surface waters from the Yantic and Shetucket Rivers and the Norwich CSOs with the more saline deeper water. The definition of the ZOI determines the level of control required of the CSO discharges to a given segment. In determining the zones of influence, the following factors were considered:

- Characteristics of the discharge;
- Allowance of a continuous Zone of Passage;
- Impacts on sensitive aquatic organisms;
- Effects of the discharge on aesthetic quality; and
- Location of the discharge with respect to other discharges and the cumulative effect of multiple discharges.

This section of the report also presents information developed under Phase 3, Tasks 7 and 11 of the Norwich CSO Long Term Control Plan, addressing:

- Overall evaluation approach, including revisions to the LTCP Phase 2 work plans to address concerns and issues raised by DEP;
- Summary of the sampling programs conducted to characterize the receiving water and collection system during storms;
- Presentation and analysis of the receiving water data;
- Discussion of observed water quality impairment;
- Presentation of plume modeling results conducted for the Thames River outfalls; and
- Discussion of the ZOI analysis and recommendations regarding ZOIs for Thames River outfalls.

3.2 Overall Approach to Water Quality Impact Evaluation

A work plan to delineate mixing zones and conduct a ZOI analysis was developed under Phase 2, Task 13 of the Norwich CSO LTCP (see Appendix 2-K). After reviewing the draft work plan, DEP staff recommended making changes to the sampling plan and analysis approach. The B&V project team had two meetings with representatives from DEP to discuss these comments: a meeting at DEP offices in Hartford on March 27, 2008 which was followed immediately by a teleconference, and a again by a teleconference on March 31, 2008. DEP recommended revising the sampling plan to focus on impacts of the CSO discharges downstream on the Thames River. Furthermore, DEP requested that the sampling program be focused to assess the areal extent of any bacterial contamination downstream of CSOs on the Thames River, as well as the length of time that elevated concentrations remain in that river, following storm events.

DEP and Black & Veatch agreed that during major overflow events plumes from several CSOs on the Shetucket River are likely to merge and influence a large portion of that river. Thames River will be influenced by the Shetucket River discharges as well as by direct discharges from five CSOs located on the Thames River. These influences would be evaluated with a combination of plume modeling and statistical analysis of the monitoring data.

Modeling was used to define individual plumes from CSOs in the Thames River. The purpose of the modeling was to define the areal extent of individual plumes, to calculate dilutions and to evaluate the effects of reducing or eliminating CSOs. Additional information on the model used, model capabilities and modeling conditions is presented in this section of the report.

A revised work plan that addressed DEP concerns was submitted in May 2008. The mixing models typically used to evaluate the impact of discharges to a river are steady-state models. These models assume that discharge and ambient conditions do not change. Although often used in marine and estuarine conditions with tidal currents and stratification, these models are

not appropriate for simulating dilution and receiving water concentrations long after a discharge event has ended. Therefore, for the evaluation in this study, mixing models were not be used to simulate water quality in the river after a discharge has ended. Instead, river sample data collected during the wet weather monitoring program has been used to evaluate the post-storm recovery period.

3.3 Other Available Data

Under Phase 2, Task 3 of this CSO Long Term Control Plan, previous studies were reviewed that contained information useful toward assessing the relationship between Norwich CSO discharges and water quality in the Shetucket and Thames Rivers (see Appendix 2-B). Useful prior information included reports from the CT DEP (2006) and from the USGS (Trench, 2005). In addition to that information and data collected during the sampling surveys, other available information was used in the current ZOI analysis and delineation of mixing zones included:

- USGS: River discharge data for the Shetucket, Quinebaug, and Yantic Rivers during the storm events;
- NOAA: Tide predictions for Norwich Harbor and New London; and
- CT DEP: Information on shellfish harvesting areas, spawning and nursery areas in the Thames River estuary.

A biological assessment of aquatic life in the vicinity of the CSO outfalls was conducted between August 7 and September 7, 2007, under Phase 2, Task 7 of the CSO LTCP.. Sediment, benthic invertebrates and 394 fish representing 16 species were collected. None of the fish exhibited tumors, lesions or any kind of deformities. Although the quality of aquatic life varied considerably throughout the area, variations were attributable to differences in habitat based on varying sediment type and water depth, and were not related to the proximity of the CSO outfalls. The report from this aquatic assessment is provided in Appendix 2-E.

3.4 Sampling Program

3.4.1 Receiving Waters Sampling Program

During Phase 2 of the LTCP project, a Quality Assurance Project Plan (QAPP) was developed to outline the Receiving Water Monitoring and Sampling Plan, and to define QA/QC objective and procedures for the sampling program. The QAPP was submitted to the City of Norwich and to CT DEP as Phase 2 Technical Memorandum No. 6 (See Appendix 2-D). The sampling program is summarized below.

This Receiving Waters Monitoring and Sampling Plan was designed to characterize the receiving waters, provide input for the mixing zone analysis, define water quality conditions, and to establish the zones of influence (ZOI) for CSO discharges. Samples were collected at eleven locations along the Yantic, Shetucket, Quinebaug and Thames Rivers during dry and wet weather. Station locations are shown on Figure 3-1. Stations RS-1, RS-2, and RS-3 were

located upstream of all CSO discharges. RS-4 and RS-5 were located on the Yantic River upstream and downstream of the wastewater treatment facility (WWTF). Station RS-6 was located on the Shetucket River at the Main Street Bridge, downstream of CSOs 18 through 25. RS-7 was in Norwich Harbor. Station RS-8 was in the Thames River near CSOs 4, 5, 31, 32, and 40. Stations RS-9, RS-10 and RS-11 were downstream of all CSO discharges.

Three types of samples were collected:

- Physical characteristics including conductivity, temperature, pH and dissolved oxygen (DO) were obtained using field probes.
- Bacteria samples were collected directly into sterile sample bottles for analysis of fecal coliform, E. coli and enterrococci bacteria.
- Water quality grab samples were obtained using a van Dorn type bottle for analysis of total suspended solids (TSS), orthophosphate (OP), ammonia, nitrate, nitrite, total Kjeldahl nitrogen (TKN), and biochemical oxygen demand (BOD)

The wet weather sampling program, outlined in the QAPP, is summarized in Table 3-1. Samples were collected from each river station for each of three rain events. Actual sample times for each rain event are presented in

Table 3-2. The sampling crews followed the same sampling sequence for each round of sample collection. The land based crew sampled from station RS-1 through station RS-5; each event took about one hour to complete. The boat crew sampled from station RS-6 through station RS-11; each event took from one to three hours to complete, depending on the specific samples collected. At three stations (RS-6, RS-8, and RS-9) additional samples were collected to measure variability across the width of the river channel. Therefore in addition to the sample collected at mid channel, samples were also collected at approximately ¼ and ¾ widths across the channel.

Figure 3-1 - Receiving Water Monitoring Locations

3/31/08

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Table 3-1 Wet Weather Sampling Program

PARAMETER	Sample Collection	Timing of Samples Collection				
		2-4 hrs after start of storm	12 hrs after start of storm	24 hrs after end of storm	48 hrs after end of storm	72 hrs after end of storm
Field Testing (Using Probe)						
Dissolved Oxygen (DO)	Vertical Profile with Probes	x	X	x	x	x
Conductivity		x	X	x	x	x
Temperature		x	X	x	x	x
pH		x	X	x	x	x
Lab Testing (EPA approved Method)						
Fecal Coliform	Surface Grab	x	X	x	x	x
E. Coli		x	X	x	x	x
Enterococci		x	X	x	x	x
Total Suspended Solids (TSS)	*Land Crew:* Surface Grab *Boat Crew:* Grabs at Three Depths	x	X			
5-day BOD		x	X			
Orthophosphate		x	X			
Nitrite		x	X			
Nitrate		x	X			
Total Kjeldahl Nitrogen (TKN)		x	X			
Ammonia-N		x	X			

Table 3-2 Sample Times for Storm Events

First Rain Event ; Start 4/28/08, 16:45; End 4/29/08, 12:00; Amount = 2.28 inches					
Hour*	**Date**	**Stations 1-5**		**Stations 6-11**	
2-4 hours	4/28/08	19:31	20:34	17:05	19:54
12 hours	4/29/08	05:58	05:58	05:06	07:25
24 hours	4/30/08	11:55	13:00	12:02	13:30
48 hours	5/1/08	12:30	13:40	12:09	13:22
72 hours	5/2/08	12:15	13:30	12:00	13:22

Second Rain Event ; Start 5/9//08, 15:00; End 5/09/08, 18:00; Amount = 0.60 inches					
Hour*	**Date**	**Stations 1-5**		**Stations 6-11**	
2-4 hours	5/9//08	17:10	18:15	16:46	19:06
12 hours	5/10/08	03:00	04:05	03:42	05:52
24 hours	5/10/08	18:00	19:30	18:00	19:00
48 hours	5/11/08	18:10	19:18	18:00	19:00
72 hours	5/12/08	18:05	19:05	18:00	18:58

Third Rain Event ; Start 7/24/08, 09:30; End 7/24/08, 17:00; Amount = 2.00 inches					
Hour*	**Date**	**Stations 1-5**		**Stations 6-11**	
2-4 hours	7/24/08	11:40	12:45	09:11	11:13
12 hours	7/24/08	21:45	22:51	22:01	23:54
24 hours	7/25/08	16:45	17:50	17:00	18:01
48 hours	7/26/08	16:54	17:50	17:00	18:01
72 hours	7/27/08	17:13	18:08	17:20	18:32

* 2-4 and 12 hour times measured from start of the storm; 24, 48 and 72 hour times measured from the end of the storm

Dry weather river sampling was conducted twice on April 23, 2008, on low slack tide and again at high slack tide. The parameters listed in Table 3-1 were measured during the dry weather sampling surveys.

In total, eleven river locations were sampled during three rain events and one dry weather period. Six locations were sampled by boat and five from land. Boat samples were collected at up to three depths for all constituents except bacteria. The boat crew also collected vertical profile of physical characteristics data with probes at all location.

3.4.2 Collection System Sampling Program

During Phase 2 of the LTCP project, a Combined Sewer System (CSS) Monitoring and Sampling Plan was developed to describe the flow and water quality monitoring programs that would be conducted in conjunction with the Receiving Water Monitoring and Sampling

Plan. The CSS Monitoring and Sampling Plan, Phase 2 Technical Memorandum No. 5, was approved by DEP before sampling began and is included in the Phase 2 appendices of this report. The main features of that CSS sampling program are summarized below.

During the wet weather monitoring program, samples were collected at selected CSO and stormwater discharges to determine typical pollutant concentrations. This information was used, in conjunction with CSO discharge flow estimates from the hydraulic model, to project the CSO pollutant loading to the rivers. While bacteria and nutrients in the CSO discharges are of greatest interest, several other parameters also were monitored including temperature, conductivity, pH, DO, TSS, BOD and Total Organic Carbon (TOC).

Twenty two flow monitors and seven automatic samplers collected flow and water quality data under this program. Flow monitors measured both velocity and water elevation within the sewers, and recorded continuously throughout the sampling program. Automatic samplers collected water during three wet weather events for lab analysis. Grab samples also were obtained at selected locations for lab analysis of more time-sensitive constituents, such as bacteria.

Samples were also taken at two locations in the city's separated stormwater system. Because the CSO study does not include hydraulic modeling of the separated stormwater collection system, flow monitors were not installed at the stormwater monitoring locations.

The Norwich WWTF is located on Hollyhock Island, between the east and west branches of the Yantic River, approximately 2000 feet upstream of where the Yantic empties into the Thames River. Effluent from the WWTF is normally discharged approximately 300 feet south of Hollyhock Island, via a submerged outfall into the Thames River. When the plant's main outfall is hydraulically limited due to high flows and/or high tides, an alternate outfall also is utilized, which discharges to the east branch of the Yantic River immediately adjacent to the WWTF. Samples of the WWTF influent and effluent were also collected as part of the monitoring program.

The sampling and flow monitoring stations at overflow structures, stormwater stations and the WWTF are listed in Table 3-3. Additional flowmeters were installed in the collection system to aid in calibration of the hydraulic model. Collection system monitoring locations were selected to represent all major portions of the collection system, with emphasis on each of the CSO sewersheds.

Most of the samples were collected using autosamplers. Four composite samples representing discharge during each storm were analyzed for each location selected for water quality analysis. Six grab samples were collected to characterize bacteria concentrations during each rain event. These samples, which were analyzed for fecal coliform, E. coli, and Enterococci, were collected at approximately the following intervals:

- Near the beginning of the rain event;
- 30 minutes after the start of the rain event;
- 2 hours after the start of the rain event;
- 4 hours after the start of the rain event;
- 8 hours after the start of the rain event; and
- 16 hours after the start of the rain event.

Table 3-3 Sampling and Flow Monitoring Locations

Station No.	Location/Description	Monitoring
CSS 1	CSO-24	F, S
CSS 2	CSO-25	F
CSS 3	CSO-22	F
CSS 4	CSO-23	F
CSS 7	CSO-18	F
CSS 8	CSO-19	F
CSS 9	CSO-20	F
CSS 10	CSO-21	F
CSS 12	CSO-4	F
CSS 13	CSO-40	F, S
CSS 21	CSO-5	F
CSS 22	Rose Alley PS (permanent flow meter) – CSO 17	F, S
Storm 1	Yantic St off of Washington Street	S
Storm 2	McKinley Ave. north of Grove Street	S
WWTF 1	WWTF Influent	S
WWTF 2	WWTF Effluent	S

F = Flow Metering

S = Water Quality Sampling (auto-samplers and grab samples)

3.5 Tide, Rainfall and Discharge Data

3.5.1 Tide Information

The Thames River experiences tidal fluctuations, typically with two high and two low tides per day. In Norwich Harbor the mean tidal range is 3.0 ft while the spring range is 3.6 feet. High and low tides occur 24 and 19 minutes, respectively, after they occur in New London. Therefore, tide predictions for Norwich Harbor are applicable to all sections of the study area under tidal influence. Tide predictions for each storm event sampled are shown on Figure 3-2,

Figure 3-3, and Figure 3-4. In each figure, the times during which sampling occurred are marked on the tide graphs.

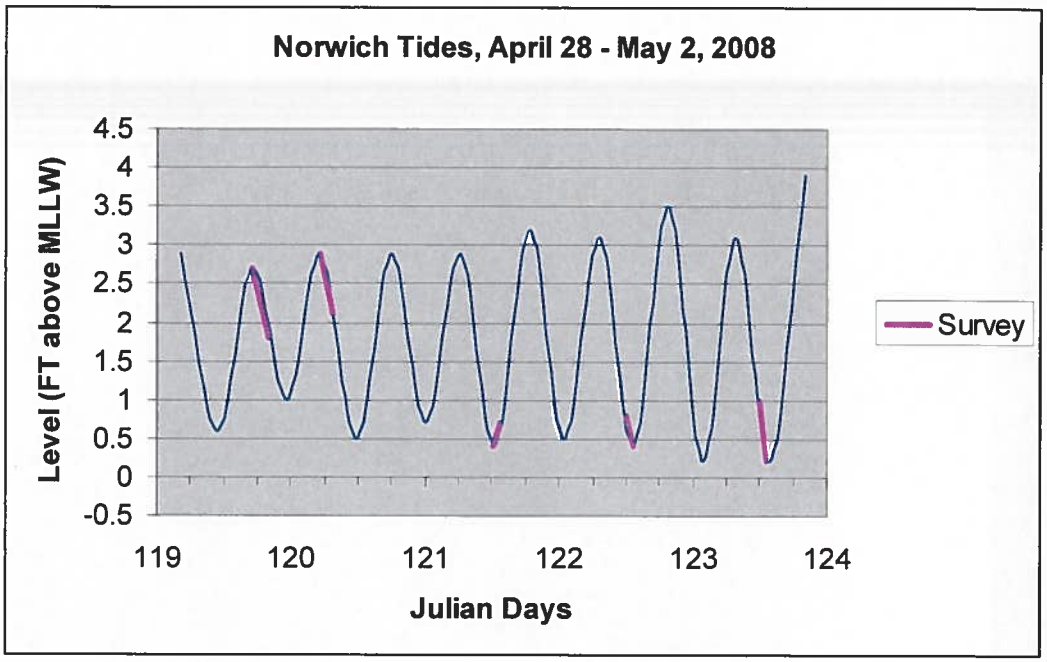


Figure 3-2 Predicted Tides and Sampling Periods for the First Storm Event

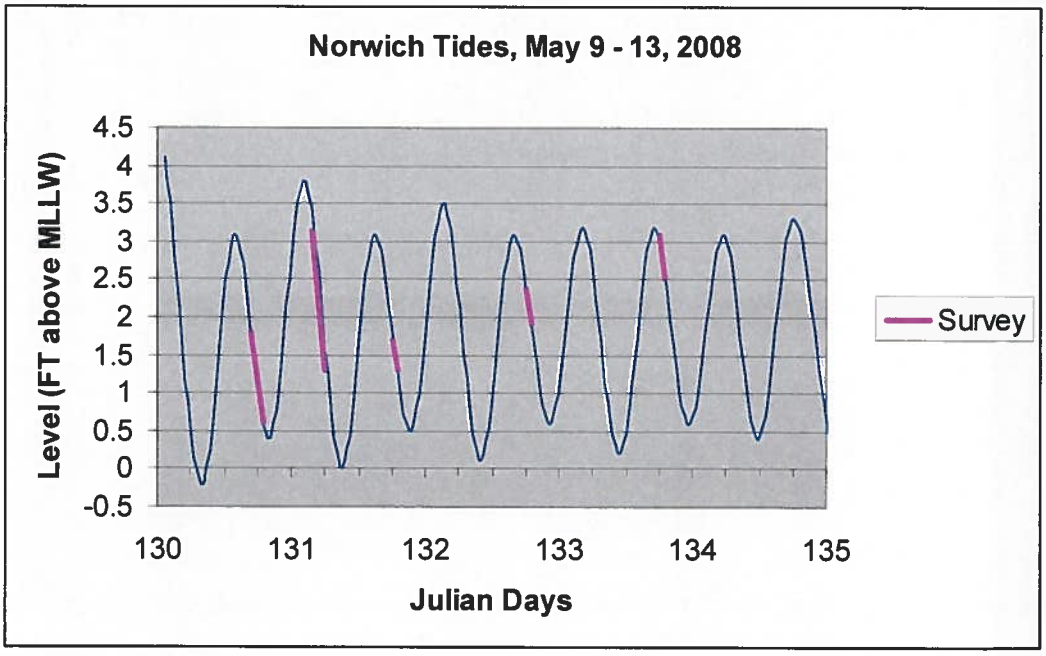


Figure 3-3 Predicted Tides and Sampling Periods for the Second Storm Event

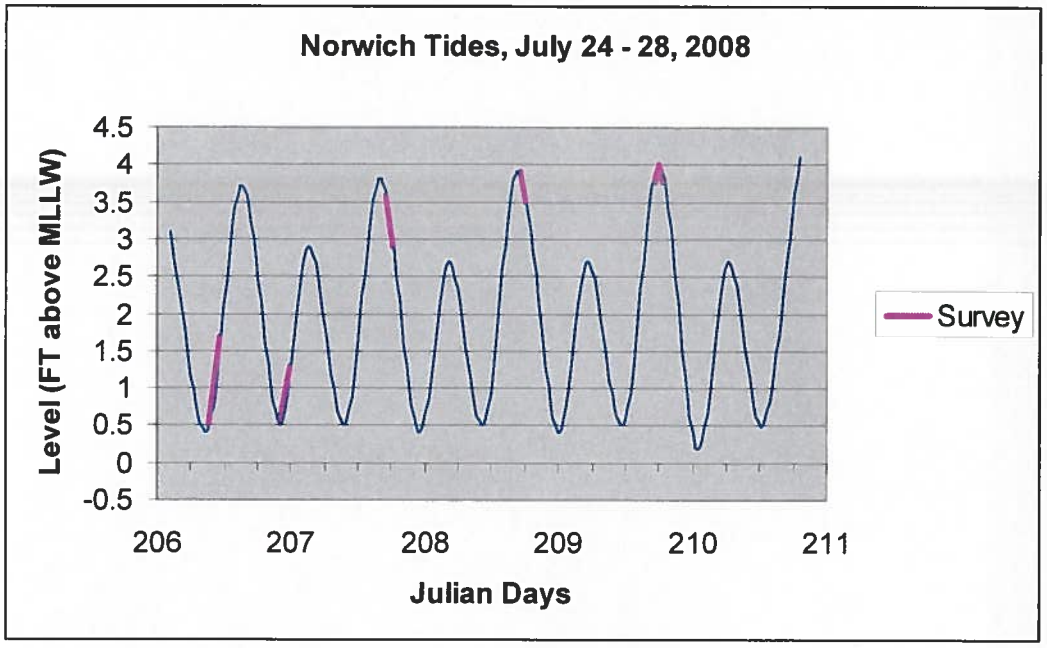


Figure 3-4 **Predicted Tides and Sampling Periods for the Third Storm Event**

3.5.2 River Flows

Three existing USGS river gauging stations provided information on flows in the Shetucket, Quinebaug and Yantic Rivers. Flow data were downloaded from the USGS web site for the duration of the sampling period. Daily flows for each river were combined to approximate the total river flow entering Norwich Harbor. These data are presented in Figure 3-5. Tidal phases during sampling events and combined river discharge for each day of sampling are summarized on Table 3-4. However, actual flows entering the harbor were higher than the recorded flows.

Not all flows entering the harbor are recorded on the USGS gauges, because the gauges are upstream in the watershed. The Quinebaug River with a drainage area of 739 square miles is the largest of the subbasins upper end of the Thames River estuary. The USGS gage at Jewett City records flow from 96 percent of the watershed. The Yantic River, with a drainage area of 98 square miles is the smallest subbasin within the Thames River Basin. The USGS gage records flow from 91 percent of the subbasin. The Shetucket River upstream of the confluence with the Quinebaug has a drainage area of 526 square miles. Twenty three percent of this drainage area is below the USGS gauge. To estimate annual or other long-term flows a drainage area correction factor is commonly used to estimate total flows. However, for storm events a drainage area correction factor is not appropriate.

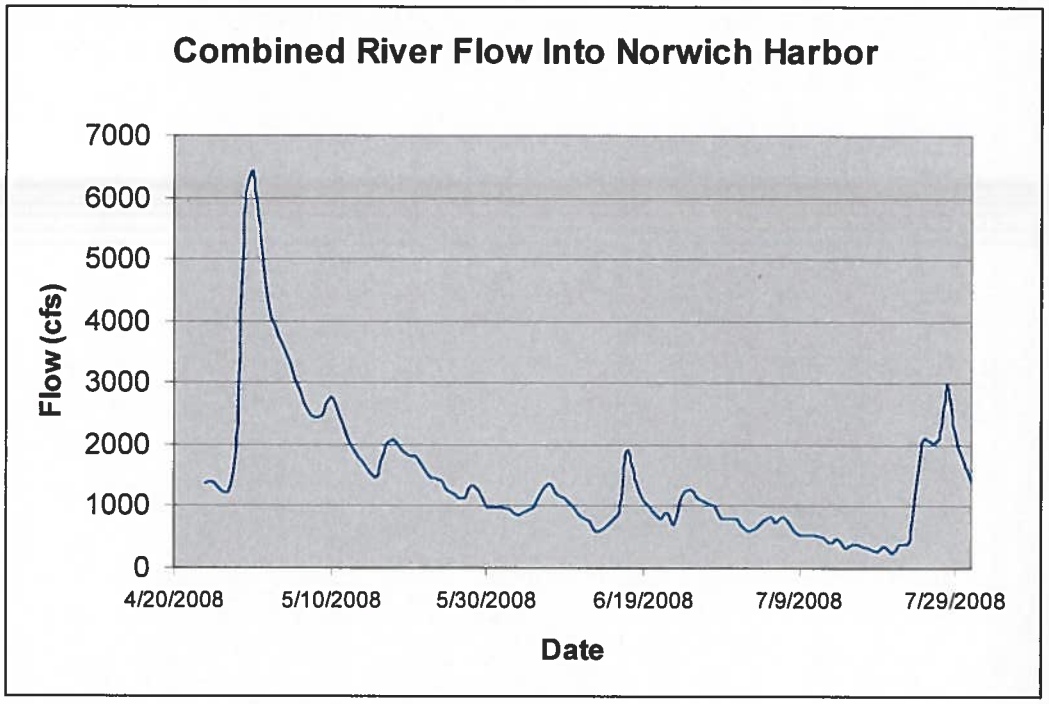


Figure 3-5 Combined River Flows into Norwich Harbor (Shetucket, Quinebaug, & Yantic Rivers)

Table 3-4 Tidal Phases and River Flow During Sampling Surveys

	Date	Sample Interval *	Tidal Phase	River Discharge (cfs)
First Storm Event	4/28/08	2-4 hours	Ebb	1944
	4/29/08	12 hours	Ebb	6039
	4/30/08	24 hours	Flood	6439
	5/1/08	48 hours	Ebb	5394
	5/2/08	72 hours	Ebb	4394
Second Storm Event	5/9/08	2-4 hours	Ebb	2486
	5/10/08	12 hours	Ebb	2775
	5/10/08	24 hours	Ebb	same day
	5/11/08	48 hours	Ebb	2489
	5/12/08	72 hours	Ebb	2169
Third Storm Event	7/24/08	2-4 hours	Flood	1321
	7/24/08	12 hours	Flood	same day
	7/25/08	24 hours	Ebb	2094
	7/26/08	48 hours	Ebb	2024
	7/27/08	72 hours	High Slack	2113

* 2-4 and 12 hour sample times are from the start of the storm;
24, 48, and 72 hour samples times are from the end of the storm

3.5.3 Rainfall and CSO Discharge Volumes

The calibrated hydraulic model was used to generate flows, shown on Figure 3-6, for each CSO during each of the three storm events. The total flow volume generated for the three events were 7.43 MG for storm No. 1, 0.73 MG for storm No. 2, and 91.1 MG for storm No. 3. Figure 3-7 through Figure 3-9 are graphs of rainfall, WWTF discharge and the combined CSO discharges. The discharges are presented as volumes (MG), not rates and the scales are different for each figure. Table 3-5 lists the daily discharges from the WWTF, the three CSOs monitored for water quality, and the combined CSO discharges.

Discharge volumes from the third storm event were much greater than the first two storms. This is because the third storm was actually a series of thunderstorms. To determine sampling times the storm was considered to start on July 24, 2008 at about 9:00 am. However, there had been 1.4 inches of rain on July 23, 2008 and rain earlier in the day on July 24. In addition, at the end of the sampling period (72 hour sampling interval), another storm occurred with 1.13 inches of rain. Therefore, the third storm event was really within a series of three storms that occurred over the five day period, producing a total of 4.56 inches of rainfall. While this was not the ideal sampling scenario, it was included as the third storm event following multiple extensions of the planned sampling program due to lack of appropriate rainfall..

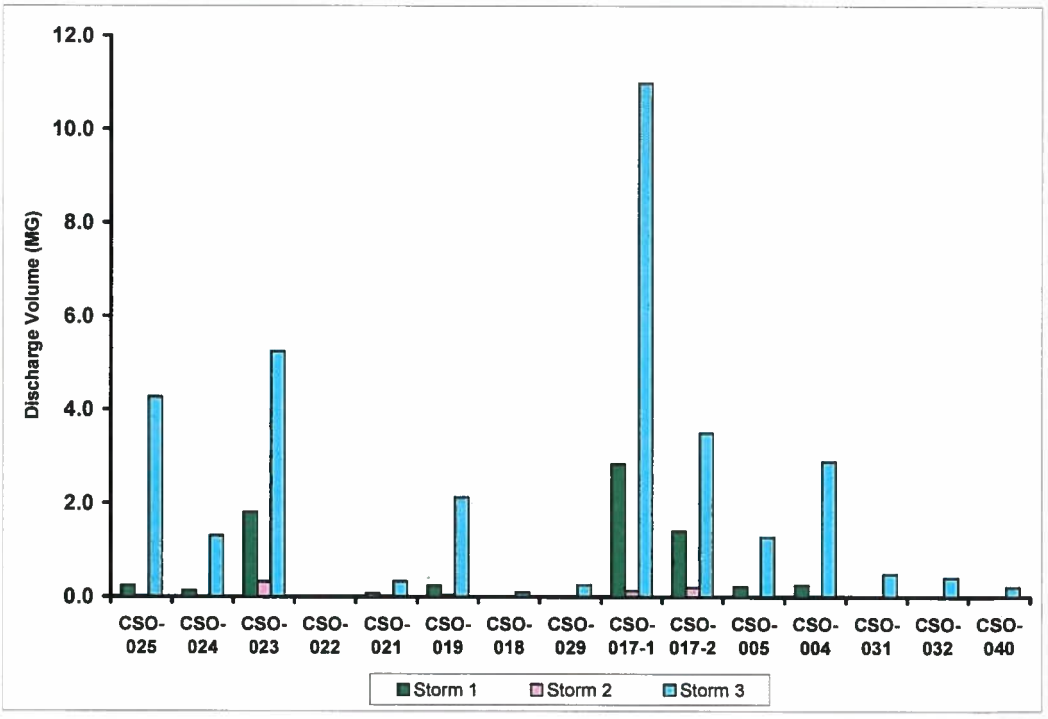


Figure 3-6 CSO Discharges for Each Storm Event

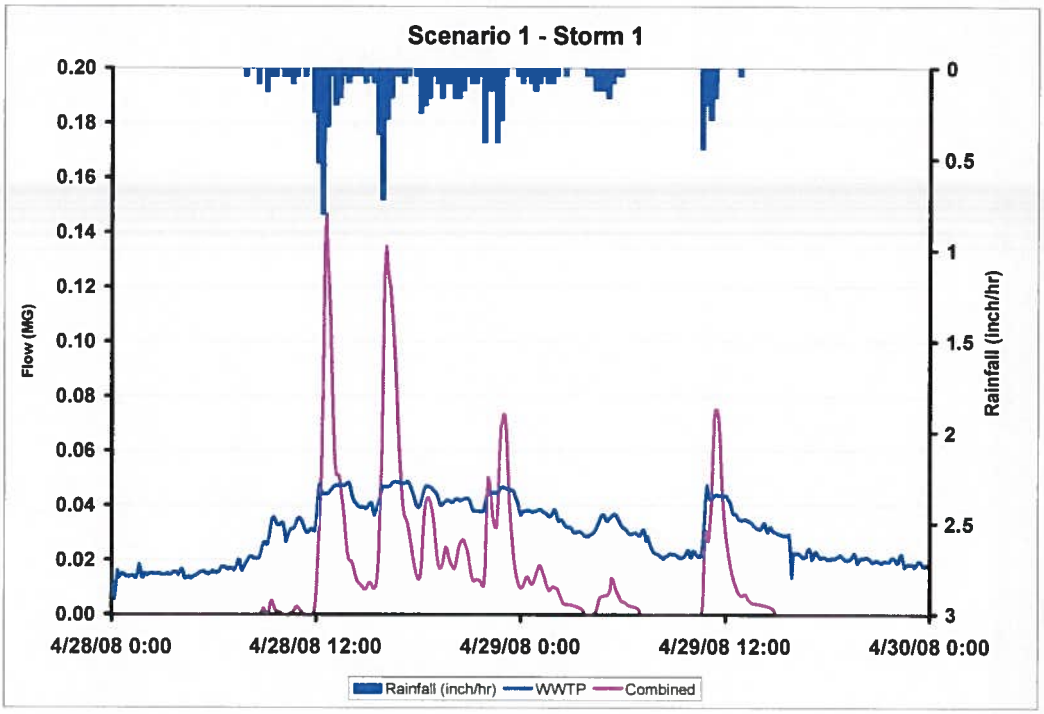


Figure 3-7 Rainfall, WWTF and CSO Discharges for Storm No. 1

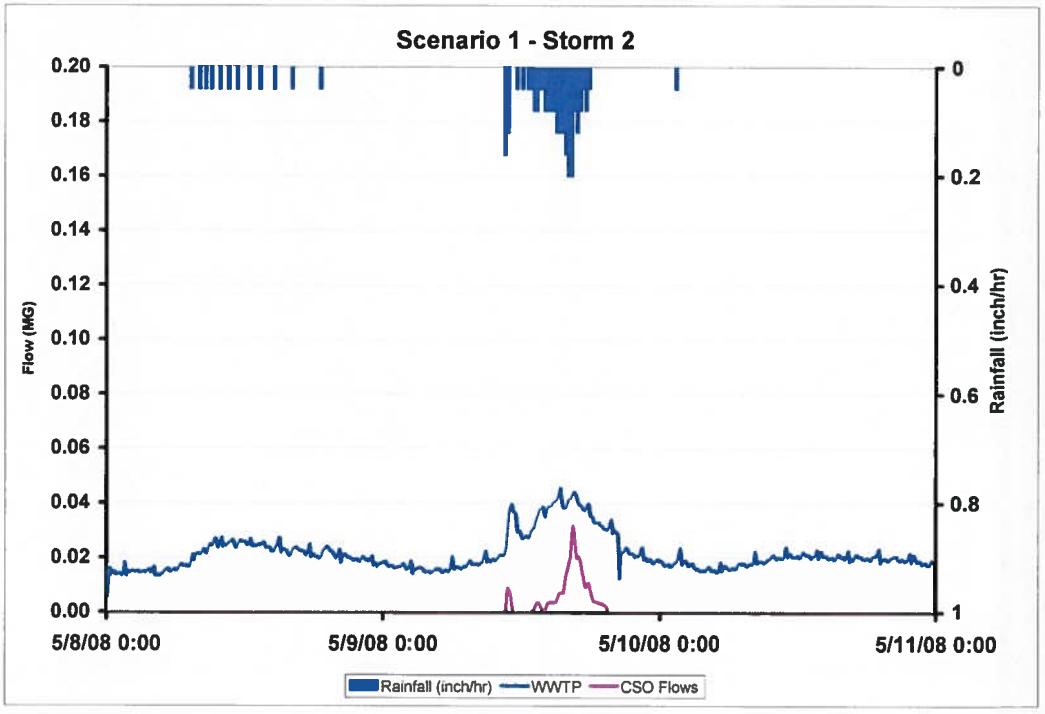


Figure 3-8 Rainfall, WWTF and CSO Discharges for Storm No. 2

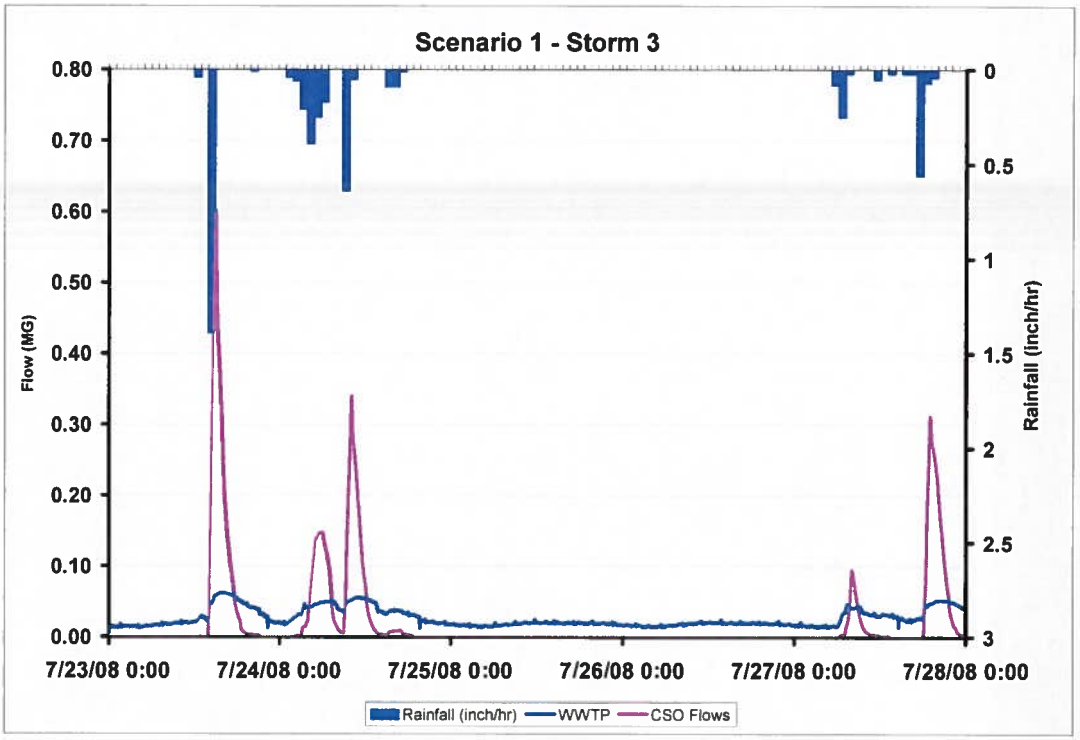


Figure 3-9 Rainfall, WWTF and CSO Discharges for Storm No. 3

Table 3-5 WWTF and CSO Discharge Rates

	Date	WWTF MGD	Combined CSOs MGD	CSO-24 MGD	CSO-17 MGD	CSO-40 MGD
Storm No. 1	4/28/08	9.14	5.62	0.13	3.29	0.00
	4/29/08	8.00	1.60	0.01	0.96	0.00
Storm No. 2	5/9/08	7.20	0.70	0.00	0.33	0.00
	5/10/08	5.46	0.00	0.00	0.00	0.00
Storm No. 3	7/23/08	8.32	11.82	0.77	4.20	0.16
	7/24/08	10.52	12.29	0.32	6.01	0.03
	7/25/08	5.41	0.00	0.00	0.00	0.00
	7/26/08	5.39	0.00	0.00	0.00	0.00
	7/27/08	9.13	9.32	0.22	4.28	0.03

3.6 Receiving Water Data

Data collected during the sampling program were analyzed to determine the effects of CSO discharges on the receiving water, far field mixing of CSO effluent, and the rate of decrease of concentrations in the river. Concentrations of pollutants in the Thames River decreased due to mixing, settling and die-off. Concentration data collected in the sampling program

were analyzed to develop relationships between receiving water concentrations and river discharge, CSO discharge, downstream location and time.

A mass balance approach was used to track the inputs and removal of bacteria from the system. This approach considered the quantity and timing of loads from the CSO discharges, the WWTF and nonpoint sources. Nonpoint source loads were defined by the sampling data characterizing water quality in the Shetucket and Quinebaug Rivers upstream of the CSO discharges and by stormwater discharge samples. The results of the data analysis describe how effluent mixes and disperses in the river and how it is flushed down the river.

Complete receiving water data listings are provided in Appendix 1-F. Receiving water data presented in this section include:

- Physical characteristics: temperature, conductivity, pH and DO;
- Bacteria: fecal coliform, E. coli and enterococci; and
- Other water quality parameters: ammonia, nitrate, nitrite, TKN, orthophosphate, BOD and TSS.

In addition to defining some important water quality measures, physical characteristics are an important factor in determining how water moves through the estuary and how effluent and river waters mix. The water quality assessment conducted during Phase 2 of the LTCP identified bacteria as the primary contaminant of concern related to CSO discharges potentially impacting water quality in the Thames River. The other water quality parameters also provide an indication of the effects of CSO discharges on the river system, and an indication of the overall environmental health of the system.

3.6.1 Physical Characteristics

Temperature, conductivity, pH and DO data collected for stations RS-1 through RS-5 are presented on Table 3-6. At these stations probe measurements were obtained from the surface of the water column. At stations RS-6 through RS-11, vertical profiles were obtained with measurements taken every 1.5 feet.

Table 3-6 Physical Characteristics: Stations RS-1 through RS-5

Date	Time	Site	Temperature (°C)	Conductivity (µS/cm)	DO (mg/L)	pH
28-Apr	19:31	RS-1	14.8	694	11.60	6.9
28-Apr	19:45	RS-2	15.0	928	12.20	7.2
28-Apr	20:01	RS-3	15.0	789	12.00	7.1
28-Apr	20:34	RS-4	13.5	435	12.20	6.7
28-Apr	20:20	RS-5	12.9	3560	12.80	7.1
29-Apr	4:58	RS-1	14.2	683	11.80	6.9
29-Apr	5:10	RS-2	14.3	920	12.80	7.1
29-Apr	5:30	RS-3	14.1	745	12.20	7.0

Date	Time	Site	Temperature (°C)	Conductivity (µS/cm)	DO (mg/L)	pH
29-Apr	5:48	RS-4	13.2	438	12.40	6.9
29-Apr	5:58	RS-5	12.6	623	12.60	7.0
30-Apr	11:55	RS-1	13.8	527	11.80	7.0
30-Apr	12:10	RS-2	13.3	662	13.00	7.0
30-Apr	12:25	RS-3	13.1	548	10.60	6.8
30-Apr	13:45	RS-4	13.5	852	12.80	6.8
30-Apr	13:00	RS-5	13.3	556	12.80	6.9
1-May	12:30	RS-1	14.5	507	10.60	6.8
1-May	12:55	RS-2	13.5	651	13.00	7.2
1-May	13:05	RS-3	13.7	557	11.20	6.9
1-May	13:20	RS-4	16.0	1630	11.40	7.0
1-May	13:40	RS-5	13.7	548	11.60	7.2
2-May	12:15	RS-1	13.0	506	12.60	6.6
2-May	12:35	RS-2	12.7	736	13.80	6.8
2-May	12:50	RS-3	12.5	587	13.20	6.5
2-May	13:15	RS-4	12.5	588	13.40	6.9
2-May	13:30	RS-5	12.4	679	13.80	6.8
9-May	17:10	RS-1	14.9	505	12.40	6.8
9-May	17:25	RS-2	15.2	686	12.20	7.1
9-May	17:40	RS-3	14.9	581	12.00	7.0
9-May	18:05	RS-4	14.0	531	13.00	7.1
9-May	18:15	RS-5	14.2	582	12.80	7.2
10-May	3:00	RS-1	14.5	478	11.00	7.1
10-May	3:15	RS-2	14.4	673	16.60	7.3
10-May	3:35	RS-3	13.7	568	12.40	7.1
10-May	3:50	RS-4	13.0	524	13.80	7.3
10-May	4:05	RS-5	13.1	1118	13.00	7.4
10-May	18:00	RS-1	15.3	617	11.00	7.1
10-May	18:17	RS-2	15.6	813	11.40	7.2
10-May	18:43	RS-3	15.3	658	11.40	7.1
10-May	19:12	RS-4	14.5	621	12.40	7.2
10-May	19:30	RS-5	14.1	879	12.60	7.2
11-May	18:10	RS-1	15.4	600	11.40	6.9
11-May	18:27	RS-2	16.1	784	12.00	7.2
11-May	18:46	RS-3	15.2	686	12.20	7.0
11-May	19:10	RS-4	15.8	678	12.80	7.1
11-May	19:18	RS-5	15.4	874	12.80	7.2

Date	Time	Site	Temperature (°C)	Conductivity (µS/cm)	DO (mg/L)	pH
12-May	18:05	RS-1	13.6	603	11.40	6.9
12-May	18:23	RS-2	14.0	775	13.60	7.0
12-May	18:40	RS-3	13.0	677	13.40	7.0
12-May	18:55	RS-4	12.9	659	14.20	7.2
12-May	19:05	RS-5	13.0	2134	14.40	7.3
24-Jul	11:40	RS-1	27.2	736	6.80	7.6
24-Jul	11:53	RS-2	26.7	1417	7.20	7.7
24-Jul	12:13	RS-3	26.6	1175	7.00	7.6
24-Jul	12:34	RS-4	24.0	2950	8.00	7.6
24-Jul	12:45	RS-5	25.3	19920	7.20	7.6
24-Jul	21:45	RS-1	24.9	732	7.60	7.4
24-Jul	22:04	RS-2	25.4	1428	8.60	7.7
24-Jul	22:23	RS-3	24.6	924	8.20	7.5
24-Jul	22:39	RS-4	23.1	1114	8.80	7.6
24-Jul	22:51	RS-5	23.1	1449	8.60	7.6
25-Jul	16:45	RS-1	26.9	732	7.80	7.3
25-Jul	17:05	RS-2	27.9	1439	8.00	7.6
25-Jul	17:20	RS-3	26.2	1538	6.60	7.3
25-Jul	17:40	RS-4	27.4	909	7.60	7.4
25-Jul	17:50	RS-5	25.1	1239	8.60	7.6
26-Jul	16:54	RS-1	26.2	776	7.60	7.4
26-Jul	17:02	RS-2	26.1	961	7.80	7.7
26-Jul	17:23	RS-3	25.4	862	7.60	7.4
26-Jul	17:39	RS-4	27.0	975	8.40	8.0
26-Jul	17:50	RS-5	27.1	5350	7.80	8.1
27-Jul	17:13	RS-1	23.9	634	7.60	6.8
27-Jul	17:28	RS-2	23.8	1017	9.20	7.3
27-Jul	17:44	RS-3	23.1	829	8.60	7.1
27-Jul	18:00	RS-4	22.5	1212	8.80	7.2
27-Jul	18:08	RS-5	22.9	7920	8.40	7.2

3.6.1.1 Stratification

Conductivity measurements provide an indication of salinity. In general, freshwater rivers have conductivities less than 800 µS/cm. Brackish water is in the range of 1600 to 4800 µS/cm while seawater in Long Island Sound has a conductivity of about 45,000 µS/cm.

Data presented on Table 3-6 indicate that freshwater was present during each of the sampling surveys for upstream stations in the Shetucket and Quinebaug Rivers. This is expected

because the Greenville Dam separates the Shetucket River from the estuary. The most downstream station on the Yantic River (RS-5) experienced brackish or saline water during most of the sampling surveys. The highest conductivity measurement was observed during a flood tide on July 24, 2008 where water from the harbor was pushed up into the river. River flow on this day was the lowest of the sampling surveys. On a few occasions brackish water was also observed at station RS-4 on the Yantic River.

DO concentrations were above 11 mg/L during each of the first and second storms at these sampling stations. DO concentrations were lower during the July storm, ranging from 6.8 mg/L to 9.2 mg/L, primarily due to higher water temperatures. The pH ranged from 6.5 to 8.1 during the sampling surveys. Within each storm event, pH did not vary greatly between stations or with time. The pH measurements were highest during the July storm event.

Stations RS-6 through RS-11 are located in the Thames River estuary. To compare characteristics between stations and illustrate trends in parameters, three stations are discussed in this section; Station RS-6 in the Shetucket River, RS-7 in Norwich Harbor and RS-10 downstream in the Thames River. Water quality data are provided in Appendix 1-F.

Station RS-6 is located at the Main Street Bridge in the estuarine portion of the Shetucket River. Dry weather samples showed virtually no vertical or lateral variations in temperature, conductivity and pH. DO concentrations were higher during the low slack tide than during high slack tide. Sampling during storm events also showed very little vertical and lateral variation in temperature, conductivity and pH concentrations. Conductivity at this location indicated freshwater at all depths during each of the sampling surveys including dry weather conditions. In general, DO concentrations were higher during the 48 and 72 hours samples than earlier in the storms.

Station RS-7 is located in Norwich Harbor where the three rivers mix and form the Thames River. During dry weather sampling, clear gradients in temperature, conductivity and pH were observed at this location with the halocline located at a depth of about 10 feet. Temperature and conductivity were also lower on the low slack tide compared to the high slack tide. Vertical stratification in temperature and conductivity were also observed during each of the storm events. Figure 3-10 shows conductivity profiles observed at this location during the first storm. As shown on the figure, the halocline deepens during the storm from about 10 feet to a depth of about 20 feet. A similar pattern was observed during the July storm. The May storm was smaller and deepening of the halocline was less, reaching a maximum of about 16 ft. The July storm lasted longer but river flows were less than during the first storm. The halocline ranged from depth of 9 feet to 15 feet during the storm, and was deepest at the 12 hour sampling interval.

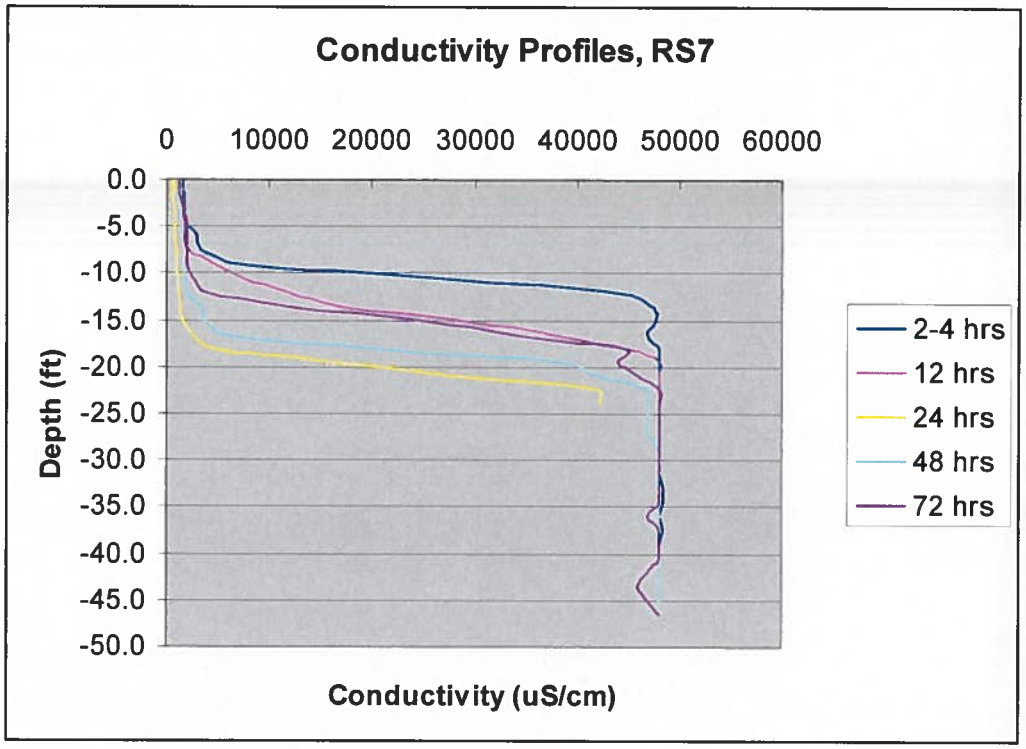


Figure 3-10 Conductivity Profiles, First Storm Event, RS-7

Vertical gradients in temperature and conductivity were observed at all Thames River stations during each of the sampling events. Conductivity tended to increase in surface waters moving downstream. The halocline tended to rise in the water column also in a downstream direction. Some of these effects are evident in Figure 3-11 which shows conductivity profiles observed at Station RS-10, located near the southern end of the study area at the Route 2A Bridge. At the start of the storm, conductivity was about 6,000 µS/cm compared to a value of 1,500 µS/cm measured at RS-7. The halocline at RS-10 was at a depth of about 7 feet compared to a depth of 10 feet for RS-7. At both the RS-7 and RS-10 stations the figures indicate that the halocline was deepest at the 24 hour sampling survey. On this day, the combined river discharge into the Thames River reached a peak and declined rapidly in the following days (Figure 3-5). Both locations provided good examples of how the freshwater layer thickened during the storm and returned close to pre-storm conditions within three days after the end of the storm.

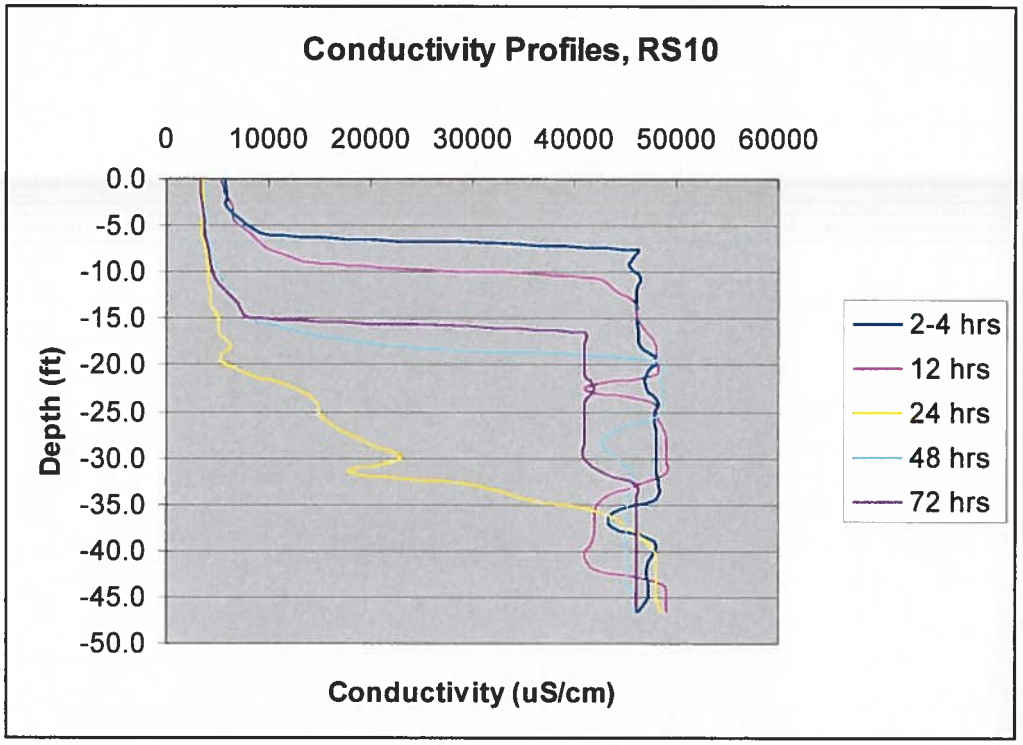


Figure 3-11 Conductivity Profiles: First Storm Event, RS-10

3.6.1.2 pH

Measurements of pH were obtained at each of the receiving water stations, three CSO discharges, two stormwater locations and the WWTP. The water quality criterion for pH for Class SB and Class B waters is to remain within the range of 6.8-8.0. Data presented on Table 3-7 indicate that the criteria for pH were met at all times at stations RS-1 through RS-5.

At stations RS-6 through RS-11, profile measurements were taken every 1.5 feet. During dry weather sampling, three of the pH measurements were outside the range of the criteria. However each of these appears to be a measurement anomaly, since each is significantly different from measurements taken one layer immediately above and below, while the other parameters measured (temperature, conductivity and DO) indicate no or only slight changes. During the first storm, one pH measurement at the bottom at RS-9 was less than 6.8. However, this may also be an anomaly because it was more than 1 pH unit below the measurement above it. All other values were in the range of 7.0 to 8.5 pH. During the second storm, several values measured at RS-11 were in the range of 8.6 to 8.8. These were all measured during one vertical profile. During another sampling interval three bottom pH measurements also at RS-11 were in the range of 6.3 to 6.7. During the third storm, several samples at stations RS-7, RS-8 and RS-9 had pH values of 6.6 or 6.7. All except one of these measurements were from below the halocline.

The range of pH values measured in the CSO discharges are summarized in Table 3-7. Overall pH values tended to be slightly lower than receiving water values.

Table 3-7 Range of pH and DO (mg/L) in CSO Discharges

Location	Parameter	Storm 1	Storm 2	Storm 3
CSO-17	pH	6.4 – 7.0	7.0 – 7.2	7.1 – 7.6
CSO-24	pH	6.6 – 6.8	6.5 – 6.7	6.0 – 6.3
CSO-40	pH	6.8 – 7.6		
CSO-17	DO	0.57 – 0.58	0.50 – 0.70	0.35 – 0.44
CSO-24	DO	0.55 – 0.59	0.53 – 0.59	0.43 – 0.44
CSO-40	DO	0.52 – 0.57		

3.6.1.3 *Dissolved oxygen*

Measurements of DO also were obtained at each of the receiving water stations, three CSO discharges, the two stormwater monitoring locations and the WWTF. The water quality criteria for DO for Class SB and Class B waters is not less than 5 mg/L at any time. Data presented on Table 6.1 indicate that the criterion for DO was met at all times at stations RS-1 through RS-5. At stations RS6 through RS-11, profiles with measurements taken every 1.5 feet were obtained. As described below there were several sampling times where the DO criterion was not met at some of the receiving water stations.

Dry weather sampling was conducted on April 23, 2008 on high slack and low slack tides. During the high tide, DO concentrations of slightly less than 5 mg/L were recorded at stations RS-8, RS-9 ¼, RS-9 ¾, and RS-10 at depths above the halocline. In addition, most of the measurements at RS-8 below the halocline were less than 5 mg/L. During the low tide, DO concentrations at station RS-6 ¾ were in the range of 4.3 to 4.8 mg/L. The data indicate that in the absence of CSO discharges, there are some violations of the DO criterion.

During the first storm event, several upper water column measurements of DO were less than 5 mg/L. Almost every station had at least one DO measurement below 5 mg/L. Most of these samples were below the halocline at RS-9, RS-10 and RS-11. During the second storm, most stations had at least one DO concentration of less than 5 mg/L. Except for RS-11, only two of these measurements were above the halocline. The location and timing of concentrations less than 5 mg/L are shown on Table 3-8. Most of the DO concentrations measured during the third storm were below the water quality criteria of 5 mg/L. This included samples collected above and below the halocline. At the beginning of the storm most of the samples below the halocline at stations RS-10 and RS-11 were below 3 mg/L. In addition to low DO water entering the estuary from Long Island Sound, the warmer temperatures in July would result in lower temperatures.

Table 3-8 Observed DO Measurements Less than 5 mg/L. (Above and Below the Halocline)

First Storm					
Location	2-4 hr	12 hr	24 hr	48 hr	72 hr
RS-6	all	most			
RS-6 ¼	one	most			
RS-6 ¾		most			
RS-7			1 above; 1 below	1, below	several, below
RS-8			several, above & below		several, below
RS-8 ¼			several, above		several, below
RS-8 ¾		5, above	2, above		
RS-9			several, below	1, below	several, below
RS-10				several, below	several, below
RS-11		2, above			
Second Storm					
Location	2-4 hr	12 hr	24 hr	48 hr	72 hr
RS-7	several, below				
RS-8	several, below				
RS-8 ¾	1, above				
RS-9	several, below				
RS-9 ¾	several, below				
RS-10	1 above, several below				
RS-11	several, below		all		

There are two ways in which CSO discharges could potentially impact DO in the receiving water. One is by simple mixing of waters with two different concentrations of dissolved oxygen; the other is through introducing additional biochemical oxygen demand. Because the CSO discharges are fresh water, they will tend to mix with water in the upper layer of the water column, above the halocline. The concentration of DO in the CSO discharges is approximately 0.5 mg/L. Therefore, mixing of CSO discharges and receiving water will decrease DO concentrations in the receiving water somewhat. However, because the volume of water discharged is small relative to the volume of water in the estuary, a decrease in DO concentrations due to mixing would affect relatively small areas of the estuary and would be quite short-term in nature. Once completely mixed, the impact would be negligible.

Through tidal action, some of the freshwater from the upper layer of the water column becomes mixed with the salt water below the halocline. This process occurs over a much long

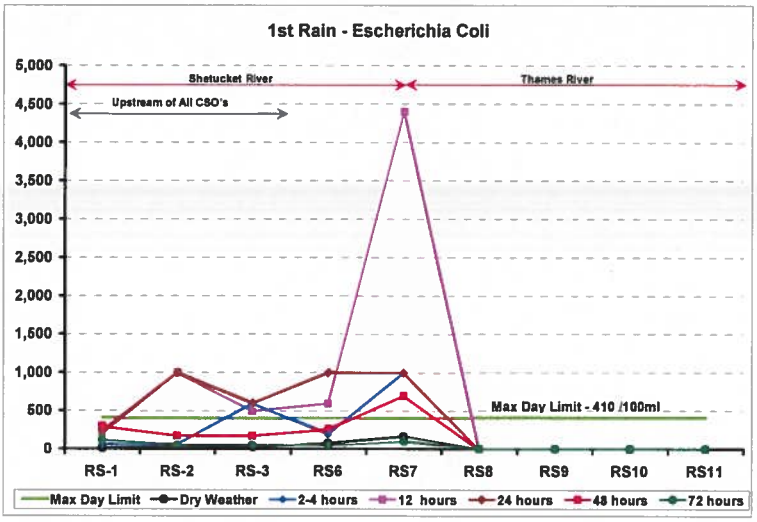
time scale. During this time BOD loading could affect DO concentrations. That effect is discussed in the Secion 3.6.3.

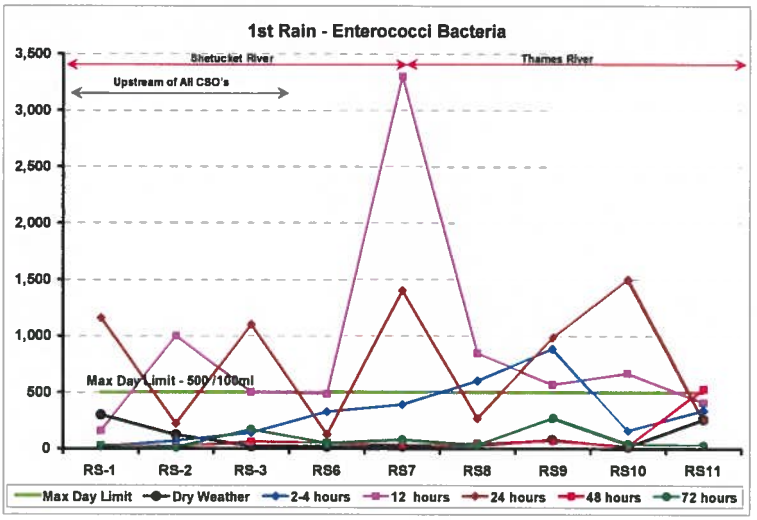
3.6.2 Bacteria

Three different types of bacteria were measured in the receiving waters, based on the fact that the water quality standards use different criteria for different river segments, depending on intended use and whether the water body is fresh or salt water. In fresh water, Escherichia coli (E. coli) is the indicator bacterium for swimming and other recreational uses. In salt water fecal coliform is the indicator for shellfish harvesting, while enterococci is the indicator for recreation uses including swimming. E. coli concentrations were measured at stations RS-1 through RS-7 (freshwater rivers and harbor area) to determine compliance with water quality criteria for fresh water. Fecal coliform bacteria and enterrococci bacteria concentrations were measured at all receiving water stations. Although water quality criteria for these parameters do not apply to all stations, it was important to measure upstream inputs to gain a better understanding of total loadings to the Thames River estuary. As discussed in Section 3.2, DEP's primary water quality-related concern here is the impact of the discharges on the Thames River, including the areal extent and time duration for elevated bacteria levels in the river. Bacteria concentrations also were monitored at the stormwater and CSO discharges, as well as WWTF effluent.

Figure 3-12 through Figure 3-14 present graphs of bacteria concentrations for the mid-channel stations through the study area. The graphs represent a transect through the Shetucket River and into the Thames River. Although not on that transect, RS-2 (located at the mouth of the Quinebaug River) also is shown on the graphs. The graphs indicate whether the stations are in the Shetucket River or the Thames River, and which stations are upstream of all CSOs. A line representing the water quality criteria also is shown on each figure. Bacteria concentrations from Yantic River stations RS-4 and RS-5 are not included on these figures. Separate graphs are shown for each type of bacteria. The graphs depict changes in concentrations at each station throughout each of the three storms surveyed.

To illustrate how concentrations change through time during and after storm events, Figure 3-15 through Figure 3-19 present graphs of bacteria concentrations versus time at selected stations. Figures are presented for stations RS-3 (Shetucket River above all CSO discharges), RS-5 (Yantic River), RS-7 (Norwich Harbor), RS-9 (Thames River below all CSO discharges) and RS-11 (the most downstream station).





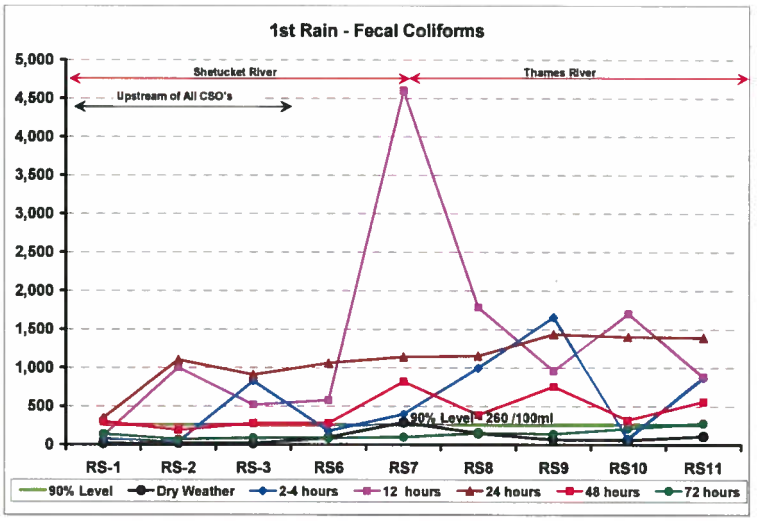


Figure 3-12 Bacteria Concentrations for the First Storm

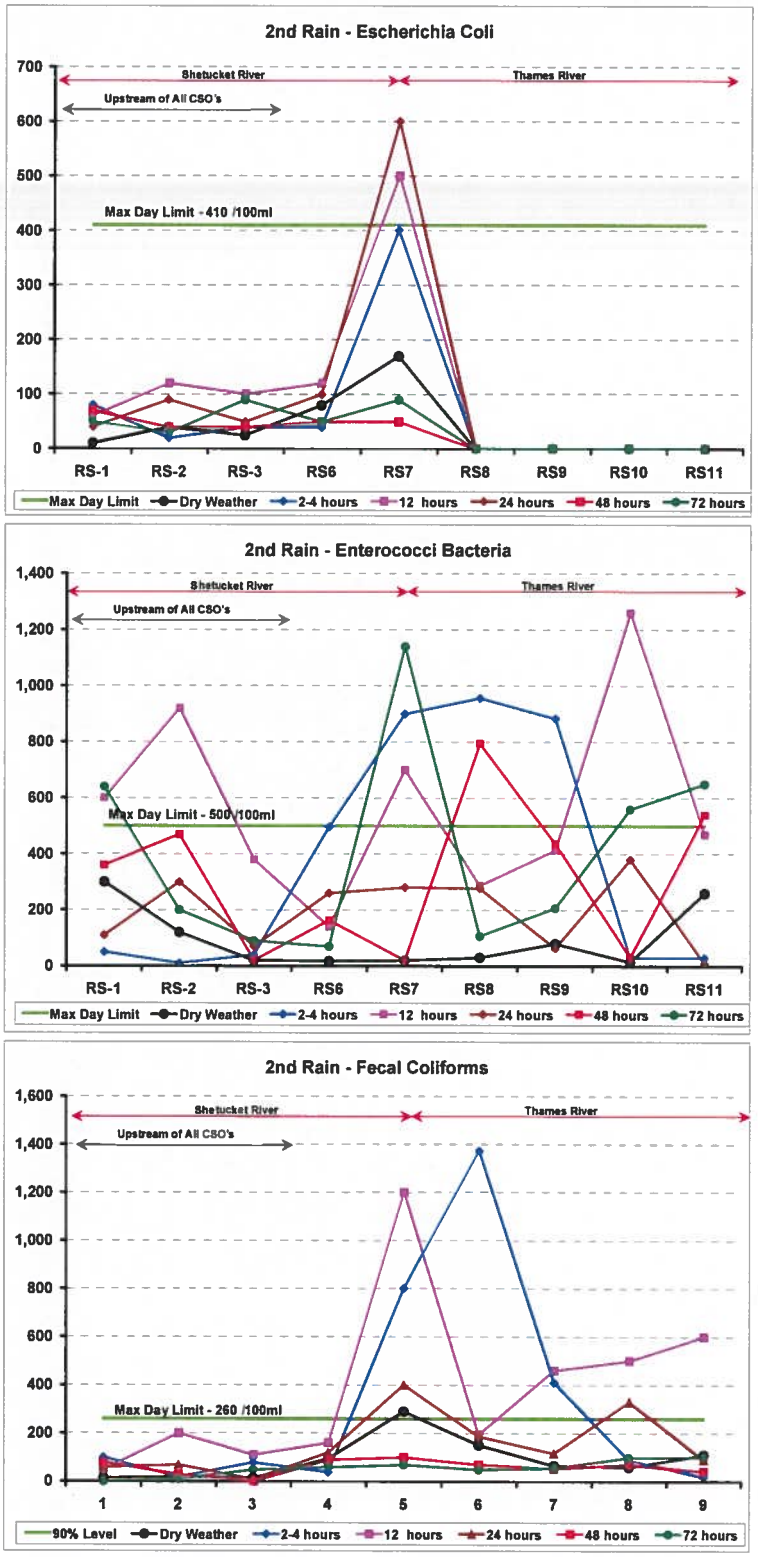


Figure 3-13 Bacteria Concentrations Second Storm

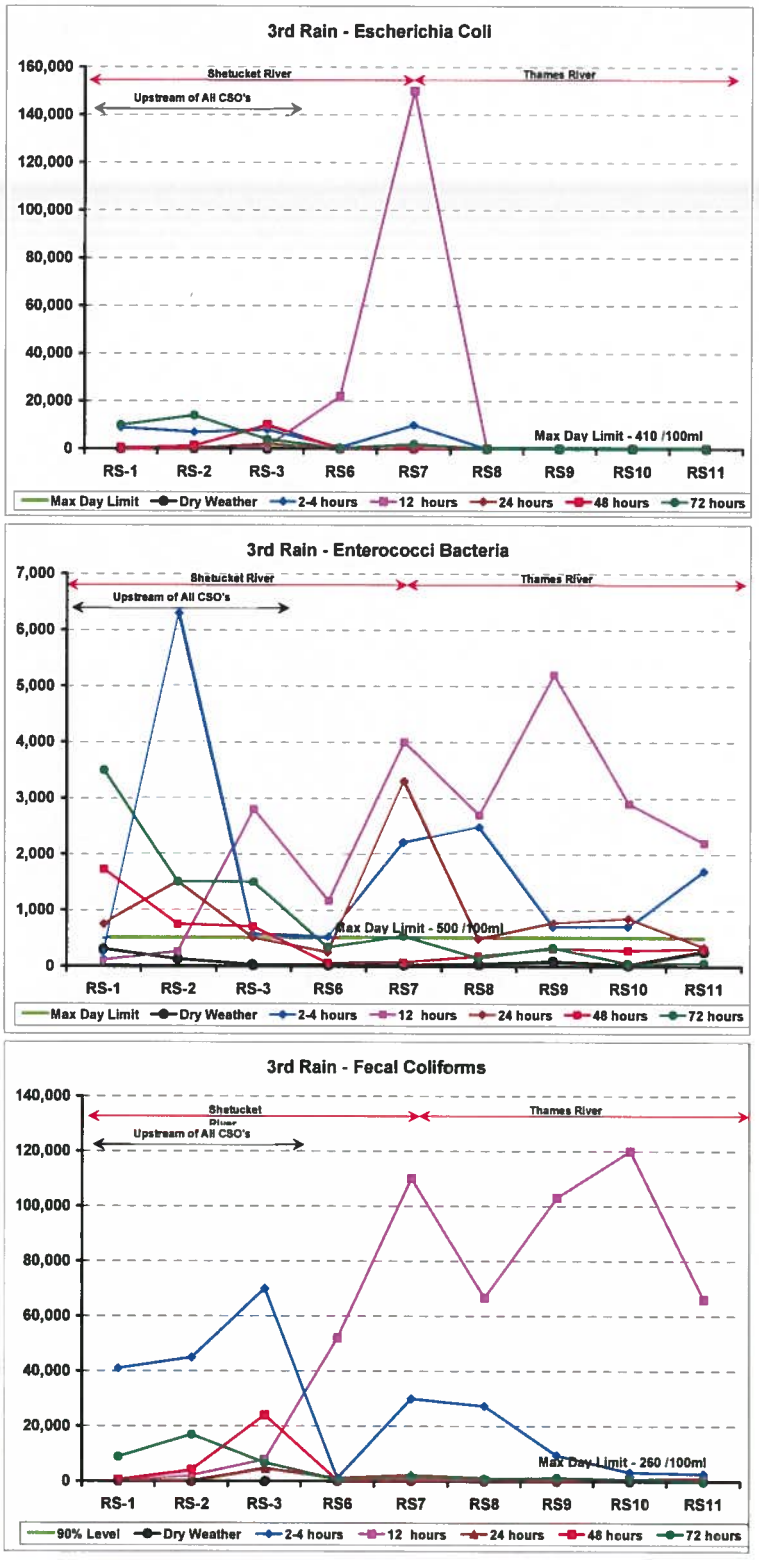


Figure 3-14 Bacteria Concentrations Third Storm

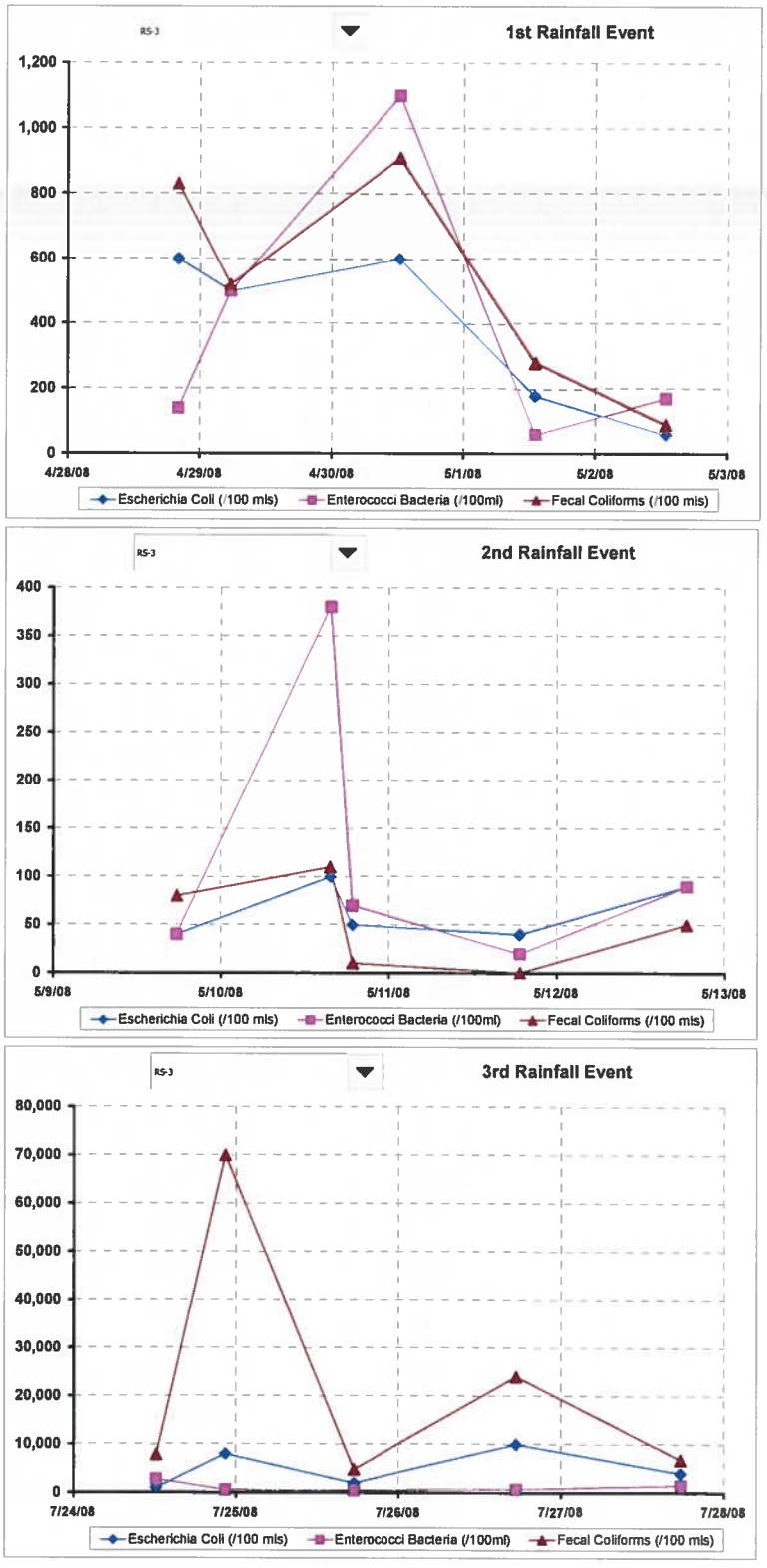


Figure 3-15 Bacteria Concentrations at Station RS-3

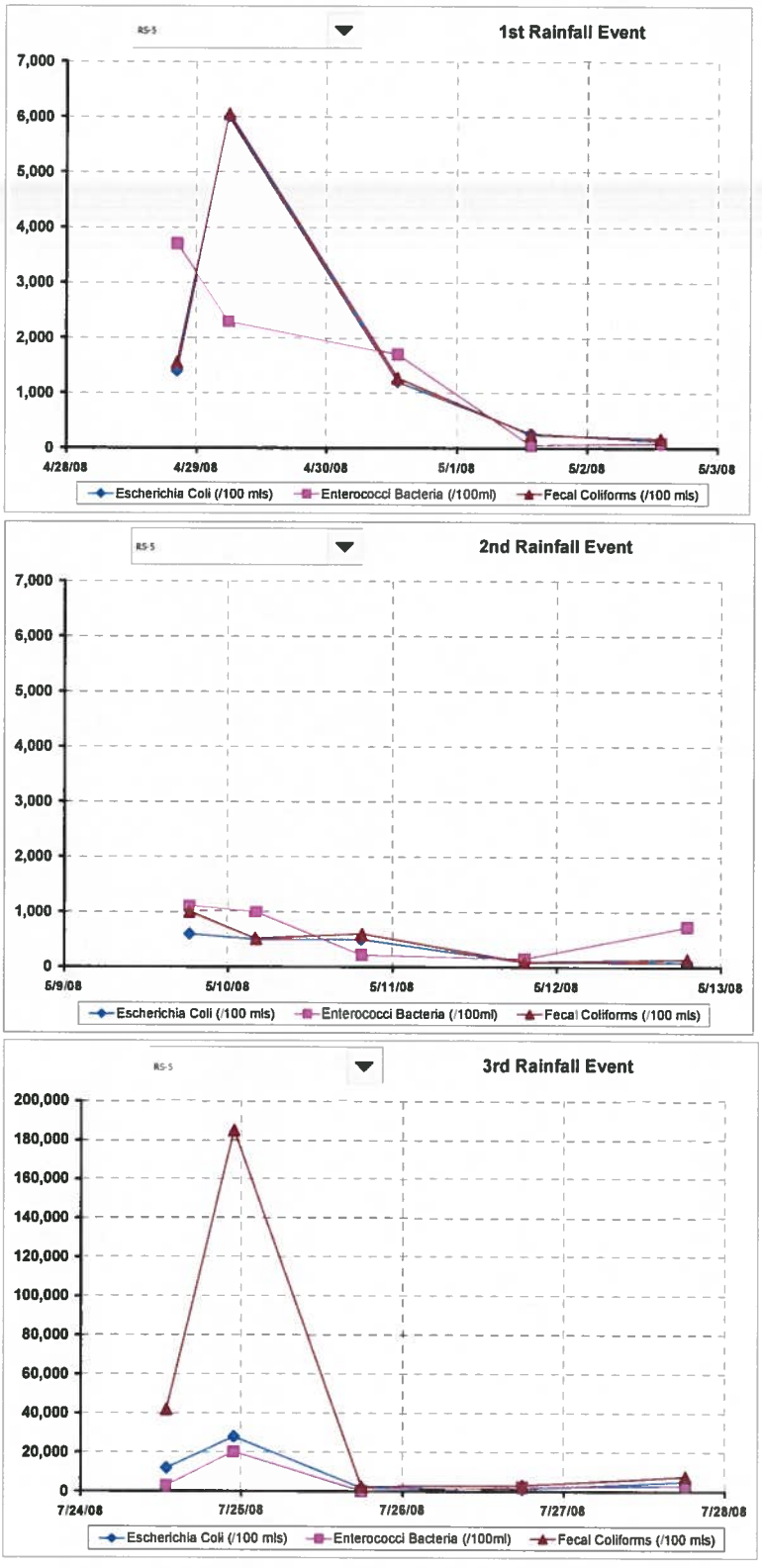
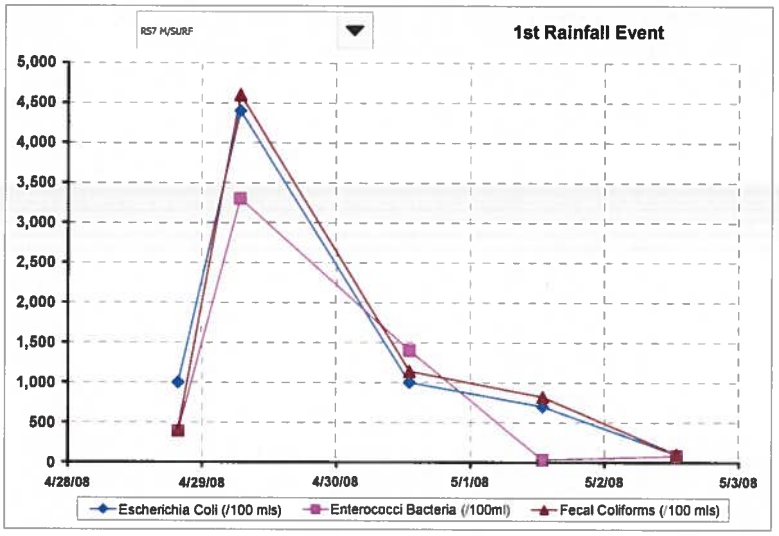
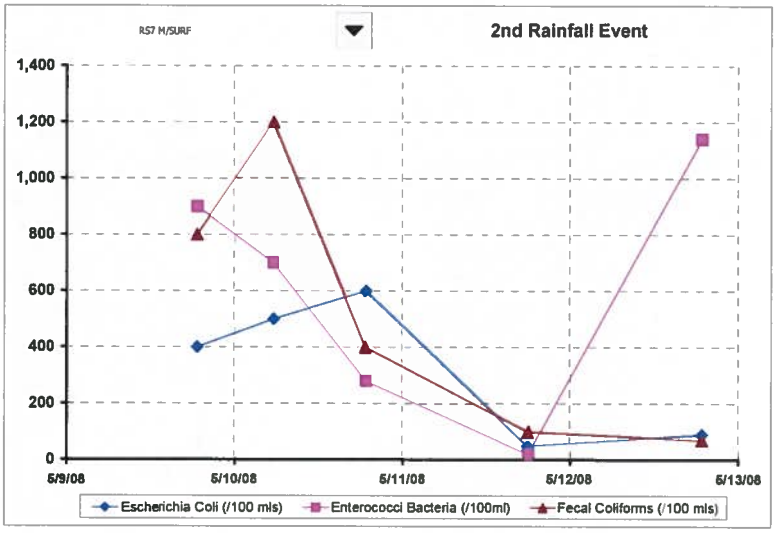


Figure 3-16 Bacteria Concentrations at Station RS-5





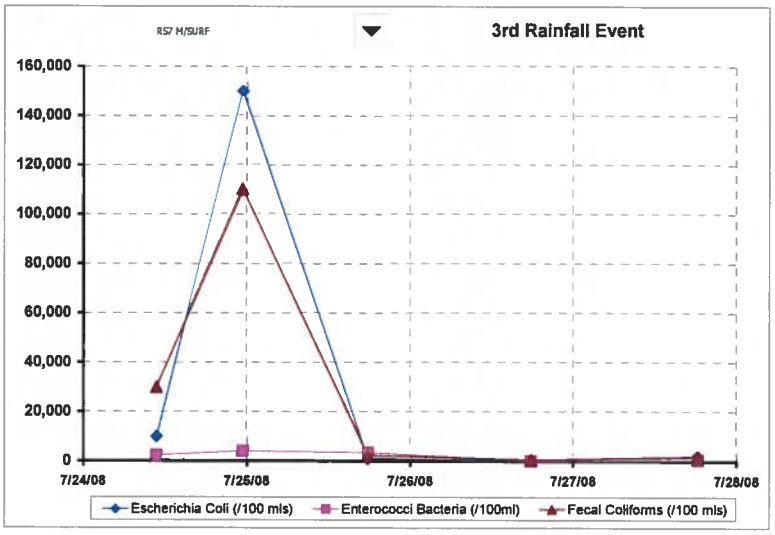


Figure 3-17 Bacteria Concentrations at Station RS-7

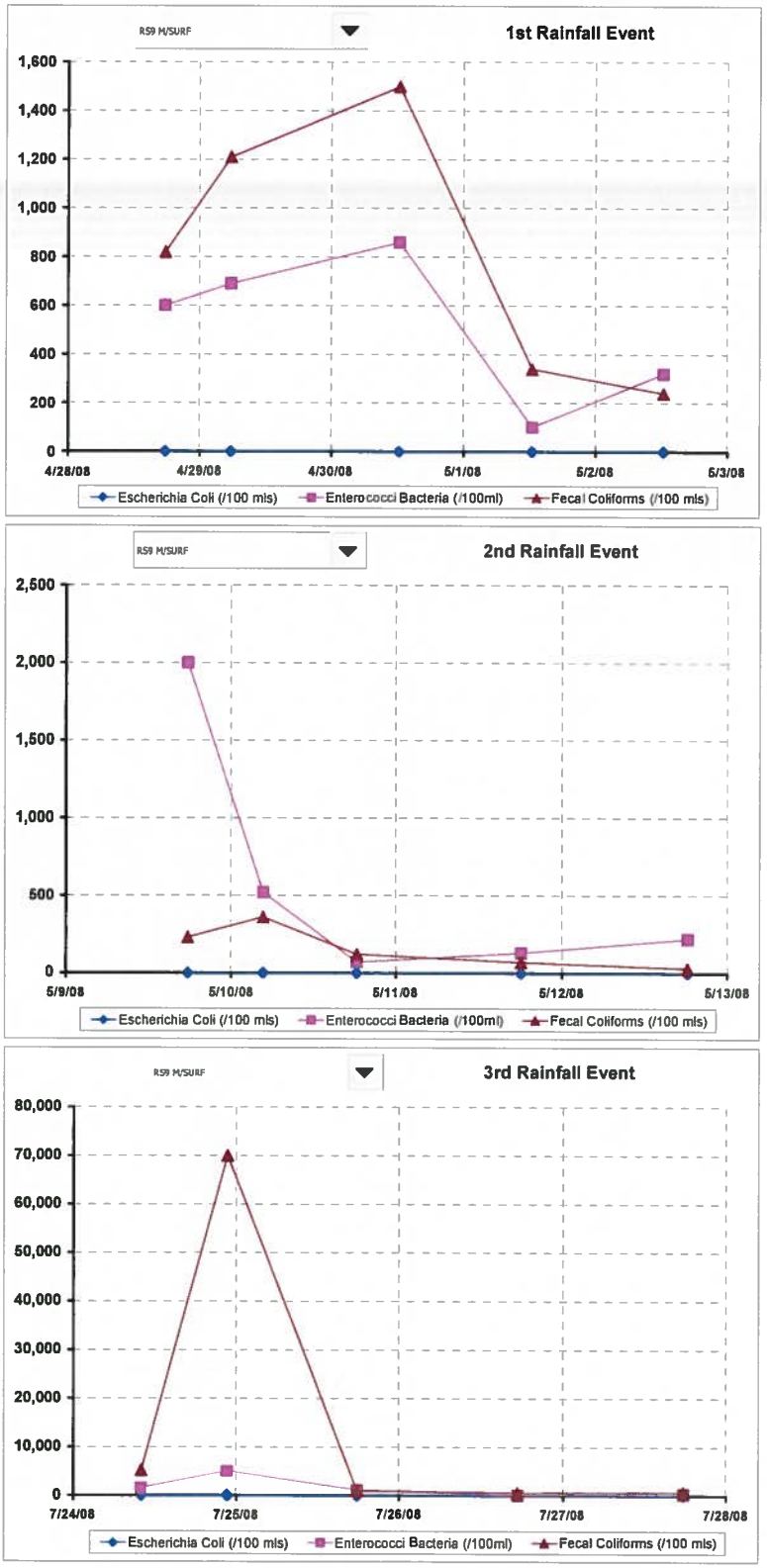
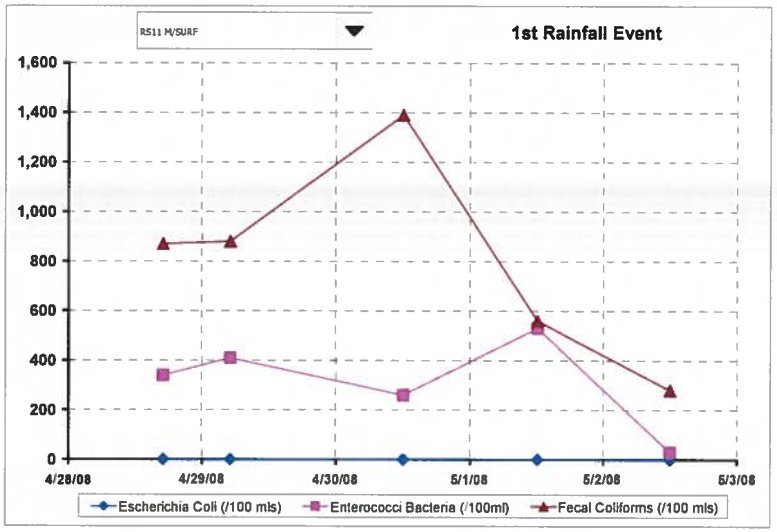
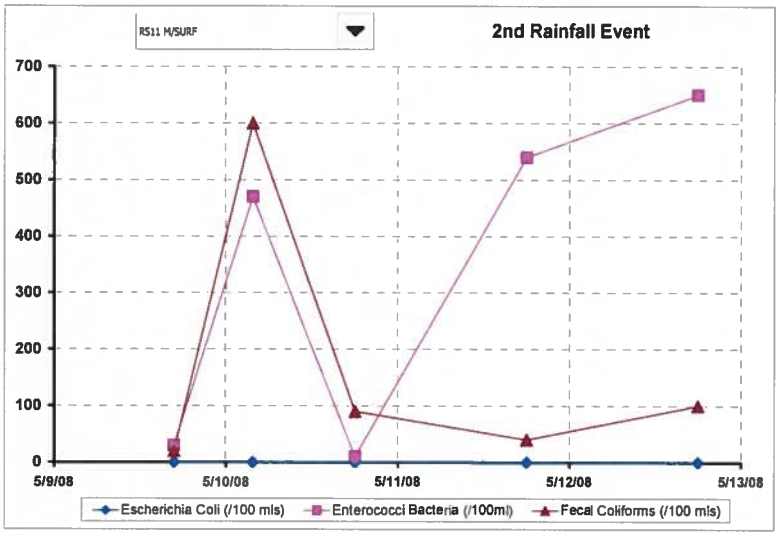


Figure 3-18 Bacteria Concentrations at Station RS-9





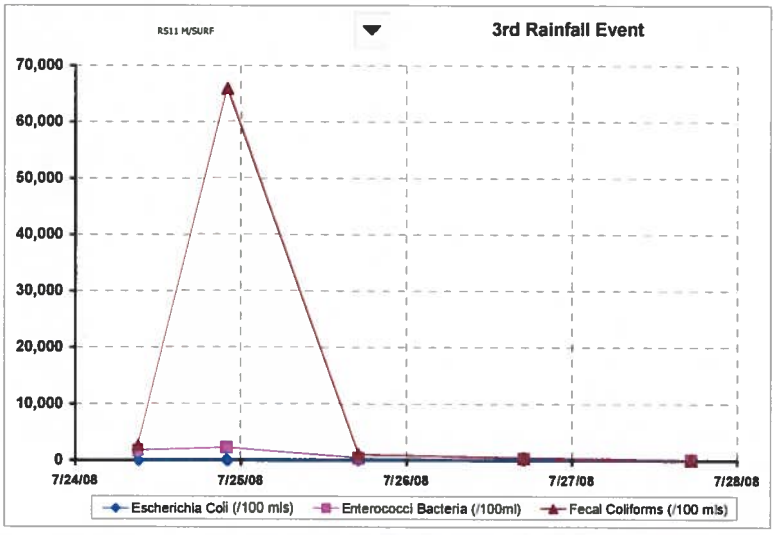


Figure 3-19 Bacteria Concentrations at Station RS-11

During the first storm the peak concentrations were measured at the 12 hour sampling interval at most stations. Generally concentrations decreased at the 24 hour, 48 hour and 72 hour sampling intervals. Except for two samples with fecal coliform concentrations of 280/100 ml, all of the 72 hour samples were below the water quality criteria.

The second storm presented a more completed pattern of bacteria concentrations. Overall, concentrations were much lower. E. coli and fecal coliform concentrations were less than the criteria at all stations at the 72 hour sampling interval. However, enterococci concentrations were above the criterion at stations RS-1, RS-5, RS-7, RS-10 and RS-11. Two of those stations are upstream of all CSO discharges.

As previous stated, the July storm event had a much higher flow volume and lower river discharge than was observed for the other two storms. Concentrations of each type of bacteria were also higher at each sampling station. Higher concentrations were observed at each of the monitored CSOs and at each of the upstream stations. The highest concentrations were observed at the 12 hour sampling interval. At most stations, concentrations decreased significantly at the 24 hour sampling interval, decreased slightly at the 48 hour interval and then increased slightly at the 72 hour interval.

The 72 hour samples for the third storm event indicated that bacteria levels at the upstream stations (RS-1 through RS-5) were significantly above the water quality criteria for all three types of bacteria. As discussed in Section 3.5.3, the July storm event was actually within a series of storms. Furthermore, the watershed areas tributary to these upstream stations on the Shetucket and Quinebaug are substantial, encompassing much of western Connecticut and extending northward into Massachusetts. In the event of a major rainstorm that impacts the entire region, it can take several days for upstream runoff to reach these monitoring stations. In view of these considerations, it is understandable that stations upstream of all the Norwich CSOs exceeded water quality standards, and also were considerably higher than levels downstream on the Thames River, three days after the third storm as indicated on Figure 3-4. This illustrates the longer-term impact of upstream nonpoint sources on bacteria levels in the Shetucket and Thames Rivers, compared to the short-term excursions that could be attributed to the CSOs.

While spatial and temporal trends have been observed in the data, these trends are not completely consistent. Part of the reason for this is that bacteria concentrations vary greatly during storm events. This is demonstrated by examining the duplicate samples taken at station RS-7. During each sampling survey, a duplicate sample was obtained to determine variability over a short time period and minor difference in location. Ratios were calculated for each duplicate sample. For E. coli, duplicate samples differed by factors between 1.2 and 12.5. For enterococci and fecal coliform the concentrations varied by factors between 1.1 and 16.3; and 1.1 and 7.0, respectively.

At three stations, RS-6, RS-8, and RS-9, additional samples were collected to measure changes that occurred across the channel. In addition to the mid-channel station, samples

were collected at approximately ¼ and ¾ distances across the channel. At these stations samples were collected at the surface for analysis of enterococci and fecal coliform bacteria. At station RS-6 no major cross-channel differences were observed in measured concentrations and there was no defined trend to determine which of the three stations exhibited the highest concentration. This result would be expected however, because RS-6 is downstream of several CSOs located on both sides of the Shetucket River.

Station RS-8 is located near five CSO discharges, including CSOs 4 and 5 located on the west bank of the Thames River and north of the station; CSO 40 located on the west bank of the river and south of the station; and CSOs 31 and 32, located on the east bank of the river north and south of the station. During the first storm, CSOs 4 and 5 discharged while the others did not. None of these CSOs discharged during the second storm. All of the CSOs discharged during the third storm, with CSOs 4 and 5 discharging the highest volume and CSO 40 the lowest volume. During the first and second storms there was no clear trend in cross channel concentrations for either enterococci or fecal coliform. During the third storm concentrations for enterococci were fairly uniform across channel but concentrations of fecal coliform were highest at the RS-8 ¾ station.

Station RS-9 is located more than a mile downstream of station RS-8 and the nearest CSO discharge point. Although significant variations in concentrations were observed at the three cross channel stations, there was no clear trend in where the highest concentrations were observed. Spatial trends were not observed for any of the three storms or for either of the bacteria sampled.

To examine the relative contributions of bacteria from the three rivers and the CSOs, a mass balance analysis was conducted. Concentration data from station RS-3 were used to represent the Shetucket River upstream of all CSOs, while data from RS-4 were used to represent the Yantic River. Station RS-3 is not under tidal influence, but station RS-4 is in a tidal portion of the Yantic River. Therefore, concentrations at this location could include some effects of CSO discharges. However, this is the most upstream station on the Yantic River and most sampling occurred during ebb tides which should reduce this effect somewhat.

Measured concentration data were used for CSOs 17, 24 and 40. These concentrations were applied to the simulated flows for these discharges. Concentrations for all other discharges used an average of the monitored outfalls. Bacteria levels in CSO the discharges tended to be highly variable. Duplicate samples were obtained at CSO 17, with the differences in concentrations varying by up to a factor of 3.4. When three or more samples were collected on one day, the median value was used to represent the concentration. The average was used if two samples were obtained during one day. Bacteria loadings from river and CSO sources are summarized in Table 3-9.

Table 3-9 Summary of Bacteria Loading During Storm Events

Source	Events	E. Coli (#, millions)	Enterococci (#, millions)	Fecal Coliform (#, millions)
All CSOs	Storm 1	7.919E+07	4.821E+06	9.928E+07
	Storm 2	2.123E+07	1.512E+06	3.005E+07
	Storm 3	8.737E+08	1.369E+07	1.080E+09
	Total	9.741E+08	2.002E+07	1.209E+09
River Flows	Storm 1	3.476E+08	5.133E+08	4.317E+08
	Storm 2	2.518E+07	4.614E+07	3.625E+07
	Storm 3	9.753E+08	2.100E+08	3.007E+09
	Total	1.348E+09	7.695E+08	3.475E+09
% CSOs	Storm 1	19%	1%	19%
	Storm 2	46%	3%	45%
	Storm 3	47%	6%	26%
	Combined	42%	3%	26%

In interpreting the data and analysis presented on Table 3-9, it is important to keep two things in mind:

- First, estimates of bacteria levels in the CSO discharges varied widely, by orders of magnitude: at different times within a storm event, from outfall to outfall and also from storm to storm. Therefore the estimate of bacterial loading should be considered very gross approximations at best.
- Second, these loadings and percentages reflect only that brief period of time while the storm event is occurring and the CSOs are discharging.

The data from water quality monitoring indicates that the CSOs may be contributing on the order of 20-50% of the E. coli and fecal coliform loading to the rivers entering Norwich Harbor *while the CSOs are discharging*. On the other hand, it appears that a minor portion of the Enterococci bacteria loading to the harbor, on the order of 1-10% may be attributed to the CSOs during storm/overflow events.

3.6.3 Nutrients, TSS and BOD

Nutrients, TSS and BOD data were measured in samples collected from the Shetucket, Quinebaug, Yantic and Thames Rivers as well as from the WWTF, two stormwater sampling locations, and at CSOs 27, 24 and 40. Receiving water samples were collected during the 2-4 hour and 12 hour sampling surveys. At other sampling locations, autosamplers were used to obtain four composite samples for each storm.

3.6.3.1 Nutrients

Receiving water nutrient data are presented on Table 3-10 through Table 3-12. Each sample was analyzed for concentrations of ammonia, nitrite, nitrate, TKN, and orthophosphate. Except for a few samples, OP concentrations were low and many samples were below the detection limit of 0.01 mg/L. Most of the higher concentrations were in the middle or bottom waters of the estuary and most occurred during the first storm.

Orthophosphate concentrations in the stormwater samples ranged from 0.02 mg/L to 0.09 mg/L with an average of about 0.05 mg/L. Concentrations in the CSO discharges ranged from 0.13 mg/L to 8.4 mg/L with an average concentration of about 0.16 mg/L. Samples from the WWTF effluent ranged from 0.77 mg/L to 2.4 mg/L. While the few elevated short-term elevated concentrations of orthophosphate observed in the receiving waters may have been influenced by CSO and stormwater discharges, it appears that these discharges did not have a significant impact on overall orthophosphate concentrations.

Total nitrogen concentrations tended to be highest in the Yantic River upstream of the WWTP and in Norwich Harbor. In most of the receiving water samples total nitrogen was primarily TKN with a smaller amount of nitrate. Nitrite concentrations very rarely were detected above the detection limit and ammonia concentrations were typically lower than nitrate.

Total nitrogen concentrations in the CSO discharges ranged from 0.13 mg/L to 8.4 mg/L, with an average concentration of about 3 mg/L. This compares to measured TN concentrations in the stormwater of 0.64 mg/L to 4.0 mg/L, with an average concentration of about 2 mg/L. Samples from the WWTF effluent ranged from 16.2 mg/L to 22.7 mg/L total nitrogen. Overall concentrations of total nitrogen in the receiving waters during wet weather were only slightly higher than those measured during dry weather. This would indicate that stormwater and CSO discharges were not significantly affecting receiving water concentrations.

Table 3-10 Receiving Water Nutrient Data, First Storm Event, April 28, 2008

River Station	2-4 HOURS AFTER START OF STORM						12 HOURS AFTER START OF STORM					
	Ammonia	Nitrite	Nitrate	TKN	Total N	OP	Ammonia	Nitrite	Nitrate	TKN	Total N	OP
RS-1	0.14	< 0.01	0.29	0.45	0.74	< 0.01	0.20	< 0.01	0.30	0.53	0.83	< 0.01
RS-2	0.04	< 0.01	0.39	0.49	0.88	< 0.01	0.11	< 0.01	0.40	0.65	1.05	0.01
RS-3	0.08	< 0.01	0.35	0.51	0.86	< 0.01	0.13	< 0.01	0.34	0.49	0.83	< 0.01
RS-4	0.19	< 0.01	0.46	0.67	1.13	0.07	0.14	< 0.01	0.36	0.64	1.00	0.03
RS-5	0.26	< 0.01	0.47	0.76	1.23	0.03	0.23	< 0.01	0.48	0.71	1.19	0.02
RS6 S	< 0.02	< 0.01	0.37	0.35	0.72	0.01	0.07	< 0.01	0.40	0.52	0.92	0.01
RS6 B	0.03	< 0.01	0.36	0.40	0.76	0.01	0.08	< 0.01	0.39	0.58	0.97	0.01
RS7 S	0.24	< 0.01	0.41	0.90	1.31	0.03	0.24	< 0.01	0.46	0.77	1.23	0.03
RS7 M	0.31	< 0.01	0.11	0.89	1.00	0.18	0.21	< 0.01	0.29	0.67	0.96	0.03
RS7 B	0.13	< 0.01	0.05	0.26	0.31	0.05	0.15	< 0.01	0.07	0.32	0.39	0.04
RS8 S	0.27	< 0.01	0.38	0.60	0.98	0.03	0.11	< 0.01	0.38	0.57	0.95	0.02
RS8 M	0.65	< 0.01	0.17	0.86	1.03	0.04	0.08	< 0.01	0.34	0.52	0.86	0.02
RS8 B	0.10	< 0.01	0.05	0.27	0.32	0.03	0.13	< 0.01	0.09	0.30	0.39	0.04
RS9 S	0.07	< 0.01	0.34	0.39	0.73	0.02	0.08	< 0.01	0.37	0.45	0.82	0.01
RS9 M	0.07	< 0.01	0.06	0.20	0.26	0.04	0.11	< 0.01	0.34	0.64	0.98	0.02
RS9 B	0.08	< 0.01	0.05	0.26	0.31	0.06	0.08	< 0.01	0.05	0.21	0.26	0.03
RS10 S	0.08	< 0.01	0.34	0.46	0.80	< 0.01	0.12	< 0.01	0.36	0.51	0.87	0.02
RS10 M	0.07	< 0.01	0.05	0.20	0.25	0.03	0.14	< 0.01	0.34	0.58	0.92	0.02
RS10 B	0.03	< 0.01	0.03	0.14	0.17	0.03	0.20	< 0.01	0.12	0.41	0.53	0.03
RS11 S	0.10	< 0.01	0.30	0.32	0.62	0.02	0.13	< 0.01	0.33	0.49	0.82	0.01
RS11 M	0.13	< 0.01	0.17	0.30	0.47	0.02	0.10	< 0.01	0.32	0.43	0.75	< 0.01
RS11 B	0.07	< 0.01	0.13	0.26	0.39	0.02	0.18	< 0.01	0.11	0.54	0.65	0.03

Table 3-11 Receiving Water Nutrient Data, Second Storm Event, May 9, 2008

River Station	2-4 HOURS AFTER START OF STORM						12 HOURS AFTER START OF STORM					
	Ammonia	Nitrite	Nitrate	TKN	Total N	OP	Ammonia	Nitrite	Nitrate	TKN	Total N	OP
RS-1	0.15	< 0.01	0.26	0.51	0.77	< 0.01	0.14	< 0.01	0.27	0.46	0.73	< 0.01
RS-2	0.10	< 0.01	0.38	0.61	0.99	< 0.01	0.09	< 0.01	0.38	0.43	0.81	< 0.01
RS-3	0.10	< 0.01	0.32	0.51	0.83	< 0.01	0.09	< 0.01	0.34	0.49	0.83	0.01
RS-4	0.10	< 0.01	0.51	0.53	1.04	< 0.01	0.09	< 0.01	0.44	0.57	1.01	< 0.01
RS-5	0.12	< 0.01	0.44	0.50	0.94	< 0.01	0.09	< 0.01	0.39	0.54	0.93	< 0.01
RS6 S	0.04	< 0.01	0.34	0.39	0.73	< 0.01	0.07	< 0.01	0.34	0.52	0.86	< 0.01
RS6 B	0.03	< 0.01	0.34	0.46	0.80	< 0.01	0.09	< 0.01	0.35	0.45	0.8	< 0.01
RS7 S	0.10	< 0.01	0.34	0.47	0.81	< 0.01	0.17	< 0.01	0.37	0.56	0.93	< 0.01
RS7 M	0.15	< 0.01	0.24	0.31	0.55	< 0.01	0.16	< 0.01	0.09	0.38	0.47	0.01
RS7 B	0.24	< 0.01	0.07	0.39	0.46	0.01	0.22	< 0.01	0.06	0.39	0.45	0.01
RS8 S	0.12	< 0.01	0.32	0.47	0.79	< 0.01	0.1	< 0.01	0.31	0.46	0.77	< 0.01
RS8 M	0.25	< 0.01	0.24	0.55	0.79	< 0.01	0.14	< 0.01	0.14	0.42	0.56	0.01
RS8 B	0.13	< 0.01	0.09	0.28	0.37	0.01	0.11	< 0.01	0.07	0.32	0.39	0.01
RS9 S	0.12	< 0.01	0.31	0.46	0.77	< 0.01						
RS9 M	0.14	< 0.01	0.32	0.84	1.16	< 0.01	0.13	< 0.01	0.1	0.29	0.39	< 0.01
RS9 B	0.14	< 0.01	0.08	0.68	0.76	0.01	0.07	< 0.01	0.07	0.27	0.34	0.01
RS10 S	0.13	< 0.01	0.30	0.44	0.74	< 0.01	0.09	< 0.01	0.3	0.27	0.57	< 0.01
RS10 M	0.07	< 0.01	0.07	0.25	0.32	0.01	0.11	< 0.01	0.08	0.47	0.55	< 0.01
RS10 B	0.07	< 0.01	0.14	0.26	0.40	0.06	0.07	< 0.01	0.06	0.28	0.34	0.01
RS11 S	0.16	< 0.01	0.28	0.46	0.74	< 0.01	0.12	< 0.01	0.28	0.4	0.68	< 0.01
RS11 M	0.10	< 0.01	0.25	0.41	0.66	< 0.01	0.06	< 0.01	0.05	0.23	0.28	0.01
RS11 B	0.10	< 0.01	0.11	0.73	0.84	0.02	0.07	< 0.01	0.04	0.23	0.27	0.02

Table 3-12 Receiving Water Nutrient Data, Third Storm Event, July 24, 2008

River Station	2-4 HOURS AFTER START OF STORM						12 HOURS AFTER START OF STORM					
	Ammonia	Nitrite	Nitrate	TKN	Total N	OP	Ammonia	Nitrite	Nitrate	TKN	Total N	OP
RS-1	0.12	< 0.01	0.20	0.60	0.80	0.01	0.19	< 0.01	0.17	0.47	0.64	< 0.01
RS-2	0.08	< 0.01	0.28	0.55	0.83	0.01	0.21	< 0.01	0.29	0.68	0.97	< 0.01
RS-3	0.10	< 0.01	0.25	0.54	0.79	0.01	0.17	< 0.01	0.28	0.57	0.85	0.01
RS-4	0.14	< 0.01	0.48	0.81	1.29	0.03	0.32	< 0.01	0.56	1.00	1.56	< 0.01
RS-5	0.16	< 0.01	0.45	0.78	1.23	0.03						
RS6 S	0.14	< 0.01	0.23	0.60	0.83	0.01	0.13	< 0.01	0.28	0.72	1.00	0.02
RS6 B	0.16	< 0.01	0.22	0.65	0.87	0.01	0.17	< 0.01	0.28	0.66	0.94	0.02
RS7 S	0.22	< 0.01	0.30	0.79	1.09	0.02	0.13	< 0.01	0.34	0.58	0.92	0.02
RS7 M	0.30	< 0.01	0.34	0.79	1.13	0.04	0.29	< 0.01	0.35	0.73	1.08	0.02
RS7 B	0.61	0.03	0.39	0.78	1.17	0.09	0.78	0.09	0.47	1.20	1.67	0.14
RS8 S	0.18	< 0.01	0.28	1.90	2.18	0.02	0.16	< 0.01	0.31	0.59	0.90	0.02
RS8 M	0.19	< 0.01	0.28	0.68	0.96	0.02	0.23	< 0.01	0.31	0.74	1.05	0.03
RS8 B	0.23	< 0.01	0.28	0.70	0.98	0.04	0.20	< 0.01	0.32	0.69	1.01	0.04
RS9 S	0.18	< 0.01	0.24	0.75	0.99	0.02	0.16	< 0.01	0.30	0.65	0.95	0.03
RS9 M	0.53	0.02	0.32	0.79	1.11	0.04	0.30	< 0.01	0.31	0.75	1.06	0.04
RS9 B	0.53	0.02	0.30	0.87	1.17	0.04	0.65	0.03	0.33	0.94	1.27	0.08
RS10 S	0.18	< 0.01	0.20	0.61	0.81	0.02	0.17	< 0.01	0.29	0.56	0.85	0.03
RS10 M	0.32	< 0.01	0.19	0.58	0.77	0.02	0.27	< 0.01	0.26	0.93	1.19	0.03
RS10 B	0.23	< 0.01	0.13	0.64	0.77	0.04	0.74	0.07	0.43	1.10	1.53	0.16
RS11 S	0.16	< 0.01	0.14	0.61	0.75	0.02	0.26	< 0.01	0.26	0.75	1.01	0.04
RS11 M	0.12	< 0.01	0.11	0.53	0.64	0.02	0.20	< 0.01	0.18	0.60	0.78	0.03
RS11 B	0.13	< 0.01	0.09	0.56	0.65	0.03	0.17	< 0.01	0.08	0.56	0.64	0.04

3.6.3.2 BOD

Five-day BOD and 20-day BOD were measured in samples obtained from the four rivers; the WWTF; two stormwater discharges; and CSOs 17, 24 and 40. Except for two measurements, BOD_5 concentrations were less than 4 mg/L at all receiving water locations. The exceptions included measurements of 7.6 mg/L, measured during the first storm at location RS-4 and a measurement of 8.3 mg/L during the second storm at location RS-10 (bottom sample). Most of the stormwater concentrations ranged from < 4 mg/L to 8.3 mg/L with one sample measured at 30 mg/L. The WWTF effluent BOD concentrations ranged from 4.7 to 15 mg/L. BOD_5 concentrations measured in the CSO discharges are summarized in Table 3-13. No consistent pattern was observed in the relationship between BOD and the size of the storm. It does not appear that CSO discharges are significantly contributing to BOD levels in the receiving waters. The two somewhat elevated concentrations were in the Yantic River upstream of all CSOs, and at a downstream location within the salt wedge of the estuary.

Table 3-13 Summary of BOD_5 (mg/L) Concentrations in CSO Discharges

Location	Composite	Storm 1	Storm 2	Storm 3
CSO-17	1	20	60	14
	2	18	54	11
	3	6	< 4	< 4
	4	< 4	< 4	< 4
CSO-24	1	65	43	11
	2	18	42	
CSO-40	1			4.1
	2			73
	3			60

The primary reason that BOD concentrations were measured was to determine potential effects on DO concentrations in the receiving water. The relative contribution of BOD from CSO discharges and from the river flows were estimated for each storm. The approach was similar to that used to determine bacteria loads. Measured concentrations were applied to the discharge volumes for each of the monitored CSOs. The average value was used to represent the concentration for the other discharges. Because the BOD concentrations in the rivers were all reported as < 4 mg/L, it was assumed that the concentration was 1 mg/L. Concentrations in the CSO discharges that were reported as < 4 mg/L were assumed to be 4 mg/L. The calculated loads are summarized in Table 3-14.

Table 3-14 BOD Loads to the Thames Rives Estuary

	CSOs (lbs)	Rivers (lbs)	Total (%)	CSO Contribution (%)
Storm 1	2,405	130,119	132,524	2%
Storm 2	196	53,379	53,575	0.4%
Storm 3	2,711	40,641	43,352	6%
Total	5,312	224,140	229,452	2%

The loading calculations indicate that CSO discharges contribute a very small fraction on the total loads, on the order of 2%, during storm events. Average BOD concentrations were in the range of those expected for effluent from secondary treatment plants. Overall, it appears that BOD loads from the CSO discharges have negligible impact on DO concentrations in the estuary.

3.6.3.3 TSS

Total suspended solids were also measured in samples obtained from the three rivers as well as the WWTF; CSOs 17, 24 and 40; and at two stormwater monitoring locations. TSS concentrations generally were below 20 mg/L at all receiving water locations, for all storms. Most of the stormwater concentrations ranged from 5 mg/L to 18 mg/L, with one sample reported at 130 mg/L during the July 24 storm. TSS concentrations in the WWTP\F effluent samples were < 6 mg/L. TSS concentrations measured in the CSO discharges are summarized in Table 3-15. Similar to what was observed regarding the BOD concentrations, no consistent pattern was observed in the relationship between TSS concentration and the size of the storm. Although some elevated concentrations of TSS were observed in the discharges during storm events, this did not have a significant effect on TSS concentration in the receiving waters.

Table 3-15 Summary of TSS (mg/L) Concentrations in CSO Discharges

Location	Composite	Storm 1	Storm 2	Storm 3
CSO17	1	36	83	44
	2	34	57	8
	3	16	< 5	8
	4	10	< 5	10
CSO 24	1	290	61	100
	2	30	44	
CSO 40	1			100
	2			64
	3			47

3.7 Water Quality Impairment

3.7.1 Bacteria

Three different bacteria were measured in the receiving waters, since the water quality standards define criteria for these bacteria in different river segments depending on (a) the intended use, and (b) if the water body is fresh or salt water. In fresh water, E. coli is used as the indicator bacteria for recreation including swimming and other recreational uses. In salt water, fecal coliform is the indicator for shellfish harvesting while enterococci is the indicator for recreation uses including swimming.

E. coli concentrations were measured at stations RS-1 through RS-7 (freshwater rivers and harbor area) to determine compliance with water quality criteria for freshwater. Fecal

coliform bacteria and enterococci bacteria concentrations were measured at all receiving water stations. Although water quality criteria for these parameters do not apply to all stations it was important to measure upstream inputs to gain a better understanding of total loadings to the Thames River estuary.

During the first storm the peak bacteria concentrations were measured at the 12 hour sampling interval at most stations. Generally concentrations decreased at the 24 hour, 48, hour and 72 hour sampling intervals. Except for two samples with fecal coliform concentrations of 280/100 mL, all of the 72 hour samples were below the water quality criteria limit.

During the second storm overall bacteria concentrations were much lower. E. coli and fecal coliform concentrations were less than the criteria at all stations at the 72 hour sampling interval. However, enterococci concentrations were above the criterion at stations RS-5, RS-7, RS-10 and RS-11. Although the criterion does not apply to RS-1, concentrations at that location were also above the criterion. Stations RS-1 and RS-5 were upstream of all CSO discharges.

As previous stated, the July storm had much higher CSO flow volumes, lower river discharge, and higher bacteria concentrations compared to the other two storms. Higher concentrations were observed at each of the monitored CSOs and at each of the upstream stations. The highest concentrations were observed at the 12 hour sampling interval. At most stations, concentrations decreased significantly at the 24 hour sampling interval, decreased slightly at the 48 hour interval and then increased slightly at the 72 hour interval.

The 72 hour samples indicated that upstream stations (RS-1 through RS-5) were significantly above the criteria for all three types of bacteria. Stations in the Thames River indicated that concentrations of Enterococci were slightly above or below the criteria. Concentrations of fecal coliform were above the criteria at most of the Thames River stations. The July storm event was actually a series of storms. At the time of the 72 hour samples additional rain had significantly increased CSO discharges particularly at CSO 17, near RS-7; CSOs 23, 25 and 19 near RS-6; and CSOs 4 and 5 near RS-8.

At three stations, RS-6, RS-8, and RS-9, additional samples were collected at approximately ¼ and ¾ distances across the channel. At station RS-6 no major cross-channel differences were observed in measured concentrations. This result would be expected however, because RS-6 is downstream of several CSOs located on both sides of the Shetucket River.

Station RS-8 was located close to five CSOs that discharged on both the east and west banks of the Thames River. During the first and second storms there was no clear trend in cross channel concentrations for either enterococci or fecal coliform. During the third storm concentrations for enterococci were fairly uniform across channel but concentrations of fecal coliform were highest at the RS-8 ¾ station.

Station RS-9 was located more than a mile downstream of station RS-8 and the closest CSO discharge point. Although significant variations in concentrations were observed at the three cross channel stations, there was no clear trend in where the highest concentrations were observed. Spatial trends were not observed for any of the three storms or for either of the bacteria sampled.

To examine the relative contributions of bacteria from the three rivers and the CSOs, a mass balance analysis was conducted. For the three monitored storm events, the combined discharges from all of the Norwich CSOs contributed about 40 percent of the E. coli discharged into the Thames River estuary. The CSOs were a minor contributor of Enterococci and contributed about one-quarter of the fecal coliform bacteria.

Based on the results of the bacteria sampling it appears that CSO discharges appear to be a significant source of E. coli and fecal coliform bacteria to the estuary during storm events. However, for each of the bacteria monitored, the CSO discharges were estimated to contribute less than half of the total loads during storm events. In view of the high bacteria levels measured in upstream stations and the load calculations, it appears that water quality standards for bacteria still would not be met even if all Norwich CSOs were eliminated.

3.7.2 Nutrients

There are no water quality criteria for the nutrients phosphorus and nitrogen. However, elevated concentrations of these nutrients can lead to eutrophication of receiving waters, with excessive algae growth and potentially decreased DO concentrations. In general, orthophosphate concentrations were low and many samples were below the detection limit of 0.01 mg/L. Most of the higher concentrations were in the middle or bottom waters of the estuary and most occurred during the first storm. The few elevated concentrations of orthophosphate observed in the receiving waters were likely due to CSO and stormwater discharges. However, it appears that these discharges did not have a significant impact on overall orthophosphate concentrations

Total nitrogen concentrations tended to be highest in the Yantic River upstream of the WWTF and in Norwich Harbor. It is likely that the elevated concentrations of total nitrogen were due to stormwater and CSO discharges in addition to effluent from the WWTF. However, overall concentrations of total nitrogen in the receiving waters during storm events were only slightly higher than those measured during dry weather. This would indicate that CSO discharges are not significantly affecting receiving water concentrations.

3.7.3 Dissolved Oxygen (DO) and BOD

The water quality criteria for DO for Class SB and Class B waters are not less than 5 mg/L at any time. Although there are no water quality criteria for BOD, this parameter is important because high BOD loads can have a detrimental effect on DO levels. BOD concentrations in natural waters, not impacted by organic loads are typically low, in the range of < 2 mg/L. The categorical standard for BOD for WWTFs providing secondary treatment is 30 mg/L.

The water quality criterion for DO was met at all times at stations RS-1 through RS-5. At stations RS6 through RS-11, there were several sampling times where the DO criterion was not met at some of the receiving water stations during both dry weather sampling and during storm events.

During dry weather sampling, DO concentrations of slightly less than 5 mg/L were recorded at several Thames River stations at depths above the halocline, and at one station below the halocline. In addition, concentrations of DO in the freshwater tidal segment of the Shetucket River were below the water criterion of 5 mg/L. These data indicated that even with all CSO discharges eliminated, there would be some violations of the DO water quality criterion.

During the storm events, several upper water column measurements of DO were less than 5 mg/L. While almost every station had at least one DO concentration of less than 5 mg/L, most of these lower concentrations were below the halocline at downstream stations. This indicates that the water within the salt wedge connected to Long Island Sound contains areas of low DO concentrations.

CSO discharges could affect receiving water concentrations of DO in two ways. One is by simple mixing of waters with two different concentrations; the other is through biochemical oxygen demand. Because the CSO discharges are fresh water they will tend to mix with water in the upper layer of the water column above the halocline. The concentration of DO in the CSO discharges is approximately 0.5 mg/L. Therefore, mixing of CSO discharges and receiving water will decrease DO concentrations in the receiving water somewhat. However, because the volume of water discharged is small relative to the volume of water in the estuary, a decrease in DO concentrations due to mixing would affect relatively small areas of the estuary and would be short-term in nature. Once completely mixed, the decrease would be negligible.

Based on the results of the monitoring, it appears that DO concentrations at the side channel station RS-8 ¾ may be decreased for short time periods by discharges from nearby CSOs. Station RS-6, located downstream of several Shetucket River CSO discharges, also experienced low DO concentrations. However, DO concentrations at that location were also low during dry weather conditions. Therefore, it is difficult to determine the cause of depressed concentrations at that location.

The density difference between the upper and lower layers of the water column inhibits mixing between the two layers. However, through tidal action some mixing of the upper fresh water and lower salt water layers occurs. This process occurs over a much long time scale than mixing of discharges of effluents with receiving waters. During this longer time period, BOD loading could affect DO concentrations. The primary reason that BOD concentrations were measured was to determine potential effects on DO concentrations in the receiving water. The relative contribution of BOD from CSO discharges and from the river flows were estimated for each storm. The loading calculations indicate that CSO discharges contributed a small fraction on the total loads during storm events. Average BOD concentrations were in

the range of those expected for effluent from secondary treatment plants. Overall it appears that BOD loads from the CSO discharges do not have significant impact on DO concentrations in the estuary.

Several of the sampling surveys indicated lower DO concentrations of water below the halocline even during the initial hours of storm events. Tidal action that promotes mixing of the two layers would also bring some of the lower concentration bottom waters into the upper layer of the estuary. This lower concentration bottom water could also contribute to the lower concentrations observed in the upper layer.

Overall, it appears that CSO discharges only have a short term impact on small areas of the receiving waters due to mixing of very low DO water with the receiving waters. Low DO concentrations below the halocline are likely not the result of CSO discharges, because the BOD loads are only a small fraction of total BOD loading to the estuary, even during storm events.

3.8 Plume Modeling

When combined sewage is discharged into receiving waters, the velocity of the jet and possible buoyancy of the effluent will cause turbulent mixing with the surrounding water. After this initial mixing, the effluent plume moves primarily horizontally with the currents. As the effluent plume is carried away by the currents, additional mixing occurs, although typically to a lesser degree than the initial mixing. The dilution achieved and the size and location of the effluent plume are affected by the density and stratification of the receiving water and by ambient currents.

Mixing zone models require the type of input information listed below.

1. Physical Characteristics of the Outfall
    - Depth of the outfall and reference point (eg., mean sea level, mean low water, or other zero point)
    - Location of the discharge point
    - Configuration of the outfall including the angle of discharge relative to the river and shape and diameter of outfall
2. Effluent Data
    - Measured concentrations of parameters of concern
    - Temperature and salinity or total dissolved solids (TDS) of the effluent during discharge
    - Flow rates
3. Receiving Water Data

- Measured concentrations of parameters of concern in the receiving water
- Salinity and temperature data near the outfall
- River flow data and river cross-section data including average depth and width

Information on the physical characteristics of the outfall structures, effluent flow rates, and effluent quality was obtained from information collected during field investigations undertaken during the collection system and outfall monitoring conducted during Phase 3 of the LTCP. Details of the CSO collection system sampling plan were developed under Phase 2 Task 5 of the CSO LTCP and were summarized in Section 3.4.2. Information on the receiving water was obtained from the Phase 3 sampling program, USGS gauging stations, and previous studies.

3.8.1 Modeling Approach

The purpose of the plume modeling analysis was to define the depth, width, length and water quality characteristics of the CSO plumes into the Thames River. The model was used to simulate measured conditions to better understand plume dynamics in the estuary. Results of this analysis were one element of the Zone of Influence (ZOI) analysis.

The two most common mixing models used today are CORMIX and PLUMES. CORMIX is most often used for river and lake modeling while PLUMES is primarily used for marine or estuarine environments. Both models require the same type of input data and both models predict dilutions and provide information on the width, depth and location of the effluent plume. The PLUMES model does not consider the effect of boundary conditions and therefore cannot simulate bank or bottom attachment of a plume. In addition, it is best used for submerged outfalls. For these reasons it is not the best model for this application. CORMIX was selected for use in the mixing zone delineation because of its ability to simulate bank and near surface discharges.

The CORMIX system is a computerized methodology for predicting the flow classification, dilution, and plume trajectory of the hydrodynamic mixing processes resulting from different discharge configurations into streams, rivers, lakes, reservoirs, estuaries, and coastal waters. The users' manual (Jirka et al., 1998) includes several references documenting that the model has been verified by the developers, has undergone independent peer review in journal proceedings, and is applicable to a wide range of situations. CORMIX1 applies to submerged single-port designs, CORMIX2 applies to multiport diffusers, and CORMIX3 applies to surface discharges. CORMIX 3 was used to simulate the CSO discharges for Norwich. Although some of the CSOs are somewhat submerged, by the definition used for the CORMIX1 model, the outfall must be located within the lowest third of the water column to be applicable. Therefore, CORMIX3 most closely simulated the actual configuration of the CSO discharges into the Thames River.

3.8.2 Input Data

Modeling was conducted for four CSO discharges into the Thames River, CSO outfalls 5, 4, 31, and 32. The CSO 40 outfall also is located on the Thames River; however it did not discharge during the first two storms, and had only a minor outflow (< 0.03 mgd) during the third storm. Therefore CORMIX modeling was not done for the CSO 40 outfall. As discussed in Section 3.5.3, CSO flows were estimated using the collection system hydraulic model. That model indicated that CSOs 4 and 5 discharged during the first two days of the first storm, while CSOs 31 and 32 did not discharge. The model indicated that none of the Thames River CSOs discharged during the second storm, but that all of the Thames River CSOs discharged on the first and last day of the third storm.

The hydraulic model estimated CSO flowrates and total flows every five minutes during the storms. Typically, these four outfalls would discharge for one to three hours and stop for several hours. To estimate the appropriate discharge rate for the mixing model, flowrates were averaged over the time periods with flow. The maximum value was then used to represent CSO discharge flowrate. For example outfall 4 discharged four times on April 28, 2008 for periods of less than one hour to 1.5 hours each time. The average flowrate during these periods of discharge ranged from 0.3 mgd to 2.3 mgd. The discharge rate of 2.3 was used in the modeling for that day.

Input values used in the CORMIX model are summarized on Table 3-16. In all cases the river width was assumed to be 625 feet. Ambient data measured at RS-8 were used in the calculations. Temperature measured for CSO discharges from the CSO 17 and 24 outfalls were used to characterize all outfalls. The values presented on the table represent twelve cases.

Table 3-16 CORMIX Input Values

Parameter	April 28, 2008	April 29, 2008	July 24, 2008	July 27, 2008
Ambient Data				
Depth (ft)	10	27	10	9
Velocity (fps)	0.31	0.36	0.21	0.38
Temperature (°C)	12	12	22	22
Discharge Data				
Temperature (°C)	14.6	13.5	22.3	22.3
Discharge (mgd)				
CSO 5	1.39	0.78	1.82	1.7
CSO 4	2.30	0.73	1.82	1.70
CSO 31	0	0	1.44	1.49
CSO 32	0	0	1.13	1.07

3.8.2.1 CORMIX Results

Results of the modeling are summarized in Table 3-17. Dilution (S) and plume width (W) are shown for various distances downstream. The distances downstream (X) represent three

points; the distance where the plume becomes bank attached, the distance where the plume will mix over the entire upper layer of the river and one kilometer downstream. The dilution factor S indicates the degree to which discharge plume water is mixed with river water. A higher the value of S indicates greater mixing. For example, an S value of 35 indicates 1 part of CSO discharge is mixed with 34 parts of ambient river water, in terms of volume.

Table 3-17 Summary of CORMIX Results

April 28, 2008						
	CSO 5			CSO 4		
	X (m)	S	W (m)	X (m)	S	W (m)
Bank Attached	3.7	5.2	1.2	7.4	6.0	1.2
Vertically Mixed	88.5	67	4.5	102	46	5.0
1,000 m	1000	230	14.8	1000	140	14.9
April 29, 2008						
	CSO 5			CSO 4		
	X (m)	S	W (m)	X (m)	S	W (m)
Bank Attached	1.9	5.5	0.7	1.8	5.4	0.7
Vertically Mixed	221	911	10.5	217	95	10.4
1,000 m	1000	1938	22.3	1000	2070	22.3
July 24, 2008						
	CSO 5			CSO 4		
	X (m)	S	W (m)	X (m)	S	W (m)
Bank Attached	9.0	5.8	1.2	13.6	4.8	0.35
Vertically Mixed	78	35	4.4	61	17	4.4
1,000 m	1000	120	14.8	1000	48	14.8
	CSO 31			CSO 32		
	X (m)	S	W (m)	X (m)	S	W (m)
Bank Attached	5.2	4.8	1.0	4.1	4.8	0.7
Vertically Mixed	75	42	4.2	69	49	4.0
1,000 m	1000	151	14.8	1000	192	14.8
July 27, 2008						
	CSO 5			CSO 4		
	X (m)	S	W (m)	X (m)	S	W (m)
Bank Attached	2.7	3.6	1.0	9.8	3.6	1.8
Vertically Mixed	48	42	3.1	55	17	3.5
1,000 m	1000	198	14.1	1000	72	14
	CSO 31			CSO 32		
	X (m)	S	W (m)	X (m)	S	W (m)
Bank Attached	2.4	3.8	0.9	1.9	4.3	0.9
Vertically Mixed	47	48	3.1	47	66	3.1
1,000 m	1000	226	14.2	1000	314	14.1

The results indicate that the discharges from the CSOs remained close to the bank even for a distance of one kilometer. In most cases, the plume width was about 15 m (50 ft) at one kilometer downstream from the outfall. In two cases the plume widths were about 22 m (72 ft); these corresponded with the lowest discharge rates and highest dilutions. Although river discharge and thickness of the upper layer had some effect on results, the primary factor affecting dilution was CSO discharge flow rate. For discharge rates in the range of 1.1 to 2.3 mgd, S values were generally between 35 and 66, indicating discharge: river water dilution ratios between 1:34 and 1:65. For discharges less than 1.0 mgd dilutions were considerably higher. The lowest predicted dilution, with S of 17, projects mixing at a 1:16 dilution with river water at a CSO 4, at a discharge rate of 1.7-1.8 mgd.

3.9 ZOI Analysis

3.9.1 Water Quality Criteria Violations

Water quality impairments in the Thames River estuary and their sources were discussed in Section 3.7. Information on bacteria, nutrients and BOD and DO was presented. The conclusions from that analysis are summarized here.

Three different bacteria were measured in the receiving waters because the water quality standards define criteria for these bacteria in different river segments depending on the use and if the water body is freshwater or saltwater. In freshwater, E. coli is used as the indicator bacteria for recreation including swimming and other recreational uses. In saltwater, fecal coliform bacteria is the indicator bacterium for shellfish harvesting while enterococci is the indicator for recreation uses including swimming.

Spatial and temporal trends for each storm were examined. For the first two storms bacteria concentrations were below the criteria at the 72 hour interval in most cases. The third storm was actually a series of storms. For this storm the highest concentrations were observed at the 12 hour sampling interval. At most stations, concentrations decreased significantly at the 24 hour sampling interval, decreased slightly at the 48 hour interval and then increased slightly at the 72 hour interval. At the time of the 72 hour samples additional rain had significantly increased CSO discharges particularly at CSO 17, near RS-7, CSOs 23, 25 and 19, near RS-6 and CSOs 4 and 5 near RS-8.

At three stations, RS-6, RS-8, and RS-9, additional samples were collected at approximately ¼ and ¾ distances across the channel. Although significant variations in concentrations were observed at the three cross channel stations, there was no consistent trend in where the highest concentrations were observed.

To examine the relative contributions of bacteria from the three rivers and the CSOs, a mass balance analysis was conducted. For the three monitored storm events, the combined discharges from all of the Norwich CSOs contributed about 40 percent of the E. coli discharged into the Thames River estuary. The CSOs were a minor contributor of Enterococci and contributed about one quarter of the fecal coliform bacteria.

Based on the results of the bacteria sampling it appears that CSO discharges are a significant source of E. coli and fecal coliform bacteria to the Thames River estuary. However, for each of the bacteria monitored, the CSO discharges were estimated to contribute less than half of the total loads during storm events. By examining the concentrations measured in upstream stations and the load calculations, it can be determined if all CSO discharges were eliminated in Norwich, water quality standards for bacteria would still not be met.

There are no water quality criteria for the nutrients phosphorus and nitrogen. However, elevated concentrations of these nutrients can lead to eutrophication of receiving waters, Analysis of orthophosphate results indicated that although some elevated samples were likely the result of the short-term effects of CSO and stormwater discharges, CSOs do not have a significant impact on overall orthophosphate concentrations. Overall concentrations of total nitrogen in the receiving waters during storm events were only slightly higher than those measured during dry weather. This would indicate that CSO discharges are not significantly affecting receiving water nitrogen concentrations.

The water quality criteria for DO for Class SB and Class B waters are not less than 5 mg/L at any time. While there are no water quality criteria for BOD, this parameter is important because high BOD loads can have a detrimental effect on DO levels in the receiving waters. BOD concentrations in natural waters, not impacted by organic loads are typically low, in the range of < 2 mg/L. The categorical standard for BOD for WWTFs providing secondary treatment is 30 mg/L.

The water quality criterion for DO was met at all times at stations RS-1 through RS-5. At stations RS-6 through RS-11, there were several sampling times where the DO criterion was not met at some of the receiving water stations during both dry weather sampling and during storm events.

During dry weather sampling, DO concentrations of slightly less than 5 mg/L were recorded at several Thames River stations at depths above the halocline and at one station below the halocline. In addition, concentrations of DO in the fresh water tidal segment of the Shetucket River were below the water quality criterion of 5 mg/L. These data indicated that in the absence of CSO discharges, there were some violations of the DO criterion.

During the storm events, several upper water column measurements of DO were less than 5 mg/L. While almost every station had at least one DO concentration of less than 5 mg/L, most of these lower concentrations were below the halocline at downstream stations. This indicates that the water within the salt wedge connected to Long Island Sound contains areas of low DO concentrations.

CSO discharges could affect receiving water concentrations of DO in two ways. One is by simple mixing of waters with two different concentrations; the other is through biochemical oxygen demand. Because the CSO discharges are fresh water they will tend to mix with water in the upper layer of the water column above the halocline. The concentration of DO in

the CSO discharges is approximately 0.5 mg/L. Therefore, mixing of CSO discharges and receiving water will decrease DO concentrations in the receiving water somewhat. However, because the volume of water discharged is small relative to the volume of water in the estuary, a decrease in DO concentrations due to mixing would affect relatively small areas of the estuary and would be short-term in nature. Once completely mixed, the decrease would be negligible.

The relative contribution of BOD from CSO discharges and from the river flows were estimated for each storm. The loading calculations indicate that CSO discharges contributed a small fraction on the total loads during storm events. Average BOD concentrations were in the range of those expected for effluent from secondary treatment plants. Overall, it appears that BOD loads from the CSO discharges should have a minor effect on DO concentrations in the estuary.

Several of the sampling surveys indicated lower DO concentrations of water below the halocline even during the initial hours of storm events. Tidal action that promotes mixing of the two layers would also bring some of the lower concentration bottom waters into the upper layer of the estuary. This lower concentration bottom water could also contribute to the lower concentrations observed in the upper layer.

Overall, it appears that CSO discharges have a very short term impact on DO in relatively small areas of the receiving waters due to mixing of very low DO water in the discharge with the receiving waters. Low DO concentrations, below the halocline, probably are not the result of CSO discharges, since the BOD loads from CSOs are a small fraction of total BOD loads to the estuary, even during storm events.

3.9.2 Risks to Human Health and the Environment

Water quality criteria have been established to protect beneficial uses of the Thames River estuary including protection of aquatic life, recreational activities and shellfish harvesting. If water quality criteria are violated there is a risk that the beneficial use may not be protected. Potential risks to human health from the CSO discharges include elevated bacteria concentrations that could affect human health during swimming or other recreational activities and consumption of shellfish. Potential risks to aquatic life include pH levels outside of the accepted range and low DO concentrations. Each of these factors was discussed in Sections 3.7 and 3.9.1.

It appears that CSO discharges are a significant source of E. coli and fecal coliform bacteria to the Thames River estuary during and immediately after storm events. However, for each of the bacteria monitored, the CSO discharges were estimated to contribute less than half of the total loads during storm events. Even if all CSO discharges were eliminated in Norwich, water quality standards for bacteria would still not be met.

Low DO concentrations were observed during the sampling surveys. However, they appear to be primarily a result of low DO concentrations in the lower layer of the Thames River and not to CSO discharges. Some excursions of the pH criteria were observed during the sampling

surveys. Some of these are likely due to CSO discharges. However, they are localized and short-term impacts.

3.9.3 Spawning and Nursery Areas

As part of Phase 2 of this LTCP, the recreational and aquatic life uses of the receiving water were defined (Kleinschmidt 2008). As part of that work benthic community and fish surveys were conducted in 2007. In addition to documenting the benthic and fish communities within the Thames River Estuary, the report also compared results of sample surveys conducted in 2007 with previous fish surveys conducted by the CTDEP.

Although 16 fish species were collected during the 2007 survey 2 species, the Atlantic menhaden and the Atlantic silverside, comprised 75 percent of the fish community. Less than one percent of the fish collected were anadromous fish. The CT DEP had similar results during their survey in 2006. The low numbers were in part due to the timing of the surveys. The conclusion of the report (Kleinschmidt 2008) was that the Thames River estuary was a low quality fish habitat due primarily to deep water, fine grained sediments and poor benthic communities.

Shellfish harvesting is prohibited in the Thames River Estuary near Norwich. The area south of RS-11 is conditionally restricted.

3.9.4 Zone of Passage

When approving a zone of influence the area allocated for mixing should not block the free passage of free-swimming or drifting organisms. Based on the results of the sampling and modeling it does not appear that the CSO discharges would block free passage of organisms through the Thames River estuary. Aquatic organisms can be affected by sudden changes in pH, DO, and temperature. Most of the measured pH values in the CSO discharges were within the range of the water quality criteria. A few values were in the range of 6.0 to 6.7. However, after mixing these would return to acceptable levels.

The CSO discharges have very low DO concentrations of about 0.5 mg/L. However, it would take a small amount of dilution to reach acceptable concentrations of DO. The plume modeling indicated that within a few meters of the outfalls, dilution would be about 4 (three parts of river water and 1 part effluent). Therefore, within a few meters the concentration of 0.5 mg/L would be raised to 4.6 mg/L, assuming a background concentration of 6 mg/L. By the time the plume is vertically mixed over the upper layer, DO concentrations would be 5.7 even at the predicted minimum dilution of 17.

The CSOs that discharge into the Shetucket River quickly become mixed with the river water. As the Shetucket River enters Norwich Harbor it will mix with the Thames River and the Yantic River. While the water in Norwich Harbor may not be completely uniform, there would be no identifiable plume from CSO discharges present in the harbor. Modeling indicated that plumes from CSO discharges into the Thames River estuary will travel along the bank in a relatively narrow band. In most cases the width of the plume would not exceed 10 percent of the river width even at a distance of one kilometer downstream of the discharge.

The CORMIX model does not account for mixing due to tidal currents. Eventually the plumes will mix across the river through tidal and wind action. However, dilutions will also increase due to these forces.

3.9.5 Cumulative Effects

The analysis conducted in this study included the combined impacts of all CSO discharges, discharges from the WWTP, and non-point source loads to the system. The primary impact of the CSO is elevated bacteria concentrations. A mass balance was developed to determine the relative loads of bacteria from CSO and non-point sources. The sampling also indicated that inflows from the salt wedge in the Thames River have an impact on pH, DO and bacteria concentrations, however, these impacts were not quantified.

3.10 Summary and Conclusions

The water quality-related portion of the study described in this section of the final report can be summarized as follows:

- An extensive water quality monitoring program was conducted in the spring/summer of 2008 to establish baseline conditions and to assess the impact of Norwich CSOs on water quality. The sampling program included dry weather and wet weather sampling (during three storm events) at eleven river monitoring stations above, near and below the areas of the CSO discharges.

- The Shetucket River is a rapidly flowing fresh water river that drains a large watershed, and discharges to the Thames River at Norwich Harbor. The Thames is a slow-moving, deep tidal river that has a fresh water lens overlaying a saline wedge. At Norwich Harbor, the halocline is typically about 10 feet below the surface. During wet weather the fresh water portion thickens and can become up to 20 feet thick before returning to its normal thickness after a storm event.

- Typically the pH and DO levels in the fresh water lens portion of the Thames River are within the range required to meet water quality standards (6.8 to 8.0 for pH and >5.0 for DO). Lower levels are observed below the halocline, but this problem occurs even during dry weather. CSOs do not appear to have any significant impact on pH or DO in the rivers.

- During storm events, it appears that CSO discharges contribute significantly to bacteria loading to the rivers, resulting in very high excursions immediately downstream of the CSOs during and immediately after the storms. However, the levels recede quickly following a storm. In the Thames River downstream of the CSOs bacteria levels return to background within 1-3 days following a storm event.

- Bacteria levels upstream of all Norwich CSOs can exceed water quality criteria for days after a storm event, presumably due to nonpoint source runoff upstream in the watershed. Furthermore, it appears that when the CSOs are discharging during wet weather events,

they are contributing less than half of the bacteria loading to the local rivers. Therefore, even if all Norwich CSOs were eliminated, the local rivers would not meet water quality standards for bacteria.

- The Norwich CSO discharges are not significant sources of nitrogen or phosphorus loading to the rivers.
- The CORMIX model of the CSO outfalls to the Thames River indicates that the plume of impact for CSO discharges will be about 50 feet in width approximately one kilometer (1,100 yards) below the outfall, and will tend to hug along the shoreline. Although the dissolved oxygen level in CSO discharges is low, in view of the high dilution factor and relatively low volume of the CSO discharge, the area with depressed DO will be small, extending only a few meters below the outfall during times of discharge. This narrow band of influence on the Thames River should not block the passage of fish or free-floating organisms.

3.11 References

CT DEP, 2002. *Water Quality Standards*. CT Dept. of Environmental Protection, Bureau of Water Management, Hartford, CT.

CT DEP, 2006. *2006 Integrated Water Quality Report to Congress*. CT Dept. of Environmental Protection, Bureau of Water Management, Hartford, CT.

Trench, E.C.T., 2005. *The Thames Science Plan: Suggested Hydrologic Investigations to support Nutrient-Related Water-Quality Improvements in the Thames River Basin, Connecticut*. U.S. Geological Survey Open-File Report 2005-1208, 47 p.

APPENDIX 1-F

Norwich, CT CSO Long Term Control Plan
All Three 2008 Monitored Storms: CSO and Stormwater
Summary Bacteria Results

Location	Date	E. Coli	Enterococci	Fecal Coliform
CSO 17				
Rose Alley	4/28/2008	78,491	12,245	63,319
	5/9/2008	82,198	18,518	104,421
	7/24/2008	1,291,019	26,056	1,458,703
	Geom Mean	202,709	18,078	212,861
	Median	82,198	18,518	104,421
CSO 24				
Eight St Bridge	4/28/2008	224,053	26,339	408,424
	5/9/2008	338,074	5,604	455,134
	7/24/2008	296,648	10,677	663,325
	Geom Mean	282,185	11,637	497,728
	Median	296,648	10,677	455,134
CSO 40				
Thamesville Shipping St	4/28/2008	935,610	16,448	1,626,259
	5/9/2008			
	7/24/2008			
	Geom Mean			
	Median			
SW - 1				
Yantic St / Residential	4/28/2008	2,714	4,190	2,923
	5/9/2008	9,754	6,488	10,648
	7/24/2008	34,641	400	56,125
	Geom Mean	9,716	2,215	12,044
	Median	9,754	4,190	10,648
SW - 2				
Franklin St / Downtown				
Residential	4/28/2008	6,303	6,068	7,822
	5/9/2008	8,144	4,657	10,158
	7/24/2008	49,407	6,394	33,098
	Geom Mean	13,637	5,653	13,803
	Median	8,144	6,068	10,158

All values above represent geometric means of samples taken

April 23 - Dry Weather

Norwich CSO Long Term Control Plan
Dry Weather Water Quality Monitoring Program 2008

Tides predicted for Norwich Harbor (from NOAA tide charts)

	Low	High	Low	High	Low
4/23/2008		0:07	6:44	12:42	18:35

Relation to CSOs	River Station		Location	Date Collected	LOW TIDE DRY WEATHER Time Collected	E. Coli	Entero	Fecal Coli	HIGH TIDE DRY WEATHER Time Collected	E. Coli	Entero	Fecal Coli
Upstream of all CSOs	1	RS-1	Sheucket Upstream	4/23/2008	6:00	10	300	10	12:10	10	< 10	20
	2	RS-2	Mouth of Quinnebaug	4/23/2008	6:22	60	230	20	12:30	20	10	< 10
	3	RS-3	Shetucket above dam	4/23/2008	6:45	20	< 10	20	13:15	30	20	10
Yantic	4	RS-4	Yantic, upstream of Hollyhock Isl.	4/23/2008	7:08	20	120	30	13:35	40	10	60
	5	RS-5	Below WWTF	4/23/2008	7:35	50	170	80	13:50	60	10	30
Downstream of CSOs 18-25	6M	RS6 M/SURF	Shetucket at Main St.	4/23/2008	10:56	70	< 10	80	14:55	90	20	110
	6-1/4	RS6 1/4 SURF		4/23/2008	10:58	N/A	10	N/A	15:08	N/A	20	N/A
	6-3/4	RS6 3/4 SURF		4/23/2008	10:59	N/A	< 10	N/A	14:59	N/A	< 10	N/A
Downstream of CSOs 17,29	7M	RS7 M/SURF	Harbor at Turning	4/23/2008	10:23	140	< 10	160	14:18	200	20	420
	7M (Dup)	RS7D M/SURF		4/23/2008	10:26	80	20	90	14:18	90	10	140
Downstream or Near CSOs 4,5,31,32,40	8M	RS8 M/SURF	Thames River near CSO 32	4/23/2008	9:20	N/A	60	140	13:40	N/A	10	170
	8-1/4	RS8 1/4 SURF		4/23/2008	9:27	N/A	30	140	14:06	N/A	50	170
	8-3/4	RS8 3/4 SURF		4/23/2008	9:25	N/A	20	180	14:01	N/A	10	110
Downstream of all CSOs	9M	RS9 M/SURF	Thames R. north of	4/23/2008	8:18	N/A	110	90	12:58	N/A	< 10	90
	9-1/4	RS9 1/4 SURF		4/23/2008	8:21	N/A	190	40	12:58	N/A	20	30
	9-3/4	RS9 3/4 SURF		4/23/2008	8:18	N/A	20	110	13:16	N/A	30	40
	10	RS10 M/SURF	Thames River at Route 2A Bridge	4/23/2008	7:37	N/A	20	100	12:46	N/A	10	20
	11	RS11 M/SURF	Thames R. at Poquetanuck Cove	4/23/2008	6:45	N/A	260	150	12:21	N/A	< 10	70

Norwich CSO Long Term Control Plan
Water Quality Field Data - 2008

TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
High Tide	4/23/2008	14:56	RS-6	MID	Surface	0	17.21	100	5.73	7.58
High Tide	4/23/2008	14:56	RS-6		1	18	17.21	190	5.49	7.59
High Tide	4/23/2008	14:56	RS-6		2	36	17.2	190	5.2	7.61
High Tide	4/23/2008	14:56	RS-6		3	54	17.2	190	5.31	7.62
High Tide	4/23/2008	14:56	RS-6		4	72	17.21	190	5.21	7.62
High Tide	4/23/2008	14:56	RS-6		5	90	17.23	190	5.37	7.61
High Tide	4/23/2008	14:44	RS-6	1/4	Surface	0	17.16	192	5.7	7.51
High Tide	4/23/2008	14:44	RS-6		1	18	17.16	192	5.19	7.53
High Tide	4/23/2008	14:44	RS-6		2	36	17.16	192	5.45	7.53
High Tide	4/23/2008	14:44	RS-6		3	54	17.17	192	5.06	7.53
High Tide	4/23/2008	14:44	RS-6		4	72	17.18	193	5.25	7.5
High Tide	4/23/2008	14:44	RS-6		5	90	17.2	192	5.65	7.56
High Tide	4/23/2008	14:50	RS-6	3/4	Surface	0	17.34	191	5.74	7.69
High Tide	4/23/2008	14:50	RS-6		1	18	17.34	190	5.16	7.7
High Tide	4/23/2008	14:50	RS-6		2	36	17.34	190	5.36	7.72
High Tide	4/23/2008	14:50	RS-6		3	54	17.33	191	5.7	7.77
High Tide	4/23/2008	14:50	RS-6		4	72	17.29	192	5.69	7.83
High Tide	4/23/2008	14:22	RS-7	MID	Surface	0	17.5	3350	6.64	7.87
High Tide	4/23/2008	14:22	RS-7		1	18	17.31	3611	6.48	7.93
High Tide	4/23/2008	14:22	RS-7		2	36	17.03	4182	6.75	7.96
High Tide	4/23/2008	14:22	RS-7		3	54	16.65	5100	6.08	7.98
High Tide	4/23/2008	14:22	RS-7		4	72	16.28	5870	5.31	7.95
High Tide	4/23/2008	14:22	RS-7		5	90	15.84	8600	6.1	7.99
High Tide	4/23/2008	14:22	RS-7		6	108	12.16	35300	6.68	7.74
High Tide	4/23/2008	14:22	RS-7		7	126	10.5	34700	6.65	7.69
High Tide	4/23/2008	14:22	RS-7		8	144	9.45	38100	6	7.76
High Tide	4/23/2008	14:22	RS-7		9	162	9.2	44200	6.14	7.77
High Tide	4/23/2008	14:22	RS-7		10	180	8.92	45600	6.84	7.78
High Tide	4/23/2008	14:22	RS-7		11	196	8.9	45700	6.56	7.79
High Tide	4/23/2008	14:22	RS-7		12	216	8.73	45900	6.74	7.78
High Tide	4/23/2008	14:22	RS-7		13	234	8.55	46000	6.3	7.77
High Tide	4/23/2008	14:22	RS-7		14	252	8.42	46000	6.62	7.75
High Tide	4/23/2008	14:22	RS-7		15	270	8.35	46100	6.92	7.74
High Tide	4/23/2008	14:22	RS-7		16	288	8.27	46100	6.66	7.74
High Tide	4/23/2008	14:22	RS-7		17	306	8.21	46100	6.64	7.72
High Tide	4/23/2008	14:22	RS-7		18	324	8.18	46100	6.99	7.71
High Tide	4/23/2008	14:22	RS-7		19	342	8.14	46200	6.79	7.7
High Tide	4/23/2008	14:22	RS-7		20	360	8.11	46200	6.54	7.69
High Tide	4/23/2008	14:22	RS-7		21	378	8.1	46200	6.8	7.69
High Tide	4/23/2008	14:22	RS-7		22	396	8.1	46200	6.45	7.69
High Tide	4/23/2008	14:22	RS-7		23	414	8.08	46200	6.51	7.69
High Tide	4/23/2008	14:22	RS-7		24	432	8.05	46200	5.94	7.67
High Tide	4/23/2008	14:22	RS-7		25	450	8.02	46200	6.42	7.65
High Tide	4/23/2008	14:22	RS-7		26	468	7.97	46200	6.15	7.64
High Tide	4/23/2008	14:22	RS-7		27	486	7.98	46200	6.75	7.65
High Tide	4/23/2008	13:47	RS-8	MID	Surface	0	17	209	5.69	7.88
High Tide	4/23/2008	13:47	RS-8		1	18	16.87	4000	6.53	7.92

Norwich CSO Long Term Control Plan
Water Quality Field Data - 2008

TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
High Tide	4/23/2008	13:47	RS-8		2	36	16.72	4800	5.21	7.99
High Tide	4/23/2008	13:47	RS-8		3	54	16.51	5400	4.95	8.04
High Tide	4/23/2008	13:47	RS-8		4	72	16.3	5880	5.81	8.09
High Tide	4/23/2008	13:47	RS-8		5	90	15.24	12000	5.47	8.04
High Tide	4/23/2008	13:47	RS-8		6	108	12.93	26600	4.92	7.94
High Tide	4/23/2008	13:47	RS-8		7	126	9.82	41000	4.51	7.98
High Tide	4/23/2008	13:47	RS-8		8	144	9.32	44000	4.92	8
High Tide	4/23/2008	13:47	RS-8		9	162	9.2	45400	4.97	7.99
High Tide	4/23/2008	13:47	RS-8		10	180	8.9	45800	6.17	7.99
High Tide	4/23/2008	13:47	RS-8		11	196	8.8	45000	5.7	8.02
High Tide	4/23/2008	13:47	RS-8		12	216	8.77	46100	2.7	8.05
High Tide	4/23/2008	13:47	RS-8		13	234	8.57	46100	5.11	9.05
High Tide	4/23/2008	13:47	RS-8		14	252	8.45	46100	3.82	7.99
High Tide	4/23/2008	13:47	RS-8		15	270	8.34	46100	4.01	7.96
High Tide	4/23/2008	13:47	RS-8		16	288	8.2	46200	4.7	7.95
High Tide	4/23/2008	13:47	RS-8		17	306	8.11	46300	4.85	7.92
High Tide	4/23/2008	13:47	RS-8		18	324	8.06	46300	3.22	7.9
High Tide	4/23/2008	13:47	RS-8		19	342	8.06	46300	4.21	7.87
High Tide	4/23/2008	13:47	RS-8		20	360	8.06	46300	3.04	7.85
High Tide	4/23/2008	13:47	RS-8		21	378	8.06	46300	3.26	7.83
High Tide	4/23/2008	13:47	RS-8		22	396	8.07	46200	3.96	7.8
High Tide	4/23/2008	13:47	RS-8		23	414	8.09	46300	4.4	7.74
High Tide	4/23/2008	13:47	RS-8		24	432	8.12	44800	3.98	7.61
High Tide	4/23/2008	13:47	RS-8		25	450	8.13	40000	3.85	7.42
High Tide	4/23/2008	13:47	RS-8		26	468	8.13	42200	2.89	7.38
High Tide	4/23/2008	13:47	RS-8		27	486	8.13	41200	3.29	7.39
High Tide	4/23/2008	13:47	RS-8		28	504	8.22	41200	3.54	7.39
High Tide	4/23/2008	13:47	RS-8		29	522	8.37	41200	4.78	7.4
High Tide	4/23/2008	13:47	RS-8		30	540	8.52	41300	4.38	7.42
High Tide	4/23/2008	13:47	RS-8		31	558	8.59	46600	5.51	7.46
High Tide	4/23/2008	13:50	RS-8	1/4	Surface	0	16.77	5090	6.96	7.76
High Tide	4/23/2008	13:50	RS-8		1	18	16.49	6600	6.48	7.77
High Tide	4/23/2008	13:50	RS-8		2	36	16.47	6600	6.58	7.81
High Tide	4/23/2008	13:50	RS-8		3	54	16.05	9200	6.45	7.84
High Tide	4/23/2008	13:50	RS-8		4	72	15.9	9900	6.55	7.96
High Tide	4/23/2008	13:50	RS-8		5	90	15.3	11800	6.67	7.9
High Tide	4/23/2008	13:50	RS-8		6	108	11.15	36100	6.77	7.76
High Tide	4/23/2008	13:50	RS-8		7	126	9.7	42600	6.36	7.77
High Tide	4/23/2008	13:50	RS-8		8	144	9.45	44000	6.44	7.7
High Tide	4/23/2008	13:50	RS-8		9	162	9.44	45000	5.94	7.76
High Tide	4/23/2008	13:50	RS-8		10	180	9.72	45000	6.5	7.73
High Tide	4/23/2008	14:05	RS-8	3/4	Surface	0	18.69	320	6.22	7.93
High Tide	4/23/2008	14:05	RS-8		1	18	18.28	2815	7.38	8.07
High Tide	4/23/2008	14:05	RS-8		2	36	17.3	3300	8	8.2
High Tide	4/23/2008	14:05	RS-8		3	54	17.09	3700	6.78	8.33
High Tide	4/23/2008	14:05	RS-8		4	72	16.57	4100	3.99	8.49
High Tide	4/23/2008	14:05	RS-8		5	90	16.06	6600	7.53	8.46

Norwich CSO Long Term Control Plan
Water Quality Field Data - 2008

TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
High Tide	4/23/2008	13:40	RS-9	MID	Surface	0	17.25	3520	6.93	7.75
High Tide	4/23/2008	13:40	RS-9		1	18	16.3	3510	6.57	7.45
High Tide	4/23/2008	13:40	RS-9		2	36	11.43	3670	7.71	7.35
High Tide	4/23/2008	13:40	RS-9		3	54	9.7	5850	8.95	7.31
High Tide	4/23/2008	13:40	RS-9		4	72	9.4	10200	9.12	7.31
High Tide	4/23/2008	13:40	RS-9		5	90	9.16	27000	8.8	7.3
High Tide	4/23/2008	13:40	RS-9		6	108	9.09	39500	8.94	7.29
High Tide	4/23/2008	13:40	RS-9		7	126	9.05	43500	8.67	7.3
High Tide	4/23/2008	13:40	RS-9		8	144	9.02	45400	8.47	7.28
High Tide	4/23/2008	13:40	RS-9		9	162	8.99	44400	8.92	7.28
High Tide	4/23/2008	13:40	RS-9		10	180	8.98	44400	9.2	7.29
High Tide	4/23/2008	13:40	RS-9		11	196	8.95	43500	9.01	7.31
High Tide	4/23/2008	13:40	RS-9		12	216	8.9	42400	9.14	7.36
High Tide	4/23/2008	13:40	RS-9		13	234	8.88	40000	9.31	7.52
High Tide	4/23/2008	13:40	RS-9		14	252	8.86	40000	9.69	7.6
High Tide	4/23/2008	13:40	RS-9		15	270	8.83	39200	10.09	7.64
High Tide	4/23/2008	13:40	RS-9		16	288	8.85	38700	10.71	7.64
High Tide	4/23/2008	13:40	RS-9		17	306	8.85	39200	10.63	7.69
High Tide	4/23/2008	13:40	RS-9		18	324	8.83	39400	10.63	7.7
High Tide	4/23/2008	13:40	RS-9		19	342	8.79	39700	10.61	7.7
High Tide	4/23/2008	13:40	RS-9		20	360	8.72	40900	10.54	7.73
High Tide	4/23/2008	13:40	RS-9		21	378	8.76	41700	10.5	7.74
High Tide	4/23/2008	13:40	RS-9		22	396	8.79	41500	10.48	7.78
High Tide	4/23/2008	13:40	RS-9		23	414	8.82	41400	10.48	7.81
High Tide	4/23/2008	13:40	RS-9		24	432	8.8	41700	10.42	7.88
High Tide	4/23/2008	13:40	RS-9		25	450	8.76	41400	10.49	8
High Tide	4/23/2008	13:40	RS-9		26	468	8.81	42200	10.44	8.07
High Tide	4/23/2008	13:40	RS-9		27	486	9.01	43800	10.22	8.09
High Tide	4/23/2008	13:40	RS-9		28	504	9.64	46900	9.97	8.09
High Tide	4/23/2008	13:40	RS-9		29	522	9.85	52200	9.72	8.05
High Tide	4/23/2008	13:40	RS-9		30	540	9.87	52200	9.46	8.03
High Tide	4/23/2008	13:28	RS-9	1/4	Surface	0	17.45	4000	5.82	7.95
High Tide	4/23/2008	13:28	RS-9		1	18	16.74	4375	6.9	7.99
High Tide	4/23/2008	13:28	RS-9		2	36	15.31	9998	4.94	7.97
High Tide	4/23/2008	13:28	RS-9		3	54	13.05	27300	6.12	7.86
High Tide	4/23/2008	13:28	RS-9		4	72	11.72	34900	7.2	7.86
High Tide	4/23/2008	13:28	RS-9		5	90	11.1	40300	6.62	7.84
High Tide	4/23/2008	13:28	RS-9		6	108	10.6	41200	6.56	7.81
High Tide	4/23/2008	13:28	RS-9		7	126	10.26	43300	6.94	7.69
High Tide	4/23/2008	13:17	RS-9	3/4	Surface	0	17.29	3950	7.22	8.03
High Tide	4/23/2008	13:17	RS-9		1	18	16.7	4000	6.39	7.36
High Tide	4/23/2008	13:17	RS-9		2	36	16.42	4125	4.98	7.32
High Tide	4/23/2008	13:17	RS-9		3	54	14.97	5564	9.41	7.3
High Tide	4/23/2008	13:17	RS-9		4	72	11.8	20200	9.36	7.31
High Tide	4/23/2008	13:17	RS-9		5	90	11.1	26900	9.05	7.32
High Tide	4/23/2008	13:17	RS-9		6	108	9.35	40000	8.12	7.32
High Tide	4/23/2008	13:17	RS-9		7	126	9.12	45000	7.52	7.33

Norwich CSO Long Term Control Plan
Water Quality Field Data - 2008

TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
High Tide	4/23/2008	13:17	RS-9		8	144	9.06	46000	7.13	7.33
High Tide	4/23/2008	13:17	RS-9		9	162	9.05	46200	7.53	7.33
High Tide	4/23/2008	13:17	RS-9		10	180	9.08	46300	8.01	7.32
High Tide	4/23/2008	13:17	RS-9		11	196	9.13	46300	8.15	7.32
High Tide	4/23/2008	13:17	RS-9		12	216	9.26	46500	7.65	7.33
High Tide	4/23/2008	13:17	RS-9		13	234	9.21	46500	8.07	7.33
High Tide	4/23/2008	13:17	RS-9		14	252	9.17	46000	7.47	7.34
High Tide	4/23/2008	13:17	RS-9		15	270	9.12	45700	7.33	7.34
High Tide	4/23/2008	13:17	RS-9		16	288	9.1	45700	7.4	7.34
High Tide	4/23/2008	13:17	RS-9		17	306	9.1	45600	8.13	7.35
High Tide	4/23/2008	13:17	RS-9		18	324	9.14	45700	7.91	7.36
High Tide	4/23/2008	13:17	RS-9		19	342	9.2	45600	7.75	7.37
High Tide	4/23/2008	13:17	RS-9		20	360	9.28	45600	7.92	7.37
High Tide	4/23/2008	13:17	RS-9		21	378	9.39	45000	7.34	7.39
High Tide	4/23/2008	13:17	RS-9		22	396	9.76	46000	7.36	7.42
High Tide	4/23/2008	13:17	RS-9		23	414	9.85	46032	7.71	7.44
High Tide	4/23/2008	13:17	RS-9		24	432	9.93	46000	7.91	7.46
High Tide	4/23/2008	13:17	RS-9		25	450	9.93	46100	8.03	7.5
High Tide	4/23/2008	13:17	RS-9		26	468	9.46	46000	8.63	7.53
High Tide	4/23/2008	13:17	RS-9		27	486	9.77	46300	8.77	7.55
High Tide	4/23/2008	13:17	RS-9		28	504	9.71	46100	9.7	7.57
High Tide	4/23/2008	13:17	RS-9		29	522	9.64	45900	9.94	7.56
High Tide	4/23/2008	13:17	RS-9		30	540	9.53	45500	9.99	7.57
High Tide	4/23/2008	13:17	RS-9		31	558	9.42	45000	10.05	7.58
High Tide	4/23/2008	12:44	RS-10		Surface	0	17.29	4600	6.06	7.22
High Tide	4/23/2008	12:44	RS-10		1	18	17.28	4700	7.48	7.76
High Tide	4/23/2008	12:44	RS-10		2	36	17.24	4700	7.75	7.8
High Tide	4/23/2008	12:44	RS-10		3	54	17.07	4695	8.66	7.89
High Tide	4/23/2008	12:44	RS-10		4	72	16.57	4870	4.68	7.99
High Tide	4/23/2008	12:44	RS-10		5	90	15.64	6600	6.82	8.12
High Tide	4/23/2008	12:44	RS-10		6	108	16.63	4160	5.01	7.86
High Tide	4/23/2008	12:44	RS-10		7	126	9.26	44800	6.29	7.89
High Tide	4/23/2008	12:44	RS-10		8	144	9.23	46900	5.74	7.89
High Tide	4/23/2008	12:44	RS-10		9	162	9.13	46500	5.94	7.89
High Tide	4/23/2008	12:44	RS-10		10	180	9	46700	6.87	7.89
High Tide	4/23/2008	12:44	RS-10		11	196	9	46800	6.87	7.89
High Tide	4/23/2008	12:44	RS-10		12	216	8.99	46800	6.14	7.88
High Tide	4/23/2008	12:44	RS-10		13	234	8.98	46800	5.92	7.88
High Tide	4/23/2008	12:44	RS-10		14	252	8.98	46800	6.01	7.88
High Tide	4/23/2008	12:44	RS-10		15	270	9	46700	7.13	7.88
High Tide	4/23/2008	12:44	RS-10		16	288	9.2	46700	6.45	7.87
High Tide	4/23/2008	12:44	RS-10		17	306	9.1	46800	8.36	7.85
High Tide	4/23/2008	12:44	RS-10		18	324	2.24	43500	6.66	7.44
High Tide	4/23/2008	12:44	RS-10		19	342	9.2	43600	7.18	7.44
High Tide	4/23/2008	12:44	RS-10		20	360	9.18	43300	6.62	7.44
High Tide	4/23/2008	12:44	RS-10		21	378	9.17	43300	7.04	7.44
High Tide	4/23/2008	12:44	RS-10		22	396	9.2	43100	6.62	7.45

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
High Tide	4/23/2008	12:44	RS-10		23	414	9.22	43100	6.76	7.45
High Tide	4/23/2008	12:44	RS-10		24	432	9.42	43000	6.94	7.45
High Tide	4/23/2008	12:44	RS-10		25	450	9.75	42900	6.5	7.45
High Tide	4/23/2008	12:44	RS-10		26	468	9.6	42800	5.62	7.46
High Tide	4/23/2008	12:44	RS-10		27	486	9.57	42580	5.73	7.49
High Tide	4/23/2008	12:44	RS-10		28	504	9.57	42475	6.24	7.48
High Tide	4/23/2008	12:44	RS-10		29	522	9.51	42400	6.53	7.47
High Tide	4/23/2008	12:44	RS-10		30	540	9.45	42100	6.44	7.47
High Tide	4/23/2008	12:44	RS-10		31	558	9.34	41500	6.41	7.49
High Tide	4/23/2008	12:02	RS-11		Surface	0	17.17	7200	6.28	7.72
High Tide	4/23/2008	12:02	RS-11		1	18	17.13	7189	6.4	7.8
High Tide	4/23/2008	12:02	RS-11		2	36	16.75	7290	6.25	7.87
High Tide	4/23/2008	12:02	RS-11		3	54	16.75	8400	5.9	6.35
High Tide	4/23/2008	12:02	RS-11		4	72	15.5	9000	5.94	6.06
High Tide	4/23/2008	12:02	RS-11		5	90	13.7	25000	6.44	7.81
High Tide	4/23/2008	12:02	RS-11		6	108	12.2	35300	6.66	7.85
High Tide	4/23/2008	12:02	RS-11		7	126	9.8	46500	6.6	7.88
High Tide	4/23/2008	12:02	RS-11		8	144	9.5	46700	6.65	7.87
High Tide	4/23/2008	12:02	RS-11		9	162	9.2	47100	6.37	7.87
High Tide	4/23/2008	12:02	RS-11		10	180	9.1	47300	6.64	7.87
High Tide	4/23/2008	12:02	RS-11		11	196	8.92	47400	5.78	7.87
High Tide	4/23/2008	12:02	RS-11		12	216	8.8	47500	7.32	7.87
High Tide	4/23/2008	12:02	RS-11		13	234	8.76	47700	6.88	7.87
High Tide	4/23/2008	12:02	RS-11		14	252	8.76	47800	6.9	7.88
High Tide	4/23/2008	12:02	RS-11		15	270	8.77	47821	5.48	7.88
High Tide	4/23/2008	12:02	RS-11		16	288	8.77	47800	7.27	7.87
High Tide	4/23/2008	12:02	RS-11		17	306	8.78	47900	6.6	7.87
Low tide	4/23/2008	10:42	RS-6	MID	Surface	0	16.58	185	7.58	7.49
Low tide	4/23/2008	10:42	RS-6		1	18	16.57	186	7.93	7.5
Low tide	4/23/2008	10:42	RS-6		2	36	16.57	186	7.93	7.51
Low tide	4/23/2008	10:42	RS-6		3	54	16.56	185	7.11	7.94
Low tide	4/23/2008	10:42	RS-6		4	72	16.56	185	7.4	7.51
Low tide	4/23/2008	10:58	RS-6	1/4	Surface	0	16.58	181	6.03	7.31
Low tide	4/23/2008	10:58	RS-6		1	18	16.57	182	6	7.33
Low tide	4/23/2008	10:58	RS-6		2	36	16.58	182	6.24	7.33
Low tide	4/23/2008	10:58	RS-6		3	54	16.58	182	6.84	7.33
Low tide	4/23/2008	10:58	RS-6		4	72	16.59	183	7.22	7.33
Low tide	4/23/2008	10:58	RS-6		5	90	16.83	184	7.92	7.4
Low tide	4/23/2008	10:58	RS-6		6	108	16.62	184	7.2	7.96
Low tide	4/23/2008	11:01	RS-6	3/4	Surface	0	16.6	5	4.78	7.39
Low tide	4/23/2008	11:01	RS-6		1	18	16.6	186	4.58	7.37
Low tide	4/23/2008	11:01	RS-6		2	36	16.59	186	4.32	7.37
Low tide	4/23/2008	11:01	RS-6		3	54	16.59	186	4.52	7.37
Low tide	4/23/2008	11:01	RS-6		4	72	16.6	186	4.59	7.36
Low tide	4/23/2008	9:54	RS-7	MID	Surface		16.13	1600	7.12	7.89
Low tide	4/23/2008	9:54	RS-7		1	18	16.1	1620	5.81	8.06
Low tide	4/23/2008	9:54	RS-7		2	36	16.05	1950	5.16	8.1

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
Low tide	4/23/2008	9:54	RS-7		3	54	15.95	2650	6.76	8.05
Low tide	4/23/2008	9:54	RS-7		4	72	14.8	9550	6.3	7.86
Low tide	4/23/2008	9:54	RS-7		5	90	13.3	22000	6.51	7.75
Low tide	4/23/2008	9:54	RS-7		6	108	12.22	27200	6.43	7.83
Low tide	4/23/2008	9:54	RS-7		7	126	9.36	39900	6	7.76
Low tide	4/23/2008	9:54	RS-7		8	144	9.3	44600	6	7.75
Low tide	4/23/2008	9:54	RS-7		9	162	8.97	45300	6.05	7.67
Low tide	4/23/2008	9:54	RS-7		10	180	8.85	45500	5.82	7.79
Low tide	4/23/2008	9:54	RS-7		11	196	8.73	45800	5.91	7.79
Low tide	4/23/2008	9:54	RS-7		12	216	8.58	45800	5.99	7.78
Low tide	4/23/2008	9:54	RS-7		13	234	8.52	45900	5.97	7.77
Low tide	4/23/2008	9:54	RS-7		14	252	8.43	46000	6.06	7.77
Low tide	4/23/2008	9:54	RS-7		15	270	8.33	46000	6.06	7.75
Low tide	4/23/2008	9:54	RS-7		16	288	8.25	46100	5.81	7.74
Low tide	4/23/2008	9:54	RS-7		17	306	8.18	46100	6.06	7.72
Low tide	4/23/2008	9:54	RS-7		18	324	8.11	46220	6.19	7.7
Low tide	4/23/2008	9:54	RS-7		19	342	8.11	46250	5.89	7.69
Low tide	4/23/2008	9:54	RS-7		20	360	8.09	46250	6.07	7.68
Low tide	4/23/2008	9:54	RS-7		21	378	8.09	46250	6.01	7.69
Low tide	4/23/2008	9:54	RS-7		22	396	8.09	46250	5.72	7.68
Low tide	4/23/2008	9:00	RS-8	MID	Surface		16.07	2050	7.07	8.3
Low tide	4/23/2008	9:00	RS-8		1	18	16	2140	6.58	8.1
Low tide	4/23/2008	9:00	RS-8		2	36	15.7	2710	7.54	7.28
Low tide	4/23/2008	9:00	RS-8		3	54	12.3	4050	7.77	7.26
Low tide	4/23/2008	9:00	RS-8		4	72	11	5000	8.51	7.28
Low tide	4/23/2008	9:00	RS-8		5	90	9.9	8800	8.38	7.29
Low tide	4/23/2008	9:00	RS-8		6	108	8.6	33200	6.8	7.3
Low tide	4/23/2008	9:00	RS-8		7	126	8.5	43200	3.26	7.29
Low tide	4/23/2008	9:00	RS-8		8	144	8.45	45200	6.2	7.29
Low tide	4/23/2008	9:00	RS-8		9	162	8.41	45600	6.18	7.29
Low tide	4/23/2008	9:00	RS-8		10	180	8.38	45700	6.09	7.29
Low tide	4/23/2008	9:00	RS-8		11	196	8.34	45900	6.03	7.28
Low tide	4/23/2008	9:00	RS-8		12	216	8.33	46000	6.24	7.27
Low tide	4/23/2008	9:00	RS-8		13	234	8.32	46000	6.61	7.25
Low tide	4/23/2008	9:00	RS-8		14	252	8.32	46100	6.56	7.23
Low tide	4/23/2008	9:00	RS-8		15	270	8.32	46050	6.82	7.2
Low tide	4/23/2008	9:00	RS-8		16	288	8.31	46000	7.04	7.18
Low tide	4/23/2008	9:00	RS-8		17	306	8.31	46000	6.97	7.19
Low tide	4/23/2008	9:00	RS-8		18	324	8.29	45600	6.98	7.19
Low tide	4/23/2008	9:00	RS-8		19	342	8.28	42800	7.4	7.19
Low tide	4/23/2008	9:00	RS-8		20	360	8.26	41700	7.46	7.19
Low tide	4/23/2008	9:00	RS-8		21	378	8.25	42400	7.45	7.2
Low tide	4/23/2008	9:00	RS-8		22	396	8.24	42400	7.47	7.21
Low tide	4/23/2008	9:00	RS-8		23	414	8.23	42400	7.51	7.21
Low tide	4/23/2008	9:00	RS-8		24	432	8.23	42700	7.35	7.22
Low tide	4/23/2008	9:00	RS-8		25	450	8.23	42600	7.33	7.24
Low tide	4/23/2008	9:00	RS-8		26	468	8.24	42900	7.28	7.27

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
Low tide	4/23/2008	9:00	RS-8		27	486	8.26	42700	7.22	7.29
Low tide	4/23/2008	9:00	RS-8		28	504	8.26	42400	7.31	7.31
Low tide	4/23/2008	9:00	RS-8		29	522	8.27	41550	7.5	7.31
Low tide	4/23/2008	9:00	RS-8		30	540	8.26	41625	7.43	7.32
Low tide	4/23/2008	9:00	RS-8		31	558	8.26	41780	7.56	7.32
Low tide	4/23/2008	9:37	RS-8	1/4	Surface		16.35	1872	6.59	7.83
Low tide	4/23/2008	9:37	RS-8		1	18	16.33	2000	5.27	7.86
Low tide	4/23/2008	9:37	RS-8		2	36	16.2	1870	5.53	8.01
Low tide	4/23/2008	9:37	RS-8		3	54	16.1	2340	6.04	8.08
Low tide	4/23/2008	9:37	RS-8		4	72	15.99	2820	5.86	8.1
Low tide	4/23/2008	9:37	RS-8		5	90	15.43	5200	5.99	8.03
Low tide	4/23/2008	9:37	RS-8		6	108	14.9	1051	6.66	8
Low tide	4/23/2008	9:37	RS-8		7	126	10.35	36000	5.89	7.74
Low tide	4/23/2008	9:37	RS-8		8	144	9.75	42000	5.61	7.76
Low tide	4/23/2008	9:37	RS-8		9	162	9.35	44500	6.06	7.79
Low tide	4/23/2008	9:37	RS-8		10	180	9.06	45100	6.02	7.79
Low tide	4/23/2008	9:37	RS-8		11	196	8.92	42000	5.91	7.8
Low tide	4/23/2008	9:37	RS-8		12	216	8.82	42100	6.16	7.8
Low tide	4/23/2008	9:37	RS-8		13	234	8.66	42500	6.1	7.79
Low tide	4/23/2008	9:37	RS-8		14	252	8.57	42600	6.13	7.78
Low tide	4/23/2008	9:37	RS-8		15	270	8.42	42700	6.2	7.77
Low tide	4/23/2008	9:37	RS-8		16	288	8.3	42700	6.17	7.74
Low tide	4/23/2008	9:37	RS-8		17	306	8.27	42800	6.1	7.73
Low tide	4/23/2008	9:37	RS-8		18	324	8.2	42800	5.9	7.7
Low tide	4/23/2008	9:37	RS-8		19	342	8.11	42800	6.04	7.66
Low tide	4/23/2008	9:37	RS-8		20	360	8.21	42600	6.2	7.67
Low tide	4/23/2008	9:37	RS-8		21	378	8.55	42200	6.05	7.43
Low tide	4/23/2008	9:37	RS-8		22	396	8.62	42100	6.26	7.45
Low tide	4/23/2008	9:37	RS-8		23	414	8.55	43100	6.28	7.53
Low tide	4/23/2008	9:37	RS-8		24	432	8.58	44000	6.21	7.54
Low tide	4/23/2008	9:37	RS-8		25	450	8.62	43400	6.04	7.55
Low tide	4/23/2008	9:37	RS-8		26	468	8.58	43870	5.99	7.55
Low tide	4/23/2008	9:37	RS-8		27	486	8.58	43700	6.12	7.56
Low tide	4/23/2008	9:26	RS-8	3/4	Surface		16.05	2050	6.72	7.79
Low tide	4/23/2008	9:26	RS-8		1	18	15.93	2050	7.32	7.82
Low tide	4/23/2008	9:26	RS-8		2	36	15.85	2530	6.29	7.85
Low tide	4/23/2008	9:26	RS-8		3	54	15.85	2744	6.28	7.9
Low tide	4/23/2008	9:26	RS-8		4	72	15.85	3140	6.82	7.8
Low tide	4/23/2008	7:51	RS-9	MID	Surface		15.63	2000	6.85	7.72
Low tide	4/23/2008	7:51	RS-9		1	18	15.6	3980	7.04	7.78
Low tide	4/23/2008	7:51	RS-9		2	36	15.45	4000	7.23	7.89
Low tide	4/23/2008	7:51	RS-9		3	54	15.52	4050	7.02	7.93
Low tide	4/23/2008	7:51	RS-9		4	72	15.63	4785	7.4	8.01
Low tide	4/23/2008	7:51	RS-9		5	90	15.63	5230	7.51	8.06
Low tide	4/23/2008	7:51	RS-9		6	108	14.9	10500	7.46	8.02
Low tide	4/23/2008	7:51	RS-9		7	126	10.82	40000	6.83	7.75
Low tide	4/23/2008	7:51	RS-9		8	144	9.7	44200	6.75	7.77

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
Low tide	4/23/2008	7:51	RS-9		9	162	9.25	45350	6.86	7.73
Low tide	4/23/2008	7:51	RS-9		10	180	8.8	45900	6.91	7.66
Low tide	4/23/2008	7:51	RS-9		11	196	8.7	46000	7.04	7.64
Low tide	4/23/2008	7:51	RS-9		12	216	8.53	46100	7.05	7.61
Low tide	4/23/2008	7:51	RS-9		13	234	8.34	46135	7.09	7.59
Low tide	4/23/2008	7:51	RS-9		14	252	8.28	46150	7.09	7.52
Low tide	4/23/2008	7:51	RS-9		15	270	8.28	44650	7.1	7.51
Low tide	4/23/2008	7:51	RS-9		16	288	8.27	45380	7.19	7.49
Low tide	4/23/2008	7:51	RS-9		17	306	8.26	44650	7.22	7.48
Low tide	4/23/2008	7:51	RS-9		18	324	8.24	44600	7.33	7.46
Low tide	4/23/2008	7:51	RS-9		19	342	8.3	43500	7.37	7.47
Low tide	4/23/2008	7:51	RS-9		20	360	8.44	44500	7.37	7.53
Low tide	4/23/2008	7:51	RS-9		21	378	8.47	44600	7.47	7.54
Low tide	4/23/2008	7:51	RS-9		22	396	8.45	47600	7.31	7.53
Low tide	4/23/2008	7:51	RS-9		23	414	8.46	47575	7.32	7.53
Low tide	4/23/2008	7:51	RS-9		24	432	8.47	47600	7.29	7.53
Low tide	4/23/2008	7:51	RS-9		25	450	8.44	47620	7.32	7.53
Low tide	4/23/2008	7:51	RS-9		26	468	8.44	47670	7.35	7.53
Low tide	4/23/2008	7:51	RS-9		27	486	8.43	47675	7.31	7.53
Low tide	4/23/2008	7:51	RS-9		28	504	8.44	47685	7.34	7.52
Low tide	4/23/2008	7:51	RS-9		29	522	8.44	47675	7.27	7.52
Low tide	4/23/2008	7:51	RS-9		30	540	8.42	47650	7.37	7.51
Low tide	4/23/2008	7:51	RS-9		31	558	8.4	47500	7.25	7.5
Low tide	4/23/2008	8:10	RS-9	1/4	Surface		15.52	2050	7.02	7.77
Low tide	4/23/2008	8:10	RS-9		1	18	15.63	3450	7.4	7.73
Low tide	4/23/2008	8:10	RS-9		2	36	15.63	3750	7.51	7.66
Low tide	4/23/2008	8:10	RS-9		3	54	14.63	4000	7.46	7.64
Low tide	4/23/2008	8:10	RS-9		4	72	13.2	4300	6.83	7.61
Low tide	4/23/2008	8:10	RS-9		5	90	10.2	4050	6.75	7.59
Low tide	4/23/2008	8:10	RS-9		6	108	9.25	4785	6.86	7.52
Low tide	4/23/2008	8:10	RS-9		7	126	9.4	5230	6.91	7.51
Low tide	4/23/2008	8:10	RS-9		8	144	8.7	10500	7.04	7.49
Low tide	4/23/2008	8:10	RS-9		9	162	8.71	40000	7.05	7.48
Low tide	4/23/2008	8:10	RS-9		10	180	8.34	44200	7.09	7.46
Low tide	4/23/2008	8:10	RS-9		11	196	8.28	45350	7.09	7.47
Low tide	4/23/2008	8:10	RS-9		12	216	8.28	45900	7.1	7.53
Low tide	4/23/2008	8:10	RS-9		13	234	8.27	46000	7.19	7.54
Low tide	4/23/2008	8:10	RS-9		14	252	8.26	46100	7.22	7.53
Low tide	4/23/2008	8:10	RS-9		15	270	8.24	46135	7.33	7.54
Low tide	4/23/2008	8:10	RS-9		16	288	8.3	46150	7.37	7.53
Low tide	4/23/2008	8:10	RS-9		17	306	8.44	44600	7.37	7.53
Low tide	4/23/2008	8:10	RS-9		18	324	8.47	47600	7.47	7.53
Low tide	4/23/2008	8:10	RS-9		19	342	8.44	47575	7.31	7.53
Low tide	4/23/2008	8:10	RS-9		20	360	8.43	47600	7.32	7.52
Low tide	4/23/2008	8:10	RS-9		21	378	8.44	47620	7.29	7.52
Low tide	4/23/2008	8:10	RS-9		22	396	8.44	47670	7.32	7.51
Low tide	4/23/2008	8:10	RS-9		23	414	8.42	47685	7.35	7.5

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
Low tide	4/23/2008	8:10	RS-9		24	432	8.44	47670	7.31	7.49
Low tide	4/23/2008	8:30	RS-9	3/4	Surface		15.62	2030	6.85	7.71
Low tide	4/23/2008	8:30	RS-9		1	18	15.6	3980	7.04	7.78
Low tide	4/23/2008	8:30	RS-9		2	36	15.45	4000	7.32	7.88
Low tide	4/23/2008	8:30	RS-9		3	54	15.52	4025	7.02	7.93
Low tide	4/23/2008	8:30	RS-9		4	72	15.6	4785	7.5	8
Low tide	4/23/2008	8:30	RS-9		5	90	15.63	5230	7.51	8.06
Low tide	4/23/2008	8:30	RS-9		6	108	14.9	11500	7.46	8.06
Low tide	4/23/2008	8:30	RS-9		7	126	11.5	40000	6.39	7.75
Low tide	4/23/2008	8:30	RS-9		8	144	10.2	44200	6.75	7.76
Low tide	4/23/2008	8:30	RS-9		9	162	9	44750	6.68	7.73
Low tide	4/23/2008	8:30	RS-9		10	180	8.8	45900	6.91	7.65
Low tide	4/23/2008	8:30	RS-9		11	196	8.7	46000	7.04	7.64
Low tide	4/23/2008	8:30	RS-9		12	216	8.53	46100	7.02	7.62
Low tide	4/23/2008	8:30	RS-9		13	234	8.3	46135	7.09	7.59
Low tide	4/23/2008	8:30	RS-9		14	252	8.28	46200	7.1	7.52
Low tide	4/23/2008	8:30	RS-9		15	270	8.28	44650	7.1	7.53
Low tide	4/23/2008	8:30	RS-9		16	288	8.25	45380	7.19	7.49
Low tide	4/23/2008	8:30	RS-9		17	306	8.26	44560	7.26	7.51
Low tide	4/23/2008	8:30	RS-9		18	324	8.24	44600	7.33	7.46
Low tide	4/23/2008	8:30	RS-9		19	342	8.25	43500	7.37	7.51
Low tide	4/23/2008	8:30	RS-9		20	360	8.44	44500	7.35	7.53
Low tide	4/23/2008	8:30	RS-9		21	378	8.39	44600	7.47	7.54
Low tide	4/23/2008	8:30	RS-9		22	396	8.45	47600	7.34	7.53
Low tide	4/23/2008	8:30	RS-9		23	414	8.46	47575	7.32	7.52
Low tide	4/23/2008	8:30	RS-9		24	432	8.38	47500	7.29	7.53
Low tide	4/23/2008	8:30	RS-9		25	450	8.44	47620	7.28	7.51
Low tide	4/23/2008	8:30	RS-9		26	468	8.44	47670	7.35	7.53
Low tide	4/23/2008	8:30	RS-9		27	486	8.42	47675	7.31	7.54
Low tide	4/23/2008	8:30	RS-9		28	504	8.44	47600	7.29	7.52
Low tide	4/23/2008	6:44	RS-10	MID	Surface		15.7	4500	7.15	7.78
Low tide	4/23/2008	6:44	RS-10		1	18	15.68	5000	6.84	7.8
Low tide	4/23/2008	6:44	RS-10		2	36	15.6	5200	6.57	7.86
Low tide	4/23/2008	6:44	RS-10		3	54	15.5	6000	6.88	7.91
Low tide	4/23/2008	6:44	RS-10		4	72	15	24600	6.38	7.87
Low tide	4/23/2008	6:44	RS-10		5	90	13	31200	6.18	7.67
Low tide	4/23/2008	6:44	RS-10		6	108	9.75	36900	6.55	7.3
Low tide	4/23/2008	6:44	RS-10		7	126	8.77	36830	6.85	7.71
Low tide	4/23/2008	6:44	RS-10		8	144	8.64	36800	6.82	7.68
Low tide	4/23/2008	6:44	RS-10		9	162	8.56	36800	6.67	7.63
Low tide	4/23/2008	6:44	RS-10		10	180	8.52	36800	6.86	7.55
Low tide	4/23/2008	6:44	RS-10		11	196	8.51	36800	6.76	7.44
Low tide	4/23/2008	6:44	RS-10		12	216	8.51	36800	6.69	7.28
Low tide	4/23/2008	6:44	RS-10		13	234	8.51	36800	6.88	7.11
Low tide	4/23/2008	6:44	RS-10		14	252	8.51	36800	7.03	7.07
Low tide	4/23/2008	6:44	RS-10		15	270	8.51	36782	6.94	7.07
Low tide	4/23/2008	6:44	RS-10		16	288	8.51	36780	7	7.07

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
Low tide	4/23/2008	6:44	RS-10		17	306	8.51	36775	6.84	7.07
Low tide	4/23/2008	6:44	RS-10		18	324	8.5	36750	6.78	7.08
Low tide	4/23/2008	6:44	RS-10		19	342	8.5	36700	6.98	7.1
Low tide	4/23/2008	6:44	RS-10		20	360	8.51	36750	7.16	7.13
Low tide	4/23/2008	6:44	RS-10		21	378	8.51	39250	6.89	7.17
Low tide	4/23/2008	6:44	RS-10		22	396	8.52	41300	6.98	7.19
Low tide	4/23/2008	6:44	RS-10		23	414	8.52	46650	6.65	7.21
Low tide	4/23/2008	6:44	RS-10		24	432	8.5	42750	6.73	7.22
Low tide	4/23/2008	6:44	RS-10		25	450	8.49	44750	6.59	7.26
Low tide	4/23/2008	6:44	RS-10		26	468	8.49	43950	6.71	7.31
Low tide	4/23/2008	6:44	RS-10		27	486	8.5	44200	6.5	7.38
Low tide	4/23/2008	6:44	RS-10		28	504	8.54	44440	5.53	7.44
Low tide	4/23/2008	6:44	RS-10		29	522	8.62	44680	6.11	7.5
Low tide	4/23/2008	6:44	RS-10		30	540	8.67	45700	6.45	7.58
Low tide	4/23/2008	6:37	RS-11	MID	Surface		15.3	5860	7.1	7.5
Low tide	4/23/2008	6:37	RS-11		1	18	15.3	6222	6.7	7.56
Low tide	4/23/2008	6:37	RS-11		2	36	15.27	9100	6.9	7.5
Low tide	4/23/2008	6:37	RS-11		3	54	15.1	11300	6.76	7.5
Low tide	4/23/2008	6:37	RS-11		4	72	14.5	13600	6.87	7.46
Low tide	4/23/2008	6:37	RS-11		5	90	14.28	29700	6.6	7.27
	4/28/2008	19:40	RS-6	MID	Surface		14.96	190	4.38	7.7
	4/28/2008	19:40	RS-6		1	18	14.96	190	4.73	7.72
	4/28/2008	19:40	RS-6		2	36	14.96	190	4.75	7.73
	4/28/2008	19:40	RS-6		3	54	14.96	190	4.41	7.74
	4/28/2008	19:40	RS-6		4	72	14.9	191	4.56	7.77
	4/28/2008	19:40	RS-6		5	90	14.96	191	4.86	7.7
	4/28/2008	19:51	RS-6	1/4	Surface		14.94	187	4.81	7.46
	4/28/2008	19:51	RS-6		1	18	14.94	186	5.15	7.46
	4/28/2008	19:51	RS-6		2	36	14.94	186	5.02	7.5
	4/28/2008	19:51	RS-6		3	54	14.94	186	5.06	7.49
	4/28/2008	19:51	RS-6		4	72	14.94	186	5.45	7.5
	4/28/2008	19:51	RS-6		5	90	14.94	186	4.72	7.52
	4/28/2008	19:51	RS-6		6	108	14.94	186	5.49	7.53
	4/28/2008	19:51	RS-6		7	126	14.9	186	5.35	7.54
	4/28/2008	19:51	RS-6	3/4	Surface		14.94	192	6.8	7.5
	4/28/2008	19:51	RS-6		1	18	14.94	192	7.09	7.58
	4/28/2008	19:51	RS-6		2	36	14.94	194	7.94	7.61
	4/28/2008	19:51	RS-6		3	54	14.94	194	8.54	7.62
	4/28/2008	19:51	RS-6		4	72	14.94	194	9.34	7.63
	4/28/2008	19:51	RS-6		5	90	14.9	195	9.65	7.82
	4/28/2008	19:07	RS-7	MID	Surface		13.3	1500	5.5	8.1
	4/28/2008	19:07	RS-7		1	18	13.3	1600	5.5	8.2
	4/28/2008	19:07	RS-7		2	36	13.5	1600	5.6	8.2
	4/28/2008	19:07	RS-7		3	54	13.7	1800	5.6	8.2
	4/28/2008	19:07	RS-7		4	72	13.8	3000	5.7	8.2
	4/28/2008	19:07	RS-7		5	90	13.84	3400	3.27	8.2
	4/28/2008	19:07	RS-7		6	108	12.4	7200	5.9	8.2

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/28/2008	19:07	RS-7		7	126	9.7	27000	5.7	7.8
	4/28/2008	19:07	RS-7		8	144	9.3	44000	6.1	7.8
	4/28/2008	19:07	RS-7		9	162	9.2	47500	5.9	7.8
	4/28/2008	19:07	RS-7		10	180	9.2	47700	5.7	7.8
	4/28/2008	19:07	RS-7		11	196	9.2	47000	5.6	7.8
	4/28/2008	19:07	RS-7		12	216	9.3	48000	5.6	7.8
	4/28/2008	19:07	RS-7		13	234	9.3	48000	5.5	7.8
	4/28/2008	19:07	RS-7		14	252	9.2	48000	5.8	7.8
	4/28/2008	19:07	RS-7		15	270	9.2	48000	5.9	7.8
	4/28/2008	19:07	RS-7		16	288	9.2	48000	5.7	7.8
	4/28/2008	19:07	RS-7		17	306	9.1	48000	5.6	7.8
	4/28/2008	19:07	RS-7		18	324	9.1	48000	5.8	7.8
	4/28/2008	19:07	RS-7		19	342	9	48000	5.6	7.8
	4/28/2008	19:07	RS-7		20	360	9	48000	5.3	7.7
	4/28/2008	19:07	RS-7		21	378	9	48000	5.8	7.7
	4/28/2008	19:07	RS-7		22	396	9	48400	5.9	7.7
	4/28/2008	19:07	RS-7		23	414	9	48400	5.7	7.6
	4/28/2008	19:07	RS-7		24	432	9.03	48000	5.46	7.76
	4/28/2008	19:07	RS-7		25	450	9.06	48400	6	7
	4/28/2008	19:07	RS-7		26	468	9.1	48000	5.79	7.72
	4/28/2008	18:35	RS-8	MID	Surface		14.3	4000	5.9	7.9
	4/28/2008	18:35	RS-8		1	18	14.3	4300	5.2	8
	4/28/2008	18:35	RS-8		2	36	14.2	4300	5.6	8.1
	4/28/2008	18:35	RS-8		3	54	13.99	6200	5.5	8.1
	4/28/2008	18:35	RS-8		4	72	13.6	8200	6.7	8.1
	4/28/2008	18:35	RS-8		5	90	12.5	10900	6.7	8.1
	4/28/2008	18:35	RS-8		6	108	10.75	26300	6.3	7.8
	4/28/2008	18:35	RS-8		7	126	9.7	40000	5.96	7.8
	4/28/2008	18:35	RS-8		8	144	9.5	46100	5.9	7.8
	4/28/2008	18:35	RS-8		9	162	9.44	46000	6.4	7.8
	4/28/2008	18:35	RS-8		10	180	9.4	47700	6.23	7.8
	4/28/2008	18:35	RS-8		11	196	9.4	47000	6.1	7.8
	4/28/2008	18:35	RS-8		12	216	9.4	48000	6.05	7.8
	4/28/2008	18:35	RS-8		13	234	9.33	48200	6.2	7.8
	4/28/2008	18:35	RS-8		14	252	9.3	48300	6	7.8
	4/28/2008	18:35	RS-8		15	270	9.28	48400	5.75	7.84
	4/28/2008	18:35	RS-8		16	288	9.27	48400	5.65	7.83
	4/28/2008	18:35	RS-8		17	306	9.25	48400	6.14	7.83
	4/28/2008	18:35	RS-8		18	324	9.2	48400	5.38	7.8
	4/28/2008	18:35	RS-8		19	342	9.19	48400	5.85	7.8
	4/28/2008	18:35	RS-8		20	360	9.18	48400	5.39	7.8
	4/28/2008	18:35	RS-8		21	378	9.24	48400	5.94	7.81
	4/28/2008	18:35	RS-8		22	396	9.3	48400	5.13	7.8
	4/28/2008	18:35	RS-8		23	414	9.32	48400	5.87	7.8
	4/28/2008	18:35	RS-8		24	432	9.29	48300	6.2	7.7
	4/28/2008	18:35	RS-8		25	450	9.15	48300	6.11	7.66
	4/28/2008	18:35	RS-8		26	468	9.08	44600	5.4	7.5

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/28/2008	18:35	RS-8		27	486	9.08	48200	5.54	7.67
	4/28/2008	18:35	RS-8		28	504	9.07	48300	5.22	7.64
	4/28/2008	18:35	RS-8		29	522	9.09	48100	5.8	7.58
	4/28/2008	18:55	RS-8	1/4	Surface		14.4	4000	6.2	7.7
	4/28/2008	18:55	RS-8		1	18	14.4	4300	6.4	7.7
	4/28/2008	18:55	RS-8		2	36	14.3	4600	6.25	7.81
	4/28/2008	18:55	RS-8		3	54	14.3	5200	6.1	7.8
	4/28/2008	18:55	RS-8		4	72	14.3	4700	6.7	7.9
	4/28/2008	18:55	RS-8		5	90	13.7	7300	6.99	7.7
	4/28/2008	18:55	RS-8		6	108	12.1	26400	5.2	7.5
	4/28/2008	18:55	RS-8		7	126	11.75	31400	5.84	7.37
	4/28/2008	19:01	RS-8	3/4	Surface		14.5	4400	6.4	7.6
	4/28/2008	19:01	RS-8		1	18	14.5	4400	5.8	7.6
	4/28/2008	19:01	RS-8		2	36	14.5	4500	6.1	7.6
	4/28/2008	19:01	RS-8		3	54	14.4	4500	6.3	7.6
	4/28/2008	19:01	RS-8		4	72	14.3	5800	5.9	7.5
	4/28/2008	19:01	RS-8		5	90	14.32	7500	6.2	7.4
	4/28/2008	17:42	RS-9	MID	Surface		14.4	5500	6.6	7.8
	4/28/2008	17:42	RS-9		1	18	14.4	5500	5.99	7.82
	4/28/2008	17:42	RS-9		2	36	14.4	5600	6.42	7.87
	4/28/2008	17:42	RS-9		3	54	14.4	5600	6.43	7.92
	4/28/2008	17:42	RS-9		4	72	14.4	5700	6.5	8
	4/28/2008	17:42	RS-9		5	90	14.4	5800	5.92	8.08
	4/28/2008	17:42	RS-9		6	108	14.3	6070	6.4	8.2
	4/28/2008	17:42	RS-9		7	126	11.4	37300	5.7	7.7
	4/28/2008	17:42	RS-9		8	144	10.2	44300	6.33	7.81
	4/28/2008	17:42	RS-9		9	162	9.95	47000	6.34	7.83
	4/28/2008	17:42	RS-9		10	180	9.7	48000	6.24	7.82
	4/28/2008	17:42	RS-9		11	196	9.57	47000	5.99	7.8
	4/28/2008	17:42	RS-9		12	216	9.54	47000	6.1	7.8
	4/28/2008	17:42	RS-9		13	234	9.52	35400	6	7.78
	4/28/2008	17:42	RS-9		14	252	9.51	38400	6.14	7.76
	4/28/2008	17:42	RS-9		15	270	9.51	38700	6.3	7.69
	4/28/2008	17:42	RS-9		16	288	9.55	42300	6.68	7.6
	4/28/2008	17:42	RS-9		17	306	9.54	44800	7.03	7.42
	4/28/2008	17:42	RS-9		18	324	9.55	32800	7.26	7.38
	4/28/2008	17:42	RS-9		19	342	9.52	42800	7	7.41
	4/28/2008	17:42	RS-9		20	360	9.52	42300	6.84	7.44
	4/28/2008	17:42	RS-9		21	378	9.53	43600	6.58	7.53
	4/28/2008	17:42	RS-9		22	396	9.54	44400	5.91	7.59
	4/28/2008	17:42	RS-9		23	414	9.55	47400	5.75	7.61
	4/28/2008	17:42	RS-9		24	432	9.56	47600	5.49	7.62
	4/28/2008	17:42	RS-9		25	450	9.62	47800	6.13	7.62
	4/28/2008	17:42	RS-9		26	468	9.81	46000	5.92	7.65
	4/28/2008	17:42	RS-9		27	486	9.86	47500	6.06	7.65
	4/28/2008	17:42	RS-9		28	504	9.83	47600	6.7	7.65
	4/28/2008	17:42	RS-9		29	522	9.8	47200	6.72	7.64

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/28/2008	17:42	RS-9		30	540	9.75	47100	6.27	7.64
	4/28/2008	17:42	RS-9		31	558	9.69	47300	5.9	7.65
	4/28/2008	18:17	RS-9	1/4	Surface		14.37	5500	6.41	7.67
	4/28/2008	18:17	RS-9		1	18	14.4	5600	6.6	7.7
	4/28/2008	18:17	RS-9		2	36	13.9	7400	7.2	7.5
	4/28/2008	18:17	RS-9		3	54	13.3	15100	7.3	7.5
	4/28/2008	18:17	RS-9		4	72	12.8	18200	6.26	7.29
	4/28/2008	18:17	RS-9		5	90	12.9	28500	6.6	7.2
	4/28/2008	18:17	RS-9		6	108	13.8	26100	6.3	7.1
	4/28/2008	18:17	RS-9		7	126	14.2	12100	6.2	7.34
	4/28/2008	18:17	RS-9		8	144	13.9	18000	6.1	7.3
	4/28/2008	18:17	RS-9		9	162	13.8	21000	5.5	7.3
	4/28/2008	18:17	RS-9		10	180	13.97	18000	5.4	7.3
	4/28/2008	18:17	RS-9		11	196	14.2	19000	5.96	7.28
	4/28/2008	18:17	RS-9		12	216	14.22	17600	6.21	7.39
	4/28/2008	18:17	RS-9		13	234	14.2	18000	6.7	7.4
	4/28/2008	18:17	RS-9		14	252	14.2	11700	6.13	7.56
	4/28/2008	18:17	RS-9		15	270	13.2	14300	6.71	7.7
	4/28/2008	18:05	RS-9	3/4	Surface		14.38	5500	6.49	7.72
	4/28/2008	18:05	RS-9		1	18	14.3	5690	7.12	8.03
	4/28/2008	18:05	RS-9		2	36	13.9	6200	6.25	8.11
	4/28/2008	18:05	RS-9		3	54	13.5	11200	7.42	8.06
	4/28/2008	18:05	RS-9		4	72	10.57	46000	5.98	7.81
	4/28/2008	18:05	RS-9		5	90	10.2	46200	6.3	7.86
	4/28/2008	18:05	RS-9		6	108	9.67	47400	5.97	7.88
	4/28/2008	18:05	RS-9		7	126	9.65	42300	6.36	7.87
	4/28/2008	18:05	RS-9		8	144	9.54	46300	6.26	7.89
	4/28/2008	18:05	RS-9		9	162	9.53	47300	5.95	7.89
	4/28/2008	18:05	RS-9		10	180	9.52	46700	6.29	7.89
	4/28/2008	18:05	RS-9		11	196	9.52	47600	5.63	7.89
	4/28/2008	18:05	RS-9		12	216	9.51	47800	6.26	7.88
	4/28/2008	18:05	RS-9		13	234	9.51	47800	5.55	7.86
	4/28/2008	18:05	RS-9		14	252	9.5	47100	5.88	7.81
	4/28/2008	18:05	RS-9		15	270	9.48	47600	6.91	7.72
	4/28/2008	18:05	RS-9		16	288	9.46	43200	5.86	7.45
	4/28/2008	18:05	RS-9		17	306	9.48	45100	5.55	7.45
	4/28/2008	18:05	RS-9		18	324	9.52	47600	6.27	7.66
	4/28/2008	18:05	RS-9		19	342	9.55	47000	5.77	7.83
	4/28/2008	18:05	RS-9		20	360	9.58	46000	6.62	7.73
	4/28/2008	18:05	RS-9		21	378	9.56	46000	6.2	7.2
	4/28/2008	18:05	RS-9		22	396	9.55	43800	6.2	7.2
	4/28/2008	18:05	RS-9		23	414	9.56	42100	6.35	7.25
	4/28/2008	18:05	RS-9		24	432	9.59	42000	5.35	7.3
	4/28/2008	18:05	RS-9		25	450	9.65	42200	5.6	7.37
	4/28/2008	18:05	RS-9		26	468	9.79	42500	6.35	7.91
	4/28/2008	18:05	RS-9		27	486	9.7	47100	5.57	7.74
	4/28/2008	17:11	RS-10	MID	Surface		14.46	5780	6.27	7.87

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/28/2008	17:11	RS-10		1	18	14.47	5800	7.05	7.94
	4/28/2008	17:11	RS-10		2	36	14.47	5870	6.6	8.01
	4/28/2008	17:11	RS-10		3	54	14.45	7444	7	8.07
	4/28/2008	17:11	RS-10		4	72	14.12	10100	7.61	8.2
	4/28/2008	17:11	RS-10		5	90	10.8	46100	6.3	7.87
	4/28/2008	17:11	RS-10		6	108	10.43	45300	6.18	7.86
	4/28/2008	17:11	RS-10		7	126	10.2	46500	6.75	7.85
	4/28/2008	17:11	RS-10		8	144	9.89	46100	6.87	7.88
	4/28/2008	17:11	RS-10		9	162	9.72	46100	6.44	7.9
	4/28/2008	17:11	RS-10		10	180	9.64	46100	6.03	7.91
	4/28/2008	17:11	RS-10		11	196	9.62	46300	5.9	7.92
	4/28/2008	17:11	RS-10		12	216	9.57	46500	6.6	7.91
	4/28/2008	17:11	RS-10		13	234	9.54	48100	5.97	7.92
	4/28/2008	17:11	RS-10		14	252	9.5	47100	6.14	7.91
	4/28/2008	17:11	RS-10		15	270	9.5	47100	6.57	7.92
	4/28/2008	17:11	RS-10		16	288	9.5	48200	6.39	7.91
	4/28/2008	17:11	RS-10		17	306	9.5	47800	6.27	7.91
	4/28/2008	17:11	RS-10		18	324	9.49	48100	5.89	7.9
	4/28/2008	17:11	RS-10		19	342	9.49	48000	6.14	7.89
	4/28/2008	17:11	RS-10		20	360	9.49	48100	5.75	7.88
	4/28/2008	17:11	RS-10		21	378	9.5	48000	6	7.84
	4/28/2008	17:11	RS-10		22	396	9.51	48300	6.46	7.69
	4/28/2008	17:11	RS-10		23	414	9.52	48100	7.41	7.3
	4/28/2008	17:11	RS-10		24	432	9.64	43800	6.67	7.34
	4/28/2008	17:11	RS-10		25	450	9.9	43700	6.48	7.37
	4/28/2008	17:11	RS-10		26	468	9.94	47800	6.56	7.45
	4/28/2008	17:11	RS-10		27	486	9.89	47600	6.48	7.54
	4/28/2008	17:11	RS-10		28	504	9.88	47000	5.57	7.54
	4/28/2008	17:11	RS-10		29	522	9.84	47200	6.03	7.55
	4/28/2008	17:11	RS-10		30	540	9.82	47200	6.05	7.55
	4/28/2008	17:11	RS-10		31	558	9.78	46300	6.11	7.57
	4/28/2008	17:00	RS- 11	MID	Surface		14.43	7500	9.49	7.83
	4/28/2008	17:00	RS- 11		1	18	14.37	7700	9.5	7.9
	4/28/2008	17:00	RS- 11		2	36	14.6	7900	9.48	7.97
	4/28/2008	17:00	RS- 11		3	54	13.75	14000	9.32	7.92
	4/28/2008	17:00	RS- 11		4	72	12.75	29300	8.62	7.7
	4/28/2008	17:00	RS- 11		5	90	11.77	42500	8.36	7.65
	4/28/2008	17:00	RS- 11		6	108	11.43	44500	8.36	7.54
	4/28/2008	17:00	RS- 11		7	126	11.31	45200	8.3	7.45
	4/28/2008	17:00	RS- 11		8	144	11.48	47600	8.98	7.56
	4/29/2008	7:06	RS-6	MID	Surface		14.2	181	4.4	7.6
	4/29/2008	7:06	RS-6		1	18	14.2	181	4.4	7.7
	4/29/2008	7:06	RS-6		2	36	14.2	180	4.1	7.7
	4/29/2008	7:06	RS-6		3	54	14.2	180	4.7	7.7
	4/29/2008	7:06	RS-6		4	72	14.2	181	4.8	7.7
	4/29/2008	7:06	RS-6		5	90	14.2	183	4.7	7.8
	4/29/2008	7:15	RS-6	1/4	Surface		14.1	176	4.5	7.5

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/29/2008	7:15	RS-6		1	18	14.1	176	5.1	7.4
	4/29/2008	7:15	RS-6		2	36	14.1	178	4.9	7.5
	4/29/2008	7:15	RS-6		3	54	14.1	180	4.8	7.5
	4/29/2008	7:15	RS-6		4	72	14.1	180	4.4	7.5
	4/29/2008	7:15	RS-6		5	90	14.1	178	4.43	7.47
	4/29/2008	7:21	RS-6	3/4	Surface		14.2	187	4.8	7.5
	4/29/2008	7:21	RS-6		1	18	14.2	187	4.7	7.5
	4/29/2008	7:21	RS-6		2	36	14.2	187	4.7	7.5
	4/29/2008	7:21	RS-6		3	54	14.2	187	4.4	7.5
	4/29/2008	7:21	RS-6		4	72	14.2	187	4.98	7.48
	4/29/2008	7:21	RS-6		5	90	14.2	187	5.14	7.5
	4/29/2008	6:58	RS7	MID	Surface		13	1000	6.3	8.2
	4/29/2008	6:58	RS7		1	18	13	1800	5.9	8.1
	4/29/2008	6:58	RS7		2	36	13	1800	6.3	8.2
	4/29/2008	6:58	RS7		3	54	13	1900	6.4	8.3
	4/29/2008	6:58	RS7		4	72	13	2000	5.8	8.3
	4/29/2008	6:58	RS7		5	90	13	2100	6.7	8.3
	4/29/2008	6:58	RS7		6	108	13	4600	6.5	8.3
	4/29/2008	6:58	RS7		7	126	13	7400	5.6	8.2
	4/29/2008	6:58	RS7		8	144	12.5	12000	5.8	8
	4/29/2008	6:58	RS7		9	162	11.5	17000	6.6	8
	4/29/2008	6:58	RS7		10	180	11	29000	6	7.9
	4/29/2008	6:58	RS7		11	196	10	38000	5.5	7.8
	4/29/2008	6:58	RS7		12	216	9.4	45000	5.4	7.8
	4/29/2008	6:58	RS7		13	234	9.3	48000	5.8	7.8
	4/29/2008	6:58	RS7		14	252	9.3	48000	5.6	7.8
	4/29/2008	6:58	RS7		15	270	9.2	48000	5.9	7.8
	4/29/2008	6:58	RS7		16	288	9.2	48000	5.2	7.8
	4/29/2008	6:58	RS7		17	306	9.2	48000	5.8	7.8
	4/29/2008	6:58	RS7		18	324	9.1	48000	5.6	7.8
	4/29/2008	6:58	RS7		19	342	9.1	48000	5.8	7.8
	4/29/2008	6:58	RS7		20	360	9	48000	5.9	7.8
	4/29/2008	6:58	RS7		21	378	9	48000	6.3	7.8
	4/29/2008	6:58	RS7		22	396	9	48000	5.6	7.8
	4/29/2008	6:58	RS7		23	414	9	48000	5.9	7.8
	4/29/2008	6:58	RS7		24	432	9	48000	4.8	7.8
	4/29/2008	6:58	RS7		25	450	9	48000	5.8	7.7
	4/29/2008	6:58	RS7		26	468	9	48000	5.9	7.7
	4/29/2008	6:58	RS7		27	486	8.6	48000	6.2	7.7
	4/29/2008	6:58	RS7		28	504	8.9	48000	5.7	7.7
	4/29/2008	6:58	RS7		29	522	8.9	48000	5.4	7.7
	4/29/2008	6:58	RS7		30	540	8.9	48000	5.2	7.7
	4/29/2008	6:58	RS7		31	558	8.9	48000	5.4	7.57
	4/29/2008	6:22	RS-8	MID	Surface		13.6	3200	6.5	7.9
	4/29/2008	6:22	RS-8		1	18	13.6	3800	6	7.9
	4/29/2008	6:22	RS-8		2	36	13.7	3900	6.6	7.9
	4/29/2008	6:22	RS-8		3	54	13.7	4500	7.1	7.9

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/29/2008	6:22	RS-8		4	72	13.7	5500	6	7.9
	4/29/2008	6:22	RS-8		5	90	13.6	7000	6.9	7.8
	4/29/2008	6:22	RS-8		6	108	13.5	8000	6.1	7.8
	4/29/2008	6:22	RS-8		7	126	13.4	8900	6.1	7.9
	4/29/2008	6:22	RS-8		8	144	13.3	9100	6.1	7.9
	4/29/2008	6:22	RS-8		9	162	13	10000	6.7	7.9
	4/29/2008	6:22	RS-8		10	180	13	11000	6.3	7.8
	4/29/2008	6:22	RS-8		11	196	12.7	12000	6.8	7.8
	4/29/2008	6:22	RS-8		12	216	12.4	14400	5.99	7.8
	4/29/2008	6:22	RS-8		13	234	12.3	18000	6.9	7.8
	4/29/2008	6:22	RS-8		14	252	12.2	23000	5.8	7.8
	4/29/2008	6:22	RS-8		15	270	12.2	25000	6.9	7.8
	4/29/2008	6:22	RS-8		16	288	11.7	25000	6.1	7.9
	4/29/2008	6:22	RS-8		17	306	11.2	27000	6.7	7.8
	4/29/2008	6:22	RS-8		18	324	10.7	29000	6.7	7.8
	4/29/2008	6:22	RS-8		19	342	10.5	38000	6.5	7.8
	4/29/2008	6:22	RS-8		20	360	9.8	37000	6.6	7.8
	4/29/2008	6:22	RS-8		21	378	9.7	47000	6.2	7.8
	4/29/2008	6:22	RS-8		22	396	9.5	47000	6.2	7.8
	4/29/2008	6:22	RS-8		23	414	9.5	47000	6.5	7.8
	4/29/2008	6:22	RS-8		24	432	9.5	48000	6.5	7.8
	4/29/2008	6:22	RS-8		25	450	9.4	48000	6.5	7.8
	4/29/2008	6:22	RS-8		26	468	9.4	48000	6.2	7.8
	4/29/2008	6:22	RS-8		27	486	9.3	48000	5.73	7.8
	4/29/2008	6:22	RS-8		28	504	9.2	48000	5.4	7.7
	4/29/2008	6:22	RS-8		29	522	9.2	48000	5.5	7.6
	4/29/2008	6:22	RS-8		30	540	9.3	48000	6.1	7.5
	4/29/2008	6:22	RS-8		31	558	9.4	48000	6.2	7.4
	4/29/2008	6:30	RS-8	1/4	Surface		13.6	4600	6	7.7
	4/29/2008	6:30	RS-8		1	18	13.6	5100	6	7.7
	4/29/2008	6:30	RS-8		2	36	13.6	5400	6.1	7.7
	4/29/2008	6:30	RS-8		3	54	13.6	6000	6.1	7.7
	4/29/2008	6:30	RS-8		4	72	13.5	6400	5.6	7.8
	4/29/2008	6:30	RS-8		5	90	13.4	6900	6	7.7
	4/29/2008	6:30	RS-8		6	108	13.3	8800	6.5	7.7
	4/29/2008	6:30	RS-8		7	126	13.3	9600	6.9	7.6
	4/29/2008	6:30	RS-8		8	144	12.9	14000	6.9	7.5
	4/29/2008	6:30	RS-8		9	162	12.47	20000	6.9	7.4
	4/29/2008	6:30	RS-8		10	180	12.4	21000	6.5	7.3
	4/29/2008	6:35	RS-8	3/4	Surface		14.1	4500	3.1	7.6
	4/29/2008	6:35	RS-8		1	18	14.1	4700	3.3	7.6
	4/29/2008	6:35	RS-8		2	36	14	4900	3.2	7.6
	4/29/2008	6:35	RS-8		3	54	13.9	5050	3.5	7.6
	4/29/2008	6:35	RS-8		4	72	13.9	5700	4	7.6
	4/29/2008	5:30	RS-9	MID	Surface		14.1	4700	5.29	7.91
	4/29/2008	5:30	RS-9		1	18	14.1	4700	6	7.9
	4/29/2008	5:30	RS-9		2	36	14.1	4700	6.2	7.9

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/29/2008	5:30	RS-9		3	54	14.1	4700	6.2	8.1
	4/29/2008	5:30	RS-9		4	72	14.1	4700	6.1	8.1
	4/29/2008	5:30	RS-9		5	90	14.1	4800	5	8.1
	4/29/2008	5:30	RS-9		6	108	13.95	5600	5.65	8.1
	4/29/2008	5:30	RS-9		7	126	13.7	7600	5.86	8.1
	4/29/2008	5:30	RS-9		8	144	13.45	10100	6.8	8
	4/29/2008	5:30	RS-9		9	162	12.7	16500	6.1	7.99
	4/29/2008	5:30	RS-9		10	180	10.4	36000	6.95	7.86
	4/29/2008	5:30	RS-9		11	196	9.58	47000	5.92	7.86
	4/29/2008	5:30	RS-9		12	216	9.55	48000	5.87	7.87
	4/29/2008	5:30	RS-9		13	234	9.52	48000	6.2	7.85
	4/29/2008	5:30	RS-9		14	252	9.5	48000	5.92	7.84
	4/29/2008	5:30	RS-9		15	270	9.5	48000	5.88	7.8
	4/29/2008	5:30	RS-9		16	288	9.52	48000	6.38	7.65
	4/29/2008	5:30	RS-9		17	306	9.55	48000	6.56	7.45
	4/29/2008	5:30	RS-9		18	324	9.6	48000	6.51	7.39
	4/29/2008	5:30	RS-9		19	342	9.57	43000	5.82	7.35
	4/29/2008	5:30	RS-9		20	360	9.55	41000	5.8	7.36
	4/29/2008	5:30	RS-9		21	378	9.55	41000	5.22	7.37
	4/29/2008	5:30	RS-9		22	396	9.54	41000	6.54	7.39
	4/29/2008	5:30	RS-9		23	414	9.56	41000	6.81	7.41
	4/29/2008	5:30	RS-9		24	432	9.58	40000	6.74	7.43
	4/29/2008	5:30	RS-9		25	450	9.63	41000	6.66	7.49
	4/29/2008	5:30	RS-9		26	468	9.82	42000	6.4	7.56
	4/29/2008	5:30	RS-9		27	486	9.85	48000	5.96	7.63
	4/29/2008	5:30	RS-9		28	504	9.83	49000	6.11	7.69
	4/29/2008	5:30	RS-9		29	522	9.81	49000	6.81	7.65
	4/29/2008	5:30	RS-9		30	540	9.78	49000	6.17	7.65
	4/29/2008	5:30	RS-9		31	558	9.76	49000	5.87	6.67
	4/29/2008	5:45	RS-9	1/4	Surface		14.1	4400	5.6	7.6
	4/29/2008	5:45	RS-9		1	18	14.1	4500	6.4	7.6
	4/29/2008	5:45	RS-9		2	36	14.1	4500	6.4	7.6
	4/29/2008	5:45	RS-9		3	54	14.1	4600	5.7	7.6
	4/29/2008	5:45	RS-9		4	72	14.1	5200	6.1	7.6
	4/29/2008	5:45	RS-9		5	90	14.1	4800	5.7	7.6
	4/29/2008	5:56	RS-9	3/4	Surface		14	4700	6.2	7.8
	4/29/2008	5:56	RS-9		1	18	14	4700	6	7.8
	4/29/2008	5:56	RS-9		2	36	14	4900	6.7	7.8
	4/29/2008	5:56	RS-9		3	54	14	5300	6.1	7.9
	4/29/2008	5:56	RS-9		4	72	14	5300	5.8	7.9
	4/29/2008	5:56	RS-9		5	90	13.9	5400	6.3	8
	4/29/2008	5:56	RS-9		6	108	13.9	5600	6.7	8
	4/29/2008	5:56	RS-9		7	126	13.7	7800	6.7	7.9
	4/29/2008	5:56	RS-9		8	144	13.2	12300	6.8	7.9
	4/29/2008	5:56	RS-9		9	162	12.5	21000	6.5	7.8
	4/29/2008	5:56	RS-9		10	180	10.2	36000	6.6	7.8
	4/29/2008	5:56	RS-9		11	196	10.2	46000	5.9	7.8

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/29/2008	5:56	RS-9		12	216	9.6	48000	6.5	7.9
	4/29/2008	5:56	RS-9		13	234	9.5	48000	6.2	7.9
	4/29/2008	5:56	RS-9		14	252	9.5	48000	6.2	7.9
	4/29/2008	5:56	RS-9		15	270	9.5	48000	6.3	7.9
	4/29/2008	5:56	RS-9		16	288	9.2	48000	6.4	7.9
	4/29/2008	5:56	RS-9		17	306	9.2	48000	6.6	7.9
	4/29/2008	5:56	RS-9		18	324	9.5	48000	5.7	7.9
	4/29/2008	5:56	RS-9		19	342	9.5	48000	6.3	7.8
	4/29/2008	5:56	RS-9		20	360	9.6	48000	6.6	7.8
	4/29/2008	5:15	RS-10	MID	Surface		14.2	5300	5.97	7.95
	4/29/2008	5:15	RS-10		1	18	14.1	5600	5.6	7.9
	4/29/2008	5:15	RS-10		2	36	14.1	6500	6.37	8
	4/29/2008	5:15	RS-10		3	54	14	6600	6.5	8.1
	4/29/2008	5:15	RS-10		4	72	13.7	8400	5.5	8.1
	4/29/2008	5:15	RS-10		5	90	12.76	10000	6.5	8.1
	4/29/2008	5:15	RS-10		6	108	13.1	15000	6.26	8.4
	4/29/2008	5:15	RS-10		7	126	10.51	42000	6.45	7.81
	4/29/2008	5:15	RS-10		8	144	10.27	44000	6.7	7.82
	4/29/2008	5:15	RS-10		9	162	10.2	46000	6.11	7.84
	4/29/2008	5:15	RS-10		10	180	10.2	46000	6.77	7.85
	4/29/2008	5:15	RS-10		11	196	9.81	47000	6.21	7.87
	4/29/2008	5:15	RS-10		12	216	9.72	48000	5.85	7.89
	4/29/2008	5:15	RS-10		13	234	9.64	48000	6.14	7.89
	4/29/2008	5:15	RS-10		14	252	9.59	48000	5.22	7.8
	4/29/2008	5:15	RS-10		15	270	9.68	40900	6.25	7.89
	4/29/2008	5:15	RS-10		16	288	9.58	47600	6.22	7.9
	4/29/2008	5:15	RS-10		17	306	9.8	48000	5.8	7.9
	4/29/2008	5:15	RS-10		18	324	9.55	48900	5.87	7.88
	4/29/2008	5:15	RS-10		19	342	9.54	49000	5.46	7.8
	4/29/2008	5:15	RS-10		20	360	9.54	49000	6	7.82
	4/29/2008	5:15	RS-10		21	378	9.54	49000	6.01	7.77
	4/29/2008	5:15	RS-10		22	396	9.57	46000	6.52	7.69
	4/29/2008	5:15	RS-10		23	414	9.6	42700	7.32	7.5
	4/29/2008	5:15	RS-10		24	432	9.64	42000	6.91	7.47
	4/29/2008	5:15	RS-10		25	450	9.62	41900	6.31	7.47
	4/29/2008	5:15	RS-10		26	468	9.61	41700	6.64	7.48
	4/29/2008	5:15	RS-10		27	486	9.64	41000	6.12	7.48
	4/29/2008	5:15	RS-10		28	504	9.75	42000	5.81	7.49
	4/29/2008	5:15	RS-10		29	522	9.82	48400	6.59	7.59
	4/29/2008	5:15	RS-10		30	540	9.84	49000	6.05	7.54
	4/29/2008	5:15	RS-10		31	558	9.78	49000	5.56	7.56
	4/29/2008	4:31	RS-11	MID	Surface		14.21	7600	7.77	7.81
	4/29/2008	4:31	RS-11		1	18	14.22	7700	7.87	7.86
	4/29/2008	4:31	RS-11		2	36	14.24	7900	8.46	7.9
	4/29/2008	4:31	RS-11		3	54	14.24	8060	9.2	8
	4/29/2008	4:31	RS-11		4	72	14.2	8250	7.33	8.01
	4/29/2008	4:31	RS-11		5	90	14.14	8300	4.68	8.03

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/29/2008	4:31	RS-11		6	108	13.97	9130	4.52	8.04
	4/29/2008	4:31	RS-11		7	126	12.7	17000	5.52	7.97
	4/29/2008	4:31	RS-11		8	144	11.4	32000	6.23	7.81
	4/29/2008	4:31	RS-11		9	162	10.23	46300	5.26	7.83
	4/29/2008	4:31	RS-11		10	180	9.98	47900	5.9	7.84
	4/29/2008	4:31	RS-11		11	196	9.82	48700	5.82	7.85
	4/29/2008	4:31	RS-11		12	216	9.72	48900	6.26	7.85
	4/29/2008	4:31	RS-11		13	234	9.7	49000	5.97	7.85
	4/29/2008	4:31	RS-11		14	252	9.69	49000	6.13	7.84
	4/29/2008	4:31	RS-11		15	270	9.68	49000	5.85	7.83
	4/29/2008	4:31	RS-11		16	288	9.67	49000	6.17	7.84
	4/29/2008	4:31	RS-11		17	306	9.67	49000	6.2	7.84
	4/29/2008	4:31	RS-11		18	324	9.67	48900	6.3	7.84
	4/29/2008	4:31	RS-11		19	342	9.67	48800	6.44	7.85
	4/29/2008	4:31	RS-11		20	360	9.68	48700	6.19	7.86
	4/29/2008	4:31	RS-11		21	378	9.68	48700	6.3	7.86
	4/29/2008	4:31	RS-11		22	396	9.68	48600	6.51	7.88
	4/29/2008	4:31	RS-11		23	414	9.68	48700	6.33	7.86
	4/29/2008	4:31	RS-11		24	432	9.7	48800	7.25	7.82
	4/29/2008	4:31	RS-11		25	450	9.78	48800	7.4	7.8
	4/29/2008	4:31	RS-11		26	468	9.85	48900	7.3	7.77
	4/29/2008	4:31	RS-11		27	486	9.78	48900	7.71	7.74
	4/30/2008	13:30	RS-6	MID	Surface		12.7	137	5.7	7.8
	4/30/2008	13:30	RS-6	1/4	Surface		12.6	131	6	7.3
	4/30/2008	13:30	RS-6	3/4	Surface		12.7	139	5.5	7.5
	4/30/2008	13:00	RS-7	MID	Surface		11.7	500	5.3	8.1
	4/30/2008	13:00	RS-7		1	18	11.7	600	5.6	8.1
	4/30/2008	13:00	RS-7		2	36	11.5	700	4.6	8.2
	4/30/2008	13:00	RS-7		3	54	11.5	800	4.9	8.2
	4/30/2008	13:00	RS-7		4	72	11.4	800	5.6	8.2
	4/30/2008	13:00	RS-7		5	90	11.4	900	5.1	8.2
	4/30/2008	13:00	RS-7		6	108	11.4	1000	5.3	8.2
	4/30/2008	13:00	RS-7		7	126	11.5	1100	5.3	8.3
	4/30/2008	13:00	RS-7		8	144	11.5	1200	4.9	8.3
	4/30/2008	13:00	RS-7		9	162	11.5	1300	5.4	8.3
	4/30/2008	13:00	RS-7		10	180	11.6	1500	5.1	8.4
	4/30/2008	13:00	RS-7		11	196	11.6	2600	4.2	8.3
	4/30/2008	13:00	RS-7		12	216	11.5	4700	5.5	8.1
	4/30/2008	13:00	RS-7		13	234	11	15300	5.1	7.8
	4/30/2008	13:00	RS-7		14	252	10.2	27400	5.4	7.6
	4/30/2008	13:00	RS-7		15	270	10.2	42000	4.9	7.4
	4/30/2008	13:00	RS-7		16	288	10.2	42200	4.7	7.2
	4/30/2008	12:35	RS-8	MID	Surface		12.4	2000	5.1	7.7
	4/30/2008	12:35	RS-8		1	18	12.4	2000	4.7	7.7
	4/30/2008	12:35	RS-8		2	36	12.4	2100	4.6	7.8
	4/30/2008	12:35	RS-8		3	54	12.4	2000	5.1	7.8
	4/30/2008	12:35	RS-8		4	72	12.4	2100	4.6	7.8

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/30/2008	12:35	RS-8		5	90	12.4	2000	5.2	7.8
	4/30/2008	12:35	RS-8		6	108	12.4	2100	5.1	7.9
	4/30/2008	12:35	RS-8		7	126	12.3	2300	4.8	7.9
	4/30/2008	12:35	RS-8		8	144	12.3	2400	5.2	7.9
	4/30/2008	12:35	RS-8		9	162	12.3	3200	4.9	7.8
	4/30/2008	12:35	RS-8		10	180	12.2	2300	4.7	7.9
	4/30/2008	12:35	RS-8		11	196	12.1	3400	5.2	7.9
	4/30/2008	12:35	RS-8		12	216	12	5400	4.9	7.9
	4/30/2008	12:35	RS-8		13	234	12	6000	4.6	7.9
	4/30/2008	12:35	RS-8		14	252	12	4800	5.9	8
	4/30/2008	12:35	RS-8		15	270	12	5600	4.9	8.1
	4/30/2008	12:35	RS-8		16	288	11.9	6000	5.6	8.2
	4/30/2008	12:35	RS-8		17	306	11.3	8000	5.1	8.2
	4/30/2008	12:35	RS-8		18	324	10.6	16000	5.8	8
	4/30/2008	12:35	RS-8		19	342	10.4	26000	4.6	7.8
	4/30/2008	12:35	RS-8		20	360	10.2	44000	4.8	7.8
	4/30/2008	12:35	RS-8		21	378	10.2	47000	4.7	7.8
	4/30/2008	12:35	RS-8		22	396	10.2	47800	5	7.8
	4/30/2008	12:35	RS-8		23	414	10.3	47800	5.2	7.8
	4/30/2008	12:35	RS-8		24	432	10.3	45000	5.3	7.8
	4/30/2008	12:35	RS-8		25	450	10.2	46900	5.2	7.8
	4/30/2008	12:35	RS-8		26	468	10.1	47900	5.2	7.8
	4/30/2008	12:35	RS-8		27	486	10.1	48000	5.3	7.8
	4/30/2008	12:35	RS-8		28	504	10.1	48000	5.5	7.8
	4/30/2008	12:35	RS-8		29	522	10.1	48000	6.7	7.8
	4/30/2008	12:35	RS-8		30	540	10.1	48000	5	7.7
	4/30/2008	12:35	RS-8		31	558	9.9	48000	5.4	7.6
	4/30/2008	12:48	RS-8	1/4	Surface		12.3	2500	4.7	7.5
	4/30/2008	12:48	RS-8		1	18	12.3	2500	2.3	7.5
	4/30/2008	12:48	RS-8		2	36	12.3	2500	4.1	7.5
	4/30/2008	12:48	RS-8		3	54	12.3	2500	4.7	7.8
	4/30/2008	12:48	RS-8		4	72	12.3	2500	5.1	7.5
	4/30/2008	12:48	RS-8		5	90	12.3	2600	5.1	7.5
	4/30/2008	12:48	RS-8		6	108	12.3	2600	4.8	7.5
	4/30/2008	12:48	RS-8		7	126	12.3	2600	4.7	7.5
	4/30/2008	12:48	RS-8		8	144	12.3	2600	4.9	7.5
	4/30/2008	12:48	RS-8		9	162	12.3	2600	4.8	7.6
	4/30/2008	12:45	RS-8	3/4	Surface		12.5	2500	5	7.6
	4/30/2008	12:45	RS-8		1	18	12.5	3100	4.9	7.5
	4/30/2008	12:45	RS-8		2	36	12.5	3200	5.3	7.4
	4/30/2008	12:45	RS-8		3	54	12.5	3300	4.4	7.4
	4/30/2008	12:45	RS-8		4	72	12.5	3400	5.4	7.4
	4/30/2008	12:45	RS-8		5	90	12.5	3400	5.2	7.4
	4/30/2008	12:45	RS-8		6	108	12.5	3400	6.5	7.3
	4/30/2008	12:20	RS-9	MID	Surface		12.6	1200	6.1	7.5
	4/30/2008	12:20	RS-9		1	18	12.5	3000	5.6	7.5
	4/30/2008	12:20	RS-9		2	36	12.4	3100	5.2	7.5

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/30/2008	12:20	RS-9		3	54	12.3	3000	5.8	7.5
	4/30/2008	12:20	RS-9		4	72	12.2	3000	6	7.5
	4/30/2008	12:20	RS-9		5	90	12.2	3200	5.1	7.5
	4/30/2008	12:20	RS-9		6	108	12.2	3300	5.3	7.5
	4/30/2008	12:20	RS-9		7	126	12.2	3300	5.4	7.5
	4/30/2008	12:20	RS-9		8	144	12.2	3300	5.3	7.5
	4/30/2008	12:20	RS-9		9	162	12.2	3300	5.8	7.5
	4/30/2008	12:20	RS-9		10	180	11.8	6200	5.2	7.9
	4/30/2008	12:20	RS-9		11	196	11.7	7500	5.7	7.9
	4/30/2008	12:20	RS-9		12	216	11.7	9300	5.3	7.9
	4/30/2008	12:20	RS-9		13	234	11.6	10500	4.4	7.8
	4/30/2008	12:20	RS-9		14	252	11.5	12000	5	7.8
	4/30/2008	12:20	RS-9		15	270	11.5	12600	4.5	7.8
	4/30/2008	12:20	RS-9		16	288	11	14000	4.9	7.8
	4/30/2008	12:20	RS-9		17	306	10.3	29000	4.3	7.6
	4/30/2008	12:20	RS-9		18	324	10.3	45000	5.2	7.5
	4/30/2008	12:20	RS-9		19	342	10.2	46000	5.6	7.8
	4/30/2008	12:20	RS-9		20	360	10.3	47000	4.8	7.8
	4/30/2008	12:20	RS-9		21	378	10.1	47000	4.9	7.8
	4/30/2008	12:20	RS-9		22	396	10.1	47000	4.9	7.8
	4/30/2008	12:20	RS-9		23	414	10.1	47900	5.7	7.7
	4/30/2008	12:20	RS-9		24	432	10.1	47900	5.4	7.5
	4/30/2008	12:20	RS-9		25	450	10.1	47900	5.9	7.7
	4/30/2008	12:20	RS-9		26	468	10.1	48000	6.9	7.7
	4/30/2008	12:20	RS-9		27	486	10.1	48000	7.3	7.8
	4/30/2008	12:20	RS-9		28	504	10.2	48000	8	7.8
	4/30/2008	12:20	RS-9		29	522	10.2	46000	7.9	7.8
	4/30/2008	12:20	RS-9		30	540	10.2	40000	8.2	7.6
	4/30/2008	12:20	RS-9		31	558	10.2	40500	2.4	7.4
	4/30/2008	12:24	RS-9	1/4	Surface		12.5	1700	5.2	7.4
	4/30/2008	12:24	RS-9		1	18	12.4	3500	5.3	7.4
	4/30/2008	12:24	RS-9		2	36	12.4	3500	5.3	7.4
	4/30/2008	12:24	RS-9		3	54	12.4	3500	5.3	7.4
	4/30/2008	12:24	RS-9		4	72	12.3	3400	4.8	7.5
	4/30/2008	12:24	RS-9		5	90	12.2	4300	5.4	7.4
	4/30/2008	12:24	RS-9		6	108	12.1	4400	4.7	7.4
	4/30/2008	12:24	RS-9		7	126	12.1	4700	5.2	7.4
	4/30/2008	12:30	RS-9	3/4	Surface		12.7	3200	5.1	7.4
	4/30/2008	12:30	RS-9		1	18	12.7	3200	5.4	7.4
	4/30/2008	12:30	RS-9		2	36	12.7	3300	5.1	7.4
	4/30/2008	12:30	RS-9		3	54	12.6	3300	5.1	7.4
	4/30/2008	12:30	RS-9		4	72	12.4	3300	5.3	7.4
	4/30/2008	12:30	RS-9		5	90	12.3	3500	5.3	7.4
	4/30/2008	12:30	RS-9		6	108	12.3	3600	5.7	7.4
	4/30/2008	12:30	RS-9		7	126	12.2	3700	5.8	7.4
	4/30/2008	12:30	RS-9		8	144	12.1	4500	5.6	7.3
	4/30/2008	12:30	RS-9		9	162	12.2	4500	5.3	7.2

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/30/2008	12:15	RS-10	MID	Surface		12.3	3500	6.3	7.7
	4/30/2008	12:15	RS-10		1	18	12.3	3600	6.6	7.7
	4/30/2008	12:15	RS-10		2	36	12.3	3500	6.3	7.8
	4/30/2008	12:15	RS-10		3	54	12.2	3600	5.8	7.8
	4/30/2008	12:15	RS-10		4	72	12.1	3600	7	7.8
	4/30/2008	12:15	RS-10		5	90	12	4000	6.5	7.8
	4/30/2008	12:15	RS-10		6	108	12	4100	6	7.9
	4/30/2008	12:15	RS-10		7	126	12	4200	5.8	7.9
	4/30/2008	12:15	RS-10		8	144	12	4300	6.5	7.9
	4/30/2008	12:15	RS-10		9	162	11.9	4400	6.6	7.9
	4/30/2008	12:15	RS-10		10	180	11.9	5000	6.5	7.9
	4/30/2008	12:15	RS-10		11	196	11.8	5000	6.2	7.9
	4/30/2008	12:15	RS-10		12	216	11.8	6300	6.4	7.9
	4/30/2008	12:15	RS-10		13	234	11.7	5300	6.4	8
	4/30/2008	12:15	RS-10		14	252	11.8	8100	6.4	7.9
	4/30/2008	12:15	RS-10		15	270	11.5	12500	6.6	7.9
	4/30/2008	12:15	RS-10		16	288	11.4	14800	6.7	7.9
	4/30/2008	12:15	RS-10		17	306	11.4	15000	5.8	7.9
	4/30/2008	12:15	RS-10		18	324	11.3	17000	6.3	7.9
	4/30/2008	12:15	RS-10		19	342	11.3	20000	6.2	7.9
	4/30/2008	12:15	RS-10		20	360	11.3	23000	5.9	7.8
	4/30/2008	12:15	RS-10		21	378	11.2	18000	6.3	7.9
	4/30/2008	12:15	RS-10		22	396	10.8	30000	5.5	7.9
	4/30/2008	12:15	RS-10		23	414	10.4	35000	5.8	7.9
	4/30/2008	12:15	RS-10		24	432	10.3	43000	5.5	7.8
	4/30/2008	12:15	RS-10		25	450	10.2	45000	6.2	7.8
	4/30/2008	12:15	RS-10		26	468	10	47000	5.6	7.8
	4/30/2008	12:15	RS-10		27	486	9.98	48000	5.8	7.8
	4/30/2008	12:15	RS-10		28	504	10	48000	5.76	7.86
	4/30/2008	12:15	RS-10		29	522	10	48000	5.76	7.86
	4/30/2008	12:15	RS-10		30	540	9.9	48000	3	7.8
	4/30/2008	12:15	RS-10		31	558	9.86	48500	6.01	7.8
	4/30/2008	12:00	RS-11	MID	Surface		12.5	4700	6.1	7.7
	4/30/2008	12:00	RS-11		1	18	12.3	4900	6.2	7.7
	4/30/2008	12:00	RS-11		2	36	12.4	4900	5.6	7.7
	4/30/2008	12:00	RS-11		3	54	12.3	4900	5.9	7.7
	4/30/2008	12:00	RS-11		4	72	12.3	5000	6.7	7.8
	4/30/2008	12:00	RS-11		5	90	12.2	5100	6.3	7.8
	4/30/2008	12:00	RS-11		6	108	12.2	5300	6.4	7.9
	4/30/2008	12:00	RS-11		7	126	12	5600	5.6	7.8
	4/30/2008	12:00	RS-11		8	144	12	6500	5.9	7.8
	4/30/2008	12:00	RS-11		9	162	11.9	7000	5.8	7.8
	4/30/2008	12:00	RS-11		10	180	11.9	7200	5.5	7.8
	4/30/2008	12:00	RS-11		11	196	11.9	9100	5.8	7.8
	4/30/2008	12:00	RS-11		12	216	11.8	7200	5.5	7.9
	4/30/2008	12:00	RS-11		13	234	11.8	9700	6.3	7.8
	4/30/2008	12:00	RS-11		14	252	11.7	10000	6.5	7.9

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	4/30/2008	12:00	RS-11		15	270	11.7	12400	6.8	7.9
	4/30/2008	12:00	RS-11		16	288	11.2	27000	4.3	7.9
	4/30/2008	12:00	RS-11		17	306	10.5	29000	6.6	7.6
	4/30/2008	12:00	RS-11		18	324	11.2	28300	6.1	7.4
	4/30/2008	12:00	RS-11		19	342	11.3	28000	5.4	7.3
	4/30/2008	12:00	RS-11		20	360	11.3	28000	5.7	7.3
	4/30/2008	12:00	RS-11		21	378	11.3	28000	5.9	7.3
	4/30/2008	12:00	RS-11		22	396	11.3	28000	6.4	7.3
	4/30/2008	12:00	RS-11		23	414	11.3	28000	6.1	7.3
	4/30/2008	12:00	RS-11		24	432	11.4	28000	6.1	7.3
	4/30/2008	12:00	RS-11		25	450	11.4	27900	5.8	7.3
	4/30/2008	12:00	RS-11		26	468	11.4	27900	5.6	7.3
	4/30/2008	12:00	RS-11		27	486	11.4	27900	5.7	7.3
	4/30/2008	12:00	RS-11		28	504	11.45	27800	5.9	7.3
	4/30/2008	12:00	RS-11		29	522	11.45	27800	5.2	7.3
	4/30/2008	12:00	RS-11		30	540	11.45	27700	5.65	7.3
	4/30/2008	12:00	RS-11		31	558	11.46	27500	5.44	7.3
	5/1/2008	13:16	RS-6	MID	Surface		12.5	138	5.5	7.5
	5/1/2008	13:20	RS-6	1/4	Surface		12.5	134	7.3	7.4
	5/1/2008	13:21	RS-6	3/4	Surface		12.6	139	6.5	7.4
	5/1/2008	12:58	RS-7	MID	Surface		12.2	1000	6.7	8.1
	5/1/2008	12:58	RS-7		1	18	12.2	1000	6.2	8.1
	5/1/2008	12:58	RS-7		2	36	12.2	1000	6.7	8.2
	5/1/2008	12:58	RS-7		3	54	12.1	1300	5.5	8.2
	5/1/2008	12:58	RS-7		4	72	12.1	1600	6.1	8.2
	5/1/2008	12:58	RS-7		5	90	12	1900	5.7	8.2
	5/1/2008	12:58	RS-7		6	108	12	1800	6.4	8.3
	5/1/2008	12:58	RS-7		7	126	12	1800	5.1	8.4
	5/1/2008	12:58	RS-7		8	144	11.9	1900	5.9	8.4
	5/1/2008	12:58	RS-7		9	162	11.8	3300	5.1	8.3
	5/1/2008	12:58	RS-7		10	180	11.8	3800	6.2	8.4
	5/1/2008	12:58	RS-7		11	196	11.3	5800	6.1	8.1
	5/1/2008	12:58	RS-7		12	216	10.4	21000	6	8.1
	5/1/2008	12:58	RS-7		13	234	10.2	38000	5.2	7.9
	5/1/2008	12:58	RS-7		14	252	9.9	42000	5.4	7.9
	5/1/2008	12:58	RS-7		15	270	9.9	47000	5.6	7.9
	5/1/2008	12:58	RS-7		16	288	9.8	47000	5.1	7.8
	5/1/2008	12:58	RS-7		17	306	9.8	47000	5.1	7.9
	5/1/2008	12:58	RS-7		18	324	9.8	47000	4.7	7.9
	5/1/2008	12:58	RS-7		19	342	9.7	47900	5.6	7.9
	5/1/2008	12:58	RS-7		20	360	9.6	48000	5.8	7.9
	5/1/2008	12:58	RS-7		21	378	9.6	48000	5.8	7.9
	5/1/2008	12:58	RS-7		22	396	9.6	48000	5.7	7.9
	5/1/2008	12:58	RS-7		23	414	9.6	48000	5.3	7.9
	5/1/2008	12:58	RS-7		24	432	9.6	48000	5.7	7.8
	5/1/2008	12:58	RS-7		25	450	9.6	48000	5.3	7.9
	5/1/2008	12:58	RS-7		26	468	9.6	48000	5.4	7.9

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/1/2008	12:58	RS-7		27	486	9.6	48000	5.4	7.8
	5/1/2008	12:58	RS-7		28	504	9.7	48000	5.1	7.8
	5/1/2008	12:58	RS-7		29	522	9.7	48000	5	7.8
	5/1/2008	12:58	RS-7		30	540	9.6	48000	5.3	7.8
	5/1/2008	12:58	RS-7		31	558	9.7	47000	5.3	7.7
	5/1/2008	12:50	RS-8	MID	Surface		12.1	1200	7	8
	5/1/2008	12:38	RS-8		1	18	12.1	2400	6.6	8.1
	5/1/2008	12:38	RS-8		2	36	12	2800	6.5	8.1
	5/1/2008	12:38	RS-8		3	54	11.9	3100	6.7	8.1
	5/1/2008	12:38	RS-8		4	72	11.9	3800	5.9	8.1
	5/1/2008	12:38	RS-8		5	90	11.8	3900	6.7	8.1
	5/1/2008	12:38	RS-8		6	108	11.7	4700	6.5	8.1
	5/1/2008	12:38	RS-8		7	126	11.7	6200	7.3	8.1
	5/1/2008	12:38	RS-8		8	144	11.5	7700	5.7	8.1
	5/1/2008	12:38	RS-8		9	162	11.4	9400	6.3	8.1
	5/1/2008	12:38	RS-8		10	180	11.3	11000	6.7	8.1
	5/1/2008	12:38	RS-8		11	196	11.2	12200	7.7	8.2
	5/1/2008	12:38	RS-8		12	216	10.3	16400	7.4	8.2
	5/1/2008	12:38	RS-8		13	234	9.7	46000	6	7.7
	5/1/2008	12:38	RS-8		14	252	9.7	48100	5.1	7.9
	5/1/2008	12:38	RS-8		15	270	9.7	48000	5.6	7.9
	5/1/2008	12:38	RS-8		16	288	9.6	48000	5.8	7.9
	5/1/2008	12:38	RS-8		17	306	9.6	48000	5.9	7.9
	5/1/2008	12:38	RS-8		18	324	9.6	48000	5.9	7.9
	5/1/2008	12:38	RS-8		19	342	9.6	48000	5.2	7.8
	5/1/2008	12:38	RS-8		20	360	9.6	48000	5.3	7.8
	5/1/2008	12:38	RS-8		21	378	9.7	48000	5.7	7.7
	5/1/2008	12:38	RS-8		22	396	9.7	44300	5.9	7.6
	5/1/2008	12:38	RS-8		23	414	9.7	43500	5.3	7.5
	5/1/2008	12:38	RS-8		24	432	9.7	43100	6	7.5
	5/1/2008	12:38	RS-8		25	450	9.7	43200	6.1	7.6
	5/1/2008	12:38	RS-8		26	468	9.7	43000	6.4	7.6
	5/1/2008	12:38	RS-8		27	486	9.8	48000	5.4	7.7
	5/1/2008	12:38	RS-8		28	504	9.8	48000	5.7	7.7
	5/1/2008	12:38	RS-8		29	522	9.8	48000	5.7	7.7
	5/1/2008	12:38	RS-8		30	540	9.8	48000	6	7.7
	5/1/2008	12:38	RS-8		31	558	9.8	48000	6.5	7.6
	5/1/2008	12:47	RS-8	1/4	Surface		12.2	3000	6.4	7.7
	5/1/2008	12:47	RS-8		1	18	12.1	3100	6.6	7.7
	5/1/2008	12:47	RS-8		2	36	12.1	3200	6.4	7.7
	5/1/2008	12:47	RS-8		3	54	12.2	3200	6	7.7
	5/1/2008	12:47	RS-8		4	72	12.2	3300	5.6	7.7
	5/1/2008	12:47	RS-8		5	90	12.2	3200	5.4	7.7
	5/1/2008	12:50	RS-8	3/4	Surface		12.6	3200	5.5	7.5
	5/1/2008	12:50	RS-8		1	18	12.4	3200	5.4	7.5
	5/1/2008	12:50	RS-8		2	36	12.4	3200	6	7.5
	5/1/2008	12:50	RS-8		3	54	12.5	3200	5.9	7.5

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/1/2008	12:50	RS-8		4	72	12.5	3100	6.1	7.5
	5/1/2008	12:50	RS-8		5	90	12.5	2700	6.7	7.6
	5/1/2008	12:50	RS-8		6	108	12.4	2600	6.4	7.6
	5/1/2008	12:50	RS-8		7	126	12.4	2800	6	7.6
	5/1/2008	12:50	RS-8		8	144	12.2	3000	5.7	7.7
	5/1/2008	12:50	RS-8		9	162	12.2	2700	5.7	7.6
	5/1/2008	12:18	RS-9	MID	Surface		12.3	3700	6.1	7.8
	5/1/2008	12:18	RS-9		1	18	12.3	3700	6.8	7.8
	5/1/2008	12:18	RS-9		2	36	12.2	3700	5.9	7.9
	5/1/2008	12:18	RS-9		3	54	12.1	3800	6	7.9
	5/1/2008	12:18	RS-9		4	72	12.1	3900	5.9	7.9
	5/1/2008	12:18	RS-9		5	90	11.9	4000	6	8
	5/1/2008	12:18	RS-9		6	108	11.7	4100	5.5	8.1
	5/1/2008	12:18	RS-9		7	126	11.5	4600	5.8	8.1
	5/1/2008	12:18	RS-9		8	144	11.5	5600	6.1	8
	5/1/2008	12:18	RS-9		9	162	11.4	8000	5.9	7.9
	5/1/2008	12:18	RS-9		10	180	11.3	9000	5.5	8
	5/1/2008	12:18	RS-9		11	196	11.1	11500	5.6	7.9
	5/1/2008	12:18	RS-9		12	216	10.5	17800	6.2	7.8
	5/1/2008	12:18	RS-9		13	234	10.2	34000	6.2	7.5
	5/1/2008	12:18	RS-9		14	252	10.2	32600	7.5	7.3
	5/1/2008	12:18	RS-9		15	270	10.2	37000	6.2	7.3
	5/1/2008	12:18	RS-9		16	288	10.2	37000	6.3	7.3
	5/1/2008	12:18	RS-9		17	306	10.2	37500	6.7	7.3
	5/1/2008	12:18	RS-9		18	324	10.2	37500	6.4	7.4
	5/1/2008	12:18	RS-9		19	342	10.4	37600	6.5	7.5
	5/1/2008	12:18	RS-9		20	360	10.3	38300	6.2	7.6
	5/1/2008	12:18	RS-9		21	378	10.2	40000	5.6	7.6
	5/1/2008	12:18	RS-9		22	396	10	44300	6.2	7.5
	5/1/2008	12:18	RS-9		23	414	9.9	45000	6.2	7.5
	5/1/2008	12:18	RS-9		24	432	9.9	46000	6.2	7.5
	5/1/2008	12:18	RS-9		25	450	9.9	46000	6	7.5
	5/1/2008	12:18	RS-9		26	468	9.9	45300	5.1	7.5
	5/1/2008	12:18	RS-9		27	486	10	46000	5.7	7.5
	5/1/2008	12:18	RS-9		28	504	10.2	46300	5.2	7.5
	5/1/2008	12:18	RS-9		29	522	10.4	46000	6.4	7.5
	5/1/2008	12:18	RS-9		30	540	10.4	44100	5.9	7.5
	5/1/2008	12:18	RS-9		31	558	10.4	44000	6.5	7.5
	5/1/2008	12:25	RS-9	1/4	Surface		12.4	4200	6.1	7.5
	5/1/2008	12:25	RS-9		1	18	12.3	4200	6.2	7.5
	5/1/2008	12:25	RS-9		2	36	12.2	4400	6.7	7.5
	5/1/2008	12:25	RS-9		3	54	12.2	4400	6.6	7.5
	5/1/2008	12:25	RS-9		4	72	12.2	4400	6.3	7.5
	5/1/2008	12:25	RS-9		5	90	12.1	4500	5.5	7.5
	5/1/2008	12:25	RS-9		6	108	11.9	4200	6.5	7.5
	5/1/2008	12:25	RS-9		7	126	11.9	4000	6.7	7.5
	5/1/2008	12:25	RS-9		8	144	11.9	4200	5.9	7.5

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/1/2008	12:20	RS-9	3/4	Surface		12.2	4100	5.2	7.8
	5/1/2008	12:20	RS-9		1	18	12.1	4100	5.4	7.8
	5/1/2008	12:20	RS-9		2	36	11.9	4200	5.4	7.8
	5/1/2008	12:20	RS-9		3	54	11.8	4300	6.2	7.8
	5/1/2008	12:20	RS-9		4	72	11.8	4400	5.9	7.8
	5/1/2008	12:20	RS-9		5	90	11.8	4400	5.9	7.9
	5/1/2008	12:20	RS-9		6	108	11.8	4400	6.4	7.9
	5/1/2008	12:20	RS-9		7	126	11.8	4700	5.8	7.9
	5/1/2008	12:20	RS-9		8	144	11.7	5000	6	7.9
	5/1/2008	12:20	RS-9		9	162	11.2	5400	6.5	7.9
	5/1/2008	12:20	RS-9		10	180	11.2	9400	6.6	8.2
	5/1/2008	12:20	RS-9		11	196	10.5	15000	6.7	8.1
	5/1/2008	12:20	RS-9		12	216	10.4	32000	4.8	7.8
	5/1/2008	12:20	RS-9		13	234	9.7	44000	5	7.7
	5/1/2008	12:20	RS-9		14	252	9.7	48000	5.2	7.5
	5/1/2008	12:20	RS-9		15	270	9.8	47000	5.3	7.3
	5/1/2008	12:10	RS-10	MID	Surface		12.5	3800	5.6	7.8
	5/1/2008	12:10	RS-10		1	18	12.3	3900	6.2	7.9
	5/1/2008	12:10	RS-10		2	36	12.2	3900	6.4	7.9
	5/1/2008	12:10	RS-10		3	54	12.2	3900	6.4	7.9
	5/1/2008	12:10	RS-10		4	72	12.1	4000	6.5	8
	5/1/2008	12:10	RS-10		5	90	11.9	4400	6.6	8.1
	5/1/2008	12:10	RS-10		6	108	11.7	4800	6.5	8.1
	5/1/2008	12:10	RS-10		7	126	11.6	5300	6.1	8.1
	5/1/2008	12:10	RS-10		8	144	11.5	6200	5.2	8.1
	5/1/2008	12:10	RS-10		9	162	11.4	6800	6.3	8.2
	5/1/2008	12:10	RS-10		10	180	11.2	8100	6.3	8.2
	5/1/2008	12:10	RS-10		11	196	10.3	13400	6.9	8.2
	5/1/2008	12:10	RS-10		12	216	9.5	22400	5.6	7.8
	5/1/2008	12:10	RS-10		13	234	9.5	48600	5.5	7.7
	5/1/2008	12:10	RS-10		14	252	9.4	48500	5.2	7.4
	5/1/2008	12:10	RS-10		15	270	9.4	48700	4.8	7.8
	5/1/2008	12:10	RS-10		16	288	9.4	48600	5.3	7.8
	5/1/2008	12:10	RS-10		17	306	9.3	48000	5.9	7.7
	5/1/2008	12:10	RS-10		18	324	9.4	43900	5.3	7.4
	5/1/2008	12:10	RS-10		19	342	9.4	42800	4.3	7.3
	5/1/2008	12:10	RS-10		20	360	9.4	44400	4.9	7.3
	5/1/2008	12:10	RS-10		21	378	9.4	45700	4.5	7.4
	5/1/2008	12:10	RS-10		22	396	9.5	45600	4.5	7.4
	5/1/2008	12:10	RS-10		23	414	9.5	45300	4.7	7.4
	5/1/2008	12:10	RS-10		24	432	9.6	45100	5.2	7.4
	5/1/2008	12:10	RS-10		25	450	9.5	45100	4.4	7.5
	5/1/2008	12:10	RS-10		26	468	9.5	45000	4.3	7.5
	5/1/2008	12:10	RS-10		27	486	9.6	45100	.3.	7.6
	5/1/2008	12:10	RS-10		28	504	10	45300	3.6	7.7
	5/1/2008	12:10	RS-10		29	522	10	45100	4.3	7.7
	5/1/2008	12:10	RS-10		30	540	9.9	46000	4.1	7.7

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/1/2008	12:10	RS-10		31	558	9.9	45600	4.1	7.7
	5/1/2008	12:00	RS-11	MID	Surface		13	4500	7.4	7.9
	5/1/2008	12:00	RS-11		1	18	12.7	4700	7.8	7.9
	5/1/2008	12:00	RS-11		2	36	12.6	5300	8.5	7.9
	5/1/2008	12:00	RS-11		3	54	12.4	5400	8.9	8
	5/1/2008	12:00	RS-11		4	72	12.3	5300	8.9	8
	5/1/2008	12:00	RS-11		5	90	12.3	5500	8.9	8
	5/1/2008	12:00	RS-11		6	108	12.2	5900	9.1	8.1
	5/1/2008	12:00	RS-11		7	126	12.1	6100	9.3	8.1
	5/1/2008	12:00	RS-11		8	144	11.9	6700	9.2	8.1
	5/1/2008	12:00	RS-11		9	162	11.8	7600	9.4	8.1
	5/1/2008	12:00	RS-11		10	180	11.7	9800	9.1	8.1
	5/1/2008	12:00	RS-11		11	196	11.6	10600	9.2	8.1
	5/1/2008	12:00	RS-11		12	216	11.2	12000	8.7	7.9
	5/1/2008	12:00	RS-11		13	234	10.75	17900	8.7	7.6
	5/1/2008	12:00	RS-11		14	252	9.8	28000	8.4	7.6
	5/1/2008	12:00	RS-11		15	270	9.6	48500	7.3	7.6
	5/1/2008	12:00	RS-11		16	288	9.6	48200	7.3	7.7
	5/2/2008	13:08	RS-6	MID	Surface		12.6	147	5.8	7.6
	5/2/2008	13:08	RS-6		1	18	12.6	148	6.3	7.6
	5/2/2008	13:08	RS-6		2	36	12.6	147	6.5	7.6
	5/2/2008	13:08	RS-6		3	54	12.6	148	6.4	7.6
	5/2/2008	13:08	RS-6		4	72	12.6	148	6.3	7.6
	5/2/2008	13:18	RS-6	1/4	Surface		12.6	124	6.8	7.3
	5/2/2008	13:18	RS-6		1	18	12.6	145	5.1	7.4
	5/2/2008	13:18	RS-6		2	36	12.6	145	6.4	7.4
	5/2/2008	13:18	RS-6		3	54	12.6	145	5.8	7.4
	5/2/2008	13:22	RS-6	3/4	Surface		12.7	150	6.5	7.3
	5/2/2008	13:22	RS-6		1	18	12.6	152	6.6	7.3
	5/2/2008	13:22	RS-6		2	36	12.6	153	6.4	7.3
	5/2/2008	12:52	RS-7	MID	Surface		12.2	1100	6.2	8.5
	5/2/2008	12:52	RS-7		1	18	12.2	1200	5.9	8.4
	5/2/2008	12:52	RS-7		2	36	12.2	1600	5.1	8.3
	5/2/2008	12:52	RS-7		3	54	12.2	1800	5.4	8.4
	5/2/2008	12:52	RS-7		4	72	12.2	1800	5.3	8.4
	5/2/2008	12:52	RS-7		5	90	12.2	1900	5.3	8.4
	5/2/2008	12:52	RS-7		6	108	12.2	2000	5.1	8.5
	5/2/2008	12:52	RS-7		7	126	12.1	2600	5.6	8.5
	5/2/2008	12:52	RS-7		8	144	11.7	4000	5.5	8.5
	5/2/2008	12:52	RS-7		9	162	11	12000	5.3	8.2
	5/2/2008	12:52	RS-7		10	180	11	25000	5.1	7.9
	5/2/2008	12:52	RS-7		11	196	9.8	34000	4.4	7.9
	5/2/2008	12:52	RS-7		12	216	9.8	45000	4.3	7.9
	5/2/2008	12:52	RS-7		13	234	9.7	44000	4	7.9
	5/2/2008	12:52	RS-7		14	252	9.5	46000	4.1	7.9
	5/2/2008	12:52	RS-7		15	270	9.4	48000	4.2	7.9
	5/2/2008	12:52	RS-7		16	288	9.4	48000	4.1	7.9

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/2/2008	12:52	RS-7		17	306	9.4	48000	3.9	7.8
	5/2/2008	12:52	RS-7		18	324	9.4	48000	3.7	7.9
	5/2/2008	12:52	RS-7		19	342	9.4	48000	4.1	7.9
	5/2/2008	12:52	RS-7		20	360	9.4	48000	4.1	7.9
	5/2/2008	12:52	RS-7		21	378	9.4	48000	4.3	7.9
	5/2/2008	12:52	RS-7		22	396	9.4	48000	4.5	7.8
	5/2/2008	12:52	RS-7		23	414	9.4	48000	3.8	7.8
	5/2/2008	12:52	RS-7		24	432	9.4	47000	3.9	7.8
	5/2/2008	12:52	RS-7		25	450	9.4	48000	3.7	7.8
	5/2/2008	12:52	RS-7		26	468	9.4	48000	3.99	7.8
	5/2/2008	12:52	RS-7		27	486	9.4	48000	3.9	7.7
	5/2/2008	12:52	RS-7		28	504	9.5	47000	4.1	7.7
	5/2/2008	12:52	RS-7		29	522	9.5	46000	4.1	7.7
	5/2/2008	12:52	RS-7		30	540	9.5	47000	4.3	7.7
	5/2/2008	12:52	RS-7		31	558	9.5	48000	4.7	7.7
	5/2/2008	12:34	RS-8	MID	Surface		12.3	3600	5.6	7.8
	5/2/2008	12:34	RS-8		1	18	12.3	3800	6.1	7.9
	5/2/2008	12:34	RS-8		2	36	12.3	4200	5.6	7.8
	5/2/2008	12:34	RS-8		3	54	12.2	5000	5.1	7.8
	5/2/2008	12:34	RS-8		4	72	12.2	5500	5.3	7.8
	5/2/2008	12:34	RS-8		5	90	12.2	6400	5.2	7.8
	5/2/2008	12:34	RS-8		6	108	12.1	5900	5.4	7.8
	5/2/2008	12:34	RS-8		7	126	12	7000	5.4	7.8
	5/2/2008	12:34	RS-8		8	144	12.1	9000	5.4	7.9
	5/2/2008	12:34	RS-8		9	162	11.9	10000	5.6	7.9
	5/2/2008	12:34	RS-8		10	180	11.8	11000	5.1	7.9
	5/2/2008	12:34	RS-8		11	196	11.7	13000	5.4	7.9
	5/2/2008	12:34	RS-8		12	216	11.6	13000	5.3	7.9
	5/2/2008	12:34	RS-8		13	234	11.5	15000	5.6	7.8
	5/2/2008	12:34	RS-8		14	252	11.7	18000	4.8	7.8
	5/2/2008	12:34	RS-8		15	270	11.4	13000	5.4	7.9
	5/2/2008	12:34	RS-8		16	288	11.2	16000	4.4	8
	5/2/2008	12:34	RS-8		17	306	10.7	22000	4.5	8
	5/2/2008	12:34	RS-8		18	324	9.7	28000	4.9	7.9
	5/2/2008	12:34	RS-8		19	342	9.4	48000	4.3	7.9
	5/2/2008	12:34	RS-8		20	360	9.4	48000	3.7	7.9
	5/2/2008	12:34	RS-8		21	378	9.4	48000	3.7	7.9
	5/2/2008	12:34	RS-8		22	396	9.4	48000	3.8	7.9
	5/2/2008	12:34	RS-8		23	414	9.4	48000	3.8	7.8
	5/2/2008	12:34	RS-8		24	432	9.4	48000	3.8	7.8
	5/2/2008	12:34	RS-8		25	450	9.4	48000	4.2	7.8
	5/2/2008	12:34	RS-8		26	468	9.4	48000	4.3	7.8
	5/2/2008	12:34	RS-8		27	486	9.5	48000	4.2	7.7
	5/2/2008	12:43	RS-8	1/4	Surface		12.3	1200	5.2	7.6
	5/2/2008	12:43	RS-8		1	18	12.3	4500	5.2	7.6
	5/2/2008	12:43	RS-8		2	36	12.3	4600	5.1	7.7
	5/2/2008	12:43	RS-8		3	54	12.2	4600	5.8	7.7

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/2/2008	12:43	RS-8		4	72	12.2	4900	5.1	7.6
	5/2/2008	12:43	RS-8		5	90	12.2	5600	5.3	7.6
	5/2/2008	12:46	RS-8	3/4	Surface		12.3	4000	5.4	7.6
	5/2/2008	12:46	RS-8		1	18	12.3	4300	5.5	7.6
	5/2/2008	12:46	RS-8		2	36	12.3	4400	5.3	7.7
	5/2/2008	12:46	RS-8		3	54	12.3	4400	5.3	7.7
	5/2/2008	12:46	RS-8		4	72	12.3	4480	5.4	7.7
	5/2/2008	12:46	RS-8		5	90	12.2	4900	5.2	7.7
	5/2/2008	12:46	RS-8		6	108	12.2	6500	4.9	7.6
	5/2/2008	12:46	RS-8		7	126	12	9500	5	7.5
	5/2/2008	12:46	RS-8		8	144	11.9	9400	5.2	7.5
	5/2/2008	12:46	RS-8		9	162	11.9	13000	5.4	7.4
	5/2/2008	12:17	RS-9	MID	Surface		12.3	3800	6.3	7.9
	5/2/2008	12:17	RS-9		1	18	12.2	4200	6.5	7.9
	5/2/2008	12:17	RS-9		2	36	12.2	4300	6.9	7.9
	5/2/2008	12:17	RS-9		3	54	12.2	4500	5.9	7.9
	5/2/2008	12:17	RS-9		4	72	12.2	4500	5.8	8
	5/2/2008	12:17	RS-9		5	90	12.2	4500	6.5	8
	5/2/2008	12:17	RS-9		6	108	12.1	5000	6.2	8
	5/2/2008	12:17	RS-9		7	126	12	7400	6.1	7.9
	5/2/2008	12:17	RS-9		8	144	11.9	9300	6.1	7.9
	5/2/2008	12:17	RS-9		9	162	11.8	9900	5.3	7.9
	5/2/2008	12:17	RS-9		10	180	11.7	12000	5.1	7.9
	5/2/2008	12:17	RS-9		11	196	11.6	13000	5.6	7.9
	5/2/2008	12:17	RS-9		12	216	11.4	14000	5.6	7.9
	5/2/2008	12:17	RS-9		13	234	11	17000	5.6	7.9
	5/2/2008	12:17	RS-9		14	252	10.3	24000	6.4	7.9
	5/2/2008	12:17	RS-9		15	270	9.6	36000	4.9	7.6
	5/2/2008	12:17	RS-9		16	288	9.4	41000	5.6	7.6
	5/2/2008	12:17	RS-9		17	306	9.4	41000	5.2	7.4
	5/2/2008	12:17	RS-9		18	324	9.4	41000	4	7.3
	5/2/2008	12:17	RS-9		19	342	9.4	41000	4.4	7.3
	5/2/2008	12:17	RS-9		20	360	9.4	41000	4.6	7.3
	5/2/2008	12:17	RS-9		21	378	9.4	41000	4.8	7.3
	5/2/2008	12:17	RS-9		22	396	9.4	43000	4.5	7.4
	5/2/2008	12:17	RS-9		23	414	9.4	43000	3.2	7.4
	5/2/2008	12:17	RS-9		24	432	9.4	43000	3.2	7.4
	5/2/2008	12:17	RS-9		25	450	9.4	43000	3.2	7.4
	5/2/2008	12:17	RS-9		26	468	9.4	43000	4	7.4
	5/2/2008	12:17	RS-9		27	486	9.3	42000	5.4	7.4
	5/2/2008	12:22	RS-9	1/4	Surface		12.4	3500	5.8	7.7
	5/2/2008	12:22	RS-9		1	18	12.3	3800	5.6	7.7
	5/2/2008	12:22	RS-9		2	36	12.2	4200	5.7	7.7
	5/2/2008	12:22	RS-9		3	54	12.2	4400	5.6	7.7
	5/2/2008	12:22	RS-9		4	72	12.2	4600	5.8	7.7
	5/2/2008	12:22	RS-9		5	90	12.2	4700	5.4	7.7
	5/2/2008	12:24	RS-9	3/4	Surface		12.3	4100	6.2	7.9

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/2/2008	12:24	RS-9		1	18	12.3	4200	6.4	8
	5/2/2008	12:24	RS-9		2	36	12.3	4200	5.3	8
	5/2/2008	12:24	RS-9		3	54	12.3	4200	5.6	8.1
	5/2/2008	12:24	RS-9		4	72	12.2	4400	5.6	8.1
	5/2/2008	12:24	RS-9		5	90	12.2	5100	6.7	8.1
	5/2/2008	12:24	RS-9		6	108	12.1	5500	6.1	8.2
	5/2/2008	12:24	RS-9		7	126	12.1	6200	5.7	8.2
	5/2/2008	12:24	RS-9		8	144	11.9	7600	4	8.2
	5/2/2008	12:24	RS-9		9	162	11.7	9200	4.9	8.2
	5/2/2008	12:24	RS-9		10	180	11.2	19000	4.7	8.1
	5/2/2008	12:24	RS-9		11	196	10	31000	4.5	8
	5/2/2008	12:24	RS-9		12	216	9.3	47000	4.4	7.9
	5/2/2008	12:24	RS-9		13	234	9.3	47000	4.4	7.9
	5/2/2008	12:24	RS-9		14	252	9.3	47000	4.7	7.9
	5/2/2008	12:24	RS-9		15	270	9.3	47000	4.6	7.9
	5/2/2008	12:24	RS-9		16	288	9.4	47000	4.5	7.8
	5/2/2008	12:24	RS-9		17	306	9.4	47000	5	7.8
	5/2/2008	12:09	RS-10	MID	Surface		12.3	3400	6.7	7.8
	5/2/2008	12:09	RS-10		1	18	12.4	3400	6.2	7.9
	5/2/2008	12:09	RS-10		2	36	12.4	3600	6.5	8
	5/2/2008	12:09	RS-10		3	54	12.3	3700	6.5	8
	5/2/2008	12:09	RS-10		4	72	12.3	3700	6.5	8.1
	5/2/2008	12:09	RS-10		5	90	12.2	4100	6.1	8.1
	5/2/2008	12:09	RS-10		6	108	12.2	4400	6.8	8.2
	5/2/2008	12:09	RS-10		7	126	12.1	4800	6	8.2
	5/2/2008	12:09	RS-10		8	144	12.1	5600	4.3	8.2
	5/2/2008	12:09	RS-10		9	162	12	7000	5.8	8.2
	5/2/2008	12:09	RS-10		10	180	11.9	8200	5.9	8.2
	5/2/2008	12:09	RS-10		11	196	9.4	41000	5.9	7.8
	5/2/2008	12:09	RS-10		12	216	9.4	41000	5.1	7.8
	5/2/2008	12:09	RS-10		13	234	9.4	41000	6	7.8
	5/2/2008	12:09	RS-10		14	252	9.5	41000	4.1	7.7
	5/2/2008	12:09	RS-10		15	270	9.4	42000	5.1	7.6
	5/2/2008	12:09	RS-10		16	288	9.4	41000	4.4	7.5
	5/2/2008	12:09	RS-10		17	306	9.4	41000	4.5	7.5
	5/2/2008	12:09	RS-10		18	324	9.4	41000	5.1	7.5
	5/2/2008	12:09	RS-10		19	342	9.4	41000	4.8	7.5
	5/2/2008	12:09	RS-10		20	360	9.4	41000	4.4	7.5
	5/2/2008	12:09	RS-10		21	378	9.6	43000	4.7	7.6
	5/2/2008	12:09	RS-10		22	396	9.6	46000	4.3	7.6
	5/2/2008	12:09	RS-10		23	414	9.6	46000	4.8	7.7
	5/2/2008	12:09	RS-10		24	432	9.6	46000	4.5	7.7
	5/2/2008	12:09	RS-10		25	450	9.6	46000	4.5	7.7
	5/2/2008	12:09	RS-10		26	468	9.6	46000	4.5	7.7
	5/2/2008	12:09	RS-10		27	486	9.6	46000	4.4	7.7
	5/2/2008	12:09	RS-10		28	504	9.6	46000	4.1	7.6
	5/2/2008	12:09	RS-10		29	522	9.6	46000	4.4	7.6

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/2/2008	12:09	RS-10		30	540	9.5	46000	4.3	7.6
	5/2/2008	12:09	RS-10		31	558	9.5	46000	6.1	7.6
	5/2/2008	12:00	RS-11	MID	Surface		12.2	4800	7.4	8
	5/2/2008	12:00	RS-11		1	18	12.2	4800	7.5	8
	5/2/2008	12:00	RS-11		2	36	12.2	4800	7.7	8.1
	5/2/2008	12:00	RS-11		3	54	12.2	4900	8.1	8.1
	5/2/2008	12:00	RS-11		4	72	12.2	5100	8.1	8.1
	5/2/2008	12:00	RS-11		5	90	12.1	5400	8.3	8.2
	5/2/2008	12:00	RS-11		6	108	12	7600	8.7	8.2
	5/2/2008	12:00	RS-11		7	126	11.9	10600	8.9	8.1
	5/2/2008	12:00	RS-11		8	144	11.6	12400	8.9	8.1
	5/2/2008	12:00	RS-11		9	162	11.5	20500	8.8	8
	5/2/2008	12:00	RS-11		10	180	11.4	31000	8.7	8
	5/2/2008	12:00	RS-11		11	196	10.5	35700	8.5	8
	5/2/2008	12:00	RS-11		12	216	9.7	38000	8.5	7.9
	5/2/2008	12:00	RS-11		13	234	9.3	39800	8.6	7.8
	5/2/2008	12:00	RS-11		14	252	9.2	39700	8.6	7.9
	5/2/2008	12:00	RS-11		15	270	9.1	39700	8.6	7.9
	5/2/2008	12:00	RS-11		16	288	9.1	42000	8.6	7.9
	5/2/2008	12:00	RS-11		17	306	9.1	41000	8.5	7.9
	5/2/2008	12:00	RS-11		18	324	9.1	14200	8.6	7.9
	5/2/2008	12:00	RS-11		19	342	9.1	40100	8.6	8
	5/2/2008	12:00	RS-11		20	360	9.1	45000	8.1	8
	5/2/2008	12:00	RS-11		21	378	9.1	45000	8.1	7.9
	5/2/2008	12:00	RS-11		22	396	9.1	45000	8.1	7.8
	5/2/2008	12:00	RS-11		23	414	9.1	45000	8.1	7.8
	5/2/2008	12:00	RS-11		24	432	9.1	44000	8.1	7.8
	5/2/2008	12:00	RS-11		25	450	9.1	45000	8.1	7.8
	5/2/2008	12:00	RS-11		26	468	9.1	44000	8.1	7.8
	5/2/2008	12:00	RS-11		27	486	9.1	45400	8.3	7.7
	5/2/2008	12:00	RS-11		28	504	9.1	43400	8.4	7.7
	5/2/2008	12:00	RS-11		29	522	9.1	41700	8.5	7.7
	5/2/2008	12:00	RS-11		30	540	9.1	41000	8.5	7.7
	5/2/2008	12:00	RS-11		31	558	9.2	41300	8.5	7.8
	5/9/2008	19:00	RS6	MID	Surface		15.65	160	6.53	7.62
	5/9/2008	19:00	RS6		1	18	15.65	170	6.76	7.66
	5/9/2008	19:00	RS6		2	36	15.65	160	6.37	7.68
	5/9/2008	19:00	RS6		3	54	15.66	160	6.1	7.68
	5/9/2008	19:00	RS6		4	72	15.65	160	6.77	7.71
	5/9/2008	19:00	RS6		5	90	15.65	160	5.94	7.68
	5/9/2008	19:00	RS6		6	108	15.65	160	6.06	7.67
	5/9/2008	19:00	RS6		7	126	15.65	160	5.92	7.72
	5/9/2008	19:00	RS6		8	144	15.64	160	5.7	7.77
	5/9/2008	19:00	RS6		9	162	15.64	160	6.64	7.79
	5/9/2008	19:00	RS6		10	180	15.64	160	6.55	7.83
	5/9/2008	19:09	RS6	1/4	Surface		15.63	160	9.2	7.86
	5/9/2008	19:09	RS6		1	18	15.63	160	9.19	7.86

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/9/2008	19:09	RS6		2	36	15.62	150	9.17	7.85
	5/9/2008	19:09	RS6		3	54	15.64	160	9.19	7.77
	5/9/2008	19:09	RS6		4	72	15.63	160	9.19	7.6
	5/9/2008	19:11	RS6	3/4	Surface		15.63	160	7.23	7.87
	5/9/2008	19:11	RS6		1	18	15.63	160	6.9	7.87
	5/9/2008	19:11	RS6		2	36	15.62	160	6.85	7.82
	5/9/2008	19:11	RS6		3	54	15.61	160	6.8	7.8
	5/9/2008	19:11	RS6		4	72	15.47	160	9.21	7.83
	5/9/2008	19:11	RS6		5	90	15.23	160	6.6	7.81
	5/9/2008	18:31	RS-7	MID	Surface		15.2	2420	6.09	7.97
	5/9/2008	18:31	RS-7		1	18	15.14	3780	6.26	7.9
	5/9/2008	18:31	RS-7		2	36	15	3780	6.21	7.91
	5/9/2008	18:31	RS-7		3	54	14.89	4900	5.97	7.87
	5/9/2008	18:31	RS-7		4	72	14.72	6850	6.59	7.83
	5/9/2008	18:31	RS-7		5	90	14.7	11240	6.88	7.76
	5/9/2008	18:31	RS-7		6	108	14.64	6170	7.2	7.89
	5/9/2008	18:31	RS-7		7	126	12.66	21810	7.31	7.82
	5/9/2008	18:31	RS-7		8	144	12.12	25650	7.08	7.74
	5/9/2008	18:31	RS-7		9	162	11.95	29510	6.77	7.73
	5/9/2008	18:31	RS-7		10	180	11.93	31640	7.67	7.72
	5/9/2008	18:31	RS-7		11	196	11.86	30740	8.01	7.73
	5/9/2008	18:31	RS-7		12	216	12.02	30330	6.85	7.7
	5/9/2008	18:31	RS-7		13	234	11.89	30630	7.67	7.75
	5/9/2008	18:31	RS-7		14	252	11.6	31970	8.1	7.76
	5/9/2008	18:31	RS-7		15	270	11.41	34840	8.62	7.76
	5/9/2008	18:31	RS-7		16	288	11.2	35440	9.02	7.76
	5/9/2008	18:31	RS-7		17	306	11.61	37510	7.2	7.76
	5/9/2008	18:31	RS-7		18	324	11.63	39800	8.28	7.75
	5/9/2008	18:31	RS-7		19	342	10.99	38620	7.89	7.76
	5/9/2008	18:31	RS-7		20	360	10.7	38710	9.01	7.76
	5/9/2008	18:31	RS-7		21	378	10.52	41190	8.77	7.74
	5/9/2008	18:31	RS-7		22	396	10.42	41710	8.71	7.74
	5/9/2008	18:31	RS-7		23	414	10.31	41920	7.32	7.73
	5/9/2008	18:31	RS-7		24	432	10.24	42170	8.64	7.73
	5/9/2008	18:31	RS-7		25	450	10.25	42380	8.62	7.72
	5/9/2008	18:31	RS-7		26	468	10.24	42510	9.18	7.7
	5/9/2008	18:31	RS-7		27	486	10.14	42630	8.74	7.67
	5/9/2008	18:31	RS-7		28	504	10.02	42710	8.85	7.63
	5/9/2008	18:31	RS-7		29	522	9.5	43610	9.02	7.57
	5/9/2008	18:31	RS-7		30	540	9.51	43720	7.7	7.48
	5/9/2008	18:03	RS-8	MID	Surface		14.85	6810	7.7	7.68
	5/9/2008	18:03	RS-8		1	18	14.88	7050	7.78	7.7
	5/9/2008	18:03	RS-8		2	36	14.8	7200	7.15	7.73
	5/9/2008	18:03	RS-8		3	54	14.64	8870	6.63	7.7
	5/9/2008	18:03	RS-8		4	72	14.58	10000	7.88	7.69
	5/9/2008	18:03	RS-8		5	90	14.46	10810	7.93	7.69
	5/9/2008	18:03	RS-8		6	108	14.69	11580	7.11	7.7

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/9/2008	18:03	RS-8		7	126	14.2	12220	7.9	7.69
	5/9/2008	18:03	RS-8		8	144	14.13	13570	8.1	7.86
	5/9/2008	18:03	RS-8		9	162	14.02	13180	7.86	7.69
	5/9/2008	18:03	RS-8		10	180	13.95	15900	7.7	7.68
	5/9/2008	18:03	RS-8		11	196	13.87	16600	7.33	7.68
	5/9/2008	18:03	RS-8		12	216	13.8	17710	7.03	7.67
	5/9/2008	18:03	RS-8		13	234	13.75	17240	7.68	7.68
	5/9/2008	18:03	RS-8		14	252	13.6	18150	7.34	7.7
	5/9/2008	18:03	RS-8		15	270	13.47	20360	7.39	7.7
	5/9/2008	18:03	RS-8		16	288	13.34	20890	8.59	7.71
	5/9/2008	18:03	RS-8		17	306	13.01	21920	8.2	7.7
	5/9/2008	18:03	RS-8		18	324	12.79	23910	8.4	7.71
	5/9/2008	18:03	RS-8		19	342	12.7	25880	8.4	7.67
	5/9/2008	18:03	RS-8		20	360	12.82	28170	8.29	7.66
	5/9/2008	18:03	RS-8		21	378	13.01	25060	8.17	7.67
	5/9/2008	18:03	RS-8		22	396	12.95	25550	8.45	7.72
	5/9/2008	18:03	RS-8		23	414	12.58	24650	7.85	7.77
	5/9/2008	18:03	RS-8		24	432	11.81	27220	8.54	7.8
	5/9/2008	18:03	RS-8		25	450	10.97	29170	8.2	7.81
	5/9/2008	18:03	RS-8		26	468	10.62	40080	8.9	7.77
	5/9/2008	18:03	RS-8		27	486	10.45	42260	8.92	7.75
	5/9/2008	18:03	RS-8		28	504	10.38	42530	9.2	7.73
	5/9/2008	18:03	RS-8		29	522	10.3	42690	8.68	7.67
	5/9/2008	18:03	RS-8		30	540	10.32	42780	8.59	7.65
	5/9/2008	18:20	RS-8	1/4	Surface		14.89	6770	6.63	7.56
	5/9/2008	18:20	RS-8		1	18	14.87	7110	7.3	7.55
	5/9/2008	18:20	RS-8		2	36	14.81	7160	8.79	7.57
	5/9/2008	18:20	RS-8		3	54	14.7	8050	5.83	7.58
	5/9/2008	18:20	RS-8		4	72	14.5	8180	6.75	7.56
	5/9/2008	18:20	RS-8		5	90	14.24	11510	6.5	7.49
	5/9/2008	18:27	RS-8	3/4	Surface		15.1	5820	7.8	7.8
	5/9/2008	18:27	RS-8		1	18	14.96	6180	8.01	7.8
	5/9/2008	18:27	RS-8		2	36	14.67	6510	7.53	7.79
	5/9/2008	18:27	RS-8		3	54	14.3	9560	8.04	7.77
	5/9/2008	18:27	RS-8		4	72	13.33	11170	7.6	7.62
	5/9/2008	18:27	RS-8		5	90	12.41	19030	8.15	7.42
	5/9/2008	18:27	RS-8		6	108	11.72	29210	8.84	7.29
	5/9/2008	18:27	RS-8		7	126	11.21	36180	7.47	7.26
	5/9/2008	18:27	RS-8		8	144	10.9	35570	8.08	7.21
	5/9/2008	18:27	RS-8		9	162	10.8	39320	8.75	7.29
	5/9/2008	18:27	RS-8		10	180	10.74	40000	8.3	7.33
	5/9/2008	18:27	RS-8		11	196	10.69	38720	8.82	7.4
	5/9/2008	18:27	RS-8		12	216	10.64	40560	8.22	7.51
	5/9/2008	18:27	RS-8		13	234	10.61	41320	7.63	7.64
	5/9/2008	18:27	RS-8		14	252	10.59	41780	8.59	7.66
	5/9/2008	18:27	RS-8		15	270	10.81	42390	8.05	7.6
	5/9/2008	17:35	RS-9	MID	Surface		15.2	6420	7.13	7.59

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/9/2008	17:35	RS-9		1	18	15.19	6510	7.18	7.59
	5/9/2008	17:35	RS-9		2	36	15.2	6850	8.13	7.6
	5/9/2008	17:35	RS-9		3	54	15.2	6800	8.12	7.62
	5/9/2008	17:35	RS-9		4	72	15.2	6740	8.06	7.64
	5/9/2008	17:35	RS-9		5	90	15.2	6470	8.28	7.66
	5/9/2008	17:35	RS-9		6	108	15.1	7000	8.3	7.65
	5/9/2008	17:35	RS-9		7	126	15.02	7440	8.8	7.64
	5/9/2008	17:35	RS-9		8	144	15.03	8000	8.52	7.6
	5/9/2008	17:35	RS-9		9	162	14.99	7870	8.89	7.64
	5/9/2008	17:35	RS-9		10	180	14.93	7860	8.25	7.64
	5/9/2008	17:35	RS-9		11	196	14.71	7620	7.04	7.65
	5/9/2008	17:35	RS-9		12	216	14.2	10720	8.45	7.61
	5/9/2008	17:35	RS-9		13	234	13.7	13720	8.1	7.5
	5/9/2008	17:35	RS-9		14	252	12.67	14930	9	7.4
	5/9/2008	17:35	RS-9		15	270	11.73	19350	9.4	7.2
	5/9/2008	17:35	RS-9		16	288	11.6	20820	10.01	7.3
	5/9/2008	17:35	RS-9		17	306	11.38	21630	9.87	7.43
	5/9/2008	17:35	RS-9		18	324	11.28	22220	9.97	5.56
	5/9/2008	17:35	RS-9		19	342	11.2	22760	10.07	7.59
	5/9/2008	17:35	RS-9		20	360	11.18	25010	10.12	7.61
	5/9/2008	17:35	RS-9		21	378	11.18	27570	10.01	7.62
	5/9/2008	17:35	RS-9		22	396	11.18	29320	10.24	7.6
	5/9/2008	17:35	RS-9		23	414	11.03	39660	10.2	7.38
	5/9/2008	17:35	RS-9		24	432	10.93	40020	10.3	7.37
	5/9/2008	17:35	RS-9		25	450	10.84	40370	10.8	7.36
	5/9/2008	17:35	RS-9		26	468	10.78	40330	10.4	7.36
	5/9/2008	17:35	RS-9		27	486	10.67	39590	10.5	7.36
	5/9/2008	17:35	RS-9		28	504	10.68	40930	10.48	7.4
	5/9/2008	17:35	RS-9		29	522	10.76	41250	10.28	7.41
	5/9/2008	17:35	RS-9		30	540	10.77	40690	10.36	7.43
	5/9/2008	17:50	RS-9	1/4	Surface		15.6	6770	8.03	7.58
	5/9/2008	17:50	RS-9		1	18	15.15	7220	7.8	7.58
	5/9/2008	17:50	RS-9		2	36	15.14	7350	8.81	7.59
	5/9/2008	17:50	RS-9		3	54	15.1	7430	7.43	7.62
	5/9/2008	17:50	RS-9		4	72	14.92	7440	7.52	7.62
	5/9/2008	17:50	RS-9		5	90	14.89	9110	7.59	7.87
	5/9/2008	17:50	RS-9		6	108	14.9	10270	7.62	7.59
	5/9/2008	17:50	RS-9		7	126	14.9	10260	7.55	7.6
	5/9/2008	17:55	RS-9	3/4	Surface		15.09	6800	8.77	7.57
	5/9/2008	17:55	RS-9		1	18	15.09	6820	8.65	7.6
	5/9/2008	17:55	RS-9		2	36	15.08	6860	8.79	7.61
	5/9/2008	17:55	RS-9		3	54	15.08	6970	8.83	7.64
	5/9/2008	17:55	RS-9		4	72	15.07	7250	8.25	7.64
	5/9/2008	17:55	RS-9		5	90	15.03	7380	8.21	7.66
	5/9/2008	17:55	RS-9		6	108	14.97	7470	9.05	7.69
	5/9/2008	17:55	RS-9		7	126	14.65	7820	8.7	7.72
	5/9/2008	17:55	RS-9		8	144	13.92	10440	9.35	7.6

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/9/2008	17:09	RS-10	MID	Surface		15.2	6910	7.11	7.95
	5/9/2008	17:09	RS-10		1	18	15.14	7200	6.96	8.01
	5/9/2008	17:09	RS-10		2	36	13.67	8670	5.14	8.06
	5/9/2008	17:09	RS-10		3	54	12.83	18880	7.61	7.94
	5/9/2008	17:09	RS-10		4	72	12.25	29270	8.16	7.88
	5/9/2008	17:09	RS-10		5	90	11.67	35950	7.47	7.88
	5/9/2008	17:09	RS-10		6	108	11.14	37240	8.46	7.87
	5/9/2008	17:09	RS-10		7	126	11.02	41350	7.47	7.88
	5/9/2008	17:09	RS-10		8	144	10.89	42370	7.98	7.88
	5/9/2008	17:09	RS-10		9	162	10.93	42190	7.29	7.87
	5/9/2008	17:09	RS-10		10	180	10.78	42680	7.1	7.88
	5/9/2008	17:09	RS-10		11	196	10.72	43440	7.37	7.88
	5/9/2008	17:09	RS-10		12	216	10.71	43530	7.08	7.87
	5/9/2008	17:09	RS-10		13	234	10.7	43570	7.24	7.87
	5/9/2008	17:09	RS-10		14	252	10.71	43740	7.36	7.87
	5/9/2008	17:09	RS-10		15	270	10.86	44050	7.12	7.84
	5/9/2008	17:09	RS-10		16	288	10.65	43940	7.42	7.88
	5/9/2008	17:09	RS-10		17	306	10.67	43830	8.04	7.88
	5/9/2008	17:09	RS-10		18	324	10.68	43450	7.7	7.86
	5/9/2008	17:09	RS-10		19	342	10.67	43540	6.92	7.86
	5/9/2008	17:09	RS-10		20	360	10.67	43660	7.6	7.87
	5/9/2008	17:09	RS-10		21	378	10.66	43880	8.12	7.86
	5/9/2008	17:09	RS-10		22	396	10.64	43950	8.09	7.85
	5/9/2008	17:09	RS-10		23	414	10.64	43960	8	7.82
	5/9/2008	17:09	RS-10		24	432	10.64	43820	7.51	7.77
	5/9/2008	17:09	RS-10		25	450	10.65	43920	8.4	7.85
	5/9/2008	17:09	RS-10		26	468	10.66	43510	8.4	7.86
	5/9/2008	17:09	RS-10		27	486	10.66	43500	8.54	7.86
	5/9/2008	17:09	RS-10		28	504	10.66	43680	7.66	7.85
	5/9/2008	17:09	RS-10		29	522	10.66	43460	6.66	7.77
	5/9/2008	17:09	RS-10		30	540	10.78	43310	8.09	7.53
	5/9/2008	16:30	RS-11	MID	Surface		15.03	21830	9.3	7.77
	5/9/2008	16:30	RS-11		1	18	15.02	22310	9.11	7.76
	5/9/2008	16:30	RS-11		2	36	14.99	25130	9.29	7.79
	5/9/2008	16:30	RS-11		3	54	14.86	25740	9.31	7.85
	5/9/2008	16:30	RS-11		4	72	14.48	27320	9.4	7.87
	5/9/2008	16:30	RS-11		5	90	14.4	29780	9.49	7.87
	5/9/2008	16:30	RS-11		6	108	12.84	32140	9.81	7.85
	5/9/2008	16:30	RS-11		7	126	13.13	33430	9.9	7.82
	5/9/2008	16:30	RS-11		8	144	12.79	33700	9.96	7.84
	5/9/2008	16:30	RS-11		9	162	12.6	33810	10	7.84
	5/9/2008	16:30	RS-11		10	180	12.49	33910	10.03	7.85
	5/9/2008	16:30	RS-11		11	196	12.2	34030	10.07	7.86
	5/9/2008	16:30	RS-11		12	216	10.65	34600	10.51	7.88
	5/9/2008	16:30	RS-11		13	234	10.42	34470	10.74	7.85
	5/9/2008	16:30	RS-11		14	252	10.35	34410	10.78	7.85
	5/9/2008	16:30	RS-11		15	270	10.3	34330	10.79	7.84

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/9/2008	16:30	RS-11		16	288	10.3	34150	10.8	7.83
	5/9/2008	16:30	RS-11		17	306	10.3	34060	10.81	7.78
	5/9/2008	16:30	RS-11		18	324	10.3	33930	10.81	7.74
	5/9/2008	16:30	RS-11		19	342	10.28	33930	10.81	7.75
	5/9/2008	16:30	RS-11		20	360	10.26	33950	10.82	7.75
	5/9/2008	16:30	RS-11		21	378	10.26	34410	10.82	7.75
	5/9/2008	16:30	RS-11		22	396	10.41	36170	10.8	7.79
	5/9/2008	16:30	RS-11		23	414	10.22	37640	10.82	7.76
	5/9/2008	16:30	RS-11		24	432	10.2	37510	10.82	7.8
	5/9/2008	16:30	RS-11		25	450	10.19	37450	10.82	7.84
	5/9/2008	16:30	RS-11		26	468	10.18	37340	10.83	7.87
	5/9/2008	16:30	RS-11		27	486	10.2	37270	10.83	7.86
	5/9/2008	16:30	RS-11		28	504	10.13	38660	10.84	7.4
	5/10/2008	5:52	RS-6	MID	Surface		14.7	150	9.5	7.9
	5/10/2008	5:52	RS-6		1	18	14.7	150	9.5	7.9
	5/10/2008	5:52	RS-6		2	36	14.7	150	9.5	8
	5/10/2008	5:52	RS-6		3	54	14.7	150	9.5	8
	5/10/2008	5:52	RS-6		4	72	14.7	150	9.5	8
	5/10/2008	5:52	RS-6		5	90	14.7	150	9.5	8.1
	5/10/2008	5:52	RS-6		6	108	14.6	150	9.4	8.1
	5/10/2008	5:59	RS-6	1/4	Surface		14.7	150	6.4	7.5
	5/10/2008	5:59	RS-6		1	18	14.7	150	6	7.5
	5/10/2008	5:59	RS-6		2	36	14.7	150	6.2	7.6
	5/10/2008	5:59	RS-6		3	54	14.7	150	6.3	7.6
	5/10/2008	5:59	RS-6		4	72	14.7	150	5.9	7.6
	5/10/2008	5:59	RS-6		5	90	14.7	150	5.9	7.6
	5/10/2008	5:59	RS-6		6	108	14.6	150	7.7	7.8
	5/10/2008	6:06	RS-6	3/4	Surface		14.7	150	6.7	7.45
	5/10/2008	6:06	RS-6		1	18	14.7	150	6.9	7.5
	5/10/2008	6:06	RS-6		2	36	14.7	160	6.3	7.5
	5/10/2008	6:06	RS-6		3	54	14.7	160	6.3	7.5
	5/10/2008	6:06	RS-6		4	72	14.6	160	6.5	7.5
	5/10/2008	6:06	RS-6		5	90	14.3	150	6	7.5
	5/10/2008	5:22	RS-7	MID	Surface		14.3	2000	7.7	8.2
	5/10/2008	5:22	RS-7		1	18	14.2	3000	6.6	8.2
	5/10/2008	5:22	RS-7		2	36	14	3000	6.8	8.2
	5/10/2008	5:22	RS-7		3	54	13.9	3000	6.3	8.2
	5/10/2008	5:22	RS-7		4	72	13.3	5000	6.6	8.2
	5/10/2008	5:22	RS-7		5	90	12.5	6000	5.8	8.2
	5/10/2008	5:22	RS-7		6	108	12.4	6300	7.3	7.8
	5/10/2008	5:22	RS-7		7	126	12	6900	7.1	7.8
	5/10/2008	5:22	RS-7		8	144	11.8	30000	6.3	7.8
	5/10/2008	5:22	RS-7		9	162	11.3	31000	7.7	7.8
	5/10/2008	5:22	RS-7		10	180	11	37000	6.7	7.8
	5/10/2008	5:22	RS-7		11	196	10.6	38000	6.3	7.8
	5/10/2008	5:22	RS-7		12	216	10.7	42000	7.2	7.8
	5/10/2008	5:22	RS-7		13	234	10.4	42000	8.5	7.8

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/10/2008	5:22	RS-7		14	252	10.4	42000	7.7	7.8
	5/10/2008	5:22	RS-7		15	270	10.5	42000	7.7	7.8
	5/10/2008	5:22	RS-7		16	288	10.6	43000	6.9	7.8
	5/10/2008	5:22	RS-7		17	306	10.6	43000	8.1	7.8
	5/10/2008	5:22	RS-7		18	324	10.6	43000	7.5	7.8
	5/10/2008	5:22	RS-7		19	342	10.6	43000	7.7	7.8
	5/10/2008	5:22	RS-7		20	360	10.6	43000	7.5	7.8
	5/10/2008	5:22	RS-7		21	378	10.6	43000	7.5	7.8
	5/10/2008	5:22	RS-7		22	396	10.6	43000	7.9	7.8
	5/10/2008	5:22	RS-7		23	414	10.6	43000	7.5	7.8
	5/10/2008	5:22	RS-7		24	432	10.6	43000	7.2	7.8
	5/10/2008	5:22	RS-7		25	450	10.6	43000	7.2	7.8
	5/10/2008	5:22	RS-7		26	468	10.6	43000	7.1	7.8
	5/10/2008	5:22	RS-7		27	486	10.6	43000	7.1	7.8
	5/10/2008	5:22	RS-7		28	504	10.6	43000	6.4	7.8
	5/10/2008	5:22	RS-7		29	522	10.6	43000	7.6	7.8
	5/10/2008	5:22	RS-7		30	540	10.6	43000	7.6	7.8
	5/10/2008	5:22	RS-7		31	558	10.6	43000	7.4	7.7
	5/10/2008	4:57	RS-8	MID	Surface		14.1	7000	7.5	7.8
	5/10/2008	4:57	RS-8		1	18	14	8000	7.1	7.8
	5/10/2008	4:57	RS-8		2	36	14	9000	7.2	7.8
	5/10/2008	4:57	RS-8		3	54	13.9	9000	7.6	7.8
	5/10/2008	4:57	RS-8		4	72	13.9	10000	7.1	7.8
	5/10/2008	4:57	RS-8		5	90	13.7	10000	7.9	7.8
	5/10/2008	4:57	RS-8		6	108	13.5	10000	9.1	7.8
	5/10/2008	4:57	RS-8		7	126	13.2	13000	6.5	7.8
	5/10/2008	4:57	RS-8		8	144	13	16000	8	7.8
	5/10/2008	4:57	RS-8		9	162	12.8	20000	7.9	7.8
	5/10/2008	4:57	RS-8		10	180	12.6	21000	7.9	7.8
	5/10/2008	4:57	RS-8		11	196	12.5	22000	7.8	7.7
	5/10/2008	4:57	RS-8		12	216	12.7	28000	7.7	7.7
	5/10/2008	4:57	RS-8		13	234	12.7	23000	7.1	7.8
	5/10/2008	4:57	RS-8		14	252	12.7	24000	7.1	7.8
	5/10/2008	4:57	RS-8		15	270	12.6	25000	7.7	7.8
	5/10/2008	4:57	RS-8		16	288	12.5	25000	7.6	7.8
	5/10/2008	4:57	RS-8		17	306	12.4	26000	7.4	7.8
	5/10/2008	4:57	RS-8		18	324	12.3	27000	7.5	7.8
	5/10/2008	4:57	RS-8		19	342	12	27000	7.1	7.8
	5/10/2008	4:57	RS-8		20	360	11.9	30000	7.3	7.8
	5/10/2008	4:57	RS-8		21	378	11.7	34000	8.1	7.8
	5/10/2008	4:57	RS-8		22	396	11.4	36000	7.7	7.8
	5/10/2008	4:57	RS-8		23	414	11.1	38000	7.3	7.8
	5/10/2008	4:57	RS-8		24	432	10.8	41000	8.4	7.8
	5/10/2008	4:57	RS-8		25	450	10.7	43000	8.1	7.8
	5/10/2008	4:57	RS-8		26	468	10.7	43000	8.3	7.8
	5/10/2008	4:57	RS-8		27	486	10.7	43000	7.8	7.8
	5/10/2008	4:57	RS-8		28	504	10.6	43000	8.1	7.8

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/10/2008	4:57	RS-8		29	522	10.5	43000	7.9	7.8
	5/10/2008	4:57	RS-8		30	540	10.5	43000	7.7	7.8
	5/10/2008	4:57	RS-8		31	558	10.6	44000	7.2	7.8
	5/10/2008	5:11	RS8	1/4	Surface		13.8	10000	6.5	7.4
	5/10/2008	5:11	RS8		1	18	13.7	10000	7.2	7.4
	5/10/2008	5:11	RS8		2	36	13.7	11000	6.1	7.4
	5/10/2008	5:11	RS8		3	54	13.6	11000	7.1	7.3
	5/10/2008	5:11	RS8		4	72	13.6	13000	6.2	7.3
	5/10/2008	5:11	RS8		5	90	13.6	12000	7.2	7.3
	5/10/2008	5:11	RS8		6	108	13.6	12000	6.7	7.4
	5/10/2008	5:14	RS8	3/4	Surface		13.9	10000	6.8	7.6
	5/10/2008	5:14	RS8		1	18	13.9	10000	7.4	7.6
	5/10/2008	5:14	RS8		2	36	13.9	10000	6.9	7.7
	5/10/2008	5:14	RS8		3	54	13.9	10000	7.3	7.7
	5/10/2008	5:14	RS8		4	72	13.8	10000	7.5	7.7
	5/10/2008	5:14	RS8		5	90	13.4	11000	8.1	7.7
	5/10/2008	5:14	RS8		6	108	13.1	13000	8.1	7.6
	5/10/2008	5:14	RS8		7	126	13.1	24000	7.7	7.4
	5/10/2008	5:14	RS8		8	144	13.1	27000	7.6	7.3
	5/10/2008	4:29	RS-9	MID	Surface		13.7	8000	7.6	7.9
	5/10/2008	4:29	RS-9		1	18	13.7	10000	7.9	7.9
	5/10/2008	4:29	RS-9		2	36	13.8	10000	7.4	7.9
	5/10/2008	4:29	RS-9		3	54	13.7	10000	8.6	7.9
	5/10/2008	4:29	RS-9		4	72	13.5	11000	7.8	7.9
	5/10/2008	4:29	RS-9		5	90	13.2	12000	8.7	7.9
	5/10/2008	4:29	RS-9		6	108	13	21000	8.1	7.8
	5/10/2008	4:29	RS-9		7	126	12.9	22000	8.3	7.9
	5/10/2008	4:29	RS-9		8	144	11.1	38000	7.8	7.8
	5/10/2008	4:29	RS-9		9	162	11	41000	8.9	7.8
	5/10/2008	4:29	RS-9		10	180	11	42000	7.9	7.8
	5/10/2008	4:29	RS-9		11	196	10.9	42000	8.1	7.9
	5/10/2008	4:29	RS-9		12	216	10.9	42000	7.7	7.8
	5/10/2008	4:29	RS-9		13	234	10.9	43000	7.8	7.8
	5/10/2008	4:29	RS-9		14	252	10.8	43000	7.3	7.8
	5/10/2008	4:29	RS-9		15	270	10.5	43000	8.3	7.8
	5/10/2008	4:29	RS-9		16	288	10.4	44000	9.1	7.8
	5/10/2008	4:29	RS-9		17	306	10.4	44000	9.1	7.8
	5/10/2008	4:29	RS-9		18	324	10.4	45000	8.8	7.8
	5/10/2008	4:29	RS-9		19	342	10.3	45000	8.9	7.8
	5/10/2008	4:29	RS-9		20	360	10.3	45000	8.8	7.8
	5/10/2008	4:29	RS-9		21	378	10.3	45000	8.3	7.8
	5/10/2008	4:29	RS-9		22	396	10.3	45000	8.2	7.8
	5/10/2008	4:29	RS-9		23	414	10.3	45000	7.6	7.8
	5/10/2008	4:29	RS-9		24	432	10.3	45000	7.9	7.3
	5/10/2008	4:29	RS-9		25	450	10.3	45000	8.1	7.6
	5/10/2008	4:29	RS-9		26	468	10.3	45000	8.1	7.5
	5/10/2008	4:29	RS-9		27	486	10.3	41000	7.1	7.5

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/10/2008	4:48	RS-9	1/4	Surface		14	10000	6.4	7.6
	5/10/2008	4:48	RS-9		1	18	14	10000	7	7.5
	5/10/2008	4:48	RS-9		2	36	14	11000	7.1	7.5
	5/10/2008	4:48	RS-9		3	54	14	11000	6.7	7.5
	5/10/2008	4:48	RS-9		4	72	13.99	11000	8.1	7.5
	5/10/2008	4:48	RS-9		5	90	13.9	11000	8.1	7.5
	5/10/2008	4:48	RS-9		6	108	13.9	11000	7.7	7.5
	5/10/2008	4:48	RS-9		7	126	13.9	12000	7.7	7.5
	5/10/2008	4:42	RS-9	3/4	Surface		13.9	10000	7.5	7.8
	5/10/2008	4:42	RS-9		1	18	13.9	11000	7.3	7.8
	5/10/2008	4:42	RS-9		2	36	13.9	11000	7.8	7.8
	5/10/2008	4:42	RS-9		3	54	13.8	12000	7.9	7.8
	5/10/2008	4:42	RS-9		4	72	13.8	12000	7.7	7.8
	5/10/2008	4:42	RS-9		5	90	13.6	14000	8.1	7.9
	5/10/2008	4:42	RS-9		6	108	13	14000	8.2	7.9
	5/10/2008	4:42	RS-9		7	126	11.7	20000	8.2	7.9
	5/10/2008	4:42	RS-9		8	144	11.4	37000	8.1	7.8
	5/10/2008	4:42	RS-9		9	162	11.1	39000	7.9	7.8
	5/10/2008	4:42	RS-9		10	180	10.9	41000	8.5	7.8
	5/10/2008	4:42	RS-9		11	196	10.8	43000	8.3	7.8
	5/10/2008	4:42	RS-9		12	216	10.8	43000	7.9	7.7
	5/10/2008	4:01	RS-10	MID	Surface		13.9	8000	8.8	7.9
	5/10/2008	4:01	RS-10		1	18	13.8	8000	8.2	7.8
	5/10/2008	4:01	RS-10		2	36	13.9	9000	9.2	7.9
	5/10/2008	4:01	RS-10		3	54	13.9	9000	9.2	7.9
	5/10/2008	4:01	RS-10		4	72	13.8	9500	8.4	8.2
	5/10/2008	4:01	RS-10		5	90	13.5	10000	8.8	8.1
	5/10/2008	4:01	RS-10		6	108	12.7	12000	9.7	8.1
	5/10/2008	4:01	RS-10		7	126	11.7	18000	9.8	8
	5/10/2008	4:01	RS-10		8	144	11.2	35000	9.1	7.8
	5/10/2008	4:01	RS-10		9	162	10.6	41000	9.8	7.8
	5/10/2008	4:01	RS-10		10	180	10.4	44000	9.7	7.8
	5/10/2008	4:01	RS-10		11	196	10.3	45000	9.7	7.8
	5/10/2008	4:01	RS-10		12	216	10.4	45000	9.8	7.8
	5/10/2008	4:01	RS-10		13	234	10.2	46000	9.7	7.9
	5/10/2008	4:01	RS-10		14	252	10.2	46000	9.8	7.9
	5/10/2008	4:01	RS-10		15	270	10.3	45000	9.8	7.9
	5/10/2008	4:01	RS-10		16	288	10.5	45000	9.2	7.9
	5/10/2008	4:01	RS-10		17	306	10.2	45000	9.1	7.9
	5/10/2008	4:01	RS-10		18	324	10.3	45000	9.4	7.9
	5/10/2008	4:01	RS-10		19	342	10.2	45000	9.2	7.9
	5/10/2008	4:01	RS-10		20	360	10.2	45000	9.6	7.9
	5/10/2008	4:01	RS-10		21	378	10.2	45000	9.7	7.9
	5/10/2008	4:01	RS-10		22	396	10.1	45000	9.4	7.9
	5/10/2008	4:01	RS-10		23	414	10.1	45000	9.8	7.9
	5/10/2008	4:01	RS-10		24	432	10.2	45000	9.1	7.9
	5/10/2008	4:01	RS-10		25	450	10.1	46000	9.7	7.8

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/10/2008	4:01	RS-10		26	468	10.1	46000	9.8	7.8
	5/10/2008	4:01	RS-10		27	486	10.1	46000	9.1	7.8
	5/10/2008	4:01	RS-10		28	504	10.1	46000	10.1	7.8
	5/10/2008	4:01	RS-10		29	522	10.1	46000	9.1	7.8
	5/10/2008	4:01	RS-10		30	540	10.1	45000	9.6	7.7
	5/10/2008	4:01	RS-10		31	558	10.1	46000	8.9	7.7
	5/10/2008	3:34	RS-11		Surface		13.8	12000	4.4	8.5
	5/10/2008	3:34	RS-11		1	18	13.8	12000	4.6	8.6
	5/10/2008	3:34	RS-11		2	36	13.6	13000	4.25	8.6
	5/10/2008	3:34	RS-11		3	54	13	15000	4.3	8.6
	5/10/2008	3:34	RS-11		4	72	12.2	25000	4.6	8.6
	5/10/2008	3:34	RS-11		5	90	11	31000	4.7	8.6
	5/10/2008	3:34	RS-11		6	108	10.7	40000	4.6	8.5
	5/10/2008	3:34	RS-11		7	126	10.4	43000	4.6	8.5
	5/10/2008	3:34	RS-11		8	144	10.2	45000	4.7	8.5
	5/10/2008	3:34	RS-11		9	162	10.1	46000	4.7	8.5
	5/10/2008	3:34	RS-11		10	180	10	46000	4.8	8.5
	5/10/2008	3:34	RS-11		11	196	10	46000	4.5	8.5
	5/10/2008	3:34	RS-11		12	216	10	46000	4.2	8.5
	5/10/2008	3:34	RS-11		13	234	10	46000	4.6	8.5
	5/10/2008	3:34	RS-11		14	252	10	46000	3.9	8.5
	5/10/2008	3:34	RS-11		15	270	10	46000	4.6	8.5
	5/10/2008	3:34	RS-11		16	288	10	46000	4.5	8.6
	5/10/2008	3:34	RS-11		17	306	10	46000	4	8.5
	5/10/2008	3:34	RS-11		18	324	10	46000	4.2	8.6
	5/10/2008	3:34	RS-11		19	342	10	46000	4.1	8.6
	5/10/2008	3:34	RS-11		20	360	9.9	46000	4.1	8.5
	5/10/2008	3:34	RS-11		21	378	9.9	46000	3.7	8.6
	5/10/2008	3:34	RS-11		22	396	9.9	46000	4.1	8.6
	5/10/2008	3:34	RS-11		23	414	9.9	46000	3.9	8.6
	5/10/2008	3:34	RS-11		24	432	9.9	46000	3.9	8.6
	5/10/2008	3:34	RS-11		25	450	9.9	46000	3.5	8.7
	5/10/2008	3:34	RS-11		26	468	9.9	45000	3.5	8.7
	5/10/2008	3:34	RS-11		27	486	9.9	46000	3.3	8.8
	5/10/2008	3:34	RS-11		28	504	9.9	43000	3.6	8.8
	5/10/2008	3:34	RS-11		29	522	9.9	45000	3.5	8.8
	5/10/2008	3:34	RS-11		30	540	9.99	46000	3.76	8.6
	5/10/2008	3:34	RS-11		31	558	9.99	42000	3.75	8.26
	5/10/2008	19:00	RS-6		Surface		15.2	160	5.9	7.9
	5/10/2008	19:00	RS-6		1	18	15.2	160	5.8	7.9
	5/10/2008	19:00	RS-6		2	36	15.2	160	6.1	7.9
	5/10/2008	19:00	RS-6		3	54	15.2	160	6.1	7.9
	5/10/2008	19:00	RS-6		4	72	15.2	160	5.9	7.9
	5/10/2008	19:00	RS-6		5	90	15.2	160	5.9	7.9
	5/10/2008	19:03	RS-6	1/4	Surface		15.1	150	6.3	7.6
	5/10/2008	19:03	RS-6		1	18	15.1	150	5.7	7.6
	5/10/2008	19:03	RS-6		2	36	15.1	150	6.4	7.6

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/10/2008	19:03	RS-6		3	54	15.1	150	5.9	7.6
	5/10/2008	19:03	RS-6		4	72	15.1	150	6.1	7.6
	5/10/2008	19:03	RS-6		5	90	15.1	150	6	7.6
	5/10/2008	19:05	RS-6	3/4	Surface		15.3	160	6.7	7.5
	5/10/2008	19:05	RS-6		1	18	15.3	160	6.7	7.5
	5/10/2008	19:05	RS-6		2	36	15.3	160	5.8	7.5
	5/10/2008	19:05	RS-6		3	54	15.3	160	6.4	7.5
	5/10/2008	19:05	RS-6		4	72	15.3	160	6.1	7.5
	5/10/2008	19:05	RS-6		5	90	15.2	160	6	7.5
	5/10/2008	18:48	RS-7		Surface		14.1	2000	5.9	8.1
	5/10/2008	18:48	RS-7		1	18	14.1	3000	5.3	8.1
	5/10/2008	18:48	RS-7		2	36	14.1	4000	7.1	8.1
	5/10/2008	18:48	RS-7		3	54	14.1	4000	5.9	8.2
	5/10/2008	18:48	RS-7		4	72	14.1	5000	5.9	8.2
	5/10/2008	18:48	RS-7		5	90	13.9	5000	6.1	8.2
	5/10/2008	18:48	RS-7		6	108	13.5	5000	6	8.2
	5/10/2008	18:48	RS-7		7	126	12.6	13000	6.5	8.1
	5/10/2008	18:48	RS-7		8	144	12.4	24000	6.6	7.9
	5/10/2008	18:48	RS-7		9	162	11.8	26000	6.5	7.9
	5/10/2008	18:48	RS-7		10	180	11.1	28000	6.7	7.9
	5/10/2008	18:48	RS-7		11	196	10.7	42000	6.9	7.8
	5/10/2008	18:48	RS-7		12	216	10.6	42000	7.6	7.8
	5/10/2008	18:48	RS-7		13	234	10.5	44000	8.1	7.9
	5/10/2008	18:48	RS-7		14	252	10.5	44000	7.4	7.8
	5/10/2008	18:48	RS-7		15	270	10.5	44000	6.8	7.9
	5/10/2008	18:48	RS-7		16	288	10.4	44000	7.4	7.8
	5/10/2008	18:48	RS-7		17	306	10.4	44000	7.1	7.8
	5/10/2008	18:48	RS-7		18	324	10.4	44000	6.3	7.8
	5/10/2008	18:48	RS-7		19	342	10.4	44000	6.6	7.8
	5/10/2008	18:48	RS-7		20	360	10.4	44000	7.3	7.8
	5/10/2008	18:48	RS-7		21	378	10.4	44000	7	7.8
	5/10/2008	18:48	RS-7		22	396	10.4	44000	7.7	7.8
	5/10/2008	18:48	RS-7		23	414	10.3	44000	6.8	7.8
	5/10/2008	18:48	RS-7		24	432	10.3	45000	8.2	7.8
	5/10/2008	18:48	RS-7		25	450	10.3	44000	7.1	7.8
	5/10/2008	18:48	RS-7		26	468	10.3	44000	7.5	7.8
	5/10/2008	18:48	RS-7		27	486	10.3	44000	6.3	7.8
	5/10/2008	18:48	RS-7		28	504	10.3	44000	6.3	7.7
	5/10/2008	18:48	RS-7		29	522	10.2	44000	8.8	7.7
	5/10/2008	18:48	RS-7		30	540	10.2	44000	6.4	7.7
	5/10/2008	18:48	RS-7		31	558	10.3	45000	7.7	7.8
	5/10/2008	18:28	RS-8		Surface		14.4	5000	5.3	8.1
	5/10/2008	18:28	RS-8		1	18	14.2	10000	7.1	8.1
	5/10/2008	18:28	RS-8		2	36	14	10000	7.5	8
	5/10/2008	18:28	RS-8		3	54	13.8	11000	7.8	7.9
	5/10/2008	18:28	RS-8		4	72	13.4	14000	7.6	7.9
	5/10/2008	18:28	RS-8		5	90	13.2	17000	7.4	7.9

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/10/2008	18:28	RS-8		6	108	13	20000	7.6	7.8
	5/10/2008	18:28	RS-8		7	126	13	22000	7.8	7.9
	5/10/2008	18:28	RS-8		8	144	12.8	23000	8.5	7.9
	5/10/2008	18:28	RS-8		9	162	12.6	23000	8.4	7.9
	5/10/2008	18:28	RS-8		10	180	12.5	25000	8.8	7.9
	5/10/2008	18:28	RS-8		11	196	11.8	26000	8.7	7.9
	5/10/2008	18:28	RS-8		12	216	10.8	31000	8.1	7.9
	5/10/2008	18:28	RS-8		13	234	10.6	42000	9.1	7.9
	5/10/2008	18:28	RS-8		14	252	10.5	44000	8.7	7.8
	5/10/2008	18:28	RS-8		15	270	10.5	43000	8.7	7.8
	5/10/2008	18:28	RS-8		16	288	10.5	45000	8.3	7.8
	5/10/2008	18:28	RS-8		17	306	10.8	42000	9.3	7.7
	5/10/2008	18:28	RS-8		18	324	10.7	43000	9.3	7.9
	5/10/2008	18:28	RS-8		19	342	10.7	43000	8.2	7.9
	5/10/2008	18:28	RS-8		20	360	10.6	43000	8.4	7.9
	5/10/2008	18:28	RS-8		21	378	10.6	43000	8.7	7.9
	5/10/2008	18:28	RS-8		22	396	10.5	43000	8.5	7.9
	5/10/2008	18:28	RS-8		23	414	10.5	44000	8.4	7.9
	5/10/2008	18:28	RS-8		24	432	10.5	44000	7.7	7.9
	5/10/2008	18:28	RS-8		25	450	10.4	45000	9.1	7.8
	5/10/2008	18:28	RS-8		26	468	10.3	45000	9	7.8
	5/10/2008	18:28	RS-8		27	486	10.3	45000	8.9	7.8
	5/10/2008	18:34	RS-8	1/4	Surface		14.4	8000	7.7	7.8
	5/10/2008	18:34	RS-8		1	18	14.3	10000	7.2	7.7
	5/10/2008	18:34	RS-8		2	36	14.2	11000	6.5	7.7
	5/10/2008	18:34	RS-8		3	54	14.1	11000	7.6	7.7
	5/10/2008	18:34	RS-8		4	72	14	12000	7.1	7.7
	5/10/2008	18:34	RS-8		5	90	13.4	13000	6.7	7.7
	5/10/2008	18:34	RS-8		6	108	13	16000	6.6	7.6
	5/10/2008	18:34	RS-8		7	126	12.99	22000	7.6	7.6
	5/10/2008	18:38	RS-8	3/4	Surface		14.6	8000	7.1	7.6
	5/10/2008	18:38	RS-8		1	18	14.7	8000	7.5	7.7
	5/10/2008	18:38	RS-8		2	36	14.5	10000	7.7	7.8
	5/10/2008	18:38	RS-8		3	54	14.1	10000	8.3	7.8
	5/10/2008	18:38	RS-8		4	72	13.5	12000	6.6	7.7
	5/10/2008	18:38	RS-8		5	90	13.2	19000	6.8	7.6
	5/10/2008	18:38	RS-8		6	108	13	21000	7.3	7.5
	5/10/2008	18:38	RS-8		7	126	12.9	20000	7	7.5
	5/10/2008	18:38	RS-8		8	144	12.7	25000	7.8	7.5
	5/10/2008	18:16	RS-9		Surface		14.4	10000	7.9	7.9
	5/10/2008	18:16	RS-9		1	18	14.4	10000	7.8	8
	5/10/2008	18:16	RS-9		2	36	14.3	10000	8.2	8.1
	5/10/2008	18:16	RS-9		3	54	14	10000	8	8.1
	5/10/2008	18:16	RS-9		4	72	13.8	13000	7.1	8.1
	5/10/2008	18:16	RS-9		5	90	13.5	14000	8.4	7.1
	5/10/2008	18:16	RS-9		6	108	12.9	16000	7.4	8.1
	5/10/2008	18:16	RS-9		7	126	11.6	25000	7.9	8

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/10/2008	18:16	RS-9		8	144	11.1	36000	8.4	7.9
	5/10/2008	18:16	RS-9		9	162	11	40000	8.8	7.9
	5/10/2008	18:16	RS-9		10	180	10.6	42000	8.5	7.9
	5/10/2008	18:16	RS-9		11	196	10.5	44000	7.9	7.9
	5/10/2008	18:16	RS-9		12	216	10.5	44000	8.7	7.9
	5/10/2008	18:16	RS-9		13	234	10.4	44000	8.3	7.8
	5/10/2008	18:16	RS-9		14	252	10.4	45000	7.4	7.8
	5/10/2008	18:16	RS-9		15	270	10.4	45000	7.5	7.8
	5/10/2008	18:16	RS-9		16	288	10.4	45000	8.9	7.7
	5/10/2008	18:16	RS-9		17	306	10.4	45000	8.6	7.7
	5/10/2008	18:16	RS-9		18	324	10.4	45000	8.8	7.6
	5/10/2008	18:16	RS-9		19	342	10.5	45000	9.2	7.5
	5/10/2008	18:16	RS-9		20	360	10.5	38000	7.5	7.5
	5/10/2008	18:16	RS-9		21	378	10.5	39000	9.6	7.5
	5/10/2008	18:16	RS-9		22	396	10.5	39000	8.9	7.5
	5/10/2008	18:16	RS-9		23	414	10.5	39000	8.5	7.5
	5/10/2008	18:16	RS-9		24	432	10.5	39000	7.1	7.5
	5/10/2008	18:16	RS-9		25	450	10.5	39000	7.8	7.5
	5/10/2008	18:16	RS-9		26	468	10.5	39000	7.7	7.5
	5/10/2008	18:16	RS-9		27	486	10.6	38000	8.2	7.5
	5/10/2008	18:16	RS-9		28	504	10.6	42000	7.8	7.5
	5/10/2008	18:16	RS-9		29	522	10.6	44000	8.2	7.5
	5/10/2008	18:16	RS-9		30	540	10.6	44000	8.6	7.5
	5/10/2008	18:16	RS-9		31	558	10.6	45000	8.2	7.5
	5/10/2008	18:21	RS-9	1/4	Surface		14.6	10000	8.8	7.8
	5/10/2008	18:21	RS-9		1	18	14.5	10000	8.7	7.7
	5/10/2008	18:21	RS-9		2	36	14.2	11000	7.8	7.7
	5/10/2008	18:21	RS-9		3	54	14	12000	7.8	7.7
	5/10/2008	18:21	RS-9		4	72	14	13000	7.3	7.7
	5/10/2008	18:21	RS-9		5	90	14.1	13000	7.6	7.7
	5/10/2008	18:23	RS-9	3/4	Surface		14.4	10000	7.6	7.7
	5/10/2008	18:23	RS-9		1	18	14.4	10000	7.8	7.8
	5/10/2008	18:23	RS-9		2	36	14.3	10000	6.6	7.8
	5/10/2008	18:23	RS-9		3	54	14.3	10000	7.7	7.8
	5/10/2008	18:23	RS-9		4	72	14.3	10000	8.1	7.8
	5/10/2008	18:23	RS-9		5	90	14.2	11000	7.8	7.8
	5/10/2008	18:23	RS-9		6	108	13.5	13000	8.3	7.8
	5/10/2008	18:23	RS-9		7	126	12.9	17000	7.6	7.8
	5/10/2008	18:23	RS-9		8	144	12.9	23000	8.1	7.7
	5/10/2008	18:08	RS-10		Surface		14.7	13000	8.2	8
	5/10/2008	18:08	RS-10		1	18	14.6	13000	7.8	8
	5/10/2008	18:08	RS-10		2	36	14.4	14000	8.7	8.1
	5/10/2008	18:08	RS-10		3	54	14.3	14000	7.3	8.1
	5/10/2008	18:08	RS-10		4	72	14	15000	8.2	8.2
	5/10/2008	18:08	RS-10		5	90	13.5	16000	8.1	8.2
	5/10/2008	18:08	RS-10		6	108	11.5	27000	8.5	8.1
	5/10/2008	18:08	RS-10		7	126	10.6	35000	8.4	7.9

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/10/2008	18:08	RS-10		8	144	10.5	40000	8.5	7.9
	5/10/2008	18:08	RS-10		9	162	10.5	41000	9.2	7.9
	5/10/2008	18:08	RS-10		10	180	10.5	41000	8.7	7.9
	5/10/2008	18:08	RS-10		11	196	10.5	40000	9.2	7.9
	5/10/2008	18:08	RS-10		12	216	10.5	38000	8.6	7.9
	5/10/2008	18:08	RS-10		13	234	10.5	38000	8.2	7.9
	5/10/2008	18:08	RS-10		14	252	10.4	38000	9.2	7.9
	5/10/2008	18:08	RS-10		15	270	10.4	38000	6.9	7.9
	5/10/2008	18:08	RS-10		16	288	10.4	38000	8.8	7.9
	5/10/2008	18:08	RS-10		17	306	10.4	38000	8.9	7.8
	5/10/2008	18:08	RS-10		18	324	10.4	38000	8.1	7.8
	5/10/2008	18:08	RS-10		19	342	10.4	38000	8.2	7.7
	5/10/2008	18:08	RS-10		20	360	10.5	38000	9.7	7.5
	5/10/2008	18:08	RS-10		21	378	10.5	37000	9.3	7.5
	5/10/2008	18:08	RS-10		22	396	10.5	37000	9.1	7.5
	5/10/2008	18:08	RS-10		23	414	10.5	37000	8.8	7.5
	5/10/2008	18:08	RS-10		24	432	10.5	37000	8.1	7.5
	5/10/2008	18:08	RS-10		25	450	10.5	37000	9.3	7.5
	5/10/2008	18:08	RS-10		26	468	10.5	36000	9.5	7.5
	5/10/2008	18:08	RS-10		27	486	10.5	36000	9.2	7.5
	5/10/2008	18:08	RS-10		28	504	10.5	36000	8.5	7.5
	5/10/2008	18:08	RS-10		29	522	10.5	36000	9.3	7.6
	5/10/2008	18:08	RS-10		30	540	10.4	36000	9.7	7.6
	5/10/2008	18:08	RS-10		31	558	10.4	36000	9.6	7.6
	5/10/2008	18:00	RS-11		Surface		14.6	15000	9.4	7.9
	5/10/2008	18:00	RS-11		1	18	14	16000	9.3	7.9
	5/10/2008	18:00	RS-11		2	36	13.3	18000	9.8	7.9
	5/10/2008	18:00	RS-11		3	54	12.8	22000	9.9	7.9
	5/10/2008	18:00	RS-11		4	72	12.4	25000	10	7.9
	5/10/2008	18:00	RS-11		5	90	11.6	30000	10.2	7.9
	5/10/2008	18:00	RS-11		6	108	10.8	38000	10.5	7.9
	5/10/2008	18:00	RS-11		7	126	10.4	42000	10.6	7.9
	5/10/2008	18:00	RS-11		8	144	10.4	44000	10.7	7.8
	5/10/2008	18:00	RS-11		9	162	10.4	45000	10.7	7.8
	5/10/2008	18:00	RS-11		10	180	10.4	45000	10.7	7.8
	5/10/2008	18:00	RS-11		11	196	10.5	44000	10.7	7.6
	5/10/2008	18:00	RS-11		12	216	10.5	41000	10.7	7.5
	5/10/2008	18:00	RS-11		13	234	10.4	40000	10.7	7.5
	5/10/2008	18:00	RS-11		14	252	10.4	38000	10.7	7.5
	5/10/2008	18:00	RS-11		15	270	10.5	37000	10.7	7.5
	5/10/2008	18:00	RS-11		16	288	10.4	37000	10.7	7.5
	5/10/2008	18:00	RS-11		17	306	10.5	38000	10.7	7.5
	5/10/2008	18:00	RS-11		18	324	10.5	38000	10.7	7.6
	5/10/2008	18:00	RS-11		19	342	10.5	38000	10.7	7.6
	5/10/2008	18:00	RS-11		20	360	10.5	38000	10.7	7.6
	5/10/2008	18:00	RS-11		21	378	10.5	39000	10.7	7.6
	5/10/2008	18:00	RS-11		22	396	10.4	40000	10.7	7.6

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/10/2008	18:00	RS-11		23	414	10.5	41000	10.7	7.6
	5/10/2008	18:00	RS-11		24	432	10.4	42000	10.7	7.7
	5/10/2008	18:00	RS-11		25	450	10.4	40000	10.7	7.7
	5/10/2008	18:00	RS-11		26	468	10.4	40000	10.7	7.7
	5/10/2008	18:00	RS-11		27	486	10.4	40000	10.5	7.7
	5/10/2008	18:00	RS-11		28	504	10.4	40000	10.6	7.8
	5/10/2008	18:00	RS-11		29	522	10.4	40000	10.5	7.8
	5/10/2008	18:00	RS-11		30	540	10.4	40000	10.3	7.8
	5/10/2008	18:00	RS-11		31	558	10.3	40000	10.7	7.8
	5/11/2008	19:29	RS-6		Surface		15.71	160	7.36	7.65
	5/11/2008	19:29	RS-6		1	18	15.71	160	7.6	7.66
	5/11/2008	19:29	RS-6		2	36	15.71	160	7.51	7.68
	5/11/2008	19:29	RS-6		3	54	15.71	160	8.1	7.7
	5/11/2008	19:29	RS-6		4	72	15.72	160	7.7	7.7
	5/11/2008	19:29	RS-6		5	90	15.72	160	7.32	7.7
	5/11/2008	19:29	RS-6		6	108	15.72	160	7.7	7.73
	5/11/2008	19:29	RS-6		7	126	15.72	160	7.37	7.44
	5/11/2008	19:29	RS-6		8	144	15.72	160	6.61	7.7
	5/11/2008	19:29	RS-6		9	162	15.72	160	6.33	7.77
	5/11/2008	19:29	RS-6		10	180	15.76	160	5.92	7.78
	5/11/2008	19:29	RS-6		11	196	15.72	160	6.4	7.79
	5/11/2008	19:31	RS-6	1/4	Surface		15.61	150	7.67	7.46
	5/11/2008	19:31	RS-6		1	18	15.61	160	7.92	7.5
	5/11/2008	19:31	RS-6		2	36	15.61	150	6.97	7.5
	5/11/2008	19:31	RS-6		3	54	15.61	150	8.02	7.52
	5/11/2008	19:31	RS-6		4	72	15.61	150	7.5	7.51
	5/11/2008	19:31	RS-6		5	90	15.61	150	7.61	7.53
	5/11/2008	19:31	RS-6		6	108	15.61	150	7.5	7.53
	5/11/2008	19:31	RS-6		7	126	15.61	150	7.21	7.54
	5/11/2008	19:31	RS-6		8	144	15.61	150	8.19	7.57
	5/11/2008	19:31	RS-6		9	162	15.61	150	7.1	7.16
	5/11/2008	19:31	RS-6		10	180	15.61	150	7.45	7.54
	5/11/2008	19:36	RS-6	3/4	Surface		15.72	160	7.37	7.46
	5/11/2008	19:36	RS-6		1	18	15.73	160	7.47	7.77
	5/11/2008	19:36	RS-6		2	36	15.76	160	7.82	7.46
	5/11/2008	19:36	RS-6		3	54	15.73	160	7.72	746
	5/11/2008	19:36	RS-6		4	72	15.73	160	7.11	7.45
	5/11/2008	19:36	RS-6		5	90	15.73	160	7.63	7.46
	5/11/2008	19:36	RS-6		6	108	15.73	160	8.06	7.45
	5/11/2008	19:36	RS-6		7	126	15.73	160	7.77	7.45
	5/11/2008	19:36	RS-6		8	144	15.72	160	7.49	7.45
	5/11/2008	19:36	RS-6		9	162	15.72	160	7.5	7.46
	5/11/2008	19:12	RS-7		Surface		15.12	1800	6.47	8
	5/11/2008	19:12	RS-7		1	18	15.11	2090	7.22	8
	5/11/2008	19:12	RS-7		2	36	15.08	2310	7.29	8.02
	5/11/2008	19:12	RS-7		3	54	15.02	2670	6.5	8
	5/11/2008	19:12	RS-7		4	72	14.88	3940	6.48	7.99

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/11/2008	19:12	RS-7		5	90	13.14	5650	7.54	7.94
	5/11/2008	19:12	RS-7		6	108	13.34	21400	8.12	7.64
	5/11/2008	19:12	RS-7		7	126	13.22	20830	7.15	7.78
	5/11/2008	19:12	RS-7		8	144	13.77	24760	6.97	7.78
	5/11/2008	19:12	RS-7		9	162	11.14	20270	6.45	8
	5/11/2008	19:12	RS-7		10	180	10.64	40760	7.02	7.86
	5/11/2008	19:12	RS-7		11	196	10.35	44440	6.76	7.86
	5/11/2008	19:12	RS-7		12	216	10.5	44620	7.46	7.84
	5/11/2008	19:12	RS-7		13	234	10.48	44710	7.72	7.84
	5/11/2008	19:12	RS-7		14	252	10.45	44770	8.4	7.83
	5/11/2008	19:12	RS-7		15	270	10.42	44900	8.85	7.83
	5/11/2008	19:12	RS-7		16	288	10.39	45000	6.31	7.82
	5/11/2008	19:12	RS-7		17	306	10.34	45040	8	7.82
	5/11/2008	19:12	RS-7		18	324	10.39	45080	8.39	7.81
	5/11/2008	19:12	RS-7		19	342	10.36	45130	8.58	7.58
	5/11/2008	19:12	RS-7		20	360	10.35	45180	8.5	7.8
	5/11/2008	19:12	RS-7		21	378	10.34	45170	8.52	7.58
	5/11/2008	19:12	RS-7		22	396	10.32	45170	9.02	7.77
	5/11/2008	19:12	RS-7		23	414	10.31	45170	8.53	7.76
	5/11/2008	19:12	RS-7		24	432	10.3	45160	8.89	7.74
	5/11/2008	19:12	RS-7		25	450	10.3	45100	8.02	7.72
	5/11/2008	19:12	RS-7		26	468	10.3	45000	7.91	7.69
	5/11/2008	19:12	RS-7		27	486	10.31	42340	7.73	7.65
	5/11/2008	19:12	RS-7		28	504	10.36	44040	7.22	7.68
	5/11/2008	19:12	RS-7		29	522	10.38	44700	8.01	7.64
	5/11/2008	19:12	RS-7		30	540	10.39	45620	8.59	7.68
	5/11/2008	18:51	RS-8		Surface		15.14	2690	7.11	8.07
	5/11/2008	18:51	RS-8		1	18	15.02	4170	6.33	8.07
	5/11/2008	18:51	RS-8		2	36	14.93	4650	6.93	8.08
	5/11/2008	18:51	RS-8		3	54	14.87	6120	7.27	8.08
	5/11/2008	18:51	RS-8		4	72	14.67	6410	7.17	8.11
	5/11/2008	18:51	RS-8		5	90	13.99	6660	6.91	8.16
	5/11/2008	18:51	RS-8		6	108	12.75	10300	6.29	8.1
	5/11/2008	18:51	RS-8		7	126	11.94	26420	6.5	7.93
	5/11/2008	18:51	RS-8		8	144	11.37	36600	6.62	7.89
	5/11/2008	18:51	RS-8		9	162	10.88	37770	6.44	7.87
	5/11/2008	18:51	RS-8		10	180	10.67	41900	6.7	7.84
	5/11/2008	18:51	RS-8		11	196	10.54	43480	7.4	7.84
	5/11/2008	18:51	RS-8		12	216	10.48	44630	6.87	7.83
	5/11/2008	18:51	RS-8		13	234	10.46	44760	7.02	7.82
	5/11/2008	18:51	RS-8		14	252	10.45	44880	6.94	7.82
	5/11/2008	18:51	RS-8		15	270	10.45	44900	6.58	7.82
	5/11/2008	18:51	RS-8		16	288	10.44	44290	6.44	7.81
	5/11/2008	18:51	RS-8		17	306	10.42	44960	6.67	7.8
	5/11/2008	18:51	RS-8		18	324	10.41	15060	6.7	7.81
	5/11/2008	18:51	RS-8		19	342	10.39	45120	6.19	7.8
	5/11/2008	18:51	RS-8		20	360	10.38	45170	6.52	7.79

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/11/2008	18:51	RS-8		21	378	10.37	45220	6.39	7.77
	5/11/2008	18:51	RS-8		22	396	10.36	45250	6.83	7.74
	5/11/2008	18:51	RS-8		23	414	10.35	39620	6.4	7.7
	5/11/2008	18:51	RS-8		24	432	10.34	39110	7.37	7.56
	5/11/2008	18:51	RS-8		25	450	10.35	38400	6.46	7.47
	5/11/2008	18:57	RS-8	1/4	Surface		15	4200	7.41	7.94
	5/11/2008	18:57	RS-8		1	18	14.94	4850	7.7	7.97
	5/11/2008	18:57	RS-8		2	36	14.88	5030	6.11	8.01
	5/11/2008	18:57	RS-8		3	54	14.64	5000	6.8	8.05
	5/11/2008	18:57	RS-8		4	72	13.87	8880	6.64	7.97
	5/11/2008	18:57	RS-8		5	90	12.9	13400	7.82	7.91
	5/11/2008	18:57	RS-8		6	108	12.4	23000	6.88	7.75
	5/11/2008	18:57	RS-8		7	126	12.51	28890	6.79	7.69
	5/11/2008	18:57	RS-8		8	144	11.96	32760	8.14	7.6
	5/11/2008	19:03	RS-8	3/4	Surface		15.33	3610	7.57	7.52
	5/11/2008	19:03	RS-8		1	18	15.35	3700	7.25	7.51
	5/11/2008	19:03	RS-8		2	36	15.32	4060	7.97	7.47
	5/11/2008	19:03	RS-8		3	54	15.29	4070	7.7	7.45
	5/11/2008	19:03	RS-8		4	72	15.29	4100	7.58	7.44
	5/11/2008	19:03	RS-8		5	90	15.28	8040	7.6	7.43
	5/11/2008	19:03	RS-8		6	108	15.28	4100	7.84	7.41
	5/11/2008	19:03	RS-8		7	126	15.28	4050	7.59	7.36
	5/11/2008	19:03	RS-8		8	144	15.28	4080	7.69	7.36
	5/11/2008	19:03	RS-8		9	162	15.28	4090	7.49	7.35
	5/11/2008	19:03	RS-8		10	180	15.28	4080	7.66	7.33
	5/11/2008	19:03	RS-8		11	196	15.27	4040	7.44	7.32
	5/11/2008	19:03	RS-8		12	216	15.26	4030	7.39	7.32
	5/11/2008	19:03	RS-8		13	234	15.26	4300	7.6	7.33
	5/11/2008	18:23	RS-9		Surface		14.92	4500	7.26	8.1
	5/11/2008	18:23	RS-9		1	18	14.48	5400	7.6	7.55
	5/11/2008	18:23	RS-9		2	36	14.17	5710	8.24	7.49
	5/11/2008	18:23	RS-9		3	54	13.85	6330	8.49	7.47
	5/11/2008	18:23	RS-9		4	72	13.14	6510	9.44	7.39
	5/11/2008	18:23	RS-9		5	90	11.95	7830	10.12	7.37
	5/11/2008	18:23	RS-9		6	108	11.38	22080	10.42	7.37
	5/11/2008	18:23	RS-9		7	126	10.88	27710	10.5	7.37
	5/11/2008	18:23	RS-9		8	144	10.69	39880	10.61	7.37
	5/11/2008	18:23	RS-9		9	162	10.57	43000	10.64	7.37
	5/11/2008	18:23	RS-9		10	180	10.51	44160	10.67	7.37
	5/11/2008	18:23	RS-9		11	196	10.51	44260	10.67	7.37
	5/11/2008	18:23	RS-9		12	216	10.51	44800	10.67	7.37
	5/11/2008	18:23	RS-9		13	234	10.51	44870	10.61	7.37
	5/11/2008	18:23	RS-9		14	252	10.5	40030	10.61	7.37
	5/11/2008	18:23	RS-9		15	270	10.49	39770	10.7	7.38
	5/11/2008	18:23	RS-9		16	288	10.48	39120	10.45	7.39
	5/11/2008	18:23	RS-9		17	306	10.48	38660	10.1	7.4
	5/11/2008	18:23	RS-9		18	324	10.47	38650	9.72	7.41

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/11/2008	18:23	RS-9		19	342	10.47	38810	9.15	7.42
	5/11/2008	18:23	RS-9		20	360	10.48	38770	9.27	7.43
	5/11/2008	18:23	RS-9		21	378	10.49	39750	9.62	7.43
	5/11/2008	18:23	RS-9		22	396	10.54	40210	9.76	7.44
	5/11/2008	18:23	RS-9		23	414	10.64	41790	8.67	7.44
	5/11/2008	18:23	RS-9		24	432	10.71	44270	9.54	7.46
	5/11/2008	18:23	RS-9		25	450	10.69	45400	8.69	7.52
	5/11/2008	18:23	RS-9		26	468	10.68	45380	8.7	7.52
	5/11/2008	18:23	RS-9		27	486	10.68	45330	9.35	7.52
	5/11/2008	18:23	RS-9		28	504	10.67	45270	9.72	7.54
	5/11/2008	18:23	RS-9		29	522	10.65	45170	8.75	7.53
	5/11/2008	18:33	RS-9	1/4	Surface		15.24	5560	8.92	7.6
	5/11/2008	18:33	RS-9		1	18	15.23	6250	7.5	7.54
	5/11/2008	18:33	RS-9		2	36	15.22	6660	8.54	7.52
	5/11/2008	18:33	RS-9		3	54	15.2	6650	8.18	7.52
	5/11/2008	18:33	RS-9		4	72	15.18	6500	8.31	7.52
	5/11/2008	18:33	RS-9		5	90	15.17	6900	7.2	7.53
	5/11/2008	18:33	RS-9		6	108	15.16	6980	7.3	7.54
	5/11/2008	18:33	RS-9		7	126	15.15	7020	7	7.56
	5/11/2008	18:33	RS-9		8	144	15.13	7040	7.24	7.57
	5/11/2008	18:33	RS-9		9	162	15.09	7130	7.19	7.57
	5/11/2008	18:33	RS-9		10	180	15.08	7160	8.2	7.59
	5/11/2008	18:33	RS-9		11	196	15.05	7150	7.5	7.62
	5/11/2008	18:33	RS-9		12	216	15.04	7160	7.49	7.61
	5/11/2008	18:40	RS-9	3/4	Surface		15.1	4120	9.35	7.9
	5/11/2008	18:40	RS-9		1	18	15.4	4460	9.28	7.34
	5/11/2008	18:40	RS-9		2	36	15.43	5470	9.24	7.93
	5/11/2008	18:40	RS-9		3	54	15.39	5800	9.24	7.49
	5/11/2008	18:40	RS-9		4	72	14.96	5830	9.25	8.07
	5/11/2008	18:40	RS-9		5	90	13.4	7400	7.49	8
	5/11/2008	18:40	RS-9		6	108	12.16	14190	10.01	7.93
	5/11/2008	18:40	RS-9		7	126	10.89	29100	10.41	7.79
	5/11/2008	18:40	RS-9		8	144	10.62	36150	10.67	7.69
	5/11/2008	18:40	RS-9		9	162	10.52	21810	10.67	7.62
	5/11/2008	18:40	RS-9		10	180	10.49	42900	9.79	7.55
	5/11/2008	18:40	RS-9		11	196	10.48	43900	8.49	7.47
	5/11/2008	18:40	RS-9		12	216	10.47	44600	9.45	7.37
	5/11/2008	18:40	RS-9		13	234	10.45	44770	9.4	7.32
	5/11/2008	18:40	RS-9		14	252	10.44	43400	9.35	7.32
	5/11/2008	18:40	RS-9		15	270	10.43	41900	8.88	7.34
	5/11/2008	18:40	RS-9		16	288	10.42	40420	8.76	7.35
	5/11/2008	18:40	RS-9		17	306	10.4	39390	9.2	7.35
	5/11/2008	18:40	RS-9		18	324	10.39	38770	8.48	7.37
	5/11/2008	18:40	RS-9		19	342	10.39	39540	7.59	7.39
	5/11/2008	18:40	RS-9		20	360	10.42	38850	8.48	7.46
	5/11/2008	18:40	RS-9		21	378	10.51	41100	9.31	7.57
	5/11/2008	18:40	RS-9		22	396	10.49	44970	8.9	7.63

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/11/2008	18:40	RS-9		23	414	10.47	44880	9.02	7.64
	5/11/2008	18:40	RS-9		24	432	10.45	44760	8.29	7.67
	5/11/2008	18:12	RS-10		Surface		15.33	7400	8.48	7.75
	5/11/2008	18:12	RS-10		1	18	15.31	7720	8.91	7.77
	5/11/2008	18:12	RS-10		2	36	15.29	7930	8.6	7.77
	5/11/2008	18:12	RS-10		3	54	14.85	7870	8.04	7.78
	5/11/2008	18:12	RS-10		4	72	13.82	9200	8.84	8.03
	5/11/2008	18:12	RS-10		5	90	13.22	13400	8.37	7.97
	5/11/2008	18:12	RS-10		6	108	12.54	18470	8.81	7.97
	5/11/2008	18:12	RS-10		7	126	11.71	24040	10.25	7.91
	5/11/2008	18:12	RS-10		8	144	11.39	36190	10.37	7.84
	5/11/2008	18:12	RS-10		9	162	11.29	40110	9.33	7.83
	5/11/2008	18:12	RS-10		10	180	11.02	40310	9.6	7.85
	5/11/2008	18:12	RS-10		11	196	10.75	42380	9.66	7.85
	5/11/2008	18:12	RS-10		12	216	10.61	43920	9.09	7.84
	5/11/2008	18:12	RS-10		13	234	10.55	44700	10.19	7.82
	5/11/2008	18:12	RS-10		14	252	10.53	44760	10.14	7.79
	5/11/2008	18:12	RS-10		15	270	10.6	44580	10.35	7.76
	5/11/2008	18:12	RS-10		16	288	10.8	44770	10.6	7.79
	5/11/2008	18:12	RS-10		17	306	11.02	45690	9.94	7.77
	5/11/2008	18:12	RS-10		18	324	10.89	45750	9.83	7.77
	5/11/2008	18:12	RS-10		19	342	10.88	45900	9.29	7.76
	5/11/2008	18:12	RS-10		20	360	11	45960	10.05	7.76
	5/11/2008	18:12	RS-10		21	378	10.98	45940	9.69	7.76
	5/11/2008	18:12	RS-10		22	396	10.9	45920	10.32	7.76
	5/11/2008	18:12	RS-10		23	414	10.88	45920	10.24	7.75
	5/11/2008	18:12	RS-10		24	432	10.9	45900	10.11	7.75
	5/11/2008	18:12	RS-10		25	450	10.84	45870	9.33	7.74
	5/11/2008	18:12	RS-10		26	468	10.72	45850	9.72	7.74
	5/11/2008	18:12	RS-10		27	486	10.67	45820	10.07	7.73
	5/11/2008	18:12	RS-10		28	504	10.68	45710	9.01	7.72
	5/11/2008	18:00	RS-11		Surface		15.3	9510	9.24	7.77
	5/11/2008	18:00	RS-11		1	18	14.95	10730	9.33	7.77
	5/11/2008	18:00	RS-11		2	36	14.51	11150	9.44	7.77
	5/11/2008	18:00	RS-11		3	54	13.82	12770	9.67	7.74
	5/11/2008	18:00	RS-11		4	72	13.3	16800	9.77	7.69
	5/11/2008	18:00	RS-11		5	90	12.23	20650	10.04	7.67
	5/11/2008	18:00	RS-11		6	108	11.16	36310	10.35	7.57
	5/11/2008	18:00	RS-11		7	126	11.1	43340	10.47	7.47
	5/11/2008	18:00	RS-11		8	144	11.09	42120	10.48	7.36
	5/11/2008	18:00	RS-11		9	162	11.05	43320	10.48	7.32
	5/11/2008	18:00	RS-11		10	180	10.94	38440	10.54	7.27
	5/11/2008	18:00	RS-11		11	196	10.95	36780	10.57	7.33
	5/11/2008	18:00	RS-11		12	216	10.96	38680	10.38	7.38
	5/11/2008	18:00	RS-11		13	234	10.95	39070	10.36	7.39
	5/11/2008	18:00	RS-11		14	252	10.99	40740	10.16	7.42
	5/11/2008	18:00	RS-11		15	270	11.08	41850	10.19	7.42

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/11/2008	18:00	RS-11		16	288	11.12	40570	10.32	7.42
	5/11/2008	18:00	RS-11		17	306	11.12	43620	10.18	7.43
	5/11/2008	18:00	RS-11		18	324	11.12	43670	10.09	7.43
	5/11/2008	18:00	RS-11		19	342	11.12	43530	10.31	7.44
	5/11/2008	18:00	RS-11		20	360	11.12	43340	10.12	7.44
	5/11/2008	18:00	RS-11		21	378	11.12	43250	10.35	7.46
	5/11/2008	18:00	RS-11		22	396	11.12	43080	10.17	7.46
	5/11/2008	18:00	RS-11		23	414	11.12	42820	10.16	7.47
	5/11/2008	18:00	RS-11		24	432	11.11	42590	992	7.48
	5/11/2008	18:00	RS-11		25	450	11.08	42460	10.21	7.5
	5/11/2008	18:00	RS-11		26	468	11.06	43480	10.24	7.52
	5/11/2008	18:00	RS-11		27	486	11.07	43200	10.13	7.55
	5/11/2008	18:00	RS-11		28	504	11.38	44210	10.39	7.67
	5/11/2008	18:00	RS-11		29	522	11.39	44240	10.21	7.63
	5/11/2008	18:00	RS-11		30	540	11.39	46320	10.36	7.6
	5/12/2008	18:58	RS-6		Surface		13.9	150	5.8	7.6
	5/12/2008	18:58	RS-6		1	18	13.9	150	7	7.5
	5/12/2008	18:58	RS-6		2	36	13.9	150	6.7	7.6
	5/12/2008	18:58	RS-6		3	54	13.9	150	6.5	7.6
	5/12/2008	18:58	RS-6		4	72	13.9	150	7.7	7.6
	5/12/2008	18:58	RS-6		5	90	13.9	150	7.9	7.4
	5/12/2008	18:58	RS-6		6	108	13.9	150	3.3	7.7
	5/12/2008	19:01	RS-6	1/4	Surface		14	150	5.5	7.1
	5/12/2008	19:01	RS-6		1	18	14	150	7	7.1
	5/12/2008	19:01	RS-6		2	36	13.9	150	7.5	7.1
	5/12/2008	19:01	RS-6		3	54	13.9	140	7.1	7.1
	5/12/2008	19:01	RS-6		4	72	13.9	150	7.5	7.2
	5/12/2008	19:01	RS-6		5	90	13.9	140	7.6	7.2
	5/12/2008	19:01	RS-6		6	108	13.9	150	8	7.3
	5/12/2008	19:06	RS-6	3/4	Surface		13.9	150	6.1	7
	5/12/2008	19:06	RS-6		1	18	13.9	150	5.8	7
	5/12/2008	19:06	RS-6		2	36	13.9	150	5.9	7.1
	5/12/2008	19:06	RS-6		3	54	13.9	150	6	7.1
	5/12/2008	19:06	RS-6		4	72	13.9	150	8.3	7
	5/12/2008	19:06	RS-6		5	90	13.9	150	5.8	7
	5/12/2008	19:06	RS-6		6	108	13.9	150	6.9	7
	5/12/2008	18:46	RS-7		Surface		13.3	6000	5.9	7.4
	5/12/2008	18:46	RS-7		1	18	13.3	7000	6.1	7.4
	5/12/2008	18:46	RS-7		2	36	13.2	10000	6.6	7.4
	5/12/2008	18:46	RS-7		3	54	13.2	10000	6.5	7.4
	5/12/2008	18:46	RS-7		4	72	12.9	10000	7.4	7.5
	5/12/2008	18:46	RS-7		5	90	12.3	10000	6.5	7.5
	5/12/2008	18:46	RS-7		6	108	11.7	24000	7	7.2
	5/12/2008	18:46	RS-7		7	126	11.2	33000	7.4	7.2
	5/12/2008	18:46	RS-7		8	144	10.7	36000	8.8	7.2
	5/12/2008	18:46	RS-7		9	162	10.6	44000	7.1	7.2
	5/12/2008	18:46	RS-7		10	180	10.6	44000	8.2	7.2

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TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/12/2008	18:46	RS-7		11	196	10.6	44000	7.9	7.2
	5/12/2008	18:46	RS-7		12	216	10.6	44000	9.2	7.2
	5/12/2008	18:46	RS-7		13	234	10.7	44000	8.1	7.2
	5/12/2008	18:46	RS-7		14	252	10.7	43000	7.3	7.2
	5/12/2008	18:46	RS-7		15	270	10.7	43000	7.7	7.2
	5/12/2008	18:46	RS-7		16	288	10.6	43000	8.2	7.2
	5/12/2008	18:46	RS-7		17	306	10.5	44000	8.5	7.2
	5/12/2008	18:46	RS-7		18	324	10.5	44000	7.9	7.2
	5/12/2008	18:46	RS-7		19	342	10.5	44000	8.5	7.2
	5/12/2008	18:46	RS-7		20	360	10.5	44000	8.1	7.2
	5/12/2008	18:46	RS-7		21	378	10.5	44000	7.7	7.2
	5/12/2008	18:46	RS-7		22	396	10.5	44000	8.4	7.2
	5/12/2008	18:46	RS-7		23	414	10.5	44000	7.5	7.2
	5/12/2008	18:46	RS-7		24	432	10.5	44000	7.9	7.2
	5/12/2008	18:46	RS-7		25	450	10.6	44000	9.3	7.2
	5/12/2008	18:46	RS-7		26	468	10.6	44000	8.3	7.2
	5/12/2008	18:46	RS-7		27	486	10.7	44000	8.8	7.1
	5/12/2008	18:46	RS-7		28	504	10.6	44000	8.8	7.1
	5/12/2008	18:46	RS-7		29	522	10.6	42000	8.6	7.2
	5/12/2008	18:46	RS-7		30	540	10.5	44000	9.2	7.1
	5/12/2008	18:46	RS-7		31	558	10.5	44000	8.2	7.1
	5/12/2008	18:27	RS-8		Surface		13.2	10000	7.1	7.2
	5/12/2008	18:27	RS-8		1	18	13.2	10000	7.1	7.3
	5/12/2008	18:27	RS-8		2	36	12.9	10000	8.3	7.3
	5/12/2008	18:27	RS-8		3	54	12.7	13000	6.9	7.2
	5/12/2008	18:27	RS-8		4	72	12.6	18000	7.8	7.2
	5/12/2008	18:27	RS-8		5	90	12.5	18000	6.9	7.2
	5/12/2008	18:27	RS-8		6	108	12.4	21000	8.9	7.2
	5/12/2008	18:27	RS-8		7	126	12.3	21000	8.1	7.2
	5/12/2008	18:27	RS-8		8	144	12.2	26000	8.5	7.2
	5/12/2008	18:27	RS-8		9	162	12.1	29000	6.5	7.2
	5/12/2008	18:27	RS-8		10	180	12.1	29000	7.1	7.2
	5/12/2008	18:27	RS-8		11	196	12	29000	8.5	7.2
	5/12/2008	18:27	RS-8		12	216	12	30000	6.8	7.2
	5/12/2008	18:27	RS-8		13	234	11.9	30000	6.8	7.2
	5/12/2008	18:27	RS-8		14	252	11.9	31000	8	7.2
	5/12/2008	18:27	RS-8		15	270	11.8	31000	6.7	7.2
	5/12/2008	18:27	RS-8		16	288	11.8	32000	7.8	7.2
	5/12/2008	18:27	RS-8		17	306	11.8	34000	6.7	7.1
	5/12/2008	18:27	RS-8		18	324	11.9	33000	7.3	7.2
	5/12/2008	18:27	RS-8		19	342	11.9	31000	8.9	7.2
	5/12/2008	18:27	RS-8		20	360	11.8	32000	6.1	7.2
	5/12/2008	18:27	RS-8		21	378	11.7	33000	7.6	7.2
	5/12/2008	18:27	RS-8		22	396	11.5	35000	6.1	7.2
	5/12/2008	18:27	RS-8		23	414	11	36000	8.6	7.2
	5/12/2008	18:33	RS-8	1/4	Surface		13	1000	6.8	7.1
	5/12/2008	18:33	RS-8		1	18	13	14000	6.9	7.2

Norwich CSO Long Term Control Plan
Water Quality Field Data - 2008

TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/12/2008	18:33	RS-8		2	36	12.8	15000	8.7	7.2
	5/12/2008	18:33	RS-8		3	54	12.7	17000	6.4	7.1
	5/12/2008	18:33	RS-8		4	72	12.5	16000	8.2	7.1
	5/12/2008	18:33	RS-8		5	90	12.2	27000	6.1	7
	5/12/2008	18:38	RS-8	3/4	Surface		13.2	10000	5.5	7.2
	5/12/2008	18:38	RS-8		1	18	13.2	10000	7.1	7.2
	5/12/2008	18:38	RS-8		2	36	13.1	11000	6.7	7.2
	5/12/2008	18:38	RS-8		3	54	13	13000	6.7	7.2
	5/12/2008	18:38	RS-8		4	72	12.8	14000	6.4	7.2
	5/12/2008	18:38	RS-8		5	90	12.4	19000	6.4	7.1
	5/12/2008	18:38	RS-8		6	108	12.7	24000	7.7	6.9
	5/12/2008	18:38	RS-8		7	126	12.2	31000	6.7	6.9
	5/12/2008	18:14	RS-9		Surface		13.2	11000	9.3	7.2
	5/12/2008	18:14	RS-9		1	18	13.3	12000	9.4	7.3
	5/12/2008	18:14	RS-9		2	36	13.2	12000	9.5	7.3
	5/12/2008	18:14	RS-9		3	54	13.2	12000	9.7	7.3
	5/12/2008	18:14	RS-9		4	72	13.1	13000	9.9	7.4
	5/12/2008	18:14	RS-9		5	90	12.8	14000	9.9	7.4
	5/12/2008	18:14	RS-9		6	108	12.5	15000	10	7.4
	5/12/2008	18:14	RS-9		7	126	11.7	20000	10.3	7.4
	5/12/2008	18:14	RS-9		8	144	10.8	36000	10.5	7.3
	5/12/2008	18:14	RS-9		9	162	10.7	44000	10.5	7.2
	5/12/2008	18:14	RS-9		10	180	10.7	45000	10.6	7.2
	5/12/2008	18:14	RS-9		11	196	11	44000	10.5	7.1
	5/12/2008	18:14	RS-9		12	216	10.9	44000	8.3	7.1
	5/12/2008	18:14	RS-9		13	234	10.9	44000	8.4	7.1
	5/12/2008	18:14	RS-9		14	252	10.9	44000	9.3	7.1
	5/12/2008	18:14	RS-9		15	270	10.9	43000	9.7	7.1
	5/12/2008	18:14	RS-9		16	288	10.8	44000	10.1	7.1
	5/12/2008	18:14	RS-9		17	306	10.8	43000	8.5	7.1
	5/12/2008	18:14	RS-9		18	324	10.8	41000	8.5	7.1
	5/12/2008	18:14	RS-9		19	342	10.8	44000	8.2	7.1
	5/12/2008	18:14	RS-9		20	360	10.8	43000	7.1	7.4
	5/12/2008	18:14	RS-9		21	378	10.8	44000	8	7.2
	5/12/2008	18:14	RS-9		22	396	10.6	43000	8.9	7.2
	5/12/2008	18:14	RS-9		23	414	10.6	45000	8.5	7.2
	5/12/2008	18:14	RS-9		24	432	10.6	41000	9.1	7.2
	5/12/2008	18:14	RS-9		25	450	10.6	46000	9	7.2
	5/12/2008	18:14	RS-9		26	468	10.6	38000	8.8	7.2
	5/12/2008	18:14	RS-9		27	486	10.6	45000	8	7.2
	5/12/2008	18:14	RS-9		28	504	10.6	46000	7.9	7.2
	5/12/2008	18:14	RS-9		29	522	10.6	45000	8.2	7.2
	5/12/2008	18:14	RS-9		30	540	10.6	45000	9.1	7.1
	5/12/2008	18:14	RS-9		31	558	10.6	45000	9.3	7
	5/12/2008	18:20	RS-9	1/4	Surface		13.4	11000	9.8	7.3
	5/12/2008	18:20	RS-9		1	18	13.3	11000	8.3	7.3
	5/12/2008	18:20	RS-9		2	36	13.2	11000	8.5	7.3

Norwich CSO Long Term Control Plan
Water Quality Field Data - 2008

TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/12/2008	18:20	RS-9		3	54	13	13000	9	7.3
	5/12/2008	18:20	RS-9		4	72	12.7	19000	9.6	7.2
	5/12/2008	18:20	RS-9		5	90	12.3	23000	8.1	7.2
	5/12/2008	18:20	RS-9		6	108	11.7	23000	9	7.2
	5/12/2008	18:20	RS-9		7	126	11.5	37000	9.7	7.1
	5/12/2008	18:20	RS-9		8	144	11.8	43000	9.9	6.9
	5/12/2008	18:22	RS-9	3/4	Surface		13.3	10000	7	7.2
	5/12/2008	18:22	RS-9		1	18	13.3	12000	7.7	7.2
	5/12/2008	18:22	RS-9		2	36	13.2	12000	8.2	7.2
	5/12/2008	18:22	RS-9		3	54	13.2	12000	7.9	7.3
	5/12/2008	18:22	RS-9		4	72	13.1	12000	8.1	7.3
	5/12/2008	18:22	RS-9		5	90	13	13000	9.1	7.3
	5/12/2008	18:22	RS-9		6	108	12.7	14000	8	7.3
	5/12/2008	18:22	RS-9		7	126	12.4	17000	8.3	7.3
	5/12/2008	18:22	RS-9		8	144	11.6	23000	8.1	7.3
	5/12/2008	18:22	RS-9		9	162	10.8	40000	8.2	7.2
	5/12/2008	18:22	RS-9		10	180	10.8	45000	8.1	7.1
	5/12/2008	18:08	RS-10		Surface		13.6	10000	7.6	7.4
	5/12/2008	18:08	RS-10		1	18	13.5	10000	7.8	7.4
	5/12/2008	18:08	RS-10		2	36	13.5	10000	7.9	7.4
	5/12/2008	18:08	RS-10		3	54	13.3	10000	7.3	7.5
	5/12/2008	18:08	RS-10		4	72	12.7	11000	8.1	7.5
	5/12/2008	18:08	RS-10		5	90	11.4	23000	8.5	7.4
	5/12/2008	18:08	RS-10		6	108	10.9	40000	8.7	7.2
	5/12/2008	18:08	RS-10		7	126	10.6	43000	8.2	7.2
	5/12/2008	18:08	RS-10		8	144	10.6	45000	8.2	7.2
	5/12/2008	18:08	RS-10		9	162	10.5	46000	8.7	7.2
	5/12/2008	18:08	RS-10		10	180	10.5	45000	7.8	7.2
	5/12/2008	18:08	RS-10		11	196	10.5	43000	9.8	7.2
	5/12/2008	18:08	RS-10		12	216	10.4	43000	8.7	7.2
	5/12/2008	18:08	RS-10		13	234	10.4	42000	9.2	7.2
	5/12/2008	18:08	RS-10		14	252	10.4	42000	10.7	7.2
	5/12/2008	18:08	RS-10		15	270	10.4	39000	8.2	7.2
	5/12/2008	18:08	RS-10		16	288	10.4	39000	8.2	7.2
	5/12/2008	18:08	RS-10		17	306	10.4	39000	8.9	7.2
	5/12/2008	18:08	RS-10		18	324	10.4	39000	8.9	7.1
	5/12/2008	18:08	RS-10		19	342	10.4	38000	8.7	6.9
	5/12/2008	18:08	RS-10		20	360	10.4	38000	8.9	6.9
	5/12/2008	18:08	RS-10		21	378	10.5	38000	8.6	6.9
	5/12/2008	18:08	RS-10		22	396	10.5	38000	8.9	6.9
	5/12/2008	18:08	RS-10		23	414	10.5	38000	9.7	6.8
	5/12/2008	18:08	RS-10		24	432	10.5	38000	9.8	6.8
	5/12/2008	18:08	RS-10		25	450	10.5	38000	8.6	6.9
	5/12/2008	18:08	RS-10		26	468	10.5	38000	8.3	6.8
	5/12/2008	18:08	RS-10		27	486	10.5	38000	8.3	6.8
	5/12/2008	18:08	RS-10		28	504	10.5	37000	8.1	6.8
	5/12/2008	18:08	RS-10		29	522	10.5	37000	9.6	6.9

Norwich CSO Long Term Control Plan
Water Quality Field Data - 2008

TIDE	DATE	TIME	SITE	CHANNEL	DEPTH	INCHES	TEMP	CONDUCTIVITY	DO	pH
	5/12/2008	18:08	RS-10		30	540	10.5	37000	8.7	6.9
	5/12/2008	18:08	RS-10		31	558	10.6	37000	8.5	6.9
	5/12/2008	18:00	RS-11		Surface		13.3	13000	9.8	7.2
	5/12/2008	18:00	RS-11		1	18	13.3	13000	9.8	7.2
	5/12/2008	18:00	RS-11		2	36	13.3	13000	9.8	7.2
	5/12/2008	18:00	RS-11		3	54	13.3	14000	9.8	7.2
	5/12/2008	18:00	RS-11		4	72	13.2	14000	9.9	7.2
	5/12/2008	18:00	RS-11		5	90	12.9	15000	9.9	7.3
	5/12/2008	18:00	RS-11		6	108	12.6	17000	10	7.2
	5/12/2008	18:00	RS-11		7	126	12.8	25000	10	7.2
	5/12/2008	18:00	RS-11		8	144	12.3	20000	10	7.3
	5/12/2008	18:00	RS-11		9	162	11.6	26000	10.3	7.3
	5/12/2008	18:00	RS-11		10	180	10.2	30000	10.2	7.2
	5/12/2008	18:00	RS-11		11	196	10.2	46000	10.3	7.2
	5/12/2008	18:00	RS-11		12	216	10.2	46000	10.1	7.2
	5/12/2008	18:00	RS-11		13	234	10.2	46000	10.2	7.1
	5/12/2008	18:00	RS-11		14	252	10.2	45000	10.3	7.1
	5/12/2008	18:00	RS-11		15	270	10.2	40000	10	7.1
	5/12/2008	18:00	RS-11		16	288	10.2	38000	10.2	7.1
	5/12/2008	18:00	RS-11		17	306	10.2	40000	10.4	7.2
	5/12/2008	18:00	RS-11		18	324	10.3	46000	10.4	7.3
	5/12/2008	18:00	RS-11		19	342	10.3	46000	10.2	7.3
	5/12/2008	18:00	RS-11		20	360	10.3	46000	10.2	7.3
	5/12/2008	18:00	RS-11		21	378	10.3	46000	10.1	7.2
	5/12/2008	18:00	RS-11		22	396	10.3	46000	10.1	7.2
	5/12/2008	18:00	RS-11		23	414	10.3	46000	10	7.2
	5/12/2008	18:00	RS-11		24	432	10.3	46000	10.2	7.2
	5/12/2008	18:00	RS-11		25	450	10.3	46000	10.1	7.2
	5/12/2008	18:00	RS-11		26	468	10.3	46000	10.3	7.1
	5/12/2008	18:00	RS-11		27	486	10.3	46000	10.2	6.9
	5/12/2008	18:00	RS-11		28	504	10.2	46000	10.1	6.9
	5/12/2008	18:00	RS-11		29	522	10.2	46000	10.1	6.7
	5/12/2008	18:00	RS-11		30	540	10.2	47000	10.2	6.6
	5/12/2008	18:00	RS-11		31	558	10.2	47000	10.1	6.3

Norwich CSO Long Term Control Plan
Water Quality Monitoring Plan Field Data 2008 - CLA Land-Based Crews

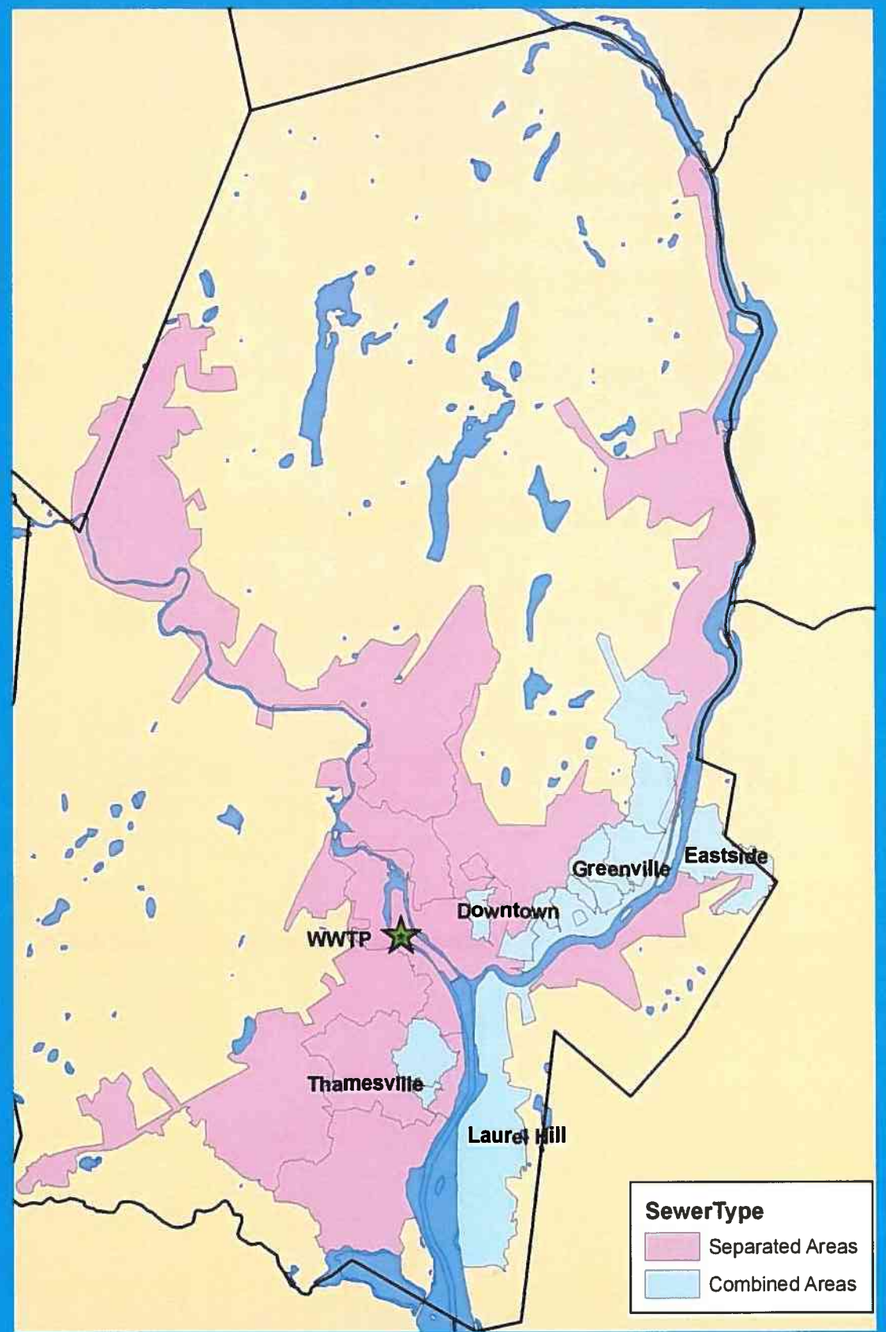
ROUND	TIDE	DATE	TIME	SITE	TEMP	CONDUCTIVITY	DO	pH
Dry Weather	High Tide	23-Apr	12:10	RS-1	20.2	658	0.38	7.1
Dry Weather	High Tide	23-Apr	12:30	RS-2	17.2	867	0.45	7.4
Dry Weather	High Tide	23-Apr	13:15	RS-3	20.5	775	0.44	7.1
Dry Weather	High Tide	23-Apr	13:35	RS-4	19.2	787	0.50	7.3
Dry Weather	High Tide	23-Apr	13:50	RS-5	18.8	1104	0.46	7.4
Dry Weather	Low Tide	23-Apr	6:00	RS-1	15.8	662	0.60	7.2
Dry Weather	Low Tide	23-Apr	6:22	RS-2	15.0	881	0.65	7.3
Dry Weather	Low Tide	23-Apr	6:45	RS-3	14.7	809	0.64	7.1
Dry Weather	Low Tide	23-Apr	7:08	RS-4	12.3	979	0.63	7.0
Dry Weather	Low Tide	23-Apr	7:35	RS-5	13.4	817	0.67	7.1
Round1		28-Apr	17:04	CSO-17	14.0	357	0.57	6.4
Round1		28-Apr	17:29	CSO-24	14.6	1125	0.55	6.8
Round1		28-Apr	16:48	CSO-40	15.2	874	0.52	6.8
Round1		28-Apr	16:55	SW-1	14.9	245	0.58	6.4
Round1		28-Apr	17:45	SW-2	13.7	1565	0.59	6.2
Round1		28-Apr	17:41	CSO-17	13.7	359	0.58	7.0
Round1		28-Apr	18:21	CSO-24	14.2	510	0.59	6.6
Round1		28-Apr	17:25	CSO-40	15.6	2109	0.55	7.6
Round1		28-Apr	18:06	SW-1	13.9	295	0.59	6.5
Round1		28-Apr	18:39	SW-2	14.9	579	0.59	6.5
Round1		28-Apr	19:00	CSO-17	14.6	368	0.58	6.7
Round1		28-Apr	19:09	CSO-24	14.6	871	0.57	6.6
Round1		28-Apr	18:48	CSO-40	15.0	670	0.57	6.8
Round1		28-Apr	18:54	SW-1	13.9	296	0.62	5.8
Round1		28-Apr	19:40	SW-2	14.5	448	0.66	6.4
Round1		28-Apr	20:55	CSO-17	15.1	283	0.55	6.9
Round1		28-Apr	21:11	CSO-24	15.0	917	0.56	6.7
Round1		28-Apr	21:12	CSO-40	na	na	na	na
Round1		28-Apr	20:54	SW-1	15.2	210	0.58	6.5
Round1		28-Apr	21:34	SW-2	14.7	851	0.58	6.6
Round1		29-Apr	0:59	CSO-17	na	na	na	na
Round1		29-Apr	1:00	CSO-24	14.3	717	0.52	6.7
Round1		29-Apr	1:01	CSO-40	na	na	na	na
Round1		29-Apr	0:55	SW-1	17.5	261	0.52	6.7
Round1		29-Apr	1:06	SW-2	14.5	1102	0.57	6.7
Round1		29-Apr	5:20	CSO-17	13.5	686	0.57	6.9
Round1		29-Apr	5:21	CSO-24	na	na	na	na
Round1		29-Apr	5:22	CSO-40	na	na	na	na
Round1		29-Apr	4:55	SW-1	15.2	165.9	0.6	6.7
Round1		29-Apr	5:31	SW-2	15.0	841.0	0.6	6.8
Round1		29-Apr	5:32	CSO-17	na	na	na	na
Round1		29-Apr	5:33	CSO-24	na	na	na	na
Round1		29-Apr	5:34	CSO-40	na	na	na	na
Round1		29-Apr	9:07	SW-1	16.2	1126	0.53	7.4
Round1		29-Apr	9:35	SW-2	12.9	2056	0.49	6.9
Round1		29-Apr	5:00	WWTP EFF	16.6	2007	0.30	6.9
Round1		28-Apr	18:00	WWTP EFF	17.0	3.15	0.29	7.2

Norwich CSO Long Term Control Plan
Water Quality Monitoring Plan Field Data 2008 - CLA Land-Based Crews

ROUND	TIDE	DATE	TIME	SITE	TEMP	CONDUCTIVITY	DO	pH
Round1		28-Apr	19:31	RS-1	14.8	694	0.58	6.9
Round1		28-Apr	19:45	RS-2	15.0	928	0.61	7.2
Round1		28-Apr	20:01	RS-3	15.0	789	0.60	7.1
Round1		28-Apr	20:34	RS-4	13.5	435	0.61	6.7
Round1		28-Apr	20:20	RS-5	12.9	3.56	0.64	7.1
Round1		29-Apr	4:58	RS-1	14.2	683	0.59	6.9
Round1		29-Apr	5:10	RS-2	14.3	920	0.64	7.1
Round1		29-Apr	5:30	RS-3	14.1	745	0.61	7.0
Round1		29-Apr	5:48	RS-4	13.2	438	0.62	6.9
Round1		29-Apr	5:58	RS-5	12.6	623	0.63	7.0
Round1		30-Apr	11:55	RS-1	13.8	527	0.59	7.0
Round1		30-Apr	12:10	RS-2	13.3	662	0.65	7.0
Round1		30-Apr	12:25	RS-3	13.1	548	0.53	6.8
Round1		30-Apr	13:45	RS-4	13.5	852	0.64	6.8
Round1		30-Apr	13:00	RS-5	13.3	556	0.64	6.9
Round1		1-May	12:30	RS-1	14.5	507	0.53	6.8
Round1		1-May	12:55	RS-2	13.5	651	0.65	7.2
Round1		1-May	13:05	RS-3	13.7	557	0.56	6.9
Round1		1-May	13:20	RS-4	16.0	1630	0.57	7.0
Round1		1-May	13:40	RS-5	13.7	548	0.58	7.2
Round1		2-May	12:15	RS-1	13.0	506	0.63	6.6
Round1		2-May	12:35	RS-2	12.7	736	0.69	6.8
Round1		2-May	12:50	RS-3	12.5	587	0.66	6.5
Round1		2-May	13:15	RS-4	12.5	588	0.67	6.9
Round1		2-May	13:30	RS-5	12.4	679	0.69	6.8
Round2		9-May	15:25	CSO-17	13.5	697	0.55	7.0
Round2		9-May	15:15	CSO-24	14.3	820	0.53	6.7
Round2		9-May	15:16	CSO-40	na	na	na	na
Round2		9-May	15:10	SW-1	14.1	173.1	0.55	6.8
Round2		9-May	15:35	SW-2	14.0	650	0.60	6.2
Round2		9-May	16:04	CSO-17	14.0	1246	0.50	7.2
Round2		9-May	15:45	CSO-24	14.0	732	0.59	6.5
Round2		9-May	15:46	CSO-40	na	na	na	
Round2		9-May	15:49	SW-1	13.7	151.8	0.64	6.8
Round2		9-May	16:05	SW-2	13.5	568	0.62	6.4
Round2		9-May	17:16	CSO-17	13.3	861	0.50	7.2
Round2		9-May	17:15	CSO-24	14.0	1526	0.59	6.7
Round2		9-May	17:16	CSO-40	na	na	na	na
Round2		9-May	17:30	SW-1	13.2	179.7	0.70	7.0
Round2		9-May	17:35	SW-2	13.4	1262	0.61	6.7
Round2		9-May	19:00	CSO-17	na	na	na	na
Round2		9-May	19:01	CSO-24	na	na	na	na
Round2		9-May	19:02	CSO-40	na	na	na	na
Round2		9-May	19:09	SW-1	12.8	404	0.74	6.6
Round2		9-May	19:35	SW-2	12.4	2150	0.63	6.7
Round2		9-May	23:15	CSO-17	na	na	na	na
Round2		9-May	23:16	CSO-24	na	na	na	na

Norwich CSO Long Term Control Plan
Water Quality Monitoring Plan Field Data 2008 - CLA Land-Based Crews

ROUND	TIDE	DATE	TIME	SITE	TEMP	CONDUCTIVITY	DO	pH
Round2		9-May	23:46	CSO-40	na	na	na	na
Round2		9-May	23:31	SW-1	13.0	2023	0.68	7.4
Round2		9-May	23:25	SW-2	12.1	2.97	0.66	6.9
Round2		10-May	3:35	CSO-17	11.3	1078	0.70	7.0
Round2		10-May	3:36	CSO-24	na	na	na	na
Round2		10-May	3:37	CSO-40	na	na	na	na
Round2		10-May	2:55	SW-1	12.4	2.29	0.64	7.4
Round2		10-May	3:17	SW-2	12.2	2.68	0.62	6.8
Round2		10-May	6:32	CSO-17	na	na	na	na
Round2		10-May	6:25	CSO-24	na	na	na	na
Round2		10-May	6:38	CSO-40	na	na	na	na
Round2		10-May	6:45	SW-1	15.3	2.26	0.57	7.7
Round2		10-May	6:58	SW-2	12.6	2.36	0.61	6.9
Round2		9-May	16:20	WWTP EFF	13.4	2.68	0.38	7.2
Round2		10-May	3:30	WWTP EFF	14.7	2.42	0.42	7.1
Round2		9-May	17:10	RS-1	14.9	505	0.62	6.8
Round2		9-May	17:25	RS-2	15.2	686	0.61	7.1
Round2		9-May	17:40	RS-3	14.9	581	0.60	7.0
Round2		9-May	18:05	RS-4	14.0	531	0.65	7.1
Round2		9-May	18:15	RS-5	14.2	582	0.64	7.2
Round2		10-May	3:00	RS-1	14.5	478	0.55	7.1
Round2		10-May	3:15	RS-2	14.4	673	0.83	7.3
Round2		10-May	3:35	RS-3	13.7	568	0.62	7.1
Round2		10-May	3:50	RS-4	13.0	524	0.69	7.3
Round2		10-May	4:05	RS-5	13.1	1118	0.65	7.4
Round2		10-May	18:00	RS-1	15.3	617	0.55	7.1
Round2		10-May	18:17	RS-2	15.6	813	0.57	7.2
Round2		10-May	18:43	RS-3	15.3	658	0.57	7.1
Round2		10-May	19:12	RS-4	14.5	621	0.62	7.2
Round2		10-May	19:30	RS-5	14.1	879	0.63	7.2
Round2		11-May	18:10	RS-1	15.4	600	0.57	6.9
Round2		11-May	18:27	RS-2	16.1	784	0.60	7.2
Round2		11-May	18:46	RS-3	15.2	686	0.61	7.0
Round2		11-May	19:10	RS-4	15.8	678	0.64	7.1
Round2		11-May	19:18	RS-5	15.4	874	0.64	7.2
Round2		12-May	18:05	RS-1	13.6	603	0.57	6.9
Round2		12-May	18:23	RS-2	14.0	775	0.68	7.0
Round2		12-May	18:40	RS-3	13.0	677	0.67	7.0
Round2		12-May	18:55	RS-4	12.9	659	0.71	7.2
Round2		12-May	19:05	RS-5	13.0	2134	0.72	7.3



CSO LONG TERM CONTROL PLAN

VOLUME 2 OF 2

Phase 2 Technical Memoranda

Prepared for

NORWICH PUBLIC UTILITIES

Norwich Public Utilities

AUGUST 17, 2012

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APPENDIX 2-B

CITY OF NORWICH, CONNECTICUT
DEPARTMENT OF PUBLIC UTILITIES

Phase II CSO Long Term Control Plan

Technical Memorandum

Task 3
DESCRIPTION OF RECEIVING WATER QUALITY AND CSO IMPACTS

&

Task 4
DESCRIPTION OF REGIONAL WATERSHED AREA SURROUNDING NORWICH

October 2007
Revised: June 2009

Prepared by:

BLACK & VEATCH
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CITY OF NORWICH, CONNECTICUT

PHASE II CSO LONG TERM CONTROL PLAN

Task 3 - Description of Receiving Water Quality and CSO Impacts

&

Task 4 - Description of Regional Watershed Area Surrounding Norwich

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EXECUTIVE SUMMARY

Purpose

The purpose of this technical memorandum is to summarize the relationship between Norwich CSO discharges and water quality in the Shetucket and Thames Rivers, based on data contained in prior studies. This information will be used to refine the objectives of the receiving water sampling program under Task 6.0, so the field program can identify sampling locations and parameters that will provide the most useful data for assessing CSO impacts.

Summary of Key Findings and Conclusions

1. Connecticut Department of Environmental Protection (CT DEP) has reported that several reaches of the major rivers in the Thames River watershed are not meeting water quality standards. A major issue is that these reaches do not meet bacterial standards for recreational uses such as swimming and shellfish harvesting. Problem areas include portions of the Shetucket and Quinebaug Rivers upstream of Norwich as well as the lower Shetucket River and upper Thames River estuary.

2. Nutrient-related problems of eutrophication and low dissolved oxygen are reported in portions of the Thames River estuary. This includes seasonal hypoxia in the lower, saline waters of the Thames River estuary just below Norwich. However, estimated nutrient contribution from Norwich CSO discharges is insignificant (less than one percent of overall nutrient contribution). Major pollutant loading of nutrients is from agricultural runoff, wastewater treatment plants, and miscellaneous non-point sources within the watershed.

3. Based on available pollutant loading information, it appears that bacteria are the only pollutants in the Norwich CSO discharge that adversely impact meeting water quality standards.

4. Based on very limited existing information, it appears that Norwich CSO discharges may account for approximately 10 percent of bacterial loading to the upper Thames River estuary, on an annual basis. Norwich stormwater discharges may be contributing approximately the same load of bacteria to the river. The receiving water sampling program should be structured to validate or refine these estimates, especially under wet weather conditions.

5. If sampling validates that approximately 90 percent of the bacterial loading is from stormwater runoff and miscellaneous upstream nonpoint sources, water quality standards still may not be met even if all Norwich CSOs are eliminated. Furthermore, separating additional urban combined sewers would increase the volume of untreated discharges from storm sewers, likely increasing bacterial

loading to local rivers from those sources. This should be evaluated further during the system modeling and alternatives analysis phases of the LTCP effort.

Recommendations

During subsequent tasks, Black & Veatch will develop a monitoring plan for the collection system and a monitoring plan for the receiving water. Many of the elements to be included in these plans have been identified in their task descriptions. The review of available data and estimates of pollutant loads to the rivers presented in this Technical Memorandum provides valuable information to be used in development of the monitoring plans. Some of the issues that need to be addressed in the monitoring plans include:

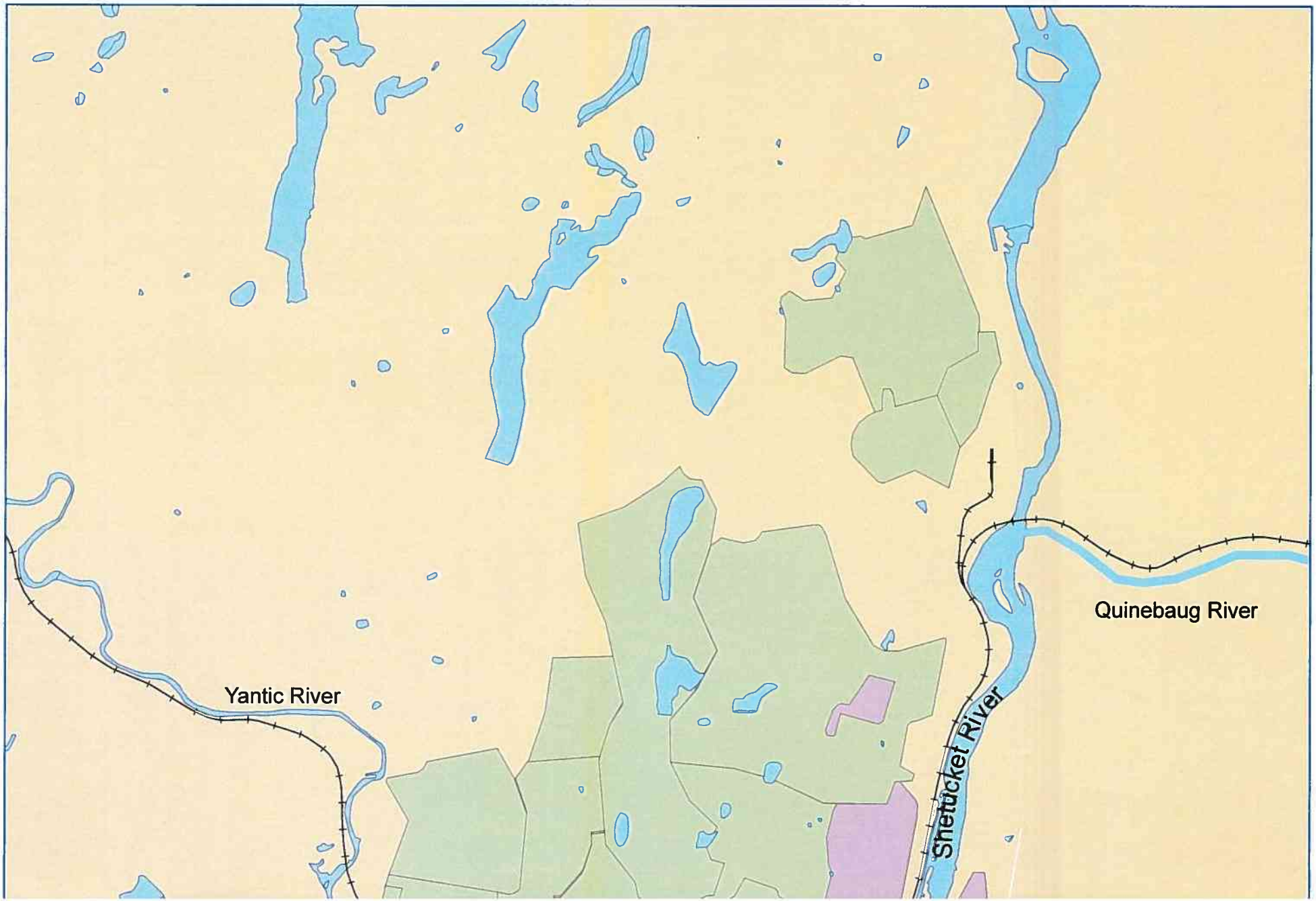
- River samples need to be collected near the study area to give a better indication of upstream pollutant loads.
- More data is needed to better characterize the concentrations and loads in the CSO and stormwater discharges.
- Sampling stations should be representative of the entire combined sewer area.
- To properly define the mixing zones, it will be necessary to collect multiple samples at each station both across the river channel (transect) and vertically with water depth if there is a density gradient, such as the pycnocline, which occurs in the Thames River.
- The sampling program should focus on bacteria, since CSOs do not contribute significantly to nutrient loading and hypoxia water quality problems in the basin.

1 INTRODUCTION

In the early 1990s, Norwich Public Utilities embarked on a study of its combined sewer system that involved flow monitoring, stream sampling and creating a Storm Water Management Model (SWMM) of the collection system and tributary areas. That study culminated in the 1994 CSO Modified Facilities Plan, which recommended a program of selected separation for cost effective reduction of CSO discharges.

Implementing the recommended separation projects reduced the 27 CSO discharge points to 15 and eliminated all discharges to the Yantic River and to the non-tidal portion of the Shetucket River upstream of Greenville Dam (See Figure 1-1). The study projected that implementing the recommended projects would reduce total overflow CSO discharge volume would be reduced by approximately 70 percent in a typical year.

The sewer separation program recommended in the Modified Facilities Plan was implemented in the late 1990s. In 2007, the Connecticut DEP and Norwich signed an order which included a schedule for Norwich to prepare a CSO Long Term Control Plan (LTCP). That plan would recommend a program to take CSO control in Norwich to the next level, focused on meeting water quality objectives in the Shetucket and Thames Rivers. The results of two of the tasks (Task 3 – Describe Receiving Water Quality and


Yantic River
Shetucket River
Quinebaug River

CSO Impacts and Task 4 – Describe Regional watershed Area Surrounding Norwich) included in that plan are presented in this Technical Memorandum.

The objective of Task 3 is to review water quality in the Shetucket and Thames Rivers in the vicinity of Norwich, compile water quality data on Norwich CSO discharges, and estimate the impact of the Norwich CSOs on water quality based on available information. The findings will be utilized in developing the Monitoring Plan for the Receiving Water System, under Task 6. The purpose of Task 4 is to (1) investigate and describe the watershed of the Shetucket and Thames Rivers in the vicinity of Norwich (2) gain an understanding of land use activities and possible river conditions that may affect the ability to meet water quality standards in the river, (3) identify sensitive areas in the Rivers, and (4) support development of a cost-effective receiving water quality monitoring program that will help evaluate Long Term Control Plan (LTCP) alternatives, as well as determine the ultimate effectiveness of the LTCP.

This Technical Memorandum includes the following information:

- Summary of results of previous studies and reports on water quality in the vicinity of Norwich
- Delineation of major subwatersheds within the Thames River watershed
- Characterization of the Thames River watershed
- Summary of available water quality data and an assessment of water quality in the Norwich area
- Calculation of pollutant loads in the river and in CSO discharges
- Evaluation of the impact of CSO discharges on water quality
- Identification of additional data needs

2 AVAILABLE DATA AND PREVIOUS STUDIES

The Thames Science Plan (Trench 2005) was developed jointly by the US Geological Survey (USGS) and the Connecticut DEP. The primary focus of the report was to identify water quality investigations that should be conducted to develop management plans for the nutrient problems in the Thames River basin. The Thames Science Plan contains a review of the historical database for the Thames River. Of particular importance to development of the LTCP is information on monitoring activities and source of nutrients in the basin.

The USGS maintains several water quality and/or flow monitoring stations within the basin including:

- Shetucket River near Willimantic: flow 1931- 2007
- Shetucket River near south Windham: water quality 1974 – 2007
- Quinebaug River near Jewett City: flow 1918 – 2007; water quality 1968 – 2007
- Yantic River at Yantic: flow 1930 – 2007; water quality 1968 – 1980

- Thames River near Mohegan: water quality 1974 – 1991

The monitoring locations are shown on Figure 2-1.

CT DEP has conducted an ambient biological monitoring program since the early 1970s focusing on the benthic invertebrate community. In 2001 the Probabilistic Monitoring Program was started to ensure that all basins within the state were monitored. A random monitoring network was established comprising 60 stations, 14 of which are within the Thames River basin. Information collected through the DEP monitoring programs is used in conjunction with other available data to assess water bodies within the state and determine whether designated uses are supported.

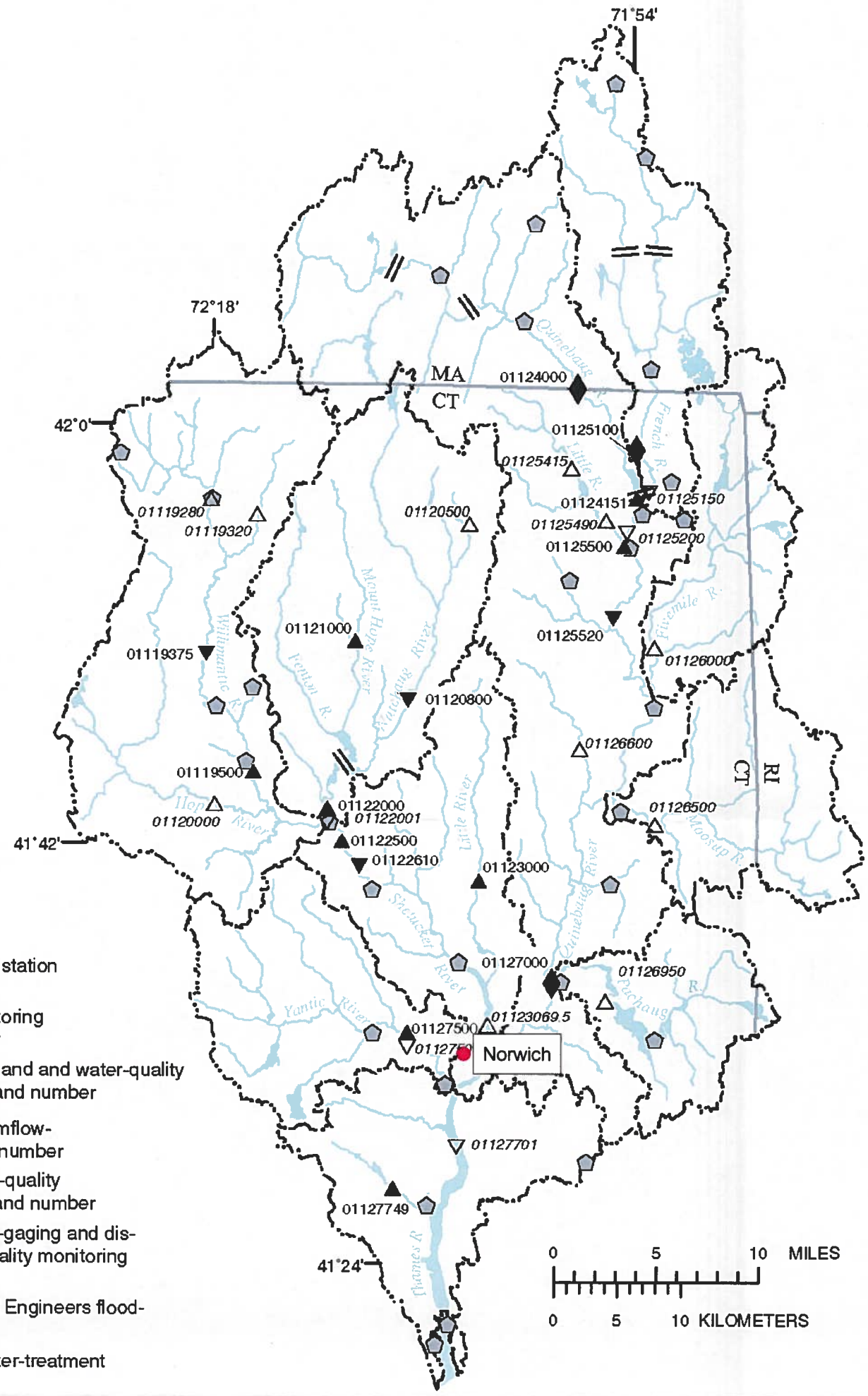
In addition to the above sources of data, samples to characterize CSO and stormwater discharges were collected during the 1994 CSO Modified Facilities Plan sampling program. Three CSOs and one stormwater outfall were sampled throughout two separate rain events.

3 THAMES RIVER WATERSHED

The Thames River watershed drains an area of about 1,471 square miles. It includes almost all of eastern Connecticut as well as parts of western Rhode Island and southern Massachusetts. Two major rivers, the Shetucket River and the Quinebaug River, drain most of the watershed. The Quinebaug River is a tributary of the Shetucket River, entering at Norwich, and has a larger drainage area and flow. However, for purposes of the land use evaluation in this Technical Memorandum they have been treated as separate rivers and information on the Shetucket River does not include contributions from the Quinebaug River. The Yantic River joins the Shetucket River at Norwich and at this location the tidal Thames River begins. The Thames River ends at Long Island Sound about 16 miles downstream of Norwich.

The major watershed sub basins are shown on Figure 3-1. The Shetucket River drains the western portion of the watershed. As shown on the figure, the upper Shetucket River basin includes the Willimantic and Natchaug Rivers while the lower Shetucket River basin includes the main stem of the Shetucket River and the Yantic River. The Quinebaug River drains the eastern portion of the watershed and is further divided into four sub basins including West Thompson Lake basin, the upper Quinebaug River basin (French and Little Rivers), Mid-Quinebaug River basin (Fiver Mile River), and Quinebaug River basin (Moosup and Pachaug Rivers).

Land uses within the watershed are shown on Figure 3-2. Forested areas within the watershed comprise about two-thirds of the total area. Other major land uses include agriculture (11.6%), wetlands and water (11.3%), and urban areas (8.7%). Land uses are summarized on Table 3-1.



EXPLANATION

- 01127000 ▲ Streamflow-gaging station and number
- 01119375 ▼ Water-quality monitoring station and number
- 01124000 ◆ Streamflow-gaging and and water-quality monitoring station and number
- *01126950* △ Discontinued streamflow-gaging station and number
- *01122001* ▽ Discontinued water-quality monitoring station and number
- 01122000 / *01122001* ◆▽ Current streamflow-gaging and discontinued water-quality monitoring station and number
- // U.S. Army Corps of Engineers flood-control dam
- ⬠ Municipal wastewater-treatment facility
- Regional drainage basin boundary

Modified from Trench (2005)

N W E S

File: Figura 2-1 Monitoring Station Locations
Version: Tasks 3 & 4
By: Black and Veetch
Date: October 12, 2007

Norwich, CT Phase 2
CSO Long Term Control Plan
Figure 2-1 Monitoring Station Locations

Norwich Public Utilities SINCE 1904

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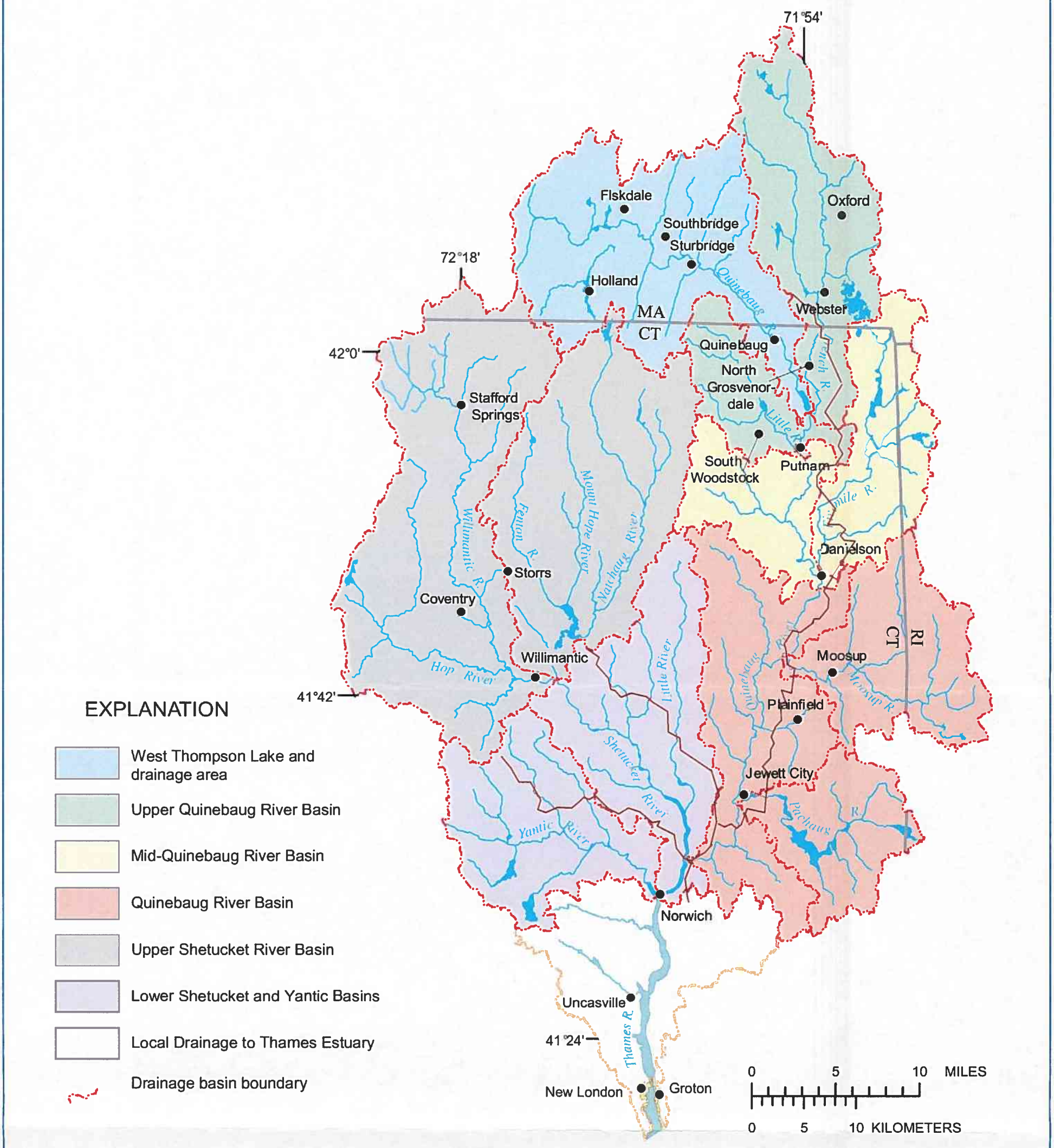

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Version: Tasks 3 & 4
By: Black and Veatch
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Norwich, CT Phase 2

CSO Long Term Control Plan

Figure 3-1 Major Sub-Watershed Areas

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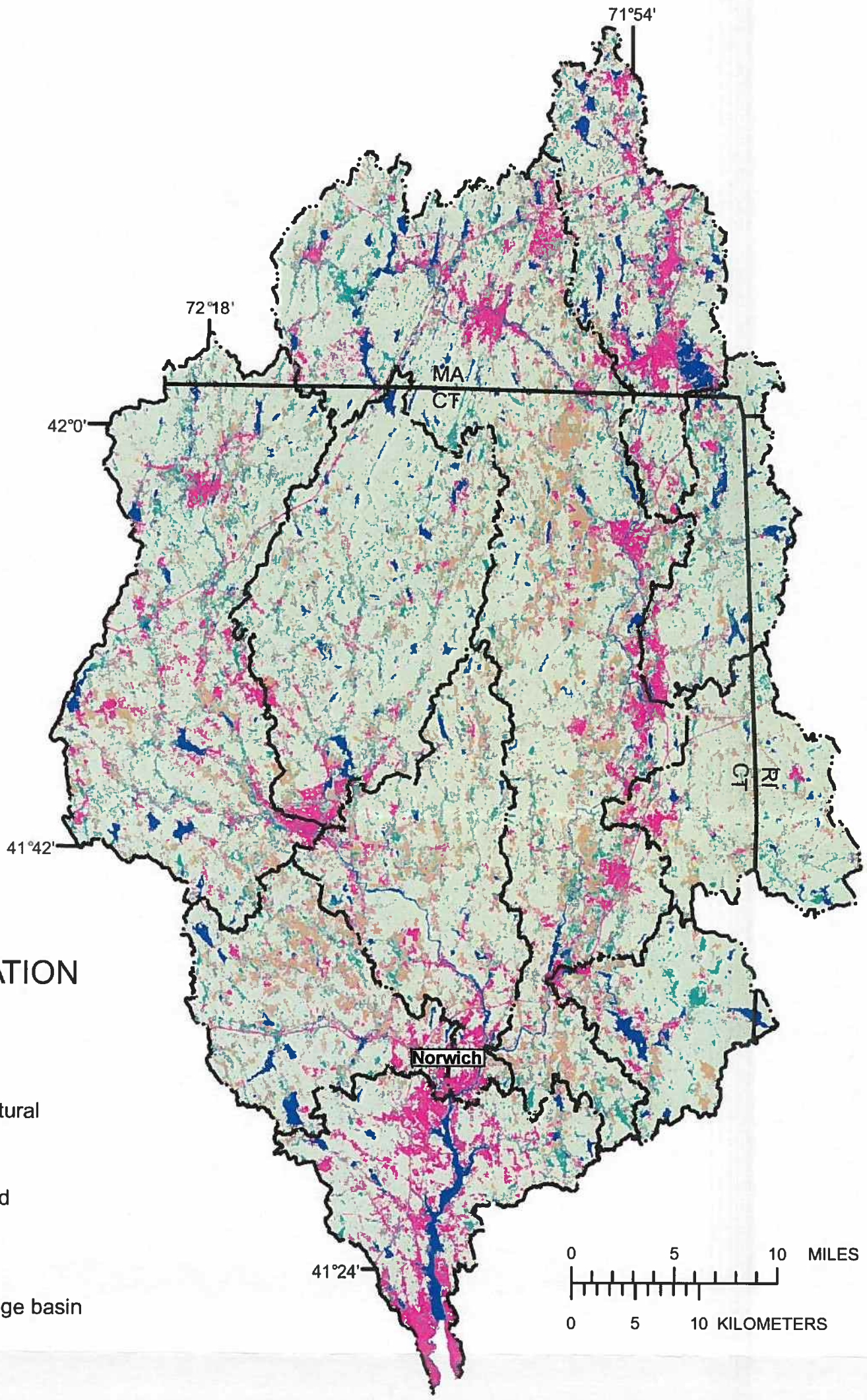

EXPLANATION

Land use

- Forest
- Agricultural
- Urban
- Wetland
- Water

Regional drainage basin boundary

Modified from Trench (2005)

N
W E
S

File: Figure 3-2 Land Use Within the Watershed
Version: Tasks 3 & 4
By: Black and Veatch
Date: October 12, 2007

Norwich, CT Phase 2

CSO Long Term Control Plan

Figure 3-2 Land Use within the Watershed

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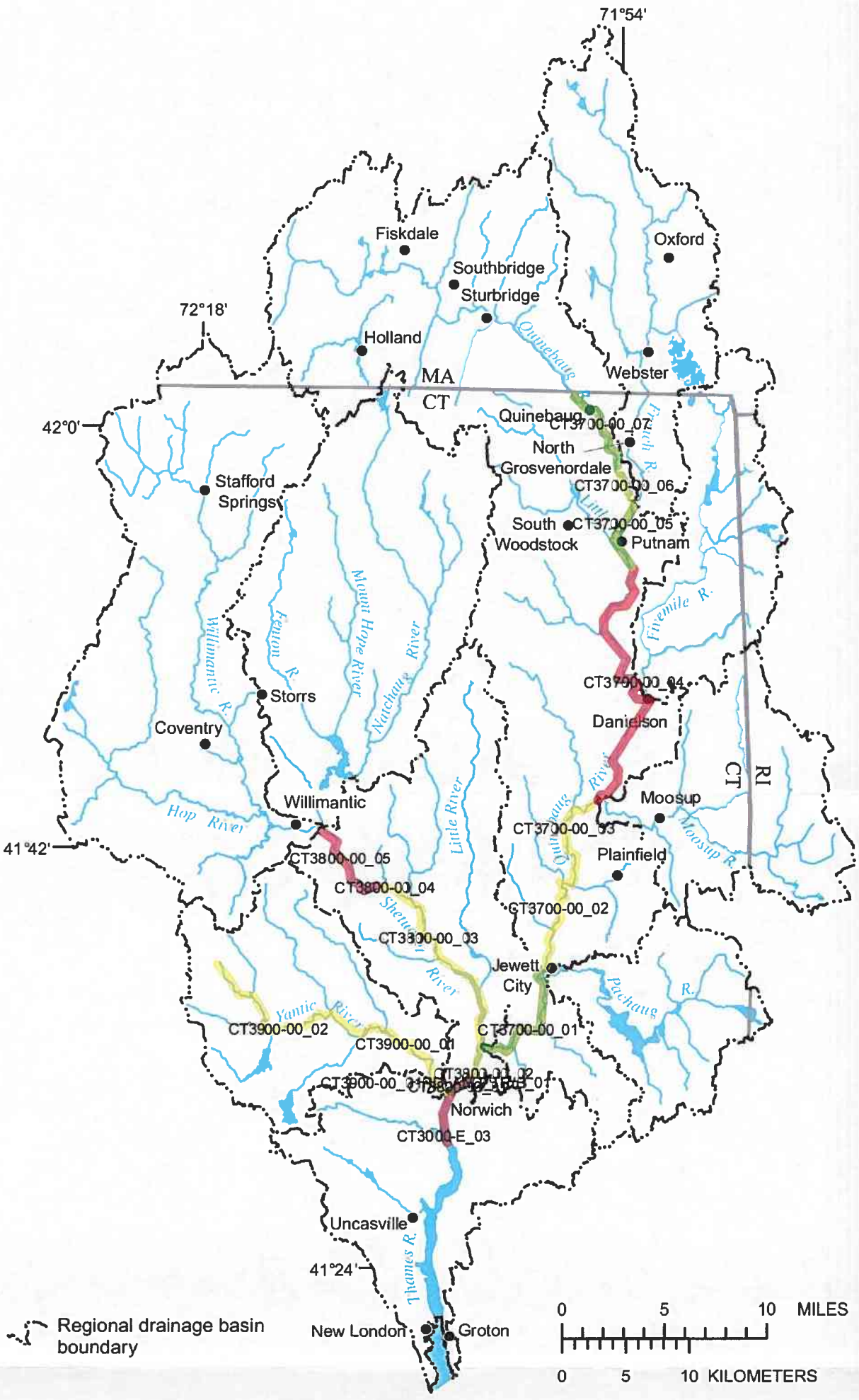

Sub-Watersheds: Trench (2005)
Segment Assessments: CT DEP (2006)

N
W E
S

File: Figure 4-1 Assessment of River Segments for Recreational Uses
Version: Tasks 3 & 4
By: Black and Veatch
Date: 10/12/07

Legend

Recreational Uses

- Not Assessed
- Not Supported
- Supported

Norwich, CT Phase 2

CSO Long Term Control Plan

Figure 4-1 Assessment of River Segments for Recreational Uses

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Segment 05, impaired due to unknown sources. A low priority has been assigned to Segment 01 where CSOs have been listed as the source of impairment.

TMDLs may need to be developed for the unnamed tributary to the Yantic River. High priorities have been assigned for TMDLs for aquatic life support which is impaired to due to discharges from the landfill and from biosolids storage, application or disposal. Six different pollutants have been listed as causes, and each may require a TMDL.

5 ANNUAL FLOWS

Information to characterize flows and pollutant concentrations is needed to project nutrients and bacteria loading. In developing the load projections presented in this Technical Memorandum, data from a variety of sources were used. Values here have been estimated based on the best available data and provide a basis for this preliminary analysis. Finding and tentative conclusions in this report will be subject to verification during later monitoring.

5.1 Norwich CSO Flows

CSO annual flow estimates have been made based on the 1994 CSO Modified Facilities Plan, prepared for the Norwich Sewer Authority by Black and Veatch. These flows are based on completion of the separation recommended in the report and "typical year" 1988 rainfall conditions (42in/yr). These separation projects have been completed, and account for a decrease in total CSO volume of approximately 70 percent, to an annual overflow of 78.3MG. Eleven million gallons was added to this total overflow number to account for approximately 170 acres of combined sewer area that was not included in the 1994 report. No data are available for the volume of overflows in this area; the 11MG estimate is based solely on an average overflow volume per acre of CSO area. The CSO area will be studied in the upcoming LTCP.

5.2 Norwich WWTP Flows

Annual wastewater treatment plant flow estimates have been based on typical flows reported in the 2004 Wastewater System Facilities Plan for the WWTP. The average daily flow projected for 2007 is 5.5MGD, which corresponds to 2008MG/yr.

5.3 Norwich Stormwater Flows

Annual stormwater flows were estimated through the use of the 1994 sewer-shed delineations used in the SWMM model. The stormwater flows were divided into areas that have been separated and those that remain combined. An annual rainfall of 42-inches was applied to the separated areas and multiplied by a runoff coefficient based on predominant land-use.

5.4 River Flows

The average flow entering the Thames River Estuary at Norwich was estimated from USGS gaging station data on the Yantic, Shetucket and Quinebaug Rivers. Because the gaging stations are not at the most downstream location in each river, they do not record all of the water draining from the watershed. Therefore, a drainage-area correction was applied to account for ungaged sections of the watershed. In applying this correction, it is assumed that the water yield per unit area is constant throughout the basin.

Drainage areas correction factors and annual flows are summarized on Table 5-1. Although the Quinebaug River is a tributary to the Shetucket River, the values listed below for the Shetucket River do not include contributions from the Quinebaug River. The average annual flow entering the Thames River Estuary is 2,460 cfs, or 579,000 MG/yr.

Table 5-1 Annual Thames River Basin Flows

	USGS Station	Drainage Area above USGS Gage (sq. mi^2)	Total Drainage Area (sq. mi2)	Annual Flow at USGS Gage (cfs)	Estimated Total Annual Flow (cfs)
Yantic River	1127500	89	98	165	181
Shetucket River	1122500	404	526	718	935
Quinebaug River	1127000	713	739	1,292	1,339
Total	-	**1210**	**1,360**	**2,180**	**2,460**

6 IMPACT OF CSOS ON NUTRIENT CONCENTRATIONS

An assessment was made to estimate the impact of Norwich CSO discharges on overall nutrient concentrations in the upper Thames River. This assessment used limited available data from the 1994 report to quantify the contribution of the CSOs and compare that with other significant sources, including stormwater outfalls, the wastewater treatment plant discharge and background loading from upstream sources.

CSO and stormwater total nitrogen (TN) concentrations have been estimated from the 1994 CSO sampling program conducted as part of the Modified Facilities Plan. As part of the plan, three CSOs and one stormwater outfall were sampled throughout two separate rain events. Median values from the data were used to estimate the pollutant concentration throughout wet weather events. Annual total nitrogen output from the

WWTP was based on the 2004 Wastewater System Facilities Plan for the WWTP. The average nitrogen discharge for 2007 was projected at 1400ppd or 511,000 pounds of nitrogen.

Annual average concentrations of nitrogen in the rivers upstream of Norwich were calculated from data obtained at two USGS stations. Total nitrogen data collected over a five year period, 2002 through 2006, from stations on the Shetucket and Quinebaug Rivers were averaged to obtain average annual TN concentrations. The average TN concentrations for the Shetucket and Quinebaug Rivers were 0.71 and 0.88 mg/L, respectively. A background concentration of 0.71 mg/L was assumed for the Yantic River, where no data was available. Using a weighted average to account for differences in the annual flows of the rivers, it was calculated that the annual average total nitrogen concentration was 0.80 mg/L.

Nutrient data used in the analysis are presented in Table 6-1. The relative contribution of total nitrogen from each major source is shown on Figure 6-1. As shown in the table and on the figure, nitrogen loads from CSOs are a very minor source of nitrogen to the Thames River.

Table 6-1 Estimate of Total Nitrogen Loading to the Upper Thames River Estuary

	Flow [MG/yr]	Total Nitrogen [mg/L]	Load [lb-N/yr]	Percent of total load
Norwich CSOs	89	2.6	1,900	<0.1
Norwich Stormwater	1,300	1.7	14,000	< 1
Norwich WWTP	2,000	30.6	510,000	12
Upstream Sources	580,000	0.8	3,900,000	88
Total	**583,400**	**-**	**4,425,900**	**100**

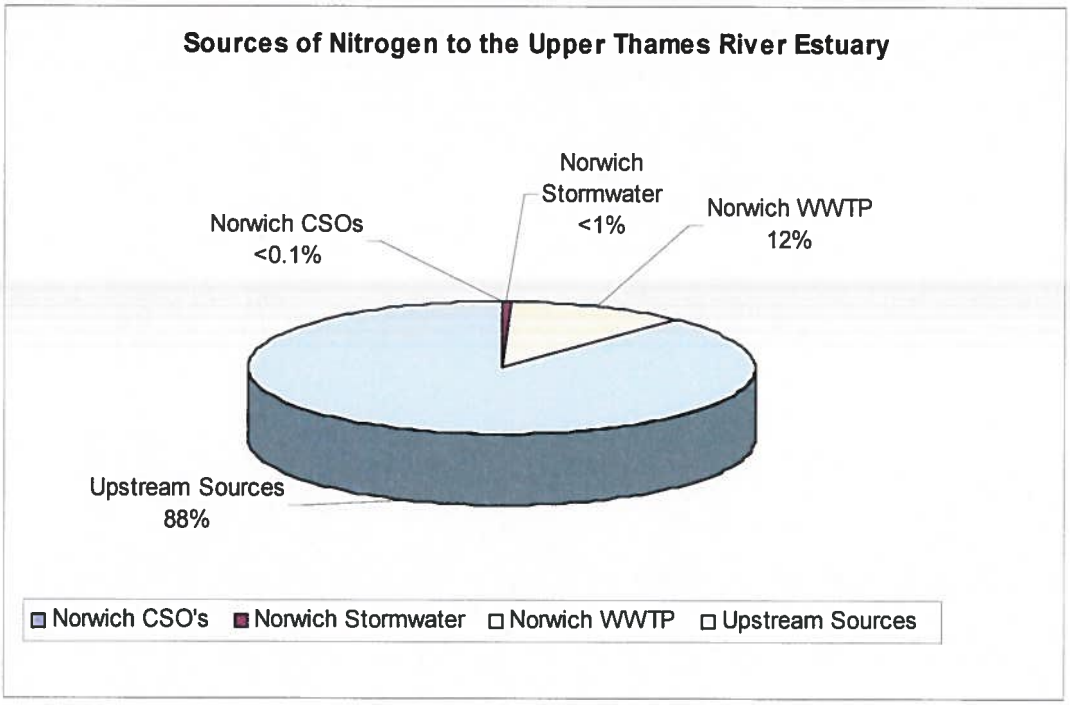

Figure 6-1– Relative Contributions of Nitrogen Sources in the Upper Thames River Estuary

7 IMPACT OF CSOS ON BACTERIA CONCENTRATIONS

An assessment was also made to determine the impact to of the Norwich CSOs on overall bacteria concentrations in the upper Thames River. Similar to the nitrogen calculations, this assessment used the limited data available from the 1994 report to estimate the contribution of the CSOs compared with other significant sources, including stormwater outfalls and background loads from upstream sources. Calculations were made to determine the relative contributions of both fecal coliform bacteria and enterococcus bacteria.

Wet weather bacteria data can exhibit wide variations over orders of magnitude based on the storm event, location and other factors. For that reason, the CSO and stormwater sampling conducted in 1994 were analyzed to determine the 25th, 50th and 75th percentile values. These values were used in the analysis to determine a range of loads and a range of percent contributions from each source.

Annual bacteria concentrations in the rivers upstream of Norwich were estimated based on data obtained at USGS stations on the Shetucket and Quinebaug Rivers. Data from 2002 through 2006 were used to determine the 25th, 50th and 75th percentile concentrations. These values were then used to determine a range of loads.

Bacteria data used in the analysis are presented in Tables 7-1 and 7-2. The relative contributions of fecal coliform and enterococci from each major source are shown on Figures 7-1 and 7-2. The values shown on the figures correspond to the 50 percentile loadings.

The available data suggests that CSOs are contributing a relatively small portion of the total bacterial loading to the upper Thames River. It appears that two thirds of the bacterial loading to the river is coming from miscellaneous upstream sources. This conclusion, if verified by future monitoring conducted as part of this LTCP, would suggests that even if all Norwich CSOs are eliminated, water quality standards related to bacteria may not be met. This preliminary analysis also points to the fact that Norwich urban stormwater may be a source of bacterial loading to the rivers that equals or exceeds that from CSOs.

Table 7-1 Estimated Annual Loading of Enterococci to the Upper Thames River Estuary						
	Flow [MG/yr]	**Concentration [col/100mL]**			**Load[(1)] [col/yr*10^12]**	**Percent[(1)] of Total Load**
		25%	**50%**	**75%**	**50%**	**50%**
Norwich CSOs	89	10,000	20,000	40,000	68	2%
Norwich Stormwater	1,300	200	1,100	6,500	55	2%
Upstream Sources	505,000	100	100	300	3,150	96%
Total	**506,400**	-	-	-	**3,300**	**100%**

(1) Projected loads based on 50th percentile value of samples taken

Table 7-2 Estimated Annual Loading of Fecal Coliform to the Upper Thames River Estuary						
	Flow [MG/yr]	**Concentration [col/100mL]**			**Load[(1)] [col/yr*10^12]**	**Percent[(1)] of Total Load**
		25%	**50%**	**75%**	**50%**	**50%**
Norwich CSOs	89	70,000	130,000	305,000	438	11%
Norwich Stormwater	1,300	10,000	10,000	85,000	500	12%
Upstream Sources	505,000	100	100	500	3,065	77%
Total	**506,400**	-	-	-	**4,000**	**100%**

(1) Projected loads based on 50th percentile value of samples taken

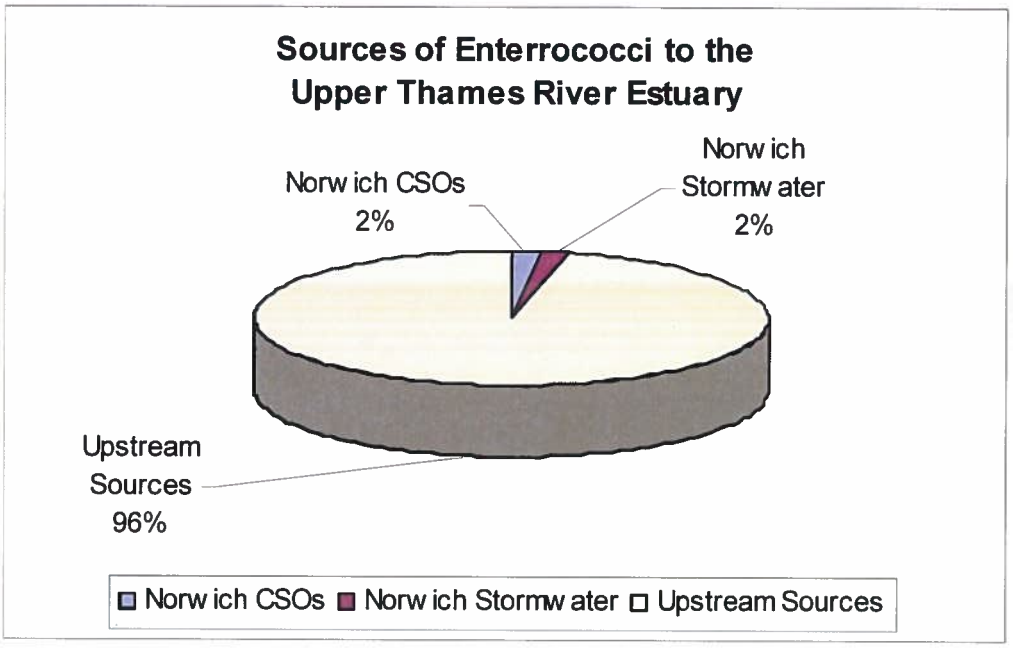

Figure 7-1– Relative Contributions of Enterococci Sources in the Upper Thames River Estuary

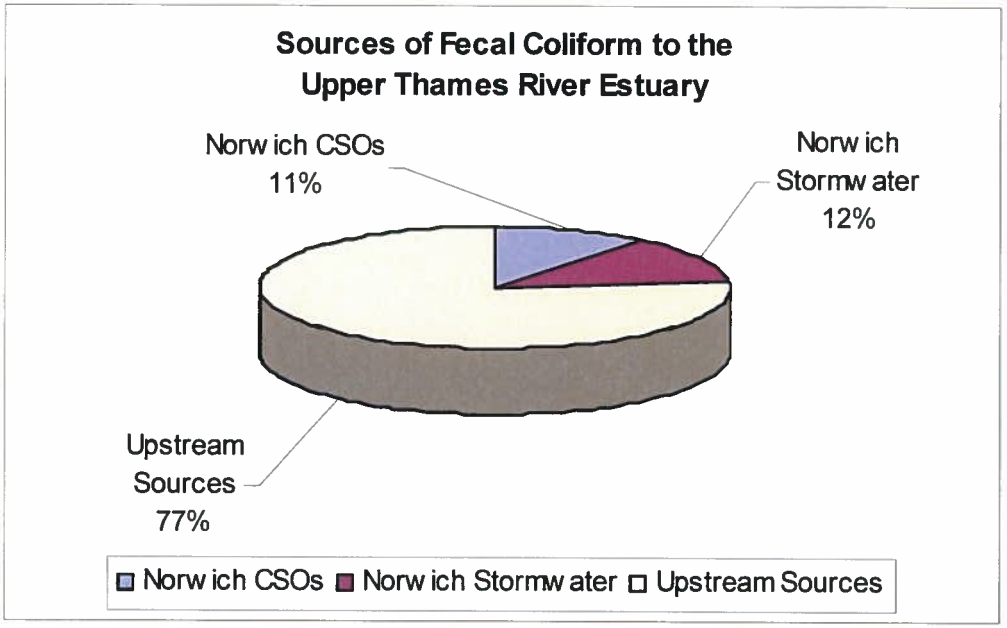

Figure 7-2 – Relative Contributions of Fecal Coliform Sources in the Upper Thames River Estuary

8 DATA NEEDS

During subsequent tasks, Black & Veatch will develop a monitoring plan for the collection system and a monitoring plan for the receiving water. The sampling described in the plans will be conducted during Phase 3 of the LTCP. The purpose of the collection system plan is to collect samples that will help characterize both the CSO frequency and volume at each CSO location, as well as establish flow rates at strategic locations within the collection system to permit calibration of a hydraulic sewer model. This additional data will be used to estimate the pollutant loadings to the area rivers resulting from Norwich CSOs. The purpose of the receiving water plan is to (1) develop a monitoring and sampling plan that will aid characterization of both flow rates and water quality at strategic locations in the receiving water, (2) permit meaningful analysis of the impact of NPU's CSOs on receiving water quality, (3) provide data to be used in defining mixing zones and (4) provide calibration data for a receiving water quality analysis using the mixing zone concept that will aid prediction of LTCP effectiveness.

The review of available data and estimates of pollutant loads to the rivers presented in this Technical Memorandum provides valuable information to be used in development of the monitoring plans. Most of the receiving water data available to characterize the rivers in the Norwich area has been collected by the USGS at the gaging stations on the Shetucket and Quinebaug Rivers. While the station on the Quinebaug River is relatively close to Norwich, the station on the Shetucket is several miles upstream. Samples need to be collected nearer to the study area to give a better indication of pollutant loads entering the upper Thames River estuary.

Bacteria in CSO and stormwater discharges have widely varying concentrations. More data is needed to better characterize the concentrations and loads in these discharges. In addition, additional information on the volume of discharge is needed. In the preliminary analysis conducted for this Technical Memorandum, assumptions were made on flow from unmonitored combined sewer areas.

River sampling in 1991 consisted of grab samples at each of the stations. A single grab sample was taken at each river sampling station, and the sampling program was repeated at specified time intervals measured form the beginning of a storm event. To properly define the mixing zones, it will be necessary to collect multiple samples at each station both across the river channel (transect) and vertically with water depth if there is a density gradient, such as the pycnocline, which occurs in the Thames River.

9 FINDINGS AND CONCLUSIONS

A summary of key finds and conclusions are listed below.

1. Connecticut DEP has reported that several reaches of the major rivers in the Thames River watershed are not meeting water quality standards. A major issue

is that these reaches do not meet bacterial standards for recreational uses such as swimming and shellfish harvesting. Problem areas include portions of the Shetucket and Quinebaug Rivers upstream of Norwich as well as the lower Shetucket River and upper Thames River estuary.

2. Nutrient-related problems of eutrophication and low dissolved oxygen are reported in portions of the Thames River estuary. This includes seasonal hypoxia in the lower, saline waters of the Thames River estuary just below Norwich. However, estimated nutrient contribution from Norwich CSO discharges is insignificant (less than one percent of overall nutrient contribution). Major pollutant loading of nutrients is from agricultural runoff, wastewater treatment plants, and miscellaneous nonpoint sources within the basin watershed.

3. Based on available pollutant loading information, it appears that bacteria are the only pollutants in the Norwich CSO discharge that adversely impact meeting water quality standards.

4. Based on very limited existing information, it appears that Norwich CSO discharges may account for approximately 10 percent of bacterial loading to the upper Thames River estuary, on an annual basis. Norwich stormwater discharges may be contributing approximately the same load of bacteria to the river. The receiving water sampling program should be structured to validate or refine these estimates, especially under wet weather conditions.

5. If sampling validates that approximately 90 percent of the bacterial loading is from stormwater runoff and miscellaneous upstream nonpoint sources, water quality standards still may not be met even if all Norwich CSOs are eliminated. Furthermore, separating additional urban combined sewers would increase the volume of untreated discharges from storm sewers, likely increasing bacterial loading to local rivers from those sources. This should be evaluated further during the system modeling and alternatives analysis phases of the LTCP effort.

REFERENCES

Black & Veatch, 1994. CSO Modification Plan Final Report. Prepared for Norwich Sewer Authority.

CT DEP, 2002. *Water Quality Standards.* CT Dept. of Environmental Protection, Bureau of Water Management, Hartford, CT.

CT DEP, 2006. *2006 Integrated Water Quality Report to Congress.* CT Dept. of Environmental Protection, Bureau of Water Management, Hartford, CT.

Trench, E.C.T., 2005. *The Thames Science Plan: Suggested Hydrologic Investigations to support Nutrient-Related Water-Quality Improvements in the Thames River Basin, Connecticut.* U.S. Geological Survey Open-File Report 2005-1208, 47 p.

APPENDIX 2-C

CITY OF NORWICH, CONNECTICUT
DEPARTMENT OF PUBLIC UTILITIES

Phase II CSO Long Term Control Plan

Technical Memorandum

Task 5
COLLECTION SYSTEM MONITORING AND SAMPLING PLAN

March 2008
Revised: October 2010

Prepared by:

BLACK & VEATCH
building a world of difference™

CITY OF NORWICH, CONNECTICUT

PHASE II CSO LONG TERM CONTROL PLAN

TASK 5 – COLLECTION SYSTEM MONITORING AND SAMPLING PLAN

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- Flow Monitoring and Sampling Locations
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Appendix C – Update to Reflect Changes Made to Plan during the 2008 Field Monitoring Program

1 INTRODUCTION

A hydraulic model of the combined sewer system (CSS) is being developed, which will be used to estimate wet weather discharges to the rivers for the existing system, as well as to project the impacts that would result from proposed improvements to the system. The hydraulic model will be calibrated with flowmeter and rain gage data collected from actual storm events. This technical memorandum outlines the plan to install flowmeters and rain gages throughout the Norwich collection system, to collect that data.

During the wet weather monitoring program, samples will be collected at selected CSO and stormwater discharges to determine typical pollutant concentrations. This information will be used, in conjunction with CSO discharge flow estimates from the hydraulic model, to project the CSO pollutant loading to the rivers.. While bacteria and nutrients in the CSO discharges are of greatest interest, several other parameters also will be monitored.

This collection system monitoring plan also includes monitoring locations and sampling procedures that will be used for the collection system-based sampling that will be done in conjunction with the Receiving Waters Monitoring Plan developed under Task 6.0.

2 SAMPLING AND FLOW MONITORING

The combined sewer system flow monitoring locations were selected to meet three general objectives. First, to provide useful data from all major trunk sewers in the City's collection system, representing all geographic area of Norwich. Second, meters were located immediately upstream of the regulators at all CSO locations conducive to temporary flow meter installation, based on field inspection of each CSO regulator during the fall of 2007. Third, additional meters were recommended for larger, remaining combined areas in downtown Norwich. The system schematic in the appendices illustrates how the metering locations selected actually meet these three objectives.

Twenty-two flow monitors and seven automatic samplers will collect flow and water quality data under this program. Flow monitors will measure both velocity and water-elevation within the sewers and will record continuously throughout the 10 week project period. Automatic samplers will collect water during three wet weather events for lab-analysis. Grab samples will also be taken at locations with autosamplers during wet weather for lab analysis of more time sensitive constituents.

The recommended sampling and flow monitoring stations are listed in Table 1, below. Each station is described in detail in the text that follows. Collection system monitoring locations were selected to represent all major portions of the collection system, with emphasis on each of the CSO sewersheds, as indicated on the appendix figures.

Table 1 – Sampling and Flow Monitoring Locations

Station No.	Location/Description	Monitoring
CSS 1	CSO 24*	F, S
CSS 2	CSO 25*	F
CSS 3	CSO 22*	F
CSS 4	CSO 23*	F
CSS 5	Shetucket Interceptor, Upstream of CSO 24	F
CSS 6	Shetucket Interceptor, Upstream of Rose Alley PS	F
CSS 7	CSO 18*	F
CSS 8	CSO 19*	F
CSS 9	CSO 20*	F
CSS 10	CSO 21*	F
CSS 11	Laurel Hill Area Input to Shetucket Int.	F
CSS 12	CSO 4*	F
CSS 13	CSO 40*	F, S
CSS 14	Thamesville Int. Upstream of Shipping Street PS	F
CSS 15	Yantic Interceptor	F
CSS 16	Yantic Interceptor at Backus Hospital	F
CSS 17	Franklin Square, Downtown Norwich	F
CSS 18	Franklin Street near Willow Street	F
CSS 19	Bath Street	F
CSS 20	West Main Street	F
CSS 21	CSO 5*	F
CSS 22	Rose Alley PS (permanent flow meter) – CSO 17	F, S
Storm 1	Yantic St off of Washington Street	S
Storm 2	McKinley Avenue North of Grove Street	S
WWTF 1	WWTF Influent	S
WWTF 2	WWTF Effluent	S
F = Flow Metering		
S = Sampling (auto-samplers and grab samples)		
* Where CSOs are listed, meters will be placed in the upstream line of the diversion chamber or manhole leading to the outfall pipe, and samplers will be located downstream of the diversion point.		

2.1 Collection System Sampling and Flow Monitoring Locations

Twenty-two flow monitoring locations were selected within the collection system along with data from the Rose Alley Pump Station and WWTF. Sites were chosen that could be used to calibrate both dry weather flow (DWF) and wet weather flow (WWF) conditions. The recommended collection system sites were field verified to ensure that they would be

accessible and suitable for meter installation. A brief description of the sites is included below. Unless otherwise stated in the descriptions, all flow meters will be installed on the influent line to the diversion manhole, upstream of regulators. Appendix A includes two figures showing the location of flow monitors, autosamplers and rain gages. Sketches based on November 2007 field site investigations are located in Appendix B

2.1.1 CSS 1 – CSO 24

Metering station CSS 1 will be installed in the diversion manhole of CSO 24, located on 8th Street near North Main Street, directly adjacent to an electrical box on the north side of 8th Street. This will monitor all of the flow in the sewershed upstream of CSO 24, in a largely urban area. Previous modeling estimated the annual overflow from this manhole at 29 million gallons, which would make it the largest single discharge in the system. Parking is available along the street and at adjacent businesses. This is a heavily trafficked area and appropriate traffic control should be utilized when accessing the manhole.

At this location, combined sewage flow through a 24-inch brick pipe, with dry weather flow (DWF) routed to the Shetucket Interceptor. Flow is restricted by a gate at the entrance to the effluent pipe. During storm events, excess flow overflows a weir in the manhole and discharges through a 30-inch brick pipe to CSO 24. A flow meter will be installed just upstream of the manhole, which is approximately 9 feet deep.

2.1.2 CSS 2 – CSO 25

Metering station CSS 2 will be located in the 7.5-foot deep diversion manhole for CSO 25, which is. Previous modeling estimated the annual overflow volume from this CSO at 2.3 million gallons. The diversion manhole is located at the intersection of Eighth Street, Roosevelt Avenue and Smith Avenue, closest to Roosevelt Avenue. The manhole receives flow from the combined areas along Roosevelt and Smith Avenues.

Combined sewage flows into the manhole through a 24-inch pipe. DWF exits through a 12-inch pipe routes effluent across the Eighth Street Bridge to the Shetucket Interceptor. Wet weather overflow tops a small weir, then flows directly to the river via a 30-inch pipe. A flow meter will be installed in the 22-inch PVC line upstream of the manhole.

2.1.3 CSS 3 – CSO 22

Metering station CSS 3 will be located in the 6-foot deep diversion manhole for CSO 22, located on the shoulder of North Main Street. This CSO collects sanitary sewage and storm water from an area with steep topography. The drainage area for this CSO runs from Boswell Avenue through the southern part of the Greenville. Previous modeling estimated the annual overflow volume from CSO 22 at 7.0 million gallons. Because of elevation changes, however, storm runoff is rapid, and reaches the point of overflow at the Shetucket River quickly through a 24-inch diameter pipe. Parking is available on the wide gravel shoulder adjacent to the diversion manhole. The manhole lid is marked with a white "C".

Combined sewage flows into the manhole through a 24-inch brick pipe. During dry weather, all flow exits through a 12-inch pipe. A sluice gate at the entrance to the pipe restricts flow. During wet weather events, excess flow overtops the weir and flows to the river through CSO 22. A flow meter will be installed in the 24- inch pipe upstream of this manhole.

2.1.4 CSS 4 – CSO 23

Metering station CSS 4 will be located in the diversion manhole on North Main Street for CSO 23. This manhole is marked with a white "C"; the closest address is 352 North Main Street. This CSO location is the discharge point for all the sanitary sewage and storm water from approximately three quarters of the Greenville Section of the City. Previous modeling estimates the annual overflow volume from this CSO at 4.8 million gallons. Greenville is a densely settled commercial and residential area with small building lots. Although the terrain is relatively flat through most of the area, there is little land area available that is undeveloped.

A 36-inch brick sewer pipe routes flow into the brick manhole structure; during dry weather, all flow is routed via a 10-inch pipe to a drop manhole, then to the Shetucket Interceptor. Excess wet weather flow overtops a bricks weir and flows into a 36-inch brick sewer. The flow meter probe will be installed in the 36-inch pipe upstream of the regulator.

2.1.5 CSS 5 – Shetucket Interceptor Upstream of CSO 24

Metering station CSS 5 will be located on the Shetucket Interceptor, upstream of CSO 24. This meter will provide one of the boundary conditions on the combined portion of the Norwich collection system. The meter will be located upstream of all of the active CSOs on the Shetucket Interceptor, and will measure flow entering the interceptor from separated areas upstream of the site.

The proposed flowmetering manhole is located on the east side of the railroad tracks, which run parallel to the interceptor. The manhole is marked with a green wooden stake; the rim of the manhole is raised above the ground's surface. Parking for manhole access is available off of 8th Street or Main Street as shown in the attached sketch. The flow meter will be installed in the 24-inch influent line of the 15-foot deep manhole.

2.1.6 CSS 6 – Shetucket Interceptor Upstream of the Rose Alley PS

Flowmetering station CSS 6 will be located on the Shetucket Interceptor, upstream of the Rose Alley Pump Station and downstream of the active Shetucket CSOs. This meter will record the total flow in the Shetucket Interceptor from the separated and combined areas in the northeastern portion of the city. It will be located after the CSOs, and upstream of where flow from the Laurel Hill area enters the Shetucket Interceptor.

The meter manhole will be located in the bus station parking lot adjacent to Viaduct Avenue (Route 12). The flow meter will be installed in the 42-inch influent line of the 10.5-foot deep manhole.

2.1.7 CSS 7 – CSO 18

Flowmetering station CSS 7 will be located between 104 and 106 North Main Street, upstream of the 7-foot deep diversion manhole for CSO 18. Based on previous modeling, the total annual overflow volume from CSOs 18, 19 and 20 is estimated at 11.7 million gallons. The meter will be installed in the upstream side of the manhole in the line perpendicular to Main Street. This manhole can be accessed from North Main Street and will require traffic control appropriate for high-traffic areas. The manhole is marked with a white "C".

The manhole receives flow from the area to the north of the site via a 36-inch line as well as a 12-inch line parallel to the street. The overflow line is blocked by a weir approximately 12 inches high and to the south, perpendicular to the street, flowing to CSO 18.

2.1.8 CSS 8 – CSO 19

Flowmetering station CSS 8 will be located in the influent line of the 8-foot deep diversion manhole for CSO 19, on North Main Street between Barron and Roath Streets. Parking is available at the site on the street and at local businesses. This is a high traffic area, which will require appropriate traffic control. Flow enters the diversion manhole through the 32-inch line, where the meter will be located. During dry weather, all flow makes a 90° turn to the right, through an open sluice gate into a 12-inch line. During wet weather events, excess flow overtops the bench, which functions as a weir, then flows into a 24-inch brick sewer. The line follows North Main Street for approximately 200 feet before turning toward the manhole located on the south side of North Main Street at the entranceway to the DPU facilities. Flow combines in this manhole with flow from a second diversion manhole serving a small area, at Roath Street and North Main Street. Flowmetering station CSS 8 will capture flow from the neighborhoods along Convent and Oakridge Streets.

2.1.9 CSS 9 – CSO 20

Flowmetering station CSS 9 will be located in the influent line of the diversion manhole for CSO 20, on South Golden Street between DPU's operations building and Norwich Self Storage. Flow enters this manhole from a line running parallel to South Golden Street. During wet weather, excess flow is diverted over a weir to CSO 20. During dry weather, all flow continues through a 15-inch line angled slightly to the right as it exits the manhole. The site can be easily accessed via South Golden Street, where parking is available.

2.1.10 CSS 10 – CSO 21

Flowmetering station CSS 10 will be located in the 6.5-foot deep diversion manhole for CSO 21 located on Erin Street just north of the railroad tracks running parallel to the Shetucket Interceptor. Flow enters this regulator structure through a 10-inch clay pipe. The dry weather flow pipe is angled slightly to the right as it exits the manhole and is diverted to the Shetucket Interceptor. During wet weather, excess flow overtops a weir and ultimately discharges to the river at CSO 21. The site is located off of North Main Street and is easily accessed. Street parking is available. This diversion manhole receives flow from the residential and commercial areas along Convent Street and North Main Street.

2.1.11 CSS 11 – Laurel Hill Area Upstream of the Shetucket Interceptor

Flowmetering station CSS 11 will be located in northwest corner of the same bus station parking lot off of Viaduct Avenue as station CSS 6. The 12-foot deep manhole at this location receives flow from the 42-inch Shetucket Interceptor as well as all of the flow from the Laurel Hill area via a 24-inch line. Flow travels to the Rose Alley Pump Station from here via a 42-inch line. The meter will be placed in the 24-inch line from Laurel Hill.

2.1.12 CSS 12 – CSO 4

Flowmetering station CSS 12 will be located upstream of the 3-foot deep diversion manhole for CSO 4. That manhole, which has an 18-inch lid and barrel, is located in the side yard of a residence at 76 West Thames Street. Flow enters the manhole through a 10-inch line. During dry weather, all flow exits through an 8-inch brick sewer to the Thamesville Interceptor; excess wet weather flow is diverted over a brick weir to CSO 4. The meter will record flow from neighborhoods along West Thames Street, Woodmansee Avenue and Summit Street. Parking is available along West Thames Street, which is separated from South Thames Street by a steep hill towards the river.

2.1.13 CSS 13 – CSO 40

Flowmetering station CSS 13 will be located in the influent line of the 4-foot deep diversion manhole for CSO 40, near the intersection of Shipping Street and Terminal Way. Flow enters this manhole through a 12-inch influent line. During dry weather, all flow continues straight through the manhole to the Shipping Street Pump Station. Excess wet weather flow is diverted through a 12-inch raised pipe in the right side of the manhole. This pipe is fitted with a flap gate in an adjacent manhole, which receives the flow and sends it to CSO 40. This meter will record flow from the neighbors and businesses north of the site along West Thames Street.

In addition to flow metering, this will be a grab sample site and will be also fitted with an auto-sampler for use during wet-weather events. This site was selected for sampling in order to compare the information collected along the Thames River to the other sample collection points along the Shetucket.

2.1.14 CSS 14 – Thamesville Interceptor Upstream of Shipping Street PS

Flowmetering station CSS 14 will be located approximately half a block south of CSS 13, along Terminal Way between Shipping Street and South Street. The meter will be placed in the 24-inch line upstream of this 10-foot deep manhole in the Thamesville Interceptor. Combined sewage flows straight through this manhole on its way to the Shipping Street Pump Station. This meter will record flow in the interceptor from the areas south and west of the Shipping Street Pump Station.

2.1.15 CSS 15 – Yantic Interceptor

Flowmetering station CSS 15 will be located across the Yantic River from the WWTF, on the Yantic Interceptor. At this point in the interceptor the pipe is exposed as it crosses the river. The meter will be installed in the 27-inch line of the first manhole upstream of the point where the interceptor is buried again. The manhole at this location also receives flow from a 10-inch line from local neighborhoods and a 6-inch lateral from the adjacent home. The site is access from Sturtevant Avenue, which dead-ends at the river. Parking is available at this dead end, which is also the starting point for a local bike path along the river. The meter will measure sanitary flow from all separated portions of the city north of this point, along the Yantic River, which discharge to the interceptor.

2.1.16 CSS 16 - Yantic Interceptor behind Backus Hospital

Flowmetering station CSS 16 will be located in the influent line of a 6-foot deep manhole in the employee parking lot near the emergency room of Backus Hospital. This manhole is located on a concrete island which is part of the sidewalk in the parking lot and is part of the 27-inch Yantic Interceptor. Flow in this area come from separated areas north of the meter along the Yantic River and interceptor. The site is easily accessed through the hospital parking lots.

2.1.17 CSS 17 – Franklin Square, Downtown Norwich

Flowmetering station CSS 17 will be located in the 18-inch effluent (downstream) line of this 11-foot deep manhole in the middle of Franklin Square. This manhole is located downstream of CSS 18. The manhole at this location receives flow from two different lines, sanitary flow from the 18-inch main from the north and combined flow from the 12-inch main along the Main St, and combines them before flowing to the Rose Alley Pump Station. Street Parking is available around Franklin Square for site access.

2.1.18 CSS 18 – Franklin Street near Willow Street

Flowmetering station CSS 18 will be located in the 18-inch line of the 15-foot deep manhole on Franklin Street just north of Willow Street, in front of the "Wagging Tails Dog Care Center". This manhole receives flow from the neighborhoods north of the meter along McKinley Avenue up to Mahan Drive as well as from areas to the east along Boswell Avenue. Parking is available in the street and at adjacent businesses in this area.

2.1.19 CSS 19 – Bath Street

Flowmetering station CSS 19 will be located in the 36-inch line of the 5-foot deep manhole located on Bath Street between the AT&T building and the Spiritual Renewal Center. The line to be metered runs parallel to Bath Street; flow in the line comes from the combined areas along Broadway and Union Streets. This manhole is located very close to a street parking lot and will likely require placement of 'No Parking' signs on this spot for the duration of the flow monitoring project.

2.1.20 CSS 20 – West Main Street

Flowmetering station CSS 20 will be located in the 24-inch line that enters this approximately 30-foot deep manhole, in the drainage area bound by North Thames Street and Westside Boulevard. The meter will record flow from the combined areas along West Main Street, west of the WWTF. The manhole is at the top of a steep slope and is accessed via a pair of 36-inch lids. Extra caution should be taken at this location due to the depth of the manhole, slope of the hill and weight of the two lids. Access to this site is limited; parking is available at businesses across the street from this site.

2.1.21 CSS 21 – CSO 5

Flowmetering station CSS 21 will be located at the 5-foot deep diversion manhole in South Thames Street. The flowmeter will be installed in the 12-inch line that enters this manhole. Dry weather flow continues straight through the manhole to the Lower Thames Pump Station; excess wet weather flow is diverted over a weir on the right side of the manhole into a pipe leading to CSO 5. Dry weather flow in this manhole comes from South Thames Street. Most of the overflow to CSO 5 comes from the South Thames Pump Station backing up during wet weather and overflowing the weir in the regulator manhole.

2.1.22 CSS 22 – CSO 17, Rose Alley Pump Station

Well over half of the wastewater to the treatment plant is pumped through the Rose Alley Pump Station, which is at the terminus of the Shetucket Interceptor. During dry weather,, combined sewage flows from the stone box culvert at Rose Alley through a pipe to the adjacent pump station. During storm events, excess flow overtops rectangular weir in the culvert, discharging into the Shetucket River. Previous modeling estimated an annual overflow of 22 million gallons from this location, making the second largest CSO in Norwich.

A permanent flow meter was installed at the pump station in 2002; the meter will be used to collect flow data during the 2008 wet weather flow monitoring period. This site will be used for CSO discharge sampling during monitored wet weather events in 2008, utilizing an automatic sampler as well as individual grab samples. This site was selected for CSO sampling due to the relatively high volume of overflow.

2.2 Storm Water Sampling Locations

Samples also will be taken at two locations in the city's separated stormwater system. Based on that data, Norwich stormwater quality and characteristics can be compared to that of the CSO discharges. Typical stormwater quality information will also be useful in assessing the overall impact of Norwich stormwater discharges on the receiving waters. Since the CSO study does not include hydraulic modeling of the separated stormwater collection system, it will not be necessary to provide flow monitors at these locations.

2.2.1 Storm 1 - Yantic St

The first sampling location will be at Yantic Street off of Washington Street, just before Yantic Street turns north. There is a 24-inch stormwater outfall at this location receiving stormwater from several blocks off Washington Street as well as Williams Street and Lincoln Avenue. This location is a relatively non-commercial section of Norwich, and is intended to be representative of a residential area.

2.2.2 Storm 2 – Franklin Street at Willow St

The second stormwater sampling point will be located in the 24-inch line in the 10-foot deep manhole on Franklin Street just north of Willow Street, in front of the "Wagging Tails Dog Care Center".

2.3 Wastewater Treatment Plant Sampling and Flow Monitoring

The Norwich WWTF is situated on Hollyhock Island, between the east and west branches of the Yantic River, approximately 2000 feet upstream of where the Yantic empties into the Thames River. Effluent from the WWTF is normally discharged approximately 300 feet south off the southern end of Hollyhock Island into the Thames River. When the plant's main outfall is hydraulically limited due to high wet weather flows and/or high tides, an alternate bypass is utilized that discharges to the east branch of the Yantic River, adjacent to the WWTF. Automatic samplers and data from flow measuring devices and a precipitation gage will be available at the WWTF for use in the CSO study.

2.3.1 Automatic Samplers

Two automatic samplers will collect WWTF influent and final effluent samples. Weirs on the samplers can be modified to adjust the sample collection rates. The WWTF samplers will collect approximately 2.5 liters over a 24-hour period, storing the samples at 6°C in a small refrigerator. Influent and final effluent will be sampled daily.

2.3.2 Flow Measurement

The WWTF uses flumes to monitor wastewater influent and effluent flows. These flows can be read directly from a measuring device at each flume. The influent gage measures flow as "percent of maximum flow"; the effluent gage measures "percent of full scale". The reading on both gages can be converted to mgd by multiplying percent by 0.2. Flow records are also maintained at the plant and are available for use in the modeling effort.

3 RAIN GAGES *(UPDATED – SEE APPENDIX C)*

Rain gages will be used to calibrate the hydraulic model of the Norwich CSS. Rain gages will be provided at four locations in the Norwich, making it possible to track the movement of storms through the town. This also will help to prevent highly localized storms from being treated as system-wide events for model calibration purposes. Tipping bucket type rain ages will record rainfall continuously throughout the duration of the study, at 15-minute intervals. Information from the gages will be downloaded regularly, typically every 1-2 weeks throughout the field monitoring phase of the project. Gages will be located at secure sites to minimize the likelihood of vandalism or theft, while still allowing access by project personnel. Table 2 below lists the locations of the rain gages. The locations of these rain gages are also shown on map in Appendix A

Table 2 – Rain Gage Locations

RG01	Roof of DPW Building, 50 Clinton Avenue (maintained by NPU)
RG02	Shore Road Pump Station (maintained by Savin Engineers)
RG03	Roof of NPU Building, South Golden Street (maintained by NPU)
RG01	Rose Alley Pump Station (maintained by Norwich DPW)

4 SAMPLING AND MONITORING PLAN

The following section outlines the data to be collected and the procedures that will be followed during its collection. The information presented below is summary and should not be used as a substitution for reviewing the individual EPA requirements and Standard Methods for sample collection and analysis.

4.1 Wet Weather Sampling – Collection System and Stormwater

Because several of the CSO sites are in heavily traveled roadways, activating sampling and flow monitoring equipment during a rain storm could be a safety concern. In addition, waiting for the beginning of a storm before activating equipment might result in the first flush not being collected at one or more of the sampling locations. Therefore, two to three hours before a storm is expected to begin, a field crew will be mobilized to activate the automatic samplers and to check the operation of sampling and flow monitoring equipment.

Before the samplers are activated prior to the start of a rain event (a rain event is defined as at least 0.5 inches of rain over a 24 hour period), 24 one-liter polypropylene sample bottles will be installed in the base of each automatic sampler. The samplers will be programmed to collect four 250 ml samples per bottle (multiplexing) with samples collected every 15 minutes over a 24 hour period. A representative from Black & Veatch will check the flow data for each CSO to determine when the initial increase in flow (first flush) occurred. The first sample bottle collected after the initial increase will be designated as Sample No. 1 for lab testing. Subsequent samples will be composited for lab testing as shown in Table 3 below, subject to confirmation or modification in the field as determined by the characteristics of the storm being sampled and the actual sample volumes collected by the sampling equipment. The purpose of the sample compositing

method is to examine the characteristics of the overflow both during the initial first flush period and during the subsequent hours of overflow during the middle and end phases of the overflow event.

Table 3 – Method for Compositing Samples from Autosamplers

Sample Bottle No. (from Autosampler)	Sample Volume Added (mL)	Total Sample Volume (mL)	Composite Sample No.
1*	1000	2000	1
2	1000		
3	1000	2000	2
4	1000		
5	500	2000	3
6	500		
7	500		
8	500		
9	500	2000	4
10	500		
11	500		
12**	500		

* Sample bottle No. 1 corresponds to the first bottle collected after the initial increase in flow (first flush).

** Composite sample No. 4 should reflect CSO conditions following the rain storm when flow has returned close to baseline. If analysis of flow data indicates that this occurs later than sample bottle No. 12, then the appropriate later sample bottles shall be composited for composite sample No. 4.

The composite samples will be delivered to the lab for analysis. The field crew will place clean sample bottles in the automatic samplers, return the samplers to their respective CSOs in preparation for the next rain event. The automatic samplers will be used to sample three storm events; the samplers will then be removed from the CSOs and turned over to Norwich. The flow meters, however, will be left in place until the end of the sampling program; therefore, periodic data collection and servicing of equipment will be required.

The flow compositing of samples was considered rather than the method outlined in Table 3; however, because some time will be required to analyze the flow data collected from the flow meters to ensure the accuracy of the data and because lab analysis should be initiated on the composite samples as soon as possible, accurate flow data will not be available to allow flow compositing. The simpler compositing procedure recommended for this sampling program should help minimize mistakes and make lab results more reliable.

Each composite CSO sample will be analyzed by a state-certified laboratory for the constituents listed in Table 4, only composite sample No. 1 from each automatic sampler will be analyzed for 21-day BOD.

Table 4 – Collection System Sampling Analysis

Grab Sample Parameters	Time Since Rain Events Begins					
	0 min	30 min	2 hr	4 hr	8 hr	16 hr
Field Testing (Using Probe)						
Dissolved Oxygen (DO)	X	X	x	X	x	x
Salinity (Conductivity)	X	X	x	X	x	x
Temperature	X	X	x	X	x	x
pH	X	X	x	X	x	x
Lab Testing (EPA approved Methods)						
Fecal Coliform	X	X	x	X	x	x
E. Coli	X	X	x	X	x	x
Enterococci	X	X	x	X	x	x

Autosampler Parameter	Composite Sample			
	1	2	3	4
Total Suspended Solids (TSS)	x	x	x	x
Volatile Suspended Solids (VSS)	x	x	x	x
Settleable Solids	x	x	x	x
5-day BOD	x	x	x	x
21-day BOD	x	n/a	n/a	n/a
Total Organic Carbon (TOC)	x	x	n/a	n/a
Orthophosphate	x	x	x	x
Nitrite	x	x	x	x
Nitrate	x	x	x	x
Total Kjeldahl Nitrogen (TKN)	x	x	x	x
Ammonia-N	x	x	x	x
x - Analytical laboratory to analyze for this parameter.				
* Time since start of rain event				

In order to reduce the delay in analyzing bacterial samples, six grab samples will be collected at each CSO sampling location during each rain event. These samples, which will be analyzed for Fecal Coliform, E. Coli and Enterococci, will be collected at approximately the following intervals:

- near the beginning of the rain event

- 30 minutes after the start of the rain event
- 2 hours after the start of the rain event
- 4 hours after the start of the rain event
- 8 hours after the start of the rain event
- 16 hours after the start of the rain event

The holding time for bacterial samples will be reduced by making multiple deliveries to the lab during each storm event. The timing of the deliveries will be coordinated with the labs normal operating hours, except when storm events occur during or near a weekend in which case the samples will be delivered outside of normal lab hours to comply with the maximum holding time of 6 hours.

4.2 WWTF Sampling Program

Samples will be collected at the Norwich WWTF during wet weather and dry weather conditions. The sampling program to be employed for the three wet-weather conditions is described in the following sections.

4.2.1 WWTF Wet-Weather Sampling

Approximately one hour after the beginning of a rain event, a field crew will collect 2 liter samples of wastewater influent and final effluent from the WWTF's automatic samplers. Separate grab samples will be collected in sterile containers for bacterial analyses (fecal and E. Coli and Enterococci). The samples will be placed in coolers containing ice to help preserve the samples while being delivered to the analytical lab for analyses. Approximately 12 hours after the start of the rain event, the sampling procedure described above will be repeated.

Each set of WWTF wet weather samples will be analyzed for the parameters listed in Table 5. Samples taken one hour after the beginning of the rain event will be analyzed for all the lab testing parameters listed in Table 5 whereas samples taken 12 hours after the rain event start will be analyzed for all the parameters except 21-day BOD and total organic carbon. The field crew will use appropriate meters to test final effluent samples on-site for dissolved oxygen, salinity, temperature and pH.

Table 5 – Norwich Wet Weather Sampling Parameters

		WWTF Influent		WWTF Effluent	
PARAMETER	**Collection**	**1 Hr***	**12 Hr***	**1 Hr***	**12 Hr***
Field Testing (Using Probe)					
Dissolved Oxygen (DO)	Grab	x	X	x	x
Salinity (Conductivity)	Grab	x	X	x	x
Temperature	Grab	x	X	x	x
pH	Grab	x	X	x	x
Lab Testing (EPA approved Methods)					
Fecal Coliform	Grab	n/a	n/a	x	x
E. Coli	Grab	n/a	n/a	x	x
Enterococci	Grab	n/a	n/a	x	x
Total Suspended Solids (TSS)	Autosampler	x	x	x	x
Volatile Suspended Solids (VSS)	Autosampler	x	X	x	x
Settleable Solids	Autosampler	x	X	x	x
5-day BOD	Autosampler	x	X	x	x
21-day BOD	Autosampler	x	n/a	x	n/a
Total Organic Carbon (TOC)	Autosampler	x	X	x	x
Orthophosphate	Autosampler	x	X	x	x
Nitrite	Autosampler	x	X	x	x
Nitrate	Autosampler	x	X	x	x
Total Kjeldahl Nitrogen (TKN)	Autosampler	x	X	x	x
Ammonia-N	Autosampler	x	X	x	x
x - Analytical laboratory to analyze sample for that parameter					
* Time since start of rain event, autosamplers should be programmed to take 2 liters during hours 1 and 12 (i.e. 500 ml every 15 min from time 0-1hr and 11-12hrs)					

Immediately after collecting samples, the field crew will also note the influent and final effluent flows at the WWTF by reading the measuring devices at the influent and effluent flow measuring flumes. At the conclusion of each rain event, rainfall data will be obtained from the continuously-recording rain gages. The WWTF wet weather sampling program will be conducted for three separate rain events.

The Norwich WWTF staff normally work from 8 a.m. to 4:30 p.m., Monday through Friday. Because the treatment plant may not be staffed when a rain event occurs, provisions will be made with Mike LaLima, NPU's Utility Engineer/Manager, to ensure access to the automatic samplers during the wet weather sampling period.

4.2.2 WWTF Dry Weather Sampling

A dry weather event is defined as having no rainfall occur for 72 hours prior to and during the sampling efforts. Two liter portions of the WWTF's composite samples of wastewater influent, primary effluent, and final effluent collected over the 24-hour period of the sampling day will be placed in polyethylene containers provided by the analytical lab. Separate grab samples will be collected in sterile containers for bacterial analyses (fecal and E. Coli, and enterococci). These samples will be transported in an ice-filled cooler to the lab for analysis. If the WWTF is not collecting a primary effluent sample on the dry weather sampling day (the WWTF samples influent and final effluent daily but only samples primary effluent once a week), the primary effluent automatic sampler will have to be activated and the sample container placed in a cooler filled with ice during sampling. An ice-filled cooler will be required to hold the primary effluent sample container in any case, because the small refrigerator in front of the samplers can only hold two sample containers during sampling.

Each set of WWTF composite dry weather samples will be analyzed for the lab testing parameters listed in Table 6. A grab sample of the final effluent will be analyzed on-site for dissolved oxygen, salinity, temperature, and pH.

Table 6 – WWTF Dry Weather Sampling Parameters

PARAMETER	Collection	Influent	Effluent
Field Testing (Using Probe)			
Dissolved Oxygen	Grab	X	X
Salinity (Conductivity)	Grab	X	X
Temperature	Grab	X	X
pH	Grab	X	X
Lab Testing (approved SM)			
Fecal Coliform	Grab	n/a	X
E. Coli	Grab	n/a	X
Enterococci	Grab	n/a	X
Total Susp. Solids	Autosampler	X	X
Volatile Susp. Solids	Autosampler	X	X
Settleable Solids	Autosampler	X	X
5-day BOD	Autosampler	X	X
21-day BOD	Autosampler	X	X
Total Organic Carbon	Autosampler	X	X
Orthophosphate	Autosampler	X	X
Nitrite	Autosampler	X	X
Nitrate	Autosampler	X	X
Total Kjeld. Nitrogen	Autosampler	X	X
Ammonia-N	Autosampler	X	X

4.3 Quality Assurance and Quality Control (QA/QC)

The Quality Assurance/Quality Control (QA/QC) program implemented for this study will consist of internal QC performed by the lab and external quality assurance performed by Black & Veatch.

The testing lab will report internal QC performed during sample testing. Internal QC tests include method blank, matrix spike recovery, and matrix spike recovery duplicate. Results from any QC tests performed on lab duplicates created from submitted samples will also be reported. The lab will also submit bench sheets for BOD tests. In some industrial wastes, the dilutions of the BOD test provide different BOD results due to inactivity of organisms at certain concentrations of waste. The cause of variations in BOD test results may be more readily determined by analyzing bench sheet data.
An independent QA program, performed by Black & Veatch, will include submission of additional samples of known concentration and duplicate and split samples with approximately identical concentrations for testing.

A stock solution, prepared in the lab by Black & Veatch personnel, will be submitted to the lab and analyzed for 5-day BOD as QA for BOD testing. This stock solution will be a glucose-glutamic acid solution as described in Standard Methods for the Examination of Water and Wastewater. The 5-day BOD of the stock solution will be prepared fresh immediately before testing and will be submitted to the lab once for each of the three rain events (when the CSO samples are delivered to the lab for compositing) and once during the dry weather sampling (when the WWTF samples are delivered to the lab).

A duplicate sample of the WWTF effluent will be tested in the lab as QA for the following constituents:

- Total suspended solids
- 5-day BOD
- Fecal coliform
- E. Coli
- Enterococci
- Orthophosphate
- Total Kjeldahl Nitrogen

The duplicate sample will be created in the field by dividing the WWTF effluent sample collected approximately one hour after the start of a rain event (for each of three rain events) and by dividing the composite WWTF effluent sample collected during dry weather sampling.

To ensure that bacteria sample bottles are not contaminated during transport and handling, a sterile sample bottle will be included with each set of bottles provided to each of the sampling crews for each sampling period. This extra bottle will be handled the

same way as the sample bottles, then filled with sterile distilled water and returned to the lab for analysis of enterococci and fecal and E. Coli.

The quality assurance testing schedule is presented in Table 7.

Table 7 – QA/QC Testing Schedule

Parameter	Rain Event No. 1	Rain Event No. 2	Rain Event No. 3	Dry Weather Sampling
Total Suspended Solids	B	B	B	B
5-Day BOD	A,B	A,B	A,B	A,B
Fecal Coliform	B	B	B	B
E. Coli	B	B	B	B
Enterococci	B	B	B	B
Orthophosphate	B	B	B	B
Total Kjeldahl Nitrogen	B	B	B	B
A) Stock Glucose-Glutamic Acid Solution				
B) Duplicate WWTF effluent sample collected 1) one hour after the start of the each rain events and 2) during dry weather sampling				

4.4 Supply Requirements

Sampling containers and other supplies required for the sampling program are discussed below. Additional equipment needed for safety purposes is described in Section 7.0.

4.4.1 Sampling Containers

The size and use of the sampling containers to be employed in the sampling program are listed in Table 8. All containers except the ones used in the automatic samplers will be supplied by the analytical lab. The lab will thoroughly clean all containers prior to the start of a sampling event. The containers used to collect samples for bacterial analysis will be sterilized in the lab and kept capped until filled by the sampling crew.

4.4.2 Miscellaneous Supplies

Additional supplies required or recommended for the sampling program are listed below:

- Frozen polypaks (or ice)
- Garbage bags
- Teflon tape
- Labels
- Pencils, indelible markers
- Mylar tape
- Scissors
- Utility knife
- Coolers
- Tool kit

- Extra pump tubing for automatic samplers
- Paper towels
- Extra batteries for flashlights, automatic samplers and flow meters
- Clipboard
- Steel ruler (12')
- Measuring tape (15' mm.)
- pH meters
- Conductivity/temperature meter and dissolved oxygen/temperature meter
- Chain-of-custody forms
- Graduated cylinders
- Calculator
- Instruction manuals for flow meters and automatic samplers
- Grease Pencils

4.5 General Duties

Prior to a sampling event, the senior person on each sampling crew should check the items listed in the previous section to ensure that an adequate number of sampling containers and supplies are available for the next sampling period. The crew's supervisor should be notified of any shortages of supplies. Inventory should be checked by the sampling crews at the beginning and end of each sampling event. General sampling duties include:

1. Arrival: Crews should arrive at their pre-assigned meeting places at least one hour before their first scheduled sample is to be taken.

2. Duties: During the first hour before the sample is taken, crews should check lists and available items (i.e., laboratory supplies, forms, etc.).

3. All forms should be completely filled out and signed by each crew before the end of the sampling period. Whenever a sample is transferred (for example, from boat crew to land-based crew, or from land-based crew to lab personnel) the transferor and the transferee must both sign and date the Chain-of-Custody form.

4. All samples must be packed in the coolers with polypaks (or ice) immediately after the sample is taken and prior to sending the samples to the laboratory for analysis.

5. All samples collected must be labeled in the following manner:
   a. The outer surfaces of the container should be wiped clean.
   b. Attach large rectangular label with Sample No. to side of bottle and cover with Mylar tape (do not use Scotch tape).
   c. Attach the small round label with sample number to the bottle cap – mylar tape is not required.
   d. Each 250 ml container for bacterial analysis should be carefully handled to prevent contamination prior to sampling and during transport to the lab.

6. The land-based crew will transport samples (properly labeled and packed in the coolers) to the lab after the sampling periods identified in Tables 4-1, 4-2, and 4-3

7. If for any reason a sample is not taken, the sampling crew responsible must notify their supervisor at the end of the sampling period.

5 DETAILED SAMPLING PROCEDURES

Sampling procedures for land-based sampling crews are presented below.

5.1 Sample Collection

The proper handling of samples in the field is essential to obtain valid data. Table 8, adapted from 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants", presents a summary of the recommended sampling procedures for the parameters of interest. Although additional preservation techniques are listed in Table 8, samples to be analyzed at the lab will only be preserved by maintaining at 6°C until delivered to the lab. A general discussion of the steps involved in collecting samples is presented below.

1. Prior to Sampling:
    a. Consult Table 8 to ensure that the container chosen for sample storage is appropriate for the analysis to be performed.
    b. Make certain that a sufficient quantity of clean containers is available.

2. After Sample Collection:
    a. Where necessary, make certain that duplicate samples have been collected.
    b. Aliquot an appropriate volume of sample for each analysis.
    c. Ensure that contamination is not introduced in the collection process.
    d. Record all field measurements in a bound notebook; the following information should be included:
        i. date, time, sampling location
        ii. signature of person performing the work
        iii. a brief description of equipment and/or method used to make the measurement.
    e. Cap each bottle securely.
    f. Before packing, mark the liquid level on each container, this will enable the lab personnel to determine if any sample loss has occurred during transportation to the lab.
    g. After samples are labeled, pack them in a container to be maintained at 6°C.
    h. Transport samples to lab, following the chain-of-custody procedures outlined in Section 6.0.

Table 8 – Containers, Preservation and Max Holding Times for Sampling Parameters

Measurement	Container [a]	Preservative [b]	Maximum Holding Time [c]
Ammonia	P,G, FP	Cool, 6°C H_2SO_4 to pH <2	28 days
Bacteria	P,G,	Cool, 6°C 0.008% $Na_2S_2O_3$ [4]	6 hours
Biochemical Oxygen Demand	P,G, FP	Cool, 6°C	48 hours
Conductivity (salinity)	P,G,	Cool, 6°C	28 days
Dissolved Oxygen (probe)	G bottle& top	Determine on site	1 hour
Hydrogen Ion (pH)	P,G, FP	Determine on site	15 minutes
Kjeldahl Nitrogen	P,G, FP	Cool, 6°C H_2SO_4 to pH <2	28 days
Nitrate	P,G, FP	Cool, 6°C	48 hours
Nitrite	P,G, FP	Cool, 6°C	48 hours
Organic Carbon	P,G, FP	Cool, 6°C	28 days
Orthophosphate	P,G, FP	Cool, 6°C H_2SO_4 to pH <2	Filter within 15mins 48 hours
Solids			
Total Suspended	P,G, FP	Cool, 6°C	7 days
Volatile Suspended	P,G, FP	Cool, 6°C	7days
Settleable	P,G, FP	Cool, 6°C	48 hours
Temperature	P,G, FP	Determine on site	Immediately

(a) Polyethylene (P), Glass (G), Fluoropolymer (FP)
(b) For this project not all preservation techniques shown will be used. Samples to be analyzed at the lab will only be preserved by, maintaining at 6°C until analysis begins.
(c) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, had data on file to show that the specific types obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability.
(d) Should only be used in the presence of residual chorine.

Reference: 40 CFR Part 136, "Guideline Establishing Test procedure for the Analysis of Pollutants".

5.2 Sample Testing Methods

The testing methods to be used on the samples collected shall be EPA-approved methods described in Standard Methods for the Examination of Water and Wastewater, 20th Edition. The designation of EPA-approved is based on 40-CFR Parts 136, 141 and 143 "Guidelines for the Analysis of Pollutants under the Clean Water Act; National Primary Drinking Water Regulations; and National Secondary Drinking Water Regulations; Methods Update", included in the appendix of this report.

Table 9 – EPA Approved Testing Methods

Parameter	Testing Method* Standard Methods	EPA
Lab Testing		
Total Suspended Solids	2540 D	-
Volatile Suspended Solids	-	160.4
Settleable Solids	2540 F	-
5-day BOD	5210 B	-
21-day BOD	-	-
	9221C or E	132
Fecal Coliform	9222D	124
	9221B, F	
	9223 B	1103.1
	9222 B, G	1603
E. Coli	9213D	1604
		1106.1
	9230 B	1600
Enterococci	9230 C	143
		365.1
Orthophosphate	4500-P F,E	365.3
	4500-NO2	353.2
Nitrite	B,F,E	300.0
		300.0
Nitrate	4110 B	300.1
	4500-N_{org} B,C	
	4500-NH3	351.1
Total Kjeldahl Nitrogen	C,D,E	351.2
	4500-NH3	
Ammonia-N	B,C,D,E,G	350.1
Field Testing		
Dissolved Oxygen	4500-O C,G	-
Conductivity (Salinity)	2510	-
pH	4500-H+ B	-
Temperature	2550 B	-

* Test numbers based 40 CFR 122,136, et al. 2007; 20th Edition of *Standard Methods*

6 RECORD KEEPING AND LABELING SYSTEM

An essential part of any sampling program is a complete recordkeeping procedure. All personnel must keep meticulous records of all the samples collected and ancillary information pertaining to their collection, preservation, and delivery to the laboratory.

6.1 Sample Identification

Adhesive labels will be affixed to the sample containers. When a sample is taken, a crew member should write the following information on the label:

- The site name and/or number and the sampling location
- The date and time sample was taken
- The analysis required
- The signature of the sample collector

In addition, the sampling location and time should be written in grease pencil directly on the container as a safeguard in case the sample label becomes illegible. The sample label should be completely covered with mylar tape to eliminate the possibility of moisture smearing the writing on the label. A small round adhesive label should also be used on the cap and labeled with the sampling location and time to facilitate checking the inventory of bottles.

6.2 Chain-of-Custody Procedures

Chain-of-custody is a process which accounts for sample identity and handling from the time of collection through disposal. A Chain-of-Custody Record must be established for each sample or group of samples. Record forms must be maintained during sample collection and transfer; the following information should be included on the Chain-of-Custody Record:

- Name of Study
- Site name/number and sampling location (sample identification)
- Date and time of sampling
- Sample type (composite or grab)
- Sample matrix (all samples collected for this study will be ("liquid")
- Analyses required
- Signature of samplers

Results of on-site analyses of river grab samples for dissolved oxygen, temperature, conductivity, and pH and comments on any unusual or unique circumstances should also be recorded. When completing sample labels and chain-of-custody records, make certain that all required information has been provided and that all writing is legible.

When turning over possession of samples, both the transferor and transferee must sign and date the record. The Chain-of-Custody forms should accompany their respective

samples during transfer to the local laboratory for analyses. After the laboratory has received samples and signed the forms, they should copy each form and retain the original. The copy should be given to the individual who delivered the samples.
The Laboratory Chain-of-Custody form must accompany samples during compositing, extracting and analysis. All originals should be sent to Black & Veatch immediately upon completion of the analyses.

The Norwich WWTF influent and effluent will be recorded throughout wet-weather event as previously described. At the end of a sampling event, this form should be forwarded to Black & Veatch.

7 SAFETY

The following section details some of the hazards that may be encountered during the monitoring program. It is the responsibility of all project personnel to understand and prepare for hazardous conditions.

7.1 Hazardous Conditions

Sampling activities are often carried out in situations where both the sampling environment and the wastewaters themselves may create hazardous conditions. Sampling personnel must always be aware of possible hazards and must take any precautions necessary to avoid dangerous situations. Some of the more common hazards are listed below.

- Hazardous Atmosphere. The manhole may contain flammable or poisonous gases or the atmosphere may be deficient in oxygen. Forced ventilation may be necessary.

- Traffic. Whenever manholes are located in the roadway, barricades and warning devices are essential to direct traffic away from an open manhole.

- Sharp Edges. Sharp edges of items in or near a manhole may cause cuts or bruises.

- Lifting Injuries. Unless proper tools are used to remove manhole covers, back injuries or injuries to hands or feet may result.

- Entry. Manholes and sewers are considered hazardous, confined spaces, monitoring personnel must obtain appropriate permits before entering manholes and be confined-space trained. Manholes will not be entered during sampling events.

7.1.1 Hazardous Atmospheres

When sampling is done near a manhole or in any unventilated area, dangerous gases may be encountered. These include not only the toxic gases (hydrogen sulfide, carbon

monoxide, hydrogen cyanide), but also explosive gases such as methane. Other gases, such as nitrogen and carbon dioxide, which are harmless under normal conditions, may build up in confined areas in quantities large enough to displace the oxygen necessary to support life. Some characteristics of common waste gases are listed in Table 10.

Table 10 – Characteristic of Common Sewer Gasses

Name	Vapor Density (air =1)	Odor	Explosive Limit (% by Vol)	Maximum Allowable Conc. (ppm)	Heath Hazard	Source/ Remarks
Carbon Dioxide	1.53	none	-	5000	Inhalation: acts on nervous system and respiratory tract	Sewer/sludge digestion
Carbon Monoxide	0.97	none	12.5 to 74	100	Inhalation: Poisonous and Explosive	Incomplete combustion of fuel
Chlorine	2.49	Choking	-	1	Inhalation or Contact: Irritates Respiratory Tract	Chlorine cylinders and feed lines
Gasoline	3 to 4	-	1.3 to 6	500	Inhalation: has anesthetic effect; highly flammable	Improperly discharged to sewers
Hydrogen	0.07	none	4 to 74	-	Causes oxygen deficiency; highly flammable	Sewer/sludge digestion
Hydrogen Sulfide	1.19	Rotten Egg	4.3 to 46	20	Inhalation; paralyzes respiratory tract, toxic	Sewer/sludge digestion
Methane	0.55	None	5 to 15	-	Inhalation; causes oxygen deficiency, highly flammable	Sewer/sludge digestion
Sludge Digestion	Varies	Virtually None	5.3 to 19.3	-	Will not support life, flammable	Sewer/sludge digestion

Sampling personnel will not enter manholes during the sampling events. Entering manholes may be required when installing automatic samplers and flowmeters at the start

of the project. All personnel entering manholes will be confined-space trained and obtain necessary permits before entering manholes.

Before entering a manhole, tests should be made for explosive atmosphere, presence of hydrogen sulfide, and oxygen deficiency. Since combustible or toxic vapors may be heavier than air, the tests on the atmosphere must be run at least 3/4 of the way down the manhole.

Whenever adverse atmosphere is encountered, the ventilating blower should be placed upwind to prevent igniting any gas emerging from the opening. When a gasoline engine blower is used, it must be located so that exhaust fumes cannot enter the manhole.

If testing equipment is not available, the manhole should be assumed to contain an unsafe atmosphere and forced ventilation must be provided. It should never be assumed that a manhole is safe just because there is no odor or because it has been entered previously.

7.1.2 Physical Hazards

At the sampling site there are always a number of physical conditions which may cause accidents. If the sample is taken from a manhole in a street or driveway, traffic control is an important consideration.

7.1.2.1 Traffic Protection

In addition to traffic cones, markers, warning signs, and barricades, a vehicle or a heavy piece of equipment should be placed between the working area and oncoming traffic. Flashing warning signals and a rotating safety light should be used to alert drivers and pedestrians. Orange safety vests should be worn by personnel stationed at the surface when the manhole is located in a vehicular traffic area.

7.1.2.2 Falling Objects

All loose items should be kept away from the manhole opening. This applies to hand tools as well as stones, gravel, and other objects.

7.1.2.3 Removing Manhole Covers

Manhole covers should be removed with a device specifically designed for removing manhole lids. Use of a pick ax, screwdriver, or small pry bar may result in injury. Even with appropriate tools, care must be exercised to prevent the cover from being dropped on the toes. Lifting should always be done with the knees, not the back, when opening a manhole.

7.1.3 Hazardous Waste Streams

Many industrial wastes may contain corrosive or toxic materials. Sampling personnel should always be aware of possible hazards which may be encountered and should take all necessary precautions to insure safety. Whenever possible, all skin contact with an

industrial waste stream should be avoided. Gloves, safety glasses, and long handled dippers should be provided when necessary.

7.1.4 Other Hazards

A wide variety of insects and rodents may inhabit manholes or sampling sites. Sampling personnel should always be on the lookout for these creatures to avoid painful and dangerous bites or stings. If presence of rodents or insects is suspected, it is advisable to carry spray type repellent.

Sampling personnel are always exposed to the possibility of infections. Good personnel hygiene is the best precaution to avoid this hazard. Open cuts or sores should never be allowed to come into contact with a waste stream.

7.2 Emergencies

Every member of the crew should be instructed on procedures to be followed in case of an emergency. Each crew chief should have a list of emergency phone numbers, including the nearest hospital and ambulance service, police precinct, fire station, and rescue or general emergency number.

7.3 Safety Equipment

Safety equipment in good working condition should always be available at the sampling site. The items listed in Table 11 are the minimum equipment for a sampling team consisting of two to three persons.

Table 11 – Minimum Safety Equipment per Sampling Crew*

Quantity	Item
1	Manhole hook or pick
100 ft.	Nylon rope, ½" dia.
3	Hard hats
3	Rubber boots
3	Safety glasses
3	Rain suits (High Visibility or with High-Visibility Vest)
3	Rubber gloves
3	Flashlight, explosion proof
1	First aid kit
12	Safety cones, 18" high
2	"Workers Ahead" signs
1	Safety "Flasher" light (compatible with standard car outlets)

*Additional safety equipment will be required during meter installation, when manhole entry is involved.

7.4 Rescue Operations and First Aid

Plans for rescue operations should always be made in advance on the assumption that they will be needed at some time. Rescue operations can be complicated when the victim of an accident at a sampling site is underground and in a confined area. The situation which caused the accident, for example dangerous gases, may still be present.

Members of sampling crews should be taught first aid methods and at least one person in any sampling group should remain in a safe location during the course of the work. Included in first aid training should be procedures for resuscitation. Every member of every sampling team should know at least the basics of first aid.

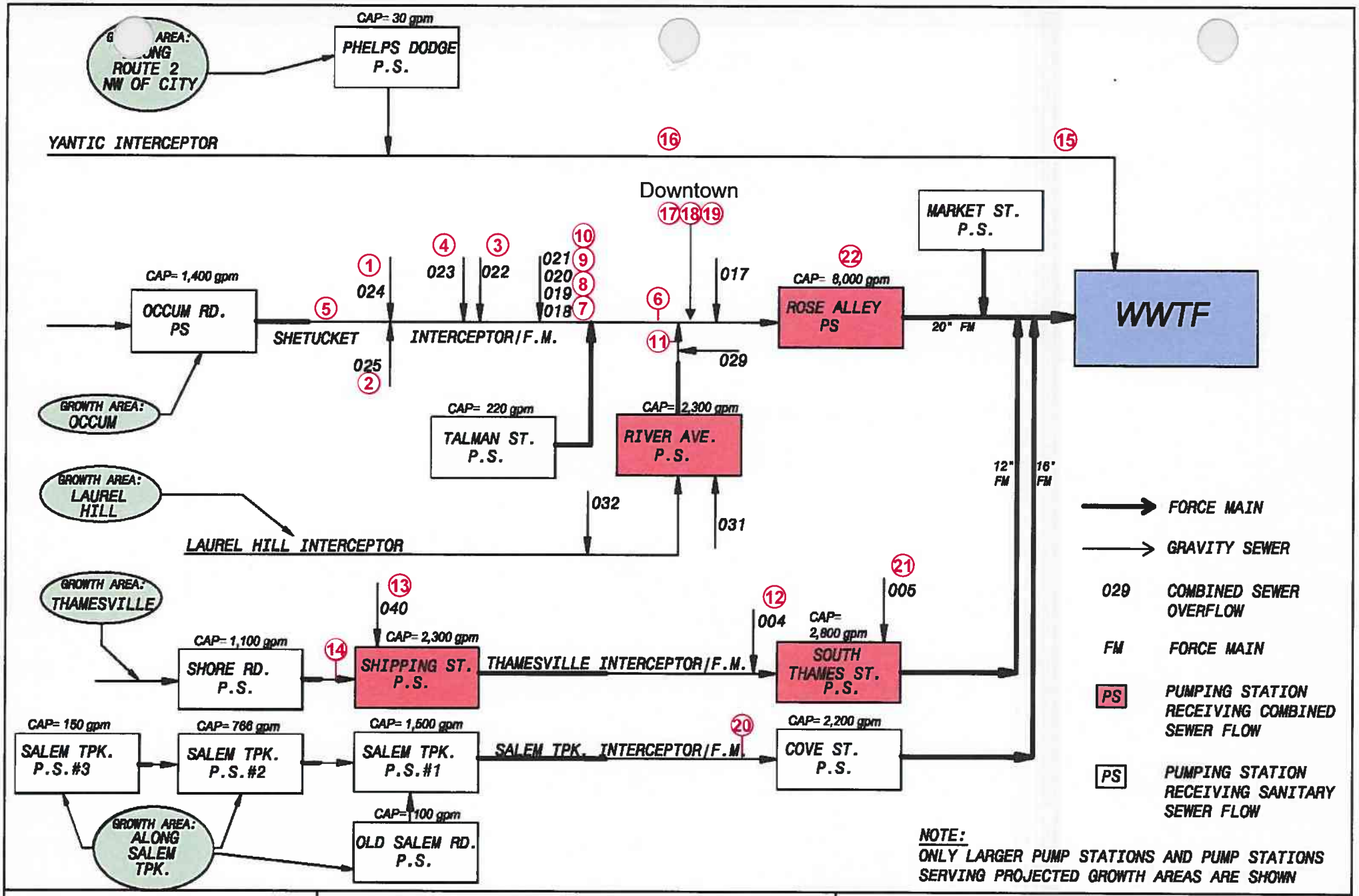
7.5 Accident Reports

Reports should be filled out on all accidents regardless of the extent of the injuries sustained. In this way conditions which cause repeated injuries may be isolated and corrected.

APPENDIX A

Collection System Schematic Showing Flow Monitoring Locations

Flow Monitoring, Sampling and Rain Gage Locations



Appendix A

NORWICH PUBLIC UTILITIES
NORWICH, CT PHASE 2 LONGTERM CSO CONTROL PLAN

NORWICH WASTEWATER
COLLECTION SYSTEM SCHEMATIC

① Flow Meter Locations

BLACK & VEATCH
building a world of difference™

CSS 16
Rain Gage 1
SW 1
SW 2
CSS 15
CSS WWTP1
CSS WWTP2
CSS 20
CSS 18
CSS 19
CSS 17
Rose Alley PS
CSS 21
CSS 11
CSS 6
29
CSS 10
CSS 8
CSS 7
CSS 9
18
19
20
0
21
Talman St PS
CSS 4
CSS 3
23
Rain Gage 2
CSS 5
24
CSS 1
25
CSS 2
0
South Thames St PS
5
CSS 21
4
CSS 12
River Ave PS
31
32
Rain Gage 3
Shipping St PS
CSS 13
CSS 14
40
0 500 1,000 2,000 Feet

Sampling Sites Only (Stormwater)
Flow Monitoring Only
Flow Monitoring and Sampling
Pump Stations
CSO
Force Mains

Sprague
Franklin
Lisbon
Bozrah
Norwich
Preston

Flow Monitoring & Sampling Locations

N
W E

BLACK & VEATCH
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RG 1
RG 3
RG 2
Talman St PS
Rose Alley PS
South Thames St PS
River Ave PS
Shipping St PS
18
19
21
22
23
24
25
29
31
32
40
Rain Gages
CSO
Pump Stations
Force Mains
Gravity Sewers
0 500 1,000 2,000 3,000
Feet
Norwich Public Utilities
SINCE 1904
Sprague
Franklin
Lisbon
Bozrah
Norwich
Preston
N
W
E
S
Rain Gage Locations
BLACK & VEATCH

APPENDIX B

Field Sketches of Flow Monitoring Locations

Flow Monitoring, Sampling and Rain Gage Locations

PGN-172B

DO NOT WRITE IN THIS SPACE

BLACK & VEATCH

Owner NORWICH, CT DPU

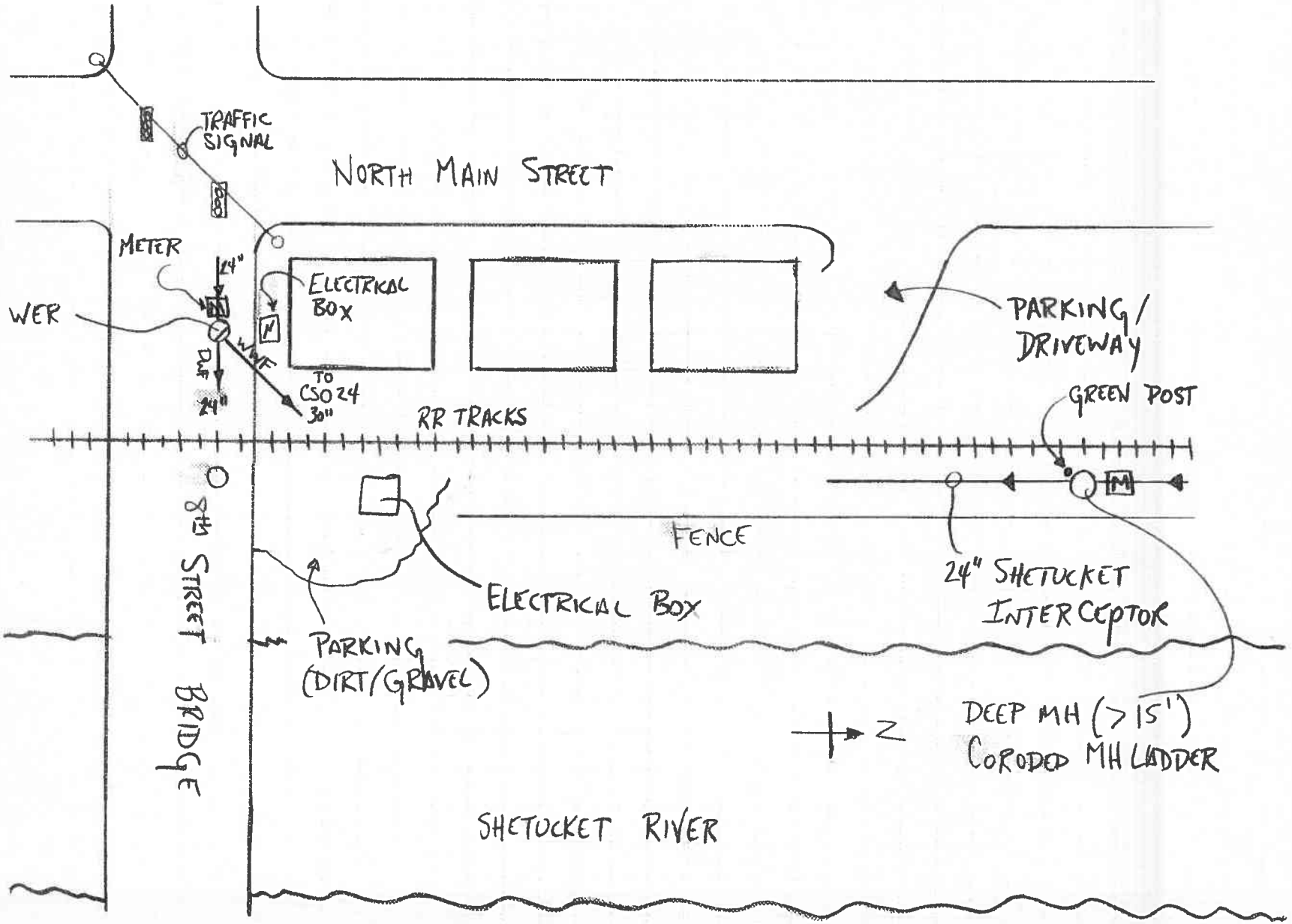
Plant _____ Unit _____ Computed By BSJ

Project No. 147615 File No. _____ Date 11/30 20 07

Title SITE #1 + SITE #5 Verified By _____

FLOW METER SITE INVESTIGATION Date _____ 20 _____

Page _____ of _____



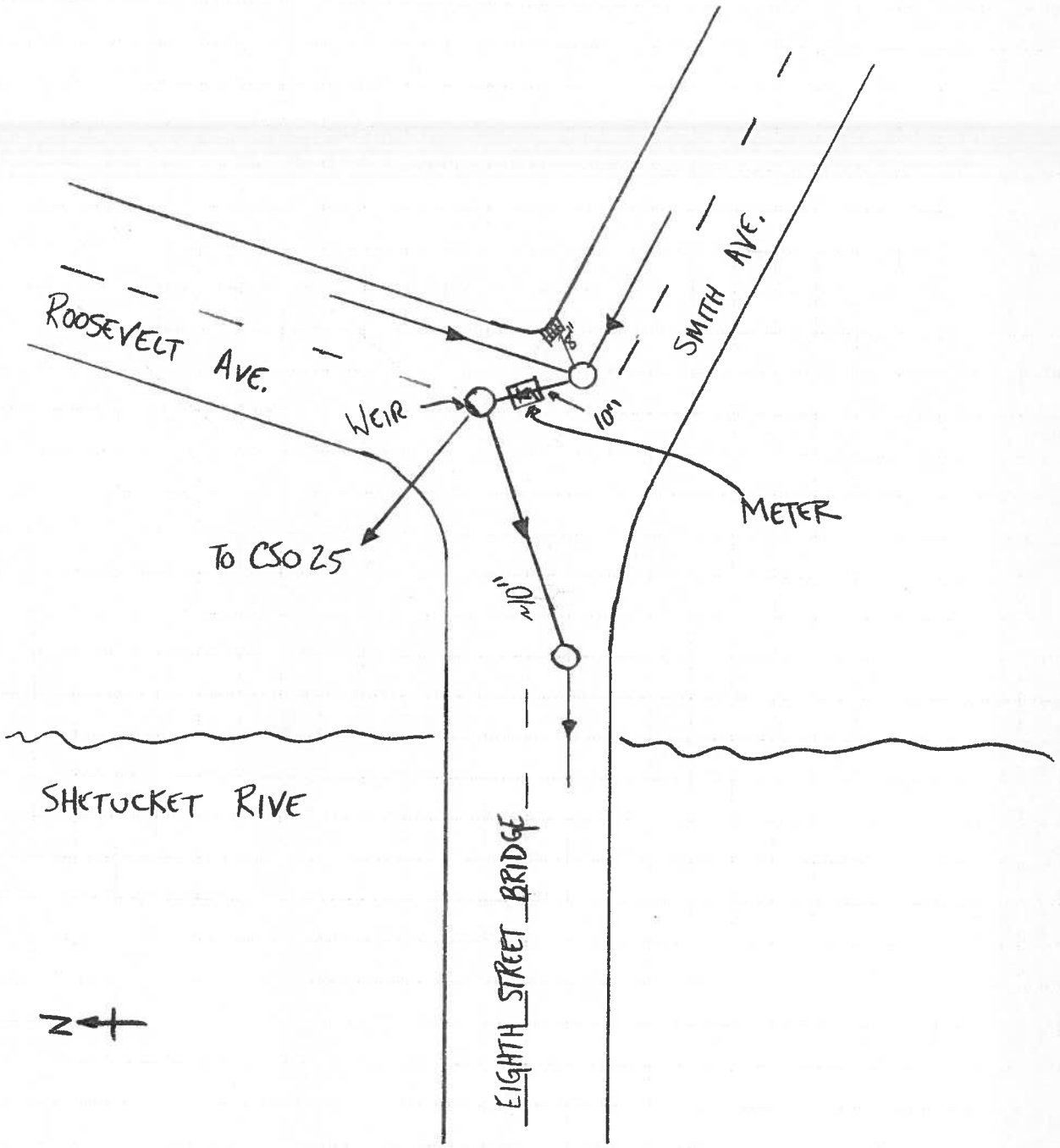
NOT TO SCALE (2 METERS SHOWN)

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

BLACK & VEATCH

Owner DPU NORWICH, CT
Plant _____ Unit _____
Project No. 147615 File No. _____
Title SITE #2
FLOW METER SITE INVESTIGATION

Computed By BST
Date 11/30 20 07
Verified By _____
Date _____ 20 _____
Page _____ of _____



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REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

BLACK & VEATCH

Owner DPU NORWICH, CT
Plant _____ Unit _____
Project No. 147615 File No. _____
Title SITE #3
FLOW METER SITE INVESTIGATION

Computed By BSJ
Date 11/30 20 07
Verified By _____
Date _____ 20 _____
Page _____ of _____

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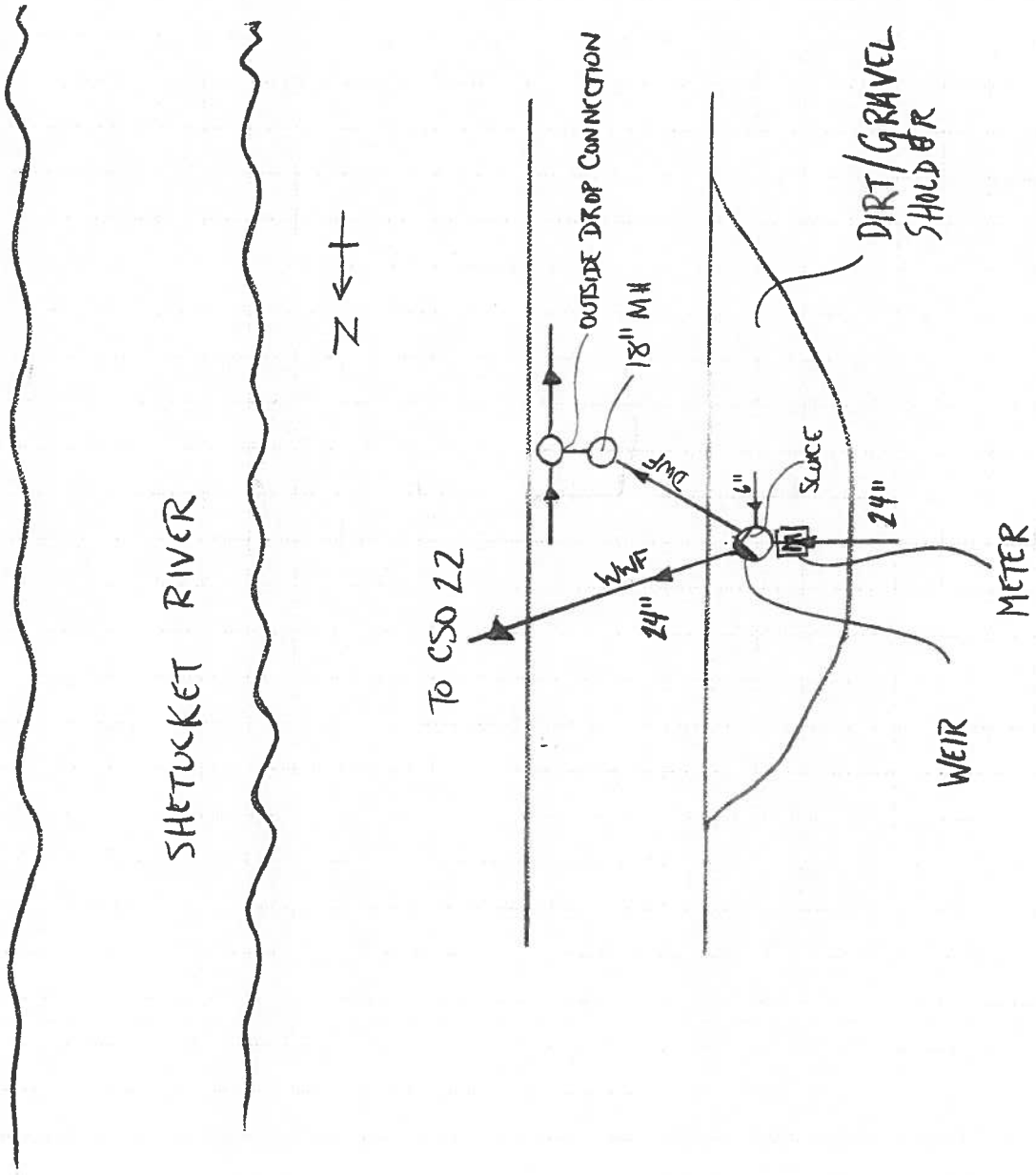

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BLACK & VEATCH

Owner DPU NORWICH, CT
Plant _____ Unit _____
Project No. 147615 File No. _____
Title SITE #4
FLOW METER SITE INVESTIGATION

Computed By BSJ
Date 11/30 20 07
Verified By _____
Date _____ 20 ____
Page _____ of _____

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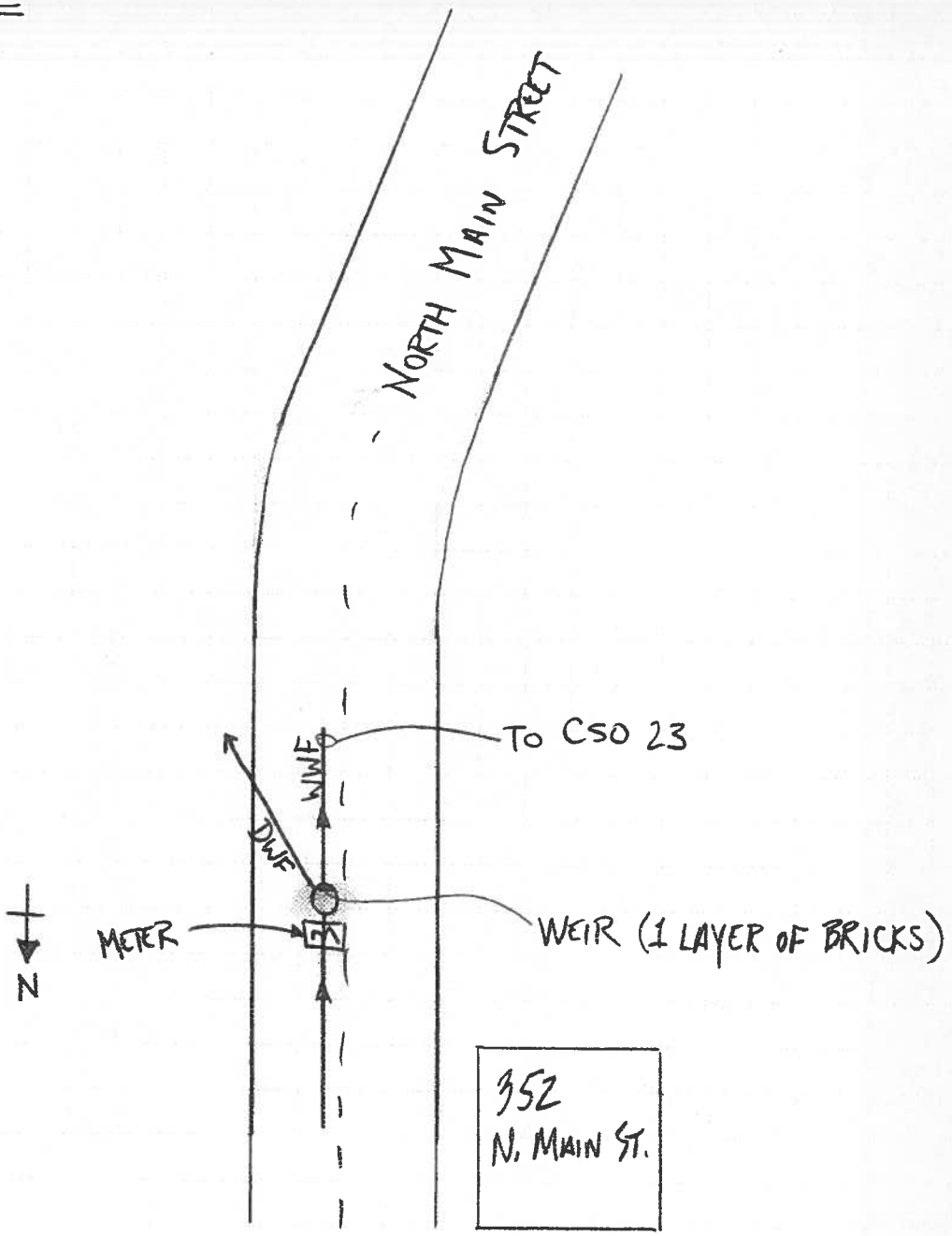
CSO 23



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Owner NPU Norwich, CT

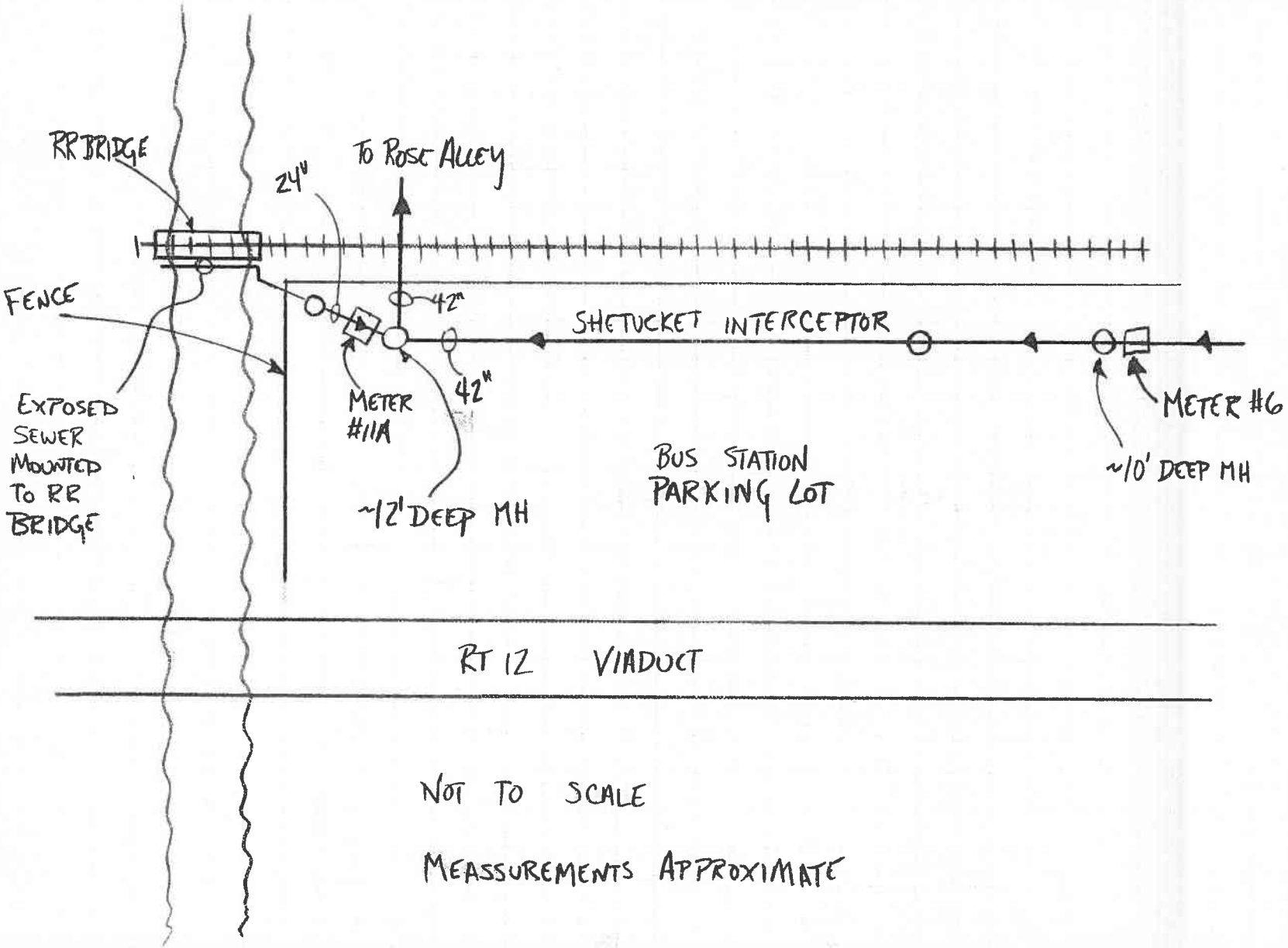
Plant _____ Unit _____ Computed By BSJ

Project No. 14765 File No. _____ Date 11/30 20 07

Title Site #6 and Site #11A Verified By _____

Flow Meter Site Investigation Date _____ 20 ____

Page _____ of _____



NOT TO SCALE

MEASSUREMENTS APPROXIMATE

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

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Owner DPU NORWICH, CT — Computed By BSJ

Plant — Unit — Date 11/30 20 07

Project No. 147615 — File No. — Verified By

Title SITE #7 — Date — 20

FLOW METER SITE INVESTIGATION — Page — of

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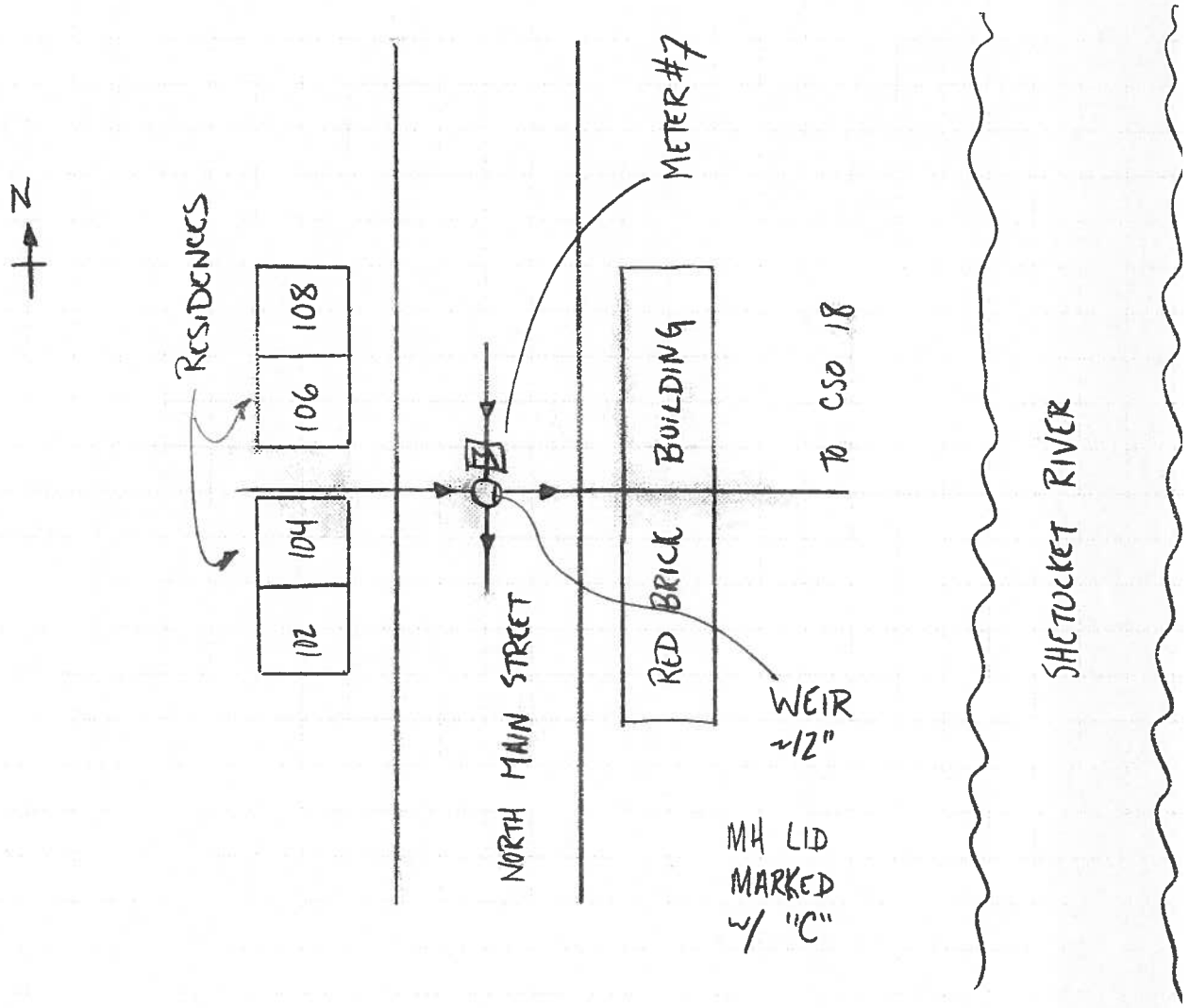

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DO NOT WRITE IN THIS SPACE

BLACK & VEATCH

Owner DPU Norwich, CT

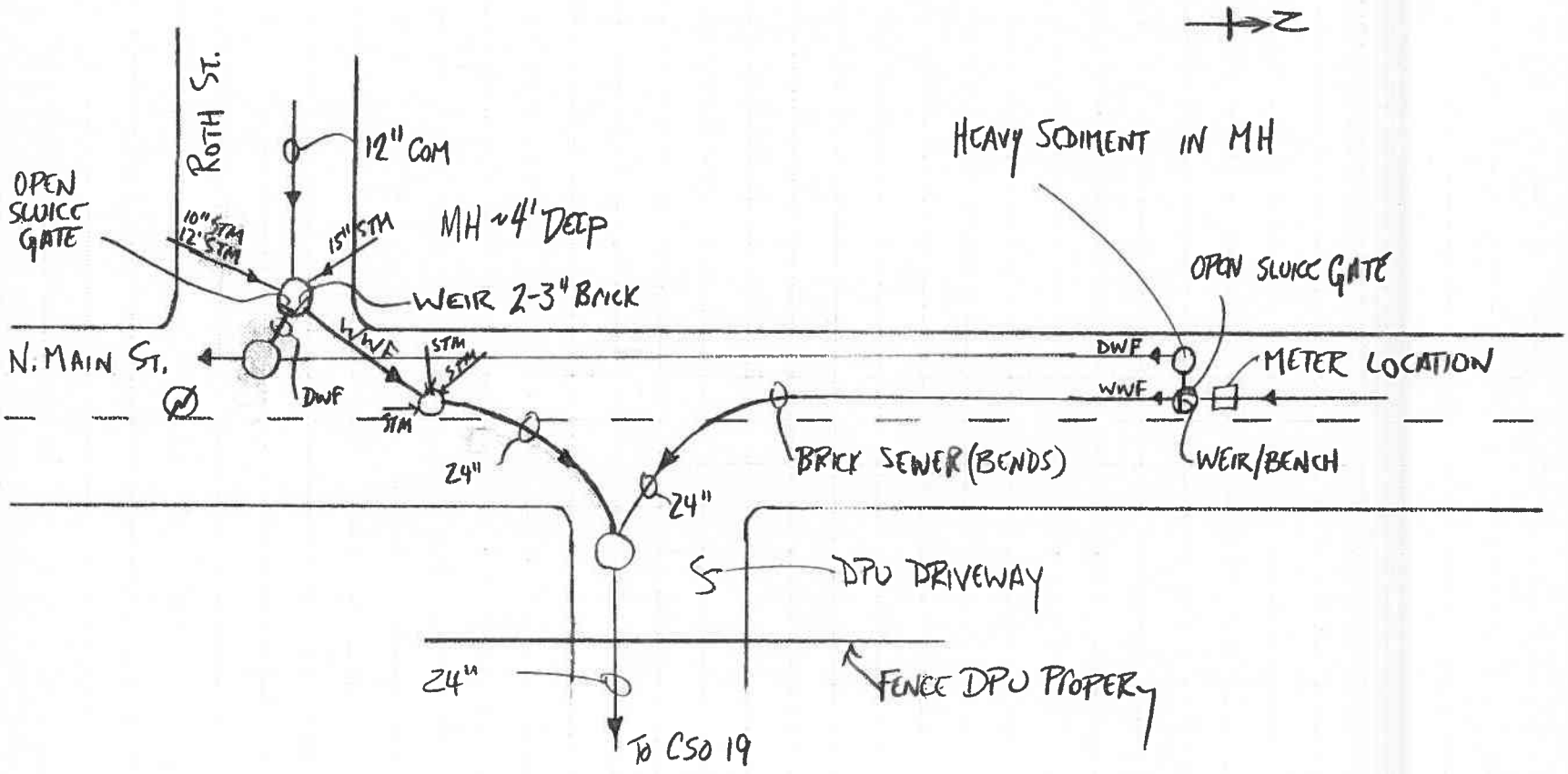
Plant _____ Unit _____ Computed By BSJ

Project No. 147615 File No. _____ Date 11/30 20 07

Title Site #8 Verified By _____

Flow Meter Site Investigation Date _____ 20 ___

Page _____ of _____



DWF - Dry Weather Flow
WWF - Wet Weather Flow
Com - Combined
STM - Storm

NOT TO SCALE

ALL MEASUREMENTS APPROXIMATE

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

BLACK & VEATCH

Owner PPU NORWICH, CT — Computed By BSJ

Plant ____ Unit ____ — Date 11/30 20 07

Project No. 147615 File No. ____ — Verified By ____

Title SITE #9 — Date ____ 20 ____

FLOW METER SITE INVESTIGATION — Page ____ of ____

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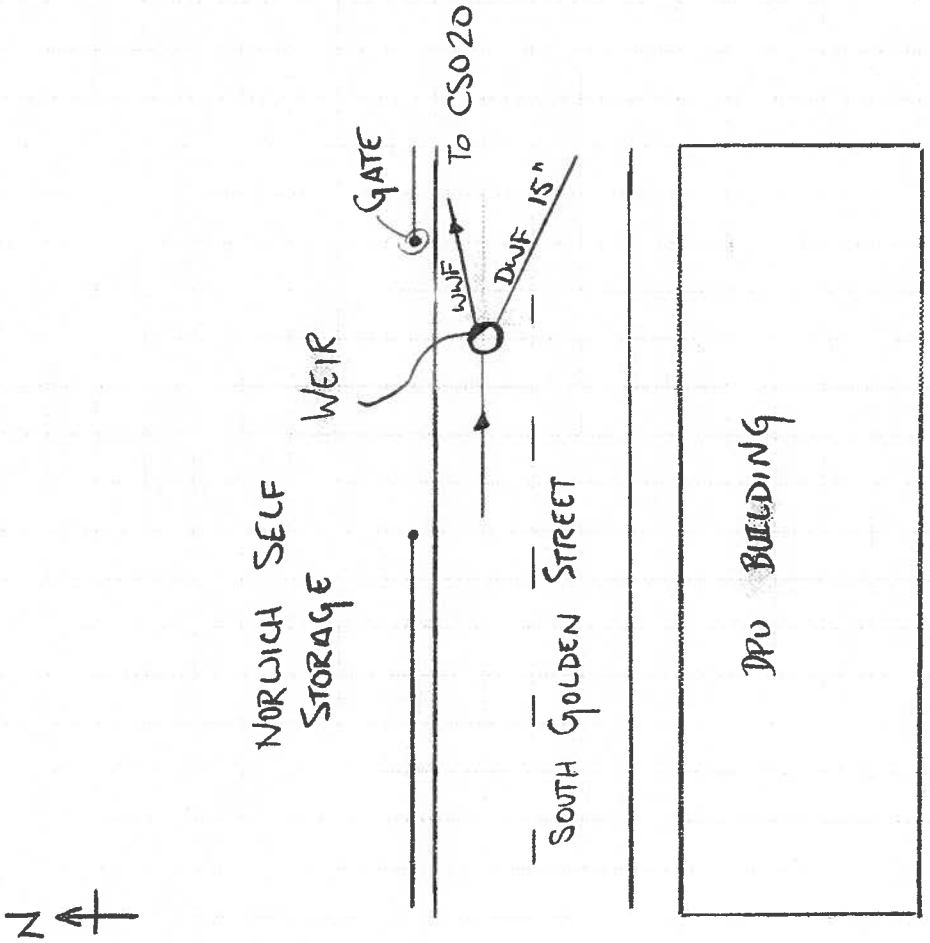
PGN-172B

CSO 20



- LINE IS TOTALLY DRY - NO SUITABLE FOR FLOW METERING
- CSO MAY NOT BE ACTIVE ANYMORE OR MAY BE STORM ONLY - FURTHER INVESTIGATION REQUIRED

NOT TO SCALE

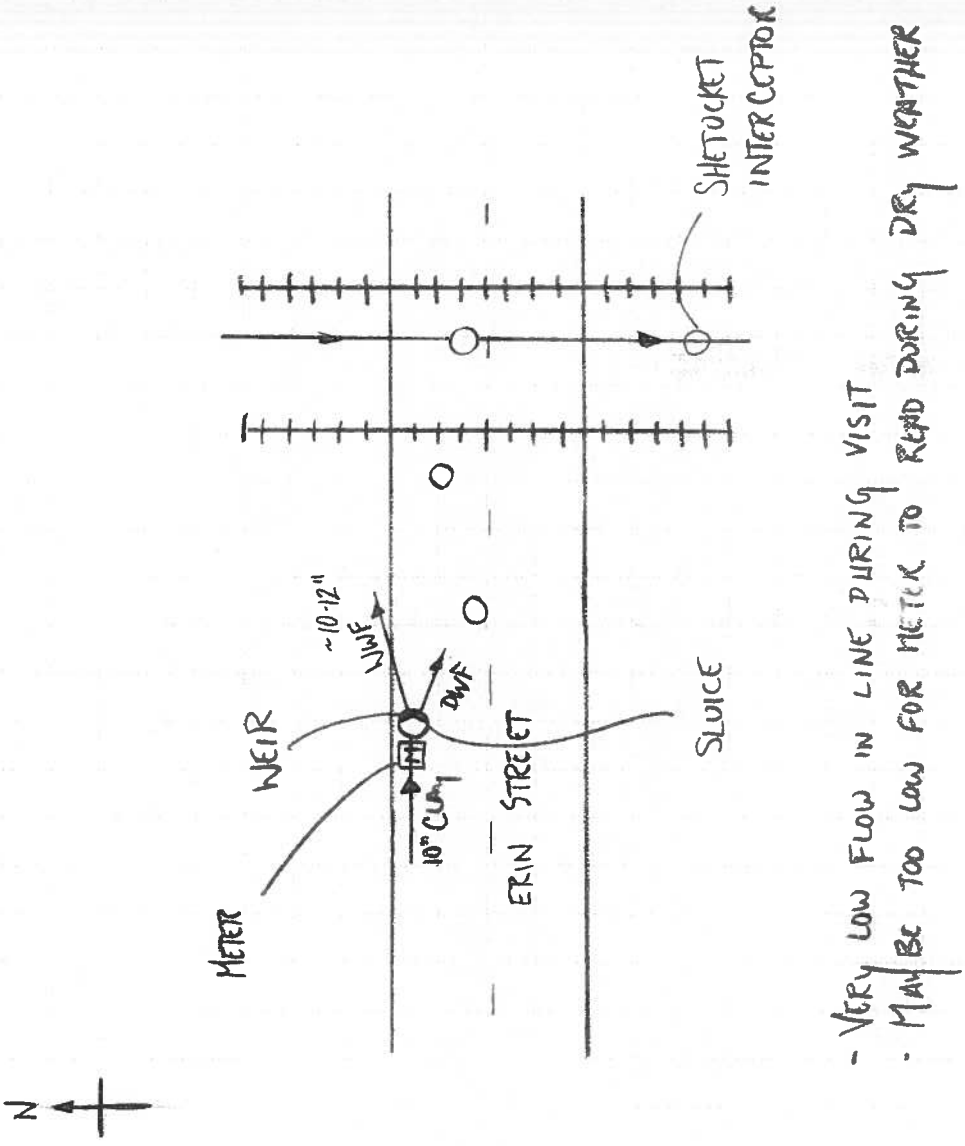
REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

BLACK & VEATCH

Owner DPU NORWICH, CT
Plant _____ Unit _____
Project No. 147615 File No. _____
Title SITE #10
FLOW METER SITE INVESTIGATION

Computed By BSJ
Date 11/30 20 07
Verified By _____
Date _____ 20 _____
Page _____ of _____

CSO 21 -



- VERY LOW FLOW IN LINE DURING VISIT
- MAY BE TOO LOW FOR METER TO READ DURING DRY WEATHER

DO NOT WRITE IN THIS SPACE

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REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED AND DATED BY THE RESPONSIBLE INDIVIDUAL.

PGN-172B

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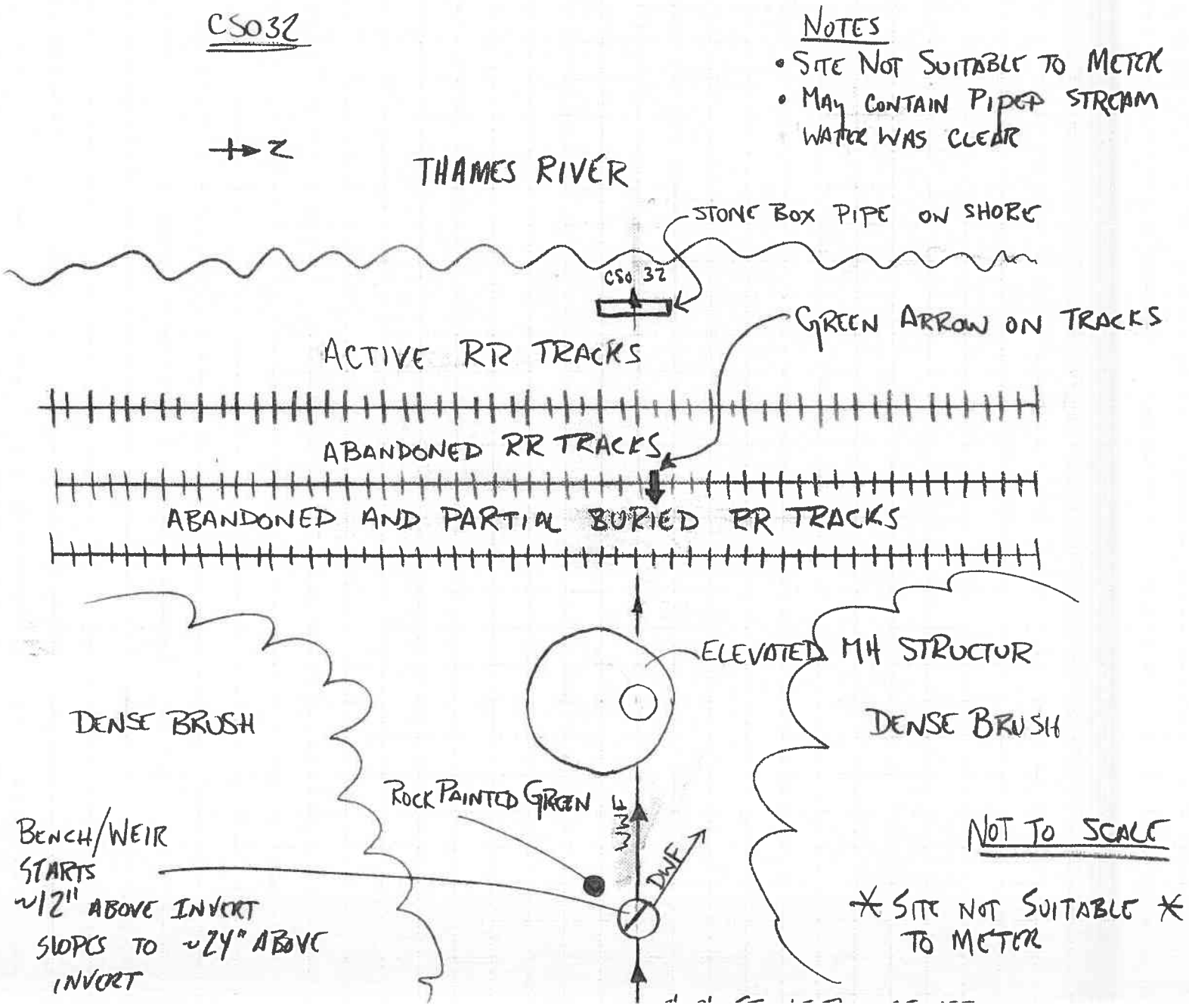
CS032

NOTES
- SITE NOT SUITABLE TO METER
- MAY CONTAIN PIPE STREAM WATER WAS CLEAR



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Owner DPU NORWICH, CT
Plant ____ Unit ____ Computed By BSJ
Project No. 147615 File No. ____ Date 11/30 20 17
Title SITE #11 Verified By ____
FLOW METER SITE INVESTIGATION Date ____ 20 ____
Page ____ of ____

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Owner DPU NORWICH, CT
Plant _____ Unit _____
Project No. 147615 File No. _____
Title SITE #12
FLOW METER SITE INVESTIGATION

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Date 11/30 2007
Verified By _____
Date _____ 20 _____
Page _____ of _____

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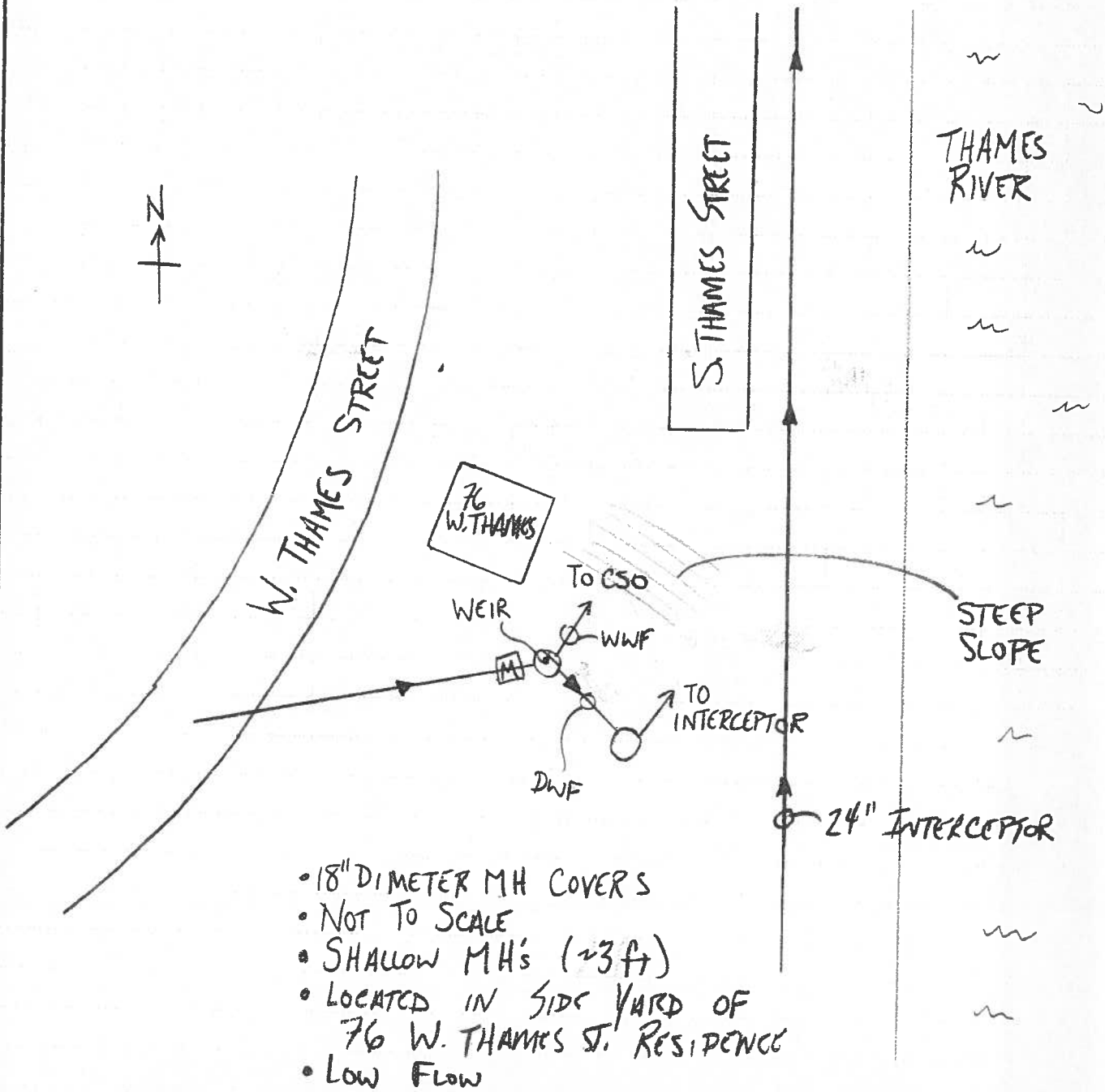
CSO 4



- 18" DIMETER MH COVERS
- NOT TO SCALE
- SHALLOW MH's (~3 ft)
- LOCATED IN SIDE YARD OF 76 W. THAMES ST. RESIDENCE
- LOW FLOW

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

PGN–172B

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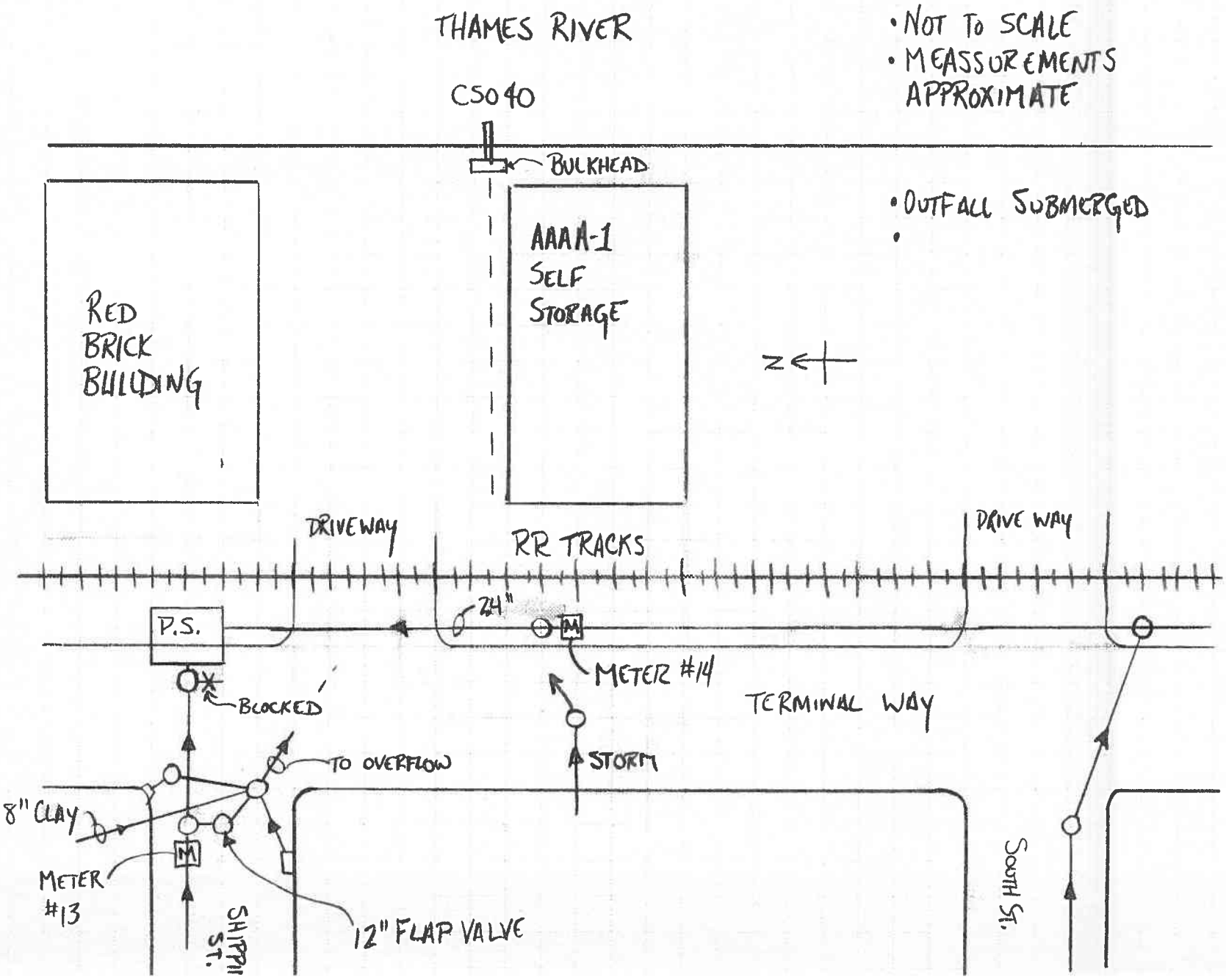
Owner DPU Norwich, CT Computed By BST

Plant _____ Unit _____ Date 11/30 20 07

Project No. 147615 File No. _____ Verified By _____

Title SITE #13 AND SITE 14 Date _____ 20 ____

FLOW METER SITE INVESTIGATION Page _____ of _____



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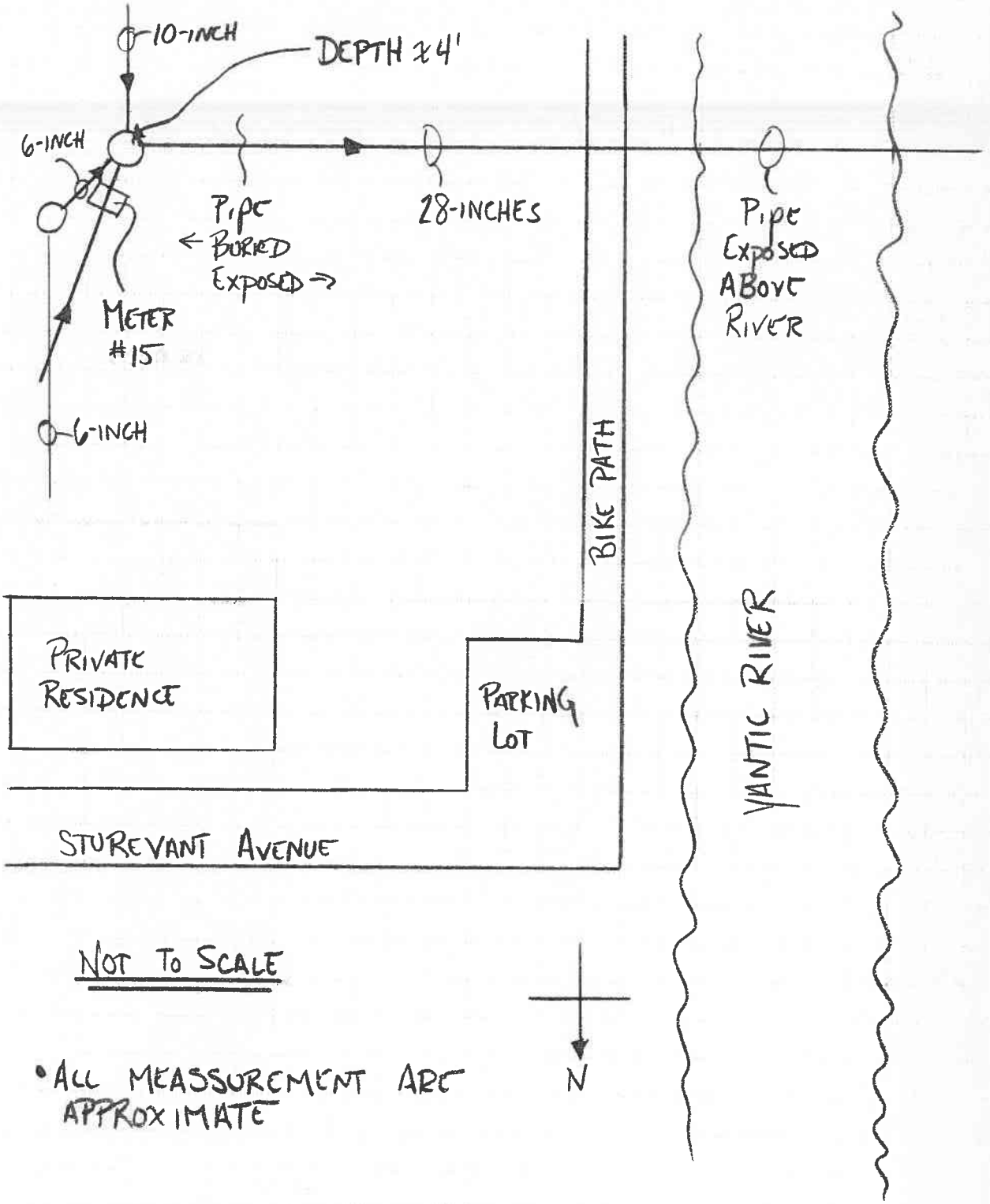
Owner DPU NORWICH, CT
Plant _____ Unit _____
Project No. 147615 File No. _____
Title SITE #15
FLOW METER SITE INVESTIGATION

Computed By BSJ
Date 11/30 20 07
Verified By _____
Date _____ 20 _____
Page _____ of _____



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Owner DPU NORWICH, CT
Plant ____ Unit ____
Project No. 147615 File No. ____
Title SITE #15A
FLOW METER SITE INVESTIGATION

Computed By BSJ
Date 11/30 20 07
Verified By ____
Date ____ 20 ____
Page ____ of ____

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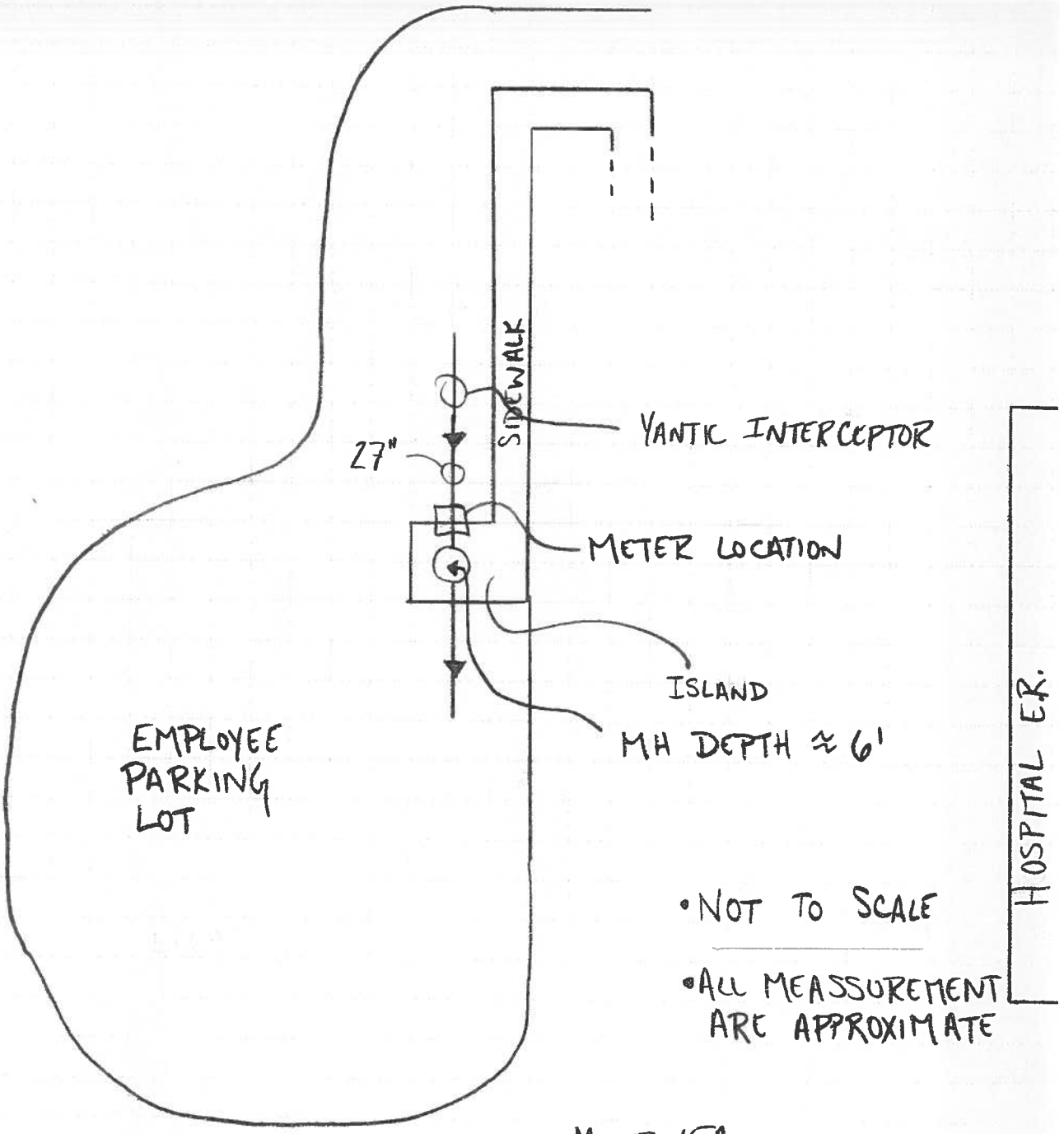

- NOT TO SCALE
- ALL MEASSUREMENT ARE APPROXIMATE

METER 15A

PGN-172B

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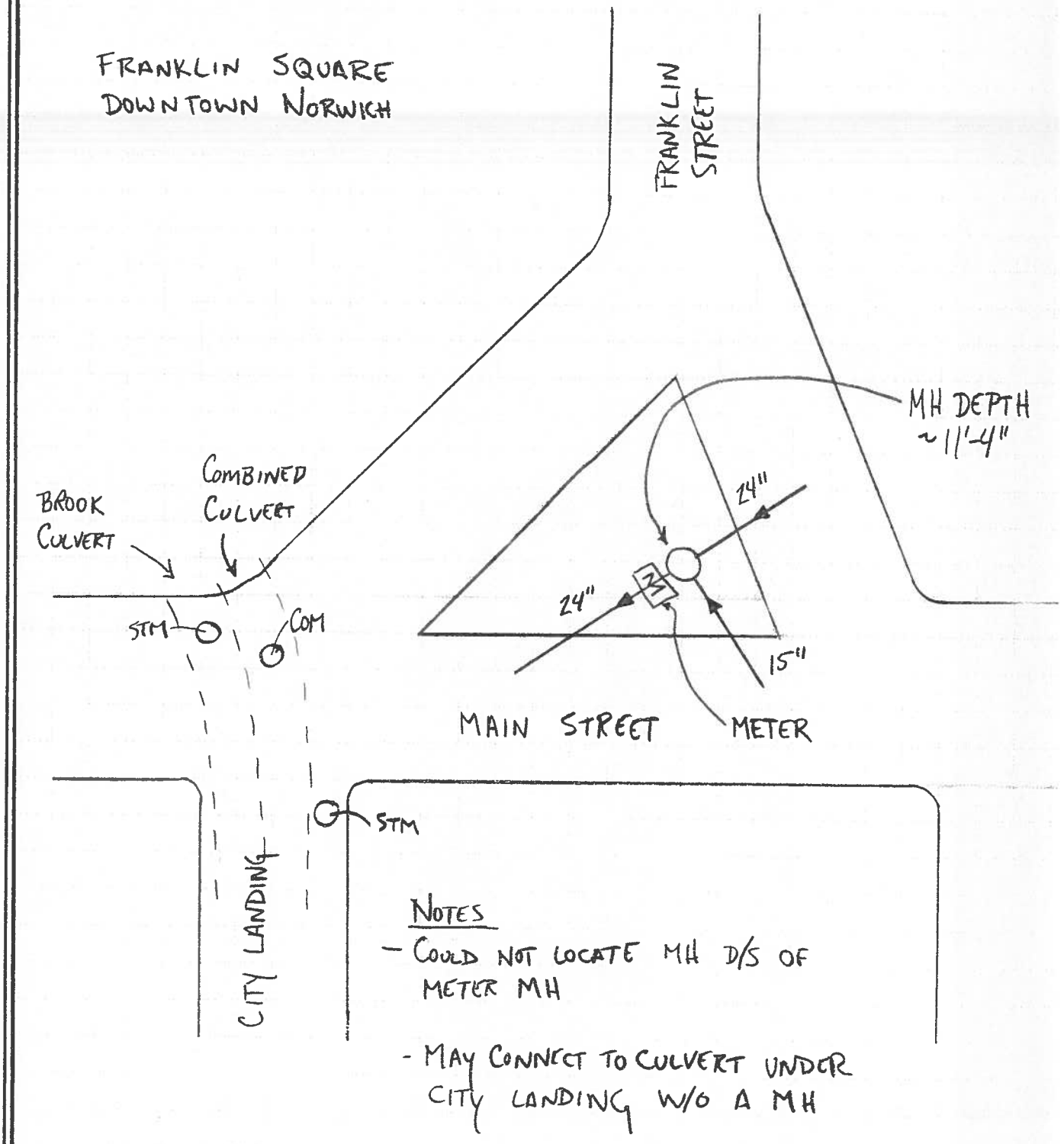
Owner DPU NORWICH, CT — Computed By BSJ

Plant — Unit — Date 11/30 20 07

Project No. 147615 — File No. — Verified By

Title SITE # 16 — Date — 20

FLOW METER SITE INVESTIGATION — Page — of



NOTES

- COULD NOT LOCATE MH D/S OF METER MH
- MAY CONNECT TO CULVERT UNDER CITY LANDING W/O A MH

DO NOT WRITE IN THIS SPACE

PGN-172B

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

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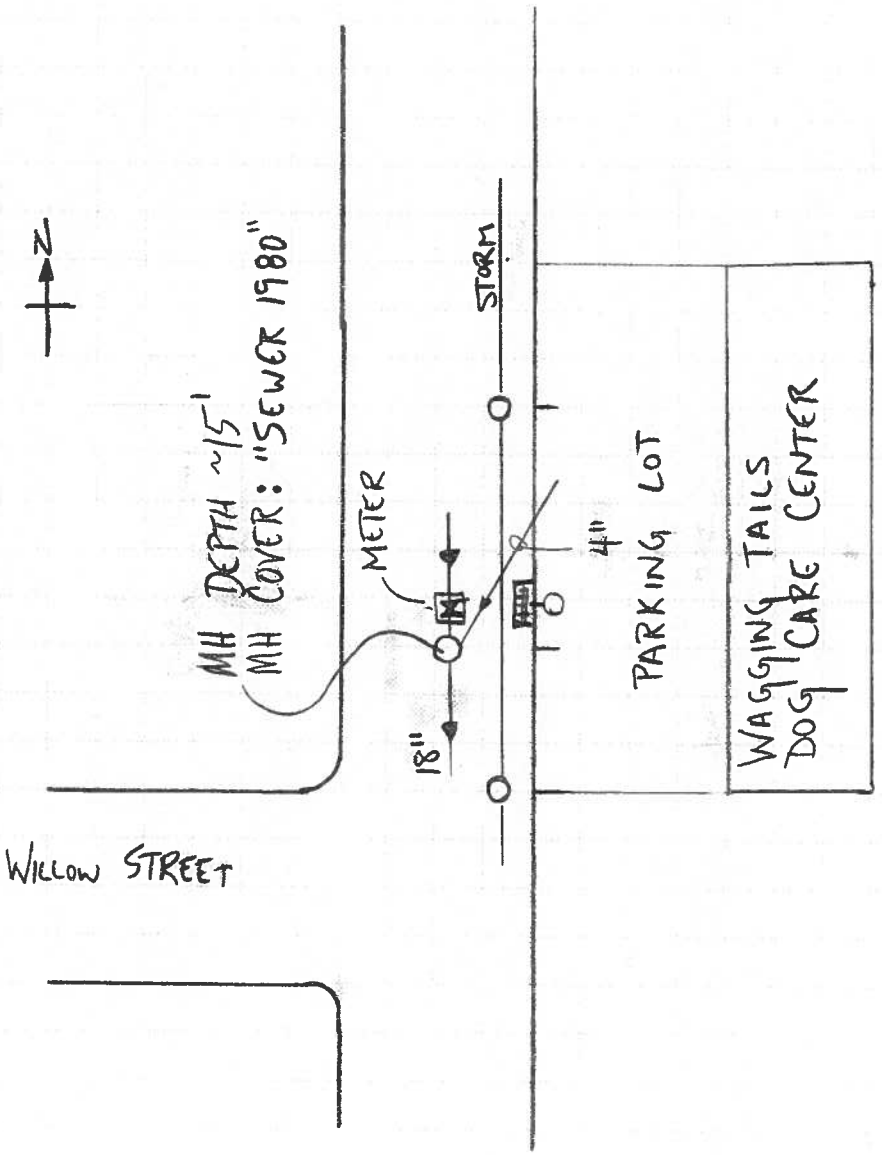
Owner DPU NORWICH, CT
Plant _____ Unit _____
Project No. 147615 File No. _____
Title SITE #17
FLOW METER SITE INVESTIGATION

Computed By BSJ
Date 11/30 20 07
Verified By _____
Date _____ 20 _____
Page _____ of _____



DO NOT WRITE IN THIS SPACE

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PGN–172B

DO NOT WRITE IN THIS SPACE

BLACK & VEATCH

Owner DPU NORWICH, CT

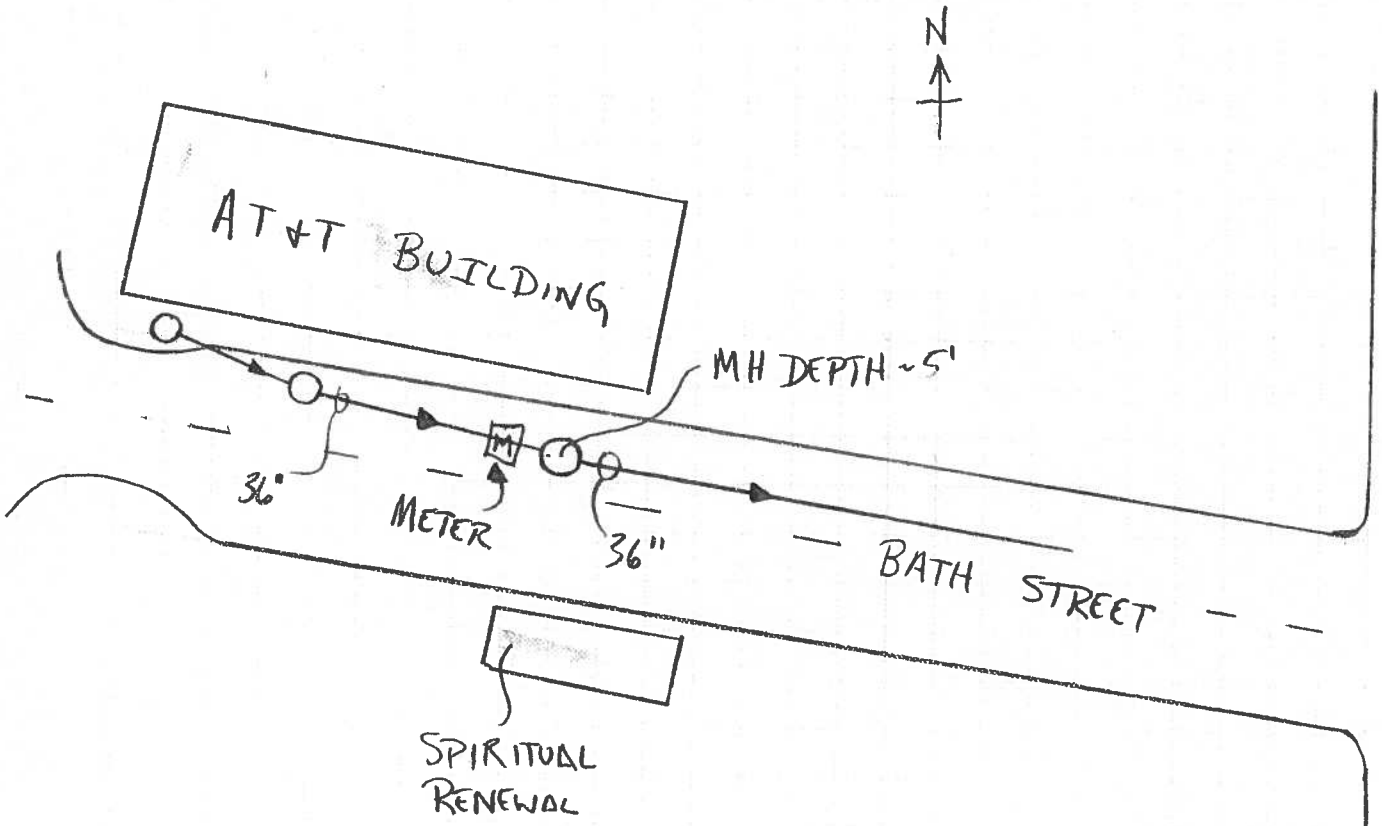
Plant _____ Unit _____ Computed By BSJ

Project No. 147615 File No. _____ Date 11/30 20 07

Title SITE # 19 Verified By _____

FLOW METER SITE INVESTIGATION Date _____ 20 _____

Page _____ of _____



NOTES

- METER CAPTURES FLOW FROM BROADWAY AND UNION STREETS
- MH IS ACCROSS FROM SPIRITUAL RENUAL
- MH IS ON A PARKING SPOT - MAY NEED "NO PARKING" SIGN ON THIS SPACE

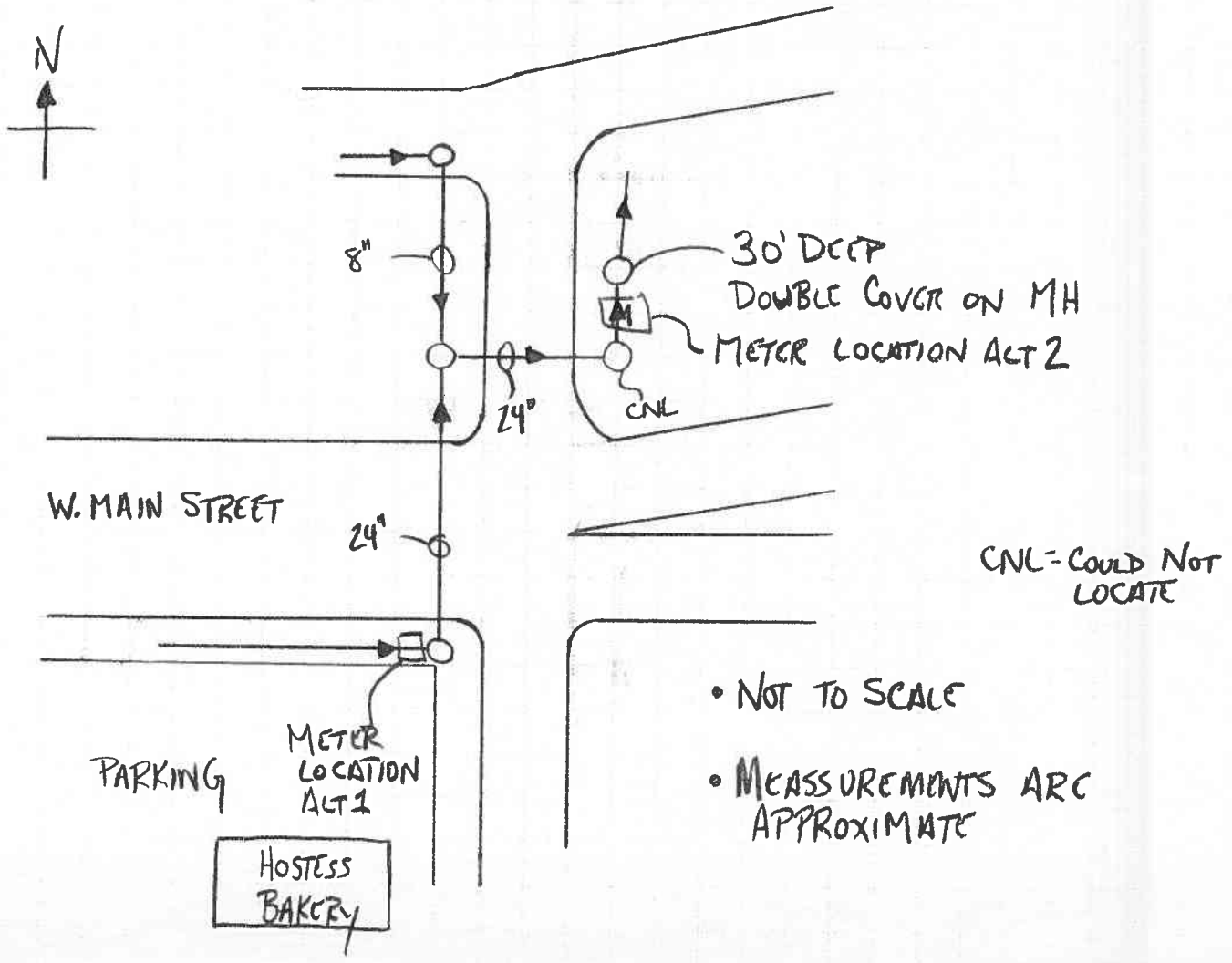
REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

PGN–172B

DO NOT WRITE IN THIS SPACE

ALT1 - EASY ACCESS, SHALLOW MH, TURBULANT FLOW @ BEND IN LINE NOT AS GOOD for METER

ALT2 - DIFFICULT ACCESS, DEEP MH, STRAIGHT POINT IN LINE, BETTER FOR METER



BLACK & VEATCH

Owner DPU NORWICH, CT

Plant ____ Unit ____ Computed By BST

Project No. 147615 File No. ____ Date 11/30 20 07

Title SITE # 20 Verified By ____

FLOW METER SITE INVESTIGATION Date ____ 20 ____

Page ____ of ____

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

BLACK & VEATCH

Owner DPU NORWICH, CT — Computed By BSJ

Plant _____ Unit _____ — Date 11/30 20 07

Project No. 147615 File No. _____ — Verified By _____

Title SITE #21 — Date _____ 20 _____

FLOW METER SITE INVESTIGATION — Page _____ of _____

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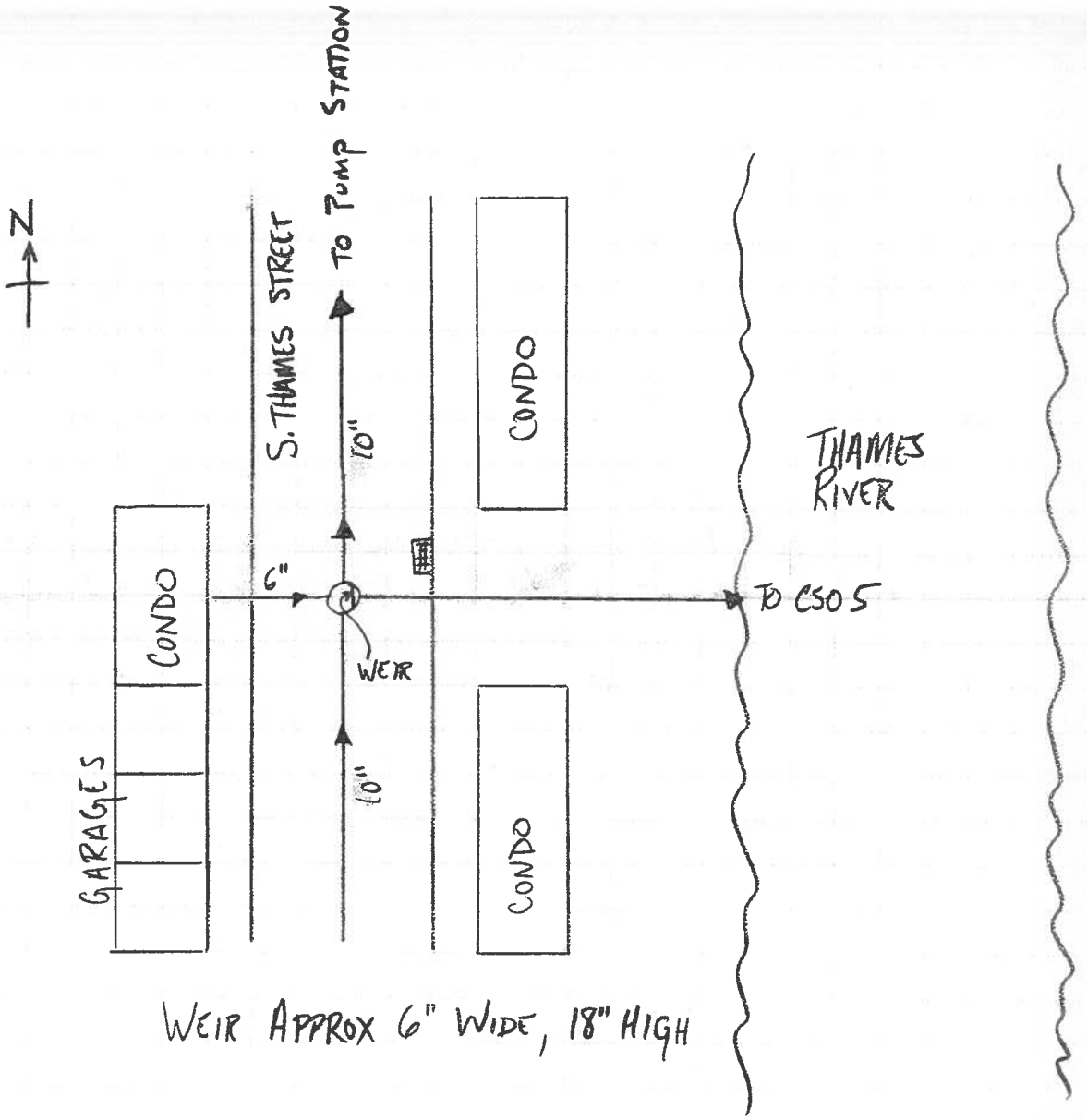
PGN-172B

CSO 5



WEIR APPROX 6" WIDE, 18" HIGH

- CSO #5 MAY ACT AS RELIEF TO D/S PUMP STATION

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

10/1/2010

Appendix C

Update to Task 5 Collection System Monitoring and Sampling Plan, to Reflect Changes Made to Plan during the 2008 Field Monitoring Program

The following modifications were made during the actual field monitoring program in 2008 based on conditions found in the field, versus what was proposed in the program proposed in the original Task 5 Monitoring and Sampling Plan.

1. Section 2: The CSS 3 flowmeter was relocated upstream one manhole on 4/15/2008 due to turbulence at the originally selected site.

2. Section 2: The CSS 9 flowmeter was installed to monitor CSO-20, at South Golden Street. During monitoring program it was confirmed that this CSO is no longer active, and it was subsequently plugged by NPU staff.

3. Section 2: The CSS 11 flowmeter was relocated to the next manhole downstream on 4/1/2008, and was again relocated to the nearby 42-inch line on 4/15/2008, due to unsteady flow conditions.

4. Section 2: A portable flowmeter was installed upstream of the Cipoletti weir at CSO-17, upstream of the Rose Alley Pump Station, on 4/29/2008 due to failure of NPU's permanent flowmeter at that site.

5. Chapter 3: During the collection system and river monitoring program, the following rain gages were used:

    a. Norwich DPW rain gage, located on the roof of the DPW Building at 50 Clinton Avenue
    b. Temporary rain gage provided by Savin Engineers, located at the Shore Road Pump Station
    c. NPU rain gage, located at the Rose Alley Pump Station
    d. NPU rain gage located on the roof of the NPU offices at South Golden Street

6. Appendix A: Capacity of the Phelps Dodge Pump Station to revised to 250 gpm.

7. Appendix B: At meter location No. 2, pipe diameter from weir to 8th Street MH is revised to 12 inches.

APPENDIX 2-D

CITY OF NORWICH, CONNECTICUT
DEPARTMENT OF PUBLIC UTILITIES

Phase II CSO Long Term Control Plan

Technical Memorandum

Task 6
Receiving Waters Monitoring and Sampling Plan

October 2008

Prepared by:

BLACK & VEATCH
building a world of difference™

CITY OF NORWICH, CONNECTICUT

PHASE II CSO LONG TERM CONTROL PLAN
TASK 6 – RECEIVING WATERS MONITORING AND SAMPLING PLAN

Title and Approval Page (A1)

Document Title:	Quality Assurance Project Plan for Norwich, CT Phase 2 CSO Long Term Control Plan, Task 6 - Receiving Waters Monitoring and Sampling Plan
Lead Organization:	Black & Veatch Corp.
Preparer's Name:	Mario Francucci, PE
Preparation Data:	February 4, 2008; revised October 16, 20008

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Engineering Manager: Charles Pike, PE Signature / Date

CLA Engineers _____
Field Sampling Subconsultant: Robert Deluca, PE Signature / Date

Kleinschmidt Associates _____
Field Sampling Subconsultant: Chris Tomichek Signature / Date

Phoenix Environmental Laboratories _____
Lab Analysis Subconsultant: Bobbi Aloisa Signature / Date

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CITY OF NORWICH, CONNECTICUT

PHASE II CSO LONG TERM CONTROL PLAN
TASK 6 – RECEIVING WATERS MONITORING AND SAMPLING PLAN

Distribution List (A3)

The individuals listed below will receive copies of the approved Quality Assurance Program Plan (QAPP) and subsequent revisions:

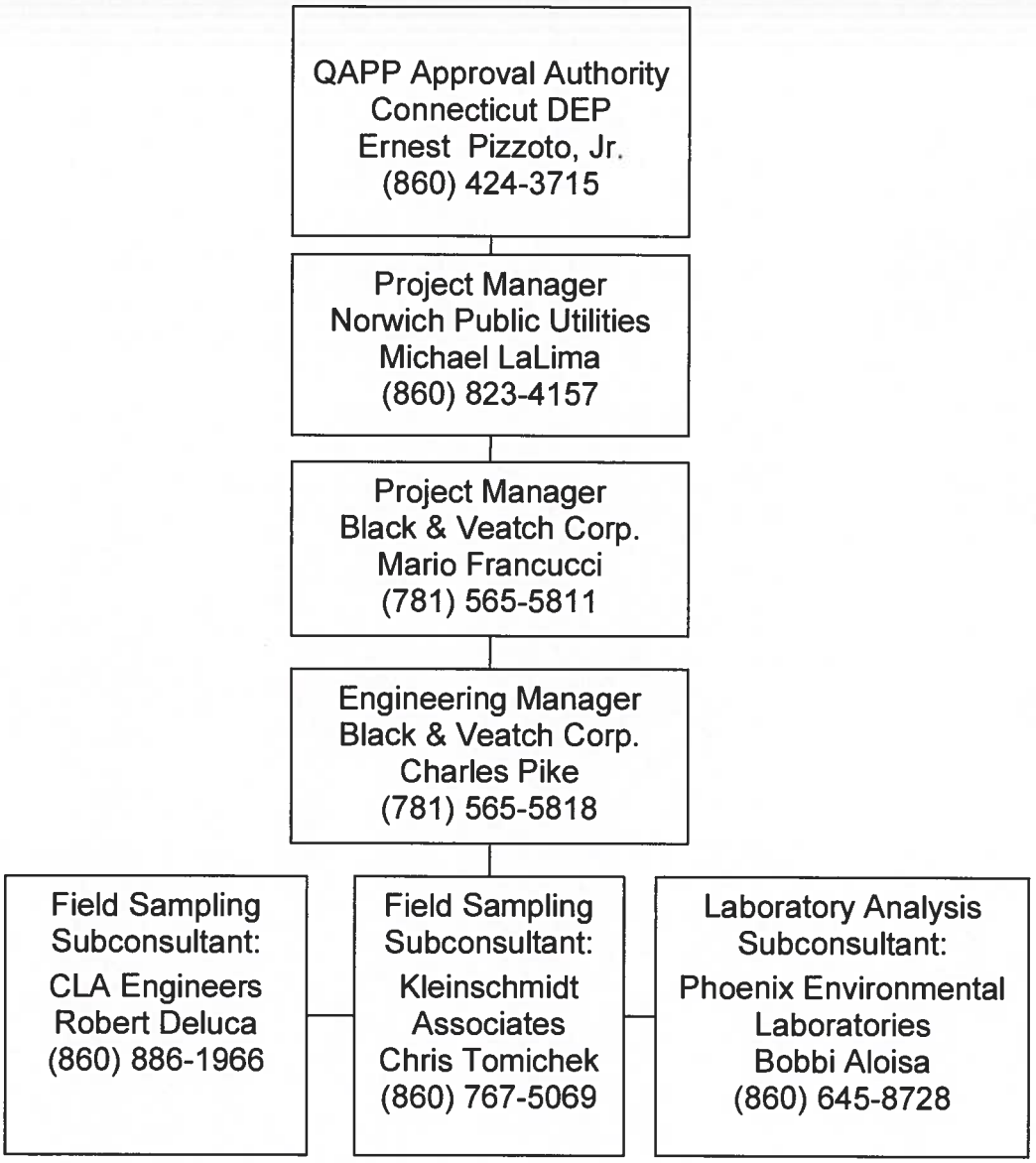
George Hicks, PE	Bureau of Water Management, CTDEP
Ernest Pizzuto, Jr.	Bureau of Water Protection and Land Re-use, CTDEP
Michael LaLima	Utility Engineer, Norwich Public Utilities
Mario Francucci, PE	Project Manager, Black & Veatch Corp.
Charles Pike, PE	Engineering Manager, Black & Veatch Corp.
Robert Deluca, PE	CLA Engineers, Inc.
Chris Tomichek	Kleinschmidt Associates
Bobbi Aloisa	Phoenix Environmental Laboratories, Inc.

Note: This plan was developed following *EPA QA/R-5: EPA Requirements for Quality Assurance Project Plans (QAPP).* Letters in parenthesis following section headings in this report correspond to QAPP elements.

1 PROJECT INTRODUCTION

1.1 Organization (A4)

A project organization chart is provided below. The individuals participating in the project and their specific roles and responsibilities are discussed following the chart.



Ernest Pizzuto, Jr., CTDEP: He will be responsible for reviewing and approving the QAPP on behalf of Connecticut Department of Environmental Protection, the QAPP Approval Authority on the Norwich CSO Long Term Control Plan project's field sampling program.

Michael LaLima, NPU Project Manager: He will be responsible for overseeing and approving the work done by Black & Veatch Corp. for Norwich Public Utilities on this project. He will also act as the primary point of contact for Black & Veatch for any required coordination between Black & Veatch Corp. and NPU during the sampling and field monitoring

Mario Francucci, PE, Black & Veatch Corp., Project Manager: He will be responsible for overseeing the preparation and revisions to the QAPP, as well as overseeing its implementation by Black & Veatch Corp. He will also be responsible for communicating changes in the QAPP to NPU and CTDEP.

Charles Pike, PE, Black & Veatch Corp., Engineering Manager: He will be responsible for preparing the QAPP, day-to-day implementation by Black & Veatch Corp. staff and overseeing the sampling and laboratory analysis subconsultants. He also will be responsible for seeing that data collection and QA practices are in compliance with the QAPP.

Robert Deluca, PE, CLA Engineers: He will be responsible for managing and overseeing the land-based field sampling team, based on the needs stated in the QAPP. He will be responsible for making sure that the land-based sampling team implements the QAPP, and for communicating any changes in or revisions to the QAPP to team members. He will report any problems to the Engineering Manager. The team that he oversees also will be responsible for transporting all land- and boat-collected samples to the laboratory, and handing these samples over to laboratory staff.

Chris Tomichek, Kleinschmidt Associates: This person will have the same duties as those listed above for Mr. Deluca, pertaining to the boat-based field sampling team. The boat-based sampling team will be responsible for collecting their samples and transferring them to the land-based team, for transport to the laboratory.

Bobbi Aloisa, Phoenix Environmental Laboratories: This person will be responsible for overseeing and managing the team responsible for analysis of the samples and for validation of the laboratory data. The team that she oversees will be responsible for receiving the samples at the laboratory, ensuring that internal laboratory audits are conducted per the laboratory's QA manual, and making sure that the QAPP requirements are followed, and subsequent revisions to the QAPP are communicated to members of the analytical team as necessary. She will also be responsible for ensuring that problems affecting data or results are reported to the Engineering Manager.

1.2 Background (A5)

Norwich Public Utilities (NPU) has fifteen (15) active combined sewer overflows (CSOs) that discharge during wet weather events to tidal portions of the Shetucket and Thames Rivers. These discharges are intermittent by nature, and include both stormwater runoff

and sanitary sewage components. During the spring of 2008 a river sampling program will be conducted in conjunction with flow monitoring in the collection system and sampling of discharges to the river. This sampling and monitoring program is designed to provide data useful for evaluation being done under the Norwich CSO Long Term Control Plan, to meet the following objectives:

- Calibrating a hydraulic model of the collection system that will project the amount of overflow generated from each CSO discharge point for a specified storm rainfall and intensity pattern
- Characterizing the biological and chemical pollutant characteristics of the wet weather CSO discharges
- Characterizing the biological and chemical characteristics of the receiving waters
- Establishing the pollutant impact to the rivers during wet weather events by pollutant parameter in terms of geographic extent of influence, degree of degradation and time duration during and after wet weather events.
- Validating a hydraulic model of the river discharges, based on PLUMES or CORMIX programs, to establish the mixing zones for the CSO discharges.
- Providing the necessary data to establish the zone of influence (ZOI) of the CSOs
- Establishing boundary conditions above and below the CSO discharge points, as well as from other local sources such as stormwater and wastewater treatment plant discharge, to determine the extent to which degradation of river water quality might be caused by other, non-CSO sources

Ultimately, the CSO Long Term Control Plan will recommend the extent and type of measures that should be taken to reduce and monitor Norwich's CSO discharges to the rivers.

1.3 Description (A6)

The receiving water sampling program will involve taking samples during dry and wet weather conditions from selected sites in the Yantic, Shetucket, Quinebaug and Thames Rivers, transporting those samples to a local analytical laboratory, and analyzing them for specific chemical and bacteriological constituents. Some of the samples will be taken from land, at locations along the river shores where access is possible; others will be taken from boats. The sampling plan will identify the locations the samples are to be taken from, depth(s) at which samples are to be taken, constituents to be sampled for, sample amounts required, laboratory holding requirements, and at what points during and after each storm event the samples are to be taken.

In addition to taking samples in bottles, data such as temperature, pH and conductivity/conductivity will be taken directly via immersed probes.

1.4 Quality Objectives and Criteria (A7)

1.4.1 Project Quality Objectives

The Quality Assurance (QA) objective for analytical data is to collect environmental monitoring data of known, acceptable and documentable quality. QA and quality control (QC) procedures are established to produce data of high quality and integrity that meet or exceed the requirements of the standard analytical methods utilized as well as meet project requirements. For this project, the objectives of quality assurance efforts are twofold. First, they will provide the mechanism for management and evaluation of measurement data. Second, quality control measures will be used to define data quality for the various measurement parameters in terms of QC parameters. The QA objectives established for the project are listed below.

- Implement the procedures outlined herein for field sampling, sample custody, equipment operation and calibration, laboratory analyses and data reporting that will ensure the consistency and thoroughness of data generation.

- Assess the quality of data generated to ensure that all data are scientifically valid, and of known and documented quality. This will be accomplished by established objectives for precision, accuracy, representativeness, completeness, and comparability as set forth herein and testing data against these acceptance criteria.

- Achieve an acceptable level of confidence in the decision made from the data by controlling the degree of total error in the data using QC checks.

- Ensure that the QA Project Plan is properly implemented by conducting audits. Verify that corrective action was executed for a nonconformance identified through QA reports to management.

Acceptance criteria have been established fro precision, accuracy and completeness. The criteria are expressed as numerical values for all laboratory analyses and field tests identified. Further discussion of all five parameters and rational for their use is presented in Section 1.4.2

1.4.2 Measurement Performance Criteria

Precision. Precision is the measure of mutual agreement among replicate or duplicate measurements of the same analyte. The closer the numerical values of the measurements are to each other, the more precise the measurement. This allows immediate comparison of the precision of different results under the same method. Precision for a single analyte is expressed as a relative percent difference between results of field duplicate samples or matrix spike duplicates.

Accuracy. Accuracy is the measure of the observed value to the true value of a parameter. Accuracy is usually expressed as the percent recovery of an analyte from a surrogate or matrix spike sample or from a standard reference material.

Representativeness. Representativeness is a qualitative parameter which expresses the degree to which sample data accurately and precisely represent a characteristic of population, parameter variations at a sampling point or an environmental condition. The design of and rationale for the sampling program in terms of selecting the sampling location, the number of samples to be collected, and the condition for sample collection, and the sampling techniques, ensures that the environmental conditions have been sufficiently represented.

Completeness. Field completeness is assessed by comparing the number of samples collected to the number of samples planned. Laboratory completeness is assessed by comparing the number of valid samples yielding valid analytical data to the number of samples submitted for analysis. Overall project completeness is assessed by comparison between the total number of measurement yielding valid data to the number of measurements planned. The results are calculated following data validation. The completeness objective for all laboratory and field measurements will be 90 percent for each sampling survey.

Comparability. Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Comparability is assured through the use of established and approved analytical methods and a laboratory QC program designed to establish consistency in the performance of these methods. The program includes traceability measurements to independent reference material to establish performance. Only when precision and accuracy are known can data sets be compared with confidence.

1.5 Special Training (A8)

The subconsultants responsible for specialized activities that will be conducted during this sampling and monitoring program (boat-based river sampling, flow monitoring in the wastewater collection system and laboratory analysis) are firms that regularly engage in this type of work. Therefore, we do not anticipate the need for any additional special training.

1.6 Record Keeping and Cygnet (A9)

All project records will be maintained on a secure Black and Veatch server system, known as Cygnet. This system is regularly backed up to prevent data loss. This is discussed in greater detail in Section 2.9.

2 SAMPLE COLLECTION AND ANALYSIS

2.1 Sampling Plan (B1)

This Receiving Waters Monitoring and Sampling Plan covers the characterization of the receiving waters, and provides input for the mixing zone analysis and water quality definition to establish the zones of influence (ZOI). Samples will be collected at eleven locations along the Yantic, Shetucket, Quinebaug and Thames Rivers during dry and wet weather. These locations are described in Section 2.1.1, below and summarized in Table 1. River Stations No. 1 through 5 will be sampled from the shore by a land-based crew. Samples from River Stations No. 6 through 11 will be obtained by boat. River samples, other than samples to be analyzed for bacteria, will be collected in a Van Dorn type water sampler at three depths. Samples to be analyzed for bacteria will be collected directly into sterile sample containers. The wet weather and dry weather sampling procedures are described in the sections below.

2.1.1 River Sampling and Flow Monitoring Locations

Grab samples will be taken from the Shetucket, Quinebaug, Yantic, and Thames Rivers at eleven sampling stations. These stations were selected to characterize the water quality in upstream, downstream and within the Norwich CSO discharge area. Sampling stations are shown in Figure 1 and are described below. Samples from river stations RS 1 through RS 5 will be collected by a two to three-person crew from shore locations. A second crew in a boat capable of day/night operations will be used to collect samples from stations RS 6 through RS 11 on the Shetucket and Thames Rivers. Boat crews will verify their locations using GPS units in order to maintain consistent sampling locations.

Table 1 – River Sampling Sites

Site No.	Location	Sampling*	GPS	Access
RS 1	Shetucket River near Ponemah Mill	A		Shore
RS 2	Quinebaug River near Shetucket	A		Shore
RS 3	Shetucket River D/S of St. Mary's Cemetery	A		Shore
RS 4	Yantic River upstream of Hollyhock Island	A		Shore
RS 5	Yantic River upstream of Norwich WWTF emergency outfall	A		Shore
RS 6	Shetucket River near Main St. bridge	B,C,D,E,F	N 41.52430 W 72.06860	Boat
RS 7	Thames River at Turning Basin	B,C,D,E	N 41.52110 W 72.07880	Boat
RS 8*	Shetucket River upstream of CSO 32	B,C,D,F,G	N 41.51450 W 72.07800	Boat
RS 9	Thames River north of Trading Cove	B,C,D,F,G	N 41.49530 W72.08080	Boat
RS 10	Thames River at Route 2A Bridge	B,C,D	N 41.48220 W 72.07490	Boat
RS 11	Thames River at Poquetanuck Cove	B,C,D	N 41.46490 W 72.06840	Boat

*

***NOTES Regarding Sampling Program:**

A Shore-based sampling: (1) vertical profile for Conductivity, Temperature, pH and DO, taken by field probe; (2) grab samples taken at the water surface for E. coli, fecal coliform and Enterococci; (3) chemical series samples taken 1 ft. below surface of the water for TSS, BOD-5, Orthophosphate, Nitrate, Nitrite, TKN, Ammonia-N.

B River sampling at mid-channel for chemical series (TSS, BOD-5, Orthophosphate, Nitrate, Nitrite, TKN, Ammonia-N). Where river depth is less than 6 feet: take one set of samples 1 foot below water surface. Where depth is 6-10 feet, take chemical series samples at two depths: (a) 3 ft. above river bed, and (b) 1 ft. below surface. Where depth is over 10 feet, take chemical series of samples at three depths: (a) 3 ft above river bed, (b) mid-depth, and (c) 1 ft. below surface.

C River sampling at mid-channel: vertical profile for Conductivity, Temperature, pH and DO, taken by field probe.

D River sampling at mid-channel, at the water surface, for: fecal coliform, Enterococci.

E River sampling at mid-channel, at the water surface, for E. coli.

F River sampling at ¼ and ¾ points across width of the river: (a) vertical profile for Conductivity, Temperature, pH and DO, taken by field probe; and (b) Enterococci, taken at the water surface

G River sampling at ¼ and ¾ points across width of the river, for: fecal coliform, taken at the water surface

2.1.1.1 RS 1: Shetucket River near Ponemah Mill (Shore-based Sampling)

Samples will be taken from the Shetucket River north of the old Helikon Furniture Co. Samples will be collected from the shore, on the opposite side of the guard rail between Route 97 and the river. An accessible portion of the river is located south of a "Do Not

Pass" sign; the guardrail here is marked with a blue band of paint. This sampling station will be used to establish background conditions in the Shetucket River upstream of Norwich.

2.1.1.2 RS 2: Mouth of Quinebaug River (Shore-based)

Samples will be obtained from the north bank of the Quinebaug River, approximately 500 feet upstream of the confluence of the Quinebaug and Shetucket Rivers. This site is accessed via a path on the south side of Route 12, which begins at a 'pull-over point' just east of the Route 12 Bridge. This station will be used to establish background conditions upstream of the CSO discharges.

2.1.1.3 RS 3: Shetucket River below St. Mary's Cemetery (Shore-based)

This sampling station is located on the western shore of the Shetucket River just downstream of the St. Mary's Cemetery. This site can be access through a gate south of the Dunkin Donuts on Route 12. Samplers can park at the Dunkin Donuts and walk to the river via an abandoned driveway through this gate to the river. There is a clearing in the shoreline brush, just south of the houses, across from the demolished building on the tracks. This site will establish boundary conditions upstream of the CSO discharges.

2.1.1.4 RS 4: Yantic River Upstream of Hollyhock Island (Shore-based)

This sampling station is located just north of Hollyhock Island, the island on which the Norwich WWTF is located. This sampling station will provide boundary condition information on the Yantic River, upstream of Norwich WWTF and CSO discharges. The sampling site can be accessed via the bike path along the eastern shore of the Yantic River. The bike path is accessible via Yantic Street, off of Washington Street.

2.1.1.5 RS 5: Yantic River on East Side of the Norwich WWTF (Shore-based)

Samples will be taken from the East Branch of the Yantic River approximately 1500 feet downstream of the WWTF, below the emergency outfall. Samples can be obtained from a small dock on the north side of the river, which is accessed via the bike path also at this location. This station will characterize water quality downstream of the Norwich Wastewater Treatment Facility.

2.1.1.6 RS 6: Shetucket River near Main St. Bridge (Boat-based Sampling)

Samples will be collected just upstream of the Route 2 Bridge. This station will characterize water quality downstream of several CSO outfalls. In addition to the samples taken at the midpoint of the river east of the island, cross section information will be collected at this site by taking a vertical profile of pH, DO, conductivity, temperature and surface samples for bacteria at the one quarter and three quarter points across the width of the river.

2.1.1.7 RS 7: Thames River at Turning Basin (Boat-based)

This sampling station is located in the Thames River Turning Basin, where the Yantic and Shetucket Rivers join to form the Thames River. Samples will be taken as close to the center of the river as possible. This station will characterize water quality at the location where the Yantic and Shetucket Rivers join, and will provide boundary conditions for CSOs 4, 5 and 31.

2.1.1.8 RS 8: Thames River Upstream of CSO 32 (Boat-based)

This sampling station is located in the Thames River upstream of CSO 32. This CSO is located along the eastern shore of the Thames River can be identified by boat as a rectangular stone outfall with a white "Notice" Sign above it. In addition to the samples taken at the midpoint of the river, vertical profile data and surface samples for bacteria will be taken at the one-quarter and three-quarter points across the width of the river. This station will characterize the effects of CSOs 4, 5 and 31.

2.1.1.9 RS 9: Thames River Upstream of Trading Cove (Boat-based)

This sampling station is located in the Thames River just upstream of Trading Cove. In addition to the samples taken at the midpoint of the river, vertical profile data and surface samples for bacteria will be taken at the one-quarter and three-quarter points across the width of the river. This sampling station will help to establish water quality conditions in the Thames River downstream of all Norwich CSO discharges.

2.1.1.10 RS 10: Thames River at the Route 2A Bridge (Boat-based)

Samples will be obtained by approximately 100 yards upstream of the Route 2A bridge, near the middle of the river. Data from this station will be used to characterize water quality downstream of all Norwich CSOs, as well as water quality of the Thames River moving into Norwich Harbor on the incoming tide.

2.1.1.11 RS 11: Thames River near Poquetanuck Cove (Boat-based)

This sampling station is at Poquetanuck Cove, which empties into the Thames River approximately one mile downstream of the Route 2A bridge. A railroad dike and bridge cross the cove near its mouth. Grab samples will be obtained near the middle of the Thames River channel at the point where Poquetanuck Cove joins the river. Data from this station will be used to characterize water quality in the Thames River downstream of all Norwich CSO discharges.

2.1.2 River Stage Gages

Three existing USGS river gauging stations will provide information on flows in the Shetucket, Quinebaug and Yantic Rivers. Locations of the gauging stations are shown in Table 2 and are described below. Fifteen minute flow and stage data is available for download from the USGS website up to 60 days after it is recorded. Fifteen minute data will be downloaded for the duration of the 10-week project; any historical analysis will be done using the daily, monthly or annual mean data.

Table 2 – Summary of River Gauging Stations

Gage	USGS No.	Description	Latitude, Longitude	Type	Area (mi^2)
RG1	01122500	Shetucket River near Willimantic, CT.	41°42'01", 72°10'57"	Real Time[1]; Flow, Stage	404
RG2	01127000	Quinebaug River at Jewett City, CT.	41°35'52", 71°59'05"	Real Time[2]; Flow, Stage	713
RG3	01127500	Yantic River at Yantic, CT.	41°33'31", 72°07'19"	Real Time[3]; Flow, Stage	89.3

[1] http://waterdata.usgs.gov/nwis/nwisman/?site_no=01122500&agency_cd=USGS

[2] http://waterdata.usgs.gov/nwis/nwisman/?site_no=01127000&agency_cd=USGS

[3] http://waterdata.usgs.gov/nwis/nwisman/?site_no=01127500&agency_cd=USGS

2.1.2.1 RG1 - Shetucket River near Willimantic, CT

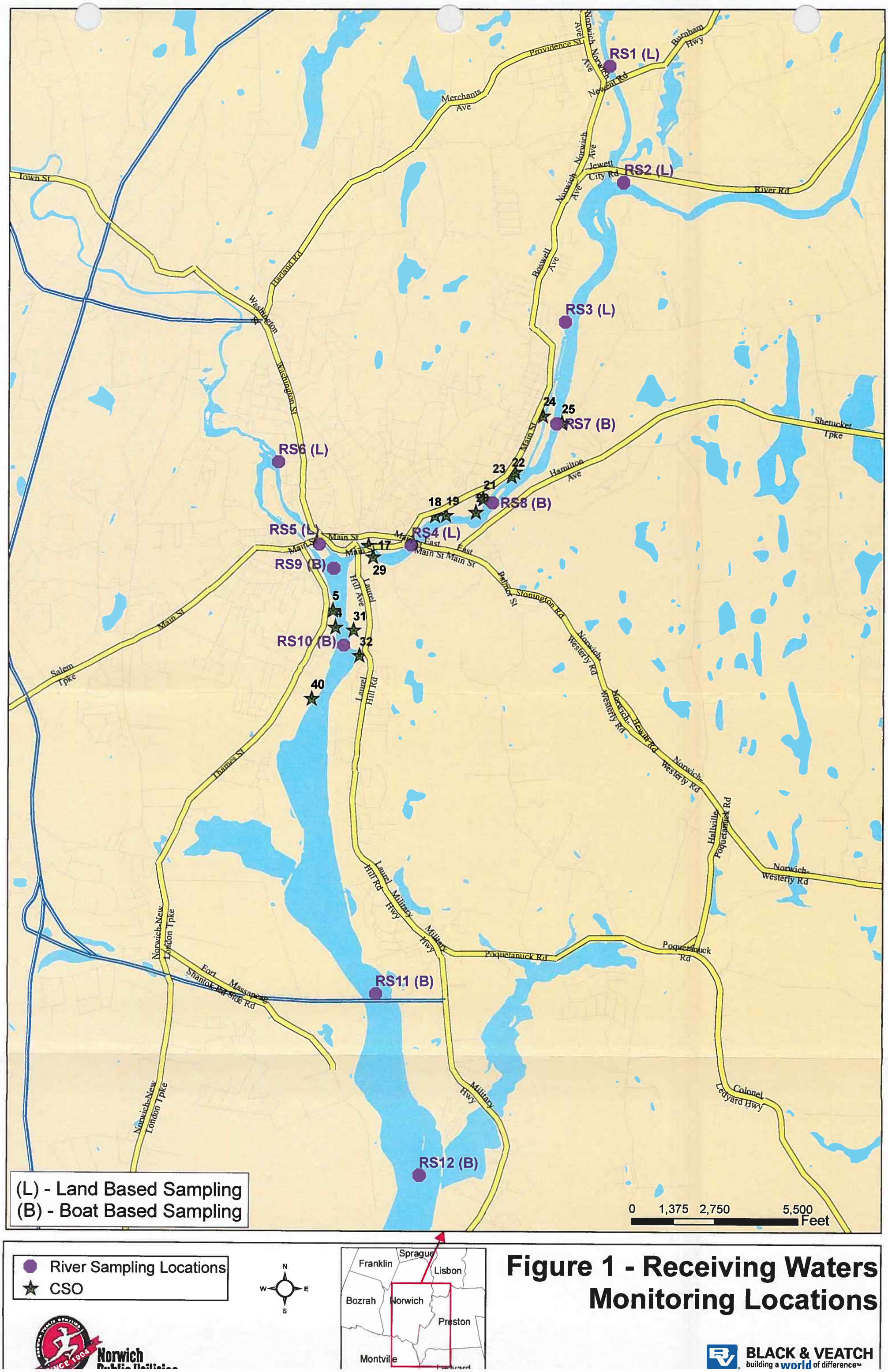
River Gauging Station No. 1 (USGS Gage No. 01122500) is located on the Shetucket River, approximately 15 miles upstream of the junction with the Quinebaug River. The drainage area for this gage is approximately 404 square miles. This is the closest active USGS meter of the Shetucket River to Norwich. This gage station provides real time flow and stage information, which is available for download online. The gage is located at the Plains Road Bridge near Willimantic, CT.

2.1.2.2 RG2 - Quinebaug River

River Gauging Station No. 2 (USGS Gage No. 01127000) is located on the west bank of the Quinebaug River on Slater Avenue in Jewett City, approximately five miles upstream of the mouth of the Quinebaug River. This station uses a continuous stage measuring device to determine flow from a drainage area of 713 square miles. Real time flow and stage data is available for download online.

2.1.2.3 RG3 - Yantic River

The third river gaging station (USGS Gage No. 01127500) is located on the east bank of the Yantic River in Yantic Village, 700 feet downstream from a stone arch highway bridge and 4.8 miles upstream from the mouth of the Yantic River. The continuously-recording gage at this station provides flow data for the Yantic River, with a drainage area of approximately 89 square miles. Real time flow and stage data is available for download online.


RS1 (L)
RS2 (L)
RS3 (L)
RS4 (L)
RS5 (L)
RS6 (L)
RS7 (B)
RS8 (B)
RS9 (B)
RS10 (B)
RS11 (B)
RS12 (B)
Providence St
Norwich Norwich Ave
Burnham Hwy
Norwich Ave
Merchants Ave
Town St
Harland Rd
Washington St
Washington St
Jewett City Rd
River Rd
Norwich Ave
Boswell Ave
Main St
Main St
Main St East
Main St Main St East
Palmer St
Stonington Rd
Shetucket Tpke
Hamilton Ave
Hill Ave
Laurel Hill Rd
Laurel Hill Rd
Main St
Salem Tpke
Thames St
Norwich-Westerly Rd
Norwich-Hewitt Rd
Norwich-Westerly Rd
Norwich-Westerly Rd
Hallville
Poquetanuck Rd
Poquetanuck Rd
Poquetanuck Rd
Military Hwy
Military Hwy
Military Hwy
Norwich-New London Tpke
Norwich-New London Tpke
Fort Shantok Rd
Massapeag Side Rd
Colonel Ledyard Hwy
5
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(L) - Land Based Sampling
(B) - Boat Based Sampling
0 1,375 2,750 5,500 Feet
River Sampling Locations
CSO
N
W
E
S
Sprague
Franklin
Lisbon
Bozrah
Norwich
Preston
Montville
Figure 1 - Receiving Waters Monitoring Locations
Norwich Public Utilities
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2.1.3 Wet Weather Sampling

Wet weather samples from each of the twelve river sampling stations will be analyzed for the parameters listed in Table 3. Samples will be collected from each river station for analysis for each of three rain events.

Table 3 – Wet Weather Sampling Program

		When Samples are to be Taken				
PARAMETER	**Sample Collection[1]**	**2-4 hrs after start of storm**	**12 hrs after start of storm**	**24 hrs after end of storm**	**48 hrs after end of storm**	**72 hrs after end of storm**
Field Testing (Using Probe)						
Dissolved Oxygen (DO)	Vertical Profile with Probes	x	x	x	x	x
Conductivity		x	x	x	x	x
Temperature		x	x	x	x	x
pH		x	x	x	x	x
Lab Testing (EPA approved Method)						
Fecal Coliform	Surface Grab	x	x	x	x	x
E. Coli		x	x	x	x	x
Enterococci		x	x	x	x	x
Total Suspended Solids (TSS)	*Land Crew:* Surface Grab *Boat Crew:* Grabs at Three Depths	x	x			
5-day BOD		x	x			
Orthophosphate		x	x			
Nitrite		x	x			
Nitrate		x	x			
Total Kjeldahl Nitrogen (TKN)		x	x			
Ammonia-N		x	x			

[1] Refer to notes at the end of Table 1 for additional details regarding sampling program requirements, locations and depths

When a rain event occurs, each river station will be sampled at the following times:

- 2 to 4 hours after the start of the rain event,
- 12 hours after the start of the rain event,
- 24 hours after the end of the rain event,
- 48 hours after the end of the rain event, and
- 72 hours after the end of the rain event.

For the first two sampling times, one-liter polyethylene containers will be filled (for lab analysis of total suspended solids, 5-day BOD, etc.), as well as separate 250-ml sterile containers (for lab analysis of bacteria). The sterile containers and one-liter polyethylene containers will be provided by the lab prior to the onset of the storm.

Three sets of post-storm sampling will be taken at the times indicated in Table 3, to help establish the length of time bacterial degradation of water quality persists in the rivers following a storm. For these three sampling periods, only one 250-milliliter sterile container must be filled at each river station for bacterial analysis. Water-column profile data (river bed to water surface) will be collected via probes and recorded during all sampling events.

A second sample for bacterial analysis will be collected from RS 7 two to four hours after the start of the rain event; this sample will be sent to the lab for analysis as a duplicate field sample as described in the Quality Assurance/Quality Control section of this report (section 2.5).

In addition to the samples collected for lab analysis, a sample from each river station will be analyzed at the sampling site for dissolved oxygen (DO), conductivity, temperature, and pH. A probe on board the boat will be used to analyze samples collected by boat for DO, conductivity, temperature, and pH, this meter and probe will use EPA-approved methods and be capable of taking reading from the river bed to the surface. The land-based crew sampling river stations from bridge and shore locations will use Hach portable meters to determine DO, temperature, conductivity and pH in the field. On-site test equipment will be calibrated prior to the start of each sampling period, in accordance with manufacturer's requirements.

All river samples collected for lab analysis will be stored in ice-filled coolers to aid sample preservation and maintain he samples below 6°C. At the conclusion of each sampling series (five per storm), the boat crew will rendezvous with the land based sampling crew at the Norwich town marina area. Samples collected by boat will be handed over to the land-based crew, for transport to the lab.

Due to crew safety concerns, no sampling will be done during lightning storm events.

2.1.4 Dry Weather Sampling

Dry weather river sampling will be performed twice on one day during the 10-week sampling period on low slack tide and high slack tide. The criterion to be met for conducting the dry weather sampling is no rainfall for 72 hours prior to and during the sampling efforts. Grab samples from each river sampling stations will be analyzed for the parameters listed in Table 4.

Table 4 – Dry Weather Sampling Plan

PARAMETER	Sample Collection[1]	Low Tide	High Tide
Field Testing (Using Probe)			
Dissolved Oxygen (DO)	Vertical Profile with Probes	x	x
Conductivity		x	x
Temperature		x	x
pH		x	x
Lab Testing (EPA approved method)			
Fecal Coliform	Surface Grabs	x	x
E. Coli		x	x
Enterococci		x	x
Total Suspended Solids (TSS)	*Land Crew:* Surface Grab *Boat Crew:* Grabs at Three Depths	x	x
5-day BOD		x	x
Orthophosphate		x	x
Nitrite		x	x
Nitrate		x	x
Total Kjeldahl Nitrogen (TKN)		x	x
Ammonia-N		x	x

[1] Refer to notes at the end of Table 1 for additional details regarding sampling program requirements, locations and depths

Samples will be analyzed in the field for dissolved oxygen, conductivity, temperature, and pH as described in the wet weather river sampling section. As with wet weather sampling, a 250-ml. sterile container (provided by the lab) will be filled at each river station for lab bacterial analysis. A duplicate sample collected from RS 7 at low tide will be sent to the lab for analysis as a duplicate field sample for quality assurance.

Handling and transfer of samples collected by boat after each sampling period, and transport of samples to the lab for analysis, will be as described in the wet weather sampling section of this plan.

2.1.5 Summary of Sampling Plan

In total, eleven river locations will be sampled during three rain events and one dry weather period. Six locations will be sampled by boat and five from land. Boat samples will be collected at up to three depths for all constituents except bacteria. The boat crew will collect vertical profile water column information with probes at all location, three locations will have two addition water-column readings collected. Bacteria samples will be duplicated at RS 7 during each sampling event and sterile blanks will be tested for bacteria counts during each timestep of each sampling event for each sampling crew. Table 5 below summaries the total number of samples that will be collected and analyzed under this project.

Table 5 – Estimated Number of Samples to be Collected

	Wet-Weather	Dry-Weather	Total
PARAMETER			
Field Testing (Using Probe)			
Dissolved Oxygen (DO)	270	36	**306**
Conductivity	270	36	**306**
Temperature	270	36	**306**
pH	270	36	**306**
Lab Testing (EPA approved Method)			
Fecal Coliform	303	41	**344**
E. Coli	303	41	**344**
Enterococci	303	41	**344**
Total Suspended Solids (TSS)	144	48	**192**
5-day BOD	144	48	**192**
Orthophosphate	144	48	**192**
Nitrite	144	48	**192**
Nitrate	144	48	**192**
Total Kjeldahl Nitrogen (TKN)	144	48	**192**
Ammonia-N	144	48	**192**

Includes QA/QC of
1 Blank bacteria per crew per timestep
1 Duplicate RS 7 bacteria per sampling event

2.2 Sampling Methods (B2)

2.2.1 General Sampling Duties

Prior to a sampling event, the senior person on each sampling crew should check the items listed in Section 2.2.3 to ensure that an adequate number of sampling containers and supplies are available for the next sampling period. The crew's supervisor should be notified of any shortages of supplies. Inventory should be checked by the sampling crews at the beginning and end of each sampling event. General sampling duties include:

1. Arrival: Crews should arrive at their pre-assigned meeting places at least one hour before their first scheduled sample is to be taken.

2. Duties: During the first hour before the sample is taken, crews should check lists and available items (i.e., laboratory supplies, forms, etc.).

3. All forms should be completely filled out and signed by each crew before the end of the sampling period. Also, whenever a sample is transferred (for example, from boat crew to the land-based crew or from land-based crew to the lab), the transferor and the transferee should both sign and date the chain of custody form.

4. All samples must be packed in the coolers with polypaks (or ice) immediately after the sample is taken and prior to sending the samples to the laboratory for analysis.

5. All samples collected must be labeled in the following manner:

   a. The outer surfaces of the container should be wiped clean.
   b. Attach large rectangular label with sample number to side of bottle and cover with mylar tape (do not use Scotch tape).
   c. Attach the small round label with sample number to the bottle cap; mylar tape is not required.
   d. Each 250 ml container for bacterial analysis should be carefully handled to prevent contamination prior to sampling and during transport to the lab.

6. The land-based crew will transport samples (properly labeled and packed in the coolers) to the lab after each sampling period (Note: there will be more than one sampling period per sampling event).

7. If for any reason a sample is not taken, the sampling crew responsible must notify their supervisor at the end of the sampling period.

2.2.2 Detailed Sample Collection

The proper handling of samples in the field is essential to obtain valid data. Table 5, adapted from 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants", presents a summary of the recommended sampling procedures for the parameters of interest. Although additional preservation techniques are listed in Table 5, samples to be analyzed at the lab will only be preserved by maintaining at 6°C until delivered to the lab. A general discussion of the steps involved in collecting samples is presented below.

Table 5 – Containers, Preservation and Max Holding Times for Sampling Parameters

Measurement	Container [a]	Preservative [b]	Maximum Holding Time [c]
Ammonia	P,G, FP	Cool, 6°C H_2SO_4 to pH <2	28 days
Bacteria	P,G	Cool, 6°C 0.008% $Na_2S_2O_3$ [d]	6 hours
Biochemical Oxygen Demand	P,G, FP	Cool, 6°C	48 hours
Conductivity	P,G,	Cool, 6°C	28 days
Dissolved Oxygen (probe)	G bottle& top	Determine on site	1 hour
pH	P,G, FP	Determine on site	15 mins
Kjeldahl Nitrogen	P,G, FP	Cool, 6°C H_2SO_4 to pH <2	28 days
Nitrate	P,G, FP	Cool, 6°C	48 hours
Nitrite	P,G, FP	Cool, 6°C	48 hours
Orthophosphate	P,G, FP	Cool, 6°C H_2SO_4 to pH <2	Filter within 15mins 48 hours
Solids Total Suspended	P,G, FP	Cool, 6°C	7 days
Temperature	P,G, FP	Determine on site	Immediately

(a) Polyethylene (P), Glass (G), Fluoropolymer (FP)
(b) For this project not all preservation techniques shown will be used. Samples to be analyzed at the lab will only be preserved by, maintaining at 6°C until analysis begins.
(c) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, had data on file to show that the specific types obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability.
(d) Should only be used in the presence of residual chorine.

Reference:40 CFR Part 136, "Guideline Establishing Test procedure for the Analysis of Pollutants", 2007.

1. Prior to Sampling:

    a. Consult Table 5 to ensure that the container chosen for sample storage is appropriate for the analysis to be performed.
    b. Make certain that a sufficient quantity of clean containers is available.

2. After Sample Collection:

    a. Where necessary, make certain that duplicate samples have been collected.
    b. Aliquot an appropriate volume of sample for each analysis.
    c. Ensure that contamination is not introduced in the collection process.
    d. Record all field measurements in a bound notebook; the following information should be included:
        i. date, time, sampling location
        ii. signature of person performing the work

iii. a brief description of equipment and/or method used to make the measurement.

e. Cap each bottle securely.
f. Before packing, mark the liquid level on each container, this will enable the lab personnel to determine if any sample loss has occurred during transportation to the lab.
g. After samples are labeled, pack them in a container to be maintained at 6°C.
h. Transport samples to lab, following the chain-of-custody procedures outlined in Section 2.3.

2.2.3 Sampling Containers

The size and use of the sampling containers to be employed in the sampling program are listed in Table 6. All containers except the ones used in the automatic samplers will be supplied by the analytical lab. The lab will thoroughly clean all containers prior to the start of a sampling event. The containers used to collect samples for bacterial analysis will be sterilized in the lab and kept capped until filled by the sampling crew.

Table 6 – Estimated Sampling Containers per Event

	Boat Crew	Land Crew
Wet-Weather	**66 x 250mL Bottles for Bacterial Samples** 1 bottle x 12 sites x 5 timesteps = 60 bottles 1 sterile bottle x 5 timesteps = 5 bottles 1 duplicate sample @ RS 7 = 1 bottle **36 x 1L Bottle for Other Constituents** 1 bottle x 6 sites x 2 timesteps x 3 depths = 36 bottles	**40 x 250mL Bottles for Bacterial Samples** 1 bottle x 5 sites x 5 timesteps = 25 bottles 1 sterile bottle x 5 timesteps = 5 bottles **12 x 1L Bottle for Other Constituents** 1 bottle x 5 sites x 2 timesteps = 10 bottles
Dry-Weather	**27 x 250mL Bottles for Bacterial Samples** 1 bottle x 12 sites x 2 timesteps = 24 bottles 1 sterile bottle x 2 timestep = 2 bottles 1 duplicate sample @ RS 7 = 1 bottle **36 x 1L Bottle for Other Constituents** 1 bottle x 6 sites x 2 timesteps x 3 depths = 36 bottles	**12 x 250mL Bottles for Bacterial Samples** 1 bottle x 5 sites x 2 timesteps = 10 bottles 1 sterile bottle x 2 timesteps = 2 bottles **10 x 1L Bottle for Other Constituents** 1 bottle x 5 sites x 2 timesteps = 10 bottles

This table assumes a single 1-liter bottle per site per timestep per depth for all non-bacterial analyses and a single 250ml bottle per site per timestep for bacterial analysis; this is subject to change based on the requirements of the analytical laboratory selected.

2.2.4 Miscellaneous Supplies

Additional supplies required or recommended for the sampling program are listed below:

- Frozen polypaks (or ice)
- Garbage bags
- Teflon tape
- Labels
- Pencils, indelible markers
- Mylar tape
- Scissors
- Utility knife

- Coolers
- Tool kit
- Extra pump tubing for automatic samplers
- Paper towels
- Extra batteries for flashlights, automatic samplers and flow meters
- Clipboard
- Steel ruler (12')
- Measuring tape (15' mm.)
- pH meters
- (Boat) Meter/Probe for conductivity, temperature, DO and pH capable of recording vertical water profiles for all parameters to depth up to 10 meters
- (Land) Meter/Probe for conductivity, temperature, DO and pH
- Chain-of-custody forms
- Graduated cylinders
- Calculator
- Instruction manuals for flow meters and automatic samplers
- Grease Pencils
- (Boat) GPS System for recording sampling location in river

2.3 Sample Identification and Chain of Custody (B3)

An essential part of any sampling program is a complete recordkeeping procedure. All personnel must keep meticulous records of all the samples collected and ancillary information pertaining to their collection, preservation, and delivery to the laboratory.

2.3.1 Sample Identification

Adhesive labels will be affixed to the sample containers. When a sample is taken, a crew member should write the following information on the label:

- The site name and/or number and the sampling location
- The date and time sample was taken
- The analysis required
- The signature of the sample collector

In addition, the sampling location and time should be written in grease pencil directly on the container as a safeguard in case the sample label becomes illegible. The sample label should be completely covered with mylar tape to eliminate the possibility of moisture smearing the writing on the label. A small round adhesive label should also be used on the cap and labeled with the sampling location and time to facilitate checking the inventory of bottles.

2.3.2 Chain-of-Custody Procedures

'Chain of custody' is a process which accounts for sample identity and handling from the time of collection through disposal. A chain of custody record must be established for each sample or group of samples. Record forms must be maintained during sample

collection and transfer; the following information should be included on the chain-of-custody record:

- Name of Study
- Site name/number and sampling location (sample identification)
- Date and time of sampling
- Sample type (composite or grab)
- Sample matrix (all samples collected for this study will be ("liquid")
- Analyses required
- Signature of samplers

Results of on-site analyses of river grab samples for dissolved oxygen, temperature, conductivity, and pH; comments on any unusual circumstances also should be recorded. When completing sample labels and chain-of-custody records, make certain that all required information has been provided and that all writing is legible.

When turning over possession of samples, both the transferor and transferee must sign and date the record. The chain-of-custody forms should accompany their respective samples during transfer to the local laboratory for analyses. After the laboratory has received samples and signed the forms, they should copy each form and retain the original. The copy should be given to the individual who delivered the samples.

The laboratory chain of custody form must accompany samples during compositing, extracting and analysis. All originals should be sent to Black & Veatch Corp. immediately upon completion of the analyses.

The Norwich WWTP influent and effluent will be recorded throughout wet-weather event as previously described. At the end of a sampling event, this form should be forwarded to Black & Veatch Corp.

A sample chain of custody form is show below in Figure 2.

Figure 2: Sample Chain of Custody Form

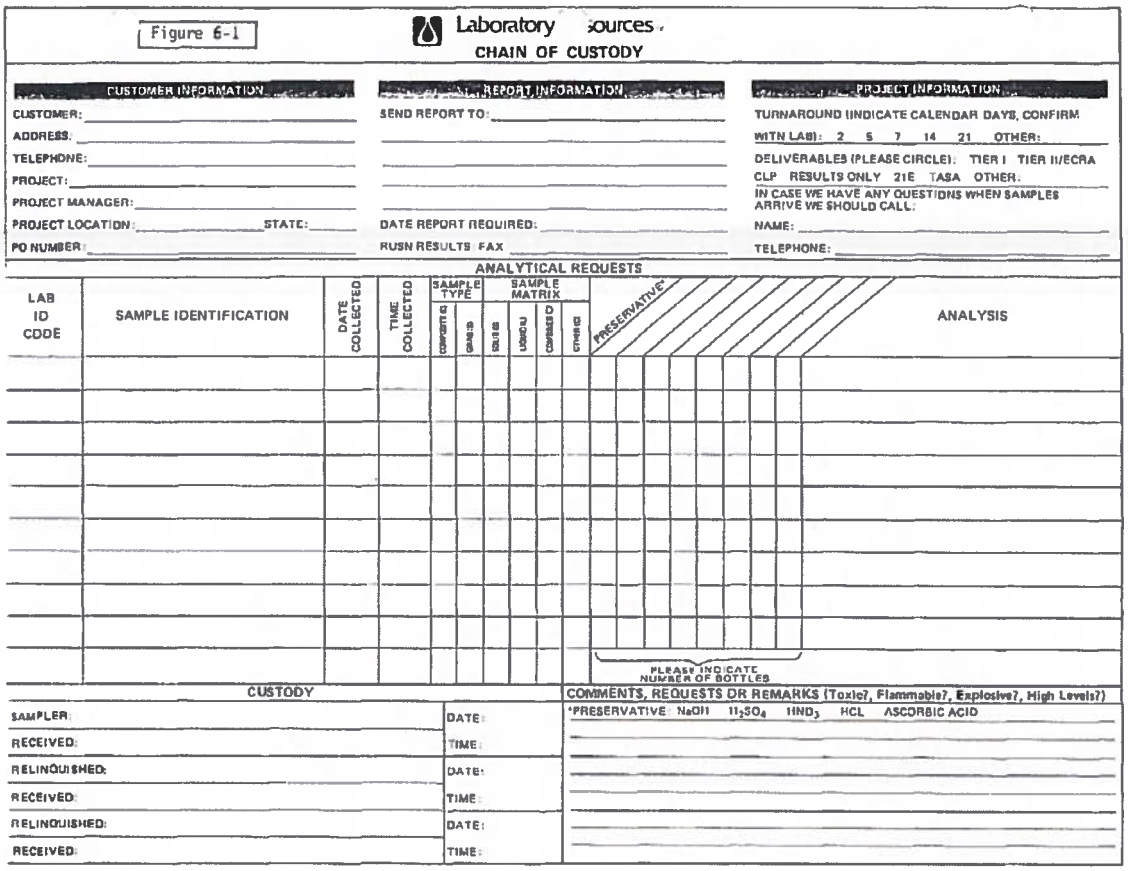

Figure 6-1

Laboratory Sources

CHAIN OF CUSTODY

CUSTOMER INFORMATION

CUSTOMER:
ADDRESS:
TELEPHONE:
PROJECT:
PROJECT MANAGER:
PROJECT LOCATION: STATE:
PO NUMBER:

REPORT INFORMATION

SEND REPORT TO:
DATE REPORT REQUIRED:
RUSH RESULTS FAX

PROJECT INFORMATION

TURNAROUND (INDICATE CALENDAR DAYS, CONFIRM WITH LAB): 2 5 7 14 21 OTHER:
DELIVERABLES (PLEASE CIRCLE): TIER I TIER II/ECRA CLP RESULTS ONLY 21E TASA OTHER:
IN CASE WE HAVE ANY QUESTIONS WHEN SAMPLES ARRIVE WE SHOULD CALL:
NAME:
TELEPHONE:

ANALYTICAL REQUESTS

LAB ID CODE	SAMPLE IDENTIFICATION	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE: COMP	SAMPLE TYPE: GRAB	SAMPLE MATRIX: SOLID	SAMPLE MATRIX: LIQUID	SAMPLE MATRIX: SEDIMENT	SAMPLE MATRIX: OTHER	PRESERVATIVE	ANALYSIS

PLEASE INDICATE NUMBER OF BOTTLES

CUSTODY

SAMPLER: DATE:
RECEIVED: TIME:
RELINQUISHED: DATE:
RECEIVED: TIME:
RELINQUISHED: DATE:
RECEIVED: TIME:

COMMENTS, REQUESTS OR REMARKS (Toxic?, Flammable?, Explosive?, High Level?)

*PRESERVATIVE: $NaOH$ H_2SO_4 HNO_3 HCL ASCORBIC ACID

2.4 Analytical Methods (B4)

The testing methods to be used on the samples collected shall be EPA approved methods described in Standard Methods for the Examination of Water and Wastewater, 20th Edition. The designation of EPA approved is based on 40-CFR Parts 136, 141 and 143 "Guidelines for the Analysis of Pollutants under the Clean Water Act; National Primary Drinking Water Regulations; and National Secondary Drinking Water Regulations; Methods Update". Table 7 summarizes the EPA-approved methods.

Table 7 – EPA Approved Testing Methods

Parameter		Testing Method*	
		Standard Method	EPA
Lab Testing			
	Total Suspended Solids	2540D	-
	5-day BOD	5210 B	-
	Fecal Coliform	9221C or E 9222D	132 124
	E. Coli	9221B, F 9223 B 9222 B, G 9213D	 1103.1 1603 1604
	Enterococci	 9230B 9230C	1106.1 1600 143
	Orthophosphate	 4500-P F,E	365.1 365.3
	Nitrite	 4500-NO2 B,F,E	353.2 300.0
	Nitrate	 4110 B	300.0 300.1
	Total Kjeldahl Nitrogen	4500-N_{org} B,C 4500-NH3 C,D,E	351.1 351.2
	Ammonia-N	4500-NH3 B,C,D,E,G	 350.1
Field Testing			
	Dissolved Oxygen	4500-O C,G	-
	Conductivity	2510	-
	pH	4500-H+ B	-
	Temperature	2550 B	-

* Test numbers given are based 40 CFR 122,136, et al. 2007; 20th Edition of Standard Methods for the Examination of Water and Wastewater.

Any analytical failure will be documented by the party committing the failure, be it the laboratory or the sampling crew. This documentation will be sent to Black & Veatch Corp. at the time of the occurrence and noted with the data at the time of data-delivery. Depending on the nature of the failure the data may be thrown out or included with a notation of the failure. Examples of failures include:

- Exceeding hold times (specify amount exceeded)
- Improper preservation
- Experimental error (specify)
- Sample loss/destruction
- Equipment failure (specify)

The documentation will include steps taken to prevent the failure in the future.

2.5 QA/QC (B5)

The Quality Assurance/Quality Control (QA/QC) program implemented for this study will consist of internal QC performed by the lab and external quality assurance performed by Black & Veatch Corp. and/or its subconsultants.

The testing lab will report internal QC performed during sample testing. Internal QC tests include method blank, matrix spike recovery, and matrix spike recovery duplicate. Results from any QC tests performed on lab duplicates created from submitted samples will also be reported. The lab will also submit bench sheets for BOD tests. In some industrial wastes, the dilutions of the BOD test provide different BOD results due to inactivity of organisms at certain concentrations of waste. The cause of variations in BOD test results may be more readily determined by analyzing bench sheet data.

An independent QA program, performed by Black & Veatch Corp. and/or its subconsultants, will include submission of additional samples of known concentration and duplicate and split samples with approximately identical concentrations for testing.

A stock glucose-glutamic acid (GGA) solution will be prepared by the lab and analyzed for 5-day BOD as QA for BOD testing. This stock GGA solution will be as described in Standard Methods for the Examination of Water and Wastewater. The 5-day BOD stock solution will be prepared for each of the three rain events and once for the dry weather sampling.

The duplicate sample will be created in the field by dividing the WWTF influent sample collected approximately one hour after the start of a rain event (for each of two rain events) and by dividing the composite WWTF influent sample collected during dry weather sampling (see Task 5).

A duplicate sample collected from RS 7 will be tested in the lab for E. coli, fecal coliform and Enterococci. The sample will be collected approximately two to four hours after each of the three rain events and at low tide during dry weather sampling.

To ensure that bacteria sample bottles are not contaminated during transport and handling, a sterile sample bottle will be included with each set of bottles provided to each of the two sampling crews for each sampling period. This extra bottle will be handled the same way as the sample bottles, then filled with sterile distilled water and returned to the lab for analysis of Enterococci and fecal and E. coli.

The quality assurance testing schedule is presented in Table 8.

Table 8 – QA/QC Testing Schedule

Parameter	Rain Event No. 1	Rain Event No. 2	Rain Event No. 3	Dry Weather Sampling
5-Day BOD	A	A	A	A
Fecal Coliform	B,C	B,C	B,C	B,C
E. Coli	B,C	B,C	B,C	B,C
Enterococci	B,C	B,C	B,C	B,C
A) Stock Glucose-Glutamic Acid Solution				
B) Duplicate field sample collected from RS 7 approximately two to four hours after the start of each rain event and at low tide during dry weather sampling				
C) Sterile distilled water added to a sterile bacterial sample bottle for each of the river grab sampling periods				

2.6 Instrument Maintenance

2.6.1 Testing, Inspection and Maintenance (B6)

Meters and probes will be used to collect, DO, pH, temperature and conductivity information at all of the sampling sites. Manufacturer's guidelines will be followed when testing and inspecting the meters and probes.

A standard maintenance kit including batteries, calibrations standards and common spare part will be included with each of the meters. The meters will be checked to ensure that they are in working condition before the crews are dispatched to the sampling sites. In the event that one of the metes is not in working condition backups will be available for use.

Any maintenance performed on the meters will be logged by field personnel in their sampling logs.

2.6.2 Calibration and Frequency (B7)

Meters and probes will be calibrated immediately prior to starting each round of sampling. The meters will be calibrated per manufacturer instructions to NIST standards. The calibration for the pH function will be at least a two point calibration and will occur in the field, in addition to the initial calibration check which will be done in the office. Calibration for the conductivity function will be performed with a potassium chloride (KCl) solution in the field. The meters will have temperature compensation; therefore, temperature differences between the sample and the calibration standards will not be an issue.

2.7 Inspection/Acceptance of Supplies and Consumables (B8)

The crew leader of each sampling crew is responsible for inspecting all sample containers to ensure that they are free from any visible defects including, cracks, punctures, poorly-

fitting lids and other apparent flaws. Any container found to be defective should be discarded and replaced.

All containers except the ones used in the automatic samplers will be supplied by the analytical lab. Containers supplied by the lab are received by the lab pre-sterilized; and in the case of bacteria bottles, factory-sealed.

2.8 Outside Data (B9)

Outside data will be obtained from river flow and stage gages operated by the United States Geological Survey (USGS). The USGS maintains continuous records of stage and flow information at locations on the Yantic, Shetucket and Quinebaug Rivers that will be used in this project. These sites are discussed in greater detail in Section 2.1.2. The information will be downloaded from their website (www.usgs.gov) and will be used by the project team to estimate river flow conditions in Norwich during wet-weather events.

2.9 Data Management (B10)

Data collected during this project will be logged electronically into databases maintained in either, Microsoft Excel or Access format. Field data collected by land-based crews may be entered onto chain-of-custody sheets, from which they will later entered into the database. These databases, as well as all other electronic information related to this project will be maintained on Black and Veatch Corp.'s globally accessible, secure web-based server system known as Cygnet. Cygnet is configured to allow access only to project personnel in order to prevent accidental changes to project information. Information stored on Cygnet must be checked-out in order for changes to be made; logs are maintained of who has checked out and changed the data stored on the server.

The Data collected in this project will be used to characterize the receiving waters, provides input for the mixing zone models (CORMIX and PLUMES) and establish the zones of influence (ZOI). These models are and analyses are discussed in greater detail in Tasks 13.

3 ASSESSMENT AND OVERSIGHT

3.1 Assessment and Response Actions (C1)

The assessments planned for this project will include audits of field surveys and verification and validation of data. An audit of the sampling program will be conducted shortly after it becomes operational to verify that data collection is occurring in accordance with this QAPP. The audit will include a review of sampling locations, frequency and timing of sample collection, parameters sampled, sample handling procedures. It will also include a review of documentation related to equipment calibration, sample collection, sample handling procedures, holding times, and chain of custody.

A written report of the results of the audit will be prepared by the QA officer. Any deviations from the QAPP will be noted in the report. The need for corrective actions, if any, will be identified during the audit of field surveys and will be included in the report. Results of the audit will be discussed with the field team leaders prior to the second sampling survey.

Laboratory assessments are detailed in the laboratory QA/QC manual. A further check on laboratory results will be achieved by following the program described in Section 2.5.

Assessments for verification and validation of data are discussed in section 4.

3.2 Reports to Managements (C2)

The report on the audit of field surveys will be prepared and submitted to the project manager. This report will also be included in the final report of the project. Reports from the laboratory containing analytical data will also include a summary of QA/QC procedures and checks performed by the laboratory. Results of the data verification and validation will be included in the final report of the project and will not be submitted in a separate report to management.

4 DATA VALIDATION AND USABILITY

4.1 Criteria (D1)

Data will be reviewed to determine if they meet the criteria for acceptance. If data do not meet the criteria they may be rejected or qualified. For data to be accepted they must meet the following criteria:

1. Actual sample locations and collection procedures were in accordance with those identified in the QAPP.
2. Actual sampling handling procedures were in accordance with those identified in the QAPP.
3. Field QC was conducted in accordance with the QAPP.
4. Equipment was calibrated as stated in the QAPP.
5. Documentation including field data sheets, field notes, and chain of custody forms is complete.
6. Field and laboratory data have been verified and validated.

4.2 Verification and Validation Procedures (D2)

Field data will be verified by an internal review of field data sheets and field notes. After sampling, the field notes and field data sheets will be examined to determine if they are complete and accurate and if the data was collected as stated in the QAPP. Any deviations from the QAPP will be noted and any corrective action required will be discussed with the field team leader prior to continuation of sampling. The reviewer will

also verify that equipment calibration was completed as specified and that proper sample handling procedures were used and that documentation is complete.

The purpose of data validation is to eliminate any unacceptable analytical data and to designate a data qualifier for any data quality limitation discovered. In some cases the analytical data may be used only for estimations. Data validation will be conducted through a detailed examination of the data to determine if parameters are within calibration ranges, if parameters have been correctly identified and to check for data entry errors. All data entered into a spreadsheet or database will be spot checked for accuracy. Maximum and minimum values will be calculated to identify possible outliers and as an additional check on data input errors. Where outliers or extreme values are observed the probe in use will be rechecked to ensure it was properly calibrated. If the outlier was a laboratory sample, documentation on the sample will be rechecked to determine if sample handling or unusual circumstances contributed to the extreme value.

4.3 Reconciliation with Requirements (D3)

This section describes how the validated data will be evaluated to determine if it meets the project quality objectives and measurement performance objectives that were presented in Section 1.2.

Precision. The relative percent difference will be calculated for each field duplicate pair whose original and duplicate values are greater than or equal to the quantitation limit.

Accuracy. Accuracy will be determined through the use of spiked samples or from a standard reference material.

Representativeness. Achieving the goal of representativeness will be determined by evaluating how closely the actual sample collection matched the sample collection plan.

Completeness. Data completeness will be evaluated by determining the total number of planned samples with the number actually collected. This will be compared to the goal for completeness.

Comparability. Data will be compared to performance criteria for precision and accuracy to ensure that different data sets can be compared with confidence.

APPENDIX 2-E

CITY OF NORWICH, CONNECTICUT
DEPARTMENT OF PUBLIC UTILITIES

Phase II CSO Long Term Control Plan

Technical Memorandum

Task 7
DEFINE RECREATIONAL AND AQUATIC LIFE USES OF RECEIVING WATERS

December 2007

Prepared by:

Kleinschmidt
Energy & Water Resource Consultants

For:

BLACK & VEATCH
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NORWICH PUBLIC UTILITIES

LONG TERM CONTROL PLAN-PHASE 2

TASK 7.0 – DEFINE RECREATIONAL AND AQUATIC LIFE USES OF RECEIVING WATERS

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NORWICH PUBLIC UTILITIES

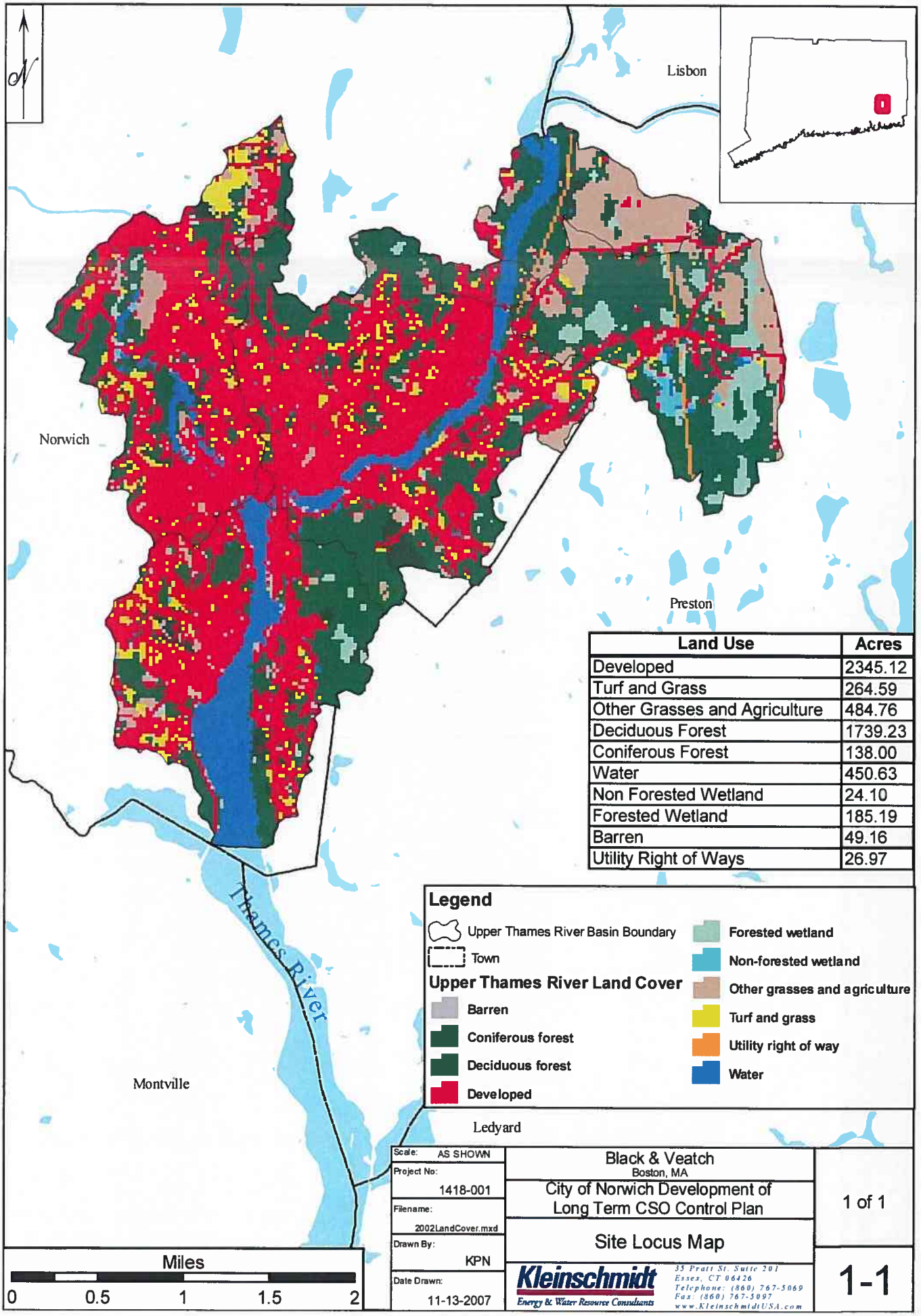
LONG TERM CONTROL PLAN-PHASE 2

TASK 7.0 - DEFINE RECREATIONAL AND AQUATIC LIFE USES OF RECEIVING WATERS

1.0 INTRODUCTION

1.1 Background

The Thames River Basin covers a drainage area of 1,478 square miles, with the major freshwater inputs including the Quinebaug and the Shetucket Rivers (Trench, 2005). The tidally influenced Thames River originates at the confluence of the Shetucket and Yantic Rivers (Norwich Harbor), which is located in the City of Norwich, Connecticut and flows for 16 miles before draining into Long Island Sound. Norwich Harbor itself extends from the confluence with the Shetucket and Yantic Rivers downstream approximately one–half mile (Trench, 2005), and the upper Thames River estuary extends from just south of Poquetanuck Cove, north to the salt water limit in the Norwich Harbor area. As defined by the Connecticut Department of Environmental Protection (CTDEP), the upper Thames River estuary also includes the Shetucket River upstream to the Greenville Dam and the Yantic River upstream to the Falls Mill lower Dam. A saltwater wedge extends upstream along the entire length of the Thames River and it is likely that the higher elevations that surround the Thames River and Norwich Harbor reduce wind-induced mixing and promote stratification (Trench, 2005). Dominant land use patterns adjacent to the Thames and Shetucket Rivers are primarily urban/residential with an agricultural and light industrial component (Figure 1–1).



Land Use	Acres
Developed	2345.12
Turf and Grass	264.59
Other Grasses and Agriculture	484.76
Deciduous Forest	1739.23
Coniferous Forest	138.00
Water	450.63
Non Forested Wetland	24.10
Forested Wetland	185.19
Barren	49.16
Utility Right of Ways	26.97

Legend

- Upper Thames River Basin Boundary
- Town

Upper Thames River Land Cover

- Barren
- Coniferous forest
- Deciduous forest
- Developed
- Forested wetland
- Non-forested wetland
- Other grasses and agriculture
- Turf and grass
- Utility right of way
- Water

Scale:	AS SHOWN
Project No:	1418-001
Filename:	2002LandCover.mxd
Drawn By:	KPN
Date Drawn:	11-13-2007

Black & Veatch
Boston, MA

City of Norwich Development of Long Term CSO Control Plan

Site Locus Map

1 of 1

1-1

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Presently, the upper Thames River estuary is listed by the CTDEP as an impaired water pursuant to §305(b) and 303(d) of the Clean Water Act (CTDEP, 2006). The general causes of impairment cited include excessive nutrients; pathogens; low dissolved oxygen/high oxygen demand; and organic enrichment (CTDEP, 2006). The CTDEP also has designated the upper Thames River estuary as being impaired for recreational use, citing elevated *Enterococcus* levels. *Enterococci* are distinguished by their ability to survive in saline waters, and are typically more human–specific than other bacteria within the larger fecal streptococcus group. For that reason they are considered the best indicator of human health risk for primary contact recreation in saline waters.

1.2 Assessment Objectives

This biological assessment evaluates habitat and aquatic life in the Shetucket and Thames Rivers in the vicinity of the 15 active Norwich CSO discharges. It also considers current recreational uses of these waters. Specific study objectives include the following:

1. Characterization of affected river habitat;
2. Characterization of affected benthic invertebrate communities in the vicinity of each CSO;
3. Characterization of general fish communities in the vicinity of each CSO, including migratory species; and
4. Identification and description of recreational use patterns.

The following section discusses the methods used to address these study objectives.

2.0 METHODS

A key concept underlying the approach to the ecological characterization presented in this assessment is that of "biological integrity". Biological integrity is a theoretically ideal condition that would exist in the absence of anthropogenic disturbance. In order to determine how closely the aquatic communities observed in the Thames and Shetucket Rivers approach biological integrity, specific attributes of the aquatic ecological community were measured.

From August 7 through September 7, 2007 field data were collected so as to effectively characterize the affected environment within the vicinity of the individual CSO discharge plumes (Figure 2–1). Information collected during this one-month period included (1) river habitat properties; (2) fish community composition; and (3) benthic invertebrate community composition.

2.1 River Habitat Characterization

Each CSO location was typically confirmed through the presence of a metal placard that identified the outfall as a City of Norwich CSO. In those instances where the discharge was not clearly labeled, the pipe was GPS located and the location was cross-referenced against its known location. Characterization of physical and chemical river properties started at the most downstream CSO and proceeded upstream sequentially. Within the nearfield environment of each CSO discharge, the following data were recorded: (1) surface water quality: a handheld YSI water quality meter was used to collect data within the surface layer including: dissolved oxygen (mg/L); salinity (‰); temperature (°C); pH; and conductivity (*us*/cm). In addition, a Lamotte turbidity meter was used to assess water clarity expressed in units of nephelometric turbidity units (NTU); (2) water depth: a 25-foot stadia rod was used to determine water depth at each sample location; and (3) substrate type. In deeper waters, sediment samples were collected with a ponar dredge mounted on a 17' Carolina skiff. Specifically, the ponar dredge was used to collect two grab samples at the outfall for a total of 3.78 liters of sample. The two grab samples were then composited and completely homogenized in a stainless steel bowl such that color and texture were uniform. In shallower waters,

Scale: AS SHOWN	Black & Veatch Boston, MA	
Project No: 1418-001	City of Norwich Development of Long Term CSO Control Plan	1 of 1
Filename: CSO_Loc.mxd	Location of Active Combined Sewer Overflows	
Drawn By: KPN		2-1
Date Drawn: 11-13-2007	Kleinschmidt Energy & Water Resource Consultants	

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ten smaller sediment grab samples were collected for a total of approximately 3.78 liters of sample, composited and homogenized in a steel bowl.

Sediment data collected at each CSO included textural analysis; color; odor e.g. H_2S (hydrogen sulfide); and where applicable, sheen. As an added means of characterizing sediments, dominant textural classes were visually documented within a 1m x 1m sample area and assigned a numerical score that increases with particle size (Table 2–1).

Table 2–1. Summary of substrate class scores.

Substrate Class	**Substrate Score**
Silt and Organics	1
Sand and Gravel	2
Cobble	3
Riprap	4
Boulders	5
Bedrock	6

2.2 Benthic Invertebrate Community

Benthic infauna has long been used for water quality assessments because their life history strategies lend themselves to eliciting water quality related effects. Perhaps the most useful aspect of their life history is the fact that benthic infauna are sedentary and can thus be used to gage localized effects with time. In fact, it is this very property that renders benthic invertebrates as the most powerful index of biological integrity; certainly more than mobile fish or planktonic assemblages. Ultimately, benthic infauna can be used as an index of *in situ* relative biotic integrity and habitat quality.

The benthic invertebrate community was sampled within the nearfield environment associated with the discharge plume of the fifteen active CSOs. A random sub–sample of 500 ml was collected from the composited sediment sample at each CSO site and placed in a polyethylene sample container and preserved with a 90% ethanol solution. All pieces of sampling equipment, e.g. ponar dredge, spoons, and bowl, were

rinsed with river water between sample locations in order to dislodge sediment and other debris.

In the laboratory, the sample grabs were sieved through 0.5 mm mesh and fixed in 10% formalin solution for 48 hours. The samples were then removed from formalin, stained with Rose bengal and preserved in 70% ethanol. Samples were sorted with the aid of s dissecting microscope and all macroinvertebrates were removed and identified. Individual organisms were classified and evaluated according to EPA's Standard Operating Procedures for sampling benthic macroinvertebrates. As proposed, and in keeping with the techniques and standards discussed in the USEPA Rapid Bioassessment Protocol (RBP) methodology, up to 100 benthic invertebrate organisms were collected from each 500 ml sediment sample (Plafkin et al., 1989).

2.3 Fish Community

In general, fishes are an important component of estuarine and marine communities, largely because of their aesthetic and ecological roles (USEPA, 2000). Fishes are good indicators of ecological health because (1) they are sensitive to most habitat disturbances; (2) they exhibit avoidance behavior leading to measurable population-level patterns reflecting that stress; and (3) they are a critical nexus between the benthic and pelagic food webs. Furthermore, fishes provide a good measure of integrated environmental health (USEPA, 2000a).

There are however, limitations to using fishes as an index of biological integrity. For example, they are situated within an upper trophic level and would not necessarily serve as an acute index of water quality impairment. Most significantly however, is the issue of spatial scale. Specifically, some fishes are resident species with limited lifetime spatial ranges, whereas other species have large ranges, thus rendering it extremely difficult to isolate probable causes of degradation.

Notwithstanding, in surveys of this type, it is essential that more than one biotic assemblage be included; thus, both benthic invertebrate and fish assemblages were sampled.

2.3.1 Fish Collection

The sampling of the fish community began in earnest on September 5, and given extreme variability in river habitat, employed a combination of (1) hoop netting; (2) trawling; (3) seining; and (4) gill netting. Fish sampling was focused in the general area of an individual CSO discharge plume. However, in those instances where two or more outfalls were located in close proximity, they were pooled and treated as a single sample. Captured fishes were placed into live wells and processed following the sampling event. Each live well was equipped with an aerator to ensure that fishes were not injured during handling. The fishes were identified to the level of species, tallied, weighed (g), and measured for total length (TL) to the nearest millimeter (mm). In addition, the overall health of the fish was characterized and any external deformity, scarring, parasite, lesion, or tumor was recorded on the field data sheet. Atlantic menhaden are vulnerable to ulcerative mycosis induced by the dinoflagellate *Pfiesteria piscicida* and the Oomycete *Aphanomyces invadans* (Dykstra and Kane, 2000). The vulnerability of the Atlantic menhaden to these organisms is heightened in those instances where water quality is poor (Dykstra and Kane, 2000) and particular care was taken when examining collected specimens of Atlantic menhaden, particularly juveniles.

Once all data had been collected, the fishes were then released downstream of the processing station. No mortality of fishes occurred during the sampling. Water quality data were collected with a hand-held YSI unit; water parameters recorded included dissolved oxygen; temperature; pH; conductivity; and salinity.

The following sections briefly summarize each gear type used during the sampling of the fish community.

Hoop Nets

Hoop nets were placed in waters that were inaccessible by boat and that consisted of quiescent pool environments where water depths ranged from 0.91–1.21 meters (m). Specifically, hoop nets were deployed within the vicinity of CSO outfall station(s) 24/25; 22/23; 20; 21; 18/19, and were allowed to fish for a 24-hour period.

Hoop nets are constructed of a series of hoops covered in net webbing that in effect create a series of holding cells. There is a single, narrow diameter internal funnel that prevents the fish from swimming out of the holding cells once they are caught. Once in the net, the fish are extracted from the "cod–end" of the net, which is tied off. In addition to the hoop net assembly, there are two "wing nets" that were oriented at roughly 45° to the long axis of the hoop net, and serve to guide the fishes into the net. Each wing measures approximately 9.1 m in length (18.3 m total), and 0.91 m in height. Both the cod-end of the net and the wings extending into the river channel were weighted with cinder blocks. Where applicable, the shore wing was simply tied off to the nearest holdfast on the shore. Once the nets were deployed, they were checked carefully to ensure that they were set properly.

Trawling

Trawling was conducted at Thames River stations 40, 31, 4, 5, lower Shetucket River stations 17 and 29, and consisted of three, 152.4 m passes with a 4.3 m trawl net centered on each individual CSO (station 40; station 31) and CSO grouping (stations 4/5 and 17/29). The duration of each pass spanned approximately four minutes and at the end of a given tow, all fishes and invertebrates were processed and released. Water quality data were collected at

each CSO station before the tow was conducted. The trawl net is constructed of a mesh with an aperture opening of 6.3 millimeters (mm), and a cod liner comprised of a mesh with 3.1 mm mesh aperture.

Seine Netting

Seine netting was conducted at CSO station 32 within a small cove where water depths measured approximately 1 m and substrates were comprised of a fine to medium sand. The seine net used for this sampling measures 1.8 m high; 15.2 m wide; and possesses a mesh aperture size of 3.1 mm. Seining of CSO station 32 consisted of a 15 minute long haul over approximately 9.1 m to the shoreline. Once on shore, fishes and invertebrates collected in the seine were processed and released.

Gill Netting

Gill netting was conducted at CSO station pair 17/29 with a gill net that measured 91.4 m in length; 1.8 m in depth; and that had a mesh aperture of 152 mm. The net was deployed across the river channel and was allowed to fish for one hour before sample collection and processing.

The following sections discuss the methods employed to translate properties of the fish and benthic invertebrate communities into the biological metric scores used to rank each of the CSO study sites.

2.3.2 Anadromous and Catadromous Fishes

The unimpeded passage of anadromous and catadromous fishes from the estuary into the Shetucket River and other associated rivers is of paramount importance; both from the perspectives of biological conservation and population dynamics. Target anadromous species include American and gizzard shad,

alewife, blueback herring, and sea-run brown trout, whereas the target catadromous species include the American eel.

Steady declines in anadromous and catadromous fish stocks have been heavily influenced by (1) non-fishing human activities in the coastal zone, (2) the effects of suburbanization, and (3) hydrologic barriers. Most significantly however, the damming of rivers for a number of uses ranging from hydropower to flood control has prevented fish from reaching all or portions of their former spawning grounds. Coastal pollution has also reduced the quality and quantity of habitat needed by juvenile fishes to feed and grow successfully. For these reasons, although the removal of physical barriers to fish migration is important to expanding the available spawning range for anadromous fish; there is also a need for improvement to the quality of the watershed's spawning habitat.

Dams located in the Shetucket River and its tributaries pose serious obstacles to migratory passage. In light of the adverse effects dams exert on anadromous fish populations, Norwich Public Utilities (NPU) has provided for the passage of anadromous and catadromous species at the Greeneville Dam (which forms the upper bound of the study area) by installing a fish lift and an eel ladder respectively. The fish lift at the Greenville Dam has been particularly effective: for example, in 1998 over 5,000 American shad were passed.

Given the importance of anadromous species, brief summaries of anadromous fishes are included in this study along with an assessment of their distribution in the study area. The catadromous American eel is also included in this discussion of anadromous fishes. Count data collected by the CTDEP within the Thames River estuary during the months of August, September, and October (2004 through 2006) have also been provided in this discussion of anadromous species. The CTDEP survey includes stations at Coho Cove West and Striped Rock, which are located opposite of CSO station 32 and near the mouth of the Thames River respectively.

2.4 Index Development

2.4.1 Site Classification

The underlying assumption of site classification is that physical habitat and water quality largely determine attributes such as taxa richness, abundance, and species dominance in estuarine communities (USEPA, 2000a). In order to objectively classify sites by habitat type, hierarchical and agglomerative cluster analysis with complete linkage and Euclidean distance was used to cluster CSO sample stations based upon seven habitat variables including: (1) river depth (m); (2) water temperature (°C); (3) dissolved oxygen (mg/L); (4) conductivity (*u*s/cm); (5) pH; (6) salinity (‰); and (7) substrate score. The dendrogram was scaled to a percentage ranging from 0 to 100 where $(D_{link}/D_{max})*100$.

Hierarchical cluster analysis elicits patterns in large, complicated data sets such as the one collected as part of this study. The numbers of clusters were divided into the lowest number of groupings possible, beyond which further divisions yielded little additional information. Additionally, the clusters were checked against the field data collected to ensure they made biological sense. Group clusters have been identified along with supporting descriptive statistics including mean for each of the seven habitat variables.

2.4.2 Multi-metric Index

The use of biologically based metrics facilitates the assessment of the effects of disturbance on ecological receptors. For the metric to effectively address the objectives of this study, it had to possess ecological relevance and sensitivity to the stressors in addition to providing a response that can effectively be segregated from natural variation. The following sections discuss each of the metrics selected from both the benthic invertebrate and fish communities sampled.

Benthic Invertebrates

Descriptive properties for invertebrate collections include total taxa richness (R); abundance (N); Shannon diversity (H_s) (Shannon, 1948); Pielou's evenness index (*j*) (Pielou, 1966); a Hilsenhoff Family Biotic Index (FBI); and finally, the percent contribution of deposit feeders; collector/gatherers; and filterers (Table 2–2).

Table 2–2. Summary of benthic macroinvertebrate community metrics.

Richness	Pollution Tolerance	Trophic/Habitat
• Abundance	• Hilsenhoff Family Biotic Index (FBI)	• % collector/gatherers
• Taxa richness		• % filterers
• Shannon Diversity Index H_s		• % deposit feeders
• Pielou's Evenness Index j		

The characterization of functional feeding groups (under the Trophic/Habitat category) is important in that a shift in a dominant feeding group corresponds with the abundance of a particular food source (Plafkin et al., 1989). In turn, the dominant feeding strategy can then be used to ascribe a specific type of impact on the community (Plafkin et al., 1989). For example, shredders are sensitive to riparian zone impacts and are particularly good indicators of toxic affects (due to either acute or chronic exposure) when the compounds are deposited on coarse particulate organic matter (CPOM), e.g. leaf litter and affect the shredders directly. Grazers and scrapers would also be expected to decrease in disturbed environments. Deposit feeders extract detritus derived from sediments (fine particulate organic matter – FPOM). The detritus comprises dead and decaying plant material, soluble compounds excreted by plants, animals and dead animal remains, and materials from dying phytoplankton blooms. As such, detritus is largely composed of organic material that includes both particulate organic matter (POM) and dissolved organic matter (DOM). Deposit feeders can be especially tolerant of organic pollution.

A modified family-level Hilsenhoff Biotic index (Plafkin et al., 1989) was assigned to invertebrate collections by substrate type. In accordance with the

Hilsenhoff scale, species tolerance values range from 0–10, with a value of zero indicating excellent water quality (organic pollution unlikely), and a value of 10 indicating very poor water quality (severe organic pollution likely) (Hilsenhoff, 1988) (Table 2–3).

Table 2–3. Hilsenhoff scale of organic pollution and associated water quality.

Family Biotic Index	Water Quality	Degree of Organic Pollution
0.00 – 3.75	Excellent	Organic pollution unlikely
3.76 – 4.25	Very good	Possible slight organic pollution
4.26 – 5.00	Good	Some organic pollution probable
5.01 – 5.75	Fair	Fairly substantial pollution likely
5.76 – 6.50	Fairly poor	Substantial pollution likely
6.51 – 7.25	Poor	Very substantial pollution likely
7.26 – 10.00	Very poor	Severe organic pollution likely

Family and species level tolerance values were obtained from published values summarized in Mandaville (2002). Using the tolerance values for each species, a family biotic index (FBI) was assigned where $FBI = \frac{\sum_{i=1}^{k} x_i t_i}{N}$ and x_i = number of individuals within a species; t_i = tolerance value of a species; k = the number of 1…k taxa; and N = total number of organisms in a sample.

Species diversity is an expression of community structure, which varies with both species richness (R) and evenness (j). For example, a community with many equally distributed species will exhibit high species diversity, whereas a community dominated by one or a few species will have low species diversity. For the purposes of discussing overall patterns in invertebrate community diversity, the Shannon diversity index (H_s) (Shannon, 1948) and an assessment of community equitability using Pielou's (j) index were used (Pielou, 1966).

The Shannon information function is represented by a single number that describes the diversity of a given community $H_s = -\sum_{i=1}^{S} p_i \ln p_i$ where: p_i = the fraction of the total sample represented by species i; $\ln p_i$ = is the natural log of the species fraction p_i; and S = the total number of species (species richness). Equitability is

represented by Pielou's community evenness index (j), whereby j is calculated as a proportion of the maximum possible value H would assume (H_{max}) if individuals were completely evenly distributed within the community: $j = \frac{H_S}{H_{max}}$; where H_s = the Shannon information function $-\sum_{i=1}^{S} P_i \ln P_i$; and H_{max}= the theoretical maximum value for H_s if all species in the sample were equally abundant (H_{max}= ln$S$) (Pielou, 1966). The Shannon diversity index is appropriate when dealing with a random sample.

A Morisita coefficient of similarity was calculated in order to further characterize the benthic invertebrate community at each CSO station. The Morisita coefficient of similarity describes similarities in the benthic invertebrate community at each CSO station and explores the degree of species turnover between sites. Although a suite of similarity/dissimilarity indices exist, the Morisita Index of Similarity (MS_{ij}) (Morisita, 1959) was selected for this analysis given its robust nature where $MS_{ij} = \frac{2\sum_{k=1}^{S} x_{ik} x_{jk}}{(\lambda_i + \lambda_j) N_i N_j}$ and MS_{ij} = Morisita similarity index for samples i and j; S = Number of total species; x_{ik} = Abundance of species k in sample i; x_{jk} = Abundance of species k in sample j; N_i = Total individuals in sample i; N_j =Total individuals in sample j; and λ_i, λ_j = Simpson's unbiased diversity estimator for samples i and j where $\lambda_i = \frac{\sum_{k=1}^{S} x_{ik}(x_{ik}-1)}{N_i(N_i-1)}$. The Morisita similarity index ranges from 0 to slightly above 1.0, with a 0 value indicating complete dissimilarity and a value of 1.0 indicating complete similarity. For the purposes of this study, similarity coefficients $\geq$0.75 (75%) are deemed to signify a high degree of similarity. The Morisita index is not affected by sample size.

Significant departures from normality for benthic macroinvertebrate data sets were tested with a Shapiro–Wilk goodness of fit test, which is appropriate in those instances where N<50. Given departures from normality, a non–parametric

Spearman rank order correlation coefficient (Rs) was used to identify the relationships between principal microhabitat variables and multimetric indices for benthic invertebrate and fish collections.

Fishes

The analysis of the fish community included taxa richness; % composition of benthic feeders; abundance expressed as catch per unit of effort (CPUE) with a basic unit of number per hour (No./hr.); and % composition of Atlantic menhaden (*Brevoortia tyrannus*) (Table 2–4). The metric of % Atlantic menhaden is significant in that as a forage species, the Atlantic menhaden is considered to be ecologically critical (keystone species). Moreover, adult Atlantic menhaden are filter feeding planktivores and it has been estimated that this species filter feeds at an estimated rate of 15 liters of water per minute (L/m), which translates into a total volume of 3.9×10^6 L in 180 days (Lippinson, 1991). Given this heightened filtering ability, when present in sufficient numbers, Atlantic menhaden is recognized as potentially having the ability to counter the effects of eutrophication in certain estuaries (Boynton et al., 1995).

Table 2–4. Summary of fish community metrics.

Richness	Pollution Tolerance	Trophic/Habitat
• Taxa richness • Abundance (CPUE No./hr)	• % Atlantic menhaden	• Proportion of generalized benthic feeders

Other descriptive properties of the fish community are provided including relative species composition. Species composition data collected as part of this study have been augmented with data collected in the Thames River by the CTDEP during the 2004–2006 timeframe.

Significant departures from normality were tested with a Shapiro - Wilk goodness-of-fit test, which is appropriate in those instances where N<50. Given departures from normality, a non–parametric Spearman rank order correlation coefficient (*Rs*) was used to identify the relationships between the fish community

metrics, the benthic invertebrate community metrics, and substrate score. This approach was conducted in order to identify potential associations across trophic levels. In those instances where CSO stations were combined for the purposes of sampling the fish community, the fish community metrics were reported separately for both stations in order to increase the degrees of freedom (*df*).

2.4.3 Derivation of Final Site Index

Discrimination Efficiency

As it applies to this study, discrimination efficiency (DE) refers to the ability of a selected biological metric to discriminate the degree to which sites have been impacted. The first step in deriving the final site index involved the identification of those individual metrics that exhibited the greatest estimated DE. In order to achieve this, the estimate for DE was defined through a combination of (1) frequency of detection; and (2) the percentage of those sites with a metric value either below the upper 75^{th} quartile or above the lower 25^{th} quartile of the values reported for all sites. In this regard, the lower 25^{th} or upper 75^{th} quartiles were used depending on how the metric responded to disturbance; that is, the lower quartile was applicable to metrics that increased with disturbance and the upper quartile was applicable to those values that decreased with disturbance.

DE threshold criteria developed for this study maintained that $\geq$50% of the values had to be above or below the applicable quartile. DE was also evaluated with respect to the frequency of detection; that is, the number of CSO metric values >0 also had to be $\geq$50%.

Normalization of Metric Scores

The second step in this process involved the normalization of metric scores. In keeping with USEPA guidance provided in the document *Estuarine and Coastal Marine Waters: Bioassessment and Biocriteria Technical Guidance*

(USEPA, 2000), metric scores were normalized to either the 5th or 95th percentiles depending upon the response to disturbance. In this regard, the 5th percentile was used for metrics that increase with disturbance while the 95th percentile was used for those metrics that decrease with disturbance. As it applied to the data sets collected as part of this effort, the 5th and 95th percentiles corresponded with the minimum (*min*) and maximum (*max*) values respectively, which were subsequently used in this analysis. For the purposes of this discussion, $m_{\min}$ is used to refer to those metrics normalized relative to *min* and $m_{\max}$ is used to refer to those metrics normalized relative to *max*.

With respect to normalizing the raw FBI and % deposit feeder values across CSO stations, the raw value for *min* was subtracted from all values (x) for a given site (j) such that large values became smaller where $m_{\min} = \min - x_j$ (Table 2–5). Assuming that the lowest raw FBI value observed was 0 and the highest raw FBI value was 10, then the lowest possible normalized value ($m_{\min}$) would be (neg.) –10. For similar reasons, the possible range for the normalized % deposit feeders would be 0 to (neg.) –100. The normalization of metric scores to the maximum value ($m_{\max}$) simply consisted of dividing the value (x) of metric (i) for a given site (j) by *max* and then converting the resulting fraction to a % where $m_{\max} = \left(\frac{x_{ij}}{\max}\right) * 100$, thus generating a value that ranged from 0–100. This overall approach was adopted because more information specific to the metric was retained.

Table 2–5. Summary of normalized metric scores.

Metric	Response to Impairment	Score Range	Method
percent collector/gatherer	Reduced	0-100	% of *max* value
% Deposit Feeder	Increased	0 to -100	$min - x_j$
% Hilsenhoff FBI	Increased	0 to -10	$min - x_j$
Benthic Invertebrate *H*	Reduced	0-100	% of *max* value
Benthic invertebrate *j*	Reduced	0-100	% of *max* value
Benthic Invertebrate N	Reduced	0-100	% of *max* value
Benthic Invertebrate R	Reduced	0-100	% of *max* value
% Atlantic menhaden	Reduced	0-100	% of *max* value
Fish CPUE (No./hr.)	Reduced	0-100	% of *max* value
Fish Taxa Richness (R)	Reduced	0-100	% of *max* value

Using this approach, the total range of metric scores is (neg.) –110 to +800 whereby the highest possible score for an excellent site would be 800, and the lowest possible score for a very poor site would be (neg.) –110. Descriptive statistics provided for each metric include sample size (N); mean; Grubb's test for outliers and associated *p*-value; median; upper and lower quartiles; and upper (95%) and lower (5%) percentiles.

As one means of understanding the relationship between CSO metric scores and the effects of habitat, the association between metric scores and the seven habitat properties was assessed with a Spearman rank order correlation coefficient. Backward stepwise linear regression was then used to isolate the single most important habitat variable associated with the metric score. Given the small number of habitat variables (seven), backward stepwise regression was deemed to be a suitable approach.

2.5 Recreation Assessment

The objective of the recreation assessment was to discuss existing recreational uses within the context of current surface water quality classifications and ascribe the potential for adverse human health risk associated with recreational activities in the upper Thames River estuary. The recreation assessment does not constitute either a formal epidemiological study or a human health risk assessment. Rather, the recreation assessment provides a means of qualitatively describing existing surface water quality criteria and circumscribing the variety of potentially adverse impacts on recreational use patterns associated with CSO discharges.

The recreation assessment also identifies those areas formally designated by the CTDEP as recreation areas, e.g. Norwich Marina, Howard T. Brown Park and have been mapped using Geographic Information Systems (GIS) technology. In addition, the types of recreational activities associated with each recreation area have been identified.

A discussion of the impacts to recreational use includes surface water quality classifications and fish consumption advisories, which were used to qualitatively assign a level of human health risk associated with primary and secondary contact with contaminated media, e.g. sediments and surface water. As an added measure, exposure pathways have been identified and assigned to each recreation type. Data sources consulted included:

Connecticut Water Quality Standards. Surface Water Quality Standards. Effective December 17, 2002.

2004 List of Connecticut Waterbodies Not Meeting Water Quality Standards. Final - April 28, 2004.

Connecticut Comprehensive Ambient Water Quality Monitoring Strategy. September 2005.

The 2006 Connecticut Waterbodies Not Meeting Water Quality Standards (Impaired Water List).

A Guide to Safe Eating of Fish Caught in Connecticut. CT Department of Public Health, 2007.

Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. US Environmental Protection Agency (USEPA), November, 2000.

3.0 RESULTS

The following sections summarize the results of the site classification; the nature of the benthic invertebrate and fish communities; the results of the biotic index development; and the recreational analysis. Summaries of benthic invertebrate and fish data are presented in Appendix A and Appendix B respectively.

3.1 River Habitat Characterization

The cluster analysis yielded a total of five CSO habitat groupings that are partitioned largely on the basis of salinity (Figure 3–1). In accordance with the six estuarine zones identified by the Venice system (1959), Groups I (CSO 40) and V (CSO stations 4 and 32) are considered to be mesohaline; Groups III (CSOs 17 and 29) and IV (CSOs 5 and 31) are considered oligohaline; and the largest Group II is limnetic and composed of Shetucket River CSO stations 23, 21, 24, 20, 19, 18, 25, and 22.

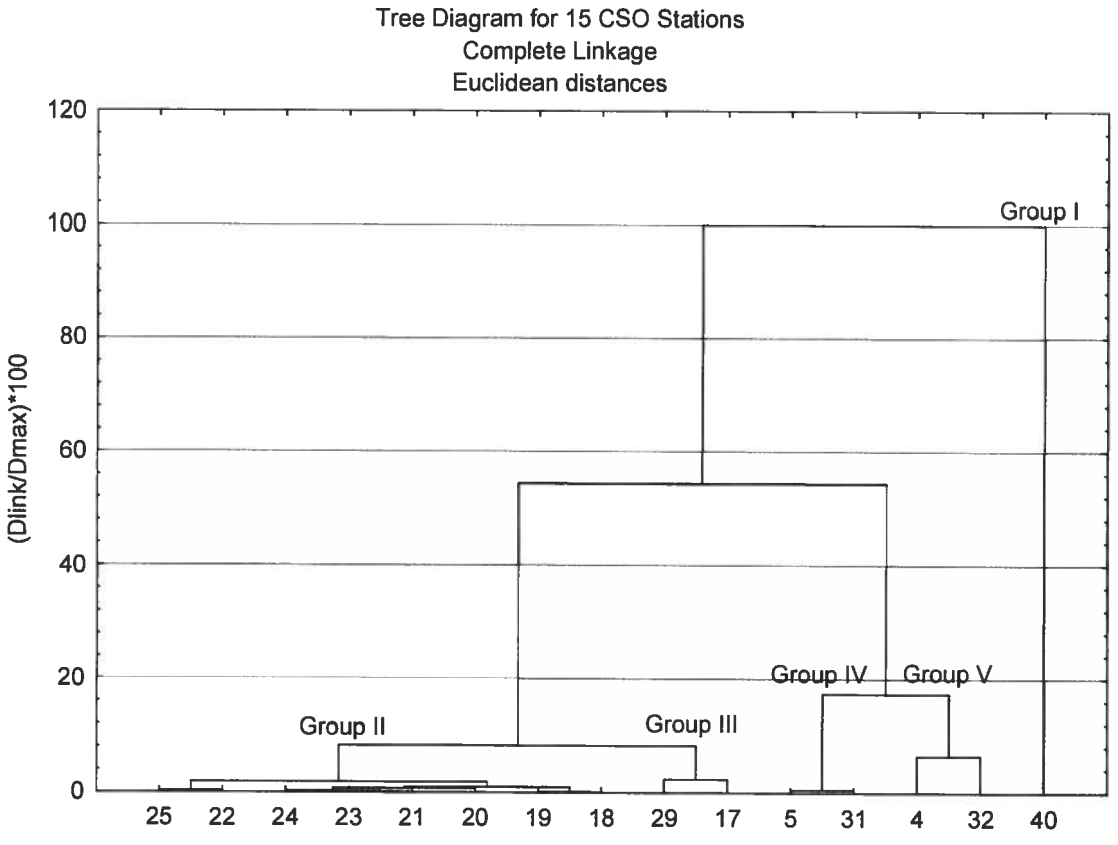


Figure 3–1. Dendrogram indicating CSO habitat groupings.

The mean habitat variables for each cluster grouping indicate that Group I exhibited the highest salinity concentration and the lowest substrate score (fine-grained organic mucks) (Table 3–1). In contrast, the Shetucket River stations exhibited the lowest salinity concentrations and the highest substrate scores (coarse grained sands with some gravel). There is also a distinct depth gradient, with the Shetucket grouping exhibiting the shallowest water depths and the Thames River stations being deeper.

CSO groupings exhibiting the highest levels of turbidity include the Shetucket River grouping (II) and Thames River group I. Dissolved oxygen levels are moderately depressed, with the Thames River CSO station 40 exhibiting the lowest surface dissolved oxygen reading.

Table 3–1. Mean habitat properties ranked by salinity.

	Dissolved Oxygen (mg/L)	pH	Salinity (‰)	Temperature (°C)	Turbidity (NTU)	Conductivity (*us*/cm)	Depth (m)	Substrate Score
Group I	5.99	7.13	15.97	24.90	2.04	23,510.00	2.74	1.00
Group V	6.64	7.41	8.72	25.74	1.65	12,074.50	2.20	1.75
Group IV	7.03	7.32	4.74	25.70	1.44	8,806.50	2.77	2.25
Group III	7.72	7.39	0.86	26.82	1.70	1,744.50	1.79	2.50
Group II	6.93	7.16	0.08	27.26	2.85	176.38	0.40	3.13

3.2 Benthic Invertebrate Community

3.2.1 Community Composition

A total of 1,148 benthic invertebrates were collected and identified during the course of this assessment. In a closer examination of the composition of each of the taxa groups, species that dominate the collections include members of the Oligochaeta (worms) and Diptera (true flies), which cumulatively accounted for 70% of the benthic invertebrate community collected (Figure 3–2). The remaining groups of taxa comprise a small percentage of the total sample and include members of the Polychaeta (worms); Nematoda (aquatic worms); and Bivalvia (bivalves and clams) amongst others.

The relative contribution of pollution intolerant species to the total invertebrate community including the percent EPT (percent of pollution sensitive *Ephemeroptera*, mayflies, *Plecoptera*, stoneflies and *Trichoptera*, caddisflies) is extremely low for members of the Trichoptera and Ephmeroptera, and members of the Plecoptera were completely absent. The high contribution of oligochaete worms and chironomid midge larvae (Chironomidae) is highly suggestive of anoxic sediments and organic enrichment. The family Chironomidae in particular includes several genera such as *Chironomus*; *Procladius*; *Cryptochironomus*; and *Cricotopus* which are generally considered to be the most abundant chironomid genera in heavily contaminated sediments.

Furthermore, species within the family Tubificidae (included under the Oligochaeta) are generally classified as tolerant of a wide range of hazardous compounds in sediments. With respect to the members of the Bivalvia, species of the genus *Sphaerium* may be somewhat tolerant to organic enrichment simply by virtue of belonging to the family Sphaeridae (fingernail clams), which reportedly is tolerant of organic enrichment. Although not identified to the level of genus, it is highly likely that the Sphaeridae identified during this study belong to the genus *Sphaerium*.

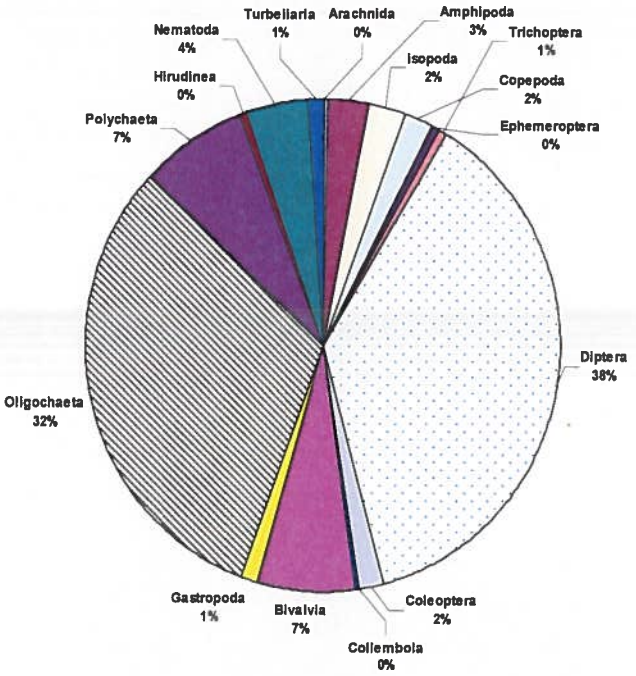


Figure 3–2. Taxonomic composition of benthic invertebrate samples.

With respect to functional feeding groups, the benthic invertebrate collections are co-dominated by collector/gatherers and deposit feeders, which cumulatively account for 84% of the total functional feeding groups observed (Figure 3–3). This pattern more or less mirrors the distribution pattern of the major taxa groups previously discussed. Other feeding strategies observed at low relative percentages include collector/filterer; predator; and scraper amongst others.

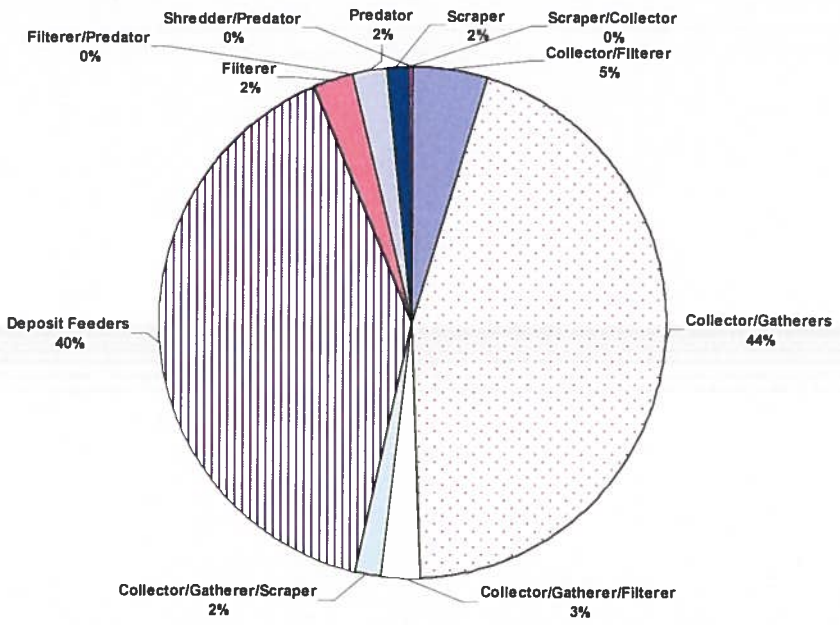


Figure 3–3. Distribution of benthic invertebrate functional feeding groups.

3.2.2 Community Metrics

The relative contribution of deposit feeders is highest at CSO station 24 and lowest at CSO station 17. Filterers are generally low throughout, with the highest relative percentage at site 21, while collector/gatherers are present at nearly all of the sites, with the exception of CSO stations 4 and 40 (Table 3–2).

Based upon the FBI calculation, a bulk of the Shetucket River CSO stations (29, 25, 18, 23, 22, 19, 24, and 20) exhibit very poor water quality (severe organic pollution likely); Thames River CSO stations 4, 5, and 31 exhibit poor water quality (very substantial organic pollution likely); CSO stations 32, 17, and 40 exhibit fairly poor water quality (substantial pollution likely); and CSO station 21 exhibits fair water quality (fairly substantial organic pollution likely).

The Shannon diversity index (H) was highest at CSO station 21 and lowest at CSO station 40. Most observed diversity indices however, ranged from 1.0 to 2.0. Pielou's evenness index indicates that the benthic invertebrate communities are unevenly distributed. In fact, the uneven distribution of organisms is one of the hallmarks of disturbed sediments. Abundance and richness were variable,

with the highest numbers of organisms observed at Station 19 and the highest species richness at Station 21.

Table 3–2. Habitat properties ranked by Hilsenhoff family biotic index.

CSO	% Collector/ Gatherer	% Filterer	% Deposit Feeder	Hilsenhoff Family Biotic Index	*H*	*j*	N	R
29	6.25	0	62.50	8.00	0.83	0.20	16	3
25	37.21	0	54.26	7.95	1.17	0.28	129	8
18	70.71	2.85	20.71	7.89	0.94	0.22	140	8
23	45.59	2.94	38.23	7.83	1.37	0.33	204	12
22	12.90	1.61	64.51	7.76	1.48	0.36	62	14
19	58.40	0	23.52	7.75	1.14	0.27	238	7
24	13.21	3.77	67.92	7.68	1.21	0.29	53	8
20	28.57	0	33.33	7.28	1.85	0.44	21	8
04	0	0	33.33	7.25	1.15	0.28	9	4
05	25.00	0	75.00	6.75	0.74	0.18	8	3
31	9.37	0	71.87	6.62	1.59	0.38	32	6
32	32.56	0	57.36	6.15	1.83	0.44	129	11
17	95.65	0	4.34	6.09	0.35	0.08	23	3
40	0	0	100.00	6.00	0	0	3	1
21	22.22	17.28	4.93	5.74	2.44	0.59	81	17

For the purposes of the following discussion, (-) denotes a statistically significant negative association, while (+) denotes a statistically significant positive association.

The spatial distribution of benthic invertebrates across stations largely reflects observed differences in salinity, depth, and substrate type. Benthic invertebrate abundance exhibited the strongest associations with salinity (-), depth (-), and substrate score (+), while species richness is associated with salinity (-), conductivity (-); and depth (-) (Table 3–3). Of these significant associations, the relationship with depth is the strongest.

The metric of percent collector/gatherer is associated with substrate score only (+); whereas the metric of percent filterer is associated with salinity (-) and depth (-). As such, filterers comprise only a small fraction of the total sample at the Thames River stations, whereas their abundance increases within the freshwater portions of the Shetucket River. The percent contribution of deposit feeders is associated with water temperature (-) and substrate score (-). In

general, deposit feeders are more strongly associated with fine grained sediments. The FBI is negatively associated with conductivity, further emphasizing the fact that many of the limnetic Shetucket River stations (low conductivity stations) are associated with a high FBI.

Table 3–3. Significant Spearman r_s correlations between benthic metrics and habitat properties.

Comparison[A]	r_s	*p*-level
% CG & Substrate Score	0.65	0.007
% Filterer & Salinity	-0.53	0.039
% Filterer & Depth	-0.63	0.011
% DF & Temperature	-0.54	0.034
% DF & Substrate Score	-0.72	0.002
FBI & Conductivity	-0.51	0.048
N & Salinity	-0.55	0.032
N & Depth	-0.87	0.00001
N & Substrate Score	0.56	0.028
R & Salinity	-0.66	0.006
R & Conductivity	-0.58	0.023
R & Depth	-0.75	0.001

[A]: CG = collector/gatherer; DF = deposit feeder; FBI = family biotic index; N = number of organisms; and R = species richness.

Based upon a pairwise comparison of species composition at each of the sites, CSO 17 is quite distinct and did not exhibit a single similarity coefficient above 0.09 (9%) (Table 3–4). Other CSO stations that exhibit apparently distinct benthic invertebrate communities include CSOs 4, 5, 21, 31, and 40. Those stations that exhibit high similarity coefficients, e.g. $\geq$0.75 (75%), do so in a comparison with stations from roughly similar habitats. For example, Shetucket River CSO 20 exhibited a high degree of similarity with other Shetucket stations, whereas the benthic invertebrate communities at the Thames River stations tend to be compositionally similar to other Thames River stations.

There is of course, some overlap between the habitat groupings generated with the cluster analysis. For example, the benthic invertebrate community at mesohaline CSO station 4 is very similar to the community at oligohaline CSO station 29.

Table 3–4. Matrix of Morisita (MS_{ij}) similarity coefficients[A].

	4	5	17	18	19	20	21	22	23	24	25	29	31	32
4	--													
5	0.198	--												
17	0.009	0.048	--											
18	0.12	0.01	0	--										
19	0.211	0	0	**0.982**	--									
20	0.701	0	0.089	0.516	0.663	--								
21	0.147	0.029	0.005	0.265	0.29	0.425	--							
22	0.408	0.004	0	0.298	0.392	**0.781**	0.122	--						
23	0.279	0.017	0.001	**0.876**	**0.919**	**0.789**	0.286	0.666	--					
24	0.41	0.029	0.001	0.466	0.555	**0.833**	0.168	**0.988**	**0.777**	--				
25	0.342	0	0	0.726	**0.79**	**0.852**	0.218	**0.868**	**0.946**	**0.944**	--			
29	**0.818**	0	0	0.259	0.369	**0.855**	0.134	**0.915**	0.596	**0.907**	**0.796**	--		
31	0.593	0	0.055	0.107	0.17	0.551	0.11	0.386	0.268	0.378	0.345	0.543	--	
32	0.25	0	0	0.128	0.148	0.23	0.082	0.095	0.15	0.112	0.145	0.187	**0.899**	--
40	0.17	**0.977**	0.048	0.009	0	0	0.022	0	0.015	0.026	0	0	0	0

[A]: Boldfaced values indicate a high degree of similarity >0.75.

The following sections discuss the nature of the fish community sampled within the study area.

3.3 Fish Community

3.3.1 Community Composition

Using a variety of collection techniques, a total of 394 fishes representing 16 species were collected and identified during the course of this assessment. With respect to the efficiency of the different collection techniques employed, trawling was particularly ineffective within some of the upper Thames River stations and the lower Shetucket River stations due to repeated snagging on boulders and other debris types. Furthermore, species richness in trawl samples was also fairly low. The beach seine method yielded a high number of species and overall abundance, but was restricted in its application. Furthermore, seine netting specifically targeted young-of-year (YOY) fishes and no adults were collected. Hoop nets generally yielded the lowest CPUE and required the greatest amount of sample effort (24 hours).

As anticipated, the fish community comprised fishes occurring across the documented estuarine salinity gradient. In a manner similar to that of the benthic invertebrate community, the fish community is very unevenly distributed and the dominant fishes collected as part of this effort included Atlantic menhaden (*Brevoortia tyrannus*) (51.1%) and the Atlantic silverside (*Menidia menidia*) (23.2%) (Table 3-5). In short, two species comprise nearly 75% of the total fish community sampled.

Fishes observed in the oligohaline and limnetic habitats included white catfish (*Ictalurus catus*); white perch (*Morone americana*); fourspine stickleback (*Apeltes quadracus*); Atlantic menhaden (*Brevoortia tyrannus*); and several centrarchids: bluegill (*Lepomis machrochirus*); pumpkinseed (*L. gibbosus*); and the smallmouth bass (*Micropterus dolomieui*). Species characteristic of saline environments collected within the Thames River included winter flounder (*Pseudopleuronectes americanus*); hogchoker (*Trinectes maculatus*); scup (*Stenotomus chrysops*); northern pipefish (*Sygnathus fuscus*); Atlantic silverside (*Menidia menidia*); Atlantic menhaden (*Brevoortia tyrannus*), and the striped killifish (*Fundulus majalis*).

In no instance was a fish collected that exhibited an external deformity, tumor, or lesion of any kind.

Although fishes were the primary target of the collection effort, several invertebrates were collected as by–catch including the blue crab (*Callinectes sapidus*) and the sand shrimp (*Crangon septemspinosa*). In addition to these species, large numbers of Ctenophora (comb jellies) were encountered within certain of the Thames River trawl net samples.

Table 3–5. Relative percent distribution of fishes, blue crab, and sand shrimp.

Species	Abundance	Relative Percent
Brevoortia tyrannus	211	51.09
Menidia menidia	96	23.24
Ictalurus catus	36	8.72
Apeltes quadracus	18	4.36
Callinectes sapidus	18	4.36
Micropterus dolomieui	11	2.66
Lepomis macrochirus	4	0.97
Fundulus majalis	3	0.73
Morone americana	3	0.73
Pseudopleuronectes americanus	3	0.73
Crangon septemspinosa	2	0.48
Stenotomus chrysops	2	0.48
Alosa pseudoharengus	1	0.24
Unidentified Alosid	1	0.24
Anguilla rostrata	1	0.24
Lepomis gibbosus	1	0.24
Syngnathus fuscus	1	0.24
Trinectes maculatus	1	0.24

The 2004–2006 data set collected by the CTDEP yielded somewhat similar species composition, with Atlantic menhaden as the dominant species (Table 3–6). Atlantic silverside was the next most abundant species, albeit at only 1.9% of the total sample. The greater number of saltwater fishes is reflective of differences in sampling location.

Table 3–6. Relative percent distribution of fish species (CTDEP 2004-2006).

Species	Abundance	Relative percent
Brevoortia tyrannus	23,361	95.538
Menidia menidia	469	1.918
Pomatomus saltatrix	314	1.284
Fundulus spp.	136	0.556
Notropis hudsonius	36	0.147
Morone americana	23	0.094
Pseudopleuronectes americanus	22	0.090
Tautoga onitis	21	0.086
Family Gasterosteidae	16	0.065
Anchoa mitchilli	12	0.049
Caranx hippos	9	0.037
Stenotomus chrysops	5	0.020
Syngnathus fuscus	5	0.020
Anguilla rostrata	4	0.016
Synodus foetens	3	0.012
Gobiosoma bosci	3	0.012
Paralichthys dentatus	3	0.012
Micropterus salmoides	2	0.008
Morone saxatilis	2	0.008
Alosa pseudoharengus	1	0.004
Strongylura marina	1	0.004
Trinectes maculatus	1	0.004
Esox lucius	1	0.004
Catostomus commersoni	1	0.004
Mugil curema	1	0.004

Although the species composition of the CTDEP samples is fairly similar to the results of this current study, additional fishes were noted. Additional species observed by the CTDEP during 2004–2006 include Atlantic needlefish, bay anchovy, tautog, bluefish, crevalle jack, inshore lizardfish, largemouth bass, naked goby, northern pike, summer flounder, spottail shiner, striped bass, white sucker, and white mullet. It is likely that the greater number of saltwater species reflects differences in sampling location, whereby some of the CTDEP stations were located further downstream of the sample stations contained in this study.

3.3.2 Anadromous and Catadromous Fishes

Those fishes collected that pass between saline and freshwater environments during spawning include the catadromous American eel (*Anguilla rostrata*) and the anadromous alewife (*Alosa pseudoharengus*). Species including the American eel and the American shad contribute very little to the overall fish

samples collected as part of this study (Table 3–7), which is an artifact of the timing of the study. The only sites where migratory species were collected occurred at CSOs 18/19 and 20.

Table 3–7. Relative contribution of anadromous species to the total study sample.

CSO Station	Total Abundance (Sample)	American eel (%)	American shad (%)
24/25	6	0	0
22/23	10	0	0
40	24	0	0
31	2	0	0
21	38	0	0
20	128	0.781	0
18/19	37	0	2.702
32	147	0	0
17/29	2	0	0
4/5	0	0	0

The trends observed with respect to the contribution of American eel and American shad are mirrored in the CTDEP data set collected from 2004 to 2006 (Table 3–8), which is also reflective of the timing of the survey, e.g. August-October. Specifically, of the 24,452 fishes collected by the CTDEP during this two-year period, American eel and American shad collectively comprise less than 0.5% of the total sample. These two species were the only migratory species collected by the CTDEP during the 2004–2006 timeframe.

Table 3–8. Relative contribution of anadromous species to the total CTDEP sample.

	Abundance	Relative Percent
American eel	4	0.016
American shad	1	0.004
Total Fishes Collected	24,452	

3.3.3 Community Metrics

The sampling technique that yielded the highest abundance (CPUE) and species richness occurred with the seine net at CSO 32 within shallow waters and upon substrates comprised of fine sand (Table 3–9). The lowest CPUE values were associated with the hoop net, particularly at the Shetucket River stations 22, 23, 24, and 25. Atlantic menhaden were especially prevalent within mesohaline

and oligohaline habitats, although the distribution was patchy and elevated percentages of this species were observed within limnetic Shetucket River stations. The contribution of benthic feeders to the overall sample was highest at CSO station 21 and were absent from CSO station pairs 24/25; 22/23; and 17/29.

Table 3–9. Summary of fish community metrics.

CSO Station	% Atlantic menhaden	% Benthic Feeders	CPUE (No./hr.)	R	Gear Type	Duration of Set (hrs)
24/25	0	0	0.25	3	hoop net	24
22/23	0	0	0.42	1	hoop net	24
40	83.33	16.67	120.0	4	14 ft. trawl	0.2
31	0	100	10.0	2	14 ft. trawl	0.2
21	5.26	89.47	1.58	3	hoop net	24
20	97.66	0.78	5.33	4	hoop net	24
18/19	91.89	5.41	1.54	3	hoop net	24
32	19.05	79.59	588.0	7	seine net	0.25
17/29	100	0	1.60	1	14 ft. trawl/gill net	1.2
4/ 5	No fishes observed in trawl samples.					

With the obvious exception of Atlantic menhaden, many of the fishes observed during this study are benthic feeders with a dietary composition that includes polychaetes, e.g. maldanids, nephthids, nereids, and flabelligerids; gammarid amphipods; caprellid amphipods; isopods; calanoid copepods; and mollusks in addition to other types of benthic invertebrates. Statistically significant associations between fish community metrics and benthic invertebrate community metrics include the negative association between % benthic feeders and the benthic invertebrate FBI (r_s= -0.52; p=0.045). This result indicates that benthic feeding fishes are typically not associated with benthic invertebrate communities that exhibit a high FBI. Fishes did not exhibit a statistically significant association with substrate score.

3.4 Index Development

3.4.1 Discrimination Efficiency

The descriptive statistics generated for each of the metrics indicates that only two of the data sets contain outliers as defined by Grubbs test including

percent filterer and CPUE (Table 3–10). These values were determined to be real and not artifacts of sampling error and were retained in the analysis. The remaining data sets did not contain outliers.

Table 3–10. Descriptive statistics for raw metrics included in discrimination efficiency assessment.

	Valid N	Mean	Grubbs Test Statistic	*p* value	Median	Lower Quart.	Upper Quart.	Percentile 5th	Percentile 95th
% CG	15	30.50	2.37	0.23	25.0	9.37	45.59	0	95.65
% Filterer	15	1.89	3.45	<0.001	0	0	2.85	0	17.28
Hilsenhoff FBI	15	7.11	1.69	1.0	7.28	6.15	7.83	5.74	8.0
% DF	15	47.45	1.90	1.0	54.26	23.52	67.92	4.34	100.0
H	15	1.20	2.01	0.91	1.17	0.83	1.59	0	2.44
j	15	0.29	2.02	0.90	0.28	0.20	0.38	0	0.58
N	15	76.53	2.15	0.57	53.0	16.0	129.0	3.0	238.0
R	15	7.53	2.10	0.68	8.0	3.0	11.0	1.0	17.0
% Atl. Men.	15	39.27	1.29	1.0	5.26	0	91.89	0	100.0
% Benthic Feeder	15	19.82	2.18	0.50	0	0	16.66	0	100.0
CPUE No./hr	15	48.83	3.54	<0.0001	1.54	0.25	5.33	0	588.0
Fish R	15	2.40	2.49	0.13	3.0	1.0	3.0	0	7.0

An assessment of the metrics originally included in the assessment indicates that three metrics including percent Filterer (benthic invertebrate); percent Benthic Feeders (fish); and fish species richness do not meet the DE criteria and were excluded from further analysis (Table 3–11). As such, the following nine biological metrics were carried forward in the ranking process: (1) percent Collector/ Gatherer; (2) Hilsenhoff Family Biotic Index; (3) percent Deposit Feeders; (4) Benthic Invertebrate *H*; (5) Benthic Invertebrate *j*; (6) Benthic Invertebrate *N*; (7) Benthic Invertebrate *R*; (8) % Atlantic Menhaden; and (9) Fish CPUE No./hr.

Table 3–11. Assessment of raw metrics with respect to discrimination efficiency.

	Threshold Used	% </> applicable quartile	Frequency of Detection (%)	Metric Retained?
Benthic Invertebrates				
Percent CG	<upper quartile	73	87	Y
Percent Filterer	<upper quartile	73	33	N
Hilsenhoff FBI	>lower quartile	73	100	Y
Percent Deposit Feeders	>lower quartile	73	100	Y
Shannon diversity H	<upper quartile	73	93	Y
Pielou *j*	<upper quartile	73	93	Y
Abundance (N)	<upper quartile	67	100	Y
Species Richness (R)	<upper quartile	73	100	Y
Fishes				
Percent Atlantic Menhaden	<upper quartile	67	53	Y
Percent Benthic Feeders	>lower quartile	47	47	N
CPUE (No./hr.)	<upper quartile	73	87	Y
Species Richness (R)	<upper quartile	47	87	N

With respect to the summed metric scores for each CSO station, many of the Shetucket River stations and the Thames River station 32 exhibited relatively high metric scores, whereas Thames River stations 40, 5, and 4 exhibited very low relative metric scores (Table 3-12). The reduction in percent collector/gatherers within the Thames River stations may have contributed to this difference. There is also a general increase in the percent contribution of deposit feeders in addition to a reduction in the abundance of benthic invertebrates within those sites with low total metric scores.

Table 3–12. Summary of normalized metric scores.

	Norm. %CG	Norm. %DF	Norm. FBI	Norm. *H*	Norm. *j*	Norm. N	Norm. R	Norm. %AM	Norm. CPUE	Total Metric Score
CSO32	34.04	-53.02	-0.41	75.29	74.92	54.20	64.71	19.05	100.00	368.77
CSO19	61.06	-19.18	-2.01	46.84	46.61	100.00	41.18	91.89	0.26	366.65
CSO21	23.23	-0.59	0.00	100.00	100.00	34.03	100.00	5.26	0.27	362.20
CSO18	73.93	-16.37	-2.15	38.89	38.64	58.82	47.06	91.89	0.26	330.98
CSO20	29.87	-28.99	-1.54	76.19	75.76	8.82	47.06	97.66	0.91	305.74
CSO23	47.66	-33.89	-2.09	56.15	55.93	85.71	70.59	0.00	0.07	280.14
CSO17	100.00	0.00	-0.35	14.59	14.58	9.66	17.65	100.00	0.27	256.40
CSO25	38.90	-49.92	-2.21	48.20	47.97	54.20	47.06	0.00	0.04	184.24
CSO22	13.49	-60.17	-2.02	60.66	61.02	26.05	82.35	0.00	0.07	181.44
CSO29	6.53	-58.16	-2.26	34.06	33.90	6.72	17.65	100.00	0.27	138.71
CSO31	9.80	-67.53	-0.88	65.16	64.41	13.45	35.29	0.00	1.70	121.40
CSO24	13.81	-63.58	-1.94	49.80	49.49	22.27	47.06	0.00	0.04	116.95
CSO4	0.00	-28.99	-1.51	47.13	47.46	3.78	23.53	0.00	0.00	91.40
CSO5	26.14	-70.66	-1.01	30.33	30.51	3.36	17.65	0.00	0.00	36.31
CSO40	0.00	-95.66	-0.26	0.00	0.00	1.26	5.88	83.33	20.41	14.96

The Spearman rank order correlation coefficient indicates that metric scores are largely associated with water depth (m) and substrate score (Table 3–13). Specifically, metric scores increase with a decrease in water depth and with a corresponding increase in grain size.

Table 3–13. Spearman rank order correlations for metric scores and habitat properties.

	Valid N	Spearman - R	t(N-2)	p-level
Metric Score & DO	15	0.47	1.96	0.07
Metric Score & pH	15	0.39	1.56	0.14
Metric Score & Salinity	15	-0.37	-1.45	0.16
Metric Score & Temperature	15	0.46	1.87	0.08
Metric Score & Turbidity	15	-0.43	-1.72	0.10
Metric Score & Conductivity	15	-0.33	-1.26	0.22
Metric Score & Depth (m)	15	-0.67	-3.26	**0.006**
Metric Score & Substrate Score	15	0.58	2.61	**0.02**

When the effects of substrate are removed through a stepwise process however, water depth (m) becomes the primary habitat factor associated with the metric score (Table 3–14).

Table 3–14. Summary of backward stepwise regression results.

Regression Summary $R=0.70$; $R^2= 0.49$; Adjusted $R^2= 0.45$; $F(1,13)=12.64$; $p<0.003$; Std. Error of estimate: 90.31						
	Beta	**Std. Err. - of Beta**	**B**	**Std. Err. - of B**	**t(13)**	***p*-level**
Intercept	–	–	303.16	34.98	8.66	0.000001
Depth (m)	-0.70	0.19	-71.08	19.98	-3.55	0.003

Given the overriding importance of water depth on the metric score, it is important to note that the effects of this habitat property could potentially eclipse those associated with water quality. Although this assertion is somewhat speculative, when it is acknowledged that water depth in this system directly and indirectly mediates habitat properties, in addition to both water and sediment quality, it is lent more credence.

The Thames River estuary would be considered of low quality when compared to a "hypothetical ideal" estuary free of anthropogenic disturbance. Translating the observed metric score into a meaningful context without a reference is difficult, but some qualitative statements can be made regarding the overall absolute quality of the biota sampled as part of this assessment. With the

single exception of Thames River station 32, many of the deeper Thames River stations exhibit biological communities that are of low quality (Figure 3–4). Even the "transitional" stations 17 and 29 located at the confluence of the Shetucket and Thames Rivers are of middling quality, and it is not until reaching the shallower Shetucket River stations that the quality of the biological communities increases. Based upon this trend, it appears the finer grained sediments in the Thames River station are likely of low quality (i.e., characterized by high sediment oxygen demand and potentially elevated levels of compounds that bind preferentially with organic materials, e.g. metals). In turn, this resulted in a poorly developed benthic invertebrate community, which may have resulted in lower numbers of benthic feeding fishes.

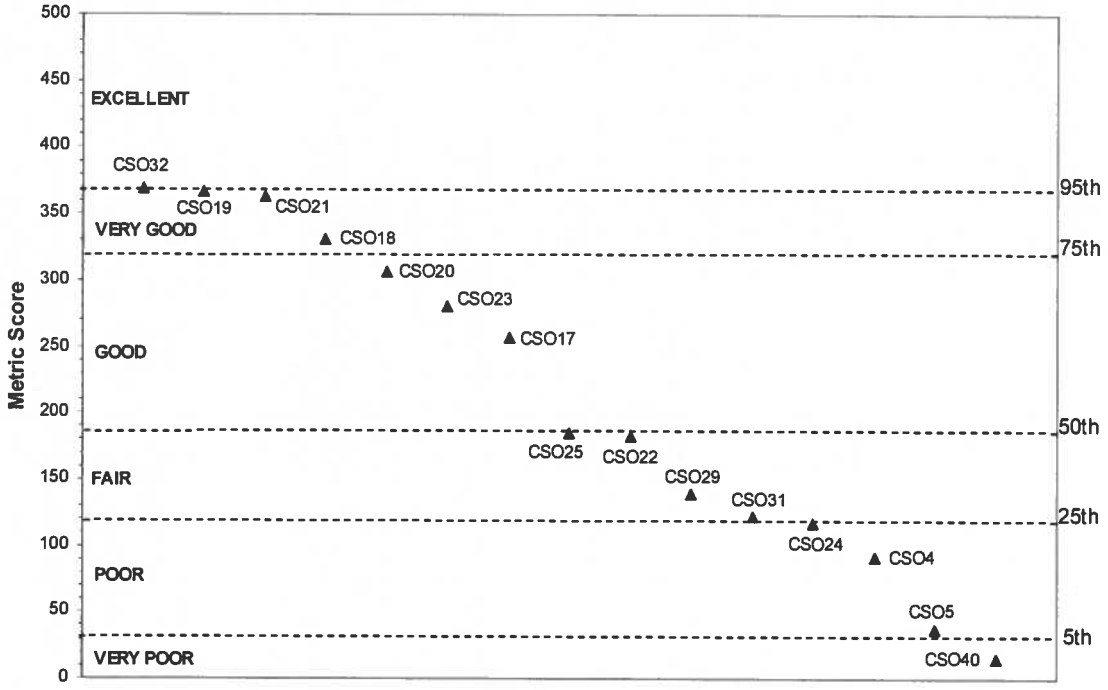


Figure 3–4. Plot of metric scores and corresponding quality of aquatic communities.

The following sections summarize the results of the qualitative recreation assessment conducted within the study area.

3.5 Recreation Assessment

3.5.1 Public Access Points

The CTDEP has designated the following public access points within Norwich Harbor and the Shetucket River as recreation areas: American Wharf Marina, Greenville Dam Fishing Area, Heritage Riverfront Park Walkway, and Howard T. Brown Park (Figure 3–5). In addition, there are a number of private access points including docks and piers not identified by the CTDEP, and trespassers were observed crossing over railroad easements and wire fences along both banks of the Thames and Shetucket Rivers.

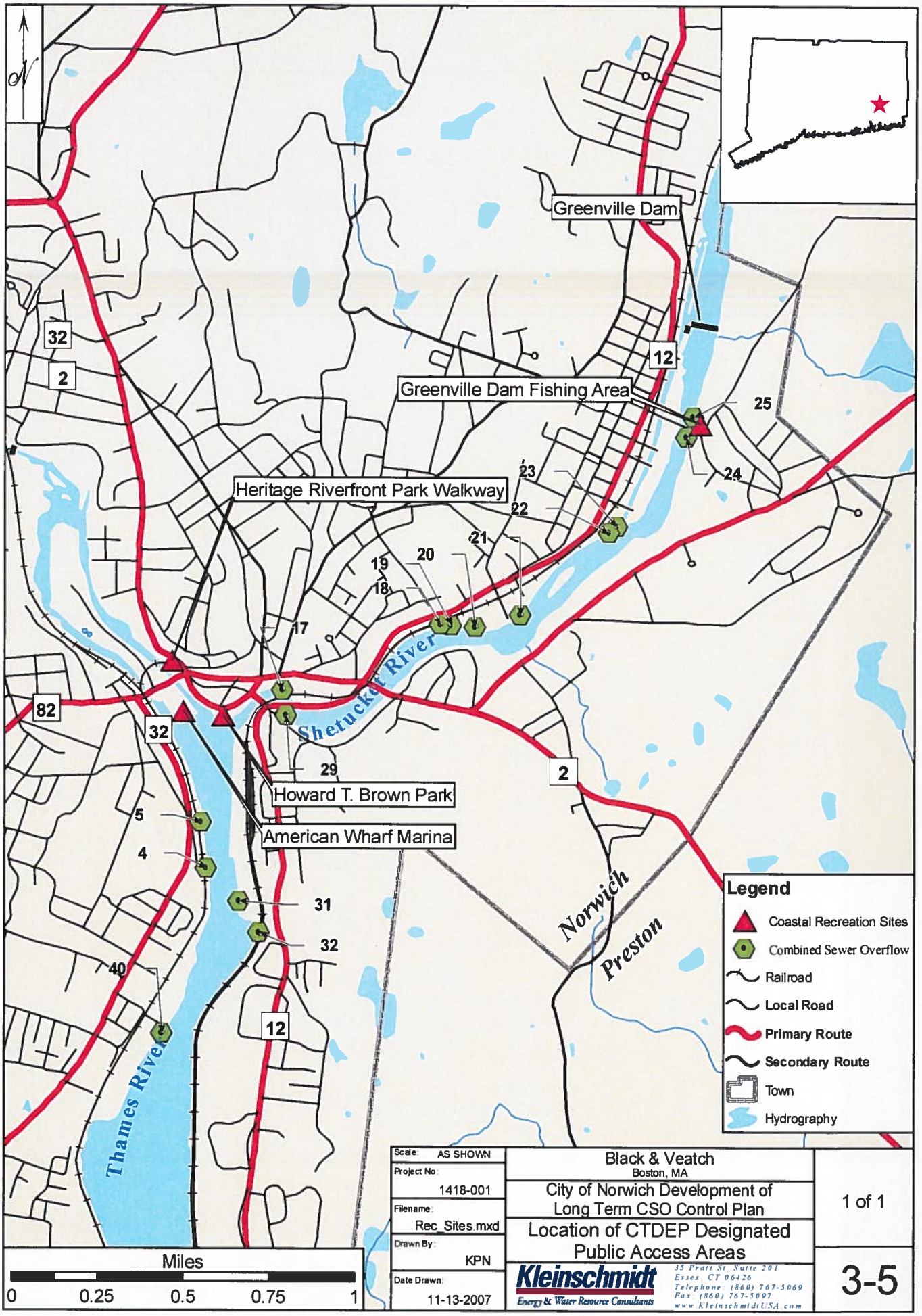
3.5.2 Recreation Activity Types

Based upon information obtained from the CTDEP's *Connecticut Coastal Access Guide* and from field observations made during September of 2007, the public access points provide a range of recreation activities including car-top boating and fishing amongst other activity types (Table 3–15).

Table 3–15. Summary of recreation activity types by recreation area.

	Pier Access	Boat Ramp/Boating	Car Top Boating	Fishing	Crabbing[A]
American Wharf Marina	X				
Greenville Dam Fishing Area			X	X	
Heritage Riverfront Park Walkway				X	
Howard T. Brown Park	X	X	X	X	X

[A]: Based upon field observation only.



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Project No:	1418-001
Filename:	Rec_Sites.mxd
Drawn By:	KPN
Date Drawn:	11-13-2007

Black & Veatch
Boston, MA

City of Norwich Development of Long Term CSO Control Plan

Location of CTDEP Designated Public Access Areas

1 of 1

Kleinschmidt
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www.KleinschmidtUSA.com

3-5

A bulk of the recreation activities identified during the field surveys occurs in Norwich Harbor and the Thames River estuary, with dominant recreational activities consisting of recreational boating and shoreline angling. Shoreline angling was largely restricted to the Thames River at Howard T. Brown Park, although there were isolated instances of anglers in the wadeable portions of the Shetucket River within and immediately downstream of the Greenville Dam Fishing Area. Primary contact recreation does not appear to make up a large component of recreation activities given the developed nature of the surroundings and the depressed water quality; and in no instance were swimmers observed.

The following sections discuss the potential threats to human health associated with the types of recreational activities identified in the Thames and Shetucket Rivers.

3.5.3 Water Quality and Human Health

As assigned by the Connecticut Water Authority (CWA), the Thames River/Shetucket study area has been identified as impaired CT waterbody segment ID CT3000-E_03, which comprises an area of 1.54 square miles. The CWA has designated uses for the Thames River Estuary (CT3000-E_03) for Primary and Secondary Contact Recreation, and Shellfishing. The functional definition of Primary Contact Recreation includes activities such as swimming, water skiing, surfing or other full body contact activities. The functional definition of Secondary Contact Recreation encompasses boating, canoeing, kayaking, fishing, aesthetic appreciation or other activities that do not require full body contact. The environmental indicators that compromise these recreational and shellfishing uses are "indicator bacteria", and that are known threats to public health (CTDEP, 2005).

The _03 segment of the Thames River Estuary does not support either Primary Contact Recreation or Shellfishing. For both uses, the cause (potential cause) of the impaired designated use is indicator bacteria (CTDEP, 2004). For Primary Contact Recreation, the indicator bacterium is *Enterococcus*, with

potential sources originating from waterfowl, agriculture, unspecified stormwater discharges, and CSO discharges. For shellfishing, the indicator bacteria is fecal coliform, with potential sources including waterfowl, unspecified non-point source discharge, CSOs, agriculture, unspecified urban stormwater, marina/boating sanitary on-vessel discharge and discharges from residential districts (CTDEP, 2006).

The CTDEP Water Quality Criteria specific to *Enterococci* and as designated for Recreational Designated Swimming reference a geometric mean less than 35/100 ml (single sample maximum 104/100 ml), and for Other Recreational Uses, a geometric mean less than 35/100 ml (single sample maximum 500/100 ml). For Shellfishing Direct Consumption, the criteria for fecal coliform include a geometric mean less than 14/100 ml (90% of samples less than 43/100 ml). For Shellfishing Commercial Harvesting, the criteria for fecal coliform include a geometric mean less than 88/100 ml and 260/100 ml (CTDEP, 2002).

A qualitative assessment of the likelihood of risk of exposure to media potentially affected by CSO discharge indicates that the highest likelihood of human health risk is associated with car–top boating (Table 3–16). Activities that likely constitute a low risk of exposure include Fishing/Crabbing and pier usage.

Table 3–16. Likelihood of human health risk associated with three recreation types.

Recreational Activity	Risk of Exposure	Exposure Pathways
Car Top Boating	Medium to high	Direct contact with affected waters during loading and unloading; inhalation of water vapor; oral ingestion of surface waters and potentially sediments
Boat Ramp and Boating	Medium	Direct contact with affected waters during loading and unloading; passive exposure through dermal cuts and abrasions
Fishing/Crabbing	Low	Passive exposure to sediments and waters through dermal cuts and abrasions and from the improper washing after handling of fish and crustaceans harvested from affected waters.
Pier Usage	Low	Passive exposure to sediments and waters through dermal cuts and abrasions. Potential inhalation of water vapor.

3.5.4 Fish Consumption Advisory

Based upon field observations and CTDEP designations of recreation activity types, fishing is a significant activity within the Thames River Estuary.

Fish consumption advisories are presently in effect for striped bass; bluefish (>25 inches total length – TL); and bluefish (13–25 inches TL) caught within Long Island Sound and connected rivers, including the Thames River (CTDOPH, 2007). The compound of interest includes PCBs (CTDOPH, 2007), which are associated with potentially adverse health effects on humans (USEPA, 2000b).

Based on concerns about PCB levels in local fish, the Connecticut Department of Public Health (CTDOPH) has imposed fish advisory consumption restrictions upon high risk groups, e.g. pregnant women. The nature of the restrictions includes no consumption for striped bass and large bluefish caught within waters of Long Island Sound and those rivers that discharge to it, while one meal per month is allowed for smaller bluefish (CTDOPH, 2007).

3.5.5 Recreation Areas and Proximity to CSOs

Of the recreation areas examined, only the Greenville Dam fishing area that is upstream of the CSO discharges. Recreation areas that could be impacted by CSO discharges include the American Wharf Marina, the Heritage Riverfront Park Walkway, and the Howard T. Brown Park. Of these recreation areas, the Howard T. Brown Park exhibits the closest proximity to CSO sites with low metric scores.

4.0 SUMMARY

1. A biological assessment of aquatic life in the vicinity of Norwich's 15 active CSO discharges to the Shetucket and Thames Rivers was conducted from August 7 through September 7, 2007. CSO locations and sampling sites are shown on Figure 2-1.

2. Sediment was collected below each CSO discharge site, characterized, and evaluated for benthic invertebrates. Those results are summarized in Figure 3-2.

3. Fish were collected by a variety of techniques, from a total of ten sites adjacent to the 15 CSO discharges. A total of 394 fish representing 16 species were identified. None exhibited external deformities, tumors or lesions of any kind. Results of the fish survey are presented in Table 3-5.

4. Based on a total of nine biological metrics developed from the benthic macroinvertebrate and fish surveys, each CSO station was ranked using a composite of all nine factors. Those metrics are presented in Table 3-12 and depicted graphically in Figure 3-4. The overall quality of the biological communities sampled ranged from very poor to excellent.

5. At the CSO sites sampled, a strong correlation for the biological metrics was observed for two of the habitat characteristics, water depth and type of sediment. Specifically, metric scores for aquatic life improved with decreased water depth and increased sediment grain size. This suggests that the differences in aquatic life observed between the monitoring sites reflect habitat differences as well as (or more than) differences in pollution levels.

6. Local recreational uses of these waters have been identified in section 3.5.5 of this report, and are shown on Figure 3-5.

7. It was not possible from this study to determine the extent to which local CSOs contribute to any degradation of local water quality observed in the aquatic survey. Future sampling done as part of the Norwich CSO Long Term Control Program should be structured to evaluate the impacts of other pollution sources as well, including upstream loading, stormwater runoff, and other local sources.

5.0 LITERATURE CITED

Agency for Toxic Substances and Disease Registry (ATSDR). 1998. Toxicological Profile for Selected PCBs. U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA.

Boynton, W.R., J.H. Garber, R. Summers, and W.M. Kemp. 1995. Inputs, transformations, and transport of nitrogen and phosphorous in Chesapeake Bay and selected tributaries. Estuaries. 18:285-314.

CTDEP (Connecticut Department of Environmental Protection). 2002. Connecticut Water Quality Standards. Surface Water Quality Standards. Effective December 17, 2002.

CTDEP. 2004. 2004 List of Connecticut Waterbodies Not Meeting Water Quality Standards. Final - April 28, 2004.

CTDEP. 2005. Connecticut Comprehensive Ambient Water Quality Monitoring Strategy. September 2005.

CTDEP. 2006. The 2006 Connecticut Waterbodies Not Meeting Water Quality Standards (Impaired Water List).

CTDOPH (Connecticut Department of Public Health). 2007. A guide to the safe eating of fish caught in Connecticut. Pamphlet based on 2007 Fish Consumption Advisory.

Dykstra, M.J. and A.S. Kane. 2000. *Pfiesteria piscicida* and ulcerative mycosis of Atlantic menhaden – current status of understanding. Journal of Aquatic Animal Health, 12: 18-25.

Heuer, O.E., A.M. Hammerum, P. Collignon, and H.C. Wegener. 2006. Human health hazard from antimicrobial –resistant *Enterococci* in animals and food. Clinical Infectious Diseases, 43: 911-916.

Hilsenhoff, W.L. 1988. Rapid field assessment of organic pollution with a family-level biotic index. J. N. Am. Benthol. Soc. 7(1):65-68.

Lippson, R. L. 1991. Atlantic menhaden (*Brevoortia tyrranus*) *in* Funderburk, S. L.; Jordan, S. J.; Mihursky, J. A.; Riley, D. (eds). 1991. Habitat requirements for Chesapeake Bay living resources. Solomons, MD: Chesapeake Research Consortium, Inc.: 7-1 to 7-6.

Mandaville, S.M. 2002. Benthic Macroinvertebrates in Freshwater – Taxa Tolerance Values, Metrics, and Protocols.

McEnroe, M., J. Armstrong, Y. Kuztenova, M. Mazzella, and H. Mutia. 2000. Use of surface respiration by *Fundulus heteroclitus* and *Fundulus majalis* from hypoxia-prone wastern Long Island Sound. *Fish Surviving in Extreme Conditions Symposium*, Proceedings of

the International Congress on the Biology of Fishes, University of Aberdeen, Scotland July 22 – 23, 2000.

Morisita, M. 1959. Measuring of interspecific association and similarity between communities. Mem. Fac. Sci. Kyushu Univ. Ser. E. (Biol.) 3:65–80.

Nacci, D., L. Coiro, D. Champlin, and S.I. Guttman. 2005. Population genetic structure of a non-migratory marine fish *Fundulus heteroclitus* across a strong gradient of PCB contamination. Environmental Toxicology and Chemistry 24(3): 717 - 725.

Pielou, E.C. 1966. The measurement of diversity in different types of biological collections. J. Theor. Biol., 13, 131-144.

Plafkin, J.L., M.T. Barbour, K.D Porter, S.K. Gross, and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and Fish. U.S. Environmental Protection Agency. USEPA 440/4-89/001. 8 chapters, Appendices A-D.

Rein, D., G. Jamesson, and R. Monteith. 1992. "Toxicity effects of alternate disinfection processes." Water Environment Federation 65th Annual Conference & Exposition. Roark, S.A.

Shannon, C.E. 1948. A mathematical theory of communication. Bell System Technical Journal 27: 379-423 and 623-656.

Simon, T.P. 1999. Assessing the sustainability and biological integrity of water resources using fish communities. CRC Press.

Trench, E.M. 2005. The Thames Science Plan: Suggested Hydrologic Investigations to Support Nutrient-Related Water-Quality Improvements in the Thames River Basin, Connecticut. Open-File Report 2005-1208.

USEPA (United States Environmental Protection Agency). 1994. The Comprehensive Conservation and Management Plan for Long Island Sound.

USEPA. 2000a. Estuarine and Coastal Marine Waters: Bioassessment and Biocriteria Technical Guidance. EPA-822-B-00-02.

USEPA. 2000b. Guidance for Assessing Chemical Contaminant Data for use in Fish Advisories. Vol. 2. Risk Assessment and Fish Consumption Limits 3rd Edition. EPA-823-B-00-008.

Venice System. 1959. The final resolution of the symposium on the classification of brackish waters. Archo Oceanogr. Limnol., 11 (suppl): 243–248.

APPENDIX A

BENTHIC INVERTEBRATE SUMMARY DATA

APPENDIX A. SUMMARY OF BENTHIC INVERTEBRATE DATA

Phylum	Class	Order	Family	Functional Group	Biotic Index	4	5	17	18	19	20	21	22	23	24	25	29	31	32	40
Crustacea																				
		Amphipoda	Gammaridae	Collector/Gatherer	6	0	0	21	0	0	1	0	0	0	0	0	0	1	0	0
			Hyalellidae	Collector/Gatherer	8	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0
			Phoxochephalidae	Collector/Gatherer	4	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
		Isopoda	Asellidae	Collector/Gatherer	8	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0
			Cyathuria polita	Collector/Gatherer	5	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0
	Copepoda			Collector/Gatherer	8	0	0	0	1	0	2	4	0	1	0	5	1	2	7	0
Insecta	Hexapoda																			
		Ephemeroptera																		
			Caeniidae	Collector/Gatherer	7	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
			Tricorythidae	Collector/Gatherer	4	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
			Heptiginiidae	Scraper/Collector	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
		Trichoptera																		
			Leptoceridae	Predator	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
			Hydropsychidae	Filterer/Predator	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
			Hydroptilidae	Scraper	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
			Glossomatidae	Scraper	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
			Polycentropodidae	Gatherer/Filterer/Predator	6	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
		Diptera	Chironomidae	Collector/Gatherer	8	0	0	0	98	139	3	8	1	88	7	42	0	0	7	0
			Stratiomyidae	Collector/Gatherer	7	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
			Ceratopogonidae	Collector/Gatherer/Filterer	6	0	0	0	0	0	0	0	2	21	0	5	0	0	0	0
			Culicidae	Collector/Filterer	8	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
		Coleoptera																		
			Elmidae	Collector/Gatherer/Scraper	4	0	0	0	0	0	1	17	1	0	0	0	0	0	0	0
			Halipilidae	Shredder/Predator	5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
			Hydrophilidae	Predator	5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		Collembola	Neelidae	Collector/Gatherer	10	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Mollusca	Bivalvia		Corbicula	Collector/Filterer	6	0	0	0	6	28	3	4	1	3	3	2	0	0	0	0
			Sphaeriidae	Filterer	8	0	0	0	4	0	0	13	1	6	2	0	0	0	0	0
	Gastropoda																			
		Basommatophora	Planorbidae	Scraper	7	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0

			Physidae	Scraper	8	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
		Mesogastropoda	Hydrobiidae	Scraper	7	1	0	0	1	0	1	0	3	0	3	0	0	0	0	0
Annelida	Oligochaeta			Deposit Feeder	5	2	0	0	28	56	7	3	40	76	35	70	10	6	6	0
			Sabellidae	Deposit Feeder	6	1	6	1	1	0	0	1	0	2	1	0	0	0	0	3
		Haplotaxida	Tubificidae	Collector/Gatherer	10	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0
			Acolosomatidae	Collector/Gatherer	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Polychaeta		Polydora cornuta	Deposit Feeder	6	0	0	0	0	0	0	0	0	0	0	0	0	11	54	0
			Polychaeta 2	Deposit Feeder	6	0	0	0	0	0	0	0	0	0	0	0	0	6	12	0
			Polychaeta 3	Deposit Feeder	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
			Polychaeta 4	Deposit Feeder	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	Hirudinea			Predator	10	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0
			Glossiphonidae	Predator	8	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Nematoda				NA	NA	5	0	0	1	10	3	3	0	2	0	0	5	6	13	0
Platyhelminthes		Turbellaria		Predator	4	0	0	0	0	1	0	12	0	0	0	0	0	0	0	0
Arthropoda																				
	Arachnida			Predator	6	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
		Hydrachnida		Predator	6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
					SUM	9	8	23	140	238	21	81	62	204	53	129	16	32	129	3

APPENDIX B

SUMMARY OF FISH DATA

APPENDIX B
SUMMARY OF FISH DATA

STATION ID	SPECIES	TOTAL LENGTH(mm)	WEIGHT(gm)
24/25	*Callinectes sapidus*	70	54
	Lepomis macrochirus	155	65
	Lepomis macrochirus	157	59
	Lepomis macrochirus	142	48
	Lepomis macrochirus	145	65
	Lepomis gibbosus	117	28
	Micropterus dolomieui	197	78
22/23	*Callinectes sapidus*	120	100
	Callinectes sapidus	109	82
	Callinectes sapidus	128	110
	Callinectes sapidus	110	68
	Micropterus dolomieui	107	14.8
	Micropterus dolomieui	78	6
	Micropterus dolomieui	105	13.9
	Micropterus dolomieui	109	14.1
	Micropterus dolomieui	99	13.8
	Micropterus dolomieui	86	8
	Micropterus dolomieui	90	8.9
	Micropterus dolomieui	90	10.2
	Micropterus dolomieui	94	9.9
	Micropterus dolomieui	85	8.7
40	*Callinectes sapidus*	125	80
	Callinectes sapidus	140	125
	Callinectes sapidus	125	140
	Callinectes sapidus	120	100
	Trinectes maculatus	60	2
	Brevoortia tyrannus	35	0.6
	Brevoortia tyrannus	35	0.6
	Brevoortia tyrannus	75	4.1
	Brevoortia tyrannus	30	0.5
	Brevoortia tyrannus	40	0.5
	Stenotomus chrysops	85	8.6
	Brevoortia tyrannus	40	0.6
	Brevoortia tyrannus	41	0.6
	Brevoortia tyrannus	32	0.5
	Brevoortia tyrannus	33	0.5
	Brevoortia tyrannus	29	0.5
	Brevoortia tyrannus	43	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	45	0.6
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	30	0.5
	Brevoortia tyrannus	25	0.5

APPENDIX B
SUMMARY OF FISH DATA

STATION ID	SPECIES	TOTAL LENGTH(mm)	WEIGHT(gm)
	Menidia menidia	40	0.5
	Menidia menidia	25	0.5
31	*Stenotomus chrysops*	135	50
	Menidia menidia	40	0.5
	Callinectes sapidus	100	80
21	*Morone americana*	240	200
	Ictalurus catus	375	600
	Ictalurus catus	415	900
	Ictalurus catus	255	175
	Ictalurus catus	380	600
	Ictalurus catus	350	500
	Ictalurus catus	435	1200
34	*Callinectes sapidus*	150	150
	Ictalurus catus	150	
	Ictalurus catus	370	
	Ictalurus catus	240	110
	Ictalurus catus	230	110
	Ictalurus catus	260	180
	Ictalurus catus	270	210
	Ictalurus catus	265	235
	Ictalurus catus	265	220
	Ictalurus catus	235	140
	Ictalurus catus	250	150
	Ictalurus catus	275	160
	Ictalurus catus	270	200
	Ictalurus catus	270	200
	Ictalurus catus	370	600
	Ictalurus catus	350	600
	Ictalurus catus	280	240
	Morone americana	245	225
	Ictalurus catus	370	700
	Ictalurus catus	245	145
	Ictalurus catus	250	180
	Ictalurus catus	315	400
	Ictalurus catus	260	190
	Ictalurus catus	265	220
	Ictalurus catus	220	140
	Ictalurus catus	250	170
	Brevoortia tyrannus	60	5
	Ictalurus catus	325	400
	Ictalurus catus	290	260
	Brevoortia tyrannus	100	20
	Ictalurus catus	255	175
	Callinectes sapidus	140	170
	Ictalurus catus	230	120
20	*Brevoortia tyrannus*	40	0.5
	Brevoortia tyrannus	40	0.5

APPENDIX B
SUMMARY OF FISH DATA

STATION ID	SPECIES	TOTAL LENGTH(mm)	WEIGHT(gm)
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	35	0.5
	Morone americana	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5

APPENDIX B
SUMMARY OF FISH DATA

STATION ID	SPECIES	TOTAL LENGTH(mm)	WEIGHT(gm)
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5

APPENDIX B
SUMMARY OF FISH DATA

STATION ID	SPECIES	TOTAL LENGTH(mm)	WEIGHT(gm)
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Anguilla rostrata	300	
	Alosid	40	0.5
	Brevoortia tyrannus	40	0.5
18/19	*Ictalurus catus*	340	400
	Ictalurus catus	210	120
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	40	0.5
	Alosa pseudoharengus	45	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5

APPENDIX B
SUMMARY OF FISH DATA

STATION ID	SPECIES	TOTAL LENGTH(mm)	WEIGHT(gm)
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	45	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	40	0.5
	Brevoortia tyrannus	35	0.5
	Brevoortia tyrannus	40	0.5
32	*Callinectes sapidus*	135	125
	Callinectes sapidus	135	130
	Callinectes sapidus	110	86
	Callinectes sapidus	95	30
	Callinectes sapidus	55	20
	Callinectes sapidus		
	Menidia menidia	105	10
	Syngnathus fuscus	165	6
	Menidia menidia	85	6
	Menidia menidia	95	10
	Menidia menidia	65	5
	Menidia menidia	35	0.1
	Menidia menidia	40	0.1
	Crangon septemspinosa	50	1
	Apeltes quadracus	45	0.1
	Menidia menidia	95	4
	Menidia menidia	90	4
	Brevoortia tyrannus	45	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	45	0.1
	Menidia menidia	45	0.1
	Menidia menidia	90	4
	Menidia menidia	95	6
	Menidia menidia	90	6

APPENDIX B
SUMMARY OF FISH DATA

STATION ID	SPECIES	TOTAL LENGTH(mm)	WEIGHT(gm)
	Menidia menidia	75	4
	Menidia menidia	85	2
	Menidia menidia	110	8
	Brevoortia tyrannus	45	0.1
	menidia menidia	85	4
	menidia menidia	110	10
	menidia menidia	90	6
	menidia menidia	90	4
	menidia menidia	85	4
	menidia menidia	85	4
	menidia menidia	105	4
	menidia menidia	75	2
	menidia menidia	35	0.1
	menidia menidia	95	6
	Apeltes quadracus	45	
	Menidia menidia	85	4
	Menidia menidia	110	6
	Menidia menidia	95	6
	Menidia menidia	105	8
	Menidia menidia	95	2
	Brevoortia tyrannus	50	0.1
	Brevoortia tyrannus	35	0.1
	Menidia menidia	90	4
	Menidia menidia	85	4
	Menidia menidia	80	2
	Menidia menidia	35	0.1
	Apeltes quadracus	35	0.1
	Pseudopleuronectes americanus	65	2
	Menidia menidia	100	4
	Menidia menidia	100	4
	Menidia menidia	90	4
	Menidia menidia	100	6
	Menidia menidia	80	2
	Brevoortia tyrannus	45	0.1
	Brevoortia tyrannus	40	0.1
	Menidia menidia	45	0.1
	Brevoortia tyrannus	40	0.1
	Brevoortia tyrannus	40	0.1
	Brevoortia tyrannus	40	0.1
	Brevoortia tyrannus	40	0.1
	Brevoortia tyrannus	40	0.1
	Brevoortia tyrannus	40	0.1
	Menidia menidia	40	2
	Menidia menidia	70	2
	Menidia menidia	80	4
	Pseudopleuronectes americanus	65	4
	Menidia menidia	90	4

APPENDIX B
SUMMARY OF FISH DATA

STATION ID	SPECIES	TOTAL LENGTH(mm)	WEIGHT(gm)
	Menidia menidia	95	4
	Menidia menidia	105	6
	Menidia menidia	95	4
	Menidia menidia	95	4
	Menidia menidia	80	4
	Menidia menidia	100	8
	Menidia menidia	90	6
	Menidia menidia	85	4
	Menidia menidia	85	4
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Brevoortia tyrannus	35	0.1
	Brevoortia tyrannus	45	0.1
	Menidia menidia	90	6
	Apeltes quadracus	40	0.1
	Apeltes quadracus	40	0.1
	Apeltes quadracus	35	0.1
	Menidia menidia	85	2
	Menidia menidia	95	4
	Brevoortia tyrannus	50	0.1
	Brevoortia tyrannus	50	0.1
	Brevoortia tyrannus	30	0.1
	Brevoortia tyrannus	30	0.1
	Pseudopleuronectes americanus	60	1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	45	0.1
	Menidia menidia	90	4
	Brevoortia tyrannus	55	0.1
	Brevoortia tyrannus	55	0.1
	Brevoortia tyrannus	55	0.1
	Brevoortia tyrannus	45	0.1
	Brevoortia tyrannus	45	0.1
	Menidia menidia	95	4
	Menidia menidia	70	2
	Menidia menidia	45	0.1
	Menidia menidia	55	0.1
	Apeltes quadracus	35	0.1
	Fundulus majalis	30	0.1
	Fundulus majalis	30	0.1
	Apeltes quadracus	35	0.1
	Apeltes quadracus	35	0.1
	Apeltes quadracus	35	0.1
	Apeltes quadracus	35	0.1
	Apeltes quadracus	35	0.1

APPENDIX B
SUMMARY OF FISH DATA

STATION ID	SPECIES	TOTAL LENGTH(mm)	WEIGHT(gm)
	Apeltes quadracus	35	0.1
	Apeltes quadracus	35	0.1
	Apeltes quadracus	35	0.1
	Apeltes quadracus	35	0.1
	Apeltes quadracus	35	0.1
	Apeltes quadracus	35	0.1
	Brevoortia tyrannus	50	0.1
	Brevoortia tyrannus	40	0.1
	Brevoortia tyrannus	45	0.1
	Brevoortia tyrannus	35	0.1
	Fundulus majalis	30	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	40	0.1
	Menidia menidia	50	0.1
	Menidia menidia	50	0.1
	Menidia menidia	50	0.1
	Brevoortia tyrannus	35	0.1
	Menidia menidia	80	2
29	*Brevoortia tyrannus*	35	0.1
	Crangon septemsinosa	20	0.1
17/29	*Brevoortia tyrannus*	330	350

CITY OF NORWICH, CONNECTICUT
DEPARTMENT OF PUBLIC UTILITIES

Phase II CSO Long Term Control Plan

Technical Memorandum

Task 12
CSO MONITORING PLAN AND SCHEDULE

April 2010

Prepared by:

BLACK & VEATCH
building a world of difference™

CITY OF NORWICH, CONNECTICUT

PHASE II CSO LONG TERM CONTROL PLAN

Task 12.0 – CSO Monitoring Plan and Schedule

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List of Appendices

Appendix A: Memo to Michael LaLima describing and listing specific equipment required for CSO monitoring at Rose Alley

1 INTRODUCTION

The purpose of this technical memorandum is to develop a monitoring plan and schedule for overflows at Norwich CSOs. The recommended monitoring program will address the following:

1. Review of existing CSO monitoring practices by Norwich
2. Recommendation regarding how many and which of the existing CSOs should be provided with permanent flowmetering
3. Review current flowmetering and data collection technology that may be appropriate for monitoring Norwich CSOs
4. Recommend flow metering system(s) for CSO sites selected
5. Recommend rain gauge(s) to be used in conjunction with monitoring Norwich CSOs
6. Recommend implementation schedule for CSO monitoring
7. Estimate probable cost for implementing recommended flow monitoring program

2 REVIEW OF CURRENT CSO MONITORING PROGRAM

As part of the Rose Alley Combined Sewer Overflow Improvements construction contract, completed in 2000, a Cipoletti weir and a Marsh McBirney Flo-Tote Model MMI 266G open channel flowmeter were installed at the end of the Rose Alley culvert, to measure overflow to the Shetucket River from the Rose Alley Culvert (CSO-017-2). Overflow volume was estimated based on measured height of water above the weir, using a standard weir overflow equation.

At approximately the same time that the Marsh-McBirney unit was placed in service, a Rosemount pressure sensor was installed nearby, adjacent to the second Rose Alley overflow point, a broad-crested weir overflow from a box culvert section of the Shetucket Interceptor (CSO-017-1), upstream of the Rose Alley Pumping Station. Overflow volume at that point was estimated using a broad-crested weir equation.

At the same time, a Rainger tipping-bucket rain gage was installed on the roof of the Rose Alley Pump Station. Data from the rain gage, both flowmeters and the Rose Alley Pump Station flowmeter were collected at the MMI cabinet in the pump station, and this information was used to generate reports correlating rainfall with overflow events. Examples of the monthly reports generated from this data are provided in the June 2004 Wastewater System Facilities Plan, Appendix I.

Both the MMI flowmeter and the Rosemount transmitter failed prior to the spring 2008 field monitoring program, therefore the Rose Alley CSO flowmetering system is no longer functioning.

During the spring of 2008, a collection system-wide flow monitoring program was conducted as part of the CSO Long Term Control Plan. The purpose of this monitoring

program was to calibrate a hydraulic model of the collection system during dry and wet weather events. Portable area-velocity flowmeters were installed at CSO discharges and other strategic points within the collection system during that calibration effort, and removed thereafter.

3 ASSESSMENT OF WHICH CSOs TO MONITOR

The Norwich collection system has fourteen (14) remaining active CSOs. Of those CSO-017 adjacent to the Rose Alley Pumping Station, is the most significant discharge in terms of volume. The calibrated model indicates that during the typical design year of rainfall (actually a synthetic year combining average months over a 40 year period), the total CSO discharged to the Shetucket and Thames Rivers during that year would be 103.4 MG. Slightly over half (51%) of that total, 52.5 MG/year, would be discharged at Rose Alley, CSO-017. All of the other CSO discharges would be significantly smaller in volume; nine of the remaining 13 would discharge less than 5.0 MG in the typical year.

It is important to note that under all of the long term control scenarios currently under consideration either all of the Norwich CSOs would be eliminated, or all would be eliminated except for Rose Alley CSO-017.

Nationally, the general approach to CSO flow monitoring has been to emphasize *representative* monitoring at certain CSOs (typically the larger ones) rather than monitoring at all sites. An example from USEPA Region 1 is MWRA in the Greater Boston area, where the NPDES discharge permit allowed the permittee to develop a monitoring plan based on using flowmeters at approximately 10% of the overflows, and relying on a calibrated model to estimate annual overflow volumes.

Since Norwich now has a calibrated sewer system model and an operating tipping-bucket type rain gage, it would be more cost-effective to measure rainfall and calculate estimated annual overflow for most of the discharges than to install and maintain additional flow monitors in the field. Model results could be corroborated periodically with data from a new permanent flow monitoring station at Rose Alley, which would measure overflows from both CSO-017-1 and CSO-017-2.

Another advantage to this proposed approach of two permanent flowmeters at Rose Alley is that it would assist in achieving one of the goals of the Nine Minimum Controls program, namely to maximize flow to the treatment plant. The current operating practice during wet weather events is to manually reduce the pumping rate at the Rose Alley Pumping Station during major wet weather events, to prevent overtopping the WWTF influent channel and washing out solids from the biological treatment process. A permanent flowmetering station at the Rose Alley CSO discharges with a real-time signal sent back to the WWTF control system would make it possible to monitor overflows more carefully and make incremental adjustments to reduce overflows at Rose Alley in the interim.

The recommended monitoring approach regarding monitoring the 13 other CSOs is to continue the current practice of visually checking the CSO regulators following storm events, to confirm wet weather activations and also to verify that none of the CSOs are discharging during dry weather. The most critical regulators to check after significant wet weather events, based on frequency of activation and overflow volume, are listed in order of importance below. All are in or near the Greenville area of the city.

1. Regulator for CSO-23: At North Main Street, near house No. 352
2. Regulators (2) for CSO-19: (a) At Roath Street at intersection with North Main Street, and (b) At North Main Street north of the DPU entrance
3. Regulator for CSO-21: At Erin Street east of North Main Street
4. Regulator for CSO-24: At Eighth Street, between North Main Street and the Eighth Street Bridge
5. Regulator for CSO-25: At Roosevelt Avenue, east of the Eighth Street Bridge

4 REVIEW OF CSO FLOW MONITORING TECHNOLOGIES

The Shetucket Interceptor overflow CSO-017-1, is in a location that is very difficult to access, inside a box culvert portion of the Shetucket Interceptor. Due to these access challenges, the best option to measure flow depth inside that interceptor is via a pressure transducer mounted on a pipe connected to the interceptor.

Since the other Rose Alley overflow (CSO-017-2), is in a more accessible location, in a chamber upstream of the Rose Alley Pumping Station, there are a number of options available for flow monitoring. This overflow discharges over a Cipoletti weir that was installed in 2000 to facilitate overflow monitoring. Therefore, a functioning flow metering station would only require water depth measurement upstream of the weir. Therefore, area-velocity type meters, such as Doppler or transit time acoustic meters, would not be required in this application. While the discharge is normally free-falling over the weir, the Shetucket River is tidal at that location, and during extreme high tide conditions it is possible for the river to overtop the weir and flow into the collection system. Therefore, it also would be useful to have a water depth sensor downstream of the weir, to detect weir surcharging or backflow conditions that might otherwise lead to overestimating the CSO overflow volume during extreme high tide or flood conditions.

There are several technologies available for measuring wastewater level, including: floats, bubbler/air pressure, radar/microwave, hydrostatic pressure, electronic conductivity and ultrasonic. For this application, the optimal system would be one that would remain out of the flow, which also would be reliable, easy to maintain and cost-effective. Also, since this system will be maintained by treatment plant staff, ideally it would be a technology that plant staff is familiar with. In view of these considerations, and based on discussions with Norwich staff and B&V instrumentations specialists, ultrasonic flowmeters were considered the best option.

5 RECOMMENDED CSO FLOW METERING TECHNOLOGY

The recommended technology for CSO-017-1 is to use a Rosemount pressure transducer to determine level, and estimate overflow using a broad-crested weir equation.

The recommended technology for CSO-017-2 is to install two ultrasonic level sensors in the chamber, one upstream of the weir and one downstream. The downstream reading would be used to verify high tide and reverse flow conditions. These would be mounted on the ceiling of the overflow chamber, in a location to avoid turbulence and with adequate clearance from a proposed underflow floatables baffle.

6 RECOMMENDED RAIN GAUGE

Norwich Pubic Utilities has an automatic recording tipping bucket type rain gage on the roof of the NPU offices at 16 South Golden Street. It measures precipitation in 0.01-inch increments. This was one of the three gages used during the 2008 model calibration effort. It also is being used for the spring 2010 SSES pilot program, programmed to record in 15-minute intervals. This gage, which is in the Greenville area of town and less than a mile from Rose Alley, will meet NPU's needs for future CSO monitoring purposes. NPU also has a similar tipping bucket type rain gage at the Rose Alley Pump Station, the signal from which can be tied into the fiber optic connection at the pump station, for remote access purposes. Therefore, it will not be necessary to purchase a new rain gage.

7 PROPOSED IMPLEMENTATION SCHEDULE

The Floatables and Solids Control Plan is recommending installation of an underflow baffle at CSO-017-1, upstream of the Cipoletti weir, to control floatable solids at that overflow location. It will be important to coordinate location of the ultrasonic level sensor with placement of the baffle, to minimize the potential for interferences that would diminish accuracy of the level reading. Therefore, the underflow baffle and level sensor should be installed at the same time.

A memorandum listing the hardware required for installing the equipment to monitor flow level at CSO -17-1 and CSO 017-2, pull in a signal from the rain gage at Rose Alley, record the data and communicate to the plant control system via the fiber optic link to the pump station is provided in Appendix A.

A proposed schedule to implement the flow monitoring follows.

1. Design underflow baffle and flow monitoring: 1 month
2. Approvals, order equipment and install 2 months
3. Testing, calibration and programming 2 months

8 PROBABLE COST TO IMPLEMENT RECOMMENDED MONITORING PLAN

The estimated cost for installing flow monitoring equipment as recommended above is $10,000-$15,000, depending on the extent to which the installation work is done with NPU staff versus being done by a contractor. This cost estimate does not include the cost of an underflow baffle for solids control at CSO-017-1, which presumably would be done at the same time.

Appendix A:
Memo to Michael LaLima Describing and Listing Specific Equipment Required for CSO Monitoring at Rose Alley

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March 23, 2010

Norwich Public Utilities
Rose Alley CSO Monitoring

MEMORANDUM

To: Michael LaLima, Norwich Public Utilities
From: Chuck Pike and Jeff S. Miller, Black & Veatch
Subject: Equipment Required for CSO Monitoring at Rose Alley

Based on discussions with Jeremiah Kvasnik of Norwich Public Utilities, we have prepared a list of the components that would be required to provide remote flow monitoring at CSO-017 adjacent to the Rose Alley Pump Station. This includes new level monitoring devices at the Cipoletti weir overflow, as well as equipment that would be needed to transmit information to remote locations where it could be used to generate overflow reports.

The ultrasonic units recommended for CSO overflow monitoring at Rose Alley CSO 017 are described in the table below. The downstream device will be used strictly for level monitoring and will be used to signal the PLC that the river is influencing the CSO site by flowing backward over the weir. The upstream sensor will be used to measure depth so that overflow volume can be calculated directly, based on the weir parameters.

Description	Quantity	Manufacturer	Part Number
Ultrasonic transducer, temperature compensated, 6 degree beam angle, Class 1 Div 1 rated, 1" NPT connection, 100 feet of cable	2	Siemens	7ML1118-0BA40
Ultrasonic transmitter, to be located in Rose Alley Pump Station via existing conduit, 120 volts ac powered, one 4-20 milliamp dc output	2	Siemens	7ML5034-1AA01

At the pump station, NPU will need the following components to convey the CSO level and flow signals back to the WWTP.

Description	Quantity	Manufacturer	Part Number
Momentum processor with Modbus TCP Ethernet communication port	1	Modicon	171CCC96030
Momentum Analog Input base, differential type	1	Modicon	170AAI03000
Momentum 120 volt ac Discrete input base	1	Modicon	170ADI54050
Panel and components for mounting PLC inside pump station: Panel (20"W x 20"H x 10" D,NEMA 12) Backpanel	 1 1	Hoffman	 CSD202010LG CP2020

Description	Quantity	Manufacturer	Part Number
Data logger, 4 analog input and 3 discrete input	1	Telog Industries, Inc.	RS-3314
Data logger software	1		S-3PC
Cable for connecting laptop to logger	1		C-21ATC
Ethernet communications module	1		eNET
AC/DC power supply	1		AC24
Terminals for power supply to panel and for analog signal wiring	Lot	Phoenix Contact or Allen Bradley	

NPU will need to run a 120 volt ac circuit to the ultrasonic level transmitters, and also will need a separate conduit for the two analog signals to be routed back to the pump station PLC.

Inside the pump station, implementation will require assembling and mounting the panel to house the PLC and data logger. It will need a 120 volt ac power connection. Sufficient length of CAT 5e cabling will be required between the PLC cabinet and the existing MOXA Ethernet switch in the pumping station.

NPU or its integrator will need to program the PLC and the WWTP SCADA system for transmitting these signals to the WWTP, displaying the information on the SCADA system, and logging the information to history. The PLC will need to provide both an instantaneous flow reading and a daily flow accumulation value. The PLC program also should have the ability to stop accumulating flow in the event that the downstream level measurement is greater than or equal to the weir height, which would indicate a high tide backflow condition.

APPENDIX 2-K

CITY OF NORWICH, CONNECTICUT
DEPARTMENT OF PUBLIC UTILITIES

Phase II CSO Long Term Control Plan

Technical Memorandum

Task 13
Work Plan for Mixing Zones Delineation

August 2008

Prepared by:

BLACK & VEATCH
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CITY OF NORWICH, CONNECTICUT

PHASE II CSO LONG TERM CONTROL PLAN

Task 13.0 – Work Plan for Mixing Zones Delineation

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EXECUTIVE SUMMARY

Purpose

The objective of Task 13 is to develop a work plan describing how mixing zones will be delineated in the Shetucket and Thames Rivers and how acceptable ZOIs can be established for the discharges. This work plan describes the procedures to be used to determine if acceptable mixing zones for achievement of Water Quality Standards in the Thames and Shetucket Rivers can be defined. This work plan also describes how the information developed during the mixing zone study will be used to establish acceptable Zones of Influence (ZOIs) for CSO discharges.

Summary of Work Plan

The work plan includes six subtasks as described in this technical memorandum. The subtasks include the following:

1. Task 13.1 Review Available Data. At the beginning of the mixing zone study, work conducted by other agencies and through other projects will be reviewed to determine if additional sampling data are available that would be useful for the mixing zone study and in the ZOI analysis.
2. Task 13.2 Develop Model Input Data. The input data needed by the mixing zone models includes physical characteristics of the outfall, effluent quality and flow data, and receiving water characteristics. Much of the information needed for the modeling will be obtained during collection system and receiving water sampling to be conducted during Phase 3 of the CSO Long Term Control Plan (LTCP). These sampling plans were developed under Tasks 5 and 6 of Phase 2 of the LTCP.
3. Task 13.3 Conduct Mixing Zone Modeling. Mixing zones in the Shetucket and Thames Rivers will be delineated using data from the sampling program and a USEPA approved model, primarily CORMIX and possibly PLUMES. The models will be used to simulated measured conditions and simulate other critical conditions that were not observed during the sampling events. The mixing zone study will be used to define the depth, width, length and water quality characteristics of the CSO plume. The results produced by the model will be compared to the results obtained during the sampling program to produce a more complete understanding of the mixing process and resulting water quality in the rivers.
4. Task 13.4 Analyze Water Quality. Using information on the effluent quality and background concentrations, the dilutions required to meet water quality standards will be calculated. Data collected during the sampling program will be analyzed to determine the far field mixing of CSO effluent and the rate of decrease of concentrations in the river.

5. Task 13.5 Conduct ZOI Analysis. The results of the mixing zone modeling and data analysis will be used in conjunction with other information to establish a zone of influence. The work conducted to delineate mixing zones and calculate downstream concentrations will be a major factor in determining if acceptable ZOIs can be established for the CSO discharges to the Shetucket and Thames rivers. However other factors, including biological characteristics of the receiving waters, will also be considered.
6. Task 13.6 Prepare Technical Memorandum. The results of the mixing zone and ZOI analyses will be documented in a technical memorandum. Locations where acceptable ZOIs can be established will be identified and supporting information will be provided. This documentation will include information on dilutions, geometric characteristics of the plumes, water quality within and outside of the ZOI, and biological characteristics of the areas identified.

1 INTRODUCTION

In the early 1990s, Norwich Public Utilities embarked on a study of its combined sewer system that involved flow monitoring, stream sampling and creating a Storm Water Management Model (SWMM) of the collection system and tributary areas. That study culminated in the 1994 CSO Modified Facilities Plan, which recommended a program of selected separation for cost effective reduction of CSO discharges.

Implementing the recommended separation projects reduced the 27 CSO discharge points to 15, and eliminated all discharges to the Yantic River and to the non-tidal portion of the Shetucket River upstream of Greenville Dam. The study projected that implementing the recommended projects would reduce total overflow CSO discharge volume by approximately 70 percent in a typical year.

The sewer separation program recommended in the Modified Facilities Plan was implemented in the late 1990s. In 2007, the Connecticut DEP issued an Administrative Order which included a schedule for Norwich to prepare a CSO Long Term Control Plan (LTCP). That plan would recommend a program to take CSO control in Norwich to the next level, focused on meeting water quality objectives in the Shetucket and Thames Rivers. The results of Task 13 – Work Plan for Mixing Zone Delineation, included in that plan, are presented in this Technical Memorandum.

The objective of Task 13 is to develop a work plan describing how mixing zones will be delineated in the Shetucket and Thames Rivers and how acceptable Zones of Influence (ZOIs) can be established for the CSO discharges. A mixing zone is defined by EPA (1994) as:

> A limited area or volume of water where initial dilution of a discharge takes place and where numeric water quality criteria can be exceeded but acutely toxic conditions are prevented.

The CT DEP defines a zone of influence as:

> An area or volume of surface water or ground water within which some degradation of water quality or inconsistency with water quality criteria is anticipated as a result of a pollutant discharge. The term zone of influence may be used to describe an area impacted by thermal, conventional, or toxic pollutants.

This work plan describes the procedures to be used to determine if acceptable mixing zones and ZOIs can be defined in the Thames and Shetucket Rivers. Properly defining the mixing zone requires recognition of the salt wedge that occurs in the Thames River. The wedge inhibits mixing of surface waters from the Yantic and Shetucket Rivers and

the Norwich CSOs with the more saline deeper water. Additional information required for ZOI analysis is described later in this Technical Memorandum.

This Technical Memorandum includes the following information:

- Required inputs to the models and sources of the information
- Description of the modeling approach
- Description of mixing zone models
- Conditions to be simulated
- Procedures to estimate downstream concentrations considering dilutions and background concentrations.
- Procedures to analyze data collected during the wet weather and dry weather sampling
- Use of mixing zone results in the ZOI analysis

2 OVERALL EVALUATION APPROACH

The B&V project team had two meetings with representatives from DEP: a meeting in Hartford on March 27, 2008 followed immediately with a teleconference; and a follow-up teleconference on March 31, 2008. The purpose of the meetings was to gain a better understanding of DEP concerns about the CSO discharges and their expectations of the sampling plan and evaluation. DEP stated that their primary concern was the impacts of the discharges on the Thames River including the areal extent of any contamination and the length of time that elevated concentrations remained in the river.

In the Shetucket River it is anticipated that during major overflow events plumes from several CSOs may merge and influence a large portion of the river. The Thames River will be influenced by both discharge from the Shetucket River and by direct discharges from five CSOs into the Thames River. Evaluation will be conducted with a combination of plume modeling and statistical analysis of sampling data.

Modeling will be used to define individual plumes from CSOs in the Thames River. The purpose of the modeling is to define the areal extent of individual plumes, to calculate dilutions and to evaluate the effects of reducing or eliminating CSOs. Although field data will also provide information on the areal extent and dilution of the CSO discharges, modeling will be used to understand the effect of reducing or eliminating CSO discharges. Additional information on the models to be used, their capabilities and modeling conditions is presented later in this Technical memorandum.

The mixing models typically used to evaluate discharges are steady state models. Therefore, they assume that discharge and ambient conditions do not change. Although they are often used in marine and estuarine conditions with tidal currents and stratification, they are not appropriate for simulating dilution and receiving water concentrations long after discharge has ended. Therefore, mixing models will not be

used to simulate water quality in the river after discharge has ended. Instead this condition will be evaluated based on an analysis of sampling data.

3 REVIEW AVAILABLE DATA

During development of Task 3, previous studies were reviewed to determine the relationship between Norwich CSO discharges and water quality in the Shetucket and Thames Rivers. That work relied primarily on information from the CT DEP (2006) and from the USGS (Trench, 2005). At the beginning of the mixing zone study, work conducted by other agencies and related projects, will be reviewed to determine if additional sampling data are available that would be useful for the mixing zone study and in the Zone of Influence analysis. Information from the following sources will be reviewed to determine if additional sampling data are available for use in the modeling study:

- Project Oceanology
- Applied Sciences Associates
- Metcalf & Eddy
- Hydroqual
- USGS
- USEPA
- WaterWatch

4 DEVELOP MIXING MODEL INPUT DATA

When combined sewage is discharged into receiving waters, the velocity of the jet and buoyancy of the effluent will cause turbulent mixing with the surrounding water. After this initial mixing, the effluent plume moves primarily horizontally with the currents. As the effluent plume is carried away by the currents, additional mixing occurs, although typically to a lesser degree than the initial mixing. The dilution achieved and the size and location of the effluent plume are affected by the density and stratification of the receiving water and by ambient currents.

Mixing zone models require the type of input information listed below.

1. Physical Characteristics of the Outfall
    - Depth of the outfall and reference point, i.e., mean sea level, mean low water, or other zero point.
    - Exact location of the discharge point
    - Configuration of the outfall including the angle or discharge relative to the river and shape and diameter of outfall.

2. Effluent Data
    - Measured concentrations of parameters of concern
    - Temperature and salinity or total dissolved solids (TDS) of the effluent during discharge
    - Flow rates
3. Receiving Water Data
    - Measured concentrations of parameters of concern in the receiving water
    - Salinity and temperature data near the outfall
    - River flow data and river cross-section data including average depth and width
    - Information on water quality, circulation, or mixing studies that may have been conducted by others

Information on the physical characteristics of the outfall structures will be obtained from the 1994 CSO study (Black & Veatch, 1994) and will be supplemented with information obtained during monitoring of the collection system and outfalls. Information on the effluent data will be obtained during the sampling program to be conducted during Phase 3 of the project. Details of the CSO collection system sampling plan were developed under Phase 2 Task 5 of the CSO LTCP and are contained in the Technical Memorandum for that task. Information on the receiving water will be obtained from the Phase 3 sampling program, from USGS gaging stations, and from previous studies. A Quality Assurance Project Plan (QAPP) containing details of the sampling program has been prepared as part of the work conducted during Phase 2, Task 6 of the LTCP.

5 CONDUCT PLUME MODELING

5.1 Modeling Approach

Mixing zones in the Thames River will be delineated using data from the sampling program and a USEPA approved model, primarily CORMIX and possibly PLUMES. The models will be used to simulate measured conditions and simulate other critical conditions that were not observed during the sampling events. The mixing zone study will be used to define the depth, width, length and water quality characteristics of the CSO plume. Results of this study will be an important element in the Zone of Influence (ZOI) analysis to be conducted during Phase 3 of the project.

The two most common mixing models used today are CORMIX and PLUMES. CORMIX is most often used for river and lake modeling while PLUMES is primarily used for marine or estuarine environments. Both models require the same type of input data and both models predict dilutions and provide information on the width, depth and location of the effluent plume. Additional information on each of these models is provided in sections 5.2 and 5.3.

CORMIX will be the primary model used in the mixing zone delineation. However, it may be necessary to supplement with some additional PLUMES model runs. CORMIX

simulates the effects of discharging near the river bank or near the bottom. However, CORMIX uses simplified stratification profiles as discussed in Section 5.2. If the monitoring data show that the stratification profiles measured in the rivers is similar to the profiles used by the model there will be no need to perform any PLUMES modeling. However, if the density profiles are more complicated, some additional PLUMES modeling may be needed to enhance our understanding of mixing within the river.

The PLUMES model does not consider the effect of boundary conditions and therefore can not simulate bank or bottom attachment of a plume. In addition, it is best used for submerged outfalls. For these reasons it is not the best model for this application. However, any stratification profile can be used as input to the PLUMES model. Therefore, in cases where stratification is very different from the profiles used by CORMIX, PLUMES may be used to examine mixing within the zone of initial dilution close to the point of discharge. This information would be used to interpret the results of the CORMIX modeling.

5.2 CORMIX

The CORMIX system is a computerized methodology for predicting the flow classification, dilution, and plume trajectory of the hydrodynamic mixing processes resulting from different discharge configurations into streams, rivers, lakes, reservoirs, estuaries, and coastal waters. The users' manual (Jirka et al., 1998) includes several references documenting that the model has been verified by the developers, has undergone independent peer review in journal proceedings, and is applicable to a wide range of situations. CORMIX1 applies to submerged single-port designs, CORMIX2 applies to multiport diffusers, and CORMIX3 applies to surface discharges.

Information about the density distribution in the ambient water body is very important for the correct prediction of effluent discharge plume behavior. CORMIX provides to option of specifying whether the ambient water is fresh water or non-fresh (i.e. brackish or saline). The user then specifies whether the ambient density can be considered as uniform or as non-uniform within the expected plume regions. For uniform conditions, the average temperature (for fresh water) or average ambient density (for non-fresh water) must be specified.

If conditions are non-uniform, CORMIX requires that the actual measured vertical density distribution be approximated by one of three schematic stratification profile types. As shown in Figure 1, the three types include a linear density profile, a two-layer system with constant densities and density jump, and a constant density surface layer with linear density profile in bottom layer separated by a density jump.

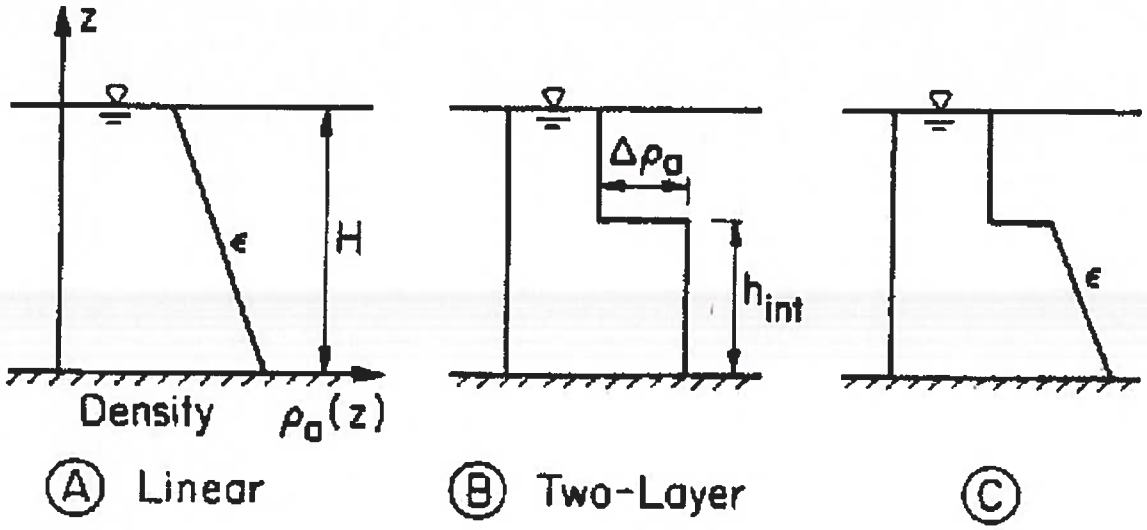

Figure 1. Density Profiles Used by CORMIX (from Jirka et al., 1998)

CORMIX3 will be the primary model used for the mixing zone analysis. Figure 2 shows the different configurations of outfall relative to the bank that can be simulated in the model. Figure 3 is a sketch for the discharge geometry and flow characteristics for a buoyant surface discharge.

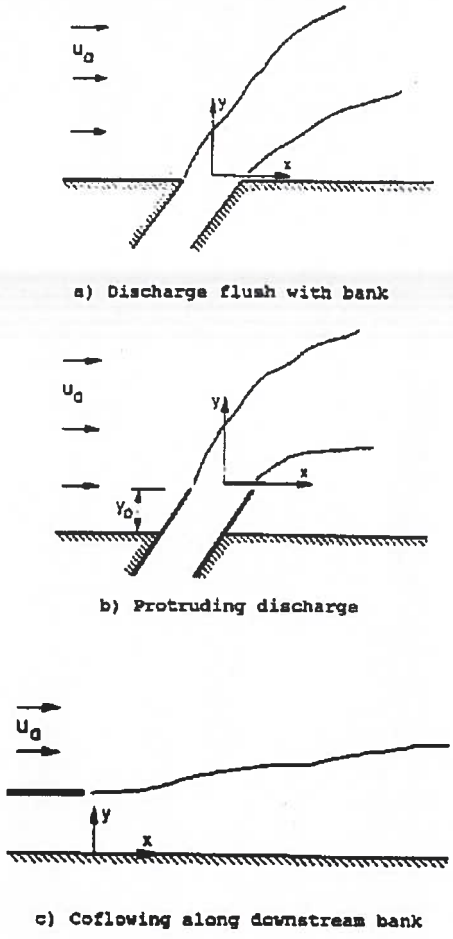

Figure 2. Discharge Configurations

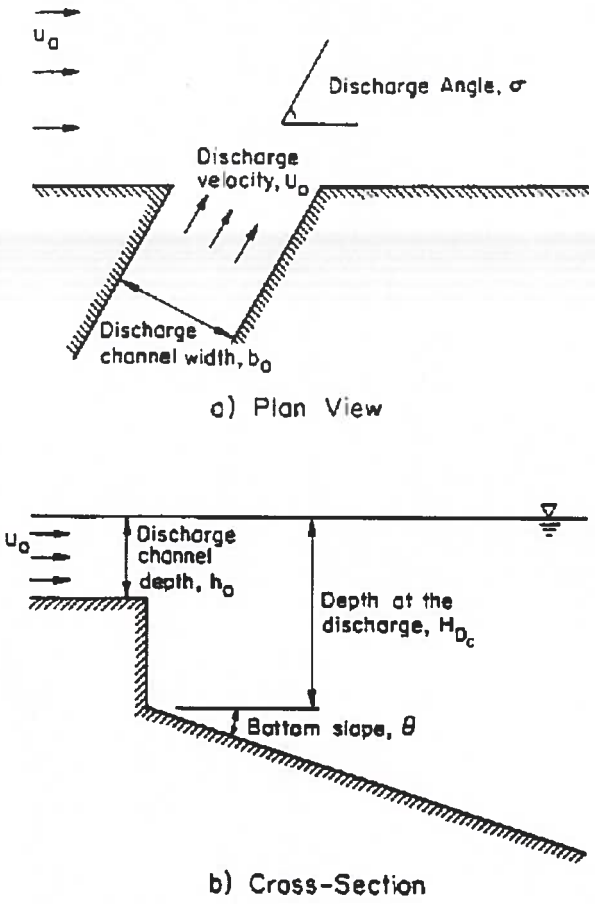

Figure 3. Discharge Channel Geometry

Inputs required by the CORMIX model include information on the discharge configuration, receiving water characteristics, and effluent characteristics. Important receiving water characteristics include river velocity and density. Important effluent characteristics include effluent flow rate and density.

5.3 PLUMES

CORMIX modeling may be supplemented with some additional PLUMES modeling if complicated stratification profiles are measured during the field surveys. Visual Plumes (VP) is a Windows-based model that supersedes the DOS PLUMES mixing zone model (Baumgartner et al., 1994). VP simulates single and multiport submerged outfalls in stratified flow and buoyant surfaces discharges. VP includes several models including some that were included in PLUMES (Baumgartner et al., 1994) and earlier versions.

However, additional features have been incorporated including a multi-stressor pathogen de cay model that predicts coliform mortality based on temperature, salinity, solar insolation and water column light absorption. The Brooks equations have also been kept in the model to simulate far field transport and dilution.

5.4 Conditions to be Modeled

The mixing zone models will be run to determine the extent of mixing, locations of the plumes and dilutions achieved in the mixing zone for each of the Thames River CSOs during each of the storms sampled. It is expected that the three storms to be sampled will provide a representative range of conditions that occur during CSO events. However, an additional critical condition will be modeled if needed. The need for additional modeling will be determined in conjunction with DEP. The decision will be based on the type of storm events sampled and a determination of how representative they were of critical conditions in the rivers. Additional sampling will not be conducted in conjunction with modeling an additional critical condition.

The results produced by the model will be compared to the samples results obtained during the sampling program to produce a more complete understanding of the mixing process and resulting water quality in the river. However, it is not expected that model results will exactly match measured conditions. Differences between modeled and measured conditions will arise for two primary reasons; first because it is recognized that the model is not completely accurate and second, because neither of the mixing models are capable of simulating some of the field conditions. For example, in both the Thames and Shetucket rivers there are locations where CSO discharges occur at approximately the same location on opposite sides of the rivers. In other cases there are discharge points very close together so the plume from one discharge point may overlap the plume from the another discharge point. The models are not capable of simulating these conditions exactly. It may be necessary to model select outfall locations as combinations of two (2) or more outfalls. It will be important to use both the model results and the sampling data to describe the mixing zones. Locations of the CSO outfalls were carefully considered when selecting station locations for sampling (Task 6). Sampling stations were selected to represent boundary conditions, to characterize water quality at several locations within the influence of CSO discharges and to characterize cross-channel difference in water quality.

6 ANALYZE WATER QUALITY

Data collected during the sampling program will be analyzed to determine the far field mixing of CSO effluent and the rate of decrease of concentrations in the river. This information in combination with results of the plume modeling will determine expected dilutions in the river. Using information on the effluent quality and background concentrations, the dilutions required to meet water quality standards will be calculated. The dilution information will be used to determine if a mixing zone can be used to achieve water quality criteria.

Concentrations of pollutants in the Thames River will decrease due to mixing, settling, and die-off. Concentration data collected in the sampling program will be analyzed to develop correlations between receiving water concentrations and river discharge, effluent discharge, downstream location and time.

The data analysis will also include an evaluation of the salinity profiles to determine the extent of stratification and provide an indication of mixing of surface and bottom waters. A mass balance approach will be used to track the inputs and removal of bacteria from the system. This approach will consider the quantity and timing of loads from the CSO discharges, the WWTP, and nonpoint sources. Nonpoint source loads will be defined by the sampling data characterizing water quality in the Shetucket and Quinnebaug Rivers upstream of the CSO discharges. The mass balance will consider four river reaches, the Shetucket River, the Yantic River, the portion of the Thames from Norwich Harbor to Trading Cove, and the portion of the Thames River between Trading Cove and Poquetanuck Cove. The results of the data analysis will be used to describe how effluent mixes and disperses in the river and is flushed out of the river.

The dilution required to meet water quality criteria can be calculated from effluent and background concentrations. Dilution, as calculated by the mixing models, is expressed by the equation:

$$S = (EC-BC)/(C-BC)$$

where:

S = the dilution after mixing
EC = the effluent concentration
BC = the background concentration
C = the concentration in the receiving stream after mixing.

Using this definition of S, dilution is expressed as a single number, not as a ratio. For example, a dilution of 10 is equivalent to 9 parts receiving water and 1 part effluent (or a dilution of 9:1). This is the most common definition of dilution and for the case when the background concentration is zero, the concentration after mixing equals the effluent

concentration divided by the dilution. By setting the concentration in the equation to the water quality standard, the minimum dilution required to achieve the water quality criteria can be calculated. Finally, it will be determined if mixing zones can be established by comparing the required dilutions with the dilutions achieved in the river.

7 ZOI ANALYSIS

The results of the mixing zone model will be used in conjunction with other information to establish a zone of influence. Zones of influence may be established by DEP on a case-by-case basis when permitting discharges in order to allocate a portion of the receiving waters for mixing and assimilation of the discharge. Water Quality Criteria apply outside of the zone of influence for a discharge. The area and/or volume of the receiving water allocated to a zone of influence are determined based on the unique physical, chemical and biological characteristics of the receiving water. In establishing a zone of influence five factors must be considered:

- Characteristics of the discharge
- Allowance of a continuous Zone of Passage for free swimming and drifting organisms
- Effects of the discharge on spawning grounds or nursery areas of sensitive organisms or on areas used by aquatic organisms for shelter and living space
- Effects of the discharge on the aesthetics quality of the receiving water
- Location of the discharge with respect to other discharges and the cumulative effect of multiple discharges.

If acceptable ZOIs are established for some of the CSOs it will affect the overall level of control required of the CSO discharges to a given segment. The work conducted to delineate mixing zone and calculate downstream concentrations will be a major factor in determining if ZOIs can be established for the CSO discharges to the Shetucket and Thames rivers. However other factors listed above must also be considered. In addition to the modeling work described in previous sections, the following tasks will be conducted to determine if ZOIs can be established:

- Using existing information and data collected during the sampling program identify the particular numeric and narrative WQS criteria that are being violated by CSO discharges at each CSO location.
- Identify characteristics of the discharge that may pose an unacceptable risk to human health or the environment
- Identify areas within the Shetucket and Thames rivers that are used for spawning grounds or nursery areas or for shelter for sensitive organisms
- Review information collected during the sampling program to identify aesthetic impacts of the discharges

- Determine if a continuous zone of passage exists using results of the mixing modeling and field data
- Evaluate the effects of multiple discharges and their cumulative effect
- Establish preliminary ZOIs for each overflow location based on the above factors.

8 PREPARE TECHNICAL MEMORANDUM

The results of the mixing zone and ZOI analyses will be documented in a Technical Memorandum. Locations where acceptable ZOIs can be established will be identified and supporting information will be provided. This documentation will include information on dilutions, geometric characteristics of the plumes, water quality within and outside of the ZOI, and biological characteristics of the areas identified.

9 REFERENCES

Baumgartner, D.J., W.E. Frick, and P.J.W. Roberts, 1994. *Dilution Models for Effluent Discharges (Third Edition).* Office of Wetlands, Oceans, and Watersheds, U.S. Environmental Protection Agency, Washington, DC. EPA/600/R-94/086.

Black & Veatch, 1994. CSO Modification Plan Final Report. Prepared for Norwich Sewer Authority.

CT DEP, 2002. *Water Quality Standards.* CT Dept. of Environmental Protection, Bureau of Water Management, Hartford, CT.

CT DEP, 2006. *2006 Integrated Water Quality Report to Congress.* CT Dept. of Environmental Protection, Bureau of Water Management, Hartford, CT.

Jirka, G.H., Doneker, R.L., and Hinton S.W., DeFrees, 1998. *User's manual for CORMIX: A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant discharges into Surface Waters.* Hydraulics Laboratory School of Civil and Environmental Engineering Cornell University Ithaca, New York 14853-3501

Trench, E.C.T., 2005. *The Thames Science Plan: Suggested Hydrologic Investigations to support Nutrient-Related Water-Quality Improvements in the Thames River Basin, Connecticut.* U.S. Geological Survey Open-File Report 2005-1208, 47 p.

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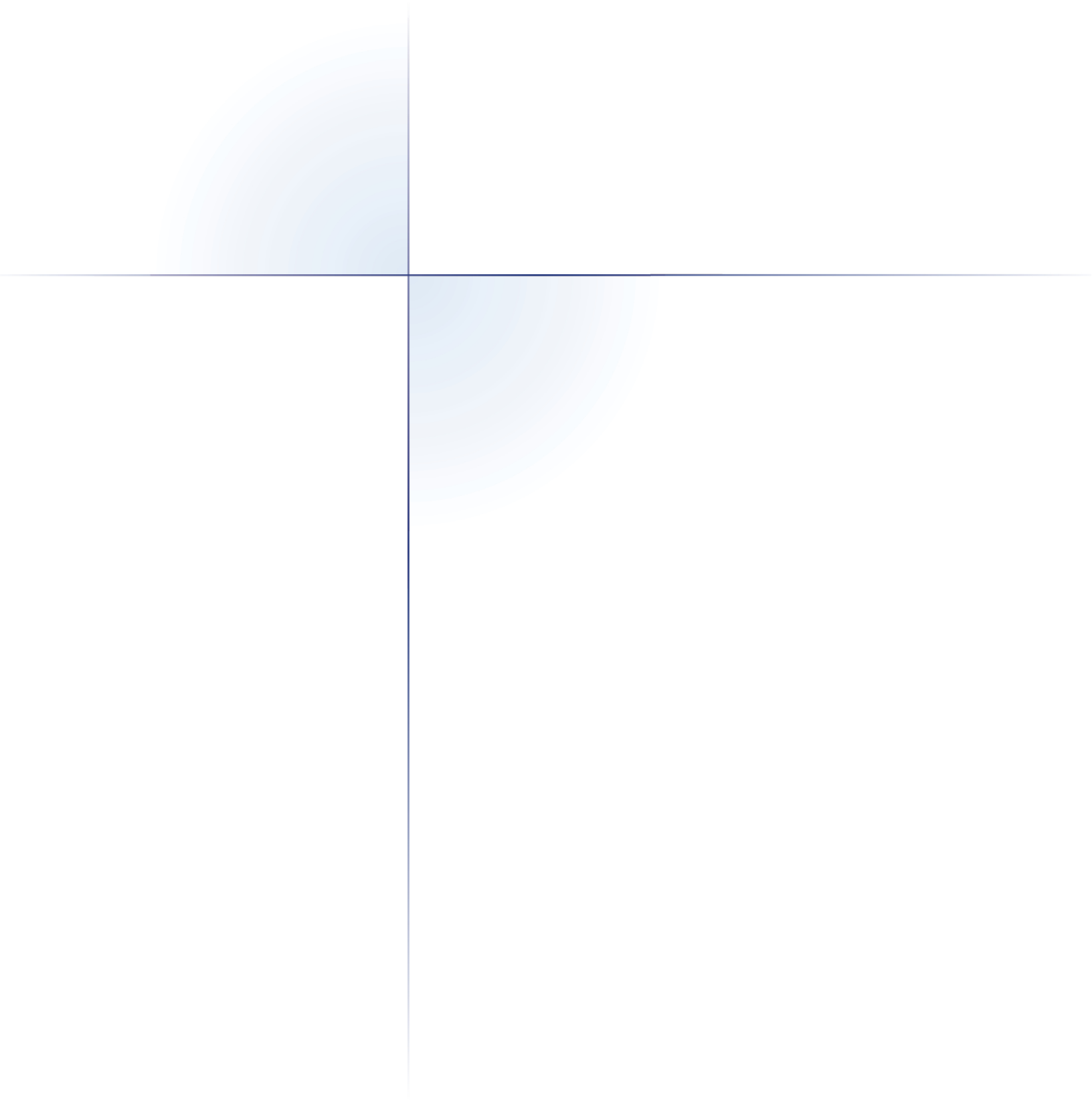

Appendix F

REPORT

COMBINED SEWER OVERFLOW LONG-TERM CONTROL PLAN

NORWICH PUBLIC UTILITIES
NORWICH, CONNECTICUT

August 14, 2018

CDM Smith

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Appendices

Appendix A - Materials from Public Information Session

Appendix B – Satellite Facility Site Assessments

Appendix C – EPA 1994 CSO Policy Document

Appendix D – CT DEEP 1990 CSO Strategy Document

List of Abbreviations, Acronyms and Initialisms

2012 LTCP – CSO Long-Term Control Plan, Final Report, prepared for Norwich Public Utilities, by Black & Veatch, August 17, 2012

2018 LTCP – CSO Long-Term Control Plan, prepared for Norwich Public Utilities, by CDM Smith, August 2018 (this report)

Alt. – alterative

ARI – average recurrence interval

BOD – biochemical oxygen demand

BFP – belt filter press

BMPs – Best Management Practices

cfm – cubic-foot-per-minute

City – City of Norwich

CMOM – Capacity, Management, Operations, and Maintenance

CSO – combined sewer overflow

CSS – combined sewer system

CT – Connecticut

CTDOT – Connecticut Department of Transportation

CWA – Clean Water Act

DAF – dissolved air flotation

DEEP – Connecticut Department of Energy and Environmental Protection

DEEP CSO Strategy – DEEP Combine Sewer Overflow Strategy, May 1990

DPW – City of Norwich Department of Public Works

e.g. – for example

EPA – United States Environmental Protection Agency

EPA CSO Policy – EPA Combined Sewer Overflow (CSO) Control Policy, April 11, 1994

FM – force main

FOG – fats, oils, and grease

FY – fiscal year

gpm – gallons per minute

HRC – high rate clarification

hrs – hours

i.e. – that is

I/I – Infiltration & Inflow

in – inch

IWQR – 2016 Integrated Water Quality Report

LF – linear feet

LID- low impact development

LTCP – Long-Term Control Plan

M – million

Mgal – million gallons

mgd – million gallons per day

MHI – median household income

MS4 General Permit - General Permit for the Discharge of Stormwater from Small Municipal Storm Sewer Systems

NMCs – Nine Minimum Control Measures

NPDES – National Pollution Discharge Elimination System

NPU – Norwich Public Utilities

O&M – operation and maintenance

POTW – publicly-owned treatment works

POC – pollutant of concern

PS – pumping station

RAS – return activated sludge

RCRA – Resource Conservation and Recovery Act

R&R – renewal and replacement

SCADA – supervisory control and data acquisition

SSO – sanitary sewer overflow

TMDL – total maximum daily load

TSS – total suspended solids

UV – ultraviolet

WAS – waste activated sludge

WPCF – water pollution control facility

Executive Summary

This section has been superseded by the revised 2020 CSO LTCP Report.

Executive Summary

ES.1 Introduction

A Long-Term Control Plan (LTCP) for controlling combined sewer overflows (CSOs) was submitted to the Connecticut Department of Energy and Environmental Protection (DEEP) by Norwich Public Utilities (NPU) in August 2012. The 2012 LTCP recommended sewer separation in the form of public inflow removal (i.e. disconnecting catch basins from the combined sewers) in all remaining combined sewer areas of the City of Norwich, Connecticut. DEEP approved the 2012 LTCP on May 26, 2016. However, NPU requested permission to update the 2012 LTCP due to several changed conditions further detailed in Section 1.

On July 3, 2017, DEEP issued Consent Order WRMU17001 to NPU. This order allows 500 days for the development of a revised LTCP (this report). DEEP approved the LTCP scope of work on April 3, 2017, which included:

- Implementation of system-wide flow metering and modeling for improved characterization of the NPU system and assessment of CSO;
- Development of a Baseline Conditions Report to document existing conditions and CSO performance under a range of conditions;
- Development and evaluation of system improvements and CSO abatement strategies to address a range of design storm conditions;
- Development of a refined and updated affordability analysis;
- Planning for ongoing public outreach during implementation of the LTCP; and
- Development of recommended projects with an implementation schedule.

NPU submitted the *CSO Control Planning Baseline Conditions Report* to DEEP on February 12, 2018. This report characterized the NPU sewer system performance in a range of design storm conditions, including the 2-year storm, as well as average annual performance to establish a benchmark for alternatives development in this 2018 LTCP. Based on comments from DEEP, a revised and final Baseline Conditions Report was submitted March 28, 2018.

The purpose of this LTCP is to summarize the NPU system investigations, alternatives evaluation, and proposed plan developed to further reduce CSO discharges in accordance with the Consent Order WRMU17001. Guidance documents from the United States Environmental Protection Agency (EPA) and DEEP were referenced in the development of this report. The following steps were taken to arrive at the recommended plan described herein:

- Screening of CSO abatement technologies to identify those most suitable for mitigation of NPU CSOs;
- Assessment of available sites for satellite storage or treatment;

- Assessment of sewer separation approaches to remove extraneous wet weather flow from the sewer system;
- Development of specific applications of viable technologies and combinations of technologies into CSO control alternatives;
- Evaluation of CSO control alternatives in terms of feasibility, cost-effectiveness, water quality benefits, affordability, and community needs; and
- Selection of the Recommended Plan.

ES.2 Existing Collection System

NPU's wastewater collection system is located primarily in Norwich and also accepts flows from the neighboring communities of Franklin, Lisbon, Montville, Preston, and Sprague. Norwich is served by both sanitary and combined sewers that are concentrated in the more densely populated areas along the Shetucket, Thames, and Yantic rivers. Large portions of Norwich, outside of the central region of the city, are served by private septic systems. Sewage is conveyed to the Hollyhock Island Water Pollution Control Facility (WPCF) for treatment.

Key characteristics of the collection system include:

- 16 CSO regulators discharging to 14 CSO outfalls
- 5 major interceptors: Laurel Hill, Thamesville, Salem Turnpike, Shetucket, and Yantic
- 117 miles of gravity sewer up to 42-inch diameter in Norwich and 3 miles outside Norwich
- 11 miles of force main in Norwich and 4 miles outside Norwich
- 39 NPU-maintained wastewater pumping stations (PS), six private pumping stations, and one state-owned pumping station

CDM Smith updated and calibrated a computer model of the NPU wastewater collection system to sewer flow metering data collected in 2017. Findings were documented in the Baseline Conditions Report and key findings that would shape alternatives development were carried forward into this LTCP.

For alternatives development and analysis, CDM Smith considered future development and planned for additional flow that is expected over the next 30 years. These future flows were added into the model on top of the existing "Baseline Conditions" to create a "Future Baseline Conditions" scenario. The future baseline flows were used in the model to simulate CSO conditions under the various alternatives evaluated. Table ES-1 depicts the performance of NPU's existing wastewater collection system under existing flows, as well as under the future baseline flows (i.e. no changes to the system except anticipated increased flows).

Table ES-1 Average Performance under Current and Future Baseline Conditions

Year	CSO Volume (Mgal)	Events	Duration (hrs)	Precipitation (in)
Current Baseline Conditions	43.3	60	355	55.0
Future Baseline Conditions	47.0	63	355	55.0

ES.3 Norwich Water Pollution Control Facility

The Norwich WPCF is located on Hollyhock Island at the mouth of the Yantic River. The first WPCF was built in 1936 but was replaced with a larger facility at the same location in 1957. Both early plants provided primary treatment. In the early 1970s, the plant was expanded and upgraded to provide secondary treatment. Since 1976, the WPCF has provided secondary treatment for all flow it receives.

The WPCF is aging and will need to be rehabilitated to continue to address National Pollution Discharge Elimination System (NPDES) permit requirements. A design for new plant upgrades was completed in 2015, but NPU could not proceed with construction due to changing flood control regulations. CSO control alternatives included consideration of upgrading the facilities to treat more collection system wet weather flow.

The existing WPCF is providing treatment for dry weather and a portion of the wet weather flow generated by the Norwich sewer system. The facility is designed for a peak flow rate of 17 million gallons per day (mgd) but receives wet weather flow up to 20 mgd, which can sometimes overwhelm the facility. Infrastructure in the facility is aging, with many systems having far exceeded their useful operational life, which has increased the operation and maintenance costs at the facility.

It is recommended that the facility receive substantial upgrades in the near-term to revitalize the operations, extend the useful life of the facility, improve reliability and reduce ongoing operations and maintenance costs. In addition, the WPCF provides significant wet weather treatment that avoids untreated CSO discharges. Alternatives to achieve CSO control in the Norwich system will continue to rely on this critical wet weather treatment capacity. It is expected that, at a minimum, the facility will be upgraded to reliably treat flows up to 20 mgd and this was assumed as a baseline for future CSO control recommendations. The need for future facility improvements to consistently treat 20 mgd should be considered in the implementation plan. Section 8 presents an assessment of required improvements at the WPCF to address CSO control.

ES.4 Water Quality Objectives

In Connecticut, DEEP has primacy, meaning the EPA has delegated primary enforcement responsibility to DEEP. This section discusses current EPA and DEEP policies, highlighting the applicability of both policies to NPU. EPA CSO Policy and DEEP CSO Strategy documents are also included as Appendices C and D.

Under strict interpretation of DEEP CSO Strategy, Connecticut's Surface Water Quality Standards, and the EPA CSO Policy, NPU must attempt to eliminate CSO discharges to the waters of the state

or mitigate it to a level deemed adequate to support designated uses. For the purposes of this LTCP, the two receiving waterbodies were deemed equal in sensitivity due to their equivalent water quality classification. Possible upstream pollution sources (as indicated in the 2012 LTCP) could make it difficult to quantify and achieve water quality standards within NPU's receiving bodies even if CSO discharges from Norwich were eliminated.

ES.5 Assessment of CSO Abatement Technologies

Section 5 describes CSO abatement technologies and assesses their applicability to the NPU CSO control objectives. Many alternative strategies are available to control pollutants discharged from CSOs ranging from no action to complete separation of the combined sewer system (CSS) into separate sanitary and stormwater systems. This assessment considers technologies presented in EPA guidance manuals. The purpose of this assessment is to select appropriate technologies for further evaluation and comparison in later sections. Specific factors that identify whether a technology is appropriate include current condition of the sewer system, characteristics of wet weather flow (e.g. peak flow rate, volume, frequency, and duration), hydraulic and pollutant loading, climate, implementation requirements (e.g. land, neighborhood, noise, and disruption), and maintenance requirements.

CSO abatement technologies were classified into five categories:

- Quantity source control measures;
- Quality source control measures;
- Collection system controls;
- Storage technologies; and
- Treatment technologies.

This assessment identified twelve technologies to carry forward into alternatives evaluation in Sections 6, 7 and 8. Collection system controls, along with storage and treatment technologies were found to be the most applicable to NPU's collection system.

ES.6 Separation

For the purposes of this report two methods of separation were considered, public inflow removal, and complete public and private separation.

Public inflow removal is a method of sewer separation where public catch basin connections are removed from the combined sewer system. This can be achieved through construction of new sewer systems or new drain systems. Public inflow removal effectiveness was evaluated, assuming that this inflow removal was completed after the completion on the "Planned Projects" described in Section 7 and that CSOs remained open. When public inflow removal is implemented citywide with these assumptions, ten of the fourteen CSO outfalls were controlled to the 3-month level or less and the entire system will not achieve even a 1-month control level. Public inflow removal citywide is estimated to cost $160 million in fiscal year (FY) 2018 dollars.

Complete public and private separation is a more comprehensive approach to sewer separation than public inflow removal. For this approach, in addition to disconnecting catch basins from the sewer system, private property inflow sources including sump pumps, yard drains and roof leaders are also removed in combined and previously separated areas, and substantial pipe rehabilitation is intended to curb infiltration. There are two different approaches to achieve this separation – new sewer systems or new drainage systems. To achieve complete public and private separation each building must either have a dedicated storm drain lateral or property that allows private stormwater to be retained on-site.

The effectiveness of complete public and private separation citywide was also evaluated. This scenario assumed brick and mortar closure of CSO regulators. This means that there would no longer be any CSO allowed from the permitted outfalls, but there would be risk of flooding and basement backups during larger storm events. To minimize the risk of sewer system flooding during storms up to a 5-year storm, extensive public and private sewer separation would be needed throughout the entire collection system, including in areas that are currently categorized as having separated sewers. Complete public and private separation citywide is estimated to cost approximately $380 million in FY 2018 dollars.

Although public inflow removal and complete public and private inflow removal are both expensive for application citywide, use of public inflow removal in localized areas is addressed in Section 8. Additionally, citywide separation strategies will be reevaluated in future LTCP updates.

ES.7 Consent Order Projects and System Optimization

The Consent Order requires NPU to implement a proposed Eastside separation project. However, model simulations indicated that if CSO 025 were closed in conjunction with separation, remaining wet weather flow would cause excessive and dangerous surcharge. Other alternatives to achieve 2-year CSO control in Eastside needed to be evaluated.

System optimization improvements were also considered. Based on model analyses, NPU identified four initial system improvement projects that can implemented in the near future to help reduce CSO in lieu of the proposed Eastside sewer separation project. DEEP has already tentatively provided favorable comment on this approach. As a result, the “Planned Projects” have been included as the foundation for all alternatives moving forward, and they include:

1. At CSO 025, installation of 780 feet of 24-inch (or equivalent) pipe across the bridge from the regulator to the Shetucket Interceptor to replace the undersized 8-inch and 12-inch pipe segments and raise the 025 weir to attain 2-year control;

2. At CSO 024, installation of 100 feet of 30-inch pipe to replace the existing connector from the regulator to the Shetucket Interceptor and raise the 024 weir attain 2-year control;

3. Installation of Supervisory Control and Data Acquisition (SCADA) controls to improve Rose Alley PS operations and maximize wet weather flow to the WPCF; and

4. Raising weirs at select regulators as described in Section 7 to retain additional volume in the system during wet weather events.

Implementation of the above will reduce average annual CSO by 30 percent from 43 Mgal to 30 Mgal and reduce system wide annual overflow from 60 to 48 events, as summarized in Table 7-1.

ES.8 Alternatives Evaluation

This Section of the report is organized to follow the process for development of alternatives. First, multiple CSO management strategies are identified for each area of the city. Then, the effectiveness of each strategy for CSO reduction is assessed. Effective solutions in each area of the city are then combined into comprehensive alternatives for systemwide CSO control. In accordance with EPA guidance manual for developing LTCPs, CSO control alternatives were developed for 1-month, 3-month, 6-month, 1-year, 2-year, and 5-year design storms.

After hydraulic effectiveness and performance statistics are developed, project costs, construction and environmental impacts, and CSO benefits achieved by implementing each design storm control strategy are also identified. Alternatives are then evaluated based on community impacts, constructability, operation and maintenance considerations and cost effectiveness. Performance and cost summary tables are presented towards the end of this Section. Top performing plans are then selected for evaluation in Section 9, and Section 10 selects the Recommended Plan. The Recommended Plan will ultimately be the alternative that achieves the highest level of control that NPU can afford over a reasonable planning period (assumed to be 30 years as beyond this duration, CSO technology, economics, demographics, and other key factors are highly uncertain).

The methodology of this report is predicated on a 2-year control target per the Consent Order. The lowest cost, and most cost effective, 2-year CSO control plan is Alternative 1, Conveyance and Centralized Treatment to a total of 80 mgd. This 2-year control alternative is estimated at $190 million (FY 2018 dollars), but this does not include other necessary infrastructure projects, including the WPCF improvements necessary to update the existing facility and increase its peak flow capacity to a nominal 20 mgd as discussed above and in Section 3. These basic and necessary WPCF improvements are estimated to add $80 million to any selected CSO alternative.

The lowest cost 2-year control plan was evaluated via a financial capability analysis as described in Section 9 of this report. However, as a result of this financial analysis, CDM Smith was forced to look at less costly control plans that could be implemented by NPU over the planning period.

The lowest cost plan for each control level was plotted against the expected number of average annual overflow events to form the cost versus performance curve seen in Figure ES-1. This formed the knee-of-the-curve analysis as recommended by EPA. As the 3-month control level was the most cost effective control level overall, and corresponds to the inflection point, or the knee-of-the-curve, this plan was also evaluated further. The lowest cost and most cost effective, 3-month CSO control plan is Alternative 2 - Conveyance and Storage.

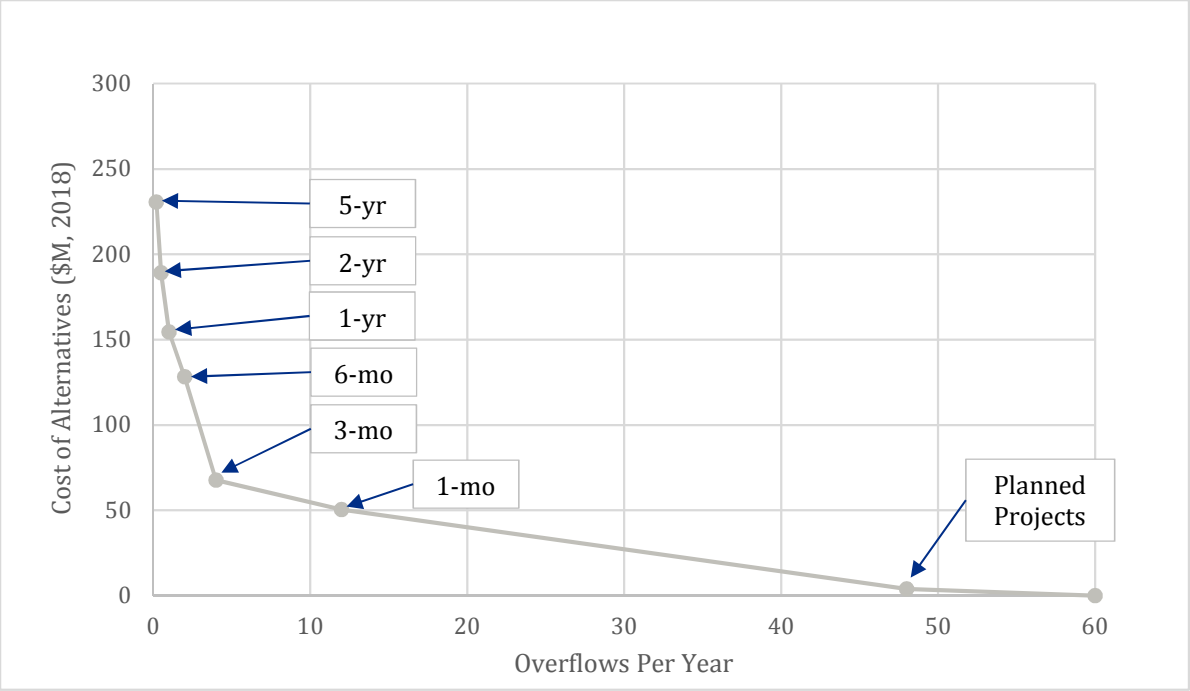


Figure ES-1
Cost vs. Performance for Most Affordable Alternatives

This 3-month control storage alternative is estimated at $70 million (FY 2018 dollars). Again, the basic WPCF improvements add $80 million to this value. In the future, this 3-month plan can be expanded and reconfigured to achieve the lowest cost 2-year control through addition of relief piping, larger pump stations, and centralized treatment to achieve the 2-year centralized treatment alternative. Sections 9 and 10 explore the merits and limitations of these two plans further, and ultimately Section 10 selects a Recommended Plan.

ES.9 Financial Capability Assessment

EPA has published guidance for a financial capability assessment which estimates the impact of anticipated capital improvements on the average residential ratepayer by evaluating household burden. Household burden is a metric defined by EPA that assesses the typical residential sewer bill as a percent of a community's median household income (MHI). Under the EPA guidance process, a household burden exceeding 2 percent of MHI is deemed a high burden.

The most affordable control alternative that meets the 2-year control target (Alternative 1, Conveyance and Centralized Treatment) is well beyond NPU's financial capacity to implement. After a detailed financial capability assessment, the household burden for 2-year control is projected to exceed 5 percent by 2037, and NPU ratepayers would face annual rate increases averaging over 10 percent across that entire period. CDM Smith then evaluated the alternative for a 2-year level of control with a 30-year implementation schedule. The projected household burden for this alternative exceeds 5 percent in 2047, with average annual rate increases of nearly 7.5 percent. This alternative, even with a longer schedule, is also beyond NPU's financial capacity to implement.

Having determined that the plan achieving 2-year level of control was not a feasible option within a reasonable planning horizon, focus shifted to the assessment for 3-month level of control. The 3-month level of control was targeted based on the knee-of-the-curve analysis presented in Section 8. Evaluation of the most affordable 3-month control plan began over a 20-year implementation period, with the results being a projected household burden of around 2.9 percent in FY 2039. In addition, the average annual projected rate increases would be approximately 6.6 percent over the next 20 years, which would pose a significant burden on its ratepayers. The 3-month control plan was then evaluated over a 30-year implementation period. The projected household burden reaches 2.9 percent in FY 2049, which is nearly a full percent point higher than the threshold deemed affordable by the EPA. The average annual rate increase would be approximately 5 percent for the next 30 years.

While a 5 percent annual increase in rates and a household burden close to 3 percent is significant, NPU believes that this impact is more feasible than the other alternatives evaluated. Figure ES-2 depicts the expected household burden over the schedule of the Recommended Plan. The projected household burden of 3-month control reaches 2.9 percent in FY 2049, which exceeds EPA's guidance for affordability, but also indicates NPU's commitment to water quality.

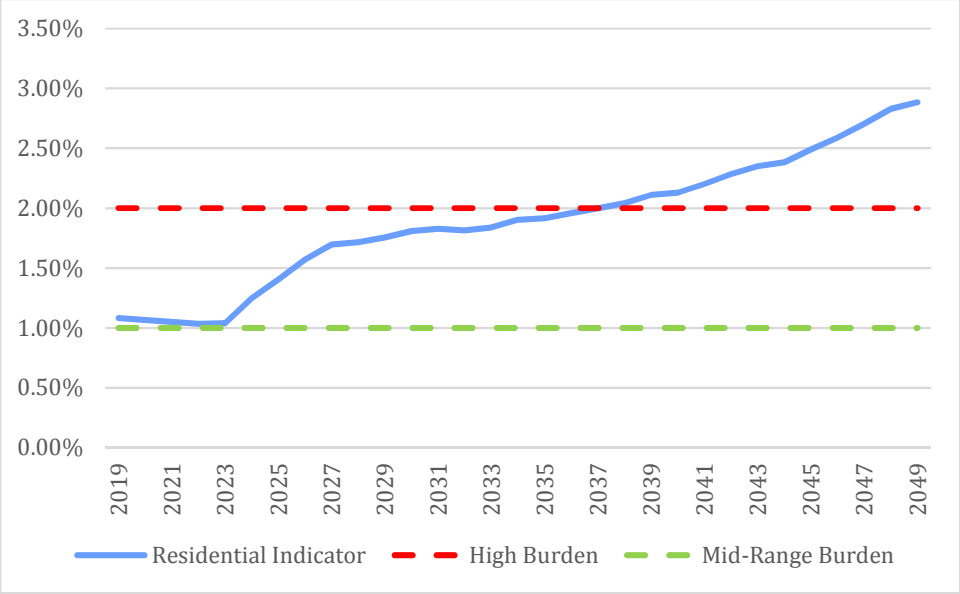


Figure ES-2
Projected Household Burden and Residential Indicator

ES.10 Recommended Plan

In consideration of their Consent Order, it is recommended that NPU do as much as financially practical to control CSO discharges and benefit water quality. Based on their status as a financially distressed community and documented limited ability to pay for capital projects, this means implementing the 3-month level of control in the near planning horizon of 30 years, while providing for expansion to the 2-year level of control in the future.

Figure ES-3 at the end of this section illustrates the components of the near-term Recommended Plan. This figure depicts the new pipelines, pumping stations, and storage tanks that are required to achieve a 3-month control. The planning level capital cost of the initial phase projects (3-month control), the necessary facility upgrades to the WPCF, and LTCP updates over 30 years is $156 million (FY 2018 dollars). The planning period of the LTCP would extend from 2019 to 2049.

The Recommended Plan (3-month conveyance and storage alternative) consists of the following components and associated capital costs in the near planning horizon:

- Complete the "Planned Projects" described in Section 7
- Implement improvements to the WPCF to increase wet weather capacity from 17 mgd to 20 mgd, improve reliability, and meet nutrient permit limits
- Improvements in the Thamesville neighborhood totaling approximately $24 million including:
  - Replace the Shipping Street PS (3.5 mgd) and FM
  - Relocate the regulator structure for CSO 004
  - Re-configure the gravity sewer system to convey flow from Route 32 and the new Shipping Street PS to the new CSO 004 regulator and nearby storage tank (2,310 linear feet (LF), 12-in to 30-in diameter)
  - Remove and replace sewer pipe tributary to the existing Shipping Street FM
  - Construct a storage tank with a 0.26 million gallon (Mgal) capacity at South Thames Street
  - Replace the South Thames Street PS (4 mgd) and FM
  - Install a gravity sewer from existing South Thames Street PS to new PS (580 LF, 10-in to 24-in diameter)
  - Raise CSO regulator weirs beyond the Planned Projects level
- Improvements in the Laurel Hill neighborhood totaling approximately $6 million including:
  - Replace the River Avenue PS (4 mgd) and FM
  - Increase the diameter of dry weather flow pipes around regulators 31 and 32 (160 LF, 18-in to 30-in diameter)
  - Raise CSO regulator weirs beyond the Planned Projects level
- Improvements in the Shetucket area (Greeneville & Downtown sewersheds) totaling approximately $33 million including:

- Install a storage tank with a 1.45 Mgal capacity at the Rose Alley commuter parking lot site
- Install relief piping for the Rose Alley combined culvert (310 LF, 24-in diameter)
- Install a sluice gate structure on the Shetucket Interceptor
- Raise CSO regulator weirs beyond the Planned Projects level
- Increase dry weather flow pipe diameters at several locations (720 LF, 15-in to 32-in diameter)

The annual performance benefits (based on simulation of the representative period, 2009-2011) associated with the initial phase (3-month conveyance and storage) of the Recommended Plan are summarized below:

- Average annual frequency of overflow events will be reduced from 60 events (current baseline) to an average of 4 events, a 93 percent reduction;
- Average annual CSO volume is reduced from 43.3 million gallons (current baseline) to 8.5 million gallons, an 80 percent reduction.

The average annual performance benefits associated with the expanded (2-year) plan are summarized below:

- Average annual frequency of overflow events will be reduced from 60 events (current baseline) to an average of 0.5 events, a 99 percent reduction;
- Average annual CSO volume is reduced from 43.3 million gallons (current baseline) to 0.25 million gallons, a 99 percent reduction.

Average annual event counts in the representative period are displayed in Table ES-2.

Table ES-2 Performance of the Lowest Cost Plans

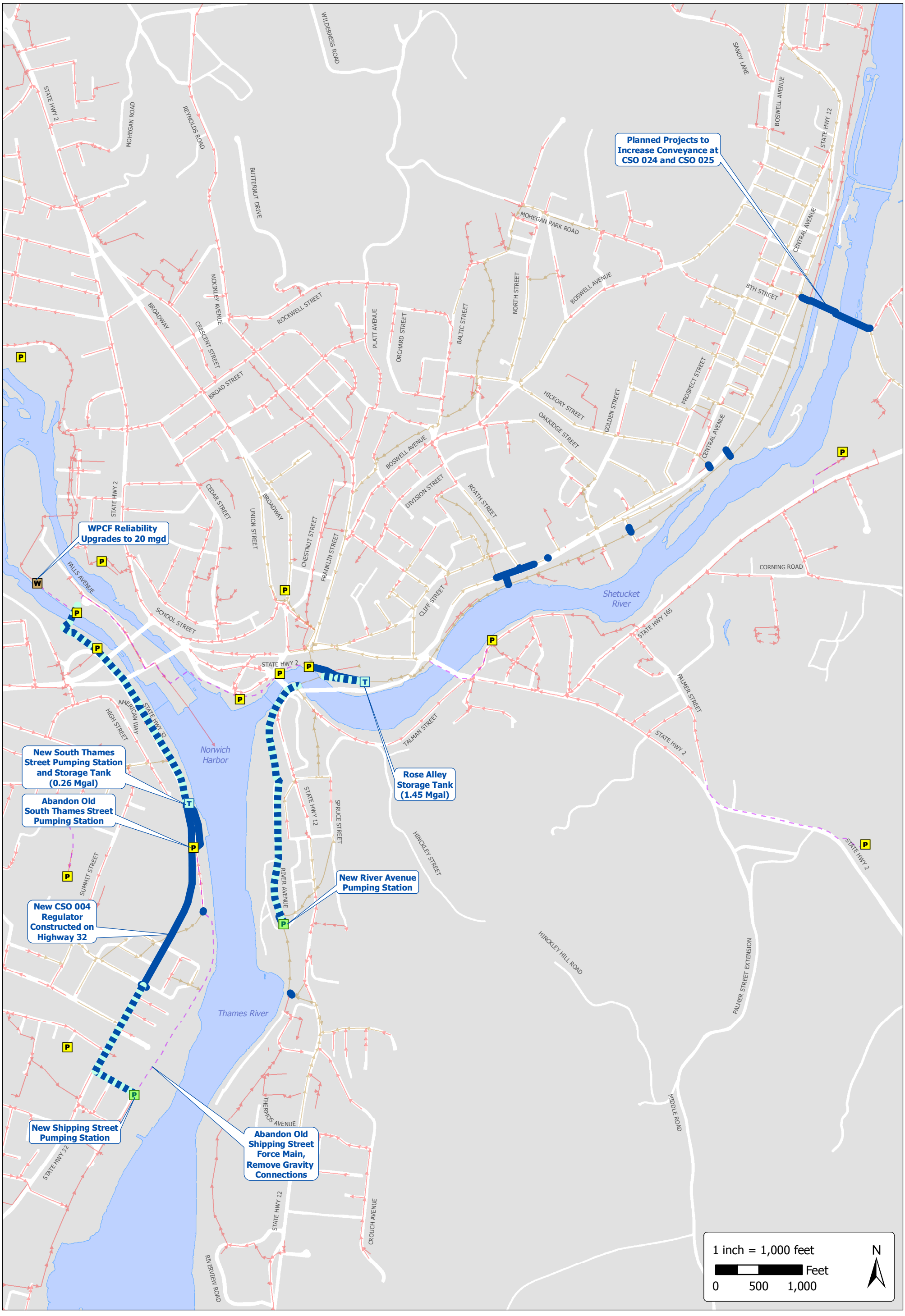
CSS Conditions	Annual CSO Volume (Mgal)	Annual Number of CSO Events
Current Baseline Conditions	43.3	60
Recommended Plan: Initial 3-Month Control	8.5	4
Future 2-Year Control	0.25	0.5

The recommended initial phase project improvements will provide at least a 3-month level of CSO control throughout the entire NPU combined sewer system. CSO and existing infrastructure projects would be alternated to promote CSO progress and prevent existing infrastructure failure. LTCP updates completed in 5-year intervals will evaluate constructed projects and reevaluate future projects through model evaluation and updated financial analysis.

It is not recommended that CSO regulators or outfalls be closed. These relief points are needed to alleviate surcharging in events larger than the 3-month storm. Closure of regulators could lead to

basement backups, street flooding and general risk to public health. The potential to safely close CSO regulators will be evaluated regularly as the LTCP is implemented and LTCP updates are completed in the future.

This CSO abatement program represents a major financial and environmental challenge. Upon completion of the initial 30-year schedule of LTCP projects, the 3-month level of control will be achieved, and these projects can be expanded to the 2-year level of control through the addition of new infrastructure. NPU cannot currently afford to achieve this 2-year level of control as presented in Section 9, and therefore the ability to achieve this goal will be revaluated every 5-years in the LTCP updates to determine if conditions have changed and based on the work completed to that point. This LTCP will allow NPU to make significant gains in improving water quality through the implementation of the initial 3-month CSO control plan, and then by completing additional projects as NPU has the financial capability to afford them.



CDM Smith

Legend

- Recommended Storage Tanks
- Recommended Pumping Stations
- Recommended Sewers
- Recommended Pressurized Mains
- Water Pollution Control Facility
- Pumping Stations
- Force Mains
- Combined Sanitary Sewers
- Separated Sanitary Sewers

LTCP Recommended Plan
Norwich, CT
Figure ES-3
Recommended 3-Month Control Plan

Section 1

This section has been superseded by the revised 2020 CSO LTCP Report.

Section 1
Introduction

1.1 General

Norwich Public Utilities (NPU) is a municipally-owned utility that provides sewer, water, electric, and gas services to customers in Norwich and surrounding communities. NPU owns and operates the sewer collection and treatment system. The sewer system is comprised of sanitary sewers and combined sewers. A combined sewer system (CSS) is one in which both stormwater and sewage are combined into a single pipe and conveyed to the water pollution control facility (WPCF) for treatment. This approach was the standard for cost-effective sewer design for many decades, and was quite common across the country, especially in early New England.

Large rain storms can overwhelm combined collection systems, causing surcharge and discharges from the system at designed hydraulic relief points called combined sewer overflow (CSO) structures. CSO discharges contain raw sewage diluted with stormwater and can create environmental issues for local receiving waters.

NPU's CSS is located within the City of Norwich, and impacted waterbodies include the Shetucket River and Thames River.

1.2 CSO Compliance History

Since the 1970s, NPU has implemented CSS improvements to address CSO discharges and to comply with evolving CSO regulations.

In the 1970s, NPU adopted an initial sewer system facilities plan to eliminate CSOs by separating all the combined sewers. Six of the proposed 33 separation projects were completed. Due to a reduction in state and federal funding, NPU suspended the implementation of the remaining sewer separation projects in the 1980s.

The United States Environmental Protection Agency (EPA) issued a 1989 interim CSO Control Policy. In response, Connecticut Department of Energy and Environmental Protection (DEEP) established its own *Combine Sewer Overflow Strategy* in May 1990 (DEEP CSO Strategy) to match the intent of the 1989 interim federal CSO policy and to identify state goals for CSO reduction.

Accordingly, NPU issued a second plan, the *Norwich CT CSO Modified Facilities Plan,* in 1994 to address these CSO control policies. This facilities plan recommended eight sewer separation projects to reduce CSO volume; NPU completed these projects and the number of CSO outfalls was further reduced.

On April 11, 1994, the EPA issued the final *Combined Sewer Overflow (CSO) Control Policy* (EPA CSO Policy). The EPA CSO Policy established a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities, and the public engage in a coordinated planning effort to develop and implement cost-effective CSO controls that ultimately meet appropriate environmental and health objectives. The EPA CSO Policy is

implemented through the National Pollution Discharge Elimination System (NPDES) permit program under the provisions of the Clean Water Act (CWA). The national policy mandated that each CSO community develop and implement a Long-Term Control Plan (LTCP) to eliminate or reduce untreated CSO discharges to the nation's receiving waterways.

On July 10, 2007, DEEP issued Consent Order WC 5445 to NPU. This order required NPU to submit an updated LTCP by October 2010 in accordance with the planning requirements of the EPA CSO Policy and the DEEP CSO Strategy.

Accordingly, NPU developed its third CSO Long-Term Control Plan, which recommended sewer separation for most combined sewers in Norwich. Comments to the plan were received and the *CSO Long-Term Control Plan, Final Report* was submitted in August 2012 (2012 LTCP) recommending public sewer separation in the remaining combined sewer areas to achieve CSO reduction up to the 2-year return frequency storm event. The 2012 LTCP also recommended leaving at least one CSO discharge open to protect public health (excessive system surcharge causing basement backups) during wet weather events greater than the 2-year storm. DEEP approved the plan on May 26, 2016.

Since the approval of the 2012 LTCP, a number of conditions had changed including increasing costs for sewer separation and inflow removal, modifications to the EPA's affordability criteria (which helps guide the implementation schedule), and Norwich was classified by the State of Connecticut as a "distressed community", which indicated a diminished ability to pay for the implementation of CSO and other capital projects. Accordingly, NPU requested permission to update the 2012 LTCP.

On July 3, 2017, DEEP issued Consent Order WRMU17001 to NPU, which allowed 500 calendar days for the development of a revised LTCP to meet the requirements of the DEEP Order and to be consistent with the EPA CSO Policy and guidance documents on the development of LTCPs. DEEP approved the LTCP scope of work on April 3, 2017, which included:

- Implementation of system-wide flow metering and modeling for improved characterization of the NPU system and assessment of CSO;
- Development of a Baseline Conditions Report to document existing conditions and CSO performance under a range of conditions;
- Development and evaluation of system improvements and CSO abatement strategies to address a range of design storm conditions;
- Development of a refined and updated affordability analysis;
- Planning for ongoing public outreach during implementation of the LTCP; and
- Development of recommended projects with an implementation schedule.

NPU submitted the *CSO Control Planning Baseline Conditions Report* on February 12, 2018. This report characterized the NPU sewer system performance in a range of design storm conditions, including the 2-year storm, as well as average annual performance to establish a benchmark for alternatives development in the 2018 LTCP. An updated Baseline Conditions Report addressing DEEP's comments was submitted March 28, 2018.

1.3 Purpose

The purpose of this LTCP is to summarize the NPU system investigations, alternatives evaluation, and proposed plan to further minimize CSO discharges in compliance with the July 3, 2017 Consent Order, EPA CSO Policy, DEEP CSO Strategy, and the Connecticut State Water Quality Standards.

NPU contracted with CDM Smith to update its sewer system model, prepare a Baseline Conditions Report, and prepare a revised LTCP to address changes since the 2012 LTCP update. As part of the Consent Order, CDM Smith has worked concurrently on a series of projects to control CSO in the Eastside Area and reduce CSO volumes throughout the system. Design is anticipated to begin late in 2018. These projects are referred to as "Planned Projects" throughout this LTCP and are explained in detail in Section 7.

1.4 Baseline Conditions

The *CSO Control Planning Baseline Conditions Report* submitted in March of 2018 presented model calibration and metering results, as well as the existing conditions of CSOs in Norwich today. The Baseline Conditions Report characterized baseline overflow statistics and associated impacts to receiving waters. Baseline conditions were established using the InfoWorks model, from the 2012 LTCP, which was subsequently modified to better reflect existing field conditions and calibrated to flow metering data that was collected as part of the 2018 LTCP update.

In this report, a future baseline was developed to incorporate projected population, commercial, and industrial changes in Norwich over the coming decades. The future baseline scenario was used to develop alternatives to address CSO and provided a benchmark of the existing system to assess future conditions as CSO control alternatives are implemented.

The LTCP alternatives were developed and evaluated to balance issues including impacts to water quality, impacts to public health, NPU's ability to finance alternatives, and community concerns.

1.5 LTCP Approach

The CSO planning process was developed to comply with the EPA CSO Policy and address the requirements of the Consent Order and those identified through technical meetings with DEEP. In general, the following steps were taken to arrive at the recommended LTCP:

- Screening of CSO abatement technologies to identify those most suitable for mitigation of NPU CSOs;
- Assessment of available sites for satellite storage or treatment;
- Assessment of sewer separation approaches to remove extraneous wet weather flow from the sewer system;
- Development of specific applications of viable technologies and combinations of technologies into CSO control alternatives;
- Evaluation of CSO control alternatives in terms of feasibility, cost-effectiveness, water quality benefits, affordability, and community needs; and

- Selection of the Recommended Plan.

1.6 Report Organization

This report is organized into ten sections as follows:

- **Section 1** – Introduces the regulatory history and purpose of this study;
- **Section 2** – Describes the existing collection system, system model, and defines the future baseline condition;
- **Section 3** – Provides a summary of NPU's Water Pollution Control Facility, which is a critical resource for handling dry and wet weather flows;
- **Section 4** – Discusses the EPA CSO Policy and DEEP CSO Strategy and applicability to NPU;
- **Section 5** – Includes an assessment of available CSO abatement technologies and their applicability to NPU;
- **Section 6** – Discusses sewer separation and wet weather inflow reduction approaches;
- **Section 7** – Provides a summary of NPU's consent order, and the planned projects anticipated in the near future;
- **Section 8** – Explains the alternatives development and analysis process, and presents the planning level costs of the alternatives developed;
- **Section 9** – Analyzes affordability of different CSO mitigation programs; and
- **Section 10** – Presents NPU's proposed LTCP program, including the components of the Recommended Plan, and a timeline of project implementation.

Section 2

Section 2
Existing Collection System

2.1 General

Norwich Public Utilities (NPU) owns and operates the wastewater collection and treatment in Norwich. The wastewater collection system collects flow from Norwich and neighboring communities and conveys it to the Norwich Water Pollution Control Facility (WPCF) on Hollyhock Island for treatment. The City of Norwich Department of Public Works owns, maintains, and operates the City's stormwater system and is a separate entity from NPU.

This section provides an overview of NPU's existing wastewater collection system and treatment facilities and discusses some of the system investigations that have been conducted for this report. NPU's existing system is aging and requires rehabilitation and replacement of key components to continue to control wet weather flows and reduce combined sewer overflows (CSOs) from current levels.

The basis for this section is the Baseline Conditions Report, which was submitted to the Connecticut Department of Energy and Environmental Protection (DEEP) in March 2018. This report characterized the wastewater collection system, CSO performance, and impacts to receiving waters under existing conditions. This characterization provided the baseline for the screening, development, and evaluation of CSO control measures to be included as part of NPU's LTCP.

The report's goals were to:

- Summarize key wastewater collection system features and characterize system performance under existing conditions and future projected conditions that account for population growth and implementation of previously planned projects;
- Describe the sewer system model developed to characterize the collection system and its wet weather response;
- Present CSO volumes and activation frequency based on design storm and representative year simulations;
- Summarize applicable water quality standards and uses of existing receiving water bodies; and
- Quantify baseline CSO impacts to receiving waters and their uses.

2.2 History and System Background

Norwich is a small city that is home to 40,000 residents in southeastern Connecticut. The city was founded in 1659 and incorporated in 1784 as one of the first five Connecticut cities. The Shetucket, Yantic, and Quinebaug Rivers combine in Norwich to become the Thames River, which

discharges to Long Island Sound at New London. Abundant hydropower provided an ideal place to build textile factories and other mills which established the city's early economy.

The combined sewers in Norwich date to the late 1800s and early 1900s. Combined sewer pipes were originally sized to carry both sewage and stormwater; this combined flow was directly discharged to the rivers. Interceptor sewers were eventually constructed to convey most flow to the WPCF, with excess wet weather flow discharged as CSO.

NPU completed a substantial number of improvements to its combined sewer system and WPCF over the last 45 years to reduce CSO discharges. In 1972, there were 43 active CSO outfalls in the City. In the 1970s and 1980s, NPU completed partial sewer separation projects that removed public stormwater sources from collection system in the Downtown and the Westside areas of the city and reduced the number of CSO outfalls to 27.

NPU submitted the *Norwich, CT Modified Facilities Plan* in August 1994 to meet consent order requirements. Through continued partial sewer separation recommended in this facilities plan, the number of CSO outfalls was reduced from 27 to 14 by 2005. Today, 16 CSO regulators discharge to 14 permitted CSO outfalls to the Shetucket River and the Thames River Estuary.

2.3 Existing Wastewater Collection System

2.3.1 General

NPU's wastewater collection system is located primarily in Norwich and also collects flows from the neighboring communities of Franklin, Lisbon, Montville, Preston, and Sprague. Norwich is served by both sanitary and combined sewers that are concentrated in the more densely populated areas along the Shetucket, Thames, and Yantic rivers. Large portions of Norwich, outside of the central portion of the city, are served by private septic systems. Sewage is conveyed to the Hollyhock Island WPCF for treatment.

Key characteristics of the collection system include:

- 16 CSO regulators discharging to 14 CSO outfalls
- five major interceptors: Laurel Hill, Thamesville, Salem Turnpike, Shetucket, and Yantic
- 117 miles of gravity sewer up to 42-inch diameter in Norwich and 3 miles outside Norwich
- 11 miles of force main in Norwich and 4 miles outside Norwich
- 39 NPU-maintained wastewater pumping stations, six private pumping stations, and one state-owned pumping station

Principal collection system features are shown in Figure 2-1 "Comprehensive Collection System Map" (following Section 2).

Following the conveyance of sewage to the WPCF, treated effluent is discharged through two permitted outfalls to the Yantic River and Thames River. The WPCF processes an average of 5 million gallons per day (mgd), with wet weather peaks often exceeding the 17 mgd design peak

capacity. Wastewater flows from within Norwich are predominantly residential, with some commercial and industrial wastewater.

2.3.2 Flow from Neighboring Communities

The WPCF receives flow from the City of Norwich, as well as the neighboring towns of Franklin, Sprague, Lisbon, and Preston. A map of neighboring communities that contribute flow to NPU's combined sewer system is shown in Figure 2-2. All these neighboring communities have separated sewage and storm water collection systems and generally do not contribute wet weather flow to the NPU system.

2.3.2.1 Franklin, CT

Wastewater from Franklin enters the system through a 36-inch line from the southernmost point of Franklin via gravity. Flow enters Norwich near CT-32 and drains to the Yantic interceptor. A small area of NPU's sewer system discharges to Franklin and then back to Norwich through the 36-inch pipe. Wastewater inputs from Franklin are limited to a small amount of gravity sewer around the New Park Avenue commercial area. CDM Smith estimates that Franklin currently contributes 1,100 gpd of sanitary flow to NPU.

2.3.2.2 Lisbon, CT

Wastewater from Lisbon enters NPU's system by gravity through a 10-inch pipe in Route 169. This sewer drains to the Shetucket Interceptor and the Rose Alley Pumping Station (PS). Gravity sewers collect flow from an area of Riverview Drive, which crosses the Shetucket River via Newent Road (Route 169). This pipe serves a waste-to-energy incinerator facility at the north end of Riverview Drive. Current flows for this facility were determined to be minor based on information obtained from NPU.

2.3.2.3 Preston, CT

Wastewater from Preston enters the system through a force main from the local waste-to-energy incinerator. NPU determined that flow from this facility is minor. Flow also enters from Preston through a force main from the former state hospital complex. Currently, approximately 6,000 gpd is contributed from commercial customers in Preston via the existing force main, but there are also plans to redevelop the former state hospital site and restore flows to former levels. This flow is (and will be) contributed via the Laurel Hill Interceptor discussed in Section 2.4.1. Both force mains enter the Norwich system from the south via Route 12, from where the system drains by gravity to the Laurel Hill Interceptor.

2.3.2.4 Sprague, CT

Wastewater from Sprague enters the north end of the Shetucket Interceptor via a 10-inch gravity line. This flow is collected by a small area of gravity sewer near the Main Street/Papermill Road area in Sprague, and then pumped over the Main Street bridge via Taftville-Occum Road. This area of Sprague is estimated to contribute 15,500 gpd of sanitary flow to NPU.

2.3.2.5 Montville, CT

NPU operates the Stony Brook Water Treatment Plant in Montville. Although Montville produces no other wastewater inputs to the NPU system, the Stony Brook Plant has a discharge flow that is tributary to the WPCF. This flow contains waste sludge, backwash, and other wastewater. A 6-

inch force main from the plant enters NPU's sewer system via Montville Road near Maplewood Cemetery. An average flow of 60,000 gpd was estimated based on data provided by NPU.

Collectively, flows from outside Norwich contribute less than 3 percent of the sanitary baseflow conveyed to the WPCF under existing conditions.

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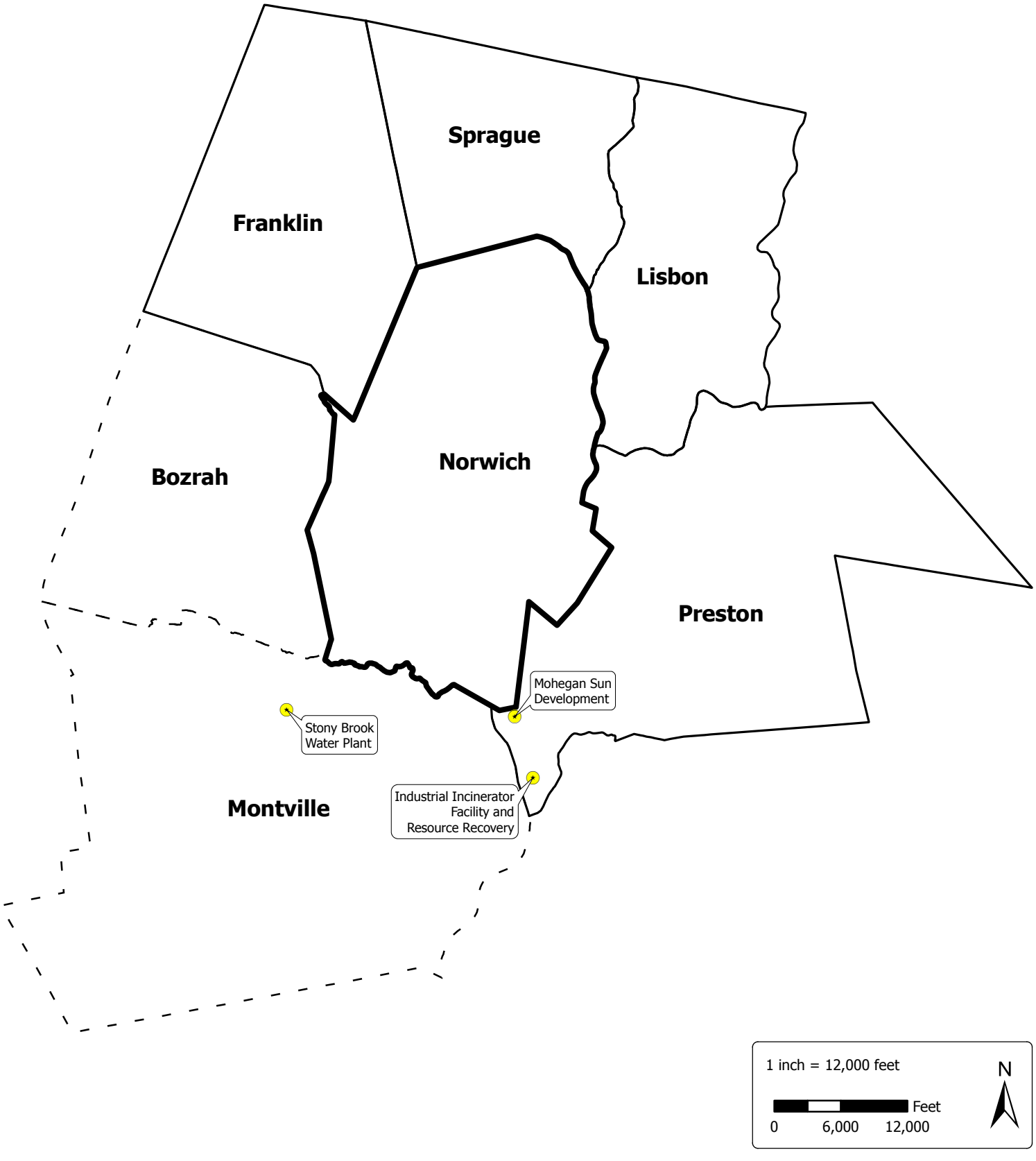

Legend

Town Contributing Sewer Flow to Norwich Public Utilities Sewer System

Town Not Contributing Sewer Flow to Norwich Public Utilities Sewer System

2018 Long Term Control Plan
Norwich Public Utilities

Figure 2-2
Sewer Service Area

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2.3.3 Description of Tributary Areas

Five of the City's nine sewer drainage areas include combined sewers: Downtown, Eastside, Greeneville, Laurel Hill, and Thamesville. These drainage areas as well as their associated CSO regulators can be seen in Figure 2-3 "Summary of Norwich's Combined Sewer System".

Downtown lies to the north of Norwich Harbor. Wastewater in this area drains by gravity to the Rose Alley Pumping Station (PS), where it is pumped to the WPCF. A Cipoletti weir (17-1) and a "pipe cutout" regulator (17-2) upstream of the pumping station relieve excess flow for Downtown and the Shetucket Interceptor. This excess CSO flow is discharged to the Thames River Estuary through CSO outfall 017.

Greeneville is northeast of Downtown and west of the Shetucket River. This area drains southwest through the Shetucket Interceptor to the Rose Alley PS by gravity. CSO outfalls 018, 019, 021, 022, 023, and 024 relieve the Shetucket Interceptor.

Eastside is south of Greeneville, on the eastern side of the Shetucket River. This area drains by gravity north across the river to the Shetucket Interceptor and then to Rose Alley PS. CSO 025 serves the Eastside Area. Separation of the Eastside area is included in the DEEP Consent Order and is discussed further in Section 7.

The Laurel Hill Area is south of the Shetucket River and East of the Thames River. Sewer from this area flows north across the Shetucket River, and eventually flows into the Rose Alley PS. Sewer flow from Laurel Hill combines with the Shetucket Interceptor, which carries flow from Greeneville and Eastside, before flowing into the pumping station. The Laurel Hill area is served by CSOs 029, 031, and 032.

The Thamesville combined area is located on the west side of the Thames River. This area drains to the South Thames Street PS and then to the WPCF. Thamesville is served by CSOs 004, 005, and 040.

2.3.4 Major Interceptors in Norwich

The NPU sewer system has five major interceptors with multiple tributary lines converging into each. These interceptors, as well as their collection areas, discharge locations, and overflow receiving waters, are listed in Table 2-1 and shown graphically in Figure 2-3. The Shetucket, Laurel Hill, and Thamesville interceptors serve the combined sewer system; the Salem Turnpike and Yantic interceptors exclusively serve separated sewers.

2.3.4.1 Laurel Hill Interceptor

The Laurel Hill Interceptor originates in the southeast corner of Norwich at Laurel Hill Road. This interceptor receives flow from a force main from the south in Preston, as well as the Laurel Hill sewershed area, and drains north towards the Shetucket Interceptor. The Laurel Hill sewershed includes CSO regulators 029, 031, and 032. This interceptor varies in diameter from 15 to 24 inches as it drains north to the River Avenue PS. Flow from this area is pumped by the River Avenue PS north, where it ultimately discharges by gravity across the Shetucket River and combines into the Shetucket Interceptor.

2.3.4.2 Salem Turnpike Interceptor

The Salem Turnpike Interceptor collects flow from Westside sewershed in the southwest corner of Norwich. The interceptor runs along Route 82 or the Salem Turnpike and drains northeast towards the Cove Street PS. This interceptor is pumped three times before entering the Cove Street PS as a 24-inch diameter gravity line. The Cove Street PS pumps directly to the WPCF. No CSO regulators or outfalls are associated with this interceptor. Pipes associated with this interceptor are partially separated. Public inflow sources have been removed, but private inflow sources such as roof leaders, drains, and sump pumps may still be connected.

2.3.4.3 Shetucket Interceptor

The Shetucket Interceptor collects flow from the north-east area of Norwich. This interceptor drains south from the northern border of Norwich, following the path of the Shetucket River. It ranges in size from 36 to 42 inches in diameter. As this interceptor runs through Greeneville, it also collects flow from the Downtown, Eastside, Laurel Hill, and Route 2 Corridor sewersheds. Thirteen CSO regulators (017-1, 017-2, 018, 019-1, 19-2, 021, 022, 023, 024, 025, 029, 031, and 032) fall within these five sewersheds. The interceptor discharges to the Rose Alley PS, which conveys flow to the WPCF.

2.3.4.4 Yantic Interceptor

The Yantic Interceptor passes through Norwich in the northwest area of the city, and drains south to the WPCF. This interceptor collects flow from the Norwichtown and Yantic sewersheds. This Interceptor's flow path follows the course of the Yantic River, and it varies in size from 15 to 28 inches in diameter. There are no CSO regulators associated this interceptor, and the tributary sewers are considered partially separated. This "partial separation" describes areas where public inflow sources have been removed, but there is a possibility for private property inflow sources.

2.3.4.5 Thamesville Interceptor

The Thamesville Interceptor collects flow from the south-western portions of Norwich. The Thamesville Interceptor follows the path of the Thames River, and flows north along the west bank. It collects flow from the Thamesville combined sewershed area. This interceptor flows past three CSO regulators (040, 004, and 005) on its way north to the WPCF. This interceptor is 21 to 24 inches in diameter along its gravity sections and is pumped via the Shipping Street and South Thames Street pumping stations.

Norwichtown
Yantic
Falls Mill PS
Yantic Interceptor
Downtown
Greeneville
Shetucket Interceptor
Victoria Landing PS
Eastside
Washington St PS
WPCF
City Hall PS
Falls Ave PS
Cove St PS
Westside
Salem Tpke Interceptor
Rose Alley PS
Court House Sq PS
Market St PS
Talman St PS
Route 2 Corridor
Shetucket River
Norwich Harbor
Summit Wood Apt PS
South Thames St PS
River Ave PS
Stonington Estates PS
Edgewood Dr PS
Potter Pl PS
Thamesville
Shipping St PS
Thamesville Interceptor
Laurel Hill Interceptor
Laurel Hill
Uncas Condos #1 PS
Uncas Condos #2 PS
Thames River
Shore Rd PS
24
25
22
23
21
19-1
19-2
18
17-1
17-2
29
5
4
31
32
40

1 inch = 1,250 feet
Feet
0 625 1,250
N

Legend

- CSO Overflow Regulator
- CSO Outfall
- Gravity Pipe
- Force Main
- Pump Stations (Norwich Public Utilities)
- Pump Stations (Private)
- Water Pollution Control Facility
- Sewershed Boundary

2018 Long Term Control Plan
Norwich Public Utilities
Figure 2-3
Summary of Norwich's Combined Sewer System

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Table 2-1 Major Interceptors, Discharge Locations, & Receiving Waters

Name	Tributary Area	Discharge Location	Diameter (in)	Receiving Waterbody
Laurel Hill Interceptor	Laurel Hill sewershed area south of River Avenue PS	Shetucket Interceptor	15-24	Thames River Estuary (CSO 029, CSO 031 & CSO 032)
Salem Turnpike Interceptor	Area tributary to Route 82 from the west of the Thames River	Cove Street PS / WPCF	18-24	No CSOs
Shetucket Interceptor	Greeneville area tributary to the Shetucket Interceptor. Parallels Shetucket River from northern Norwich border south to Rose Alley PS	Rose Alley PS / WPCF	36-42	Shetucket River and Thames River Estuary (CSOs 018, 019, 021, 022, 023, and 024), Thames River Estuary only (CSO 017)
Thamesville Interceptor	Thamesville sewershed area parallel to Thames River from southern Norwich border north via Shipping Street & South Thames Street PS	South Thames PS / WPCF	21-24	Thames River Estuary (CSOs 004, 005, and 040)
Yantic Interceptor	Collects flow from along the Yantic River. Drains south to WPCF by gravity	WPCF	15-28	No CSOs

2.3.5 Overflow Regulators

NPU has sixteen overflow regulators. The purpose of these structures is to regulate internal system flow (or head) and relieve excess flow in order to avoid manhole surcharge or flooding in the system. NPU's sewer system has CSO regulators, which allow flow from a combined pipe to enter another sewer pipe, storm drain, or receiving water.

Historically, overflow regulators were installed to protect areas prone to sewer backups or flooding. CSO regulators allow excess wet weather flow to discharge without causing dangerous surcharge in the system. The majority of the CSO structures in Norwich are typical manholes with a weir structure that allows excess flow to discharge into the river. In most cases in Norwich, the downstream pipes within the regulators were designed to be smaller in diameter than the upstream pipes. This was an intentional design feature typical of CSO regulators to back up flow until the depth of flow could relieve itself over the weir to an outfall.

Currently the 16 CSO regulator structures in NPU's system drain to 14 CSO river outfalls, including two locations where regulator structures discharge to a shared outfall pipe. The location of these regulators and outfall pipes is shown in Figure 2-1. NPU has a regular maintenance and inspection program for all collection system regulators. Regular maintenance and inspection is an excellent tool for monitoring operation of the sewer system and helping to diagnose problems such as sewer backups. Additionally, NPU monitors their regulator structures via a long-term flow metering program, which includes alarms to inform NPU staff of CSO activations.

2.3.6 CSO Receiving Waters

NPU's CSO outfalls discharge to the Shetucket River and the Thames River Estuary during wet weather conditions. The Shetucket River flows into the Thames River Estuary at Norwich Harbor and the Thames River Estuary flows south to Long Island Sound. It should be noted that DEEP GIS mapping of the Thames River Estuary and Shetucket Rivers segments overlap. This means that some CSO outfalls discharge to two different receiving waters at one outfall location. Table 2-2 shows the CSO outfall numbers, the regulator numbers, the receiving waterbody. Note that the "Outfall Number" with the preceding zeros, represents the NPDES permitted CSO outfalls, while the "Regulator Number" describes the regulator structures.

Table 2-2 Table of CSO Locations

Neighborhood	Outfall Number	Regulator Number	Regulator Location	Receiving Water
Thamesville	004	4	Backyard of 76 Thames Street	Thames River Estuary
Thamesville	005	5	South Thames Street	Thames River Estuary
Downtown	017	17-1	Rose Alley near PS	Thames River Estuary
		17-2	Rose Alley near PS	Thames River Estuary
Greeneville	018	18	North Main Street	Shetucket River/Thames River Estuary
Greeneville	019	19-1	North Main Street near Barron Street	Shetucket River/Thames River Estuary
		19-2	North Main Street at Roath Street	Shetucket River/Thames River Estuary
Greeneville	021	21	Erin Street	Shetucket River/Thames River Estuary
Greeneville	022	22	North Main Street	Shetucket River/Thames River Estuary
Greeneville	023	23	North Main Street	Shetucket River/Thames River Estuary
Greeneville	024	24	8th Street at Route 12	Shetucket River/Thames River Estuary
Eastside	025	25	Roosevelt Avenue at 8th Street	Shetucket River/Thames River Estuary
Laurel Hill	029	29	Talman Street	Thames River Estuary
Laurel Hill	031	31	River Avenue Extension near PS	Thames River Estuary
Laurel Hill	032	32	Near Railroad Tracks off Crown Street	Thames River Estuary
Thamesville	040	40	Shipping Street at Terminal Way	Thames River Estuary

2.3.7 System Performance

2.3.7.1 Pumping Stations

There are 46 wastewater pumping stations throughout Norwich's service area, many of which are tributary to the combined portion of the system areas in Norwich. The major pumping stations within the combined portion of the sewer system are at Cove Street, Rose Alley, River Avenue, Shipping Street, South Thames Street, and Talman Street. Table 2-3 lists Norwich's pumping stations.

All pumping stations located within NPU's sewer system tributary area have emergency power connections, and most major pumping stations have dedicated on-site emergency generators. In the event of a power outage, stations without an on-site emergency generator have wet well capacities ranging from one to three hours, which allow crews adequate time to respond with mobile generators.

Table 2-3 List of Pumping Stations

Number	GIS ID #	Pumping Station (PS) Name	Location Description	Owner
1	1	Rose Alley PS	Located at the end of Rose Alley	NPU
2	2	Market St PS	Located near the intersection of Market St & Chelsea Harbor Dr	NPU
3	3	River Ave PS	Located at the end of River Ave Extension	NPU
4	4	Shipping St PS	Shipping St at Terminal Way	NPU
5	5	South Thames St PS	South Thames St near West Thames St intersection	NPU
6	6	Cove St PS	Located at the end of Cove St across the Yantic River from the WPCF	NPU
7	7	Talman St PS	Talman St Extension	NPU
8	8	Salem Turnpike #1 PS	Located near 66 Salem Turnpike	NPU
9	9	Salem Turnpike #2 PS	Located between Maplewood Court and Salem Turnpike	NPU
10	10	Marcus Plaza PS	Norman Road at Rose Hill Estates	NPU
11	11	Phelps Dodge PS	Located at Wawecus St & the Yantic River	NPU
12	12	Occum Road PS	Occum Road near Pilling St	NPU
13	13	Shore Road PS	Located at the end of Shore Road	NPU
14	14	Washington St PS	Near Washington St & Route 32 Intersection	NPU
15	16	Falls Mill PS	Located at the Falls Mills Condominiums	NPU
16	17	Falls Ave PS	Located on Holly Hock Island at the WPCF	NPU
17	18	Bolduc Lane PS	Located Adjacent to 39 Buldoc Lane	NPU
18	19	New London Turnpike #1 PS	Intersection of New London Turnpike and Nordon Ave	NPU
19	20	Dodd Stadium PS	Located in the Parking lot of Dodd Stadium	NPU
20	21	Great Plain Road PS	Located at the intersection of Great Plain Road & Elk Dr	NPU
21	22	Sunnyside St PS	Near the Sunnyside and Sunnyside East Streets intersection	NPU
22	23	Old Salem Road	Located at Old Salem Road and Gifford St Intersection	NPU
23	24	Salem Turnpike #3 PS	Salem Turnpike near intersection with Arrowhead Dr	NPU
24	25	Edgewood Dr PS	Located at the end of Edgewood Dr	NPU
25	26	Mallon Chevrolet PS	Located at 774 West Thames St	NPU
26	27	Dunham St PS	Located across from 222 Dunham St	NPU
27	28	Uncas Condominiums PS	Located at the Uncas Condominiums off of West Thames St	NPU
28	29	Parkwood Condominium PS	Located at the Condominiums on Parkwood Dr	NPU
29	30	Victoria Landing PS	Located at the Victoria Landing condominium complex, 296 Hamilton Ave	NPU
30	31	Yantic Landing Condominiums PS	Located at the Yantic Landing Condominiums, 86 Otrobando Ave	NPU
31	32	Forestview Dr PS	Located on Forestview Dr in the Forest View Estates development	NPU
32	46	New London Turnpike #2 PS	Grounds of Norwich Regional Technical Vocational High School	NPU
33	47	Potter Place PS	Located at the end of Potter Place	Private
34	n/a	Lambert Dr PS	Located near 78 Lambert Dr	NPU
35	n/a	Court House Square PS	Behind 34 Court House Square on the bank of the Thames	NPU
36	n/a	Newton St Sewer Extension PS	Located at the end of Ash St	NPU
37	n/a	Uncas Condominiums #2 PS	Located at the intersection of West Thames St and Uncas Condominiums	Private
38	n/a	Stonington Estates PS	Located at the Stonington Estates Apartments	Private
39	n/a	Old State Hospital Site PS	Located at the old state hospital site on Laurel Hill Road	Town of Preston - NPU Maintained
40	n/a	Comfort Suites PS	Located at the Comfort Suites on Otrobando Ave	Private
41	n/a	City Hall PS	Located at Norwich City Hall	City of Norwich - NPU Maintained
42	n/a	Summit Wood Apartment PS	Located at Summitwood Apartment Complex	Private
43	n/a	DOT PS	Located at the DOT Site off of Laura Boulevard	State of CT
44	n/a	New Concord Dr PS	Located on New Concord Dr in the New Concord Green Development	NPU
45	n/a	Old Pond Lane PS	Located in the Private Development on Old Pond Road	Private
46	n/a	Water Pollution Control Facility	WPCF	NPU

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The Cove Street, S. Thames Street, and Rose Alley pumping stations all discharge to the WPCF. These pumping stations have capacities of approximately 3, 4, and 11.5 mgd respectively. The South Thames Street PS force main passes by the Cove Street PS, and the two force mains enter the WPCF from the Eastside of Holly Hock Island. The Rose Alley force main discharges to the plant from the east of Hollyhock Island, and the Yantic Interceptor is the only major gravity connection to the WPCF.

The pumping station of the most concern is the Rose Alley PS. Rose Alley is the largest pumping station that handles most flow to the WPCF. During wet weather, conveying combined sewer flows that causes the WPCF to exceed its design capacity could cause flooding or damage to the WPCF treatment systems. Additionally, excessive flows from the force mains during these conditions could cause the Yantic Interceptor to back up and potentially overtop manholes or flood basements upstream. NPU employees monitor flow at the WPCF and manually regulate flows from Rose Alley PS to prevent flooding at the WPCF or surcharge in the Yantic Interceptor. Manual flow adjustments at Rose Alley forces overflow at CSO 017 but prevents other problems elsewhere in the collection system and at the WPCF.

Many of the pumping stations throughout NPU's sewer system are aging and are well past their expected lifespan. The Shipping Street, River Avenue, and S. Thames Street pumping stations and forcemains are all in need of immediate repair. All three of these pumping stations are adjacent to CSO regulators, and future failure or poor performance could increase instances of CSO.

- The Shipping Street PS was constructed in the mid-1960s and has not been upgraded since 1973 (Black and Veatch, 2004 WW facilities plan). NPU staff indicated that the PS has chronic capacity problems during wet weather (Black and Veatch, 2004 WW facilities plan). Additionally, the Shipping Street PS's forcemain accepts two separate gravity connections directly to the pressurized forcemain, which is not a preferred hydraulic configuration.
- The River Avenue PS was originally constructed in the 1930s, upgraded in the 1950s, then completely overhauled in 1973 (Black and Veatch, 2004 WW facilities plan). The 2004 Facilities Plan rated the PS in poor condition; this was 14 years prior to the writing of this 2018 LTCP. The River Avenue PS forcemain suffered a recent break in 2018, highlighting the need for immediate repair of both the PS and forcemain.
- The South Thames Street PS was constructed in 1975. The PS was evaluated in the 2004 Facilities Plan and was determined to be beyond its useful life and in fair condition. This station was ultimately recommended for a complete overhaul in the 2004 Facilities Plan.

2.3.7.2 WPCF Wet Weather Capacity

By 1973, a large secondary treatment plant was constructed and commenced full service in 1976. Minor unit process upgrades have occurred since 1976, including biosolids upgrades in 2012. The current WPCF is operating essentially as the plant that was built in 1976.

Currently, the average daily flow at the Norwich WPCF is roughly 5 mgd. The plant is currently permitted for 8.5 mgd under NPDES. The designed peak flow of the facility is 17.0 mgd. Technically, this peak flow rate was for dry weather peak flow rates, but the plant is operated to provide secondary treatment to all flow that enters the facility. However, wet weather flows

conveyed to the plant often exceeds the design peak capacity. When wet weather flows exceed the sewer system's peak hydraulic capacity, the WPCF influent junction box becomes a constraint on the sewer system. When the facility cannot handle additional flow, the interceptors surcharge and release upstream overflows. To help control overflows and protect the WPCF, NPU paces flows from the Rose Alley PS. More detail on the WPCF and its wet weather operations is discussed in Section 3.

2.3.7.3 Infiltration and Inflow

Infiltration and inflow (I/I) can contribute a significant amount of flow to any sewer system. Significant sources of inflow include street drainage, as well as private roof leaders and sump pumps that could be connected to the sewer. Infiltration, or groundwater that seeps into the sewers, commonly occurs where there are loose joints, broken pipe sections, or root intrusion. Infiltration can add a considerable amount of flow to the collection system, especially in areas with high groundwater tables. It is desirable to remove I/I sources from any sewer collection and treatment system, to maximize the system's hydraulic capacity and to eliminate the expense of treating stormwater.

Although there is a wet weather I/I response in the separated areas of Norwich, it is relatively small in comparison with I/I from the combined sewer areas. The Downtown, Eastside, Greeneville, Laurel Hill, and Thamesville sewersheds all contain combined sewers. The remaining sewersheds are partially separated, as public inflow sources have been removed, but private inflow sources remain connected.

All neighboring communities that contribute flow to the collection system have separated sewage and storm water collection systems. However, since these communities can contribute I/I, they can also use wet weather capacity and indirectly contribute to CSOs in Norwich. NPU is currently updating its sewer use regulations. It is planned that the new regulations will prohibit inflow sources to separated sewers. This would give NPU authority to control and mitigate I/I from neighboring communities.

2.4 Collection System Model

2.4.1 Previous Work

The LTCP developed for NPU and submitted to DEEP in 2012 used a model of the Norwich wastewater collection system developed using Innovyze Software's InfoWorks. The model incorporated 1,700 pipes and 1,700 subcatchments. Asset characteristics were primarily obtained from geographic information system (GIS) mapping, including most pipes with diameters of 10 inches or greater. The model also included pump curves for 11 pumping stations including operations at Rose Alley pumping station. Subcatchments were not spatially represented; rather, contributing areas were assigned to each modeled manhole without corresponding polygons identifying contributing areas. Flow meters were deployed at 21 sites for three months in spring 2008 to support model calibration. Modeled flow was calibrated to a single storm. Calibration plots presented in the 2012 LTCP report show limited correspondence between observed and simulated flows at 13 sites; no effort was made to calibrate hydraulic grade lines.

2.4.2 Methodology

For the present study, the model was updated and improved to develop baseline conditions for the existing system. The updated model incorporates additional survey data and field checks at key locations, revised hydrology, revised dry weather flow estimates, and represents the receiving rivers. A comprehensive metering program was conducted in April and May 2017. A CSO metering program began in June 2017. The metering programs provided rainfall and flow data to inform model calibration over an extended period. The calibrated model is used to simulate design flow conditions and aided with development and evaluation of alternatives to meet the goals of the revised LTCP.

2.4.3 Model Update

Data from a variety of sources was incorporated to refine the model configuration and extend the calibration period, with a focus on high priority areas of the system. Hydraulics were updated to include:

- New survey at all regulators detailing weir elevations, weir dimensions, pipe sizes, and pipe inverts.
- New survey at key points detailing information on flow splits, sediment depths, pipe sizes, and critical interceptors.
- Observations during meter installation including photographs and sketches of regulators detailing pipe sizes, meter orientation, and sediment depths.
- As-builts of Rose Alley PS and set points for station operations. NPU operates this pumping station with the intent to maximize flow to the WPCF, but also to cap WPCF flows to its rated capacity of 17 mgd. This is currently manually controlled such that if the flow to the WPCF exceeds 13 mgd in wet weather, the variable frequency drives at Rose Alley are manually turned down to 6 mgd. When the storm is over, the pumping station is manually restored to automatic control. These operations were approximated in the model.
- 1979 design plans for the sewer system by CE Maguire, Inc. The planned designs were never constructed, but information on the existing system in the plans was used to validate pipe sizes where there were discrepancies between data sources (survey meter sketches, and GIS pipes).

Hydrology was updated to include:

- Refined subcatchment area delineations considering topography, sewer connectivity, and city parcels.
- Refined slopes for each subcatchment calculated using a digital elevation model. Slope was calculated as the contour interval times the total length of contours divided by the drainage area (Maidment, 1993).
- Updated soil properties for each subcatchment area.

- Refined estimates of percentages of impervious and pervious area for each subcatchment based on the 2011 National Land Cover Database.
- Drainage sketches from NPU, identifying areas as combined or separated.
- Partitioning of dry weather flow into sanitary and infiltration components.
- Wastewater from the neighboring communities of Franklin (1,100 gpd) and Sprague (15,500 gpd) and from NPU's Stony Brook water treatment plant (60,000 gpd).
- Representation of the receiving rivers to simulate tail water influence on the system.

During the short-term metering period in April and May 2017, 25 meters were installed to monitor flow in key locations throughout the system and upstream of regulators. These 25 meters were used to calibrate the model and ensure that modeled flows matched observed flows entering regulators. At the end of May, the meters upstream of regulators were relocated downstream to monitor the wet weather overflow pipes as part of the long-term CSO metering program. The other meters were removed, leaving one meter for each regulator. Data from the remaining 16 meters was collected beginning June 2017. Data from this long-term metering program was used to calibrate CSO volume, frequency, and duration. Rain gauges were also installed at three locations in Norwich throughout the metering periods.

The updated model includes 1,700 conduits and 1,900 subcatchments. The subcatchments comprise 580 acres of combined sewer area and 5,200 acres of separated sewer area. Combined areas include parts of Greeneville, Downtown, Eastside, northern Thamesville, and northern Laurel Hill. Additional information on the model update, including details on model conduits, subcatchments, and flow metering can be found in the March 2018 Baseline Conditions Report.

2.5 Future Baseline Conditions

In the Baseline Conditions Report, CDM Smith evaluated and calibrated the model to the existing conditions that NPU's collection system experiences today. This was considered the "Baseline Conditions" for purposes of model calibration. However, for alternatives analysis CDM Smith considered the future development and additional flow that is expected over the next 20 to 30 years as to not underestimate future flows when sizing alternatives. These future flows were added into the model on top of the "Baseline Conditions" flows to create the "Future Baseline Conditions" scenario. The future baseline flows were used in the model to simulate CSO conditions under the various alternatives evaluated.

2.5.1 Projected Flows

Four additional sources of increased wastewater flows were added into the model beyond what was presented in the Baseline Conditions Report to establish the "Future Baseline Conditions". These sources included projected development in Preston, Franklin, and Bozrah.

This first source of additional flows projected to contribute to Norwich's collection system is an entertainment complex in neighboring Preston. There is a former state hospital site in Preston that has been undeveloped for many years and previously contributed significant flow to Norwich's collection system and WPCF. The Mohegan Tribal Gaming Authority has plans to

redevelop this site with amenities that could include an indoor water park, a senior living center, shopping and a sports complex. This new development could restore as much as 500,000 gpd to NPU's collection system that has not been present since the closure of the former state hospital complex. This flow rate was used in the model as a component of the "Future Baseline Conditions". The existing 10" force main (still in use today to convey commercial flows from Preston) would be rehabilitated or replaced, and flow would discharge to Norwich at the southern end of the Laurel Hill Interceptor in Route 12. It is noted that this flow is deemed an in-kind replacement to the flows lost when the former state hospital was closed. Flows would be conveyed via the existing pumping station and force main, though this infrastructure would likely have to be updated.

A second source of future flow from Preston is expected from a mixed used development along Route 2. This development is expected to contribute approximately 100,000 gpd to NPU's collection system. This development would most likely have its own pumping station and force main, which would discharge to the eastern side of the Route 2 Corridor sewershed area. 100,000 gpd of flow was added at this location in the model as part of the "Future Baseline Conditions".

The third source of future flows is from the Town of Bozrah along Route 82. A development in Bozrah is expected to add 12,000 gpd of flow over the next few years. NPU expects this flow contribution to grow to approximately 100,000 gpd over the next decade. This contribution would discharge to the Salem Turnpike Interceptor on Route 82, and is tributary to the Cove Street PS. The value of 100,000 gpd was ultimately used in the "Future Baseline Conditions" scenario.

The final source of future wastewater flow is from the Town of Franklin. NPU expects a new pumping station to be constructed that would contribute another 100,000 gpd to NPU's collection system. This flow would be tributary to the Yantic Interceptor, where it would flow by gravity to the WPCF.

These four new contributions of wastewater were included in the model on top of the "Baseline Conditions" scenario presented in the Baseline Conditions Report to create the "Future Baseline Conditions" scenario. This new scenario was used as the basis to evaluate all LTCP alternatives. It can be expected that all alternatives will need to be sized to control CSO with these new wastewater inputs included in the system. It is also noted that the WPCF, rated at 8.5 mgd average daily flow, has more than enough capacity to accept these additional / future flows.

2.5.2 Design Storms

Previous CSO control plan modeling for Norwich used a synthetic 2-year design storm, three smaller historic storms recorded at Mansfield, 17 miles northwest of Norwich, and a representative year composited from eight discrete months of historic data at Mansfield and four months at Bradley Airport in Windsor Locks (Black and Veatch, 2012). The selection of representative precipitation was re-examined in the Baseline Report, considering updated precipitation statistics and additional sources of precipitation data.

Norwich has greater average annual precipitation than most communities in southern New England. The best source of long-term precipitation data and design storm hyetographs for Norwich was determined to be Providence Airport data with consideration for climatic

differences between the locations. The 54.8 inch estimated annual precipitation used for Norwich in this report is much greater than the 40.3 inches used in the 2012 Facilities Plan or the 42 inches used in Norwich's 1994 plan. This is primarily due to the earlier plans using hourly data from neighboring towns (Mansfield, Jewett City, Windsor Locks) that receive significantly less rainfall than Norwich.

Design storms were selected from Providence long-term hourly and sub-hourly data to align with the Norwich precipitation frequency estimates. Historic events were chosen instead of synthetic hyetographs to ensure realistic distribution of rainfall over the duration of a storm event. Table 2-4 presents 15-minute through 24-hour maximum depths for the selected design storms in the original data, along with adjusted 15-minute through 1-hour maxima in the final 15-minute hyetographs.

Table 2-4 Design Storms from Providence Hourly Data

Event	Date	15-Minute Hyetograph Maxima (inches)								Hourly Data Peak Hour (inches)
		15-min	30-min	60-min	2-hr	3-hr	6-hr	12-hr	24-hr	
1-month	April 20, 2015	0.20	0.27	0.35	0.50	0.61	0.82	0.95	1.03	0.30
3-month	September 6, 1974	0.37	0.47	0.58	0.82	0.99	1.41	1.82	1.89	0.46
6-month	September 26, 2008	0.51	0.70	0.77	0.98	1.17	1.68	2.40	2.53	0.52
1-year	September 19, 1972	0.56	0.79	1.00	1.38	1.62	1.99	2.66	2.86	0.74
2-year	August 30, 1985	0.67	0.95	1.22	1.83	2.01	2.23	3.17	3.43	1.01
5-year	August 9, 1954	0.85	1.20	1.54	2.15	2.29	2.88	3.27	4.17	1.34

2.5.3 Representative Period

The representative period of 2009-2011 was chosen to represent three consecutive years with average annual rainfall totals and average seasonal distributions of rainfall. For each year in this period, the number of three-month through one-year events at durations from 1 to 24 hours were close to the long-term expected values. Over an average three-year period, a system with 2-year performance would be expected to experience approximately one overflow. Continuous simulation of these three years was completed to verify targeted performance.

2.5.4 Future Baseline Wet Weather Flows

InfoWorks was used to simulate wet weather flow at the CSO outfalls for six design storms and the representative period. Simulations of each design storm were used to identify the costs and benefits of CSO remediation. The representative period was used to generate annual CSO statistics and to assess how well the desired control level was met.

The 1-month, 3-month, 6-month, 1-year, 2-year, and 5-year design storms were applied to the InfoWorks model. Peak flows and total volumes for each design storm under future baseline conditions are summarized by CSO outfall in Table 2-5 and Table 2-6. This assumes that the future flows are added to the system, but the combined sewer system remains as existing. System-wide CSO volume ranges from 1.1 million gallons (Mgal) for the 1-month storm to 6.97 Mgal for the 5-year storm. Approximately half of the total CSO volume for each storm occurs at

CSO 017. Relatively large CSO discharges also occur at 024, 023, and 019, which are on the Shetucket interceptor.

Table 2-5 Future Baseline Conditions Design Storm CSO Peak Flow Summary

	Peak Flow (mgd)					
CSO	1-month	3-month	6-month	1-year	2-year	5-year
004	2	5	8	9	10	14
005	0	1	1	1	2	2
017	16	17	31	35	37	44
018	3	5	7	8	10	15
019	3	6	9	10	12	20
021	0	1	2	2	2	2
022	2	4	6	7	8	10
023	5	9	13	14	16	21
024	4	8	14	15	19	27
025	1	2	4	5	5	8
029	0	0	0	0	1	2
031	0	2	5	6	6	8
032	0	1	4	5	6	10
040	0	0	0	1	1	3
Total	**35**	**62**	**104**	**118**	**135**	**186**

Table 2-6 Future Baseline Conditions Design Storm CSO Volume Summary

	CSO Volume (Mgal)					
CSO	1-month	3-month	6-month	1-year	2-year	5-year
004	0.01	0.05	0.11	0.16	0.28	0.35
005	0.00	0.02	0.03	0.06	0.10	0.11
017	0.78	1.11	1.91	2.51	2.91	3.16
018	0.03	0.09	0.17	0.21	0.34	0.39
019	0.03	0.09	0.17	0.22	0.36	0.46
021	0.00	0.01	0.02	0.02	0.04	0.12
022	0.01	0.04	0.09	0.12	0.21	0.25
023	0.07	0.17	0.32	0.42	0.66	0.72
024	0.06	0.14	0.27	0.34	0.54	0.63
025	0.09	0.13	0.19	0.22	0.28	0.34
029	0.00	0.00	0.00	0.00	0.01	0.02
031	0.00	0.03	0.07	0.11	0.20	0.24
032	0.00	0.01	0.03	0.05	0.08	0.13
040	0.00	0.00	0.00	0.00	0.02	0.05
Total	**1.10**	**1.90**	**3.38**	**4.46**	**6.02**	**6.97**

The three-year representative simulation from 2009 to 2011 was run to generate annual CSO statistics for the future baseline. Annual CSO volumes for each year ranged from 43.85 Mgal in 2009 to 51.91 Mgal in 2010, with an average annual CSO volume of 47.04 Mgal (Table 2-7). The updated future baseline condition estimates 54% less total CSO volume than the 2012 LTCP update. The Baseline Conditions Report explores and explains these differences.

Table 2-7 Representative Period Summary under Future Baseline Conditions

Year	Volume (Mgal)	Events	Duration (hrs)	Precipitation (in)
2009	43.85	57	359	54.9
2010	51.91	52	340	53.5
2011	45.37	81	367	56.7
Average	47.04	63	355	55.0
2012 LTCP	103.3	90	NA	40.28

Town of Sprague

Town of Franklin

Town of Lisbon

Town of Bozrah

Town of Montville

Town of Preston

Yantic

Downtown

Greeneville

Route 2 Corridor

Laurel Hill

Norwichtown

Westside

Thamesville

Eastside

Shetucket Interceptor

Yantic Interceptor

Salem Tpke Interceptor

Thamesville Interceptor

Laurel Hill Interceptor

6" Stony Brook Water Treatment Plant Waste Sludge and Backwash Line

10" Force Main from Old State Hospital Site

Neighborhood	Discharge Number	Regulator Number	Regulator Location	Receiving Water
Thamesville	004	4	Backyard of 76 Thames Street	Thames River Estuary
Thamesvile	005	5	South Thames Street	Thames River Estuary
Downtown	017	17-1	Rose Alley near Pump Station	Thames River Estuary
		17-2	Rose Alley near Pump Station	Thames River Estuary
Greeneville	018	18	North Main Street	Shetucket River/Thames River Estuary
Greeneville	019	19-1	North Main Street near Barron Street	Shetucket River/Thames River Estuary
		19-2	North Main Street at Roath Street	Shetucket River/Thames River Estuary
Greeneville	021	21	Erin Street	Shetucket River/Thames River Estuary
Greeneville	022	22	North Main Street	Shetucket River/Thames River Estuary
Greeneville	023	23	North Main Street	Shetucket River/Thames River Estuary
Greeneville	024	24	8th Street at Route 12	Shetucket River/Thames River Estuary
Eastside	025	25	Roosevelt Avenue at 8th Street	Shetucket River/Thames River Estuary
Laurel Hill	029	29	Talman Street	Thames River Estuary
Laurel Hill	031	31	River Avenue Extension near Pump Station	Thames River Estuary
Laurel Hill	032	32	Near Railroad Tracks off Crown Street	Thames River Estuary
Thamesvile	040	40	Shipping Street at Terminal Way	Thames River Estuary

Legend

- Pump Stations (Norwich Public Utilities)
- Pump Stations (Private)
- Pump Stations (State)
- Water Pollution Control Facility
- CSO Outfall
- WPCF Outfall
- CSO Overflow

Norwich Public Utilities

Separated Sanitary Sewers

- Other/Unknown Diameter
- Diameter < 24"
- Diameter >= 24"

Private Separated Sanitary Sewers

- Other/Unknown Diameter
- Diameter < 24"
- Diameter >= 24"

- Sewer Manhole
- Storm Drain Manhole
- Force Main
- Sewershed Boundary

City of Norwich Storm Drains

- Storm Drain Pipe

Norwich Public Utilities

Combined Sanitary Sewers

- Other/Unknown Diameter
- Diameter < 24"
- Diameter >= 24"

Private Combined Sanitary Sewers

- Other/Unknown Diameter
- Diameter < 24"
- Diameter >= 24"

1 inch = 800 feet

0 800 1,600 2,400 Feet

N

CDM Smith

2018 Long Term Control Plan
Norwich Public Utilities
Figure 2-1
Comprehensive Collection System Map

Section 3

Section 3

Norwich Water Pollution Control Facility

3.1 General

The Norwich Water Pollution Control Facility (WPCF) is located on Hollyhock Island at the mouth of the Yantic River. The first WPCF was built in 1936 but was replaced with a larger facility at the same location in 1957. Both early plants provided primary treatment. In the early 1970s, the plant was expanded and upgraded to provide secondary treatment. Since 1976, the WPCF has provided secondary treatment for all flow it receives.

Treated flow discharges via National Pollutant Discharge Elimination System (NPDES) permitted outfalls 001 to the Thames River and 002 to the Yantic River. The WPCF currently processes an average daily flow of around 5 million gallons per day (mgd), with wet weather peaks often exceeding the 17 mgd design peak capacity. Wastewater flow is predominantly residential, with some commercial and industrial wastewater.

The WPCF is aging and will need to be rehabilitated to continue to address the NPDES permit requirements. A design for new plant upgrades was completed in 2015 but Norwich Public Utilities (NPU) did not proceed with construction due to changing flood control regulations. Combined sewer overflow (CSO) control alternatives included consideration of upgrading the facilities to treat more collection system wet weather flow.

3.2 Existing System

The WPCF utilizes conventional activated sludge secondary treatment process and is designed for an 8.5 mgd average flow rate. Figure 3-1 shows the existing site plan. An assessment of the replacement needs for the existing facilities is included below.

3.2.1. Processes

The facility provides for removal, treatment, and disposal of settleable and floating solids and for reduction of suspended and dissolved organic material through primary and secondary processes. Raw sludge, scum, and waste activated sludge are dewatered, digested, and then sent offsite for disposal. Effluent is disinfected by chlorination on a seasonal basis prior to discharge to the Thames River, with a secondary discharge to the Yantic River during high river conditions.

3.2.2 Flow Pattern

Untreated wastewater first passes through one mechanically-cleaned bar screen. Grit is removed in two aerated grit chambers. After passage through the grit chambers, flow proceeds to two rectangular primary settling tanks equipped with traveling bridge sludge and scum collection mechanisms. From the primary tanks, flow is conveyed to two aeration tanks for secondary treatment. From the aeration tanks, flow proceeds to three circular secondary clarifiers. Final effluent is chlorinated and normally discharged to the Thames River.

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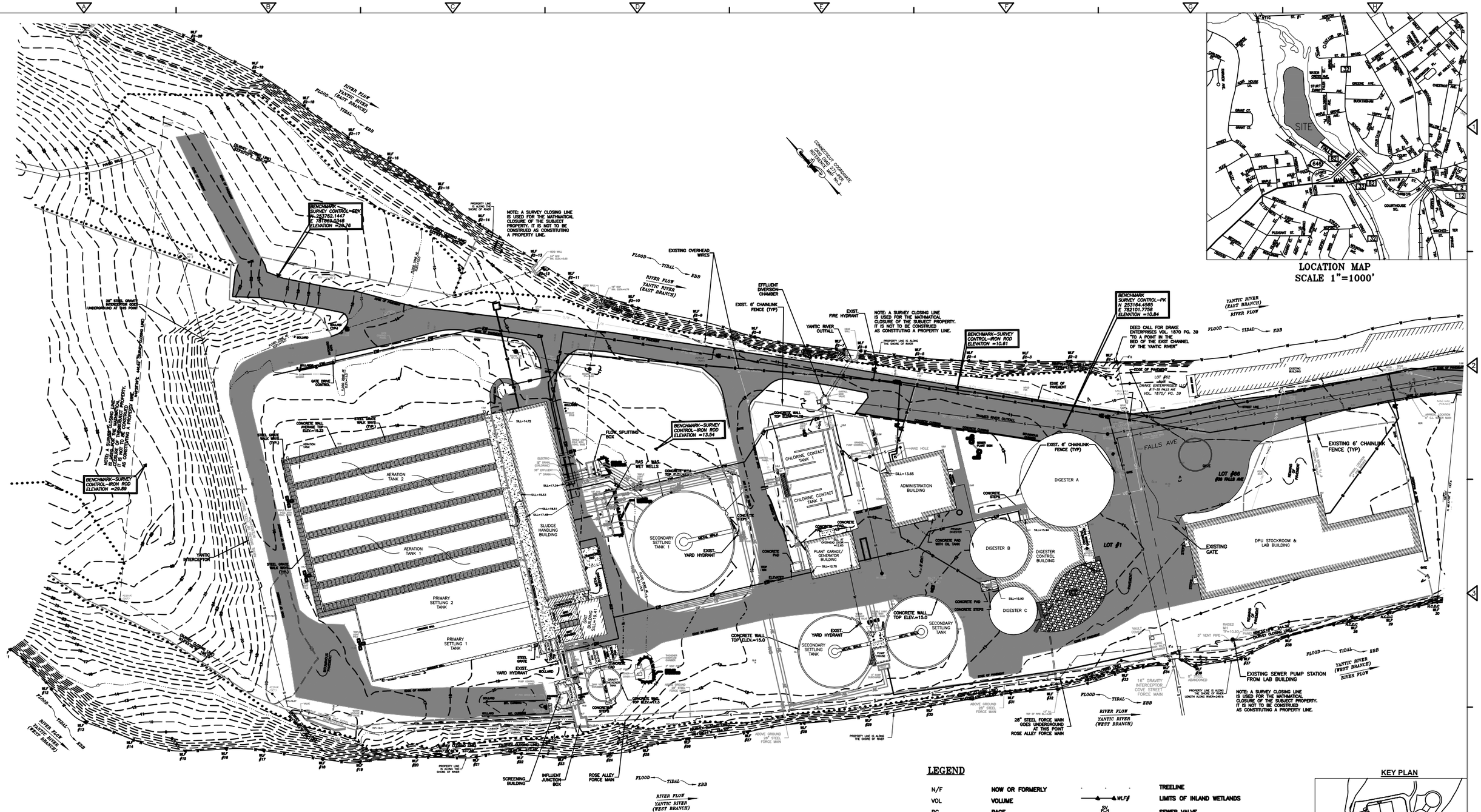


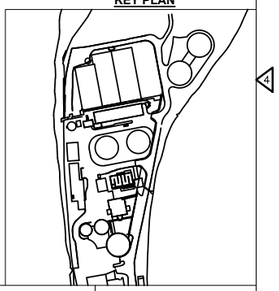
LOCATION MAP
SCALE 1"=1000'

SCALE: 1"=40'

LEGEND

N/F	NOW OR FORMERLY		TREELINE
VOL	VOLUME	WLF#	LIMITS OF INLAND WETLANDS
PG	PAGE	SV	SEWER VALVE
SF	SQUARE FEET	GV	GAS VALVE
TOP	TOP OF PIPE	WV	WATER VALVE
× 12.7	SPOT GRADE	G	BURIED GAS LINE
MH	MAN HOLE	W	BURIED WATER LINE
APPROX.	APPROXIMATE	E	BURIED ELECTRIC LINE
— 10 —	EXISTING CONTOURS	T	BURIED TELEPHONE LINE
	RETAINING WALL	O/W	OVERHEAD WIRES
	CHAIN LINK FENCE	S	BURIED SEWER LINE
	PAVING		
	ROCK		

KEY PLAN



REV. NO.	DATE	DRWN	CHKD	REMARKS

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SHEET CHK'D BY: W. LENGYEL
CROSS CHK'D BY: W. LENGYEL
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DATE: OCTOBER 2014

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Green Site Design — LLC —
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CITY OF NORWICH, CONNECTICUT
CONTRACT: CWF-625-C
WATER POLLUTION CONTROL FACILITY UPGRADE

EXISTING CONDITIONS

PROJECT NO. 96538-76995
FILE NAME: GSD05
SHEET NO. 3-1

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3.2.3 Screening and Grit Handling

Screenings and grit handling provides preliminary treatment for raw sewage. The first step in preliminary treatment is removal of large solids by screening. Screenings are automatically removed by one mechanically cleaned bar screen. Screenings are lifted out of the channel by the screen and deposited into a washer/compactor. From the washer/compactor, screenings discharge to a dumpster for off-site disposal. The bar screen has ¾-inch openings and can handle flow up to 10 mgd. During higher flow, operators open a standby channel and a portion of the influent wastewater is not screened.

Following screening, sewage passes through two aerated grit chambers, each 22.5 feet long, 15 feet wide, and 10 feet deep. Grit settles to the bottom of the chambers where screw conveyors in troughs move the grit to the downstream ends of the chambers. Bucket elevators remove grit from the trough and deposit it in dumpsters for off-site disposal. Aeration is provided to the tanks through coarse bubble diffusers causing a spiral roll velocity pattern perpendicular to the flow. Air is supplied by the same blowers used for the aerations basins. Both aerated grit chambers are typically in operation except when maintenance is performed.

3.2.4 Primary Treatment Systems

After grit removal, primary treatment occurs in two rectangular primary clarifiers. Flow is split via slide gates. Inlet baffles distribute flow to minimize turbulence. Solids that settle and floating scum are collected with traveling bridges operating at two feet per minute. Both scum and sludge are pushed toward the influent end of the tanks where scum is removed with a manual rotating sludge trough and sludge accumulates in withdrawal sumps. Flow leaves the tank over V-notch weirs and is conveyed into an aerated channel. Coarse bubble diffusers keep solids suspended.

3.2.5 Secondary Treatment Systems

From the primary effluent channel, flow is conveyed along the north end of the WPCF to the two aeration basins. Each basin consists of three paths which can be used for various process configurations including conventional activated sludge, step aeration, and contact stabilization.

Air is introduced into the basins from a system of two 9,000 cubic-foot-per-minute (cfm) blowers and one 3,000 cfm blower in the sludge handling building. Operators take manual dissolved oxygen readings to confirm proper aeration. The basins are equipped with froth spray systems to prevent foam and scum accumulation.

The WPCF has three secondary clarifiers for final sludge removal. Two 60-foot diameter tanks were constructed in 1958 and converted to secondary clarifiers in 1975. A third, 85-foot diameter tank was constructed in 1973 to increase secondary clarification capacity. Flow from the aeration basins is split among the secondary clarifiers. Each is equipped with rotating sludge collection mechanisms. Flow leaves the clarifiers via V-notch weirs and effluent troughs.

3.2.6 Disinfection and Effluent Discharge Systems

Flow from the secondary clarifiers recombines and is conveyed to the disinfection splitter box where it is dosed with sodium hypochlorite and enters one of two serpentine chlorine contact tanks. Sodium hypochlorite is stored in a room of the sludge handling building and is pumped at varying speeds based on plant flow through the Parshall flume after the contact tanks.

Chlorination is only required seasonally from May through October per the current NPDES permit. There is no dechlorination system. Operators take effluent grab samples to confirm proper chlorine residual levels.

Plant effluent typically flows through a 30-inch diameter, 2,500-foot long outfall to the Thames River. The short 36-inch diameter outfall to the Yantic River is only used when high river stage creates a tailwater and significant headloss for the Thames River outfall. In this instance, the plant effluent flow rate is hydraulically limited (depending on river stage) and the Yantic River outfall must be used to maintain flow through the plant.

3.2.7 Solids Handling Systems

Sludge collected from the primary settling basins is pumped to a gravity thickener. This produces thickened primary sludge generally with a 4.5 percent solids concentration. Thickened primary sludge is pumped to the primary digester along with thickened waste activated sludge (WAS).

Return activated sludge (RAS) is withdrawn from the secondary clarifiers and pumped to the influent end of the aeration basins.

WAS is collected from the hoppers of the secondary clarifiers and pumped to a rotary drum thickener which thickens to a concentration between 4 and 6 percent at a rate of 250 gallons per minute (gpm). Thickened WAS is pumped to the primary digester along with the thickened primary sludge.

The 80-foot primary digester receives the thickened sludge, heats it, and mixes it using a gas mixing system. Gas is collected in a dual membrane cover and used for heating the digester and digester building. Sludge overflows from the primary digester into two smaller, secondary digesters which are used mainly for storage. Sludge is then pumped back to the sludge handling building and sent to a belt filter press (BFP). The 1.5-meter BFP produces sludge cake with a solids concentration of 20 percent. The sludge cake is sent to a regional incinerator.

3.2.8 Administration Building and Laboratory

The Administration Building is a former incinerator converted to a main plant control room, staff offices, staff locker rooms, and storage. The analytical laboratory is housed in a separate one-story brick building at the southern end of the plant site. The laboratory analyzes all samples except for toxicity, metals, and some nutrients, which are sent to an outside laboratory.

3.3 2015 WPCF Upgrade Design

From 2010 to 2012, CDM Smith produced a conceptual design report for a plant-wide upgrade. The *CSO Long-Term Control Plan Final Report*, prepared in August 2012 by Black & Veatch, recommended expanding plant capacity to 33 mgd to accommodate more wet weather flow. Based on this recommendation, CDM Smith progressed the WPCF design from 2012 to 2015 to meet permit limits at the higher flows (33 mgd peak) and replace aging equipment and controls for increased reliability and operational flexibility. The intent was to provide full secondary treatment to wet weather flows. This WPCF Upgrade Design was completed in 2015.

The design process included multiple value engineering sessions, coordination with NPU, and review and input from the Connecticut Department of Energy and Environmental Protection (DEEP) to refine the scope and design. As of August 2018, the design has not been implemented due to a variety of reasons including, but not limited to, local funding limitations and changes to flood protection and resiliency regulations.

Several new secondary processes were evaluated for nutrient removal during preliminary design including the modified Ludzack-Ettinger (MLE) Process, four stage Bardenpho, and integrated fixed film activated sludge (IFAS). An (IFAS) media system was selected for the biological treatment process to upgrade from the existing activated sludge process due to its ability to achieve the nutrient removal goals within the site space available.

This subsection describes the major components of the 2015 design. The design is based on a recommendation from the 2012 Long Term Control Plan to increase plant capacity to 33 mgd. While this recommendation for a 33 mgd peak flow capacity is no longer the preferred approach, some of its components will still be included in the recommended approach for additional wet weather treatment for CSO control. A process flow diagram specific of the liquid train specific to this design is shown in Figure 3-2.

3.3.1 Septage Receiving Facility

A new septage receiving facility would provide updated receiving and tracking features along with septage storage to reduce slug loading to the influent. The receiving station would be located next to the headworks and include a storage tank, submersible pumps, and basic septage treatment to remove rocks. A fats, oils, and grease (FOG) receiving station was also designed adjacent to the septage receiving station, providing similar functionality.

3.3.2 Headworks

The single mechanical bar screen at the plant is insufficient at flows above 10 mgd. The 2015 design addressed this by providing three trains of two screens in series, each train would have one ¾-inch mechanical coarse bar screen followed by one ¼-inch mechanical perforated plate fine screen. Two trains would be active at peak flow, with one on standby. Screenings would be discharged to sluiceways and conveyed to washer compactors. The fine screens were required for the downstream IFAS secondary treatment process. The coarse screens were required to removal the larger debris and rags which could damage the fine screens. The headworks would also include two vortex grit units. These are low maintenance and have a smaller footprint than aerated grit tanks. Pumps would remove grit from the bottom of the vortex units and convey it to grit classifiers in the same area as the screenings' washer compactors.

The headworks was designed as a completely new structure located on the western side of the plant site at the location of the existing smaller secondary tanks. Some rerouting of influent pipes was designed to bring all flows to an influent junction box upstream of the headworks.

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INFLUENT JUNCTION CHAMBER
COVE STREET FORCE MAIN
ROSE ALLEY FORCE MAIN
YANTIC INTERCEPTOR
AREA VELOCITY FLOW METER
FM
WASH PRESS
WASH PRESS
COARSE SCREENS
FINE SCREENS
WASH PRESS DRAIN
GRIT PUMPS
GRIT
GRIT WASHER
VORTEX GRIT CHAMBERS
GRIT PUMPS
GRIT
GRIT WASHER
GRIT WASHER DRAIN
INFLUENT SCREW PUMPS
HEADER BOX
BELT FILTER PRESS FILTRATE
ROTARY DRUM THICKENER CONCENTRATE
PRIMARY INFLUENT CHANNEL
PRIMARY SETTLING TANK 1
PRIMARY SETTLING TANK 2
ALKALINITY ADJUSTMENT
SUPPLEMENTAL CARBON
IFAS TANK NO. 1
MIXED LIQUOR CHANNEL
IFAS TANK NO. 2
SUPPLEMENTAL CARBON
RAS DISTRIBUTION BOX
RAS
RAS
FLOW SPLITTING BOX
LOW LEVEL PUMP STATION
GRAVITY THICKENER OVERFLOW
BIOFILTER LEACHATE
ON SITE SANITARY FLOWS
DIGESTER SUPERNATANT
EXISTING SECONDARY SETTLING TANK # 1
NEW SECONDARY SETTLING TANK # 2
NEW SECONDARY SETTLING TANK # 3
NEW SECONDARY SETTLING TANK # 4
RAS
RAS
PARSHALL FLUME
UV DISINFECTION
YANTIC RIVER
EFFLUENT PUMP STATION
THAMES RIVER
SEPTAGE HOLDING TANK WITH SEPTAGE PUMPS

REV. NO.	DATE	DRWN	CHKD	REMARKS

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CITY OF NORWICH, CONNECTICUT
CONTRACT: CWF-625-C
WATER POLLUTION CONTROL FACILITY UPGRADE

PROCESS FLOW DIAGRAM LIQUID TRAIN

PROJECT NO. 96538-76995
FILE NAME: GPRFD001.DWG
SHEET NO. 3-2

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3.3.3 Influent Pumping Station

While the current plant operates without influent or effluent pumping, increasing flow to meet 2012 Long-Term Control Plan (LTCP) recommendations and upgrading systems would require influent pumping. A pumping station was added after the headworks to drive flow through the rest of the plant. The design featured four screw pumps; three duty and one standby.

3.3.4 Primary Clarifiers

The primary clarifiers are sufficient for the design flows, but the traveling bridge mechanisms have far exceeded their expected life. The 2015 design includes replacement with new chain and flight mechanisms.

3.3.5 Aeration Tanks

The existing aeration tanks would be converted to an IFAS system to improve biological performance within the existing aeration tank footprint. This would include upgraded aeration blowers and piping. It is noted that IFAS may not have been needed for a lower design flow rate.

3.3.6 Secondary Clarifiers

To handle peak flow and as the headworks is specified at the location of the existing 1957 smaller clarifiers, three new 85-foot diameter clarifiers were designed. One would be located east of the existing 85-foot clarifier. The other two would be located northeast of the existing plant limits. The existing 85-foot clarifier mechanism would also be replaced.

3.3.7 Disinfection Facility

The existing chlorine contact tanks cannot provide sufficient contact time at peak flow under 2012 LTCP conditions. Instead of expanding or building new tanks, an ultraviolet (UV) light system was designed to be installed within the current footprint of the chlorine contact tanks. Flow measurement using a new Parshall flume would follow the disinfection facility.

3.3.8 Effluent Pumping Station

At typical river stage, the plant can discharge flow to the Thames River by gravity. At higher river stages and at peak flow, the WPCF cannot discharge by gravity to either river. Therefore, an effluent pumping station was designed to pump during higher flows and coincidental flood levels. The pumping station consists of five effluent pumps to provide for a range of flows.

3.3.9 Solids Handling Improvements

To address the additional solids generated by treatment of higher flows and the IFAS process, additional solids handling improvements were required in the 2015 design.

3.3.9.1 Gravity Thickener

The design includes replacement of the gravity thickener mechanism and cover.

3.3.9.2 Sludge Handling Building

The design includes replacement of all sludge handling pumps and piping as well as replacement of aeration blowers, chemical systems, and electrical infrastructure. The existing rotary drum thickener and belt filter press would remain.

3.3.9.3 Sludge Digestion

Secondary digesters B and C have far exceeded their design life. The design calls for replacing mixing systems and covers. This would restore the secondary digesters to useful service, as opposed to their current use for sludge storage. The primary digester, A, would remain.

3.3.10 Administration Building

The design included demolishing the existing administration building to its foundation and constructing a new one-story building on the foundation to meet the needs of the plant staff. A laboratory would also be constructed within the administration building.

3.3.11 Hollyhock Landfill Expansion and Closure

To limit the disposal and transportation costs of excavated material, the existing landfill at the north end of Hollyhock Island would be expanded to accept most of the displaced materials. After construction, the landfill would be capped to modern standards.

3.3.12 Odor Control

The design included an odor control system located north of the headworks. This system would capture odors from the headworks, including the screenings and grit removal facilities, influent pumping station, and gravity thickener, and reduce odors before release to the environment. The system is desirable due to the WPCF's proximity to residential and commercial areas of Norwich.

3.4 Limitations of the Existing Facility

Improvements to the WPCF facilities are being considered in this LTCP for wet weather treatment and CSO control. The 2015 design for WPCF improvements considered providing secondary treatment to excess wet weather flow received at the WPCF. The following subsections explore some of the key limitations of the existing facility that influence the proposed improvements that could be considered for future use of the WPCF as part of the CSO control plan.

3.4.1 Treatment Process Capacity and Hydraulic Limitations

The WPCF is currently rated for an average flow of 8.5 mgd with a 17 mgd peak. However, the plant currently receives flows up to 20 mgd during many storms. This elevated flow rate is significant enough that it has, at times in the past, caused tank overflows and other problems. The existing screening facilities are undersized for the current plant peak flows, and the aerated grit, secondary treatment, disinfection, and yard piping are also undersized for some increased plant flow scenarios. Process upsets occur at flows as low as 13 mgd as the influent channel would overtop if the standby channel stop logs are not pulled out, and solids begin to wash out of the shallow 60-ft diameter secondary clarifiers from the 1950's. To maximize the peak wet weather flow capacity of the plant, staff often need to temporarily open the standby channel around the mechanical screen to lower the flow depth in the influent channel level, but this practice exposes the downstream processes to additional debris. CSO control alternatives that focus on maximizing treatment at the WPCF should consider the hydraulic limitations of the plant. Treatment at the WPCF for flows greater than 17 mgd will require upgrades to consistently accept and process wastewater with reliable treatment.

The liquid train of the plant currently operates entirely by gravity. A detailed hydraulic modeling exercise was not performed in support of this study, as treatment capacity is governed by the unit capacity of various WPCF components. Development of an updated facility hydraulic profile is recommended prior to design of any long-term improvements at the WPCF. However, based on the 2012 conceptual design and 2015 WPCF design, certain river stages limit the gravity discharge of peak flows from the plant. Therefore, influent and effluent pumping will likely be required to overcome additional headloss and high river stages with high plant flow.

3.4.2 Limitations of WPCF Equipment

As mentioned previously, the WPCF was last upgraded in the 1970s. While some individual processes have been replaced or upgraded, most of the plant has exceeded its expected service life. Almost all mechanical systems will require replacement or rehabilitation as it becomes increasingly risky and maintenance-intensive to run the systems. As an example, one of the secondary clarifier mechanisms from 1957 required emergency replacement in 2016 due to components failure.

Postponing upgrades and rehabilitation of the plant could compromise the plant's ability to reliably meet its NPDES permit and subject NPU to penalties. The aging equipment and control systems do not meet current standards; replacement with modern equipment will provide increased operational control and flexibility. Modern equipment would also provide efficiency benefits over older equipment.

3.4.3 Limitations of the WPCF Site

The WPCF is located on an island which was formerly used as a municipal landfill from 1937 to 1971. As a result, much of the island is filled municipal solid waste. This presents a challenge for structural support as settlement of the underlying soil is common throughout the island. Most existing structures are pile-supported. Those which are not exhibit significant settling. The 2015 WPCF upgrade design included bedrock-supported piles for all structures regardless of size and for all large diameter piping. All alternatives that include construction on Hollyhock Island should include bedrock-supported piles to prevent settlement.

Soil and groundwater testing were performed at the site in 2010. From these investigations it was found that there are some wastes that could be disturbed in performing upgrades at the WPCF. Most soils can be reused on site if they are replaced in the same location. An estimated 12% of soils may be considered Resource Conservation and Recovery Act (RCRA) hazardous waste due to leachable metals concentrations. Groundwater dewatered during construction may require treatment prior to discharge either via the WPCF or other treatment process.

As would be expected with a facility location on an island, the existing WPCF site is highly space-constrained. The former landfill area north of the plant is available for WPCF improvements, but the East and West Branches of the Yantic River and the public portion of Falls Avenue to the South form the major boundaries for any proposed improvements. If the laboratory can be relocated from its current location, then the footprint of that building could be used for expansion or improvements.

3.4.4 High River Discharge Limitations

The 2015 design placed all facilities above the 100-year floodplain for flood prevention. In 2017, DEEP released *Clean Water Fund Memorandum (2017-001), Storm Resiliency of Municipal Wastewater Infrastructure*. This memorandum requires infrastructure funded by the Clean Water Fund to place all critical infrastructure three feet above the 100-year floodplain and all non-critical infrastructure two feet above the 100-year floodplain. The 2015 design, even though it was completed prior to the release of the memorandum, will be subject to the memorandum as communicated by DEEP.

CDM Smith believes the areas listed below may require re-design to meet the new requirements. Flood protection and resiliency will be considered for these areas in future designs.

- Screening and Grit Washing
- Grit Pumping
- Primary Sludge Pumping
- Secondary Treatment
- UV Disinfection
- Effluent Pumping
- Odor Control
- Digester Control Building
- Aeration Blowers
- Carbon Storage
- Main Electrical Substation
- Administration Building

3.5 Summary

The existing WPCF is providing treatment for dry weather and a portion of the wet weather flow generated by the Norwich sewer system. The facility is designed for 17 mgd but receives wet weather flow up to 20 mgd, which can sometimes overwhelm the facility. Infrastructure in the facility is aging, with many systems having exceeded their useful operational life, which has increased the operation and maintenance costs at the facility.

It is recommended that the facility receive substantial upgrades in the near term to revitalize the operations, extend the useful life of the facility, improve reliability and reduce ongoing operations and maintenance costs. In addition, the WPCF provides significant wet weather treatment that avoids untreated CSO discharges. Alternatives to achieve CSO control in the Norwich system will continue to rely on this critical wet weather treatment capacity. It expected that, at a minimum, the facility will continue to receive flows up to 20 mgd and this was assumed as a baseline for future CSO control recommendations. The need for future facility improvements to consistently treat this high flow rate should be considered in the implementation plan. Section 8 presents the assessment of required improvements at the WPCF to address CSO control.

Section 4

This section has been superseded by the revised 2020 CSO LTCP Report.

Section 4
Water Quality Objectives

4.1 General

For the first two decades of implementation of the federal Clean Water Act (CWA), regulatory agencies focused on cleanup of continuous waste discharges. Publicly owned treatment works (POTWs) were typically required to provide secondary treatment, or at least provide a level of treatment greater than primary sedimentation. Industrial dischargers were required to install best available treatment for their discharges.

Combined sewer overflow (CSO) control presents communities with distinct challenges as system improvements for CSO control can be expensive and water quality impacts from CSOs are temporary and limited to periods when discharges occur during storms. In addition, many studies indicate that CSO control alone may not meet water quality objectives as stormwater runoff also adversely affects water quality during and after wet weather conditions.

In recent years, regulators have sought coherent policies that tie the environmental benefits of CSO control with the costs to achieve these benefits. Both federal and state agencies recognize that compliance with state water quality standards for CSO discharges is costly. Accordingly, both governments have developed separate, but similar, CSO control policies to guide the abatement of CSO discharges given the technical, social, and economic challenges for communities.

In Connecticut, the Department of Energy and Environmental Protection (DEEP) has primacy, meaning the federal entity United Sates Environmental Protection Agency (EPA) has delegated primary enforcement responsibility to the state entity (DEEP). This section discusses current EPA and DEEP policies, highlighting the applicability of both policies to Norwich Public Utilities (NPU).

4.2 EPA Policy

CSOs are point source discharges to the waters of the United States, subject to the CWA and the National Pollution Discharge Elimination System (NPDES). Like other point source discharges, CSOs are subject to both technology-based and water quality-based requirements of the CWA. The 1994 *Combined Sewer Overflow (CSO) Control Policy* (EPA CSO Policy) provides EPA guidance for controlling CSOs. The policy was adopted as law in 2000. The EPA CSO Policy is included as Appendix C. There are two key objectives of the policy: implementation of the Nine Minimum Controls (NMC), and development and implementation of Long-Term Control Plans (LTCPs).

4.2.1 Nine Minimum Controls

NMC measures represent low-cost, technology-based actions that can reduce CSO and its receiving water quality impacts. In 1995, EPA issued the guidance document *Combined Sewer Overflows: Guidance for Nine Minimum Controls*. The intent of NMCs is not to eliminate CSO, but to provide some CSO reduction while control plans are developed and implemented. NMCs do not require significant engineering studies or construction and can generally be implemented in a short time frame through careful operation and maintenance of combined sewer systems. It is the

intent of the EPA CSO Policy that the NMCs be compatible with the LTCP. The EPA CSO Policy required all combined sewer communities to implement NMCs by 1997.

The NMCs are:

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

Selection and implementation of actual control measures is based on site-specific considerations. Documentation of the NMCs may include: operation and maintenance plans, revised sewer use ordinances for industrial users, sewer system inspection reports, infiltration/inflow studies, pollution prevention programs, public notification plans, and facility plans for maximizing capacities of the existing collection, storage, and treatment systems. NMC documentation may also include contracts and schedules for minor construction projects to improve operation of the existing system.

4.2.2 Long-Term Control Plan

The NPDES permitting authority in Connecticut determines whether NMCs satisfy the technology-based requirements of the CWA. If further controls are necessary to meet water quality standards, then the NPDES permitting authority will require development of a LTCP. In Connecticut, DEEP is the NPDES permitting authority. This subsection describes the EPA requirements for a LTCP. NPU will ultimately need to meet the requirements of the DEEP consent order and DEEP's CSO guidance policy, as described below.

In 2001, EPA issued the document titled *Guidance: Coordinating CSO Long-Term Planning with Water Quality Standards Reviews*. The document identifies two approaches for CSO communities to consider while evaluating CSO control and selecting alternatives. These are the "presumption" and "demonstration" approaches. These approaches are defined in the document as:

- The "presumption approach," under which achievement of certain performance criteria (i.e., four to six untreated overflow events or 85% by volume capture) would be presumed to provide an adequate level of control to attain water quality standards;

- The "demonstration approach," developing and implementing an LTCP that meets applicable water quality standards.

In general, if sufficient data is available to demonstrate that the proposed plan will result in an appropriate level of CSO control, the demonstration approach is selected. If the data collected by a community cannot provide enough evidence that CSO controls will provide an appropriate level of protection to meet water quality standards, the presumption approach may be considered. These approaches are further discussed below.

4.2.2.1 Demonstration Approach

Under the "demonstration approach," communities collect and present data in the LTCP sufficient to show that proposed controls are adequate to meet appropriate water quality standards. Through technical and financial analysis, the demonstration approach identifies the maximum pollution reduction benefits reasonably attainable, to ultimately demonstrate that the level of control proposed complies with state water quality standards and the CWA. The level of control proposed under the demonstration approach may be more or less than that required under the presumption approach. The CSO Control Policy states that four criteria must be met for successful use of the demonstration approach:

- The control program will protect water quality standards, unless standards cannot be met as a result of natural conditions or other pollution sources;
- Overflows remaining after implementation of the control program will not prevent attainment of water quality standards;
- The control program will achieve maximum reasonably attainable pollution reduction benefits; and
- The control program is designed to allow cost effective expansion or cost retrofitting if additional controls are subsequently determined necessary to meet water quality standards.

Where water quality standards cannot be met because of natural conditions or other pollutant sources, a total maximum daily load (TMDL) approach or other means should be used to apportion pollutant loads within the watershed.

4.2.2.2 Presumption Approach

The "presumption approach" assumes that achievement of certain performance criteria will be sufficient to meet current applicable water quality standards. The presumption approach requires meeting one of the following three criteria:

- No more than an average of four overflow events per year;
- Elimination or capture of no less than 85% by volume of the combined sewage collected in the combined sewer system during precipitation events on a system-wide annual average basis; or

- Elimination or removal of no less than the mass pollutants identified as causing water quality standards impairment.

As part of the presumption approach, there must be sufficient information available to indicate that these levels of control can reasonably be expected to meet state water quality standards. Communities following the presumption approach are also expected to conduct post-LTCP monitoring, to show that water quality standards are being met.

Regardless of whether the demonstration or presumption approach is used, the CSO control program ultimately selected must be sufficient to meet water quality standards and other CWA requirements. The 2001 guidance document also indicates that, if the receiving water is on the state's 303(d) list for development of a TMDL, then TMDL studies and the LTCP should be linked and contain a schedule for water quality reviews. This could facilitate future re-evaluation of planned CSO controls based upon whether water quality improvements are already achieved.

As set forth in the CWA, CSO discharges that remain after implementation of CSO controls must not interfere with attainment of the state's water quality standards. Under the CSO Control Policy, communities with combined sewer systems are expected to develop LTCPs to provide for attainment of water quality.

4.3 Connecticut Policy for Abatement of CSOs

As discussed previously, DEEP is the NPDES permitting authority in Connecticut, and a summary of their CSO strategy is described below.

DEEP developed a *Combined Sewer Overflow Strategy* in May 1990 (DEEP CSO Strategy) as a guidance document for municipalities in the process of developing CSO control strategies. DEEP lays out in this document that their goal is to protect public health and the environment from the impacts of combined sewer overflows. The interim objective of the strategy is to eliminate the discharge of untreated sewage from CSOs and achieve fishable/swimmable water quality. The long-term goal of DEEP is to eliminate CSO discharges entirely. DEEP divides their CSO strategy into immediate corrective actions, intermediate corrective actions, and long-term corrective actions.

The Long-Term corrective action laid out in the DEEP CSO Strategy involves the continual implementation of a CSO abatement program with periodic reviews until the long-term goal of CSO abatement has been attained. Regular review of facilities planning recommendations at reasonable intervals assure that the goals of CSO abatement are being attained and that the program is still appropriate. Regular review can also redirect the course of the planning based on changes to technologies, fiscal status, priority waterbodies, and assessment of previous CSO program impacts. The DEEP CSO Strategy document is provided as Appendix D.

4.4 Connecticut Water Quality Standards

The federal government requires individual states to develop and adopt surface water quality standards applicable to their water bodies. Section 22a-426 of the Connecticut General Statutes requires that the Commissioner of Environmental Protection adopt standards of water quality

consistent with the federal CWA. To fulfill this requirement, Connecticut has established the Connecticut Water Quality Standards.

Three elements comprise the Connecticut Water Quality Standards: The Standards themselves, the Criteria, and the Classification Maps. The standards include the text of the policy statements that discuss designated use, anti-degradation, allowable types of discharges, fundamental principles of waste assimilation, and a variety of other subjects. The criteria are descriptive and numerical figures that describe the allowable parameters and goals for various water quality classifications. The classification maps show the class assigned to each surface and ground water resource throughout Connecticut.

As defined in the Connecticut Water Quality Standards, discharges to surface waters shall be limited as follows:

Class AA - Inland water source of uniform good to excellent quality. These waters are very close to natural quality with designated uses that include drinking water supply, fish and wildlife habitat, recreational use (may be restricted), agricultural and industrial supply.

Class A - Inland water source of uniform good to excellent quality. Inland Surface water is known or presumed to meet Water Quality Criteria which support designated uses, which may include potential drinking water supply; fish and wildlife habitat; recreational use; agricultural, industrial supply and other legitimate uses, including navigation.

Class B - Inland surface water source that may be of good to excellent quality. Uses include fishing, swimming, and recreation, industrial supply, and agricultural use. These waters generally have a healthy aquatic habitat, are generally rivers or large streams, and may have point source wastewater discharge.

Class SA - Coastal or marine surface water of uniform good to excellent quality. These waters are very close to natural quality. Uses include fishing, swimming, and recreation. These waters are a healthy marine habitat, and direct shellfish consumption is possible. These waters usually do not accept treated wastewater.

Class SB - Coastal or marine surface water of uniform good quality. Uses include fishing, swimming, and recreation, industrial supply, commercial shellfish harvesting (may require purification). These waters generally have a healthy marine habitat and may have point source wastewater discharges.

NPDES discharge permit applicants must comply with Connecticut Surface Water Quality Standards, as well as Sections 22a-426, 22a-430, and 22a-436 of the General Statutes. In addition, a discharge permit may also require additional treatment measures deemed necessary to prevent pollution and maintain high water quality.

The state's goal of achieving a level of water quality that provides for protection and propagation of fish, shellfish, and wildlife and recreation, in and on the water, must be met except where the following conditions apply:

- A use attainability analysis is prepared pursuant to federal regulation 40 CFR §131.10(g) and (j), that demonstrates that the surface water has been irreparably altered to the extent that certain designated uses have been permanently lost; and
- Quality criteria necessary to protect all other existing and designated uses of the surface water have been adopted by the Commissioner, as a revision to the Connecticut Water Quality Standards, in accordance with Section 22a-426 of the General Statutes.

Use Attainability Analyses are studies that use technical data and that follow procedural steps to show that fully achieving Class B designated uses everywhere, all the time, is not attainable. This process is used to formally change the water quality standards of a receiving body. This process requires a demonstration to the Commissioner that the proposed new classification is consistent with all existing or designated uses made of, or presently possible in, such surface waters. This type change in a Water Quality Classification is considered a revision to the Connecticut Water Quality Standards and would only be initiated after a CSO LTCP process is complete and it is determined water quality standards still cannot be met.

4.5 Applicability to NPU

CSO planning efforts in Norwich are influenced by a few critical factors, as described below.

4.5.1 Receiving Body Water Quality Classifications

The Shetucket River and the Thames River Estuary are the receiving water bodies for all Norwich CSO discharges. As described in the Baseline Conditions Report, both waterbodies are impaired and are designated as Class SB waterbodies with equal sensitivity.

4.5.2 Lack of Receiving Water TMDL Designations

No TMDL has been established for the receiving waters of the NPU CSO outfalls. In the 2016 Integrated Water Quality Report (IWQR), DEEP lists the Thames River in Norwich on the priority list of waters for action plan development including TMDL development. The expected plan completion timeframe as stated in the 2016 IQWR was by the end of 2017, and as of July 2018 a TMDL does not yet exist. DEEP identifies the Shetucket River in Norwich as a waterbody that will have an action plan by 2022.

4.5.3 Upstream Pollutant Sources

Lastly, there are many pollution sources upstream of Norwich contributing to water quality degradation. The IWQR lists the Shetucket River as having impaired use for recreation due to E. coli. The IWQR lists the Thames River Estuary as impaired for recreation, commercial shellfish harvesting, and habitat for marine fish, other aquatic life and wildlife uses due to enterococci bacteria, fecal coliform, and low dissolved oxygen concentrations respectively.

Potential sources of these impairments as listed in the IWQR include stormwater, illicit discharges, CSO, municipal discharges, landfills, insufficient on-site treatment systems, and/or septic systems. All these potential sources could be present upstream of the impaired sections of the Shetucket River and Thames River Estuary. Both the Quinebaug and Shetucket Rivers are tributary to the impaired sections and extend north towards Massachusetts. The tributary rivers receive effluent from other communities' WPCF facilities, including Willimantic, Griswold, and

Killingly. Additionally, numerous stormwater communities discharge to these rivers that must comply with the General Permit for the Discharge of Stormwater from Small Municipal Storm Sewer Systems (MS4 General Permit).

As presented in the Baseline Conditions Report, the 2012 LTCP concluded that:

- pH and dissolved oxygen in the saline portion of the Thames River were below water quality standards, but the cause did not appear to be CSO-related because the problems also occurred during dry weather.
- Bacteria levels in the rivers upstream of Norwich CSOs can exceed water quality criteria for days after a storm. This was primarily attributed to nonpoint source runoff. During wet weather, CSOs contributed less than half the bacteria loading in the receiving waters. Even if all CSOs in Norwich were eliminated, the Shetucket and Thames Rivers would not meet bacteria water quality standards.
- Norwich CSOs contribute significantly to bacteria levels in the receiving waters during storms. However, bacteria levels recede relatively quickly after wet weather events. In the Thames River, bacteria concentrations downstream of CSOs returned to background levels within one to three days after storms.

The 2012 LTCP also concluded that even if NPU were to fully eliminate CSO discharges, it is unknown if there would continue to be water quality impairment in the Shetucket River and Thames River Estuary segments within Norwich.

4.6 Summary

Under strict interpretation of DEEP CSO Strategy, Connecticut's Surface Water Quality Standards, and the EPA CSO Policy, NPU must attempt to eliminate CSO discharges to the waters of the state or mitigate it to a level deemed adequate to support designated uses. For the purposes of this LTCP, the two receiving waterbodies were deemed equal in sensitivity due to their equivalent water quality classification. Possible upstream pollution sources (as indicated in the 2012 LTCP) could make it difficult to quantify and achieve water quality standards within NPU's receiving bodies even if CSO discharges from Norwich were eliminated.

Section 5

Section 5

Assessment of CSO Abatement Technologies

5.1 General

This section describes combined sewer overflow (CSO) abatement technologies and assesses their applicability to the Norwich Public Utilities (NPU) CSO control objectives. Many alternative strategies are available to control pollutants discharged from CSOs ranging from no action to complete separation of the combined sewer system (CSS) into separate sanitary and stormwater systems. This assessment considers technologies presented in US Environmental Protection Agency (EPA) guidance manuals. The purpose of this assessment is to select appropriate technologies for further evaluation and comparison in later sections. Specific factors that identify whether a technology is appropriate include current condition of the sewer system, characteristics of wet weather flow (e.g. peak flow rate, volume, frequency, and duration), hydraulic and pollutant loading, climate, implementation requirements (e.g. land, neighborhood, noise, and disruption), and maintenance requirements.

Norwich has both combined and separated sewer systems, which affects the division of responsibility for stormwater between NPU and the City of Norwich (City). In the areas with separate sewer systems, NPU is fully responsible for the sanitary sewer system and the City is fully responsible for the stormwater system. In the areas with a combined sewer system, the responsibilities are shared. The city is fully responsible for the catch basins and associated piping that have no flow during dry weather. For the pipes that carry sewage and stormwater, NPU maintains the system but the material cost for repairs and improvements is split evenly between NPU and the city.

The City is the permittee for the General Permit for the Discharge of Stormwater from Small Municipal Storm Sewer Systems (MS4 General Permit). Under that permit, the City will be implementing programs to reduce stormwater runoff and improving stormwater quality.

5.2 Screening of CSO Abatement Technologies

CSO abatement technologies were classified into five categories:

- Quantity source control measures;
- Quality source control measures;
- Collection system controls;
- Storage technologies; and
- Treatment technologies.

Many of the source control methods are best management practices (BMPs) that are already addressed by NPU or by the City, usually through the Department of Public Works (DPW). Typically, BMPs refer to watershed/drainage basin type controls that are complemented by public housekeeping efforts such as litter control, household hazardous waste collection, and illegal dumping ordinances. Collection system controls, as well as storage and treatment technologies, involve structural enhancements that improve existing infrastructure to reduce

CSOs. Each of these controls is discussed below. Each technology is described below and evaluated regarding its effectiveness and feasibility in Norwich as a solution for NPU's CSO issues. Technologies that are infeasible for implementation or that offer no benefit to the CSO program were eliminated from further consideration. The remaining technologies are identified as NMCs or BMPs controls or Long-Term Control Plan (LTCP) alternatives. Technologies that should be considered as long term CSO mitigation alternatives are evaluated further in Sections 6 through 8.

Table 5-1 lists the CSO abatement technologies considered for this report and identifies the results of the technology evaluation/screening. The technologies have been identified by the following categories:

- **Technology not feasible or appropriate**. These technologies are not considered appropriate for CSO control, or will not work effectively in Norwich.
- **Continue current practice**. These technologies are already practiced by NPU or the City of Norwich and will help optimize system operations and minimize CSO and impacts to receiving water bodies.
- **LTCP technology**. These technologies are feasible structural controls that will reduce and/or eliminate NPU's CSOs and are being carried forward for further evaluation.

5.3 Source Control Measures

Source control measures are techniques than can be employed to decrease the quantity of water entering the system (i.e. quantity control) or exclude pollutants from the waste stream at their source (i.e. quality control). Source control techniques typically do not require significant structural improvements and thus have low capital costs. However, these measures are labor intensive and incur high operation and maintenance (O&M) costs. Successful source control reduces the need for capital-intensive structural CSO control facilities. Quantity source control measures are addressed in Section 5.4. Quality source control measures are addressed in Section 5.5.

5.4 Quantity Control Measures

Quantity control measures are intended to reduce and/or eliminate portions of the wet weather flow generated in the basin tributary to the CSO regulator. Quantity control measures include use of porous pavements, flow detention ponds, area drain and roof leader disconnection programs, use of pervious area for infiltration, and catch basin modifications using flow retardation devices.

Due to the delineation of responsibility between NPU and the City of Norwich, green infrastructure, and storm water controls in general, fall under the City DPW realm of responsibility. As a result, these controls have primarily been left for DPW to address through their storm water planning process. If DPW makes significant strides in green infrastructure and storm water controls, the planned CSO projects presented herein will be more effective than intended, which is beneficial. These efforts will be realized, and their benefits captured at each successive 5-year LTCP update as the flow metering data pool is supplemented and the NPU sewer model is re-calibrated.

5.4.1 Porous Pavement

The quantity of runoff that enters a CSS may be reduced or attenuated through porous pavement. Porous pavement is potentially more cost effective in new developments than existing paved areas because pavement removal is expensive and disruptive to traffic. It is unlikely that wide-spread use of porous pavement would be cost effective in Norwich. It would take a significantly long period of time and cost to regrade and pave impervious areas in order to achieve flow control. In addition, pore spaces in porous pavement can eventually plug with sand, silt and other particulates and may also fill with ice during the winter season, which creates a maintenance issue. Porous pavements are also less durable than traditional pavement materials, especially in a colder climate.

Porous pavement has also not been historically successful in heavily traveled areas or areas which could generate contaminated runoff such as auto salvage yards, gas stations, and loading/unloading areas. Also, the application of salt to de-ice roads and parking lots should not be practiced on porous pavement because of the potential to contaminate groundwater. Additionally, NPU does not have jurisdiction over new paving, or resurfacing of existing pavement. For the above reasons, porous pavement does not seem well suited in terms of applicability, reliability, cost-benefit, and implementation for NPU CSO mitigation. Further consideration may be given to this technology in subsequent 5-year LTCP updates as the technology continues to improve.

5.4.2 Flow Detention

Detention ponds, bioretention areas, and bioswale systems located in upstream areas of the tributary basin can temporarily store stormwater runoff, attenuate flow peaks, and minimize potential downstream treatment capacities. Bioretention areas are shallow, vegetated basins that collect and absorb stormwater runoff. Bioswales are vegetated, mulched, or xeriscaped channels that provide treatment and retention as they move stormwater from one place to another. After storms, collected water drains back into the system and is conveyed to the treatment facility. However, Norwich's CSS service area is densely developed, which restricts the feasibility of this technology. Additionally, stormwater management and investment in detention technology would fall under the responsibility of the City of Norwich. Accordingly, flow detention in the upstream reaches of the CSS will not be evaluated further in this study as an appropriate LTCP technology. Further consideration may be given to this technology in subsequent 5-year LTCP updates as the technology continues to improve.

5.4.3 Area Drain and Roof Leader Disconnection

In urban areas such as Norwich, roof leaders from gutters, roofs, and area drains are often connected to the CSS. Direct connection to the system avoids excessive surface runoff across properties to catch basins or street drainage. However, these direct inflow connections increase sewer peak flow rates and volumes by decreasing travel time and preventing runoff from infiltrating into pervious surfaces. Identification of roof leader and area drain connections in the combined system is relatively inexpensive to perform (by smoke testing), although removal can be more complicated in heavily impervious areas where disconnection may result in more overland flow. Area drain and roof leader disconnection is a viable, low cost CSO abatement alternative that warrants further evaluation. This will be considered as an LTCP technology under inflow removal alternatives with private property disconnection work.

5.4.4 Use of Pervious Areas for Infiltration

Pervious area infiltration combines aspects of the previous strategies by attempting to maximize the use of pervious areas for infiltration. Facility types include grassed swales, infiltration basins, and subsurface leaching. This type of control is usually more appropriate for new developments or redevelopment with significant pervious area consisting of well-draining soils. Proposed flow detention ponds could be constructed with pervious soils on the bottom to take advantage of available infiltration. Due to dense development, lack of large areas for detention, steep grades and the rocky topography of Norwich this technology is not appropriate for CSO control in Norwich's CSS. As such, this technology will not be given further consideration.

5.4.5 Catch Basin Modifications

Modifications to existing catch basins can be made to reduce peak stormwater inflows to the CSS. Catch basins within a drainage area can be retrofitted with devices, such as vortex valves, that retard surface water runoff entering the sewer system. These devices, however, can cause the catch basin and adjacent street area to flood. This is also a concern as street flooding can be a problem during the winter with ice and snow. Accordingly, the selection of appropriate size vortex valve is important to limit the extent of street flooding. Typically, the selection of the appropriately sized vortex valve is made through a trial and error process. This is commonly referred to as flow slipping and has been successfully implemented across the country.

NPU has not typically considered flow slipping as a feasible CSO mitigation strategy. The City of Norwich owns and maintains the stormwater system as a separate entity from NPU. An NPU project that involved flow slipping could cause flooding and difficulties for the City of Norwich DPW. It is unlikely that any city flow slipping program would be desirable. Therefore, this technology will not be carried forward for consideration in the LTCP alternatives analysis.

5.4.6 Urban Parks and Green Spaces

Urban parks and green spaces reduce impervious area draining to a CSS, thereby helping mitigate CSOs. These features promote infiltration while providing attractive recreational areas for the community. Trees and other vegetation add to the effectiveness of these areas in decreasing inflow to the CSS. Conceivably, these areas could also provide surface detention with proper landscape design and implementation of inlet control devices, as discussed above.

Because urban parks and green spaces help mitigate CSO impacts, it is recommended that NPU support any efforts for their development. However, since there are few opportunities for increasing urban parks and green spaces in the urbanized combined sewer area that lead directly to quantifiable CSO benefits, this technology will not be considered further as a practical component of the LTCP.

5.4.7 Green Roofs

Green roofs are a low-impact development (LID) technique which controls the timing and volume of stormwater discharges from impervious roofs. Green roofs can reduce the quantity of stormwater runoff by absorbing precipitation and delaying the peak discharge. There are two typical types of green roofs, intensive and extensive. Both extensive and intensive green roofs can absorb up to 75% of the rainfall that falls on them during typical rainfall, decreasing runoff volume and peak discharge.

Intensive green roofs installed on flat roofs are landscaped for aesthetic and recreational uses. Vegetation can include food producing, garden plants, or trees and shrubs. A high level of management is required for intensive green roofs.

Extensive green roofs, or eco-roofs, are primarily used for environmental benefits rather than for aesthetic and recreational uses. Low maintenance vegetation appropriate to the local climate is typically planted. Little maintenance is required beyond one or two years after installation. Irrigation systems are not usually required with extensive green roofs as they are needed for intensive green roofs, thereby decreasing the load on the roof.

Disadvantages of green roofs include the difficulty to repair possible leaks under the soil and vegetative layers and the potential need for additional structural support. Flat roofs require a drainage system for excess water not absorbed by the vegetation, and steep slopes may need erosion control measures. Maintenance costs may exceed the costs of maintaining a conventional roof.

Many buildings in Norwich are old and may not be able to structurally support the weight of a green roof. Additionally, green roofs can be expensive to install. While NPU should encourage private adoption of this technology throughout the city, it will not be further evaluated as an LTCP component.

5.4.8 Bioretention

Bioretention is an LID technique that filters and infiltrates stormwater runoff from impervious areas. An area of soil and vegetation collects stormwater runoff from impervious areas and allows it to infiltrate. An example of bioretention system is a rain garden designed to hold up to six inches of water for several days and has a mix of herbaceous and woody species planted in a soil mixture that optimizes percolation and pollutant removal. Tree pits or bioswales along sidewalks are potential applications of bioretention in more urban environments. In these systems, pavement slopes to a depressed, soiled area with a planted tree or vegetation. Drainage pipes and catch basins can also be reconfigured to convey flows to these systems.

Bioretention reduces the volume and peak flow rate of stormwater runoff. Disadvantages include potential clogging of the ponding area if regular maintenance is not conducted. Retrofitting an existing impervious area can be costly due to the need to break up concrete and asphalt or reconfigure underground utilities to install the bioretention system.

Bioretention will not be evaluated further as an LTCP technology in Norwich due to the difficulty of implementation in an older urban environment, as well as a likely need to implement this technology on private property. NPU should encourage private use of this technology throughout Norwich.

5.4.9 Water Conservation

Efficiently using water to conserve energy and water and reduce wastewater flow is also an LID technique. Water conservation methods include utilization of water efficient fixtures (e.g. low-flush toilets, low-flow faucets), rain harvesting (rain barrels), waterless technologies (composting toilets, waterless urinals), and water recycling (greywater reuse). Changes in plumbing and potential treatment for reuse of greywater would be needed in the City of Norwich.

Water conservation could be implemented via a public education and outreach campaign. NPU should encourage any initiative to conserve water within Norwich. NPU itself has implemented water conservation measures during drought conditions in the past. Generally during a storm, wet weather flows in a CSS overwhelm baseflows, however a reduction in baseflow can still result in a reduction of CSO. NPU should continue its current practice of periodically encouraging water conservation and consider a public outreach campaign to provide public education on water conservation measures.

5.4.10 Infiltration Sumps

The feasibility of infiltration sumps as a flow control measure depends on subsurface soil conditions. Infiltration sumps are essentially large, deep catch basins with no pipe outlet. They collect storm water and allow it to infiltrate into the soil. Consequently, these relatively low-cost structures are not effective in areas with soils exhibiting low permeability or areas with underlaying bedrock close to the surface. It is expected that depth to bedrock in Norwich will cause issues with the implementation of infiltration sumps. Additionally, the City of Norwich Public Works Department holds responsibility of catch basin modification and maintenance. Since this technology is not considered feasible or practical for NPU to implement, it will not be evaluated further.

5.5 Quality Source Control Measures

Quality control measures help to reduce pollutant concentrations at sources in the tributary basins and improve stormwater runoff quality before it enters the CSS. Most of these measures directly address source control before a pollutant is dissolved in rainfall and/or conveyed to the catch basin. Catch basin cleaning retards introduction of additional pollutants to the combined wastewater flow. Many of these technologies also have beneficial environmental effects in separated stormwater collection areas. Quality control measures alone have no impact to CSO volumes or event occurrences and would only reduce the concentrations of pollutants in the CSO discharge. Therefore, while they were considered in this LTCP for additional environmental benefits, most do not contribute to NPU's goal of CSO control.

5.5.1 Air Pollution Reduction

Particulate matter in the atmosphere ultimately settles and becomes a source of stormwater runoff contamination. The contamination is a result of both natural causes (fugitive dust from soils and pollen) and manmade processes (grinding and pulverizing processes, combustion, construction dust, etc.).

This source of pollution is not significant compared to other sources, is likely outside of NPU's ability to control, and therefore does not warrant further evaluation in the context of this study.

5.5.2 Solid Waste Management

Improper disposal of litter, including leaves, grass clippings, waste paper, wrappings, cigarettes, metal, glass, and paper containers on city streets, in parks and along vacant properties often results in these items entering the collection system and potentially being discharged to the receiving water. The floatable nature of these items can cause visible pollution.

It is assumed that the City of Norwich has ordinances to help prevent this solid waste accumulation. NPU has no jurisdiction over solid waste management but should support any policies made by other entities. Any policies enforced for solid waste management and mitigation in the City of Norwich should continue.

5.5.3 Fats, Oil, and Grease Control Programs

Fats, oil, and grease (FOG) are often improperly disposed of by pouring down the sink. FOG builds up in sewers over time and often causes blockages and reduces the capacity of the pipe to convey flow. EPA's August 2004 "Report to Congress on Impacts and Control of CSOs and SSOs," reports that 47 percent of sewer blockages can be attributed to grease buildup. These blockages account for nearly half of all sanitary sewer overflows.

Connecticut Department of Energy and Environmental Protection (DEEP) recognizes FOG as a problem and issued the General Permit for the Discharge of Wastewater Associated with Food Service Establishments on October 5, 2015. This Permit applies to any food preparation facility which discharges to a sanitary sewer line and then to a publicly owned treatment works (POTW). The best way to prevent these blockages is to keep FOG from entering the sewer system, and the general permit accomplishes this by requiring and standardizing the routine removal of FOG from all food preparation establishments. Ultimately, this will help to increase sanitary sewer capacity and reduce sanitary sewer overflows.

Education programs about proper disposal of FOG can reduce the problems in the sewer system associated with FOG. At a minimum, restaurants should have and regularly maintain grease traps to remove the FOG floating on top. This is required under the General Permit. Grease traps slow the flow of wastewater and allow FOG to cool and float to the top where it can be removed, so it does not move downstream in the sewer system.

Education programs should be tailored to the audience, such as a "Do and Don't" list for residents to discuss proper disposal, and a workshop or separate mailing for commercial establishments, such as restaurants. The effectiveness of pollution prevention programs, such as educating owners about FOG, is highly dependent on individual actions. The effect of the education and removal of FOG cannot be quantified.

As a BMP, FOG control is prudent practice and NPU currently does not have a FOG Control Program. However, NPU is actively developing a plan to meet DEEP's General Permit for the Discharge of Wastewater Associated with Food Preparation Establishments by revising their sewer regulations. NPU has drafted an additional Article to lay out the FOG Program, including requirements and fees. The FOG Program, along with other revisions to the Sewer Regulations, have been reviewed by NPU and are going through NPU Board reviews in August and September 2018. Once NPU's Sewer Regulations have been revised to include FOG, NPU will begin implementation of the next phase of FOG control, which includes inspections and notification of violations. NPU has made notable improvements to their FOG control practices and it is recommended that they continue their current practices and proceed with development of their FOG Program.

5.5.4 Street Sweeping

Street sweeping is a common practice in urban areas to improve the aesthetic environment by removing litter and debris from gutters. This practice can also improve the water quality of surface runoff by reducing the quantity of solids and floatables entering the CSS. Street sweeping is performed using mechanical brooms or vacuum sweepers.

According to the Norwich Public Works Department, Citywide street sweeping occurs twice per year, once in the spring, and once in the fall. The downtown area is swept twice per week, as weather conditions allow. It is unlikely that additional street sweeping will eliminate a substantial amount of floatables in the combined system. Additionally, street sweeping doesn't fall under NPU's responsibilities. Accordingly, it is recommended that the current practices by the City of Norwich be continued.

5.5.5 Fertilizer/Pesticide Control

The use of fertilizers and pesticides can increase pollutant levels, primarily nutrients, in stormwater runoff. While controlling chemical use and storage can help reduce this pollutant loading, effective control of these pollutant sources is difficult.

It is unlikely that fertilizers and pesticides can be found as significant waste stream pollutants in NPU's CSO discharges, since the combined sewer service area in Norwich is mostly urbanized and the outlying communities are primarily residential areas. The outlying residential areas where fertilizers and pesticides are more likely to be used on lawns and gardens are primarily on private septic systems. Additionally, NPU does not have jurisdiction over fertilizer and pesticide application in Norwich. Therefore, additional control of fertilizers and pesticides as an overall drainage basin program for CSO mitigation will not be considered by NPU. However, it is advisable that NPU staff consider the implications of any fertilizer and pesticide use on NPU owned properties within the watersheds.

5.5.6 Snow Removal and Deicing Practices

Salting roadways during the winter to reduce icing can increase surface runoff pollutant loads, particularly chloride concentrations. Improper storage of salt can also contribute to high chloride concentrations, especially if the salt is not covered or protected from rain. Generally, salt is mixed with sand to reduce skidding on roadways. The sand can accumulate in catch basins and eventually enter the CSS contributing to the solids loading in CSO discharges.

The City of Norwich has the responsibility of snow and ice control. Generally, the Public Works Department will pre-treat the heavier travel roads immediately prior to the onset of imminent winter weather. Solids deposition in the sewer system may contribute to increased CSO related pollutant loads. Accordingly, the City of Norwich could consider minimizing the use of salt and sand levels as long as safe travel conditions during winter storm events are not impacted. In addition, City of Norwich should also ensure that salt and sand are properly stored to avoid wash off into the sewer system. NPU should ultimately support these actions by the City of Norwich, but de-icing practices will not be considered by NPU for further study as an alternative to minimize CSO impacts.

5.5.7 Soil Erosion Control

Construction sites and other environmental disturbances can contribute to sediment in surface runoff. This can increase the sediment loadings in CSO discharge, as well as reduce pipe conveyance capacity and therefore increasing CSO volumes. DEEP published the *Connecticut Guidelines for Soil Erosion and Sediment Control in 2002*. The guidelines fulfill the requirements of Connecticut's Soil Erosion and Sediment Control Act, and present methods and techniques for minimizing erosion and sedimentation based on the best available technology. NPU, as well as the City of Norwich should continue enforcement of these guidelines, as they can maintain reduced suspended solids loadings to the receiving waters.

Although soil erosion is not a significant source of CSO-related pollution in NPU's combined sewer service area, erosion and sediment control practices should continue to be enforced at all construction sites. Additional controls will not be considered.

5.5.8 Commercial/Industrial Runoff Control

CSO pollutant discharge quality can be improved through the control of runoff from commercial and industrial establishments in the drainage area. Gas stations and other petrochemical establishments pose particular concern. Oil traps or permanent oil collection systems can be used to reduce the quantity of pollutants entering the system. Regulation of these types of establishments would fall under the City of Norwich's responsibility, although NPU should be sure to follow any existing regulations at their fueling stations and any other applicable NPU owned location.

Any existing commercial and industrial runoff control measures should be continued.

5.5.9 Animal Waste Removal

Animal excrement is a source of stormwater pollution, especially nitrogen and pathogenic organisms (E. Coli is an indicator). Proper disposal of animal waste could reduce bacteria and nutrient concentrations in CSO discharges. It is expected that current solid waste disposal, littering ordinances, and street sweeping programs in the City of Norwich are adequate to address this potential problem.

Because the impact of this pollution source is limited and not within NPU's responsibility, this technology will not be considered further for CSO abatement.

5.5.10 Catch Basin Cleaning

Catch basins collect and convey surface runoff to a sewer or drainage system. Basins are typically designed with a sump below the outlet pipe to capture sand, grit, and solids. Catch basins require periodic cleaning to remove the solids and floatables captured in the sump. Structures can be cleaned using a bucket or vacuum. Properly maintained catch basins can help to reduce the quantity of solids that enter the CSS.

As discussed previously, The City of Norwich has ownership of all catch basins and drainage pipes that carry no dry weather flow within the City. The City maintains an active catch basin cleaning program in Norwich which is effective in reducing the volume of floatables entering the CSS from surface runoff. Neighboring communities are responsible for maintaining their own storm water collection systems, including catch basins. However, all contributing neighboring towns have separated sewer systems, and should not contribute floatables into NPU's CSS via catch basins.

Because increasing the frequency of catch basin cleaning will not eliminate or significantly reduce the need for downstream structural CSO controls, and the infrastructure is not owned by NPU, additional cleaning will not be considered further as a LTCP technology. The current practice, however, should be continued by the City of Norwich to minimize the amount of road debris introduced to the CSS.

5.5.11 Catch Basin Modifications

Catch basins can be modified with devices, such as hoods or baffles, to help capture floatables within the catch basin until the sump is cleaned. These devices can effectively remove

floatables and coarse solids that may enter the combined system and be discharged to the receiving water.

The City of Norwich maintains ownership of catch basins in Norwich. NPU will not give this type of source control any additional consideration under the LTCP. However, it is recommended that the City of Norwich designs any new catch basins to utilize these capture devices.

5.5.12 End of Pipe Controls

End-of-pipe containment controls consist of netting systems or booms in the water to contain floatables which discharge from the end of the pipes. Skimmer vessels are then used to collect the floatables. Containment booms can be located downstream of several CSO outfalls to collect floatable material. Netting systems are sized based on peak flow rate, maximum flow velocity and the quantity of floatables expected.

Booms cannot be used in winter months and can become dislodged with high river velocities and fluctuations in water level. In areas near waterfront development, the floatables and containment system can look unsightly.

Due to the ineffectiveness of end-of-pipe controls during winter months and during high river levels, when large CSO events often occur, and the obstacles the booms or nets cause to boats, this technology will not be evaluated further. Floatables derived from stormwater runoff from roads and highways are addressed with other programs, such as street sweeping.

5.5.13 Staffing and Operations

CDM Smith completed a memorandum of typical staffing level recommendations for NPU in 2013. At that time, NPU employed 13 full-time personnel that operated and maintained the complex network of pipes, structures and pumping stations that convey flow to NPU's WPCF. CDM Smith recommended that NPU maintain five full-time positions for collections system maintenance and 12 full-time positions at the WPCF. The recommendation for the WPCF was made on the assumption that the treatment plant would be upgraded to 33 mgd. This will need to be re-evaluated when the plant is upgraded in the future as 33 mgd is no longer the recommended peak WPCF capacity. Having adequately trained staff has been an important factor in NPU's continued successful operation and maintenance of the CSS to minimize CSO.

Employing staff with competencies in mechanical, construction, electrical, and computer backgrounds has allowed NPU's Wastewater Division to implement several in-house projects to support successful operation of the CSS. It is critical that these staff are continuously trained in industry standards and to increase staffing levels as needed to meet growing regulatory requirements. Therefore, staffing and operations are considered to fall under the Continue Current Practice category as an LTCP control.

5.6 Collection System Controls

Collection system controls and modifications reduce CSO by removing inflow sources, increasing use of existing interceptor capacity and pipeline storage, and/or optimizing performance of the collection system. These controls include existing system management, regulator modifications, sewer line cleaning and flushing, sewer separation, infiltration / inflow control, polymer injection (to increase pipe capacity), regulating and backflow gate modifications, real time control, flow diversion, and relocation of outfalls to less sensitive areas.

5.6.1 Existing System Management

System management techniques can improve receiving water quality by reducing CSO discharge volumes and capturing first flush pollutant loads. Regular maintenance of CSO regulators and the interceptor piping system is essential to maintain proper hydraulic conditions in the system and minimize the frequency of CSO discharges. Sediment accumulations or blockages in the regulators or interceptor pipes can reduce the hydraulic capacity of the interceptor connections increasing the frequency of CSO discharges, and in severe cases, causing dry weather overflows.

NPU regularly inspects CSO regulator structures and regularly cleans the sewers (combined and sanitary) and the interceptor systems. The City of Norwich regularly cleans catch basins. In 2017 NPU implemented real-time monitoring of its 16 CSO regulators, so they are alerted to activations and can respond accordingly. CDM Smith recommends that NPU continue practices to minimize sediment accumulation and other issues within the existing system.

5.6.2 Regulator Modifications

Regulators can be modified to convey more flow to the interceptor or to take advantage of upstream pipeline storage, thereby reducing CSO. These modifications are low cost and simple to implement. Other low-cost system optimization measures include relieving small bottlenecks in regulators or the interceptor system.

There are some areas that constrict flow, as confirmed using the collection system model. These bottlenecks are typically small dry weather flow pipes on the regulators that force flow over the weirs as CSO. Generally, the best way to pass flow through the regulators in NPU's CSS, as indicated by the computer model, is to raise weirs, and increase the diameter of these undersized dry weather flow pipes. NPU must be very careful when implementing these kind of modifications, as they may cause backups or upstream flooding. Additionally, passing more flow through one regulator may simply increase CSO discharge volumes at the next downstream regulator.

The computer model has indicated that many of NPUs regulators can be modified safely. This technology will be carried forward and evaluated as a LTCP component.

5.6.3 Sewer Cleaning/Flushing

Deposition of solids is a common problem in combined systems. As the sewers were designed to handle peak wet weather flow, hydraulic capacity greatly exceeds typical dry weather flow rates. Consequently, dry weather flow velocities are often much lower than the full pipe velocity and may cause solids to settle in the pipelines. Flow restrictions in wet weather also cause decreased velocities and settling of solids in upstream pipe sections. During large storms, these solids are resuspended resulting in high pollutant concentrations during the initial period of a storm.

To avoid this "first flush" phenomenon (the re-suspension of settled solids due to storm flow), sewers may be cleaned by either mechanical means (rodding or draglines) or by flushing. Either technique will flush the solids through the system during dry weather, when system capacity is available to convey flow to the WPCF. This will reduce solids discharged from CSOs to receiving waters during storm events. In severe cases of solids deposition, storm flows will not resuspend the settled materials and the settled solids will eventually accumulate, decreasing the hydraulic capacity of the pipe.

NPU currently performs sewer cleaning on a regular basis in problem areas based on institutional knowledge of where issues occur and how frequently. Some areas of the CSS are cleaned very frequently while others are cleaned less frequently. Cleaning helps minimize the effects of sediment deposition, which can decrease the capacity of pipes, and lead to additional CSO volume. It is recommended that NPU continue all preventative sewer cleaning and flushing practices.

5.6.4 Sewer Separation

Sewer separation is defined as the reconstruction of an existing CSS into non-interconnected sanitary and storm sewer systems. The sanitary sewer system is tributary to the wastewater treatment facility, and the storm sewer system discharges directly to local receiving waters.

Typically, to separate an existing combined sewer area, either a new drainage system is constructed or new sewer pipelines are installed and the existing combined sewer is used as the sanitary or separate storm drain, respectively. If portions of the CSS were found to be susceptible to structural failure, they would likely require complete replacement and new pipes would likely be constructed for both the separate sewer and drainage systems.

Throughout the 1970s and 1980s NPU completed public inflow removal projects which removed public stormwater sources from the CSS. These were mainly completed in the Downtown and Westside areas. In 1994, NPU published the *Norwich, CT Modified Facilities Plan* and began work on more public inflow separation projects. These projects helped reduce the number of CSO outfalls from 43 to 14 by 2005. However, it is noted that these early separation projects did not remove private inflow sources, and that the remaining wet weather flow impacts have consumed much of the existing capacity that was available in the interceptor systems. Future projects will need to work harder to achieve CSO reductions.

Unlike storage and treatment alternatives, which reduce the frequency of CSO discharges, complete public and private sewer separation of a CSS eliminates CSOs by diverting all sanitary flow to the wastewater treatment facility and discharging stormwater to receiving waters. EPA CSO abatement policies require that CSS separation be evaluated as a step in CSO facilities planning. Although complete public and private separation eliminates CSOs, it may not, in all cases, be the most appropriate alternative in terms of addressing site-specific water quality objectives. Complete separation eliminates pollutant loadings to receiving waters caused by the sanitary flow in CSOs; however, impacts caused by stormwater pollutants and the frequency of these impacts often increase. Such pollutants may include bottles, cans, cups, wrappers, cigarette butts, leaves, sediment, and other items that enter the storm drains.

Under the EPA Phase II stormwater program, communities will be required to assess their stormwater quality. The 2004 EPA "Report to Congress, Impacts and Control of CSOs and SSOs" states that implementation of stormwater controls may be necessary following separation to obtain pollutant load reductions necessary for water quality standard attainment. Stormwater control and quality have been City of Norwich concerns, as the City owns the stormwater infrastructure.

DEEP issued the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 Permit), which requires communities to assess and improve their stormwater quality through the six minimum control measures that are public education and outreach; public participation; illicit discharge detection and elimination; construction site runoff control; post-construction stormwater management; and pollution

prevention and good housekeeping. The City of Norwich is an MS4 permittee since it owns and maintains the stormwater infrastructure.

Two levels of separation are assessed in this LTCP. One is complete public and private sewer separation, in which all public inflow and private inflow sources are removed. With complete public and private separation, DEEP expects the full closure of downstream regulators. The other strategy presented is the removal of public inflow only through catch basin removal. NPU's previous separation projects would fall under this category because only public inflows were removed from the system.

Both types of separation projects may be implemented city-wide or in targeted areas of the system. Targeted separation projects, such as the ones NPU has already completed, focus on specific areas where CSO reduction benefits outweigh the construction costs and other impacts. Typically, local areas targeted for separation are less congested and will not be impacted as much by construction activities. Targeted separation aims to divert enough storm flow out of a portion of the combined system so that local CSOs may be eliminated or greatly reduced. Areas where flooding is a known problem are typically good candidates for separation projects.

Sewer separation, including system-wide, complete public and private separation; system-wide public inflow removal (catch basin removal); and targeted public inflow removal will be carried forward as potential LTCP technologies. These technologies are discussed further in Section 6.

5.6.5 Infiltration/Inflow Control

To maximize the collection system's capacity, it is necessary to remove extraneous flows caused by infiltration and inflow. Infiltration is groundwater that enters the system through broken or cracked pipes, defective joints, depressed manholes, and manhole walls. Replacing or lining defective pipes, pipes joints and manholes can reduce infiltration. Infiltration problems are generally difficult to isolate, which impacts the cost-effectiveness of this measure. Often, significant lengths of sewer must be rehabilitated before gaining notable infiltration reductions.

By design, surface runoff is the primary source of inflow into a CSS. Inflow can result from direct connections to the system from catch basins, roof leaders, cellar and yard drains, commercial and industrial drains, and malfunctioning flap gates.

It is difficult to eliminate all inflow from a combined system. However, the measures discussed in previous sections may be taken to reduce and attenuate peak flows. In addition, controlling inflow sources in the separated portions of communities that contribute to NPU's system would likely help reduce CSOs and minimize control structures by removing flow from the system before entering the combined system. Inflow sources could be diverted to a separate storm drains in these separated areas at a lower cost than in combined areas, since the storm drains are likely already in place. Public and private inflow removal techniques are discussed further in Section 6.

In light of the above discussion, the benefits associated with achievable levels of I/I reduction in the both the combined and separated portions of NPU's sewer system will be evaluated further as a LTCP technology.

5.6.6 Polymer Injection

Injecting polymers into a collection system can effectively decrease pipe friction and thereby increase the pipe's hydraulic capacity. A literature search was performed on the use of polymer injection in other combined sewer systems. The EPA performed most of the studies available between 1969 and 1977. According to one source, the addition of a polymer into gravity sewer lines could increase pipe flow to the treatment plant and reduce CSOs. Polymer slurry injections into gravity sewer lines have decreased hydraulic friction and increased pipeline capacities up to 144 percent.

Polymer injection requires construction of facilities to store and inject polymer into pipelines. Instrumentation to monitor flow and regulate polymer dosage is also required. In addition, there are some problems that occur with the use of polymers, including: polymer coagulation and settling, molecular breakdown of the polymer that reduces its effectiveness, limited storage life, and high cost. Based on these issues, this technology will not be considered further.

5.6.7 Regulating Devices and Backwater Gates

This technology utilizes control valves and devices to optimize system operations through control of flow into and through the interceptor system. Regulating devices include vortex valves, inflatable dams, and motorized or hydraulically operated sluices or control valves. These devices are used to restrict downstream flow conveyance, thereby maximizing existing pipeline storage. Backwater gates, such as tide gates, flap gates, or elastomeric gates, are used to restrict the receiving water from entering the interceptor system.

The volume of inflow through flap gates is not significant. In the Baseline Conditions Report the receiving waters were modeled to simulate tailwater influence on the CSS. It was determined that the receiving waters only impact five of the outfalls, and most of those are only impacted under extreme conditions. Use of regulating devices to hold back flow will be considered further as a LTCP technology.

5.6.8 Remote Monitoring and Control/Flow Diversion

Diverting flow from one drainage basin of limited hydraulic capacity to a drainage basin having excess capacity can reduce the volume and frequency of CSO discharge. Available and existing pipeline capacity may be used to convey flow or as in-line storage. Components of a remote monitoring program include a data gathering system to monitor rainfall, pumping rates, treatment rates and regulator positions; a central computer processing center to provide real time control; and an instrumentation and control system to remotely regulate pumps, gates, valves and regulators.

Real-time control programs are available for providing either system-wide or localized control. System-wide, real-time control can provide integrated control of regulators, gates, and pump station operations based on anticipated flows from rainfall events and actual flow conditions within the system. System response to control commands may be evaluated prior to execution using computer models linked to the real-time control system. Such global real-time control provides a means for optimization of the entire collection system (i.e. maximized flow to the treatment plant and minimized untreated discharges to receiving waters) for a variety of conditions. Local real-time control impacts specific dynamic regulators, based on feedback control from flow monitoring points located upstream or downstream of the point of interest.

Real-time control, especially at the Rose Alley Pump Station, is seen as a viable CSO technology to improve efficiency of operation and maximize the flow conveyed to the WPCF. Additionally, this technology appears to be promising in combination with regulating devices such as sluice gates to regulate and detain flow. This technology will be considered further in the alternatives analysis.

5.6.9 Relocation of CSO Outfalls & Regulators (combine and relocate)

Relocation of CSO outfalls involves routing overflows through new pipe to a new outfall location, sometimes with the goal of discharging to a less sensitive receiving water body. Relocation of regulators may also be done to consolidate CSO discharges to minimize the number of CSO control facilities or to improve regulator access for maintenance.

NPU's receiving waterbody classifications are all equivalent, so there is no less sensitive waterbody to move CSO outfalls to. NPU already has four CSO regulators that are consolidated into two outfalls as well. However, many of Norwich's regulators and outfalls are in difficult locations for access and maintenance of the structures. Relocation of CSO outfalls and regulators where applicable to increase ease of access and maintenance of CSO structures will be considered further as a viable CSO control technology.

5.6.10 CSO Regulation Remote Monitoring

Remote monitoring of overflow locations is used to monitor real-time performance during wet weather and to more promptly identify issues that may result in a dry weather discharge. However, remote monitoring is difficult and expensive, as it requires proper placement of metering devices, selection of the most appropriate device, data validation, and maintenance of equipment. In some instances, it may not be possible to monitor at certain points due to system hydraulics or system configuration; this is particularly true in portions of NPU's combined system where many of the regulators discharge to conduits that convey stormwater or have multiple pipes that discharge to a common point.

Norwich currently has long-term CSO meters in place, which give live alerts at the time of CSO activation. NPU should continue monitoring their CSO regulators with the currently installed meters.

5.7 Storage Technologies

Storage of CSO flows can be performed either at a local site adjacent to a regulator (or other control device) or downstream at a central site that receives consolidated flows and eliminates the need for several facilities. Storage facilities are typically used to hold CSO discharge until after a storm event, at which time the flow can be conveyed to the treatment facility. However, storage facilities can also be designed to provide some sedimentation treatment capacity for flow greater than the storage volume.

Storage technologies generally represent larger, costly structural modifications to a CSS. These modifications are rarely undertaken without a complete assessment of the CSO discharges and interceptor system. These technologies are presented briefly below and include inline storage, off-line storage, and surface storage.

5.7.1 Inline Storage

The use of inline storage is considered a cost-effective method of reducing combined sewer overflows by utilizing available pipeline storage volume, inline storage tanks where the dry

weather flow passes directly through the tank, or parallel relief sewers. Providing new storage volume or utilizing existing storage capacity helps to both dampen peak flows and detain combined wastewater for later treatment at the WPCF. Inflatable dams, control gates, or other devices, such as weirs, can be used to create or optimize inline storage in existing pipes during a rainfall event. Also, new oversized pipes may be constructed in the interceptor or collection system for improved inline storage capacity.

Control devices are generally located in combined sewer interceptors downstream of dry weather connections. The devices, which can be remotely controlled, are normally activated to divert dry weather flows into the interceptor and store wet weather flows in the combined sewer. If flows exceed the system capacity and upstream flooding occurs, the devices are deactivated to release the stored flow.

Control gates have been used frequently in such applications and are superior to inflatable dams in terms of precision and durability. Other devices used in conjunction with inline storage are stop logs, weirs, bending weirs, and orifice type restrictions. Stop logs provide operating flexibility similar to inflatable dams but require manual insertion and removal, which is difficult during storm events. Orifice type restrictions can be used in order to store flow in pipe reaches of combined sewers upstream of the dry weather connections. Finally, vortex flow regulators can also be used with inline storage volume.

Orifice type restrictions require similar maintenance as static regulators to prevent clogging. All inline storage technologies may increase combined sewer system cleaning and maintenance requirements since the storage of flow in pipes reduces flow velocities and increases the possibility of solids deposition.

Inline storage can be a viable CSO abatement technology if the existing sewer system pipelines are large enough and deep enough to provide significant storage volume. Pipes which are steeply sloped require numerous flow control devices at regular grade changes to maximize the use of available storage. With numerous flow control devices, inline storage is more difficult to control and less cost-effective than downstream controls.

Construction of inline storage tanks, or parallel relief sewers can provide additional capacity to the CSS in a more permanent manner than regulators. These tanks and parallel interceptors are usually only constructed when the existing sewers do not have capacity to store all the required flow with regulating devices. These tanks and relief interceptors can be used in conjunction with regulating devices to maximize the total storage volume.

Evaluation of further inline storage opportunities to hold wet weather flows will be considered further as a LTCP measure.

5.7.2 Off-Line Storage

Off-line storage and pump-back to the interceptor system is one of the most widely used and effective methods for CSO mitigation. As with inline storage, off-line storage facilities temporarily store wet weather overflow volumes until the flow can eventually be conveyed and treated at the WPCF. Types of storage facilities include underground tanks or conduits, abandoned pipelines, or deep tunnels. Off-line storage is usually located at individual overflow points for storage of localized CSOs. The storage facilities may also be located near dry weather or wet weather treatment facilities, or at pump stations in lower reaches of the system, where the off-line storage would consolidate overflows conveyed from upstream

locations. These facilities can be relatively simple in design and operation, and can effectively reduce the frequency of overflows.

Storage facilities can also be designed to remove settleable solids, with periodic cleaning by dredging, mechanical chain and flight scrapers, or other means. In effect, some primary treatment (sedimentation) takes place due to quiescent conditions. The settled solids can be handled by:

- Collecting and pumping to the interceptor as a concentrated slurry to be handled at the WPCF during the event;
- Collecting, storing and pumping to the interceptor as a concentrated slurry to be handled at the WPCF after the event;
- Collecting and dewatering at the storage site then transported to the sludge processing facilities;
- Resuspending solids in the stored mixed flow during the pump-back period for transportation to and handling at the WPCF; and
- Excessively long detention times can result in the settled solids causing offensive odors. Prompt solids removal and proper odor control equipment are necessary.

Off-line storage facilities will be further evaluated as a CSO Long-Term control technology.

5.7.3 Surface Storage

There are several ways in which stormwater runoff can be captured and stored, prior to entering the collection system. Some means for storage include: roof storage, playground storage, natural ponds, or man-made basins or lagoons.

Roof storage can be effective in locations with buildings having flat roofs. However, stored water can seep into the buildings and/or damage the structural integrity of the building. Roof storage is most attractive for new construction in warm climates where snow and ice will not collect on flat roofs. Therefore, it is not usually an effective means for storage in cold weather climates like New England.

Playground and recreational areas can be used to detain rainfall for a limited time to reduce peak flow in the system. Space availability, public acceptance, and potential hazardous conditions are drawbacks associated with this method. In addition, use of these facilities to store runoff may interfere with their intended use and increase maintenance requirements.

Depending on existing land use and existing natural topography, temporary stormwater detention may be implemented for runoff attenuation. Storm flow retention in areas with porous soils will allow some or all detained flow to infiltrate into the soil instead of entering the CSS. Section 5.4 describes quantity control measures.

In general, open space in densely developed urban areas such as Norwich is limited to parking lots and park /recreational areas. Typically, use of these areas for storage of runoff interferes with their intended use; thus, this technology is not desirable and will not be considered further.

5.8 Treatment Technologies

Treatment technologies target reduction of pollutant loads in combined sewer overflows to receiving waters. Specific technologies address specific pollutants, such as suspended solids, floatables, chemicals, or bacteria. Treatment residuals must be addressed as part of the implementation plan. Technologies used for treating CSOs prior to discharge are presented below.

5.8.1 Satellite Treatment Facilities

In general, a satellite facility is sited near a regulator structure to capture overflows as they occur, and to take advantage of existing regulating structures to divert overflows to the satellite facility and minimize piping and possible pumping requirements.

Satellite treatment facilities are designed to remove or reduce pollutants from CSO discharges to levels consistent with water quality goals. In some cases, overflow volumes may be reduced as well, due to the increased storage capacity associated with some treatment technologies. In all cases, satellite treatment facilities must be designed for reliable and effective treatment of intermittent and highly variable influent flows and pollutant concentrations characteristic of CSOs. Solids removal and disinfection are typically required for reliable and effective CSO pollutant reduction (or removal). This usually equates with physical-chemical treatment, which is most suitable for highly variable, intermittent influent flows and pollutant concentrations.

NPU is not interested in pursuing satellite treatment facilities within the City of Norwich. Satellite treatment plants located around Norwich would experience highly varying flow and pollutant loads, and would provide an operational challenge that NPU would prefer to avoid. It is likely that additional staff would be needed to operate and maintain these facilities. Additional staff training would be needed, for a system may only operate in a very heavy rainstorm. Operations and maintenance costs for satellite treatment can be exceedingly high. This is due to additional manpower, electrical, chemical, and transportation costs associated with owning and maintaining a satellite facility. Additionally, with most of the treatment technologies described in the subsequent sections, additional disinfection would need to follow primary treatment.

In many cases, except for high rate clarification, a low enough level of turbidity would not be achieved for proper pathogenic organism removal using ultraviolet (UV) disinfection. UV disinfection destroys pathogens by using UV light to kill or inactivate organisms by disrupting their DNA. Thus, UV disinfection requires a high-clarity effluent to allow UV light to reach all microorganisms and prevent shielding of microorganisms by suspended solids in the effluent. The alternative to using UV disinfection is hypochlorite which can be corrosive and reactive. Disinfection is explained in greater detail in Section 5.8.11. The areas around the outfalls where satellite treatment would be sited are densely developed, and storage of hazardous chemicals away from the main WPCF on Hollyhock Island in lightly used satellite treatment facilities is not preferred. Due to the above reasons, satellite treatment will not be considered within Norwich. All other specific technologies described within Section 5.8 would be implemented in a central location on Hollyhock Island as part of the existing WPCF site.

5.8.2 Water Pollution Control Facility Improvements

Increasing the capacity of the Water Pollution Control Facility to handle higher peak wet weather flows is one way to reduce the frequency and volume of untreated CSO discharges

upstream in the collection system. This alternative will likely require improvements to the existing headworks facilities, as well as the wet weather treatment system, and installation of a pump station upstream of the WPCF.

Another option that may allow more flow to pass through the WPCF during wet weather events is to increase primary treatment and disinfection capabilities, and bypass secondary treatment. The WPCF does not currently have a separate wet weather treatment process that could provide primary treatment and disinfection for flows exceeding secondary capacity. A wet weather treatment facility would allow the WPCF to provide screening, sedimentation, and disinfection before discharging excess flow to receiving bodies while preventing beneficial organisms from washing out of the secondary treatment tanks during high flows.

To maximize flow to any treatment facility at Hollyhock Island, improvements to the collection system infrastructure would also be required. NPU's interceptor system appears to be undersized to deliver the higher flows. Overall this alternative represents an attractive means for reducing CSOs and maximizing flow through the treatment plant and will be evaluated further as a CSO control alternative.

5.8.3 Screening

Screens for wastewater treatment are available in various types and sizes ranging from bar racks to coarse/fine screens or microstrainers. Screens are effective in removing large solids and floatables from the wastewater flow, with the effectiveness being dependent on the clear opening of the screen. The size of the screen openings determines the level of treatment achieved. Microstrainers can, in theory, achieve primary treatment levels by removing 60 percent of the suspended solids, though they can be susceptible to clogging in practice.

Screens can be installed at either inline or at off-line facilities. Inline facilities must be closely monitored and cleaned to prevent loss of hydraulic capacity, which could cause flooding.

Bar screens are almost always installed at the entrance to storage and treatment facilities for removal of large objects, trash, and debris, and to protect treatment and pumping equipment. Often two sets of screens in series are used. The first set usually consists of coarse screens with 1 1/2" bar spacing. Finer screens with 1/2" to 1" spacing are located just downstream. A double screen set up also has a less tendency to be blocked than one fine screen.

In lieu of stationary fine bar screens, traveling woven wire mesh or perforated plate screens are sometimes used. These types of screens provide more efficient removal of floatables, however, operation and maintenance requirements are extremely high. Since the media are cleaned using a high-velocity water jet spray, handling and disposal of this sidestream would greatly increase operation complexity, as well as the required building size, operational requirements, and, consequently costs. In addition, the head loss through this unit is two to three times that of a stationary unit. Accordingly, this method of fine screening is not considered applicable for use at CSO storage or treatment facilities.

Screening is not a viable treatment alternative to meet CSO control strategies. While screening alone will remove floatables and large solids, it does not address coliform violations in receiving waters. To meet all water quality goals, screening in conjunction with disinfection (as discussed below in Section 5.8.11) are generally considered together as a treatment method. This method of CSO treatment is generally inexpensive when compared to other treatment methods. However, it is generally not viewed by DEEP as an effective method of

addressing CSO control due to lack of coliform control, and screening alone will not be considered further as its own CSO treatment technology.

5.8.4 Sedimentation

Gravity sedimentation using high surface overflow rates (to conserve space) can achieve 20 to 40 percent BOD removal and 50 to 70 percent TSS removal in CSOs. Land requirements and residual solids handling are important considerations in determining the feasibility of sedimentation.

Sedimentation reduces solids loadings from CSOs by gravitational settling and removal of suspended solids. As a result, metals and BOD loadings are also reduced. In addition, the process is used in many wastewater treatment applications providing an extensive base of full scale operating data.

The major disadvantage of sedimentation is that land requirements are relatively high. Because land availability is usually limited in urban areas, siting of CSO abatement facilities with sedimentation basins can be an important issue.

Experience has shown sedimentation to be a reliable, cost-effective CSO abatement technology. However, additional sedimentation at the WPCF site, or other satellite sites will not be considered due to land limitations and the urbanized locations of most of NPU's CSOs. Additionally, to meet all water quality objectives, disinfection following sedimentation would need to be included as part of the treatment process. Sedimentation will not be considered as a viable CSO control method for NPU.

5.8.5 Enhanced High-Rate Clarification

Another process used for treating storm flows is enhanced high-rate clarification (HRC). This technology, which can be operated intermittently during storm events, is a physical-chemical process in which coagulant and polymer are added to wastewater. The coagulant aggregates the suspended solids in the flow into a floc. The resulting floc particles adsorb onto either very fine sand added to the wastewater, or recirculated solids with the aid of a polymer. The fine sand (or recirculated solids) acts as ballast and increases the settling rate of the adsorbed floc. Hence, the process is also known as "ballasted flocculation." Screening is required prior to the ballasted flocculation treatment component and disinfection is required after. UV disinfection can be utilized with ballasted flocculation treatment because of the high level of suspended solids removal.

A typical ballasted flocculation system consists of addition of a coagulant (alum or ferric chloride), polymer, and "microsand" (sand approximately 100 microns in diameter) to wastewater. The wastewater and additives are rapidly mixed (flash mixing), then slowly stirred in a maturation tank before settling in a clarifier. The sludge from settling is passed through a hydrocyclone, where the microsand is removed from the sludge and recycled.

Several suppliers provide enhanced high-rate clarification systems including Kruger's Actiflo process, which uses microsand as ballast and Degremont Technologies DensaDeg process, which uses recirculated solids as ballast.

BOD and TSS removal rates associated with HRC have been shown to be roughly double those of traditional clarification. BOD removal is between 65 and 80 percent and TSS removal is between 70 and 95 percent according to the EPA's August 2004 "Report to Congress on the Impacts and Control of CSOs and SSOs". Other benefits of this process are:

- Land area requirements are only one-tenth of traditional clarification land area requirements (5 to 15 percent of the space required for conventional primary treatment);
- Can handle high hydraulic loading rates and treat rapidly varying flows; and
- Able to achieve secondary treatment concentration standards for BOD and TSS (without a biological process).

The storage of chemicals may be of concern if this technology is implemented at a satellite location, away from the WPCF. Other disadvantages of this technology include the increased operational cost relative to biological treatment and conventional clarification due to the cost of chemicals, ballasted media, and sludge disposal and the limited ability to remove soluble pollutants. Many of the technologies reviewed have limited ability in removing soluble pollutants. Given the relative infrequent operation of the high rate clarification system, the increased operational costs may not be as substantial as initially expected. The August 2004 "Report to Congress on the Impacts and Control of CSOs and SSOs" illustrates the operating cost of a chemical or physical treatment process, like ballasted flocculation versus the operating cost of a biological process. Since the biological process must operate continuously, albeit at small flows most of the time, the annual operating costs are higher than for the intermittent operation of a process such as ballasted flocculation.

In summary, high-rate clarification provides significantly higher treatment capacities than conventional primary treatment with significantly higher BOD and TSS removals in a relatively small footprint. Therefore, high-rate clarification is considered a viable alternative to evaluate further for providing higher wet weather treatment flow capacity and reducing CSOs in Norwich. Potentially higher O&M requirements associated with this technology may limit its applicability to areas that can support these requirements. For example, high-rate clarification may be viable for implementation at the regularly staffed WPCF, but may be more difficult to support at unmanned satellite treatment facilities. High rate clarification appears to be a promising CSO technology for utilization at the WPCF site but will not be considered for satellite treatment in Norwich.

5.8.6 Chemical Flocculation

Chemical flocculation is a high-rate treatment process utilizing metal salts and polymers to aggregate particles in CSO flow. Depending on their density, the aggregate of particles, or floc, will either sink to the bottom or float to the top where it can be removed. A concentrated sludge is produced, requiring no additional thickening. Chemical flocculation can remove 40 to 80 percent BOD and 60 to 90 percent TSS. Like ballasted flocculation, chemical flocculation can handle high hydraulic loading rates and treat rapidly varied flow. Chemical flocculation is limited in its ability to remove soluble pollutants. There is a potential increase in sludge production due to the addition of treatment chemicals and an increased operational cost due to the cost of chemicals. Since ballasted flocculation achieves similar results to chemical flocculation but the hydraulic capacity for chemical flocculation is much less (20,000 gpd/sq. ft for chemical versus 90,000 gpd/sq. ft. for ballasted flocculation); chemical flocculation will not be further considered.

5.8.7 Dissolved Air Flotation

Dissolved air flotation (DAF) relies on small air bubbles to suspend particulate matter to float to the surface for removal. Oil, grease, and other floatables can also be removed. This

technology has been used to treat CSOs and has proved to be relatively effective in removing up to 20 to 50 percent of the suspended solids and floatables.

Small and light suspended matter can be removed more efficiently and quickly by this process than by sedimentation. Chemical addition (generally polymer) is usually used to improve removal efficiency. Operating costs are relatively high due to pumping costs to pressurize the water and compressed air, and chemical requirements. The process is also sensitive to operational control.

DAF has been used primarily for processing sludges in municipal, industrial water, and wastewater treatment applications and most recently for water treatment. Due to the relatively high operating costs and sensitivity to operational control associated with DAF, other less costly and complex technologies have been developed that have replaced DAF in many applications.

DAF is not recommended for CSO abatement because of operational demands that are further complicated by the characteristics of CSOs, such as the need for start-up on short notice and ability to handle highly variable flow rates. Consequently, DAF is not considered feasible for NPU's CSOs and will not be considered further.

5.8.8 Swirl Concentrators

Swirl regulators/concentrators operate as a solids/liquid separator removing both suspended solids and floatables through rotationally induced forces. Swirls have been reported to remove up to 50 percent of the suspended solids from the combined sewer flow. Helical concentrators are similar in design but are more effective as an inline device (rather than an off-line device). The flow is separated into overflow, which is discharged to the receiving water (typically after chlorination) and underflow (a concentrated low volume of wastewater that is intercepted for treatment at a treatment plant).

Swirl and helical bend concentrators have some limitations and potential drawbacks, including:

- The rate of underflow diversion is subject to design limitations relative to the incoming combined flow.
- The relatively short detention time will require high rate disinfection or construction of contact tanks to provide adequate detention time for bacteria kill before discharge to the receiving water.
- The configuration of the swirl concentrator results in a large hydraulic headloss requirement between the influent combined sewer and the underflow pipe.
- Relatively little long-term data on performance and reliability.

Some of the drawbacks can be satisfied by storage and pump back facilities in conjunction with a concentrator, but pumping will also require electricity, additional space, remote/automatic controls for operation and additional costs. Interceptor and treatment capacity must be available for underflow during a storm event. If underflow rates exceed the available interceptor capacity or sufficient grade is not available, the underflow may need to be stored and pump back following the storm may be required.

In order to operate effectively, most swirl concentrators need to be cleaned regularly. A maintenance schedule should be established based on solids loading and accumulation rates.

Some types of swirl concentrators must be dewatered and cleaned with a vacuum truck, which will increase work demands of the city's collection system maintenance crews. Other types of systems are designed to pump out the debris that is screened out of the flow, which can potentially create sedimentation and grit accumulation in pipelines.

The uncertainty concerning solids removal efficiencies, the lack of bacteria removal, space requirements and the level of maintenance required for swirls are some of the reasons why swirl concentrators are not given further consideration in this report.

5.8.9 Biological Treatment

Biological treatment processes, including contact stabilization, trickling filters, rotating biological contactors, treatment lagoons, and land application, have been most successfully used in the treatment of sanitary sewage and industrial wastewater. Their exclusive use for the treatment of combined sewer overflows has several drawbacks including:

- Difficulty maintaining biomass (used to assimilate nutrients in combined sewage) during dry weather (continuous operation is required);
- Difficulty in handling erratic loading conditions inherent to combined sewer overflows;
- Potential odors and snail population problems;
- High clogging potential
- Costly O&M;
- Highly skilled operators are required; and
- Extensive level of treatment provided by biological treatment is not required for combined sewage

Due to the above stated disadvantages, biological treatment will not be considered further as a viable LTCP technology in this report.

5.8.10 Filtration

Filtration is a physical treatment process that removes solids by straining wastewater through a filter medium, such as sand, charcoal (carbon adsorption), or membranes. Deep bed filtration can treat high and rapidly varying flows. Filtration can consistently achieve secondary treatment concentration standards for BOD and TSS. Its major disadvantage is the tendency to clog rapidly during use, thus limiting its hydraulic capacity and ability to remove solids; or the need for frequent backwashing to prevent clogging. It can be used after sedimentation to reduce clogging, but this level of treatment is typically not required for CSO applications. Consequently, filtration will not be considered further.

5.8.11 Disinfection

Disinfection is used to destroy pathogenic microorganisms. Many disinfection technologies are available including chlorination, ozonation, and ultraviolet radiation. The most common method is chlorine addition, although its apparent toxicity to aquatic life is a concern. For this reason, dechlorination is often required.

Disinfection agents used for wastewater and stormwater treatment include: gaseous chlorine, hypochlorite (calcium and sodium), chlorine dioxide, and ozone. All these disinfection agents are oxidizing agents, corrosive to equipment, and are highly toxic to microorganisms and other life. Selecting a CSO disinfection system is based on the following considerations:

- Capability to meet highly variable fluctuations, in terms of both quantity and quality.
- Availability of trained operators to carefully handle dangerous gases, typically chlorine, chlorine dioxide, or ozone. Although there are fewer hazards associated with hypochlorite, it requires bulk storage.

When selecting a disinfection system, the capacity and location of the treatment facility must be considered. Use of toxic gases is undesirable in densely populated areas and small-scale facilities that are only monitored periodically. Norwich is densely populated, and the use of gaseous chlorine will not be considered.

Ozone has been proven to be effective, although it is considered expensive. Generally, chlorination (hypochlorite) is accepted as the most cost-effective and technically reliable disinfection treatment to reduce coliform levels in CSOs. Chlorination will be considered in conjunction with screening, sedimentation, and HRC. To eliminate the potential toxic effect of residual chlorine on biota, CSOs would be dechlorinated prior to discharge at the wet weather treatment facility under consideration. General dechlorination practice indicates that sodium bisulfite is a reliable and cost-effective chemical to remove chlorine residuals from the wastewater effluent.

In addition to the above, UV is also used as a disinfecting agent; however, its pathway for disinfection is different where microorganisms are inactivated by disrupting cell DNA and impacting the microorganism's ability to infect and reproduce. UV light is only effective on highly treated effluent and not on turbid mixed flow typical of a CSO discharge. It can be effective on treatment of less turbid discharges from treatment methods such as high rate clarification.

Disinfection will be considered further for use to complement other treatment methods and provide additional pathogenic organism treatment, but only hypochlorite and UV disinfection will be considered for use in Norwich.

5.8.12 Summary of Treatment Technologies

No treatment technology alone is adequate to meet all water quality objectives. Various combinations of treatment methods, and various levels of treatment plant capacity expansions, can be used to meet CSO abatement goals. These concepts are discussed further in Sections 6 through 8.

5.9 Summary

This assessment has identified twelve technologies to carry forward into alternatives evaluation as shown in Table 5-1. Collection system controls, along with storage and treatment technologies were found to be the most applicable to NPU's collection system. Many of these technologies were carried forward for alternatives analysis. Quality source controls aim to improve the concentrations of contaminants discharged to the receiving bodies. NPU and City of Norwich already practice many of these activities, which are helpful, but do not reduce the volume of CSO contributed to the water. Some of these technologies listed as

Continue Current Practice are already identified as recommended nine minimum control measures. These technologies will incorporate good maintenance practices to ensure that system operation is maximized to the extent possible before more expensive structural controls are implemented. Finally, many alternatives were eliminated from further consideration for NPU's Long-Term CSO planning. As discussed previously quantity source controls, especially green infrastructure and storm water controls generally fall under the City DPW realm of responsibility. Other eliminated technologies will not directly address the CSO impacts identified in receiving water quality.

Table 5-1 List of CSO Abatement Technologies

CSO Control Technology	Technology Not Feasible, Appropriate, or Applicable	Continue Current Practice	LTCP Technology
QUANTITY SOURCE CONTROL MEASURES			
Porous Pavement	√		
Flow Detention	√		
Area Drain and Roof Leader Disconnection			√
Utilization of Pervious Areas for Infiltration	√		
Catch Basin Modifications	√		
Urban Parks and Green Spaces	√		
Green Roofs	√		
Bioretention	√		
Water Conservation		√	
Infiltration Sumps	√		
QUALITY SOURCE CONTROL MEASURES			
Air Pollution Reduction	√		
Solid Waste Management		√	
Fat, Oil, and Grease Control Programs		√	
Street Sweeping		√	
Fertilizer/Pesticide Control	√		
Snow Removal and Deicing Practices	√		
Soil Erosion Control		√	
Commercial/Industrial Runoff Control		√	
Animal Waste Removal	√		
Catch Basin Cleaning		√	
Catch Basin Modifications - Hoods/Baffles	√		
End-of-Pipe Controls	√		
Staffing and Operation		√	
COLLECTION SYSTEM CONTROLS			
Existing System Management		√	
Regulator Modifications			√
Sewer Cleaning/Flushing		√	
Sewer Separation			√
Infiltration/Inflow Control			√
Polymer Injection	√		
Regulating Devices and Backwater Gates			√
Remote Monitoring and Control/Flow Diversion			√
Relocation of CSO Outfalls & Regulators (Combine & Relocate)			√
CSO Regulation Remote Monitoring		√	
STORAGE FACILITIES			
In-Line Storage			√
Off-Line Storage			√
Surface Storage	√		
TREATMENT TECHNOLOGIES			
Satellite Treatment Facilities	√		
Wastewater Treatment Plant Improvements			√
Screening	√		
Sedimentation	√		
Enhanced High-Rate Clarification			√
Chemical Flocculation	√		
Dissolved Air Flotation	√		
Swirl Concentrators	√		
Biological Treatment	√		
Filtration	√		
Disinfection			√

Section 6

Section 6

Sewer Separation

6.1 Background

Norwich Public Utilities (NPU) owns and maintains 16 miles of combined sewer in Norwich. During wet weather, stormwater enters the collection system and combines with sewage. Wet weather flow can exceed system conveyance capacity, causing combined sewer overflow (CSO). Sewer separation replaces combined sewers with separate systems for sewage and stormwater that operate without excessive surcharge or flooding at their intended level of service.

In Norwich, many areas categorized as having sanitary sewers are former combined systems that had public wet weather inflow sources removed. Public inflow was typically removed through installation of new storm drains and catch basins, though on some streets stormwater travels by gutter flow to a downstream catch basin. The focus of these past projects was to remove public stormwater connections (i.e. catch basins) from the combined sewers; private inflow removal was not a focus of these projects.

The Norwichtown, Route 2 Corridor, Westside, and Yantic sewersheds are served by sanitary sewers; they no longer have combined sewers. The Route 2 Corridor sewershed is tributary to the Shetucket Interceptor and CSO 017. The Norwichtown, Westside, and Yantic sewersheds are directly tributary to the water pollution control facility (WPCF) via the Yantic Interceptor. Remaining stormwater inflow to these sewers is limited and does not directly contribute to CSO. However, wet weather induced flows to the Yantic Interceptor do reduce the facility's capacity to accept flow from other areas.

The 2012 CSO Long Term Control Plan (LTCP) recommended "full sewer separation" in the remaining combined sewer system plus pumping station and force main upgrades to achieve the goal of CSO control with CSO 017 to remain open to limit flood risk during storms exceeding a 2-year average recurrence interval (ARI). "Full sewer separation" as defined by the 2012 LTCP is identified in this report as "citywide public inflow removal" and only includes removal of public inflow sources (i.e. catch basins) as discussed further later in this section. The 2012 LTCP did include a small (5%) allowance for work on private property, but this did not include work inside buildings or actual removal of private inflow.

The term "partial separation" was used in the 2012 LTCP to describe the use of public inflow removal in a portion of the combined sewer system (but not citywide). The 2012 LTCP did not consider private property inflow removal, but noted that public inflow removal alone would not eliminate CSO during storms exceeding a 2-year ARI. This current study was completed based on NPU's understanding that DEEP policy is that CSOs must be closed with brick and mortar in areas where pubic separation is implemented. The approach presented here only recommends CSO closure where system configuration allows hydraulic relief that does not increase surcharge or flood risk in events exceeding a 2-year ARI.

The Connecticut Department of Transportation (CTDOT) 2004 Connecticut Stormwater Quality Manual requires peak flow control for design of conveyance systems leading to, from, and through stormwater management facilities based on a 10-year, 24-hour storm. Section 6.3 of this report re-evaluates the effectiveness and costs associated with citywide public inflow removal (formerly called

full separation) and evaluates the option to perform complete public and private separation, which would be necessary in Norwich to achieve a 10-year level of control. It is assumed that DEEP would expect that the collection system convey up to a 10-year storm without flooding.

6.2 Public Inflow Removal

Public inflow removal is a method of sewer separation where catch basin connections are removed from the sanitary sewer system. This can be achieved through construction of new sewers or new drains.

6.2.1 New Sanitary Sewers

To provide pubic inflow removal in a combined sewer system, one option is to install new sanitary sewers. The former combined system is then cleaned and only used for stormwater conveyance. Because combined sewers were originally designed to convey both sewage and stormwater, these pipes are often large enough to provide adequate stormwater conveyance.

Construction of new sanitary sewers can be expensive since this approach requires new service connections for each building. While new sanitary pipes can be smaller than storm drains, sanitary pipes generally must be constructed in every street to provide the service connection, and they are typically constructed deeper than storm drains, entailing greater construction expense.

Using the existing combined sewer system for stormwater conveyance can be more effective in areas that have high groundwater infiltration due to old pipes that can be cracked, worn, intruded by roots, or have deteriorated joints. New sanitary sewers typically minimize infiltration, especially in combination with construction of new service connections that replace old ones that are similarly likely to be subject to high infiltration rates.

6.2.2 New Storm Drains

The second option to provide public inflow removal in a combined sewer system is to install new storm drains. The former combined sewer subsequently serves as the sanitary sewer. Because combined sewers were designed to convey both sewage and stormwater, a hydraulic analysis is needed to show adequate flushing velocity remains after stormwater is removed to avoid sediment buildup.

When new storm drains are constructed, they often do not need to be in every street, as gutter flow can provide adequate conveyance in some locations. While storm drains have larger diameters than sanitary sewers, they can be installed shallower in systems where you don't need to pick up building foundation drains. On streets where you are not trying to address private inflow contributions, it is also possible to achieve a high level of inflow reduction without connecting building roof leaders or foundation drains to the new storm drains. Depending on the goal of the project and configuration of the system, new storm drains may be less costly (or more costly) to install than new sanitary sewers.

6.3 Complete Public and Private Separation

Complete public and private separation is a more comprehensive approach to sewer separation than just public inflow removal. For this approach, in addition to disconnecting catch basins from the sewer system, private property inflow sources including sump pumps, yard drains and roof leaders are also removed. There are two different approaches to achieve this separation – new sewer systems or new drainage systems. To achieve complete public and private separation each building must either have a dedicated storm drain lateral or property that allows private stormwater to be retained on-site.

6.3.1 New Sanitary Sewers

To provide complete public and private separation in a combined sewer system, one option is to install new sanitary sewers as described in Section 6.2.1. The former combined system is then cleaned and used only for stormwater conveyance. This option lends itself well to the addition of private property separation because the existing lateral can be converted to a storm lateral and a new sewer lateral can be added that only connects the private sewer to the main line. This approach is more likely to have high costs in Norwich due to the need for rock excavation, but new sewers will be smaller than new drains, so costs must be evaluated on a case by case basis.

6.3.2 New Storm Drains

The second option to provide complete public and private separation in a combined sewer system is to install new storm drain pipes, and the combined (existing system) is used as the sanitary sewer. However, the addition of private storm drain laterals to the drainage system reduces some of the benefits described in Section 6.6.2. When you are addressing private inflow sources, a new storm lateral may be required to pick up roof leaders, sump pumps or building foundation drains. The addition of this storm lateral tends to push the new storm drain as deep or deeper than the sanitary sewer. If new storm drains are constructed to accommodate private drain laterals to each property, they would also need to be in every street. Under this scenario, new storm drains may not have a cost advantage over sanitary sewers. Rock excavation may also be a challenge depending on the depth and diameter of the new drains.

6.3.3 Private Inflow Removal

The first step in private inflow removal is to perform a detailed inspection of each property in the project area. The inspection needs to be performed by a qualified inspector to identify all possible interior and exterior sources of private inflow. Private inflow sources are on both the interior and exterior of buildings and include sump pumps, roof leaders, floor drains, foundation drains, condensate lines, and yard drains. The inspector takes photographs and videos, draws sketches, interviews the owner, and makes a preliminary determination on the plumbing configuration. In some cases, a visual inspection is not adequate; smoke testing and dye testing may be necessary to confirm or identify how private inflow sources connect to the sewer.

The data collected during the house inspection is then used by the design engineer to develop a design solution for the property. The buildings in Norwich range in use from single-family residential to larger multi-unit residential, commercial, and industrial. Interior separation in a building can be challenging, especially in cases where the sewer and drain systems are interconnected inside the building.

Once private inflow sources are removed during construction, each property must be restored to its original condition. It is challenging to work with numerous private property owners and restoring interior spaces, driveways, walkways, stone walls, and landscaping.

Working with private property owners is a process that requires extensive coordination and documentation of agreements. It starts in design when the owners are identified and introduced to the project and continues for years until the property owner and utility provider are satisfied that he property has been justly restored. Legal contracts and overview of the process are typically required.

6.4 Public Inflow Removal in Norwich

Public inflow removal in Norwich could be performed in all the remaining combined sewers to achieve "citywide public inflow removal" or it could be performed in targeted areas in conjunction with other CSO abatement technologies.

6.4.1 Citywide Public Inflow Removal

In the past, NPU performed public inflow removal projects to reduce the number of CSO outfalls in Norwich. The 2012 LTCP presented citywide public inflow removal (formerly "full separation") as the recommended plan for CSO control in Norwich, which included public inflow removal in the remaining combined sewers in Norwich.

For this study, the collection system model was used to evaluate the effectiveness of public inflow removal in the tributary areas to each CSO regulator. Analyses were completed based on assumed prior completion of the improvements identified as the "planned projects" presented in Section 7. This analysis concluded that Norwich CSOs could be controlled to varying levels as identified in Table 6-1. Public inflow removal alone would not meet 2-year control at most CSO regulators. For regulators where sewer separation does meet 2-year control, the cost of separation, as discussed further below, is compared with other CSO control strategies to evaluate which approach is more cost-effective.

Table 6-1 Public Inflow Removal Effectiveness

Sewershed	CSO	Control Level
Downtown	017	<1-month
Eastside	025	5-year
Greenville	018	<1-month
Greenville	019	<1-month
Greenville	021	3-month
Greenville	022	1-month
Greenville	023	<1-month
Greenville	024	5-year
Laurel Hill	029	5-year
Laurel Hill	031	3-month
Laurel Hill	032	3-month
Thamesville	040	5-year
Thamesville	004	1-month
Thamesville	005	3-month

Note: Estimates assume completion of the planned projects described in Section 7 in addition to public inflow removal

The cost for completing citywide public inflow removal was also re-evaluated. The 2012 LTCP used a basic approach to assume a unit cost for new sewers at $265/linear foot (p.121 of the 2012 report) x 86,000 feet in the combined system plus $13.9 million for pumping stations and force mains. This yielded an overall program cost of approximately $50+ million after the 2012 report factored in engineering and contingency. However, based on actual bid results from similar communities in New England, we know actual costs would be much higher.

For this study, unit costs were composited from previously bid CSO projects in Hartford and New Haven, Connecticut, and New Bedford and Lowell, Massachusetts. Each sewershed was assigned a density and unit cost for public inflow removal based on local characteristics. Table 6-2 presents

public inflow removal cost estimates for all remaining / existing combined sewers. Citywide public inflow removal would cost $160 million. Construction is assumed to include new catch basins, storm drains, outfalls, and associated stormwater infrastructure. Costs for each sewershed are further discussed below.

Table 6-2 Public Inflow Removal Cost

Sewershed	Density	Acres	Separation Cost (per acre)	Total[1] (million)
Downtown	high	70	$200,000	$21
Eastside	low	72	$120,000	$13
Greeneville	high	303	$200,000	$91
Laurel Hill	medium	63	$170,000	$16
Thamesville	medium	75	$170,000	$19
Total		**583**		**$160**

[1] includes 25% project contingency and 20% engineering

6.4.2 Local Public Inflow Removal

Local public inflow removal applies the same CSO abatement techniques discussed earlier in this section in targeted areas. Public inflow removal costs vary based on factors including development density, commercial activity, traffic volume, utility conflicts, and depth of bedrock. Comparison of the costs to remove public inflow and anticipated CSO reduction in each area provides insight into where public inflow removal may be cost-effective.

- Downtown is a high-density urban area. This busy urban center has many commercial properties with restaurants and stores, as well as residential buildings. Streets tend to be steep and narrow with an exceptionally short time of concentration. Following public inflow removal in its combined service area, CSO 017 would continue to overflow in a one-month storm.
- Eastside is a low-density suburban area that was evaluated for public inflow removal in 2018. Based on preliminary design and modeling, it was determined that public inflow alone would not remove enough stormwater flow for closure of CSO 025, the only CSO outfall on the Eastside. This is further discussed in Section 7. The latest consent decree requires separation in Eastside to achieve a 2-year level of control at CSO 025. Given the inadequacy of public inflow removal at achieving this, Section 7.2 of this LTCP identifies alternatives to meet the 2-year goal. Alternatives evaluated include public inflow removal, complete public and private separation, storage, and conveyance.
- Greeneville is a high-density urban area with a mix of residential and commercial properties. It is served by six CSOs and has some very steep streets and a high concentration of visually obvious bedrock formations. Following public inflow removal in the combined portion of the sewer system, CSOs 018, 019, and 023 would continue to overflow in a one-month storm.
- Laurel Hill is a medium-density, primarily residential, suburban area. This area's steep hills and its sewers adjacent to railroad tracks and the Thames River present significant construction challenges. If public inflow removal were performed in the entire combined service area, 3-month control could be achieved at CSOs 031 and 032.

- Thamesville is a medium-density, suburban area. The sewershed poses construction challenges due to its steep hills and multiple pumping stations. Public inflow removal in the entire combined sewer portion of Thamesville would achieve 1-month control at CSO 004 and 3-month control at CSO 005.

6.5 Complete Public and Private Separation in Norwich

DEEP has targeted a 2-year level of control in Norwich. However, they have also indicated that with separation they would require brick and mortar closure of the CSO regulators. This means that there would no longer be any CSO allowed from the permitted outfalls, but there would be risk of flooding and basement backups for a range of storm events exceeding the 2-year ARI. To minimize the risk of sewer system flooding during storms up to a 10-year storm, extensive public and private sewer separation would be needed throughout the entire collection system, including in areas that are currently categorized as having separated sewers. If CSO control was implemented to attain 2-year level of control without inflow removal to provide 10-year control, sewer flooding would be expected to occur in any event exceeding a 2-year ARI. As discussed in Section 6.1, the 10-year control level corresponds with guidance in the CTDOT Stormwater Manual.

In portions of Norwich with combined sewers, the following improvements would provide full separation of sewage and stormwater:

- New mainline storm drains or sewer pipes in the roadway
- New catch basins and outfalls to convey public inflow
- Disconnection of all private inflow from all buildings
- Dedicated storm laterals
- Pipe rehabilitation (when the combined sewer becomes the sanitary sewer, 100% sewer lining is required)
- Utility relocation
- Full width roadway paving (or reconstruction in some areas)

Areas of Norwich that currently have sanitary sewers would need the following improvements:

- Disconnect all private inflow. It is assumed that private inflow connections would be present at 50% of properties (this might require additional storm drains which would increase costs)
- Pipe lining of all sewers
- Lining of manholes

Ten-year sewer flood control is achievable as described above. The work is estimated to cost $380 million and includes projects on every street with sewer service in Norwich. Table 6-3 summarizes system statistics and Table 6-4 summarizes costs by sewershed, detailing the cost breakdown between combined and separated sewer areas.

Table 6-3 Sewershed Statistics

Sewershed	Separated Sewer Area (acres)	Combined Sewer Area (acres)	Sanitary Sewer (ft)	Combined Sewer (ft)	Density
Downtown	470	70	66,000	15,000	high
Eastside	60	72	9,000	5,000	low
Greeneville	750	303	102,000	43,000	high
Laurel Hill	330	63	21,000	10,000	medium
Norwichtown	1,410	-	111,000	-	-
Route 2 Corridor	200	-	23,000	-	-
Thamesville	670	75	53,000	12,000	medium
Westside	890	-	100,000	-	-
Yantic	360	-	51,000	-	-

Table 6-4 Complete Public and Private Separation Costs[1]

Sewershed	COMBINED AREAS		SEPARATED AREAS		
	Separation Cost (per acre)	Separation in Combined Areas (million)	Private Inflow Removal[2] (million)	Pipe Rehabilitation[3] (million)	Total[4] (million)
Downtown	$280,000	$19	$8	$5	$48
Eastside	$200,000	$14	$1	$1	$24
Greeneville	$280,000	$84	$10	$7	$150
Laurel Hill	$250,000	$16	$3	$1	$30
Norwichtown	$0	$0	$10	$8	$27
Route 2 Corridor	$0	$0	$4	$2	$9
Thamesville	$250,000	$18	$8	$4	$45
Westside	$0	$0	$13	$7	$30
Yantic	$0	$0	$8	$4	$18
Total					**$380**

Notes:
1. Table assumes that the Planned Projects are completed plus the addition of Public and Private Inflow Removal
2. Assume 50% of parcels require private property separation at $25,000 each
3. Assume 100% of sewers require pipe lining at $70 per foot
4. Total includes 25% Project Contingency and 20% Engineering Contingency

6.6 Additional Considerations

Considerations aside from water quality and capital costs also determine whether complete public and private separation or public inflow removal is desirable. As with all CSO abatement technologies there are advantages and disadvantages that need to be considered.

Sewer separation offers is often accompanied by a newly paved road, a valued public amenity. Separation also provides an opportunity to renew aging infrastructure. Older gas mains and water mains can be replaced as part of the same construction project so that streets do not need to be

opened repeatedly for other utility upgrades. Street flooding and basement backups can also be addressed through separation projects. Another advantage of sewer separation is that are there are only minor incremental long-term operation and maintenance costs.

A disadvantage of sewer separation is the disturbance caused by construction, including road excavation, changed traffic patterns, restricted access to commercial establishments, and disruption of other utilities. Before implementing a separation program, existing utilities must be located and surveyed to determine where new pipelines will go, and what conflicts there may be. Once this information is available, utility owners must approve any proposed relocations or upgrades before the new collection system can be designed. New sewer designs typically require deeper sewers to pick up all existing sewer connections. Norwich has shallow bedrock in many areas, entailing potentially costly construction of deep sewers.

For private inflow removal, coordination with homeowners and business owners can be challenging and the work can disrupt occupants' lives and businesses. Interior and exterior house inspections need to be performed and documented. Legal agreements may be required in advance of the work as well as final certification that work has been completed and the property has been restored.

6.7 Conclusions

While citywide public inflow removal will not fully attain one-month CSO control, localized public inflow removal has the potential to be cost-effective and can be combined with other technologies to create comprehensive CSO control alternatives. Local public inflow removal in each neighborhood is assessed further in Section 8. In future LTCP updates, citywide removal will be re-evaluated as an alternative for CSO mitigation.

While complete public and private separation could eliminate CSO in Norwich, it is costly, creates significant disruption to the public, and introduces uncertainty regarding how much effort is required to successfully remove all inflow sources. Citywide complete public and private sewer separation is assessed as a CSO control in the alternatives analysis presented in Section 8.

Section 7

This section has been superseded by the revised 2020 CSO LTCP Report.

Section 7

Consent Order Projects and System Optimization

7.1 Introduction

As discussed in Section 1, the Connecticut Department of Energy and Environmental Protection (DEEP) issued Consent Order WRMU17001 to Norwich Public Utilities (NPU) allowing 500 calendar days for development of a revised long-term control plan (LTCP). As part of this process, DEEP required NPU to proceed immediately with separation of the Eastside area tributary to CSO 025. Separation of this area was identified in the 2012 LTCP as the recommended combined sewer overflow (CSO) control plan to avoid discharges at CSO 025 during a 2-year design storm. Design of this separation project was to be concurrent with development of this updated LTCP. The Consent Order then required that upon completion of the Eastside project, NPU proceed with CSO reduction projects in Thamesville to achieve a 2-year level of control at CSO 004, CSO 005, and CSO 040. The Consent Order requires that the Eastside separation project be completed by December 31, 2020 and that a Thamesville CSO project be completed by December 31, 2025.

This section discusses the feasibility and benefits that could be achieved by the Eastside separation project using the collection system model, as well as projects across the city that can improve system operations and reduce CSO discharges. Alternatives for CSO reduction in Thamesville are discussed in Section 8.

7.2 Eastside CSO Control (CSO 025)

7.2.1 Background

CSO 025 serves the Eastside sewershed. It is the most upstream CSO along the Shetucket River. It receives flow from 68 acres of combined sewerage and 57 acres of sanitary sewerage. Dry weather flow is conveyed through the CSO regulator and across the 8th Street Bridge into the Shetucket Interceptor, via a pipe with an 8-inch segment and a 12-inch segment in series, as shown in Figure 7-1. During wet weather, flow exceeding the capacity of the 8th Street Bridge pipes overtops a weir and discharges as CSO into the Shetucket River.

As discussed in the Baseline Conditions Report, on average, CSO 025 discharges 2 million gallons (Mgal) per year over 60 events. By comparison, the 2012 LTCP reported 8 Mgal and 23 CSO events per year. The updated model indicates higher peak flow but shorter overflow durations.

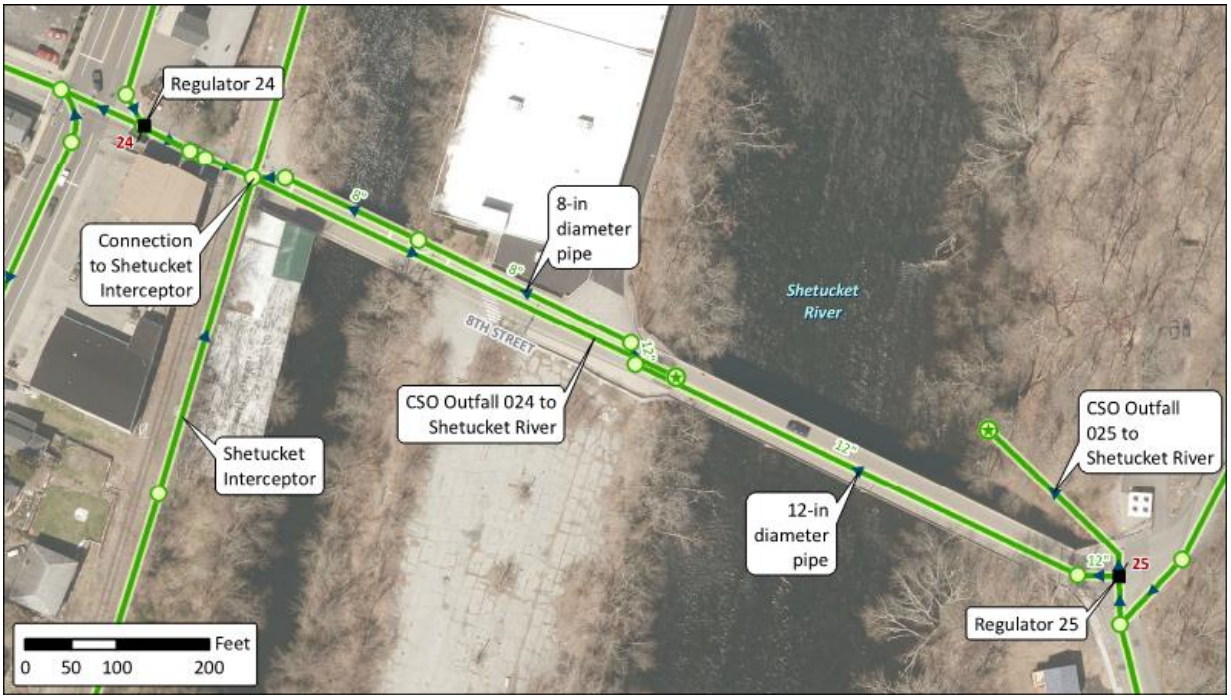

Figure 7-1
Plan View Showing Regulator 25 to the Shetucket Interceptor

7.2.2 Implementing Sewer Separation for CSO 025

7.2.2.1 Introduction

CDM Smith developed a preliminary design for separation of public inflow from the Eastside combined sewer area. This design was prepared concurrently with the LTCP update to meet the goals of the Consent Order and the 2012 LTCP. Separation by both installation of new sewers or drains was considered during the design. Installation of new sewers was determined to be the best approach for NPU, as it operates the sewer system and would gain a new collection system that didn't need to be rehabilitated, thereby helping to reduce infiltration and inflow. This approach may also remove more extraneous flow from the system. Approximately 3,800 feet of new sewer would be installed to divert the city's catch basins from the sewer system. Section 6 of this report identifies challenges associated with public and private inflow separation programs.

7.2.2.2 Public Inflow Reduction

Flow metering for this project indicated that both the combined and sanitary systems tributary to CSO 025 contribute wet weather flow. Model simulations indicated that if only public inflow separation were completed in the Eastside area (i.e. removal of city catch basins) and CSO 025 were closed, remaining private inflow from the combined area and from the existing sanitary service area would still create excessive surcharge at the 8th Street Bridge during storm events.

Figure 7-2a shows the existing hydraulic grade line (HGL) from the upstream tributary area in Eastside to the Shetucket Interceptor during the 2-year design storm. Figure 7-2b shows the expected reduction in sewer flow levels, during the same storm, if NPU completed public inflow removal. Both figures show hydraulic profiles assuming CSO 025 remains open with the weir at

the existing elevation. During the 2-year storm, peak CSO flow would be reduced from 5.5 mgd to 2.0 mgd and CSO volume would be reduced from 0.28 Mgal to 0.10 Mgal.

While public inflow removal offers substantial CSO reduction, there would be remaining CSO discharges at even the 1-month design storm. If CSO 025 were closed, sewer system flooding could occur in a 3-month storm, and there would be significant flooding in a 2-year storm (and larger storms) as shown in Figure 7-2c. To avoid flooding and sewer backup problems following public inflow removal, a relief structure and CSO outfall would be needed, or larger diameter pipes would be needed to convey flow across the 8th Street Bridge to the Shetucket Interceptor.

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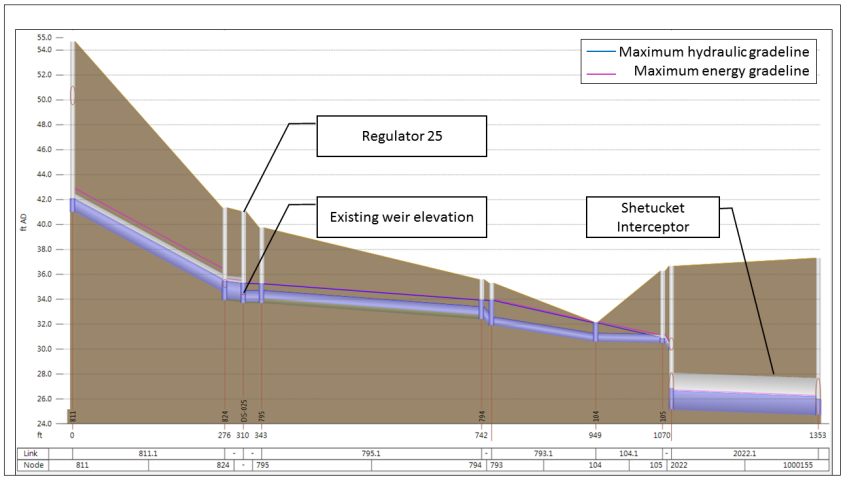

Figure 7-2a - Future Baseline with Regulator 25 Open

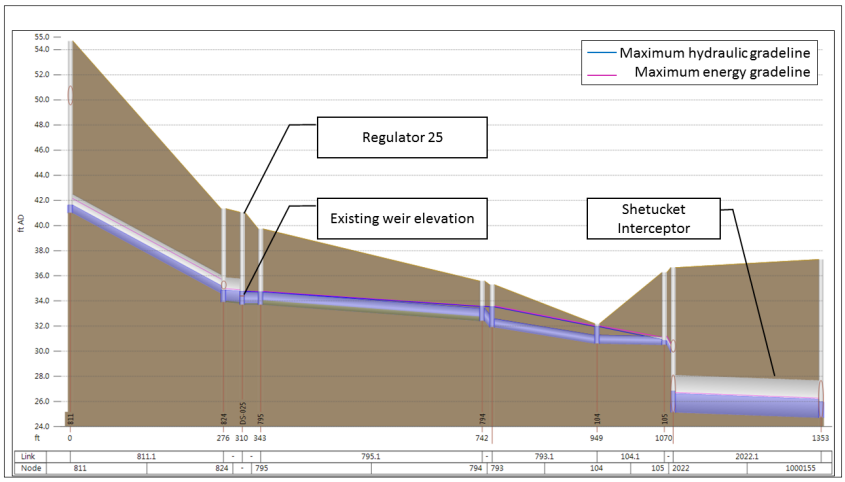

Figure 7-2b - Eastside Public Inflow Removal with Regulator 25 Open

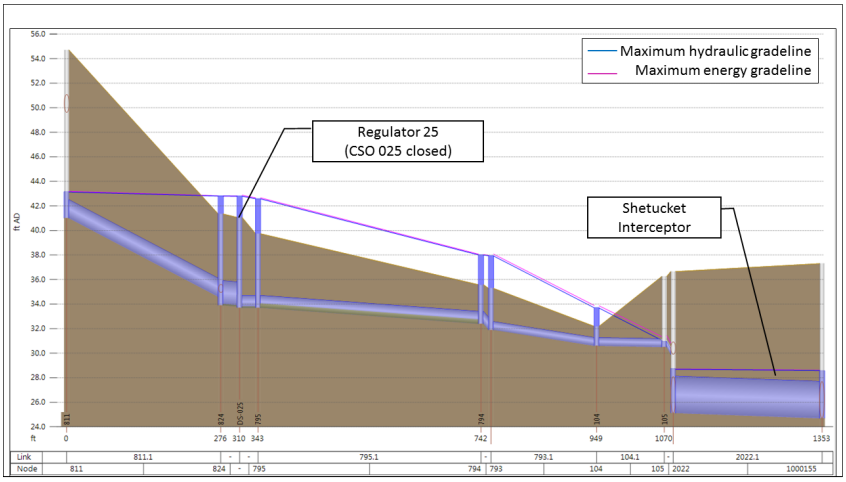

Figure 7-2c - Public Inflow Removal with Regulator 25 Closed

Figure 7-2
Peak HGL in Eastside to Shetucket Interceptor During 2-Year Storm

7.2.2.3 Public and Private Inflow Elimination

If both public and private inflow were removed in the Eastside combined sewer area, CSO 025 could be managed to a 1-month level of control with a 95 to 99 percent overflow reduction anticipated for the remaining design storms. In the 2-year storm, overflow volume would be reduced from 0.28 Mgal to 0.004 Mgal and peak CSO flow would be reduced from 4.7 mgd to 0.2 mgd. Consequently, surcharge would be significantly reduced from future baseline levels, as shown in Figure 7-3a.

However, even with the substantial reduction in peak flow, remaining flow during storms exceeding the 1-month event would still exceed the conveyance capacity of the 8th Street Bridge pipes, causing CSO. If this level of inflow removal were accompanied by closure of CSO 025, street flooding would likely occur for storms equaling or exceeding the 2-year event (Figure 7-3b). During a 5-year storm, flooding would likely occur at additional manholes over the bridge, and sewer surcharge near the regulator could reach within 2-3 feet of ground surface (Figure 7-3c), potentially causing basement backups.

Even with both public and private inflow reduction, if the CSO regulator was eliminated, additional conveyance across the 8th Street Bridge would be required to achieve 2-year control at CSO 025 and avoid excessive system surcharge.

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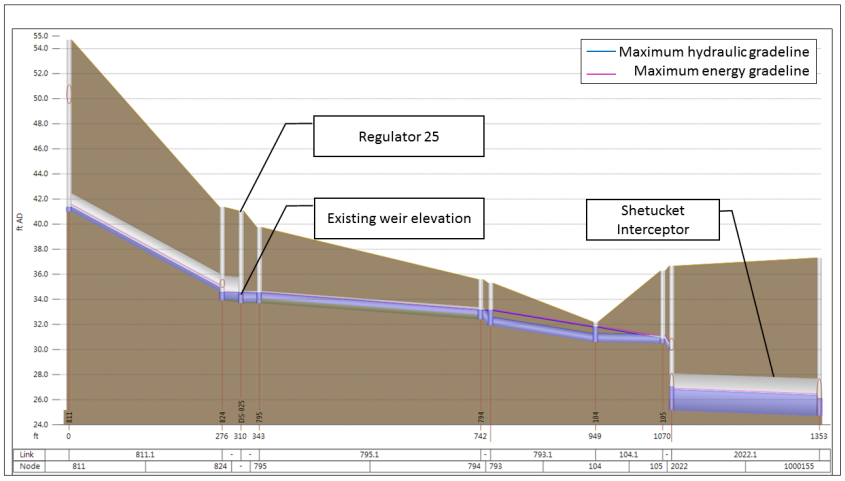


Figure 7-3a - Public and Private Inflow Removal, 2-Year Storm

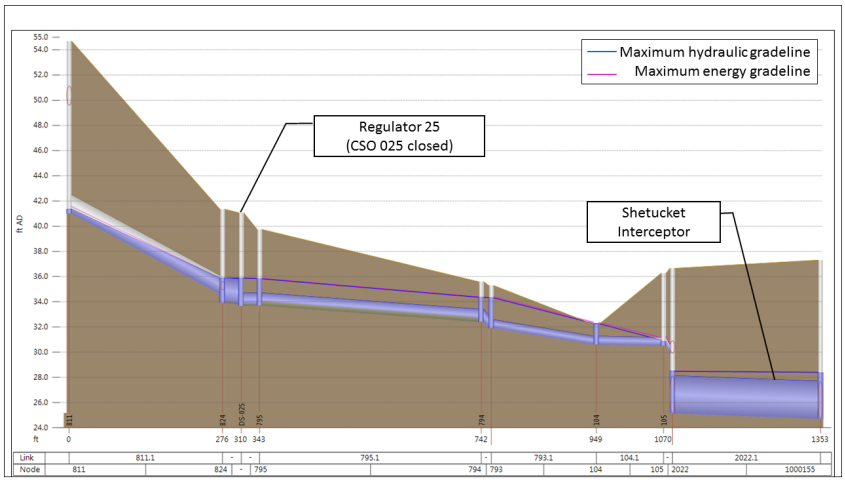


Figure 7-3b - Public and Private Inflow Removal, Overflow 025 Closed, 2-Year Storm

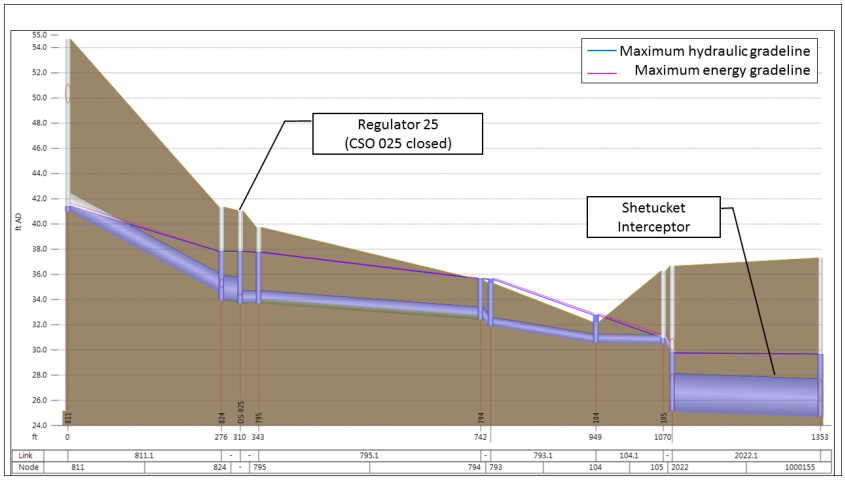


Figure 7-3c - Public and Private Inflow Removal, Overflow 025 Closed, 5-Year Storm

Figure 7-3
Peak HGL in Eastside to Shetucket Interceptor for Different Storms

7.2.3 Other CSO 025 Control Alternatives

Due to the surcharge and flooding concerns associated with separation and potential CSO closure, CDM Smith considered alternative methods for control of CSO 025. It was determined that replacement of the 8th Street sewer pipes would be required along with public and private inflow removal if the CSO 025 regulator were closed. Thus, it made sense to consider what size pipe would be required to convey the design flow across the river without upstream sewer separation.

Design storm simulations indicated that the upstream segments of the Shetucket Interceptor near CSO 025 have capacity to convey more flow downstream. Simulations also showed that a new 780-foot-long, 24-inch pipe replacing the existing 8-inch and 12-inch pipes over the bridge would convey the 2-year storm flow from Eastside to the Shetucket Interceptor in conjunction with weir adjustment at the CSO regulator.

Flow conveyed across the bridge would be small in comparison with total flow in the Shetucket Interceptor and would not adversely affect downstream conditions. CSO 025 flow could then be managed cost-effectively with existing Shetucket Interceptor flows in downstream consolidated system improvements. Alternatives to manage CSO along the Shetucket Interceptor are discussed in detail in Section 8. With this improvement, CSO 025 would be managed to a 2-year level of control. While satellite storage was also considered as an option for mitigating Eastside CSO, there are no suitable locations for storage facilities in the locale of CSO 025.

7.2.4 Summary

Installation of a 24-inch equivalent diameter conveyance pipe along the 8th Street Bridge, downstream of CSO 025, represents the best approach to attain 2-year control at CSO 025. This alternative precludes potential system flooding and public health impacts due to excessive surcharge in large storms if the CSO regulator were eliminated. NPU has presented these initial findings to DEEP, which provided tentative favorable commentary on the alternative conveyance approach. NPU has provided DEEP with a scope for design of this improved conveyance.

7.3 System Optimization

The model was also used to evaluate system improvements that could be readily implemented to reduce NPU's CSO discharges.

7.3.1 Supervisory Control and Data Acquisition (SCADA) at Rose Alley PS

Maximizing flow to the water pollution control facility (WPCF) is one of the Nine Minimum Controls (NMC) recommended by the US Environmental Protection Agency (EPA). Under current wet weather flow operations, the Yantic Interceptor discharges to the WPCF by gravity, while the Cove Street, South Thames Street, and Rose Alley pumping stations (PS) discharge directly to the WPCF. To avoid exceeding WPCF capacity, NPU staff manually adjust the variable frequency drive pumps at Rose Alley during storms. As Rose Alley and WPCF flow rates vary semi-independently, WPCF capacity may be inadvertently underutilized at times.

It is not feasible for NPU staff at Rose Alley to continuously adjust pumping rates to match WPCF flows and capacity. Accordingly, a real-time control (RTC) system at Rose Alley would provide better control, allowing NPU to better utilize WPCF capacity during wet weather. This would reduce CSO at regulators 17-1 and 17-2. RTC could automatically adjust pumping at Rose Alley to

match WPCF design capacity during wet weather. Although the WPCF is rated for 17 mgd design flow, it sometimes receives up to 20 mgd under existing conditions. Section 8 discusses WPCF improvements needed to reliably treat up to 20 mgd.

NPU can implement this RTC approach in the immediate future to help modulate pumping station operations. As WPCF improvements are implemented, consistent wet weather treatment up to 20 mgd can be implemented on a regular basis and additional CSO reduction will be achieved. In the interim, RTC will still improve system performance.

7.3.2 CSO 024

Alternatives evaluation for Eastside separation indicated that there is available capacity in the upstream portion of the Shetucket Interceptor. To improve Shetucket River water quality, NPU proposes modifying the CSO 024 regulator to attain 2-year control. The existing 100-foot long, 12-inch to 18-inch diameter dry weather flow pipe, shown in Figure 7-4, would be replaced with a 30-inch pipe. The pipe would have to be jacked under railroad tracks to connect to a new junction structure to be constructed on the Shetucket Interceptor. The larger connection to the interceptor would yield 2-year control when made in conjunction with raising the overflow weir from 31.0 to 33.1 feet (NAVD88).

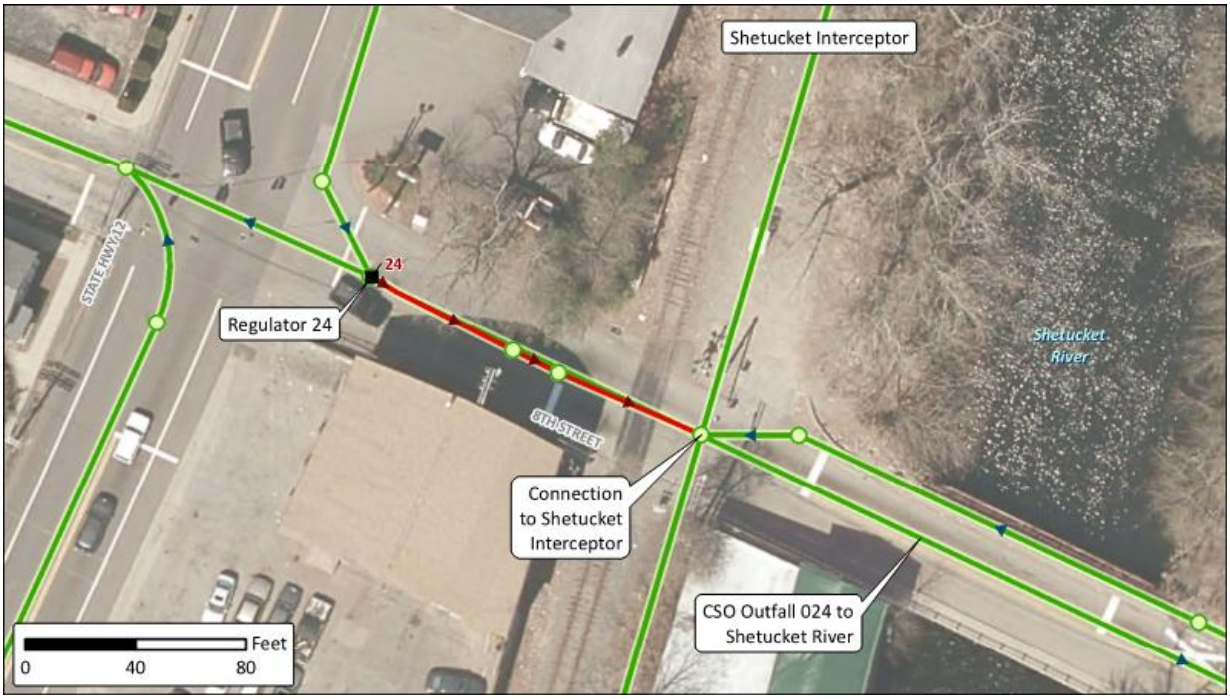


Figure 7-4
Plan View Showing Combined Sewer Pipes from the Regulator to CSO 024 to the Shetucket Interceptor (red)

Site storage and separation of the upstream tributary combined sewer area were also considered. However, there are no available storage sites near CSO 024. Separation of this densely developed area would be disruptive and expensive. If combined with CSO closure, it would likely increase the risk of excessive surcharge, flooding and backups in large storms.

CSOs 024 and 025 are the most upstream overflows along the Shetucket. With the improvements discussed above, 2-year control would be achieved along the half-mile reach shown in Figure 7-5. CSO along this section of river would be dramatically reduced from its current frequency of 60 events per year.

7.3.3 CSO Regulator Modifications

As discussed in Section 5, regulator modifications are a low-cost method of retaining more flow in the collection system and providing CSO reduction. Model simulations indicate that CSO reduction could be achieved if weirs were raised by approximately 6 inches (actual modifications range from 3-inches to 8-inches, depending on the location) at CSO regulators 4, 5, 18, 19-1, 19-2, 21, 22, 23, 29, and 40. Weirs cannot be safely raised at CSO regulators 17-1, 17-2, 31, and 32. Regulators 17-1 and 17-2 are the most downstream relief in the combined sewer system. Without further WPCF improvements, adjusting these regulators would cause adverse system impacts. Regulator 31 consists of a high outlet pipe with a raised invert rather than a weir and could not be readily modified. The weir at regulator 32 is already 2.5 ft higher than the dry weather flow pipe and could not be readily raised in this round of system improvements. The weirs at regulators 24 and 25 will be modified as discussed above. Raising weir height also provides the opportunity for NPU to repair any structural deficiencies that may contribute to CSO discharges. Increasing the size of the dry weather flow connector pipes may provide additional CSO benefit. Such work is considered as part of individual alternatives described in Section 8.

7.4 Summary

The Consent Order requires NPU to implement a proposed Eastside separation project. However, model simulations indicated that if CSO 025 were closed in conjunction with separation, remaining extraneous wet weather flow would cause excessive and dangerous surcharge. Other alternatives to achieve 2-year Eastside CSO control were thus evaluated.

System optimization improvements were also considered. Based on analyses described above, NPU identified four initial system improvement projects that can implemented in the near future to help reduce CSO. One project would be completed in lieu of the proposed Eastside sewer separation project. DEEP has already tentatively provided favorable comment this modification. As a result, the “Planned Projects” include:

1. At CSO 025, installation of 780 feet of 24-inch (or equivalent) pipe across the bridge from the regulator to the Shetucket Interceptor to replace the undersized 8-inch and 12-inch pipe segments and raise the 025 weir to attain 2-year control;

2. At CSO 024, installation of 100 feet of 30-inch pipe to replace the existing connector from the regulator to the Shetucket Interceptor and raise the 024 weir attain 2-year control;

3. Installation of SCADA controls to improve Rose Alley PS operations and maximize wet weather flow to the WPCF; and

4. Raising weirs at select regulators as described above.

Implementation of the above will reduce average annual CSO by 30 percent from 43 Mgal to 30 Mgal and reduce system wide annual overflow from 60 to 48 events, as summarized in Table 7-1.

Table 7-1: Average Annual CSO Reduction with Proposed Eastside and System Optimization Projects[1]

	CSO Volume (Mgal)		Event Duration (hrs)		Events	
CSO	Baseline Conditions	Planned Projects[2]	Baseline Conditions	Planned Projects	Baseline Conditions	Planned Projects
004	0.93	1.16	53	46	25	23
005	0.16	0.19	28	26	15	13
017	25.92	19.11	218	152	50	48
018	2.27	2.08	200	163	45	44
019	2.27	2.06	153	117	42	37
021	0.18	0.11	12	13	13	11
022	1.03	0.67	112	46	36	24
023	4.2	3.7	210	155	46	42
024	3.68	0.06	255	<1	51	<1
025	2	0.02	355	<1	60	<1
029	0.02	0.01	3	0	5	1
031	0.45	0.65	30	30	14	16
032	0.19	0.21	5	6	8	8
040	0.01	0.01	<1	<1	1	<1
Total	**43.3**	**30.0**	**355**	**163**	**60**	**48**

Notes: 1) Statistics based on three-year simulation. Overflow increases slightly at some locations
2) These projects are referred to as "proposed" above, but are redefined below as the "Planned Projects"

The statistics presented in Table 7-1 include proposed RTC at Rose Alley PS and assume that 20 mgd can be reliably treated at the WPCF during wet weather. While the plant has treated up to 20 mgd, it is not known whether this can be consistently sustained given its current condition. Section 8 identifies proposed plant improvements that would be necessary to ensure reliable treatment up to 20 mgd. In the interim, if NPU determines that operating the WPCF at 20 mgd would cause significant operational issues, there would be less CSO reduction than presented in Table 7-1 until the proposed WPCF projects are implemented. The improvements also significantly reduce total CSO duration on an average annual basis. By replacing the (ineffective) Eastside separation projects required by the Consent Order with these four projects, NPU can achieve nearly three times the CSO benefit (improving from 0.28 Mgal reduction to 0.8 Mgal reduction in the 2-year storm). Given their wide reaching benefit and applicability to all future work, these projects are included in all subsequent alternatives and are referred to as the "Planned Projects".

Section 8 reviews the Consent Order requirement to implement Thamesville CSO reduction.

Norwichtown
Yantic
Falls Mill PS
Yantic Interceptor
Downtown
Greeneville
Shetucket Interceptor
Victoria Landing PS
See Note 1
Washington St PS
WPCF
City Hall PS
Falls Ave PS
Cove St PS
Shetucket River
Talman St PS
Westside
Rose Alley PS
Court House Sq PS
Route 2 Corridor
Salem Tpke Interceptor
Market St PS
Norwich Harbor
South Thames St PS
Summit Wood Apt PS
Stonington Estates PS
River Ave PS
Edgewood Dr PS
Potter Pl PS
Thamesville
Shipping St PS
Laurel Hill Interceptor
Thamesville Interceptor
Laurel Hill
Uncas Condos #1 PS
Uncas Condos #2 PS
Thames River
Shore Rd PS
22
23
21
19-1
19-2
18
17-1
17-2
29
5
4
31
32
40
24
25

Note 1: The proposed Planned Projects control CSO from outfalls 024 and 025 for storms up to and including the 2-Year design storm. This will remove CSO in the 2-Year storm from approximately 2,500 feet of the Shetucket River between CSOs 024 and 025 downstream to CSO 023 as shown.

1 inch = 1,250 feet

Feet

0 625 1,250

N

CDM Smith

Legend

- CSO Overflow Regulator
- CSO Outfall
- Gravity Pipe
- Force Main
- Pump Stations (Norwich Public Utilities)
- Pump Stations (Private)
- Water Pollution Control Facility
- Sewershed Boundary

2018 Long Term Control Plan
Norwich Public Utilities
Figure 7-5
Planned Projects

Section 8

This section has been superseded by the revised 2020 CSO LTCP Report.

Section 8
Alternatives Evaluation

8.1 General

8.1.1 Introduction

Section 5 described available combined sewer overflow (CSO) control technologies and identified those most appropriate for application in Norwich. Section 6 discussed how sewer separation in particular could be implemented in Norwich, and the expected impact of its implementation on CSO and collection system function. This section builds on those discussions by presenting how selected CSO technologies can be strategically implemented in combination with one another to create a comprehensive CSO control plan.

This Section of the report is organized to follow the development of alternatives. First, multiple CSO management strategies are identified for each area of the city. Then, the effectiveness of each strategy for CSO reduction is assessed. Effective solutions in each area of the city are then combined into comprehensive alternatives for systemwide CSO control. In accordance with the United States Environmental Protection Agency (EPA) guidance manual for developing long-term control plans (LTCPs), CSO control alternatives were developed for 1-month, 3-month, 6-month, 1-year, 2-year, and 5-year design storms.

After hydraulic effectiveness and performance statistics are developed, project costs, construction and environmental impacts, and CSO benefits achieved by implementing each design storm control strategy are also identified. Alternatives are then evaluated based on community impacts, constructability, operation & maintenance (O&M) considerations and cost effectiveness for managing CSO. Performance summary tables and cost summary tables are presented towards the end of this Section. Top performing plans are then selected for evaluation in Section 9, and Section 10 will select the Recommended Plan. The Recommended Plan will ultimately be the one that achieves the highest level of control that NPU can afford over a reasonable planning period (assumed to be 30 years as beyond this duration, CSO technology, economics, demographics, and other key factors are highly uncertain).

8.1.2 Alternatives Development

Section 5 identified LTCP technologies not currently practiced by NPU that could reduce CSO. These technologies were further assessed as part of alternatives development. They include:

- Sewer separation, consisting of area drain and leader disconnection, sewer separation, and infiltration/inflow control;
- Inline and offline storage;
- Increased conveyance including larger and supplemental pipes, larger pumping stations, regulator modifications, regulating devices and backwater gates;

- Increased capacity to accept wet weather flow at the Water Pollution Control Facility (WPCF) through addition of enhanced high-rate clarification and disinfection; and
- Combinations of each of the above to achieve the best fit for any given area.

CSO control strategies were first developed separately for Thamesville, Laurel Hill, and the Shetucket Interceptor sewersheds. These are the three hydraulically distinct sections of the system with combined sewers. The Shetucket Interceptor serves Greeneville, Downtown, and the Eastside. CSO control for the Eastside area was addressed in Section 7 via the "Planned Projects" that serve as the foundation for all alternatives discussed in this Section 8.

Combined and separate sewer flows from Thamesville are conveyed directly to the WPCF via Shipping Street Pumping Station (PS) and South Thames Street PS. The Shetucket Interceptor conveys combined and separated flows from Eastside, Greeneville, and Downtown to Rose Alley PS. The Laurel Hill Interceptor collects combined and separated flow from the Laurel Hill area and discharges it to the lower Shetucket Interceptor (via the River Avenue PS) just upstream of Rose Alley PS. The Rose Alley PS conveys flow directly to the WPCF via a force main which also receives flow from Market Street PS. The WPCF also receives flow directly from the Yantic and Westside separated areas via Yantic Interceptor and Cove Street PS respectively. CSO control strategies focused on alternatives for the areas of the city with combined flows.

CSO control strategies could be considered for each section of the city in isolation due to the divided hydraulic nature of the system. These separate solutions are then combined to achieve citywide control. When the solutions are merged, the effects on downstream conditions must be considered. For example, since Laurel Hill and the area tributary to the Shetucket Interceptor both drain to Rose Alley PS, Rose Alley's capacity to pump flow from both areas must be considered. The WPCF's capacity to accept flow is a consideration for increased conveyance options for all three areas.

The WPCF was evaluated with two future flow capacity scenarios. In the first scenario, the WPCF receives necessary upgrades, secondary treatment capacity is expanded from 17 million gallons per day (mgd) to 20 mgd, and the sewer collection system is managed within this constraint. In the second scenario, WPCF wet weather capacity is increased to a total of 80 mgd (20 mgd through secondary and an additional 60 mgd through a new wet weather treatment process) and each sewershed can deliver increased flow. For every alternative, consideration was given to which area of the city had priority for sending flow directly to the WPCF versus areas that should detain or reduce flow to free capacity at the WPCF for flow from other parts of the city. Citywide CSO control alternatives were developed to manage CSO to each of the six design storms. To manage CSO in each area, four broad CSO control strategies were considered as discussed below.

- Complete citywide public and private separation – extensive public and private sewer separation throughout the entire sewer system would include areas that are currently categorized as having sanitary sewers. The result would be dedicated sanitary sewers and a complete storm drainage system conveying all public and private inflow, as described in Section 6.

- Local public inflow removal – This alternative removes stormwater from the collection system by disconnecting catch basins currently draining to the combined sewer system, as described in Section 6. This alternative reduces CSO in targeted areas and can be implemented in conjunction with other CSO control technologies to mitigate CSO.
- Conveyance to the WPCF – This alternative conveys all sewer system flow to the WPCF. This alternative requires upgrading the WPCF to treat up to 80 mgd.
- Storage – This alternative stores peak wet weather flow at strategic locations in the system and maintains existing conveyance to the WPCF.

Combination or hybrid approaches were also developed as described later in this Section.

8.2 Thamesville

Three CSOs serve Thamesville:

- Furthest south, at the upgradient end of the system, CSO 040 relieves Shipping Street PS.
- CSO 004 relieves flow from Route 32/West Thames Street that cannot be conveyed into the Shipping Street force main (FM).
- CSO 005, the northernmost relief point, is triggered when flow exceeds capacity at the South Thames Street PS.

Table 8-1 presents Thamesville design storm CSO statistics after completion of the Planned Projects described in Section 7. The Planned Projects will control CSO 040 up to the 1-year design storm. Total peak discharge for the three CSOs ranges from 2 to 18 mgd, while CSO volume ranges from 0.01 to 0.51 million gallons (Mgal).

Table 8-1 Thamesville CSO Statistics After Completion of Planned Projects

CSO Statistics	Design Storm	CSO 004	CSO 005	CSO 040	Thamesville Total	System Total
CSO Peak Flow (mgd)	1-month	1.8	0.2	0	2.0	25
	3-month	4.7	0.6	0	5.3	52
	6-month	7.7	1.0	0	8.7	86
	1-year	8.9	1.8	0	11	99
	2-year	10.3	2.1	<0.1	12	114
	5-year	15.0	2.3	0.9	18	152
CSO Volume (Mgal)	1-month	0.01	<0.01	0	0.01	0.49
	3-month	0.05	0.01	0	0.06	1.24
	6-month	0.11	0.02	0	0.13	2.38
	1-year	0.18	0.04	0	0.22	3.54
	2-year	0.31	0.08	<0.01	0.39	5.10
	5-year	0.40	0.10	0.01	0.51	5.79

8.2.1 Necessary Upgrades

Some components of the combined sewer system in Thamesville require upgrades to correct deficiencies. These upgrades are incorporated into each alternative. The upgrade of Shipping Street PS and FM is part of every control plan. As discussed in Section 2, these facilities are old and require immediate repair. The pump capacity required to pass the full wet weather flow exceeds current capacity in the 6-month design storm. Shipping Street FM parallels a railroad along the west bank of the Thames River. NPU staff recall that the pipe proved challenging to access and repair when there was a FM break some years ago. Due to the difficult construction encountered previously along the railroad, removal and replacement of the Shipping Street FM in its current location is not possible. Additionally, the FM currently accepts two gravity connections, which is a challenging hydraulic configuration. All alternatives, therefore, propose upgrading Shipping Street PS, abandoning the existing FM along the railroad, and installing a new FM up Shipping Street and Route 32 until a high point where the FM can discharge to a new gravity sewer. The gravity sewer will connect to an existing manhole near the intersection of West Thames Street and Cahoon Street. Sewer laterals from properties along the Thames River that connect to the existing Shipping Street FM will be redirected to the new FM discharging to a new gravity line in Route 32.

Due to the change in direction and magnitude of flow coming from southern Thamesville, additional system modifications will be required near CSOs 004 and 005. The manhole into which the new gravity line down West Thames Street will tie will be converted into a new, intra-system regulator, replacing existing regulator 4. Under existing conditions, this manhole in Route 32 directs flow to regulator 4. High flows overtop the weir and discharge to CSO 004 while dry weather flow drains into the existing Shipping Street FM (Figure 8-1). With the abandonment of this FM, dry weather flow pipes from the existing regulator will be disconnected from the FM and instead connect to the 10-inch sewer in South Thames Street. These dry weather flow pipes are undersized and difficult to access due to their location on a hillside at a residential property. Rather than enlarge these pipes to accommodate increased flow from Shipping Street, regulator 4 will be relocated to Route 32 to route flow away from the existing regulator and down West Thames Street instead via a new gravity pipe. The regulator weir and relief pipe size can be set to pass all flow and manage CSO 004 to the desired control level. The existing regulator 4 will be converted into a standard manhole to convey overflow to CSO 004. Dry weather flow pipes extending from the existing regulator will be sealed so that they only collect sanitary flow from three properties that currently tie into this portion of the system. Figure 8-2 summarizes the proposed relocation of regulator 4 and the surrounding reconfiguration.

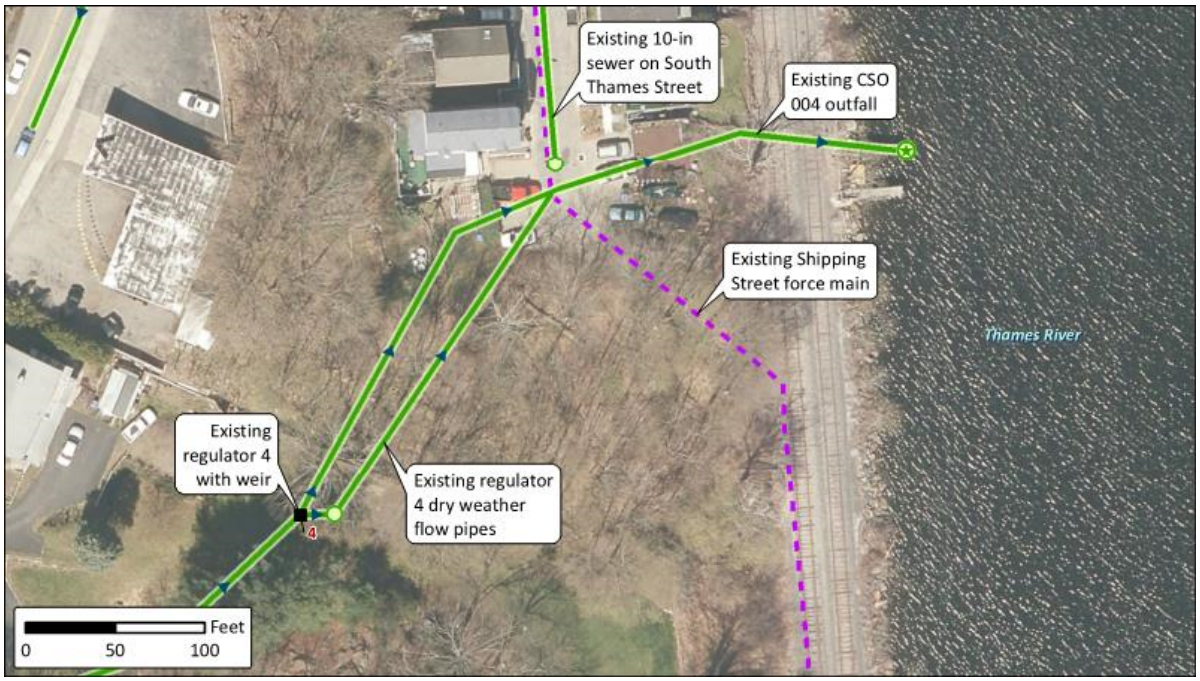


Figure 8-1
Existing Configuration of Pipes Around Regulator 4

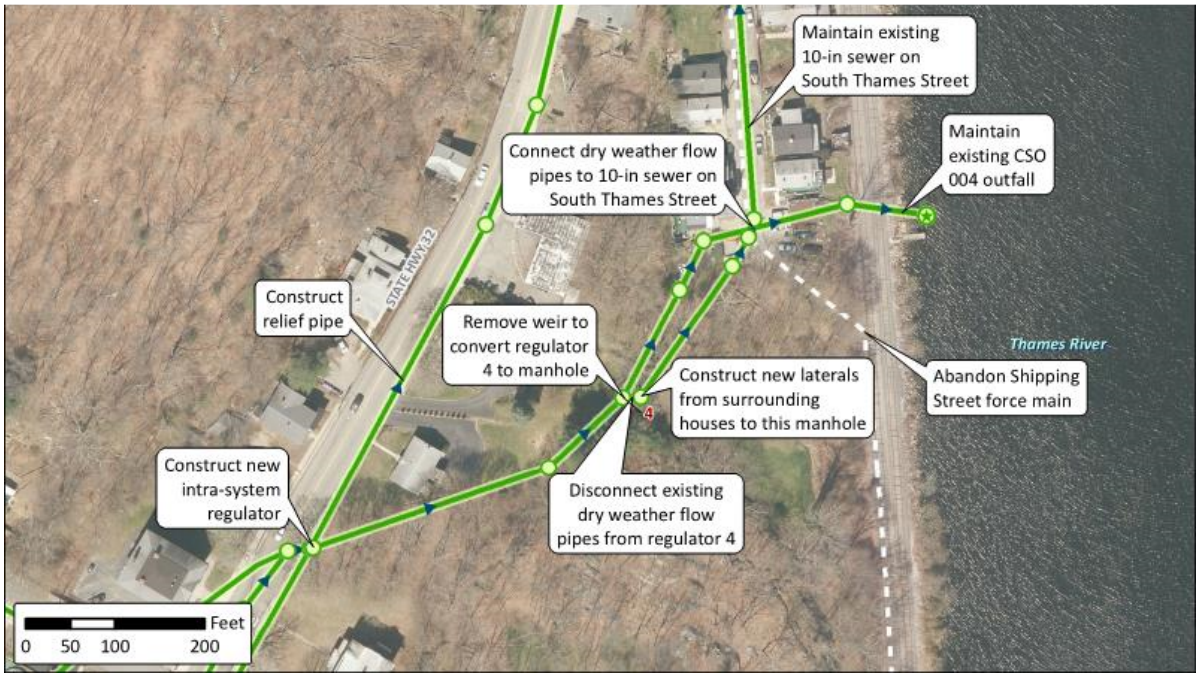


Figure 8-2
Relocation of Regulator 4 and Associated Reconfiguration of Downstream System

Flow from the new West Thames Street gravity pipe and from the South Thames Street 10-inch sewer will converge at a central location downstream. Depending on the alternative and the level of control the alternative aims to achieve, flow will either be pumped directly to the WPCF or will flow to an inline storage tank to be released after the peak flow recedes at the WPCF.

8.2.2 Separation

Section 6 describes the effectiveness of citywide complete public and private separation in Norwich and local public inflow removal in Thamesville.

8.2.2.1 Complete Public and Private Separation

Complete removal of public and private inflow is expected to control through the 5-year storm. This level of separation is both costly and difficult to guarantee, as impediments to complete separation may reduce effectiveness. For example, complete separation depends on the willingness of each homeowner to approve work on private property to disconnect roof leaders and yard drains and/or install new sewer laterals. Furthermore, if complete separation is accompanied by closure of overflows, sanitary sewer overflow (SSO) and basement flooding may occur during large storms, posing public health risks.

8.2.2.2 Local Public Inflow Removal

Local public inflow removal in Thamesville was identified in Section 6 as a feasible option for cost-effective CSO mitigation. The reduction in CSO allows remaining flow to be managed with smaller, lower cost, supplementary technologies. Thamesville is a medium density, suburban area. Construction to separate public inflow may be less disruptive and costly than in more densely developed areas of the city. Public inflow removal in Thamesville is expected to control CSO 004 to a 1-month storm and CSO 005 to a 3-month storm, while CSO 040 would be controlled through the 5-year storm (Table 8-2). The collection system model estimates that public inflow removal will reduce CSO volume in the 2-year storm by 62 percent and peak flow by 78 percent.

Table 8-2 CSO Statistics with Public Inflow Removal in Thamesville as Compared to Future Baseline CSO Statistics

CSO Statistics	Design Storm	CSO 004	CSO 005	CSO 040	Total	Future Baseline	Reduction
CSO Peak Flow (mgd)	1-month	0.0	0.0	0.0	0.0	2	100%
	3-month	0.9	0.0	0.0	0.9	5	83%
	6-month	2.5	0.4	0.0	2.9	9	66%
	1-year	3.1	0.6	0.0	3.7	11	66%
	2-year	3.9	0.7	0.0	4.6	12	62%
	5-year	5.9	1.0	0.0	6.9	18	62%
CSO Volume (Mgal)	1-month	0.00	0.00	0.00	0.00	0.01	100%
	3-month	0.01	0.00	0.00	0.01	0.06	91%
	6-month	0.02	0.00	0.00	0.03	0.13	80%
	1-year	0.03	0.01	0.00	0.04	0.22	81%
	2-year	0.06	0.03	0.00	0.09	0.39	78%
	5-year	0.09	0.03	0.00	0.13	0.51	75%

8.2.3 Conveyance

To convey total flows in Thamesville to the WPCF, the Shipping Street and South Thames Street pump stations must be upgraded, and pipe capacity must be increased. As described in Section 8.2.1, Shipping Street PS and FM urgently need repair and replacement. All alternatives include

upgrading Shipping Street PS, abandoning the existing FM along the Thames River, and installing a new FM up Shipping Street and Route 32. Multiple other changes in configuration are necessary downstream to accommodate the new capacity and direction of the Shipping Street FM.

The existing Shipping Street PS has a maximum pumping capacity of 3.3 mgd and a 12-inch FM leaving the station. For the 1-month to 2-year level of control, the recommended upgrade would have a 3.5 mgd capacity and a 12-inch FM. A 3.5 mgd PS was selected to provide a small increase in capacity that when combined with regulator and dry weather flow connector modifications, would provide a 2-year level of control at CSO 040. To achieve a 5-year level of control, Shipping Street PS must be enlarged to a capacity of 7 mgd with an 18-inch FM.

The South Thames Street PS has an existing 4.2 mgd capacity that would need to be upgraded to 5 mgd to convey the 1-month storm. It is expected that the existing PS could be upgraded in place to 5 mgd. The existing 12-inch FM from the PS to the WPCF is still adequate to pass the minor increase in flow from the PS. Flow from the new West Thames Street relief pipe is directed to the upgraded South Thames Street PS. The relief pipe must have a 15-inch diameter to convey the peak flows in a 1-month storm. The South Thames Street 10-inch sewer conveys flows to the South Thames Street PS under existing conditions and does not need to be replaced for 1-month control. The 1-month conveyance configuration in Thamesville is summarized in Figure 8-3.

Figure 8-3
Configuration of 1-Month Conveyance Alternative in Thamesville

Starting with the 3-month storm, peak flows reaching the South Thames Street PS require more pumping capacity than the PS could be upgraded in place to support. The PS must be relocated to a location with additional land area available for a larger PS. Appendix B identifies the potential locations for storage tanks in each part of the city. The best location for a storage tank in Thamesville is on a vacant lot on the eastern side of Thames Street, north of a condominium complex. This is also the most suitable location for a larger PS in Thamesville. For the 3-month

through 5-year storms, a PS and FM of varying sizes are proposed on this lot to pump flows from Thamesville directly to the WPCF.

For the 3-month through 5-year storms, the relief pipe down West Thames Street would be constructed to convey flows to the new PS, rather than to the existing South Thames Street PS, as in the 1-month storm configuration. The existing PS would be abandoned and flows that are currently connected to the PS (the 10-inch sewer on South Thames Street and flow from Mopsic Street to the north) would be conveyed to the new PS via new pipes running between the condominiums and the Thames River. The sizes of relief pipes and the conveyance pipes from the existing PS increase with increasingly intense design storms. The configurations of the 3-month through the 5-year conveyance alternatives are the same and are summarized in Figure 8-4. Sizes of the PS and pipes are not included in the figure but are summarized in Table 8-3.

Figure 8-4
Configuration of 3-Month through 5-Year Conveyance Alternatives in Thamesville

Table 8-3 Size of Main Components of the Thamesville Conveyance Alternative

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Shipping Street PS (mgd)	3.5	3.5	3.5	3.5	3.5	7
Shipping Street FM (diameter, inches)	12	12	12	12	12	18
West Thames Street Relief Pipe (diameter, inches	15	21	24	24	24	30
South Thames Street PS (Existing Location, mgd)	5	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned
Relocated PS (mgd)	NA	10	14	15	16	23
South Thames Street FM (diameter, inches)	12	18	20	24	24	30

8.2.4 Storage

Another method of CSO control evaluated in Thamesville was storing sewer flow until the peak flow has passed the WPCF. A storage tank is needed for the 3-month through 5-year levels of control. As described in Section 8.2.1, Shipping Street PS and FM are in urgent need of repair and replacement. All alternatives include upgrading Shipping Street PS, abandoning the existing FM along the Thames River, and installing a new FM up Shipping Street and Route 32. Multiple other changes in configuration are necessary downstream to accommodate the new capacity and direction of the Shipping Street FM.

For the 1-month storm, total system sewer flows are low enough that Thamesville flows can be conveyed directly to the WPCF with no storage. Shipping Street PS is upgraded to a capacity of 3.5 mgd with a 12-inch FM from the 1-month to the 2-year level of control. The existing Shipping Street PS has a maximum pumping capacity of 3.3 mgd and a 12-inch FM leaving the station. For the 1-month to 2-year level of control, the recommended upgrade would have a 3.5 mgd capacity and a 12-inch FM. A 3.5 mgd PS was selected to provide a small increase in capacity that when combined with regulator and dry weather flow connector modifications, would provide a 2-year level of control at CSO 040. To achieve a 5-year level of control, Shipping Street PS must be enlarged to 7 mgd with an 18-inch FM.

Achieving the 1-month level of control in Thamesville under the storage configuration requires the same components as the 1-month conveyance scenario. Shipping Street PS and FM would need to be upgraded as described above, South Thames Street PS would need to be upgraded in place to 5 mgd, and the West Thames Street 15-inch new sewer would also be required. Figure 8-3 shows this identical 1-month control layout.

In the 3-month and larger storms, managing Thamesville CSO by increasing its conveyance to the WPCF would limit the plant's capacity to accept flow from other parts of the system. A Thamesville storage tank is therefore needed to detain flows during the peak of the storm. As described in Appendix B, based on preliminary research the best storage location in Thamesville is the vacant lot on the eastern side of Thames Street, north of a condominium complex. For the 3-month through 5-year storms, an inline storage tank of varying capacity is proposed on this lot to store combined sewer flow until the WPCF passes the peak flow and has sufficient capacity to receive additional flow. A 4 mgd pump from the tank is proposed for the 3-month through 2-year storms to maintain approximately the same flow rate from Thamesville to the WPCF as under existing conditions. The dewatering pump would connect to a new FM (diameter varies by level of control), which would run parallel to the existing FM to the WPCF. Dry weather flows would be pumped continuously through the tank without filling. During rain events, the pump rate would be reduced, allowing the tank to fill. This can be accomplished via a real-time control relating the dewatering pump rate to flows at another location in the system, either upstream flows or directly at the WPCF. As discussed in Appendix B, the maximum size storage tank that could fit at this location is estimated at 0.63 Mgal. The maximum size storage tank is not needed until the 1-year storm. In the 5-year storm, flows reach 23 mgd and would overwhelm the 0.63 Mgal storage tank. To prevent the tank from flooding, the dewatering pump would have to be increased to 9 mgd with an 18-inch FM.

For the 3-month through 5-year storms, the relief pipe down West Thames Street would be constructed to convey flows to the storage tank, rather than to the existing South Thames Street PS, as in the 1-month storm. The existing PS would be abandoned and flows that are currently connected to the PS (the 10-inch sewer on South Thames Street and flow from Mopsic Street to the north) would be conveyed to the storage facility via new pipes running between the condominiums and the Thames River. The sizes of relief pipes and the conveyance pipes from the existing PS increase with increasingly intense design storms. The configurations of the 3-month through the 5-year storage alternatives are the same as one another and are summarized in Figure 8-5. Sizes of the storage tank, pump, and pipes are not included in the figure but are summarized in Table 8-4.

Figure 8-5
Configuration of 3-Month through 5-Year Storage Alternatives in Thamesville

Table 8-4 Size of Main Components of the Thamesville Storage Alternative

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Shipping Street PS (mgd)	3.5	3.5	3.5	3.5	3.5	7
Shipping Street FM (diameter, inch)	12	12	12	12	12	18
West Thames Street Relief Pipe (diameter, inch)	15	21	24	24	24	30
South Thames Street PS (Existing Location, mgd)	5	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned
Storage Tank (Mgal)	NA	0.3	0.4	0.6	0.6	0.6
Storage Tank Dewatering Pump (mgd)	NA	4	4	4	4	9
South Thames Street FM (diameter, inch)	12	12	12	12	12	18

8.3 Laurel Hill

Flow from the southern portion of Laurel Hill are collected at River Avenue PS and conveyed to the north end of Laurel Hill. The FM then merges with flows from northern Laurel Hill, and the total sewer flow is conveyed over a bridge to the Shetucket Interceptor, just upstream of Rose Alley PS. There are three overflows located in Laurel Hill. CSOs 031 and 032 discharge into the Thames River and are located approximately 1,000 ft from each other. These overflows serve to protect the River Avenue PS, which is located between the two regulators. The pipes conveying flow from the regulators to River Avenue PS run between a rail road and a steep hillside, limiting access. CSO 029 is located in the northern end of Laurel Hill near the intersection of Talman Street and Winchester Place. Flows that pass regulator 29 merge with the FM from River Avenue PS before being piped over a railroad bridge to the Shetucket Interceptor. Table 8-5 presents CSO statistics for the design storms after completion of the planned projects described in Section 7. With completion of the planned projects, the collection system model simulates that CSO outfall 029 will be managed to the 1-year level of control and CSO outfall 032 will be managed at the 1-month level of control. Peak Laurel Hill CSO flows range from 0.4 mgd in the 1-month storm to 19 mgd in the 5-year storm while CSO volumes range from <0.01 Mgal in the 1-month storm to 0.39 Mgal in the 5-year storm.

Table 8-5 Laurel Hill CSO Statistics

CSO Statistics	Design Storm	CSO 029	CSO 031	CSO 032	Laurel Hill Total	System Total
CSO Peak Flow (mgd)	1-month	0	<1	0	<1	25
	3-month	0	2	1	3	52
	6-month	0	5	4	9	86
	1-year	1	6	5	11	99
	2-year	1	6	6	13	114
	5-year	2	8	9	19	152
CSO Volume (Mgal)	1-month	0.00	<0.01	0.00	<0.01	0.49
	3-month	0.00	0.03	0.01	0.04	1.24
	6-month	0.00	0.07	0.03	0.10	2.38
	1-year	<0.01	0.11	0.05	0.16	3.54
	2-year	<0.01	0.20	0.08	0.28	5.10
	5-year	0.02	0.24	0.13	0.39	5.79

8.3.1 Necessary Upgrades

Some components of the combined sewer system in Laurel Hill require upgrades to correct deficiencies. As discussed in Section 2, the River Avenue PS and FM need immediate repair. The collection system model indicates inflows exceed River Avenue PS capacity even in the 1-month design storm. The River Avenue FM suffered a recent break in May 2018, highlighting the need for an upgrade of the FM as well. Due to the inadequacy of this existing infrastructure, all alternatives include an upgrade of River Avenue PS and the construction of a new FM. The size and route of the new FM varies between alternatives and levels of control.

8.3.2 Separation

Section 6 describes the effectiveness of citywide separation in Norwich and local public inflow removal in Laurel Hill.

8.3.2.1 Complete Public and Private Inflow Separation

Complete public and private separation is expected to achieve CSO control through the 5-year storm. This level of separation is both costly and difficult to guarantee, as impediments to complete separation may reduce the effectiveness. For example, complete separation will depend on the willingness of each homeowner to approve work on private property to disconnect roof leaders and yard drains and/or install new sewer laterals. If complete separation is accompanied by the closure of overflows, SSOs may occur during very large storms, creating a public health risk.

8.3.2.2 Local Public Inflow Removal

Local public inflow removal in Laurel Hill was identified in Section 6 as one option for reducing CSO volumes to a limited extent. The reduction in CSO allows remaining flows to be managed with smaller, lower cost, supplementary technologies. Laurel Hill is a medium density, suburban area. Construction to separate public inflow may be less disruptive and costly than in more densely developed areas of the city. Construction in Laurel Hill is, however, challenging due to steep slopes and the presence of pipes adjacent to railroad tracks and the Thames River floodway.

Public inflow removal in Laurel Hill is expected to control CSOs 031 and 032 to a 3-month level of control and to control CSO 029 through the 5-year level of control (Table 8-6). The collection system model estimates that public inflow removal will reduce CSO volume in the 2-year storm by 74 percent and peak flow by 70 percent.

Table 8-6 CSO Statistics with Public Inflow Removal in Laurel Hill as Compared to Future Baseline CSO Statistics

CSO Statistics	Design Storm	CSO 029	CSO 031	CSO 032	Total	Future Baseline	Reduction
CSO Peak Flow (mgd)	1-month	0.0	0.0	0.0	0.0	0.1	100%
	3-month	0.0	0.0	0.0	0.0	3	100%
	6-month	0.0	1.7	0.5	2.2	9	75%
	1-year	0.0	2.2	1.0	3.2	11	71%
	2-year	0.0	2.5	1.5	4.0	13	70%
	5-year	0.0	4.0	3.6	7.6	19	60%
CSO Volume (Mgal)	1-month	0.00	0.00	0.00	0.00	0.1	100%
	3-month	0.00	0.00	0.00	0.00	0.04	100%
	6-month	0.00	0.02	0.00	0.02	0.1	80%
	1-year	0.00	0.03	0.01	0.04	0.16	76%
	2-year	0.00	0.06	0.01	0.07	0.28	74%
	5-year	0.00	0.08	0.04	0.12	0.39	69%

8.3.3 Conveyance

To convey total flow from Laurel Hill to the Shetucket Interceptor and Rose Alley PS, River Avenue PS must be upgraded, and conveyance pipes must be replaced with larger pipes. Since CSOs 031 and 032 serve to relieve River Avenue PS, the PS must be upgraded to a larger capacity to avoid overflows at these discharge locations. The required sizes of River Avenue PS and FM increase with larger design storms. Depending on the design storm to be controlled, some of the dry weather flow connector pipes from regulators 31 and 32 to River Avenue PS must also be enlarged to convey the total flows. Enlarging these dry weather flow pipes is not trivial as they are located between a railroad and a steep hill side. In each alternative, the length of pipe along this stretch to be replaced was kept as low as possible while maintaining acceptable levels of surcharge. With increased flows coming from River Avenue PS, the pipe conveying total Laurel Hill flows to the Shetucket Interceptor becomes overwhelmed. This pipe must be enlarged starting in the 6-month storm to reduce surcharge and avoid overflow at CSO 029. To convey the 5-year storm, one of the dry weather flow connector pipes downstream of regulator 29 must also be enlarged. The overall configuration of the conveyance alternatives for all design storms in Laurel Hill is the same and is depicted in Figure 8-6. The sizes of the components vary by design storm and are summarized in Table 8-7.

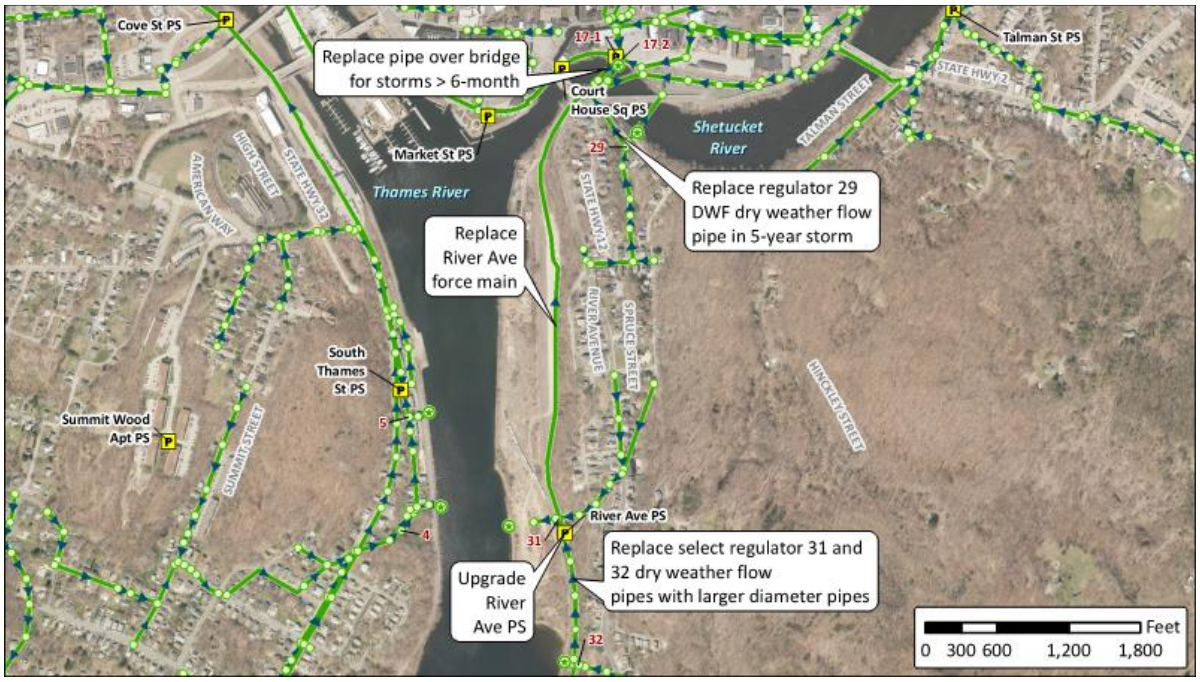


Figure 8-6
Configuration of Conveyance Alternatives in Laurel Hill

Table 8-7 Principal Components of Laurel Hill Conveyance Alternative

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
River Ave PS (mgd)	4	4	10	10	12	18
River Ave FM (diameter, inches)	14	14	20	18	20	24
Pipe replacement along Railroad (length, feet)	31	141	141	141	743	953
Pipe over Bridge to Shetucket Interceptor (diameter, inches)	As-is	As-is	30	30	30	30

8.3.4 Storage

To store flow in Laurel Hill until the peak flow has passed the Rose Alley PS downstream, a storage tank is needed for the 6-month through 5-year levels of control. Flows from Laurel Hill in the 1-month and 3-month storms are low enough that they can be conveyed directly to the Shetucket Interceptor and Rose Alley PS without storage. As was done for the conveyance alternatives, CSO at 031 and 032 can be controlled by upgrading River Avenue PS, replacing the FM, and enlarging dry weather flow pipes from regulators 31 and 32 (Figure 8-7).

Figure 8-7
Configuration of 1-Month and 3-Month Storage Alternatives in Laurel Hill

As the flow rate that must be pumped from River Avenue PS to achieve higher levels of control increases, the Shetucket Interceptor and Rose Alley PS become overwhelmed. Starting at the 6-month level of control, some storage in Laurel Hill is necessary to detain peaks. As discussed in Appendix B, two potential storage locations were considered:

- The floodway between the rail road and the Thames River, across the railroad tracks from the existing River Avenue PS
- A park at the intersection of Laurel Hill Avenue and Center Street. The park area was identified as the better alternative due to the challenging construction that would be encountered working adjacent to a railroad and in a floodway.

For the 6-month and larger storms, the River Avenue PS will be upgraded to pump higher flows and the FM will be re-routed up River Avenue to the park site. The FM will discharge before the park into a gravity line, allowing the storage tank to be operated off-line. A sluice gate operated by real time controls (RTC) is proposed in the gravity line to allow low flow to bypass the storage tank and continue down Laurel Hill Avenue to the Shetucket Interceptor via the bridge. During rain events, the sluice gate will close to send all flow to the storage tank. A 1 mgd pump will dewater the tank as capacity becomes available downstream. Figure 8-8 summarizes the overall configuration of the 6-month through 5-year storage alternatives in Laurel Hill. Figure 8-9 provides additional detail on the proposed configuration around the storage tank.

The main components that vary in Laurel Hill are the length of pipe adjacent to the rail road that must be replaced, the size of River Avenue PS and FM, and, when storage is required, the size of the storage tank, dewatering pump, and gravity line down Laurel Hill Avenue. These are summarized in Table 8-8.

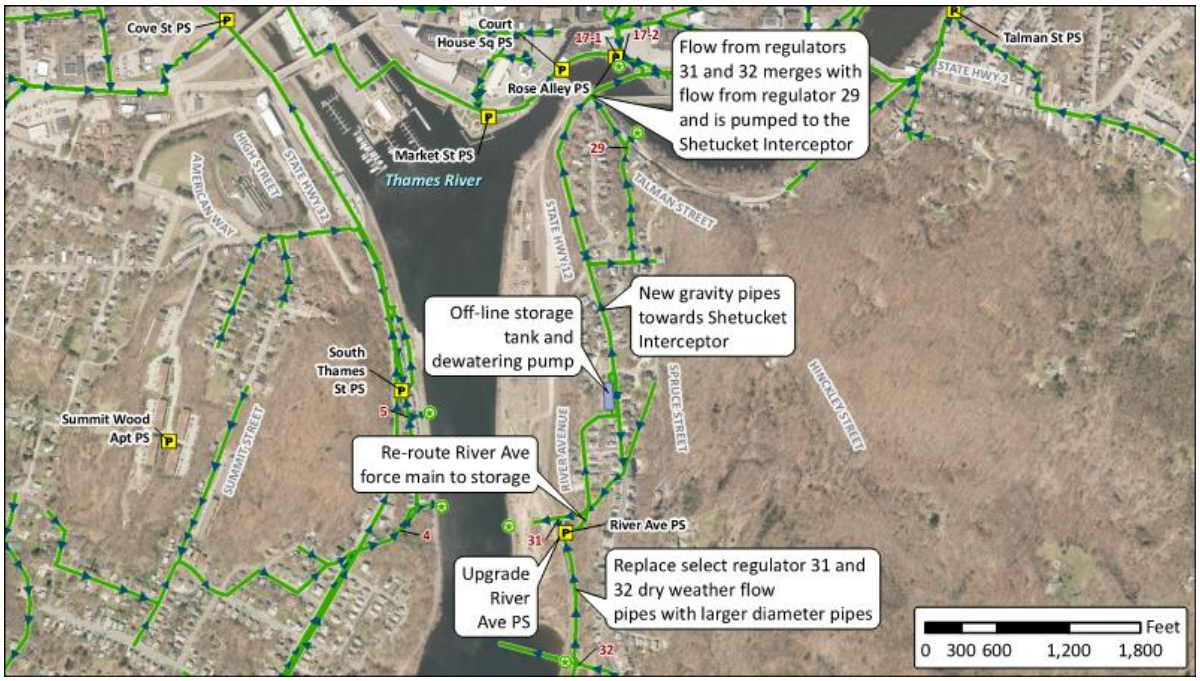


Figure 8-8
Configuration of 6-Month through 5-Year Storage Alternatives in Laurel Hill

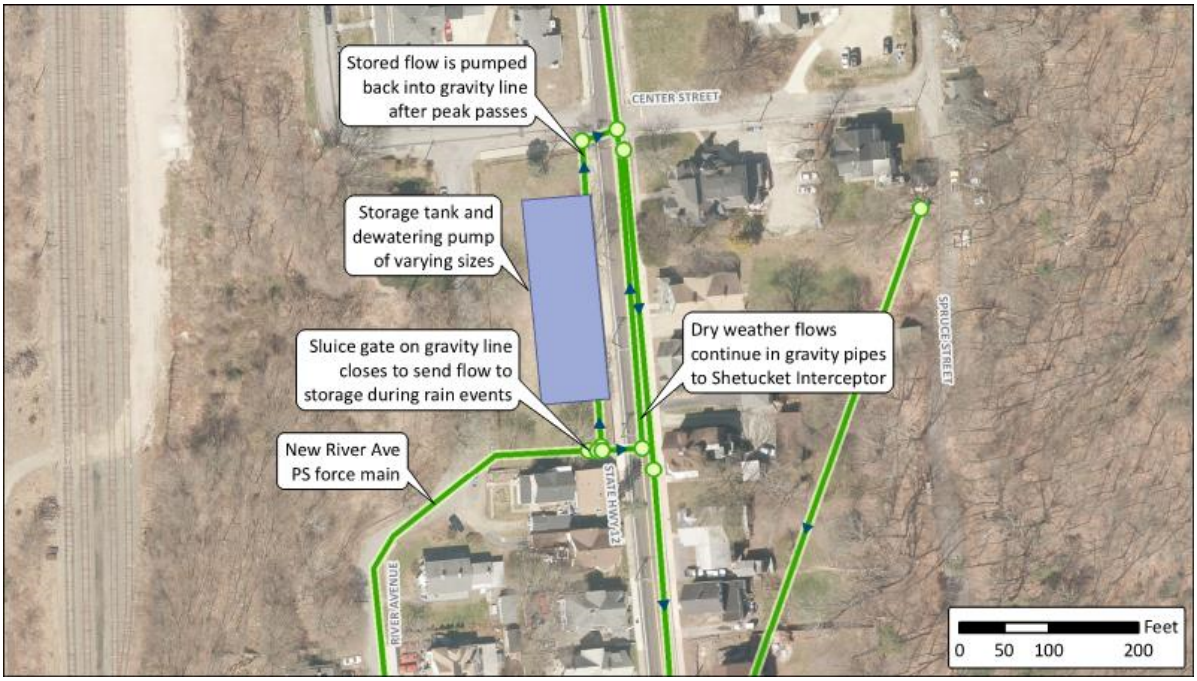


Figure 8-9
Configuration Around Proposed Storage Tank in Laurel Hill for 6-Month through 5-Year Levels of Control

Table 8-8 Size of Main Components of the Laurel Hill Storage Alternative

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
River Ave PS (mgd)	4	4	10	10	11	18
River Ave FM (diameter, inches)	14	14	18	18	18	24
River Ave FM Route	To Shetucket Interceptor, as existing	To Shetucket Interceptor, as existing	To Storage Tank	To Storage Tank	To Storage Tank	To Storage Tank
Storage Tank (Mgal)	NA	NA	0.53	0.84	1.05	1.05
Storage Tank Dewatering Pump (mgd)	NA	NA	1	1	1	1
Gravity Pipe to Shetucket (diameter, inches)	NA	NA	12	12	12	15
Pipe Replacement Along Railroad (length, feet)	97	141	141	532	743	953

8.4 Shetucket

The Shetucket Interceptor runs from the border of Taftville and Greeneville in the north to Rose Alley PS in the south, collecting flows from Greeneville and Downtown along the way. Flows from Eastside discharge from across the river to the upper Shetucket Interceptor, and flows from Laurel Hill discharge to the lower Shetucket Interceptor just upstream of the PS. Seven overflows serve to protect the Shetucket Interceptor and downstream infrastructure from excess flows. There are nine regulators to these seven overflows. Overflows from regulators 17-1 and 17-2 are

combined into one outfall pipe, as are overflows from regulators 19-1 and 19-2. As such, these overflows are reported as one CSO each. Table 8-9 presents CSO statistics for the design storms after completion of the planned projects described in Section 7 (CSO 025 from Eastside is also included in Table 8-9 as its flows will be conveyed to the Shetucket Interceptor with the completion of the Planned Projects). CSO 024 (Greeneville) and CSO 025 (Eastside) are managed to the 2-year control level by conveying the total flows into the Shetucket Interceptor. Remaining peak CSO flows along the Shetucket range from 23 mgd in the 1-month storm to 115 mgd in the 5-year storm while CSO volumes range from 0.48 Mgal in the 1-month storm to 4.9 Mgal in the 5-yr storm.

Table 8-9 Shetucket CSO Statistics after completion of Planned Projects

CSO Statistics	Design Storm	CSO 017	CSO 018	CSO 019	CSO 021	CSO 022	CSO 023	CSO 024	CSO 025	Shetucket Total	System Total
CSO Peak Flow (mgd)	1-month	12	2.4	2.7	0	1.2	4.5	0	0	23	25
	3-month	19	5.1	5.8	1.0	3.3	8.6	0	0	43	52
	6-month	32	7.4	8.6	1.6	5.5	13	0	0	68	86
	1-year	37	8.3	10	1.7	6.2	14	0	0	77	99
	2-year	41	10	12	1.7	7.5	16	0	0	88	114
	5-year	51	15	18	1.9	10	20	0	0	115	152
CSO Volume (Mgal)	1-month	0.36	0.03	0.03	0	0.01	0.06	0	0	0.5	0.5
	3-month	0.80	0.08	0.07	0.01	0.03	0.15	0	0	1.1	1.2
	6-month	1.5	0.15	0.15	0.02	0.07	0.29	0	0	2.1	2.4
	1-year	2.2	0.21	0.21	0.02	0.09	0.39	0	0	3.2	3.5
	2-year	2.9	0.37	0.35	0.03	0.16	0.62	0	0	4.4	5.1
	5-year	3.1	0.44	0.44	0.06	0.21	0.67	0	0	4.9	5.8

8.4.1 Necessary Upgrades

There are no known necessary upgrades along the Shetucket Interceptor that will be part of every solution. All modifications to the existing system will vary by solution and design storm.

8.4.2 Separation

Section 6 describes the effectiveness of citywide separation in Norwich and local public inflow removal in the areas draining to the Shetucket Interceptor.

8.4.2.1 Complete Public and Private Inflow Separation

Complete removal of public and private inflow is expected to achieve 5-year CSO control. However, this level of separation is both costly and difficult to guarantee, as impediments to complete separation may reduce the effectiveness. For example, complete separation will depend on the willingness of each homeowner to approve work on private property to disconnect roof leaders and yard drains and/or install new sewer laterals. If complete separation is accompanied by the closure of overflows, SSOs may occur during very large storms, creating public health risks.

8.4.2.2 Local Public Inflow Removal

Local public inflow removal in the areas draining to the Shetucket Interceptor is costly for a moderate CSO benefit. Greeneville and Downtown both have combined areas that drain to the Shetucket Interceptor. While Laurel Hill and Eastside also have combined area draining to the Shetucket Interceptor, public inflow removal there is evaluated in other sections (Section 8.3.2 and Section 7.3, respectively). As described in Section 6.4.1, Greeneville and Downtown are high-density urban areas. Greeneville has residential and commercials properties while Downtown is largely commercial. Costs for separation in these areas is estimated to be higher than other areas of Norwich because of the high concentration of homes and businesses that would be impacted during construction. With public inflow removal, four CSOs are still active in the 1-month storm (Table 8-10). In the 2-year storm, CSO volume is reduced by 66 percent and peak flow is reduced 52 percent. Due to the higher costs and construction impacts and smaller percentage reduction of CSO volume in these areas compared to other areas, it is not recommended that Greeneville or Downtown have contributing public inflow removed at this time. This recommendation can be reevaluated in the next LTCP update.

Table 8-10 CSO Statistics with Public Inflow Removal for the Area Draining to the Shetucket Interceptor as Compared to Future Baseline CSO Statistics

CSO Statistics	Design Storm	CSO 017	CSO 018	CSO 019	CSO 021	CSO 022	CSO 023	CSO 024	Total	Future Baseline	Reduction
CSO Peak Flow (mgd)	1-month	1.8	0.3	0.1	0.0	0.0	0.4	0.00	2.6	23	88%
	3-month	6.1	1.5	1.5	0.0	0.3	2.6	0.00	12.0	43	72%
	6-month	18.2	2.5	2.7	0.2	1.2	4.6	0.00	29.4	68	57%
	1-year	23.6	2.8	3.3	0.4	1.5	5.3	0.00	36.9	77	52%
	2-year	26.0	3.5	3.9	0.6	2.0	6.5	0.00	42.5	88	52%
	5-year	32.1	5.1	7.0	1.4	3.2	9.5	0.00	58.3	115	49%
CSO Volume (Mgal)	1-month	0.02	<0.01	<0.01	0.00	0.00	<0.01	0.00	0.02	0.48	95%
	3-month	0.13	0.01	0.01	0.00	0.00	0.02	0.00	0.18	1.1	84%
	6-month	0.41	0.03	0.03	0.00	0.01	0.05	0.00	0.53	2.1	75%
	1-year	0.66	0.03	0.03	0.00	0.01	0.07	0.00	0.82	3.2	74%
	2-year	1.21	0.06	0.06	0.00	0.02	0.13	0.00	1.47	4.4	66%
	5-year	1.41	0.08	0.09	0.01	0.03	0.17	0.00	1.80	4.9	63%

8.4.3 Conveyance

To increase conveyance of flows from the area draining to the Shetucket Interceptor to the WPCF, the capacity of Rose Alley PS must be upgraded. Modifications are needed upstream as well to convey flow to Rose Alley PS. Regulators 23, 22, 21, 19-1, 19-2, and 18 can be modified to raise the weirs and enlarge the dry weather flow pipes connecting to the Shetucket Interceptor to force all flow into the interceptor. For the 1-month and 3-month storms, these changes are sufficient to convey all flow to Rose Alley PS. Rose Alley PS would have to be upgraded to 26 mgd and 38 mgd to pass the incoming 1-month and 3-month flows, respectively.

In the 6-month design storm, conveying flow from all CSOs into the Shetucket Interceptor would overwhelm the capacity of the interceptor. Additional conveyance is needed to transport total

flows to Rose Alley PS. The Shetucket Interceptor is already at capacity upstream of where regulator 23 discharges to it and would be overwhelmed by the addition of regulator 23 flows into the system. A relief pipe is proposed from regulator 23 down North Main Street and into the Shetucket Interceptor just before the storage tank at the Rose Alley commuter parking lot (Figure 8-10). This proposed relief pipe routing in North Main Street was selected due to the space limitations near the current interceptor. The Shetucket Interceptor is currently located in a tight window between the railroad tracks and the Shetucket River, with no room for construction of a parallel interceptor. Therefore, North Main Street was selected for an easier construction location, while staying close to the CSO regulators to be able to redirect excess flow from the overburdened Shetucket Interceptor.

Even after the removal of regulator 23 flow from the interceptor, capacity becomes an issue again where flows from regulators 18 and 19 enter the interceptor. The dry weather connector pipe carrying the combined flow from regulators 18 and 19 can be disconnected from the Shetucket Interceptor and a new pipe can be constructed to convey this flow to the relief pipe. The relief pipe will also accept flow downstream from Park Street before reaching Rose Alley PS. The upper section of the relief pipe has a 30-inch pipe at a 0.5 percent slope to get down the hill from regulator 23 to the low point near CSO 019. Topography slopes upward again moving towards the storage tank, so the relief pipe flattens out to a 0.1 percent slope to minimize the depth of the pipe. Due to the smaller slope and the additional flows from regulators 18 and 19 and from Park Street, the relief pipe diameter increases to 48 inches in the lower section to maintain adequate capacity. Rose Alley PS would need a capacity of 61 mgd to pass the 6-month storm.

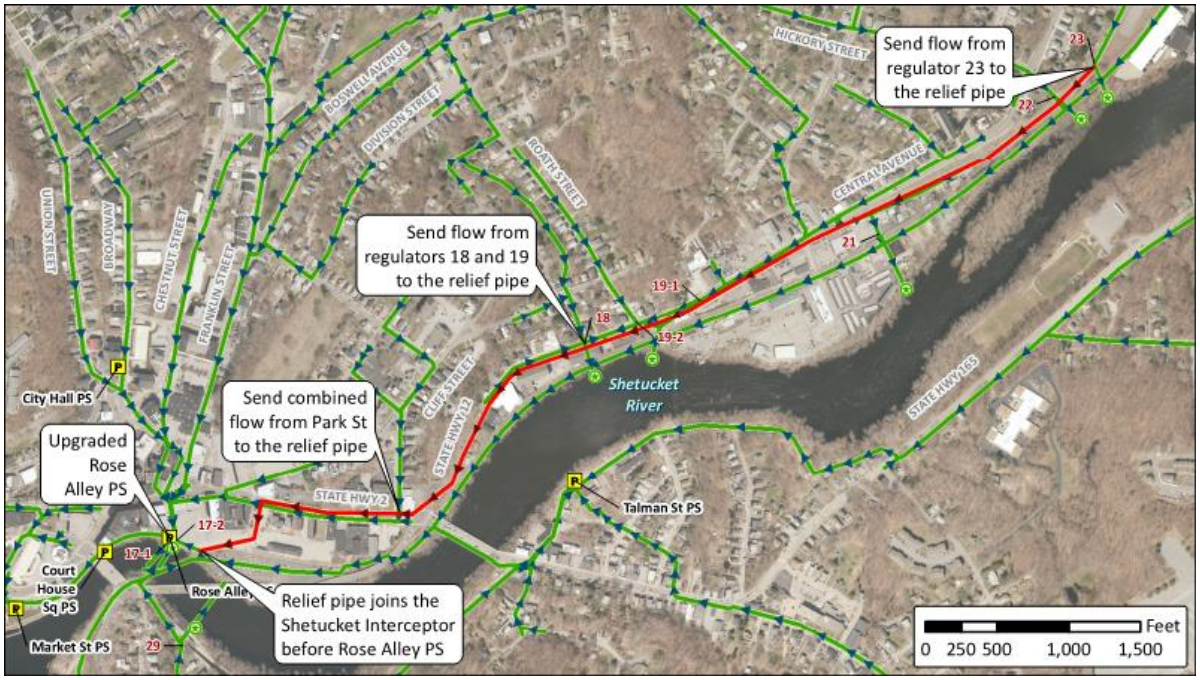


Figure 8-10
Configuration of 6-Month Conveyance Alternative Along the Shetucket

In the 1-year storm, flows coming to Rose Alley PS exceed 87 mgd. The capacity of possible WPCF expansion is limited to 80 mgd due to available space at Hollyhock Island, so for the 1-year through 5-year design storms, the capacity of the WPCF becomes a limiting factor. For the development of conveyance alternatives for the Shetucket Interceptor area only, it is assumed that Rose Alley PS can send 65 mgd to the WPCF to maintain capacity for other areas of the system (separated and combined). Excess flows from the Shetucket Interceptor must be held back in storage. Excess flows in the 1-year storm can be held back by a 0.35 Mgal storage tank in the Rose Alley commuter lot. This storage tank would be constructed with modular box culverts (likely 12' wide by 13' deep by 6' long sections) to accommodate the most simplistic construction approach. The 1-year storm tank would require approximately 52 box culvert sections. These would be configured in series, so that when one row of culverts filled, it would spill over a weir connection and fill the next row of box culverts. The rows of box culvert sections would be sloped slightly, and a pump chamber to dewater the tank would be located on the downstream end. A tank of this size could be constructed adjacent to where the interceptor runs through the lot. A sluice gate operated by RTC can send high flows to the storage tank while a dewatering pump, also operated by RTC, pumps flows back into the interceptor as downstream capacity becomes available.

To control the 2-year storm, the configuration stays the same as in the 1-year storm except the storage tanks and relief pipes are larger to accommodate increased flows (Figure 8-11). In the 5-year storm, the storage tank required at the Rose Alley commuter lot is too large to be constructed adjacent to the Shetucket Interceptor and the interceptor must be re-routed to accommodate the larger storage tank (Figure 8-12). This would involve moving the conduit for dry weather interceptor flow closer to the railroad tracks to the north. It would likely be recommended that this conduit be made of box culvert sections to maximize inline storage, and excess flow would be directed into the storage tank. Relocating in the interceptor would likely require bypass pumping of the interceptor during construction. The main components of the conveyance alternatives for each level of control along the Shetucket Interceptor, assuming the WPCF may accept 80 mgd, are summarized in Table 8-11.

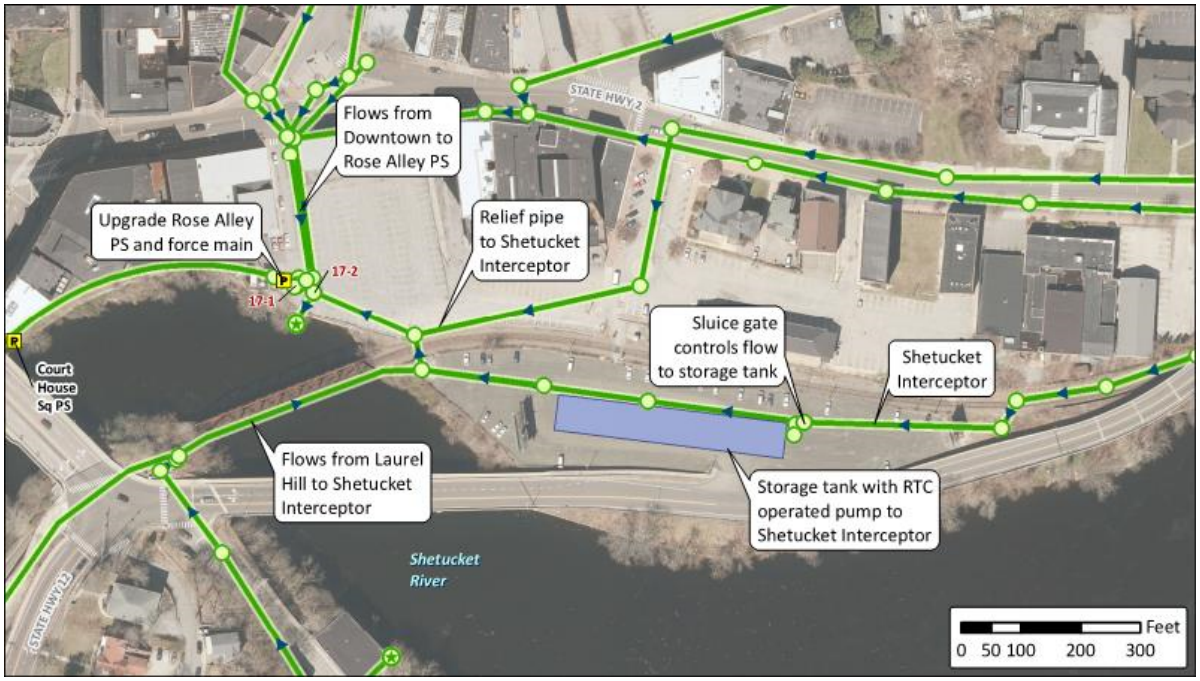


Figure 8-11
Configuration near Rose Alley PS and Proposed Commuter Lot Storage Tank in 1-Year to 2-Year Conveyance Alternatives

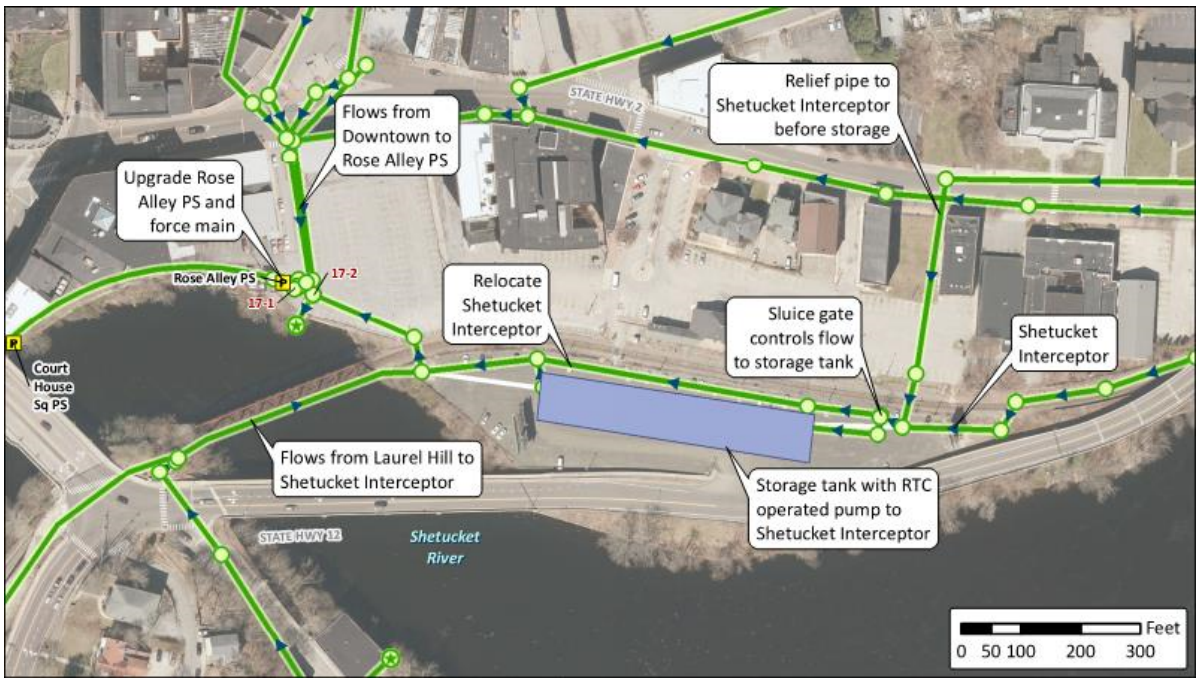


Figure 8-12
Configuration Near Rose Alley PS and Proposed Commuter Lot Storage Tank in 5-Year Conveyance Alternative

Table 8-11 Size of Main Components of the Shetucket Maximum Conveyance Alternatives

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Rose Alley Lot Storage (Mgal)	NA	NA	NA	0.35	0.9	2
Rose Alley Lot Storage Dewatering Pump (mgd)	NA	NA	NA	0.35	2	4
Re-Route Shetucket to Accommodate Storage Tank	No	No	NA	No	No	Yes
Shetucket Interceptor Relief Pipe (diameter, inches)	NA	NA	30 to 48	30 to 48	36 to 48	42 to 60
Relief Culvert North of Rose Alley PS	NA	NA	NA	NA	NA	NA
Rose Alley PS (mgd)	26	38	61	65	65	65
Rose Alley FM (diameter, inches)	30	36	42	42	42	42
WPCF Capacity (mgd)	35	49	80	80	80	80

8.4.4 Storage

To store flows in the areas draining to the Shetucket Interceptor until peak flows pass Rose Alley PS and the WPCF, up to two storage tanks are required. The storage alternatives assume the WPCF maintains its existing 20 mgd capacity and Rose Alley PS maintain its 11.5 mgd capacity. Opportunities to utilize existing storage capacity in the system are targeted before new storage facilities are proposed.

1-Month Storage Alternative on the Shetucket

In the 1-month design storm, there is remaining capacity in the Shetucket Interceptor that is not being utilized even with the addition of all flow from regulators 24 and 25. To utilize that available capacity, regulators 23, 22, 21, 19-1, 19-2, and 18 can be modified to raise the weirs and enlarge the dry weather flow pipes connecting to the Shetucket Interceptor to force all the flow into the interceptor. With these modifications, 18 mgd reaches Rose Alley PS from the Shetucket Interceptor. Rose Alley PS also receives 4 mgd from Laurel Hill and 8 mgd directly from the portion of Downtown that doesn't flow to the interceptor. Figure 8-13 shows incoming flows to Rose Alley PS. With an existing capacity of 11.5 mgd, the PS cannot handle the full 30 mgd reaching it. Regardless of how much capacity is available at the WPCF, storage is needed upstream to prevent the backups at the PS that cause CSO at 017.

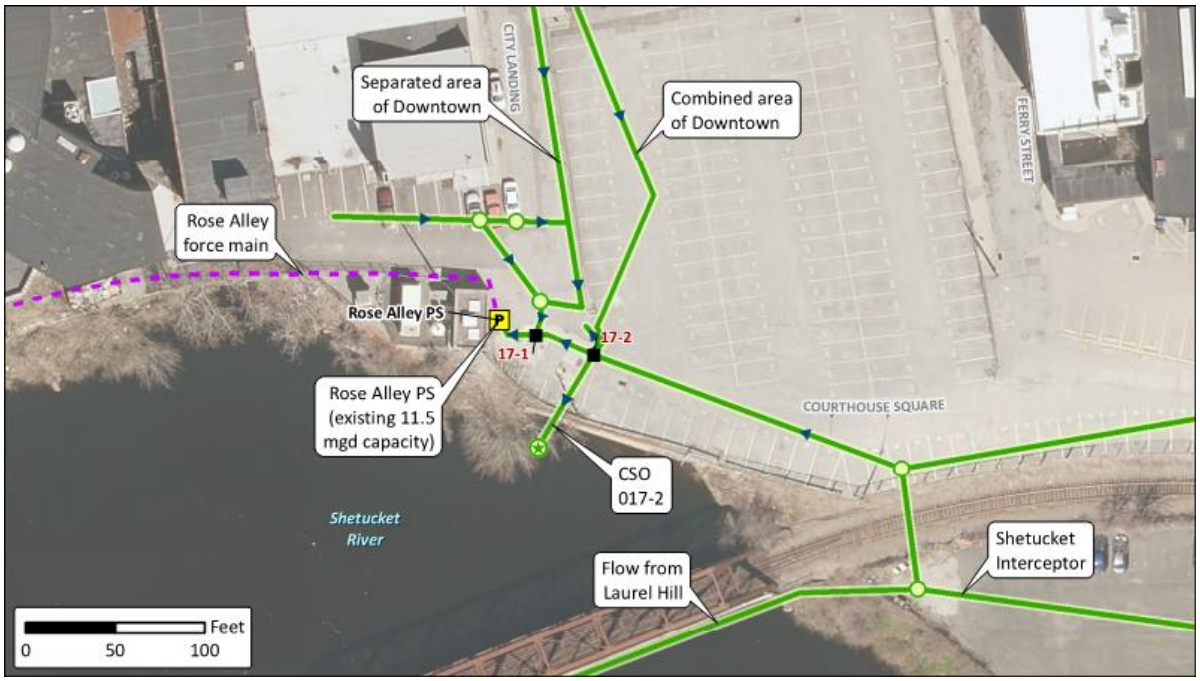


Figure 8-13
Configuration of Incoming and Outgoing Pipes at Rose Alley PS

Flows from the Shetucket Interceptor in the 1-month storm can be held back from the PS with a 1 Mgal storage tank at the Rose Alley commuter lot. The storage tank can be constructed adjacent to where the Shetucket Interceptor passes through the parking lot. This storage tank would be constructed with modular box culverts (likely 12' wide by 13' deep by 6' long sections) to accommodate the most simplistic construction approach. These culvert rows would also fill in series and be sloped towards a dewatering pump chamber. This 1-month storm tank would require approximately 146 box culvert sections. It is expected that this tank could be built without relocation of the existing Shetucket Interceptor. A 30-inch pipe would connect the interceptor to the storage tank. The storage tank would operate off-line by installing a sluice gate in the interceptor. Operated by RTC, the sluice gate would remain open to allow low flows to pass by the storage tank to the Rose Alley PS and would close during high flows to force all flow into the storage tank. Once peak flows pass the PS and WPCF, a 2 mgd dewatering pump would empty the tank via a 10-inch pipe connected to the Shetucket Interceptor. The dewatering pump would also be operated by RTC to adjust the pumping rate based on downstream capacity at the PS and WPCF.

3-Month Storage Alternative on the Shetucket

In the 3-month design storm, the Shetucket Interceptor still has sufficient capacity to convey all flows from regulators 23 to 18. However, the northern section of the interceptor has more capacity than the southern, flatter section of the interceptor. To utilize the capacity upstream and reserve downstream capacity, a modulating sluice gate can be installed in the interceptor just upstream of CSO 023. The pipes upstream of CSO 023 have available capacity and are deep. Surcharge caused by holding back flow is not expected to cause local flooding (Figure 8-14).

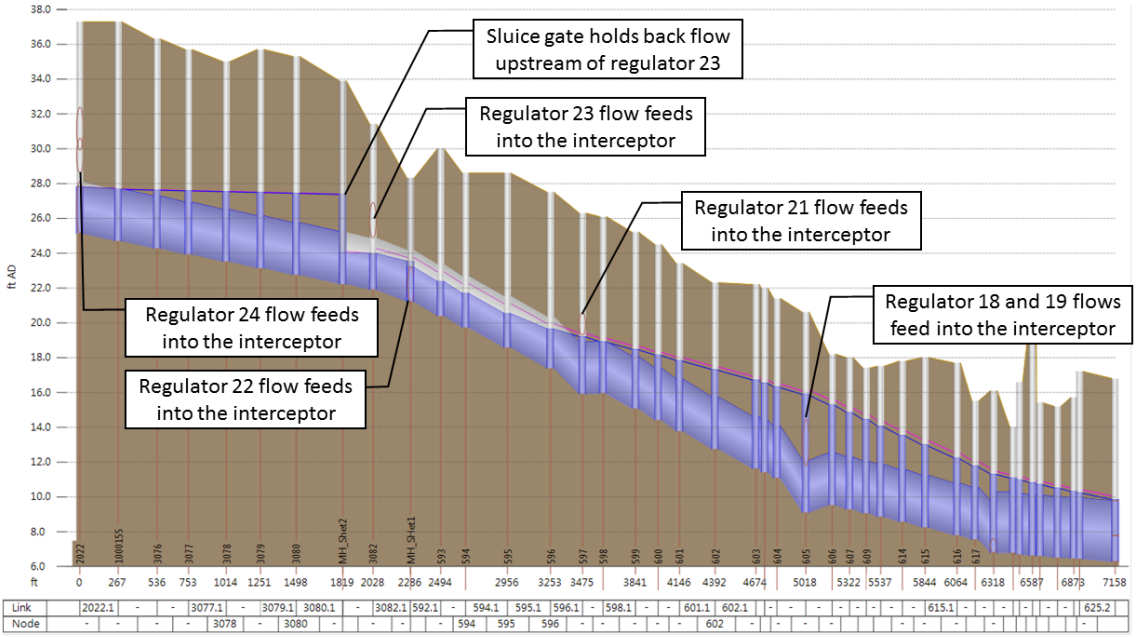


Figure 8-14
Profile of the Shetucket Interceptor in the 3-Month Storage Alternative

With higher flows coming to Rose Alley PS, more storage capacity is needed at the Rose Alley commuter lot than in the 1-month storm. A 1.45 Mgal storage tank with a 2 mgd dewatering pump is sufficient to capture and store excess flows. This storage tank would also be constructed with modular box culverts (likely 12' wide by 13' deep by 6' long sections) to accommodate the most simplistic construction approach. This storage tank would require approximately 210 box culvert sections. As with the other tank set ups, the storage culverts would fill in series, and drain to a dewatering pump after the passage of a storm event. In the 3-month storm, peak flow coming from Downtown exceeds 13 mgd and peak flow from Laurel Hill exceeds 5 mgd. Even with all flow from the Shetucket Interceptor conveyed into storage, Rose Alley PS still does not have capacity to pass incoming flows without causing overflow at regulator 17-1. Of the 13 mgd flow from Downtown, 10 mgd comes to Rose Alley PS via a large culvert that serves the Downtown combined area. It is necessary to connect a relief pipe from this culvert to the Rose Alley commuter lot storage tank to intercept some of this flow before it gets to the PS. A new weir would be constructed on the combined culvert, which would redirect flow into this relief pipe. The relief pipe would intercept the culvert at Rose Alley and would convey flow back to the storage tank by crossing under at least one other gravity sewer line and the existing railroad tracks via pipe jacking. Construction of a relief pipe in this area is expected to be difficult due to utility and railroad crossing; however, it is needed to control overflow at CSO 017-1 and 017-2. This relief pipe for the combined culvert will be necessary (with varying diameters) for the 3-month through 5-year storage alternatives.

6-Month Storage Alternative on the Shetucket

As with the conveyance alternative, conveying flow from all CSOs into the Shetucket Interceptor in the 6-month design storm would overwhelm the interceptor's capacity. Additional conveyance is needed to transport total flow to the storage tank. A relief pipe is proposed from CSO 023 down

North Main Street and into the Shetucket Interceptor just before the storage tank at the Rose Alley commuter lot, following the route described in the conveyance section (Figure 8-15). Even after the removal of regulator 23 flow from the interceptor, capacity becomes an issue again where flows from regulators 18 and 19 enter the interceptor. The dry weather connector pipe carrying the combined flow from regulators 18 and 19 can be replaced by two pipes; one pipe will connect regulator 18/19 to the relief pipe, then a second pipe with a raised invert will connect the relief pipe to the Shetucket Interceptor (Figure 8-16). With this configuration, the relief pipe accepts 60 percent of the 18/19 flow and the remaining 40 percent flows to the Shetucket Interceptor, relieving the surcharge on the interceptor. The relief pipe will also accept flow from Park Street. By connecting the Park Street flows into the relief pipe, flow that is conveyed directly to Rose Alley PS under existing conditions instead is conveyed upstream of the storage tank where it may be stored during high flows. The relief pipe starts at a 30-inch diameter in the upper section of the pipe and increases to 42 inches in the lower, flatter section (Figure 8-17). The relief pipe lowers the surcharge in the Shetucket Interceptor to acceptable levels (Figure 8-18).

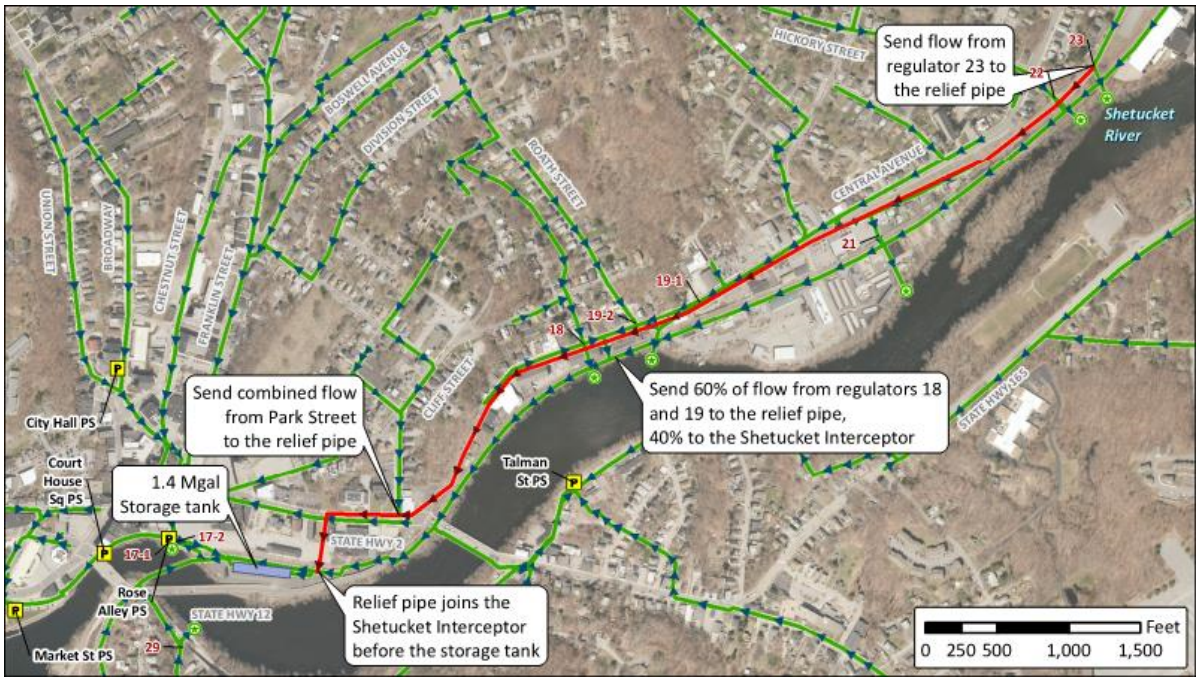


Figure 8-15
Route of the Relief Pipe in the 6-Month Storage Alternative (Highlighted in Red)

Figure 8-16
Configuration Near 018/019 to Convey 60 percent of Flow to the Relief Pipe and 40 percent to the Shetucket Interceptor

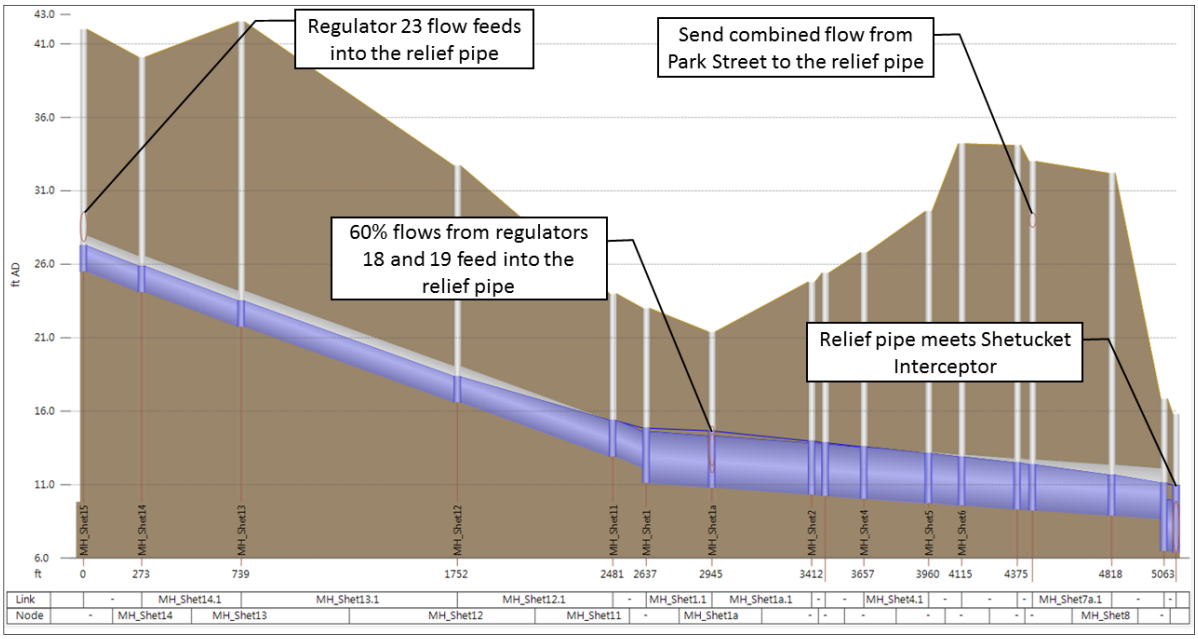


Figure 8-17
Profile of the Relief Pipe in the 6-Month Storage Alternative

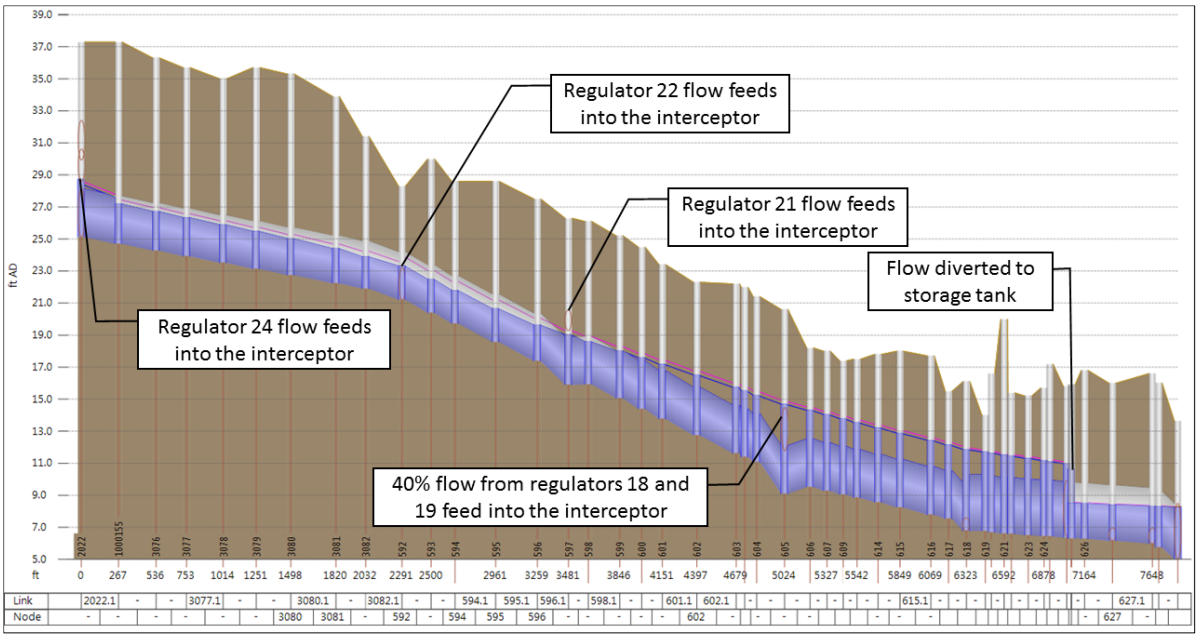


Figure 8-18
Profile of the Shetucket Interceptor in the 6-Month Storage Alternative

To manage CSO on the Shetucket to a 6-month level of control, the maximum available storage at the Rose Alley commuter parking lot is utilized. A 3 Mgal tank with a 4 mgd pump is proposed at this location. This tank would be built using numerous box culverts for ease of construction. It would require approximately 435 box culvert sections (assuming a 12' wide by 13' deep by 6' long size). Like the other storage tanks, the tank would fill in series when each row of culvert sections spills into the next. The tank floor would be sloped towards a dewatering pump. To accommodate the larger storage tank, the Shetucket Interceptor must be relocated through the parking lot. This would be done using an inline box culvert conduit directly adjacent to the northern railroad tracks to convey the Shetucket Interceptor flows. As in the smaller design storms, the sluice gate directing flow to the storage tank and the dewatering pump operate on RTC based on capacity at Rose Alley PS and WPCF.

1-Year Storage Alternative on the Shetucket

With capacity at the Rose Alley commuter lot maxed out in the 6-month storm, storage upstream on the Shetucket at the NPU facilities yard becomes necessary to manage CSO to a 1-year level of control. A 1.3 Mgal storage tank at the NPU yard functions in the same way as the tank in the commuter lot, with a sluice gate sending high flows to the off-line storage tank and a dewatering pump emptying the tank as capacity downstream becomes available (Figure 8-19). Flow would be intercepted from the Shetucket Interceptor on South Golden Street and redirected into the NPU Headquarters parking lot. The storage tank would be located beneath the parking lot and would then pump out the storage tank following a storm event. This storage tank would require approximately 205 box culvert sections for storage (assuming a 12' deep by 12' wide, by 6' long box culvert section). The culvert rows would fill in series and drain to a dewatering PS. The upper Shetucket Interceptor still does not have enough capacity to accept flows from regulator 23, so the relief pipe from regulator 23 to the storage tank at the commuter lot is required and will

follow the same route as shown in Figure 8-15. The storage tank at the NPU parking lot would discharge into the relief pipe in North Main Street.

Because the NPU storage tank removes additional flow from the Shetucket Interceptor during the peak of the storm, there is capacity in the interceptor to accept all 18/19 flows and not send any of this flow to the relief pipe. The size of the lower portion of the relief pipe can be reduced from the 42-inch required in the 6-month storm to 36-inch for the 1-year storm. With a portion of the Shetucket Interceptor flow being held upstream in the NPU storage tank, a 2.3 Mgal storage tank at the Rose Alley commuter lot is sufficient to manage CSO. This orientation at the Rose Alley commuter lot would require approximately 334 box culvert sections (assuming a 13' deep by 12' wide by 6' long box culvert section). It would also require the relocation of the Shetucket Interceptor north against the railroad tracks for additional storage capacity as discussed under the previous alternatives. This tank would fill in series and drain via a dewatering PS on the downstream end.

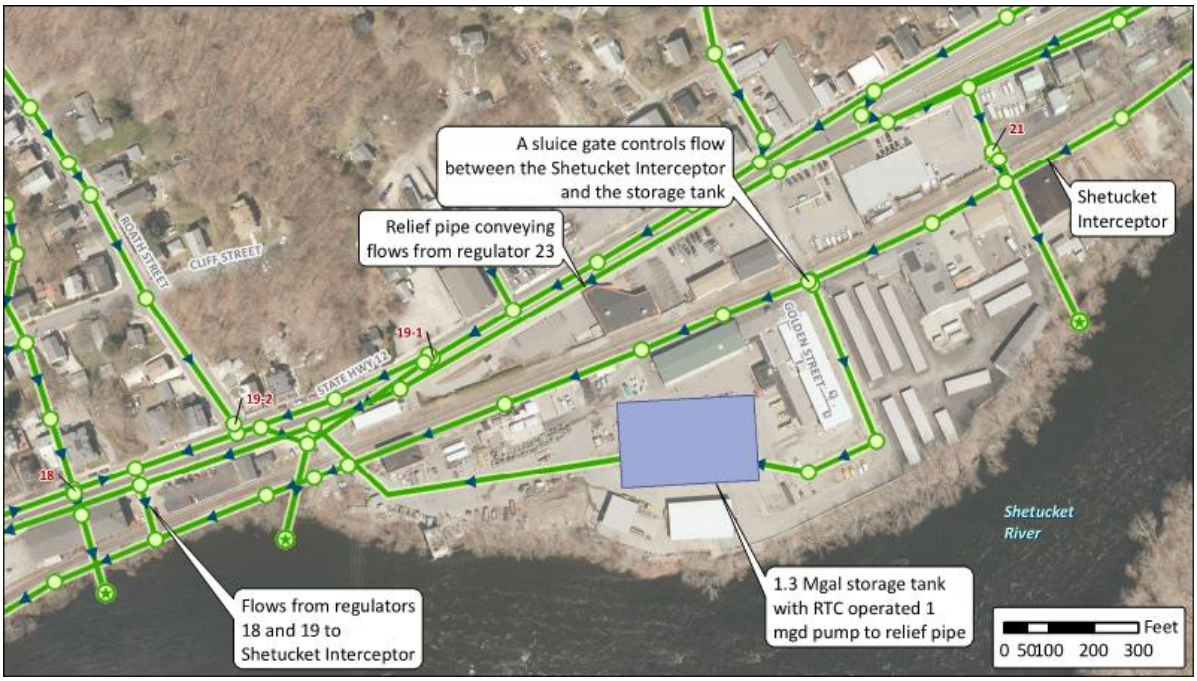


Figure 8-19
Configuration of NPU Yard Storage Tank in the 1-Year Storage Alternative

2-Year Storage Alternative on the Shetucket

The 2-year storage alternative has the same configuration as the 1-year storage alternative, only with larger conveyance and storage components. To achieve the 2-year level of control, the maximum available storage capacity at the two Shetucket storage locations is utilized, with 3 Mgal stored at the Rose Alley commuter lot and 2.24 Mgal stored at the NPU yard. The storage tank at the Rose Alley commuter lot has a 4 mgd dewatering pump and the storage tank at the NPU yard has a 1 mgd dewatering pump. The configuration at the Rose Alley commuter parking lot would require approximately 435 box culvert sections (assuming a 13' deep by 12' wide by 6' long box culvert section). These would be configured in series, so that when one row of culverts

filled, it would spill and fill the next row of box culverts. The floor of the tank would be sloped slightly towards the western side of the tank where it would be dewatered following a storm event.

The relief pipe conveys flow from regulator 23 and Park Street to the storage tank (same route as shown in Figure 8-15). To provide sufficient capacity for these flows, the upper stretch of the relief pipe is 30-inch and the lower stretch is 42-inch. A sluice gate upstream of the NPU yard sends wet weather flows from the upper Shetucket Interceptor (minus flows from regulator 23) to the NPU storage tank. The NPU headquarters storage tank would be 2.24 Mgal under this alternative, which would require approximately 352 box culvert sections (assuming a 12' deep by 12' wide by 6' long box culvert section). This tank would be configured in series, as with the other storage tanks, with a dewatering PS on the downstream side.

With the relief pipe and upstream storage redirecting and detaining flows, the Shetucket Interceptor has capacity to accept the full regulator 18/19 flows. The relief pipe from the combined culvert north of Rose Alley PS conveys 10 mgd of the 13 mgd from the combined area of Downtown away from Rose Alley PS and to the commuter lot storage tank as described under previous alternatives.

5-Year Storage Alternative on the Shetucket

In the 5-year storm, the Shetucket Interceptor is overwhelmed by the addition of flows from regulators 24 and 25. To relieve this upper stretch of the Shetucket Interceptor, the relief pipe is extended further upstream to capture flows from regulator 24 (relief pipe is highlighted in red in Figure 8-20). Flows from regulator 23 exceed 40 mgd in the 5-year storm and cannot be conveyed by the Shetucket Interceptor (even if there were no other flows). Regulator 23 flows are instead directed to the relief pipe. Flow from regulators 025, 022, and 021 remain in the interceptor, and is conveyed to the NPU storage yard tank by the RTC operated sluice gate in the interceptor. Even when all wet weather flows from the 5-year storm are conveyed to the storage tank, the tank only fills to 1.6 Mgal. This is because storage in the NPU tank is limited by how much flow can be conveyed in the interceptor to enter the tank. The 5-year design storm selected for this analysis consists of one intense peak (Figure 8-21), whereas the 2-year design storm had a large peak followed by multiple smaller increases in intensity (Figure 8-22); it is these later increases in intensity that allowed the NPU storage tank to fill to capacity in the 2-year storm.

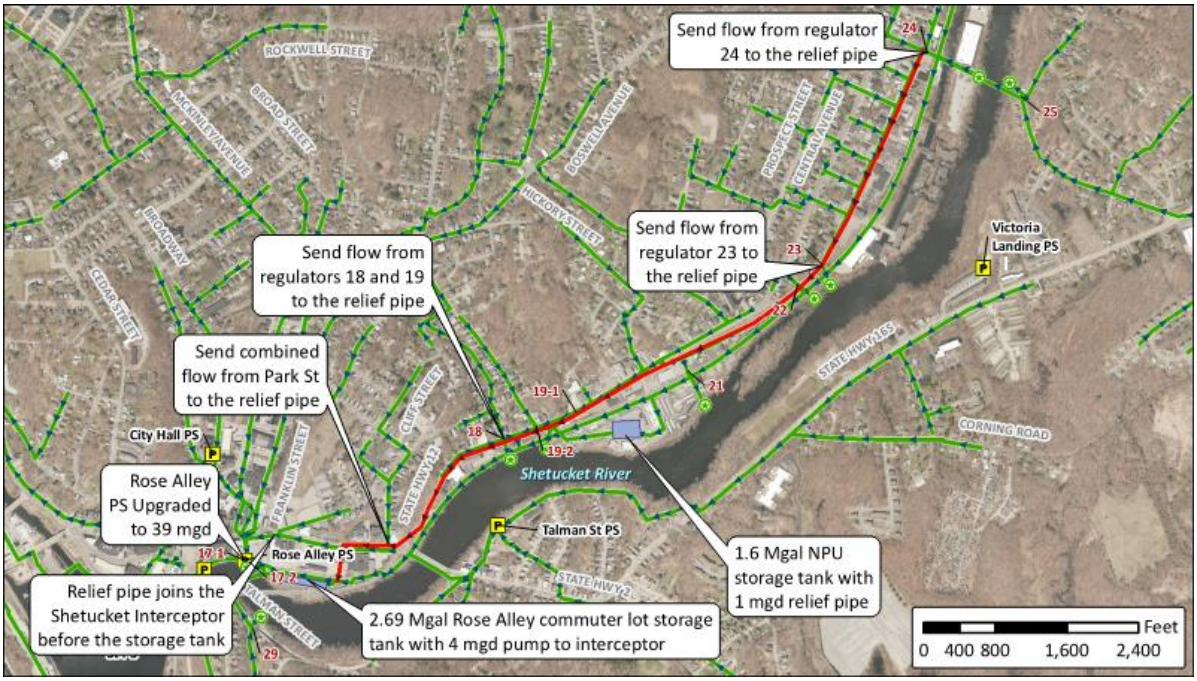


Figure 8-20
Shetucket Configuration in the 5-year Storage Alternative

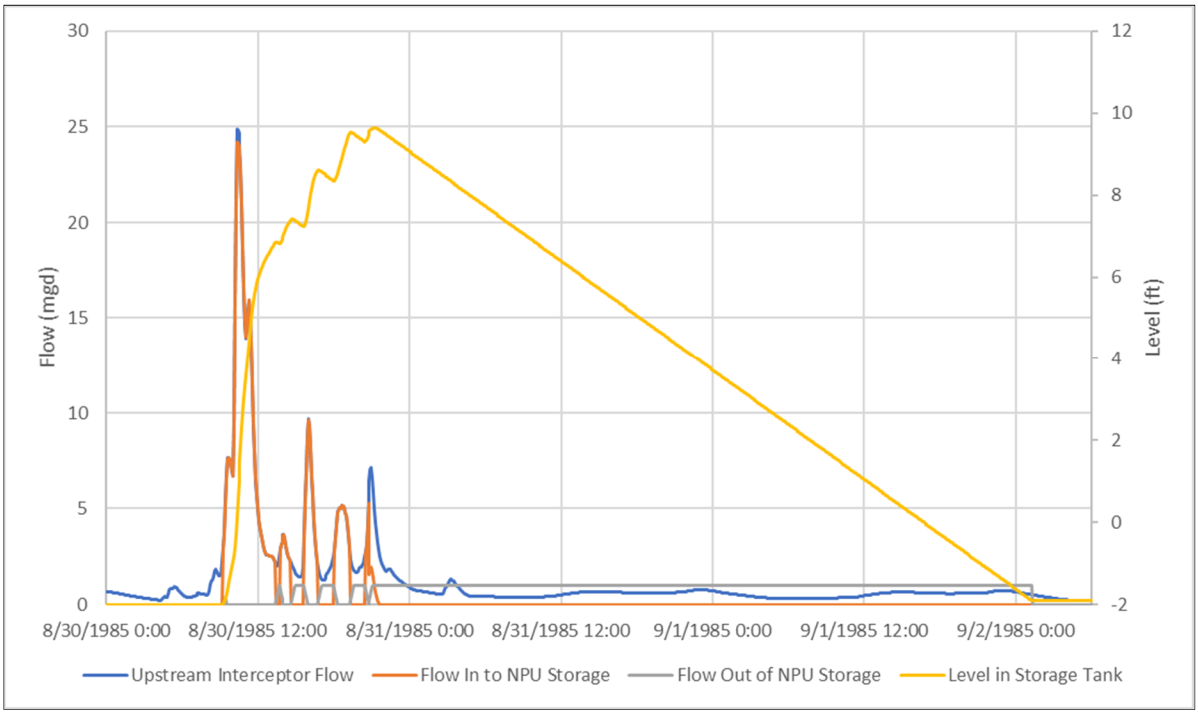


Figure 8-21
Flows in and out of the NPU Yard Storage Tank and Levels in the Storage Tank in the 2-Year Design Storm

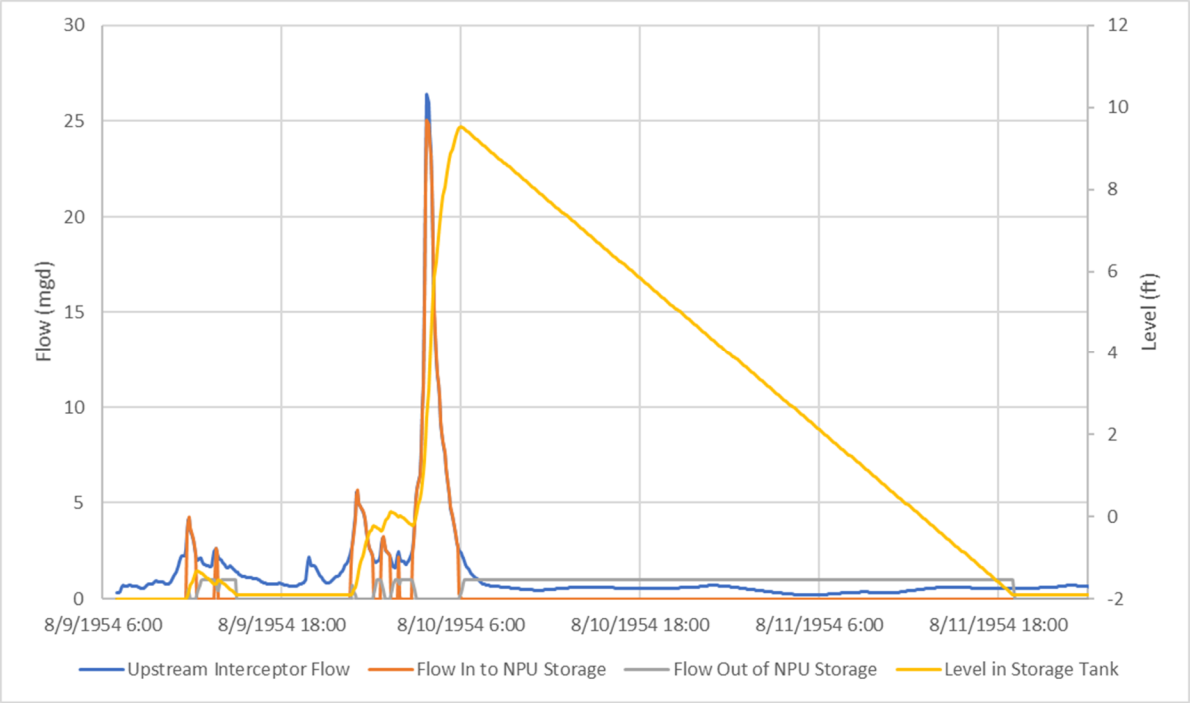


Figure 8-22
Flows in and out of the NPU Yard Storage Tank and Levels in the Storage Tank in the 5-Year Design Storm

The drainage areas to regulators 18/19 generate a peak flow of 37 mgd in the 5-year storm, which is too high to all be conveyed into the Shetucket Interceptor. This alternative proposes splitting this flow between the relief pipe and the Shetucket Interceptor, with 10 mgd being allotted to the interceptor. Where the Shetucket Interceptor and relief interceptor merge upstream of the commuter lot storage tank, peak flows reach 70 mgd. There is not enough slope from this point to the storage tank to force all this flow into storage, so 15 mgd of this peak flow must bypass the storage tank and flow to Rose Alley PS. The PS also receives 5 mgd from Laurel Hill, 10 mgd from the separated portion of Downtown, and 7 mgd from the combined portion of Downtown (10 mgd is conveyed via the culvert relief pipe to storage). With the addition of the 15 mgd from the Shetucket Interceptor, the PS is overwhelmed. To manage CSO at Rose Alley to the 5-year level of control, Rose Alley PS must be upgraded to convey 39 mgd to the WPCF. Consequently, the WPCF must be upgraded to accommodate 50 mgd total wet weather flow. This includes the 20 mgd WPCF upgrade recommended in Section 3, and an additional 30 mgd of wet weather treatment that would be provided by a high rate clarification (HRC) facility at Holly Hock Island. Figure 8-20 summarizes the configuration of the 5-year storage alternative along the Shetucket.

The main components of the storage alternatives on the Shetucket Interceptor are summarized in Table 8-12.

Table 8-12: Size of Main Components of the Shetucket Storage Alternative

Component	Control Level					
	1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Rose Alley Lot Storage (Mgal)	1	1.45	3	2.3	3	2.69
Rose Alley Lot Storage Pump (mgd)	2	2	4	4	4	4
Re-Route Shetucket to Accommodate Storage Tank	No	No	Yes	Yes	Yes	Yes
NPU Storage (Mgal)	NA	NA	NA	1.31	2.24	1.62
NPU Storage Pump (mgd)	NA	NA	NA	1	1	1
Shetucket Relief Pipe (diameter, inches)	NA	NA	30 to 40 (5,100 ft)	30 to 36 (5,100 ft)	30 to 42 (5,100 ft)	30 to 60 (7,100 ft)
Relief Culvert North of Rose Alley PS (diameter, inches)	NA	24	24	30	30 to 36	36
Rose Alley PS (mgd)	As-is	As-is	As-is	As-is	As-is	39
Rose Alley FM (diameter, inches)	As-is	As-is	As-is	As-is	As-is	42
WPCF Capacity (mgd)	20	20	20	20	20	50

8.5 WPCF

To address the alternatives described in the preceding sections for Thamesville, Laurel Hill, and Shetucket, upgrades are needed to the WPCF. The current conditions at the plant including its limitations and a description of the 2015 WPCF Upgrade Design are included in Section 3. The WPCF is older than its intended design life and still aging. Improvements to the WPCF are necessary to ensure successful operation while addressing CSO. This section presents a revised design intent and recommended upgrades to the WPCF.

8.5.1 Revised Design Intent

The 2012 LTCP recommendation to increase peak WPCF capacity to 33 mgd was included in the 2015 design. This LTCP explores additional options which may provide a cost benefit over conveyance and treatment. Regardless of the alternatives considered, CDM Smith recommends a base increase in plant peak capacity to 20 mgd (not 33 mgd), reliably matching the existing peak flows that are already realized (but which are problematic) at the WPCF. This 20 mgd capacity will ensure successful operation of the treatment plant while any CSO controls are implemented. Expansions beyond the 20 mgd base increase in plant peak capacity are discussed later in the alternatives analysis.

This revised 20 mgd design has some impacts on the 2015 design:

- One less secondary clarifier is required.
- A smaller headworks could be constructed, possibly with fewer trains.
- Reduced influent and effluent pumping station capacity.

- Reduced UV disinfection system capacity.
- Elimination of IFAS media, or reduced IFAS media quantity. The IFAS recommendation should be revisited to determine if another technology would be favored given the reduced plant capacity and the time that has passed since the 2011 technology preselection.
- Reduced sizes of liquid train yard piping.
- Fewer secondary tanks, a smaller headworks, smaller influent and effluent pumping stations, and less excavation would result in relocation of less material to the landfill on the island. Landfill design would need to be modified to account for the reduced size.
- The hydraulic profile of the plant would need to be revisited for the revised flow rate and changes in process. This could result in the elimination of the need for an effluent or influent pumping station.

Additionally, all future designs will consider new flood protection and resiliency requirements which were not in effect during preparation of the in the 2015 design. Flood protection regulations and WPCF components which may require modification are presented in Section 3.

To properly plan for the revised peak capacity and flood control issues, CDM Smith recommends a WPCF Facility Plan update to fully address needed changes from the 2015 WPCF Upgrade Design. The Facility Plan update would integrate the selected CSO approach to ensure the WPCF and collection system are upgraded and operated properly.

This LTCP provides an overview and costs for potential WPCF improvements needed to meet CSO goals of the collection system, but defers specific details to a future WPCF Facility Plan update.

8.5.2 WPCF Base Improvements

Regardless of the alternative selected, CDM Smith recommends a base upgrade of the WPCF to 20 mgd. This upgrade will likely be comprised of some components from the 33 mgd WPCF Upgrade Design from 2015. A WPCF Facility Plan update should establish sequencing guidelines to aid transitions between projects. In total there are eight projects anticipated to increase the capacity of the plant and upgrade aging equipment which needs replacement.

8.5.2.1 WPCF Project 1: New Secondary Tanks, Landfill Modifications, Main Electrical System Upgrades, and New Headworks

The first project will include upgrades to major components of the plant which will increase headworks and secondary treatment capacity and replace aging electrical system equipment allowing for easier electrical connections on future projects.

Upgrade of the Headworks is desired as the mechanical bar screen installed cannot pass current peak flows. At flows higher than 10 mgd, the screen floods, putting strain on downstream processes. A new headworks would be constructed in the location of the existing smaller secondary clarifiers. The headworks would include new mechanical bar screens to remove large debris and rags, fine screens to remove smaller debris as required by the IFAS biological treatment process, and grit removal by vortex grit units. Screening and grit washers would also be included in the headworks building. Screens would be provided for all flow ranges up to peak

capacity with a standby screen offline for redundancy. This new headworks would provide a much-improved preliminary treatment system and provide proper protection for downstream processes.

If needed, as determined by a Facility Plan update, an influent pumping station would also be constructed after the headworks to account for additional headloss from new processes and provide proper head conditions for the remainder of the plant.

At least two new secondary tanks will be needed to replace the tanks removed to provide space for the new headworks. While the 2015 design called for three new 85-foot diameter clarifiers, it is expected that only two will be required. These tanks will be constructed northeast of the existing plant limits, along with a new sludge pumping station to convey RAS and WAS. One tank could be constructed adjacent to the existing 85-foot secondary clarifier, but this is not desirable due to yard piping constraints in the vicinity. Construction of these secondary tanks will provide sufficient secondary clarification for 20 mgd of flow.

Excavation for two new secondary clarifiers will yield excavated material that will need to remain on site to reduce disposal costs. This will require constructing the landfill on the north end of the island to accommodate these soils. The landfill may need to remain open for future projects, so this component may need to be separated from the other components in this project.

8.5.2.2 WPCF Project 2: New Administration and Laboratory Building

The second project includes replacement of the administration building as designed in 2015. The building will be demolished to its foundation and a new one-story building will be built in its place on the existing foundation. This building will house the main WPCF SCADA control center, the electrical distribution gear for the new UV disinfection equipment and effluent pumping station, and the wastewater testing laboratory. The ability to adequately disinfect peak flows and effectively push treated effluent out of the plant against a flooded river are deemed critical to wet weather operations and CSO reduction in the collection system.

8.5.2.3 WPCF Project 3: Ultraviolet Disinfection and Effluent Pumping Station

The next recommended project includes upgrading the disinfection and constructing an effluent pumping station after disinfection. Disinfection is currently accomplished with sodium hypochlorite dosed upstream of two serpentine channels to provide plug flow conditions for adequate contact time. The recommended Facility Plan should evaluate whether this treatment is viable at the increased plant capacity of 20 mgd. If chemical disinfection is not viable with the existing tanks, then UV disinfection will be retrofit into the existing structure as designed in 2015. The UV system is advantageous over chemical disinfection as it requires a smaller footprint and chemical purchase, storage, and pumping is not needed. This results in a cheaper life cycle cost even when considering capital and electricity costs.

Depending on a final hydraulic profile developed as part of a recommended facility plan, an effluent pumping station may be required as a part of this project. Under lower flows and low river stages, the plant can discharge to the Thames River by gravity. At higher river stages the plant may be able to discharge to the Yantic River by gravity, but this may restrict the plant hydraulically and an effluent pumping station may be required. If effluent pumping is required, a station will be included in this project like the one designed in 2015. The station should be

capable of delivering the entire plant capacity at high river stage, while also allowing the plant to discharge by gravity when pumping is not needed.

8.5.2.4 WPCF Project 4: Secondary Digester Upgrade and Secondary Clarifier Retrofit

Secondary digesters B and C are currently used for digested sludge storage, but their covers and mixing systems are over 40 years old and have far exceeded their useful life. This project will replace the covers and mixing systems as designed in 2015.

This project also includes a retrofit to the 85-foot secondary clarifier mechanism. The existing mechanism is over 40 years old and has also far exceeded its useful life. This retrofit would complete the secondary clarifier upgrades to provide a minimum of three working clarifiers.

8.5.2.5 WPCF Project 5: Sludge Pumping and Piping and Gravity Thickener Upgrades

The sludge handling building houses primary sludge, thickened primary sludge, return activated sludge, waste activated sludge, and thickened waste activated sludge pumps. Most of these pumps are over 40 years old and have exceeded their useful life. This project will replace some of these pumps and suction and discharge piping to provide better reliability of plant operations. This project will also replace the gravity thickener mechanism and cover for improved longevity.

8.5.2.6 WPCF Project 6: Primary, Aeration, and Chemical Addition Upgrades

This project will consist of three main components: upgrades to the primary mechanisms, aeration tanks, and chemical addition systems.

The primary traveling bridge mechanisms need replacement after more than 40 years of operation. These will be replaced with new chain and rake mechanisms in the existing tanks. Additional tanks will not be required for the increased design flows.

The aeration tanks may be insufficient for conventional activate sludge treatment at higher design flows. This should be evaluated in an updated Facility Plan. If the existing tanks cannot be operated through a conventional process, then IFAS, as designed in 2015, or another process may be used to increase the capacity of the tanks and eliminate the need for additional tanks. This project component will upgrade the existing aeration tanks as needed to meet the increased design flows.

Depending on the secondary treatment process selected by the facility plan, upgrades to chemical addition will be necessary to supplement the process. These may include carbon and soda ash as designed in 2015 or other chemical systems.

8.5.2.7 WPCF Project 7: Sludge Pumping and Piping

The sludge handling building houses primary sludge, thickened primary sludge, return activated sludge, waste activated sludge, and thickened waste activated sludge pumps. Most of these pumps are over 40 years old and have far exceeded their useful life. This project will replace the remaining pumps and suction and discharge piping which were not replaced under the first sludge pumping and piping project listed in Section 3.5.1.5.

8.5.2.8 WPCF Project 8: Odor Control and Final Sitework Improvements

The final recommended project comprises an odor control system and final sitework improvements.

The WPCF does not currently have an odor control system. While odors are mild at the site, the plant is located close to commercial and residential areas of Norwich. NPU desires an odor control system for the upgraded plant. This project will construct a biofilter with piping to the headworks, influent pumping station, sludge handling building, gravity thickener, and influent channel to the primary settling tanks. Covers would also be installed over relevant tanks to provide a comprehensive odor control system. This system is not critical to WPCF operation and could be removed from the design if determined cost prohibitive or if there are funding limitations.

The second component of this project will include sitework to provide final paving, landscaping, security, and fencing. This will restore the site to finished condition following the various preceding projects.

8.5.3 WPCF Wet Weather Improvements

For some CSO alternatives presented in this LTCP, the 20 mgd base upgrade proposed for the core primary / secondary treatment systems will be sufficient. For other alternatives, increased wet weather capacity will be required to treat peak flows. However, space is limited on the WPCF site. CDM Smith has estimated a maximum of 60 mgd additional flow could be treated on site for a maximum total of 80 mgd. Wet weather treatment of 60 mgd is based on preliminary sizing performed by I. Kruger, Inc. for CDM Smith assuming HRC treatment at the location of the existing laboratory building, south of the existing digesters. This facility would provide wet weather treatment to produce better effluent water quality, increase capacity to reduce CSO volumes, streamline wet weather treatment, and improve WPCF operations. The following paragraphs describe the upgrades required to treat additional wet weather flow.

8.5.3.1 Wet Weather Headworks

A junction box could be designed as a diversion structure to direct flow to the plant or the wet weather treatment facility. Gates or weirs could be used to accomplish this diversion. Details such as the size of the structure and diversion concept should be considered in a future design.

A wet weather pretreatment facility will be required for alternatives requiring additional wet weather treatment. This could be an integrated facility to treat all flow or a standalone facility to provide treatment only for flow above 20 mgd. If an integrated facility is desired, then careful planning will be needed to facilitate expandable facilities and coordinated designs. Pretreatment for wet weather flows would consist of screening and grit removal.

Screening mechanical details such as number and type of screens, and the depth and width of screen channels should be considered in a future design. However, the following conceptual issues should be considered in any future screening design efforts:

- The facility must be low enough to allow free discharge from the interceptors to the Headworks, but also high enough to be above the CT Department of Energy and Environmental Protection (DEEP) mandated flood protection elevations.

- The facility should be designed to withstand the velocities and sediment loading associated with wet weather flow.
- The facility should be designed to efficiently provide free flowing conditions across the range of flows expected at the WPCF.
- Screening channels must be free-flowing to avoid surcharging the Yantic Interceptor or reducing upstream PS capacities. The facility should be designed to monitor liquid level at the screening channels and automatically increase cleaning rates or bring more screening channels on line in the event of elevated liquid levels.
- The facility will need fine screening capabilities to facilitate the wet weather treatment processes proposed in this section.
- The facility should have adequate screenings storage to accommodate prolonged wet weather flow and pump-out of upstream storage.

Grit removal mechanical details such as number and type of units and the structure sizes will be considered in a future design. However, the following conceptual issues should be considered in any future grit removal design:

- The facility should be designed to receive sediment loads associated with wet weather flow.
- The facility should provide high removal efficiency to protect downstream processes.
- The facility should provide free flowing conditions across the range of flows expected at the WPCF.
- The facility should have adequate grit storage, handling and disposal capabilities to accommodate prolonged wet weather flow and pump-out of upstream storage.

A fundamental issue not addressed in this report is the type of grit removal system to be installed. Aerated grit removal technology is currently utilized at the WPCF, but the 2015 design included a vortex type removal system. Technology selection for basic grit removal is not the focus of this document and will be left for a future design.

8.5.3.2 Wet Weather Treatment

CSO alternatives that include flows to the plant above 20 mgd are beyond the capacity of the base WPCF upgrades. An HRC facility is recommended for wet weather treatment.

Design of the HRC facility at the WPCF should consider the reduced treatment efficiency that will be experienced during startup. It may prove beneficial to start running the wet weather treatment facility before flow to the secondary process exceeds 20 mgd so that wet weather treatment is functioning at full effectiveness during periods when flows peak above 20 mgd.

It is anticipated that HRC effluent will need to be disinfected on a seasonal basis prior to discharge to the Thames and Yantic Rivers to remain consistent with current requirements. NPU currently disinfects effluent using sodium hypochlorite at a chlorine contact tank. Upgrades to the plant may include a transition to UV. Dechlorination is not required. Effluent from the HRC

process may continue to be disinfected in this fashion, provided there is sufficient contact time for increased flows. For planning purposes, UV disinfection will be considered as the primary option given the relatively small footprint required and the fact that chemicals for chlorination and potential future dechlorination would not be needed.

To limit costs of outfall construction, effluent from the HRC facility is proposed to be blended with effluent from secondary processes and discharged via the existing outfalls pending approval from regulators. Final configuration of the HRC facility and seasonal disinfection system should be evaluated during the WPCF Facility Plan Update and during detailed design to consider both the effluent quality limits of the HRC facility and the effect of HRC effluent on the blended effluent from the HRC and secondary processes. Future design should also consider the adequacy of the current outfall for high flows. A new outfall is recommended only if the existing outfall proves inadequate to handle the proposed flow rates, operational benefits are realized during the design process, or National Pollutant Discharge Elimination System (NPDES) permit requirements or DEEP require separate outfalls.

Future design should also consider the need for an effluent pumping station, as the plant may not be able to convey high flow when discharging to high river stage. The PS should be able to pump all flow it receives, but only when pumping is required.

8.6 Citywide CSO Control Alternatives

This section considers the effectiveness and anticipated impacts associated with each of the area-specific solutions described above and combines the solutions to create alternatives that manage CSO citywide. Solutions for each area of the city are combined to create alternatives that, with components scaled up or down in size, achieve varying levels of CSO control.

8.6.1 Alternative 1 – Conveyance and Centralized Treatment

The first set of CSO control alternatives combines the conveyance options from every area of the city. For these alternatives, capacity of the WPCF is increased up to the maximum the available land can support, 80 mgd. To achieve CSO control throughout the system, the first objective is to increase conveyance capacity to convey total flows to the WPCF. For larger design storms, incoming system flows exceed even the increased capacity of the plant and storage is required to manage the excess flows.

When the separate solutions for each area are combined, some modifications are needed to adjust for the solutions' effects on their common downstream conditions. For the 1-month through 6-month storms, all flows from each area can be conveyed to the WPCF. The required WPCF capacities for these three storms are 35 mgd, 49 mgd, and 80 mgd, and the required Rose Alley PS capacities are 26 mgd, 38 mgd, and 61 mgd. For larger storms, if pump stations in each area are upgraded to convey all flows, the 80 mgd capacity of the expanded WPCF will be exceeded. For the 1-year and 2-year storms, storage at the Rose Alley commuter lot is sufficient for holding back the maximum flows from Rose Alley PS and allows flows from Thamesville and Laurel Hill to be pumped directly downstream. In the 5-year storm, flows from Thamesville become so high that they take up over a quarter of the capacity at the WPCF and a small storage tank in Thamesville becomes necessary. To manage CSO to a 5-year level of control in Thamesville, 23 mgd would need to be pumped to the WPCF. In comparison, if there were no storage in Rose Alley, in the 5-

year storm, 144 mgd would reach Rose Alley PS. Rather than construct a second storage tank on the Shetucket to hold back these large flows, a storage tank in Thamesville can help achieve the same level of systemwide control and can be constructed for a lower cost and with a smaller impact than a second Shetucket storage tank at the NPU yard. The 5-year solution therefore includes a 0.63 Mgal storage tank with a 12 mgd pump in Thamesville. The main components for each design storm using the conveyance strategy are summarized in Table 8-13.

In these alternatives, the required WPCF wet weather capacity ranges from 35 mgd in the 1-month storm to 80 mgd in the 6-month through 5-year storms. These increases in treatment plant capacity beyond the 20 mgd capacity that was recommended in Section 3 are achieved by utilizing a high rate clarification (HRC) facility at Hollyhock Island for additional wet weather treatment. Conveying flows from each part of the city to the upgraded WPCF minimizes construction costs associated with storage tanks, particularly those in challenging locations (as in Laurel Hill and the NPU yard) or with potentially contaminated soils (NPU yard). Reducing the number of storage tanks by prioritizing the conveyance of wet weather flows eases the operation and maintenance burden on NPU staff. At the same time, additional staff would likely be required to manage the enlarged WPCF. This alternative does not include private or public inflow removal, reducing construction impacts by not requiring construction on every street and/or adjusting sewer or drainage connections from private properties. Without any type of inflow removal, stormwater flows from the combined areas will pass through the WPCF for wet weather treatment, rather than discharging untreated to the river as would occur if inflows were separated. Despite these benefits, these alternatives will have large, expensive pumping stations. The construction of the relief pipe will disrupt traffic, particularly at the intersection of Main Street and North Main Street/Route 12. The expansion of wet weather capacity at the WPCF will also add significantly to the costs of these alternatives. Costs are presented in Section 8.7.

Table 8-13: Components of Comprehensive Conveyance Alternatives

Component		Control Level					
		1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Thamesville	Shipping Street PS (mgd)	3.5	3.5	3.5	3.5	3.5	7
	Shipping Street FM (diameter, inches)	12	12	12	12	12	18
	South Thames Street PS(Existing Location, mgd)	5	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned
	Relocated Thamesville PS (mgd)	NA	10	14	15	16	NA
	Storage Tank (Mgal)	NA	NA	NA	NA	NA	0.63
	Storage Tank Pump (mgd)	NA	NA	NA	NA	NA	12
	Thamesville FM (diameter, inches)	12	18	20	24	24	20
	West Thames Street Relief Pipe (diameter, inches)	15	21	24	24	24	30
	Separation	NA	NA	NA	NA	NA	NA
Laurel Hill	River Ave PS (mgd)	4	4	10	10	12	18
	River Ave FM (diameter, inches)	14	14	20	18	20	24
	Storage Tank	NA	NA	NA	NA	NA	NA
	Storage Tank Pump	NA	NA	NA	NA	NA	NA
	Gravity Pipe to Shetucket	NA	NA	NA	NA	NA	NA
	Pipe Replacement Along Railroad (length, feet)	31	141	141	141	743	953
	Pipe over Bridge to Shetucket (diameter, inches)	As-is	As-is	30	30	36	36
	Separation	NA	NA	NA	NA	NA	NA
Shetucket	Rose Alley Lot Storage (Mgal)	NA	NA	NA	0.35	0.90	2.02
	Rose Alley Lot Storage Pump (mgd)	NA	NA	NA	0.35	2	4
	Re-Route Shetucket to Accommodate Storage	No	No	NA	No	No	Yes
	NPU Storage	NA	NA	NA	NA	NA	NA
	NPU Storage Pump	NA	NA	NA	NA	NA	NA
	Shetucket Relief Pipe (diameter, inches)	NA	NA	30 to 48	30 to 48	36 to 48	42 to 60
	Relief Culvert from Rose Alley PS	NA	NA	NA	NA	NA	NA
	Rose Alley PS (mgd)	26	38	61	64	65	70
	Rose Alley FM (diameter, inches)	30	36	42	42	42	42
	WPCF Capacity (mgd)	35	49	80	80	80	80
	Separation	NA	NA	NA	NA	NA	NA

8.6.2 Alternative 2 – Storage

The second set of CSO control alternatives combines the storage options from every area of the city to achieve citywide CSO control. These alternatives maintain existing WPCF and Rose Alley PS capacities and focus on managing excess flows using storage facilities. The size and number of storage tanks required varies with the size of the design storm controlled. For the largest, 5-year storm, peak flows are so large that the WPCF capacity must be increased.

In Norwich, limited capacity of conveyance pipes poses a challenge for CSO planning. Pipes throughout the system were not originally designed to convey the full system peak flows, as the overflows are designed to relieve the system under these conditions. Therefore, storage alternatives include increased conveyance to transport flows into the storage tanks. Increased conveyance ranges from increasing the size of dry weather flow connector pipes to constructing a parallel relief interceptor for the larger storms.

Appendix B describes the process for identifying potential storage sites in Norwich and assessing which are most feasible. Based on this assessment, the storage alternatives include storage tanks in up to four locations:

- The Rose Alley commuter lot (maximum capacity of 3.0 Mgal),
- The NPU facilities lot (maximum capacity of 2.24 Mgal),
- The park at the intersection of Laurel Hill Avenue and Center Street (maximum capacity of 1.05 Mgal), and
- The vacant lot on the eastern side of Thames Street and north of a condominium complex (maximum capacity of 0.63 Mgal).

The general strategy for development of the storage alternatives was to minimize the number and size of storage tanks required for each level of control to limit capital and O&M costs and ease the O&M burden on NPU staff. With the constraint that the WPCF maintain its existing capacity, the three areas must be managed so that a maximum of 20 mgd reaches the WPCF. To manage CSO for smaller design storms, storage can be strategically employed in one area of the city to allow other areas to discharge their full flow downstream. For larger storms with higher peak flow, storage will be required at multiple sites to hold back flow.

When flows in the system exceed conveyance and treatment capacity, the first location storage is proposed is in the Rose Alley commuter lot. The Rose Alley commuter lot has the most available area for storage and the Rose Alley PS, just downstream, contributes the most flow to the WPCF. The construction of a storage tank in this lot will hold back Shetucket Interceptor flows until after peak passes through the PS and the WPCF. Combined with increased conveyance in other areas of the city, one storage tank at the Rose Alley commuter lot is sufficient to manage CSO to a 1-month level of control.

For the 3-month design storm, a second storage tank is necessary and is added in Thamesville. The South Thames Street PS in Thamesville would need to be upgraded to 10 mgd to pass the 3-month storm, which would take up half the capacity of the WPCF and prevent Rose Alley PS from being able to operate at its capacity during wet weather. A storage tank here reduces the peak

flows from Thamesville to 4 mgd, freeing up capacity at the WPCF for other areas. A storage tank in Thamesville is needed in the 3-month through 5-year storage alternatives.

For the 6-month design storm, a third storage tank is added in Laurel Hill. In the 6-month storm, 10 mgd would need to be pumped from River Avenue PS to Rose Alley PS to manage CSO, which, combined with flows from Downtown, would overwhelm Rose Alley PS. A storage tank in Laurel Hill can reduce peak flows to the Shetucket Interceptor to approximately 1 mgd, freeing up capacity at Rose Alley PS for flows from Downtown and the Shetucket Interceptor. A storage tank in Laurel Hill is needed in the 6-month through 5-year storage alternatives.

In the 1-year through 5-year design storms, CSO volumes on the Shetucket exceed what can be stored at the commuter lot and additional storage is required upstream at the NPU facilities site. Adding storage at the NPU site is a last alternative due to the difficult nature of construction at this site. The lot is used by NPU staff for storing and maintaining vehicles. Additionally, the soil on this site is expected to be contaminated and may require off-site disposal. A storage tank at the NPU yard is needed in the 1-year through 5-year storage alternatives.

Storage tanks alone are not sufficient to manage the 5-year storm, and the capacities of the WPCF and Rose Alley PS must be increased to manage CSOs to a 5-year level of control. For all design storms, necessary upgrades are assumed at the WPCF to manage 20 mgd as discussed previously. Any alternative that exceeds the 20 mgd treatment capacity of the upgraded WPCF includes an HRC facility for additional wet weather treatment. Table 8-14 summarizes the main components of the storage alternatives for each level of control.

The 1-month through 2-year alternatives also manage CSO with 20 mgd WPCF capacity, reducing the costs associated with WPCF wet weather flow upgrades. These alternatives do not include private or public inflow removal, reducing construction impacts by not requiring construction on every street and/or adjusting sewer or drainage connections from private properties. Without any type of inflow removal, stormwater flows from the combined areas will pass through the WPCF for wet weather treatment, rather than discharging untreated to the river as would occur if inflows were separated. Despite these benefits, these alternatives will have large, and in some cases, multiple, storage tanks. While the number of storage tanks for each level of control was minimized, the operation of each storage tank requires additional, trained NPU staff. The NPU facilities yard may contain contaminated soils that would be more challenging and costly to manage during construction. The construction of storage tanks in the Rose Alley commuter lot and the NPU yard will drastically impact the normal activities occurring at these sites. Parking in the lot will be limited and NPU will need to relocate their activities. As noted in the conveyance alternatives description, the construction of the relief pipe will disrupt traffic, particularly at the intersection of Main Street and North Main Street/Route 12. The expansion of wet weather capacity at the WPCF to attain 5-year control will also add significantly to the costs of this alternatives. Costs are presented in Section 8.7.

Table 8-14 Components of Comprehensive Storage Alternatives

Component		Control Level					
		1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Thamesville	Shipping Street PS (mgd)	3.5	3.5	3.5	3.5	3.5	7
	Shipping Street FM (diameter, inches)	12	12	12	12	12	18
	South Thames Street PS (Existing Location, mgd)	5	Abandoned	Abandoned	Abandoned	Abandoned	Abandoned
	Relocated Thamesville PS	NA	NA	NA	NA	NA	NA
	Thamesville Storage Tank (Mgal)	NA	0.26	0.42	0.63	0.63	0.63
	Thamesville Storage Tank Pump (mgd)	NA	4	4	4	4	9
	Thamesville FM (diameter, inches)	12	12	12	12	12	18
	West Thames Street Relief Pipe (diameter, inches)	15	21	24	24	24	30
	Separation	NA	NA	NA	NA	NA	NA
Laurel Hill	River Ave PS (mgd)	4	4	10	10	11	18
	River Ave FM (diameter, inches)	14	14	18	18	18	24
	Storage Tank (Mgal)	NA	NA	0.53	0.84	1.05	1.05
	Storage Tank Pump (mgd)	NA	NA	1	1	1	1
	Gravity Pipe to Shetucket (diameter, inches)	NA	NA	12	12	12	18
	Pipe Replacement Along Railroad (length, feet)	97	141	141	532	743	953
	Pipe over Bridge to Shetucket	As-is	As-is	As-is	As-is	As-is	As-is
	Separation	NA	NA	NA	NA	NA	NA
Shetucket	Rose Alley Lot Storage (Mgal)	1	1.45	3	2.3	3	2.69
	Rose Alley Lot Storage Pump (mgd)	2	2	4	4	4	4
	Re-Route Shetucket to Accommodate Storage	No	No	Yes	Yes	Yes	Yes
	NPU Storage (Mgal)	NA	NA	NA	1.31	2.24	1.62
	NPU Storage Pump (mgd)	NA	NA	NA	1	1	1
	Shetucket Relief Pipe (diameter, inches)	NA	NA	30 to 42	30 to 36	30 to 42	30 to 60
	Relief Culvert from Rose Alley PS (diameter, inches)	NA	24	24	30	30 to 36	36
	Rose Alley PS (mgd)	As-is	As-is	As-is	As-is	As-is	40
	Rose Alley FM (diameter, inches)	As-is	As-is	As-is	As-is	As-is	42
	WPCF Capacity (mgd)	20	20	20	20	20	49
	Separation	NA	NA	NA	NA	NA	NA

8.6.3 Alternative 3 – Public Inflow Removal in Thamesville with Storage as Needed

The third set of alternatives also maintains existing WPCF capacity but aims to reduce the storage volume required by using local public inflow removal in areas where it appears to be most cost effective. These alternatives combine the public inflow removal solution in Thamesville with the storage solutions in Laurel Hill and along the Shetucket. Section 6 and Section 8.2.1 identified public inflow removal in Thamesville as promising due to development being less dense than in other areas of the city and the reduction in CSO predicted by the collection system model. After public inflow is removed, remaining wet weather flows for small design storms are small enough that they can be pumped downstream to the WPCF and not take up too large a portion of the WPCF's capacity. To make up for the increase in flows to the WPCF from Thamesville, additional flow from the Shetucket can be held back in storage. In the larger storms, a small storage tank is needed in Thamesville to dampen the flow rate sent to the WPCF.

These alternatives, combining public inflow removal in Thamesville with satellite storage facilities, were developed for the 3-month, 6-month, 1-year, and 2-year levels of control to demonstrate how this alternative would work for the DEEP desired level of control and three intermediate levels of control. For the 3-month storm, public inflow removal is implemented in Thamesville and the remaining wet weather flows can be handled with the existing South Thames Street PS and FM. The relief pipe down West Thames Street to the South Thames Street PS must be 15-inch. With the same peak flow rate reaching the WPCF from Thamesville as in the 3-month storage solution, the 3-month storage solutions in Laurel Hill and along the Shetucket described in the previous sections can be implemented in combination with the public inflow removal solution in Thamesville.

For the 6-month storm, a larger, 7 mgd PS is needed to convey remaining wet weather flows from Thamesville to the WPCF. This size PS requires more land area than is available at the current South Thames Street PS site and must be constructed in the vacant lot to the north. The WPCF can accept the full 7 mgd from Thamesville by holding additional flows back from Rose Alley PS at the Rose Alley commuter lot. The 6-month storage solutions in Laurel Hill and along the Shetucket, with some modifications in sizing of components, can be combined with this solution in Thamesville to achieve citywide CSO control at the 6-month level.

In the 1-year storm, a 0.42 Mgal storage tank in Thamesville is required to reduce the area's peak flow from 9 mgd to 1 mgd. With only 1 mgd from Thamesville, additional flow can be sent to the WPCF from Rose Alley PS, so that only one storage tank at the Rose Alley commuter lot is required. In the storage only, 1-year alternative (Section 8.5.2), peak flow from the Thamesville storage tank is 4 mgd, requiring a second storage tank at the NPU yard to hold back additional flow from Rose Alley PS. A storage tank is also needed in Laurel Hill.

In the 2-year storm, a 0.16 Mgal tank is used to reduce peak flows from Thamesville to the WPCF from 9.3 mgd to 4 mgd. This solution in Thamesville is combined with the 2-year storage solutions in Laurel Hill and along the Shetucket to control CSO to a 2-year level. The maximum storage tank sizes are needed in Laurel Hill and along the Shetucket, to hold back high flows. For the 2-year solution, the benefit of the public inflow reduction in Thamesville is seen in the reduction in size of the Thamesville storage tank.

This set of alternatives resembles the all-storage alternatives, except storage in Thamesville is eliminated or reduced because the cost to remove public inflow in Thamesville is similar to the cost of the necessary storage infrastructure. By removing public inflow, a storage tank in Thamesville is not needed until the 1-year storm. For these smaller storms, NPU does not have the operation and maintenance requirements associated with a Thamesville storage tank; they would, however, need to operate and maintain the existing or an upgraded PS. Outside of Thamesville, the system has the benefit of having less overall flow which can mean more flow from other parts of the city can be sent to the treatment plant. One downside of this solution, is the separated stormwater flows in Thamesville will be discharged directly to the river, whereas in the conveyance or storage alternatives, they are eventually treated at the WPCF. Overall though, the solutions in Laurel Hill and the area draining to the Shetucket are very similar to what is required in the all storage alternatives, with some variation in sizing. Components required in Alternative 3 under different design storms are shown in Table 8-15. Costs are presented in Section 8.7.

Table 8-15: Components of Alternative Set 3 with Public Inflow Removal in Thamesville and Storage as Needed

Component		Control Level					
		1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Thamesville	Shipping Street PS (mgd)		3.5	3.5	3.5	3.5	
	Shipping Street FM (diameter, inches)		12	12	12	12	
	South Thames Street PS (Existing Location)		As-is	Abandoned	Abandoned	Abandoned	
	Relocated Thamesville PS (mgd)		NA	7	NA	NA	
	Thamesville Storage Tank (Mgal)		NA	NA	0.42	0.16	
	Thamesville Storage Tank Pump (mgd)		NA	NA	1	4	
	Thamesville FM (diameter, inches)		As-is	18	12	12	
	West Thames Street Relief Pipe (diameter, inches)		15	18	20	20	
	Separation		Public Inflow Removal	Public Inflow Removal	Public Inflow Removal	Public Inflow Removal	
Laurel Hill	River Ave PS (mgd)		4	10	10	11	
	River Ave FM (diameter, inches)		14	18	18	18	
	Storage Tank (Mgal)		NA	0.34	0.72	1.05	
	Storage Tank Pump (mgd)		NA	1	1	1	
	Gravity Pipe to Shetucket (diameter, inches)		NA	12	12	12	
	Pipe Replacement Along Railroad (length, feet)		As-is	141.3	532.8	744.1	
	Pipe over Bridge to Shetucket (diameter, inches)		As-is	As-is	As-is	18	
	Separation		NA	NA	NA	NA	
Shetucket	Rose Alley Lot Storage (Mgal)		1.38	1.9	3	3	
	Rose Alley Lot Storage Pump (mgd)		2	4	4	4	
	Re-Route Shetucket to Accommodate Storage		No	Yes	Yes	Yes	
	NPU Storage (Mgal)		NA	NA	NA	2.24	
	NPU Storage Pump (mgd)		NA	NA	NA	1	
	Shetucket Relief Pipe (diameter, inches)		NA	30 to 42	36 to 48	30 to 42	
	Relief Culvert from Rose Alley PS (diameter, inches)		24	24	30	30	
	Rose Alley PS (mgd)		As-is	As-is	As-is	As-is	
	Rose Alley FM (diameter, inches)		As-is	As-is	As-is	As-is	
	WPCF Capacity (mgd)		20	20	20	20	
	Separation		NA	NA	NA	NA	

8.6.4 Alternative 4 – Public Inflow Removal in Thamesville and Laurel Hill with Storage as Needed

The fourth set of alternatives resembles the third set in that it maintains existing WPCF capacity and aims to reduce storage volume required by using local public inflow removal in areas where it appears to be most cost effective. These alternatives remove public inflow in Laurel Hill in addition to Thamesville, with storage elsewhere as needed to manage remaining flows. Section 6 and Section 8.3.2 also noted public inflow removal in Laurel Hill as promising and worth being investigated further as part of a hybrid alternative. Constructing storage in Laurel Hill is challenging due to a lack of feasible storage sites. The best storage site requires a pump station to pump against roughly 70 ft of head to the top of a hill; a new, 920-ft force main; and a new, 2,150-ft gravity line. Alternatively, public inflow removal appears promising in Laurel Hill due to development being less dense than in other areas of the city and the substantial reduction in CSO predicted by the collection system model. Furthermore, because Laurel Hill flows to the Shetucket Interceptor then to Rose Alley PS, the wet weather flows from Laurel Hill that remain after public inflow removal can be accommodated at Rose Alley PS by holding back additional flows from the Shetucket Interceptor with storage at the Rose Alley commuter lot. (Doing this the other way, with public inflow removal in the areas draining to the Shetucket and storage in Laurel Hill, would be far more costly and likely unable to reduce flows to Rose Alley sufficiently since Shetucket flows are so much higher.)

This set of alternatives was developed for the 3-month, 6-month, and 2-year levels of control. For the 3-month level of control, public inflow is removed in Thamesville and Laurel Hill. In both areas of the city, no additional work is required beyond the "Necessary Upgrades" described in previous sections. In Thamesville, the existing South Thames Street PS and FM are sufficient to pass the reduced wet weather flows, and a 15-in relief pipe down West Thames Street is required to convey flow to the PS. In Laurel Hill, River Avenue PS must be upgraded to 4 mgd and the 14-inch FM can be replaced to follow the existing route to the Shetucket Interceptor in the north. Along the Shetucket, the 3-month Shetucket storage solution described in Section 8.4.4 can be used in combination with the public inflow removal solutions in Thamesville and Laurel Hill.

For the 6-month storm, Thamesville requires a 7 mgd PS to replace the existing South Thames Street PS. The PS must be relocated to the vacant lot to the north. The FM and relief pipe must be 18-inch to pass the remaining wet weather flows. In Laurel Hill, River Avenue PS must be upgraded to 5 mgd with a 15-inch FM to pass the remaining wet weather flows. Along the railroad, 141 ft of dry weather flow pipe must be replaced with larger pipe. The storage solution along the Shetucket is like the 6-month Shetucket storage solution with some variation in component size.

For the 2-year storm, a small storage tank is needed in Thamesville to reduce the flow rate to the WPCF. With a 0.43 Mgal tank, the maximum flow rate reaching the WPCF is 1 mgd. An 8-inch FM is required to pass this pumping rate, and a 20-inch relief pipe down West Thames Street is needed to convey flows to the storage tank and pump. In Laurel Hill, River Avenue PS must be upgraded to 6 mgd with a 15-inch FM following the existing route. No storage is needed, as this flow can be conveyed directly to the Shetucket Interceptor and Rose Alley PS. Along the Shetucket, the storage solution is similar to the 2-year Shetucket storage solution.

One downside of this solution, is the separated stormwater flows in Thamesville will be discharged directly to the river, whereas in the conveyance or storage alternatives, they are eventually treated at the WPCF.

As with alternative set 4 discussed above, these alternatives remove public inflow in areas where it is expected the cost of inflow reduction will be similar to the cost of storing and slowly releasing flows. The need for a storage tank in Thamesville is eliminated through the 6-month storm. In Laurel Hill, a storage tank is not even needed to achieve 2-year control. This reduces the required size of River Avenue PS and eliminates the need to have it pump up to the storage tank at the top of the hill. Reducing the number of storage tanks in these solutions eliminates operation and maintenance requirements for NPU; they would, however, need to operate and maintain the existing or upgraded pump stations. One downside of this solution, is the separated stormwater flows in Thamesville and Laurel Hill will be discharged directly to the Thames river, whereas in the conveyance or storage alternatives, they are eventually treated at the WPCF. Overall, the solutions in the area draining to the Shetucket are very similar to what is required in the all storage alternatives, with some variation in sizing. Components of the Alternative 3 variations for different design storms are presented in Table 8-16. Costs are presented in Section 8.7.

Table 8-16: Components of Alternative Set 4 with Public Inflow Removal in Thamesville and Laurel Hill with Storage as Needed

Component		Control Level					
		1-Month	3-Month	6-Month	1-Year	2-Year	5-Year
Thamesville	Shipping Street PS (mgd)		3.5	3.5		3.5	
	Shipping Street FM (diameter, inches)		12	12		12	
	South Thames Street PS (Existing Location)		As-is	Abandoned		Abandoned	
	Relocated Thamesville PS (mgd)		NA	7		NA	
	Thamesville Storage Tank (Mgal)		NA	NA		0.43	
	Thamesville Storage Tank Pump (mgd)		NA	NA		1	
	Thamesville FM (diameter, inches)		As-is	18		8	
	West Thames Street Relief Pipe (diameter, inches)		15	18		20	
	Separation		Public Inflow Removal	Public Inflow Removal		Public Inflow Removal	
Laurel Hill	River Ave PS (mgd)		4	5		6	
	River Ave FM (diameter, inches)		14	15		15	
	Storage Tank		NA	NA		NA	
	Storage Tank Pump		NA	NA		NA	
	Gravity Pipe to Shetucket		NA	NA		NA	
	Pipe Replacement Along Railroad (length, feet)		As-is	141.3		141.3	
	Pipe over Bridge to Shetucket (diameter, inches)		As-is	As-is		18	
	Separation		Public Inflow Removal	Public Inflow Removal		Public Inflow Removal	
Shetucket	Rose Alley Lot Storage (Mgal)		1.38	1.9		3	
	Rose Alley Lot Storage Pump (mgd)		2	4		4	
	Re-Route Shetucket to Accommodate Storage		No	Yes		Yes	
	NPU Storage (Mgal)		NA	NA		2.24	
	NPU Storage Pump (mgd)		NA	NA		1	
	Shetucket Relief Pipe (diameter, inches)		NA	30 to 42		30 to 42	
	Relief Culvert from Rose Alley PS (diameter, inches)		24	24		30	
	Rose Alley PS (mgd)		As-is	As-is		As-is	
	Rose Alley FM (diameter, inches)		As-is	As-is		As-is	
	WPCF Capacity (mgd)		20	20		20	
	Separation		NA	NA		NA	

8.6.5 Alternative 5 – Complete Public and Private Separation

As described in section 6 and again in Section 8.2 through 8.4, complete public and private separation is necessary to manage CSO to a 5-year level of control. This would require extensive and intrusive construction in roadways and on private properties. Components of this work include new storm drains or sewer pipes, disconnection of all private inflows, pipe rehabilitation (when the combined sewer becomes the sanitary sewer, 100 percent sewer lining is required), and new catch basins and river outfalls. This type of construction will cause disruption from digging up roads, changing traffic patterns, restricting access to commercial establishments, and disrupting other utilities. One benefit of this work however, is that no storage tanks are required, and pumping stations can stay close to their existing capacity, and the WPCF does not require additional wet weather capacity beyond the 20 mgd described above. This also limits O&M costs for pumping and treatment systems. Furthermore, aging sewer infrastructure can be upgraded or replaced. This includes other nearby underground utilities (such as water mains) and surface pavement. However, by separating the drainage and sewage systems, untreated stormwater would be discharged to waterways. If complete public and private separation were accompanied by CSO closure, sanitary sewer overflows (SSOs) would occur in large storms since there is no longer relief to receiving rivers. The SSOs could occur out of manholes in roadways and grassy areas or in buildings if sewage backs up from the main line into the sewer connection. Depending on the location, SSOs may pose a more acute public health risk than a CSO to the river.

8.7 Cost Analysis

8.7.1 Cost Estimating Methodology

Following the development of each of the alternatives under the different design storm conditions, a planning level cost was developed for each alternative. Details on the components of each alternative were extracted from the model and used for cost estimating. These components included pipe size, pipe length, pipe depth, facility sizes, acres of inflow reduction, and other relevant information for cost estimating.

An inventory list was created for each alternative that included all the components needed for that specific alternative. Costs for components were estimated using base costs described in Section 8.7.1.1. In addition to the base costs, additional costs were added for special conditions, as described in Section 8.7.1.2. A total cost for each alternative was estimated by the sum of all its components with project contingency and an engineering cost (described in Section 8.7.1.3) added on top of the cost of the components. The total costs of each alternative can be seen in Section 8.7.2.

8.7.1.1 Base Costs

CDM Smith established base costs for pipe, facilities, and inflow removal based upon real project bid costs seen in other areas of the Northeast. All costs were escalated to FY 2018 US dollars.

Construction costs for sewer and drain pipe were established primarily based on projects in the Hartford area. These costs per linear foot of pipe can be seen in Table 8-17. Construction of pipeline projects in the Hartford are typically higher than other small cities in New England because of local regulations and construction challenges. CDM Smith believes these costs are appropriate for planning level costs in Norwich since the two cities are only 40 miles apart and

there is a level of expected difficulty of construction in Norwich. The topography of Norwich is steep with rocky slopes descending toward the Yantic, Shetucket, and Thames River at the center of downtown. Construction in rock and near floodways presents challenges that will add complexity and cost to pipeline projects. When developing cost estimates, it is useful to have recent bids for similar projects for comparison. However, NPU has not bid pipeline projects similar to the scope of the proposed LTCP work in recent years. Cost estimates in future LTCP updates will have the benefit of data from construction projects in Norwich.

These base costs for pipeline work include trenching, pipe installation, manhole structures, service connections, utility relocation, backfill, and restoration. Since installing deep pipes has a significantly higher cost than installing shallow pipes, two depth classes were considered, 5 to 18 feet, and 19 to 30 feet deep. These pipe costs apply to all standard pipe materials including ductile iron, polyvinyl chloride, and prestressed concrete cylinder pipe. Cured-in-place pipe (CIPP) lining costs were included in this table for pipe rehabilitation costs.

Table 8-17 Base Costs for Pipeline Work (Dollars/Linear Foot)

Pipe Diameter (in)	Base Costs (Depth 5-18 Feet)	Base Costs (Depth 19-30 Feet)	CIPP Lining
6	$425	$1955	-
8	$555	$2000	$55
10	$595	$2040	$60
12	$640	$2085	$70
15	$680	$2210	$85
18	$850	$2550	$125
24	$1275	$3400	$250
30	$1700	$3615	$350
36	$2125	$3825	$400
42	$2550	$4335	$450
48	$2975	$4675	$500
54	$3190	$4890	$550
60	$3400	$5100	$600
66	$3615	$5315	$650
72	$3825	$5525	$700

Facility costs were established using EPA cost curves and curves developed for previous planning projects in New England. It is expected that facilities costs in Norwich will be comparable with these values. Costs for pumping, high rate clarification (HRC), and satellite storage are shown in Table 8-18**.** These costs were included in estimates for each alternative based on expected peak flows or required storage volumes. Costs for facilities that did not match these benchmark sizes were extrapolated to find the needed value.

Table 8-18 Base Costs for Facilities ($M, 2018)

Flow (mgd)	Volume (Mgal)	Pumping Cost ($M)	HRC Cost ($M)	Satellite Storage Tank ($M)
0.1	0.1	$0.2	$0.4	$1.6
0.2	0.2	$0.3	$0.6	$2.8
0.3	0.3	$0.3	$0.8	$3.9
0.4	0.4	$0.4	$0.9	$4.9
0.5	0.5	$0.5	$1.1	$5.9
0.6	0.6	$0.5	$1.2	$6.8
0.7	0.7	$0.6	$1.4	$7.8
0.8	0.8	$0.7	$1.5	$8.7
0.9	0.9	$0.7	$1.6	$9.6
1	1	$0.8	$1.7	$10.4
2	2	$1.2	$2.8	$18.5
3	3	$1.6	$3.6	$25.8
4	4	$2.0	$4.4	$32.8
5	5	$2.3	$5.1	$39.4
6	6	$2.6	$5.8	$45.8
7	7	$2.9	$6.4	$52.0
8	8	$3.2	$7.0	$58.1
9	9	$3.5	$7.6	$64.1
10	10	$3.7	$8.2	$69.9
20	20	$6.0	$13.0	$123.9
30	30	$8.0	$17.1	$173.1
40	40	$9.8	$20.7	$219.6
50	50	$11.4	$24.0	$264.0
60	60	$12.9	$27.1	$307.0
70	70	$14.4	$30.1	$348.6
80	80	$15.7	$32.9	$389.3
90	90	$17.1	$35.6	$429.1
100	100	$18.4	$38.2	$468.1

Costs for complete public and private separation and public inflow removal were developed based on bid results from multiple sources as presented in Tables 6-2 and 6-3. These costs were applied to alternatives that included inflow removal components. Applicable per acre costs were multiplied by the total acreage that received complete separation or public inflow removal under the alternative. These were considered as a component of these plans, in addition to other required components such as pipe, storage tanks, and pump stations.

8.7.1.2 Auxiliary Costs

In addition to the base costs included in final estimates for each alternative, allowances were included for costs beyond the base estimates that are expected to be incurred for the following items:

- Property purchase, where applicable
- Neighborhood disruption and redevelopment
- Disruption of business activities for construction
- Disruption of utility operations at NPU headquarters for facility construction
- Railroad crossings
- Hazardous soil removal
- Heavy dewatering
- Rock removal

These auxiliary costs were primarily added to alternatives that had a satellite storage facility or centralized treatment facility and would require significant disruption of both public and private areas to construct. A property purchase allowance was added in Thamesville to alternatives where there was a need to build on private property. The final three items on the above list were added in areas where CDM Smith expects to find soil contamination, high groundwater levels, or bedrock. This was determined based on available information from NPU, floodplain mapping resources, and limited boring data from the 1970s. A contingency was added to all costs to account for unforeseen expenditures as described below.

8.7.1.3 Contingency and Engineering Costs

Upon completion of estimating pipeline and facility base costs for each alternative, and addition of any auxiliary costs, a contingency and engineering value was added. A project contingency of 25 percent was added to the subtotals for each alternative, along with an engineering allowance of 20 percent of the sum of the alternative subtotal and project contingency. In total, this adds 50 percent to each alternative's cost.

8.7.2 Planning Level Costs of Alternatives

The final estimated planning cost for each alternative presented in Section 8.6 is shown in Table 8-19**.** These costs include base costs for piping and facilities, additional auxiliary costs as needed, and project contingency and engineering. All costs are presented in 2018 US dollars. The centralized treatment scenarios are shown in the table with a treatment capacity in mgd. This refers to the total capacity of both the treatment plant (assumed at 20 mgd after an upgrade as previously discussed) and any additional wet weather treatment capacity (i.e. HRC).

Table 8-19 Alternative Cost Estimates ($M, 2018)

Design Storm	Technology or Approach (Alternative Number), Description	Cost ($M)
5-Year Storm	(Alt 1) Conveyance and Centralized Treatment (80 mgd)	$231
	(Alt 2) Storage (53 mgd)	$280
	(Alt 5) Complete Public and Private Separation	$381
2-Year Storm	(Alt 1) Conveyance and Centralized Treatment (80 mgd)	$189
	(Alt 2) Storage	$200
	(Alt 3) Thamesville Public Inflow Removal, Storage	$205
	(Alt 4) Thamesville/Laurel Hill Public Inflow Removal, Storage	$197
1-Year Storm	(Alt 1) Conveyance and Centralized Treatment (80 mgd)	$178
	(Alt 2) Storage	$174
	(Alt 3) Thamesville Public Inflow Removal, Storage	$155
6-Month Storm	(Alt 1) Conveyance and Centralized Treatment (80 mgd)	$161
	(Alt 2) Storage	$137
	(Alt 3) Thamesville Public Inflow Removal, Storage	$129
	(Alt 4) Thamesville/Laurel Hill Public Inflow Removal, Storage	$129
3-Month Storm	(Alt 1) Conveyance and Centralized Treatment (49 mgd)	$97
	(Alt 2) Storage	$70
	(Alt 3) Thamesville Public Inflow Removal, Storage	$72
	(Alt 4) Thamesville/Laurel Hill Public Inflow Removal, Storage	$87
1-Month Storm	(Alt 1) Conveyance and Centralized Treatment (35 mgd)	$74
	(Alt 2) Storage	$50

The cost estimates above show that "storage" (which is really conveyance and storage as described above) is less expensive under the smaller design storms, but as storm size increases, other alternatives become more affordable. Conveyance and Centralized Treatment ultimately becomes the most affordable at the 2-year design storm control level.

8.7.3 Cost-Benefit & Knee-of-the-Curve Analysis

EPA's 1995 "Guidance for Long-Term Control Plan" guidance document recommends evaluation of present-worth cost values and measures of performance using cost/performance curves. The most common way to evaluate this is through "knee-of-the-curve" analysis. Knee-of-the-curve analysis acknowledges that incremental performance improvements become progressively smaller in relation to incremental increases in cost, i.e., marginal benefits diminish as control level and costs increase. Facility size and cost to capture increasingly rare storm events grows geometrically. The knee-of-the-curve identifies the point at which costs grow disproportionately with improvement in performance. The knee-of-the-curve measure is widely used to help size CSO control measures.

The cost/performance curves shown in Figure 8-23 and Figure 8-24 identify the knee-of-the-curve for two of the most promising control strategies, storage (Section 8.5.2) and centralized treatment (Section 8.5.1). These curves identify the average number of annual overflows on the x-axis and the estimated cost on the y-axis. The x-axis values are inversely proportional with the average recurrence intervals of the design storms. For example, 1-month control corresponds to 12 overflows per year, 3-month control corresponds with four overflows per year, and 1-year control corresponds with 1 overflow per year. The coordinate representing 60 overflows per year and zero cost is the baseline condition. The coordinate for 48 overflows per year is the anticipated system performance after implementation of the "Planned Projects". As described earlier, these projects are included in every proposed alternative. Thus, the planned projects are also included in all the cost estimates.

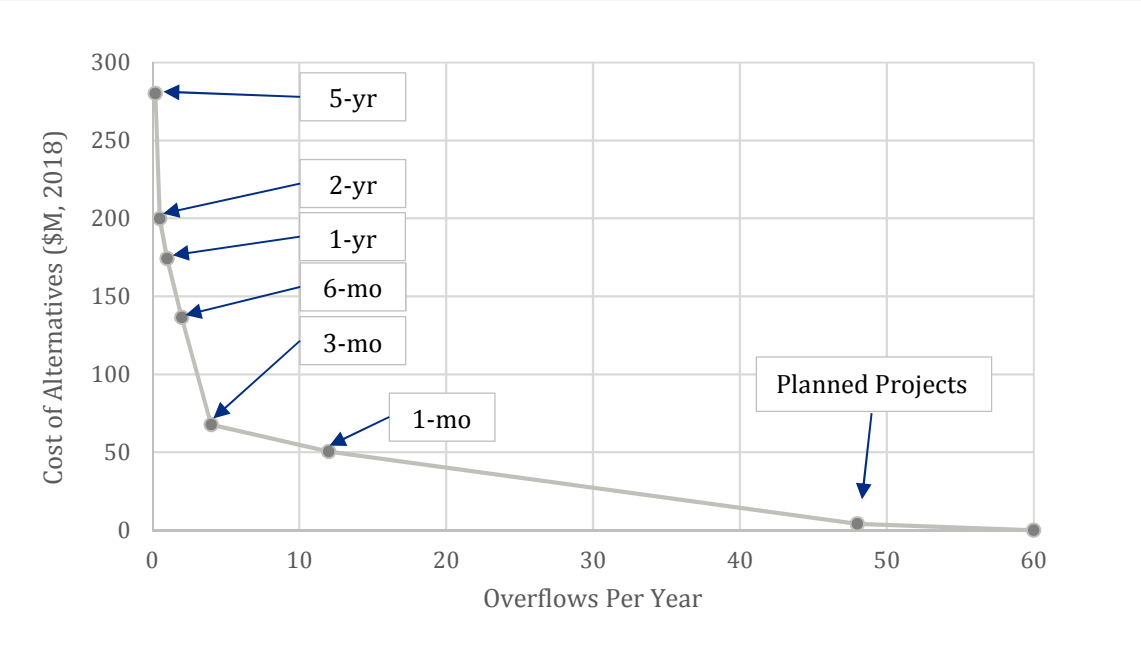


Figure 8-23
Cost vs. Performance for Storage

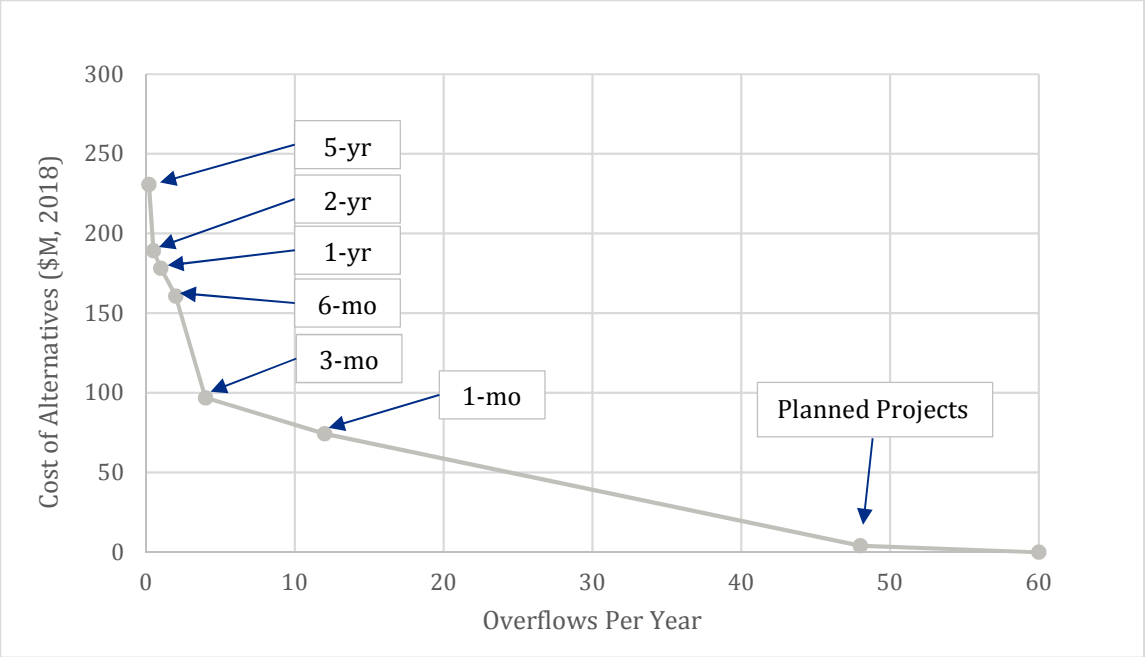


Figure 8-24
Cost vs. Performance for Conveyance and Centralized Treatment

Both figures show that costs increase dramatically beyond the 3-month control level. The 3-month control level is the knee-of-the-curve for both the storage and centralized treatment alternatives. The cost/performance curve shown in Figure 8-25 was developed using the least expensive alternative for each design storm.

The most cost-effective plans for each design storm are:

- 1-Month Storm, $50M, (Alt 2) Storage
- 3-Month Storm, $70M, (Alt 2) Storage
- 6-Month Storm, $128M, (Alt 3) Thamesville/Laurel Hill Public Inflow Removal, Storage
- 1-Year Storm, $155M, (Alt 3) Thamesville/Laurel Hill Public Inflow Removal, Storage
- 2-Year Storm, $189M, (Alt 1) Conveyance and Centralized Treatment (80 mgd)
- 5-Year Storm, $231M, (Alt 1) Conveyance and Centralized Treatment (80 mgd)

These costs represent the most affordable options developed to meet each control level. In Figure 8-25, the inflection point of the graph is also at four overflows per year (i.e. 3-month control). Three-month control appears as the inflection point at least partially due to the limited capacity of the Shetucket Interceptor. Under existing conditions, the Shetucket Interceptor can convey all flow in the 3-month design storm if some flow is stored in the underutilized upper sections. However, in the 6-month and larger storms, the Shetucket Interceptor cannot convey all flow it receives to Rose Alley PS, requiring significant cost to convey or limit these flows. The substantial

cost increases at the 6-month control level are due to the additional conveyance piping, storage tanks, or inflow removal needed to reduce or convey peak flows and mitigate CSO.

With 3-month control, NPU can expect 93 percent reduction in the number of CSO events, from the current average of 60 overflows to four events per year. As shown in Figure 8-25, advancing from 3- to 6-month control would cost almost as much as the improvement from existing conditions to 3-month control.

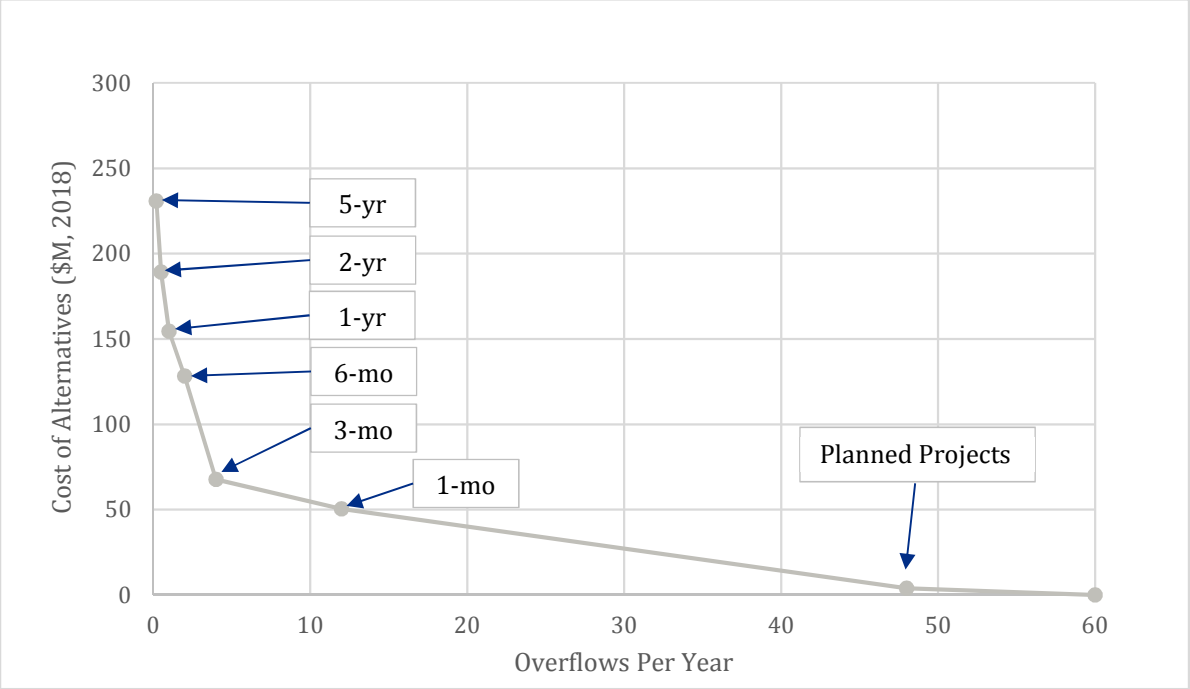


Figure 8-25
Cost vs. Performance for Most Affordable Alternatives

Annual CSO volume is another way to look at the knee-of-the-curve. Annual CSO volume has been plotted for the most affordable control alternatives as shown in Figure 8-26. The Baseline Conditions Report indicated that annual CSO averages 43.3 Mgal under existing conditions. Figure 8-26 depicts the annual volume reductions anticipated and respective cost at each control level. Again, we see that the 3-month level of control is the most cost-effective, and represents the inflection point of the knee-of-the-curve graph. Two-year control is estimated to cost nearly three times as much as 3-month control.

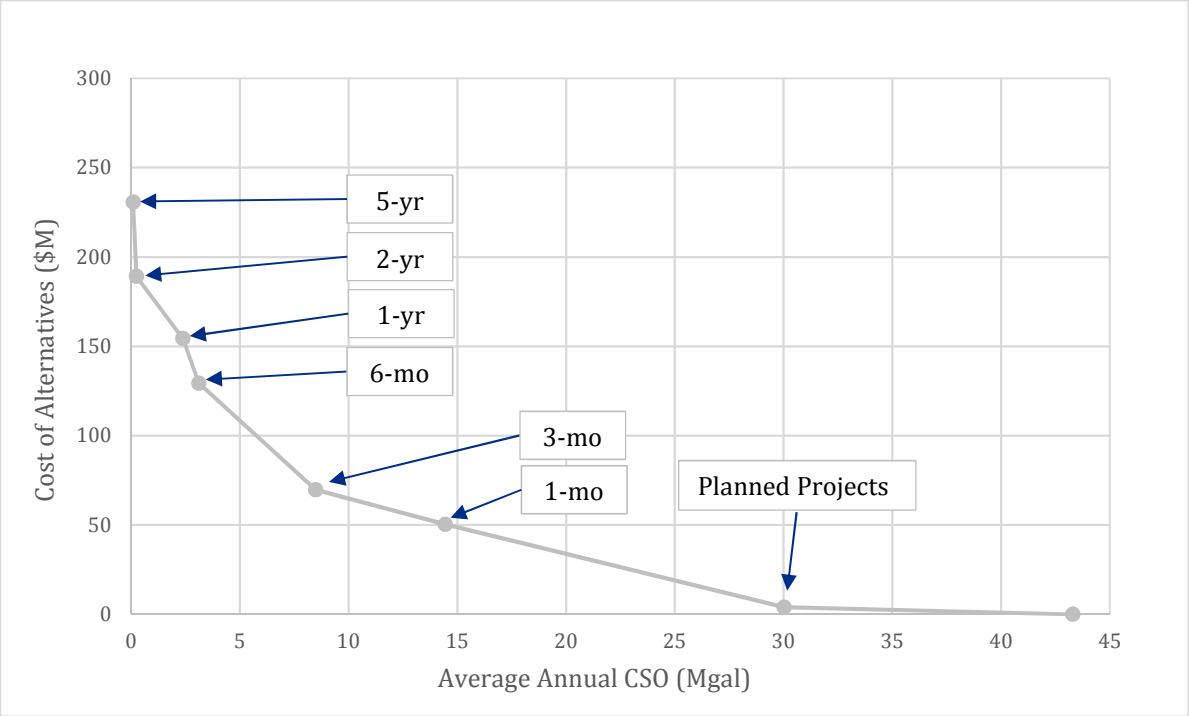


Figure 8-26
Cost vs. Performance for Most Affordable Alternatives (Mgal CSO)

8.8 Selection of Least Cost CSO Control Plans

As stated previously, the methodology of this report is predicated on a 2-year control target per the Consent Order. The least cost, and most cost effective, 2-year CSO control plan is Alternative 1 (Conveyance and Centralized Treatment to a total of 80 mgd). This 2-year control alternative is estimated at approximately $190 million, but this does not include other necessary infrastructure projects, including the WPCF improvements necessary to update the existing facility and increase its peak flow capacity to a nominal 20 mgd as discussed above and in Section 3. These basic and necessary WPCF improvements are estimated to add $80 million to any selected CSO alternative.

The least cost 2-year control plan was evaluated via a financial capability analysis as described in Section 9 of this report. However, as a result of this financial analysis, CDM Smith was forced to look at less costly control plans that could be implemented by NPU over a reasonable planning period (assumed to be 30 years as beyond this duration, CSO technology, economics, demographics, and other key factors are highly uncertain).

As the 3-month control level was the most cost effective plan overall, and corresponds to the knee-of-the-curve, this plan was also evaluated. The least cost, and most cost effective, 3-month CSO control plan is Alternative 2 (Conveyance and Storage). This 3-month control alternative is estimated at approximately $70 million. Again, the basic WPCF improvements add $80 million to this value. It is worth noting that this 3-month plan can be expanded and reconfigured to achieve 2-year control through addition of relief piping, larger pump stations, and centralized treatment to achieve the 2-year centralized treatment alternative selected above. Sections 9 and 10 explore the merits and limitations of these two plans further, and ultimately Section 10 selects a Recommended Plan.

Section 9

This section has been superseded by the revised 2020 CSO LTCP Report.

Section 9
Financial Capability Assessment

9.1 Introduction

This section presents the financial assessment of evaluated alternatives following the framework developed by the US Environmental Protection Agency (EPA) in *Combined Sewer Overflows — Guidance for Financial Capability Assessment and Schedule Development*, published in 1997 and updated in 2014. The first phase of the EPA financial capability assessment estimates the impact of anticipated capital improvements on the average residential ratepayer by evaluating the household burden. Household burden is a metric defined by EPA that assesses the typical residential sewer bill as a percent of a community's median household income (MHI). Under the EPA guidance process, a household burden exceeding two percent of MHI is deemed a high burden.

Based on discussions with the Connecticut Department of Energy and Environmental Protection (DEEP), the evaluation began with assessing achievement of a 2-year level of CSO control with a 20-year implementation schedule. This is a relatively high level of control compared with other regulatory authorities throughout the US, including EPA. The control level defined by the knee-of-the-curve analysis is often three months. However, the most affordable control alternative meeting the 2-year control target (Alt. 1, Conveyance and Centralized Treatment) is well beyond NPU's capacity to implement. After a detailed financial capability assessment, the household burden for 2-year control is projected to exceed 5 percent by 2037, and NPU ratepayers would face annual rate increases averaging over 10 percent across that entire period. CDM Smith then evaluated the alternative for a 2-year level of control with a 30-year implementation schedule. The projected household burden for this alternative exceeds 5 percent in 2047, with average annual rate increases of nearly 7.5 percent. This alternative, even with a longer schedule, is also beyond NPU's capacity to implement.

Having determined that the plan achieving 2-year level of control was not a feasible option within a reasonable planning horizon, focus shifted to the assessment for 3-month level of control. The 3-month level of control was targeted based on the knee-of-the-curve analysis presented in Section 8. Evaluation of the most affordable 3-month control plan began over a 20-year implementation period, with the results being a projected household burden of around 2.9 percent in FY 2039. In addition, the average annual projected rate increases would be approximately 6.6 percent over the next 20 years, which would pose a significant burden on its ratepayers.

The 3-month control plan was then evaluated over a 30-year implementation period. The projected household burden reaches 2.9 percent in FY 2049, which is nearly a full percent point higher than the threshold deemed affordable by the EPA. The average annual rate increase is approximately 5 percent for the next 20 years, and 4.9 percent for the next 30 years. While a 5 percent annual increase in rates and a household burden close to 3 percent is significant, NPU believes that this impact is more feasible than the other alternatives evaluated.

9.2 Methodology and Assumptions

This report and financial capability assessment has been prepared in accordance with EPA's financial capability assessment guidance document and standard industry practices. Data was obtained from various sources to develop a financial projection model to project the impact of the proposed capital program on future revenue requirements and rates for the City and its residents. All data used in this report have been gathered from NPU or credible public sources.

This financial capability assessment projects financial changes over a 30-year time frame. Given the forecasting horizon, numerous assumptions are necessary and have been used in this assessment. The critical assumptions used for this analysis are described below.

- Consistent with EPA guidance, only sewer and stormwater related costs are included in this analysis.
- Projections are based on cash basis; annual depreciation expense is not factored into revenue requirement.
- It is assumed NPU maintains an operating reserve equal to 2 months of annual operating expenses, and a debt service reserve fund balance equal to 2 months of annual debt service. The projections assume NPU meets a debt service coverage ratio of 120% on total annual debt service for all bond issues.
- The projections assume $486,000 in non-LTCP cash funded capital as an annual allowance for ongoing renewal and replacement (R&R). This represents the average cash-funded capital NPU carried for FY 2018 and FY 2019 for technology, main installations, service installations, manholes/frames/covers, and other capital categories.
- An annual allowance for Capacity, Management, Operation, and Maintenance (CMOM) programs and stormwater projects included:
    - $200,000 for CMOM, increasing annually over 10 years to a maximum of $500,000 per year
    - $100,000 for stormwater, increasing annually over 10 years to a maximum of $300,000 per year
    - Amounts are assumed cash funded
- Operating and maintenance (O&M) costs are assumed to inflate at an average annual rate of 3.0 percent.
- Capital costs are projected to increase at an average annual rate of 4.0 percent.
- Miscellaneous revenues are assumed to remain constant over the projection period. Miscellaneous and non-rate revenues can be erratic and are generally beyond NPU's control, so NPU has been conservative in holding those constant at current budgeted levels.

- Incremental O&M resulting from program implementation has been estimated and included in the analysis. It is assumed that incremental O&M for the relevant projects starts at the end of project construction and is inflated annually at the rate of O&M inflation. The annual cost for incremental O&M for projects included in the analysis is presented in Table 9-1.

Table 9-1 Incremental O&M Costs Associated with Recommended 3-Month Plan

Project	Annual Cost ($ 2018)
New secondary tanks, landfill modifications, Main electrical system upgrades, and new headworks	$50,000
UV and effluent pumping station	$100,000
S. Thames storage tank (0.26 Mgal) & property purchase allowance	$50,000
Rose Alley Commuter Lot tank: 1.45 Mgal storage tank, 2 mgd dewatering pump station, new FM, new gravity pipe, sluice gate diversion structure, and allowance for disruption.	$100,000
Odor control and final sitework improvements	$50,000

- This analysis assumes NPU would finance capital costs by issuing revenue bonds at 5.0 percent for a term of 20 years, with issuance costs of 1.0 percent.
- NPU currently employs a fixed base charge, and consumption-based usage and mandatory upgrades charges. For FY 2019, the current sewer annual base charge is $105.48, the usage rate is $7.52 per hundred cubic feet (HCF) and the mandatory upgrades charge is $0.83 per HCF.
- MHI for Norwich in 2016 was $51,758 based on U.S. Census Bureau, American Community Survey (ACS) data. MHI is assumed to increase 1.5 percent annually.
- To be consistent with EPA guidance, it was necessary to determine residential-only sewer consumption, and the associated residential dwelling units accounting for that consumption. NPU categorizes some large multi-unit residential properties as commercial customers, so for this analysis total residential consumption has been assumed to be the total of the residential and commercial categories from NPU's billing system. Total annual consumption is 881,408 HCF, and the number of occupied residential dwelling units from Census estimates is 15,333. The typical residential dwelling unit is thus estimated to consume 57.49 HCF (43,000 gallons) annually.

9.3 Financial Analysis

This section summarizes projected sewer revenue requirements for NPU, including the impact of the proposed $156M capital program (2018 dollars) through FY 2049. Figure 9-1 details annual capital spending for this program in 2018 dollars. A more detailed description of the projects associated with the spending totals are in Section 10 of this report.

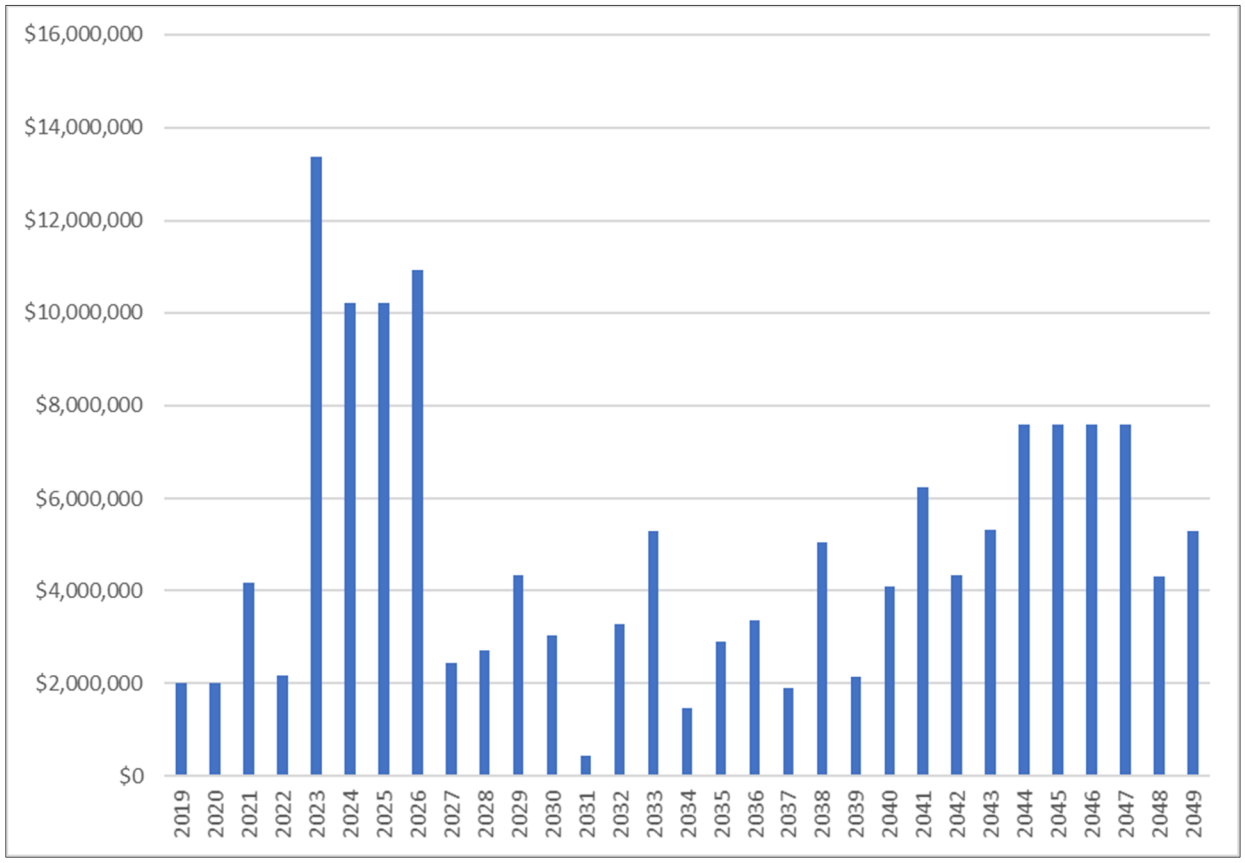


Figure 9-1
Proposed LTCP Spending by Year (FY $2018)

The $156M in capital spending represents the projects related to the LTCP and water pollution control facility (WPCF) upgrade, in 2018 dollars. Since the costs displayed in Figure 9-1 are stated in 2018 dollars, actual costs will be higher when construction commences due to inflation.

Projected revenue requirements will be summarized in four main components:

- O&M costs, which include incremental costs attributable to the LTCP.
- Debt service and capital expenditures.
- Miscellaneous revenue.
- Transfers for reserves.

The following sections summarize the projected sewer expenses and revenue requirements.

9.3.1 Operations and Maintenance

Operations and maintenance costs exist for all aspects of the sewer utility. O&M expenses have been separated into eight general categories, generally consistent with NPU's budget structure:

- Operations Wages — salary costs related to the sewer utility.

- Employee Benefits — costs of benefits offered to employees.
- Operations and Maintenance — includes general sewer O&M costs for the treatment plant, laboratory, pump stations and collection system.
- Insurance — insurance costs associated with property and vehicles, directors and officers, claims, and liability.
- Customer Service —fees and costs related to outside services, utilities, software support, collections, payment processing, employee training, equipment, and postage.
- General and Administrative — general operating costs, including costs related to consulting, legal and software fees.
- Bad Debt Expense — allowance for expense incurred due to lack of payment from customers.
- Incremental O&M — anticipated incremental O&M increases resulting from implementation of the capital program.

Total operating expenses are projected to grow from $6.1 million in FY 2019 to $15.6 million in FY 2049. This represents an average annual cost increase of 3.2 percent. Anticipated operating expenses over time are summarized in Table 9-2.

Table 9-2 Projected Operating Expenses

O&M Category	FY 2019	FY 2025	FY 2031	FY 2037	FY 2043	FY 2049
Operations Wages	$2,496,957	$2,981,000	$3,560,000	$4,251,000	$5,076,000	$6,061,000
Employee Benefits	$873,400	$1,043,000	$1,245,000	$1,487,000	$1,775,000	$2,120,000
Operations & Maintenance	$2,120,432	$2,532,000	$3,023,000	$3,610,000	$4,310,000	$5,147,000
Insurance	$160,804	$192,000	$229,000	$274,000	$327,000	$390,000
Customer Service	$90,680	$108,000	$129,000	$154,000	$184,000	$220,000
General & Administrative	$339,164	$405,000	$484,000	$577,000	$689,000	$823,000
Depreciation	$0	$0	$0	$0	$0	$0
Bad Debt Expenses	$31,000	$37,000	$44,000	$53,000	$63,000	$75,000
Incremental O&M	$0	$0	$73,000	$263,000	$419,000	$750,000
Total Operations and Maintenance	**$6,112,437**	**$7,298,000**	**$8,787,000**	**$10,669,000**	**$12,843,000**	**$15,586,000**

9.3.2 Debt Service and Capital Expenditures

Capital costs can be financed through annual cash payments as cash funded capital, or through bonded debt as debt service. Debt service and capital expenditures have been separated into three categories: existing debt service, anticipated debt service, and cash funded capital.

Existing debt service represents sewer-related debt that is outstanding as of FY 2018. Anticipated debt service describes annual debt service payments projected from implementation of the proposed plan.

Cash funded capital is annual capital projects that NPU elects to fund directly through current year rate revenue without issuing debt. As noted in the assumptions, NPU assumes the entirety of LTCP capital costs will be debt financed, except for allowances for CMOM, stormwater and R&R, which will be funded using current rate revenues.

Table 9-3 shows the projected capital and debt obligations through FY 2049, including costs associated with the proposed program.

Table 9-3 Debt Service and Capital Expenditures

	FY 2019	FY 2025	FY 2031	FY 2037	FY 2043	FY 2049
Existing Debt Service	$800,669	$627,000	$627,000	$0	$0	$0
Anticipated Debt Service	$52,520	$4,279,000	$7,718,000	$9,423,000	$12,687,000	$18,646,000
Cash Funded Capital	$817,779	$1,473,000	$2,142,000	$2,710,000	$3,429,000	$4,339,000
Total Debt Service and Capital	**$1,670,987**	**$6,379,000**	**$10,487,000**	**$12,133,000**	**$16,117,000**	**$22,985,000**

9.3.3 Reserve Transfers

The projections include an allowance for reserve fund transfers to fund an operating reserve and debt service reserve fund. The operating reserve fund balances is set to 2 months of annual operating expenses, and the debt service reserve fund is set to 2 months of annual debt service. The existence of these funds and maintenance of an adequate balance is good practice to account for any large fluctuations in annual expenses or unforeseen cash flow issues. In addition, as part of the analysis it was assumed that NPU maintains a debt service coverage ratio of 120 percent.

Table 9-4 shows the reserve transfers in increments through FY 2049. No additional deposits for coverage are required after accounting for the projected rate increases to cover revenue requirements.

Table 9-4 Reserve Transfers

	FY 2019	FY 2025	FY 2031	FY 2037	FY 2043	FY 2049
Transfer to Operating Revenue	$49,342	$35,000	$43,000	$52,000	$62,000	$76,000
Transfer to Debt Service Reserve Fund	$0	$207,000	$29,000	$55,000	$112,000	$129,000
Total Reserve Transfers	**$49,342**	**$242,000**	**$72,000**	**$106,000**	**$175,000**	**$204,000**

9.3.4 Miscellaneous Revenue

Miscellaneous, or non-rate sewer revenue is not directly related to sewer rates. Table 9-5 summarizes miscellaneous revenues through the projection period.

Table 9-5 Projected Miscellaneous Revenue

Miscellaneous Revenue	FY 2019	FY 2025	FY 2031	FY 2037	FY 2043	FY 2049
Penalties	$50,400	$50,000	$50,000	$50,000	$50,000	$50,000
Other Revenues	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000
Capital Connection Fees	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000
Capital Contributions	$855,000	$855,000	$855,000	$855,000	$855,000	$855,000
Total Miscellaneous Revenue	**$1,049,400**	**$1,049,000**	**$1,049,000**	**$1,049,000**	**$1,049,000**	**$1,049,000**

9.3.5 Revenue Requirement

The revenue requirement is the total revenue that must be generated annually through sewer rates to fund NPU's sewer expenses. The sewer revenue requirement is calculated by subtracting non-rate sewer revenue from total sewer expenses. Table 9-6 shows the total revenue requirement, which includes projections for implementing projects in the proposed plan. The total revenue requirement is projected to grow from $6.8 million in FY 2019 to $37.7 million in FY 2049, equivalent to an average annual increase of 5.9 percent. Within the next 10 years, the revenue requirement is projected to more than double from current levels as a result of the proposed plan and other items described in this report.

Table 9-6 Projected Revenue Requirement

	FY 2019	FY 2025	FY 2031	FY 2037	FY 2043	FY 2049
Operating Expenses	$6,112,437	$7,298,000	$8,787,000	$10,669,000	$12,843,000	$15,586,000
Debt Service and Capital	$1,670,987	$6,379,000	$10,487,000	$12,133,000	$16,117,000	$22,985,000
Reserve Transfers	$49,342	$242,000	$72,000	$106,000	$175,000	$204,000
Total Expenses	**$7,832,766**	**$13,919,000**	**$19,346,000**	**$22,908,000**	**$29,134,000**	**$38,775,000**
Less: Miscellaneous Revenue	($1,049,400)	($1,049,000)	($1,049,000)	($1,049,000)	($1,049,000)	($1,049,000)
Revenue Requirement	**$6,783,366**	**$12,870,000**	**$18,297,000**	**$21,859,000**	**$28,086,000**	**$37,726,000**

Figure 9-2 graphically depicts the projected revenue requirement for the proposed $156M program.

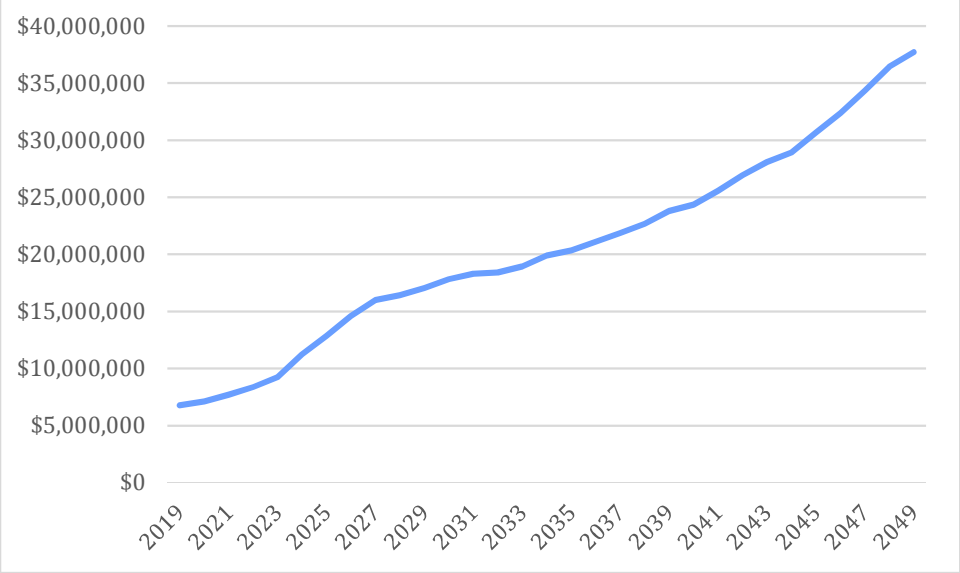


Figure 9-2
Projected Revenue Requirement – With Proposed Program

The projected revenue requirements shown in Figure 9-2 will directly translate into increased sewer rates and burden for City households. The revenue requirement under the proposed program is expected to more than double over the next 10 years, and nearly triple in 15 years. Revenue requirement increases of this magnitude will mandate significant rate increases in the short term and in the future.

9.4 Residential Indicator

The "Residential Indicator" is defined as the typical dwelling unit sewer bill compared to MHI and is used as a benchmark by EPA in assessing the affordability of a proposed program. The estimated sewer household bill for FY 2019 in Norwich is $585 based on annual sewer use of 57.49 HCF per residential dwelling unit.

The projected growth in the typical household sewer bill, MHI and the corresponding Residential Indicator are shown in Table 9-7 for the proposed $156M program. Figure 9-3 graphs the household burden increase through FY 2049. For the first 10 years, residents will face average annual rate increases of nearly 7 percent.

Table 9-7 Projected Household Bill, MHI and Residential Indicator

	FY 2019	FY 2025	FY 2031	FY 2037	FY 2043	FY 2049
Estimated Household Bill	$585	$830	$1,180	$1,410	$1,820	$2,440
MHI	$54,122	$59,180	$64,710	$70,760	$77,370	$84,600
Residential Indicator	1.08%	1.41%	1.83%	2.00%	2.35%	2.88%

The residential indicator reaches 2 percent by FY 2037 under the proposed program and reaches 2.88 percent by FY 2049. The City would experience rate increases of nearly 5 percent annually for the next 30 years. A program of this size will create a significant burden on the City's

residents. As previously mentioned, to the extent additional funding becomes available or costs are lower than anticipated, NPU is committed to evaluating potential acceleration of projects.

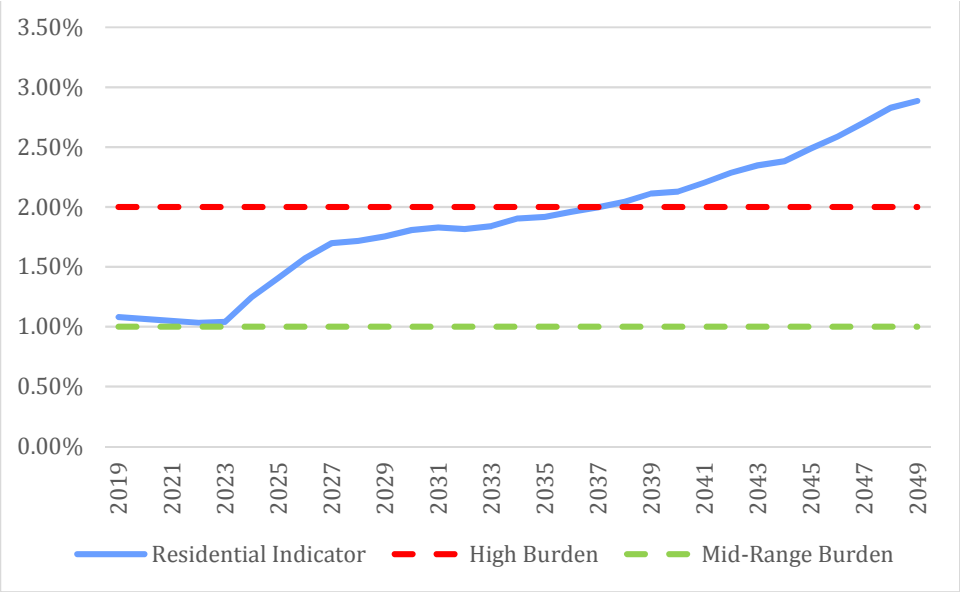


Figure 9-3
Projected Household Bill, MHI, and Residential Indicator

9.5 Phase 2 Evaluation

This section presents the Phase 2 financial impact indicators, which are benchmarks as defined by EPA. These indicators evaluate ancillary factors that may affect an entity's ability to fund the proposed LTCP. This assessment identifies three categories, each with two indicators as listed below:

- Debt: bond rating and overall net debt
- Socio-economic: MHI and unemployment rate
- Financial management: property tax revenue and property tax collection rate

While the Phase 1 assessment (residential indicator) is a time-series analysis, the Phase 2 assessment is a cross-sectional view of financial capability for the City of Norwich.

9.5.1 Debt Indicators

The two debt indicators used in Phase 2 of the financial capability assessment are bond rating and overall net debt. These indicators are indicative of the City's capacity to access capital markets to raise the necessary capital for implementing the anticipated capital improvement plan.

9.5.1.1 Bond Rating

The bond rating indicator addresses a general capacity to undertake debt. While rating designations vary by credit rating agencies, long-term bond ratings range from AAA/Aaa (high grade) to C/D (in default). Table 9-8 shows the most recent ratings from Moody's Investors

Service (MIS) and from Standard & Poor's (S&P). The scoring for this indicator include the ratings as follows:

- ***Strong (Score = 3)*** — a high grade or strong bond (e.g., Aaa or AAA, Aa or AA, A).
- ***Mid-Range (Score = 2)*** — a medium grade bond (e.g., Baa or BBB). These are the minimum "investment grade" bond ratings.
- ***Weak (Score = 1)*** – a speculative or "junk" bond (e.g. Ba or BB, or lower)

Based on benchmarks provided in the EPA guidance document, this indicator for the City is rated strong and earns a score of 3. Both the MIS rating of Aa3 and the S&P rating of AA equate to a "Strong" rating, so for this assessment, these scores are the same.

Table 9-8 Current Bond Rating

Item	Rating
Standard & Poor's	AA
Moody's Investors Service (MIS)	Aa3
Bond Rating Indicator Score	3

9.5.1.2 Overall Net Debt as a Percent of Full Market Property Value

Overall net debt is the amount of tax-backed bonded debt for all taxing units not supported by revenue from sewer user fees. Indicator scores for overall net debt are based on the percentage of full-market property value. The EPA benchmarks for overall net debt are:

- ***Strong (Score = 3)*** — overall net debt is below two percent of the full-market property value.
- ***Mid-Range (Score = 2***) — overall net debt is two to five percent of the full-market property value.
- ***Weak (Score = 1)*** — overall net debt is more than five percent of the full-market property value.

Overall net debt for the City is taken from its consolidated debt schedule, and the market value of property for the City is based on the State of Connecticut's Office of Policy Management Equalized Grand List. The information is shown in Table 9-9.

Table 9-9 Overall Net Debt Rating

Item	Value
Direct net debt (2018)	$29,375,991
Debt of overlapping entities (proportionate share of multi-jurisdictional debt)	$0
Overall net debt (2018)	$29,375,991
Market value of property (2016)	$2,711,519,845
Overall net debt as a percent of full market property value	1.1 percent
Overall Net Debt Indicator Score	3

Overall net debt for the City in 2018 was $29.4 million with $4.3 million total debt service. The City's market value of property (equalized valuation) is $2.7 billion, making overall net debt 1.1 percent of full-market property value. This indicator is thus rated as "Strong".

9.5.2 Socio-economic Indicators

The socio-economic indicators used in Phase 2 of the financial capability assessment are unemployment rate and median household income. These indicate the City's general economic condition.

9.5.2.1 Unemployment Rate

Unemployment rate is a measure of the City's labor force that is unemployed but seeking employment. The EPA guidance document benchmarks for unemployment rate are:

- ***Strong (Score = 3)*** — unemployment rate is more than one percent below the national average.
- ***Mid-Range (Score = 2)*** — unemployment rate is within one percent of the national average.
- ***Weak (Score = 1)*** — unemployment rate is more than one percent above the national average.

The unemployment rate for Norwich, as compared to national average, is shown in Table 9-10. Since the City's unemployment rate is within one percent of the national average, it receives a "Mid-Range" rating for this indicator.

Table 9-10 Unemployment Rate Comparison

Item	Value
Norwich: Unemployment Rate (2017)	4.0 percent
Connecticut: Unemployment Rate (2017)	4.5 percent
U.S.: Unemployment Rate (2017)	4.1 percent
Comparison of Norwich with National (2017)	0.1 percent below
Unemployment Rate Indicator Score	2

9.5.2.2 Median Household Income

This indicator is related to the Residential Indicator in that they both consider MHI. While the Residential Indicator compares MHI and average annual household bills, the median household income indicator simply compares Norwich's MHI with national MHI. Thus, this benchmark is a measure of the relative wealth or poverty of the service area. The EPA guidance document benchmarks for median household income are:

- ***Strong (Score = 3)*** — MHI is more than 25 percent above the national average.
- ***Mid-Range (Score = 2)*** — MHI is within 25 percent (+/-) of the national average.
- ***Weak (Score = 1)*** — MHI is more than 25 percent below the national average.

City and national MHI values, shown in Table 9-11, are based on the most recent ACS data.

Table 9-11 Median Household Income Comparison

Item	Value
Most recent Norwich estimate (2016 ACS)	$51,758
Most recent National estimate (2016 ACS)	$55,322
Compare Permittee with Average National MHI	6.9 percent below
Median Household Income Indicator Score	2

Figure 9-4 compares City, state average and national average MHI. Since 1990, national and state average MHI have grown at average annual rates of 2.4 and 2.1 percent respectively, while MHI for Norwich has grown at a rate of 1.7 percent.

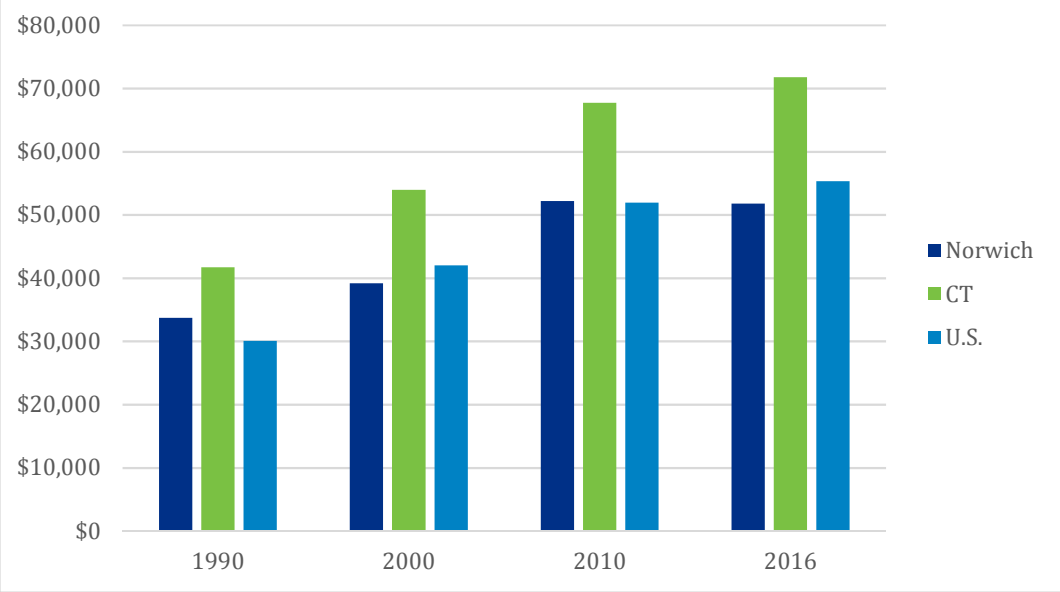


Figure 9-4
Median Household Income –Time Series

In addition to the City slightly lagging in MHI, the U.S. Census Bureau estimated that in 2016, 15.8 percent of the City's residents were living below the poverty line, as compared to a national average of 15.1 percent and a state average of 10.4 percent. Poverty in Norwich has increased during this decade, as the poverty rate was 11.5 percent in 2010.

9.5.3 Financial Management Indicators

Two financial management indicators assess a community's capacity to support debt as described below.

9.5.3.1 Property Tax Revenues as a Percent of Full Market Property

Property tax revenue as a percent of full market property value indicates the funding capacity available to support debt, based on the wealth of the community. The EPA guidance document benchmarks for property tax revenues are:

- ***Strong (Score = 3)*** — property tax revenue is below two percent of the full-market property value.
- ***Mid-Range (Score = 2)*** — property tax revenue is two to four percent of the full-market property value.
- ***Weak (Score = 1)*** — property tax revenue is more than four percent of the full-market property value.

In the City, property tax revenues collected in 2017 were $72.2 million, with a full-market property value of $2.7 billion. As shown in Table 9-12, the calculated property tax revenue indicator for the City is 2.7 percent, rating the City as "Mid-Range".

Table 9-12 Property Tax Revenues

Item	Value
Full market value of real property (2016)	$2,711,519,845
Property tax revenue (2017)	$72,150,315
Property tax revenue as a percentage of full market property value	2.7 percent
Property Tax Revenue Indicator Score	2

9.5.3.2 Property Tax Collection Efficiency

The property tax collection rate represents the relationship of property taxes collected versus property taxes levied. The EPA benchmarks for property tax collection efficiency are:

- ***Strong (Score = 3)*** — property taxes collected are above 98 percent of the property taxes levied.
- ***Mid-Range (Score = 2)*** — property taxes collected are between 94 and 98 percent of the property taxes levied.
- ***Weak (Score = 1)*** — property taxes collected are less than 94 percent of the property taxes levied.

Computation of this indicator rating is shown in Table 9-13, and is based on the City's data for the 2017 tax year. The City's property tax collection rate is 97 percent of the taxes levied. This data is indicative of "Mid-Range" financial capability.

Table 9-13: Property Tax Collection Efficiency

Item	Value
Property tax revenue collected (2017)	$72,150,315
Property taxes levied (2017)	$74,365,626
Property tax revenue collection rate	97.0 percent
Tax Collection Efficiency Indicator Score	2

9.5.4 Summary of Financial Impact Indicators

Table 9-14 shows EPA's Phase 2 Financial Impact Indicator benchmarks used to evaluate the six indicators. The indicators are shown in the left-hand column. Corresponding EPA benchmarks for each indicator are shown for "Strong", "Mid-Range" or "Weak" ratings. The blue-shaded boxes in this table indicate where Norwich scores for each indicator.

Table 9-14 Financial Impact Assessment Benchmarks

Indicator	Strong (Score=3)	Mid-Range (Score=2)	Weak (Score=1)
1. Bond Rating	AAA to A (S&P) or	BBB (S&P) or	BB to D (S&P) or
	Aaa to A (MIS)	Baa (MIS)	Ba to C (MIS)
2. Overall Net Debt	Below 2 percent	2 percent to 5 percent	Above 5 percent
3. Unemployment Rate	>1 percent below National Average	±1 percent of National Average	>1 percent above National Average
4. Median Household Income	>25 percent above adjusted National MHI	±25 percent of adjusted National MHI	>25 percent below adjusted National MHI
5. Property Tax Revenue	Below 2 percent	2 percent to 4 percent	Above 4 percent
6. Property Tax Collection Rate	Above 98 percent	94 percent to 98 percent	Below 94 percent

Note: The highlighted values represent NPU's benchmark scores

Table 9-15 summarizes Norwich's values and scores for the EPA indicators. EPA considers an overall average score below 1.5 weak and an overall score above 2.5 strong. An overall score between 1.5 and 2.5 is considered mid-range. Overall, the unweighted average score for the Phase 2 evaluation is 2.33, within the mid-range of the financial capability scale.

Table 9-15 Financial Impact Assessment Summary

Financial Impact Indicator	Value	Score
1. Bond rating	AA/Aa3	3
2. Overall net debt as a percent of property value	1.1 percent	3
3. Unemployment rate compared with national average	0.1 percent below	2
4. Median household income compared with national average	6.9 percent below	2
5. Property tax revenue as a percent of property value	2.7 percent	2
6. Property tax collection rate	97 percent	2
Overall Financial Impact Indicator Score		**2.33**

As discussed previously, the 2-year control level is unrealistic for implementation within a reasonable planning horizon. Instead, the 3-month control level is recommended over a 30-year period. The projected household burden of 3-month control reaches 2.9 percent in FY 2049, which exceeds EPA's guidance for affordability, but indicates NPU's commitment to water quality. This plan, including the implementation schedule, is described further in Section 10.

Section 10

This section has been superseded by the revised 2020 CSO LTCP Report.

Section 10
Recommended Plan

10.1 General

Norwich Public Utilities (NPU), like many New England wastewater utilities, is burdened by aging infrastructure and increasing regulation. This Long-Term Control Plan (LTCP) focuses on the improvements required to address Connecticut Department of Energy and Environmental Protection's (DEEP's) Consent Order WRMU17001, which requires NPU to achieve a 2-year level of control for combined sewer overflow (CSO) discharges in Norwich. Through an extensive process of alternatives development and screening, model simulations, and comprehensive evaluation, as detailed in Sections 5 through 9 of this report, NPU has determined that the least costly 2-year CSO control plan is estimated to cost approximately $190 Million (FY 2018 dollars), which is an extraordinary burden that does not address other infrastructure.

NPU's aging infrastructure requires major investment at the Hollyhock Island water pollution control facility (WPCF) as well. Section 8 identifies necessary upgrades that will cost an estimated $80 Million (FY 2018 dollars) that must be completed to ensure reliable and consistent treatment before wastewater is discharged to the Yantic and Thames Rivers. The WPCF upgrades are also critical for the proposed CSO control plan, as the WPCF treats a significant portion of the wet weather flow generated by the Norwich system.

Finally, ongoing operation and maintenance (O&M) costs of the collection system and treatment facilities must also be considered, in addition to the increased O&M costs for new CSO control facilities.

Section 9 assessed the financial burden of implementing 2-year CSO control as part of a collective wastewater program on NPU ratepayers, based on US Environmental Protection Agency (EPA) affordability guidelines, and determined that these extensive, but necessary programs are not affordable for NPU to implement over a typical planning horizon. Implementing 2-year CSO control, along with other necessary infrastructure improvements, would push NPU rate payers to an average annual household burden over 5% of median household income even if implemented over a 30-year planning horizon. Accordingly, other implementation periods were considered.

NPU is committed to achieving the DEEP goal of 2-year CSO control as required by DEEP Consent Order WRMU17001. However, NPU must reasonably implement capital projects at a pace its rate payers can afford. Per EPA guidance and the discussion in Section 9, a household burden of 2% of median household income is often deemed affordable.

Due to the financial impact of implementing the 2-year CSO level of control in the near term, NPU evaluated incremental approaches that progressively achieve CSO control, while also allowing it to meet non-CSO needs. As discussed in Section 8, a knee-of-the-curve analysis identified 3-month control as the most cost-effective performance level for NPU. In the affordability analysis presented in Section 9, it was determined that the 3-month plan could be implemented over a reasonable planning period along with necessary non-CSO programs. This plan would provide a

significant reduction in CSO impacts (listed below) and serve as an interim stepping stone to allow NPU to eventually achieve 2-year CSO control.

While this assessment represents a balanced approach for the regulatory and operational requirements for NPU, implementation of the 3-month CSO control plan will still significantly affect rate payers. The affordability analysis shows that the 3-month solution pushes rate payers to a household burden of nearly 3% of median household income in the 30-year planning period. This burden exceeds the financial impact levels typically deemed affordable by EPA guidance. Implementation of other improvements to achieve the 2-year level of control will be implemented as NPU can afford to complete additional projects.

Achieving 3-month CSO control as an initial phase is estimated to have a capital cost of approximately $70M (FY 2018 dollars) and reduces CSOs from the current 60 events per year to 4 events per year. Average annual CSO volume will be reduced from 43.3 million gallons per year today to 8.5 million gallons per year. The 3-month plan could then be expanded to attain 2-year control through conveyance and centralized treatment at the WPCF. The total cost associated with a progressive plan that first implements 3-month control and then progresses to 2-year control level is slightly higher than if the 2-year plan were implemented directly.

The environmental benefits of this approach are significant. NPU can make great strides to improve water quality in the near-term, while positioning itself to meet 2-year control in the future. Components of the Recommended Plan, as well as details of plan expansion into 2-year control are detailed in this Section. Other specifics, including average annual performance, cost-effectiveness, and implementation schedule are also discussed.

10.2 Public Participation Plan

Public outreach is an important part of the CSO planning process, where stakeholders and the planning entity (NPU) discuss CSO control requirements, alternatives, costs and benefits, and build consensus on the Recommended Plan. NPU will receive a better sense of what issues are most important to the community, while the community can learn more about the impact of CSOs. NPU is committed to gathering public input for the mitigation of CSOs, as the public bears the costs of implementing these solutions and benefits from improved water quality.

Public outreach is required as a part of NPU's Consent Order. A public information session was held on August 1, 2018, prior to submittal of the LTCP to DEEP. This session provided interested parties with a general background on the collection system, EPA policy, NPU's consent order, and the CSO planning process for the Norwich Sewer System. Materials from this meeting are included in Appendix A.

NPU plans to hold public information sessions like the one provided for this LTCP prior to construction of any individual CSO project. Additionally, the LTCP will be updated at 5-year intervals to evaluate the success of past projects, update financial projections and guide the direction of future CSO controls. Public information sessions will be held prior to submittal of each 5-year LTCP update as well. NPU will keep the public informed of its progress in mitigating CSO discharges and of completed and planned system improvements.

10.3 Recommended Long-Term Control Plan Components

It is recommended that NPU do as much as financially practical to control CSO discharges and benefit water quality. Based on Norwich's status as a financially distressed community and documented limited ability to pay for capital projects, this means implementing 3-month control over a 30-year planning horizon, with a design that facilitates future advancement to 2-year control. Subsequent subsections discuss components of the Recommended Plan, as well as the pathway for expansion to a cost effective 2-year control plan.

10.3.1 Recommended Plan Components

Figure 10-1 illustrates the components of the Recommended Plan. This figure depicts the new pipelines, pumping stations (PS), and storage tanks required to achieve 3-month control. As presented in Section 8, the Recommended Plan (the "3-month storage alternative") consists of the following components and associated capital costs:

- Complete the "Planned Projects" described in Section 7
- Implement improvements to the WPCF to increase wet weather capacity from 17 mgd to 20 mgd, improve reliability, and meet nutrient permit limits
- Improvements in the Thamesville neighborhood totaling approximately $24 million including:
  - Replace the Shipping Street PS (3.5 mgd) and FM
  - Relocate the regulator structure for CSO 004
  - Re-configure the gravity sewer system to convey flow from Route 32 and the new Shipping Street PS to the new CSO 004 regulator and nearby storage tank (2,310 linear feet (LF), 12-in to 30-in diameter)
  - Remove and replace sewer pipe tributary to the existing Shipping Street FM
  - Construct a storage tank with a 0.26 million gallon (Mgal) capacity at South Thames Street
  - Replace the South Thames Street PS (4 mgd) and FM
  - Install a gravity sewer from existing South Thames Street PS to new PS (580 LF, 10-in to 24-in diameter)
  - Raise CSO regulator weirs beyond the Planned Projects level
- Improvements in the Laurel Hill neighborhood totaling approximately $6 million including:
  - Replace the River Avenue PS (4 mgd) and FM
  - Increase the diameter of dry weather flow pipes around regulators 31 and 32 (160 LF, 18-in to 30-in diameter)

- Raise CSO regulator weirs beyond the Planned Projects level

- Improvements in the Shetucket area (Greeneville and Downtown sewersheds) totaling approximately $33 million including:
  - Install a storage tank with a 1.45 Mgal capacity at the Rose Alley commuter parking lot site
  - Install relief piping for the Rose Alley combined culvert (310 LF, 24-in diameter)
  - Install a sluice gate structure on the Shetucket Interceptor
  - Raise CSO regulator weirs beyond the Planned Projects level
  - Increase dry weather flow pipe diameters at several locations (720 LF, 15-in to 32-in diameter)

The major facilities in the recommended 3-month control plan include a CSO storage tank in Thamesville, and another in the Downtown area. As discussed previously, these storage tanks are recommended to be built with modular pre-cast concrete box culvert sections. The culvert sections would be sloped slightly to one side, so that the storage tank can drain to a dewatering pump station following a storm. Figure 10-2 and Figure 10-3 show the conceptual storage tank layouts needed in these two locations during the 3-month Recommended Plan.

The Recommended Plan controls the approximately 1.89 Mgal of CSO volume resulting from the 3-month storm and greatly reduces average annual overflow. This plan has an estimated capital cost of $70M (FY 2018 dollars). In addition to these capital expenditures, O&M costs will be incurred to support the new facilities and to improve the performance of the combined sewer system (CSS). These O&M costs include $350,000 per year (FY 2018 dollars) to support the new WPCF facilities and the recommended storage tanks.

10.3.2 Conveyance Expansion Components

Figure 10-4 depicts the components of the least cost 2-year control plan expansion. This is the 2-year conveyance and centralized treatment alternative. This alternative represents the most cost effective 2-year control option. It is also the plan that can most readily be achieved by expanding upon the initial 3-month control plan. This option has a total capital cost of approximately $190M if built on its own. The cost associated with expanding from the initial 3-month control level to the 2-year control level is slightly higher as described below. This plan includes the following major components:

- Complete the Planned Projects

- Implement improvements to the WPCF to increase wet weather capacity from 17 mgd to 20 mgd, improve reliability, and meet nutrient permit limits

- Improvements in the Thamesville neighborhood totaling $27M including:
  - Replace the Shipping Street PS (3.5 mgd) and FM
  - Relocate the regulator structure for CSO 004

- Reconfigure the gravity sewer system to convey flow from Route 32 and the new Shipping Street PS to the new CSO 004 regulator and nearby storage tank (2,310 LF, 15-in to 24-in diameter)
- Remove and replace sewer pipe tributary to the existing Shipping Street FM
- Replace the South Thames Street PS (16 mgd) and FM
- Install a new gravity sewer from existing South Thames Street PS to new PS (580 LF, 15-in to 30-in diameter)
- Raise CSO regulator weirs beyond the Planned Projects level

- Improvements in the Laurel Hill neighborhood totaling $15M including:
  - Replace the River Avenue PS (16 mgd) and FM
  - Increase the diameter of dry weather flow pipes around regulators 31 and 32 (960 LF, 24-in to 36-in diameter)
  - Raise CSO regulator weirs beyond the Planned Projects level
- Improvements in the Shetucket area (Greeneville and Downtown sewersheds) totaling $55M including:
  - A 0.9 Mgal storage tank at the Rose Alley commuter parking lot site (Note that this is smaller than the tank initially constructed in the 3-month control solution due to the additional conveyance constructed as part of this 2-year alternative. The larger "existing" tank would remain as constructed for the 3-month solution. The "extra" volume will continue to add value through peak flow attenuation in large storms.)
  - Install Shetucket Relief Interceptor (5,680 LF, 36-in to 48-in diameter)
  - Raise CSO regulator weirs beyond the Planned Projects level
  - Increase the diameter of dry weather flow pipe diameter at several locations (830 LF, 12-in to 32-in diameter)
- Improvements to the Rose Alley Pumping Station and wet weather expansion at the WPCF site totaling $87M including:
  - Replace the Rose Alley PS (65 mgd) and FM
  - Construct an enhanced High Rate Clarification (HRC) Facility on Hollyhock Island (WPCF site - 60 mgd wet weather expansion)

Approximately $1,000,000 per year (FY 2018 dollars) in O&M costs have been estimated for the completed 2-year level of control. This is due to the additional relief pipeline that is needed, as well as the HRC facility at the treatment plant and larger pumping stations.

Comparison of Figure 10-1 and Figure 10-4 indicates some differences between the near-term 3-month control plan, and the long-term 2-year control plan. After achieving 3-month control, the main components needed to achieve 2-year control are larger pumping stations to convey flow to the WPCF, construction of the Shetucket Relief Interceptor, and a HRC facility on Hollyhock Island. To allow for the complete expansion of control, some components of the 3-month control plan need to be oversized to anticipate eventual expansion to 2-year control. For example, pipelines in the 3-month plan may need to be sized to pass 2-year peak flows to ensure 2-year control can be reached in the future, without building a second pipeline. In cases where this is not hydraulically feasible, a second pipeline may be needed in the future. These conditions were reflected in the alternatives development.

In Laurel Hill, both the 3-month and 2-year control levels use the same strategy to control CSO. Existing pipe sections identified by the model to cause bottlenecks are to be replaced, and flow is then pumped out of Laurel Hill to the Shetucket Interceptor. The major difference in the 3-month and 2-year control levels is that more pipe replacement and a larger River Avenue PS and FM are required under the recommended 2-year control plan. This pump station and force main is an immediate priority and could be initially replaced with a 4 mgd replacement to achieve 3-month control. A larger pumping station would be installed when NPU had the financial resources to fund expansion to the 2-year control level. Table 10-1 illustrates the major differences between the two recommended control levels.

The estimated cost to expand from the 3-month control level to the 2-year control level in Laurel Hill is approximately $15M.

Table 10-1 Laurel Hill Near-Term vs. Long Term Recommended Plan Comparison

Component	3-Month Storage	2-Year Conveyance
River Avenue PS (mgd)	4	12
River Avenue FM (diameter, inches)	14	20
Pipe Replacement 18-inch to 30-inch diameter (length, feet)	160	960
Weirs Raised Beyond Planned Project Level	2	3

In Thamesville, the two control levels require somewhat different approaches. The first requires a small storage tank to store the excess flow, while the latter requires a large pumping station to push the flow to the WPCF. Many of the conveyance components of both plans are very similar as can be seen in Table 10-2**.** The Shipping Street Pumping Station upgrade would be identical, although the West Thames Street relief pipe would need to be built as a 24-inch pipe under the 3-month plan to accommodate the future 2-year level of control. The cost of this pipe size increase in West Thames Street is not substantial and will not significantly change costs for the 3-month solution.

The main difference between these two levels of control in Thamesville is the South Thames Street Pumping Station. This pumping station would need to be built as a 4 mgd capacity station initially but would then need to be expanded to 16 mgd with a larger force main under the 2-year control plan. It is recommended that NPU proceed with replacement of the S. Thames Pumping Station sized for the 3-month control initially, with the intention of expanding to the larger size in the future when NPU can afford to do the project. Additionally, the storage tank is not needed

under the proposed 2-year control plan due to the increased PS conveyance, although the storage tank's effectiveness should be reevaluated under a future LTCP update. It is anticipated that this storage tank would still be utilized in the 2-year control scenario to downsize the capacity of the future pumping station.

The estimated cost to expand from the recommended 3-month control level to the recommended 2-year control level in Thamesville is approximately $14M.

Table 10-2 Thamesville Near-Term vs. Long Term Recommended Plan Comparison

Component	3-Month Storage	2-Year Conveyance
Shipping Street PS (mgd)	3.5	3.5
Shipping Street FM (diameter, inches)	12	12
Relocation of Gravity Connections from Existing FM	Yes	Yes
West Thames Street Relief Pipe (diameter, inches)	21	24
South Thames Street PS (Existing Location)	Abandoned	Abandoned
South Thames Street Storage Tank (Mgal)	0.26	Not Needed
Relocated S. Thames PS (mgd)	4	16
South Thames Street FM (diameter, inches)	12	24
Weirs Raised Beyond Planned Projects Level	1	1

In the Greeneville and Downtown sewersheds, expansion from the 3-month recommended control plan to the 2-year recommended control plan involves extensive infrastructure changes. The differences between these two plans along the Shetucket Interceptor can be seen in Table 10-3. Both control plans require a tank at Rose Alley, which will need to be built in the 3-month solution with a 36-in gravity inlet pipe in anticipation of the 2-year peak flows. In the 2-year recommended control plan, the Shetucket Interceptor can no longer convey the total peak flows to Rose Alley, and therefore the relief pipe will need to be constructed. Finally, under the 2-year control alternative, a large Rose Alley PS must be constructed, along with an HRC facility at the WPCF to expand the total treatment capacity to 80 mgd (20 mgd through secondary and 60 mgd through a new wet weather HRC facility). As it can be seen in Table 10-3, some components will be built in the 3-month control plan that are not needed or are larger than needed in the 2-year control scenario. These items include the Rose Alley CSO tank (0.55 Mgal larger than needed for the 2-year level), the combined culvert relief pipe (not needed for the 2-year level), and the interceptor sluice gate (not needed for the 2-year level). These items will be re-evaluated in subsequent LTCP updates to identify the effects of these components on the 2-year recommended control plan. It is anticipated that this additional infrastructure could help reduce the necessary Rose Alley PS size, and potentially reduce the wet weather treatment capacity required at the WPCF. As is intended by the need for periodic LTCP updates, future flow metering and model re-calibration will help guide selection and final sizing of the proposed 2-year control infrastructure.

The estimated cost to expand from the 3-month recommended level of control to the 2-year level of control along the Shetucket, including an HRC facility at the WPCF is approximately $120M.

Table 10-3 Shetucket and WPCF Near-Term vs. Long Term Recommended Plan Comparison

Component	3-Month Storage	2-Year Conveyance
Shetucket Relief Interceptor (diameter, inches)	N/A	36 to 48
Rose Alley Commuter Lot Storage Tank (Mgal)	1.45	0.9
Rose Alley Tank Dewatering PS (mgd, FM diameter in inches)	2, 10	2, 10
Rose Alley Gravity Pipe into Storage Tank (diameter, inches)	30	36
Rose Alley PS Upgrade (mgd)	Existing	65
Rose Alley FM (diameter, inches)	Existing	42
WPCF Capacity (mgd)	20	80
Rose Alley Combined Culvert Relief Pipe (diameter, inches)	24	N/A
Sluice Gate on Shetucket Interceptor	1	N/A
Various Pipe Replacements 12-in to 32-in Diameter (length, feet)	720	830
Weirs Raised Beyond Planned Projects Level	5	7

10.4 Performance and Benefits

The Recommended Plan provides a system-wide 3-month level of control within a reasonable planning period and prevents overflows in events up to and including the 3-month design storm. This approach allows for the expansion to the 2-year level of control as NPU can afford to fund additional projects. The 3-month recommended control level will reduce annual CSO volume by 80% compared to the baseline conditions. The expansion to the 2-year level of control will reduce annual CSO volumes by 99% when compared to the baseline conditions. These results can be seen in Table 10-4.

Although the entire system will be initially controlled to the 3-month level of control, some specific areas will be controlled to a higher level. For example, the Planned Projects will control CSO's 024 and 025 to the 2-year level of control, as discussed in previous sections. The majority of overflow will continue to occur at the 017 outfall from regulators 17-1 and 17-2.

There will be combined sewer overflows in the CSS for storm events greater than 3-month return periods or for larger back-to-back storms with little recovery time between events. The combined sewer overflows corresponding to storm events greater than a 3-month event, or consecutive storms in the course of a year, will be substantially smaller than they are today.

However, the CSOs will contribute to exceedances of water quality standards. The only way to prevent CSO discharges from causing or contributing to exceedances of water quality standards under all conditions is to completely separate the combined sewer system throughout all of Norwich. As discussed in Section 6 and Section 8, the cost of this city-wide separation alternative is approximately $380M. This alternative represents a complete solution for elimination of CSOs, and removes the need for other components (storage, larger pumping stations and force mains, and wet weather treatment at the WPCF) but at significant incremental cost. It also increases pollutant loading from urban stormwater to receiving waters, which will have its own impact to water quality. Sewer separation and private property inflow removal would also result in widespread disruption during construction. This alternative would also not be affordable for NPU, as it is twice the cost of the (already unaffordable) 2-year control level described above.

At this time, the initial 3-month Recommended Plan represents an investment that is cost effective (in that it reaches the knee-of-the-curve as discussed in Section 8), already exceeds EPA affordability criteria (as discussed in Section 9), and results in significant reduction in annual CSO volumes. It is further noted that NPU could expand upon this plan to reach 2-year CSO control as they can afford to construct additional projects.

As described in Section 8, the term knee-of-the-curve reflects the point along the cost-benefit curve where incremental improvements in performance become progressively smaller in relation to incremental increases in facility size and cost. In other words, the incremental cost-benefit of reducing CSO's become smaller and smaller as the level of control increases. This pattern is intensified in the case of CSO control since the size of facilities required to capture increasingly rare events grows geometrically. The knee-of-the-curve identifies the point at which costs increase disproportionately for only a marginal improvement in CSO capture and improved water quality. Therefore, the knee-of-the-curve is a measure widely used to help establish optimal cost effectiveness and the recommended size of an overall CSO control system.

As discussed in Section 8, the knee-of-the-curve for NPU's CSS is at the 3-month level of control, allowing approximately 4 overflows per year. Although DEEP has the ultimate goal for NPU's CSS to reach the 2-year control, achieving this level of control in the near term is not affordable (and thus is not realistic) for NPU within a reasonable planning horizon (assumed to be 30 years). More detail on affordability is provided in Section 9.

10.4.1 Design Storms and the Representative Period

The Baseline Conditions Report selected representative design storms for the 1-month, 3-month, 6-month, 1-year, 2-year, and 5-year average recurrence intervals (ARI). These storms were selected from historic rainfall data. Design storms are a valuable tool for planning or design of hydraulic control features and can be simulated much more quickly than a representative period, which can take many hours.

The Baseline Conditions Report also selected a representative period which contained the appropriate number of storms at each ARI. The selected three-year representative period from 2009 to 2011 was identified as a period that would yield appropriate annual statistics for CSO volume, duration, and frequency for present conditions, as well as for control levels up to 1-year. Obtaining robust statistics for assessing two-year control would require a six-year or longer simulation period, which would impose considerable computational burden.

The 2009 to 2011 representative period contains the appropriate number of storms at each ARI. However, some of the storms exceed a two-year ARI at various durations. Two had especially high ARIs:

- July 8, 2011: 10-year 15-minute rainfall, 20-year 30-minute rainfall, 8-year 1-hour rainfall, and 3-year 2-hour rainfall
- March 29-30, 2010: 3-year 6-hour rainfall, 10-year 12-hour rainfall, and 40-year 24-hour rainfall

It can thus be expected that model simulations of 2-year control scenarios may still have significant CSO or surcharge in the largest storm of the three-year representative period.

Similarly, while the representative period was chosen to have close to ideal numbers of events at various durations, simulations using these data may yield overflow frequencies that do not exactly correspond with the performance levels identified using design storms.

10.4.2 Modeled Results

The annual performance benefits (based on simulation of the representative period, 2009-2011) associated with the initial phase (3-month storage) of the Recommended Plan are summarized below:

- Average annual frequency of overflow events will be reduced from 60 events to an average of 4 events, a 93% reduction;
- Average annual CSO volume is reduced from 43.3 million gallons to 8.5, an 80% reduction.

The average annual performance benefits associated with the expanded (2-year) plan are summarized below:

- Average annual frequency of overflow events will be reduced from 60 events to an average of 0.5 events, a 99% reduction;
- Average annual CSO volume is reduced from 43.3 million gallons to 0.25, a 99% reduction.

Average annual event counts in the representative period are displayed in Table 10-4.

Table 10-4 Performance of the Least Cost Plans

CSS Conditions	Annual CSO Volume (Mgal)	Annual Number of CSO Events
Baseline Conditions	43.3	60
Recommended Plan: Initial 3-Month Control	8.5	4
Future 2-Year Control	0.25	0.5

10.4.3 Other Benefits

Other benefits of the Recommended Plan include significant improvements to system operation and performance that are not easily measurable through CSO reductions, only.

These improvements include:

- Renewal of failing infrastructure throughout NPU's CSS. The River Avenue pumping station had a force main break in 2018. The South Thames Street Pumping Station and Shipping Street Pumping Station have each had force main breaks in recent years. The Recommended Plan puts focus on these pumping stations as well as other failing infrastructure and can reduce CSO volumes while preventing future infrastructure failure.
- Improvement of treatment facilities and operations at the WPCF. Increasing treatment capacity slightly (to the recommended 20 mgd) and modernizing equipment and facilities here (as discussed in Section 3) will improve treatment reliability and capacity therefore alleviating some CSO issues. The expansion to a 2-year control level requires a new HRC facility which will further improve treatment capacity during high flow conditions.

- An allowance for CMOM activities was included in the financial analysis presented in Section 9. These activities could not be quantified in the current modeling efforts, but it is likely that additional cleaning of the CSS would increase the conveyance of the system and reduce CSO occurrence further. An increase in CMOM activities is expected in the coming years, and effects of these could be evaluated in the next LTCP update.

- Improved supervisory control and data acquisition (SCADA) controls at the Rose Alley pumping station, which are included in the planned projects, will improve CSO and O&M operations. As discussed in the Baseline Conditions report, NPU currently manually throttles this pumping station to maintain peak capacity at the WPCF and prevent junction chamber overflow at the WPCF during storm events. SCADA controls will increase the flow accepted at the WPCF, reduce CSO, and eliminate the need for this manual throttling activity.

The Recommended Plan optimizes the existing facilities and infrastructure to the extent possible. In the initial 3-month control phase, much of the system has capacity, but storage needs to be added to reduce the peak flows. Upon extension to the 2-year control level, the system capacity is generally exceeded, and the relief interceptor, larger pumping stations, and additional treatment capacity is needed. Additionally, the Recommended Plan renews existing infrastructure and assets that have exceeded their useful life, while greatly reducing occurrence of CSOs in Norwich.

10.5 Balancing the Approach to Implementation

The Recommended Plan includes infrastructure renewal projects such as the WPCF upgrade and pumping station and force main replacements at River Avenue, Shipping Street and South Thames Street. These projects, while necessary to maintain overall system reliability, have also been planned to generate a direct benefit in terms of CSO conveyance and/or treatment. Pumping station capacities will increase, and the WPCF will undergo a nominal but meaningful peak flow capacity expansion from 17 mgd to 20 mgd. The proposed levels of CSO control cannot be achieved without these projects. Conversely, upgrade of core infrastructure alone is not sufficient to achieve the stated levels of control of the Recommended Plan. As such, a balanced compromise is needed in implementation.

The Recommended Plan contains a balance of water pollution control facility improvements, CSO structure improvements, existing infrastructure renewal, storage, conveyance improvements, and sewer relief. Given the variety of technologies and projects in the Recommended Plan, it provides a favorable measure of flexibility to provide the best value moving forward. As projects are implemented, the sizes of conveyance piping and storage tanks can vary to accommodate future conditions. The initial 3-month control phase gives NPU the ability to make major gains in CSO reduction, while providing a path to achieve the two 2-year level of control in a subsequent phase.

Selecting a Recommended Plan that can ultimately be expanded to the target control level ensures that NPU does not build infrastructure that prevents them from improving their CSO control level or makes the addition of more infrastructure prohibitively more expensive. NPU plans to revisit the Recommended Plan every five years during implementation to reevaluate the effectiveness of implemented and planned projects and to stay on course with meeting the overall objectives of the plan.

10.6 Implementation Sequence

If one component is affected by other components within the Recommended Plan, then it is sensible to defer implementation of the dependent component until the independent components are implemented. This will ensure that the alternative is appropriately sized to achieve the targeted level of control, and prerequisite projects are in place to accept design flows. In general, priority was based on addressing public health, water quality standards, CSO reduction, cost-effectiveness, and logical sequencing of work. Overall, the implementation schedule should allow sufficient time to construct projects in a planned and sensible manner, to minimize disturbance to neighborhoods, to evaluate the effectiveness of each project and resize controls as appropriate, and to ease the financial burden on NPU's ratepayers.

In terms of prioritization, it is recommended that projects that address public health issues be addressed first. NPU does not historically have problems with basement backups or SSOs, and the receiving waterbodies are all of the same classification, and therefore CSOs and the potential for failed infrastructure are the most important priorities. The Planned Projects (as described in Section 7) will be implemented first and have been modeled as a part of this LTCP. Additionally, the WPCF needs rehabilitation, which is not dependent on the size of CSO controls, as sizing the WPCF for the peak CSO flows would not be an effective strategy. It is recommended that CSO conveyance, relief piping, and the first WPCF projects be implemented first, with storage components recommended for implementation in later years. This ensures that the more expensive storage components are not oversized in earlier years, before the rest of the CSO controls are put in place. Additionally, it is recommended that the WPCF upgrade be segmented to allow for more affordable construction. The general strategy of implementation is recommended to be alternating CSO and WPCF projects to stagger costs and make improvements to both failing infrastructure and CSO controls. This ensures that NPU infrastructure does not fail while their financial capacity is exhausted on CSO controls, nor that their CSOs are ignored while improvements to failing infrastructure is are made.

The Planned Projects will be implemented first and will involve weir adjustments and reconstruction, SCADA upgrades, and conveyance improvements at CSO 024 and CSO 025 as discussed in Section 7. These projects will provide immediate 2-year control to the upstream most section of the Shetucket River. These projects are relatively cost effective and provide substantial water quality benefits. A 2,500-foot section of the Shetucket River will be free of CSO up to and including the 2-year design storm.

The next area of focus after the Planned Projects that warrants prioritization is Laurel Hill. CSO control in this area is also fairly cost effective. As mentioned previously, the River Avenue Pumping Station had a force main break in 2018, and there have been infrastructure issues in this area in the past. It is recommended that this pumping station be replaced, along with a few pipes that need increased capacity, and additional weir modifications beyond the Planned Projects levels. Additionally, NPU is expecting to receive additional flow from the south side of Laurel Hill as described in Section 2. Completing these repairs and modifications in the early years of the LTCP ensures that NPU can accept these flows and thus provide themselves with more financial capacity to construct subsequent CSO projects.

Following the Laurel Hill area, it is recommended that NPU complete a project focused on renewing its WPCF infrastructure. This would include new secondary tanks, landfill

modifications, main electrical system upgrades, and new headworks. Upon completion of this WPCF project, it is recommended that conveyance projects along the Shetucket Interceptor (Greeneville and Downtown Sewer sheds) receive the next focus. Dry weather pipe size increases, as well as raising weirs beyond the Planned Projects level can reduce CSO along the Shetucket. The Shetucket Interceptor has the greatest number of CSO outfalls, and this project should be a priority early in the LTCP. It is expected that these projects could be completed in the first ten years of the LTCP.

The recommended areas of focus in the midterm of the LTCP timeline (between years ten and twenty) are Thamesville CSO projects and additional treatment plant upgrades. Thamesville priority CSO projects include the West Thames Street relief pipe, removing gravity connections from the existing Shipping Street FM, construction of a new Shipping Street Pumping Station and force main, and the South Thames Street storage tank. WPCF improvements recommended to be made in the midterm include, a new administration building, a new UV disinfection and effluent pumping station, and a retrofit of digesters B and C and of an existing secondary clarifier.

Finally, in the last stages of the LTCP timeline (between years twenty and thirty), the focus is recommended to be on the final storage tank and final WPCF improvements. The Rose Alley commuter lot storage tank, and combined culvert relief pipe would be constructed to complete the 3-month level of control. The size of the Rose Alley storage tank will ultimately be dependent on the effectiveness of the earlier CSO projects. It is anticipated that 5-year LTCP updates would evaluate the effectiveness of the previously constructed CSO projects, and the tank would be sized accordingly to achieve the 3-month level of control. Sludge pumping, piping, and odor control improvements at the WPCF would also be completed in this time frame, along with final sitework improvements at the Hollyhock Island WPCF site.

In summary, in the initial phase of the Recommended Plan (3-month control level) NPU will balance CSO projects and renewal of aging infrastructure. NPU will make improvements to the CSO infrastructure to the best of their financial capability while ensuring that their aging infrastructure does not fail. NPU will achieve significant improvements in CSO discharges, reducing their annual occurrences by 90%, and their total annual CSO volume by 80%. Following these improvements in the near planning horizon, NPU intends to expand their level of control to the 2-year control level as affordability constraints allow. Effectiveness of implemented CSO controls will be evaluated with 5-year LTCP updates, which will continue to evaluate the CSS and guide the direction of the LTCP.

10.7 Component Implementation

Based on the approach described above, these general timelines and areas of focus have been broken down into smaller projects with more specific implementation recommendations. The recommended initial projects and proposed durations for implementation are presented in Table 10-5 at the end of this Section. The capital costs of the initial phase projects (3-month control), the necessary facility upgrades to the WPCF, and LTCP updates over 30 years is $156M (FY 2018 dollars). The planning period of the LTCP would extend from 2019 to 2049.

The recommended initial phase project improvements will provide a 3-month level of control throughout the entire NPU combined sewer system. CSO and existing infrastructure projects would be alternated to promote CSO progress and prevent existing infrastructure failure. LTCP

updates completed in 5-year intervals will evaluate constructed projects and reevaluate future projects through model evaluation and updated financial analysis.

It is not recommended that CSO regulators or outfalls be closed. These relief points are needed to alleviate surcharging in events larger than the 3-month storm. Closure of regulators could lead to basement backups, street flooding and general risk to public health. The potential to safely close CSO regulators will be evaluated regularly as the LTCP is implemented and LTCP updates are completed in the future.

This CSO abatement program represents a major financial, economic, and environmental challenge. Upon completion of the initial 30-year schedule of LTCP projects, the 3-month level of control will be achieved, and these projects can be expanded to the 2-year level of control through the addition of new infrastructure. NPU cannot currently afford to achieve this 2-year level of control as presented in Section 9, and therefore the ability to achieve this goal will be revaluated every 5-years in the LTCP updates to determine if conditions have changed and based on the work completed to that point. This LTCP will allow NPU to make large gains in improving water quality through the implementation of the initial 3-month control plan and then completing additional projects as NPU has the financial capability to afford them.

Table 10-5

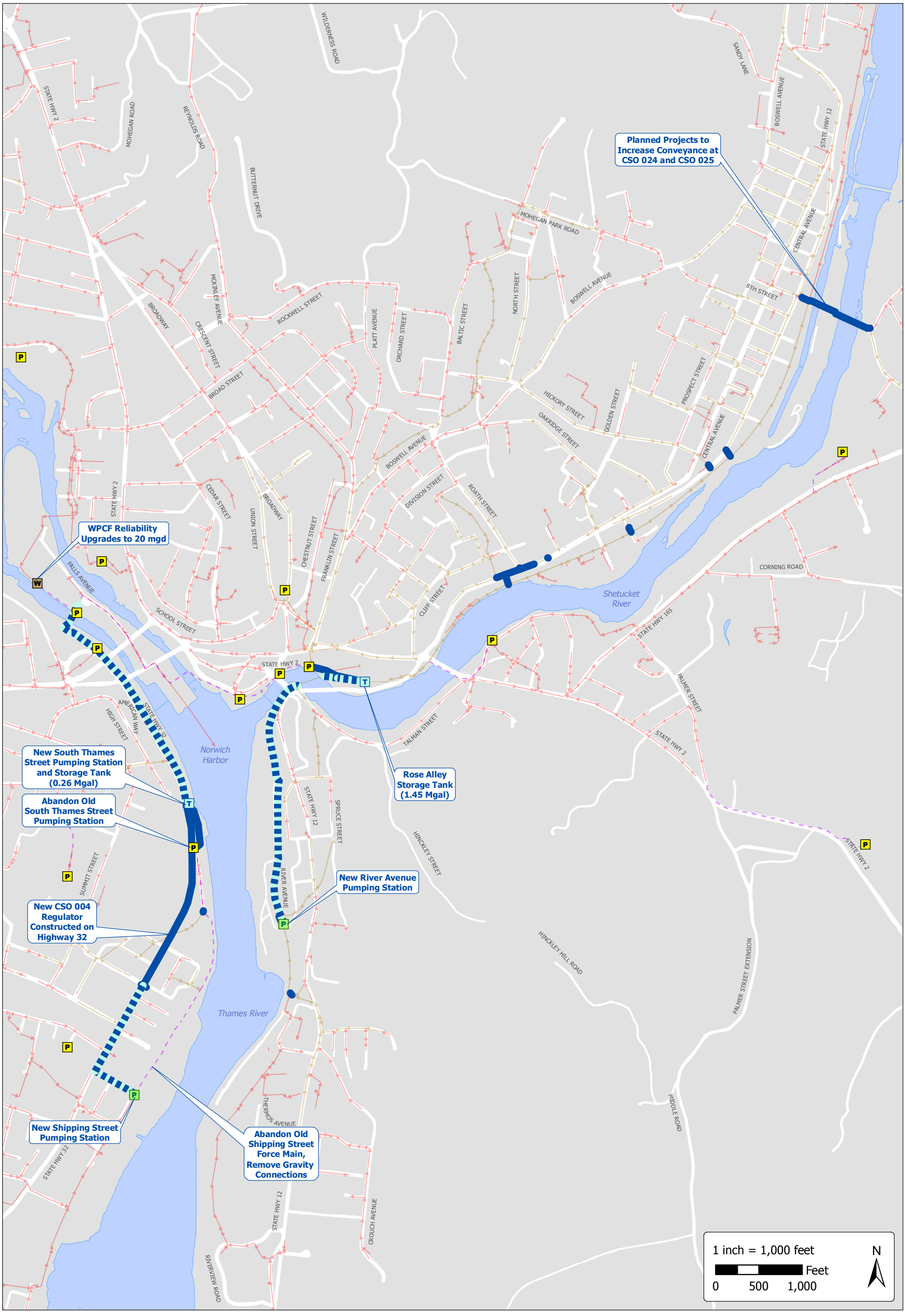
Norwich Public Utilities
2018 CSO Long Term Control Plan

3-Month CSO and WPCF Projects
Over 30 Years (Recommended Plan)

Project Order	Approximate Duration (Years)[1]	Area[2]	Item[3]	Program Years	Calendar Year	Rounded Costs ($ 2018)[4]
1	3	Eastside	"Planned Projects"	1-3	2019-2021	$ 6,000,000
2	3	Laurel Hill	New River Avenue Pump Station and FM	3-5	2021-2023	$ 6,100,000
3	3	Laurel Hill	Raising Weirs beyond Planned Projects Level, Replace Dry Weather Flow Pipes from 032 and 031	3-5	2021-2023	$ 500,000
4	1	LTCP Update	Long Term Control Plan Update	5	2023	$ 1,000,000
5	4	WPCF	New Secondary Tanks, Landfill Modifications, Main Electrical System Upgrades, and New Headworks	5-8	2023-2026	$ 41,000,000
6	2	Shetucket	Various Dry Weather Flow Pipe Diameter Increases, Raise Five Weirs Beyond Planned Project Levels	8-9	2026-2027	$ 1,500,000
7	3	Thamesville	Gravity Pipe down Highway 32 to New Regulator	9-11	2027-2029	$ 5,200,000
8	1	LTCP Update	Long Term Control Plan Update	10	2028	$ 1,000,000
9	2	WPCF	New Admin Building	11-12	2029-2030	$ 5,200,000
10	3	Thamesville	Cahoon Street, Thames Terrace, Kinney Avenue Gravity Sewers. Raising Weirs. Abandoning Old CSO 004 Regulator. New Building Services Near Old CSO Regulator 004	12-14	2030-2032	$ 1,400,000
11	2	WPCF	UV and Effluent Pumping Station	14-15	2032-2033	$ 5,600,000
12	1	LTCP Update	Long Term Control Plan Update	15	2033	$ 1,000,000
13	3	Thamesville	New Shipping Street PS and FM	15-17	2033-2035	$ 4,400,000
14	2	WPCF	Digesters B and C and Retrofit Secondary #1	17-18	2035-2036	$ 2,900,000
15	3	Thamesville	S. Thames Storage Tank (0.26 mgal) & Property Purchase Allowance	18-20	2036-2038	$ 5,700,000
16	1	LTCP Update	Long Term Control Plan Update	20	2038	$ 1,000,000
17	3	Thamesville	S. Thames New Gravity Sewer (Old PS to New PS)	20-22	2038-2040	$ 600,000
18	3	Thamesville	New S. Thames PS and FM	20-22	2038-2040	$ 5,900,000
19	2	WPCF	Sludge Pumping and Piping I and GT Upgrades	22-23	2040-2041	$ 3,800,000
20	3	WPCF	Primary, Aeration, and Chemical Addition Upgrades	23-25	2041-2043	$ 13,000,000
21	1	LTCP Update	Long Term Control Plan Update	25	2043	$ 1,000,000
22	3	Shetucket	Rose Alley Commuter Lot Tank (1.45 mgal), 2 mgd Dewatering Pump Station, New FM, New Gravity Pipe, Sluice Gate Diversion Structure, and Allowance for Disruption.	26-28	2044-2047	$ 32,000,000
23	3	Shetucket	Rose Alley Relief Pipe and New Combined Culvert Weir	26-28	2044-2047	$ 700,000
24	2	WPCF	Sludge Pumping and Piping II	29-30	2048-2049	$ 3,500,000
25	2	WPCF	Odor Control and Final Sitework Improvements	29-30	2048-2049	$ 5,000,000
26	1	LTCP Update	Long Term Control Plan Update	30	2049	$ 1,000,000
						$ 156,000,000

Notes:

1) Project duration includes time for design, bidding, and construction to substantial completion.
2) Some projects, like the WPCF projects, will require additional planning or conceptual design.
3) See Sections 3, 7, and 8 for more detail on project components.
4) It is understood, as described in Section 9, that total program cost will be higher when adjusted for inflation over the life of the projects.



CDM Smith

Legend

- Recommended Storage Tanks
- Recommended Pumping Stations
- Recommended Sewers
- Recommended Pressurized Mains
- Water Pollution Control Facility
- Pumping Stations
- Force Mains
- Combined Sanitary Sewers
- Separated Sanitary Sewers

LTCP Recommended Plan
Norwich, CT
Figure 10-1
Recommended 3-Month Control Plan

N

NEW 30" DIA CULVERT RELIEF PIPE

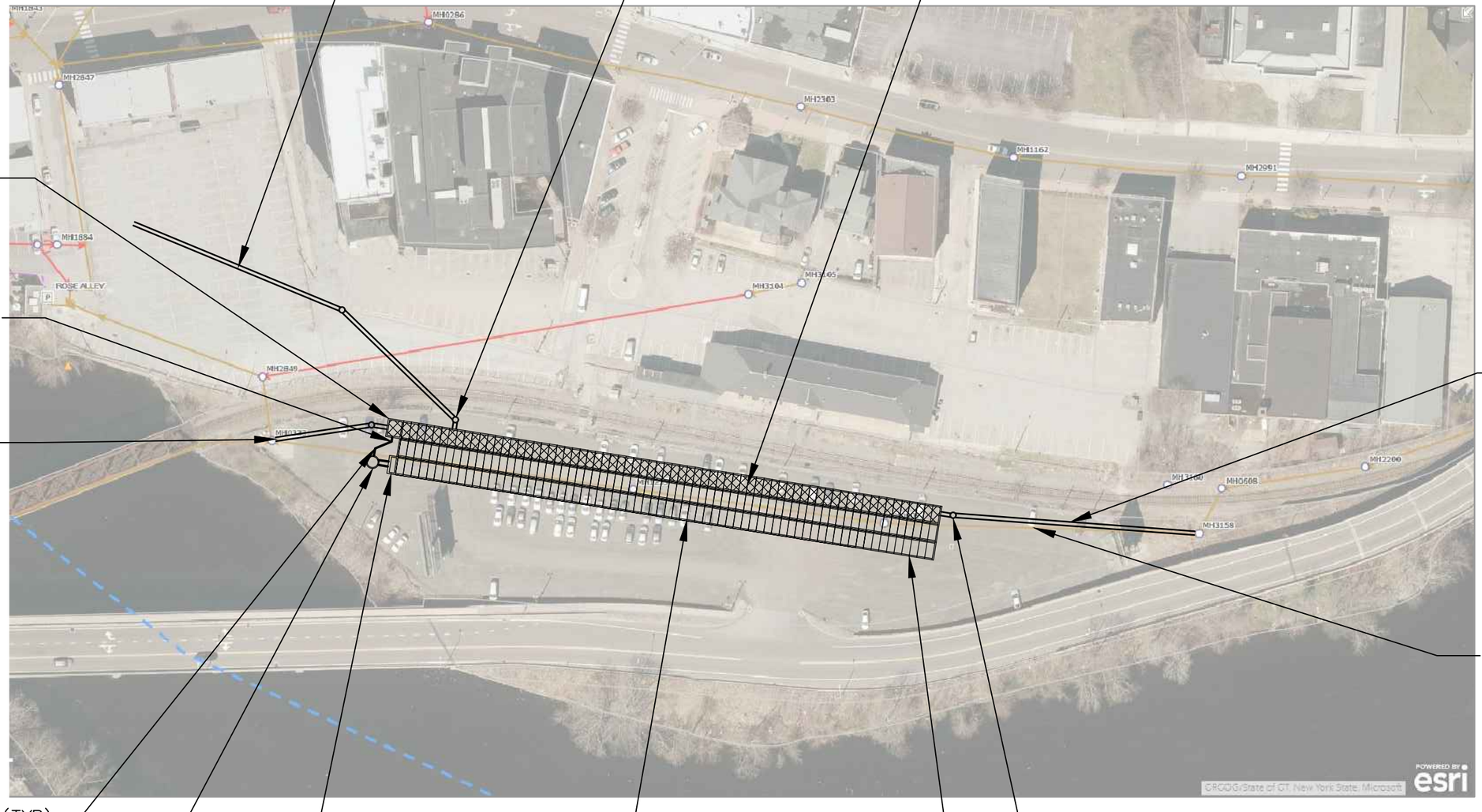
CONNECTION FROM CULVERT RELIEF PIPE TO WET WEATHER STRUCTURE

BOX CULVERT PORTION OF INTERCEPTOR TO HAVE V-NOTCH BOTTOM WITH OVERFLOW WEIRS TO WET WEATHER STORAGE STRUCTURE

TRANSITION STRUCTURE FROM BOX CULVERT TO PCCP

FORCEMAIN CONNECTION TO TRANSITION STRUCTURE

CONNECTION FROM NEW INTERCEPTOR TO EXISTING INTERCEPTOR MH



42" DIA PCCP GRAVITY PIPE (TYP)

DEMO EXISTING INTERCEPTOR AND ROUTE FLOW THROUGH STORAGE STRUCTURE

10" DI FORCEMAIN (TYP)

PUMP STATION VALVE VAULT

4 MGD PUMP STATION WET WELL

PRECAST WET WEATHER STORAGE STRUCTURE

PRECAST 13' X 12' X 6' LENGTH BOX CULVERT SECTION (TYP OF 210)

PRECAST MH (TYP)

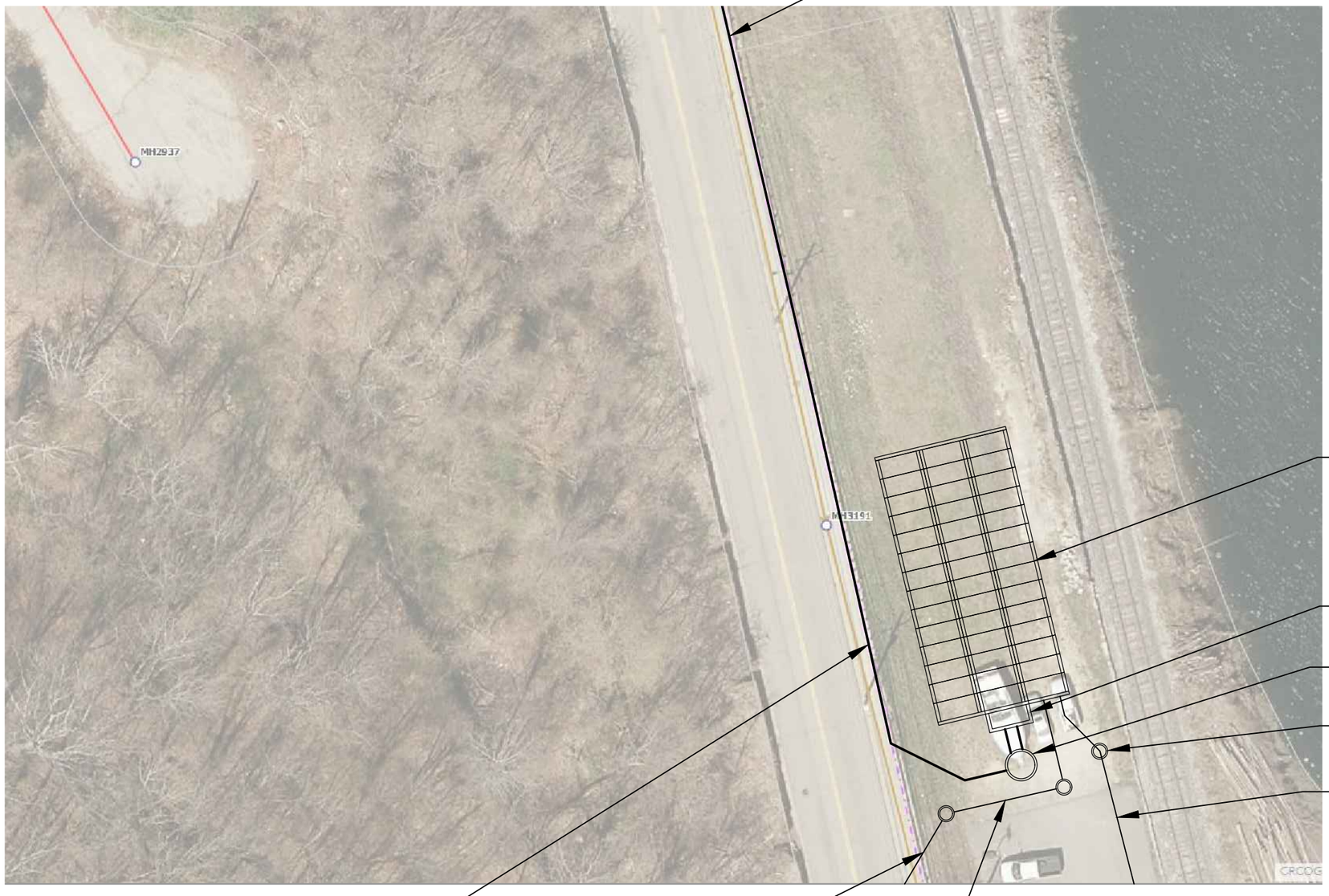
CDM Smith

NOT TO SCALE

NORWICH PUBLIC UTILITIES

FIGURE 10-2
STORAGE TANK AND PUMP STATION
ROSE ALLEY FACILITY LAYOUT

3-MONTH STORM – 1.45 MG STORAGE



NOT TO SCALE

NORWICH PUBLIC UTILITIES

FIGURE 10–3
STORAGE TANK AND PUMP STATION
THAMESVILLE FACILITY LAYOUT

3–MONTH STORM – 0.26 MG STORAGE

Planned Projects to Increase Conveyance at CSO 024 and CSO 025

WPCF Reliability Upgrades to 20 mgd

60 mgd High Rate Clarification Facility Constructed at WPCF

New Shetucket Relief Interceptor

New Rose Alley Pumping Station

Rose Alley Storage Tank (0.9 Mgal)

New South Thames Street Pumping Station

Abandon Old South Thames Street Pumping Station

New CSO 004 Regulator Constructed on Highway 32

New River Avenue Pumping Station

New Shipping Street Pumping Station

Abandon Old Shipping Street Force Main, Remove Gravity Connections

1 inch = 1,000 feet

Feet

0 500 1,000

N

Legend

- Recommended Storage Tanks
- Recommended Pumping Stations
- Recommended Sewers
- Recommended Pressurized Mains
- Water Pollution Control Facility
- Pumping Stations
- Force Mains
- Combined Sanitary Sewers
- Separated Sanitary Sewers

LTCP Recommended Plan
Norwich, CT
Figure 10-4
Recommended 2-Year Control Plan

Appendix A

Memorandum

To: *File*

Date: *August 14, 2018*

Subject: *Appendix A Contents*

A public meeting was conducted on August 1, 2018 on the status of the Norwich Combined Sewer Overflow (CSO) Draft Long-Term Control Plan (LTCP). The purpose of this meeting was to share information and solicit input from the public prior to finalizing the plan and submitting the report to the Connecticut Department of Energy and Environmental Protection (DEEP). The meeting was held at 6:00pm at the NPU office at 16 South Golden Street, Norwich CT 06360. Materials from this meeting are provided in Appendix A. These include the following items:

- A public notice announcing the meeting and soliciting input,
- Slides of the presentation given at the public meeting,
- Notes from the public meeting, and
- A news article about the meeting from the Norwich Bulletin.

Public Meeting for Norwich Public Utilities CSO / Long-term Control Plan

Norwich Public Utilities (NPU) will conduct a public meeting on the updated draft of its existing Combined Sewer Overflow Long-Term Control Plan (CSO/LTCP) in accordance with the Connecticut Department of Energy and Environmental Protection (CT DEEP) Clean Water Fund regulations.

NPU invites residents and property owners of Norwich and any other interested parties to attend the public meeting on August 1, 2018 at 6:00 pm at the NPU office at 16 South Golden Street, Norwich, CT 06360.

The CSO / LTCP is the planning document for the construction of sewer improvements which establish the overall direction for NPU's wastewater system upgrades. This plan is being developed to comply with an enforcement actions by CT DEEP related to combined sewer overflows and the U.S. Environmental Protection Agency (EPA) related to sanitary sewer overflows.

This public meeting will include a presentation on the revisions to the original CSO / LTCP dated June 6, 2012, as well as the schedule for the work to be completed by NPU. The purpose of the meeting is to share information and solicit input from the public for consideration prior to finalizing the plan and securing final approval from CT DEEP.

The public meeting will also inform the public of possible subterranean easements that may be required for this important work to move forward.

A copy of the draft CSO / LTCP will be available for review at NPU's Administrative Offices at 16 South Golden Street, Norwich, CT 06360. The draft report may also be viewed on the NPU website at www.norwichpublicutilities.com / CSO-LTCP.

Written comments may be submitted to NPU prior to the meeting to:

Lawrence Sullivan, P.E.
Norwich Public Utilities
16 South Golden Street
Norwich, CT 06360

Or to:
larrysullivan@npumail.com

Norwich Public Utilities
CSO Long Term Control Plan

August 1, 2018

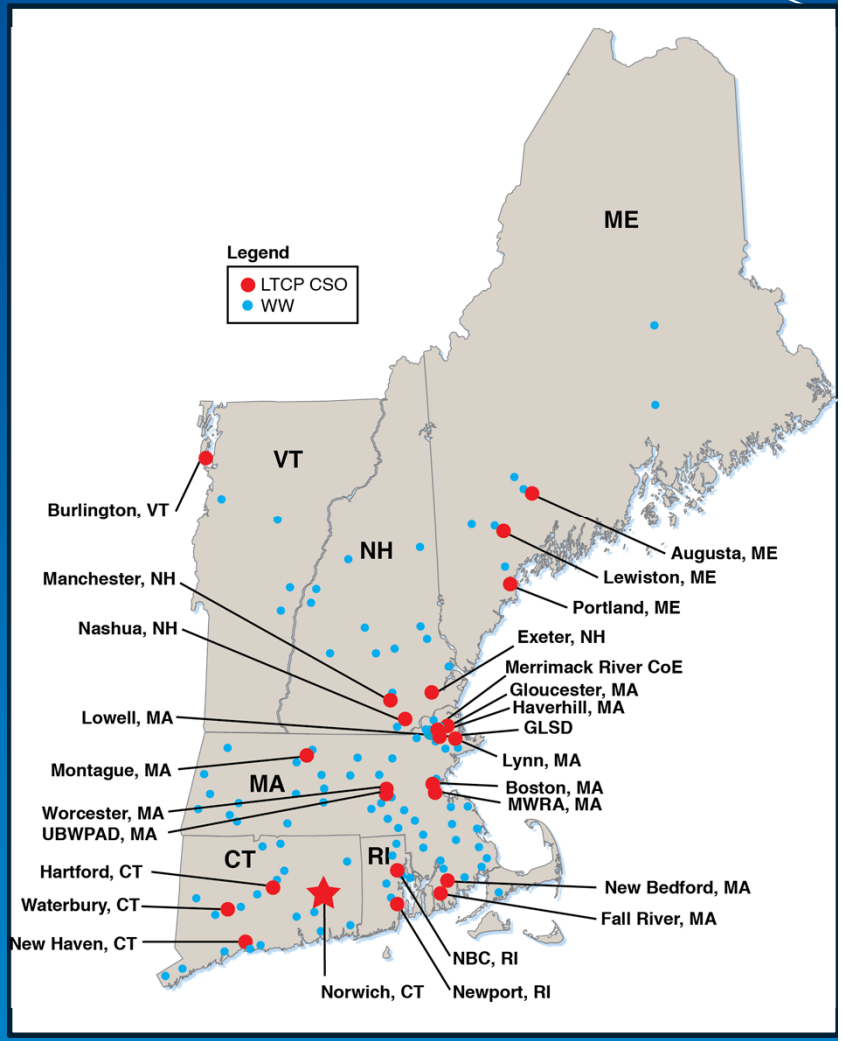
CDM Smith®

Agenda

1. Introductions
2. Sewer System
3. Water Pollution Control Facility
4. Modern CSO Policy / Regulation
5. DEEP CSO Consent Order
6. CSO Long Term Control Plan
7. Potential Alternatives
8. Balancing Infrastructure Needs
9. Next Steps

CDM Smith Brings Extensive CSO Experience

- National experience
- Affordable CSO programs
- More CSO experience in New England than anyone
- Extensive negotiating with DEEP, EPA and others
- Strong track record managing complex projects on budget
- Proven performance securing CWF and other funding

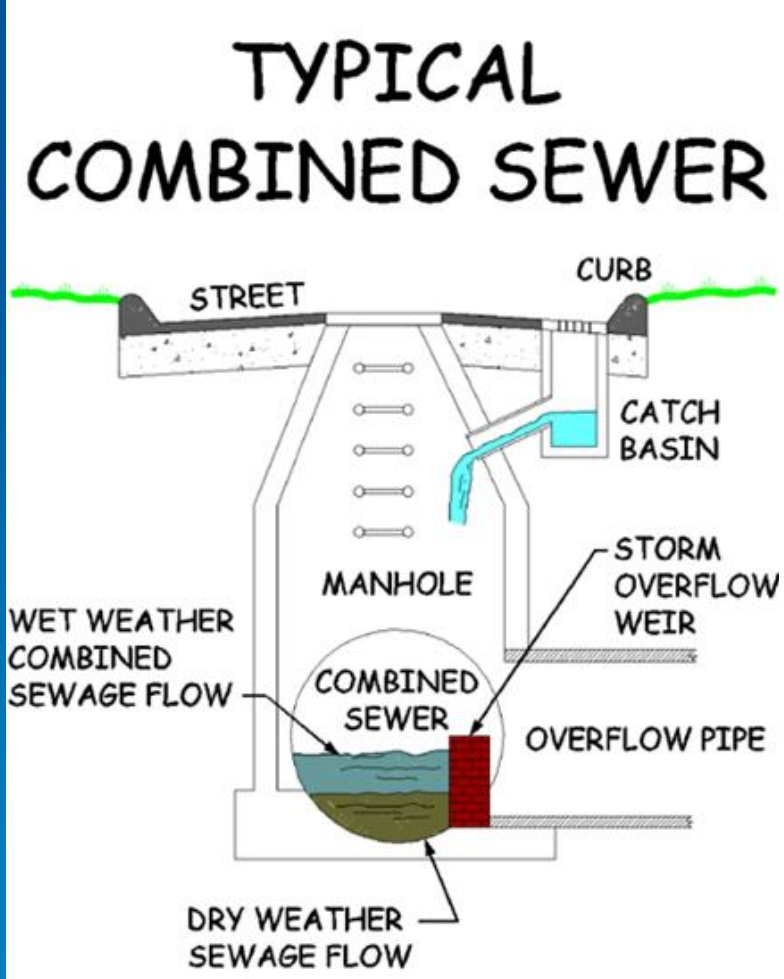


Historical Perspective on Sewers

Norwich has combined sewers

- Historical design standard
- Common in older systems
- Combines sewage and storm water into one pipe
- Hydraulic relief points needed: Combined Sewer Overflows (CSOs)

- www.sewerhistory.org



Historical Perspective on Sewers (continued)

- Sanitary Engineering, Volume I, 3rd Edition, p. 45, 1909: A combined sewer system allows small rain runoff to enter the sewer, while large (presumably cleaner) runoff is discharged into a river.

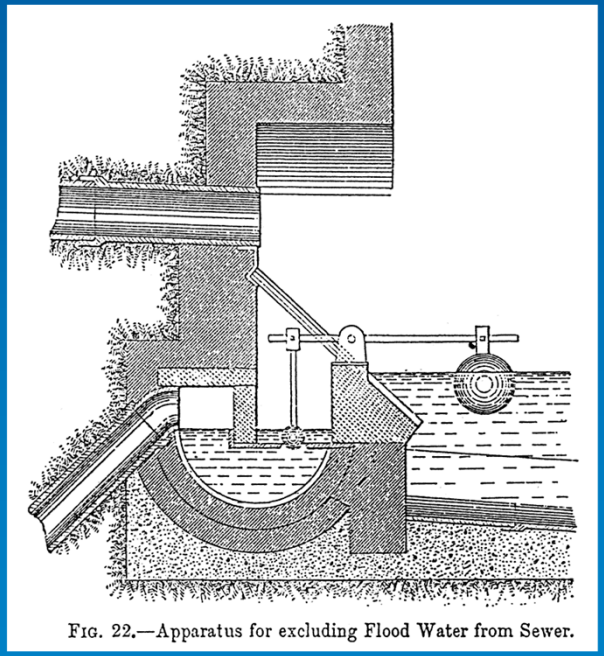


FIG. 22.—Apparatus for excluding Flood Water from Sewer.

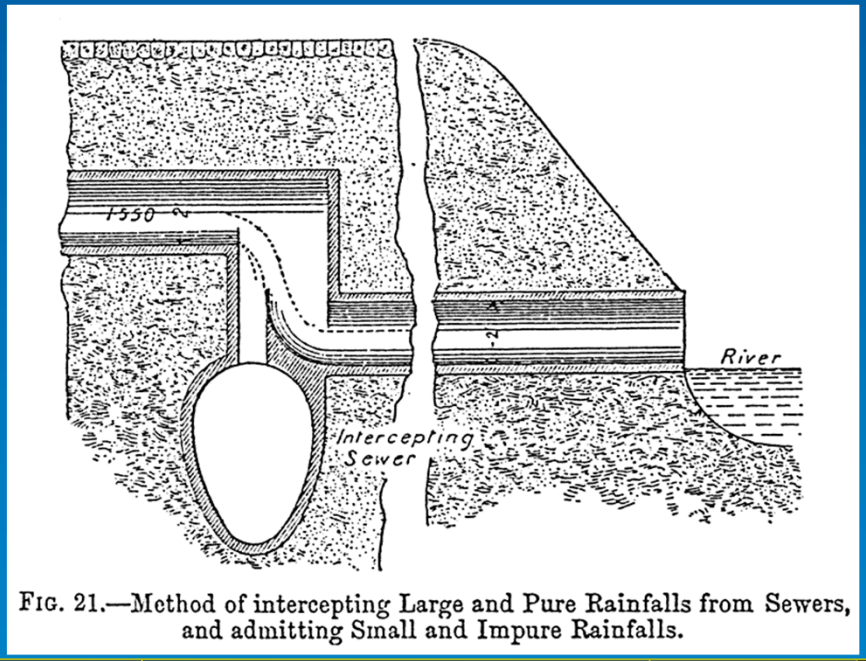
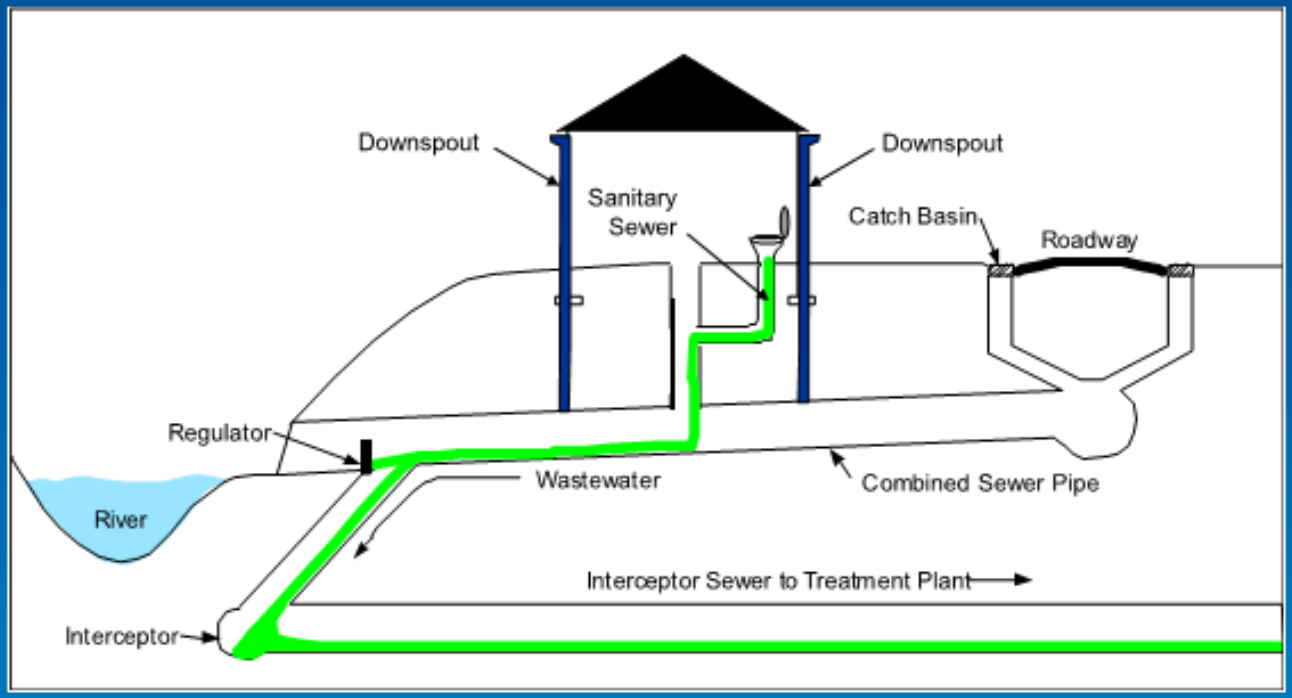


FIG. 21.—Method of intercepting Large and Pure Rainfalls from Sewers, and admitting Small and Impure Rainfalls.

Combined Sewer Operation (Dry Weather)

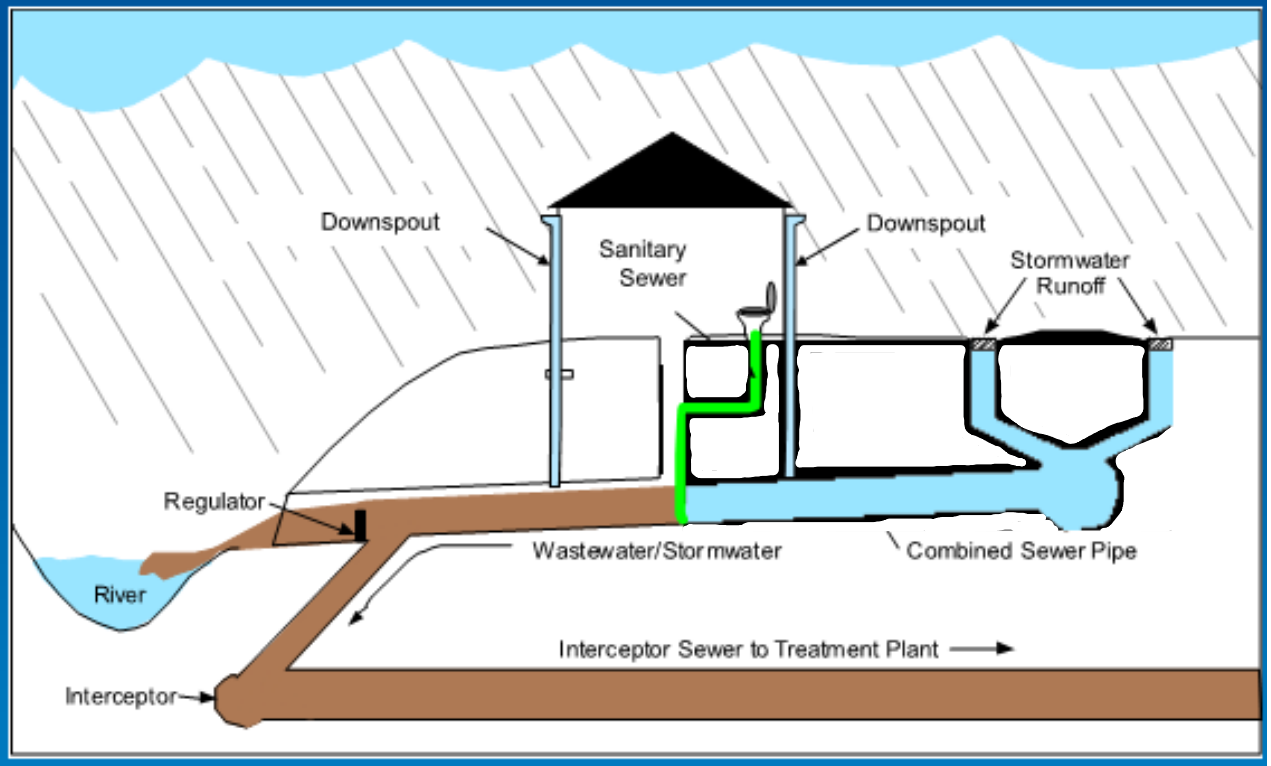
All sewer flows are routed to treatment facilities



Dry Weather Conditions

Combined Sewer Operation (Wet Weather)

Combined Sewer Overflows result from storm water inflow during rain events.



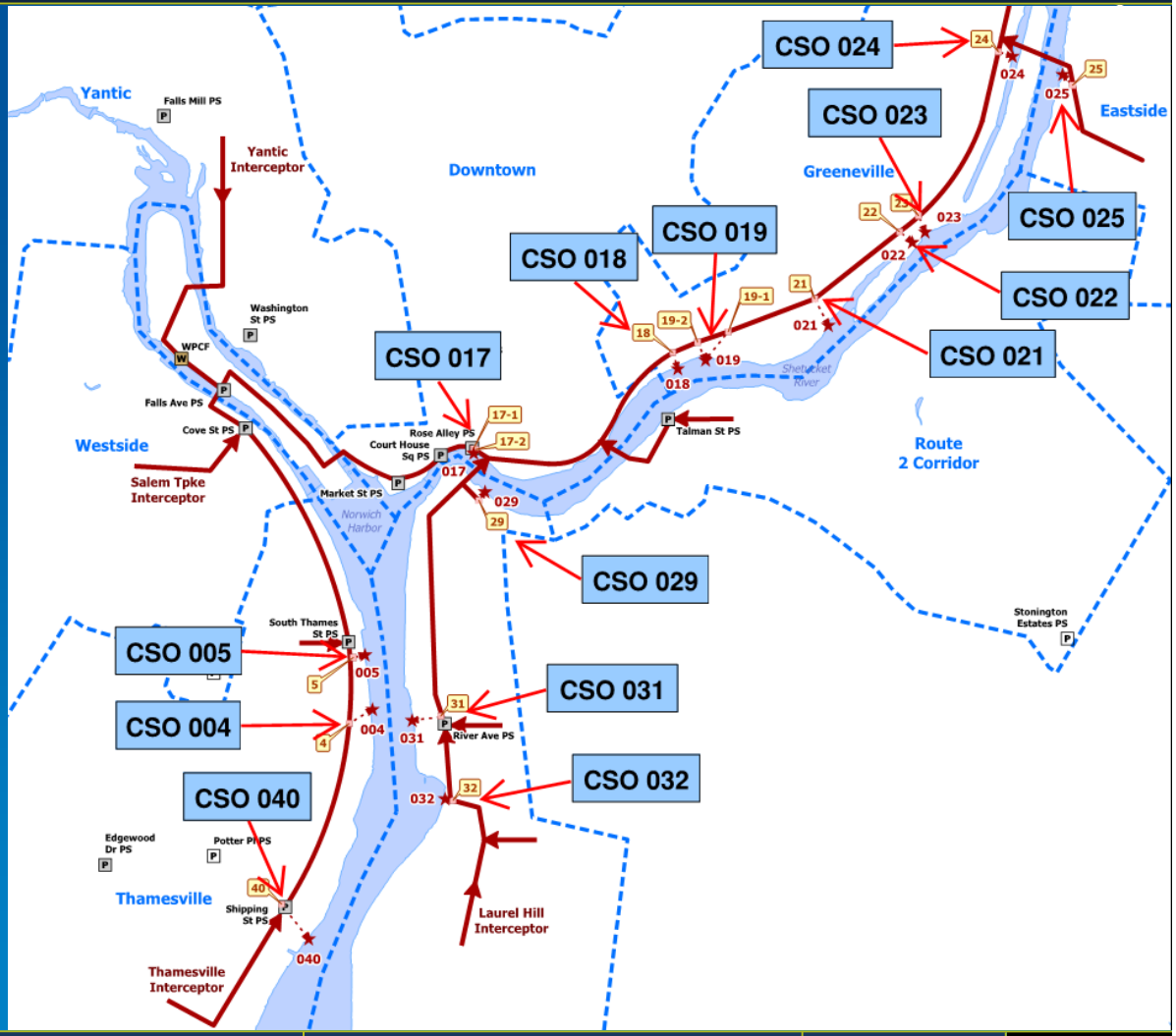
Wet Weather Conditions

What Do Combined Sewers Carry?

- Raw Sewage
- Storm water
- Bacteria
- Solid Materials
- Trash and Debris
- Nutrients
- Metals
- Sand and Road Salt
- Oils and Greases
- Leaves
- Other Contaminants

Norwich System Overview

- 16 overflow regulators
- 14 permitted outfalls
- CSOs Discharge to the Shetucket and Thames Rivers



Baseline Statistics

- In March 2018, NPU submitted a Baseline Conditions Report to CT DEEP.

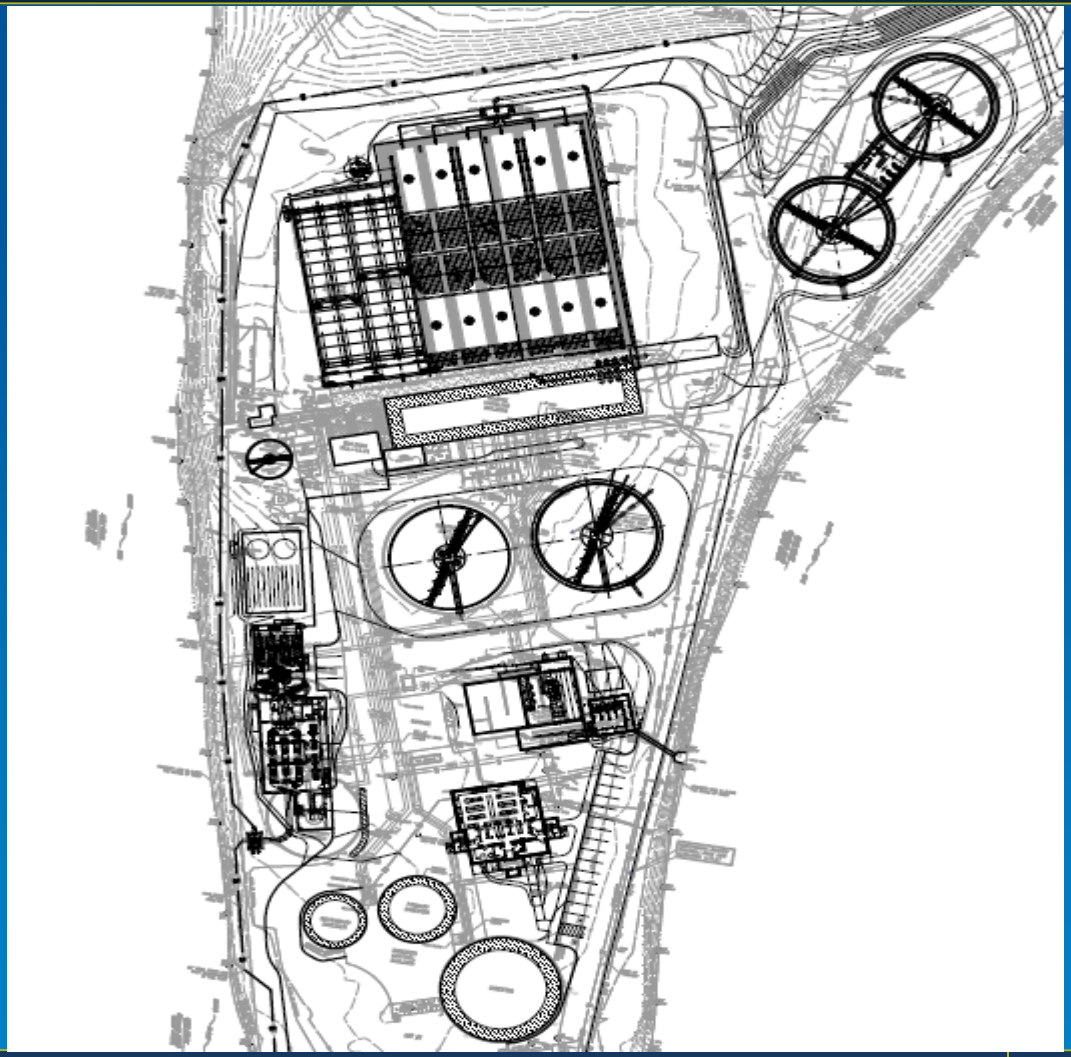
- Annual CSO numbers
  - 60 overflow events
  - 43 million gallons
  - 355 hours of overflow

Water Pollution Control Facility

WPCF Overdue for Upgrade

- 1950's construction
- Expanded in 1970's
- General O&M since
- Digester repairs
- Typical 20 year service
- Upgrade needed:
  - Aging equipment
  - Permit limits (Nitrogen)
  - Disinfection, reliability, SCADA, energy efficiency, safety, CSO flows, flood resiliency, landfill closure.

Anticipated WPCF Upgrade



- New headworks
- Influent pumping
- Upgrade primary
- Upgrade aeration
- New secondary
- Remove bottlenecks
- Upgrade sludge processing systems

Anticipated WPCF Upgrade (continued)

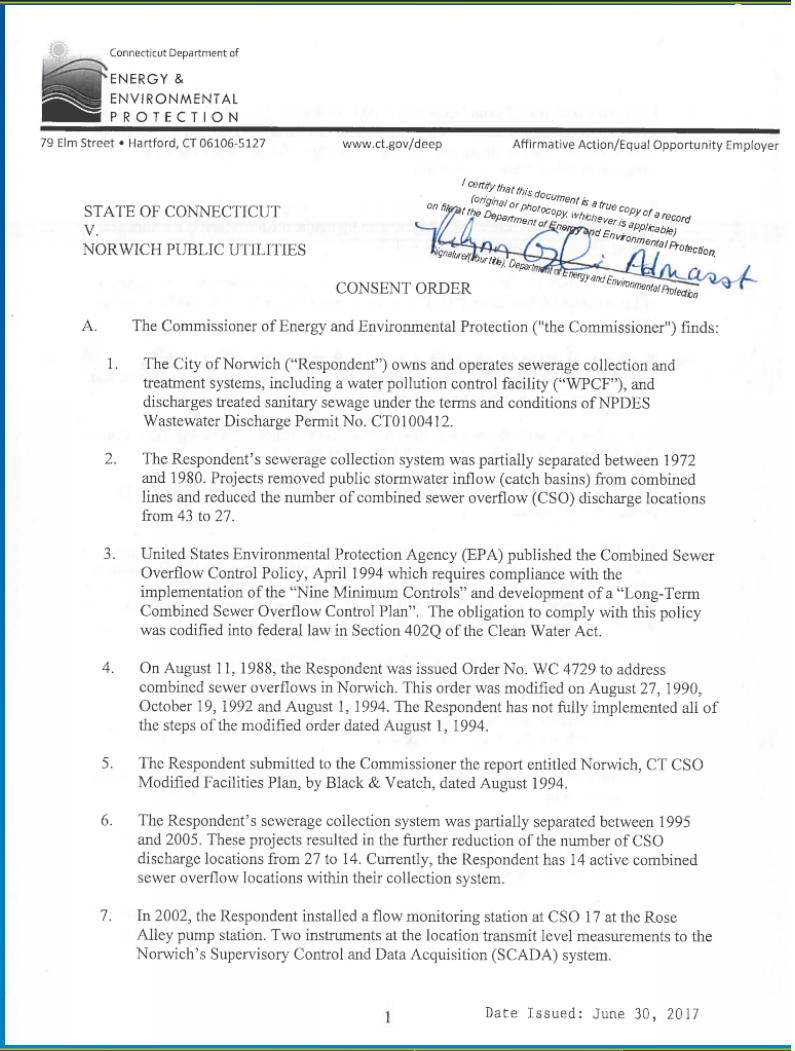
- New UV disinfection
- New electrical distribution
- New SCADA controls
- Effluent pumping
- Upgrade digesters
- Flood protection
- Modern lab facilities

Modern CSO Policy / Regulation

- CSOs no longer design standard
- 1994 EPA CSO policy set abatement guidelines
- DEEP governs in CT – goal to eliminate all CSOs
- Only 6 CSO communities remain in CT
- Many communities have made significant progress
- Norwich performed early CSO work in the 90's

DEEP CSO Consent Order

- Requires 2-year CSO control
- Water quality focused
- LTCP is evaluating engineering and economics
- Norwich's ability to pay for projects must be considered in any implementation plan



Connecticut Department of
ENERGY & ENVIRONMENTAL PROTECTION

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I certify that this document is a true copy of a record (original or photocopy, whichever is applicable) on file at the Department of Energy and Environmental Protection.
(Signature and Title), Department of Energy and Environmental Protection

STATE OF CONNECTICUT
V.
NORWICH PUBLIC UTILITIES

CONSENT ORDER

A. The Commissioner of Energy and Environmental Protection ("the Commissioner") finds:

1. The City of Norwich ("Respondent") owns and operates sewerage collection and treatment systems, including a water pollution control facility ("WPCF"), and discharges treated sanitary sewage under the terms and conditions of NPDES Wastewater Discharge Permit No. CT0100412.

2. The Respondent's sewerage collection system was partially separated between 1972 and 1980. Projects removed public stormwater inflow (catch basins) from combined lines and reduced the number of combined sewer overflow (CSO) discharge locations from 43 to 27.

3. United States Environmental Protection Agency (EPA) published the Combined Sewer Overflow Control Policy, April 1994 which requires compliance with the implementation of the "Nine Minimum Controls" and development of a "Long-Term Combined Sewer Overflow Control Plan". The obligation to comply with this policy was codified into federal law in Section 402Q of the Clean Water Act.

4. On August 11, 1988, the Respondent was issued Order No. WC 4729 to address combined sewer overflows in Norwich. This order was modified on August 27, 1990, October 19, 1992 and August 1, 1994. The Respondent has not fully implemented all of the steps of the modified order dated August 1, 1994.

5. The Respondent submitted to the Commissioner the report entitled Norwich, CT CSO Modified Facilities Plan, by Black & Veatch, dated August 1994.

6. The Respondent's sewerage collection system was partially separated between 1995 and 2005. These projects resulted in the further reduction of the number of CSO discharge locations from 27 to 14. Currently, the Respondent has 14 active combined sewer overflow locations within their collection system.

7. In 2002, the Respondent installed a flow monitoring station at CSO 17 at the Rose Alley pump station. Two instruments at the location transmit level measurements to the Norwich's Supervisory Control and Data Acquisition (SCADA) system.

1 Date Issued: June 30, 2017

Long Term Control Plan - Methodology

- Prescribed methodology defined by EPA
- Understand & meter existing sewer system
- Develop & calibrate computer model
- Identify system needs & potential solutions
- Test alternatives against modeled storms
- Identify least cost solution that meets stakeholder goals (DEEP, NPU, City)

Potential Alternatives

- Sewer separation
- Storage
- Conveyance
- Treatment
- Green technologies
- Mixture of all

- Each has strengths and weaknesses, and a cost

Sewer Separation

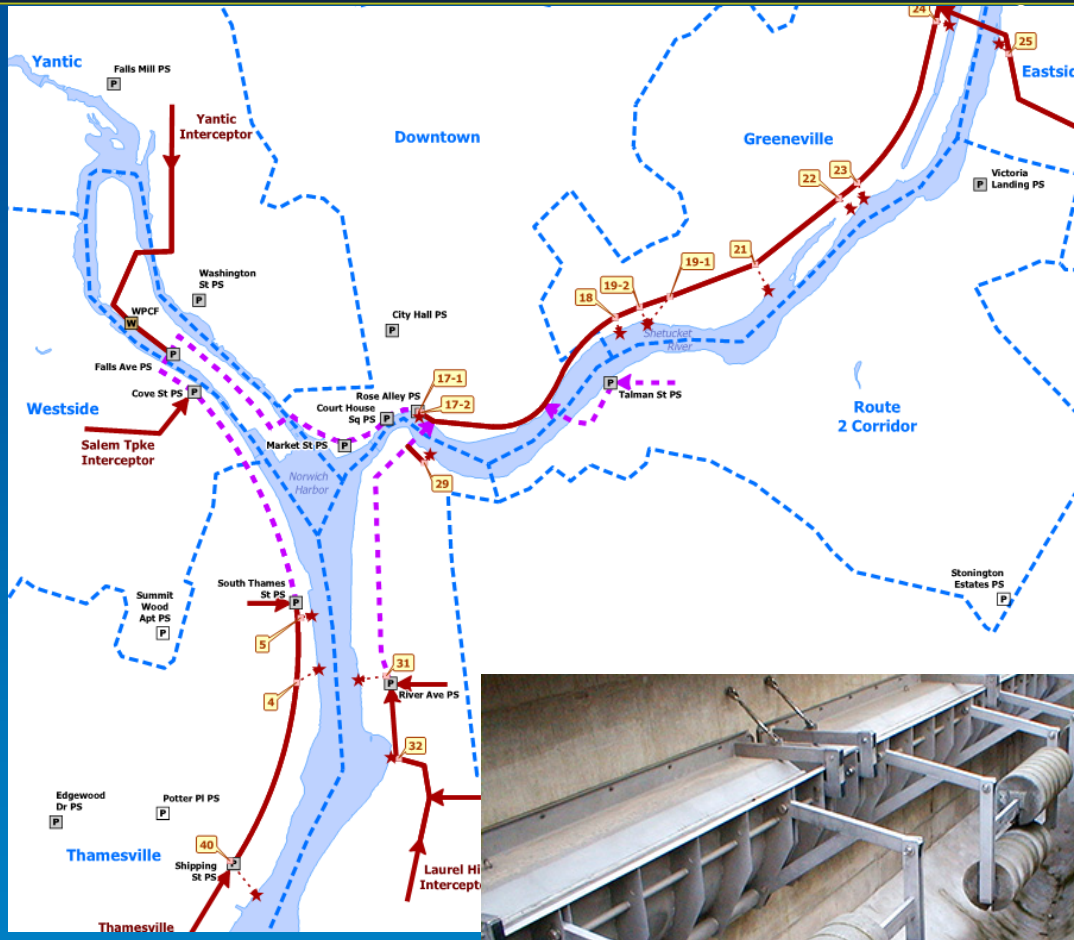
- Disruptive
- Costly
- Impacts other utilities
- Need to inspect & modify homes
- Can be effective

Storage of CSO flows

- Helpful for systems that peak quickly (like Norwich)
- Can be simple or complex
- Can be cost effective
- Underground (surface can be parking lot, ball field, etc.)

Conveyance of CSO flows

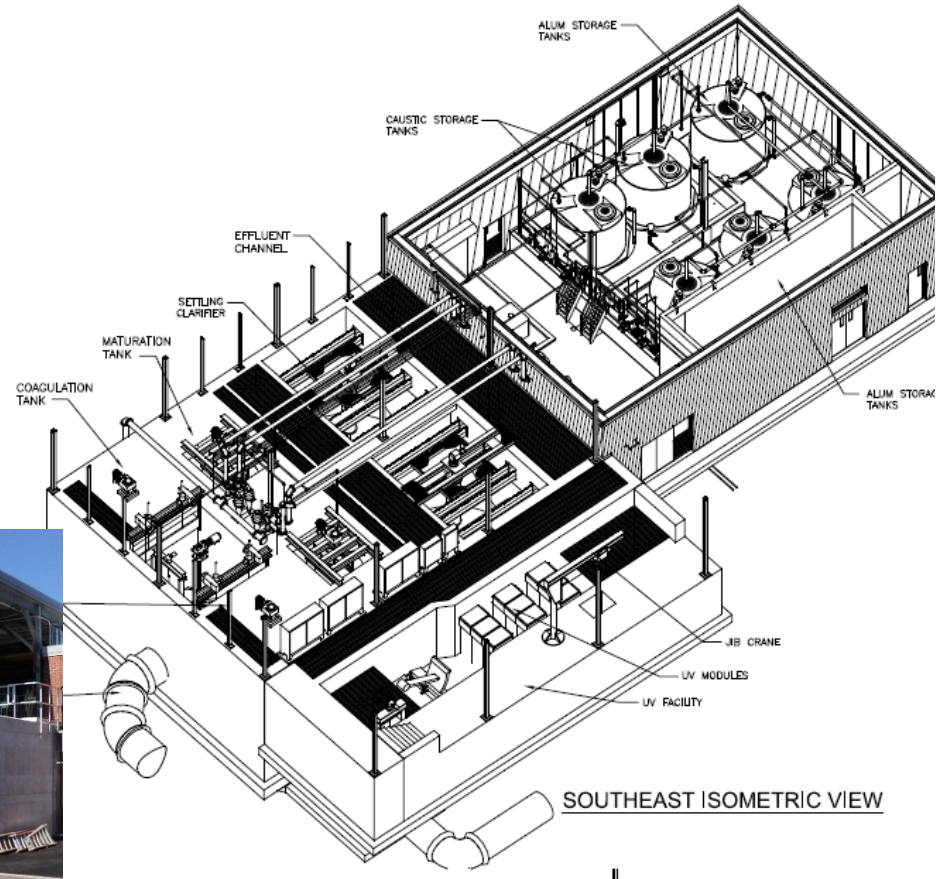
- Bring flows to where they can be better handled
- Need increased pumping
- Need increased pipe capacity
- Gates to hold water in pipes longer



CDM Smith

Treatment of CSO flows

- Construct new capacity and treatment process at WPCF
- High Rate Clarification (HRC) is viable option



Green Technologies

- Aim to reduce and retain flows
  - Reduce impervious areas
  - Green and blue roofs
  - Roadway infiltration sumps
  - Rain gardens
- Responsibility of City of Norwich DPW, who governs over the City's storm water systems
- Moderate initial expense
- Significant ongoing O&M responsibility
- Challenging in areas with steep topography

Green Infrastructure for Dense Urban Areas

Porous Pavements

Bioretention / Rain Gardens / Street Planters

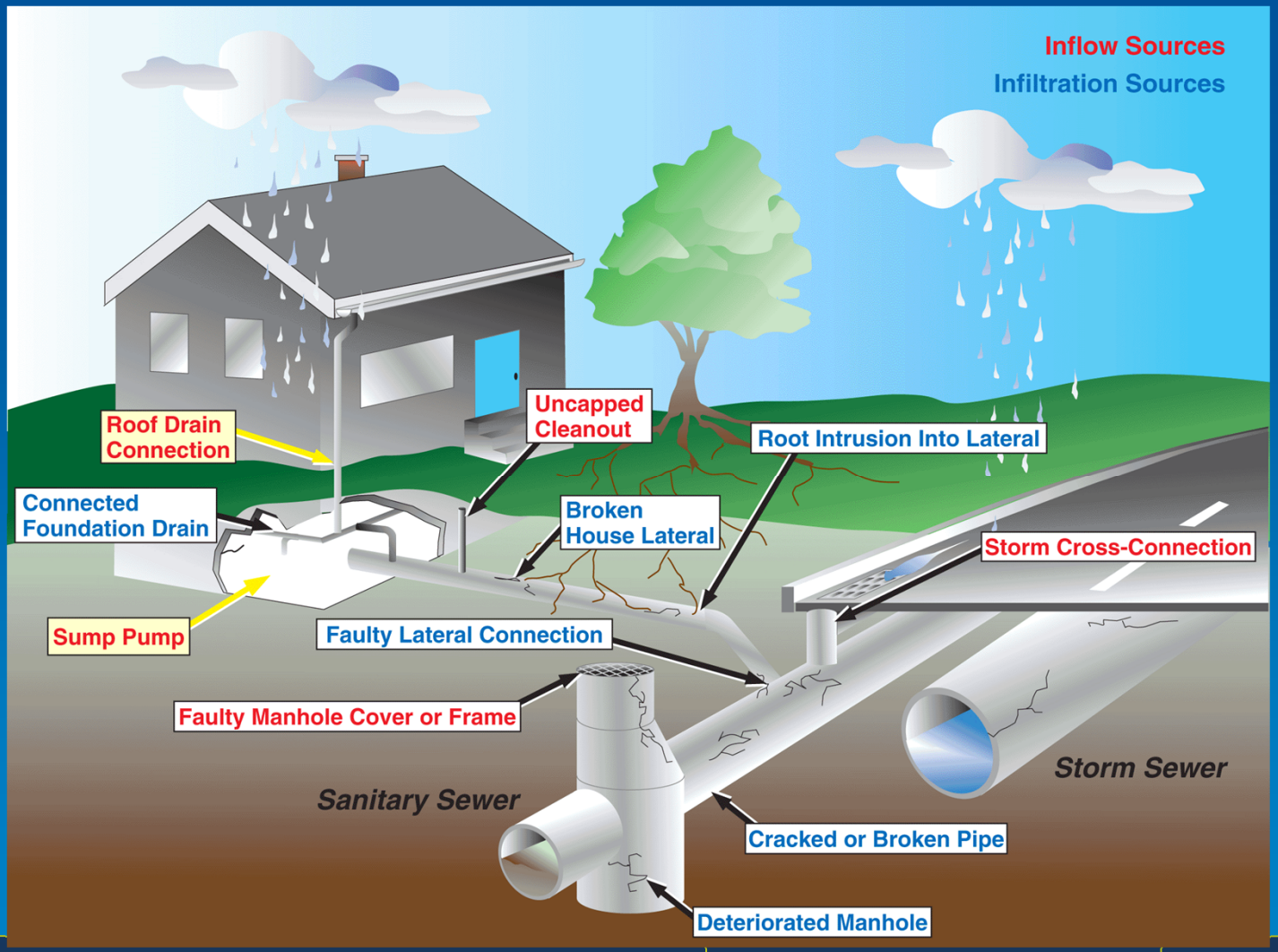
Subsurface Storage/Infiltration

Green Roof

Blue Roof

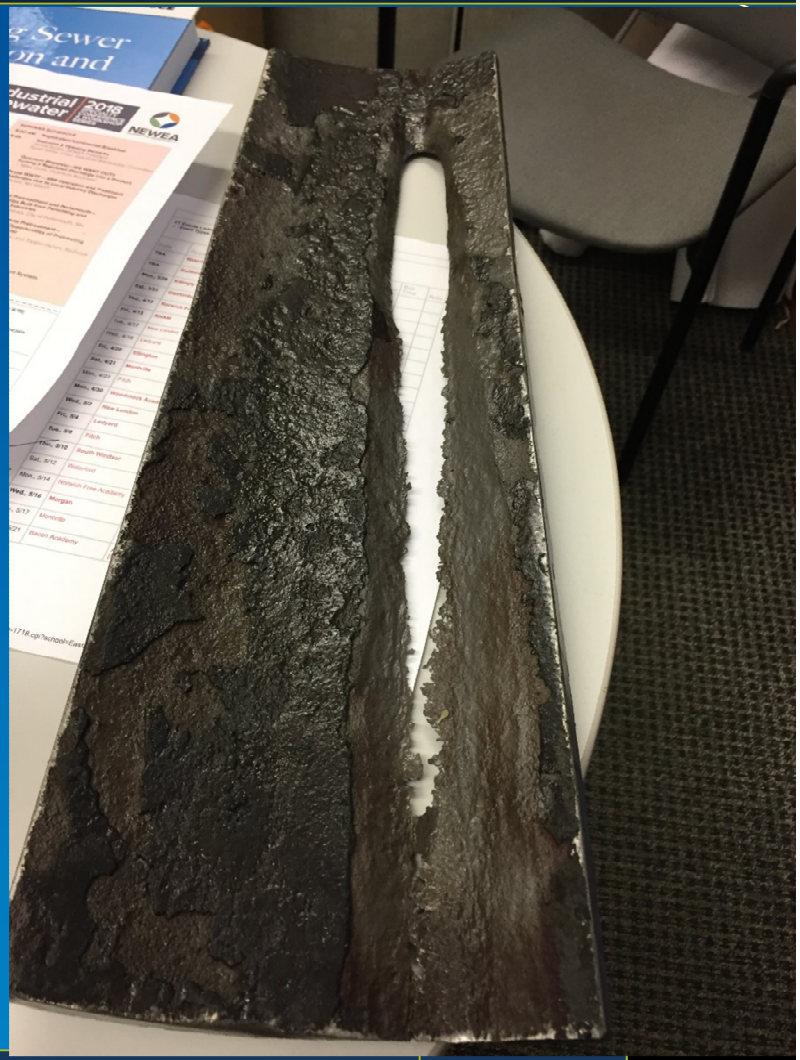
Rainwater Harvesting

Norwich Has an Aging System

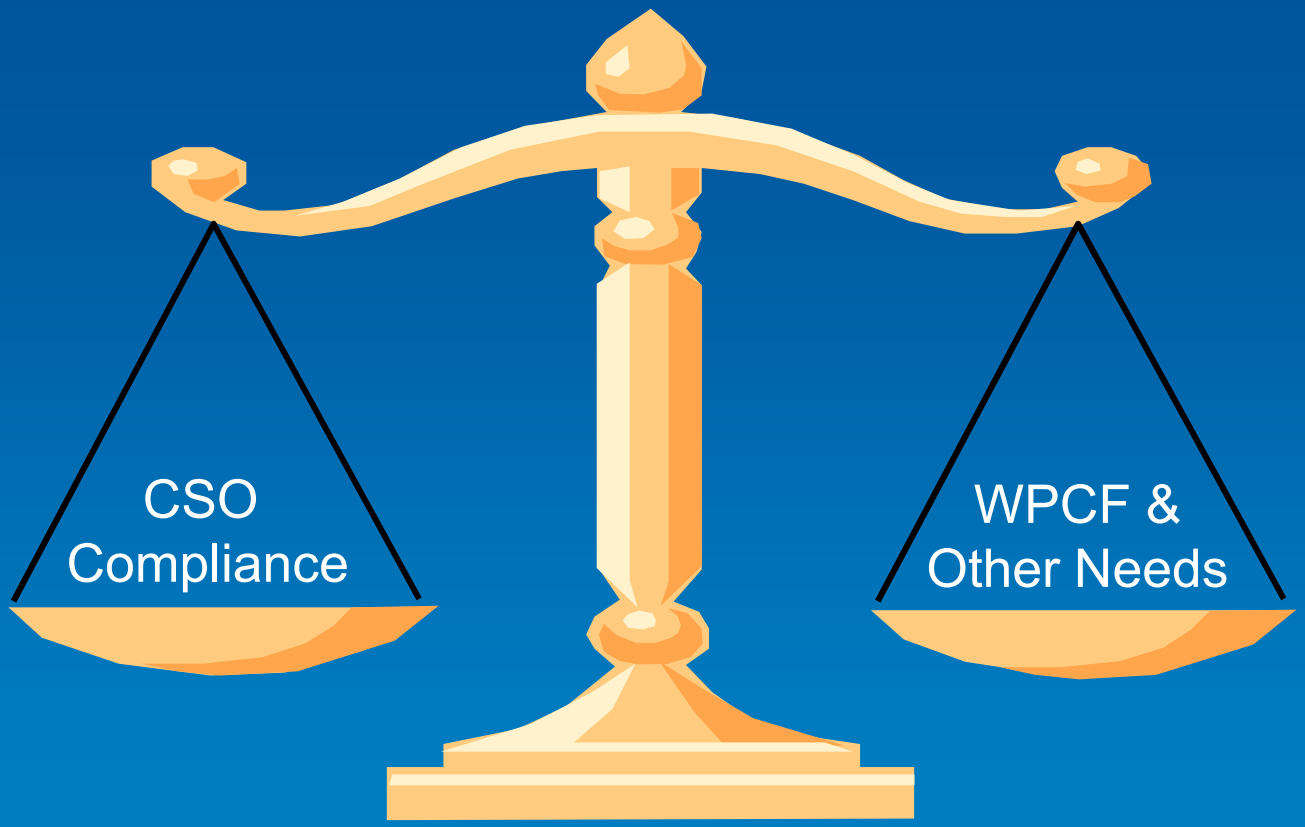


Many Pipes Have Exceeded Useful Life Expectancy

- Pipe breaks & pump failures impact water quality too
- Renewal is needed
- O&M must be included
- LTCP focuses on:
  - CSO abatement
  - System reliability
  - Balanced & fiscally responsible long term plan



Balancing Infrastructure Needs



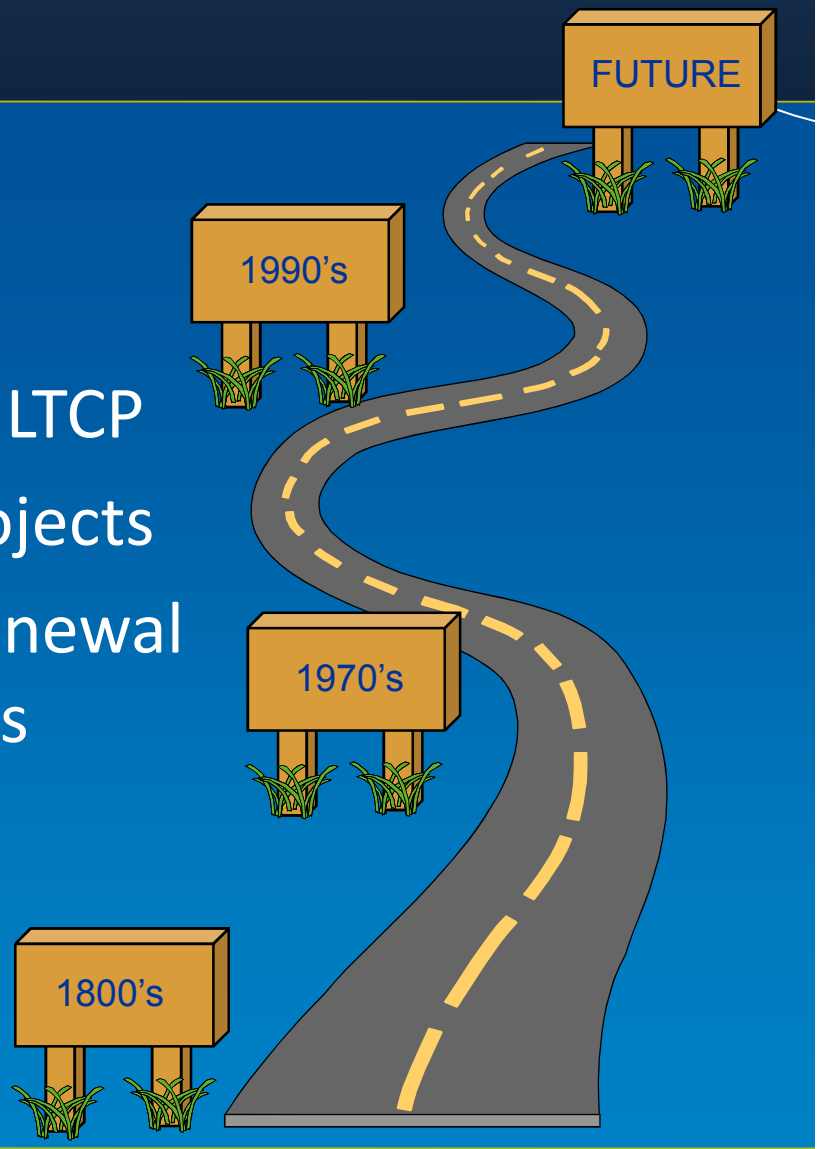
Approach Focused on Overall Environmental Benefit

Phasing of CSO and Other Capital Projects

- All CSO = infrastructure fails in the process
- All Infrastructure (and no CSO) = misses DEEP goals
- A compromise is needed
  - Break WPCF into pieces to address urgent needs
  - Upgrade failing infrastructure to prevent SSOs
  - Construct CSO plan in pieces
  - Address needs on a priority scale
  - Maintain balanced approach

Next Steps

- Refine cost and alternatives
- Final report to DEEP
- DEEP comment or approval of LTCP
- Design and construction of projects
- Comprehensive wastewater renewal program that will span decades



Meeting Notes: Norwich CSO LTCP Public Information Meeting

August 1, 2018 – Approximate Time 6:00-7:00 pm

Attendees:
Craig Wagner, CDM Smith– Presenter
Tim Dupuis, CDM Smith
Pat Hughes, CDM Smith
Brendan Ennis, CDM Smith

Chris LaRose, Norwich Public Utilities
Larry Sullivan, Norwich Public Utilities
Chris Riley, Norwich Public Utilities
Bill Coughlin, Norwich Public Utilities

Public Attendees (underlined):
Stewart Peil, Vice Chairman NPU Commissioners, asked a question regarding the status of the upgrades to the Wastewater Treatment Plant both Craig Wagner and Larry Sullivan explained that DEEP returned comments (after a considerable review period) indicating that the facility had to be elevated above the flood plain and that CSO work was reprioritized. Mr. Peil further asked if it made sense to just increase the capacity of the plant versus creating upstream storage and conveyance projects. Craig Wagner and Pat Hughes explained that it was hydraulically infeasible to increase the capacity of the plant to handle a 2-year storm without also building conveyance out in the collection system to help get flow to the plant.

Mr. Peil also asked what NPU had presently committed to fund. Mr. LaRose responded that NPU has funded the LTCP along with design of improvements to the East Side drainage area. The East Side Drainage area recommendations have already been modified based on the recent flow monitoring and modeling engineering results.

Mr. Peil also asked about priority of future funding on the collection system versus the WPCF. Mr. LaRose responded that the draft plan would recommend funding concurrent improvements to both in phases over an extended schedule of 30 years.

Kevin Aherne, Norwich Bulletin Reporter, provided a brief synapsis of Craig Wagner's presentation and asked for factual confirmation of his understanding of the presentation, which Craig Wagner provided. Mr. Aherne then wrote an article for the Norwich Bulletin, which is available at the following link, and is also included in Appendix A of the 2018 LTCP. http://www.norwichbulletin.com/news/20180801/npu-presents-updated-norwich-sewer-plan

Two additional people attended, Ben Lathrop and his wife. Both arrived prior to Craig Wagner's presentation and left before his presentation.

The Bulletin

NPU presents updated Norwich sewer plan

By Kevin Aherne kaherne@norwichbulletin.com (860) 425-4256

Posted Aug 1, 2018 at 8:10 PM
Updated Aug 1, 2018 at 8:10 PM

NORWICH - The city is one of six Connecticut municipalities that still utilize combined sewer overflow sewer systems, and state's environmental protection agency said that's a problem.

Norwich Public Utilities held a public informational meeting on Wednesday to present to the public an updated draft of its Combined Sewer Overflow Long Term Control Plan. CSOs are sewer systems that collect rainwater, sewage and industrial waste in one pipe.

The original plan was drafted following a June 2017 consent order from Department of Energy and Environmental Protection to NPU in order to compel compliance with CSO requirements.

"Nothing is wrong with Norwich's system," D. Craig Wagner, senior project manager for engineering design consultant CDM Smith said. "It works, but it's an antiquated system where overflow goes into the river."

Wagner said the efforts to upgrade the CSO system in Norwich have been going on since the 1990s, but there is much work to be done. He said there were originally 43 overflow regulators discharging wastewater into local rivers, but there are currently only 16.

In March 2018, NPU submitted a baseline conditions report to DEEP, indicating that last year Norwich's CSO experienced 60 overflow events with 43 million gallons of wastewater entering rivers. The DEEP consent order requires a system that produces only one overflow event every two years.

Wagner explained there are a number of potential alternatives that each have varying strengths, weaknesses and costs. These alternatives include sewer separation, storage, conveyance, treatment, green technologies, or a mixture of each.

"The methodology of this plan is to identify the least-cost solution that meets the goals for CT DEEP, NPU and the city of Norwich," Wagner said.

NPU operations manager Chris LaRose said this project is vital but complicated.

"It's a very complicated project that needs to be done in phases balancing the need for CSO compliance with the needs of an aging treatment plant," he said. "There is still a lot of work that needs to be done in order to identify the best solution."

Next, NPU and CDM Smith will work to refine the plan with specific alternatives and costs and submit a final report to DEEP for approval.

Appendix B

Memorandum

To: *File*

Date: *August 14, 2018*

Subject: *2018 LTCP Appendix B – CSO Satellite Facility Site Selection Analysis*

The purpose of this memorandum is to provide background and detail on the combined sewer overflow (CSO) satellite facility site selection process for components of Norwich Public Utility's (NPU's) 2018 CSO Long Term Control Plan (LTCP). In general, a satellite facility is a CSO mitigation technology that is sited near a regulator structure to capture or treat overflows as they occur, and to take advantage of existing regulating structures to divert overflows to the satellite facility and minimize piping and possible pumping requirements. Early in the LTCP planning process, more than twenty potential satellite facility sites were screened for use in alternatives development. Eventually this was narrowed down to the ten sites for detailed analysis, which are outlined in this memorandum. The ten sites were evaluated based on size, location, topography, uses, ownership, and other criteria. Based on the evaluation, four sites were selected for detailed LTCP alternatives analysis. The LCTP will be implemented over several decades and over time the uses of individual sites may change. During each LTCP update, satellite facility sites should be re-evaluated.

Methodology

Site selection in Norwich is challenging. Norwich is a city with a hilly topography, and the major sewer interceptors are either pumped or flow by gravity in the highly developed riverfront areas. Early in the LTCP planning process, many parcels in Norwich that appeared to be unused or vacant were considered as potential sites for satellite facilities. These sites were then screened further, using the sewer model to identify areas where sewer system capacity was limited and identify the areas that satellite facilities would be the most effective. This narrowed the list of promising facility sites down to the ten presented in this memorandum. These sites were evaluated based on criteria including size, location, topography, availability, uses, ownership, and feasibility of construction. These sites are described further in the subsequent pages.

Sites were ultimately evaluated in the Downtown, Greeneville, Laurel Hill, and Thamesville sewersheds. These sewershed areas were targeted due to sewer model evaluation that indicated satellite facilities would be most helpful in these locations. Additionally, this is where the combined sewers are primarily located, and implementation of satellite facilities in sanitary sewer areas would be minimally helpful to CSO volumes. One potential site was desired in both the Laurel Hill and Thamesville sewersheds. However, two sites were desired along the Shetucket Interceptor (Downtown and Greenville sewersheds) due to the prevalence of CSO regulators in these areas and indication through the sewer model that multiple facilities might be desirable here.

Figures B-1 through B-10 are illustrations of the ten site summaries show the areas around the sites, including the area of interest, sewer infrastructure and imagery. The shapes outlined in blue on the figures represent the areas of interest. Combined sewers are shown in brown, sanitary sewers in red, and force mains are shown as purple dashed lines. Pumping stations (PS) are indicated by a boxed icon with a "P", including the PS name.

Data presented in these site summaries was obtained from a variety of sources. Primary information on ownership, property appraisals, areas, and elevation were obtained using the City of Norwich's Geographic Information Systems (GIS) online map services. According to the most recent disclaimer, property data on the City's GIS mapping services was last updated on August 8, 2018. The property assessment value represents 70% of the market value at the time of the last valuation.

This memorandum is focused on engineering feasibility of using sites in Norwich for satellite CSO facilities. It is understood that purchasing a property, obtaining an easement onto a property, and/or changing the use of a city-owned property for use in the sewer system is a process that involves many considerations beyond engineering feasibility. Therefore, CDM Smith subcontracted with Green Site Design, LLC, a Norwich-based company, to do research on potential sites to identify any issues that would prevent the re-development of the sites for use for a satellite facility. At this time, no specific concerns that would prevent the use of sites have been identified, but there are no agreements with property owners and it is understood that these sites would have to be further evaluated during the conceptual design phase.

List of Potential Sites for Satellite Facilities

- **Laurel Hill**
  - Site 1: River Avenue Floodway
  - Site 2: Laurel Hill Avenue Park
- **Shetucket (Downtown & Greeneville Sewersheds)**
  - Site 3: Rose Alley (Viaduct Road) Commuter Parking Lot
  - Site 4: Rose Alley and Ferry Street Parking Lot
  - Site 5: Norwich Public Utilities Headquarters
  - Site 6: Norwich Self Storage, South Golden Street
  - Site 7: North Main Street at 5th Street, Swift Performance Automotive

- **Thamesville**
  - Site 8: Shipping Street
  - Site 9: South Thames Street Condominium Site North
  - Site 10: South Thames Street Condominium Site South

Site 1: River Avenue Floodway

Location

This site is located off the end of River Avenue in the Laurel Hill sewershed area. The evaluated site is across the railroad tracks from the River Avenue PS. The site is bounded by the Thames River to the west and south, railroad tracks to the east, and the combined sewer overflow (CSO) 031 outfall pipe to the north. See Figure B-1 below.

Figure B-1
Site 1 – River Avenue Floodway

Ownership

This property parcel is owned by the Providence and Worcester Railroad Company, with a valuation of $162,100. The parcel itself extends further north and further south, following the railroad tracks.

Area
This total parcel has an approximate land area of 41 acres; the desired area depicted in Figure B-1 is approximately 3.1 acres.

Elevation
The elevation of this site ranges from approximately 2 feet to 8. This entire site falls within the FEMA Floodway designation.

Site Access and Traffic
Access at this site is difficult. Two narrow roads (River Avenue, New Wharf Road) can be used to reach this site, but there is no permanent railroad crossing at either road, and one would need to be established for construction. Access for large trucks and construction vehicles to this site would be very difficult. There is plenty of room here for construction staging once access to the site is established.

Current Land Use
This site appears to have no current residential or commercial use; however, it is within the Thames River Floodway. Above ground construction would obstruct the ability for the river to flood into this area and would make permitting difficult and construction challenging.

Advantages
This site is at a comparable elevation with the CSO regulators and the Laurel Hill interceptor which reduces the need for pumping flow to a facility. This site also has necessary space for construction of any type of facility. The site appears to have no current residential or commercial use.

Disadvantages
This site (or an easement) would need to be purchased from the railroad company and a permanent at-grade railroad crossing easement would need to be established to gain access to this site. Additionally, this site is located in the floodway, which would require additional permitting, it is likely that nothing critical could be built above grade, heavy dewatering would be needed, along with construction on piles to counter buoyant forces. Pipes would need to be jacked beneath the railroad tracks as well.

Site 2: Laurel Hill Avenue Park

Location

This site is located at the corner of Center Street and Laurel Hill Avenue. The evaluated site is currently an open park space. The site is bounded by Center Street to the North, River Avenue to the west, Laurel Hill Avenue to the east, and private property to the south. See Figure B-2 below.

Figure B-2
Site 2 – Laurel Hill Avenue Park

Ownership

This property parcel is owned by the City of Norwich with a valuation of $25,300 according to the City of Norwich property records.

Area

This total site has an approximate land area of 0.59 acres.

Elevation
This site is relatively flat and ranges from approximately 84 feet to 88 feet in elevation.

Site Access and Traffic
This site is easily accessible. Laurel Hill Avenue is a major road in Norwich and can easily accommodate construction vehicles and equipment. It is expected that there is enough room at this site to stage construction, and if needed River Avenue west of the site could also be utilized as a secondary staging area.

Current Land Use
This site is currently open park space, with benches and picnic tables. However, there are no buildings or facilities in this location.

Advantages
This site is owned by the City of Norwich and is not used for any critical activities. This location is one of the few open parcels available in Laurel Hill that is near the CSO regulators. This site has easy access and room for construction.

Disadvantages
This site is at least 70 feet higher in elevation than the River Avenue PS. To utilize this site for storage or other CSO mitigation facilities, flow must be pumped up the River Avenue hill to this location. Gravity piping from this site down towards the Shetucket Interceptor must be in place to utilize this site. Additionally, this site is in a neighborhood location instead of a lesser used area. It is likely that if this site is used, only below ground facilities, with an enhanced park area replaced on top of the new CSO facilities would be acceptable. Additionally, odor control technologies would need to be considered depending on the type of satellite facility located here.

Site 3: Rose Alley (Viaduct Road) Parking Lot

Location
This site is located at a commuter parking lot off of Viaduct Road. This is located on the southern side of the railroad tracks from the Rose Alley PS. See Figure B-3 below.

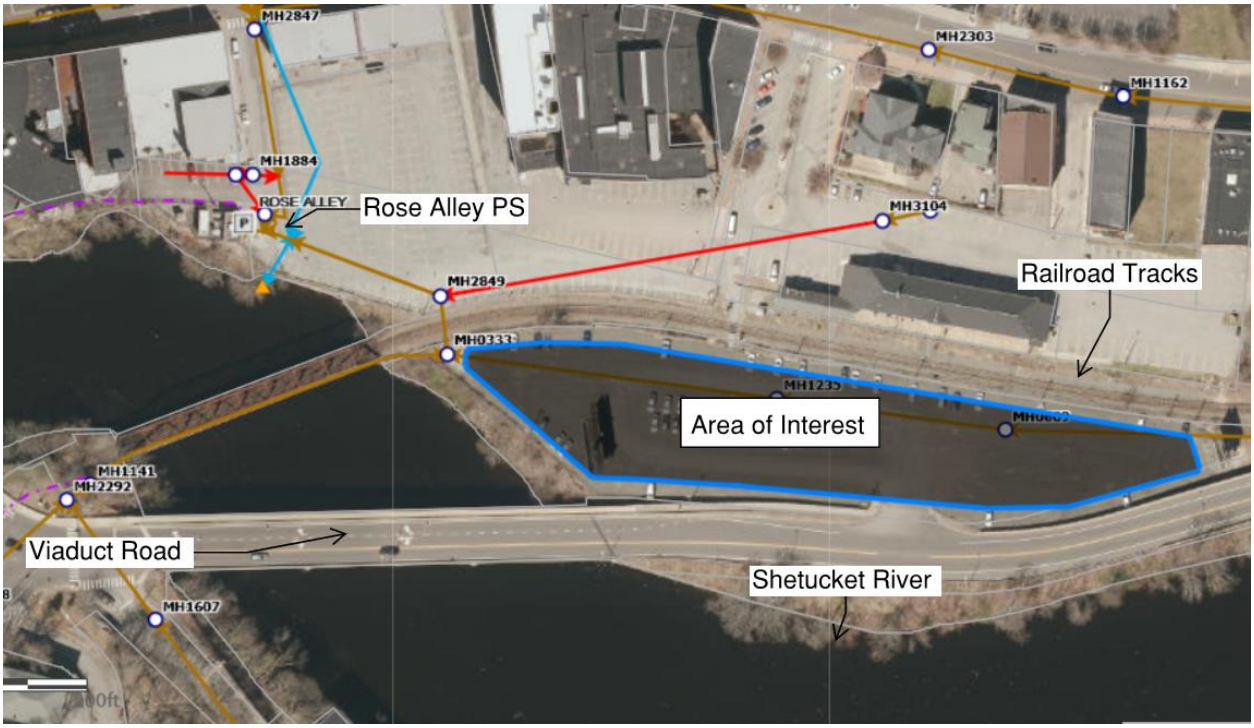


Figure B-3
Site 3 – Rose Alley Parking Lot

Ownership
This property parcel is owned by the City of Norwich with a valuation of $141,700 according to the City of Norwich property records.

Area
This total site has an approximate land area of 1.5 acres. The parking lot area presented in Figure B-3 has an approximate area of 1.4 acres.

Elevation
This site is relatively flat and ranges from approximately 14 feet to 17 feet in elevation.

Site Access and Traffic
This site is easily accessible. Viaduct Road is a major road in Norwich and should be able to easily accommodate construction vehicles and equipment. It is expected that there is enough room at this

site to stage construction of smaller facility sizes, but facilities for the larger design storms may be too large for the site.

Current Land Use
This site is currently used as a public commuter parking lot.

Advantages
This site is located near the end of the Shetucket interceptor, where capacity is needed. It is at an elevation that is comparable to the existing interceptor. It is owned by the City of Norwich and is does not have any uses beyond public parking. And winter snow storage by DPW. It is relatively accessible for construction.

Disadvantages
This site is currently utilized as public parking, which would be temporarily eliminated during the construction period, but could be restored post construction assuming facilities are built underground. Although the interceptor is near the site, it runs through the center of the parking lot, which could require relocation or bypass pumping during construction. Construction staging areas could be limited during construction of a larger design storm alternative.

Site 4: Rose Alley and Ferry Street Parking Lot

Location
This site is located at a commuter parking lot between Rose Alley and Ferry Street. This is located on the northern side of the railroad tracks from the Rose Alley PS. It is bounded at the north by private buildings, to the east by Ferry Street, to the west by Rose Alley, and to the south by an unnamed connecting road as well as the Shetucket River and railroad tracks. See Figure B-4 below.

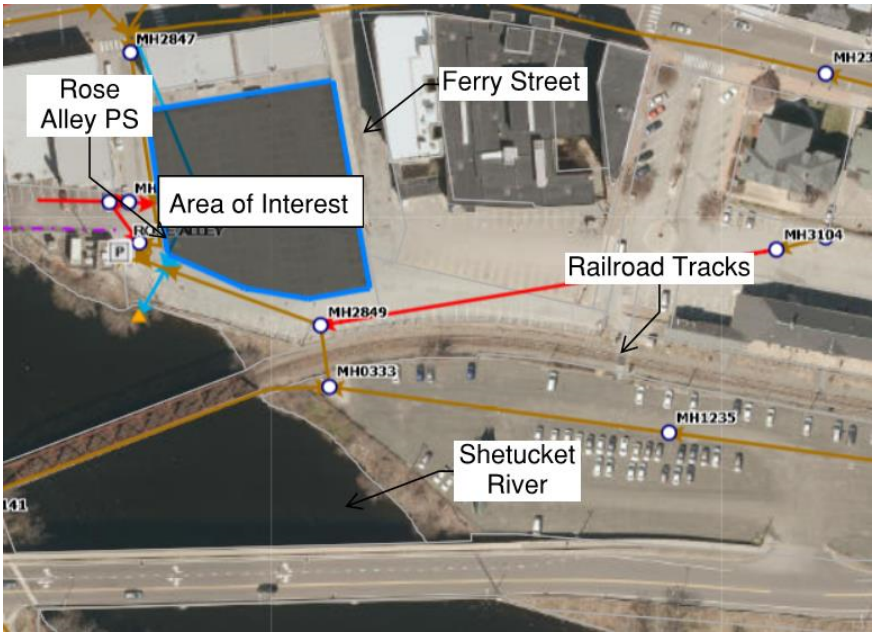


Figure B-4
Site 4 – Rose Alley and Ferry Street Parking Lot

Ownership
This area of interest is owned by two entities: "Lord Family Nominee Trustlord" and the City of Norwich according to the City of Norwich Assessor's Office property records. The privately-owned parcel is valued at $144,300, while the City of Norwich parcel is valued at $7,600.

Area
The two parcels have an approximate combined land area of 1.27 acres. The area of interest presented in Figure B-4 has an approximate area of 0.58 acres.

Elevation
This site is relatively flat and ranges from approximately 14 feet to 18 feet in elevation.

Site Access and Traffic
This site is moderately accessible for construction. Although Main Street is a major thoroughfare, two minor streets (Rose Alley & Ferry Street) provide access to this parking lot. It is expected that

construction staging, and construction here would be difficult due to narrow access and adjacent businesses.

Current Land Use
This site is currently used as a private commuter parking lot for business in downtown Norwich.

Advantages
This site is located near the end of the Shetucket interceptor, where the model has indicated that additional capacity is needed. It is partially owned by the City of Norwich. This is one of the few undeveloped parcels in the Downtown area.

Disadvantages
This site is currently utilized as public parking, which would be eliminated during the construction period, but could be restored post construction assuming the facilities are built underground.

Site 5: Norwich Public Utilities Headquarters

Location
This site is located at the NPU Headquarters on South Golden Street. The site is bound to the north by the railroad tracks and existing structures, to the east by South Golden Street, and to the south by the Shetucket River. The specific area of interest includes NPU's rear parking lot. See Figure B-5 below.

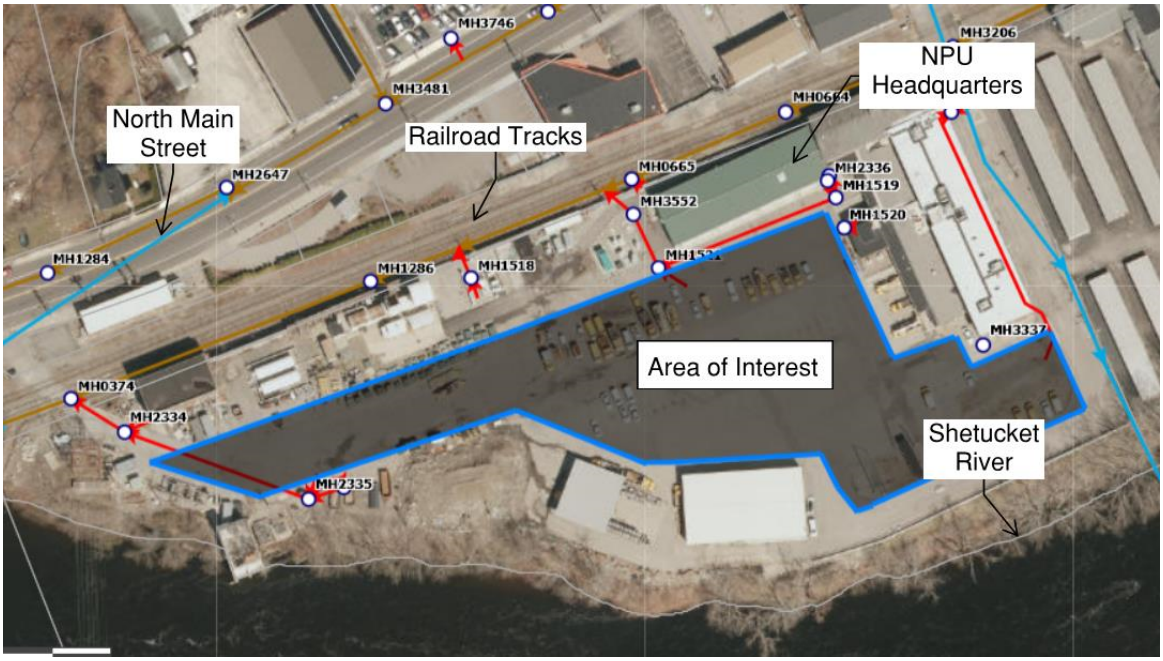


Figure B-5
Site 5 – NPU Headquarters

Ownership
This site is owned by Norwich Public Utilities and valued at $1,111,600 according to the City of Norwich Assessment records.

Area
The area of interest presented in Figure B-5 has an approximate area of 2.0 acres.

Elevation
This site is relatively flat and ranges from approximately 18 feet to 22 feet in elevation.

Site Access and Traffic

This site is very accessible for construction. North Main Street is a major road that is accessible for construction vehicles, and NPU currently uses their yard for vehicle storage and maintenance

activities. Although this site is not anticipated to create any traffic problems on North Main Street, it could cause congestion issues within NPU's yard and potentially cause issues in NPU's normal business operations.

Current Land Use

This site is currently used by NPU as parking for their headquarters building, as well as for vehicle storage and maintenance.

Advantages

This site is located near the interceptor, in a location where capacity is needed. The site is owned by NPU and would not provide any additional public disruption. The site has easy access for construction activities. Additionally, this site is already in an industrial area, and would have minimal impact on the public.

Disadvantages

The main disadvantage to this site is the implication to NPU's business operations. Building here could impede normal vehicle maintenance and office operations. Parking would be eliminated during the construction period but could be restored post construction assuming the facilities are built underground. Additionally, NPU has indicated that the soils on the site could be contaminated and require additional removal and disposal costs. Although the interceptor is on the south side of the tracks closer to the site, under some alternatives, pipe jacking under the railroad to a relief interceptor yields additional complications.

Site 6: Norwich Self Storage

Location
This site is located adjacent to the NPU Headquarters on South Golden Street. The site is bound to the north by the railroad tracks, to the east by Erin Street, to the West by South Golden Street and to the south by the Shetucket River. The specific area of interest includes an active self-storage business. See Figure B-6 below.

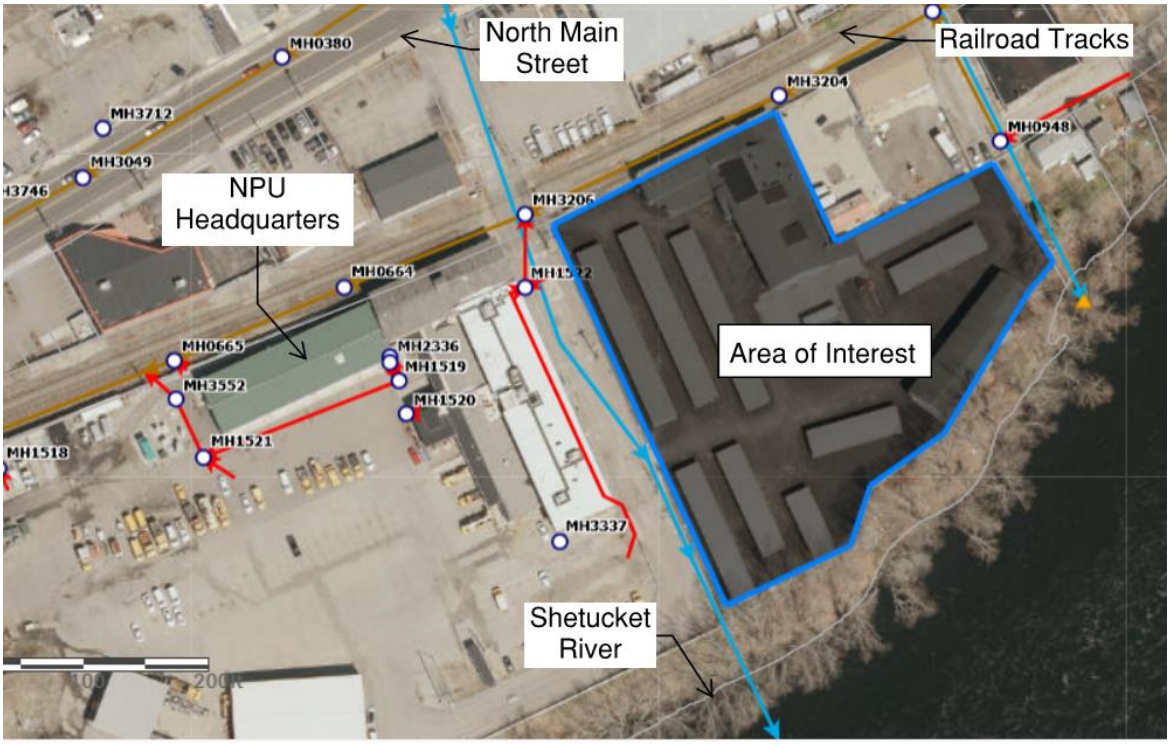


Figure B-6
Site 6 – Norwich Self Storage

Ownership
This site is privately owned by "43 Corporation" with a valuation of $880,300.

Area
The self-storage lot presented in Figure B-6 has an approximate area of 2.39 acres.

Elevation
This site is relatively flat and ranges from approximately 22 feet to 24 feet in elevation.

Site Access and Traffic

This site is moderately accessible for construction. North Main Street is a major road that is accessible for construction vehicles, however South Golden Street is a narrow access road for NPU headquarters and this site. Although this site is not anticipated to create any traffic problems on North Main Street, it could cause congestion issues on South Golden Street.

Current Land Use

This site is currently used by Norwich Self Storage as a storage business and rental facility.

Advantages

This site is located near the interceptor, in a location where capacity is needed. The site is adjacent to NPU and would provide easy access to any facilities built here. If facilities are built underground here, the area can be used for additional NPU parking, vehicle garages, or staging area.

Disadvantages

This site would need to be purchased and the buildings would need to be relocated to build any CSO facilities here, which presents a very large initial challenge. There is the potential that construction here could impede normal NPU vehicle maintenance and office operations. Additionally, NPU has indicated contaminated soil conditions at the neighboring NPU headquarters site; therefore, there is the potential that contaminated soils could be found at this adjacent site as well. Although the interceptor is on the south side of the tracks closer to the site, under some alternatives, pipe jacking under the railroad to a relief interceptor provides additional complications.

Site 7: North Main Street at 5th Street, Swift Performance Automotive

Location

This site is located at North Main Street and 5th Street. The site is bound to the north by 5th Street, to the east by the railroad tracks and the Shetucket River, to the west by North Main Street and to the south by 4th Street. See Figure B-7 below.

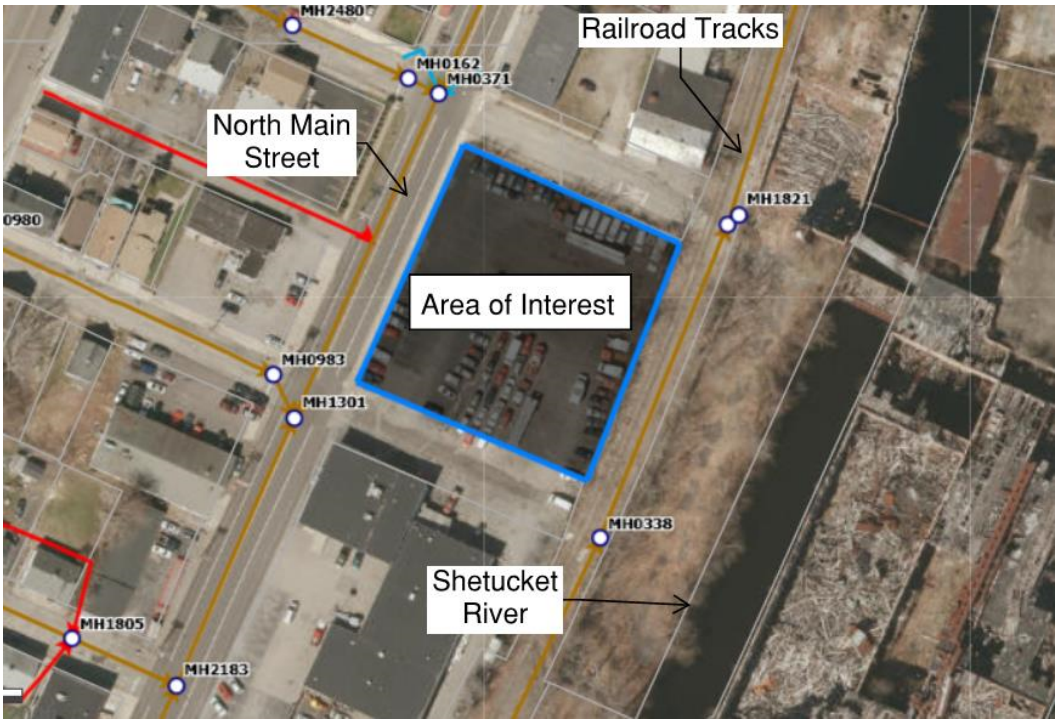


Figure B-7
Site 7 – North Main Street at 5th Street, Swift Performance Automotive

Ownership

This site is not listed on the City's assessors' records within the online GIS resources. The desired parcel appears to be a parking lot for the adjacent "Swift Performance Automotive" business. The adjacent parcel (Swift Performance Automotive) is privately owned by "401 North Main Realty LLC" with a valuation of $258,700.

Area

The parcel of interest presented in Figure B-7 has an approximate area of 0.87 acres.

Elevation

This site is moderately sloped and ranges from approximately 40 feet to 50 feet in elevation.

Site Access and Traffic

This site is very accessible for construction. North Main Street is a major road that is accessible for construction vehicles and this site. The dead ends of 4th Street and 5th Street could potentially be used as a construction staging area. It is not anticipated that construction here would impede traffic on North Main Street.

Current Land Use

This site appears to be used as a vehicle storage and parking lot for Swift Performance Automotive.

Advantages

This site is located near the interceptor, in a location where capacity is needed. The site has easy access to the sewer lines in North Main Street and relatively easy access to the interceptor. Although the lot is privately owned, it doesn't appear to have any critical uses. Use of this site would prevent disruption of the NPU Headquarters lot. If facilities are built underground, there is the potential for restoration of parking on top of the facilities.

Disadvantages

This site would need to be purchased from the current owner. If a facility was built to detain flows from North Main Street, and convey them to the Shetucket Interceptor, a pipe would need to be jacked under the railroad tracks.

Site 8: Shipping Street

Location
This site is located at Shipping Street and Terminal Way. The site is bound to the north and west by private property, to the east by the railroad tracks, and to the south by Shipping Street. See Figure B-8 below.

Figure B-8
Site 8 – Shipping Street

Ownership
This parcel is owned by the City of Norwich. The desired parcel is a vacant lot valued at $71,500

Area
The parcel of interest presented in Figure B-8 has an approximate land area of 1.5 acres.

Elevation
This site is relatively flat and the area of interest ranges from approximately 8 feet to 12 feet.

Site Access and Traffic
This site is moderately accessible for construction. West Thames Street is a major road that is accessible for construction vehicles. Additionally, Shipping Street, South Street, and Terminal Way

are lightly used but would be accessible for construction equipment. It is not anticipated that construction here would significantly impede traffic anywhere in Norwich.

Current Land Use
This site is currently an undeveloped empty lot owned by the City of Norwich.

Advantages
There is a substantial amount of room available at this lot for construction of a CSO satellite facility. The lot is owned by the City of Norwich and is conveniently located near the Shipping Street Pumping Station (PS) and CSO 040.

Disadvantages
Although this plot of available land is close to some of NPU's critical infrastructure, the system has sufficient capacity here. This location does not align with system capacity needs. Additionally, this site is listed as a brownfield that is in a "Remediation Started" category on the City GIS Viewer.

Site 9: South Thames Street Condominiums Site - North

Location

This site is located at the condominiums off South Thames Street on the north side. The site is bound to the north by a City of Norwich parcel, to the east by the railroad tracks and Thames River, to the west by West Thames Street, and to the south by condominiums. See Figure B-9 below.

Figure B-9
Site 9 – South Thames Street Condominiums Site - North

Ownership

This parcel is privately owned by 190 South Thames Street LLC. The valuation of the entire parcel is $92,800.

Area

The parcel of interest presented in Figure B-9 has an approximate land area of 0.4 acres.

Elevation
This site is moderately sloped and the area of interest ranges from approximately 10 feet to 24 feet in elevation.

Site Access and Traffic
This site has difficult access for construction of facilities. West Thames Street is a major throughway, but South Thames Street and the condo driveway are narrow and could potentially impede site access for construction vehicles. The area of interest itself is a tight construction area and could prove to be difficult for construction staging as well.

Current Land Use
This site is currently an unused grassy area within a private riverfront condominium complex.

Advantages
This site is conveniently located near existing infrastructure (South Thames Street Pumping Station & CSO 005) where CSO capacity is needed.

Disadvantages
Private ownership, as well as tight construction windows are the main disadvantages of this site. There is limited land available to build a facility, and for construction staging. The site is between West Thames Street and the railroad tracks which provide a narrow window of construction.

Site 10: South Thames Street Condominiums Site - South

Location

This site is located at the southern side of the condominium complex off South Thames Street. The site is bound to the north by condominium buildings, to the east by the railroad tracks and Thames River Estuary, to the west by West Thames Street, and to the south by private property. See Figure B-10 below.

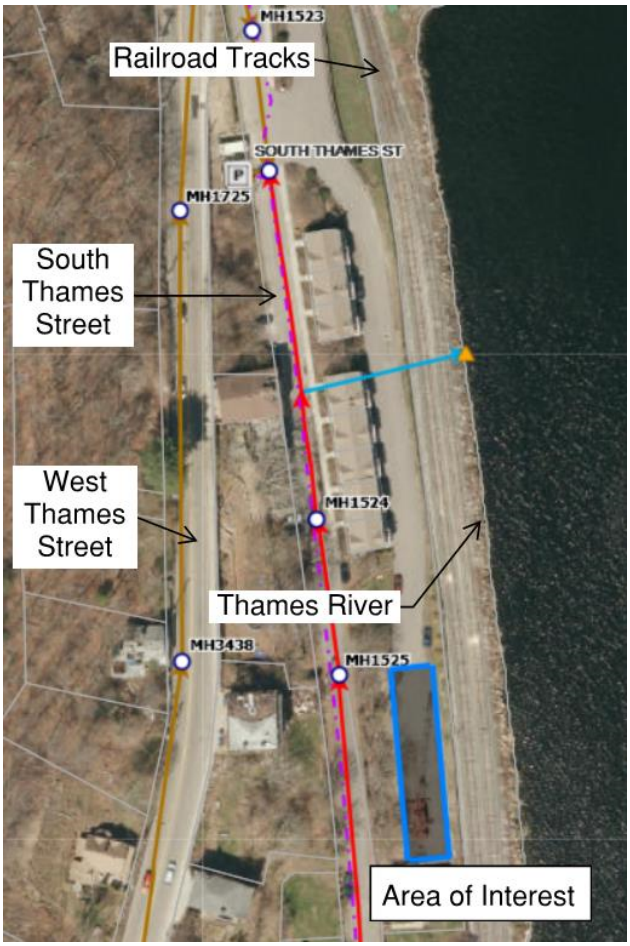


Figure B-10
Site 10 – Site 10: South Thames Street Condominiums Site - South

Ownership

This parcel is privately owned by 190 South Thames Street LLC. The valuation of the entire parcel is $92,800.

Area

The area of interest presented in Figure B-9 has an approximate land area of 0.1 acres.

Elevation
This site is relatively flat and the area of interest ranges from approximately 6 feet to 10 feet in elevation.

Site Access and Traffic
This site has difficult access for construction of facilities. West Thames Street is a major throughway, but South Thames Street and the condominium complex driveway are narrow and could potentially impede site access for construction vehicles. The area of interest itself is a tight construction area and could prove to be difficult for construction staging as well.

Current Land Use
This site is currently an unused paved area on the south side of a private riverfront condominium complex.

Advantages
This site is conveniently located near existing infrastructure (South Thames Street Pump Station & CSO 005) where CSO capacity is needed.

Disadvantages
Private ownership, as well as tight construction windows are the main disadvantages of this site. There is limited land available to build a facility, and for construction staging. The site is between West Thames Street and the railroad tracks which provide a narrow window of construction. Additionally, the western side of this site is a more significant elevation change than the northern condominium site. Finally, this site has less available land area than the northern site.

Evaluation

To identify the best sites for a CSO satellite facility, decision matrices were used to systematically identify, analyze, and rate the ten preliminary sites. The following is a description of each criteria and the matrices is presented in tables Table B-1 through B-3:

Location describes the type of location where the site is located.

Size refers to the available acreage of a site.

Constructability refers to the available construction windows, anticipated obstacles, and general feasibility of construction at the site. Sites that are anticipated to be straightforward areas to build in were given a good rating, while those with less desirable construction factors, such as floodplains or possible contamination were given a fair or poor rating.

Ownership refers to availability and use of a site. Site are indicated as owned by NPU, The City of Norwich, or under private ownership.

Public impact refers to the expected impact to the public while constructing CSO facilities on the given sites. Sites directly adjacent to public areas or residential areas were given a poor or fair rating. Sites that were more distant from the public and are anticipated to have less impact were given a good rating.

Topography refers to how flat the site is, and whether is situated significantly lower or higher in elevation than existing infrastructure, and proximity to a flood way. Generally, flat sites located at comparable elevations to existing infrastructure were given a good rating, while sloped sites and sites that were at a much different elevation than the existing infrastructure were given a fair or poor rating. Sites in a floodway were given a poor rating.

Based on this, four sites were selected sites for evaluation in Section 8 of the 2018 LTCP. These are highlighted in Tables B-1 through B-3 and explained below.

Laurel Hill Selection

In the Laurel Hill sewershed two sites were evaluated, and Site 2 at the Laurel Hill Avenue Park, was selected as the recommended CSO Satellite Facility site for the LTCP. Although Site 1 is at a comparable elevation with existing infrastructure in Laurel Hill, constructability in this floodway area was deemed too challenging. Pumping will be required to convey flow from the existing Laurel Hill interceptor to Site 2, but construction in this area was deemed more feasible. This site was evaluated using the model and ultimately presented as a facility location in the LTCP alternatives analysis, but no satellite facilities sited here were included in the recommended plan.

Table B-1 Evaluation of Satellite Sites, Laurel Hill

Site	Location	Size	Constructability	Ownership	Public Impact	Topography
1	Located in Floodway	3.1 Acres	Poor	Private	Low	Poor
2	Public Park	0.6 Acres	Good	City of Norwich	High	Fair

Shetucket (Greeneville and Downtown Sewersheds) Selection

Site 3 was ultimately selected as a facility site on the lower Shetucket Interceptor. This site has easy access to the interceptor, plenty of space for construction under most alternatives, and it is anticipated that its use could be restored if underground facilities are utilized. The Site 4 parking lot was similar in its advantages to Site 3, although smaller and privately owned. Additionally, this parking lot is typically more utilized than the parking lot at Site 3. Site 4 was ultimately eliminated due to a preference towards Site 3 in the Downtown Area. Site 3 was evaluated using the model and ultimately presented as a facility location in Section 8 of this LTCP. This location was used as a satellite facility location under many of the LTCP alternatives and was ultimately included in the recommended plan.

On the upper Shetucket Interceptor, three sites were evaluated. Site 5 is owned by NPU, would have enough room for construction of a facility, and construction would have minimal impact on the public. Site 6 is a fully developed private business and implementation of any CSO control technology here would be extremely difficult. Site 7 is a parking lot for a private business, which would also provide an obstacle for implementation of any CSO technology here as well. Site 5 was ultimately modeled as a CSO facility site in Section 8 of the 2018 LTCP but was not included in the current recommended plan. These sites on the upper Shetucket Interceptor will be reevaluated in future LTCP updates.

Table B-2 Evaluation of Satellite Sites, Shetucket

Site	Location	Size	Constructability	Ownership	Public Impact	Topography
3	Public Parking Lot	1.4 Acres	Good	City of Norwich	High	Good
4	Private Parking Lot	0.6 Acres	Good	Private	High	Good
5	NPU Parking Lot	2.0 Acres	Fair	NPU	Low	Good
6	Private Storage Center	2.4 Acres	Poor	Private	High	Good
7	Private Auto Lot	0.9 Acres	Good	Private	Medium	Fair

Thamesville Selection

Based on the site analysis, Site 8 originally was considered a promising site for a CSO technology due to its location near CSO 040, the Shipping Street PS, and the open space available. However, modeling indicated that capacity here was adequate and CSO mitigation technology would not be needed in this location. This site does appear to be a promising location to relocate the Shipping Street PS to if it is desired. Sites 9 and 10 were better positioned near critical infrastructure than Site 8. Although both of these sites are private, they appear to be unused land within a private parcel. Site 9, the northern site, was determined to be better positioned, and was preferred to Site 10. This site was evaluated by the model and presented as a location in several alternatives and included in the recommended plan as a satellite facility site.

Table B-3 Evaluation of Satellite Sites, Thamesville

Site	Location	Size	Constructability	Ownership	Public Impact	Topography
8	Empty Lot	1.5 Acres	Fair	City of Norwich	Medium	Good
9	Private Unimproved Area	0.4 Acres	Fair	Private	Medium	Fair
10	Private Unimproved Area	0.1 Acres	Poor	Private	Medium	Good

Appendix C

federal register

Tuesday
April 19, 1994

Part VII

Environmental Protection Agency

Combined Sewer Overflow (CSO) Control Policy; Notice

ENVIRONMENTAL PROTECTION AGENCY

[FRL-4732-7]

Combined Sewer Overflow (CSO) Control Policy

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final policy.

SUMMARY: EPA has issued a national policy statement entitled "Combined Sewer Overflow (CSO) Control Policy." This policy establishes a consistent national approach for controlling discharges from CSOs to the Nation's waters through the National Pollutant Discharge Elimination System (NPDES) permit program.

FOR FURTHER INFORMATION CONTACT: Jeffrey Lape, Office of Wastewater Enforcement and Compliance, MC-4201, U.S. Environmental Protection Agency, 401 M Street SW., Washington, DC 20460, (202) 260-7361.

SUPPLEMENTARY INFORMATION: The main purposes of the CSO Control Policy are to elaborate on the Environmental Protection Agency's (EPA's) National CSO Control Strategy published on September 8, 1989, at 54 FR 37370, and to expedite compliance with the requirements of the Clean Water Act (CWA). While implementation of the 1989 Strategy has resulted in progress toward controlling CSOs, significant public health and water quality risks remain.

This Policy provides guidance to permittees with CSOs, NPDES authorities and State water quality standards authorities on coordinating the planning, selection, and implementation of CSO controls that meet the requirements of the CWA and allow for public involvement during the decision-making process.

Contained in the Policy are provisions for developing appropriate, site-specific NPDES permit requirements for all combined sewer systems (CSS) that overflow as a result of wet weather events. For example, the Policy lays out two alternative approaches—the "demonstration" and the "presumption" approaches—that provide communities with targets for CSO controls that achieve compliance with the Act, particularly protection of water quality and designated uses. The Policy also includes enforcement initiatives to require the immediate elimination of overflows that occur during dry weather and to ensure that the remaining CWA requirements are complied with as soon as practicable.

The permitting provisions of the Policy were developed as a result of extensive input received from key stakeholders during a negotiated policy dialogue. The CSO stakeholders included representatives from States, environmental groups, municipal organizations and others. The negotiated dialogue was conducted during the Summer of 1992 by the Office of Water and the Office of Water's Management Advisory Group. The enforcement initiatives, including one which is underway to address CSOs during dry weather, were developed by EPA's Office of Water and Office of Enforcement.

EPA issued a Notice of Availability on the draft CSO Control Policy on January 19, 1993, (58 FR 4994) and requested comments on the draft Policy by March 22, 1993. Approximately forty-one sets of written comments were submitted by a variety of interest groups including cities and municipal groups, environmental groups, States, professional organizations and others. All comments were considered as EPA prepared the Final Policy. The public comments were largely supportive of the draft Policy. EPA received broad endorsement of and support for the key principles and provisions from most commenters. Thus, this final Policy does not include significant changes to the major provisions of the draft Policy, but rather, it includes clarification and better explanation of the elements of the Policy to address several of the questions that were raised in the comments. Persons wishing to obtain copies of the public comments or EPA's summary analysis of the comments may write or call the EPA contact person.

The CSO Policy represents a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities and the public engage in a comprehensive and coordinated planning effort to achieve cost effective CSO controls that ultimately meet appropriate health and environmental objectives. The Policy recognizes the site-specific nature of CSOs and their impacts and provides the necessary flexibility to tailor controls to local situations. Major elements of the Policy ensure that CSO controls are cost effective and meet the objectives and requirements of the CWA.

The major provisions of the Policy are as follows.

CSO permittees should immediately undertake a process to accurately characterize their CSS and CSO discharges, demonstrate implementation of minimum technology-based controls identified in the Policy, and develop long-term CSO control plans which evaluate alternatives for attaining compliance with the CWA, including compliance with water quality standards and protection of designated uses. Once the long-term CSO control plans are completed, permittees will be responsible to implement the plans' recommendations as soon as practicable.

State water quality standards authorities will be involved in the long-term CSO control planning effort as well. The water quality standards authorities will help ensure that development of the CSO permittees' long-term CSO control plans are coordinated with the review and possible revision of water quality standards on CSO-impacted waters.

NPDES authorities will issue/reissue or modify permits, as appropriate, to require compliance with the technology-based and water quality-based requirements of the CWA. After completion of the long-term CSO control plan, NPDES permits will be reissued or modified to incorporate the additional requirements specified in the Policy, such as performance standards for the selected controls based on average design conditions, a post-construction water quality assessment program, monitoring for compliance with water quality standards, and a reopener clause authorizing the NPDES authority to reopen and modify the permit if it is determined that the CSO controls fail to meet water quality standards or protect designated uses. NPDES authorities should commence enforcement actions against permittees that have CWA violations due to CSO discharges during dry weather. In addition, NPDES authorities should ensure the implementation of the minimum technology-based controls and incorporate a schedule into an appropriate enforceable mechanism, with appropriate milestone dates, to implement the required long-term CSO control plan. Schedules for implementation of the long-term CSO control plan may be phased based on the relative importance of adverse impacts upon water quality standards and designated uses, and on a permittee's financial capability.

EPA is developing extensive guidance to support the Policy and will announce the availability of the guidances and other outreach efforts through various means, as they become available. For example, EPA is preparing guidance on the nine minimum controls, characterization and monitoring of CSOs, development of long-term CSO control plans, and financial capability.

Permittees will be expected to comply with any existing CSO-related requirements in NPDES permits,

onsent decrees or court orders unless evised to be consistent with this Policy.

The policy is organized as follows:

I. Introduction
A. Purpose and Principles
B. Application of Policy
C. Effect on Current CSO Control Efforts
D. Small System Considerations
E. Implementation Responsibilities
F. Policy Development
II. EPA Objectives for Permittees
A. Overview
B. Implementation of the Nine Minimum Controls
C. Long-Term CSO Control Plan
1. Characterization, Monitoring, and Modeling of the Combined Sewer Systems
2. Public Participation
3. Consideration of Sensitive Areas
4. Evaluation of Alternatives
5. Cost/Performance Consideration
6. Operational Plan
7. Maximizing Treatment at the Existing POTW Treatment Plant
8. Implementation Schedule
9. Post-Construction Compliance Monitoring Program
III. Coordination With State Water Quality Standards
A. Overview
B. Water Quality Standards Reviews
IV. Expectations for Permitting Authorities
A. Overview
B. NPDES Permit Requirements
1. Phase I Permits—Requirements for Demonstration of the Nine Minimum Controls and Development of the Long-Term CSO Control Plan
2. Phase II Permits—Requirements for Implementation of a Long-Term CSO Control Plan
3. Phasing Considerations
V. Enforcement and Compliance
A. Overview
B. Enforcement of CSO Dry Weather Discharge Prohibition
C. Enforcement of Wet Weather CSO Requirements
1. Enforcement for Compliance With Phase I Permits
2. Enforcement for Compliance With Phase II Permits
D. Penalties

List of Subjects in 40 CFR Part 122

Water pollution control.

Authority: Clean Water Act, 33 U.S.C. 1251 *et seq.*

Dated: April 8, 1994.

Carol M. Browner,

Administrator.

Combined Sewer Overflow (CSO) Control Policy

I. Introduction

A. Purpose and Principles

The main purposes of this Policy are to elaborate on EPA's National Combined Sewer Overflow (CSO) Control Strategy published on September 8, 1989 at 54 FR 37370 (1989 Strategy) and to expedite compliance with the requirements of the Clean Water Act (CWA). While implementation of the 1989 Strategy has resulted in progress toward controlling CSOs, significant water quality risks remain.

A combined sewer system (CSS) is a wastewater collection system owned by a State or municipality (as defined by section 502(4) of the CWA) which conveys sanitary wastewaters (domestic, commercial and industrial wastewaters) and storm water through a single-pipe system to a Publicly Owned Treatment Works (POTW) Treatment Plant (as defined in 40 CFR 403.3(p)). A CSO is the discharge from a CSS at a point prior to the POTW Treatment Plant. CSOs are point sources subject to NPDES permit requirements including both technology-based and water quality-based requirements of the CWA. CSOs are not subject to secondary treatment requirements applicable to POTWs.

CSOs consist of mixtures of domestic sewage, industrial and commercial wastewaters, and storm water runoff. CSOs often contain high levels of suspended solids, pathogenic microorganisms, toxic pollutants, floatables, nutrients, oxygen-demanding organic compounds, oil and grease, and other pollutants. CSOs can cause exceedances of water quality standards (WQS). Such exceedances may pose risks to human health, threaten aquatic life and its habitat, and impair the use and enjoyment of the Nation's waterways.

This Policy is intended to provide guidance to permittees with CSOs, National Pollutant Discharge Elimination System (NPDES) permitting authorities, State water quality standards authorities and enforcement authorities. The purpose of the Policy is to coordinate the planning, selection, design and implementation of CSO management practices and controls to meet the requirements of the CWA and to involve the public fully during the decision making process.

This Policy reiterates the objectives of the 1989 Strategy:

1. To ensure that if CSOs occur, they are only as a result of wet weather;
2. To bring all wet weather CSO discharge points into compliance with the technology-based and water quality-based requirements of the CWA; and
3. To minimize water quality, aquatic biota, and human health impacts from CSOs.

This CSO Control Policy represents a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities and the public engage in a comprehensive and coordinated planning effort to achieve cost-effective CSO controls that ultimately meet appropriate health and environmental objectives and requirements. The Policy recognizes the site-specific nature of CSOs and their impacts and provides the necessary flexibility to tailor controls to local situations. Four key principles of the Policy ensure that CSO controls are cost-effective and meet the objectives of the CWA. The key principles are:

1. Providing clear levels of control that would be presumed to meet appropriate health and environmental objectives;
2. Providing sufficient flexibility to municipalities, especially financially disadvantaged communities, to consider the site-specific nature of CSOs and to determine the most cost-effective means of reducing pollutants and meeting CWA objectives and requirements;
3. Allowing a phased approach to implementation of CSO controls considering a community's financial capability; and
4. Review and revision, as appropriate, of water quality standards and their implementation procedures when developing CSO control plans to reflect the site-specific wet weather impacts of CSOs.

This Policy is being issued in support of EPA's regulations and policy initiatives. This Policy is Agency guidance only and does not establish or affect legal rights or obligations. It does not establish a binding norm and is not finally determinative of the issues addressed. Agency decisions in any particular case will be made by applying the law and regulations on the basis of specific facts when permits are issued. The Administration has recommended that the 1994 amendments to the CWA endorse this final Policy.

B. Application of Policy

The permitting provisions of this Policy apply to all CSSs that overflow as a result of storm water flow, including snow melt runoff (40 CFR 122.26(b)(13)). Discharges from CSSs during dry weather are prohibited by the CWA. Accordingly, the permitting provisions of this Policy do not apply to CSOs during dry weather. Dry weather flow is the flow in a combined sewer that results from domestic sewage, groundwater infiltration, commercial and industrial wastewaters, and any other non-precipitation related flows (e.g., tidal infiltration). In addition to

'he permitting provisions, the nforcement and Compliance section of .nis Policy describes an enforcement initiative being developed for overflows that occur during dry weather.

Consistent with the 1989 Strategy, 30 States that submitted CSO permitting strategies have received EPA approval or, in the case of one State, conditional approval of its strategy. States and EPA Regional Offices should review these strategies and negotiate appropriate revisions to them to implement this Policy. Permitting authorities are encouraged to evaluate water pollution control needs on a watershed management basis and coordinate CSO control efforts with other point and nonpoint source control activities.

C. Effect on Current CSO Control Efforts

EPA recognizes that extensive work has been done by many Regions, States, and municipalities to abate CSOs. As such, portions of this Policy may already have been addressed by permittees' previous efforts to control CSOs. Therefore, portions of this Policy may not apply, as determined by the permitting authority on a case-by-case basis, under the following circumstances:

1. Any permittee that, on the date of ublication of this final Policy, has .ompleted or substantially completed construction of CSO control facilities that are designed to meet WQS and protect designated uses, and where it has been determined that WQS are being or will be attained, is not covered by the initial planning and construction provisions in this Policy; however, the operational plan and post-construction monitoring provisions continue to apply. If, after monitoring, it is determined that WQS are not being attained, the permittee should be required to submit a revised CSO control plan that, once implemented, will attain WQS.

2. Any permittee that, on the date of publication of this final Policy, has substantially developed or is implementing a CSO control program pursuant to an existing permit or enforcement order, and such program is considered by the NPDES permitting authority to be adequate to meet WQS and protect designated uses and is reasonably equivalent to the treatment objectives of this Policy, should complete those facilities without further planning activities otherwise expected by this Policy. Such programs, however, should be reviewed and modified to be onsistent with the sensitive area, financial capability, and post-construction monitoring provisions of this Policy.

3. Any permittee that has previously constructed CSO control facilities in an effort to comply with WQS but has failed to meet such applicable standards or to protect designated uses due to remaining CSOs may receive consideration for such efforts in future permits or enforceable orders for long-term CSO control planning, design and implementation.

In the case of any ongoing or substantially completed CSO control effort, the NPDES permit or other enforceable mechanism, as appropriate, should be revised to include all appropriate permit requirements consistent with Section IV.B. of this Policy.

D. Small System Considerations

The scope of the long-term CSO control plan, including the characterization, monitoring and modeling, and evaluation of alternatives portions of this Policy may be difficult for some small CSSs. At the discretion of the NPDES Authority, jurisdictions with populations under 75,000 may not need to complete each of the formal steps outlined in Section II.C. of this Policy, but should be required through their permits or other enforceable mechanisms to comply with the nine minimum controls (II.B), public participation (II.C.2), and sensitive areas (II.C.3) portions of this Policy. In addition, the permittee may propose to implement any of the criteria contained in this Policy for evaluation of alternatives described in II.C.4. Following approval of the proposed plan, such jurisdictions should construct the control projects and propose a monitoring program sufficient to determine whether WQS are attained and designated uses are protected.

In developing long-term CSO control plans based on the small system considerations discussed in the preceding paragraph, permittees are encouraged to discuss the scope of their long-term CSO control plan with the WQS authority and the NPDES authority. These discussions will ensure that the plan includes sufficient information to enable the permitting authority to identify the appropriate CSO controls.

E. Implementation Responsibilities

NPDES authorities (authorized States or EPA Regional Offices, as appropriate) are responsible for implementing this Policy. It is their responsibility to assure that CSO permittees develop long-term CSO control plans and that NPDES permits meet the requirements of the CWA. Further, they are responsible for coordinating the review of the long-term CSO control plan and the development of the permit with the WQS authority to determine if revisions to the WQS are appropriate. In addition, they should determine the appropriate vehicle (i.e., permit reissuance, information request under CWA section 308 or State equivalent or enforcement action) to ensure that compliance with the CWA is achieved as soon as practicable.

Permittees are responsible for documenting the implementation of the nine minimum controls and developing and implementing a long-term CSO control plan, as described in this Policy. EPA recognizes that financial considerations are a major factor affecting the implementation of CSO controls. For that reason, this Policy allows consideration of a permittee's financial capability in connection with the long-term CSO control planning effort, WQS review, and negotiation of enforceable schedules. However, each permittee is ultimately responsible for aggressively pursuing financial arrangements for the implementation of its long-term CSO control plan. As part of this effort, communities should apply to their State Revolving Fund program, or other assistance programs as appropriate, for financial assistance.

EPA and the States will undertake action to assure that all permittees with CSSs are subject to a consistent review in the permit development process, have permit requirements that achieve compliance with the CWA, and are subject to enforceable schedules that require the earliest practicable compliance date considering physical and financial feasibility.

F. Policy Development

This Policy devotes a separate section to each step involved in developing and implementing CSO controls. This is not to imply that each function occurs separately. Rather, the entire process surrounding CSO controls, community planning, WQS and permit development/revision, enforcement/compliance actions and public participation must be coordinated to control CSOs effectively. Permittees and permitting authorities are encouraged to consider innovative and alternative approaches and technologies that achieve the objectives of this Policy and the CWA.

In developing this Policy, EPA has included information on what responsible parties are expected to accomplish. Subsequent documents will provide additional guidance on how the objectives of this Policy should be met. These documents will provide further guidance on: CSO permit writing, the nine minimum controls, long-term CSO

control plans, financial capability, sewer system characterization and receiving water monitoring and modeling, and application of WQS to CSO-impacted waters. For most CSO control efforts however, sufficient detail has been included in this Policy to begin immediate implementation of its provisions.

II. EPA Objectives for Permittees

A. Overview

Permittees with CSSs that have CSOs should immediately undertake a process to accurately characterize their sewer systems, to demonstrate implementation of the nine minimum controls, and to develop a long-term CSO control plan.

B. Implementation of the Nine Minimum Controls

Permittees with CSOs should submit appropriate documentation demonstrating implementation of the nine minimum controls, including any proposed schedules for completing minor construction activities. The nine minimum controls are:

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

Selection and implementation of actual control measures should be based on site-specific considerations including the specific CSS's characteristics discussed under the sewer system characterization and monitoring portions of this Policy. Documentation of the nine minimum controls may include operation and maintenance plans, revised sewer use ordinances for industrial users, sewer system inspection reports, infiltration/inflow studies, pollution prevention programs, public notification plans, and facility plans for maximizing the capacities of the existing collection, storage and treatment systems, as well as contracts and schedules for minor construction programs for improving the existing system's operation. The permittee should also submit any information or data on the degree to which the nine minimum controls achieve compliance with water quality standards. These data and information should include results made available through monitoring and modeling activities done in conjunction with the development of the long-term CSO control plan described in this Policy.

This documentation should be submitted as soon as practicable, but no later than two years after the requirement to submit such documentation is included in an NPDES permit or other enforceable mechanism. Implementation of the nine minimum controls with appropriate documentation should be completed as soon as practicable but no later than January 1, 1997. These dates should be included in an appropriate enforceable mechanism.

Because the CWA requires immediate compliance with technology-based controls (section 301(b)), which on a Best Professional Judgment basis should include the nine minimum controls, a compliance schedule for implementing the nine minimum controls, if necessary, should be included in an appropriate enforceable mechanism.

C. Long-Term CSO Control Plan

Permittees with CSOs are responsible for developing and implementing long-term CSO control plans that will ultimately result in compliance with the requirements of the CWA. The long-term plans should consider the site-specific nature of CSOs and evaluate the cost effectiveness of a range of control options/strategies. The development of the long-term CSO control plan and its subsequent implementation should also be coordinated with the NPDES authority and the State authority responsible for reviewing and revising the State's WQS. The selected controls should be designed to allow cost effective expansion or cost effective retrofitting if additional controls are subsequently determined to be necessary to meet WQS, including existing and designated uses.

This policy identifies EPA's major objectives for the long-term CSO control plan. Permittees should develop and submit this long-term CSO control plan as soon as practicable, but generally within two years after the date of the NPDES permit provision, Section 308 information request, or enforcement action requiring the permittee to develop the plan. NPDES authorities may establish a longer timetable for completion of the long-term CSO control plan on a case-by-case basis to account for site-specific factors which may influence the complexity of the planning process. Once agreed upon, these dates should be included in an appropriate enforceable mechanism.

EPA expects each long-term CSO control plan to utilize appropriate information to address the following minimum elements. The Plan should also include both fixed-date project implementation schedules (which may be phased) and a financing plan to design and construct the project as soon as practicable. The minimum elements of the long-term CSO control plan are described below.

1. Characterization, Monitoring, and Modeling of the Combined Sewer System

In order to design a CSO control plan adequate to meet the requirements of the CWA, a permittee should have a thorough understanding of its sewer system, the response of the system to various precipitation events, the characteristics of the overflows, and the water quality impacts that result from CSOs. The permittee should adequately characterize through monitoring, modeling, and other means as appropriate, for a range of storm events, the response of its sewer system to wet weather events including the number, location and frequency of CSOs, volume, concentration and mass of pollutants discharged and the impacts of the CSOs on the receiving waters and their designated uses. The permittee may need to consider information on the contribution and importance of other pollution sources in order to develop a final plan designed to meet water quality standards. The purpose of the system characterization, monitoring and modeling program initially is to assist the permittee in developing appropriate measures to implement the nine minimum controls and, if necessary, to support development of the long-term CSO control plan. The monitoring and modeling data also will be used to evaluate the expected effectiveness of both the nine minimum controls and, if necessary, the long-term CSO controls, to meet WQS.

The major elements of a sewer system characterization are described below.

a. Rainfall Records—The permittee should examine the complete rainfall record for the geographic area of its existing CSS using sound statistical procedures and best available data. The permittee should evaluate flow variations in the receiving water body to correlate between CSOs and receiving water conditions.

b. Combined Sewer System Characterization—The permittee should evaluate the nature and extent of its sewer system through evaluation of available sewer system records, field inspections and other activities necessary to understand the number, location and frequency of overflows and their location relative to sensitive areas and to pollution sources in the collection system, such as indirect significant industrial users.

c. CSO Monitoring—The permittee should develop a comprehensive, representative monitoring program that measures the frequency, duration, flow rate, volume and pollutant concentration of CSO discharges and assesses the impact of the CSOs on the receiving waters. The monitoring program should include necessary CSO effluent and ambient in-stream monitoring and, where appropriate, other monitoring protocols such as biological assessment, toxicity testing and sediment sampling. Monitoring parameters should include, for example, oxygen demanding pollutants, nutrients, toxic pollutants, sediment contaminants, pathogens, bacteriological indicators (e.g., Enterococcus, E. Coli), and toxicity. A representative sample of overflow points can be selected that is sufficient to allow characterization of CSO discharges and their water quality impacts and to facilitate evaluation of control plan alternatives.

d. Modeling—Modeling of a sewer system is recognized as a valuable tool for predicting sewer system response to various wet weather events and assessing water quality impacts when evaluating different control strategies and alternatives. EPA supports the proper and effective use of models, where appropriate, in the evaluation of the nine minimum controls and the development of the long-term CSO control plan. It is also recognized that there are many models which may be used to do this. These models range from simple to complex. Having decided to use a model, the permittee should base its choice of a model on the characteristics of its sewer system, the number and location of overflow points, and the sensitivity of the receiving water body to the CSO discharges. Use of models should include appropriate calibration and verification with field *measurements.* The sophistication of the model should relate to the complexity of the system to be modeled and to the information needs associated with evaluation of CSO control options and water quality impacts. EPA believes that continuous simulation models, using historical rainfall data, may be the best way to model sewer systems, CSOs, and their impacts. Because of the iterative nature of modeling sewer systems, CSOs, and their impacts, monitoring and modeling efforts are complementary and should be coordinated.

2. Public Participation

In developing its long-term CSO control plan, the permittee will employ a public participation process that actively involves the affected public in the decision-making to select the long-term CSO controls. The affected public includes rate payers, industrial users of the sewer system, persons who reside downstream from the CSOs, persons who use and enjoy these downstream waters, and any other interested persons.

3. Consideration of Sensitive Areas

EPA expects a permittee's long-term CSO control plan to give the highest priority to controlling overflows to sensitive areas. Sensitive areas, as determined by the NPDES authority in coordination with State and Federal agencies, as appropriate, include designated Outstanding National Resource Waters, National Marine Sanctuaries, waters with threatened or endangered species and their habitat, waters with primary contact recreation, public drinking water intakes or their designated protection areas, and shellfish beds. For such areas, the long-term CSO control plan should:

a. Prohibit new or significantly increased overflows;

b. i. Eliminate or relocate overflows that discharge to sensitive areas wherever physically possible and economically achievable, except where elimination or relocation would provide less environmental protection than additional treatment; or

ii. Where elimination or relocation is not physically possible and economically achievable, or would provide less environmental protection than additional treatment, provide the level of treatment for remaining overflows deemed necessary to meet WQS for full protection of existing and designated uses. In any event, the level of control should not be less than those described in Evaluation of Alternatives below; and

c. Where elimination or relocation has been proven not to be physically possible and economically achievable, permitting authorities should require, for each subsequent permit term, a reassessment based on new or improved techniques to eliminate or relocate, or on changed circumstances that influence economic achievability.

4. Evaluation of Alternatives

EPA expects the long-term CSO control plan to consider a reasonable range of alternatives. The plan should, for example, evaluate controls that would be necessary to achieve zero overflow events per year, an average of one to three, four to seven, and eight to twelve overflow events per year. Alternatively, the long-term plan could evaluate controls that achieve 100% capture, 90% capture, 85% capture, 80% capture, and 75% capture for treatment. The long-term control plan should also consider expansion of POTW secondary and primary capacity in the CSO abatement alternative analysis. The analysis of alternatives should be sufficient to make a reasonable assessment of cost and performance as described in Section II.C.5. Because the final long-term CSO control plan will become the basis for NPDES permit limits and requirements, the selected controls should be sufficient to meet CWA requirements.

In addition to considering sensitive areas, the long-term CSO control plan should adopt one of the following approaches:

a. "Presumption" Approach

A program that meets any of the criteria listed below would be presumed to provide an adequate level of control to meet the water quality-based requirements of the CWA, provided the permitting authority determines that such presumption is reasonable in light of the data and analysis conducted in the characterization, monitoring, and modeling of the system and the consideration of sensitive areas described above. These criteria are provided because data and modeling of wet weather events often do not give a clear picture of the level of CSO controls necessary to protect WQS.

i. No more than an average of four overflow events per year, provided that the permitting authority may allow up to two additional overflow events per year. For the purpose of this criterion, an overflow event is one or more overflows from a CSS as the result of a precipitation event that does not receive the minimum treatment specified below; or

ii. The elimination or the capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis; or

iii. The elimination or removal of no less than the mass of the pollutants, identified as causing water quality impairment through the sewer system

haracterization, monitoring, and odeling effort, for the volumes that would be eliminated or captured for treatment under paragraph ii. above. Combined sewer flows remaining after implementation of the nine minimum controls and within the criteria specified at II.C.4.a.i or ii, should receive a minimum of:

- Primary clarification (Removal of floatables and settleable solids may be achieved by any combination of treatment technologies or methods that are shown to be equivalent to primary clarification.);
- Solids and floatables disposal; and
- Disinfection of effluent, if necessary, to meet WQS, protect designated uses and protect human health, including removal of harmful disinfection chemical residuals, where necessary.

b. "Demonstration" Approach

A permittee may demonstrate that a selected control program, though not meeting the criteria specified in II.C.4.a. above is adequate to meet the water quality-based requirements of the CWA. To be a successful demonstration, the permittee should demonstrate each of the following:

i. The planned control program is adequate to meet WQS and protect designated uses, unless WQS or uses cannot be met as a result of natural background conditions or pollution sources other than CSOs;

ii. The CSO discharges remaining after implementation of the planned control program will not preclude the attainment of WQS or the receiving waters' designated uses or contribute to their impairment. Where WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load, including a wasteload allocation and a load allocation, or other means should be used to apportion pollutant loads;

iii. The planned control program will provide the maximum pollution reduction benefits reasonably attainable; and

iv. The planned control program is designed to allow cost effective expansion or cost effective retrofitting if additional controls are subsequently determined to be necessary to meet WQS or designated uses.

5. Cost/Performance Considerations

The permittee should develop appropriate cost/performance curves to demonstrate the relationships among a comprehensive set of reasonable control alternatives that correspond to the different ranges specified in Section II.C.4. This should include an analysis to determine where the increment of pollution reduction achieved in the receiving water diminishes compared to the increased costs. This analysis, often known as knee of the curve, should be among the considerations used to help guide selection of controls.

6. Operational Plan

After agreement between the permittee and NPDES authority on the necessary CSO controls to be implemented under the long-term CSO control plan, the permittee should revise the operation and maintenance program developed as part of the nine minimum controls to include the agreed-upon long-term CSO controls. The revised operation and maintenance program should maximize the removal of pollutants during and after each precipitation event using all available facilities within the collection and treatment system. For any flows in excess of the criteria specified at II.C.4.a.i., ii. or iii and not receiving the treatment specified in II.C.4.a, the operational plan should ensure that such flows receive treatment to the greatest extent practicable.

7. Maximizing Treatment at the Existing POTW Treatment Plant

In some communities, POTW treatment plants may have primary treatment capacity in excess of their secondary treatment capacity. One effective strategy to abate pollution resulting from CSOs is to maximize the delivery of flows during wet weather to the POTW treatment plant for treatment. Delivering these flows can have two significant water quality benefits: First, increased flows during wet weather to the POTW treatment plant may enable the permittee to eliminate or minimize overflows to sensitive areas; second, this would maximize the use of available POTW facilities for wet weather flows and would ensure that combined sewer flows receive at least primary treatment prior to discharge.

Under EPA regulations, the intentional diversion of waste streams from any portion of a treatment facility, including secondary treatment, is a bypass. EPA bypass regulations at 40 CFR 122.41(m) allow for a facility to bypass some or all the flow from its treatment process under specified limited circumstances. Under the regulation, the permittee must show that the bypass was unavoidable to prevent loss of life, personal injury or severe property damage, that there was no feasible alternative to the bypass and that the permittee submitted the required notices. In addition, the regulation provides that a bypass may be approved only after consideration of adverse effects.

Normally, it is the responsibility of the permittee to document, on a case-by-base basis, compliance with 40 CFR 122.41(m) in order to bypass flows legally. For some CSO-related permits, the study of feasible alternatives in the control plan may provide sufficient support for the permit record and for approval of a CSO-related bypass in the permit itself, and to define the specific parameters under which a bypass can legally occur. For approval of a CSO-related bypass, the long-term CSO control plan, at a minimum, should provide justification for the cut-off point at which the flow will be diverted from the secondary treatment portion of the treatment plant, and provide a benefit-cost analysis demonstrating that conveyance of wet weather flow to the POTW for primary treatment is more beneficial than other CSO abatement alternatives such as storage and pump back for secondary treatment, sewer separation, or satellite treatment. Such a permit must define under what specific wet weather conditions a CSO-related bypass is allowed and also specify what treatment or what monitoring, and effluent limitations and requirements apply to the bypass flow. The permit should also provide that approval for the CSO-related bypass will be reviewed and may be modified or terminated if there is a substantial increase in the volume or character of pollutants being introduced to the POTW. The CSO-related bypass provision in the permit should also make it clear that all wet weather flows passing the headworks of the POTW treatment plant will receive at least primary clarification and solids and floatables removal and disposal, and disinfection, where necessary, and any other treatment that can reasonably be provided.

Under this approach, EPA would allow a permit to authorize a CSO-related bypass of the secondary treatment portion of the POTW treatment plant for combined sewer flows in certain identified circumstances. This provision would apply only to those situations where the POTW would ordinarily meet the requirements of 40 CFR 122.41(m) as evaluated on a case-by-case basis. Therefore, there must be sufficient data in the administrative record (reflected in the permit fact sheet or statement of basis) supporting all the requirements in 40 CFR 122.41(m)(4) for approval of an anticipated bypass.

For the purposes of applying this regulation to CSO permittees, "severe property damage" could include

situations where flows above a certain level wash out the POTW's secondary treatment system. EPA further believes that the feasible alternatives requirement of the regulation can be met if the record shows that the secondary treatment system is properly operated and maintained, that the system has been designed to meet secondary limits for flows greater than the peak dry weather flow, plus an appropriate quantity of wet weather flow, and that it is either technically or financially infeasible to provide secondary treatment at the existing facilities for greater amounts of wet weather flow. The feasible alternative analysis should include, for example, consideration of enhanced primary treatment (e.g., chemical addition) and non-biological secondary treatment. Other bases supporting a finding of no feasible alternative may also be available on a case-by-case basis. As part of its consideration of possible adverse effects resulting from the bypass, the permitting authority should also ensure that the bypass will not cause exceedances of WQS.

This Policy does not address the appropriateness of approving anticipated bypasses through NPDES permits in advance outside the CSO context.

8. Implementation Schedule

The permittee should include all pertinent information in the long term control plan necessary to develop the construction and financing schedule for implementation of CSO controls. Schedules for implementation of the CSO controls may be phased based on the relative importance of adverse impacts upon WQS and designated uses, priority projects identified in the long-term plan, and on a permittee's financial capability.

Construction phasing should consider:

a. Eliminating overflows that discharge to sensitive areas as the highest priority;

b. Use impairment;

c. The permittee's financial capability including consideration of such factors as:

i. Median household income;

ii. Total annual wastewater and CSO control costs per household as a percent of median household income;

iii. Overall net debt as a percent of full market property value;

iv. Property tax revenues as a percent of full market property value;

v. Property tax collection rate;

vi. Unemployment; and

vii. Bond rating;

d. Grant and loan availability;

e. Previous and current residential, commercial and industrial sewer user fees and rate structures; and

f. Other viable funding mechanisms and sources of financing.

9. Post-Construction Compliance Monitoring Program

The selected CSO controls should include a post-construction water quality monitoring program adequate to verify compliance with water quality standards and protection of designated uses as well as to ascertain the effectiveness of CSO controls. This water quality compliance monitoring program should include a plan to be approved by the NPDES authority that details the monitoring protocols to be followed, including the necessary effluent and ambient monitoring and, where appropriate, other monitoring protocols such as biological assessments, whole effluent toxicity testing, and sediment sampling.

III. Coordination With State Water Quality Standards

A. Overview

WQS are State adopted, or Federally promulgated rules which serve as the goals for the water body and the legal basis for the water quality-based NPDES permit requirements under the CWA. WQS consist of uses which States designate for their water bodies, criteria to protect the uses, an anti-degradation policy to protect the water quality improvements gained and other policies affecting the implementation of the standards. A primary objective of the long-term CSO control plan is to meet WQS, including the designated uses through reducing risks to human health and the environment by eliminating, relocating or controlling CSOs to the affected waters.

State WQS authorities, NPDES authorities, EPA regional offices, permittees, and the public should meet early and frequently throughout the long-term CSO control planning process. Development of the long-term plan should be coordinated with the review and appropriate revision of WQS and implementation procedures on CSO-impacted waters to ensure that the long-term controls will be sufficient to meet water quality standards. As part of these meetings, participants should agree on the data, information and analyses needed to support the development of the long-term CSO control plan and the review of applicable WQS, and implementation procedures, if appropriate. Agreements should be reached on the monitoring protocols and models that will be used to evaluate the water quality impacts of the overflows, to analyze the attainability of the WQS and to determine the water quality-based requirements for the permit. Many opportunities exist for permittees and States to share information as control programs are developed and as WQS are reviewed. Such information should assist States in determining the need for revisions to WQS and implementation procedures to better reflect the site-specific wet weather impacts of CSOs. Coordinating the development of the long-term CSO control plan and the review of the WQS and implementation procedures provides greater assurance that the long-term control plan selected and the limits and requirements included in the NPDES permit will be sufficient to meet WQS and to comply with sections 301(b)(1)(C) and 402(a)(2) of the CWA.

EPA encourages States and permittees jointly to sponsor workshops for the affected public in the development of the long-term CSO control plan and during the development of appropriate revisions to WQS for CSO-impacted waters. Workshops provide a forum for including the public in discussions of the implications of the proposed long-term CSO control plan on the water quality and uses for the receiving water.

B. Water Quality Standards Reviews

The CWA requires States to periodically, but at least once every three years, hold public hearings for the purpose of reviewing applicable water quality standards and, as appropriate, modifying and adopting standards. States must provide the public an opportunity to comment on any proposed revision to water quality standards and all revisions must be submitted to EPA for review and approval.

EPA regulations and guidance provide States with the flexibility to adapt their WQS, and implementation procedures to reflect site-specific conditions including those related to CSOs. For example, a State may adopt site-specific criteria for a particular pollutant if the State determines that the site-specific criteria fully protects the designated use (40 CFR 131.11). In addition, the regulations at 40 CFR 131.10(g), (h), and (j) specify when and how a designated use may be modified. A State may remove a designated use from its water quality standards only if the designated use is not an existing use. An existing use is a use actually attained in the water body on or after November 28, 1975. Furthermore, a State may not remove a designated use that will be attained by implementing the

technology-based effluent limits required under sections 301(b) and 306 of the CWA and by implementing cost-effective and reasonable best management practices for nonpoint source controls. Thus, if a State has a reasonable basis to determine that the current designated use could be attained after implementation of the technology-based controls of the CWA, then the use could not be removed.

In determining whether a use is attainable and prior to removing a designated use, States must conduct and submit to EPA a use attainability analysis. A use attainability analysis is a structured scientific assessment of the factors affecting the use, including the physical, chemical, biological, and economic factors described in 40 CFR 131.10(g). As part of the analysis, States should evaluate whether the designated use could be attained if CSO controls were implemented. For example, States should examine if sediment loadings from CSOs could be reduced so as not to bury spawning beds, or if biochemical oxygen demanding material in the effluent or the toxicity of the effluent could be corrected so as to reduce the acute or chronic physiological stress on or bioaccumulation potential of aquatic organisms.

In reviewing the attainability of their WQS and the applicability of their implementation procedures to CSO-impacted waters, States are encouraged to define more explicitly their recreational and aquatic life uses and then, if appropriate, modify the criteria accordingly to protect the designated uses.

Another option is for States to adopt partial uses by defining when primary contact recreation such as swimming does not exist, such as during certain seasons of the year in northern climates or during a particular type of storm event. In making such adjustments to their uses, States must ensure that downstream uses are protected, and that during other seasons or after the storm event has passed, the use is fully protected.

In addition to defining recreational uses with greater specificity, States are also encouraged to define the aquatic uses more precisely. Rather than "aquatic life use protection," States should consider defining the type of fishery to be protected such as a cold water fishery (e.g., trout or salmon) or a warm weather fishery (e.g., bluegill or large mouth bass). Explicitly defining the type of fishery to be protected may assist the permittee in enlisting the support of citizens for a CSO control plan.

A water quality standard variance may be appropriate, in limited circumstances on CSO-impacted waters, where the State is uncertain as to whether a standard can be attained and time is needed for the State to conduct additional analyses on the attainability of the standard. Variances are short-term modifications in water quality standards. Subject to EPA approval, States, with their own statutory authority, may grant a variance to a specific discharger for a specific pollutant. The justification for a variance is similar to that required for a permanent change in the standard, although the showings needed are less rigorous. Variances are also subject to public participation requirements of the water quality standards and permits programs and are reviewable generally every three years. A variance allows the CSO permit to be written to meet the "modified" water quality standard as analyses are conducted and as progress is made to improve water quality.

Justifications for variances are the same as those identified in 40 CFR 131.10(g) for modifications in uses. States must provide an opportunity for public review and comment on all variances. If States use the permit as the vehicle to grant the variance, notice of the permit must clearly state that the variance modifies the State's water quality standards. If the variance is approved, the State appends the variance to the State's standards and reviews the variance every three years.

IV. Expectations for Permitting Authorities

A. Overview

CSOs are point sources subject to NPDES permit requirements including both technology-based and water quality-based requirements of the CWA. CSOs are not subject to secondary treatment regulations applicable to publicly owned treatment works (*Montgomery Environmental Coalition vs. Costle*, 646 F.2d 568 (D.C. Cir. 1980)).

All permits for CSOs should require the nine minimum controls as a minimum best available technology economically achievable and best conventional technology (BAT/BCT) established on a best professional judgment (BPJ) basis by the permitting authority (40 CFR 125.3). Water quality-based requirements are to be established based on applicable water quality standards.

This policy establishes a uniform, nationally consistent approach to developing and issuing NPDES permits to permittees with CSOs. Permits for CSOs should be developed and issued expeditiously. A single, system-wide permit generally should be issued for all discharges, including CSOs, from a CSS operated by a single authority. When different parts of a single CSS are operated by more than one authority, permits issued to each authority should generally require joint preparation and implementation of the elements of this Policy and should specifically define the responsibilities and duties of each authority. Permittees should be required to coordinate system-wide implementation of the nine minimum controls and the development and implementation of the long-term CSO control plan.

The individual authorities are responsible for their own discharges and should cooperate with the permittee for the POTW receiving the flows from the CSS. When a CSO is permitted separately from the POTW, both permits should be cross-referenced for informational purposes.

EPA Regions and States should review the CSO permitting priorities established in the State CSO Permitting Strategies developed in response to the 1989 Strategy. Regions and States may elect to revise these previous priorities. In setting permitting priorities, Regions and States should not just focus on those permittees that have initiated monitoring programs. When setting priorities, Regions and States should consider, for example, the known or potential impact of CSOs on sensitive areas, and the extent of upstream industrial user discharges to the CSS.

During the permittee's development of the long-term CSO control plan, the permit writer should promote coordination between the permittee and State WQS authority in connection with possible WQS revisions. Once the permittee has completed development of the long-term CSO control plan and has coordinated with the permitting authority the selection of the controls necessary to meet the requirements of the CWA, the permitting authority should include in an appropriate enforceable mechanism, requirements for implementation of the long-term CSO control plan, including conditions for water quality monitoring and operation and maintenance.

B. NPDES Permit Requirements

Following are the major elements of NPDES permits to implement this Policy and ensure protection of water quality.

1. Phase I Permits—Requirements for Demonstration of Implementation of the Nine Minimum Controls and Development of the Long-Term CSO Control Plan

In the Phase I permit issued/modified to reflect this Policy, the NPDES authority should at least require permittees to:

a. Immediately implement BAT/BCT, which at a minimum includes the nine minimum controls, as determined on a BPJ basis by the permitting authority;

b. Develop and submit a report documenting the implementation of the nine minimum controls within two years of permit issuance/modification;

c. Comply with applicable WQS, no later than the date allowed under the State's WQS, expressed in the form of a narrative limitation; and

d. develop and submit, consistent with this Policy and based on a schedule in an appropriate enforceable mechanism, a long-term CSO control plan as soon as practicable, but generally within two years after the effective date of the permit issuance/modification. However, permitting authorities may establish a longer timetable for completion of the long-term CSO control plan on a case-by-case basis to account for site-specific factors that may influence the complexity of the planning process.

The NPDES authority should include compliance dates on the fastest practicable schedule for each of the nine minimum controls in an appropriate enforceable mechanism issued in conjunction with the Phase I permit. The use of enforceable orders is necessary unless Congress amends the CWA. All orders should require compliance with the nine minimum controls no later than January 1, 1997.

2. Phase II Permits—Requirements for Implementation of a Long-Term CSO Control Plan

Once the permittee has completed development of the long-term CSO control plan and the selection of the controls necessary to meet CWA requirements has been coordinated with the permitting and WQS authorities, the permitting authority should include, in an appropriate enforceable mechanism, requirements for implementation of the long-term CSO control plan as soon as practicable. Where the permittee has selected controls based on the "presumption" approach described in Section II.C.4, the permitting authority must have determined that the presumption that such level of treatment will achieve water quality standards is reasonable in light of the data and analysis conducted under this Policy. The Phase II permit should contain:

a. Requirements to implement the technology-based controls including the nine minimum controls determined on a BPJ basis;

b. Narrative requirements which insure that the selected CSO controls are implemented, operated and maintained as described in the long-term CSO control plan;

c. Water quality-based effluent limits under 40 CFR 122.44(d)(1) and 122.44(k), requiring, at a minimum, compliance with, no later than the date allowed under the State's WQS, the numeric performance standards for the selected CSO controls, based on average design conditions specifying at least one of the following:

i. A maximum number of overflow events per year for specified design conditions consistent with II.C.4.a.i; or

ii. A minimum percentage capture of combined sewage by volume for treatment under specified design conditions consistent with II.C.4.a.ii; or

iii. A minimum removal of the mass of pollutants discharged for specified design conditions consistent with II.C.4.a.iii; or

iv. performance standards and requirements that are consistent with II.C.4.b. of the Policy.

d. A requirement to implement, with an established schedule, the approved post-construction water quality assessment program including requirements to monitor and collect sufficient information to demonstrate compliance with WQS and protection of designated uses as well as to determine the effectiveness of CSO controls.

e. A requirement to reassess overflows to sensitive areas in those cases where elimination or relocation of the overflows is not physically possible and economically achievable. The reassessment should be based on consideration of new or improved techniques to eliminate or relocate overflows or changed circumstances that influence economic achievability;

f. Conditions establishing requirements for maximizing the treatment of wet weather flows at the POTW treatment plant, as appropriate, consistent with Section II.C.7. of this Policy;

g. A reopener clause authorizing the NPDES authority to reopen and modify the permit upon determination that the CSO controls fail to meet WQS or protect designated uses. Upon such determination, the NPDES authority should promptly notify the permittee and proceed to modify or reissue the permit. The permittee should be required to develop, submit and implement, as soon as practicable, a revised CSO control plan which contains additional controls to meet WQS and designated uses. If the initial CSO control plan was approved under the demonstration provision of Section II.C.4.b., the revised plan, at a minimum, should provide for controls that satisfy one of the criteria in Section II.C.4.a. unless the permittee demonstrates that the revised plan is clearly adequate to meet WQS at a lower cost and it is shown that the additional controls resulting from the criteria in Section II.C.4.a. will not result in a greater overall improvement in water quality.

Unless the permittee can comply with all of the requirements of the Phase II permit, the NPDES authority should include, in an enforceable mechanism, compliance dates on the fastest practicable schedule for those activities directly related to meeting the requirements of the CWA. For major permittees, the compliance schedule should be placed in a judicial order. Proper compliance with the schedule for implementing the controls recommended in the long-term CSO control plan constitutes compliance with the elements of this Policy concerning planning and implementation of a long term CSO remedy.

3. Phasing Considerations

Implementation of CSO controls may be phased based on the relative importance of and adverse impacts upon WQS and designated uses, as well as the permittee's financial capability and its previous *efforts to control* CSOs. The NPDES authority should evaluate the proposed implementation schedule and construction phasing discussed in Section II.C.8. of this Policy. The permit should require compliance with the controls proposed in the long-term CSO control plan no later than the applicable deadline(s) under the CWA or State law. If compliance with the Phase II permit is not possible, an enforceable schedule, consistent with the Enforcement and Compliance Section of this Policy, should be issued in conjunction with the Phase II permit which specifies the schedule and milestones for implementation of the long-term CSO control plan.

V. Enforcement and Compliance

A. Overview

It is important that permittees act immediately to take the necessary steps to comply with the CWA. The CSO enforcement effort will commence with

an initiative to address CSOs that discharge during dry weather, followed by an enforcement effort in conjunction with permitting CSOs discussed earlier in this Policy. Success of the enforcement effort will depend in large part upon expeditious action by NPDES authorities in issuing enforceable permits that include requirements both for the nine minimum controls and for compliance with all other requirements of the CWA. Priority for enforcement actions should be set based on environmental impacts or sensitive areas affected by CSOs.

As a further inducement for permittees to cooperate with this process, EPA is prepared to exercise its enforcement discretion in determining whether or not to seek civil penalties for past CSO violations if permittees meet the objectives and schedules of this Policy and do not have CSOs during dry weather.

B. Enforcement of CSO Dry Weather Discharge Prohibition

EPA intends to commence immediately an enforcement initiative against CSO permittees which have CWA violations due to CSOs during dry weather. Discharges during dry weather have always been prohibited by the NPDES program. Such discharges can create serious public health and water quality problems. EPA will use its CWA Section 308 monitoring, reporting, and inspection authorities, together with NPDES State authorities, to locate these violations, and to determine their causes. Appropriate remedies and penalties will be sought for CSOs during dry weather. EPA will provide NPDES authorities more specific guidance on this enforcement initiative separately.

C. Enforcement of Wet Weather CSO Requirements

Under the CWA, EPA can use several enforcement options to address permittees with CSOs. Those options directly applicable to this Policy are section 308 Information Requests, section 309(a) Administrative Orders, section 309(g) Administrative Penalty Orders, section 309 (b) and (d) Civil Judicial Actions, and section 504 Emergency Powers. NPDES States should use comparable means.

NPDES authorities should set priorities for enforcement based on environmental impacts or sensitive areas affected by CSOs. Permittees that have voluntarily initiated monitoring and are progressing expeditiously toward appropriate CSO controls should be given due consideration for their efforts.

1. Enforcement for Compliance With Phase I Permits

Enforcement for compliance with Phase I permits will focus on requirements to implement at least the nine minimum controls, and develop the long-term CSO control plan leading to compliance with the requirements of the CWA. Where immediate compliance with the Phase I permit is infeasible, the NPDES authority should issue an enforceable schedule, in concert with the Phase I permit, requiring compliance with the CWA and imposing compliance schedules with dates for each of the nine minimum controls as soon as practicable. All enforcement authorities should require compliance with the nine minimum controls no later than January 1, 1997. Where the NPDES authority is issuing an order with a compliance schedule for the nine minimum controls, this order should also include a schedule for development of the long-term CSO control plan.

If a CSO permittee fails to meet the final compliance date of the schedule, the NPDES authority should initiate appropriate judicial action.

2. Enforcement for Compliance With Phase II Permits

The main focus for enforcing compliance with Phase II permits will be to incorporate the long-term CSO control plan through a civil judicial action, an administrative order, or other enforceable mechanism requiring compliance with the CWA and imposing a compliance schedule with appropriate milestone dates necessary to implement the plan.

In general, a judicial order is the appropriate mechanism for incorporating the above provisions for Phase II. Administrative orders, however, may be appropriate for permittees whose long-term control plans will take less then five years to complete, and for minors that have complied with the final date of the enforceable order for compliance with their Phase I permit. If necessary, any of the nine minimum controls that have not been implemented by this time should be included in the terms of the judicial order.

D. Penalties

EPA is prepared not to seek civil penalties for past CSO violations, if permittees have no discharges during dry weather and meet the objectives and schedules of this Policy. Notwithstanding this, where a permittee has other significant CWA violations for which EPA or the State is taking judicial action, penalties may be considered as part of that action for the following:

1. CSOs during dry weather;
2. Violations of CSO-related requirements in NPDES permits; consent decrees or court orders which predate this policy; or
3. Other CWA violations.

EPA will not seek penalties for past CSO violations from permittees that fully comply with the Phase I permit or enforceable order requiring compliance with the Phase I permit. For permittees that fail to comply, EPA will exercise its enforcement discretion in determining whether to seek penalties for the time period for which the compliance schedule was violated. If the milestone dates of the enforceable schedule are not achieved and penalties are sought, penalties should be calculated from the last milestone date that was met.

At the time of the judicial settlement imposing a compliance schedule implementing the Phase II permit requirements, EPA will not seek penalties for past CSO violations from permittees that fully comply with the enforceable order requiring compliance with the Phase I permit and if the terms of the judicial order are expeditiously agreed to on consent. However, stipulated penalties for violation of the judicial order generally should be included in the order, consistent with existing Agency policies. Additional guidance on stipulated penalties concerning long-term CSO controls and attainment of WQS will be issued.

Paperwork Reduction Act

The information collection requirements in this policy have been approved by the Office of Management and Budget (OMB) under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq* and have been assigned OMB control number 2040–0170.

This collection of information has an estimated reporting burden averaging 578 hours per response and an estimated annual recordkeeping burden averaging 25 hours per recordkeeper. These estimates include time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Chief, Information Policy Branch; EPA; 401 M Street SW. (Mail Code 2136); Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and

Budget, Washington, DC 20503, marked "Attention: Desk Officer for EPA."

[FR Doc. 94–9295 Filed 4–18–94; 8:45 am]
BILLING CODE 6560–50–P

Appendix D

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

State of Connecticut
Combine Sewer Overflow Strategy
May 1990

The Connecticut DEP has developed this combined sewer overflow strategy as a guidance document for municipalities facing the task of controlling combined sewer overflows. It is to be utilized by the municipalities and their respective planning consultants in the development of individual municipal CSO control strategies and by the Ct. DEP as a measurement document to achieve a consistent and balanced review of each municipality's strategy for compliance with the stated goals. While establishing goals and timetables for action, this strategy is not a workplan commitment between DEP and EPA.

The strategy has been developed with a statement of the long term goal and long term objectives followed by immediate, intermediate and long term corrective actions which should approach the long term goals and objectives.

PREAMBLE

LONG TERM GOAL:

Protect public health and the environment from the impacts of combined sewer overflows.

INTERIM OBJECTIVE:

Eliminate the discharge of untreated sewage from combined sewer overflows. Achieve fishable/swimmable water quality (Connecticut Water Quality Standards; Federal Clean Water Act, Section 101). Construct, maintain and operate sewerage systems to achieve the long term goal, provide for monitoring and maintenance programs to minimize the accidental discharge of raw sewage and efficiently locate and correct sewerage system infrastructure defects.

LONG TERM OBJECTIVE:

Eliminate the discharge of combined sewer overflows.

Discussion: The DEP recognizes that eliminating all raw sewage discharges from Connecticut's combined sewer overflows will be very expensive and will take many years to accomplish. However, DEP also believes that the "fishable swimmable" objective should not be abandoned due to these realities. The Connecticut Clean Water Fund was designed in 1986 to correct combined sewer overflow problems by the year 2010. Furthermore, "Environment 2000: Connecticut's Environmental Plan", also endorses complete elimination of combined sewer overflows.

In working towards the achievement of this goal, it is important to also establish interim and long term objectives, and a detailed management strategy as well. It will be these interim objectives which the public must live with for up to several decades.

Numerous short term combined sewer overflow abatement strategies presently being developed and pursued, representing substantial commitments of private, municipal and State monies, will greatly reduce the impacts of combined sewer overflows. The projects represent the first and perhaps most important steps towards achieving the long term goal, however in most cases there will be needs for additional commitments if Connecticut's long term goal is to be realized.

Periodically each municipality will update its CSO facilities plan to effectively coordinate local, State or Federal redevelopment or transportation projects which require modification of sewerage system infrastructure.

The DEP will not actively seek to downgrade the Water Quality Standards in areas impacted by CSO. However, the DEP is required to consider proposals from municipalities for downgrading after the development of detailed facility plans and compliance with the requirements of the Federal Clean Water Act and the Connecticut Water Quality Standards. Most likely the current standard of C/B will be maintained through the lengthy period of time required for CSO control. This will require the development of esource management strategies such as swimming advisories.

CURRENT STATUS

The following municipalities have combined sewers and the resultant combined sewer overflows:

(1) Bridgeport	(2) Middletown	(1) Norwich	(3)Portland
(3) Enfield	(2) New Haven	(0) Waterbury	
(1) Hartford	(3) Norwalk	(3) Derby	
(2) Jewett City	(3) Westport	(3) Shelton	

(0) - Facility planning not initiated
(1) - Facility planning active
(2) - Phased construction started; design on-going
(3) - Construction completed; new evaluation needed

Appendix A includes a listing of the combined sewer overflows for each municipality. This listing is based upon current knowledge of the sewer systems including existing NPDES permits, facilities plans and DEP surveys where conducted (Bridgeport, New Haven and Norwich).

A municipality is listed as having combined sewers only when the sewerage system was intentionally constructed years ago to serve the needs of both sanitary sewage and storm water runoff in a single conveyance system. Overflows of sewage from sanitary sewers caused by inflow conditions are not considered as CSO's. DEP will take administrative actions against municipalities with overflows of this nature requiring the elimination of the overflows through inflow removal. The DEP will be reviewing all NPDES permits as the permits are being renewed for overflows that are currently permitted and caused by infiltration and inflow conditions. Once identified the renewed permit will not give official recognition to the overflow as a permitted discharge. Concurrently, the municipality will be issued an Abatement Order requiring the elimination of the overflow on a defined schedule. Any discharge from an unpermitted overflow is considered as a bypass of the system and must be reported as such to the DEP in accordance with the applicable regulations. (Section 22a-430-3(k).)

ADMINISTRATIVE ACTIONS AVAILABLE TO ADDRESS CSO PROBLEMS

It is the intent of DEP to issue a separate NPDES permit for combined sewer overflows at the same time the municipality POTW permit is reissued. Similar to POTW permits, the CSO permit will contain restrictions and operating requirements but not include schedules for reports, design and construction. Coupled with the NPDES permit for the CSO's will be the issuance of or modification of an Administrative Order requiring facility planning, design and construction as needed with a defined schedule. Implementation of corrective action will be controlled by the Administrative Order issued under the Connecticut General Statutes. Enforcement of the Administrative Orders through a referral to the Attorney General's office will be utilized as necessary to achieve compliance.

Where dry weather overflows are determined to be the result of poor operation and maintenance of the sewerage system, DEP will recommend legal action through the Attorney General's office. Forfeitures, schedules of corrective action and future stipulated penalties are available for inclusion in the legal action and will be determined case by case.

INTERIM MEASURES

Recognizing the time that will be required in the larger municipalities to achieve the long-term goal of eliminating untreated combined sewage overflows, there is a need to develop corrective action plans for the immediate, intermediate and long term time periods.

1) Immediate Corrective Action

a) Eliminate dry weather overflows -

The DEP has surveyed Bridgeport, New Haven and Norwich to date for the purpose of verifying CSO locations and to clarify and resolve discrepancies between permits, facilities plans, and other records. Each field survey has resulted in a detailed report developed by the DEP field inspectors which identifies overflow locations, their current status and a map of each overflow location. This field work has also identified dry weather overflows. The DEP will issue Administrative Orders to any municipality requiring corrective action when a dry weather overflow is identified. The time table for corrective action will not be tied to a long-term phased CSO correction plan. In addition to the Administrative Action, a referral to the Attorney Generals office for a forfeiture will also be initiated.

b) Permitting requirements -

The DEP will prepare NPDES permits for the CSO's at the time the POTW permit for the municipality is to be renewed. The CSO permit will be prepared as a separate permit for the POTW permit.

Coupled with the final CSO permit will be the issuance of or modification of an Administrative Order requiring facility planning, design and construction as needed with a defined schedule.

c) Inventory - The DEP will continue its field survey of CSOs with the Hartford (MDC) system. It is felt that it might not be necessary to conduct a similar effort in the smaller systems such as in Enfield, Derby, Shelton, Portland, Westport, Jewett City, Middletown, Norwalk and Waterbury. Each of these projects will be reviewed with the area engineer after reviewing all available information to determine if a survey is warranted.

It is the intent of the Department at this time to conduct re-inspections of the CSO systems on a five year cycle.

d) Included as a key measure to maximize benefits with smaller capital investment is the requirement for each municipality to develop and implement a CSO inspection and maintenance program. Each municipality should develop an appropriate inspection program for each outfall and system overflow structure including tide gates at a reasonable frequency to verify proper operation during both wet weather and dry weather. Routine maintenance shall be performed on the appropriate facilities to assure continuous proper operation. Sewer inspection and cleaning of large interceptors shall be accomplished to provide maximum storage within the conveyance system. Maximization of flow to the treatment plant for treatment shall be required. Unnecessary overflow locations which are not utilized shall be permanently abandoned. Proper sewer system personnel shall be hired and retained for this inspection and maintenance program.

These requirements stated above will be analyzed on a case by case need and will be included as enforceable conditions in the CSO NPDES permit.

e) Removal of private inflow sources. In those small CSO communities which have achieved the reduction of CSOs from public sources (Derby, Shelton, Enfield, Portland, Westport) new Abatement Orders shall be issued requiring the verification during wet weather that CSOs are effectively eliminated and the overflow structure sealed or abandoned.

Where CSO's continue to occur (Derby, Enfield) due to private inflow sources, the municipalities must develop a short term program (up to 3 yrs.) to eliminate private inflow sources.

f) Prevention of new CSO sources - It shall be the policy of the DEP that no new CSO's be permitted nor shall combined sewer systems be extended. In addition, municipalities shall be required to adopt ordinances which prevent the additional contribution of storm waters to existing combined sewer systems. This ordinance must address both new development (requirement to construct separate sewer systems), in-filling in already developed areas with combined sewers and rehabilitation of structures in areas with combined sewers (requirement to separate storm water and sanitary sewage system on private property).

g) Field identification of overflow structures - Within the NPDES permit to be issued for CSO discharges, it is intended to requires of the permittee that actual discharge locations be marked to identify the discharge as a CSO discharge. Further discussion will be required on the issue to determine the benefits to be derived, the costs to implement and the practicality of implementing before this intent becomes a requirement.

h) Monitoring and assessment of CSO structures

Local system monitoring - Until CSOs are eliminated, municipalities must develop inspection programs as appropriate to monitor the overflows and system bypasses during both wet and dry periods.

State monitoring - The DEP has completed system inspections in Bridgeport, New Haven and Norwich. Hartford MDC should be completed in early 1990. Other systems may be inspected by DEP if deemed necessary. DEP will periodically, consistent with demands on manpower, conduct inspections of any CSO system for dry weather overflows.

2) <u>Intermediate Corrective Action</u> -

Depending upon the current status of each municipality, the immediate and intermediate corrective actions may be consecutive and concurrent actions.

a) Facilities planning - The development and adoption of this document(s) is the initial step for the intermediate corrective action. Facilities planning shall include:

i. Establishment of priority waterbodies with consideration given to existing and potential uses including:

- shellfishing (commercial and recreational)
- swimming
- aesthetics
- access to water and recreational potential
- water quality impacts
- habitat

ii. Evaluation of abatement alternatives, while guided by municipality-wide alternatives, must take into account individual priority waterbodies which may result in multiple alternatives being recommended for each municipality. This approach will create distinct projects and allow for phasing of individual projects.

iii. In all projects the priority for phasing will be case by case for each municipality. The priority evaluation shall include water quality impacts, use impairment and resource value.

iv. Alternatives include separation, maximization of flow to the plant for treatment, maximum use of existing facilities including system storage, consolidation of overflows, treatment at overflows, treatment at STP's;

v. Alternatives must minimize or eliminate impacts on environmentally significant areas and where treatment at POTWs is recommended evaluate the effect the proposal has on nutrient removal requirements associated with the Long Island Sound Management Plan;

vi. Alternatives must evaluate and be consistent with the goals of the Water Quality Standards including dissolved oxygen, coliform bacteria, and aesthetics;

vii. Design a management plan/CSO warning system to inform commercial and recreational users of periods when water bodies do not meet adopted goals. Where significant recreational uses of waterbodies are impacted by combined sewer overflow, the DEP will encourage the local water pollution control authority to develop a resource management use plan in conjunction with the local Director of Health.

viii. Evaluation of the benefits of long term water quality monitoring of the water body resources impacted by combined sewer overflows.

The facilities plan, as adopted by the municipality through a public process and approved by DEP, will identify discrete projects and their individual priority such that the overall correction strategy will be reflected by individual projects on the Clean Water Fund Priority List for financial assistance.

The facilities plan becomes the "master plan" for correction activities which will ultimately attain the goal of the elimination of untreated sewage from CSOs and the attainment of fishable/swimmable water quality. Municipalities should be guided by this "master plan" in all of their sewerage construction activities including stormwater systems regardless of the funding source (i.e. private development, block grants, transportation projects, HUD grants or others).

b) Appropriation of local financing - The facilities planning shall develop a phased implementation schedule which can range from three years up to twenty years. The schedule shall be determined after careful review of construction sequencing, local fiscal impact and Clean Water Fund fiscal impact while recognizing the priority waterbodies established in the facility plan. Local financing may also be phased but should not be an annual event.

3) Long Term Corrective Action

The long term corrective action shall be the continual implementation of the CSO abatement program after periodic reviews until the long term goal of CSO abatement has been attained.

Review of facilities planning recommendations - At reasonable intervals in the implementation program the municipality shall review with the DEP the CSO program for that municipality to assure that the goals of CSO abatement are being attained and that the program is still appropriate. Mid-course modifications may be desirable for a number of reasons including new technology, changes in fiscal status, revisions to priority waterbodies, and assessment of previous phases impacts.

PRIORITIES OF CSO PROJECTS

Projects which are in facility planning or phased construction are identified and rated on the priority point score sstem contained in the State of Connecticut Financial Assistance Program. The primary CSO communities of Bridgeport, Middletown, MDC (Hartford), Norwich, Norwalk and New Haven rate between 29 and 35 points on the priority list. These ratings indicate that the projects are essentially the same with little difference in water quality impacts between these projects. Therefore, DEP is pursuing these now concurrently and will continue to pursue each project concurrently. The project schedule will be determined by the recommendations of the individual facility plans coupled with consideration of the ability to finance the project through the Clean Water Fund and the municipality. It is the intent of DEP to secure a long term commitment from each municipality to implement the project over a defined period of time. The period of time may range from five years up to twenty years. The Clean Water Fund is anticipated to be able to finance these high rated projects as various phases are ready to proceed to construction.

Secondary CSO projects are identified as Enfield, Jewett City, Westport, Waterbury, Derby, Shelton and Portland. These secondary projects are all in various stages of project completion. Because the number of projects is small and because completion of each project can be accomplished in five years or less, DEP will pursue all of them concurrently. In the case of Westport, Enfield, Derby, Shelton, Portland and Waterbury new Administrative Orders will be required. These will be issued prior to October, 1991.

Minimum Technology - Based Limits

All CSO facility planning shall recognize that CSO discharges are required to meet the following minimum technology - based requirements;

1) Proper operation and maintenance for the sewer system and overflow structures.

2) Maximum use of the sewer system/or storage.

3) Maximization of flow to the treatment plant for treatment.

4) Prohibition of dry weather overflows

5) Control of solid and floatable materials.

Water Quality Standards/Use Attainability

The DEP will only consider a proposal from a municipality to lower the designated use goal after the municipality has completed its detailed facilities planning efforts. The municipality shall be required to comply with state requirements (Water Quality Standards, Section II Surface Water Standards, paragraph 3 - use attainability and paragraph 4 - changing water quality goal) and federal requirements (40.CFR 131.10(g) - Criteria for modifying state water quality standards and 40 CFR 131.20(b) - notice and opportunity for public hearing). Modifications to the standards may address the impacts of CSO's during and shortly after the CSO event.

Consistency of Facility Planning With the Long Island Sound Study (LISS)

The DEP will continue to monitor the development of the LISS and will assure that CSO facility planning is consistent with the management plan to be developed as part of the LISS. The Comprehensive Management Plan is anticipated to be completed by November, 1991. When issued, this CSO strategy will be reviewed to assure consistency between the two document.

Annual Report - An annual status report will be prepared by DEP for use by the Department, the Legislature and the public. Its purpose will be to provide a concise overview of the development of CSO projects and will include contacts for further information and details. Please refer to Appendix B for a format for this report.

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