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Comprehensive Wastewater Resilience Feasibility Study

Town of Scituate, Massachusetts

June 30, 2019

File No. 01.0173977.00

PREPARED FOR:

Town of Scituate, Massachusetts

GZA GeoEnvironmental, Inc.

249 Vanderbilt Avenue | Norwood, MA 02062
781.278.3700

32 Offices Nationwide
www.gza.com

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249 Vanderbilt Avenue
Norwood, MA 02062
T: 781.278.3700
F: 781.278.5701
F: 781.278.5702
www.gza.com

(E-Mail Transmission)

June 30, 2019
01.0173977.00

Attention: Mr. Brad Washburn, Director
Office of Planning and Development
Town Hall
600 Chief Justice Cushing Highway
Scituate, MA 02066

Re: **Final Report**
Comprehensive Wastewater Resilience Feasibility Study
Scituate, Massachusetts

Dear Mr. Washburn:

Enclosed GZA is pleased to provide the final report for the Comprehensive Wastewater Resilience Feasibility Study. This report serves as our final deliverable for the services GZA has performed under our contract #: 19-PD-03 with the Town of Scituate dated November 7, 2018.

The Resilience Feasibility Study Report includes: 1) an evaluation the Town of Scituate Sewer Collection and Treatment System's coastal flood vulnerability; 2) identification of preliminary flood protection strategies; and 3) proposed recommendations for flood mitigation alternatives at the feasibility study level.

The Study is intended to: 1) support Town resilience and financial planning; 2) identify resilience and flood protection priorities; 3) position the Town for outside funding, including federal and state grants; and 4) support future changes to user rates and the general budget to cover the cost of resilience and flood protection.

We appreciate your trusting in us for this project and thank you for this opportunity. If you should have any questions, please do not hesitate to contact me at 781-278-3847 or at samuel.bell@gza.com.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Samuel J. Bell, CFM
Senior Project Manager/Resiliency Planner

Daniel Stapleton, P.E.
Principal-in-Charge

Attachments: Final Report

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1: Limitations
2: Treatment System Summary (Pump Stations)
3: Treatment System Summary (Wastewater Treatment Plant)
4: Flood Hazard Characterization
5: Flood Vulnerability Assess (Collection System-Pump Stations)
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7: External Flood Vulnerability Assessment (Wastewater Treatment Plant)
8: Collection and Treatment System Vulnerability
9: Pump Station and Treatment Plant Flood Mitigation Measures

Executive Summary

The Town of Scituate owns and operates a municipal Wastewater Collection and Treatment System that serves approximately 3,000 families. The system includes: 1) the Scituate Wastewater Treatment Plant (WWTP); 2) 9 pump stations; and 3) about 32 miles of sewers. The treatment system is a critical Scituate Lifeline System and failure or disruption of system operations will result in significant impacts to the Town and its residents. There is an increasing resident demand for expanded system capacity.

The sewer collection and treatment system is vulnerable to flooding, in particular coastal flooding. The Scituate Climate Vulnerability Assessment and Action Plan, "Building a Resilient Scituate", March, 2018 identified a flood vulnerability assessment and flood mitigation of the treatment system as a top action priority. During March, 2018, the Town sewer collection and treatment system incurred over $200,000 in storm-related damages during a nor'easter including impacts to equipment, pumping stations and other support systems. The system's flood vulnerability can result in direct damages, disruption of service and unanticipated environmental releases. The risk associated with the Town of Scituate Sewer Collection and Treatment System can also negatively affect the future Town's municipal bond rating as well as the Town's general budget.

GZA completed a Resilience Feasibility Study of the Town of Scituate Sewer Collection and Treatment System. The study was funded by the Massachusetts Executive Office of Energy and Environmental Affairs Municipal Vulnerability Preparedness (MVP) Program. The approach, methodology, findings and recommendations of the study are presented herein.

Key findings include:

1. Seven of the 9 pumps stations and the wastewater treatment plant are vulnerable to coastal flooding as determined by the effective FEMA Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) and based on GZA's flood vulnerability analysis using multiple information sources.
2. The vulnerability was assessed by characterizing the flood hazard, predicting flood conditions at each asset location (current and future, considering climate change-induced sea level rise), and comparing to regulatory and industry standards including the "Guide for the Design of Wastewater Treatment Works", prepared by the New England Interstate Water Pollution Control Commission, Revised 2011 Edition (TR-16). Regulatory and industry standards are generally benchmarked to the 100-year recurrence interval flood. This event has a 1/100 chance of being experienced or exceeded in any given year.
3. System flood vulnerabilities include: a) direct damage due to flood inundation and flood-related environmental loads; b) disruption or loss of service due to flood inundation; and c) damage or loss of service due to excessive wastewater flow within the system. The last vulnerability is a result of excessive Infiltration and Inflow (I/I) due to stormwater and/or groundwater entering the system.
4. Previous analysis of I/I by CDM Smith identified excessive I/I to the system, which has significant implications relative to system treatment capacity and system impacts during coastal flood events. The study did not appear to include coastal flood effects and recommendations to revise I/I estimates are presented herein.
5. The March, 2018 flood events, and observed system response, indicates that this level of event approximately represents the functional capacity of the system and that more intense flood events will likely shut down the system with potentially significant damage. The estimated recurrence interval of the peak March, 2018 flood is on the order of 30 to 50 years. This probability is unacceptably high for a critical Lifeline system and does not meet current industry standards. This high flood risk is due largely to I/I issues rather than external flooding of assets.
6. Measures to mitigate I/I have been developed and presented by CDM Smith (included with this report for reference).
7. This report has preliminarily identified additional (non-I/I) flood mitigation measures. These flood mitigation measures are presented herein and were developed, along with approximate cost estimates, for planning and feasibility analysis purposes.
8. Recommendations are also presented herein for implementation of resilience measures, included within a framework of political, regulatory and cost recovery implementation steps. Overall, it is recommended that the

Town form a Water and Wastewater planning committee and develop a comprehensive, long range plan for Water and Wastewater management, including wastewater system expansion and incorporation of coastal flood resilience measures.

9. The current and future flood risk of the Town's Wastewater Collection and Treatment System represents a long-term and growing financial risk to the Town, including the general budget, dedicated funding and (potentially) the Town's municipal bond rating. A water/sewer rate analysis has been performed by Tighe & Bond including proforma analyses through the year FY2028. GZA has only been provided with limited information from this analysis. However, it appears to identify a clear need for on-going rate increases. The analysis appeared to include I/I improvements but did not include additional, non-I/I flood mitigation measures. Recommendations to include these costs, as well as extend the period of analysis, are presented herein.

10. Both near-term and long-term measures are presented. Long-term measures should not be implemented until a comprehensive, long range plan for Water and Wastewater management (referenced above) is completed.

Section 1: Introduction and Acknowledgements

GZA completed a Resilience Feasibility Study of the Town of Scituate Sewer Collection and Treatment System. **Figure 1** presents an overview of the system. The treatment system is a critical Scituate Lifeline System and failure or disruption of system operations will result in significant impacts to the Town and its residents. The sewer collection and treatment system is vulnerable to flooding, in particular coastal flooding. The system's coastal flood risks include:

- direct damages due to flood inundation, corrosion, mold and structure damage;
- disruption or loss of service due to temporary or long term repair
- and unanticipated environmental releases. The risk associated with the Town of Scituate Sewer Collection and Treatment System can also negatively affect the future Town's municipal bond rating. The system's coastal flood vulnerability will increase in the future due to climate change-induced sea level rise and increased precipitation frequency and intensity.

The Scituate Climate Vulnerability Assessment and Action Plan, "Building a Resilient Scituate", March, 2018 identified a flood vulnerability assessment and flood mitigation of the treatment system as a top action priority. During March, 2018, the Town sewer collection and treatment system incurred over $200,000 in storm-related damages during a nor'easter including impacts to equipment, pumping stations and other support systems.

For sewer collection and treatment systems, flood resilience refers to the ability of the wastewater utility to withstand a flooding event, minimize damage and rapidly recover from disruptions to service. Utilities can build resilience by implementing mitigation measures. A mitigation measure can be an emergency planning activity, equipment modification/upgrade or new capital investment/construction project.

System upgrades and expansion should consider the coastal flood risk, including sea level rise and changes to precipitation intensity and frequency, and incorporate flood mitigation measures into future design and construction.

The goals of the Resilience Feasibility Study are to: 1) evaluate and document the Town of Scituate Sewer Collection and Treatment System's coastal flood vulnerability; 2) preliminarily identify flood protection strategies; and 3) propose flood mitigation alternatives at the feasibility study level. The Study is intended to: 1) support Town resilience and financial planning; 2) identify resilience and flood protection priorities; 3) position the Town for outside funding, including federal and state grants; and 4) support future changes to user rates and the general budget to cover the cost of resilience and flood protection.

The Study included:

- characterization of the flood hazard (flood elevations, water depths, duration and flood-related loads) at each system component of concern, relative to hazard probability;
- determination of the wastewater treatment system vulnerability (including individual Structures, Systems and Components [SSCs]) to different probability flood events;
- estimation of the probable maximum loss and average annualized loss associated with coastal flooding;
- identification of risk mitigation strategies and alternatives;
- preliminary recommendations for a flood mitigation measures; and
- a planning level cost estimate.

The study was funded by the Massachusetts Executive Office of Energy and Environmental Affairs Municipal Vulnerability Preparedness (MVP) Program. As described herein, additional studies, engineering and design will be required as the next phase in creating a resilient Sewer Collection and Treatment System.

Acknowledgements

Town of Scituate Department of Planning and Development

- Brad Washburn, Director
- Kyle Boyd, Coastal Management Officer

Town of Scituate Department of Public Works

- Kevin Cafferty, P.E. Director,
- Sean McCarthy, P.E., Town Engineer

Town of Scituate Department of Public Works Sewer Division

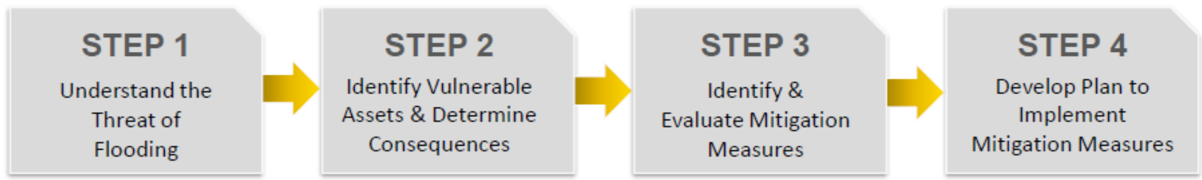
- William Branton, Director

Planning and Engineering Consultant

- GZA GeoEnvironmental, Inc.

Section 2: Study Approach

GZA's study approach followed the recommendations of the Environmental Protection Agency (EPA) (reference "EPA Flood Resilience: Basic Guide for Water and Wastewater Utilities". The EPA developed this guide to help drinking water and wastewater utilities become more resilient to flooding). This guide utilizes four basis steps for achieving utility flood resilience:



GZA's specific approach included:

1. Development of the treatment system details including systems, structures and components (SSC). This information, including key SSC elevations and system capacities, is critical to identifying the treatment system coastal flood hazard vulnerability.

2. Characterization of the coastal flood hazard. GZA characterized the flood hazard (including wind, waves, water levels and flood duration) for multiple recurrence intervals using several data sources. These sources include: FEMA; the USACE North Atlantic Coast Comprehensive Study; GZA's statistical analysis of wind data; GZA's statistical analysis of NOAA tide gage water level data; and the NOAA 2017 sea level rise projections.

3. Evaluation of treatment system vulnerability. This step involved comparing the flood hazard characteristics (including predicted water levels, waves and flood duration) to the treatment system SSCs (including the treatment plant and pump stations) to identify specific and system-wide coastal flood hazard vulnerabilities. The system vulnerability was identified relative to: 1) industry guidance and regulation applicable to wastewater treatment systems (which focuses on 100-year and 500-year recurrence interval floods); and 2) an evaluation of the system vulnerability to higher probability floods (1-year to 50-year recurrence interval floods).

4. Identification of Resilience Strategies and Measures. This step included development of a resilience strategy and recommendations for implementing near-term and long term resilience measures, order-of-magnitude costs and an evaluations of benefits and costs.

5. Stakeholder Outreach and Public Meetings. GZA performed stakeholder outreach with Town professionals (e.g., Public Works) and presented at two public meetings (May 31, 2019 and June 24, 2019).

Section 3: Study Overview

This Study report is organized as follows. The report presents a brief summary of findings within the report text, supported by the following detailed attachments:

- Attachment 1 - Purpose and Limitations to the Study
- Attachment 2 - Treatment System Overview (Collection System and Pump Stations)
- Attachment 3 - Treatment System Overview (Wastewater Treatment Plant)
- Attachment 4 - Coastal Flood Hazard Characterization
- Attachment 5 - External Flood Vulnerability Assessment (Collection System and Pump Stations)
- Attachment 6 - Infiltration and Inflow Vulnerability (Collection System)
- Attachment 7 - External Flood Vulnerability Assessment (Wastewater Treatment Plant)
- Attachment 8 - Collection and Treatment System External Flood Vulnerability
- Attachment 9 - Preliminary Recommendations for Flood Mitigation Measures

Section 4: Scituate Sewer Collection and Treatment System

The Town of Scituate owns and operates a sanitary sewer collection and treatment system. Management of the sewer collection system is the responsibility of the Town of Scituate Department of Public Works Sewer Division.

Major System Components:

The Scituate sewer collection and treatment system consists of the following major components:

- Scituate Wastewater Treatment Plant (WWTP);
- 9 pump stations;
- 32 miles of sewers; and
- 2,946 sewer manholes.

Attachments 2 and **3** present relevant system details.

The Town's sanitary sewer system is separated from the stormwater collection system. It is divided into 9 collection areas, which are further divided into 14 collection sub-areas. The collection sub-areas typically include about 20,000 linear feet of sewer pipe. The sytem serves about 7,500 people (about 20 percent of the Town's population).

Attachment 2 presents the collection system details including the pump stations.

The purpose of the WWTP is to remove and treat settled and floating solids, to reduce suspended solids and dissolve organic material, and to disinfect the final effluent (treated water leaving the WWTP) in order to reduce the possibility of water-borne diseases. The wastewater treatment facility was initially put in operation in 1965 and upgraded in 1984 and 2000. The facility discharges through Outfall 001, to an unnamed tidal creek that is a tributary to the Herring River, which in turn discharges into the North River Estuary. The facility serves a population of 7,500 (about 20% of the Town's population, primarily consisting of coastal properties for which on-site treatment is not a viable alternative).

Expansion of the Sewer Collection System included:

- Expansion of collector system into the Greenbush/Reservoir area during November 2005 (Phase I).
- Expansion of collector system into Third Cliff area in October 2006 (Phase II)
- Expansion of the collector system into the First and Second Cliff areas in the summer of 2007 (Phase III).

Future expansion Phases IV, V and VI are proposed for areas of Front Street, North Scituate and Minot.

In June, 2006 the Town started a "Sump Pump Amnesty Program" which helps residents to redirect their sump pump discharges out of the sewer system.

The WWTP was designed as a secondary treatment plant utilizing the extended aeration mode of the activated sludge (microorganisms) process. The WWTP was upgraded during 1984 to add septic receiving station, aerobic sludge digesters and a sludge dewatering building. These additions allowed further treatment of the sludge (settled solids). The sludge was dewatered by a belt filter press and disposed at the Town's sanitary landfill. A second upgrade was completed during 2000, increasing the design of the WWTP from 1.0 mgd to 1.6 mgd along with a secondary treatment upgrade to an advanced treatment capable of nitrogen removal (nitrification/denitrification). The use of ultraviolet light (UV) has replaced chlorination (residual chlorine can be toxic to aquatic life) as the means of disinfecting the final effluent.

The treatment process is described as follows. **Attachment 3** presents the treatment system structures and components. Raw influent arrives at the WWTP through a 36-inch diameter sewer. Preliminary treatment consists of a mechanical bar screen or optional manual (hand) screen followed by two wet wells and two aerated grit tanks. Wastewater then flows from the grit tank to a distribution tank, where it is distributed to the (new) Number 4 aeration tank. Flows exceeding the tank Number 4 capacity are discharged to the three older aeration tanks as offline storage. Following aeration, flow is channeled to three settling tanks followed by four down-flow filters (for nitrogen removal). Disinfection is by two banks of ultraviolet lights. The effluent receives post treatment aeration in 2 tanks and flow is measured by a Parshall flume prior to discharge through a 20 inch diameter pipe to the tidal creek. The WWTP has two parallel ultra-violet disinfection units consisting of two 36-foot channels with three lamp banks each. Each channel is designed to provide an energy dose level of approximately 64,000 uW-sec/cm^2 at peak flow, with a 45 second retention time at peak flow. The power supply is automatically varied in direct proportion to plant flow. Effluent discharge is to the Herring River/North River Estuary.

The plant is designed for a peak hourly flow of 4.34 million gallons per day (MGD) (3.6 MGD actual) and a peak daily flow of 3.33 MGD. The plant is permitted for a daily flow of 1.6 MGD.

Since the closure of the landfill, sludge generated by the wastewater treatment belt filter press process; about 1,100 wet tons/year) has been hauled off site by a contractor for beneficial reuse.

Section 5: Scituate Coastal Flood Characterization

The coastal setting of Scituate, ranging from ocean beach to estuaries, creates complex flow conditions. Coastal flooding includes both flood inundation (due to storm surge and tides) and the effects of waves (wave height, run-up and overtopping). Coastal flood evaluation includes consideration of the effects of flood waters as well as environmental flood loads.

In accordance with the recommendations of TR-16, GZA characterized the coastal flood hazard at each of the key collection and treatment structures (including pump stations and treatment plant) (presented in **Attachment 4**). The coastal flood hazard was characterized based on the effective FEMA Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs). The FEMA FIS and FIRMs have certain limitations relative to applying to this Study. The information presented is limited to low probability floods (i.e., the 100-year recurrence interval flood). The FIS did not include hydrodynamic modeling and the available stillwater flood elevation data may not reflect all areas of concern (such as those located within estuaries). The FEMA FIS may also have excessive conservatism relative to wave set-up at certain locations. Due to these limitations, GZA's coastal flood characterization utilized additional information, including results of the USACE North Atlantic Coast Comprehensive Study (NAACS) which did include hydrodynamic modeling (although at coarse model resolution). Sea level rise was included in the coastal flood characterization.

As described in **Attachment 4**, the coastal flood hazard details may differ depending upon the source information used. We note that a comprehensive analysis of the coastal flood hazard using new hydrodynamic and wave numerical modeling and wave run-up and overtopping analyses and environmental load development was beyond the scope of this Study.

GZA's coastal flood characterization included the following information sources:

- NOAA Boston Tide Station. GZA performed a statistical analysis of the NOAA Boston Tide Station monthly and annually maximum water level data using Generalized Extreme Value (GEV) statistics.
- The FEMA Flood Insurance Study (FIS) and related Flood Insurance Rate Maps (FIRMs).
- The results of the Army Corps of Engineers (USACE) North Atlantic Coast Comprehensive Study (NAACS). This study was performed by the USACE after Hurricane Sandy to characterize coastal flood hazards in areas impacted by Hurricane Sandy (from the Chesapeake Bay to New Hampshire). The study included statistical analysis and computer modeling of storm surge and waves. The study provides nearshore storm surge and wave hazard data at multiple locations around Scituate.
- Wind data presented in ASCE 7-10, 3-second gust velocities and Logan Airport historical, observed wind data. GZA converted ASCE 3-second gusts for representative frequencies to the sustained 1-minute, 10-meter wind speed. GZA performed statistical analysis of Logan Airport observed 1, 2 - minute sustained, 10-meter wind speeds.
- NOAA Atlas 14 precipitation data.
- NOAA 2017 Sea Level Rise Projections as presented in the USACE Sea level Curve Calculator Version 2019.21.

The purpose of the coastal flood hazard characterization was to develop vulnerability assessment flood levels representative of a range of probabilities (1-year to 500-year recurrence intervals) and reflective of future sea level rise effects. The characterization of the coastal flood hazard at each area of interest included several flood components, including:

- Stillwater elevation (SWE), which is the projected elevation of floodwaters (storm tide) in the absence of wave effects.
- Significant wave height (H_s), which represents the average height of the highest one-third of the waves in a given time period.
- Wave setup.
- Total water level (TWL), which includes the stillwater level plus wave setup.
- Wave crest elevation, which is the elevation of the top of the wave crest.

Attachment 4 also provides a brief explanation of probability.

GZA also performed simple, GIS elevation-based inundation modeling using the flood hazard data described above and recent LIDAR topographic data; the results are presented in **Attachment 4**.

Section 6: Scituate Sewer Collection and Treatment System Coastal Flood Vulnerability

Review of the effective FEMA Flood Insurance Rate Map (FIRM) clearly indicates that much of the collection system piping, seven of the pump stations and the treatment plant are located within the effective (i.e., current) FEMA 100-year recurrence interval (FEMA Base Flood) coastal floodplain and are vulnerable to coastal flooding (see **Table 1**). The flood vulnerability, however, is not uniformly distributed and differs by: 1) location (e.g., not all pump stations are equally vulnerable); 2) probability of occurrence; and 3) consequences. Each of the system structures and components are individually vulnerable. The collection and treatment system vulnerability is a function of the cumulative, inter-connected performance of the individual structures and components.

Flood Effects

Flood effects include:

1. Direct damage to SSCs due to: 1) flood inundation; b) corrosion; c) mold; and d) environmental flood loads (hydrostatic, hydrodynamic and wave loads).
2. Loss of service (operational disruption) due to temporary or permanent direct damage.
3. Loss of service (operational disruption) due to excessive flow (exceeding system capacity, causing internal flooding and/or managed system shutdown to avoid damage).

Flood Vulnerability Criteria

GZA evaluated the vulnerability of the system components relative to two frameworks: 1) the first involved comparison of the existing system condition relative to industry guidelines and regulatory requirements, which are focused on the 100-year and 500-year recurrence interval floods; and 2) the second involved consideration of vulnerability due to higher probability flood events (i.e., 1-year through 50-year recurrence interval floods) which will more definitively characterize flood risk and influence flood mitigation prioritization.

Each of these frameworks consider internal and external flood vulnerabilities and effects. External flooding is the result in flood inundation or wetting of external structures, systems and components (SSCs) and penetration into structure interiors through water penetration entry points such as doors, vents, windows, etc. Internal flooding typically occurs due to unmanaged, excessive wastewater flow through the collection system and into wet wells, dry wells and structure interiors. Excessive flow within the system occurs when the flow exceeds the pumping and/or treatment capacity. Excessive flow within the Scituate system is due to extensive infiltration and inflow (I/I) of non-sanitary wastewater water due to system leakage (including groundwater, rainwater and flood inundation).

Industry guidance is presented in the "Guides for the Design of Wastewater Treatment Works", prepared by the New England Interstate Water Pollution Control Commission, Revised 2011 Edition (TR-16). Regulatory requirements are presented in the federal flood regulations and State building codes (incorporating by reference ASCE 24-14 "Flood Resistant Design and Construction". Municipal wastewater treatment systems, like the Scituate Sewer Collection and Treatment System, are generally classified in accordance with ASCE 24-14 under the building code as Flood Design Class 3 structures since they "pose a high risk to the public or significant disruption to the community should they be damaged, be unable to perform their intended functions after flooding, or fail due to flooding" and are included with structures that "if their operations were interrupted by a flood, would cause significant disruption in day-to-day life or significant economic losses in a community".

TR-16 flood protection guidance includes:

- Collection system Infiltration/Inflow: the sewer collection system (including manholes) should be protected from (I/I) during wet weather conditions including effects of precipitation, groundwater, tidal conditions and flood inundation (within the 100-year recurrence interval flood floodplain).
- New pump stations, new facilities within a treatment plant and new wastewater treatment plants should be designed:
    - to provide uninterrupted operation of all units during conditions of a 100-year recurrence interval flood; and
    - be placed above, or protected against, the structural, process and electrical equipment damage that might occur in an event that results in a water elevation above the 100-year recurrence interval flood:

- All first floors, tank walls and structural openings should be protected against damage to the 100-year recurrence interval flood elevation water level.
- Critical Equipment should be protected against damage up to a water elevation that is 3 feet above the 100-year flood elevation (100-year recurrence interval flood level + 3 feet). Critical Equipment includes conveyance and treatment system components identified for protection including, but not limited to, all electrical, mechanical, and control systems associated with pump stations and treatment facilities that are responsible for conveyance of wastewater to and through the treatment facility to maintain primary treatment and disinfection during the flood event. It also includes equipment that, if damaged by flood conditions, will prevent the facility from returning to pre-event operation after cessation of flood conditions is also critical equipment.
- Non-critical equipment should be protected against damage up to a water surface elevation that is 2 feet above the 100-year flood elevation.
- SCADA system components and instrumentation used to monitor and control facility operation should be protected from flood conditions to the maximum extent practical.
- Emergency back-up power should be available to maintain normal operation of the treatment processes at all times. Furnish the backup power supply for critical equipment by using emergency power generation or an alternative power source of sufficient capacity. In addition, ensure that there is enough fuel to run under full load or peak flow for at least 48 hours, or under normal operating conditions for at least 96 hours, whichever requires the greater amount of fuel to supply power to critical equipment in the event of a power outage.
- Submersible Pump Motors (flood considerations):
  - Terminal and connectors should have watertight seals located outside of the wetwell.
  - Motor control center should be located outside of the wetwell, above the 100-year recurrence interval flood elevation.

- Hydraulic Capacity: the hydraulic design should allow for peak hourly flows, including associated sidestream flows, to be passed through the plant with the largest of longest flow path of each unit process removed from service and with the receiving water at the 100-year recurrence interval flood elevation (including considerations of climate change).
- Flood protection requirements for existing facilities[1] are developed in consideration of risk and benefit/cost. Existing pump stations and treatment facilities that are planned for upgrade or expansion should be improved to the maximum extent possible to meet the flood protection criteria for new facilities.

State Building Code flood regulations generally apply only to building structures and, therefore, are not always directly applicable to wastewater treatment systems, structures and components. They do, however, indicate minimum flood protection goals for wastewater treatment systems, structures and components. As summarized in ASCE 24-14, flood protection requirements for Flood Class 3 structures include:

- FEMA Coastal A Zones and Coastal High Hazard Areas:
  - The minimum elevation of the bottom of the lowest supporting horizontal member of the lowest floor, relative to the FEMA Base Flood Elevation (BFE) or Design Flood Elevation (DFE) shall be the BFE plus 2 feet or the DFE, whichever is higher.
- FEMA Flood Areas not identified as Coastal A Zones and Coastal High Hazard Areas:
  - The minimum elevation of the top of the lowest floor, relative to the FEMA Base Flood Elevation (BFE) or Design Flood Elevation (DFE) shall be the BFE plus 1 foot or the DFE, whichever is higher.

The FEMA Base Flood is the flood having a recurrence interval of 100 years (aka 1% annual chance). The FEMA Base Flood Elevation (BFE) is typically the elevation of flooding, including wave height, having a recurrence interval of 100

[1] Existing facilities of the era of the Scituate Collection and Treatment System were typically designed to: 1) provide for uninterrupted operations of all units during conditions of a 25-year recurrence interval flood; and 2) be placed above or protected against the structural, process and electrical equipment damage that might occur during a 100-year recurrence interval flood. Therefore, existing facilities are often out of compliance with current industry risk standards. Further the coastal flood risk has increased due to sea level rise and other factors.

years. The FEMA BFE, as shown on the Scituate FEMA Flood Insurance Rate Maps (FIRMs), may also reflect additional conditions such as wave run-up.

The Design Flood, per ASCE 24-14, is the flood associated with the greater of the following two areas: 1) area within a floodplain subject to a 1% or greater chance of flooding in any year, or 2) area designated as a flood hazard area on a community's flood hazard map or otherwise legally designated. The Design Flood Elevation is the elevation of the design flood, including wave height, relative to the datum specified on the community's flood hazard map.

External Coastal Flood Vulnerability Assessment

The coastal flood vulnerability of the collection and treatment was preliminarily evaluated. This included:

- GZA reviewed site plans and conducted site visits to inventory of key structures, components and equipment at the pump stations and the treatment plant, including associated elevations (see **Attachments 2** and **3**).
- Identification of structure, component and equipment impact by flood water elevation (see **Attachments 5** and **7**).
- Review of an analysis of Infiltration and Inflow (I/I) performed by CDM Smith (included for reference in **Attachment 6**) and observed pumps stations flow rates during a March, 2018 coastal flood event (nor'easter), for the purpose of evaluating the impact of I/I on the collection system during a coastal flood event.
- Evaluation of the system impact and response due to external flooding (i.e., not considering I/I impacts) (see **Attachment 8**).
- Estimation of coastal flood-related system losses due to external flooding (i.e., not considering I/I impacts) see **Attachment 8**).

The flood vulnerability assessment considered flood water elevations at each of the pump stations and the treatment plant associated with the range of recurrence interval flood events (1-year through 500-year). The flood water levels are developed in **Attachment 4**. Consistent with ASCE 24-14, water levels associated with wave crest elevations (i.e., stillwater plus wave set-up plus a portion of the wave height) were used for the vulnerability assessment. The flood vulnerability associated with the current FEMA BFE was also evaluated. **Attachments 5** and **7** present the details of the vulnerability assessment at the pump stations (**Attachment 5**) and the wastewater treatment plant (**Attachment 7**).

For this feasibility study (i.e., preliminary analyses), engineering judgement was used to assess the importance of structure, component and system impacts to estimate: 1) percent of service area impacted (based on number of buildings within service area); 2) estimated percent damage; and 3) estimated losses, including damage losses, labor costs, and loss of service costs. Damage estimates were developed using: 1) system response curves (depth-damage curves) developed by the US Army Corps of Engineers and used by FEMA (HAZUS MH Loss Estimation Model) for pumps stations and treatments plants with comparable flow and treatment capacities; 2) system response curves for service disruption developed by GZA based on our asset inventory (pump stations and treatment plant); 3) asset values (pumps stations and treatment plant) based on information provided by the Town; and 4) loss of service costs utilized by FEMA Benefit-Cost Analysis software (FEMA BCA Toolkit Version 5.3). GZA's approach will support project BCAs performed for future FEMA grant applications. Losses were estimated for specific recurrence interval floods. Average Annualized Losses (AALs) were also estimated for purposes of estimated average annual cost risk.

Estimated losses are typically highly uncertain (and often overestimated) due: 1) to uncertainty associated with flood hazards (i.e., probability of water levels and waves, resolution of predictive information, etc.); and 2) uncertainty associated with predicting impact to structures, components, equipment and systems. The losses are also based on asset value data provided to GZA by the Town, which is considered highly approximate. Regardless, it is still a valuable tool for assessing the consequences of flood impacts, identifying flood mitigation strategies and measures, prioritizing implementation of these measures, and long term planning (including comparing alternative strategies). GZA has attempted, based on the available data, to verify/calibrate our estimated losses based on actual event-specific loss data provided by the Town.

Attachment 8 summarized the system response and estimated losses.

Flood Vulnerability Findings

In brief, the system vulnerabilities include the following categories:

1. Flow management issues and equipment damage, due to significant coastal flood-related leakage (I/I) into the system;

2. Direct damage to SSCs;
3. Loss of service (operational disruption) due to direct damage;
4. Loss of service (operational disruption) due to excessive flows (exceeding system capacity, causing internal flooding and/or flow voluntarily disrupted to avoid damage); and
5. Potential for uncontrolled release of untreated effluent.

Each of these vulnerabilities are differentiated by location (e.g., not all pump stations are equally vulnerable) and by probability.

Infiltration and Inflow

In 2016 CDM Smith conducted a flow monitoring program and Infiltration/Inflow (I/I) study and prepared a memorandum summarizing the study results (dated August 10, 2016; revised October 2, 2017).

Infiltration includes flow that enters the system through stormwater pipes (faulty joints, structural defects, service connections), manholes and other structures. Base Infiltration is groundwater which enters the sewer system and is observed at an increased rate during winter and early spring when the groundwater is highest due to ground thaw, snow melt and rainfall. Tidal Infiltration is a secondary source of infiltration from the ocean that is observed at an increased rate during high tide. Where present, tidal infiltration can occur year round.

Inflow in a sewer system is the total flow from direct and indirect sources as defined below. Inflow is present throughout the year. Direct inflow enters the sewer system through direct connections to the collection system such as catch basins and roof leaders. The primary source of inflow is storm water, including rainfall runoff, and, if it is a significant source, can be observed during rainfall events year round. Indirect, or delayed inflow enters the sewer system through connections to sources such as building sump pumps and foundation drains. Its primary source is the wet weather (rainfall) influence on groundwater and may be prevalent for extended periods during the late winter and early spring and for shorter periods following rainfall events year round.

The purpose of the study was to estimate the amount of infiltration caused by base infiltration from ground water and tidal action and rain derived infiltraton and inflow. The study divided Scituate's sewer system into 12 drainage sub-areas to locate which areas are most susceptible to I/I. The program was conducted by Flow Assessment Service INC and supervised by CDM Smith from February 23 to April 19, 2016, a time of year when groundwater elevations were considered the highest.

Details of the study are presented in **Attachment 6**. The dry condition analysis found that tidal action had a significant impact on base infiltration. The net base infiltration for the entire system during high and low tide was 1.03 mgd and 0.88 mgd respectively. The study calculated average infiltration for each sub-area and found 5 out of 12 sub-areas (5-1, 4-2, 6-1, 4-1, and 2-1) exceeded the 4,000 gallons per day per inch diameter mile of sewer established by MassDEP infiltration guidelines. Pumping stations (PS) located within or down stream of these identified sub areas are Chain Pond PS, Sand Hills PS, and Hatherley School PS.

Infiltration to the system under wet weather conditions was determined by measuring the increase in metered flow during and following rainfall events when compared to a baseline of dry weather flow just prior to rainfall. During the analysis period, the largest storm occurred on March 14-15 (1.4 in of rainfall) and was used by the study as its wet weather analysis period. During that storm and the following days, the estimated increased inflow over dry weather conditions was 2.08 MG, of which 0.37 MG occurred during the storm due to direct flow and 1.71 MG occurred post storm by indirect means likely due to the elevated groundwater levels. For reference, a rainfall event with a recurrence interval of 1-year for a 24hr storm is 2.81 inches for the Scituate area. Assuming the 1.4 inches of rainfall that was measured on March 14-15 occurred in a 24 hour period, this storm would be considered an average rainfall event for Scituate.

The study estimated net inflow during this storm for each sub-area and recommended further investigation in 7 sub areas based on MassDEP guidelines. Sub-area 4-2, located near the Sand Hills PS experienced the highest inflow severity at 24,516 gallons per inch diameter mile of sewer more than twice as high as the as the second highest sub-area, 6-1 with 10,364 gallons per inch diameter mile of sewer.

The study provides clear evidence of significant infiltration/Inflow and identified sub-areas 4-1, 4-2, 5-1 and 6-1 as high priority areas for having exceeded MassDEP guidelines for both infiltration and inflow thresholds. The report also notes sub-areas 4-2 and 6-1 had recently received sewer repairs; however, both areas still exhibit significant infiltration. It is believed most sewer mains in Sub-area 4-2 are below low tide elevation and is located upstream of Sand Hills PS.

The study, however, did not capture the effects of coastal flooding which include flood inundation (resulting in increased inflow) and increased tidal infiltration associated with storm surge. Both of these conditions are expected to significantly increase I/I flow volume into the system. Eight drainage subareas are located within the effective FEMA Base Flood floodplain.

The implications of the inflow and infiltration are as follows:

1. CDM Smith study concluded:
   - System I/I concentrated in certain drainage sub-areas
   - I/I consists mostly of groundwater/tidal infiltration and indirect inflow (sumps, foundation drains)
   - High priority mitigation areas include: 4-1,**4-2**, 5-1 and **6-1 (Bold** indicates previously repaired)
   - A significant portion of the overall treated flow volume consists of stormwater and groundwater
2. I/I contributes to increased flows during storm events and can exceed pumping and collection system capacity
3. System-wide I/I can result in flows during storm events that exceed plant treatment capacity
4. Effects will increase during coastal flood events and over time due to sea level rise
5. I/I can result in: disruption of service; pump damage; system surcharge; internal (wastewater) flooding at pump stations and treatment plant; external (wastewater) flooding; unplanned environmental release; and financial loss

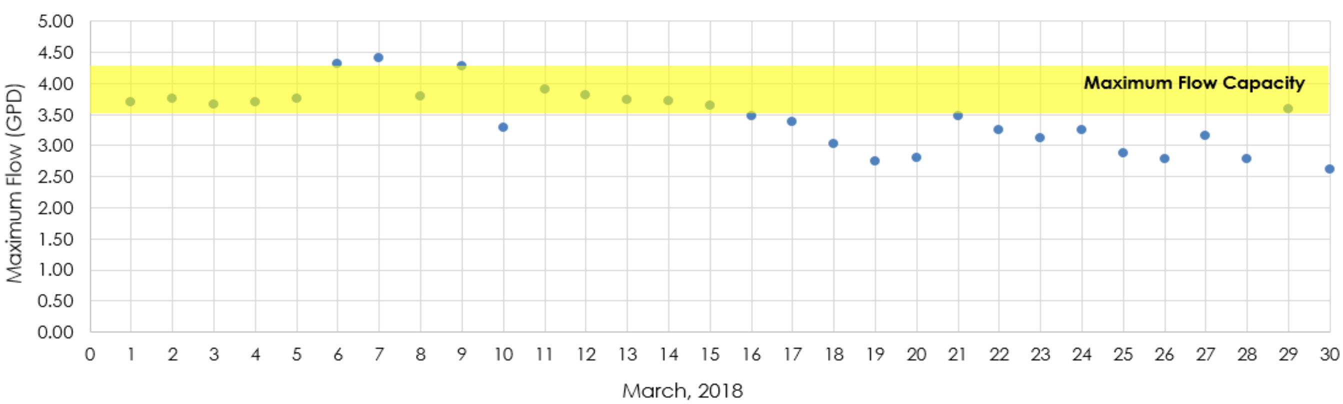
The effect of coastal flooding on I/I was in evidence during the March 2018 coastal flood (see **Attachment 4** for storm details). Four subareas were significantly affected due to I/I. Flood inundation in the area of the wet well at the Musquashcut pump station caused significant leakage via the wet well hatch cover. Excess wastewater flow within the Sand Hills pump station caused back-up and overflow within the pump well and also pump failure. Electrical "brown outs" caused failure of the treatment plant return pumps. Flow had to be manually reduced (throttled) at the treatment plant and at Sand Hills pump station.

Even though the Waste Water Pollution Control Plant (WWPCF) did not experience direct flooding impacts from the March 2018 nor'easter to facilities, an outfall hydraulically connected to the marsh surcharged through a standpipe into the overflow area. This resulted in additional stress on the WPCF capability to process excess seawater that drained back into the sewer processing system.

The damages resulted in the need for the Sewer division to increase resources and replace several sewer system operational components including but not limited to the following:

- replace critical operational components at the Sand Hills and Chain Pond pumping stations;
- increase in resources (e.g. gas for emergency generators, larger amounts of soda-ash, methanol, MetClear, and SoliSep, standby pumps, etc.) needed to support the function of the overall sewer system during the event;
- overtime of Sewer Division staff time to support the operations before, during and after the nor'easter event; and
- replacement of additional sewer system operational components damaged including various types of pumps, manhole covers and frames, motors, and other components.

Additional nor'easters hit Massachusetts a few days later during March 6 to 7, March 12 to 14, and March 20 to 22, 2018. Excessive flows at the treatment plant continued for several days after the storm. As shown below, the March, 2018 data indicates that repetitive coastal flood elevations on the order of 6 feet NAVD88 will result in I/I flows causing the treatment plant to operate at near maximum flow capacity.



In general, the results of this study indicate that the current collection and treatment system capacity system is reached during a coastal flood event with stillwater elevations on the order of 9 feet NAVD88 or greater, which currently corresponds to an approximately 50 year recurrence interval. This probability is unacceptably high for a critical Lifeline system. This risk is significantly due to excessive I/I. I/I also significantly limits the expansion capacity of the system, since so much of the treated flow consists of stormwater and groundwater.

Pump Station Vulnerability

In addition to the effects of I/I, certain pump station are also vulnerable to external flood damage and operational disruption, including flood inundation and flood-related structure loads. Seven pump station are located within the effective FEMA flood hazard zones (see **Table 1**). **Attachment 5** indicates the component vulnerability details at each of the pump stations. **Attachment 5 Table 5-8** summarizes the overall external flood hazard by station and water level.

Relative to flood water level and associated probability, pump station impacts initiate at the flowing flood levels:

<u>Flood Elevation 8 feet NAVD88:</u>

- Musquashcut Pump Station
- Sands Hill Pump Station

<u>Flood Elevation 10 feet NAVD88:</u>

- Edward Foster Pump Station
- Peggotty Beach Pump Station

<u>Flood Elevation 12 feet NAVD88:</u>

- Chain Pond Pump Station

<u>Flood Elevation 16 feet NAVD88:</u>

- Collier Road Pump Station

Treatment Plant Vulnerability

In addition to the effects of I/I on treatment capacity, certain treatment plant systems and components are also vulnerable to external flood damage and operational disruption, including flood inundation and flood-related structure loads. **Attachment 7** indicates the treatment plant component vulnerability details. **Attachment 7 Table 7-14** summarizes the overall external flood hazard by system and component.

Relative to flood water level and associated probability, pump station impacts initiate at the flowing flood levels:

<u>Flood Elevation 7 to 8 feet NAVD88:</u>

- Effluent discharge outlets are submerged
- Stormwater discharge outfalls are submerged

<u>Flood Elevation 10 feet NAVD88:</u>

- Design outfall elevation (for treatment system hydraulic head) is exceeded
- Lined lagoon dike crest is overtopped
- Lined lagoon overflow outlet is submerged
- Certain instrumentation impacted

<u>Flood Elevation 12 feet NAVD88:</u>

- Sludge Dewatering Building inundated
- Operations Building inundated

<u>Flood Elevation 13 feet NAVD88:</u>

- Generator Building inundated
- Filter Building inundated

Flood Elevation 14 feet NAVD88:

- Settling tanks overtopped

Flood Elevation 16 feet NAVD88:

- Complete plant inundation

Effectively, the plant is significantly impacted at flood elevations on the order of 12 feet NAVD88 and shut down with extensive damage at flood elevations on the order of 14 feet NAVD88. The effective FEMA Base Flood Elevation is 16 feet NAVD88.

Overall Collection and Treatment System Vulnerability

Attachment 8 describes the overall system connectivity and vulnerability. The cost impact (i.e., estimated financial loss) associated with external coastal flooding, for each of the pump stations and the treatment plant, was estimated based on: 1) system response curves representing percent damage relative to water depth; and 2) assumed asset values. As noted previously, the system response curves were developed utilizing generic federal government response curves (consistent with FEMA HAZUS software) for comparable wastewater systems. The assumed asset values were provided by the Town (see **Attachment 8**, **Tables 8-2** through **8-6**).

The estimated losses presented **Attachment 8**, **Tables 8-2** through **8-6** represent the costs associated with different probability flood events. GZA also estimated the current 2019 Average Annualized Loss (AAL). The AAL can be considered to represent the average annual cost, assuming that losses are amortized on an annual basis (i.e., expected average annual cost). The 2019 AAL was estimated for two flood assumptions: 1) GZA's estimate of the current flood levels based on multiple data sources; and 2) current flood levels as determined by FEMA. The AAL for future climate conditions was also determined based on GZA's estimate of the flood levels based on multiple data sources and NOAA 2017 Intermediate sea level rise projections. The estimated AALs are:

Current 2019 AAL:

- GZA flood analysis: $45,500/year
- FEMA flood analysis: $600,000/year

2040 AAL:

- GZA flood analysis: $160,000/year

2070 AAL:

- GZA flood analysis: $500,000/year

These cost estimates should be considered highly approximate (in particular, asset values have not been robustly developed and there is significant uncertainty relative to the future effects of climate change). Also, as indicated above, there is a significant range in AAL dependent upon the flood hazard characterization.

Regardless, the range of estimated AAL are indicative of the Town's potential financial cost exposure and are appropriate for planning purposes. Assuming a future service life of 20 years (approximately year 2040), the estimated service life losses are on the order of $2.1M to $12M. Assuming a future service life of 50 years (approximately year 2070), the estimated service life losses are on the order of $5.5M to $30M. (These estimates cap the future cost associated with FEMA flood characterization at $600,000 per year, which may be unconservative.)

The costs presented above are related to external flood effect and do not include costs associate with I/I, which can include: 1) disruption of service costs; 2) additional damage loss; 3) cost premium associated with system expansion. These costs also do not consider losses associated with unplanned and/or repetitive environmental wastewater releases (potentially including loss of operating permit).

FEMA flood characterization, and associated losses, should be assumed for benefit/cost analysis associated with evaluation of flood protection measures.

Section 7: Scituate Sewer Collection and Treatment System Coastal Flood Resilience Flood Protection Measures

A phased approach that includes near-term and long-term measures is recommended to improve the resilience of the wastewater collection and treatment system. An overview of the purpose, goals, priorities and representative measures included for the near-term and long-term strategies is presented below. **Attachment 9** includes further details outlining specific measures with approximate costs for planning purposes for each pump station and the wastewater treatment plant.

Flood Protection Objectives

Based on the results of the coastal flood vulnerability assessment, including Infiltration and Inflow (I/I) (see **Attachment 6**), the wastewater collection system and pump stations (see **Attachment 5)** and the wastewater treatment plant (see **Attachment 7**), the following objectives (in order of priority) have been identified:

I. Reduction to Elimination of Infiltration/Inflow:

- 4 high priority drainage areas; 4 lower priority drainage areas

II. Flood Protection of Pump Stations (in order of priority)

- Sand Hills
- Musquashicut
- Herring Brook
- Chain Pond
- Peggotty Beach
- Edward Foster
- Collier Road

III. Flood Protection of Treatment Plant:

- Plant SSCs
- Plant outfalls
- Stormwater outfalls
- Hydraulic Gradient

IV. Enhance Treatment Plant Overflow Capacity:

- Liner restoration
- Conversion to constructed wetlands/treatment

Flood Risk Mitigation Strategies

Available flood mitigation strategies include: 1) retreat (i.e., facility relocation); or 2) protect (by elevating structures or by the implementation of flood protection measures). Facility relocation (i.e., individual pump stations and/or the wastewater treatment plant) was considered but determined to not be cost effective. Elevation of certain pump stations was also considered, but was also determined to not be cost effective. Elevating structures is generally only cost effectiveness during a complete structure replacement (i.e., constructing a new pump station). Two of the vulnerable pump stations are relatively old; however, based on discussions with the Town it was determined that, due to past improvement investments for these pump stations, replacement of these two stations is not considered cost effective at this time.

Wastewater utilities typically build resilience by implementing permanent and deployable mitigation measures. A mitigation measure can be an emergency planning activity, equipment modification/upgrade or new capital investment/construction project.

Typical examples of mitigation measures include:

- Emergency response plans
- Barriers around key assets
- Elevated electrical equipment
- Emergency generators
- Bolted down chemical tanks

Implementing these mitigation measures requires financial investment by the utility; however, the implementation of flood mitigation measures prevents financial loss and enables the utility to provide more reliable service to customers during a disaster.

Permanent flood protection measures generally require higher capital investment, but do not require operational support and cost. Construction of permanent flood protection measures also requires typical construction design and permitting. Use of deployable flood protection measures generally require lower capital investment but require operational support and costs. Operational support includes the manpower required to temporarily deploy flood protection systems. This operational support can be provided either using utility staff or on a subcontract basis.

New construction to provide system expansion should inherently incorporate flood protection, including the effects of climate change.

Near-Term Measures

The purpose of near-term (2 to 5 years) flood protection measures is to improve the level of flood protection at locations that: 1) are most vulnerable to impacts from coastal flood hazards, in particular higher frequency flood events; 2) are less costly and will be more likely to be implemented in the near term in consideration of available funding; and 3) maintain the current system capability.

The primary goals for the near-term are:

- reduction/elimination of I/I of collection system in accordance with recommendations presented in the CDM Smith memorandum (**Attachment 6**);
- decrease the wastewater treatment plant system surcharge risk by providing temporary overflow storage in the lined lagoon;
- flood risk reduction at the vulnerable pumping stations using deployable, lower cost measures; and
- flood risk reduction at the wastewater treatment plant focused on:
    a. effluent outfall
    b. stormwater outfalls
    c. electrical manholes
    d. deployable perimeter barrier (at the treatment system)
    e. development and implementation of an Emergency Response and Flow Management Plan.

This study has identified near-term flood protection measures, including preliminary cost estimates, for planning purposes. Additional evaluation and design will be required to confirm the suitability of these measures, construction cost and design detail. Near-term flood protection measures, identified for planning purposes, include:

- Implement I/I measures for the 4 high priority drainage areas (4-1, 4-2, 5-1, 6-1) per the 2017 CDM Smith:
    a. See **Attachment 6** for details.
- Pump station flood protection measures (see **Attachment 9** for details).
    a. The measures vary by location and include:
        - Perimeter flood protection;
        - Dry floodproofing buildings, including: 1) flood doors; and 2) watertight penetration covers;
        - Watertight hatches at exterior wet wells;
        - Elevating critical equipment (i.e., generators, electric controls, etc.).
- Treatment Plant:
    a. Existing lined lagoon restoration:
        - Impermeable liner replacement;
        - Existing dike repair, crest elevation increase;

- Outfall and standpipe modifications.

b. Install 20-inch diameter effluent outfall backflow prevention.

c. Install stormwater outfall backflow prevention, including two (2) 15-inch diameter pipes and one (1) 6-inch diameter pipes.

d. Install deployable perimeter barrier (at plant)

e. Install watertight electric manholes at 10 locations

- Emergency Response Plan, including:
    a. Implementation of deployable flood protection measures
    b. Effluent flow volume management during flood events

Long-Term Measures

The purposes of long-term (6 to 10 years) measures are to: 1) eliminate I/I at lower priority drainage areas; 2) achieve compliance with TR-16 flood protection guidance at all facility locations; and 3) integrate flood resilience into all system expansion projects. The long-term measures are generally focused on more capital-intensive, permanent construction projects that are designed to support an extended system service life challenged by climate change, increased sea levels and increased flood risk. An additional, potential long-term goal is to utilize a constructed wetland system (including modification of the lined lagoon) for temporary, storm-related wastewater storage, including secondary treatment.

This study has identified long-term flood protection measures, including preliminary cost estimates, for planning purposes. Additional evaluation and design will be required to confirm the suitability of these measures, construction cost and design detail. Long-term flood protection measures, identified for planning purposes, include:

- I/I measures for the 4 low priority drainage area (1-1, 2-1, 5-2, 7-2) per the 2017 CDM Smith Study
    a. See **Attachment 6** for details.
- Permanent perimeter flood protection, including a combined sheetpile flood wall and levee system located along the perimeter of the lined lagoon and east and west perimeters of the treatment plant area.
- A new pump station to manage effluent flow (if warranted by additional study).
- Possible development of constructed wetland for storm wastewater overflow management and treatment (if warranted by additional study outlined as a Near Term measure - no cost estimate included for this study)
- Install permanent flood protection measures at all pump stations within coastal floodplain.

Estimated Costs

Table 2 provides a breakdown of the preliminary ("order-of-magnitude") costs associated with flood protection measures. These costs are approximate and are presented for planning purpose only.

Benefit/Cost

GZA has not performed benefit-cost analyses as part of this study. However, Benefit-Cost Ratios (BCRs) greater than 1 are expected for the proposed flood protection measures.

Section 8: Scituate Sewer Collection and Treatment System Coastal Flood Resilience Implementation

Implementation will require moving forward deliberately within political, budgetary and regulatory frameworks (i.e. implementation frameworks).

Political Implementation:

- Achieving community consensus for greater investment in wastewater treatment
- Water/Wastewater Planning Group (Comprehensive Water/Wastewater Planning Study)
- Coastal Resilience Planning Group (Comprehensive Municipal Resilience Plan - Project Specific)
- Town Governance/Administration

Cost Recovery/Revenue Opportunities:

- Grants
- Rate revenue (increase)
- Sewer Connection Fee
- General Budget (Capital Expenses; Operating Budget)
- Bonds
- Fines
- Interest (REB)
- System Expansion Funding
- Risk Transfer

Regulatory Implementation:

- Town of Scituate Sewer Rules and Regulations Amended August 2012: Article XI – Sewers in Flood Prone Areas: New or replacement sanitary sewers within flood-prone areas shall be designed, located,, elevated and constructed as to minimize or eliminate flood damage and to minimize or eliminate infiltration of flood water into systems and discharge from the systems into flood waters.
- Compliance with State Building Code Flood regulations (including ASCE 24)
- Compliance with TR-16 guidance
- Integrate study results into existing regulations, programs and plans such as the next Natural Hazard Mitigation Plan Update and future Comprehensive Plans

Additional study, engineering and design will also be required and is identified below.

Additional Study, Engineering and Design

Completion of the following plans and studies will assist the Town in the implementation of the near- and long-term measures:

a. Include the effect of coastal flooding in the I/I analysis (CDM Smith/Woodard-Curran). The revised 2017 CDM Smith *Flow Monitoring Program and I/I Analysis Memorandum* provided to the Town did not appear to include an analysis of the effect of coastal flooding on I/I, which will substantially increase the estimated I/I volume and rate. While it may not change the proposed construction recommendations, revised flow estimates will aid the development of an Emergency Response and Flow Management Plan.

b. Incorporate the projected flood mitigation costs into the water/sewer rate analysis. Tighe & Bond has performed a rate analysis through the fiscal year 2028. GZA has only been provided limited information about the analysis, but it appears that I/I improvements have been included but additional (non-I/I) resilience and flood mitigation costs have not. Of concern, the proforma analysis of the existing rate structure indicates a significant financial gap between cost and income. The flood risk and amplifying effect of climate change on this risk, coupled with an underfunding of the utility, presents a significant long term financial sustainability risk to the Town including the potential negative effect of a decrease in service capability.

c. Perform an evaluation of the existing emergency generator capacity at the treatment plant and at vulnerable pump stations. Emergency back-up power should be available to maintain normal operation of the treatment processes at all times. Furnish the backup power supply for critical equipment by using emergency power generation or an alternative power source of sufficient capacity. In addition, ensure that there is enough fuel to run under full load or peak flow for at least 48 hours, or under normal operating conditions for at least 96 hours, whichever requires the greater amount of fuel to supply power to critical equipment in the event of a power outage.

d. Prepare and implement an Emergency Response and Flow Management Plan.

e. Re-evaluate the plant hydraulic profile assuming a revised head at the effluent outfall reflective of the future 100-year recurrence interval flood elevation, inclusive of sea level rise.

f. Final Engineering & Design, Construction Documents and Permitting:

   i. I/I projects (on-going)

   ii. Near-term pump station flood mitigation, including detailed system/components assessment

   iii. Near-term treatment plant flood mitigation, including detailed system/components assessment

   iv. Liner/Lagoon and Dike Replacement/Repair

   v. Long term pump station replacement and flood mitigation

   vi. Long term treatment plant flood mitigation

   vii. Comprehensive Feasibility Study for Expansion of the Scituate Wastewater Collection and Treatment System, including evaluation of a Constructed Wetland alternative. It is recommended that this study be performed as part of a comprehensive Water/Wastewater planning process. It is also recommended that this study be performed prior to moving forward with the long-term measures presented herein.

Implementation Recommendations

The following presents proposed implementation steps for the 3 implementation frameworks outlined above. These steps will provide a roadmap to assist the Town in the implementation of proposed near- and long-term study recommendations.

Political Implementation:

Step 1: Present the results of this study to the Board of Selectmen and Planning Board to present the study results and recommendations, focused on communicating the existing and future physical and financial risk.

Step 2: Build community consensus among the sewer rate payers to support rate increases and the community at large for increased taxes to assist in the implementation of near- and long-term study measures. As recommended above, updating the cost and rate analysis by Tighe & Bond to reflect projected resilience costs and extend to a longer time frame would facilitate the process.

Step 3: Establish a Water/Wastewater Planning Group to 1) prioritize proposed study projects; 2) serve as the lead in building community consensus among existing sewer rate payers and the community to support funding near- and long-term study implementation through rate increases and incremental tax increases; and 3) prepare a Comprehensive Water Supply and Wastewater Planning Study that includes wastewater resiliency measures outlined in this study as well as system expansion.

Step 4: Participation by Water/Wastewater Planning Group in Town municipal climate adaptation and natural hazard risk management planning.

Step 5: Include members from Town Boards, Commissions and Departments on the both the Water/Wastewater Planning Group and Coastal Resilience Planning Group to assist in the integration of the results of this study and future studies/plans into the day-to-day administration of relevant existing Town programs and regulations.

Cost Recovery/Revenue Opportunities Implementation:

Cost recovery is a primary challenge to implementation of resilience measures. The Town of Scituate's Wastewater System is operated as Enterprise Funds, which means that the system essentially pays for itself by generating revenue that is equal to the expenses required to maintain and operate the existing wastewater system. The 2018 Tighe & Bond Water and Sewer Rate Study indicates that costs to operate and maintain the Town's Wastewater System currently exceed revenue and are are projected to increase in FY19 through FY22 (exclusive of the additional resilience costs presented here).

Therefore, implementation will be facilitated by developing a comprehensive financial plan that depends principally on user fees but also utilizes multiple potential funding sources. These can include some or all of the following:

Step 1: Apply for state and federal grants for 1) near term measures including studies, final design and permitting and construction projects and 2) long-term studies that meet the eligibility requirements as presented in **Tables 3 and 4**.

Step 2: Establish a Wastewater Resilience Fund Account to set-aside funding for implementation of measures outlined in this study. Future funding can be generated from setting a portion of funding (i.e. a set percentage) from a diversity of existing wastewater funding sources including: 1) future sewer rate increase; 2) increased sewer connection fees; 3) future General Budget expenditures; 4) fines; and 5) interest.

Step 3: Apply the results of an updated rate increase study as the basis for future incremental rate increases to assist in funding implementation of study measures.

Step 4: Incrementally increase the Sewer Connection Fee as the wastewater system expands to support implementation of study measures. Based on the increased fee apply a portion of the funds from the additional fee into wastewater resilience fund to assist in the implementation of measures outlined in this study.

Step 5: Include near-term measures as line items in the General Budget (Capital Expenses; Operating Budget) for: 1) lower cost measures including recommended plans and studies; 2) as matching funds to support state and federal wastewater resilience grant applications; and 3) annual wastewater improvement funds to assist in the implementation of measures up to $50,000.

Step 6: Evaluate the applicability of feasibility of emerging risk transfer products such as Resilience Bonds. This are not likely appropriate for the Town, but warrant further consideration.

Step 7: Set aside a portion of fines generated from non-compliance to assist in funding implementation of study measures.

S**tep 8**: Utilize system expansion bond funding to include long term flood mitigation improvements.

Regulatory Implementation:

Step 1: Integrate the study recommendations into 2020 Master Plan Update to assist in making actions more competitive for state and federal funding opportunities outlined in **Tables 3 and 4**.

Step 2: Prepare final engineering and design for the near- and long-term measures outlined in this study in compliance with

- Town of Scituate Sewer Rules and Regulations Amended August 2012: Article XI – Sewers in Flood Prone Areas: New or replacement sanitary sewers within flood-prone areas shall be designed, located,, elevated and constructed as to minimize or eliminate flood damage and to minimize or eliminate infiltration of flood water into systems and discharge from the systems into flood waters.
- State Building Code Flood regulations (including ASCE 24)
- TR-16 guidance

Step 3: Integrate the study recommendations into the next Natural Hazard Mitigation Plan Update (HMP Update). Incorporation of these study recommendations as actions into the next HMP Update will make the actions more competitive for FEMA Hazard Mitigation Assistance (HMA) grant funding.

Figures

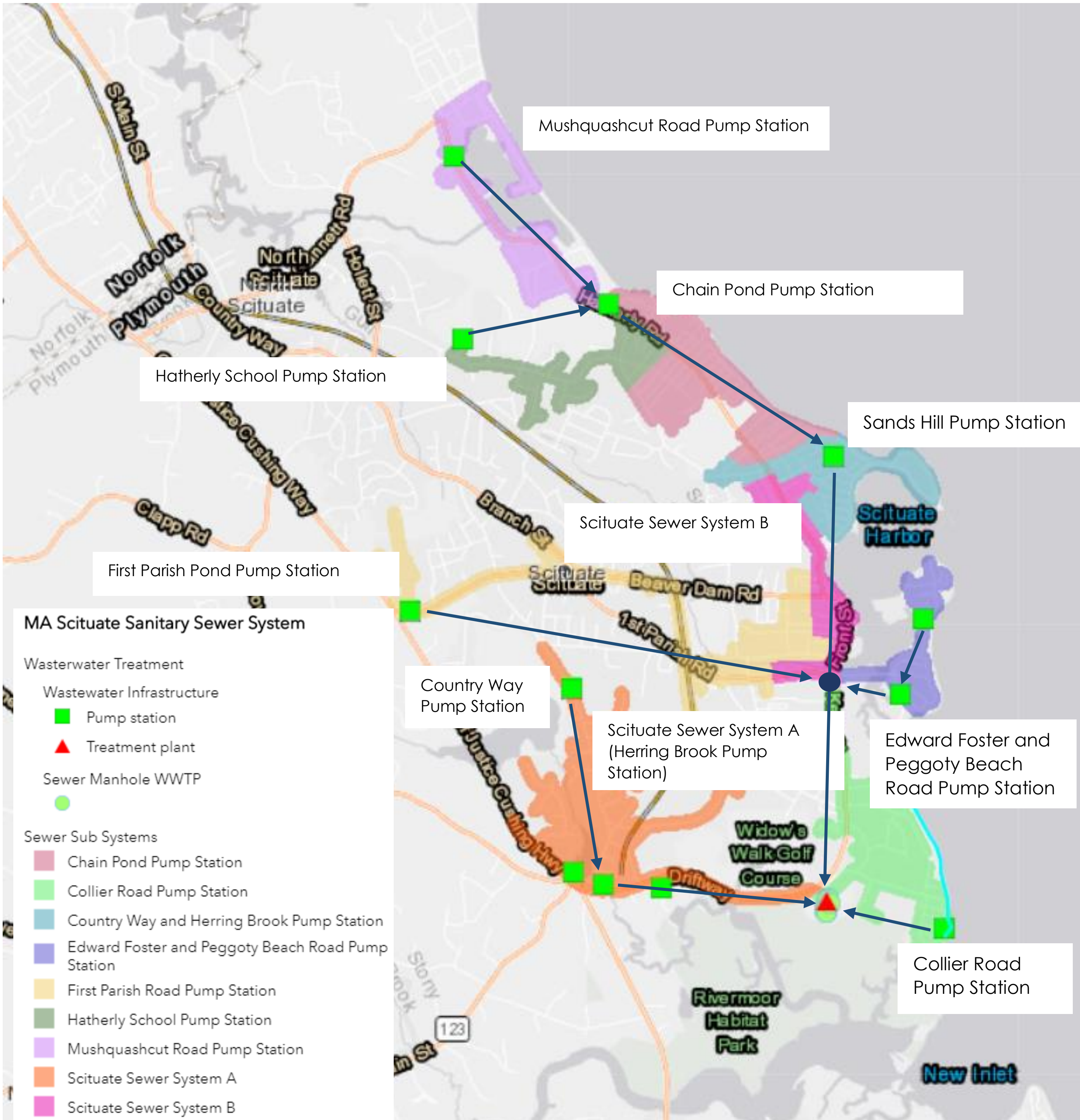


Figure 1: Town of Scituate Wastewater Collection and Treatment System

Tables

Location	Ground Surface Elevation (ft, NAVD88)	FEMA Flood Hazard Zone	FEMA Base Flood Elevation (ft; NAVD88)
Musquashicut Pump Station	7	AE	13
Chain Pond Pump Station	11 to 12	AE	14
Sands Hill Pump Station	5 to 7	AE	15
Edward Foster Pump Station	9 to 10	AE	16
Peggotty Beach Pump Station	9 to 10	VE	17
Herring Brook Pump Station	9 to 10	AE	16
Collier Road Pump Station	15.5 to 16	AE (outside but close to FEMA AE zone	16
Wastewater Treatment Plant	11 to 15	AE	16

Table 1: Summary of Flood Vulnerability based on Location and FEMA Flood Hazard Zones

	Near Term	Long Term
Time Horizon	2 to 5 years	6 to 10 years
Infiltration/Inflow Costs		
• **Investigations**	$140,000	$255,000
• **Construction Improvements Range**	$7,200,000 to $9,100,000	$9,500,000
Infiltration/Inflow Cost Subtotal	$7.4M to $9.3M	$9.8M to 14.7M
Additional (non I/I) costs:		
• **Additional Studies/Plans**	$200,000	
• **Final Engineering and Design and Permitting**	$130,000 to $250,000	$150,000 to $300,000
• **Pump Stations Measures**	$300,000 to $550,000	$1.26M to $1.5M
• **Treatment Plant Measures**	$1.7M to $1.9M	$2.4M to $3.2M (excluding constructed wetlands)
Additional non-I/I Cost subtotal	$2.4M to $2.9M	$3.8M to $5.0M
TOTAL	**$9.8M to $12.2M**	**$13.6M to $19.7M**

Table 2: Summary of Approximate Flood Mitigation Costs

FEMA Hazard Mitigation Assistance (HMA) and Disaster Recovery Grant Programs	Eligible Study Measures
Hazard Mitigation Grant Program (HMGP): FEMA's HMGP provides funding to municipalities, states, regional planning entities, and other eligible applicants to help communities implement hazard mitigation measures following a Presidential major disaster declaration. A major disaster declaration typically opens a host of disaster recovery and mitigation programs to assist states in recovering from and mitigating the future impacts from all-natural hazards. The funding for FEMA's HMGP is 15% of the total assessed damages for a given disaster for states that meet FEMA's standard Mitigation Plan requirements, which applies to the state of Massachusetts. The HMGP application period is open for one year from the disaster declaration date. https://www.fema.gov/hazard-mitigation-grant-program (accessed 05/28/19)	• Phased flood mitigation projects that includes Final Engineering & Design (i.e. Phase 1); Permitting and Construction (i.e. Phase 2) for Near and Long-Term Measures at the pumping stations and wastewater treatment plant. • Permitting and Construction funding for Near and Long- Term Flood Mitigation Project Measures with completed final engineering and design plans including: a) flood wall around the wastewater treatment plant that would include; b) deployable flood mitigation for pump stations and wastewater treatment plant.
Flood Mitigation Assistance (FMA): The purpose of the FMA program is to reduce or eliminate insurance claims under the National Flood Insurance Program (NFIP). FMA provides funding to States, Territories, federally-recognized tribes and local communities for projects that reduce or eliminate long-term risk of flood damage to structures insured under the NFIP. FMA funding is available for flood hazard mitigation projects, plan development and management costs. Funding for PDM and FMA is appropriated by Congress annually and awarded on a nationally competitive basis. https://www.fema.gov/flood-mitigation-assistance-grant-program (accessed 05/28/19)	• Permitting and Construction funding for Near and Long-Term Flood Mitigation Project Measures with completed final engineering and design plans including: a) flood wall around the wastewater treatment plant that would include • Advance assistance funding which is limited to $100k-200k /year per state is available for possibly funding Near-Term and Long-Term studies including: for possibly funding near-term studies including: a) Study on the effect of coastal flooding on I/I; b) Pump Station Replacement Benefit-Cost Analysis and Feasibility Study; c) Benefit-Cost Study of Constructed Wetland for Overflow Storage and Treatment; d) 100-year flood elevation/ overflow evaluation for Plant Hydraulic Gradient with new, elevated discharge.
Pre-Disaster Mitigation (PDM): The purpose of PDM is to reduce overall risk to communities and structures from future hazard events including coastal flooding, while also assisting communities in recovering more quickly from future natural disasters. PDM funds mitigation planning and project grants designed to reduce future losses in advance of potential disaster. Funding for PDM and FMA is appropriated by Congress annually and awarded on a nationally competitive basis. Many of the proposed hazard mitigation projects and actions are eligible activities for funding under PDM. https://www.fema.gov/pre-disaster-mitigation-grant-program (accessed 05/28/19)	• Flood mitigation projects such as a building a flood wall around the wastewater treatment plant that would include $ solely for Construction under the regular program • Advance assistance funding which is limited to $100k-200k/year per state is available for possibly funding near-term studies including a) Study on the effect of coastal flooding on I/I; b) Pump Station Replacement Benefit-Cost Analysis and Feasibility Study; c) Benefit-Cost Study of Constructed Wetland for Overflow Storage and Treatment; d) 100-year flood elevation/ overflow evaluation for Plant Hydraulic Gradient with new, elevated discharge.
Public Assistance (PA): The purpose of the Public Assistance (PA) Grant Program is to support communities' recovery from major disasters by providing them with grant assistance for debris removal, life-saving	• Funding to rebuild/mitigate sewer and stormwater infrastructure as well as roadways after a disaster event impacting any of the wastewater and/or stormwater sites included in the study.

emergency protective measures, and restoring public infrastructure. Local governments, states, tribes, territories and certain private nonprofit organizations are eligible to apply. Public Assistance is FEMA's largest grant program. Since 2017, FEMA gave over five billion dollars through PA grants to help communities clear debris and rebuild roads, schools, libraries, and other public facilities. https://www.fema.gov/public-assistance-local-state-tribal-and-non-profit (accessed on 05/28/2019)	
Environmental Protection Agency (EPA)	**Eligible Study Measures**
Clean Water State Revolving Fund (CWSRF) Loan Program for Wastewater Projects: The CWSRF program aids in constructing and upgrading publicly owned municipal wastewater treatment plants, implementing nonpoint pollution management programs, developing and implementing management plans under the National Estuary Program, and supporting other eligible activities. Projects or activities eligible for funding were, initially, those needed for constructing or upgrading (and planning and designing) publicly owned municipal wastewater treatment plants. As defined in Clean Water Act Section 212 devices and systems used in the storage, treatment, recycling, and reclamation of municipal sewage are eligible. These include construction or upgrading of secondary or advanced treatment plants; construction of new collector sewers, interceptor sewers, or storm sewers; and projects to correct existing problems of sewer system rehabilitation, infiltration/inflow of sewer lines, and combined sewer overflows. Operation and maintenance are not eligible activities. All funds in the clean water SRF resulting from federal capitalization grants are first to be used to assure compliance with enforceable deadlines, goals, and requirements of the act, including municipal compliance. Grant funds are provided to states to capitalize loan funds with an 80%/20% Federal/Nonfederal Cost Share. Average capitalization grant to state in FY2018 was $30.1 million. https://www.epa.gov/cwsrf (accessed on 06/04/2019)	• Funding for I/I investigations for the 4 high and 4 low priority areas. • Funding for Near and Long Term I/I Construction Improvement Measures for the 4 high and 4 low priority subareas. • Funding is potentially available for studies/plans outlined in Near and Long Term Measures including: a) Study on the effect of coastal flooding on I/I; b) Pump Station Replacement Benefit-Cost Analysis and Feasibility Study; c) Benefit-Cost Study of Constructed Wetland for Overflow Storage and Treatment; d) 100-year flood elevation/ overflow evaluation for Plant Hydraulic Gradient with new, elevated discharge. • Funding for Near and Long-Term Measures including: a) Upgrades of existing Pump Stations and b) upgrades to the wastewater treatment plant. • Funding for Long-Term Measures including: a) New pump station to manage hydraulic head including generator upgrade and b) Pump Station Replacement based on the results of the Benefit Cost Analysis Feasibility Study.
Water Infrastructure Finance and Innovation Act (WIFIA) Program: In contrast to SRF programs, EPA will provide the credit assistance directly to an eligible recipient. Most of the credit assistance will likely be secured loans, as the agency stated that it does not expect much demand for loan guarantees. To be eligible for WIFIA assistance, projects must generally have costs of $20 million or more. In general, WIFIA cannot exceed 49% of total project costs. Categories eligible for assistance by EPA include the following: 1) wastewater treatment and community drinking water facilities; 2) enhanced energy efficiency of a public water system or wastewater treatment works; 3) repair or rehabilitation of aging wastewater and drinking water systems; 4) desalination, water recycling, aquifer recharge, or development of alternative water supplies to reduce aquifer depletion; 5) prevention,	• Funding for Near and Long Term I/I Construction Improvement Measures for the 4 high and 4 low priority subareas. • Funding for Long-Term Measures including: a) New pump station to manage hydraulic head including generator upgrade and b) Pump Station Replacement based on the results of the Benefit Cost Analysis Feasibility Study. • A combined project including a combination of Near- and Long-Term Measures including all I/I construction and pump replacements.

reduction, or mitigation of the effects of drought; or 6) a combination of eligible projects. For FY2019, the Consolidated Appropriations Act, 2019 (P.L. 116-6) provided $68 million for the WIFIA program (including $5 million for administrative costs). To receive funding, a prospective borrower submits a letter of interest to EPA. The letter includes project eligibility, financial creditworthiness, engineering feasibility, and alignment with EPA's policy priorities. From these submittals, the agency selects projects for funding. On March 29, 2019, EPA announced a third round of WIFIA funding. EPA estimated that its budget authority ($63 million) would provide approximately $6 billion in credit assistance. **https://www.epa.gov/wifia** (accessed on 06/04/2019)	

Table 3: Summary of Federal Grant and Loan Programs

STATE GRANT PROGRAMS	
Executive Office of Energy and Environmental Affairs	**Eligible Study Measures**
Municipal Vulnerability Preparedness Grant Program: The Municipal Vulnerability Preparedness grant program (MVP) provides support for cities and towns in Massachusetts to begin the process of planning for climate change resiliency and implementing priority projects. The state awards communities with funding to complete vulnerability assessments and develop action-oriented resiliency plans. Communities who complete the MVP program become certified as an MVP community and are eligible for MVP Action grant funding and other opportunities. https://www.mass.gov/municipal-vulnerability-preparedness-mvp-program (accessed on 05/28/2019)	• Funding is potentially available for studies/plans outlined in Near and Long Term Measures including: a) Study on the effect of coastal flooding on I/I; b) Pump Station Replacement Benefit-Cost Analysis and Feasibility Study; c) Benefit-Cost Study of Constructed Wetland for Overflow Storage and Treatment; d) 100-year flood elevation/ overflow evaluation for Plant Hydraulic Gradient with new, elevated discharge. • Final Engineering & Design and Permitting for Near-Term and Long-Term Pump Station and Wastewater Treatment construction projects that do not exceed funding limits. • Construction funding for Near-Term and Long-Term pump station and wastewater treatment construction projects that do not exceed funding limits.
Coastal Resilience Grant Program: To help address these issues, CZM administers the Coastal Resilience Grant Program to provide financial and technical support for local efforts to increase awareness and understanding of climate impacts, identify and map vulnerabilities, conduct adaptation planning, redesign vulnerable public facilities and infrastructure, and implement non-structural (or green infrastructure) approaches that enhance natural resources and provide storm damage protection. Managed through CZM's StormSmart Coasts program, grants are available for a range of coastal resilience approaches—from planning, public outreach, feasibility assessment, and analysis of shoreline vulnerability to design, permitting, construction, and monitoring. https://www.mass.gov/service-details/coastal-resilience-grant-program (accessed on 05/28/2019)	• Studies outlined in Near and Long Term Measures including: a) Study on the effect of coastal flooding on I/I; b) Pump Station Replacement Benefit-Cost Analysis and Feasibility Study; c) Benefit-Cost Study of Constructed Wetland for Overflow Storage and Treatment; d) 100-year flood elevation/ overflow evaluation for Plant Hydraulic Gradient with new, elevated discharge. • Final Engineering & Design and Permitting for Near-Term and Long-Term Pump Station and Wastewater Treatment construction projects that do not exceed funding limits. • Construction funding for Near-Term and Long-Term pump station and wastewater treatment construction projects that do not exceed funding limits.
Dams and Seawall Repair or Removal Program Grants and Funds: The Dam and Seawall Repair or Removal Program offers financial resources to qualified applicants for projects that share our mission to enhance, preserve, and protect the natural resources and the scenic, historic and aesthetic qualities of the Commonwealth of Massachusetts. The program offers grant funding and loans to municipalities and non-profit organizations. Certain private owners of dams may apply for loan financing. https://www.mass.gov/service-details/dam-and-seawall-repair-or-removal-program-grants-and-funds (accessed on 05/28/2019)	• Engineering and design and permitting for Long-Term Wastewater Treatment Measures including: a) permanent sea wall around wastewater treatment plant. • Construction funding for Long-Term Wastewater Treatment Measures including: a) permanent sea wall around wastewater treatment plant.
Massachusetts Department of Environmental Protection	**Eligible Study Measures**
Water Utility Resilience Program: This program supports local drinking water and wastewater utilities in their efforts to build up resilience to severe weather events. Assistance provided through this program includes: identifying helpful and practical resiliency resources, finding opportunities for local and regional partnerships, offering infrastructure mapping and adaptation planning assistance, and coordinating training opportunities. WURP works closely with the MassDEP Emergency Preparedness Officer to ensure climate	• Funding is potentially available for studies/plans outlined in Near and Long Term Measures including: a) Study on the effect of coastal flooding on I/I; b) Pump Station Replacement Benefit-Cost Analysis and Feasibility Study; c) Benefit-Cost Study of Constructed Wetland for Overflow Storage and Treatment; d) 100-year flood elevation/ overflow evaluation for Plant Hydraulic Gradient with new, elevated discharge.

change resilience is part of an all hazards approach to technical assistance for DW and WW utilities. https://www.mass.gov/guides/water-utility-resilience-program	
State Revolving Fund (SRF) Loan Program: The State Revolving Fund (SRF) offers affordable loan options to cities and towns to improve water supply infrastructure and drinking water safety; and to help them to comply with federal and state water quality requirements that deal with wastewater treatment plants and collection systems, while addressing issues such as watershed management priorities, stormwater management, and green infrastructure. Additionally, the SRF supplies financial assistance to address communities with septic system problems. https://www.mass.gov/state-revolving-fund-srf-loan-program (accessed on 06/04/2019) • Under the SRF Clean Water Program funding is available for the planning and construction projects including: CSO mitigation • New wastewater treatment facilities and upgrades of existing facilities • Infiltration/inflow correction • Wastewater collection systems • Nonpoint source pollution abatement projects, such as: o Landfill capping o Community programs for upgrading septic systems (Title 5) o Brownfield remediation o Pollution prevention o Stormwater remediation https://www.mass.gov/service-details/srf-clean-water-program (accessed on 06/04/2019)	• Funding for I/I investigations for the 4 high and 4 low priority areas. • Funding for Near and Long Term I/I Construction Improvement Measures for the 4 high and 4 low priority subareas. • Funding is potentially available for studies/plans outlined in Near and Long Term Measures including: a) Study on the effect of coastal flooding on I/I; b) Pump Station Replacement Benefit-Cost Analysis and Feasibility Study; c) Benefit-Cost Study of Constructed Wetland for Overflow Storage and Treatment; d) 100-year flood elevation/ overflow evaluation for Plant Hydraulic Gradient with new, elevated discharge. • Funding for Near and Long-Term Measures including: a) Upgrades of existing Pump Stations and b) upgrades to the wastewater treatment plant. • Funding for Long-Term Measures including: a) New pump station to manage hydraulic head including generator upgrade and b) Pump Station Replacement based on the results of the Benefit Cost Analysis Feasibility Study.

Table 4: Summary of State Grant and Loan Programs

Attachment 1
Limitations

Use of Report

1. GeoEnvironmental, Inc. (GZA) prepared this Report on behalf of, and for the exclusive use of the Town of Scituate (Client) for the stated purpose(s) and location(s) identified in the Report. Use of this Report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

Standard of Care

2. Our findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Report and/or proposal, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this Report may be found at the subject location(s).

3. The interpretations and conclusions presented in the Report were based solely upon the services described therein, and not on scientific tasks or procedures beyond the scope of the described services. The work described in this Report was carried out in accordance with the agreed upon Terms and Conditions of Engagement.

4. GZA's flood evaluation was performed in accordance with generally accepted practices of qualified professionals performing the same type of services at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made. The findings of the risk characterization are dependent on numerous assumptions and uncertainties inherent in the risk assessment process. The findings of the flood evaluation are not an absolute characterization of actual risks, but rather serve to highlight potential sources of risk at the site(s).

5. The Report included analysis of information from Federal Agencies, including NOAA Precipitation and Tide Gage Data, current FEMA reports, and the US Army Corps of Engineers (USACE) North Atlantic Coast Comprehensive Study (NAACS) developed using the data and methodologies available when the Report was completed. The development of flood elevations by FEMA relied on readably available historical flow data. GZA did not perform an independent hydraulic analysis to confirm the hydraulic analysis results presented in the FEMA's FIS report. More recent data or future floods or precipitation events that impact the project area may result in changes to the flood-frequency curves and precipitation estimates, respectively.

6. Unless specifically stated otherwise, the flood evaluations performed by GZA and associated results and conclusions are based upon evaluation of historic data, trends, references, and guidance with respect to the current climate and sea level conditions. Future climate change may result in alterations to inputs which influence flooding at the site (*e.g*. rainfall totals, storm intensities, mean sea level, *etc*.). Such changes may have implications on the estimated flood elevations, wave heights, flood frequencies and/or other parameters contained in this Report.

Reliance on Information from Others

7. In conducting our work, GZA has relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Any inconsistencies in this information which we have noted are discussed in the Report.

Standard of Care & Compliance with Codes and Regulations

8. We used reasonable care in identifying and interpreting applicable codes and regulations necessary to execute our scope of work. We used industry guidelines and regulatory requirements, which are focused on the 100-year and 500-year recurrence interval floods. Industry guidance is presented in the "Guides for the Design of Wastewater Treatment Works", prepared by the New England Interstate Water Pollution Control Commission, Revised 2011 Edition (TR-16). Regulatory requirements are presented in the federal flood regulations and State building codes (incorporating by reference ASCE 24-14 "Flood Resistant Design and Construction". These codes and regulations are subject to various, and possibly contradictory, interpretations. Interpretations with codes and regulations by other parties are beyond our control.

General

9. Observations were made of the wastewater infrastructure sites and of structures on each site as indicated within the Report. Where access to portions of the site, or to structures on the site was unavailable or limited, GZA renders no opinion as to the condition of that portion of the site or structure.

10. In reviewing this Report, it should be realized that the reported condition of wastewater and stormwater infrastructure is based on observations of field conditions during the course of this study along with data made available to GZA. It is important to note that the condition of the wastewater and stormwater systems depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the wastewater and stormwater systems will continue to represent the condition of the both systems at some point in the future. Only through continued inspection and care can there be any chance that unsafe conditions be detected.

11. The report presents planning-level, "order-of-magnitude" costs. The estimated approximate costs included in this report should be considered approximate and are not to be used for final design or construction estimating purposes. Also, additional engineering and analysis will need to be conducted beyond what is presented in this feasibility study for each recommended measure relative to the specific site conditions at each site for final design and construction purposes. Note that this may result in an increase or decrease in the costs for implementation of the measures presented in this study depending on the results of the final engineering and design.

Additional Information

12. In the event that the Client or others authorized to use this Report obtain information on conditions at the site(s) not contained in this Report, such information shall be brought to GZA's attention forthwith. GZA will evaluate such information and, on the basis of this evaluation, may modify the opinions stated in this Report.

13. Additional analyses are required to refine the flood-frequency curves at the project site(s) and to include wave effects and to define flood hydrographs and flow velocities.

Additional Services

14. GZA recommends that we be retained to provide services during any future investigations, design, implementation activities, construction, and/or property development/ redevelopment at the Site. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

Attachment 2
Treatment System Overview (Collection System and Pump Stations)

Collection System Details

The Scituate Sewer Collection System consists of 9 collection sub-areas, serviced by 10 pump stations. The sub-areas are generally limited to about 20,000 linear feet of sewer pipe or less. In brief, individual buildings discharge to gravity or pressure sewer collection piping, which ultimately discharge to the Scituate Wastewater Treatment Plant (WWTP). The network of sewer pipe is partially pressurized to enhance flow by the pump stations. In total, there is approximately 40 miles of sewer pipes, about 83% of the system's pipes by length are gravity fed collector pipes while 17% percent are pressurized force mains.

The system mostly serves residences in close proximity to the coast with a few collection areas reaching inland communities. Wastewater generally flows in a north south direction until it reaches The Scituate Waste Water Treatment Plant (WWTP) at the southern end of town.

The WWTP became operational during November, 1967 with an average daily flow of 1.0 million gallons per day (mgd) treatment capacity. The WWTP was designed as a secondary treatment plant utilizing the extended aeration mode of the activated sludge (microorganisms) process. The WWTP was upgraded during 1984 to add septic receiving station, aerobic sludge digesters and a sludge dewatering building. These additions allowed further treatment of the sludge (settled solids). The sludge was dewatered by a belt filter press and disposed at the Town's sanitary landfill. A second upgrade was completed during 2000, increasing the design of the WWTP from 1.0 mgd to 1.6 mgd along with a secondary treatment upgrade to an advanced treatment capable of nitrogen removal (nitrification/denitrification). The use of ultraviolet light (UV) has replaced chlorination (residual chlorine can be toxic to aquatic life) as the means of disinfecting the final effluent. Since the closure of the landfill, the sludge generated (over 1,100 wet tons/year) by the belt filter presses in the dewatering building has been hauled off site by a contractor for beneficial reuse.

Expansion of the Sewer Collection System included:

- Expansion of collector system into the Greenbush/Reservoir area during November 2005 (Phase I – planned but not constructed)
- Expansion of collector system into Third Cliff area in October 2006 (Phase II)
- Expansion of the collector system into the First and Second Cliff areas in the summer of 2007 (Phase III).

Future expansion Phases IV, V and VI are proposed for areas of Front Street, North Scituate and Minot.

Pump Stations

The general location of these pump stations and a simplified flow path is shown **Figure 2-1**. Each pump station collects flow from part or all of the collection sewer pipes for the associated collection area. As indicated on **Figure 2-1**, the pump stations function in parallel or series, meaning that the functionality of certain pumps stations (in series) are dependent on the vulnerability and performance of the downstream pump station.

The most upstream collection area (from the WWTP) is served by the Musquashicut Avenue Pump Station, which is located along the northern coast of Scituate (within District 1A) (see **Figure 2-2).** Wastewater collected from each building discharges to gravity flow sewer pipe except for the buildings located along Surfside Avenue (south of Mitchell Avenue), which have individual residence pumps and discharge to 3-inch diameter pressurized PVC pipe. This small diameter pressurized pipe discharges to the sewer manhole located at the intersection of Mitchell Avenue and Surfside Road. Wastewater from buildings located within the Musquashicut Pond collection area north of Musquashicut Brook discharge via gravity flow sewer pipe to the Musquashicut Avenue Pump Station. Wastewater from buildings located within the Musquashicut Pond collection area south of Musquashicut Brook and north of Boardman Avenue discharge to 2-inch diameter pressurized PVC sewer pipes, which in turn discharge to sewer manholes at the intersections of Mary's Lane and Boardman Avenue and Hatherly Road and Boardman Avenue. The wastewater from the pressurized 6-inch DIP Musquashicut Avenue Pump Station Wastewater sewer main also discharges to the manhole located at the intersection of Hatherly Road and Boardman Avenue. Wastewater from buildings located within the Musquashicut Pond collection area south of Boardman Avenue flows, along with the combined pump station and building flow, discharges to the Chain Pond Pump Station. In summary, wastewater from the Musquashicut Pond collection area, along with flow from the Hatherley School Pump Station collection area, discharges to the Chain Pond Pump Station.

The Hatherley School Pump Station collection area (see **Figure 2-3**) consists of both gravity flow and pressurized sewer pipe. The pressurized pipes discharge to sewer manholes (west of the intersection of Amy's Way and Tilden Road) and gravity flow pipe, before discharging to the Chain Pond Pump Station.

Wastewater from buildings within the Chain Pond Pump Station collection area (see **Figure 2-4**) north of Carver Avenue discharge to gravity flow sewer pipe which in turn discharges to the Chain Pond Pump Station. The wastewater from the pump station flows via a 14-inch pressurized DIP sewer main and discharges to the sewer manhole located in Egypt Avenue midway between Carver Avenue and Standish Avenue. The remaining buildings within the Chain Pond Pump Station collection area

The combined wastewater from the Musquashicut, Hatherly School and Chain Pond Pump Stations flows southeast to the (Sand Hills) Pump Station, where effluent is pumped to a higher gradient before flowing via gravity along a main central pipe until it reaches the WWTP.

This route serves as the main "artery" for the sewer system with 4 separate collection areas branching off this main line. First Parish Road collection area and Sewer System A reach out to the west to serve inland residences. The Collier Road collection area and Edward Foster and Peggotty Beach collection system branch out to the east towards coastal residences. Because these 4 collection areas are connected in a parallel formation rather than in series, they are independent from conditions upstream in the system. For example, if only the Sand Hills Pump Station goes out of service, residences within collection areas downstream of the Sand Hills Pump Station will likely be unaffected since they are only reliant on gravity and or the pressure generated from their own respective pump stations. Any residences located upstream of the Sand Hills Pump Station however, could experience backups in this scenario.

The Sandhills, First Parish Road and Chain Pond Pump Stations have been in operation since the late 60s to early 70s. In the late 2000s 7 additional pump stations were added to the sewer system expanding service to a larger population. These recently built pump stations include Collier Road, Edward Foster Road, Peggotty Beach Road, Country Way, Musquashicut Avenue, Hatherley School and Herring Brook Pump Stations. These stations were designed by Weston and Sampson and share a similar design and layout.

Table 2-1 provides a statistical summary of each collection area. The collection subs-area are comprised of both pressurized and gravity fed systems. A summary of pump station capacity is provided in **Table 2-2**. Existing pipes were constructed using a wide variety of materials, most were constructed out of either clay, ductile iron, polyvinyl chloride, or reinforced concrete. A list of known pipes and their size and material organized by collection sub-area is provided in the section titled **Sewer Collection Pipe Inventory.**

Table 2-1: Collection Area Statistics

Collection Area	No. Parcels	No. Buildings	Stub (l.f.)	Collector Pipe (l.f.)	Force Main (l.f.)	Total Pipe (l.f.)	No. of Manholes
Chain Pond Road	737	657	0	26,163	0	26,163	161
First Parish Road Pump Station	355	371	164	25,166	3,435	28,765	129
Edward Foster and Peggotty Beach Road Pump Station	170	159	0	10,016	3,913	13,929	68
Scituate Sewer System A	361	399	27	33,898	12,612	46,537	201
Collier Road Pump Station	337	356	47	21,639	1,064	22,703	151
Scituate Sewer System B	312	274	11	16,328	192	16,520	83
Country Way and Herring Brook Pump Station	549	495	0	20,476	0	20,476	116
Musquashicut Avenue Pump Station	348	334	53	14,538	11,204	25,742	99
Hatherly School Pump Station	250	258	0	7,200	4,466	11,666	63

In general, at each pump station wastewater is first discharged into a wet well. At the bottom of the wet well sits one or more submersible pumps that pump effluent to a higher elevation and through a valve vault containing a shutoff valve. Wastewater then passes a flow meter before leaving the pump station pressurized through a force main. Both the wet well and valve vault are below ground elevation and are accessed via locked hatch covers. Above the ground surface sits a generator shed or building which houses a gas-powered backup generator that powers the pumps in the event the pump station loses power. Note the design of each pump station varies depending on the time at which it was built. In general, the interior of the pump stations includes control panels and other electrical components, exhaust fans, gas powered heaters and plumbing fixtures. Also, the free floor elevation of each pump station with respect to ground elevation varies presumably depending on flood risk. Detailed construction drawings of each pump station, a photo log and elevations of crucial components and possible water entry points are provided below.

Table 2-2: Pump Station Capacity

Pump Station	Dry Ave. Flow (GPD)	Wet Ave. Flow (GPD)	Design Flow (GPM)
Chain Pond	200,000	250,000	1,200
First Parish	5,000	7,500	550
Edward Foster	5,000	25,000	260
Peggotty Beach	10,000	25,000	280
Collier Road	50,000	150,000	260
Country Way	6,500	15,000	260
Herring Brook	35,000	70,000	1,000
Musquashicut	10,000	13,000	600
Sand Hills	600,000	1,000,000	1600
Hatherly School	unknown	unknown	unknown

Figure 2-1: Scituate Wastewater Collection System

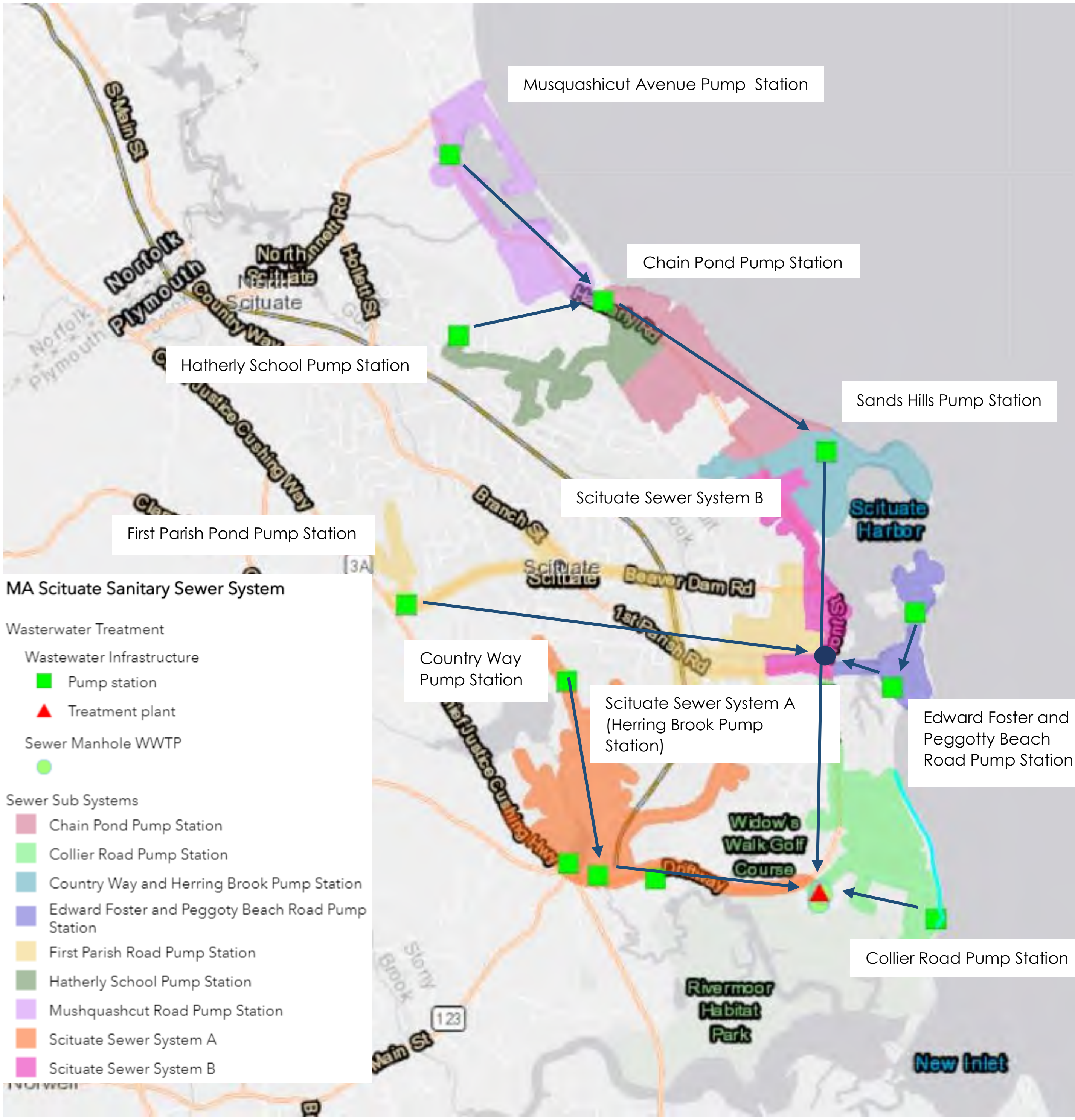


Figure 2-2: Musquashcut Road Pump Station Sewer System

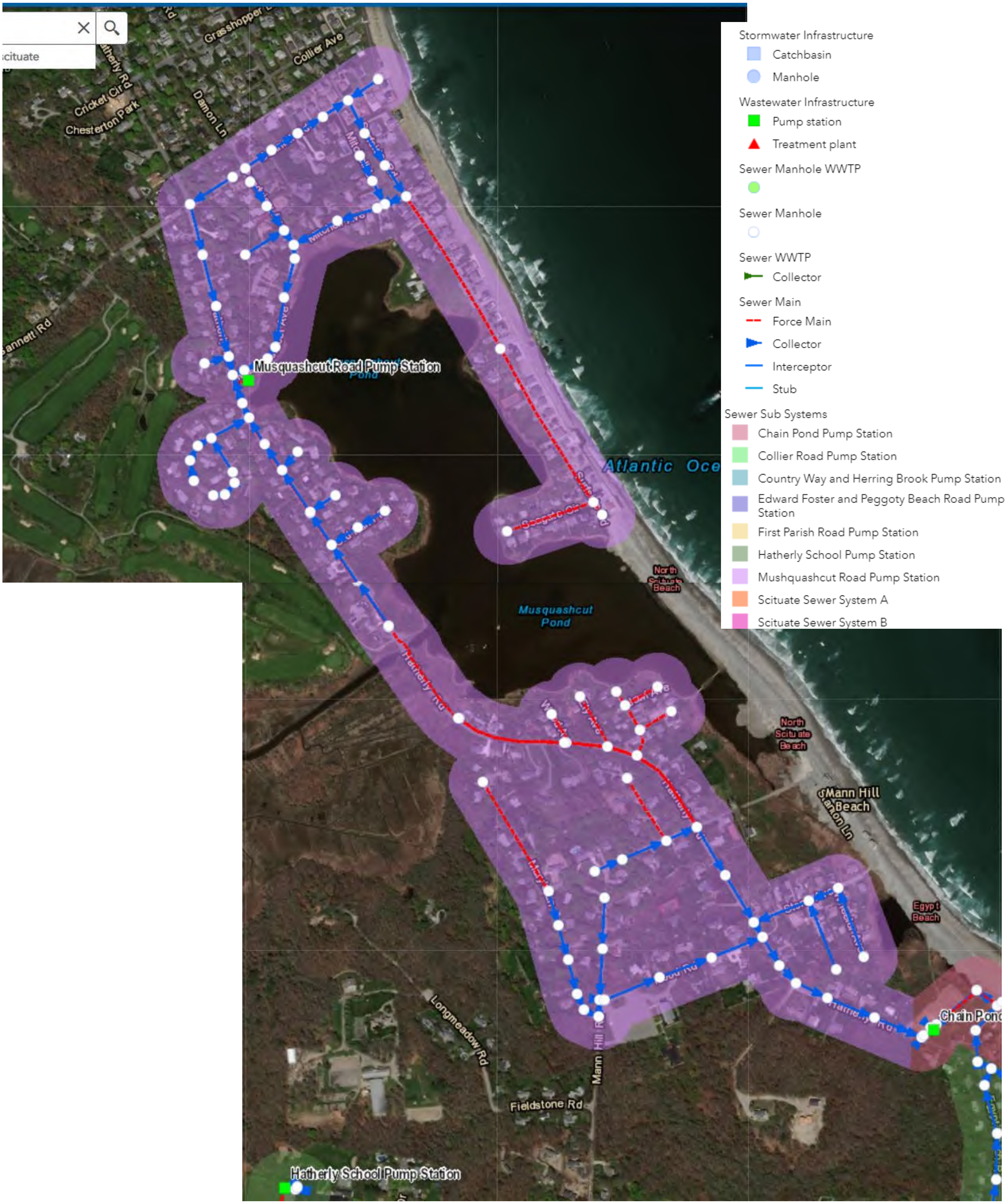


Figure 2-3: Chain Pond Pump Station Sewer System

Figure 2-4: Sand Hills Pump Station Sewer System

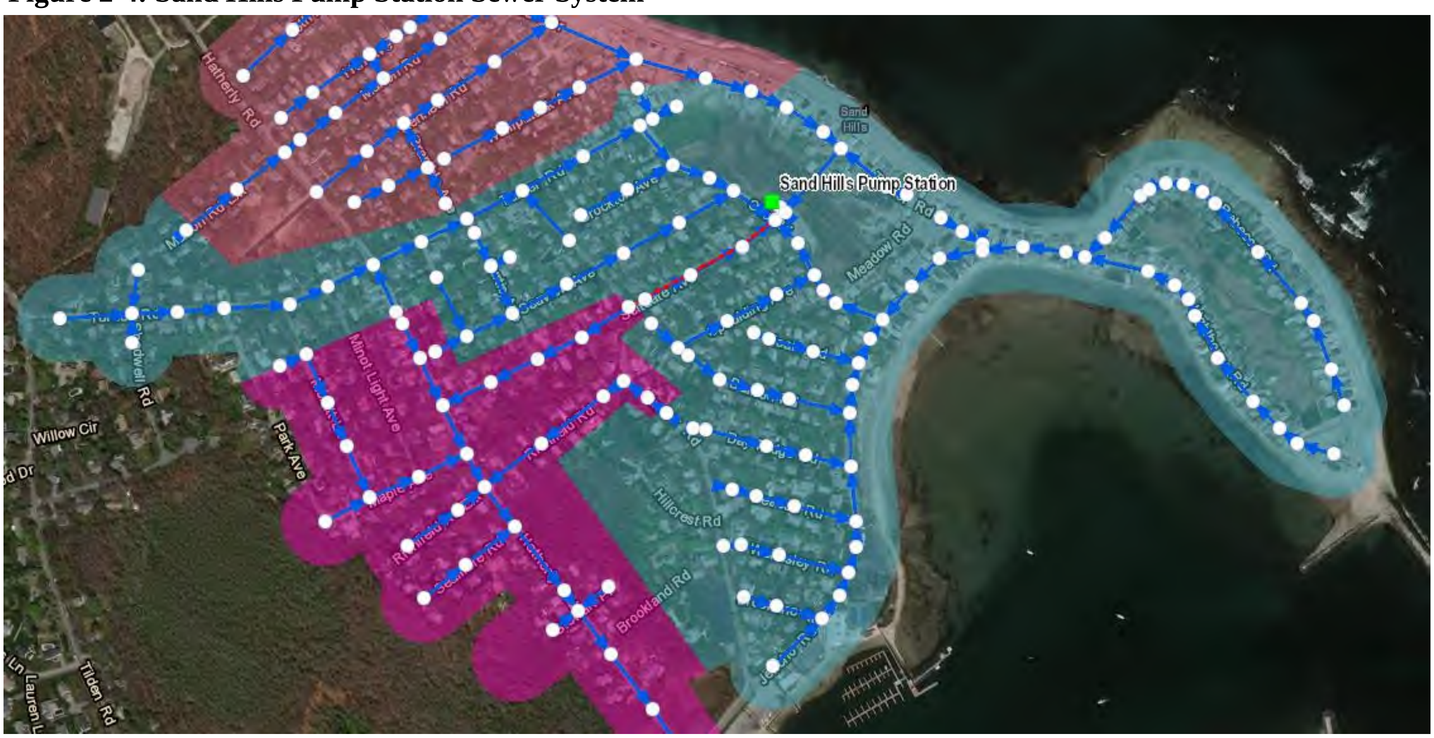


Figure 2-5: Collier Road Pup Station Sewer System

Figure 2-6: Edward Foster Pump Station and Peggotty Beach Pump Station Sewer System

Pump Station Details

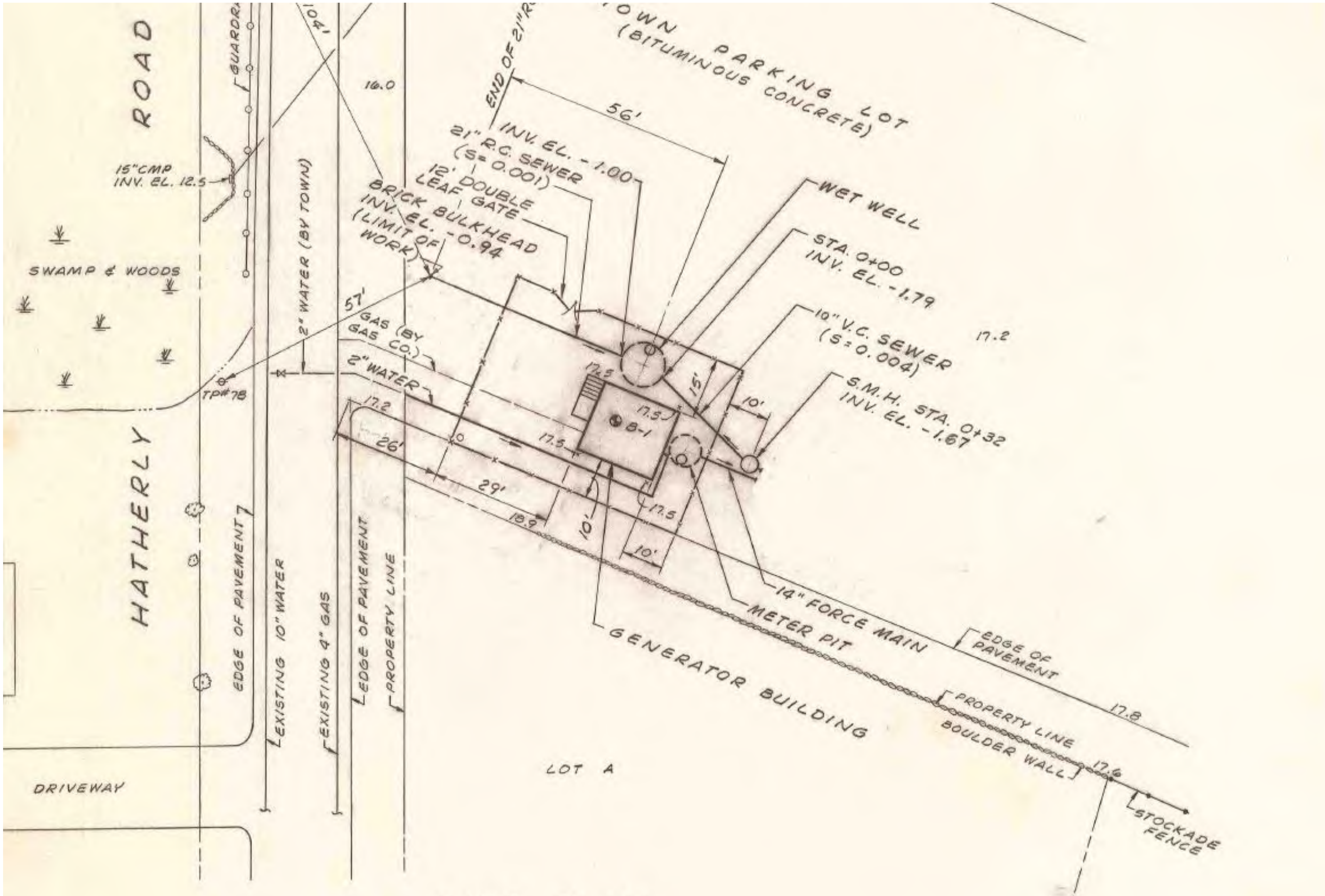
Chain Pond Pump Station:

Latitude: 42°13'08.8"N
Longitude: 70°44'52.4"W

Facility Location and Ground Surface Elevation:

Site Location

Elevation, feet NAVD88



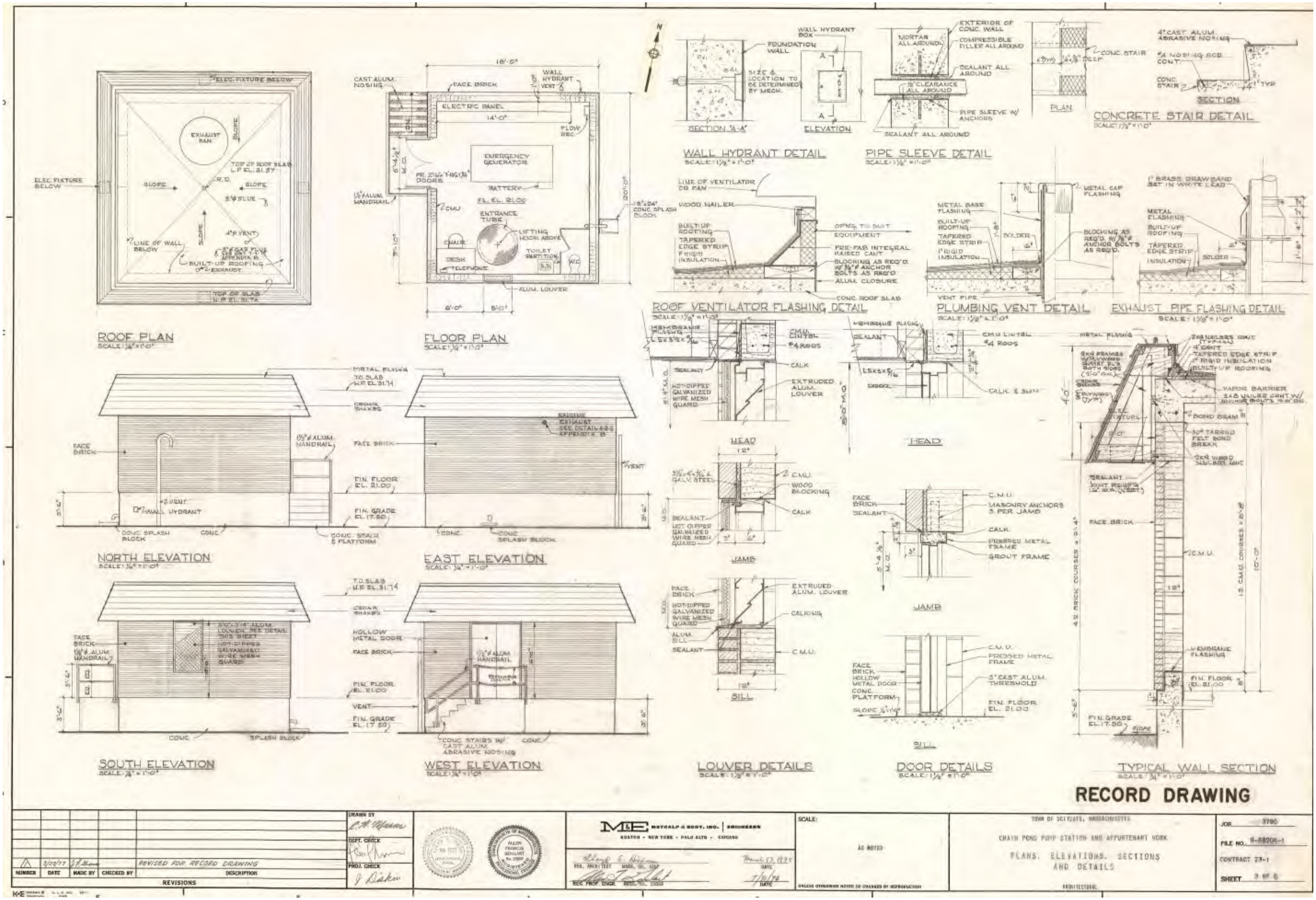
SITE PLAN

SCALE: 1"=20'

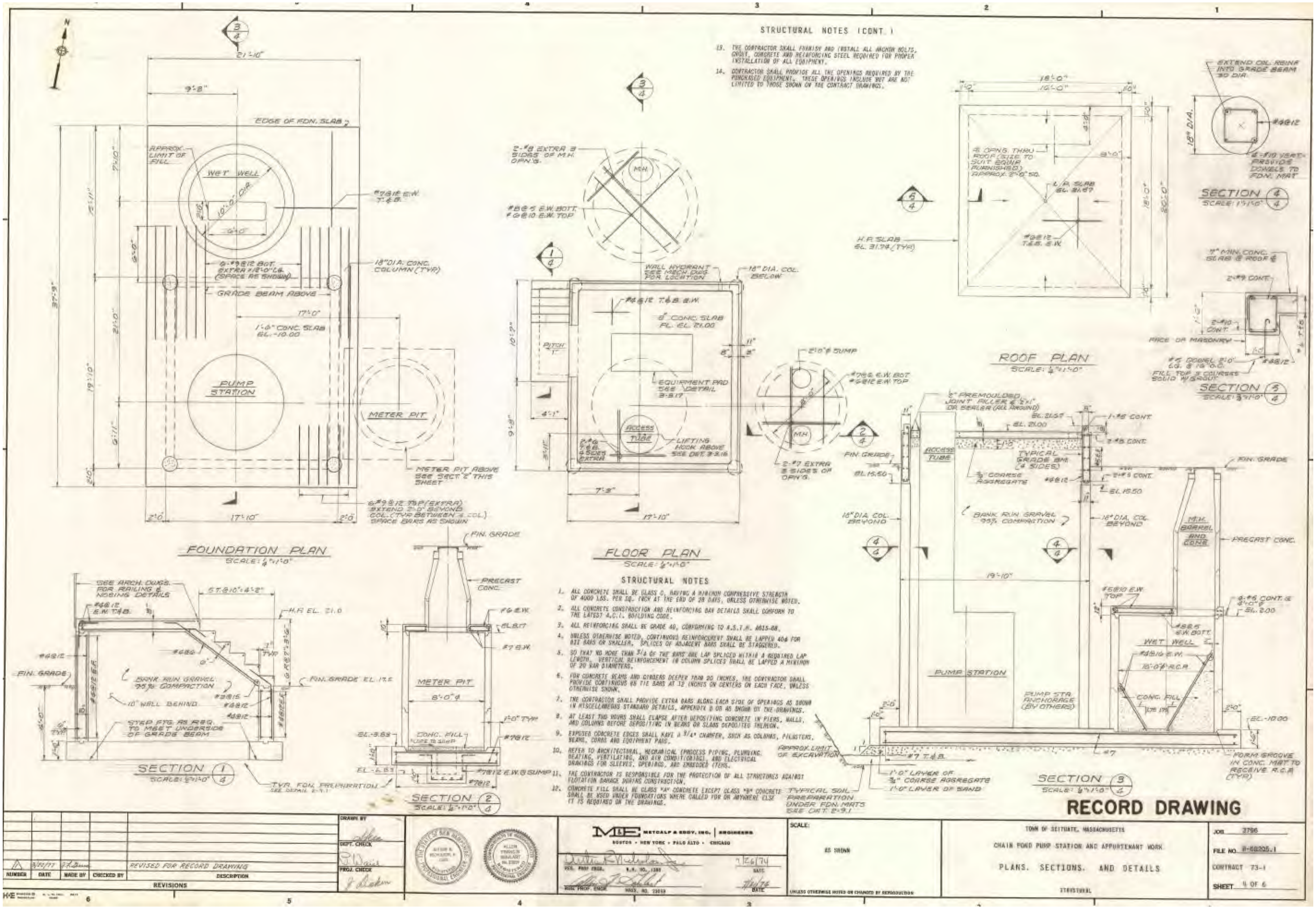
RECORD DRAWING NOTES:

1. CHAIN LINK FENCE NOT YET INSTALLED

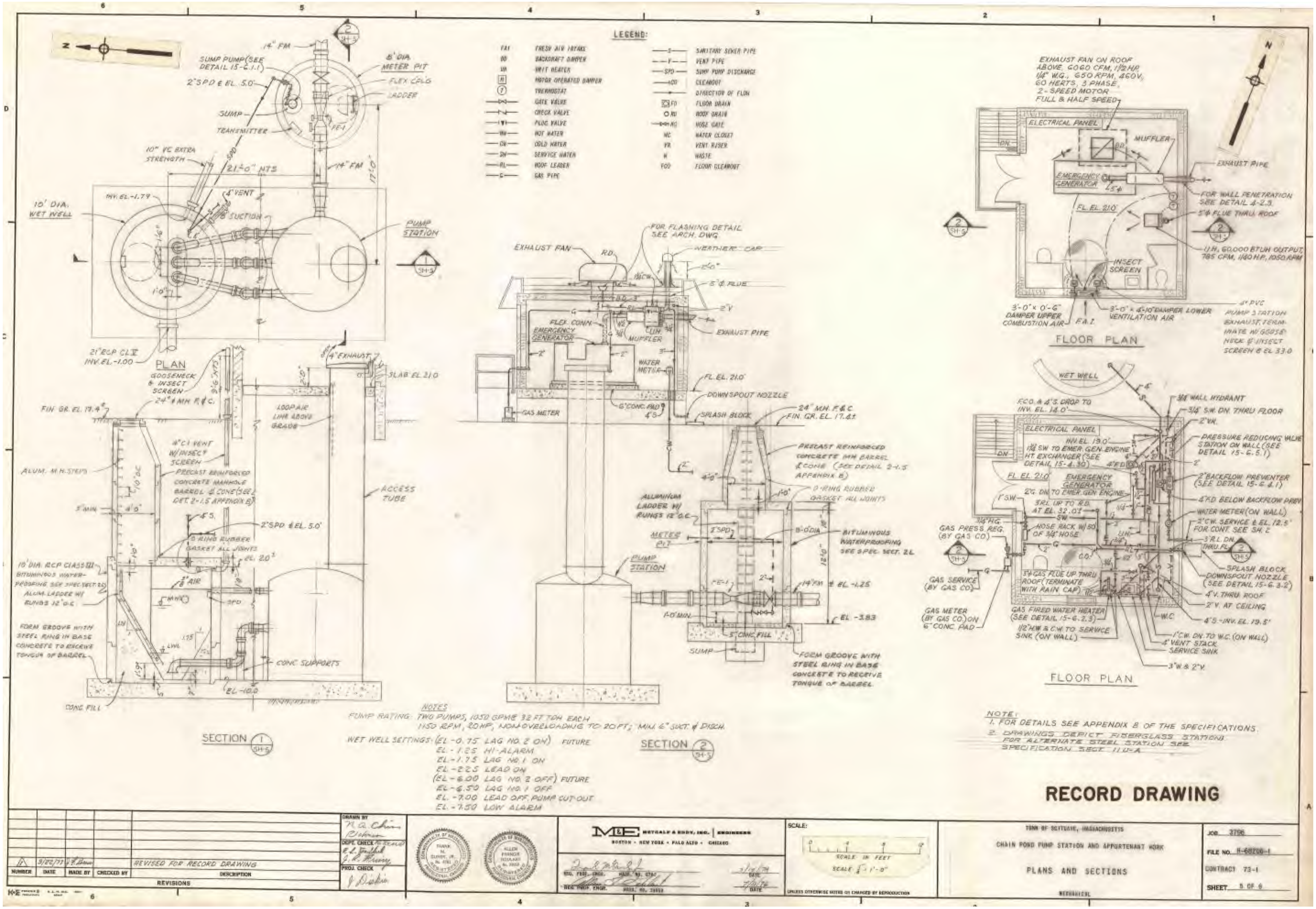
Chain Pond Pump Station



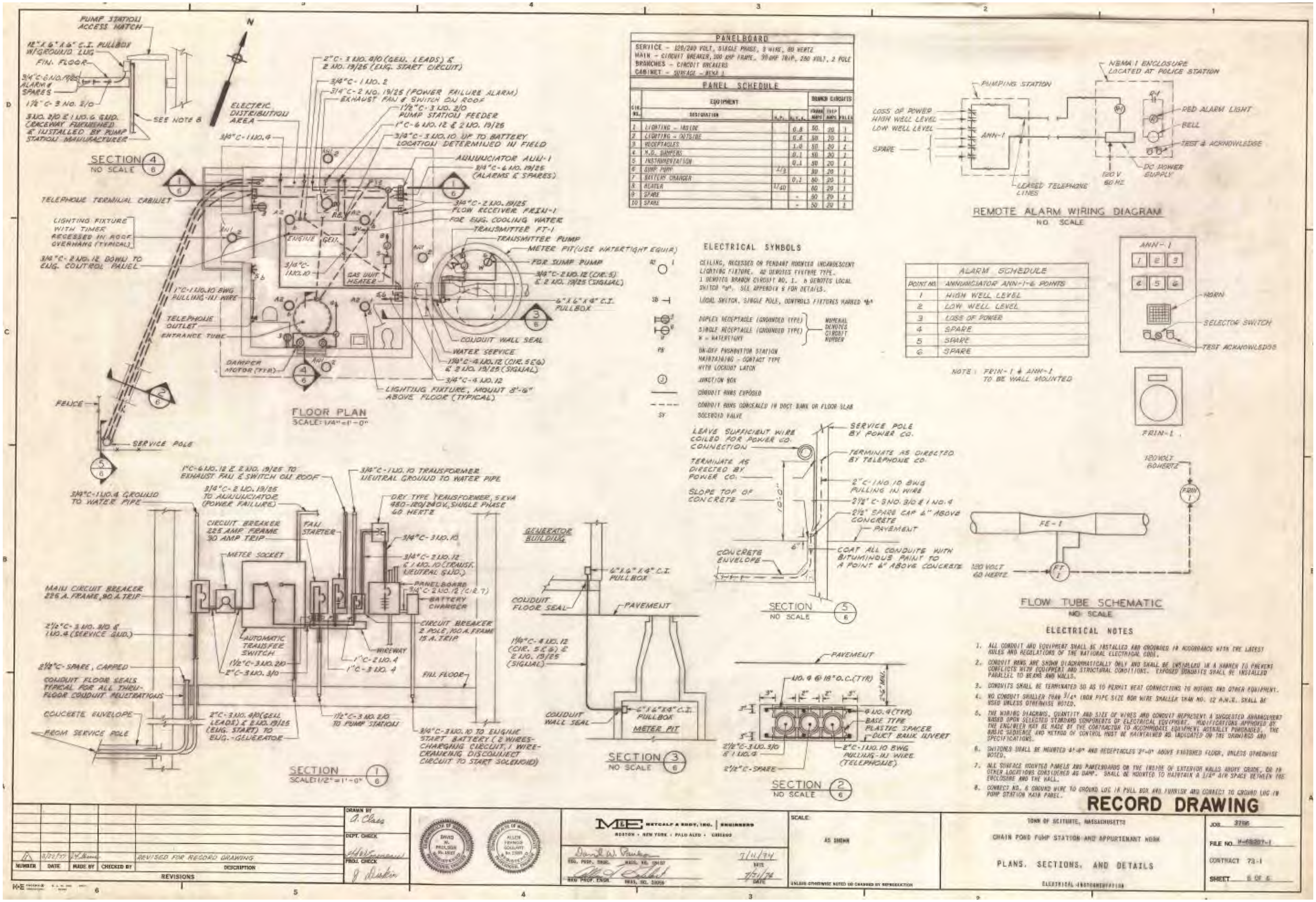
Chain Pond Pump Station



Chain Pond Pump Station



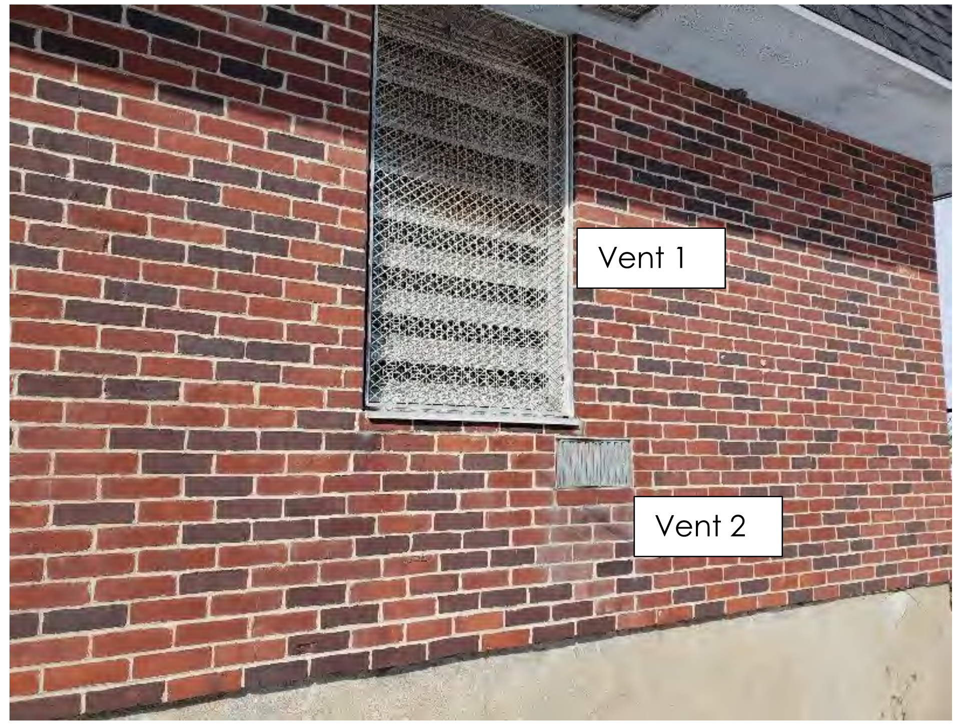
Chain Pond Pump Station



Chain Pond Pump Station

Client Name: Town of Scituate	Site Location: Scituate Waste Treatment Plant Pump Stations	Project No. 01.0173977.00

Photo 1 Chain Pond PS Entrance	**Photo 2** Chain Pond PS Electric Conduits
	

Photo 3 Chain Pond PS Wet Well	**Photo 4** Chain Pond PS Louvered Vents
	

Chain Pond Pump Station: Water Entry Elevation Table

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:		None Observed		
Doors (Personnel and Public):				
Personnel entryway		Door Threshold elev.	16.3±	15.5±
Vents:				
18’’ x 24’’ Fresh Air Intake	Vent 1	Bottom of Vent	22.3±	21.5±
24’’ x 36’’ Fresh Air Intake	Vent 2	Bottom of Vent	18.1±	17.3±
20’’ x 20” Fresh Air Intake	Vent 3	Bottom of Vent	23.0±	22.2±
24’’ x 30’’ Exhaust Louver	Vent 4	Bottom of Vent	17.3±	16.5±
20’’ x 20’’ Muffler Vent	Vent 5	Bottom of Vent	23.3±	22.5±
Other:				
Outside Electric Meter Panel		Lowest Elevation	20.6±	19.8±
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Exterior Stairs		None Observed		
Electrical Conduit Wall Penetrations:		None Observed		
Outside Gas Pressure Regulator		Lowest Elevation	15.8±	15.0±
Gas Connection		Wall Penetration	17.0±	16.2±
Generator Exhaust		Invert of Pipe	24.2±	23.4±
Wet well Manhole/Hatch Rim		Hatch/Rim Elevation	16.1±	15.3±
Wet well Vent Pipe		Pipe Outlet	19.3±	18.5±
Inside Generator Skid Top Elev.		Lowest Elevation	16.8±	16.0±

Edward Foster Road Pump Station (First Cliff Pump Station):

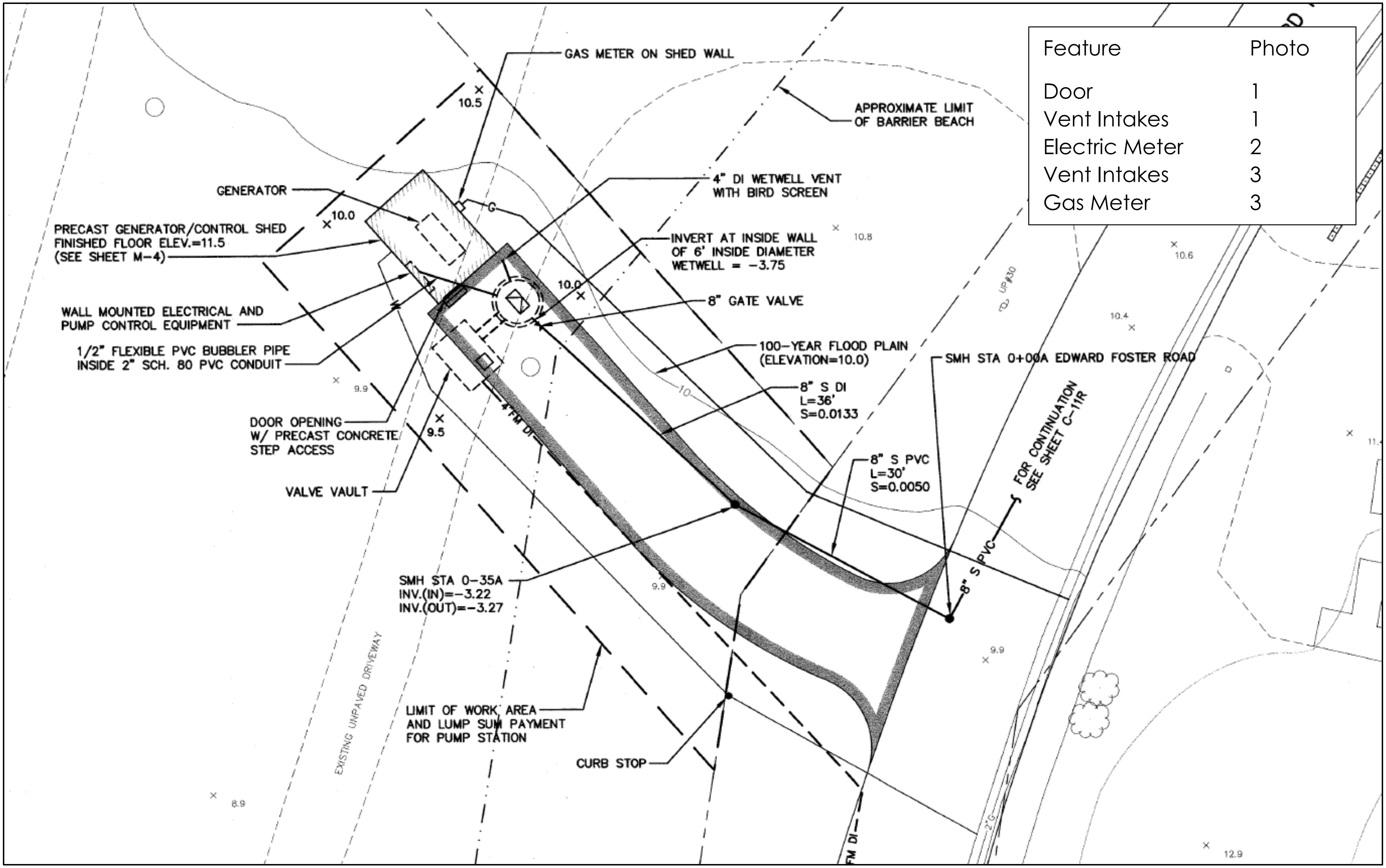
Latitude: 42°13'47.1"N
Longitude: 70°45'46.7"W

Year Constructed: 2011

Facility Location and Ground Surface Elevation:

Site Location

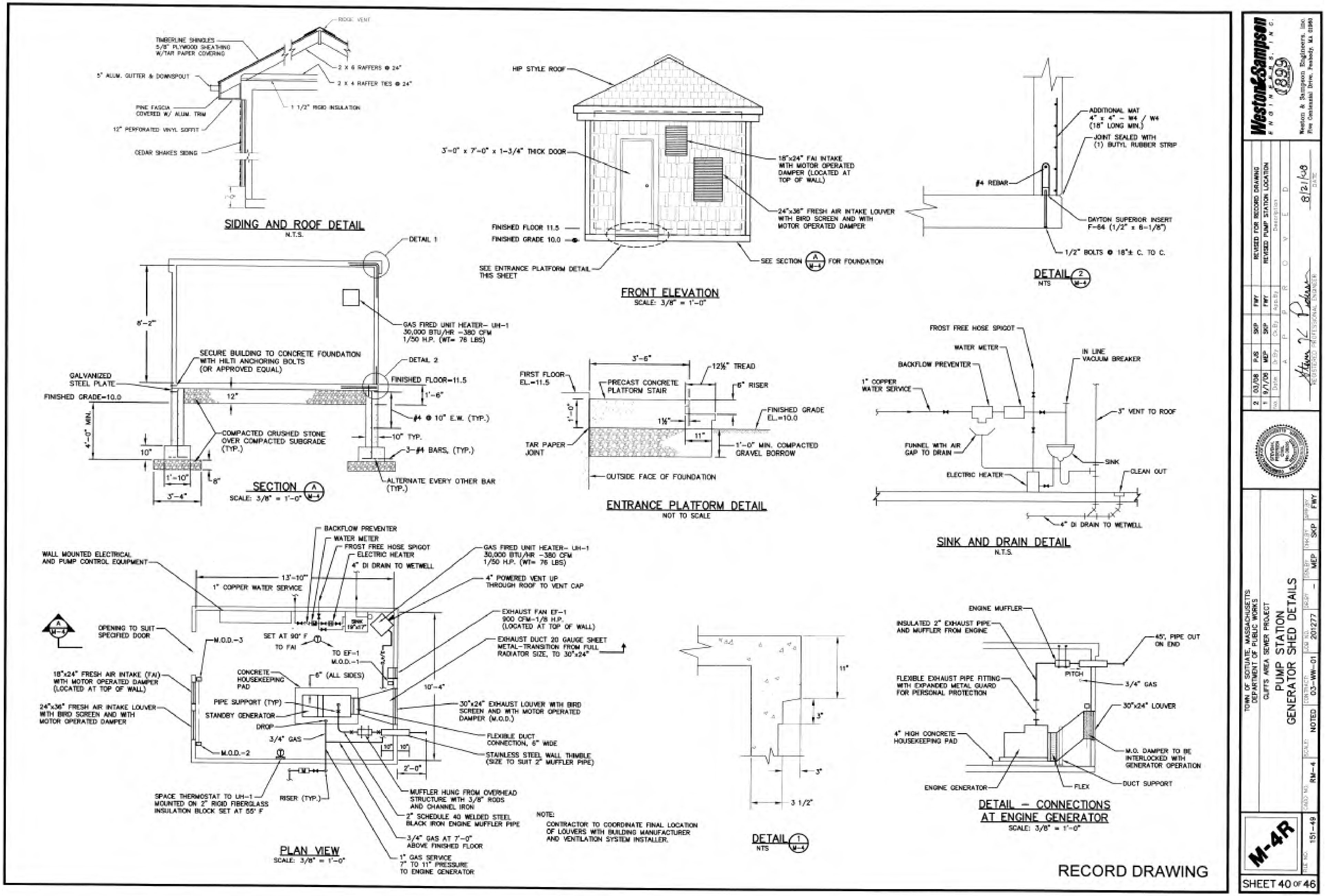
Elevation, feet NAVD88



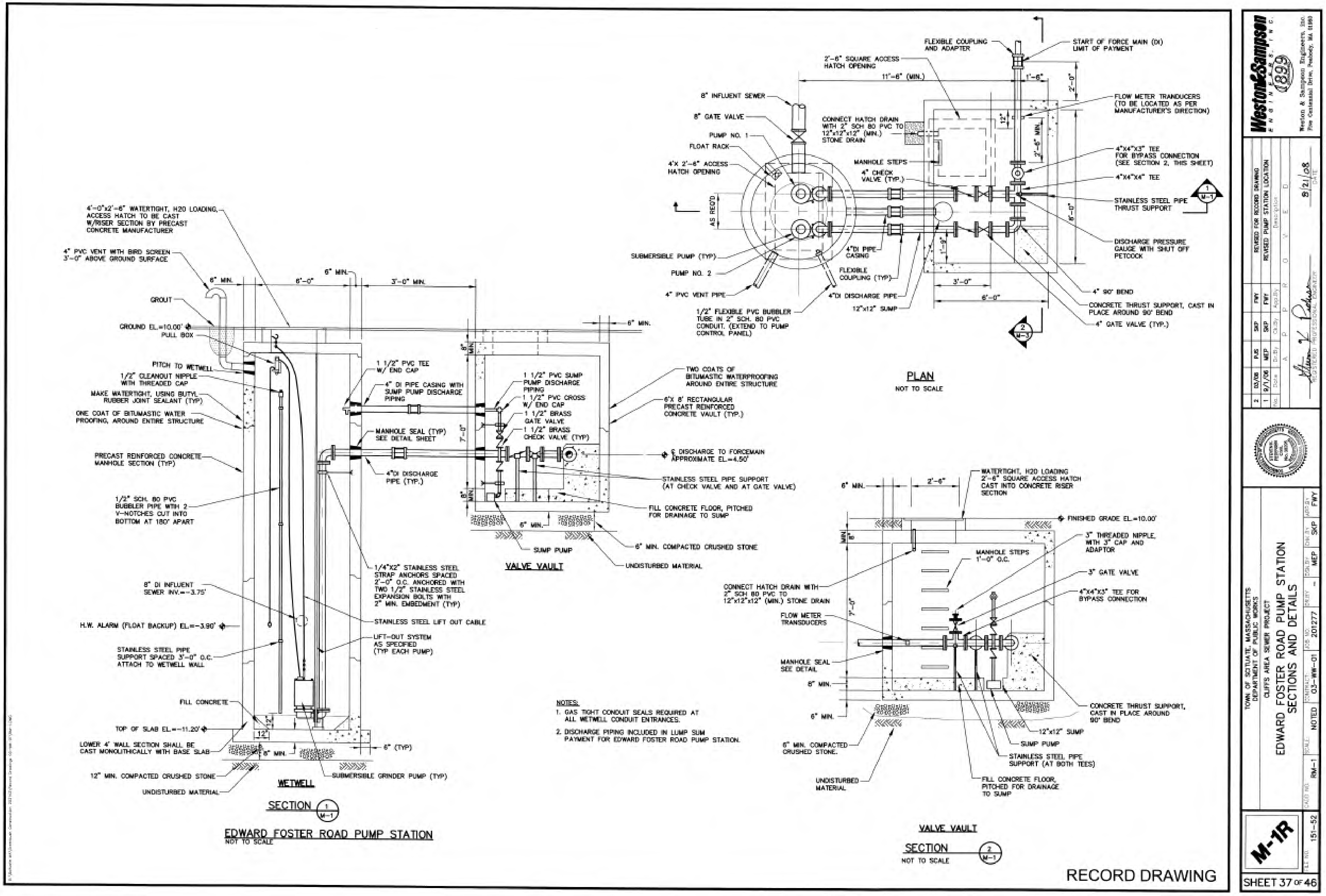
Feature	Photo
Door	1
Vent Intakes	1
Electric Meter	2
Vent Intakes	3
Gas Meter	3

Source: C-32R Edward Forest Road Pump Station Site Plan

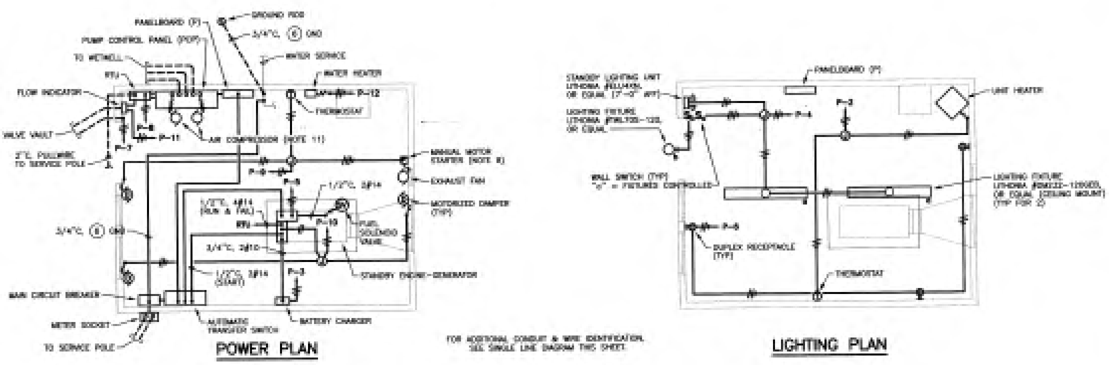
Edward Foster Road Pump Station



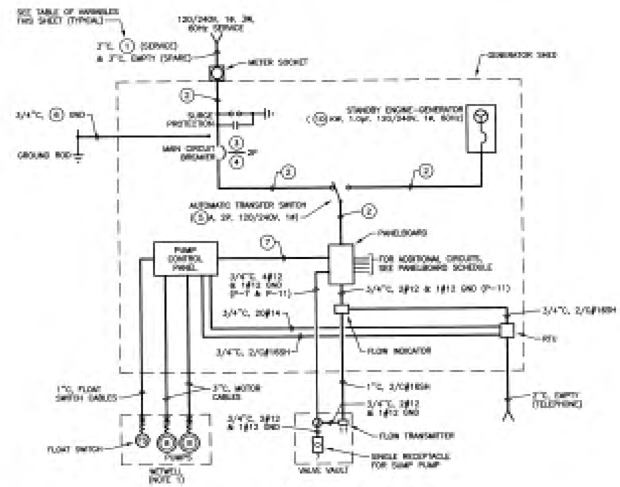
Edward Foster Road Pump Station



Edward Foster Road Pump Station



GENERATOR SHED
SCALE: 3/8"=1'-0"
(TYPICAL EXCEPT AS NOTED)



SINGLE LINE DIAGRAM
(TYPICAL EXCEPT AS NOTED)

LOCATION: GENERATOR SHED

PANELBOARD

SERVICE: 120/240V, 1Ø, 3W, 60Hz — (3) AMP MAINS
MOUNTING: SURFACE — (4) AMP MAIN CIRCUIT BREAKER

CKT #	CIRCUIT DESCRIPTION	LOAD KW	LOAD HP	BREAKER POLES	BREAKER TRIP
1	SEWAGE PUMPS (2)		(8)	2	(9)
2	UNIT HEATER	0.1		1	20
3	BATTERY CHARGER	0.1		1	20
4	LIGHTING	0.4		1	20
5	ENGINE HEATER	1.0		2	30
6	RECEPTACLES	0.4		1	20
7	SUMP PUMP (VALVE VAULT)		0.5	1	20
8	RTU	0.1		1	20
9	EXHAUST FAN		0.2	1	15
10	ENGINE DAMPERS	0.1		1	20
11	FLOW INDICATOR & TRANSMITTER	0.1		1	20
12	WATER HEATER	1.5		1	20
13	SPARE			1	20
14	SPARE			1	20

TABLE OF VARIABLES

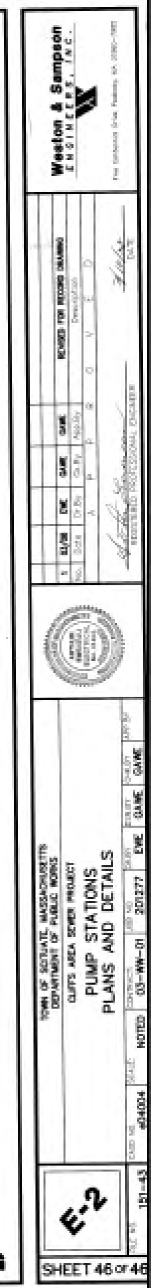
ITEM	PUMP STATION: [illegible] TERRACE	PUMP STATION: PEGGOTTY BEACH	PUMP STATION: COLLIER ROAD
(1) SERVICE WIRE	3#3	3#3	3#1/0
(2) CONDUIT & WIRE	1½"C, 3#3 & 1#8 GND	1½"C, 3#3 & 1#8 GND	1½"C, 3#1/0 & 1#6 GND
(3) FRAME	100	100	225
(4) TRIP	100	100	150
(5) AUTOMATIC TRANSFER SWITCH RATING	100	100	150
(6) GROUND WIRE	1#8	1#8	1#6
(7) CONDUIT & WIRE	1"C, 3#4 & 1#8 GND	1"C, 3#4 & 1#8 GND	1½"C, 3#1 & 1#6 GND
(8) PUMP MOTOR HP	5	5	7½
(9) PUMP BRANCH CIRCUIT TRIP	90	90	125
(10) ENGINE-GENERATOR STANDBY RATING	30	30	60

NOTES:

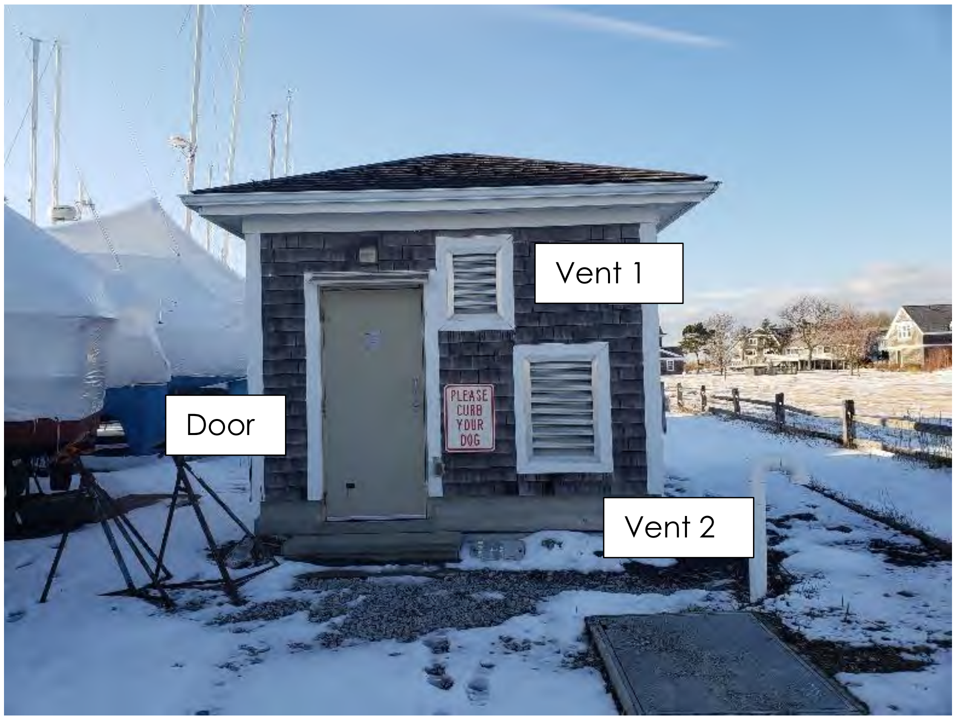
1. ALL MATERIALS AND INSTALLATIONS PROVIDED IN THE WETWELLS SHALL CONFORM TO MASSACHUSETTS ELECTRICAL CODE REQUIREMENTS FOR CLASS I, DIVISION 1, GROUP D HAZARDOUS LOCATIONS.
2. MAKE CONDUIT PENETRATIONS INTO THE WETWELL AND THE VALVE VAULT WITH CONDUIT WALL SEALS.
3. ALL WORK AND MATERIALS FOR THE ELECTRIC AND TELEPHONE SERVICES SHALL BE IN ACCORDANCE WITH THE UTILITY COMPANY REQUIREMENTS.
4. THE PUMP CONTROL PANEL SHALL BE FURNISHED AND INSTALLED UNDER SECTION 11302 AND THE RTU SHALL BE FURNISHED AND INSTALLED UNDER SECTION 13450. MAKE ALL NECESSARY CONNECTIONS.
5. TERMINATE THE SPARE SERVICE CONDUIT 6" ABOVE FINISHED GRADE AT THE SERVICE POLE AND BELOW THE METER SOCKET USING THREADED REMOVABLE CAPS.
6. TERMINATE THE CONDUITS IN THE WETWELL WITH AN EXPLOSIONPROOF CONDUIT SEAL FITTING AND A STRAIN-RELIEF, COMPRESSION TYPE CABLE BUSHING HAVING A GLAND SUITABLE FOR THE MOTOR AND CONTROL CABLE FURNISHED.
7. FURNISH AND INSTALL A WARNING NAMEPLATE ON THE MAIN CIRCUIT BREAKER ENCLOSURE: "CAUTION – TO COMPLETELY DISCONNECT SYSTEM, TURN OFF GENERATOR AND OPEN THIS BREAKER".
8. FURNISH NOTED MANUAL MOTOR STARTER WITH HAND-OFF-AUTO SELECTOR SWITCH AND IN NEMA TYPE 12 ENCLOSURE.
9. MOUNT WALL SWITCHES 4'-0" ABOVE FLOOR, EXCEPT AS OTHERWISE NOTED. MOUNT RECEPTACLES 3'-6" ABOVE FLOOR.
10. FOR STATION ORIENTATIONS AND CONDUIT ROUTINGS, SEE ELECTRICAL SITE PLANS ON SHEET E-1.
11. PROVIDE 3/4" FLEX, 2#12, 1#12 GND & 2#14 (PS) FOR EACH BUBBLER SYSTEM AIR COMPRESSOR.
12. PROVIDE CONDUIT WALL SEALS AT EACH CONDUIT PENETRATION INTO THE WETWELLS AND VALVE VAULTS.

3/4" CONDUIT WITH #12 AWG WIRES.
LONG SLASH LINES = QUANTITY OF PHASE/NEUTRAL WIRES.
SHORT SLASH LINES = QUANTITY OF EQUIPMENT GROUND WIRES.

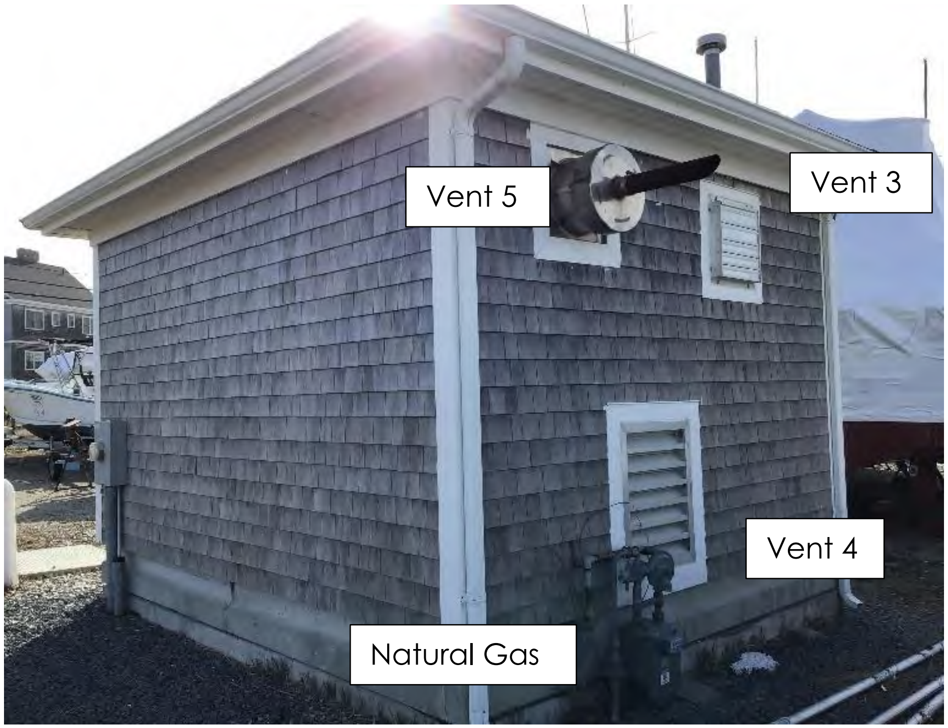
RECORD DRAWING



Client Name: Town of Scituate	**Site Location:** Scituate Waste Treatment Plant Pump Stations	**Project No.** 01.0173977.00

Photo 1 Edward Foster PS Entrance	**Photo 2** Edward Foster PS Electric Meter
	

Edward Foster Road Pump Station

Photo 3 Edward Foster Exhaust Vents	**Photo 4** South Side of Edward Foster PS
	

Edward Foster Road Pump Station: Water Entry Elevation Table

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:		None Observed		
Doors (Personnel and Public):				
Personnel entryway		Door Threshold elev.	10.9±	10.1±
Vents:				
18'' x 24 Fresh Air Intake	Vent 1	Bottom of Vent	16.9±	16.1±
24'' x 36'' Fresh Air Intake	Vent 2	Bottom of Vent	12.7±	11.9±
20'' x 20 Fresh Air Intake	Vent 3	Bottom of Vent	17.6±	16.8±
24'' x 30'' Exhaust Louver	Vent 4	Bottom of Vent	11.9±	11.1±
20'' x 20 Muffler Vent	Vent 5	Bottom of Vent	17.9±	17.1±
Other:				
Outside Electric Meter Panel		Lowest Elevation	13.2±	12.4±
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Exterior Stairs		None Observed		
Electrical Conduit Wall Penetrations:		None Observed		
Outside Gas Pressure Regulator		Lowest Elevation	10.0±	9.2±
Gas Connection		Wall Penetration	11.4±	10.6±
Generator Exhaust		Invert of Pipe	18.8±	18.0±
Wet well Manhole/Hatch Rim		Hatch/Rim Elevation	9.9±	9.1±
Wet well Vent Pipe		Pipe Outlet	12.6±	11.8±
Inside Generator Skid Top Elev.		Lowest Elevation	11.4±	10.6±

Peggotty Beach Pump Station:

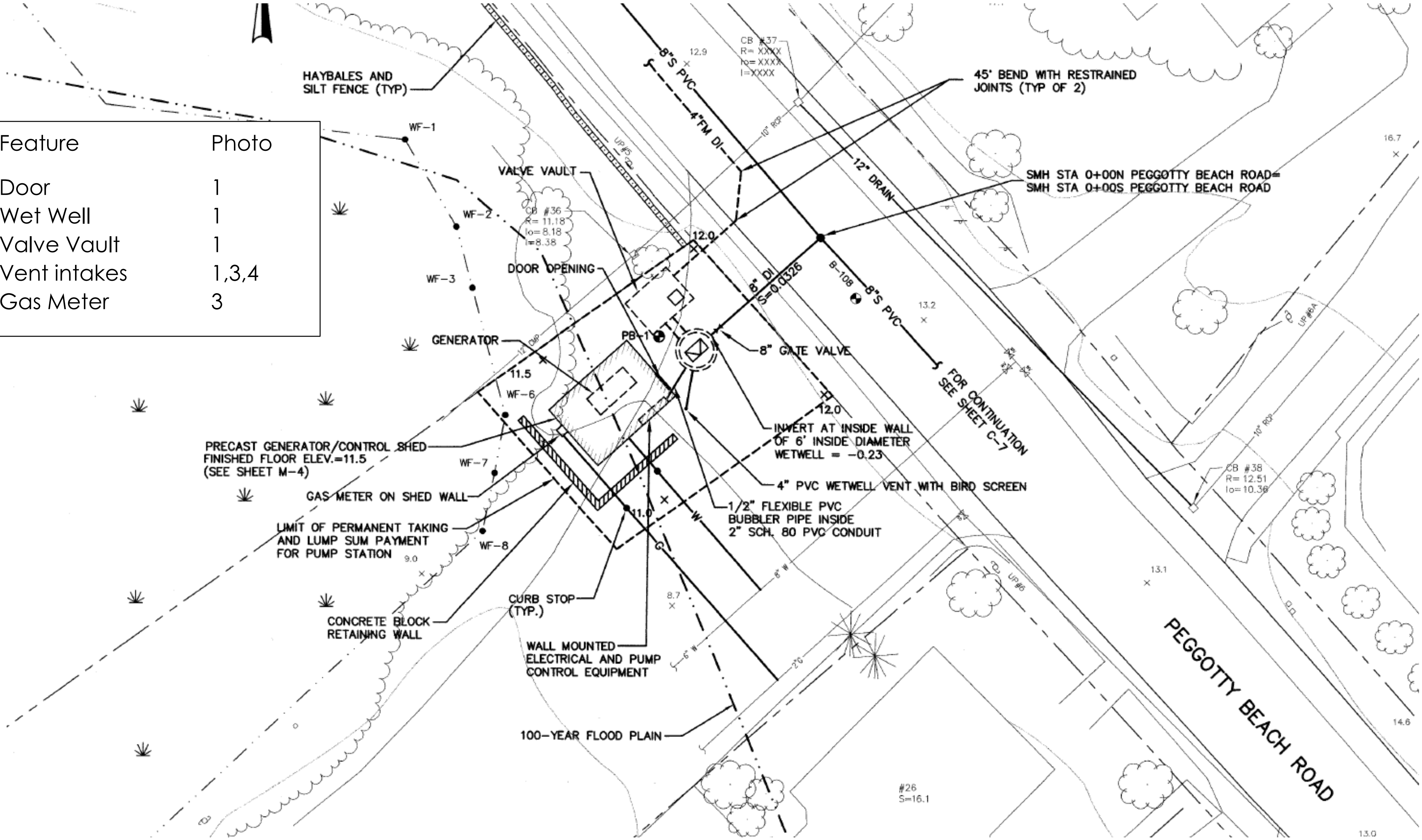
Latitude: 42°11'26.9"N
Longitude: 70°43'10.0"W

Facility Location and Ground Surface Elevation:

Site Location

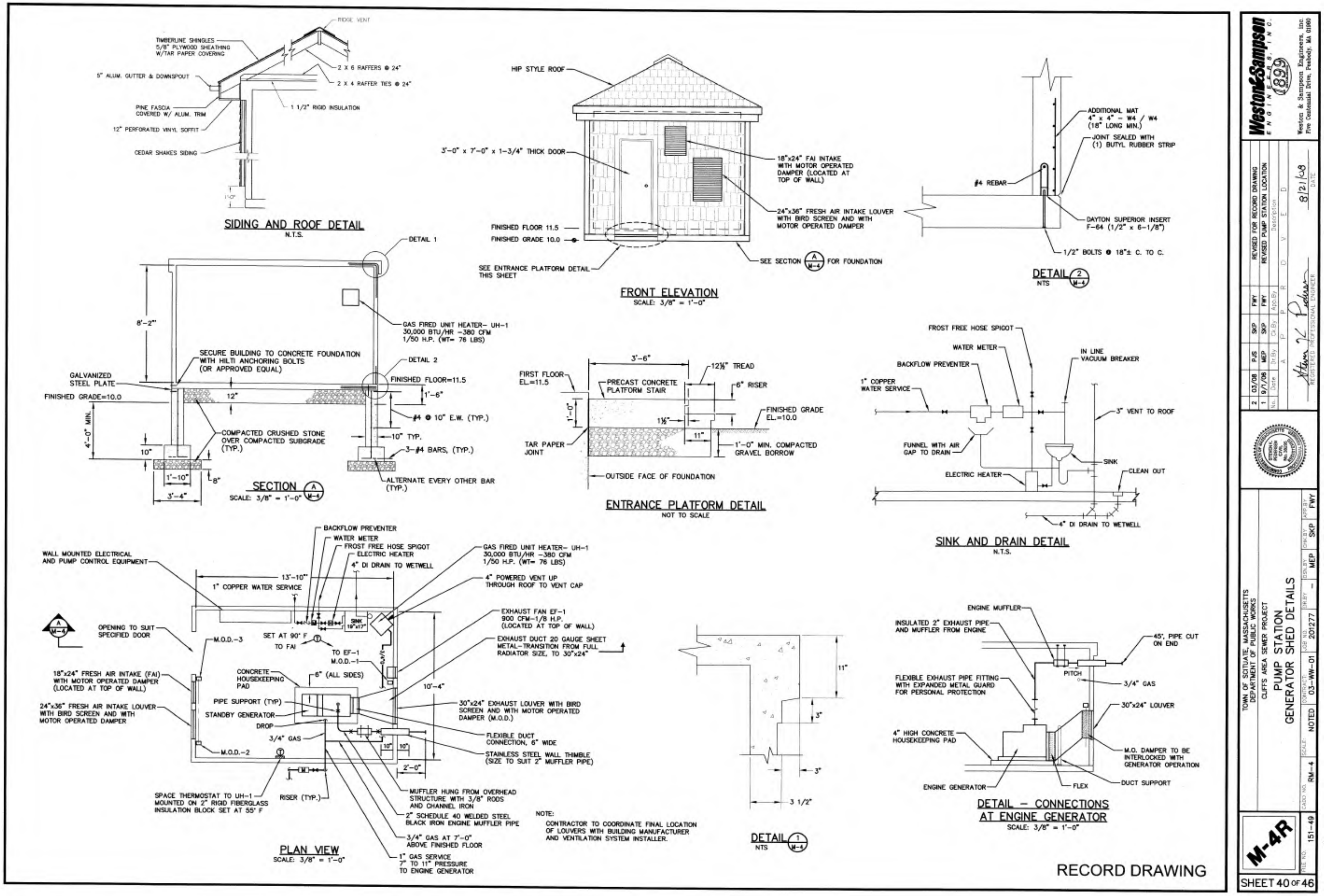
Elevation, feet NAVD88

Feature	Photo
Door	1
Wet Well	1
Valve Vault	1
Vent intakes	1,3,4
Gas Meter	3

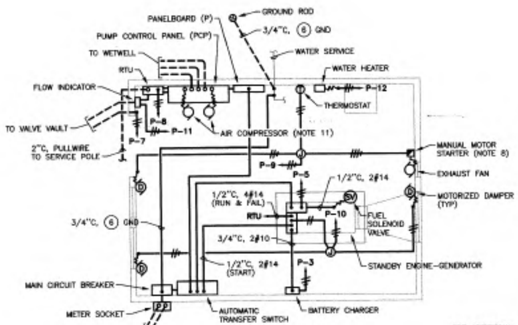


Source: C-33 Peggotty Beach Pump Station Site Plan

Peggotty Beach Pump Station

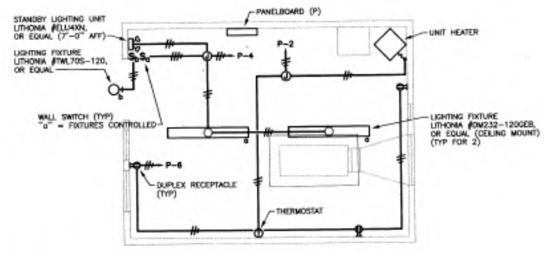


Peggotty Beach Pump Station



POWER PLAN

FOR ADDITIONAL CONDUIT & WIRE IDENTIFICATION, SEE SINGLE LINE DIAGRAM THIS SHEET.



LIGHTING PLAN

GENERATOR SHED

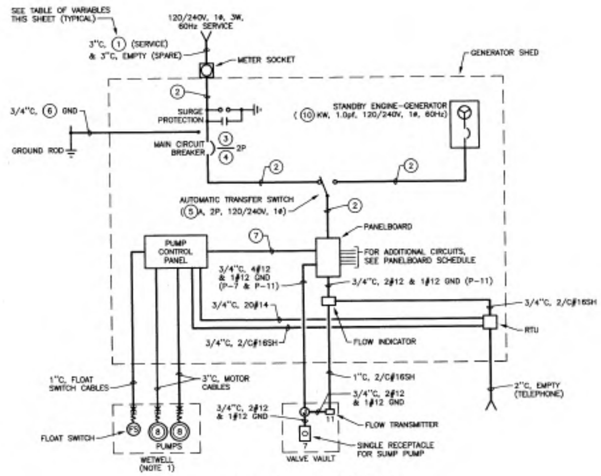
SCALE: 3/8"=1'-0"
(TYPICAL EXCEPT AS NOTED)

LOCATION: GENERATOR SHED

PANELBOARD					
SERVICE: 120/240V, 1ø, 3W, 60Hz		(3) AMP MAINS			
MOUNTING: SURFACE		(4) AMP MAIN CIRCUIT BREAKER			
CKT #	CIRCUIT DESCRIPTION	LOAD		BREAKER	
		KW	HP	POLES	TRIP
1	SEWAGE PUMPS (2)		(8)	2	(9)
2	UNIT HEATER	0.1		1	20
3	BATTERY CHARGER	0.1		1	20
4	LIGHTING	0.4		1	20
5	ENGINE HEATER	1.0		2	20
6	RECEPTACLES	0.4		1	20
7	SUMP PUMP (VALVE VAULT)		0.5	1	20
8	RTU	0.1		1	20
9	EXHAUST FAN		0.2	1	15
10	ENGINE DAMPERS	0.1		1	20
11	FLOW INDICATOR & TRANSMITTER	0.1		1	20
12	WATER HEATER	1.0		1	20
13	SPARE			1	20
14	SPARE			1	20

TABLE OF VARIABLES

ITEM	PUMP STATION		
	CONROY TERRACE	PEGOTTY BEACH	COLLIER ROAD
(1) SERVICE WIRE	3#3	3#3	3#1/0
(2) CONDUIT & WIRE	1¼"C, 3#3 & 1#8 GND	1¼"C, 3#3 & 1#8 GND	1½"C, 3#1/0 & 1#6 GND
(3) FRAME	100	100	225
(4) TRIP	100	100	150
(5) AUTOMATIC TRANSFER SWITCH RATING	100	100	150
(6) GROUND WIRE	1#8	1#8	1#6
(7) CONDUIT & WIRE	1"C, 3#4 & 1#8 GND	1"C, 3#4 & 1#8 GND	1½"C, 3#1 & 1#6 GND
(8) PUMP MOTOR HP	5	5	7½
(9) PUMP BRANCH CIRCUIT TRIP	90	90	125
(10) ENGINE-GENERATOR STANDYBY RATING	30	30	50



SINGLE LINE DIAGRAM

(TYPICAL EXCEPT AS NOTED)

NOTES:

1. ALL MATERIALS AND INSTALLATIONS PROVIDED IN THE WETWELLS SHALL CONFORM TO MASSACHUSETTS ELECTRICAL CODE REQUIREMENTS FOR CLASS I, DIVISION 1, GROUP D HAZARDOUS LOCATIONS.
2. MAKE CONDUIT PENETRATIONS INTO THE WETWELL AND THE VALVE VAULT WITH CONDUIT WALL SEALS.
3. ALL WORK AND MATERIALS FOR THE ELECTRIC AND TELEPHONE SERVICES SHALL BE IN ACCORDANCE WITH THE UTILITY COMPANY REQUIREMENTS.
4. THE PUMP CONTROL PANEL SHALL BE FURNISHED AND INSTALLED UNDER SECTION 11303 AND THE RTU SHALL BE FURNISHED AND INSTALLED UNDER SECTION 13450. MAKE ALL NECESSARY CONNECTIONS.
5. TERMINATE THE SPARE SERVICE CONDUIT 6" ABOVE FINISHED GRADE AT THE SERVICE POLE AND BELOW THE METER SOCKET USING THREADED REMOVEABLE CAPS.
6. TERMINATE THE CONDUITS IN THE WETWELL WITH AN EXPLOSIONPROOF CONDUIT SEAL FITTING AND A STRAIN-RELIEF, COMPRESSION TYPE CABLE BUSHING HAVING A GLAND SUITABLE FOR THE MOTOR AND CONTROL CABLE FURNISHED.
7. FURNISH AND INSTALL A WARNING NAMEPLATE ON THE MAIN CIRCUIT BREAKER ENCLOSURE "CAUTION – TO COMPLETELY DISCONNECT SYSTEM, TURN OFF GENERATOR AND OPEN THIS BREAKER".
8. FURNISH NOTED MANUAL MOTOR STARTER WITH HAND-OFF-AUTO SELECTOR SWITCH AND IN NEMA TYPE 12 ENCLOSURE.
9. MOUNT WALL SWITCHES 4'-6" ABOVE FLOOR. EXCEPT AS OTHERWISE NOTED. MOUNT RECEPTACLES 2'-6" ABOVE FLOOR.
10. FOR STATION ORIENTATIONS AND CONDUIT ROUTINGS, SEE ELECTRICAL SITE PLANS ON SHEET E-1.
11. PROVIDE 3/4" FLEX, 2#12, 1#12 GND & 2#14 (PS) FOR EACH BUBBLER SYSTEM AIR COMPRESSOR.
12. PROVIDE CONDUIT WALL SEALS AT EACH CONDUIT PENETRATION INTO THE WETWELLS AND VALVE VAULTS.

-///- 3/4" CONDUIT WITH #12 AWG WIRES.
LONG SLASH LINES = QUANTITY OF PHASE/NEUTRAL WIRES.
SHORT SLASH LINES = QUANTITY OF EQUIPMENT GROUND WIRES.

RECORD DRAWING

Weston & Sampson ENGINEERS, INC.

No.	Date	Dr.By	Ck.By	App.By	Description
1	03/08	EWE	GAWE	GAWE	REVISED FOR RECORD DRAWING

APPROVED

REGISTERED PROFESSIONAL ENGINEER

TOWN OF SCITUATE, MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS
CLIFFS AREA SEWER PROJECT

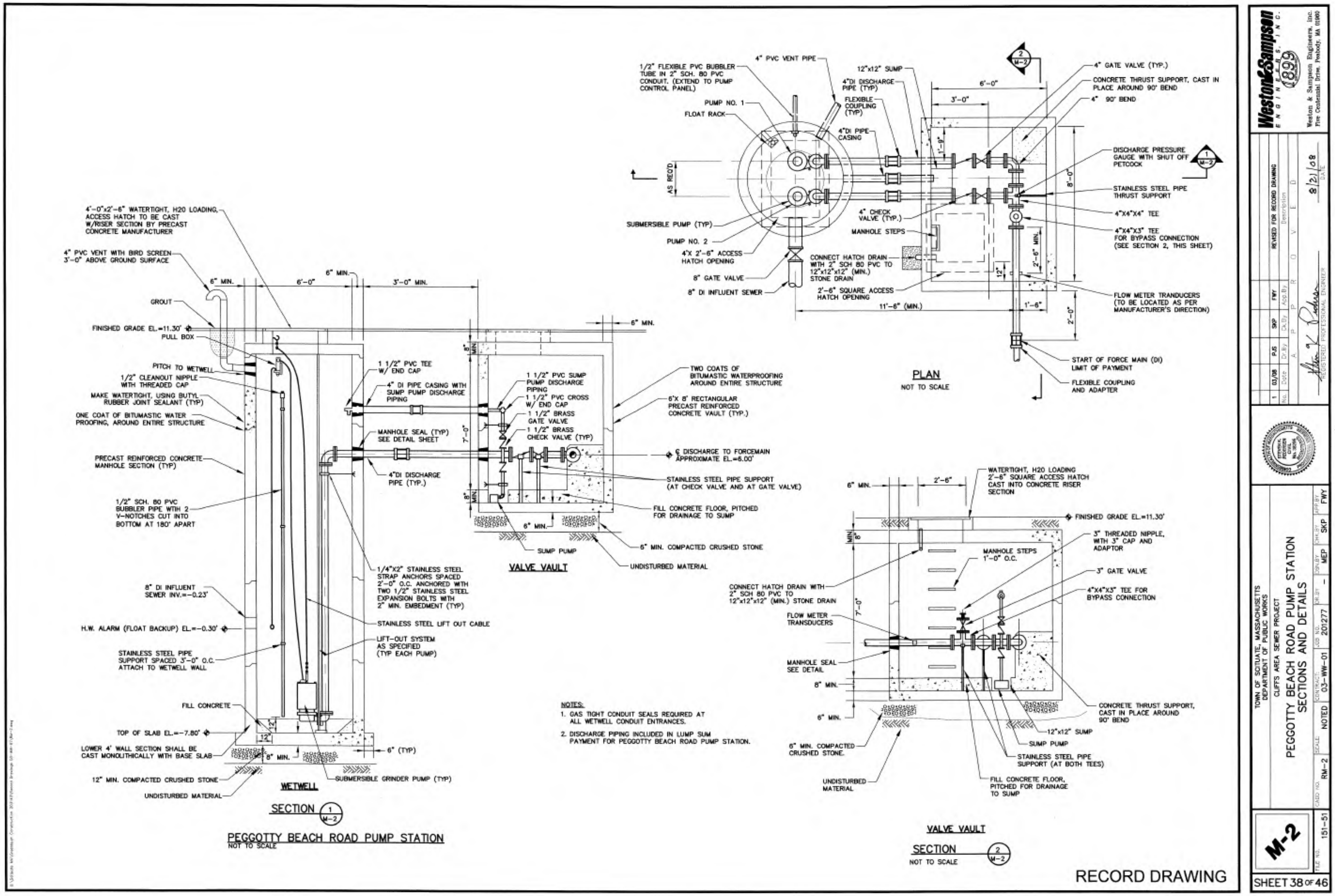
PUMP STATIONS
PLANS AND DETAILS

FILE NO.	CADD NO.	SCALE	CONTRACT	JOB NO.	DR. BY	DSN. BY	CHK. BY
151-43	e04004	NOTED	03-WW-01	201277	EWE	GAWE	GAWE

E-2

SHEET 46 OF 46

Peggotty Beach Pump Station



Peggotty Beach Pump Station

Client Name: Town of Scituate	Site Location: Scituate Waste Treatment Plant Pump Stations	Project No. 01.0173977.00

Photo 1 Peggotty Beach PS	**Photo 2** Peggotty Beach PS Gas Meter

Peggotty Beach Pump Station

Photo 3 Peggotty Beach PS Exhaust Vents	**Photo 4** Peggotty Beach PS Fresh Air Intake
	

Peggotty Beach Pump Station: Water Entry Elevation Table

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:		None Observed		
Doors (Personnel and Public):				
Personnel entryway		Door Threshold elev.	11.5±	10.7±
Vents:				
18’’ x 24 Fresh Air Intake	Vent 1	Bottom of Vent	17.5±	16.7±
24’’ x 36’’ Fresh Air Intake	Vent 2	Bottom of Vent	13.3±	12.5±
20’’ x 20 Fresh Air Intake	Vent 3	Bottom of Vent	18.2±	17.4±
24’’ x 30’’ Exhaust Louver	Vent 4	Bottom of Vent	12.5±	11.7±
20’’ x 20 Muffler Vent	Vent 5	Bottom of Vent	18.5±	17.7±
Other:				
Outside Electric Meter Panel		Lowest Elevation	14.4±	13.6±
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Exterior Stairs		None Observed		
Electrical Conduit Wall Penetrations:		None Observed		
Outside Gas Pressure Regulator		Lowest Elevation	10.5±	9.7±
Gas Connection		Wall Penetration	12.2±	11.4±
Generator Exhaust		Invert of Pipe	19.4±	18.6±
Wet well Manhole/Hatch Rim		Hatch/Rim Elevation	11.3±	10.5±
Wet well Vent Pipe		Pipe Outlet	13.0±	12.2±
Inside Generator Skid Top Elev.		Lowest Elevation	12.0±	11.2±

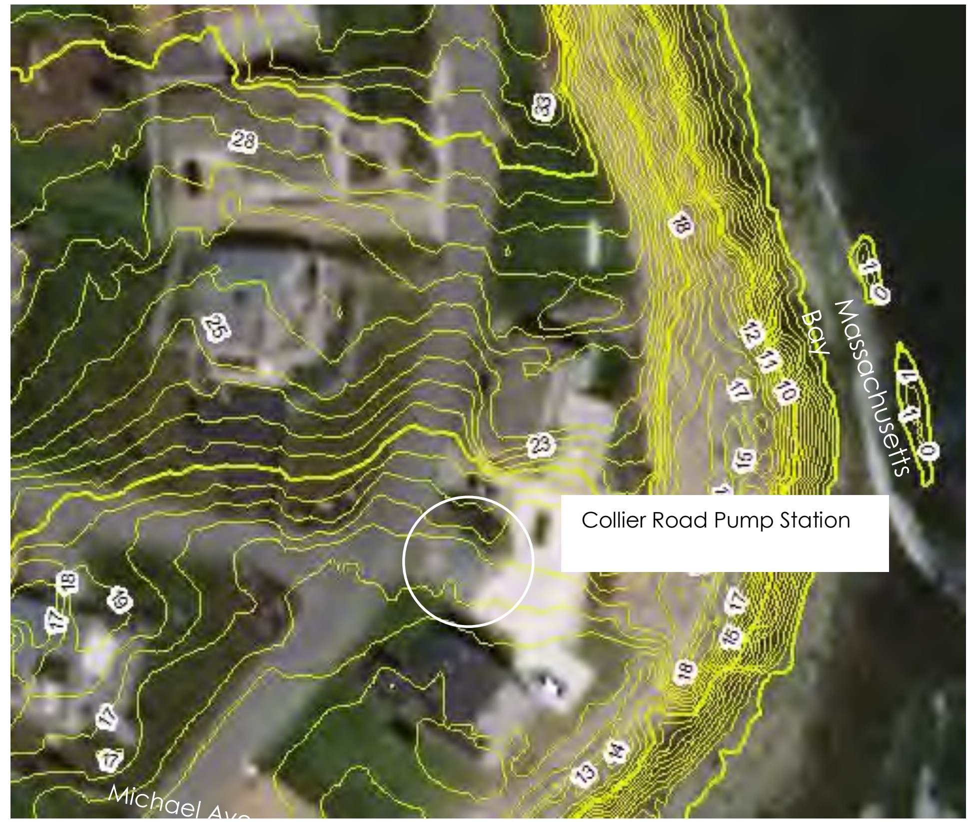
Collier Road Pump Station:

Latitude: 42°10'26.7"N
Longitude: 70°42'53.6"W

Year Constructed: 2008

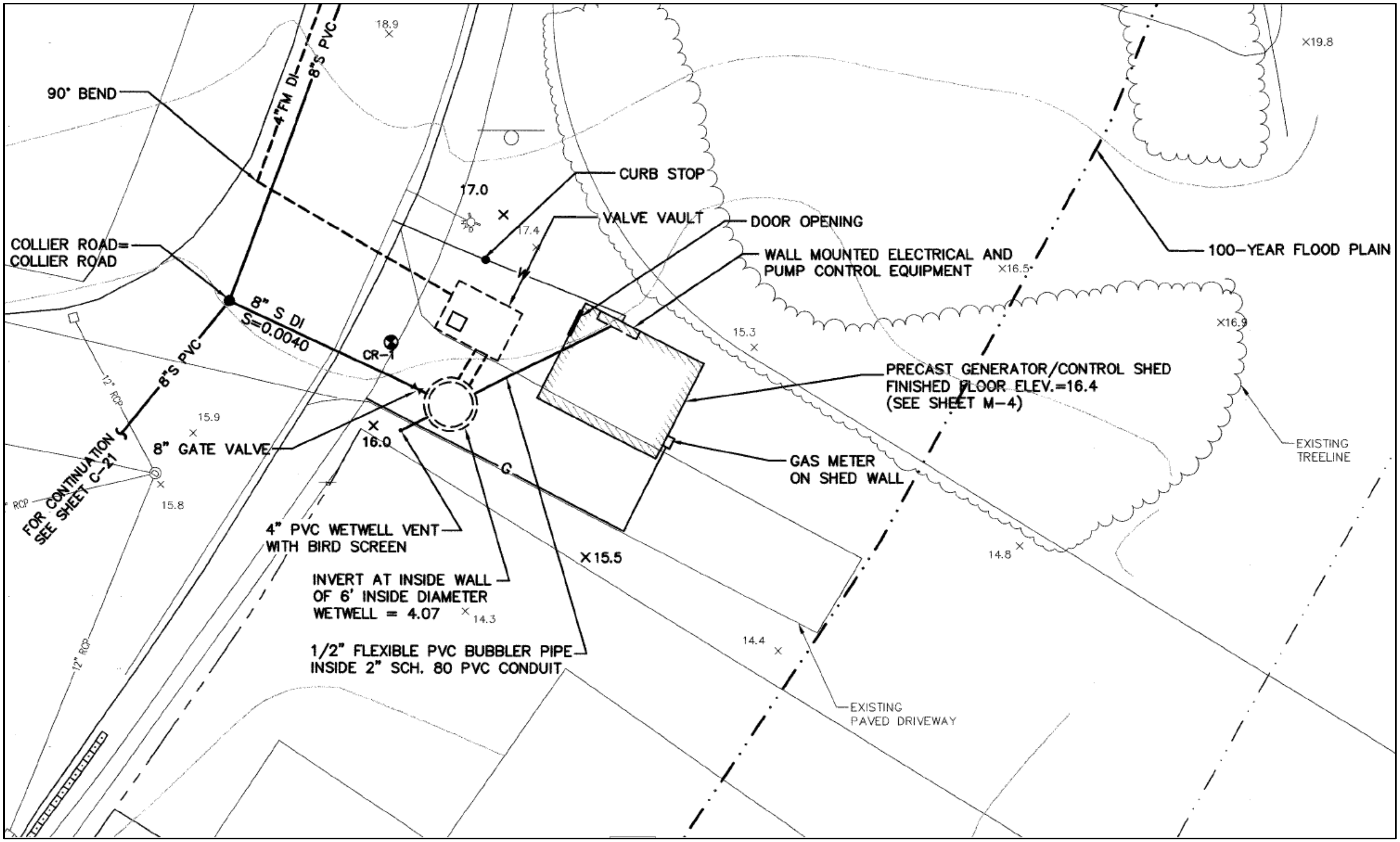
Facility Location and Ground Surface Elevation:

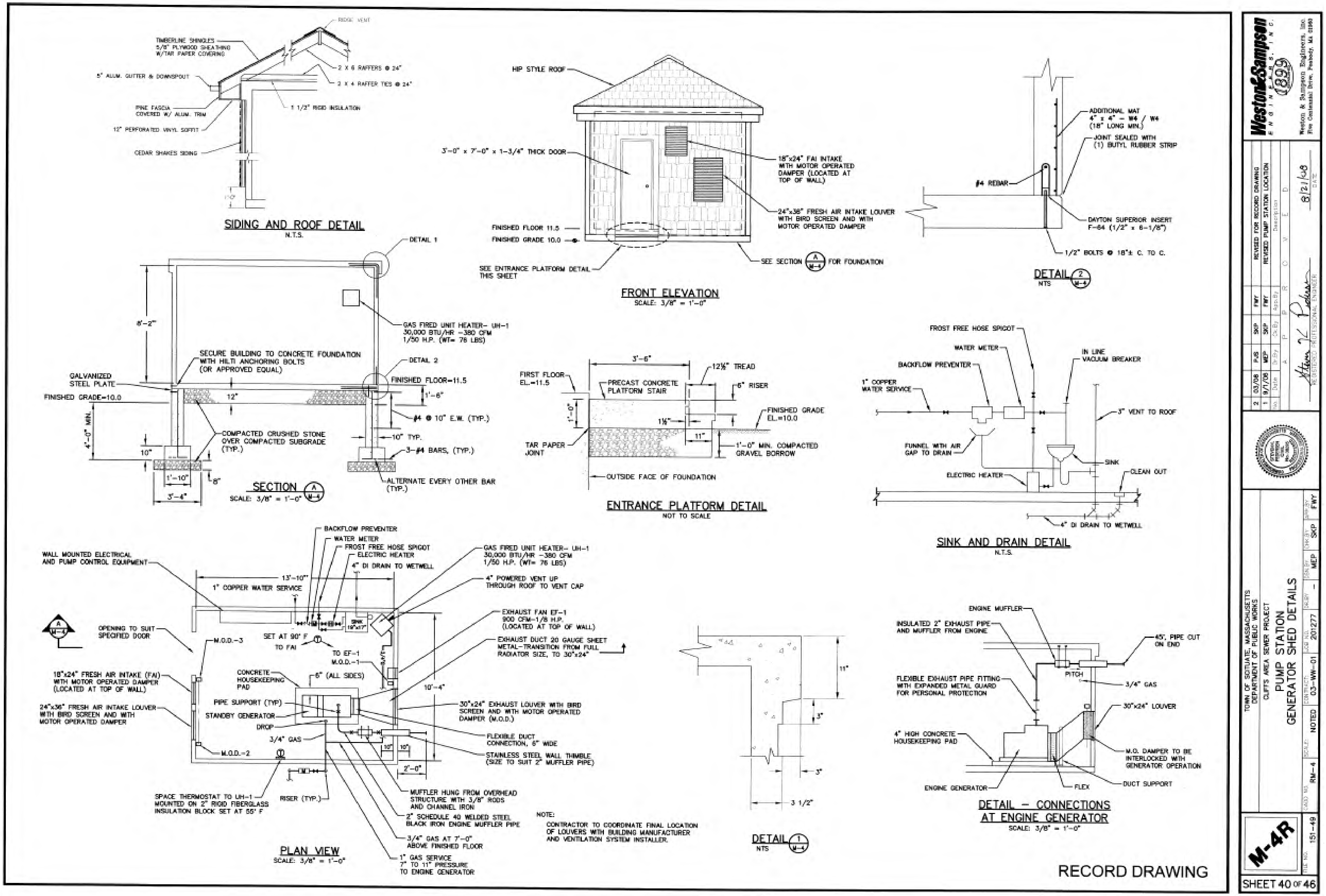
Site Location



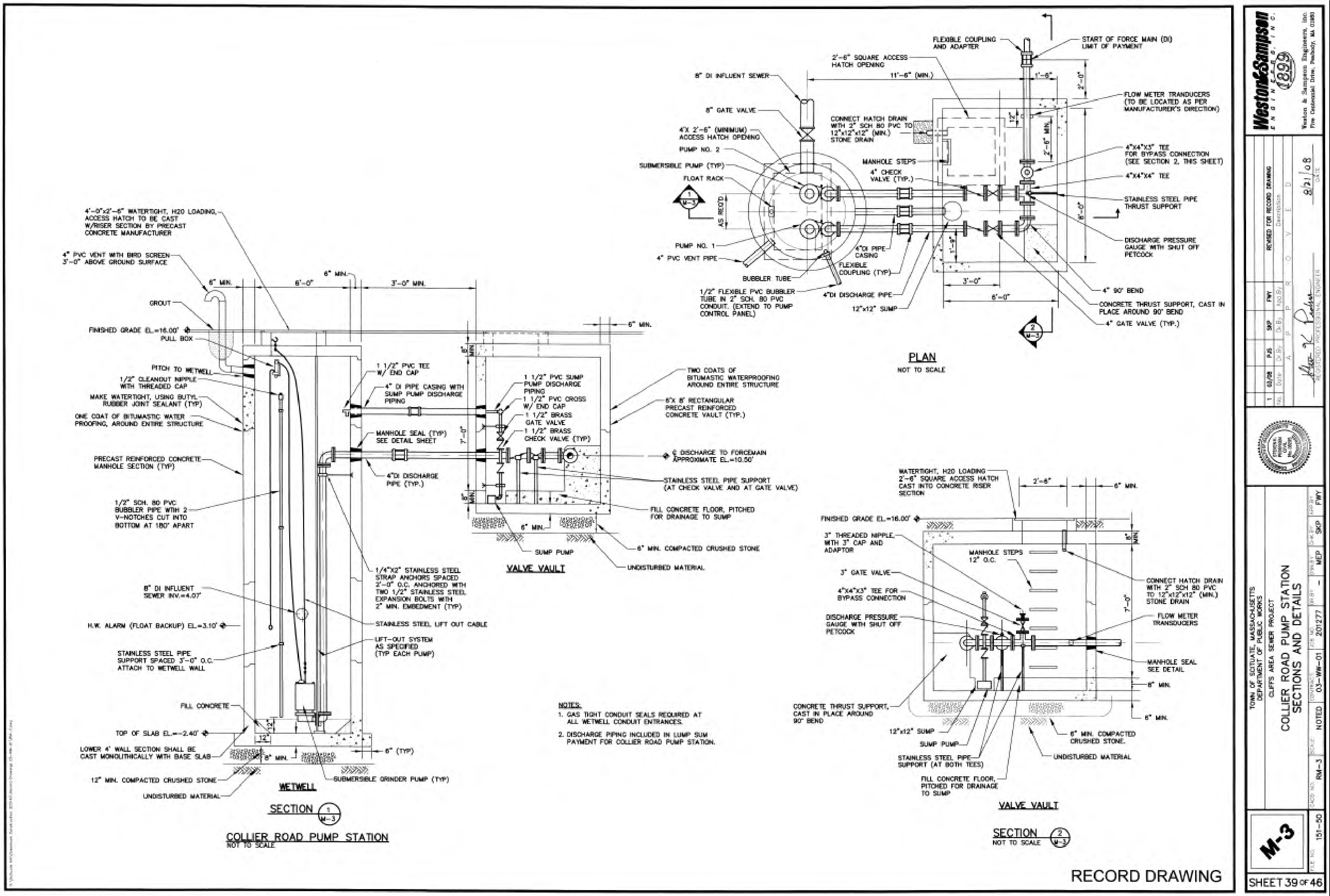
Elevation, feet NAVD88

Source: C-34 Collier Road Pump Station Site Plan

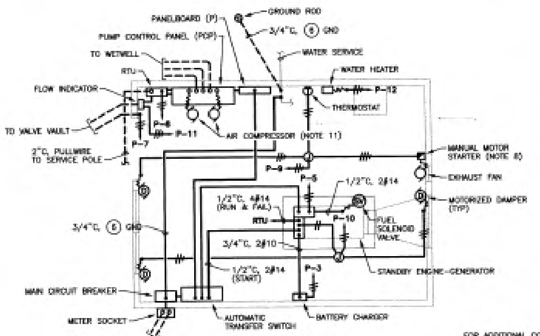




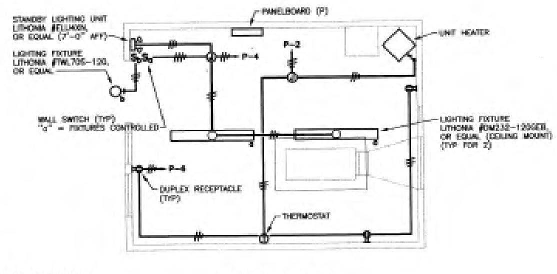
Collier Road Pump Station



Collier Road Pump Station



POWER PLAN

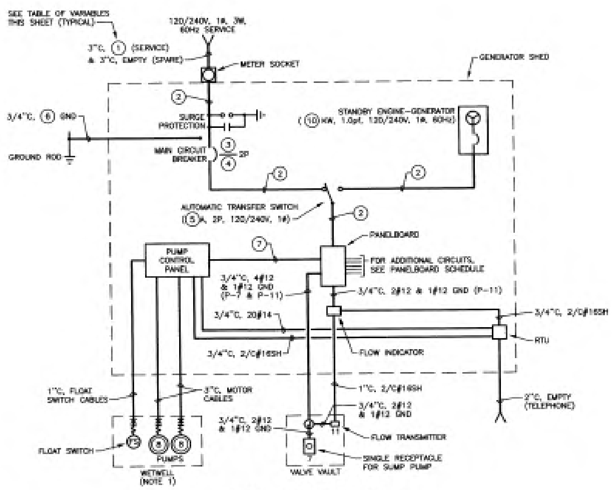


LIGHTING PLAN

FOR ADDITIONAL CONDUIT & WIRE IDENTIFICATION, SEE SINGLE LINE DIAGRAM THIS SHEET.

GENERATOR SHED

SCALE: 3/8"=1'-0"
(TYPICAL EXCEPT AS NOTED)



SINGLE LINE DIAGRAM

(TYPICAL EXCEPT AS NOTED)

LOCATION: GENERATOR SHED

PANELBOARD

SERVICE: 120/240V, 1Ø, 3W, 60Hz — (3) AMP MAINS
MOUNTING: SURFACE — (4) AMP MAIN CIRCUIT BREAKER

CKT #	CIRCUIT DESCRIPTION	LOAD KW	LOAD HP	BREAKER POLES	BREAKER TRIP
1	SEWAGE PUMPS (2)		(8)	2	(9)
2	UNIT HEATER	0.1		1	20
3	BATTERY CHARGER	0.1		1	20
4	LIGHTING	0.4		1	20
5	ENGINE HEATER	1.0		2	20
6	RECEPTACLES	0.4		1	20
7	SUMP PUMP (VALVE VAULT)		0.5	1	20
8	RTU	0.1		1	20
9	EXHAUST FAN		0.2	1	15
10	ENGINE DAMPERS	0.1		1	20
11	FLOW INDICATOR & TRANSMITTER	0.1		1	20
12	WATER HEATER	1.0		1	20
13	SPARE			1	20
14	SPARE			1	20

TABLE OF VARIABLES

ITEM	PUMP STATION: CONROY TERRACE	PEGOTTY BEACH	COLLIER ROAD
(1) SERVICE WIRE	3#3	3#3	3#1/0
(2) CONDUIT & WIRE	1¼"C, 3#3 & 1#8 GND	1¼"C, 3#3 & 1#8 GND	1½"C, 3#1/0 & 1#6 GND
(3) FRAME	100	100	225
(4) TRIP	100	100	150
(5) AUTOMATIC TRANSFER SWITCH RATING	100	100	150
(6) GROUND WIRE	1#8	1#8	1#6
(7) CONDUIT & WIRE	1"C, 3#4 & 1#8 GND	1"C, 3#4 & 1#8 GND	1½"C, 3#1 & 1#6 GND
(8) PUMP MOTOR HP	5	5	7½
(9) PUMP BRANCH CIRCUIT TRIP	90	90	125
(10) ENGINE-GENERATOR STANDBY RATING	30	30	50

NOTES:

1. ALL MATERIALS AND INSTALLATIONS PROVIDED IN THE WETWELLS SHALL CONFORM TO MASSACHUSETTS ELECTRICAL CODE REQUIREMENTS FOR CLASS I, DIVISION 1, GROUP D HAZARDOUS LOCATIONS.
2. MAKE CONDUIT PENETRATIONS INTO THE WETWELL AND THE VALVE VAULT WITH CONDUIT WALL SEALS.
3. ALL WORK AND MATERIALS FOR THE ELECTRIC AND TELEPHONE SERVICES SHALL BE IN ACCORDANCE WITH THE UTILITY COMPANY REQUIREMENTS.
4. THE PUMP CONTROL PANEL SHALL BE FURNISHED AND INSTALLED UNDER SECTION 11303 AND THE RTU SHALL BE FURNISHED AND INSTALLED UNDER SECTION 13450. MAKE ALL NECESSARY CONNECTIONS.
5. TERMINATE THE SPARE SERVICE CONDUIT 6" ABOVE FINISHED GRADE AT THE SERVICE POLE AND BELOW THE METER SOCKET USING THREADED REMOVEABLE CAPS.
6. TERMINATE THE CONDUITS IN THE WETWELL WITH AN EXPLOSIONPROOF CONDUIT SEAL FITTING AND A STRAIN-RELIEF, COMPRESSION TYPE CABLE BUSHING HAVING A GLAND SUITABLE FOR THE MOTOR AND CONTROL CABLE FURNISHED.
7. FURNISH AND INSTALL A WARNING NAMEPLATE ON THE MAIN CIRCUIT BREAKER ENCLOSURE "CAUTION – TO COMPLETELY DISCONNECT SYSTEM, TURN OFF GENERATOR AND OPEN THIS BREAKER".
8. FURNISH NOTED MANUAL MOTOR STARTER WITH HAND-OFF-AUTO SELECTOR SWITCH AND IN NEMA TYPE 12 ENCLOSURE.
9. MOUNT WALL SWITCHES 4'-6" ABOVE FLOOR, EXCEPT AS OTHERWISE NOTED, MOUNT RECEPTACLES 2'-6" ABOVE FLOOR.
10. FOR STATION ORIENTATIONS AND CONDUIT ROUTINGS, SEE ELECTRICAL SITE PLANS ON SHEET E-1.
11. PROVIDE 3/4" FLEX, 2#12, 1#12 GND & 2#14 (PS) FOR EACH BUBBLER SYSTEM AIR COMPRESSOR.
12. PROVIDE CONDUIT WALL SEALS AT EACH CONDUIT PENETRATION INTO THE WETWELLS AND VALVE VAULTS.

-///- 3/4" CONDUIT WITH #12 AWG WIRES.
LONG SLASH LINES = QUANTITY OF PHASE/NEUTRAL WIRES.
SHORT SLASH LINES = QUANTITY OF EQUIPMENT GROUND WIRES.

RECORD DRAWING

Weston & Sampson ENGINEERS, INC.

No.	Date	Dr.By	Ck.By	App.By	Description
1	03/08	EWE	GAME	GAME	REVISED FOR RECORD DRAWING

REGISTERED PROFESSIONAL ENGINEER

TOWN OF SCITUATE, MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS
CLIFFS AREA SEWER PROJECT

PUMP STATIONS
PLANS AND DETAILS

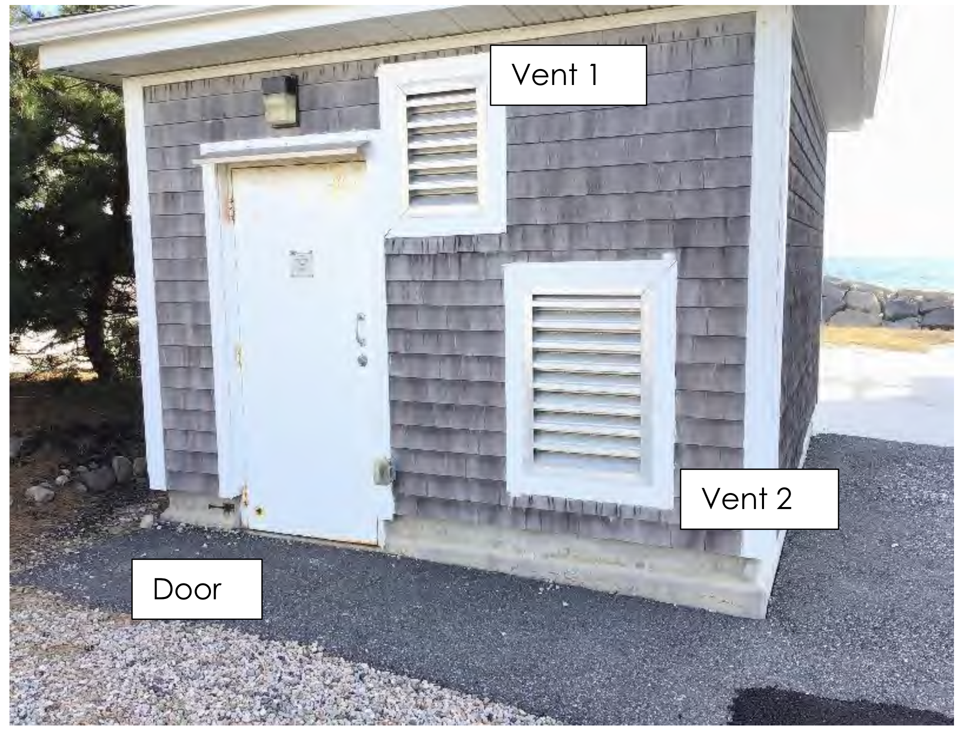
SCALE: NOTED — CONTRACT: 03-WW-01 — JOB NO. 201277 — DR.BY EWE — DSN.BY GAME — CHK.BY GAME
CADD NO. e04004 — FILE NO. 151-43

E-2

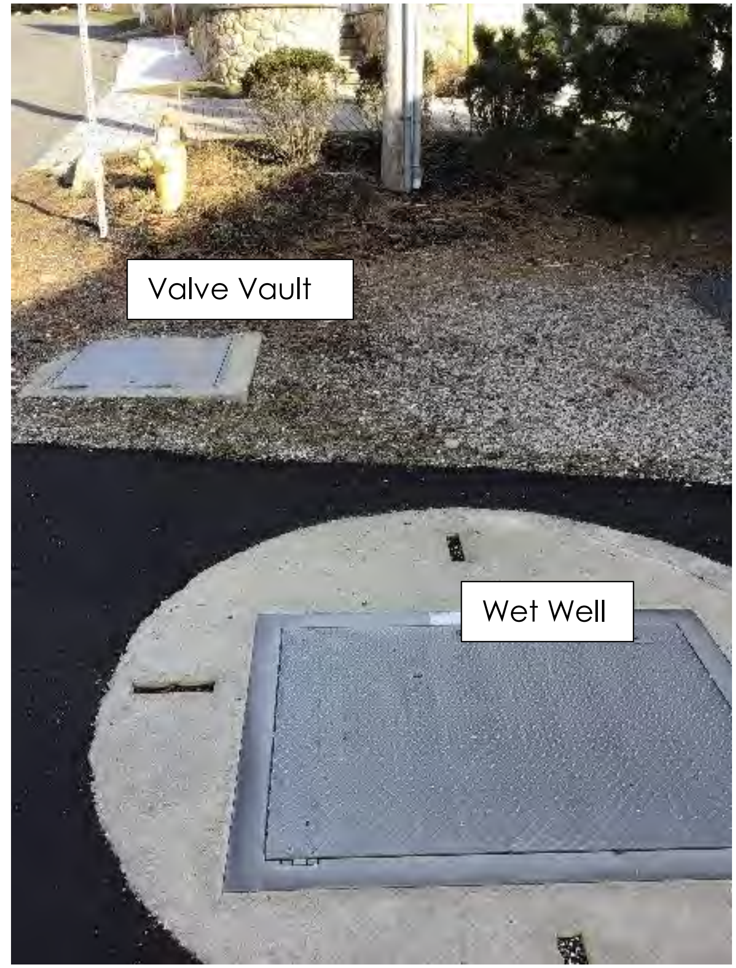
SHEET 46 OF 46

Collier Road Pump Station

Client Name: Town of Scituate	Site Location: Scituate Waste Treatment Plant Pump Stations	Project No. 01.0173977.00

Photo 1 Collier Road PS	**Photo 2** Collier Road PS Entrance
	

Collier Road Pump Station

Photo 3 Collier Road PS Exhaust Vents	**Photo 4** Collier road PS Wet Well Hatch
	

Collier Road Pump Station: Water Entry Elevation Table

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:		None Observed		
Doors (Personnel and Public):				
Personnel entryway		Door Threshold elev.	16.3±	15.5±
Vents:				
72'' x 36'' Vent	Vent 1	Bottom of Vent	19.4±	18.6±
15'' x 8'' Vent	Vent 2	Bottom of Vent	18.6±	17.8±
Other:				
Outside Electric Meter Panel		Lowest Elevation	16.7±	15.9±
Pipe Wall Penetrations to daylight or unsealed vaults/manholes	Manhole	Inlet Threshold Elevation	12.6±	11.8±
Exterior Stairs		Bottom of Step	12.7±	11.9±
Electrical Conduit North Wall Penetrations		Wall Penetration	18.5±	17.7±
Electrical Conduit East Wall Penetrations		Wall Penetration	18.2±	17.4±
Outside Gas Pressure Regulator		Lowest Elevation	12.8±	12.0±
Gas Connection		Wall Penetration	18.4±	17.6±
Generator Exhaust		Invert of Pipe	24.8±	24.0±
Roof Drain		Invert of Pipe	13.7±	12.9±
Wet well Manhole/Hatch Rim		Hatch/Rim Elevation	12.8±	12.0±
Wet well Vent Pipe		Pipe Outlet	19.5±	18.7±
Inside Generator Skid Top Elev.		Lowest Elevation	16.8±	16.0±

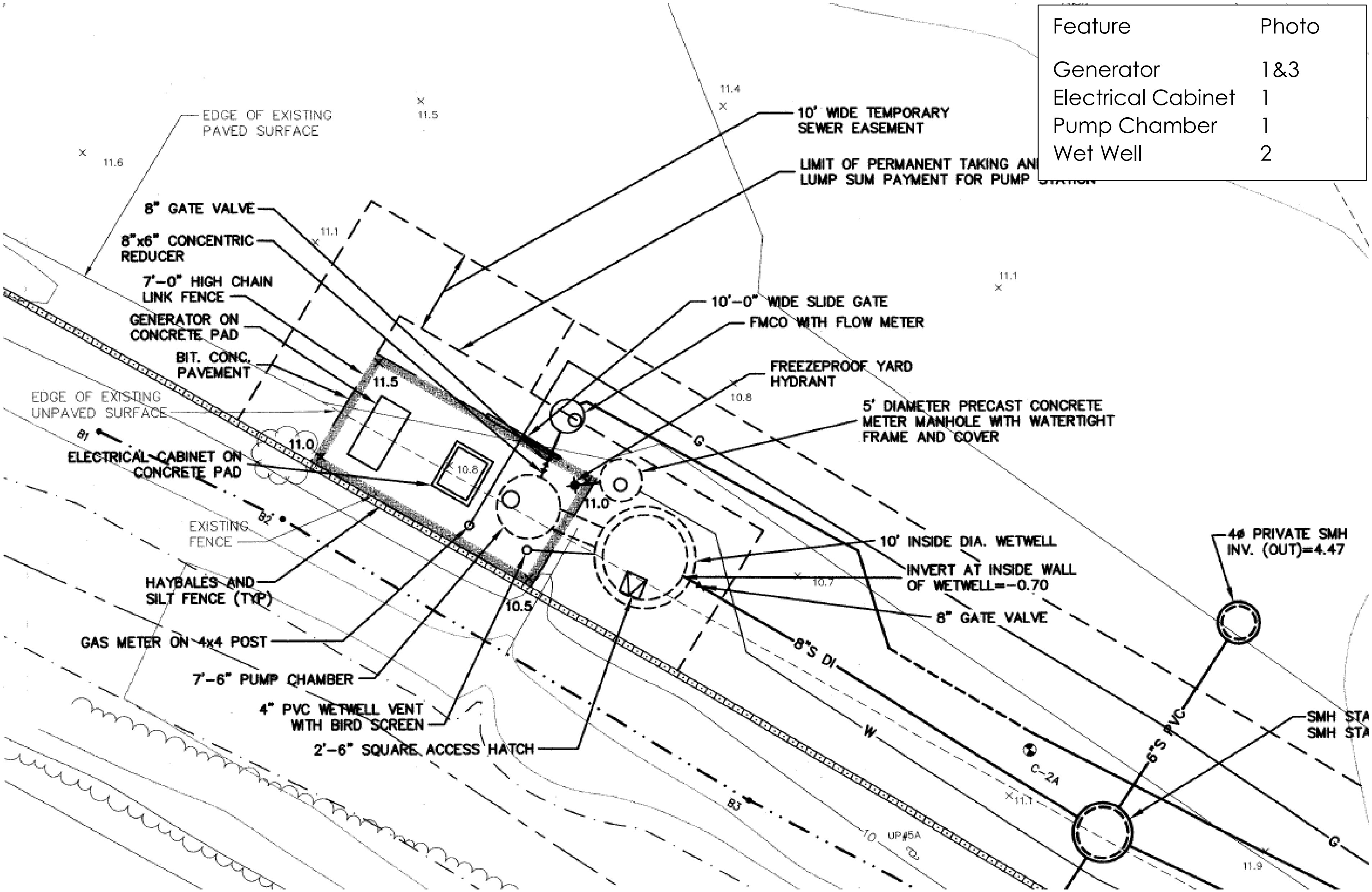
Herring Brook Pump Station:

Latitude: 42°10'37.5"N
Longitude: 70°44'54.4"W

Facility Location and Ground Surface Elevation:

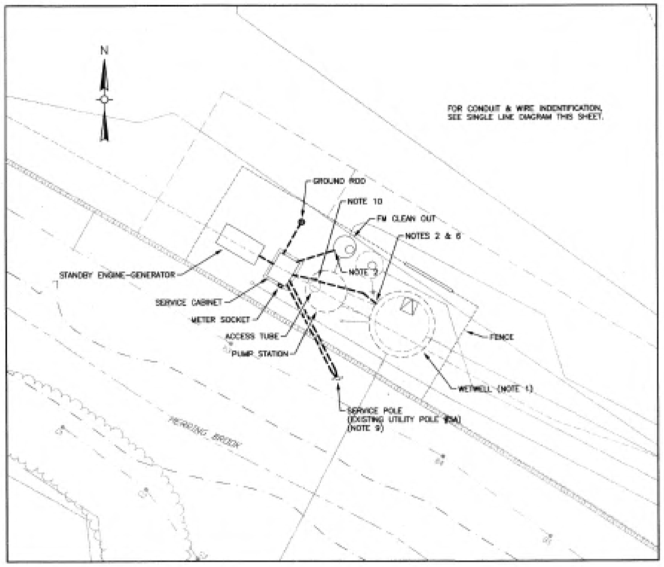
Site Location

Elevation, feet NAVD88



Feature	Photo
Generator	1&3
Electrical Cabinet	1
Pump Chamber	1
Wet Well	2

Source: C49 – Herring Brook Pump Station Site Plan



SITE PLAN
SCALE: 1"=10'

NOTES:

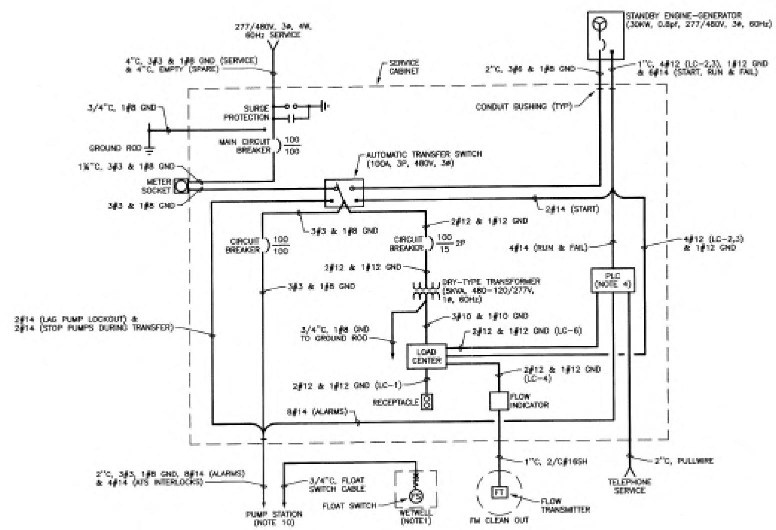
1. ALL MATERIALS AND INSTALLATIONS PROVIDED IN THE WETWELL SHALL CONFORM TO MASSACHUSETTS ELECTRICAL CODE REQUIREMENTS FOR CLASS 1, DIVISION 1, GROUP D HAZARDOUS LOCATIONS.
2. MAKE CONDUIT PENETRATIONS INTO THE WETWELL AND THE FM CLEAN OUT WITH CONDUIT WALL SEALS.
3. ALL WORK AND MATERIALS FOR THE ELECTRIC AND TELEPHONE SERVICES SHALL BE IN ACCORDANCE WITH THE UTILITY COMPANY REQUIREMENTS.
4. THE PLC SHALL BE FURNISHED UNDER SECTION 13450 AND INSTALLED UNDER DIVISION 16. MAKE ALL NECESSARY CONNECTIONS.
5. TERMINATE THE SPARE SERVICE CONDUIT 6" ABOVE FINISHED GRADE AT THE SERVICE POLE AND AT THE SERVICE CABINET USING THREADED REMOVEABLE CAPS.
6. TERMINATE THE CONDUIT IN THE WETWELL WITH AN EXPLOSIONPROOF CONDUIT SEAL FITTING AND A STRAIN-RELIEF, COMPRESSION TYPE CABLE BUSHING HAVING A GLAND SUITABLE FOR THE CONTROL CABLE FURNISHED.
7. FURNISH AND INSTALL A WARNING NAMEPLATE ON THE MAIN CIRCUIT BREAKER ENCLOSURE "CAUTION – TO COMPLETELY DISCONNECT SYSTEM, TURN OFF GENERATOR AND OPEN THIS BREAKER".
8. FOR COMPLETE SITE PLAN, SEE SHEET C-49.
9. FURNISH AND INSTALL ELECTRIC AND TELEPHONE SERVICE RISERS ON THE NOTED SERVICE POLE IN ACCORDANCE WITH THE UTILITY COMPANY REQUIREMENTS.
10. CONNECT THE NOTED CONDUITS TO THE FITTINGS PROVIDED ON THE PUMP STATION AND EXTEND THE ASSOCIATED WIRES TO THE PUMP STATION CONTROL PANEL. MAKE ALL NECESSARY CONNECTIONS IN THE CONTROL PANEL.
11. BOXES AND FITTINGS INSTALLED IN THE FM CLEAN OUT SHALL BE NEMA TYPE 4.

LOCATION: SERVICE CABINET

LOAD CENTER

SERVICE: 120/240V, 1Ø, 3W, 60Hz — 100 AMP MAINS
MOUNTING: SURFACE — 30 AMP MAIN CIRCUIT BREAKER

CKT #	CIRCUIT DESCRIPTION	LOAD		BREAKER	
		KW	HP	POLES	TRIP
1	RECEPTACLE	0.2		1	20
2	ENGINE HEATER	1.6		1	20
3	BATTERY CHARGER	0.1		1	20
4	FLOW INDICATOR	0.1		1	20
5	SPARE			1	20
6	PLC	0.1		1	20
7	SPARE			1	20
8	SPARE			1	20



SINGLE LINE DIAGRAM

RECORD DRAWING

Weston & Sampson ENGINEERS, INC.

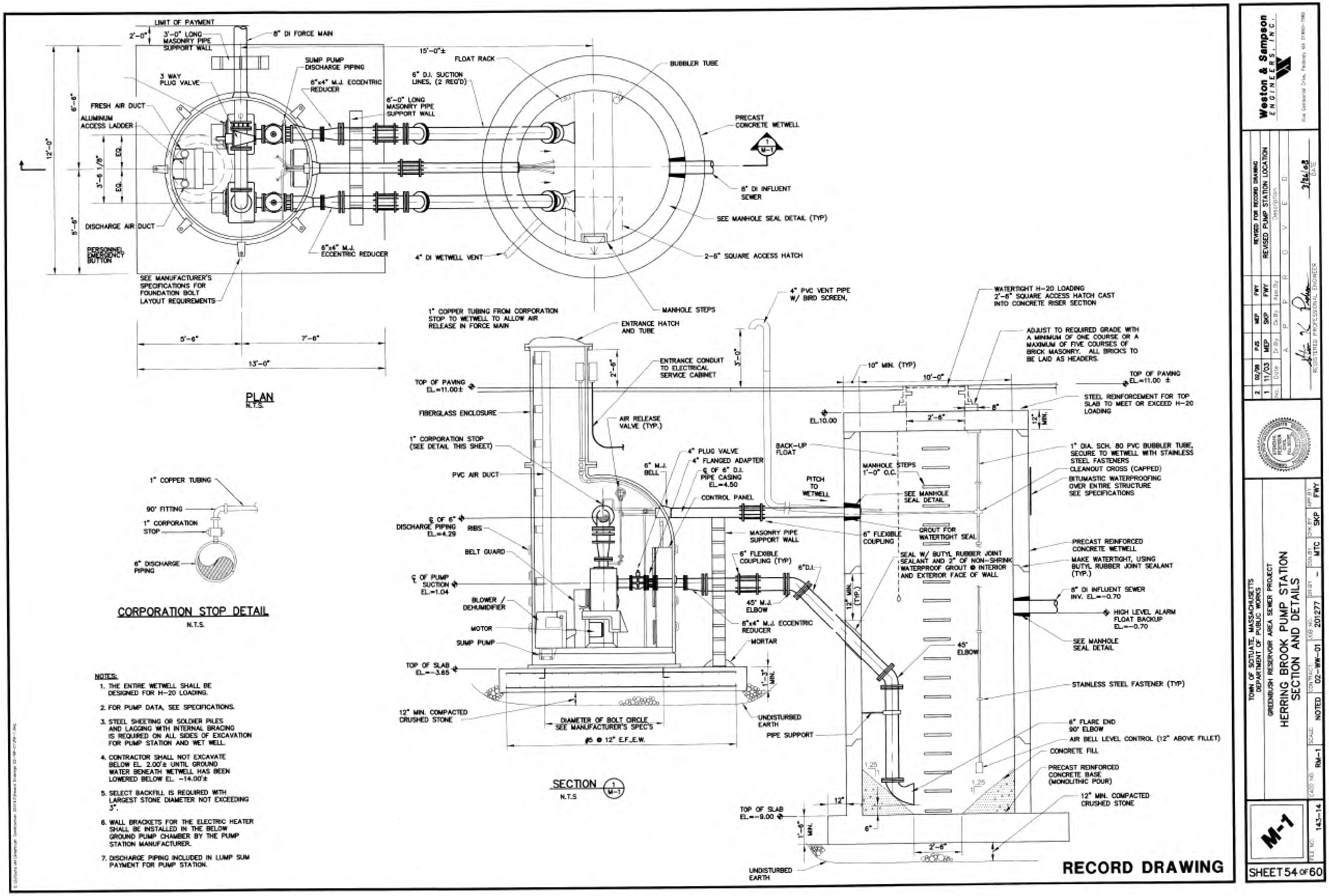
TOWN OF SCITUATE, MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS
GREENBUSH/RESERVOIR AREA SEWER PROJECT

HERRING BROOK PUMP STATION

E-1

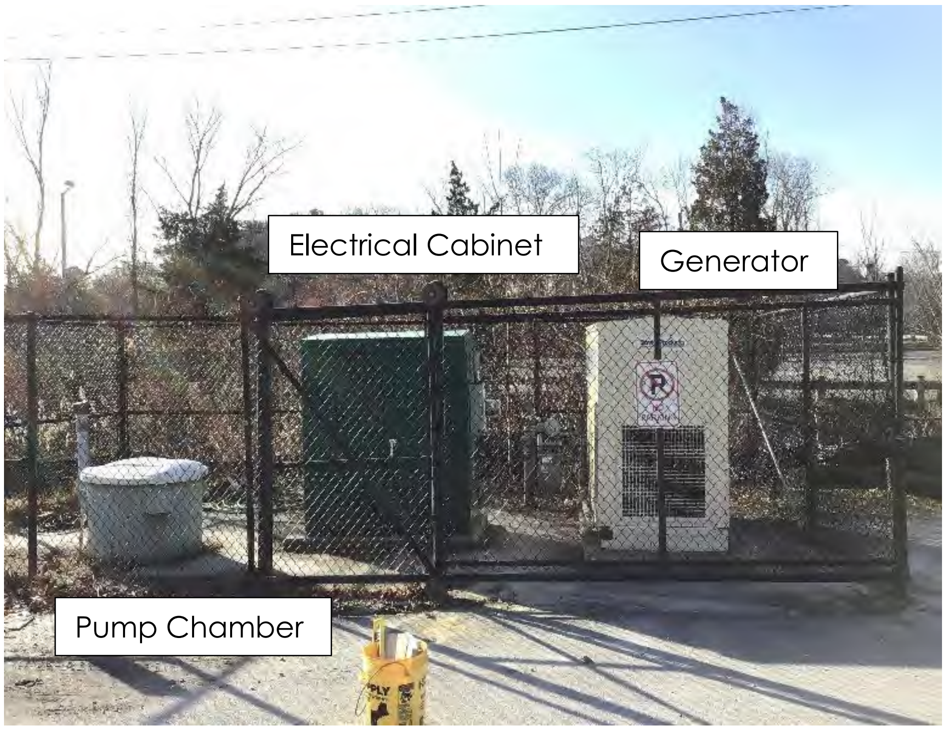
SHEET 58 OF 60

Herring Brook Pump Station



Herring Brook Pump Station

Client Name: Town of Scituate	Site Location: Scituate Waste Treatment Plant Pump Stations	Project No. 01.0173977.00

Photo 1 **Photo 25** Herring Brook PS	**Photo 2** **Photo 26** Herring Brook PS Wet Well
	

Herring Brook Pump Station

Photo 3 **Photo 27** Herring Brook PS Generator	**Photo 4** **Photo 28** Herring Brook PS Generator Elevation
	

Herring Brook Pump Station: Water Entry Elevation Table

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:		None Observed		
Doors (Personnel and Public):		None Observed		
Vents:		None Observed		
Other:				
Outside Electric Meter Panel		Lowest Elevation	13.8±	13.0±
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Exterior Stairs		None Observed		
Electrical Conduit Wall Penetrations:		None Observed		
Outside Gas Pressure Regulator		Lowest Elevation	11.8±	11.0±
Gas Connection		None Observed		
Generator Exhaust		Invert of Pipe	17.8±	17.0±
Wet well Manhole/Hatch Rim		Hatch/Rim Elevation	10.6±	9.8±
Wet well Vent Pipe		Pipe Outlet	13.8±	13.0 ±
Generator Skid Top Elev.		Lowest Elevation	10.7±	9.9±

Musquashicut Avenue Pump Station:

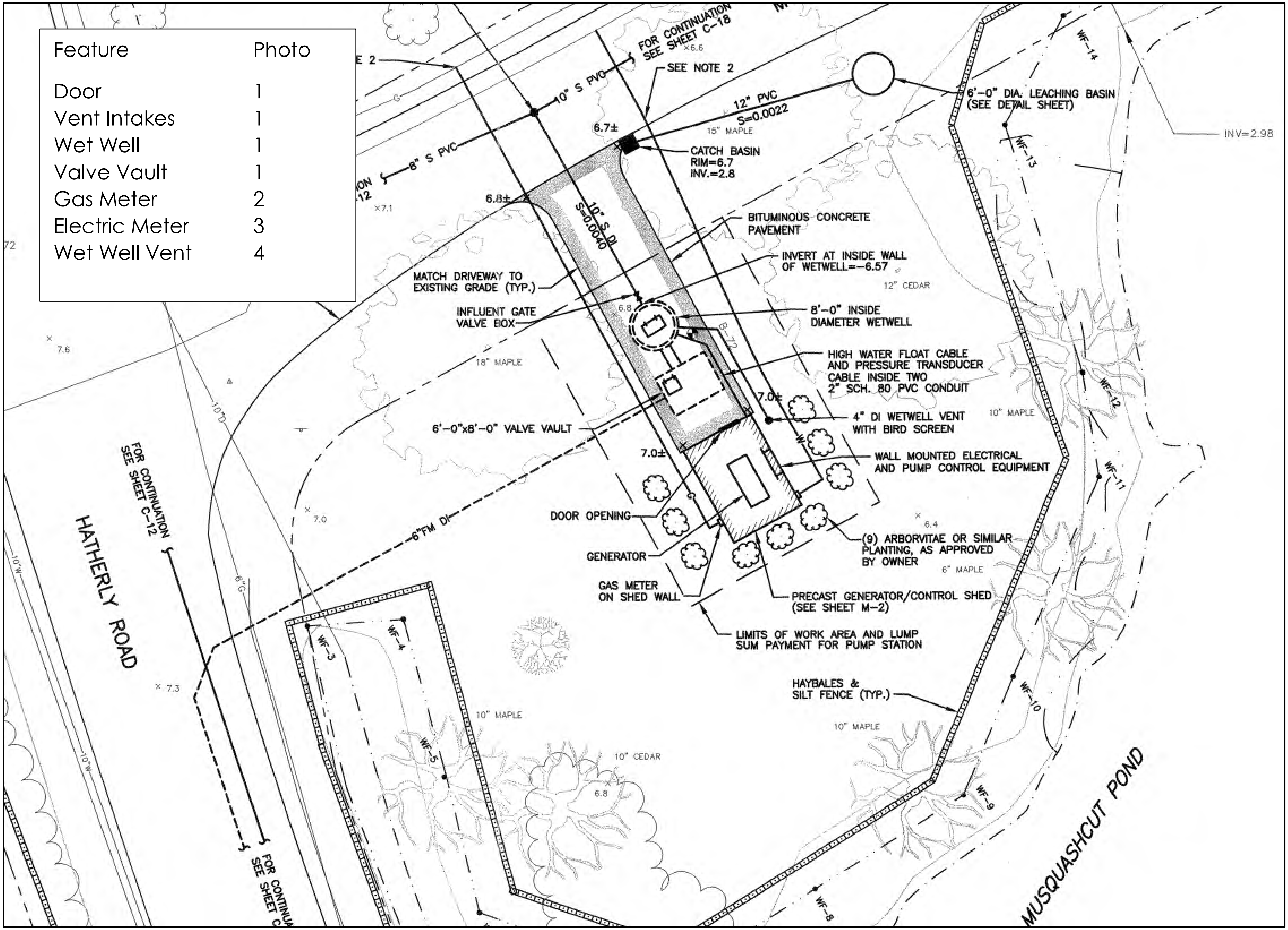
Latitude: 42°13'47.1"N
Longitude: 70°45'46.7"W

Facility Location and Ground Surface Elevation:

Site Location

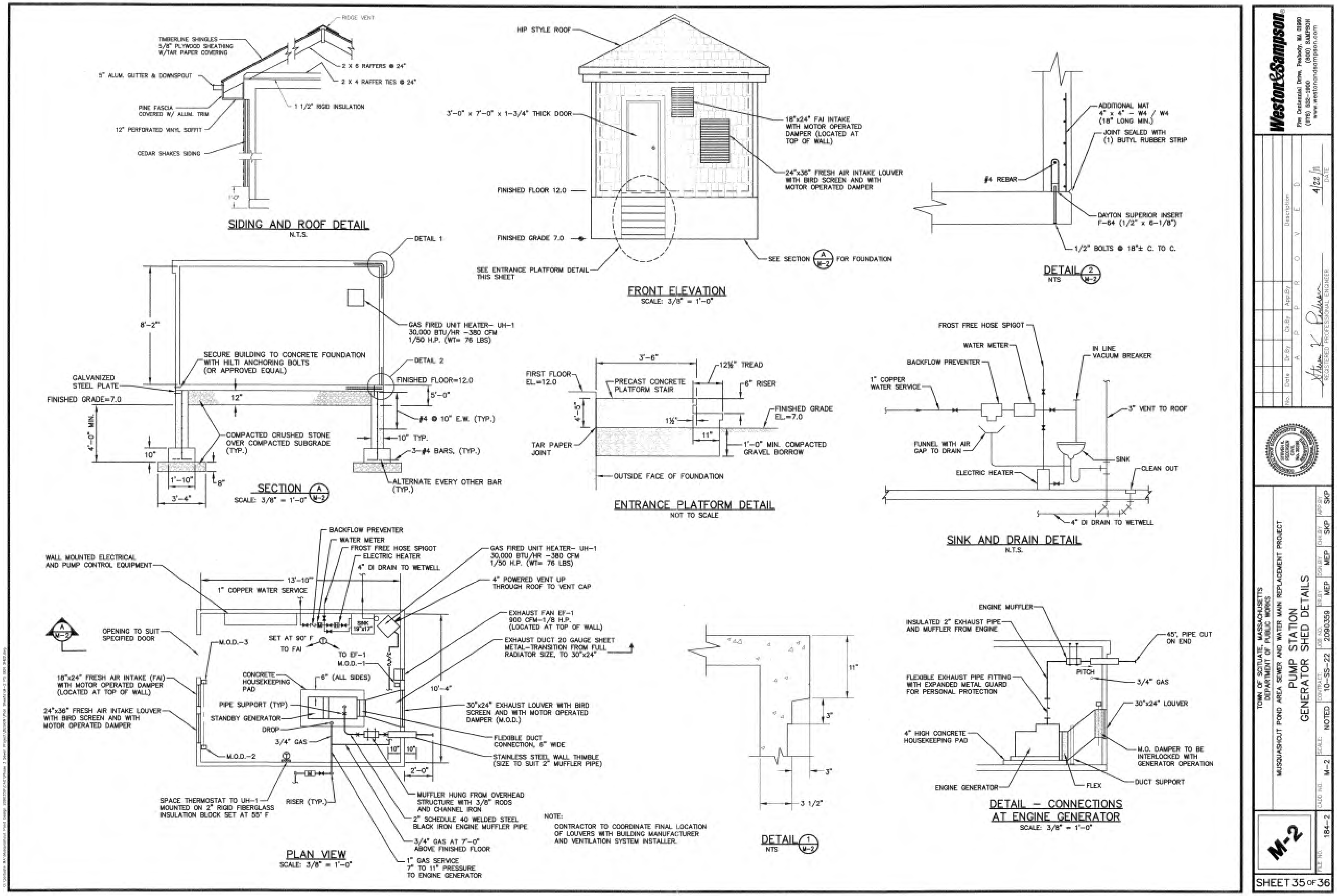
Elevation, feet NAVD88

Feature	Photo
Door	1
Vent Intakes	1
Wet Well	1
Valve Vault	1
Gas Meter	2
Electric Meter	3
Wet Well Vent	4

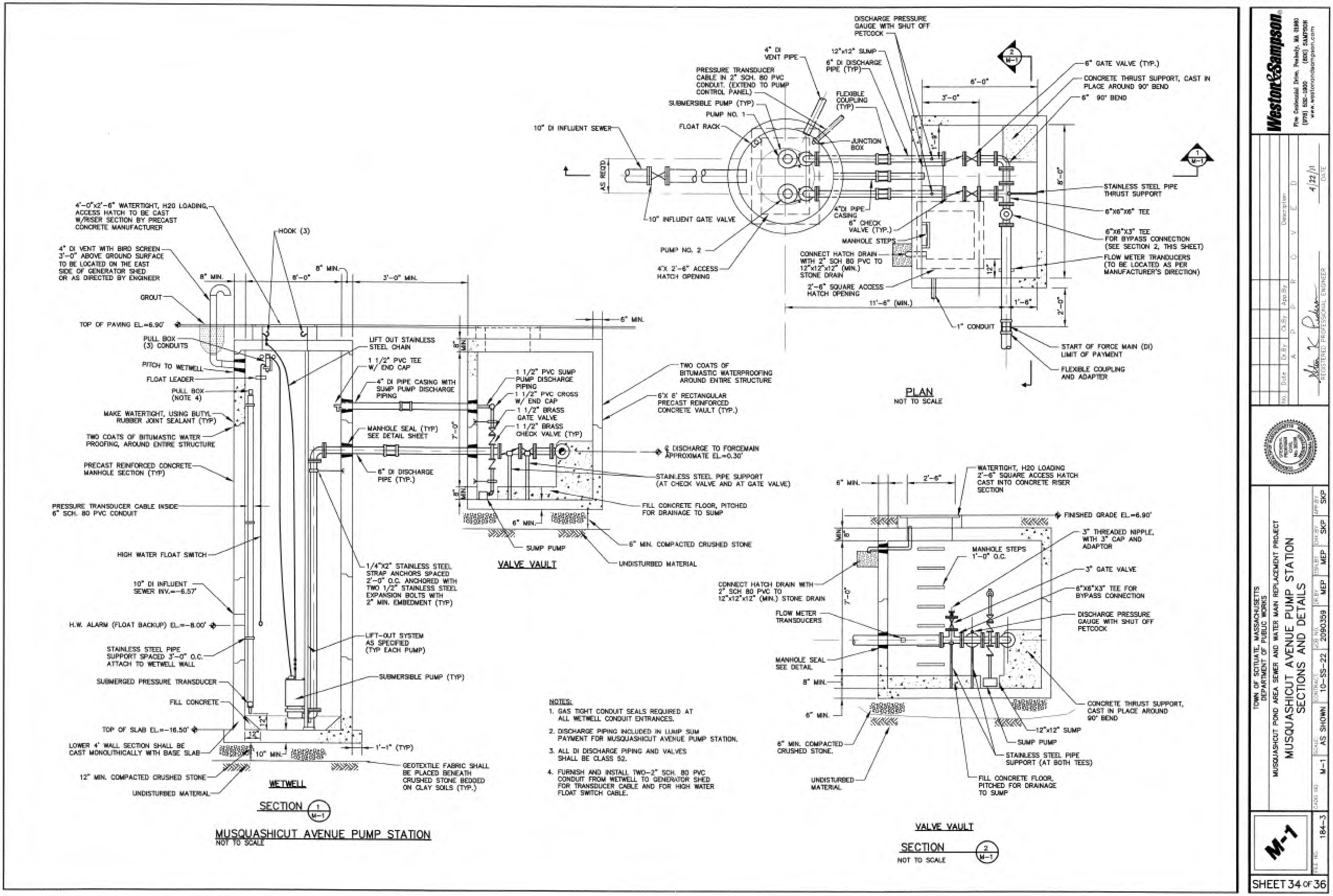


Source: C-31 Musquashcut Avenue Pump Station Site Plan

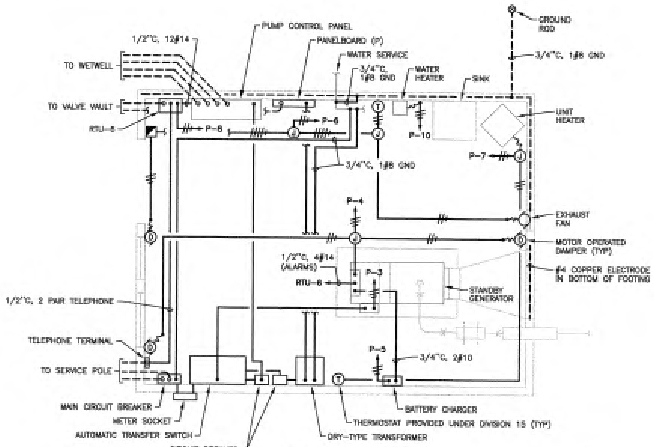
Musquashicut Avenue Pump Station



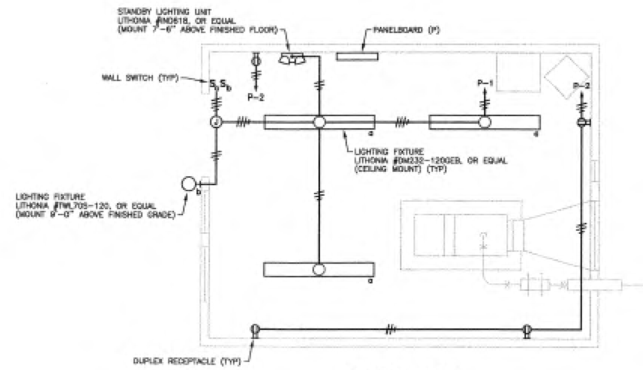
Musquashicut Avenue Pump Station



Musquashicut Avenue Pump Station



POWER PLAN
SCALE: 1/2"=1'-0"

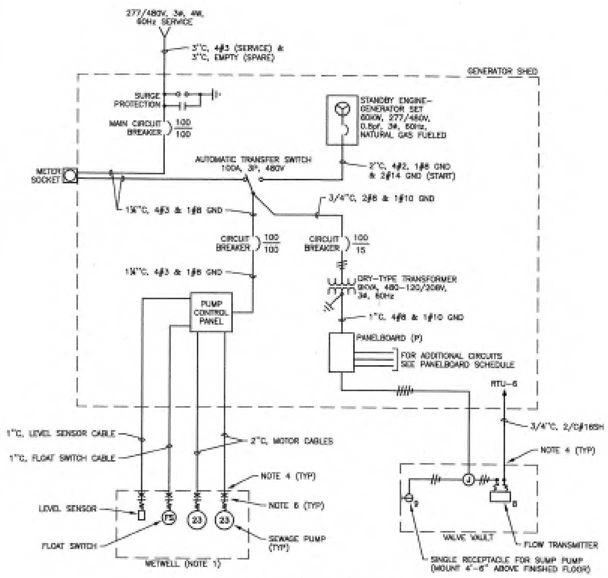


LIGHTING PLAN
SCALE: 1/2"=1'-0"

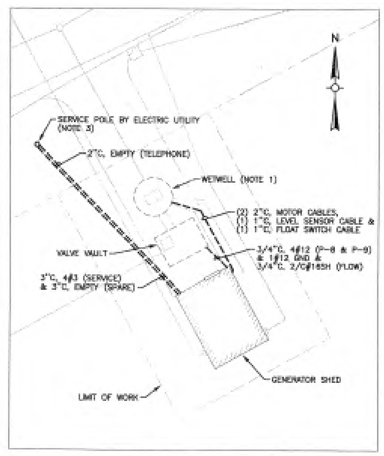
NOTES:

1. PROVIDE ALL MATERIALS AND INSTALLATIONS IN THE WETWELL IN ACCORDANCE WITH MASSACHUSETTS ELECTRICAL CODE REQUIREMENTS FOR CLASS I, DIVISION 1, GROUP D HAZARDOUS LOCATIONS.
2. PROVIDE ALL WORK AND MATERIAL FOR THE ELECTRIC AND TELEPHONE SERVICES IN ACCORDANCE WITH UTILITY COMPANY REQUIREMENTS.
3. PROVIDE ELECTRIC AND TELEPHONE CONDUIT RISERS ON THE NOTED SERVICE POLE IN ACCORDANCE WITH UTILITY COMPANY REQUIREMENTS.
4. MAKE CONDUIT PENETRATIONS INTO THE WETWELL AND VALVE VAULT WITH CONDUIT WALL SEALS.
5. TERMINATE THE SPARE SERVICE CONDUIT 6 INCHES ABOVE GRADE AT THE SERVICE POLE AND AT THE MAIN CIRCUIT BREAKER USING NEOPRENE PLUGS OR THREADED, REMOVABLE CAPS.
6. TERMINATE CONDUITS IN THE WETWELL WITH EXPLOSIONPROOF CONDUIT SEAL FITTINGS AND STRAIN-RELIEF, COMPRESSION TYPE BUSHINGS HAVING GLANDS SUITABLE FOR THE MOTOR AND CONTROL CABLES FURNISHED.
7. PROVIDE A WARNING NAMEPLATE ON THE MAIN CIRCUIT BREAKER ENCLOSURE MARKED "CAUTION – TO COMPLETELY DISCONNECT SYSTEM, TURN OFF GENERATOR AND OPEN THIS BREAKER".
8. FOR THE COMPLETE SITE PLAN, SEE SHEET C-31.
9. BOXES AND ENCLOSURES SHALL BE NEMA TYPE 12 EXCEPT PANELBOARD BOXES AND AUTOMATIC TRANSFER SWITCH ENCLOSURE SHALL BE NEMA TYPE 1.
10. THE NOTED THERMOSTATS SHALL BE PROVIDED UNDER DIVISION 15.
11. PROVIDE THE NOTED MANUAL MOTOR STARTER WITH A HAND-OFF-AUTO SELECTOR SWITCH.

3/4" CONDUIT WITH #12 AWG WIRES.
LONG SLASH LINES = QUANTITY OF PHASE/NEUTRAL WIRES.
SHORT SLASH LINES = QUANTITY OF EQUIPMENT GROUND WIRES.



SINGLE LINE DIAGRAM



SITE PLAN
SCALE: 1"=10'

PANELBOARD (P)					
SERVICE: 120/208V, 3Ø, 4W, 60Hz MOUNTING: SURFACE				100 AMP MAINS 40 AMP MAIN CIRCUIT BREAKER	
CKT #	CIRCUIT DESCRIPTION	LOAD		BREAKER	
		KW	HP	POLES	TRIP
1	LIGHTING	0.4		1	20
2	RECEPTACLES	0.8		1	20
3	ENGINE HEATER	1.5		1	20
4	ENGINE DAMPER	0.1		1	20
5	BATTERY CHARGER	0.1		1	20
6	EXHAUST FAN		0.13	1	15
7	UNIT HEATER	0.1		1	15
8	INSTRUMENTATION	0.1		1	20
9	VALVE VAULT SUMP PUMP		0.5	1	20
10	WATER HEATER	1.0		1	20
11	SPARE			1	20
12	SPARE			1	20
13	----SPACE----			1	--
14	----SPACE----			1	--
15	----SPACE----			1	--
16	----SPACE----			1	--

Weston&Sampson
Five Centennial Drive, Peabody, MA 01960
(978) 532-1900 (800) SAMPSON
www.westonandsampson.com

No.	Date	Dr.By	Ck.By	App.By	Description

A P P R O V E D

REGISTERED PROFESSIONAL ENGINEER — DATE

TOWN OF SCITUATE, MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS
MUSQUASHCUT POND AREA SEWER AND WATER MAIN REPLACEMENT PROJECT

PLANS AND DETAILS

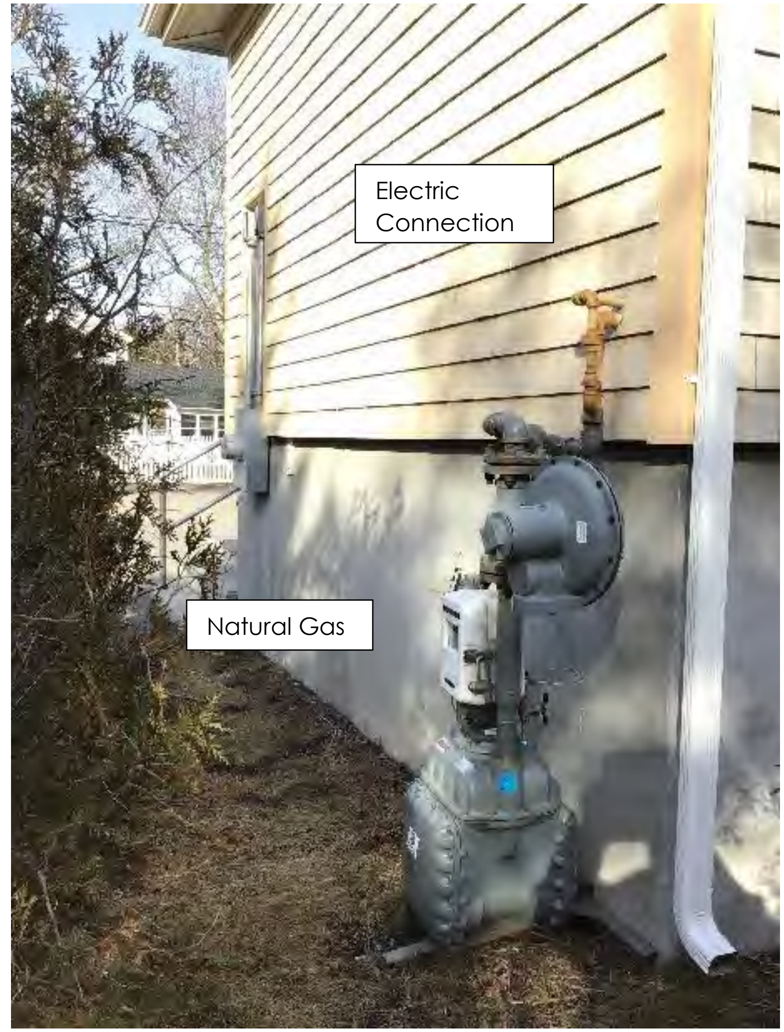
FILE NO.	CADD NO.	SCALE	CONTRACT	JOB NO.	DR.BY	DSN.BY	CHK.BY	APP.BY
184-1	e10010	NOTED	10-SS-22	2090359	EWE	GAWE	GAWE	SKP

E-1

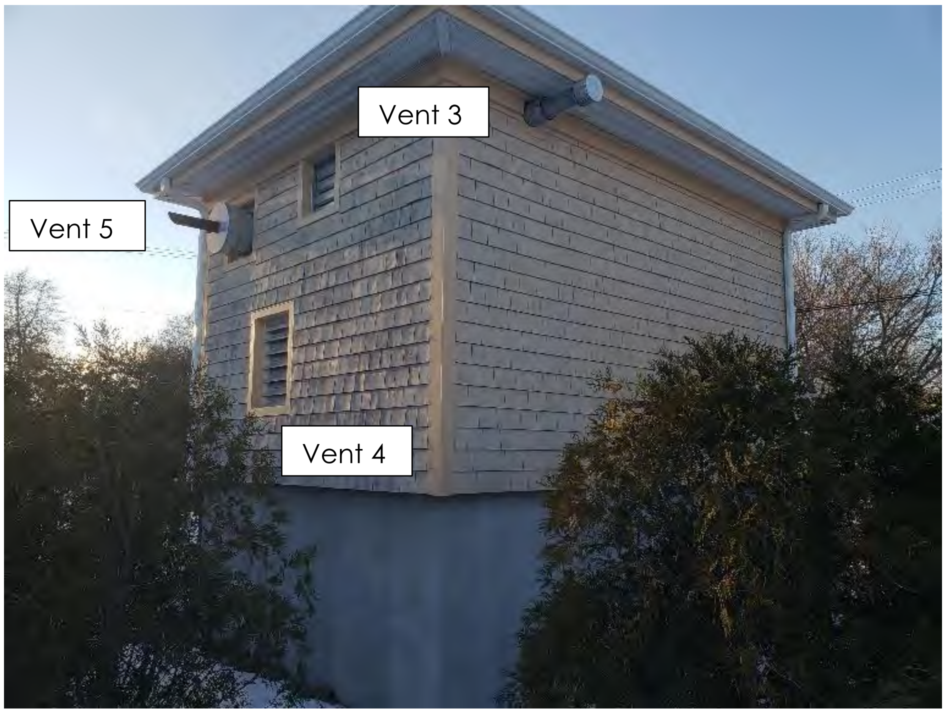
SHEET 36 OF 36

Musquashicut Avenue Pump Station

Client Name: Town of Scituate	**Site Location:** Scituate Waste Treatment Plant Pump Stations	**Project No.** 01.0173977.00

Photo 1 Musquashicut Avenue PS Entrance	**Photo 2** Musquashicut Avenue PS gas Meter
	

Client Name: Town of Scituate	Site Location: Scituate Waste Treatment Plant Pump Stations	Project No. 01.0173977.00

Photo 3 Musquashicut Avenue Exhaust Vents	Photo 4 East Side of Musquashicut Avenue PS
	

Musquashicut Avenue Pump Station: Water Entry Elevation Table

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:		None Observed		
Doors (Personnel and Public):				
Personnel entryway		Door Threshold elev.	12.4±	11.6±
Vents:				
18’’ x 24 Fresh Air Intake	Vent 1	Bottom of Vent	18.4±	17.6±
24’’ x 36’’ Fresh Air Intake	Vent 2	Bottom of Vent	14.2±	13.4±
20’’ x 20 Fresh Air Intake	Vent 3	Bottom of Vent	19.1±	18.3±
24’’ x 30’’ Exhaust Louver	Vent 4	Bottom of Vent	13.4±	12.6±
20’’ x 20 Muffler Vent	Vent 5	Bottom of Vent	19.4±	18.6±
Other:				
Outside Electric Meter Panel		Lowest Elevation	11.2±	10.4±
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Exterior Stairs		Bottom Step	7.9±	7.1±
Electrical Conduit Wall Penetrations:		None Observed		
Outside Gas Pressure Regulator		Lowest Elevation	7.9±	7.1±
Gas Connection		Wall Penetration	13.2±	12.4±
Generator Exhaust		Invert of Pipe	19.5±	18.7±
Wet well Manhole/Hatch Rim		Hatch/Rim Elevation	7.9±	7.1±
Wet well Vent Pipe		Pipe Outlet	12.7±	11.9±
Inside Generator Skid Top Elev.		Lowest Elevation	12.9±	12.1±

Sand Hills Pump Station:

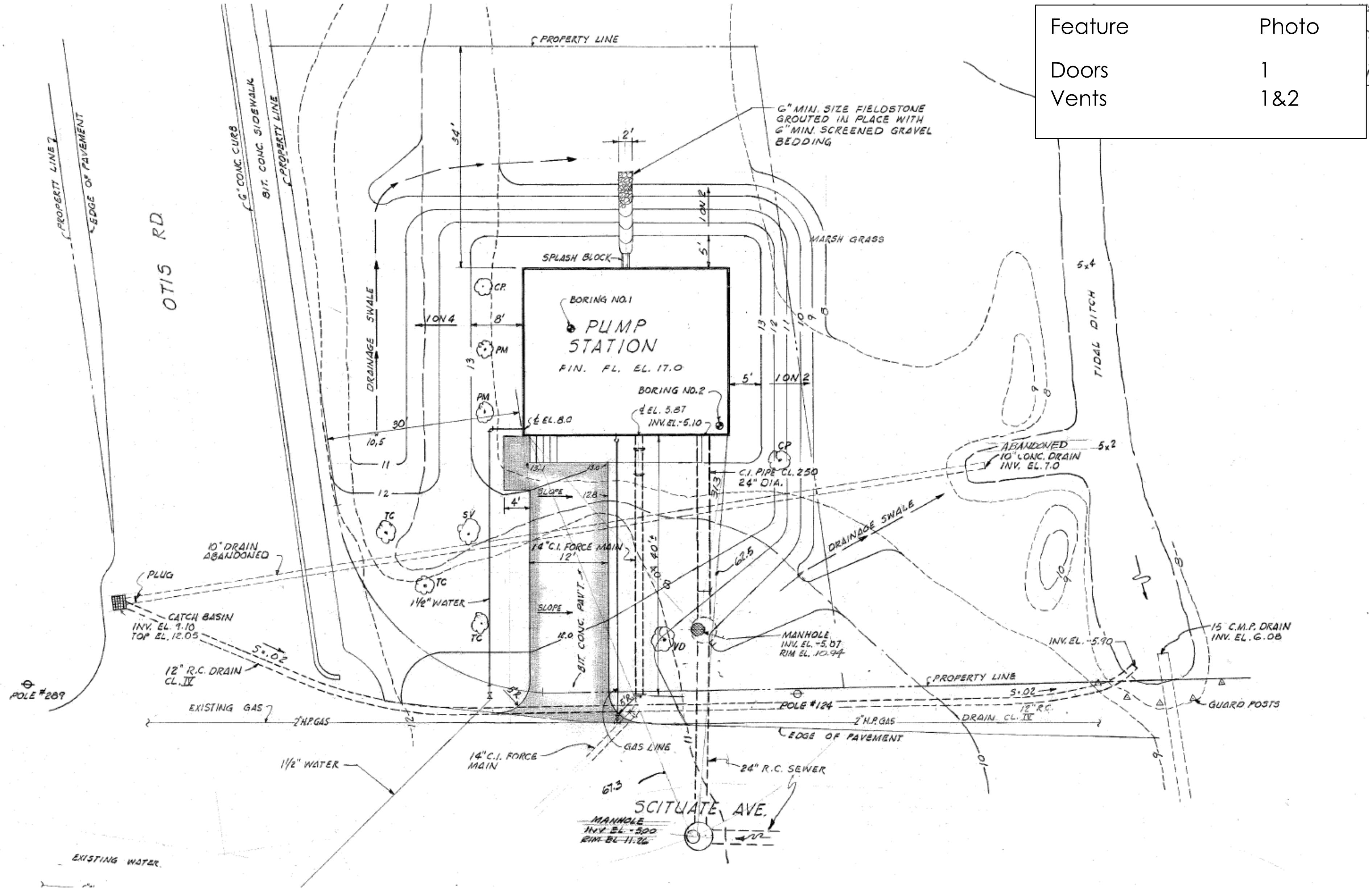
Latitude: 42°12'29.2"N
Longitude: 70°43'33.0"W

Facility Location and Ground Surface Elevation:

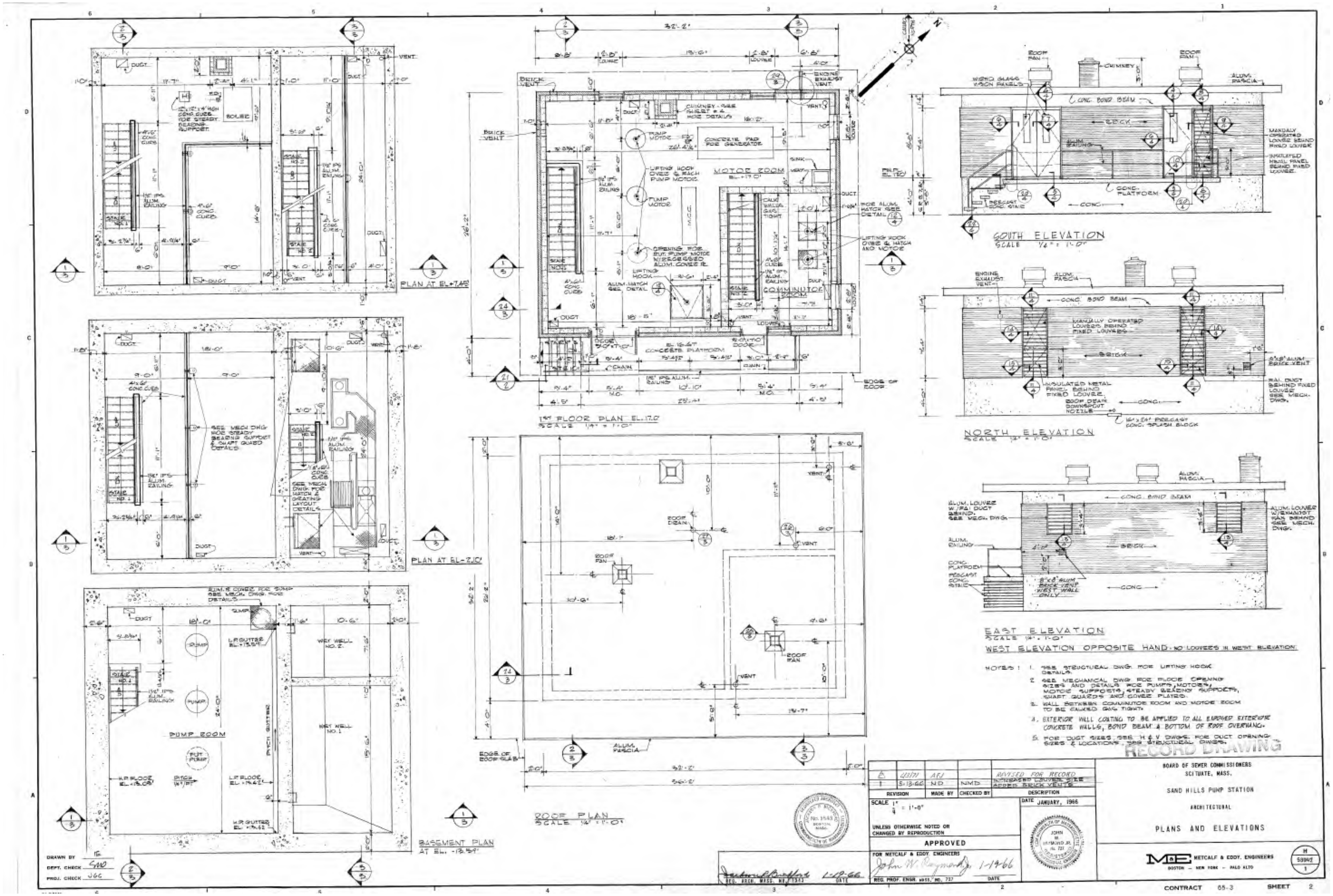
Site Location

Elevation, feet NAVD88

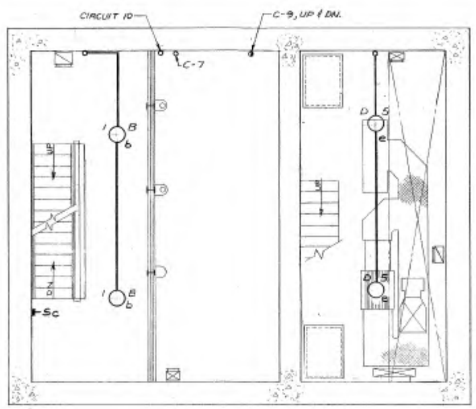
Feature	Photo
Doors	1
Vents	1&2



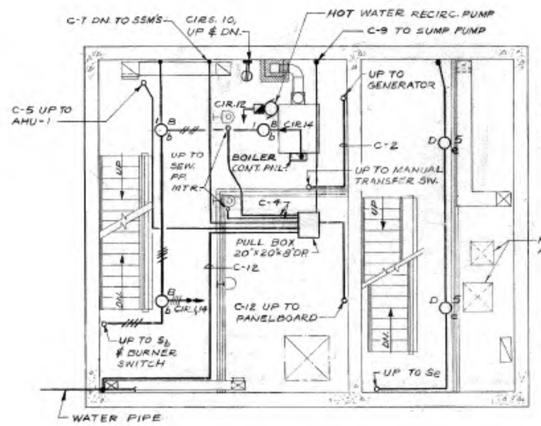
Source: Sheet 1 – Sand Hill Pump Station Civil Site Plan



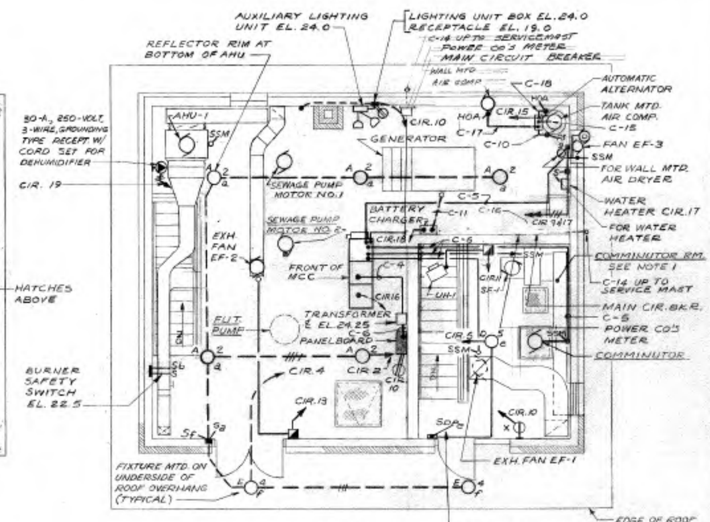
Sand Hills Pump Station



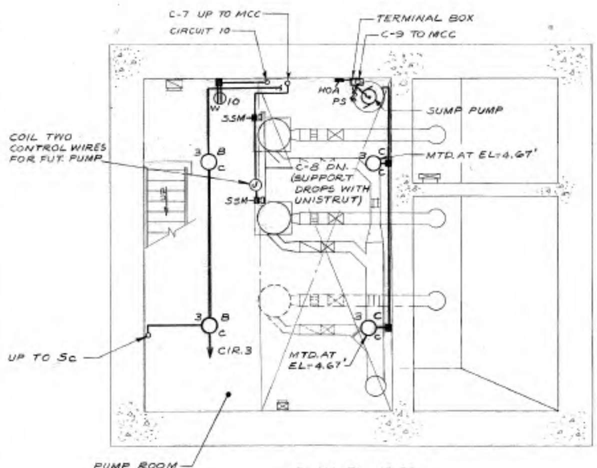
PLAN EL.- 2.10
SCALE: 1/4" = 1'-0"



PLAN EL. +7.45'
SCALE: 1/4" = 1'-0"



PLAN EL.+ 17.0'
SCALE: 1/4" = 1'-0"



PLAN EL.-13.59
SCALE: 1/4" = 1'-0"

LIGHTING FIXTURE SCHEDULE

FIXTURE TYPE	FIXTURE MTG	LAMP TYPE	LAMP WATTS	MANUFACTURER & CATALOG NUMBER	
A	CEIL.	INC.	300	BENJAMIN — C-1804	
B	CEIL.	INC.	200	6562	VAPORTIGHT
C	WALL	INC.	200	7124-X	VAPORTIGHT
D	CEIL.	INC.	300	7554-CX	EXPLOSIONPROOF
E	SURF.	INC.	2-100	McPHILBEN 43-85	WEATHERPROOF

WIRE AND CONDUIT SCHEDULE

CONDUIT NO.	CONDUIT SIZE	CABLE NO.	CABLE SIZE	REMARKS
C-1	1½	3	2	SERVICE
C-2	1¼	3	4	GENERATOR LEADS
C-3				
C-4	3/4	3	10	POWER
C-5	3/4	3	12	POWER
		2	19/25	CONTROL
C-6	1¼	4	6	TRANSF. SECONDARY
C-7	1	6	19/25	CONTROL
C-8	3/4	2	19/25	CONTROL
C-9	1	3	12	POWER
		3	19/25	CONTROL
C-10	3/4	4	19/25	CONTROL
C-11	3/4	2	10	D.C. BATTERY SUPPLY
C-12	3/4	1	6	GROUND
C-13	3/4	1	2	THW - POWER CO'S NEUTRAL
C-14	3	3	2	SERVICE
		1	2	THW - POWER CO'S NEUTRAL
C-15	3/4	2	12	
C-16	2	4	2	SERVICE
C-17	3/4	2	12	
		3	19/25	
C-18	3/4	3	19/25	

NOTES:

1. ALL ELECTRICAL EQUIPMENT, INCLUDING CONDUIT AND FITTINGS USED WITHIN THE COMMINUTOR ROOM - BOTH UPPER AND LOWER AREAS - SHALL COMPLY WITH THE LATEST REQUIREMENTS OF THE NATIONAL ELECTRICAL CODE FOR HAZARDOUS LOCATIONS, CLASS I, DIVISION I, GROUP D.
2. ALL CONDUIT PENETRATIONS IN COMMINUTOR ROOM SHALL HAVE EXPLOSION-PROOF FITTINGS. WALL PENETRATIONS SHALL BE THROUGH SLEEVES - CAULKED GAS TIGHT.
3. FOR SYMBOLS AND GENERAL NOTES SEE E-2.
4. ALL ENCLOSURES USED BELOW THE MOTOR ROOM SHALL BE NEMA TYPE 4.
5. ALL CONDUIT BELOW EL. 17.0 SHALL BE RUN EXPOSED.

RECORD DRAWING

REVISION		MADE BY	CHECKED BY	DESCRIPTION
2	6/3/71	AFJ		REVISED FOR RECORD
1	5-16-66	J.L.M.	RNC	ADDED SF-1, UH-1 & DEHUMIDIFIER DELETED AHU-1, CHANGED EF-1

SCALE AS SHOWN
UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

DATE JANUARY, 1966

APPROVED
FOR METCALF & EDDY, ENGINEERS
John W. Raymond, Jr. 1-19-66
REG. PROF. ENGR. MASS. NO. 727 DATE

COMMONWEALTH OF MASSACHUSETTS JOHN W. RAYMOND JR. No. 727 REGISTERED PROFESSIONAL ENGINEER

BOARD OF SEWER COMMISSIONERS
SCITUATE, MASS.

SAND HILLS PUMP STATION

ELECTRICAL

PLANS

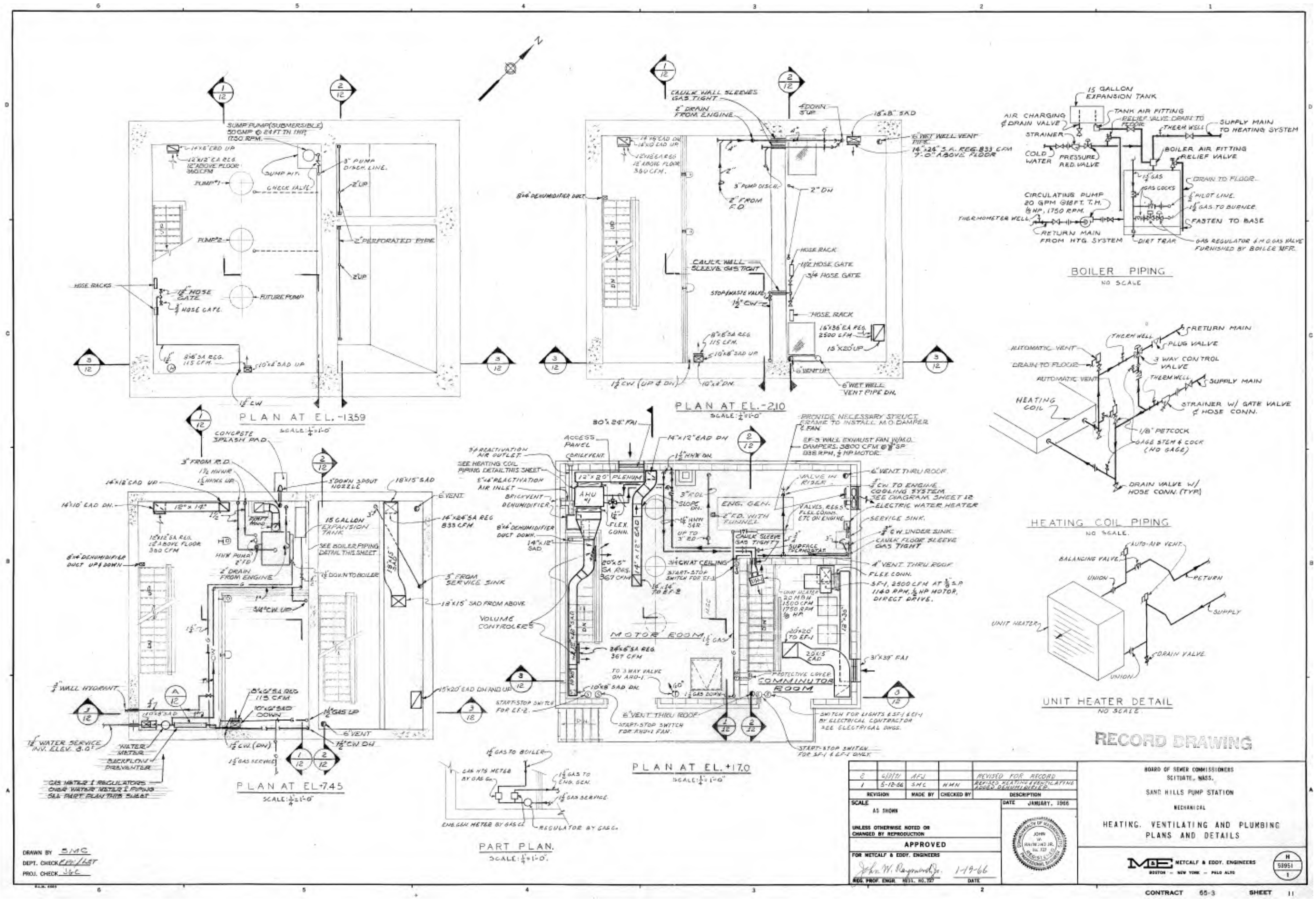
M&E METCALF & EDDY, ENGINEERS
BOSTON — NEW YORK — PALO ALTO

H 53953 1

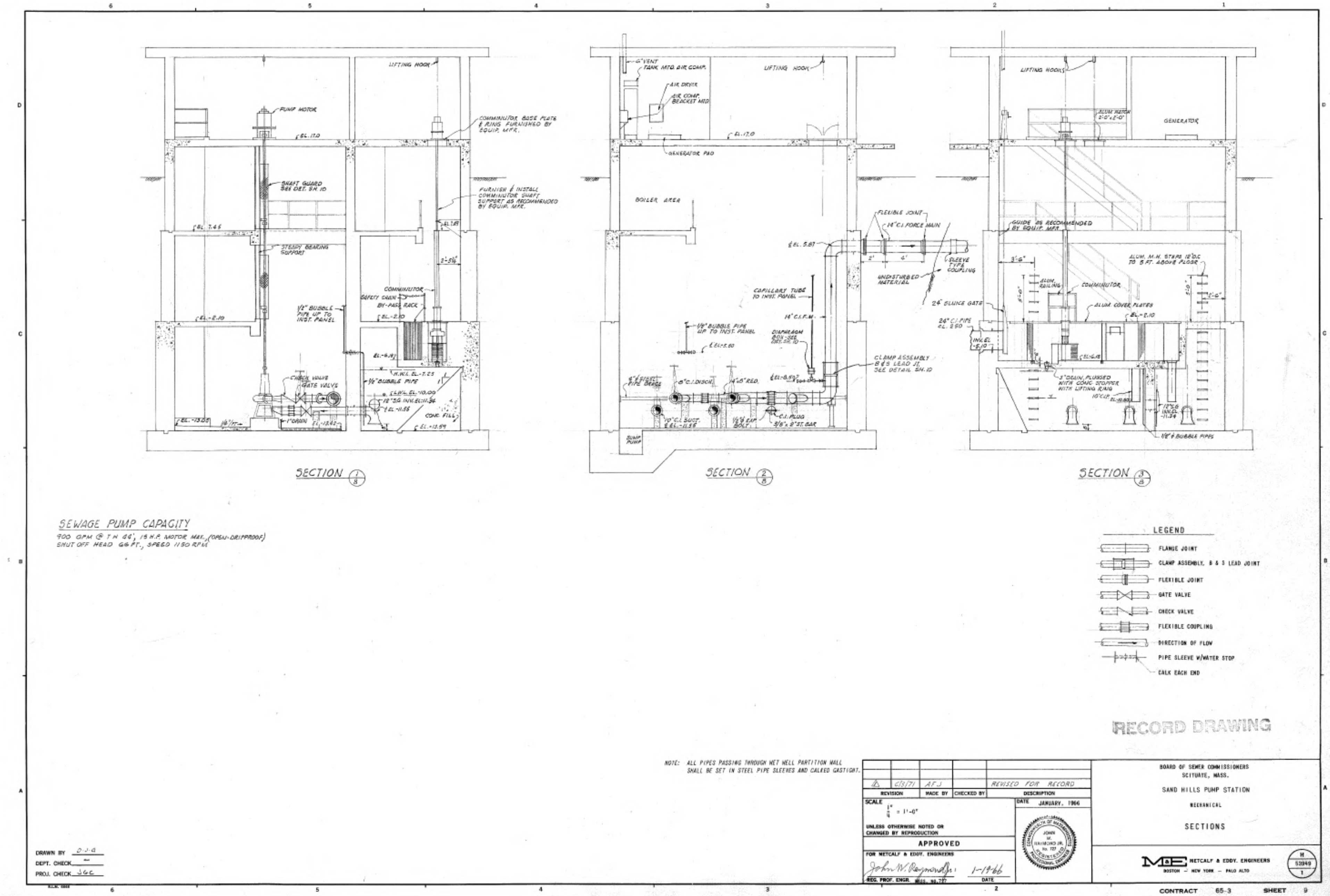
DRAWN BY RJC & RNC
DEPT. CHECK RNC
PROJ. CHECK JGC

CONTRACT 65-3 SHEET 13

Sand Hills Pump Station

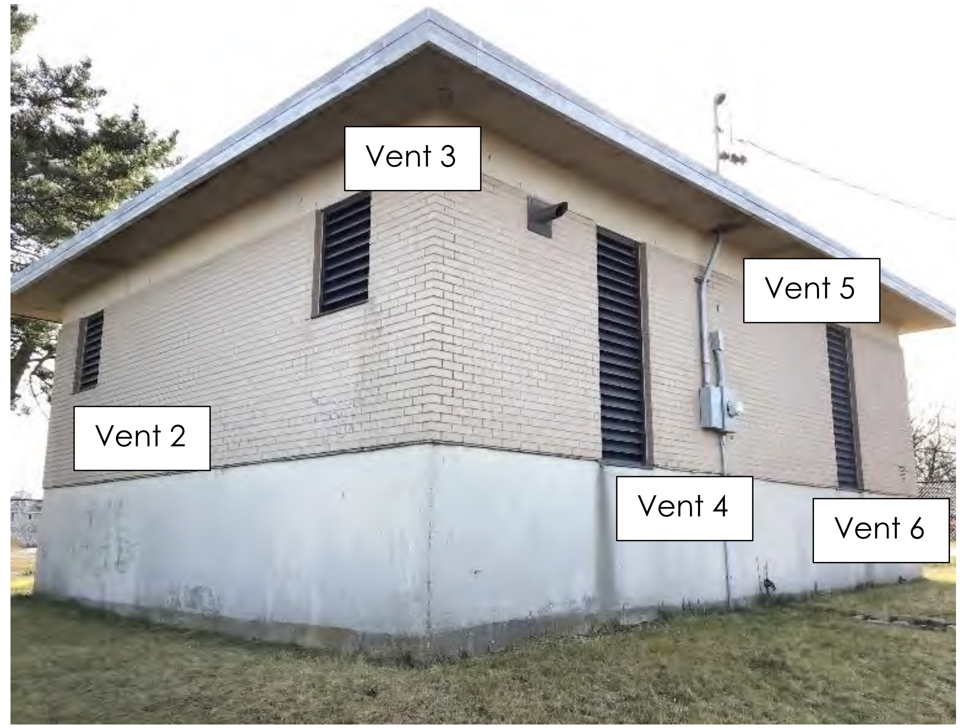


Sand Hills Pump Station



Sand Hills Pump Station

Client Name: Town of Scituate	Site Location: Scituate Waste Treatment Plant Pump Stations	Project No. 01.0173977.00

Photo 1 **Photo 21** Sand Hills PS	**Photo 2** **Photo 22** Sand Hills PS North and East Sides
	

Sand Hills Pump Station

Photo 3 **Photo 23** Sand Hill PS West Side	**Photo 4** **Photo 24** Sand Hill PS Electric Meter
	

Sand Hills Pump Station: Water Entry Elevation Table

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:		None Observed		
Doors (Personnel and Public):				
Personnel entryway	1	Door Threshold elev.	12.2±	11.4±
Personnel entryway	2	Door Threshold elev.	12.2±	11.4±
Vents:				
18'' x 88'' Vent	Vent 1	Bottom of Vent	12.2±	11.4±
28'' x 40'' Vent	Vent 2	Bottom of Vent	16.7±	15.9±
28'' x 40'' Vent	Vent 3	Bottom of Vent	16.7±	15.9±
28'' x 88'' Vent	Vent 4	Bottom of Vent	12.2±	11.4±
28'' x 88'' Vent	Vent 5	Bottom of Vent	12.2±	11.4±
8'' x 8'' Vent	Vent 6	Bottom of Vent	12.4±	11.6±
8'' x 8'' Vent	Vent 7	Bottom of Vent	14.0±	13.2±
Other				
Outside Electric Meter Panel		Lowest Elevation	13.9±	13.1±
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Exterior Stairs		Bottom of Step	8.1±	7.3±
Electrical Conduit North Wall Penetrations		Wall Penetration	19.3±	18.5±
Electrical Conduit East Wall Penetrations		Wall Penetration	16.1±	15.3±
Outside Gas Pressure Regulator		Lowest Elevation	8.2±	7.4±
Gas Connection		Wall Penetration	8.8±	8.0±
Generator Exhaust		Invert of Pipe	18.8±	18.0±
Roof Drain		Invert of Pipe	8.8±	8.0±
Wet well Manhole/Hatch Rim		None Observed		
Wet well Vent Pipe		None Observed		
Inside Generator Skid Top Elev.		Lowest Elevation	12.7±	11.9±

Sewer Collection Pipe Inventory

Type	Pipe Material	FlowType	Pipe Size	Year I nst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Chain Pond Pump Station	61.75	1
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Chain Pond Pump Station	20.53	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	284.42	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	60.93	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	36.72	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	238.43	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	163.80	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	176.12	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	277.80	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	268.64	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	273.51	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	281.23	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	31.21	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	241.86	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	243.13	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	139.16	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	102.20	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	230.67	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	176.45	1
Collector	Reinforced Concrete Pipe	Gravity	24 in		Chain Pond Pump Station	233.20	1
Collector	Vitrified clay pipe	Gravity	10 in		Chain Pond Pump Station	154.84	1
Collector	Vitrified clay pipe	Gravity	10 in		Chain Pond Pump Station	311.39	1
Collector	Vitrified clay pipe	Gravity	15 in		Chain Pond Pump Station	96.52	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	180.42	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	313.62	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	141.38	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	125.24	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	209.47	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	334.19	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	339.74	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	360.64	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	350.81	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	348.87	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	347.53	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	329.38	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	302.09	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	265.26	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	243.56	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	307.01	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	195.92	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	191.45	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	113.55	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	152.91	1

Type	Pipe Material	FlowType	Pipe Size	Year I nst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	137.59	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	123.13	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	247.84	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	93.05	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	301.66	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	198.97	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	200.99	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	288.68	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	200.23	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	273.59	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	317.41	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	314.73	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	176.60	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	194.90	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	296.00	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	212.30	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	187.24	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	314.11	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	315.83	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	305.71	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	292.15	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	300.86	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	211.17	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	276.22	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	213.30	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	235.40	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	153.92	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	265.31	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	185.00	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	176.20	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	232.40	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	77.26	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	124.50	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	196.57	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	280.32	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	50.86	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	177.62	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	201.87	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	210.88	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	243.41	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	255.29	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	408.47	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	138.60	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	190.73	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station	226.97	1

Type	Pipe Material	FlowType	Pipe Size	Year I nst.	Name		Length (feet)	FID Sewer Sub Systyems
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		154.34	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		292.93	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		250.38	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		35.40	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		70.49	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		317.19	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		299.17	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		176.09	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		198.68	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		217.86	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		229.10	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		196.39	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		199.00	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		308.55	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		137.63	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		154.63	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		314.72	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		253.46	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		242.91	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		264.82	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		179.14	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		272.85	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		185.04	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		131.73	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		217.05	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		244.72	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		92.92	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		0.33	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		4.54	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		243.99	1
Collector	Vitrified clay pipe	Gravity	8 in		Chain Pond Pump Station		237.75	1
Collector	Reinforced Concrete Pipe	Vacuum	24 in		Chain Pond Pump Station		423.00	1
Collector	Reinforced Concrete Pipe	Vacuum	24 in		Chain Pond Pump Station		332.80	1
	Poly Vinyl Chloride	Gravity			Chain Pond Pump Station		82.28	
	Reinforced Concrete Pipe	Gravity			Chain Pond Pump Station		3,459.48	
	Vitrified clay pipe	Gravity			Chain Pond Pump Station		21,865.44	
	Reinforced Concrete Pipe	Vacuum			Chain Pond Pump Station		755.79	
						Stub	0.00	
						Collector	26,162.99	
						Force Main	0.00	
						Total	**26,162.99**	

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Ductile iron pipe	Gravity	8 in	1979	First Parish Road Pump Station	50.83	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	344.64	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	9.86	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	213.89	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	349.11	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	239.10	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	340.93	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	156.31	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	149.85	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	211.92	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	136.20	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	97.20	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	321.79	2
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	First Parish Road Pump Station	170.73	2
Stub	Reinforced Concrete Pipe	Gravity	12 in		First Parish Road Pump Station	5.20	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	104.40	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	199.22	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	65.63	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	326.69	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	242.80	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	289.91	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	180.77	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	187.25	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	292.87	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	331.09	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	180.60	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	78.48	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	333.15	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	178.77	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	193.91	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	342.23	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	228.21	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	237.52	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	230.39	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	181.43	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	327.16	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	198.79	2
Collector	Reinforced Concrete Pipe	Gravity	24 in		First Parish Road Pump Station	420.03	2
Collector	SDR-35 PVC	Gravity	8 in	2013	First Parish Road Pump Station	155.39	2
Collector	SDR-35 PVC	Gravity	8 in	2013	First Parish Road Pump Station	125.46	2
Collector	SDR-35 PVC	Gravity	8 in	2013	First Parish Road Pump Station	66.54	2
Collector	SDR-35 PVC	Gravity	8 in	2013	First Parish Road Pump Station	119.10	2
Collector	SDR-35 PVC	Gravity	8 in	2013	First Parish Road Pump Station	165.00	2
Collector	SDR-35 PVC	Gravity	8 in	2013	First Parish Road Pump Station	132.87	2
Collector	SDR-35 PVC	Gravity	8 in	2013	First Parish Road Pump Station	44.88	2

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	SDR-35 PVC	Gravity	8 in	2013	First Parish Road Pump Station	154.05	2
Stub	Unknown material	Gravity	8 in	1979	First Parish Road Pump Station	5.82	2
Collector	Unknown material	Gravity	Unknown	1979	First Parish Road Pump Station	25.79	2
Collector	Unknown material	Gravity	Unknown	1979	First Parish Road Pump Station	121.40	2
Collector	Vitrified clay pipe	Gravity	24 in		First Parish Road Pump Station	365.70	2
Collector	Vitrified clay pipe	Gravity	24 in		First Parish Road Pump Station	184.43	2
Collector	Vitrified clay pipe	Gravity	24 in		First Parish Road Pump Station	238.07	2
Collector	Vitrified clay pipe	Gravity	6 in	1979	First Parish Road Pump Station	342.46	2
Collector	Vitrified clay pipe	Gravity	6 in	1979	First Parish Road Pump Station	269.07	2
Collector	Vitrified clay pipe	Gravity	6 in	1979	First Parish Road Pump Station	278.43	2
Collector	Vitrified clay pipe	Gravity	6 in	1979	First Parish Road Pump Station	341.78	2
Collector	Vitrified clay pipe	Gravity	6 in	1979	First Parish Road Pump Station	380.90	2
Collector	Vitrified clay pipe	Gravity	6 in	1979	First Parish Road Pump Station	99.30	2
Collector	Vitrified clay pipe	Gravity	6 in	1979	First Parish Road Pump Station	127.84	2
Collector	Vitrified clay pipe	Gravity	6 in	1979	First Parish Road Pump Station	63.79	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	349.01	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	354.09	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	294.05	2
Collector	Vitrified clay pipe	Gravity	8 in	1979	First Parish Road Pump Station	39.01	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	332.85	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	304.45	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	331.08	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	140.31	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	16.89	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	27.79	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	172.08	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	291.66	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	68.16	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	119.64	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	50.33	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	113.94	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	49.92	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	124.28	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	114.77	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	240.35	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	258.18	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	118.37	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	301.38	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	134.83	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	151.17	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	293.60	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	301.38	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	48.82	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	300.91	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	284.01	2

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	347.28	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	334.26	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	342.86	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	23.58	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	315.56	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	295.35	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	35.73	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	325.92	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	121.25	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	193.97	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	141.53	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	301.75	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	85.36	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	311.57	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	70.55	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	307.69	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	306.59	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	315.12	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	195.23	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	327.68	2
Stub	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	4.57	2
Stub	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	6.79	2
Stub	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	5.99	2
Stub	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	130.23	2
Stub	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	5.72	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	7.77	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	1.55	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	219.30	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	228.11	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	213.56	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	335.07	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	321.55	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	332.87	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	359.90	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	160.49	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	111.95	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	277.89	2
Collector	Vitrified clay pipe	Gravity	8 in		First Parish Road Pump Station	223.94	2
Force Main	Ductile iron pipe	Pressurized	6 in	1979	First Parish Road Pump Station	3412.92	2
Force Main	Unknown material	Pressurized	6 in	1979	First Parish Road Pump Station	21.98	2

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name		Length (feet)	FID Sewer Sub Systyems
	Ductile iron pipe	Gravity			First Parish Road Pump Station		50.83	
	Poly Vinyl Chloride	Gravity			First Parish Road Pump Station		2,741.54	
	Reinforced Concrete Pipe	Gravity			First Parish Road Pump Station		5,356.48	
	SDR-35 PVC	Gravity			First Parish Road Pump Station		963.29	
	Unknown material	Gravity			First Parish Road Pump Station		153.01	
	Vitrified clay pipe	Gravity			First Parish Road Pump Station		16,065.16	
	Ductile iron pipe	Pressurized			First Parish Road Pump Station		3,412.92	
	Unknown material	Pressurized			First Parish Road Pump Station		21.98	
						Stub	164.00	
						Collector	25,166.29	
						Force Main	3,434.90	
						Total	**28,765.20**	

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Ductile iron pipe	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	45.82	3
Collector	Ductile iron pipe	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	25.61	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	130.86	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	189.38	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	94.41	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	167.26	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	131.69	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	172.93	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	95.84	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	213.83	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	132.36	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	301.67	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	147.42	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	95.69	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	284.02	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	204.22	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	87.12	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	224.98	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	47.90	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	188.81	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	134.54	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	183.29	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	201.06	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	235.28	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	216.41	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	172.94	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	51.51	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	80.37	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	50.27	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	283.57	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	257.33	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	209.86	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	403.41	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	250.28	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	72.15	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	350.85	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	203.45	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	103.17	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	121.06	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	100.99	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	117.22	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	358.98	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	76.91	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	87.04	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	81.76	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station	76.78	3

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name		Length (feet)	FID Sewer Sub Systyems
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		271.73	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		57.56	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		257.55	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		335.21	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		71.90	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		61.21	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		78.12	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		162.53	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		202.17	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		264.84	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		25.30	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		187.18	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		276.39	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		181.96	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		31.20	3
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Edward Foster and Peggoty Beach Road Pump Station		88.84	3
Force Main	Ductile iron pipe	Pressurized	4 in	2008	Edward Foster and Peggoty Beach Road Pump Station		98.94	3
Force Main	Ductile iron pipe	Pressurized	4 in	2008	Edward Foster and Peggoty Beach Road Pump Station		693.34	3
Force Main	Ductile iron pipe	Pressurized	4 in	2008	Edward Foster and Peggoty Beach Road Pump Station		273.08	3
Force Main	Ductile iron pipe	Pressurized	4 in	2008	Edward Foster and Peggoty Beach Road Pump Station		914.16	3
Force Main	Ductile iron pipe	Pressurized	4 in	2008	Edward Foster and Peggoty Beach Road Pump Station		417.58	3
Force Main	Ductile iron pipe	Pressurized	4 in	2008	Edward Foster and Peggoty Beach Road Pump Station		568.19	3
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2008	Edward Foster and Peggoty Beach Road Pump Station		505.04	3
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2008	Edward Foster and Peggoty Beach Road Pump Station		443.05	3
	Ductile iron pipe	Gravity			Edward Foster and Peggoty Beach Road Pump Station		71.43	
	Poly Vinyl Chloride	Gravity			Edward Foster and Peggoty Beach Road Pump Station		9,944.62	
	Ductile iron pipe	Pressurized			Edward Foster and Peggoty Beach Road Pump Station		2,965.30	
	Poly Vinyl Chloride	Pressurized			Edward Foster and Peggoty Beach Road Pump Station		948.08	
						Stub	0.00	
						Collector	10,016.05	
						Force Main	3,913.38	
						Total	**13,929.43**	

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Ductile iron pipe	Gravity	4 in	2008	Scituate Sewer System A	111.74	4
Collector	Ductile iron pipe	Gravity	4 in	2008	Scituate Sewer System A	195.07	4
Collector	Ductile iron pipe	Gravity	8 in	2008	Scituate Sewer System A	243.56	4
Collector	Ductile iron pipe	Gravity	8 in	2008	Scituate Sewer System A	79.50	4
Collector	Ductile iron pipe	Gravity	8 in	2008	Scituate Sewer System A	45.79	4
Collector	High-density polyethylene pipe	Gravity	8 in	2008	Scituate Sewer System A	206.94	4
Collector	High-density polyethylene pipe	Gravity	8 in	2008	Scituate Sewer System A	329.49	4
Collector	High-density polyethylene pipe	Gravity	8 in	2008	Scituate Sewer System A	170.75	4
Collector	Poly Vinyl Chloride	Gravity	6 in	2008	Scituate Sewer System A	32.20	4
Collector	Poly Vinyl Chloride	Gravity	6 in	2008	Scituate Sewer System A	17.72	4
Collector	Poly Vinyl Chloride	Gravity	6 in	2008	Scituate Sewer System A	85.53	4
Collector	Poly Vinyl Chloride	Gravity	6 in	2008	Scituate Sewer System A	47.29	4
Collector	Poly Vinyl Chloride	Gravity	6 in	2008	Scituate Sewer System A	81.77	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	165.73	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	206.01	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	296.99	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	228.20	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	285.20	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	286.63	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	290.62	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	213.85	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	232.83	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	205.22	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	254.24	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	344.56	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	248.80	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	202.26	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	142.25	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	91.21	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	94.48	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	159.64	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	356.35	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	122.68	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	110.74	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	104.77	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	231.31	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	144.56	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	334.29	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	72.83	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	374.90	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	95.22	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	87.55	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	295.33	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	203.53	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	133.22	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	94.75	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	109.25	4

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	80.62	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	205.13	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	341.11	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	141.55	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	137.18	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	160.89	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	296.32	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	191.03	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	190.49	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	104.95	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	103.82	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	151.39	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	100.11	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	108.22	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	325.82	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	168.21	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	82.86	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	266.96	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	37.11	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	376.30	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	188.98	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	212.13	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	143.17	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	170.49	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	201.41	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	198.41	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	388.78	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	243.58	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	221.12	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	66.51	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	320.57	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	239.44	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	354.67	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	156.11	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	172.33	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	462.63	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	136.25	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	158.97	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	30.20	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	152.80	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	80.01	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	335.41	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	211.87	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	211.35	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	153.07	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	60.82	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	315.92	4

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	109.03	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	243.99	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	282.10	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	191.40	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	86.99	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	79.46	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	39.22	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	302.63	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	188.44	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	208.08	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	362.49	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	291.42	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	142.21	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	192.74	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	76.97	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	212.76	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	152.33	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	224.85	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	279.16	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	90.37	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	63.20	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	77.04	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	82.26	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	245.73	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	77.23	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	221.07	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	88.48	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	217.82	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	481.91	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	200.96	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	146.24	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	130.91	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	33.68	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	54.45	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	125.06	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	62.31	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	143.57	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	117.31	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	126.91	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	310.95	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	220.40	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	340.35	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	143.05	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	126.33	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	228.52	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	241.98	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	38.23	4

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	181.84	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	200.57	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	101.45	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	238.68	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	339.96	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	203.30	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	160.08	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	284.39	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	352.38	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	228.53	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	360.13	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	178.95	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	237.06	4
Stub	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	27.06	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	325.47	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	145.79	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	155.58	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	167.81	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	228.74	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	200.92	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	196.92	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	186.87	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	116.52	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	154.53	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	300.71	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	255.11	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	283.36	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	182.89	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	145.06	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	201.30	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	351.13	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	249.80	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	324.54	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	147.91	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	256.39	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	180.09	4
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Scituate Sewer System A	345.84	4
Force Main	Ductile iron pipe	Pressurized	4 in	2008	Scituate Sewer System A	595.88	4
Force Main	Ductile iron pipe	Pressurized	4 in	2008	Scituate Sewer System A	749.48	4
Force Main	Ductile iron pipe	Pressurized	8 in	2008	Scituate Sewer System A	929.57	4
Force Main	Ductile iron pipe	Pressurized	8 in	2008	Scituate Sewer System A	1156.35	4
Force Main	Ductile iron pipe	Pressurized	8 in	2008	Scituate Sewer System A	970.55	4
Force Main	Ductile iron pipe	Pressurized	8 in	2008	Scituate Sewer System A	1115.74	4
Force Main	Ductile iron pipe	Pressurized	8 in	2008	Scituate Sewer System A	873.74	4
Force Main	Ductile iron pipe	Pressurized	8 in	2008	Scituate Sewer System A	750.66	4
Force Main	Poly Vinyl Chloride	Pressurized	1 in	2008	Scituate Sewer System A	22.16	4
Force Main	Poly Vinyl Chloride	Pressurized	1.5 in	2008	Scituate Sewer System A	190.52	4

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name		Length (feet)	FID Sewer Sub Systyems
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2008	Scituate Sewer System A		194.81	4
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2008	Scituate Sewer System A		350.98	4
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2008	Scituate Sewer System A		398.77	4
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2008	Scituate Sewer System A		321.77	4
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2008	Scituate Sewer System A		183.66	4
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2008	Scituate Sewer System A		502.50	4
Force Main	Poly Vinyl Chloride	Pressurized	4 in	1997	Scituate Sewer System A		17.66	4
Force Main	Poly Vinyl Chloride	Pressurized	4 in	1997	Scituate Sewer System A		78.55	4
Force Main	Poly Vinyl Chloride	Pressurized	4 in	1997	Scituate Sewer System A		119.21	4
Force Main	Poly Vinyl Chloride	Pressurized	4 in	1997	Scituate Sewer System A		495.61	4
Force Main	Poly Vinyl Chloride	Pressurized	4 in	1997	Scituate Sewer System A		504.85	4
Force Main	Poly Vinyl Chloride	Pressurized	4 in	1997	Scituate Sewer System A		513.29	4
Force Main	Poly Vinyl Chloride	Pressurized	4 in	1997	Scituate Sewer System A		465.74	4
Force Main	Poly Vinyl Chloride	Pressurized	4 in	1997	Scituate Sewer System A		477.30	4
Force Main	Poly Vinyl Chloride	Pressurized	4 in	1997	Scituate Sewer System A		347.17	4
Force Main	Poly Vinyl Chloride	Pressurized	4 in	1997	Scituate Sewer System A		35.85	4
Force Main	Poly Vinyl Chloride	Pressurized	4 in	1997	Scituate Sewer System A		19.67	4
Force Main	Unknown material	Pressurized	4 in	1997	Scituate Sewer System A		111.31	4
Force Main	Unknown material	Pressurized	5 in	1997	Scituate Sewer System A		118.67	4
	Ductile iron pipe	Gravity			Scituate Sewer System A		675.66	
	High-density polyethylene pipe	Gravity			Scituate Sewer System A		707.19	
	Poly Vinyl Chloride	Gravity			Scituate Sewer System A		32,541.89	
	Ductile iron pipe	Pressurized			Scituate Sewer System A		7,141.97	
	Poly Vinyl Chloride	Pressurized			Scituate Sewer System A		5,240.07	
	Unknown material	Pressurized			Scituate Sewer System A		229.98	
						Stub	27.00	
						Collector	33,897.74	
						Force Main	12,612.02	
						Total	**46,536.76**	

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Ductile iron pipe	Gravity	8 in	2008	Collier Road Pump Station	23.50	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	301.53	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	102.02	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	233.49	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	257.29	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	227.92	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	139.12	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	179.61	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	102.09	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	280.78	5
Stub	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	15.67	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	253.10	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	27.67	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	248.10	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	162.99	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	207.78	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	136.64	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	232.33	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	49.61	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	260.97	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	225.80	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	349.56	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	244.05	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	131.65	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	246.35	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	342.51	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	229.48	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	154.32	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	237.91	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	140.79	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	217.35	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	209.32	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	95.42	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	224.47	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	78.89	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	183.04	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	284.44	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	62.36	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	70.51	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	121.47	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	178.51	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	74.57	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	113.67	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	101.59	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	84.21	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	89.38	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	110.38	5

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	44.60	5
Collector	Poly Vinyl Chloride	Gravity	8 in	1981	Collier Road Pump Station	168.76	5
Collector	Poly Vinyl Chloride	Gravity	8 in	1981	Collier Road Pump Station	100.57	5
Collector	Poly Vinyl Chloride	Gravity	8 in	1981	Collier Road Pump Station	112.24	5
Collector	Poly Vinyl Chloride	Gravity	8 in	1981	Collier Road Pump Station	174.73	5
Collector	Poly Vinyl Chloride	Gravity	8 in	1981	Collier Road Pump Station	236.62	5
Collector	Poly Vinyl Chloride	Gravity	8 in	1981	Collier Road Pump Station	131.36	5
Collector	Poly Vinyl Chloride	Gravity	8 in	1981	Collier Road Pump Station	121.59	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	133.61	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	81.30	5
Collector	Poly Vinyl Chloride	Gravity	8 in	2008	Collier Road Pump Station	187.11	5
Collector	Reinforced Concrete Pipe	Gravity	36 in		Collier Road Pump Station	106.48	5
Collector	Reinforced Concrete Pipe	Gravity	36 in		Collier Road Pump Station	65.69	5
Collector	Reinforced Concrete Pipe	Gravity	36 in	1967	Collier Road Pump Station	689.45	5
Collector	Reinforced Concrete Pipe	Gravity	36 in	1967	Collier Road Pump Station	366.92	5
Collector	Reinforced Concrete Pipe	Gravity	36 in	1967	Collier Road Pump Station	125.54	5
Collector	Reinforced Concrete Pipe	Gravity	36 in	1967	Collier Road Pump Station	78.89	5
Collector	Reinforced Concrete Pipe	Gravity	36 in	1967	Collier Road Pump Station	163.91	5
Collector	Reinforced Concrete Pipe	Gravity	36 in	1967	Collier Road Pump Station	153.25	5
Collector	Reinforced Concrete Pipe	Gravity	36 in	1967	Collier Road Pump Station	187.36	5
Collector	Reinforced Concrete Pipe	Gravity	36 in	1967	Collier Road Pump Station	177.13	5
Collector	Reinforced Concrete Pipe	Gravity	36 in	1967	Collier Road Pump Station	134.40	5
Collector	Reinforced Concrete Pipe	Gravity	36 in	1967	Collier Road Pump Station	110.27	5
Collector	Reinforced Concrete Pipe	Gravity	36 in		Collier Road Pump Station	145.49	5
Collector	Reinforced Concrete Pipe	Gravity	36 in		Collier Road Pump Station	203.75	5
Collector	Reinforced Concrete Pipe	Gravity	36 in		Collier Road Pump Station	196.21	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	89.64	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	108.49	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	301.89	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	102.17	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	280.48	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	274.35	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	347.57	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	221.60	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	205.85	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	271.76	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	339.89	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	50.08	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	238.96	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	291.17	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	175.21	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	181.58	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	203.71	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	208.68	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	105.30	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	85.08	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station	268.80	5

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name		Length (feet)	FID Sewer Sub Systyems
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		263.94	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		307.06	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		297.30	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		212.67	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		248.42	5
Stub	Vitrified clay pipe	Gravity	8 in	1967	Collier Road Pump Station		31.51	5
Collector	Vitrified clay pipe	Gravity	8 in	1967	Collier Road Pump Station		5.33	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		261.48	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		263.33	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		206.02	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		43.18	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		363.33	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		135.90	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		290.36	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		266.13	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		223.99	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		214.77	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		154.96	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		211.00	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		232.00	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		305.03	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		164.76	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		25.73	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		5.55	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		23.84	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		5.53	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		39.88	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		5.91	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		30.79	5
Collector	Vitrified clay pipe	Gravity	8 in		Collier Road Pump Station		6.01	5
Force Main	Ductile iron pipe	Pressurized	4 in	2008	Collier Road Pump Station		606.31	5
Force Main	Ductile iron pipe	Pressurized	4 in	2008	Collier Road Pump Station		457.58	5
	Ductile iron pipe	Gravity			Collier Road Pump Station		23.50	
	Poly Vinyl Chloride	Gravity			Collier Road Pump Station		9,513.23	
	Reinforced Concrete Pipe	Gravity			Collier Road Pump Station		2,904.74	
	Vitrified clay pipe	Gravity			Collier Road Pump Station		9,197.96	
	Ductile iron pipe	Pressurized			Collier Road Pump Station		1,063.90	
						Stub	47.00	
						Collector	21,592.43	
						Force Main	1,063.90	
						Total	**22,703.33**	

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Asbestos cement pipe	Gravity	30 in		Scituate Sewer System B	145.68	6
Collector	Asbestos cement pipe	Gravity	30 in		Scituate Sewer System B	537.38	6
Collector	Poly Vinyl Chloride	Gravity	8 in		Scituate Sewer System B	119.91	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	49.61	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	244.23	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	169.79	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	364.33	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	114.25	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	249.65	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	244.95	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	303.80	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	312.62	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	259.28	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	227.48	6
Collector	Reinforced Concrete Pipe	Gravity	18 in		Scituate Sewer System B	238.81	6
Collector	Reinforced Concrete Pipe	Gravity	24 in		Scituate Sewer System B	115.58	6
Collector	Reinforced Concrete Pipe	Gravity	24 in		Scituate Sewer System B	220.83	6
Collector	Reinforced Concrete Pipe	Gravity	24 in		Scituate Sewer System B	27.44	6
Collector	Reinforced Concrete Pipe	Gravity	27 in		Scituate Sewer System B	297.24	6
Collector	Reinforced Concrete Pipe	Gravity	27 in		Scituate Sewer System B	251.56	6
Collector	Reinforced Concrete Pipe	Gravity	27 in		Scituate Sewer System B	254.53	6
Collector	Reinforced Concrete Pipe	Gravity	27 in		Scituate Sewer System B	231.61	6
Collector	Reinforced Concrete Pipe	Gravity	27 in		Scituate Sewer System B	264.95	6
Collector	Reinforced Concrete Pipe	Gravity	27 in		Scituate Sewer System B	242.48	6
Collector	Reinforced Concrete Pipe	Gravity	27 in		Scituate Sewer System B	206.79	6
Collector	Reinforced Concrete Pipe	Gravity	30 in		Scituate Sewer System B	170.26	6
Collector	Reinforced Concrete Pipe	Gravity	30 in		Scituate Sewer System B	293.84	6
Collector	Reinforced Concrete Pipe	Gravity	30 in		Scituate Sewer System B	128.57	6
Collector	Reinforced Concrete Pipe	Gravity	36 in		Scituate Sewer System B	41.73	6
Collector	Reinforced Concrete Pipe	Gravity	36 in		Scituate Sewer System B	225.44	6
Collector	Reinforced Concrete Pipe	Gravity	36 in		Scituate Sewer System B	142.38	6
Collector	Reinforced Concrete Pipe	Gravity	36 in		Scituate Sewer System B	300.41	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	294.07	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	173.00	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	270.15	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	297.34	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	90.35	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	239.77	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	44.72	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	117.14	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	176.10	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	238.83	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	231.78	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	247.63	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	239.90	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	132.17	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	121.00	6

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	130.37	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	237.02	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	220.22	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	255.03	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	285.36	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	157.96	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	354.63	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	329.27	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	230.89	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	243.02	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	286.33	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	158.97	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	279.20	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	246.60	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	291.57	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	253.39	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	259.20	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	69.79	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	69.51	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	115.36	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	307.22	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	279.96	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	96.33	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	258.18	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	223.05	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	190.28	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	117.14	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	27.71	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	186.40	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	58.08	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	3.40	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	6.21	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	6.45	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	5.73	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	4.61	6
Stub	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	6.21	6
Stub	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	5.08	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	7.31	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	86.70	6
Collector	Vitrified clay pipe	Gravity	8 in		Scituate Sewer System B	77.96	6
Force Main	Ductile iron pipe	Pressurized	4 in	2008	Scituate Sewer System B	191.81	6

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name		Length (feet)	FID Sewer Sub Systyems
	Asbestos cement pipe	Gravity			Scituate Sewer System B		683.06	
	Poly Vinyl Chloride	Gravity			Scituate Sewer System B		119.91	
	Reinforced Concrete Pipe	Gravity			Scituate Sewer System B		6,194.44	
	Vitrified clay pipe	Gravity			Scituate Sewer System B		9,341.63	
	Ductile iron pipe	Pressurized			Scituate Sewer System B		191.81	
						Stub	11.29	
						Collector	16,327.76	
						Force Main	191.81	
						Total	**16,519.56**	

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Reinforced Concrete Pipe	Gravity	24 in		Country Way and Herring Brook Pump Station	387.33	7
Collector	Reinforced Concrete Pipe	Gravity	24 in		Country Way and Herring Brook Pump Station	47.80	7
Collector	Reinforced Concrete Pipe	Gravity	24 in		Country Way and Herring Brook Pump Station	156.25	7
Collector	Reinforced Concrete Pipe	Gravity	24 in		Country Way and Herring Brook Pump Station	143.83	7
Collector	Reinforced Concrete Pipe	Gravity	24 in		Country Way and Herring Brook Pump Station	196.92	7
Collector	Reinforced Concrete Pipe	Gravity	24 in		Country Way and Herring Brook Pump Station	113.47	7
Collector	Vitrified clay pipe	Gravity	10 in		Country Way and Herring Brook Pump Station	90.09	7
Collector	Vitrified clay pipe	Gravity	10 in		Country Way and Herring Brook Pump Station	195.03	7
Collector	Vitrified clay pipe	Gravity	10 in		Country Way and Herring Brook Pump Station	198.82	7
Collector	Vitrified clay pipe	Gravity	10 in		Country Way and Herring Brook Pump Station	181.51	7
Collector	Vitrified clay pipe	Gravity	10 in		Country Way and Herring Brook Pump Station	200.88	7
Collector	Vitrified clay pipe	Gravity	12 in		Country Way and Herring Brook Pump Station	228.56	7
Collector	Vitrified clay pipe	Gravity	12 in		Country Way and Herring Brook Pump Station	84.12	7
Collector	Vitrified clay pipe	Gravity	12 in		Country Way and Herring Brook Pump Station	83.60	7
Collector	Vitrified clay pipe	Gravity	12 in		Country Way and Herring Brook Pump Station	163.66	7
Collector	Vitrified clay pipe	Gravity	12 in		Country Way and Herring Brook Pump Station	144.35	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	240.89	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	214.56	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	305.97	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	192.15	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	232.92	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	239.83	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	149.79	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	310.98	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	96.68	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	235.26	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	299.22	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	313.29	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	130.89	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	111.98	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	118.39	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	117.43	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	252.12	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	242.04	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	129.29	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	102.75	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	59.82	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	25.12	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	155.81	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	217.82	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	183.18	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	328.54	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	112.06	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	184.33	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	292.86	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	289.77	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	182.12	7

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	214.51	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	185.16	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	179.87	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	148.30	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	289.18	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	71.71	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	215.95	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	213.80	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	121.92	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	104.40	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	164.43	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	257.41	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	257.45	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	192.90	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	237.58	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	269.34	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	191.81	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	231.90	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	180.11	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	125.28	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	233.52	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	60.45	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	85.33	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	235.15	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	280.64	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	300.10	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	291.74	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	284.32	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	243.24	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	235.45	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	331.62	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	209.49	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	236.54	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	285.93	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	316.42	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	298.36	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	171.39	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	110.03	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	170.39	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	257.23	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	215.31	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	81.40	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	89.44	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	141.22	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	297.39	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	175.70	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station	233.33	7

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name		Length (feet)	FID Sewer Sub Systyems
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		96.02	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		307.06	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		295.25	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		78.36	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		98.45	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		81.60	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		78.81	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		50.16	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		250.51	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		129.71	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		117.98	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		25.18	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		270.94	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		124.59	7
Collector	Vitrified clay pipe	Gravity	8 in		Country Way and Herring Brook Pump Station		63.60	7
	Reinforced Concrete Pipe	Gravity			Country Way and Herring Brook Pump Station		1,045.59	
	Vitrified clay pipe	Gravity			Country Way and Herring Brook Pump Station		19,430.87	
						Stub	0.00	
						Collector	20,476.46	
						Force Main	0.00	
						Total	**20,476.46**	

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Ductile iron pipe	Gravity	10 in	2011	Musquashicut Avenue Pump Station	62.30	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	141.61	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	202.65	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	303.51	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	242.13	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	328.08	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	327.96	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	99.73	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	196.44	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	79.89	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	242.21	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	300.87	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	80.19	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	159.28	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	135.14	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	50.02	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	249.66	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	299.64	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	190.26	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	184.85	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	180.63	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	180.38	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	220.27	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	223.00	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	226.08	8
Collector	Poly Vinyl Chloride	Gravity	10 in	2011	Musquashicut Avenue Pump Station	224.60	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	70.87	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	175.63	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	95.38	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	185.17	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	184.89	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	300.46	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	234.60	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	300.76	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	325.43	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	315.35	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	315.38	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	310.24	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	113.47	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	149.24	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	298.98	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	299.95	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	300.01	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	100.45	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	29.94	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	327.36	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	349.71	8

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	329.51	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	180.03	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	279.63	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	199.72	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	274.89	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	175.47	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	176.19	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	106.54	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	169.34	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	158.59	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	188.83	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	191.37	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	185.17	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	143.13	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	210.24	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	209.97	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	209.98	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	100.24	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	96.85	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	119.82	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	99.57	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	94.56	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	255.50	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	69.60	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	89.05	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	64.82	8
Collector	Poly Vinyl Chloride	Gravity	8 in	2011	Musquashicut Avenue Pump Station	244.52	8
Stub	Unknown material	Gravity	8 in	2011	Musquashicut Avenue Pump Station	29.95	8
Stub	Unknown material	Gravity	8 in	2011	Musquashicut Avenue Pump Station	22.64	8
Force Main	Ductile iron pipe	Pressurized	6 in	2011	Musquashicut Avenue Pump Station	997.08	8
Force Main	Ductile iron pipe	Pressurized	6 in	2011	Musquashicut Avenue Pump Station	658.92	8
Force Main	Ductile iron pipe	Pressurized	6 in	2011	Musquashicut Avenue Pump Station	694.25	8
Force Main	Ductile iron pipe	Pressurized	6 in	2011	Musquashicut Avenue Pump Station	975.04	8
Force Main	Poly Vinyl Chloride	Pressurized	1.5 in	2011	Musquashicut Avenue Pump Station	98.24	8
Force Main	Poly Vinyl Chloride	Pressurized	1.5 in	2011	Musquashicut Avenue Pump Station	90.98	8
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2011	Musquashicut Avenue Pump Station	245.52	8
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2011	Musquashicut Avenue Pump Station	666.26	8
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2011	Musquashicut Avenue Pump Station	431.48	8
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2011	Musquashicut Avenue Pump Station	219.71	8
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2011	Musquashicut Avenue Pump Station	220.98	8
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2011	Musquashicut Avenue Pump Station	160.89	8
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2011	Musquashicut Avenue Pump Station	169.72	8
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2011	Musquashicut Avenue Pump Station	340.03	8
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2011	Musquashicut Avenue Pump Station	187.83	8
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2011	Musquashicut Avenue Pump Station	547.67	8
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2011	Musquashicut Avenue Pump Station	755.96	8
Force Main	Poly Vinyl Chloride	Pressurized	3 in	2011	Musquashicut Avenue Pump Station	560.86	8

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name		Length (feet)	FID Sewer Sub Systyems
Force Main	Poly Vinyl Chloride	Pressurized	3 in	2011	Musquashicut Avenue Pump Station		179.68	8
Force Main	Poly Vinyl Chloride	Pressurized	3 in	2011	Musquashicut Avenue Pump Station		1071.67	8
Force Main	Poly Vinyl Chloride	Pressurized	3 in	2011	Musquashicut Avenue Pump Station		1072.14	8
Force Main	Poly Vinyl Chloride	Pressurized	6 in	2011	Musquashicut Avenue Pump Station		859.34	8
	Ductile iron pipe	Gravity			Musquashicut Avenue Pump Station		62.30	
	Poly Vinyl Chloride	Gravity			Musquashicut Avenue Pump Station		14,475.47	
	Unknown material	Gravity			Musquashicut Avenue Pump Station		52.59	
	Ductile iron pipe	Pressurized			Musquashicut Avenue Pump Station		3,325.28	
	Poly Vinyl Chloride	Pressurized			Musquashicut Avenue Pump Station		7,878.99	
						Stub	52.59	
						Collector	14,537.77	
						Force Main	11,204.27	
						Total	**25,742.04**	

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Collector	Asbestos cement pipe	Gravity	10 in	2000	Hatherly School Pump Station	13.64	9
Collector	Asbestos cement pipe	Gravity	10 in	2000	Hatherly School Pump Station	25.88	9
Collector	Poly Vinyl Chloride	Gravity	8 in	1980	Hatherly School Pump Station	191.59	9
Collector	Poly Vinyl Chloride	Gravity	8 in	1980	Hatherly School Pump Station	126.47	9
Collector	Poly Vinyl Chloride	Gravity	8 in	1980	Hatherly School Pump Station	137.03	9
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	Hatherly School Pump Station	150.23	9
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	Hatherly School Pump Station	221.18	9
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	Hatherly School Pump Station	174.53	9
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	Hatherly School Pump Station	124.12	9
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	Hatherly School Pump Station	156.71	9
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	Hatherly School Pump Station	89.08	9
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	Hatherly School Pump Station	103.09	9
Collector	Poly Vinyl Chloride	Gravity	8 in	1979	Hatherly School Pump Station	249.50	9
Collector	SDR-35 PVC	Gravity	8 in	2000	Hatherly School Pump Station	34.75	9
Collector	Unknown material	Gravity	4 in	2000	Hatherly School Pump Station	73.81	9
Collector	Unknown material	Gravity	4 in	2000	Hatherly School Pump Station	77.07	9
Collector	Unknown material	Gravity	Unknown	1979	Hatherly School Pump Station	130.02	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	314.45	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	312.20	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	299.09	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	355.64	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	103.99	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	44.23	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	203.75	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	240.08	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	183.64	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	223.89	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	291.81	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	65.31	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	230.14	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	262.29	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	349.70	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	214.72	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	223.40	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	158.82	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	355.32	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	348.43	9
Collector	Vitrified clay pipe	Gravity	8 in		Hatherly School Pump Station	340.40	9
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2009	Hatherly School Pump Station	153.09	9
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2009	Hatherly School Pump Station	633.96	9
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2009	Hatherly School Pump Station	304.83	9
Force Main	Poly Vinyl Chloride	Pressurized	2 in	2009	Hatherly School Pump Station	275.77	9
Force Main	Poly Vinyl Chloride	Pressurized	2.5 in	2000	Hatherly School Pump Station	45.78	9
Force Main	Poly Vinyl Chloride	Pressurized	3 in	2009	Hatherly School Pump Station	526.37	9
Force Main	SDR-21 PVC	Pressurized	2 in	2000	Hatherly School Pump Station	557.50	9
Force Main	SDR-21 PVC	Pressurized	2 in	2000	Hatherly School Pump Station	491.22	9
Force Main	SDR-21 PVC	Pressurized	2 in	2000	Hatherly School Pump Station	28.02	9

Type	Pipe Material	FlowType	Pipe Size	Year Inst.	Name	Length (feet)	FID Sewer Sub Systyems
Force Main	SDR-21 PVC	Pressurized	2 in	2000	Hatherly School Pump Station	30.01	9
Force Main	SDR-21 PVC	Pressurized	2.5 in	2000	Hatherly School Pump Station	403.28	9
Force Main	SDR-21 PVC	Pressurized	2.5 in	2000	Hatherly School Pump Station	1,015.91	9
Collector	Asbestos cement pipe	Gravity			Hatherly School Pump Station	39.52	
Collector	Poly Vinyl Chloride	Gravity			Hatherly School Pump Station	1,758.28	
Collector	Unknown material	Gravity			Hatherly School Pump Station	280.90	
Collector	Vitrified clay pipe	Gravity			Hatherly School Pump Station	5,121.28	
Force Main	Poly Vinyl Chloride	Pressurized			Hatherly School Pump Station	2,497.30	
Force Main	SDR-21 PVC	Pressurized			Hatherly School Pump Station	2,525.93	
					Stub	0.00	
					Collector	7,199.97	
					Force Main	4,465.73	
					Total	**11,665.71**	

Attachment 3
Treatment System Overview (Wastewater Treatment Plant)

Wastewater Treatment Plant Summary

Figures 3-1 through **3-3** identify the key treatment plant systems and components and treatment flow path. The Scituate Wastewater Treatment Plant utilizes an activated sludge process. This process is a biological process that is used to oxidize carbonaceous biological matter (i.e. sewage), oxidize nitrogenous matter (i.e., ammonium and nitrogen in biological matter) and remove nutrients (nitrogen and phosphorus). The process uses aerobic micro-organisms that digest organic matter in sewage, and clump together (by flocculation) as they do so, producing a liquid that is relatively free from suspended solids and organic material. The activated sludge process generally includes:

- Aeration tank where air (or oxygen) is injected in the mixed liquor.
- Settling tank (usually referred to as "final clarifier" or "secondary settling tank") to allow the biological flocs (the sludge blanket) to settle, thus separating the biological sludge from the clear treated water.

Treatment of nitrogenous matter or phosphate involves additional steps where the mixed liquor is left in anoxic condition (meaning that there is no residual dissolved oxygen).

The major treatment plant components include:

Influent Pump Station: The influent pump station pumps flows from the low elevation of the piped influent to higher elevations, to allow continuous and cost-effective treatment through unit processes within the plant.

Aerated Grit Chamber: Wastewater contains large solids and grit that can interfere with treatment processes or cause undue mechanical wear and increased maintenance on wastewater treatment equipment. To minimize potential problems, these materials require separate handling. Preliminary treatment removes these constituents from the influent wastewater. Preliminary treatment consists of: a) screening; b) grit removal; c) septage handling; d) odor control; and e) flow equalization. Grit includes sand, gravel, cinder, or other heavy solid materials that are “heavier” (higher specific gravity) than the organic biodegradable solids in the wastewater. Grit also includes eggshells, bone chips, seeds, coffee grounds, and large organic particles, such as food waste. Removal of grit prevents unnecessary abrasion and wear of mechanical equipment, grit deposition in pipelines and channels, and accumulation of grit in anaerobic digesters and aeration basins.

Distribution Box: The screened influent leaving the Aerated Grit Chamber discharges to a Distribution Box which distributes flow to the aerobic Selector Tanks and Aeration Tanks.

Aerobic Digesters: The natural process of aerobic digestion (i.e., in the presence of oxygen) involves microorganisms which break down organic materials (i.e., the sewage sludge) and reduce the volume of sludge. The process is usually run as a batch process with more than one digester tank in operation at any one time. Air is pumped through the tank and the contents are stirred to keep the contents fully mixed. Carbon dioxide, waste air and small quantities of other gases including hydrogen sulfide are given off. These waste gases require treatment to reduce odors. The digestion is continued until the percentage of degradable solids is reduced to between 10% and 20%. The treated sludge then flows to the Aeration Tanks.

Aeration Tanks: The Aeriation Tanks are used as part of the secondary sludge treatment. Aeration in an activated sludge process is based on pumping air into a tank, which promotes the microbial growth in the wastewater. The microbes feed on the organic material, forming flocks which can easily settle out. After settling in a separate settling tank, bacteria forming the "activated sludge" flocks are continually recirculated back to the aeration basin to increase the rate of decomposition. Aeration provides oxygen to bacteria for treating and stabilizing the wastewater. Oxygen is needed by the bacteria to allow biodegradation to occur. The supplied oxygen is utilised by bacteria in the wastewater to break down the organic matter containing carbon to form carbon dioxide and water.

Blower Building: The Blower Building is located adjacent to Aeration Tank 2 and the Septage Building. The Blower Building provides the aeration system for the four Aeration Tanks. It also houses a system which provides aerated grit blowers for the aerated grit chamber.

Settling Tanks: The Aeration Tanks discharge to the Settling Tanks, which are used for gravity separation of settleable solids contained in the wastewater. Depending on their function, settling tanks are classified in two general categories: primary and secondary. The main purpose of the primary settling tanks is to remove suspended solids from the wastewater treatment plant influent. Secondary clarifiers are located downstream of the plant's biological treatment facilities, such as aeration basins or tricking filters, and are used to separate the biomass generated during the secondary treatment process from the treated plant effluent.

Intermediate Wet Well: Settling tanks discharge into the intermediate wet wells located adjacent to the Filter Building. Water is drawn from the wet well via 3 intermediate pumps and discharged into one of four Filter Beds.

Methanol Storage and Treatment Facilities: Before effluent enters into one of four filter beds, methanol is added to reduce nitrate levels through a process called denitrification. High levels of nitrate in discharged effluent can cause algal blooms which prevent sunlight and oxygen from reaching aquatic life below. Methanol accelerates the breakdown of nitrate converting it into nitrogen gas which is vented into the atmosphere. The methanol storage tank is located at south end of the plant adjacent to the filter building.

Parshall Flume: The Parshall flume is an open channel flow metering device that measures effluent flow prior to discharge to the adjacent tidal marsh and pond.

Sludge Dewatering Building: The sludge dewater building is located in the northeast corner of the site. After aerobic digestion, sludge is pumped into the Sludge Dewatering Building where it is pressed to reduce volume and water content. A polymer solution is added to the sludge to improve dewatering before it passes through one of two Belt Filter Presses which apply pressure to the sludge squeezing out water and producing a dense sludge cake. The sludge cake is dispensed into a hopper where it is collected and disposed of offsite. Filtrate from the Belt Filter Press is sent back into the influent wet well.

Septage Building: The septage building, located adjacent to the Blower Building, receives septage that is trucked on site. No plans were found for this building. There is an outdoor concrete pad behind the building where influent is received and passed through a bar rack. Presumably the flow is then pumped to the influent wet well at the Operations Building.

Electrical and Communications Utilities

Grid power is delivered to a transformer pad north of Aeration Tank where the transformer and meter pedestal are located on the pad.

Back-up power is provided via an emergency generator. Nearby and adjacent to the blower building is the Diesel Back-up Generator for emergency power for the facility.

Electric and telecommunications cables are located below-ground and accessible via manholes. Manhole covers are not watertight.

The wastewater treatment plant utilizes a supervisory control and data acquisition system (SCADA), which involves telecommunications between the various facility infrastructure. Communications is generally hardwired via a series of manholes and conduits. An instrumentation vault and electrical vault are located in front of the Filter Building, each having a manhole which needs to be sealed.

Stormwater Management

There are several stormwater catch basins in the paved areas of the plant. These include one stormwater drainage networks in the vicinity of the Sludge Dewatering Building and the Operations Building. The northerly stormwater network includes a Stormcepter treatment system located in the northerly access road shoulder and drain line discharging to a ditch and culvert which ultimately discharges to the marsh at the southeasterly property boundary.

The second stormwater network is located in the vicinity of the Blower Building, Settling Tank 3 and the Filter Building. The system includes a Stormcepter treatment system at the Filter Building southeasterly corner and 15-inch drain line discharging to a ditch which ultimately discharges to wetlands at the southerly property boundary.

None of the drain outlets are fitted with a flat valve, check valve or tide flex pinch valve. There is a potential vulnerability for reverse flow into the drainage system under an extreme storm event. If the facility is to be protected by floodwall, protection of the stormwater system from surcharging during extreme tide events will need to be implemented.

Roof drains appear to generally discharge to the existing ground. However, the roof leaders and floor drains from the Filter Building connect to the storm drain system to the north and east.

Figure 3-10 presents the plant treatment flow path and hydraulic profile. The wastewater treatment plant flow path involves:

1. **Influent into Plant (Piped)**: Raw sewage influent flow from the wastewater treatment collection system enters the treatment plant via a below-ground 36-inch diameter pipe (influent main) which discharges to the influent pump station. The influent pump station includes: a) channel screening; b) a wet well; and c) 4 influent lift pumps. These are located within the Operations Building.
2. **Influent into Plant (Trucked):** Sewage influent from pump trucks discharge to the Septage Building. An outside inlet has a concrete sill at Elevation 16.5± feet NAVD88 (±17.3 feet NGVD29). No plans were found for this building. Presumably the flow is pumped to the influent wet well at the Operations Building.
3. **Hydraulic Elevation Lift**: The hydraulic head of the influent discharging from the 36-inch influent main to the Influent Wet Well and is lifted by the Influent Pump Station (four pumps). The influent main invert elevation is -7.79 feet NAVD88 (-6.97 feet NGVD29). The Influent Pump Station increases the hydraulic head at the Aerated Grit Chamber to Elevation 21.43 feet NAVD88 (22.25 feet NGVD29) during average flow conditions.
4. **Screening:** The lift pumps discharge to an Aerated Grit Tank and Distribution Box having weir outlet control. Large solids and grit are separated from the influent within the Aerated Grit Chamber. After screening, the influent is distributed (at the Distribution Box) to the Aerobic Selector Tanks and Aeration Tanks.
5. **Aerobic Selector Tank**: The selector tanks control and limit the growth of filamentous bacteria, and enhance the sedimentation ability of the sludge prior to aeration.
6. **Aeration:** The influent flow is then distributed to the four Aeration Tanks.
7. **Settling:** After aeration, wastewater influent flows by gravity to the three Settling Tanks where scum and activated sludge are separated from the influent.
8. **Sludge:** Activated sludge from the Settling Tanks is returned to the Distribution Box ahead of the Aeration Tank. Scum and waste activated sludge from the Settling Tanks is pumped to the 3 Aerobic Digesters. Decant from the Aerobic Digesters returns to the raw wastewater Influent Wet Well. Sludge from the three Aerobic Digesters is pumped to the two belt filter presses in the Sludge Dewatering Building.
9. **Filtration:** The Settling Tank influent flows to the Intermediate Wet Well from which three intermediate pumps draw and discharge to the head of the four effluent filters. Filtration effluent can flow to adjacent Clearwell Storage for reuse. Filtrate from the belt filter press is returned to the raw wastewater influent wet well.
10. **Methanol Treatment**: Methanol from the Methanol Storage and Treatment Facilities (located on south side of the Filter Building) is injected at the filter influent. The Methanol Storage and Treatment Facilities have a concrete pad elevation of 13.1 feet NAVD88 (13.9 NGVD29). The Methanol Storage Tank is valved at a low level fill connection, and vented at the roof. The Methanol Feed Equipment is housed in a fiberglass shelter on the same pad. The access door has a raised sill, but is not watertight. Chemical pumps and instrumentation are located inside.

11. **UV Disinfection:** Primarily, filtration effluent passes through a UV Disinfection Channel flowing then by gravity to the post-treatment Aeration Tanks.

12. **Post-Treatment Aeration:** The post-treatment Post Aeration Tanks are open to atmosphere, with a concrete sill at Elevation 15.18 feet NAVD 88 (16.0 NGVD29).

13. **Effluent Discharge:** Flow from the post-treatment Aeration Tanks is metered through the Parshall Flume which normally discharges to a tidal ditch connecting Herring Brook which then confluences with the North River. The Parshalls Flume is open-top with a top of wall at Elevation 12.68 feet NAVD88. The 20-inch diameter outlet from the flume discharges to the tidal ditch at Elevation 7.5 NAVD88 (8.3 NGVD29).

14. **Temporary Effluent Emergency Storage:** An intermediate tee between the Parshall Flume and the outlet branches to a riser within the lined effluent storage lagoon. During elevated tides (coastal storm or high astronomical tides above Elevation 9.18 feet NAVD88 (10.0 NGVD29), the tailwater effect causes an effluent "bubbler" discharging treated effluent into the lagoon. An existing valve prevents flow from the lagoon, but there is no check valve in the effluent outlet that prevents inflow from seawater entering and filling the lagoon under extreme tides.

15. **Sludge Disposal**: Solids are disposed of by trucking off-site.

16. **Filter Backwash:** During filter backwash, filter effluent which has been stored in the clearwell is pumped back through the filters. Waste backwash water discharges to an adjacent mudwell. Waste backwash water is pumped back to the raw wastewater influent wet well. Both the clearwell and mudwell are located outside adjoining the Filter Building, having concrete top slabs with manholes, vent piping and access hatches. Top of concrete is Elevation 15.4 feet NAVD 88 (16.2 NGVD29).

17. **Reclaimed Water**: The treatment plant has a reclaimed water system ("effluent flushing water") using three pumps and a hydropneumatic tank to maintain pressure to yard hydrants. The supply water is treated effluent taken from a clearwell after the UV disinfection channel. The water is used for washing down the belt filter press, aeration tanks, settling tanks, and other equipment and processes within the facility.

Treatment Capacity

While the plant was designed for a peak flow of 4.34 million gallons per day (MGD), system leakage limits the system capacity to about 3.6 MGD. In order to manage high flows during times of high inflow and infiltration of sea water and groundwater into the sewer system, the water supervisor utilizes reserve storage within the waste water treatment plant along with flow restriction at the headworks. Excess flow is stored in the fourth aeration tank and in spare holding tank volume. Eventually the excess flows overwhelm the storage capacity, and the waste water treatment process fails. This typically happens within 3 to 5 days of extended coastal flooding.

The hydraulic profile (**Figure 3-10**) indicates that the system flow gradient can support up to an Elevation 9.6 feet NAVD88 (10.4 feet NGVD29) head (water elevation) at the discharge outlet (20-inch diameter discharge to the tidal ditch).

Lined Effluent Storage Lagoon

The area of lined emergency effluent storage located between the wastewater plant infrastructure and the marsh has multiple inlets and outlets. This area originally served as sand filter ration beds for treatment, with the effluent overflowing into riser pipes which then discharge to the tidal marsh. One riser remains within the pond which is connect to the affluent discharge to the title ditch. During extreme high tides when the effluent discharge pipe is submerged under pressure, effluent from the plant then escapes through the overflow pipe. If storm surge is sufficiently high, the overflow pipe also serves as a means of seawater to enter the lined lagoon. Adjacent to the treated effluent pipe is a 12-inch diameter culvert through the dike between the lagoon and the ditch. The flap valve is located on the lagoon side of the culvert and does not prevent the seawater from entering it should it rise to the culvert elevation. These pipes are located at the southerly end of the lagoon.

At the northerly end of the lagoon there are 12-inch and 6-inch diameter outlet pipes. The 6-inch outlet pipe is connected to the northerly stormwater system. The 6-inch drain is valved and appears to drain the lagoon of stormwater if needed. The 12-inch outlet is also valved and connects into the plant headworks to return any untreated water wastewater that may have been temporarily held in the lagoon during high flows. The wastewater supervisor advises that there is a problem with the pipe elevations which prevents this drain line from being functional. The 12-inch gate valve was confirmed to operate but it is unknown (without further testing) whether or not the drop-tight shut off works.

The Sewer Division is considering future use of a portion of the lagoon area as a tipping pad for settlement of sediment from storm sewer cleaning. The wastewater division would also like to consider use of the lagoon as a means of polishing treatment for seawater and stormwater which overwhelm the sewer system during high-flow storm events. The drain line connecting to the headworks manhole slopes from the lagoon, so pumping may be necessary to implement this concept.

GZA Site Visit

GZA visited the Scituate Waste Water Treatment Plant and its pump stations on January 4, 2019 and February 21, 2019. The purpose of the visits was to gather information on the layout of the treatment plant's components, inspect for possible water entry points and vulnerable systems, and record elevation data at critical locations. A photolog was created using pictures taken during both inspections and is attached below. **Figures 3-4** through **3-9** show the location and direction of photographs taken as well as major system components and possible water entry points at each building. The elevation data collected during the site visits was compiled into **Tables 3-1** through **3-13**. The tables summarize the elevations of potential flood water entry points and other critical components including but not limited to aeration tanks, aerobic digesters, settling tanks, filter beds, on site stormwater infrastructure and electrical and instrumentation manholes.

Table 3-1: Summary of Water Entry Points – WWTP Sludge Dewatering Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:				
East Windows		Sill Elevation	22.5±	21.7±
South Windows		Sill Elevation	22.5±	21.7±
Doors (Personnel and Public):				
East Personnel Entryway	Door 1	Door Threshold elev.	18.5±	17.7±
East Personnel Entryway	Door 2	Door Threshold elev.	18.5±	17.7±
North Personnel Entryway	Door 4	Door Threshold elev.	15.6±	14.8±
North Personnel Entryway	Door 5	Door Threshold elev.	18.5±	17.7±
West Personnel Entryway	Door 6	Door Threshold elev.	18.5±	17.7±
Doors (Garage and Overhead):				
Garage Entryway	Door 3	Door Threshold elev.	15±	14.2±
Outside Air Conditioning Units				
		None Observed		
Brick/Block Vents:				
North Side Louvered Vent		Sill Elevation	18.4±	17.6±
South Side Air Vents		Sill Elevation	19.3±	18.5±
Pipe Vents:				
South Side Pipe Vents		Pipe Invert	18.4±	17.6±
Exterior Depressed Stairwell:				
East Stairwell 1		Bottom of Step	12.1±	11.3±
East Stairwell 2		Bottom of Step	12.3±	11.5±
Other:				
Roof Drains		Invert of pipe at wall	12.8±	12.0±
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Electrical Conduit Wall Penetrations:		None Observed		
Chemical Fill Line Connections				
Sodium Hydroxide Fill Line		Invert of pipe at wall	15.4±	14.6±
Outside Gas Pressure Regulator Elev.		None Observed		

Table 3-2: Summary of Water Entry Points – WWTP Operations Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:				
East Window		Sill Elevation	12.5±	11.7±
South Windows		Sill Elevation	12.5±	11.7±
North Windows		Sill Elevation	12.5±	11.7±
Doors (Personnel and Public):				
East Personnel Entryway	Door 1	Door Threshold elev.	12.5±	11.7±
East Personnel Entryway	Door 2	Door Threshold elev.	12.5±	11.7±
South Personnel Entryway	Door 3	Door Threshold elev.	12.5±	11.7±
South Personnel Entryway	Door 4	Door Threshold elev.	12.5±	11.7±
North Personnel Entryway	Door 6	Door Threshold elev.	12.5±	11.7±
Doors (Garage and Overhead):				
West Garage Entryway	Door 5	Door Threshold elev.	12.5±	11.7±
Outside Air Conditioning Units		None Observed		
Other:				
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Electrical Conduit Wall Penetrations:		None Observed		
Chemical Fill Line Connections		None Observed		
East Side Sewage Effluent Pipe		Invert of pipe at wall	15.5±	14.7±
South Side Sewage Effluent Pipe		Invert of pipe at wall	15.5±	14.7±
Outside Gas Pressure Regulator Elev.		Lowest Elevation	12.3±	11.5±

Table 3-3: Summary of Water Entry Points – WWTP Septage Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:				
East window	W1	Sill Elevation	20.1±	19.3±
Doors (Personnel and Public):				
Personnel Entryway	Door 1	Door Threshold elev.	18.5±	17.7±
Doors (Garage and Overhead):		None Observed		
Outside Air Conditioning Units		None Observed		
Pipe Vents:				
South Side Pipe Vents		Pipe Invert	21.3±	20.5±
Exterior Depressed Stairwell:		None Observed		
Other:				
Septage Tank Pad		Top of concrete pad	17.3±	16.5±
Roof Drains		Pipe Invert	16.8±	16.0±
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Electrical Conduit Wall Penetrations:		Wall penetration	17.8±	17.0±
Chemical Fill Line Connections		None Observed		
Outside Gas Pressure Regulator Elev.		None Observed		

Table 3-4: Summary of Water Entry Points – WWTP Blower Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:				
South Windows		Sill Elevation		
North Windows		Sill Elevation		
Doors (Personnel and Public):				
South Personnel Entryway	Door 1	Door Threshold elev.	16.4±	15.6±
South Personnel Entryway	Door 2	Door Threshold elev.	16.4±	15.6±
North Personnel Entryway	Door 3	Door Threshold elev.	16.4±	15.6±
Doors (Garage and Overhead):		None Observed		
Outside Air Conditioning Units		Pad Elevation	16.2±	15.4±
Pipe Vents:				
West Side Pipe Vent		Pipe Invert	26.4±	25.6±
Other:				
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Electrical Conduit Wall Penetrations:		Wall penetration	17.9±	17.1±
Chemical Fill Line Connections		None Observed		
Outside Gas Pressure Regulator Elev.		None Observed		

Table 3-5: Summary of Water Entry Points – WWTP Generator Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:		None Observed		
Doors (Personnel and Public):				
East Personnel Entryway	Door 1	Door Threshold elev.	19.2±	18.4±
West Personnel Entryway	Door 2	Door Threshold elev.	19.2±	18.4±
Doors (Garage and Overhead):		None Observed		
Outside Air Conditioning Units		None Observed		
Pipe Vents:		None Observed		
Exterior Depressed Stairwell:				
East Stairwell		Bottom of Step	16.2±	15.4±
West Stairwell		Bottom of Step	16.2±	15.4±
Other:				
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Electrical Conduit Wall Penetrations:		None Observed		
Chemical Fill Line Connections		None Observed		
Outside Gas Pressure Regulator Elev.		None Observed		

Table 3-6: Summary of Water Entry Points – WWTP Filter Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Windows:				
Window 1	W1	Sill Elevation	18.8±	18±
Window 2	W2	Sill Elevation	18.8±	18±
Window 3	W3	Sill Elevation	15.5±	14.7±
Window 4	W4	Sill Elevation	15.5±	14.7±
Window 5	W5	Sill Elevation	18.8±	18.0±
Window 6	W6	Sill Elevation	18.8±	18.0±
Window 7	W7	Sill Elevation	18.8±	18.0±
Doors (Personnel and Public):				
Main Public and Personnel Entryway	Door 1	Door Threshold elev.	15.5±	14.7±
Personnel Entryway	Door 2	Door Threshold elev.	15.5±	14.7±
Personnel Entryway	Door 3	Door Threshold elev.	21.5±	20.7±
Personnel Entryway	Door 4	Door Threshold elev.	17.5±	16.7±
Personnel Entryway	Door 6	Door Threshold elev.	13.0±	12.2±
Doors (Garage and Overhead):				
Garage Entryway	Door 5	Door Threshold elev.	15.5±	14.7±
Outside Air Conditioning Units		None Observed		
Pipe Vents:		None Observed		
Exterior Depressed Stairwell:				
West Stairwell		Bottom of Step	15.5±	14.7±
East Stairwell 1		Bottom of Step	13.5±	12.7±
East Stairwell 2		Bottom of Step	13.5±	12.7±
Other:				
Fire Pipe Connection		Invert of pipe at wall	17.8±	17.0±
Concrete Pad		Lowest Point	16.2±	15.4±
Top Filter Beds		Lowest Point	21.3±	20.5±
Wet Well Manhole covers		Rim elevation	15.7±	14.9±
Outside Gas Pressure Regulator Elev.		Lowest Elevation	15.8±	15.0±
Electrical Conduit Wall Penetrations:		Wall Penetration	17.5±	16.7±
Chemical Fill Line Connections		None Observed		
Control Panel		Lowest Elevation	17.8±	17.0±
Electric Meter		Lowest Elevation	18.3±	17.5±

Table 3-7: Summary of Water Entry Points – WWTP Methane Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Outside Storage Closet	Door 1	Door Threshold elev.	14.2±	13.4±
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed		
Electrical Conduit Wall Penetrations:		None Observed		
Chemical Fill Line Connections				
Methane Fill Line		Pipe Invert	16.3±	15.5±

Table 3-8: Summary of Water Entry Points – WWTP Aeration Tanks

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Top of Lowest Wall				
Aeration Tank 1	1	Lowest Point	16.2±	15.4±
Aeration Tank 2	2	Lowest Point	16.2±	15.4±
Aeration Tank 3	3	Lowest Point	16.2±	15.4±
Aeration Tank 4	4	Lowest Point	20.6±	19.8±
Post Aeration Tank		Lowest Point	16.0±	15.2±

Table 3-9: Summary of Water Entry Points – WWTP Aerobic Digestors

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Top of Lowest Wall				
Aerobic Digester 1	1	Lowest Point	17.3±	16.5±
Aerobic Digester 2	2	Lowest Point	17.3±	16.5±
Aerobic Digester 3	3	Lowest Point	16.2±	15.4±

Table 3-10: Summary of Water Entry Points – Soda Ash Silo

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Concrete Base Pad		Concrete Pad	17.7±	16.9±
Personnel entryway	Door 1	Door Threshold elev.	17.8±	17.0±
Control Panel		Lowest Elevation	21.3±	20.5±
Electric Conduit Wall Penetration		Wall Penetration	24.8±	24.0±

Table 3-11: Summary of Water Entry Points – WWTP Settling Tanks

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)
Top of Lowest Point on Settling Tank Wall				
Settling Tank 1	1	Lowest Point	14.7±	13.9±
Settling Tank 2	2	Lowest Point	14.6±	13.8±
Settling Tank 3	3	Lowest Point	15.7±	14.5±

Table 3-12: Summary of Water Entry Points – North River WWTP Site - Electrical & Instrumentation

Water Entry Points	ID	Rim Elevation (feet, NGVD29)	Rim Elevation (feet, NAVD88)
Electrical			
Manhole/Hatch Rim	E1	16.1±	15.3±
Manhole/Hatch Rim	E2	14.9±	14.1±
Manhole/Hatch Rim	E3	15.0±	14.2±
Manhole/Hatch Rim	E4	16.1±	15.3±
Manhole/Hatch Rim	E5	16.0±	15.2±
Instrumentation			
Manhole/Hatch Rim	I1	15.9±	15.1±
Manhole/Hatch Rim	I2	14.9±	14.1±
Manhole/Hatch Rim	I3	15.1±	14.3±
Manhole/Hatch Rim	I4	11.7±	10.9±
Other			
Transformer Base Elev.		16.0±	15.2±

Table 3-13: Summary of Water Entry Points – North River WWTP Site – Stormwater and Sewer Structures

Water Entry Points	ID	Inv Elevation (feet, NGVD29)	Inv Elevation (feet, NGVD29)	Rim Elevation (feet, NAVD88)	Rim Elevation (feet, NAVD88)
Stormwater					
Catch Basin Rim	CB 1	12.9±	12.1±	16.1±	15.3±
Catch Basin Rim	CB 2	12.0±	11.2±	14.5±	13.7±
Catch Basin Rim	CB 3	11.6±	10.8±	14.8±	14.0±
Catch Basin Rim	CB 4	11.8±	11.0±	17.3±	16.5±
Catch Basin Rim	CB 5	9.6±	8.8±	15.1±	14.3±
Catch Basin Rim	CB 6	6.3±	5.5±	9.5±	8.7±
Inlet	Inlet 1	13.3±	12.5±	16.2±	15.4±
Inlet	Inlet 2	12.9±	12.1±	16.2±	15.4±
Inlet	Inlet 3	13.0±	12.2±	16.2±	15.4±
Inlet	Inlet 4	12.8±	12.0±	16.2±	15.4±
Inlet	Inlet 5	12.0±	11.2±	15.3±	14.5±
Drain Manhole Rim	MH 1	16.2±	15.4± (out)	16.1±	15.3±
Drain Manhole Rim	MH 2	11.5±	10.7± (out)	15.7±	14.9±
Drain Manhole Rim	MH 3	9.8±	9.0± (out)	15.0±	14.2±
Drain Manhole Rim	MH 4	9.8±	9.0± (out)	12.9±	12.1±
Stormceptor	1	NA	NA	14.4±	13.6±
Stormceptor	2	NA	NA	11.6±	10.8±
Sewer					
Sewer Manhole Rim	MH 2A	-1.8±	-2.6± (out)	15.2±	14.4±
Sewer Manhole Rim	MH 5	6.1±	5.3± (out)	11.5±	10.7±
Sewer Manhole Rim	MH 6	-7.1±	-7.9± (out)	11.8±	11.0±
Sewer Manhole Rim	MH 7	-6.4±	-7.2± (out)	12.1±	11.3±
Sewer Manhole Rim	MH 6	NA	NA	14.4±	13.6±
Sewer Manhole Rim	MH 7	NA	NA	11.7±	10.9±
Sewer Manhole Rim	MH 8	NA	NA	11.8±	11.0±
Sewer Manhole Rim	MH 9	NA	NA	15.5±	14.7±
Other	**ID**	**Description Critical Elevation**		**Elevation (feet, NGVD29)**	**Elevation (feet, NAVD88)**
Lagoon Riser		Pipe Inver		10.0±	9.2±
Lagoon Overflow Outlet to Marsh		Pipe Invert		10.0±	9.2±
Top of Lagoon Levee (low point)		Top of Dike		11.5±	10.7±
Drain Pipe Outlet		Pipe Invert		6.6±	5.8±
Drain Pipe Riser		Pipe Invert		7.1±	6.3±
Top of Parshall Flume		Top of Structure		13.5±	12.7±
Parshall Flume		Outlet to Lagoon		8.3±	7.5±


Legend
Effluent Piping
Stormwater Piping
SODA ASH SILO
GENERATOR
TRANSFORMER
AERATION TANK #2
AERATION TANK #3
SLUDGE DEWATERING BUILDING
BLOWER BUILDING
SEPTAGE BUILDING
AERATION TANK #4
AEROBIC DIGESTERS #1 & #2
GRIT TANK
FILTER BEDS
AERATION TANK #1
OPERATIONS BUILDING
METHANOL STORAGE AND FEED SYSTEM
AEROBIC DIGESTER #3
FILTER BUILDING
SETTLING TANK #3
SETTLING TANK #2
SETTLING TANK #1
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0 30 60 120
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SCALE: 1" = 60 FEET
1
DATE: MARCH, 2019
PROJECT NO. 01.0173977.00
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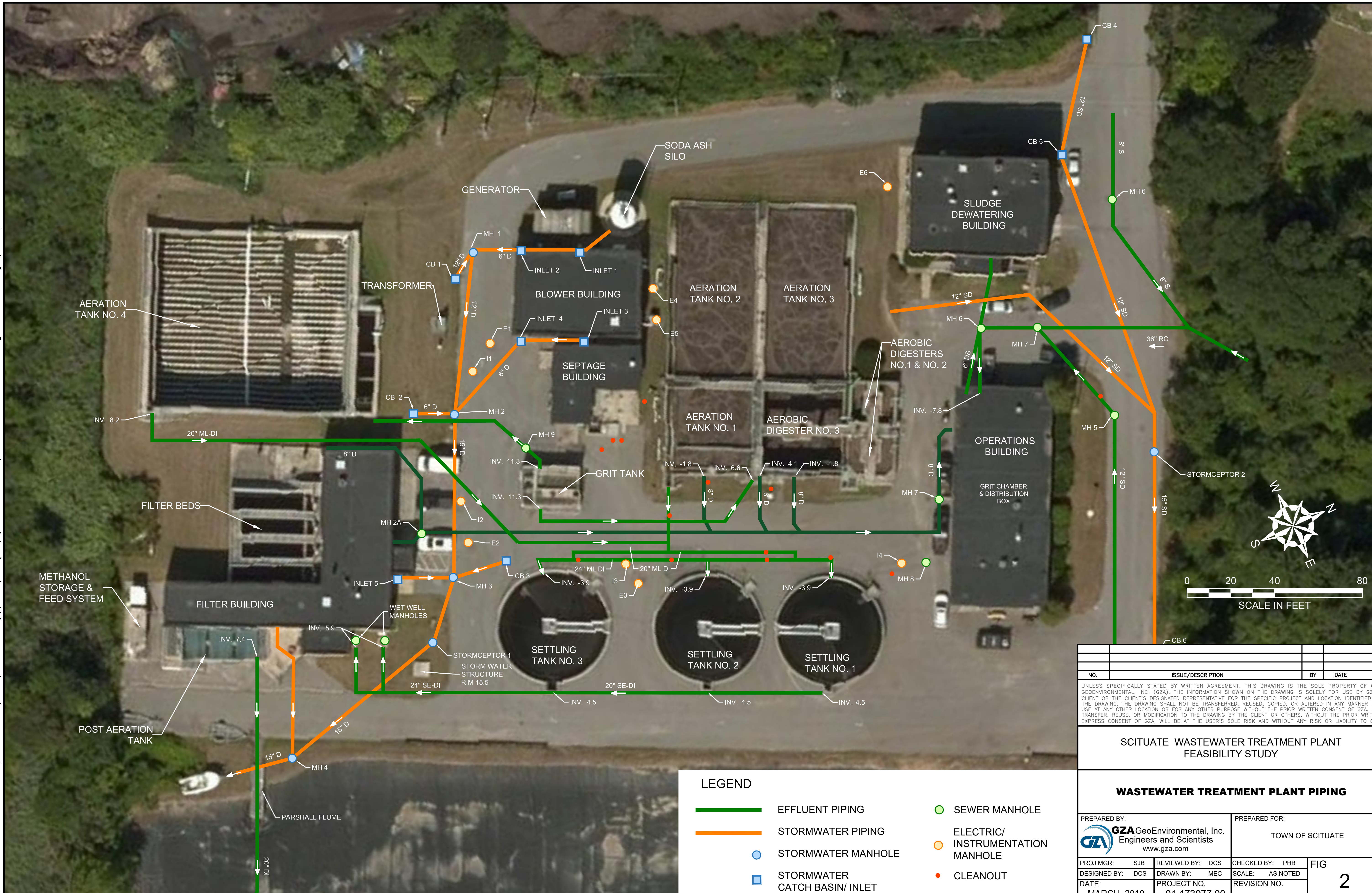

LEGEND

- EFFLUENT PIPING
- STORMWATER PIPING
- STORMWATER MANHOLE
- STORMWATER CATCH BASIN/ INLET
- SEWER MANHOLE
- ELECTRIC/ INSTRUMENTATION MANHOLE
- CLEANOUT

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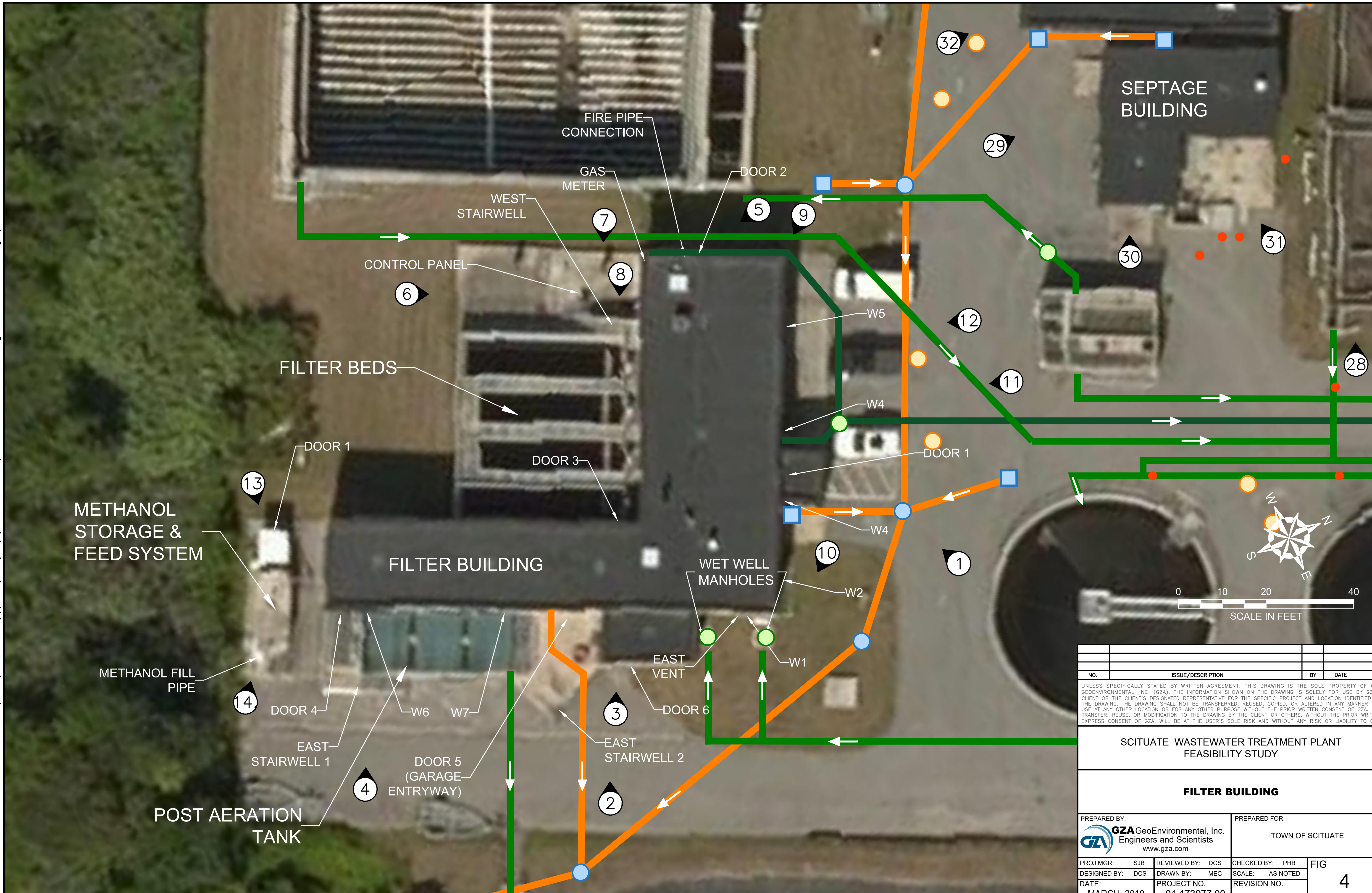

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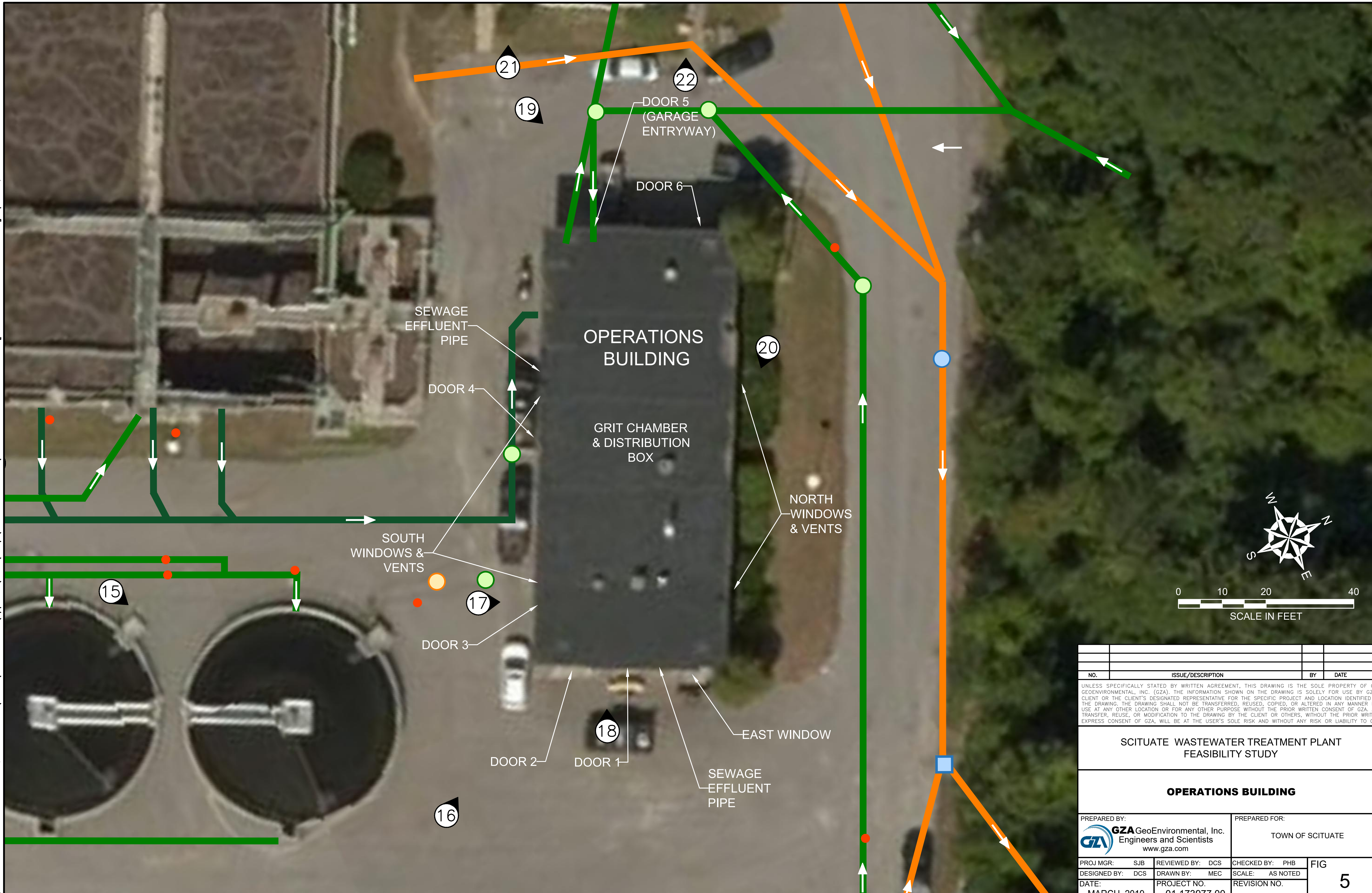

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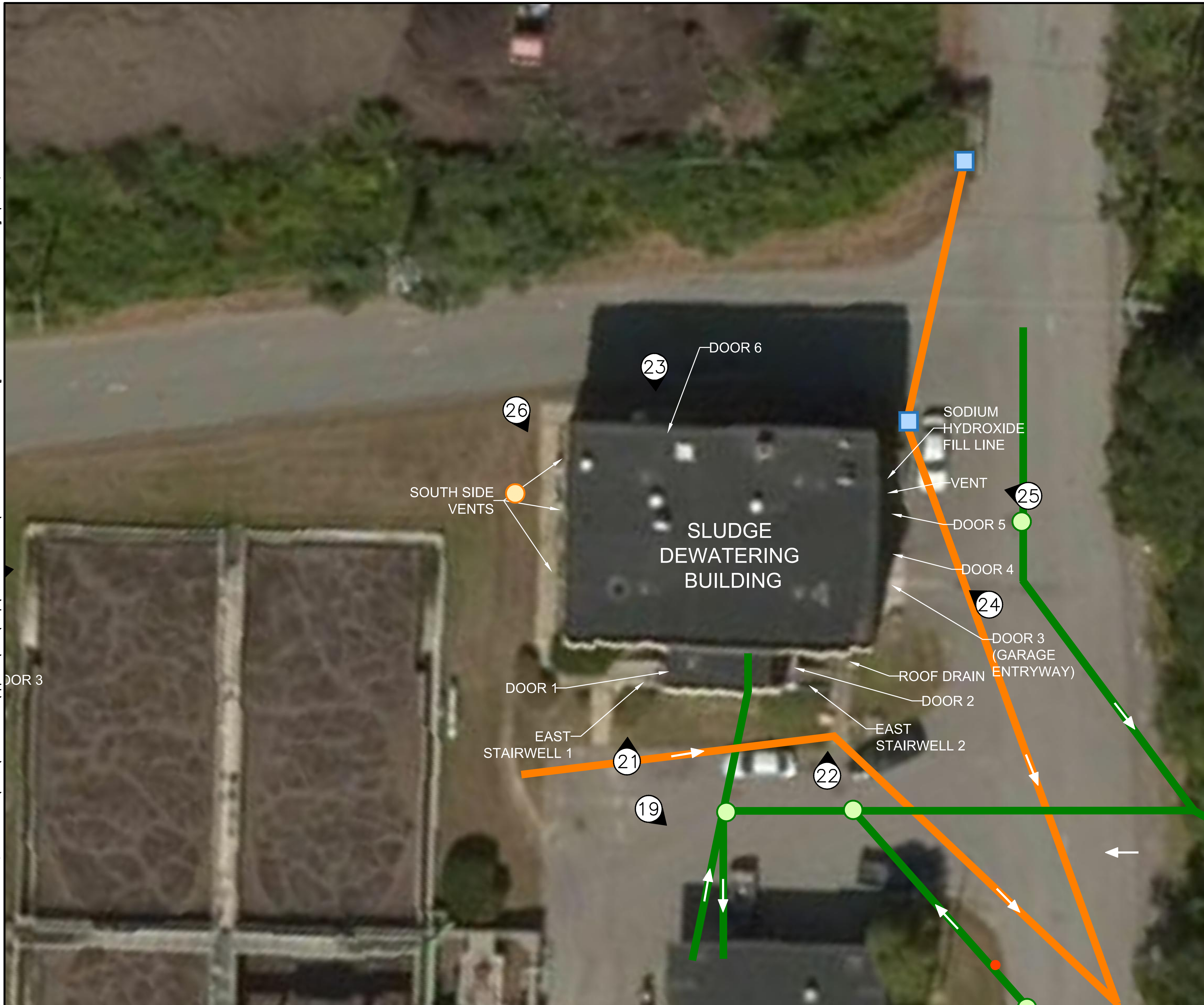

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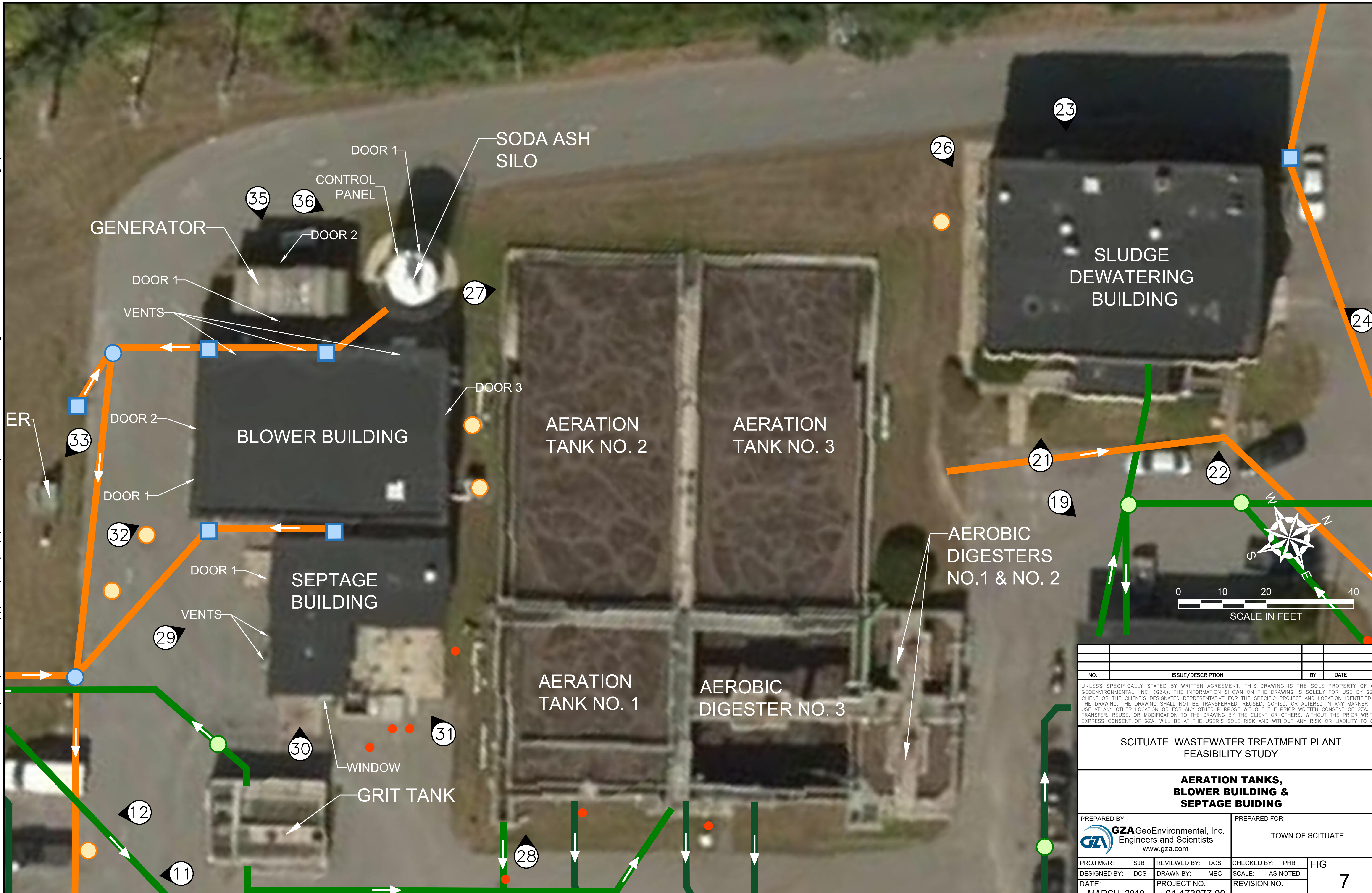

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**AERATION TANKS,
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SEPTAGE BUIDING**

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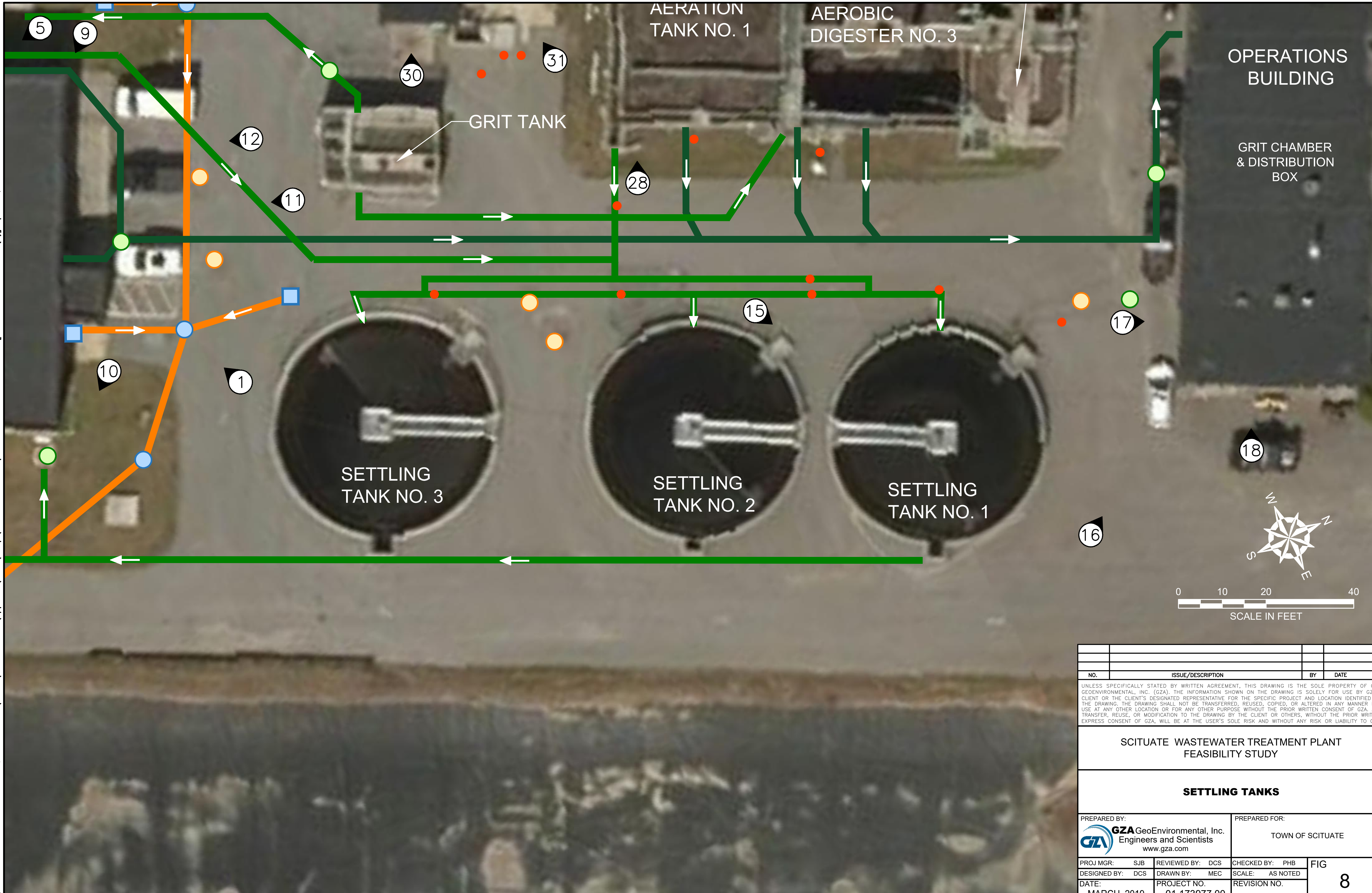

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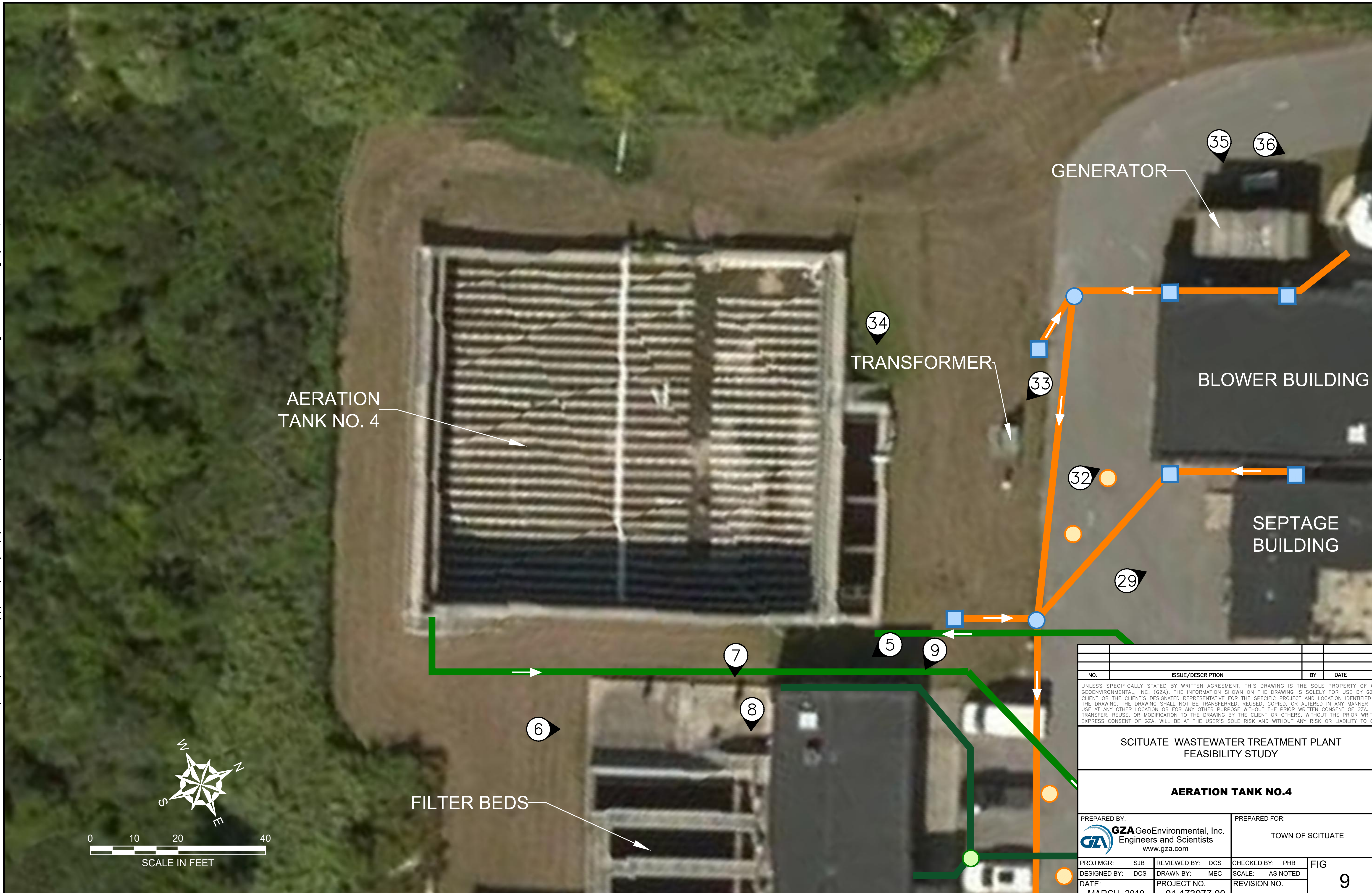

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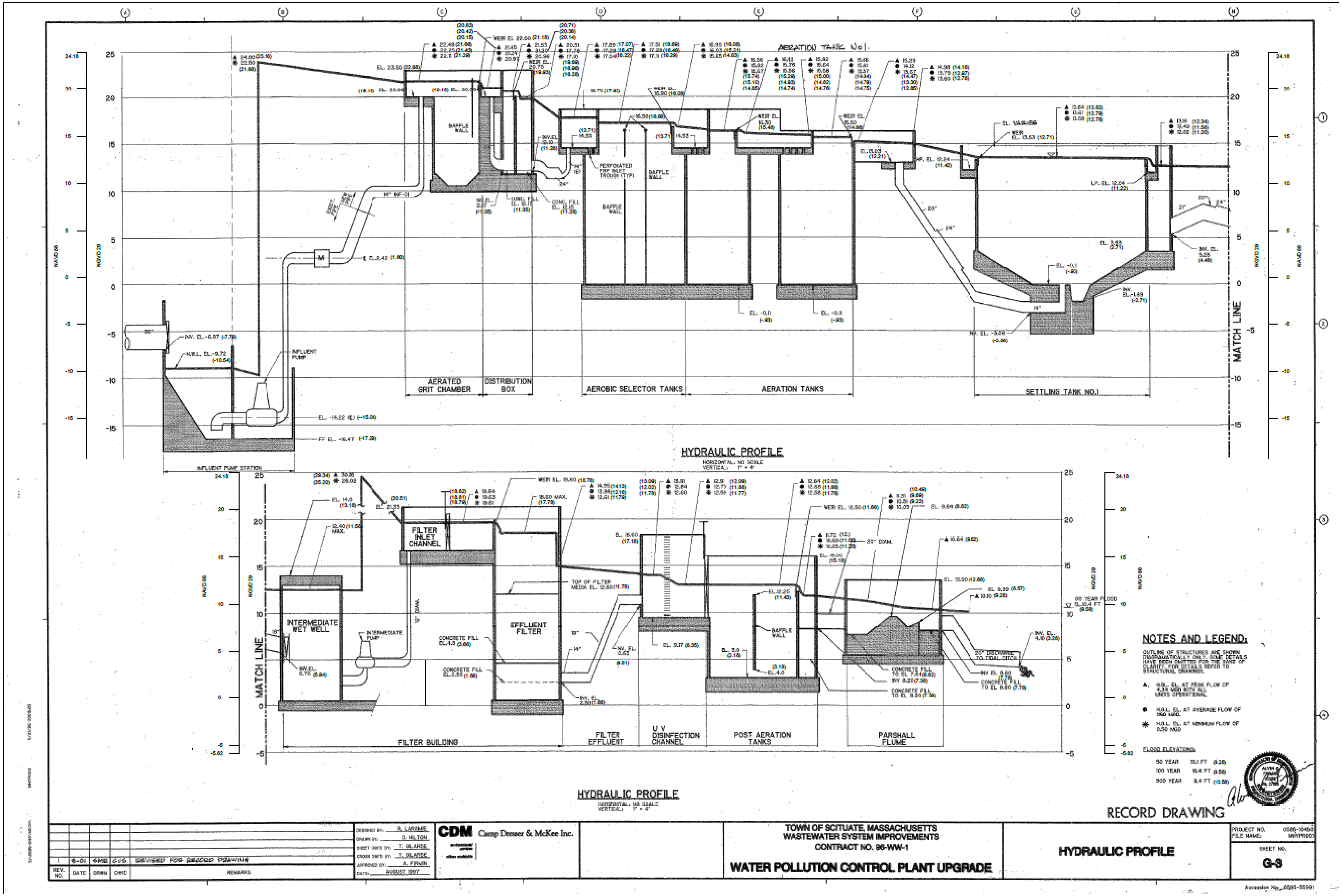


Figure 3-10 Hydraulic Profile

External Photographic Log

Client Name: Town of Scituate	**Site Location:** Scituate Waste water Treatment Plant	**Project No.** 01.0173977.00

Photo 1 Office Building/ Filter Building Main Entrance	**Photo 2** Door and Garage on East Side of Filter Building
	
Photo 3 Door 6 on East Side of Filter Building	**Photo 4** Door 4 and East Side Stairs of Fiter building

External Photographic Log

Client Name: Town of Scituate	Site Location: Scituate Waste water Treatment Plant	Project No. 01.0173977.00

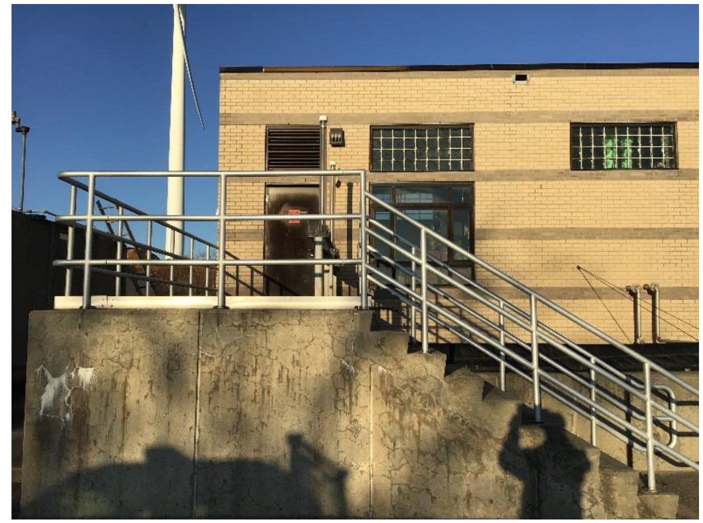


Photo 5 Doors 2 on West Side of Office building

Photo 6 Overview of Concrete Pad Adjacent to Filter Beds

External Photographic Log

Client Name: Town of Scituate	**Site Location:** Scituate Waste water Treatment Plant	**Project No.** 01.0173977.00

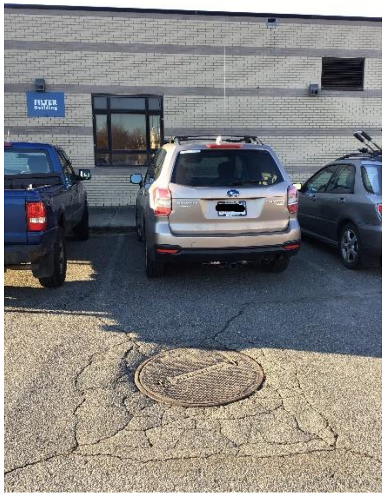
Photo 7 Concrete Pad Adjacent to Filter Beds	**Photo 8** Control panel
	
Photo 9 Electric Box on West Side of Filter Building	**Photo 10** Wet Well Manhole on NorthSide of Filter Building

External Photographic Log

Client Name: Town of Scituate	**Site Location:** Scituate Waste water Treatment Plant	**Project No.** 01.0173977.00

Photo 11 Electirc Manhole in Front of Filter Building

Photo 12 Instrumentation Manhole inFront of Filter building



External Photographic Log

Client Name: Town of Scituate	**Site Location:** Scituate Waste water Treatment Plant	**Project No.** 01.0173977.00

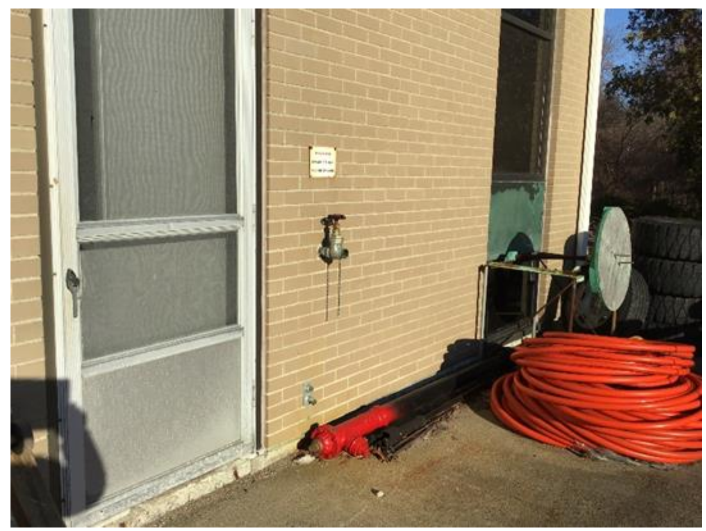
Photo 13 Fibergalss Shed for Methanol Pumps	**Photo 14** East Side of Methanol Storage Tank
	
Photo 15 Settling Tanks 1 and 2	**Photo 16** Operations Building

External Photographic Log

Client Name: Town of Scituate	**Site Location:** Scituate Waste water Treatment Plant	**Project No.** 01.0173977.00

Photo 17 Door on South Side of Operations Building

Photo 18 Door on East Side of Operations Building



External Photographic Log

Client Name: Town of Scituate	**Site Location:** Scituate Waste water Treatment Plant	**Project No.** 01.0173977.00

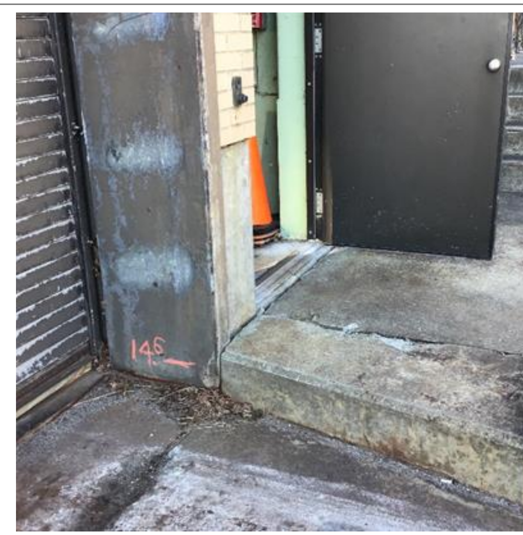
Photo 19 Garage on West Side of Operations Building	**Photo 20** Windows on North Side of Operations building
	
Photo 21 Left Stairway on East Side of Dewatering Building	**Photo 22** Right Stairway on East Side of Dewtering Building

External Photographic Log

Client Name: Town of Scituate	**Site Location:** Scituate Waste water Treatment Plant	**Project No.** 01.0173977.00

Photo 23 Door on West Side of Operations Building

Photo 24 Garage and Door on North Side of Operations Building



External Photographic Log

Client Name: Town of Scituate	**Site Location:** Scituate Waste water Treatment Plant	**Project No.** 01.0173977.00

Photo 25 Door on North Side of Operations Building	**Photo 26** Vents on South Side of Operations Building
	
Photo 27 Sill Elevation of Aeration Tank 2	**Photo 28** Sill Elevation of Aeration Tank 1

External Photographic Log

Client Name: Town of Scituate	**Site Location:** Scituate Waste water Treatment Plant	**Project No.** 01.0173977.00

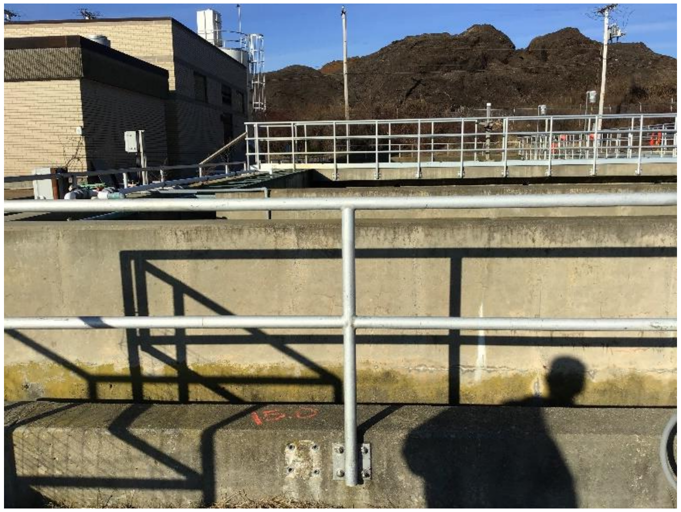


Photo 29 South Side of Septage Building

Photo 30 Window on East Side of Septage building

External Photographic Log

Client Name: Town of Scituate	**Site Location:** Scituate Waste water Treatment Plant	**Project No.** 01.0173977.00

Photo 31 Septage Tank Concrete pad	**Photo 32** Doors on South Side of Blower building
	
Photo 33 Electric Box Near Aeration Tank 4	**Photo 34** Sill Elevation of Aeration Tank 4

External Photographic Log

Client Name: Town of Scituate	Site Location: Scituate Waste water Treatment Plant	Project No. 01.0173977.00

Photo 35 Door to Generator Housing

Photo 36 Soda and Ash Silo

Attachment 4
Coastal Flood Hazard Characterization

Flood Hazard Characterization

The Town of Scituate is located along the Massachusetts South Shore, within Massachusetts Bay and just north of Cape Cod Bay (and north of Cape Cod). The description of the general physical and hydrologic setting of the sites are based on GZA's review of topographic data (U.S. Geologic Survey (USGS) topography maps), and other information obtained from the Massachusetts Geographic Information System (MassGIS). **Figure 4-1** presents the hydrologic site setting. The Sewer Collection System, including the 10 pumps stations, the Wastewater Treatment Plant and the sewer collection piping are also indicated. Key hydrologic features relative to the flood vulnerability of the Sewer Collection System include: 1) the ocean shoreline, including Scituate Harbor; 2) the tidal wetlands at the coastal inlet of the North River and the tidal North River; 3) the tidally-connected Cohasset Harbor, the Gulf and the Musquashcut Brook (and tide gate) and adjacent tidal wetlands; 4) Musquashcut Pond; 5) the hydraulically-connected First Herring Brook, Tack Factory Pond and Old Oaken Bucket Pond; and Satuit Brook (which discharges to Scituate Harbor).

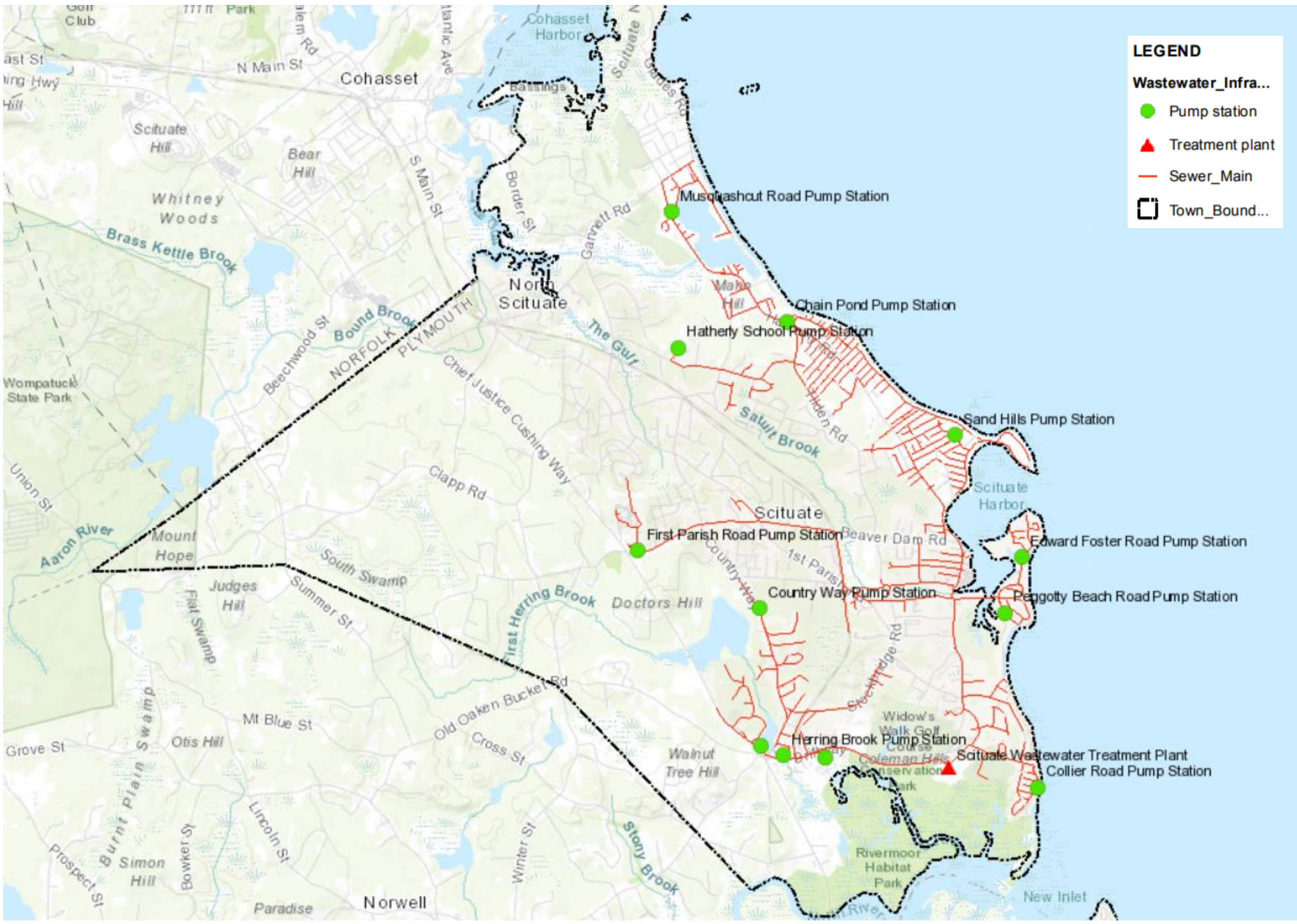
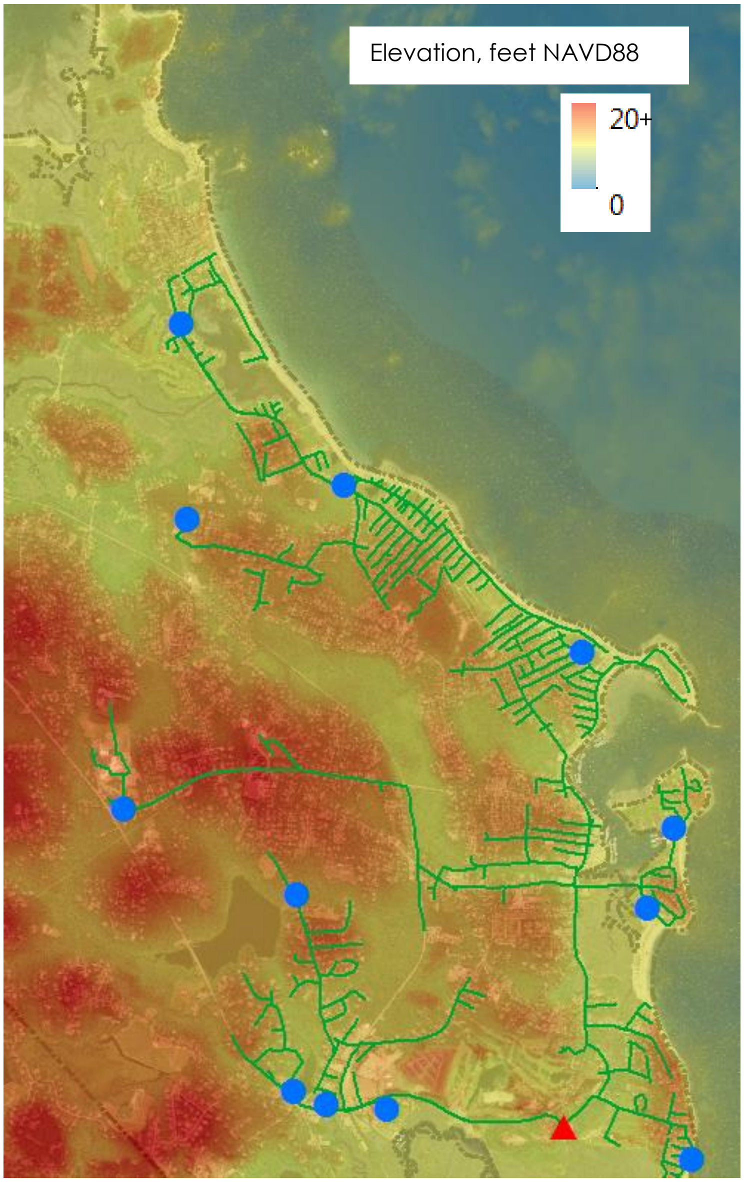


Figure 4-1: Hydrologic Site Setting

Figure 4-2 presents the general topographic (ground surface elevation) setting. The surficial geology (**Figure 4-3**) consists principally of glacial till, with localized deposits of sand and gravel and floodplain alluvium. The topography is characterized by high topographic relief. Low-lying areas, defined as Elevation 20 feet NAVD88 and below, are shown in **Figure 4-2**. The low-lying areas are generally indicative of coastal flood vulnerability. These areas are hydraulically-connected via a network of tidal wetlands and tidal rivers, resulting in backwater flooding during coastal flood events. The shoreline and nearshore areas are also low-lying and directly vulnerable to coastal flooding.



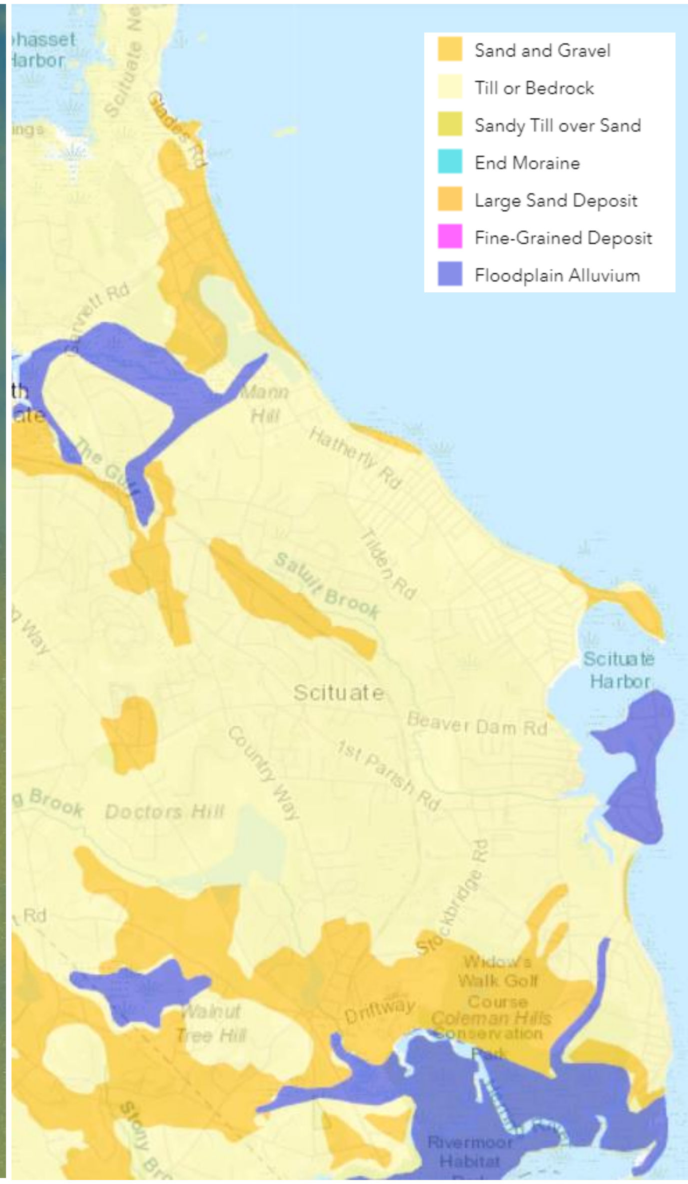


Figure 4-2: Topographic Site Setting with Pump Stations and Treatment Plant Locations Indicated

Figure 4-3: Surficial Geology

The Town of Scituate, including the Scituate Sewer Collections System and Wastewater Treatment Plant, is vulnerable to flooding due to coastal flooding. Intense rainfall, high winds and/or snow can occur coincident with coastal flood events.

Figure 4-4 shows the locations of the pump stations and the wastewater treatment plant, relative to the limits of flood inundation as shown on the effective FEMA Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS). As shown on these figures, 7 of the 10 pump stations and the Wastewater Treatment Plant are located within areas currently mapped by FEMA as special flood hazard areas due to coastal flooding. The pump stations include: Musquashcut Pond Pump Station; Chain Pond Pump Station; Sands Hill Pump Station; Edward Foster Road Pump Station; Peggotty Beach Road Pump Station; Collier Road Pump Station; and Herring Brook Pump Station. The other pumps stations are located within areas characterized by FEMA as Areas of Minimal Flood Hazard Zone X.

This report attachment (**Attachment 4**) characterizes the coastal flood hazards. Coastal flood hazards include flood inundation and waves, and are characterized in terms of their annual exceedance probability (AEP), recurrence interval and service life probability.

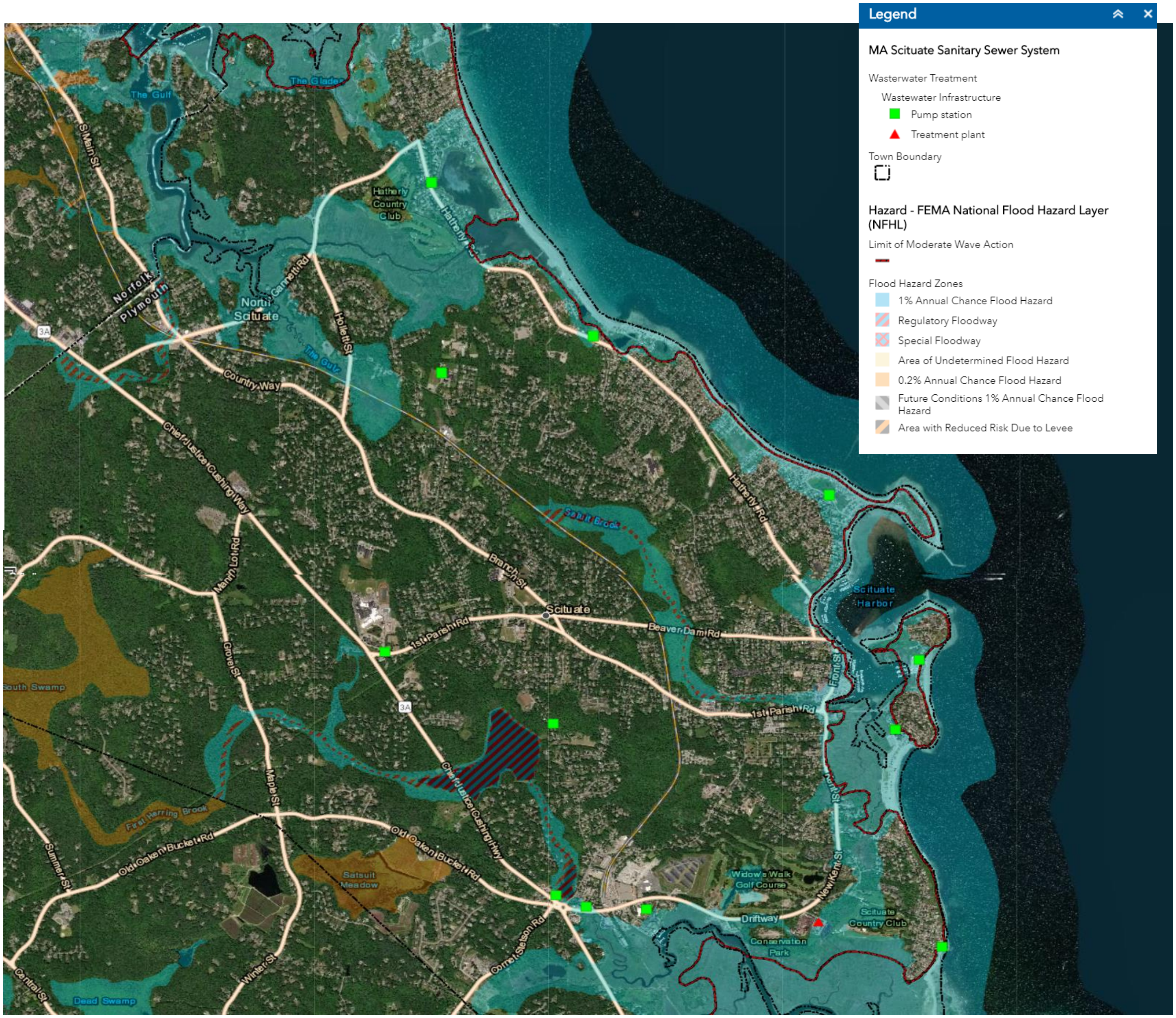


Figure 4-4: Location of Pump Stations and Wastewater Treatment Plant relative to FEMA Flood Hazard Zones
Note: See Figure 4-10 for pump station identifications.

Flood Probability

Flood conditions are characterized in terms of probability (i.e., their likelihood of occurrence). If the hazard probability is defined, then the probability of its effects (e.g., building damage, loss, etc.) can also be defined. This is essential information for understanding flood risk and for performing benefit-cost analyses of flood mitigation measures.

Annual Exceedance Probability (Recurrence Interval)

Environmental flood conditions (i.e., wind, water levels and waves) are characterized in terms of their probability, specifically their annual exceedance probability. This probability can also be defined in terms of "recurrence intervals". For example, a 100-year recurrence interval event has a 1% chance of being met or exceeded in any given year (1% annual exceedance probability). A 10-year recurrence interval has a 10% chance of being met or exceeded in any given year (10% annual exceedance probability). A 5-year recurrence interval has a 20% chance of being met or exceeded in any given year (20% annual exceedance probability). A 1-year recurrence interval has a near 100% chance of being met or exceeded in any given year. The FEMA Base Flood Elevation (BFE) used for national flood insurance (and building code) purposes refers to the 100-year recurrence interval (1% annual exceedance probability) flood. The building code and industry standards for flood protection of wastewater treatment systems also reference the 500-year recurrence interval (0.2% annual exceedance probability) flood.

Service Life Encounter Probability

The probability of experiencing an event during a project or facility service life is also an important factor to understand risk. Assuming a 50-year service life (end of service life in the year 2070), the exceedance probabilities (i.e., chance of experiencing the event at least once over the service life are summarized below. For example, the 100-year recurrence interval event has about a 40% chance of occurring at least once during the assumed 50 year service life.

Recurrence Interval (years)	Occurrence Exceedance Probability (%)
5	100.0%
10	99.5%
20	92.3%
50	63.6%
100	39.5%
500	9.5%

Table 4-1: Probability of Meeting or Exceeding Event during 50 year Service Life

The vulnerability and performance of the Scituate Wastewater Collection System structures and components (and associated repair and replacement costs) are also a function of the effect of multiple storms occurring during the design life. Utilizing a Poisson distribution, the occurrence probabilities for different numbers of events for multiple recurrence intervals and an assumed 50-year service life are summarized below. For example, the 100-year recurrence interval event has about a 40% chance of occurring at least once but is unlikely to occur more than 3 times during the 50-year service life.

Recurrence Interval (years)	No. of Event Occurrences:	1	2	3	4	5	6	7	8	9	10
		Occurrence Probabilities (%)									
5		0.1%	0.2%	0.8%	1.9%	3.8%	6.3%	9.0%	11.3%	12.5%	12.5%
10		3.4%	8.4%	14.4%	17.6%	17.6%	14.6%	10.4%	6.5%	3.6%	1.8%
20		20.5%	25.6%	21.4%	13.4%	6.7%	2.8%	1.0%	0.3%	0.1%	0.0%
50		36.8%	18.4%	6.1%	1.5%	0.3%	0.1%	0.1%	0	0	0
100		30.3%	7.6%	1.3%	0.6%	0.2%	0	0	0	0	0
500		9.1%	0.5%	0	0	0	0	0	0	0	0

Table 4-2: Probability of Multiple Events during 50 year Design Life

The probability of multiple events is also often presented in terms of cumulative probability during a 50-year period; for example, the chance that an event will occur 1 or more time, 2 or more times, 3 or more times, etc. These probabilities are presented below.

Recurrence Interval (years)	> No. of Event Occurrences:	1	2	3	4	5	6	7	8	9	10
5		100.0%	99.9%	99.7%	99.0%	97.1%	93.3%	87.0%	78.0%	78.0%	54.2%
10		99.5%	96.1%	87.7%	73.3%	55.7%	38.2%	23.6%	13.1%	6.6%	3.0%
20		92.3%	71.8%	46.2%	24.8%	11.4%	4.7%	1.9%	0.9%	0.6%	0.3%
50		63.6%	26.8%	8.4%	2.3%	0.7%	0.4%	0.4%	0.3%	0.3%	0.3%
100		39.5%	9.2%	1.6%	0.3%	0.0%	0	0	0	0	0
500		9.5%	0.5%	0	0	0	0	0	0	0	0

Table 4-3: Probability of Meeting or Exceeding Multiple Events during 50 year Design Life

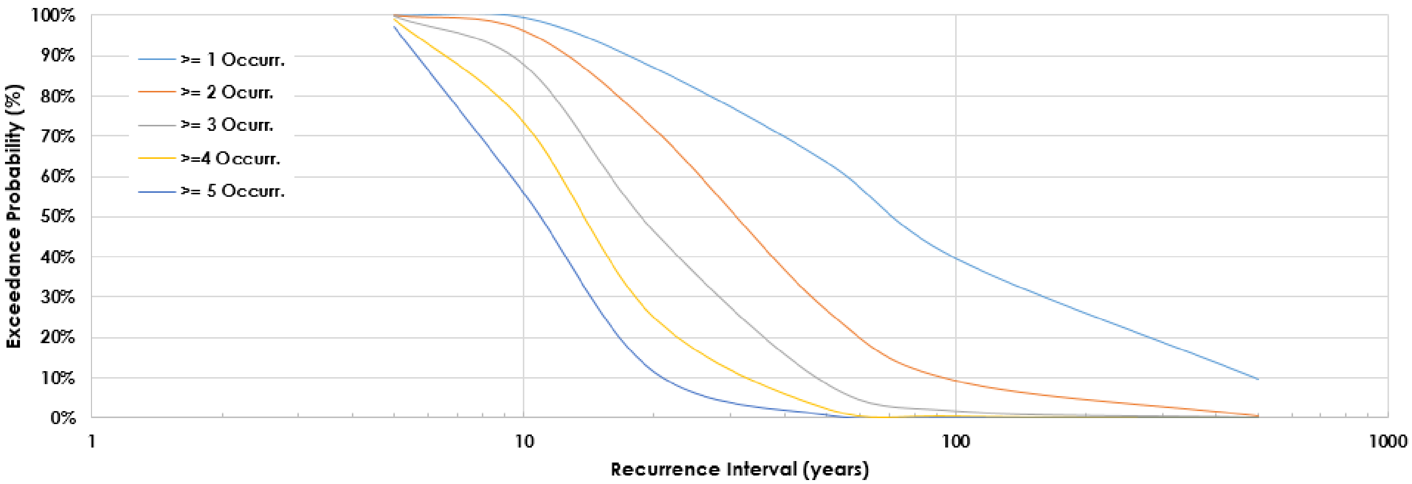


Figure 4-5: Probability of Meeting or Exceeding Multiple Events during 50 year Design Life

Climate Change and Sea Level Rise

As discussed later in this Attachment, climate change (in particular sea level rise) will affect the future probabilities of flood hazards.

Flood Effects

Coastal flooding can result in damage to the Scituate Wastewater Collection system, structures and components (SSCs), resulting in temporary disruption of service and/or permanent damage requiring repair or replacement. Flood effects also include risk to employee and public safety. Effects include damage due to floodwater inundation, exposure to flood loads and the residual effects from flood inundation (such as mold, exposure to corrosive salt water, etc.). Flood loads include: hydrostatic, hydrodynamic, wave and debris impact loads. Flood effects may also occur simultaneously with other hazards such as extreme wind or extreme precipitation.

The flood risk is characterized as: *the probability of the flood hazard x the consequences*. As noted previously, the flood risk is typically described in terms of probability or likelihood of occurring one or more times during a period of time (e.g., facility service life).

Coastal Flooding

Coastal flooding at Scituate includes several components:

1. Storm surge, which is the water height that results from water being pushed toward the shore by strong winds during a storm. The height of the storm surge is affected by many variables, including storm intensity, storm track and speed, the presence of waves, offshore depths, and shoreline configuration. When combined with tides, the storm surge is referred to as the storm tide. This rise in water level can cause severe flooding in coastal areas, particularly when the storm coincides with high tides.

2. Stillwater elevation (SWE), which is the projected elevation of floodwaters (storm tide) in the absence of wave effects.

3. Wind-generated waves, which can occur coincident with storm surge and are characterized by:

   - Wave height (vertical distance from trough to crest)
   - Wave length (distance from crest to crest in the direction of propagation)
   - Wave period (time interval between arrival of consecutive crests at a stationary point)
   - Wave propagation direction

4. Significant wave height (H_s), which represents the average height of the highest one-third of the waves in a given time period (usually chosen somewhere in the range from 20 minutes to twelve hours), or in a specific wave or storm system. Other wave statistics are relevant to evaluating flood risk include (assuming a Rayleigh wave distribution): 1) $H_{1/10} = H_s \times 1.27$; 2) $H_{1/100} = H_s \times 1.67$; and 3) $H_{1/1000} = +/- H_{max} = +/- H_s \times 2$.

5. Wave setup, which is the increase in the water level caused by the onshore mass transport of water that happens due to waves breaking during a storm. Wave setup is affected by the wave height, the speed at which waves approach the shore, and the slope of the shore.

6. Total water level (TWL), which includes the stillwater level plus wave setup.

7. Wave crest elevation, which is the elevation of the top of the wave crest. The portion of the wave occurring above the total water (or stillwater) level is dependent upon the wave characteristics and shoaling effects. For depth-limited waves, about 70% of the wave height is above the stillwater level.

Coastal floods in Scituate are associated with both tropical cyclones (tropical storms and hurricanes) and extratropical nor'easters. Hurricanes are relatively rare, but nor'easters occur fairly frequently. Nor'easters are also generally slow-moving meaning that they have a high probability of having a high storm surge coinciding with at least one high astronomical tide.

Nor'easters are extratropical storms, generally occurring during the months of November through April. These storms are relatively frequent events, occurring several times a year. Nor'easters are typically of less intensity (peak and sustained wind speeds) than hurricanes, but of longer duration, lasting several tide cycles. In New England, nor'easters occur as synoptic low pressure systems migrating in a northeast direction up the coast from the Caribbean or from the Great Lakes region in a west to east direction. A common characteristic of nor'easters is that the dominant wind comes from the north to east quadrant.

Hurricanes are relatively rare in the vicinity of Scituate but can result in extreme wind, waves and elevated water levels due to storm surge. They can be high intensity, but are typically of short duration. Exceptions to this are hybrid storms (e.g., Superstorm Sandy, the "Perfect Storm") which consist of both tropical and extratropical components and can result in large wind fields and longer storm durations. The effects of hurricanes on Scituate are a function of: 1) recurrence rate (i.e., the frequency that hurricanes occur in the vicinity of Scituate); 2) the storm track (considering that hurricanes occur with a counterclockwise wind direction); and 3) the combination of meteorological parameters that determine the storm's translation speed, radius of maximum wind and intensity (central pressure deficit and wind speed).

Coastal Flood Conditions

Coastal flood conditions include: 1) flood inundation due to elevations defined by stillwater elevations; 2) localized increase in water levels due to wave set-up; and 3) waves. These conditions typically occur contemporaneously with high winds and extreme precipitation (rain and/or snow).

The stillwater elevations summarized below are the elevations of the floodwater water due to the effects of the astronomical tides and storm surge on the water surface without wave effects. Waves may occur contemporaneously with stillwater flooding. Within the wave breaking zone (i.e., along the ocean shoreline), the momentum of the breaking waves causes wave set-up. Where wave set-up occurs, the combined stillwater elevation and wave set-up is referred to as the Total Water Level (TWL). Wave set-up has been predicted by FEMA for the Base Flood (100-year recurrence interval coastal flood) Wave set-up has also been approximately estimated (by GZA) for this study as 15% of the significant or depth-limited wave height.

Wave characteristics (wave height, wave period) are characterized statistically. The wave heights (unless depth-limited) experienced during a storm event are assumed to be randomly distributed consistent with a Rayleigh distribution. The significant wave height (Hs) is the average of the top third of the waves and has about a 13% probability of being exceeded. The average of the highest 10% of the waves (H_{10}) has about a 4% exceedance probability and is equal to about 1.27 x H_s. The average of the highest 1% of the waves (H_{10}) has about a 0.35% exceedance probability and is equal to about 1.68 x H_s. H_{max} is approximately the top 0.1% of the waves and is equal to about 2 x H_s. Depth-limited wave heights achieve a maximum wave height condition.

FEMA assumes a depth-limited wave height (H_b) when calculating overland flood conditions. The portion of the wave that occurs above the stillwater elevation is assumed by FEMA to be 0.7 x the wave height. The wave crest elevation is representative of the Total Water Level plus the portion of the wave above the stillwater elevation. The Base Flood Elevation (BFE) presented on FEMA Flood Insurance Rate Maps (FIRMS) for coastal flood zones typically (but not always) represents the wave crest elevation. Waves breaking over flat or sloped surfaces (e.g., a beach) result in wave run-up beyond the limit where the stillwater elevation equals the ground elevation. Waves encountering vertical surface (e.g., building walls, flood walls, etc.) can result wave reflection and in wave run-up. When the wave crest or run-up elevation exceeds a wall or berm elevation (such as roadway or levee), wave overtopping can occur which can result if flooding and ponding behind (upland of) the structure.

FEMA characterizes flood zones where wave heights are 3 feet or greater during the Base Flood (100-year recurrence interval flood) as High Velocity Zones (VE). These are areas where wave heights are such that significant structural damage should be anticipated during the Base Flood. Structural damage (in particular, wood structures) can also be damaged when exposed to waves of about 1.5 feet in height. These areas are also defined by FEMA as coastal high hazard (AE) zones and their limits are often shown of FEMA Flood Insurance Rate Maps (FIRMs) as the Limit of Moderate Wave Action (LMWA). **Figure 4-6** presents FEMA coastal flood hazard zones.

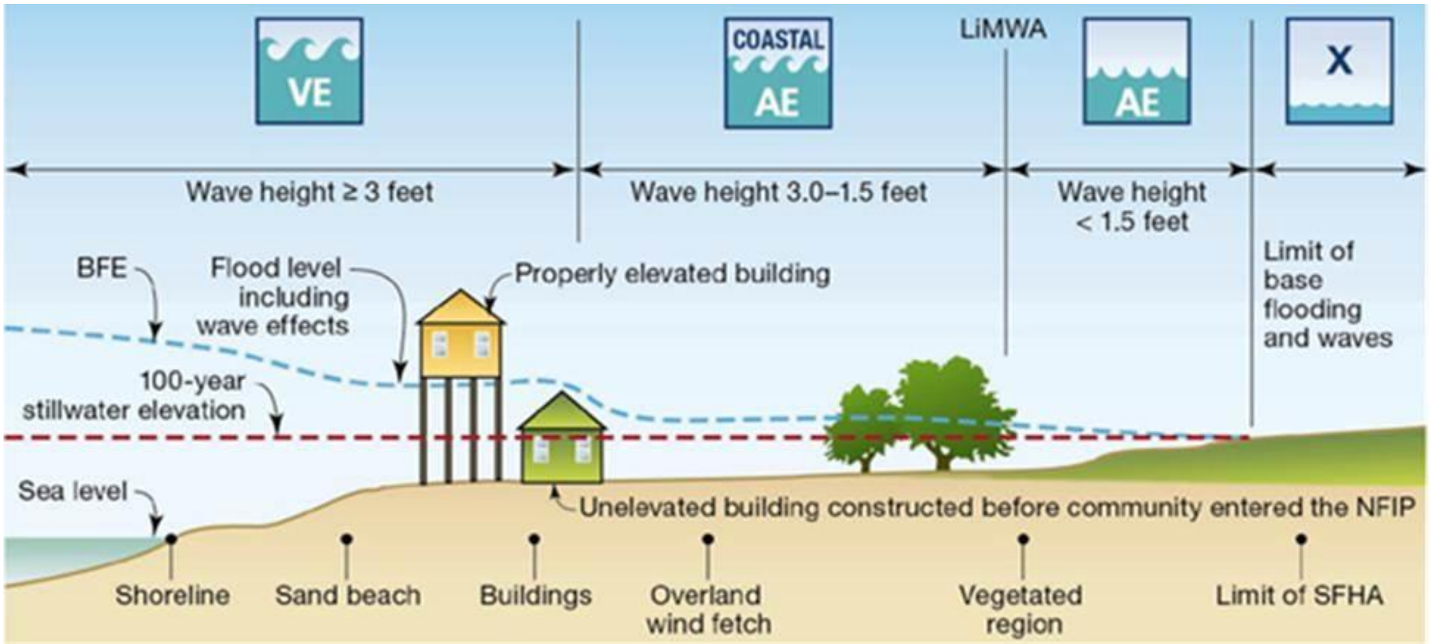


Figure 4-6: FEMA Coastal Flood Zones

Characterizing Coastal Flood Elevations

The coastal flood hazards at Scituate are characterized utilizing information presented in:

- NOAA Boston Tide Station. GZA performed a statistical analysis of the NOAA Boston Tide Station monthly and annually maximum water level data using Generalized Extreme Value (GEV) statistics.
- The FEMA Flood Insurance Study (FIS) and related Flood Insurance Rate Maps (FIRMs).
- The results of the Army Corps of Engineers (USACE) North Atlantic Coast Comprehensive Study (NAACS). This study was performed by the USACE after Hurricane Sandy to characterize coastal flood hazards in areas impacted by Hurricane Sandy (from the Chesapeake Bay to New Hampshire). The study included statistical analysis and computer modeling of storm surge and waves. The study provides nearshore storm surge and wave hazard data at multiple locations around Nantucket.
- Wind data presented in ASCE 7-10, 3-second gust velocities and Logan Airport historical, observed wind data. GZA converted ASCE 3-second gusts for representative frequencies to the sustained 1-minute, 10-meter wind speed. GZA performed statistical analysis of Logan Airport observed 1, 2 - minute sustained, 10-meter wind speeds.
- NOAA Atlas 14 precipitation data.

Vertical Datum Conversion

Flood elevations developed using these sources reference the NAVD88 datum. Ground, structure and flood elevations for the Wastewater Treatment System reference the NGVD29 datum. The conversion factor from NGVD29 to NAVD88 is -0.8 foot, and from NAVD88 to NGVD29 is +0.8 foot.

National Oceanic and Atmospheric Administration (NOAA) Tide Gage

The NOAA Boston Harbor tide stations (Station 8443970), located approximately 18 miles from Scituate, is the closest NOAA tide gage and is the control station for Scituate, MA. The period of record for the Boston tide station is 99 years (1921 to current). The observed water levels at the Boston tidal station are used to predict both tidal datums and extreme (i.e., coastal storm surge) water levels.

Tidal Datums:

Tidal datums at Boston were estimated using the National Oceanic and Atmospheric Administration (NOAA) VDatum software and tidal datums for the NOAA Boston tidal station and the subsidiary Scituate tide station (8445138). The tidal datums for the current tidal epoch (1983-2001) are summarized in **Tables 4-4** and **4-5** relative to the NAVD88 vertical datum. As shown below, Scituate tidal range is marginally smaller than Boston and high tide elevations are less.

Tidal Datum	Elevation (NAVD88 feet)
Mean Higher High Water (MHHW)	4.77
Mean High Water (MHW)	4.33
Mean Sea Level (MSL)	-0.3
Mean Lower Low Water (MLW)	-5.16
Mean Lower Low Water (MLLW)	-5.51
Highest Astronomical Tide (HAT)	6.92
Mean Range of Tide (feet)	9.49

Table 4-4: NOAA Boston Tidal Datums

TIDAL DATUM	ELEVATION (NAVD88 feet)
Mean Higher High Water (MHHW)	4.43
Mean High Water (MHW)	3.98
Mean Sea Level (MSL)	-0.44
Mean Lower Low Water (MLW)	-5.00
Mean Lower Low Water (MLLW)	-5.35

Table 4-5: NOAA Scituate Tidal Datums

Extreme Water Levels:

The top ten observed water levels (uncorrected for sea level rise) are shown in **Table 4-6** relative to MHHW and **Table 4-7** relative to NAVD88.

Top Ten Highest Water Levels for long-term stations in feet above MHHW (as of 4/2018)

* --- Inferred Level & --- Last Recorded Level # --- High Water Mark

Station Number	Station Name	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Ninth	Tenth
8443970	Boston, MA	1/4/2018	2/7/1978	3/2/2018	1/2/1987	10/30/1991	1/25/1979	12/12/1992	12/29/1959	2/19/1972	1/3/2014
	(since 1921)	4.89	4.82	4.36	3.92	3.86	3.76	3.75	3.70	3.62	3.56

Table 4-6: Top Ten Highest Observed Water Levels at the NOAA Boston Tide Station (relative to MHHW)
Note: Flood elevations not corrected for sea level rise.

Date	Stillwater Elevation (NAVD88 feet)
1/4/2018	9.65
2/7/1978	9.59
3/2/2018	9.16
1/2/1987	8.69
10/30/1991	8.63
1/24/1979	8.53
12/12/1992	8.52
3/3/2018	8.36
1/3/2014	8.33
12/29/1959	8.33

Table 4-7: Top Ten Highest Observed Water Levels at the NOAA Boston Tide Station (relative to NAVD88)
Note: Flood elevations not corrected for sea level rise.

Date	Stillwater Elevation (NAVD88 feet)
1/4/2018	9.65
3/2/2018	9.16
3/3/2018	8.36
1/3/2014	8.33
1/27/2015	8.11
5/26/2017	7.9
1/30/2018	7.73
5/28/2017	7.59
11/25/2018	7.54
9/10/2018	7.03

Table 4-8: Recent (Last 5 years) Peak Observed Water Levels at the NOAA Boston Tide Station

As indicated by the dates in **Tables 4-6** and **4-7**, 9 of the 10 top water levels at Boston were due to Nor'easters. The 5th largest water level was due to a hybrid tropical/extratropical storm (The Perfect Storm).

The monthly high water levels at the Boston station over the period of record are presented in **Figure 4-7**. The annual high water levels (original and corrected for observed sea level rise) are presented in **Figure 4-8**.

Monthly high-water levels recorded at the NOAA Boston Harbor tide gage (Station 8443970) were statistically evaluated by GZA and are presented in **Figure 4-9** and **Table 4-9.**

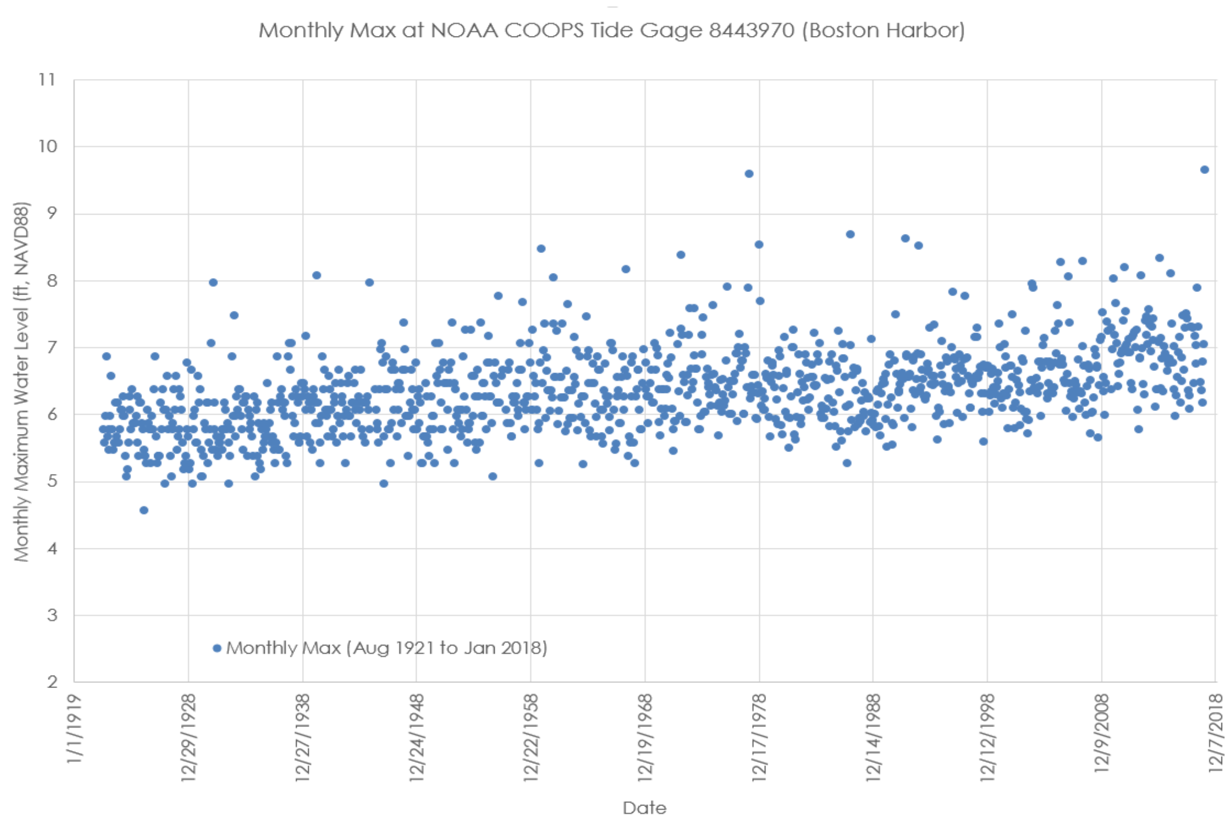


Figure 4-7: Monthly Maximum Water Levels (stillwater elevation) at the NOAA Boston Tide Station

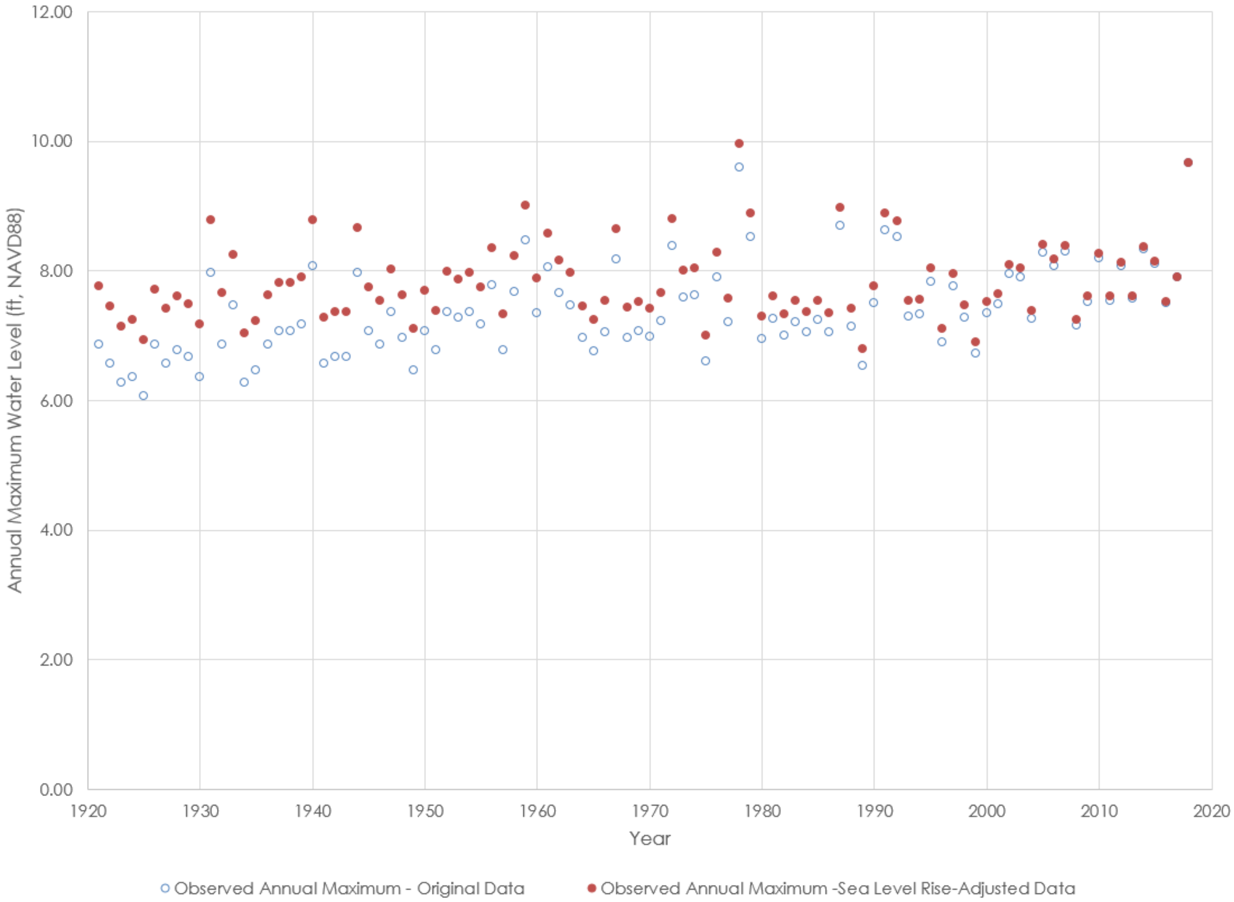


Figure 4-8: Annual Maximum Water Levels (stillwater elevation) at the NOAA Boston Tide Station

Recurrence Interval (years) (annual exceedance %)	Stillwater Elevation (NAVD88 feet)
1	6.8
2	7.6
5	8.3
10 (10%)	8.6
20	8.8
50 (2%)	9.4
100 (1%)	9.7
500 (0.2%)	10.5

Table 4-9: GZA-Predicted Flood-Frequency Curve (stillwater elevation) at NOAA Boston Tide Gage

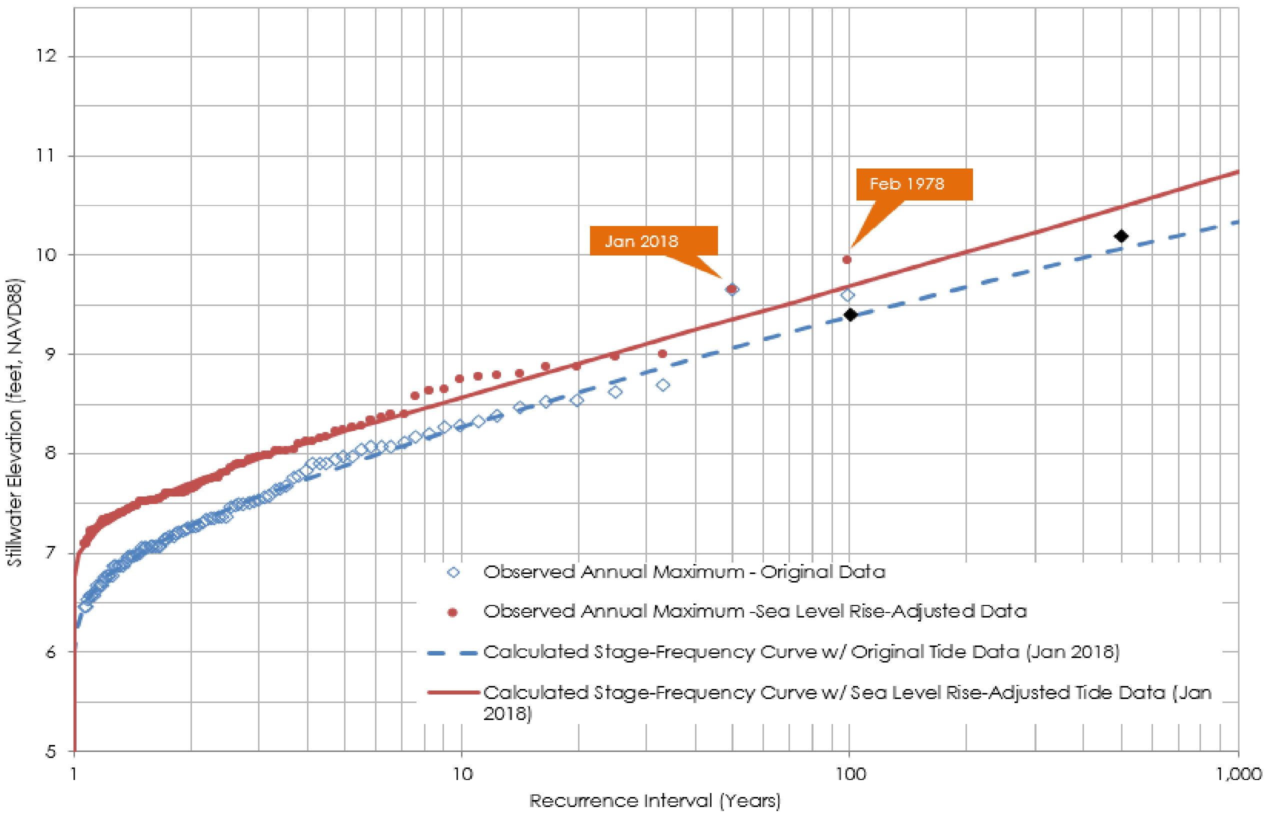


Figure 4-9: GZA-Predicted Flood-Frequency Curve (stillwater elevation) at NOAA Boston Tide Gage

Federal Emergency Management Agency (FEMA)

FEMA is responsible for defining the flood hazard for purposes of the National Flood Insurance Program (NFIP), including Flood Insurance Studies (FIS) and Flood Insurance Rate Maps (FIRMs):

- FEMA Flood Insurance Study (FIS), Plymouth County (all jurisdictions), Massachusetts, Four Volumes, #25025CV000BC, Effective Date November 4, 2016.
- FEMA Flood Insurance Rate Map (FIRM), Suffolk County (all jurisdictions), Massachusetts, Effective Date November 4, 2016:
  - Panel 0109K (109 of 650), Map Number Panel # 25023C0109K
  - Panel 0128K (128 of 650), Map Number Panel # 25023C0128K
  - Panel 0129K (129 of 650), Map Number Panel # 25023C0129K
  - Panel 0117K (117 of 650), Map Number Panel # 25023C0117K
  - Panel 0136K (136 of 650), Map Number Panel # 25023C0136K
  - Panel 0137K (137 of 650), Map Number Panel # 25023C0137K
  - Panel 0107K (107 of 650), Map Number Panel # 25023C0107K
  - Panel 0126K (126 of 650), Map Number Panel # 25023C0126K

The hydrologic and hydraulic analysis used in the 2016 FIS report was completed in 2013. The 2013 study superseded the 1999 coastal analysis which was used in the 2003 FIS. The coastal wave height analysis resulted in revisions to the FIRM for Scituate. According to the effective FIS (dated 2016), the digital base map information used for Plymouth county FIRM updates was derived from MassGIS orthophotography created from 30-cm pixel resolution photography dated April 2008.

The coastal analyses in the 2009 FIS used NOAA tidal gages and statistical methods to calculate stillwater flood elevations, and the National Academy of Sciences methodology to determine wave heights associated with storm surge flooding. The 2013 coastal analysis re-analyzed the Boston tide gage (which is located near the Site) using a statistical frequency analysis using L-Moments. During the appeal of the 2013 proposed map changes, the Boston tide gage was analyzed further, reducing the proposed 2013 1% flood stillwater elevation from 10.04 feet NAVD88 to 9.4 feet NAVD 88. The latter was adopted to develop the effective FIRM.

The Plymouth County FIS included a 2016 Coastal Study Update using numerical modeling (STWAVE wave model) to estimate deepwater wave parameters. This information is presented in the 2016 FEMA FIS and representative coastal transect data are summarized in **Table 4-10**. All flood elevations shown in the FEMA FIS report and on the FIRMs are referenced to the NAVD88.

Transect	**Stillwater Elevation (NAVD88 feet)**						
	10	**50**	**100**	**500**	**Total Water Level (feet, NAVD88)**	**Wave Set-up (feet)**	**Base Flood Elevation (BFE) (feet, NAVD88)**
32	8.3	9.1	9.5	10.3	15.6	5.3	AE 13-15 VE 20
35	8.3	9.1	9.5	10.3	15.0	5.5	AE 11-16 AO 3 VE16
42	8.3	9.1	9.5	10.3	11.4	1.9	AE 15-16 VE 16
46	8.3	9.1	9.5	10.3	14.9	5.4	AE 15-16 VE 18
48	8.3	9.1	9.5	10.3	13.9	4.4	AE 14 VE 17
50	8.3	9.1	9.5	10.3	15.3	5.8	AE 16 VE 17
51	8.3	9.1	9.5	10.3	14.9	5.4	AE 16 VE 17
52	8.3	9.1	9.5	10.3	12.7	3.2	AE 13-15 VE 17
53	8.3	9.1	9.5	10.3	15.3	5.8	AE 14-15 VE 23

Table 4-10: FEMA Flood Insurance Study (2016) Flood Elevations at Scituate Coastal Transects

USACE North Atlantic Coast Comprehensive Study (NACCS)

The U.S. Army Corps of Engineers (USACE) conducted the North Atlantic Coast Comprehensive Study (NACCS) to quantify extreme water levels in the northeast coastal region. Numerical modeling of storm surge and waves was performed by the USACE after Hurricane Sandy for the area from the Chesapeake Bay to the New Hampshire border. This study provides an additional assessment of coastal flood hazard along the Scituate shoreline.

USACE NACCS data for key, representative save points are presented in **Table 4-11**. The NACCS-predicted flood elevation (elevation of the mean stillwater plus wave set-up elevation) at each save point are presented. The uncertainty associated with the mean values is generally on the order of 2.5 to 3 feet.

Save Point	Mean Stillwater Elevation (feet, NAVD88)	Recurrence Interval in years (annual exceedance probability %)							
		1	2	5	10 (10%)	20	50 (2%)	100 (1%)	500 (0.2%)
92	Stillwater Elevation (feet, NAVD88)	5.8	6.3	6.8	7.3	7.7	8.2	8.6	9.4
93	Stillwater Elevation (feet, NAVD88)	5.8	6.4	7.0	7.4	7.8	8.2	8.6	9.2
1823	Stillwater Elevation (feet, NAVD88)	5.8	6.4	7.0	7.4	7.8	8.3	8.6	9.3
1824	Stillwater Elevation (feet, NAVD88)	5.8	6.4	7.0	7.4	7.9	8.4	8.7	9.4
1825	Stillwater Elevation (feet, NAVD88)	5.8	6.4	7.0	7.4	7.8	8.2	8.6	9.7
1826	Stillwater Elevation (feet, NAVD88)	5.8	6.3	6.9	7.3	7.7	8.2	8.5	9.2
1827	Stillwater Elevation (feet, NAVD88)	5.8	6.4	6.9	7.3	7.6	8.1	8.4	9.0
1833	Stillwater Elevation (feet, NAVD88)	5.8	6.4	6.9	7.5	7.8	8.3	8.6	9.3
9461	Stillwater Elevation (feet, NAVD88)	6.0	6.6	7.5	8.1	8.6	9.3	9.8	10.7
9462	Stillwater Elevation (feet, NAVD88)	6.1	6.9	7.9	8.6	9.1	9.8	10.2	11.0
9463	Stillwater Elevation (feet, NAVD88)	6.8	7.6	8.7	9.4	10.0	10.7	11.2	12.0
9465	Stillwater Elevation (feet, NAVD88)	6.6	7.5	8.9	9.6	10.3	11.0	11.4	12.3
9505	Stillwater Elevation (feet, NAVD88)	6.1	7.0	8.2	8.9	9.4	10.0	10.4	11.2
9506	Stillwater Elevation (feet, NAVD88)	5.9	6.5	6.7	8.0	8.5	9.1	9.5	10.4
9509	Stillwater Elevation (feet, NAVD88)	5.8	6.5	7.3	7.8	8.3	8.9	9.2	9.9

Along the Scituate shoreline, the predicted 1% annual chance (100-year return period) stillwater flood elevation ranges between 8.4 feet and 11.2 feet NAVD88. The predicted 0.2% (500-year return period) stillwater flood elevation ranges

Table 4-11: USACE North Atlantic Coast Comprehensive Study Stillwater Elevation Data at Representative Save Points

between 9.0 feet and 12.0 feet NAVD88. The lower values are generally associated with ocean nearshore coastal flood stillwater elevations. The higher values are generally at save points located within estuaries, where backwater and other hydrodynamic effects increase the stillwater elevation relative to the nearshore coastal water levels.

The NACCS-predicted flood nearshore mean significant wave heights (in feet) at each save point are presented in **Table 4-12**.

Save Point	Mean Significant Wave Height (feet)	Recurrence Interval in years (annual exceedance probability %)							
		1	2	5	10 (10%)	20	50 (2%)	100 (1%)	500 (0.2%)
92	Significant Wave Height	6.8	8.5	8.8	8.9	9.1	9.2	9.3	9.5
93	Significant Wave Height	9.3	16.6	22.7	25.4	27.0	28.3	28.8	29.3
1823	Significant Wave Height	8.9	15.9	22.1	25.4	27.4	28.9	29.6	30.2
1824	Significant Wave Height	9.2	16.0	19.8	20.7	21.3	21.9	22.2	22.5
1825	Significant Wave Height	13.2	20.1	25.5	28.8	30.9	32.4	33.1	33.7
1826	Significant Wave Height	10.3	18.3	21.4	22.1	22.3	23.2	23.6	24.2
1827	Significant Wave Height	9.6	16.4	21.2	24.5	26.2	27.3	27.8	28.3
1833	Significant Wave Height	9.0	15.9	20.3	23.0	24.7	26.0	26.5	27.0
7118	Significant Wave Height	6.2	6.7	7.0	7.2	7.3	7.4	7.5	7.7
9461	Significant Wave Height	8.1	11.9	12.7	13.2	13.6	14.0	14.3	14.6
9462	Significant Wave Height	8.6	11.2	11.8	12.4	12.6	13.0	13.3	13.8
9463	Significant Wave Height	7.1	8.3	9.5	10.1	10.5	10.8	10.9	11.3
9464	Significant Wave Height	6.4	6.6	6.6	6.7	6.7	6.8	6.8	6.9
9465	Significant Wave Height	6.5	6.9	7.2	7.3	7.3	7.4	7.5	7.6
9505	Significant Wave Height	2.2	2.5	3.3	3.9	4.4	4.9	5.3	6.1
9506	Significant Wave Height	5.8	7.7	8.2	8.4	8.7	8.9	9.2	9.6
9507	Significant Wave Height	12.2	14.1	14.8	15.2	15.6	16.0	16.3	16.7
9509	Significant Wave Height	7.9	12.4	13.1	13.5	13.9	14.4	14.8	15.6

Table 4-12: USACE North Atlantic Coast Comprehensive Study Wave Heights at Representative Save Points

Relative Sea Level Rise

The effect of sea level rise will be to increase the frequency (and/or magnitude) of future flood elevations. The Relative Sea Level Rise (RSLR) is the difference between the sea surface and land surface. RSLR in the area of Scituate is a function of several, complex global and regional scale factors including: 1) volumetric change due to ice melt; 2) thermal expansion of seawater; 3) gravitational changes due to mass dispersion from ice melt; 5) ocean dynamics and changes to the Gulf Stream; 6) seawater density change due to the introduction of fresh water; and 7) vertical land movement due to glacial isostatic adjustment. Additional RSLR can occur locally due to localized ground settlement (such as may occur due to filling coastal sites underlain by compressible soils). **Figure 4-10** shows the historic, observed RSLR at the NOAA Boston Tide Station. The plot shows the monthly mean sea level without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents. The long-term linear trend is also shown, including its 95% confidence interval. As shown in **Figure 4-10**, the overall trend in the average rate of RSLR observed historically, for the years 1921 to current, in the Boston vicinity, has been about 0.0093 feet per year (NOAA Boston Tidal Station).

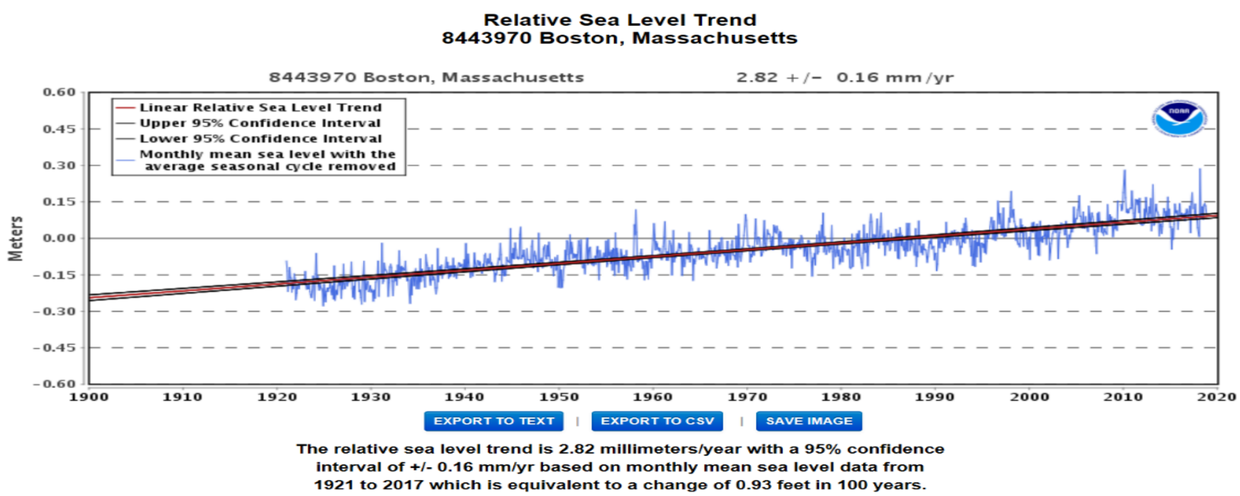


Figure 4-10: Observed Sea Level Rise at the NOAA Boston Tide Station

At that average historic rate, the RSLR by the years 2050 and 2100 (compared to today) are predicted to be 0.3 foot to 0.75 foot, respectively. The rate of future RSLR is expected to increase from that historically observed; however, there is significant uncertainty as to the amount of change. The predicted relative sea level rise (RSLR) at Boston was estimated using the USACE sea level rise calculator and the 2017 NOAA projections and can be found at this link: http://www.corpsclimate.us/ccaceslcurves.cfm

NOAA 2017 Sea Level Rise Projections

NOAA and the USACE have developed ranges of RSLC for NOAA tide stations around the United States. **Figure 4-11** presents six NOAA 2017 projections (Low, Intermediate-Low, Intermediate, Intermediate-High, High and Extreme) representing several possible future climate scenarios (Representative Concentration Pathways RCP 2.6, RCP 4.5, RCP 8.5) adopted by the Intergovernmental Panel on Climate Change (IPCC) for its fifth Assessment Report (AR5). In general, the median "Intermediate-Low" is considered appropriate as an "analysis and planning lower bound" and either the median "Intermediate" or median "Intermediate-High" is appropriate as an "analysis and planning upper bound". **Table 4-13** presents estimated exceedance probabilities associated with the six NOAA 2017 projections (based on global mean sea levels).

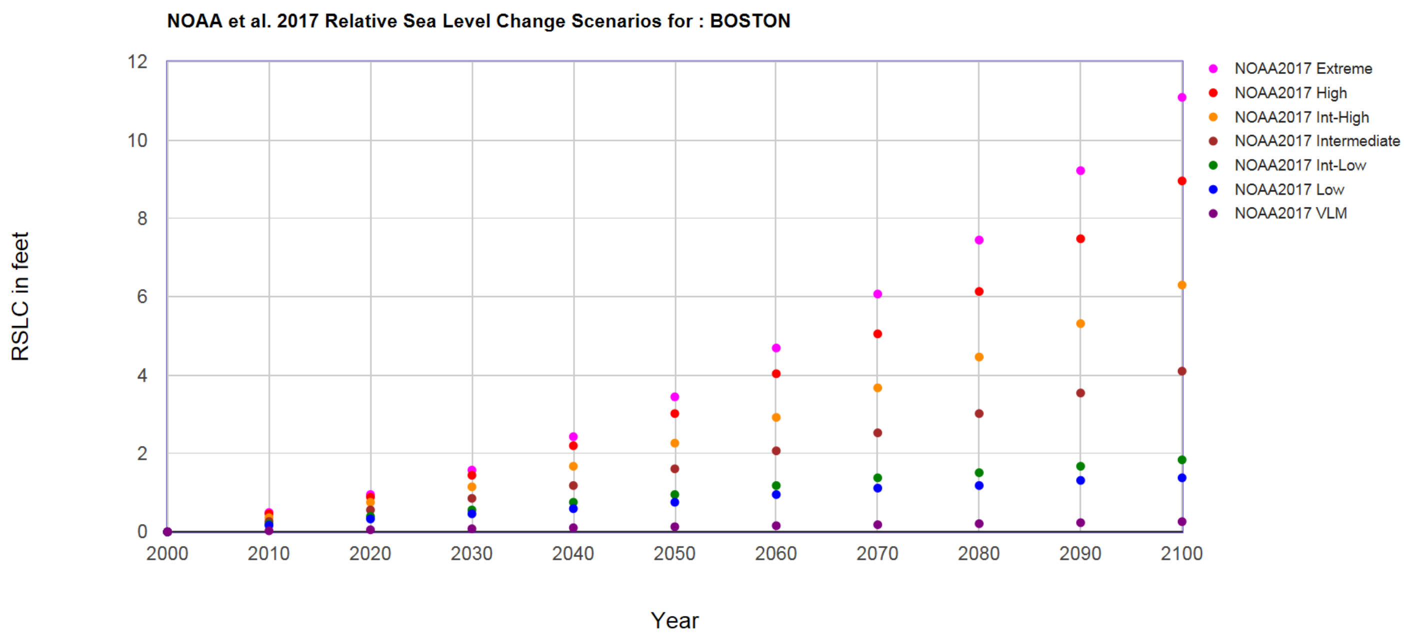


Figure 4-11: Predicted Relative Sea Level Rise Projections at NOAA Boston Tide Gage based on NOAA 2017

GMSL Rise Scenario	RCP 2.6	RCP 4.5	RCP 8.5
Low (0.3 m)	94%	98%	100%
Intermediate-Low (0.5 m)	49%	73%	96%
Intermediate (1.0 m)	2%	3%	17%
Intermediate-High (1.5 m)	0.4%	0.5%	1.3%
High (2.0 m)	0.1%	0.1%	0.3%
Extreme (2.5 m)	0.05%	0.05%	0.1%

Table 4-13: Probability of Exceeding Global Mean Sea Levels in 2100 for Several Representative Concentration Pathways (RCP) Scenarios relative to NOAA 2017 Global SLR Projections

Table 4-14 presents NOAA 2017 RSLR projections for the Boston tide station relative to the year 2000. **Table 4-15** presents NOAA 2017 RSLR projections for the Boston tide station relative to the year 2020. The following compares four NOAA 2017 Intermediate RSLR scenario projections (for the years 2030, 2050, 2070, and 2100) in relation to the year 2000.

- by the year 2030, the likely range (17th percentile to 83rd percentile) of the NOAA 2017 Intermediate RSLR compared to the year 2000 is 0.62 to 1.05 feet higher with a median of 0.85 feet;
- by the year 2050, NOAA 2017 Intermediate RSLR compared to the year 2000 is 1.21 to 1.9 feet with a median of 1.61 feet;
- by the year 2070, NOAA 2017 Intermediate RSLR compared to the year 2000 is 2.00 to 2.99 feet higher with a median of 2.53 feet; and
- by the year 2100, NOAA 2017 Intermediate RSLR compared to the year 2000 is 3.28 to 4.76 feet higher with a median of 4.1 feet.

Year	NOAA2017	NOAA2017	NOAA2017	NOAA2017	NOAA2017	NOAA2017	NOAA2017
	VLM	Low	Int-Low	Intermediate	Int-High	High	Extreme
2000	0	0	0	0	0	0	0
2010	0.03	0.16	0.2	0.26	0.36	0.46	0.49
2020	0.05	0.33	0.39	0.56	0.75	0.89	0.95
2030	0.08	0.46	0.56	0.85	1.15	1.44	1.57
2040	0.1	0.59	0.75	1.18	1.67	2.2	2.43
2050	0.13	0.75	0.95	1.61	2.26	3.02	3.44
2060	0.16	0.95	1.18	2.07	2.92	4.04	4.69
2070	0.18	1.12	1.38	2.53	3.67	5.05	6.07
2080	0.21	1.18	1.51	3.02	4.46	6.14	7.45
2090	0.23	1.31	1.67	3.54	5.31	7.48	9.22
2100	0.26	1.38	1.84	4.1	6.3	8.96	11.09

Table 4-14: NOAA 2017 SLR Projections at the NOAA Boston Tide Station (relative to 2000)

Year	NOAA2017	NOAA2017	NOAA2017	NOAA2017	NOAA2017	NOAA2017	NOAA2017
	VLM	Low	Int-Low	Intermediate	Int-High	High	Extreme
2020	0	0	0	0	0	0	0
2030	0.03	0.13	0.17	0.29	0.4	0.55	0.62
2040	0.05	0.26	0.36	0.62	0.92	1.31	1.48
2050	0.08	0.42	0.56	1.05	1.51	2.13	2.49
2060	0.11	0.62	0.79	1.51	2.17	3.15	3.74
2070	0.13	0.79	0.99	1.97	2.92	4.16	5.12
2080	0.16	0.85	1.12	2.46	3.71	5.25	6.5
2090	0.18	0.98	1.28	2.98	4.56	6.59	8.27
2100	0.21	1.05	1.45	3.54	5.55	8.07	10.14

Table 4-15: NOAA 2017 SLR Projections at the NOAA Boston Tide Station (relative to 2020 – current date)

Boston Research Advisory Group

The Boston Research Advisory Group (BRAG) Report, developed for the Climate Ready Boston project, reviewed existing literature to establish a consensus on the possible impacts of sea level rise to the City of Boston. The report summarizes the current understanding of the local factors that influence Boston's future exposure to sea level rise.

The 2016 BRAG projections pre-date and are lower than the 2017 NOAA projections. Estimates from both reports reference the NOAA tidal gage (Station 8443970) located in Boston Harbor.

Below is a comparison of four BRAG Intermediate RSLR scenario projections (for the years 2030, 2050, 2070, and 2100) in relation to the year 2000.

- by the year 2030, the likely range (17th percentile to 83rd percentile) of the BRAG Intermediate RSLR compared to the year 2000 is 0.3 to 0.7 foot higher with a median of 0.5 feet;
- by the year 2050, BRAG Intermediate RSLR compared to the year 2000 is 0.7 to 1.4 feet higher with a median of 1.0 feet;
- by the year 2070, BRAG Intermediate RSLR compared to the year 2000 is 1.3 to 2.6 feet higher with a median of 1.9 feet; and
- by the year 2100, BRAG Intermediate RSLR compared to the year 2000 is 2.4 to 5.1 feet higher with a median of 3.6 feet.

Massachusetts State Hazard Mitigation and Climate Adaptation Plan

The Massachusetts State Hazard Mitigation and Climate Adaptation Plan references data from the Northeast Climate Science Center (NE CASC) Massachusetts Climate Change Projections Report. For the March 2018 report, the NE CASC conducted a probabilistic assessment of future relative sea level rise to create projections for the Boston tide gage.

The 2018 projections supersede the NOAA and BRAG data and are considered the most current RSLR values. The NE CASC values Estimates from all reports reference the NOAA tidal gage (Station 8443970) located in Boston Harbor.

Below is a comparison of four BRAG intermediate RSLR scenario projections (for the years 2030, 2050, 2070, and 2100) in relation to the year 2000.

- by the year 2030, the median RSLR of the NE CASC Intermediate scenario compared to the year 2000 is 0.7 feet;
- by the year 2050, the median RSLR of the NE CASC Intermediate scenario compared to the year 2000 is 1.4 feet;
- by the year 2070, the median RSLR of the NE CASC Intermediate scenario compared to the year 2000 is 2.3 feet; and
- by the year 2100, the median RSLR of the NE CASC Intermediate scenario compared to the year 2000 is 4.0 feet.

Effect of Sea Level Rise on Extreme Water Levels

The relative sea level rise values can be linearly-superimposed to the predicted current tides and flood-frequency curves. **Table 4-16** indicates predicted FEMA stillwater flood levels relative to current (year 2020) for different Recurrence Intervals assuming NOAA 2017 Intermediate RSLR Projection. **Table 4-17** indicates the predicted FEMA 100-year recurrence interval stillwater flood levels relative to current (year 2020) for different Recurrence Intervals for the range of NOAA 2017 RSLR projections.

Recurrence Interval (yrs)	2020	2030	2050	2070	2100
(Annual Chance)	**SWEL**	**SWEL**	**SWEL**	**SWEL**	**SWEL**
10-year (10%)	8.3	8.59	9.35	10.27	11.84
50-year (2%)	9.1	9.39	10.15	11.07	12.64
100-year (1%)	9.5	9.79	10.55	11.47	13.04
500-year (0.2%)	10.3	10.59	11.35	12.27	13.84

Table 4-16: Predicted Water Levels for different Recurrence Intervals at Scituate assuming NOAA 2017 Intermediate RSLR Projection and Current FEMA Stillwater Elevations

Year	NOAA2017	NOAA2017	NOAA2017	NOAA2017	NOAA2017	NOAA2017
	Low	Int-Low	Intermediate	Int-High	High	Extreme
2020	9.5	9.5	9.5	9.5	9.5	9.5
2030	9.63	9.67	9.79	9.9	10.05	10.12
2040	9.76	9.86	10.12	10.42	10.81	10.98
2050	9.92	10.06	10.55	11.01	11.63	11.99
2060	10.12	10.29	11.01	11.67	12.65	13.24
2070	10.29	10.49	11.47	12.42	13.66	14.62
2080	10.35	10.62	11.96	13.21	14.75	16
2090	10.48	10.78	12.48	14.06	16.09	17.77
2100	10.55	10.95	13.04	15.05	17.57	19.64

Table 4-17: Predicted Water Levels for 100-year Recurrence Interval at Scituate assuming NOAA 2017 RSLR Projections and Current FEMA Stillwater Elevations

Precipitation

Precipitation frequency-intensity relationships for the Site have been generated using the internet-based precipitation frequency application of the NOAA Atlas 14.

A summary of rainfall amounts for several different durations and annual probabilities are presented in **Table 4-18**.

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.304	0.375	0.491	0.588	0.721	0.824	0.926	1.07	1.26	1.41
10-min	0.43	0.531	0.696	0.833	1.02	1.17	1.31	1.52	1.79	1.99
15-min	0.506	0.625	0.819	0.98	1.2	1.37	1.54	1.78	2.1	2.34
30-min	0.708	0.874	1.15	1.37	1.68	1.92	2.16	2.5	2.95	3.29
60-min	0.909	1.12	1.47	1.76	2.16	2.47	2.78	3.22	3.79	4.23
2-hr	1.17	1.46	1.94	2.33	2.88	3.29	3.71	4.33	5.16	5.78
3-hr	1.37	1.7	2.26	2.71	3.34	3.83	4.32	5.04	6	6.73
6-hr	1.79	2.2	2.88	3.44	4.21	4.81	5.4	6.27	7.42	8.28
12-hr	2.32	2.8	3.59	4.25	5.15	5.84	6.53	7.49	8.75	9.7
24-hr	2.82	3.4	4.35	5.13	6.21	7.05	7.88	9	10.5	11.6
2-day	3.21	3.93	5.09	6.06	7.39	8.41	9.44	10.9	12.8	14.2
3-day	3.52	4.28	5.54	6.57	8	9.1	10.2	11.8	13.8	15.4
4-day	3.8	4.59	5.88	6.96	8.43	9.57	10.7	12.3	14.4	16
7-day	4.58	5.4	6.76	7.88	9.42	10.6	11.8	13.4	15.5	17
10-day	5.29	6.15	7.55	8.71	10.3	11.5	12.8	14.3	16.4	17.9
20-day	7.37	8.32	9.88	11.2	12.9	14.3	15.7	17.2	19.2	20.7
30-day	9.09	10.1	11.8	13.2	15.1	16.6	18.1	19.5	21.5	22.9
45-day	11.3	12.4	14.2	15.7	17.8	19.4	21	22.4	24.2	25.7
60-day	13.1	14.3	16.2	17.8	20	21.7	23.4	24.7	26.5	27.9

Table 4-18: NOAA Atlas 14 Precipitation Data for Scituate

Flood Forecasting

Local weather stations provide forecasts 1-3 days in advance of extreme precipitation events.

The National Weather Service (NWS) Advanced Hydrologic Prediction Service website can provide advanced warning of potential flooding in Boston Harbor by up to 60 hours. Typical warning time are 24-48 hours for hurricanes, and 48-72 hours for Nor'easters. https://water.weather.gov/ahps2/hydrograph.php?wfo=box&gage=bhbm3

Coastal Flood Duration

Due to the nature of high tide flooding during storm events it is expected the flooding could occur over the course of several tide cycles, with peak flooding occurring for several hours multiple times.

ASCE 7-16 Wind Speeds

The 2017 American Society of Civil Engineers standard ASCE 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, providence guidance for wind loads in the 2018 International Building Code. ASCE/SEI presents 3-second gust wind speeds for multiple Risk Factor structures and multiple recurrence intervals. The ASCE/SEI 7-16 wind speeds applicable to Scituate reflect hurricane-dominated wind events (i.e., hurricane prone region). GZA converted the 3-second gusts to 1-minute and 10-minute sustained wind speeds using wind speed conversion factors for tropical cyclones presented in “Guidelines for Converting between Various Wind Averaging Periods in Tropical Cyclone Conditions”, World Meteorological Organization, 2008.

ASCE 7-16 wind speeds (3-second gust) are viewable by address at this location: https://hazards.atcouncil.org/

Category	Wind Speed (3 sec, mph)	Wind Speed (1min, mph)	Wind Speed (10min, mph)
MRI 10-year	76	62	55
MRI 25-year	86	70	62
MRI 50-year	97	79	70
MRI 100-year	101	82	73
Risk Category I (300-year)	113	92	82
Risk Category II (700-year)	123	100	89
Risk Category III (1,700-year)	132	107	96
Risk Category IV (3,000-year)	136	111	99

Table 4-19: ASCE 7-16 Wind Speeds for Scituate

GZA also performed an independent wind frequency analysis of area wind speed and directionality. Hourly wind data at the Logan Airport, located near Scituate, was downloaded from the National Climatic Data Center (NCDC) and statistically analyzed. The period of record covers 1948 to present, a total of 71 years. The maximum wind speeds (1 and/or 2 minute sustained wind speed) relative to different directional quadrants and “all direction” are summarized below. Extreme value statistical analysis was performed based on the monthly and annual maximum wind speed values extracted from the dataset. The wind frequency curve was based on the best fit using the Generalized Extreme Value (GEV) distributions. The North quadrant represents northerly winds with 315º to 45º compass (NW to NE) from true north. The East quadrant represents easterly winds with 45º to 135º compass (NE to SE) from true north. The South quadrant represents southerly winds with 135º to 225º compass (SE to SW) from true north. The West quadrant represents westerly winds with 225º to 135º compass (SW to NW) from true north. All-direction 3-second gust data was also analyzed using GEV.

Direction	Bearing Range (Degrees)	Wind Speed[1] in 100-Year Return Period		Wind Speed[1] in 500-Year Return Period	
		(m/s)	(mph)	(m/s)	(mph)
All Directions	0 - 360	33.3	74.5	40.0	89.5
West	247.5 -292.5	22.0	49.2	23.0	51.4
Northwest	292.5 - 337.5	28.0	62.6	33.0	73.8
North	337.5 - 22.5	26.0	58.2	29.5	66.0
Northeast	22.5 - 67.5	27.0	60.4	28.5	63.8
East	67.5 - 112.5	26.0	58.2	28.5	63.8
Southeast	112.5 - 157.5	30.0	67.1	39.5	88.4
South	157.5 - 202.5	25.0	55.9	27.0	60.4
Southwest	202.5 - 247.5	23.0	51.4	25.0	55.9

Note:
1. The wind speed based on1/2-min averaging duration.

Table 4-20: GZA Statistical Analysis of Logan Airport Wind Data

Scituate Wastewater Treatment System Location-Specific Coastal Flood Hazards

The coastal flood hazard differs at each of the pump stations and at the wastewater treatment plant. Location-specific flood characterizations are presented for the treatment plant and pump stations. The characterizations are based on the available flood data (e.g., FEMA, USACE NACCS) and engineering judgement.

Wastewater Treatment Plant:

The wastewater treatment plant is located on the North River tidal marsh. The ground surface elevation of the wastewater treatment plant ranges from 10 feet to 15 feet NAVD88. Coastal flooding on the marsh is complex and includes the following components:

- stillwater flood inundation due to storm surge and tide. Stillwater flooding initially enters the tidal marsh via the North River inlet.
- The North River inlet is fronted by a barrier beach with a primary dune at Elevation +/- 10 feet NAVD88. During coastal storms, large waves break seaward of the dune. Wave set-up increases the total water elevation (stillwater plus set-up) within the wave break zone.
- Wave run-up, erosion and overtopping of the primary dune causes additional inland flooding.
- Within the tidal wetlands and North River:
    - the stillwater elevations are predicted to increase relative to the coastal/nearshore values due to hydrodynamic effects;
    - wave heights will attenuate. The ocean waves effectively break along the shoreline. Under an extreme storm, the primary dune may erode completely and ocean waves may propagate into the tidal marsh and developed areas located inland of the primary dune.
    - smaller waves within the tidal marsh will be generated due to local wind fetch (est. 1.5 feet to 3 feet).
- The wastewater treatment plant flooding is initiated by stillwater flood inundation encroaching the earthen dike (crest elevation +/- 10 feet NAVD88). Small waves will run-up and overtop the dike.
- The effluent and stormwater outfall inverts are submerged.
- At floodwater elevation 10 feet NAVD88, the lined storage basin is completely flooded.
- At floodwater elevation 10 feet NAVD88 the northeast corner of the treatment plant site begins to be inundated.
- At floodwater elevation 16 feet NAVD88 the treatment plant site is completely inundated.

The coastal flood hazard in the vicinity of the wastewater treatment plant is characterized by:

- FEMA Flood Insurance Study (FIS) and Flood Insurance rate Map (FIRM):
    - Coastal Transects 51, 52 and 53 Stillwater Elevations, Wave Set-up and Total Water Elevations
    - FEMA FIRM BFE at Plant: Zone AE Elevation 16 feet
- NACCS Save Points: 1824; 9461; 9465; 9463; 9462; 1823
- NOAA 2017 Intermediate Sea Level Rise

Figure 4-12 presents the estimated flood-frequency curves that are the most representative of the stillwater flood elevations at the Wastewater Treatment Plant (NAACS save points 9463 and 9465 and FEMA). The predicted flood-frequency with sea level rise (Intermediate SLR projection by the year 2070) is also shown. As shown on **Figure 4-12**, the NACCS stillwater elevations (which indicate hydrodynamic effects within the marsh) are higher than FEMA stillwater elevations (which represent the ocean nearshore stillwater elevation).

Figures 4-13 and **4-14** show inundation limits, stillwater elevations and wave set-up (FEMA) for the 100-year and 500-year recurrence interval floods, respectively. Stillwater elevation (SW), total water elevation (TW) and wave set-up (WSetup) are shown.

Figures 4-15 through **4-16** show inundation limits, stillwater elevations and wave heights (NACCS) for the 100-year, 500-year and 1-year recurrence interval floods, respectively.

Figures 4-17 through **4-26** show approximate flood inundation at the Wastewater Treatment Plant for floodwater elevations ranging from 8 feet to 16 feet NAVD88.

Based on the available flood hazard data and engineering judgement, **Table 4-21** summarizes the estimated coastal flood hazard characteristics at the wastewater treatment plant.

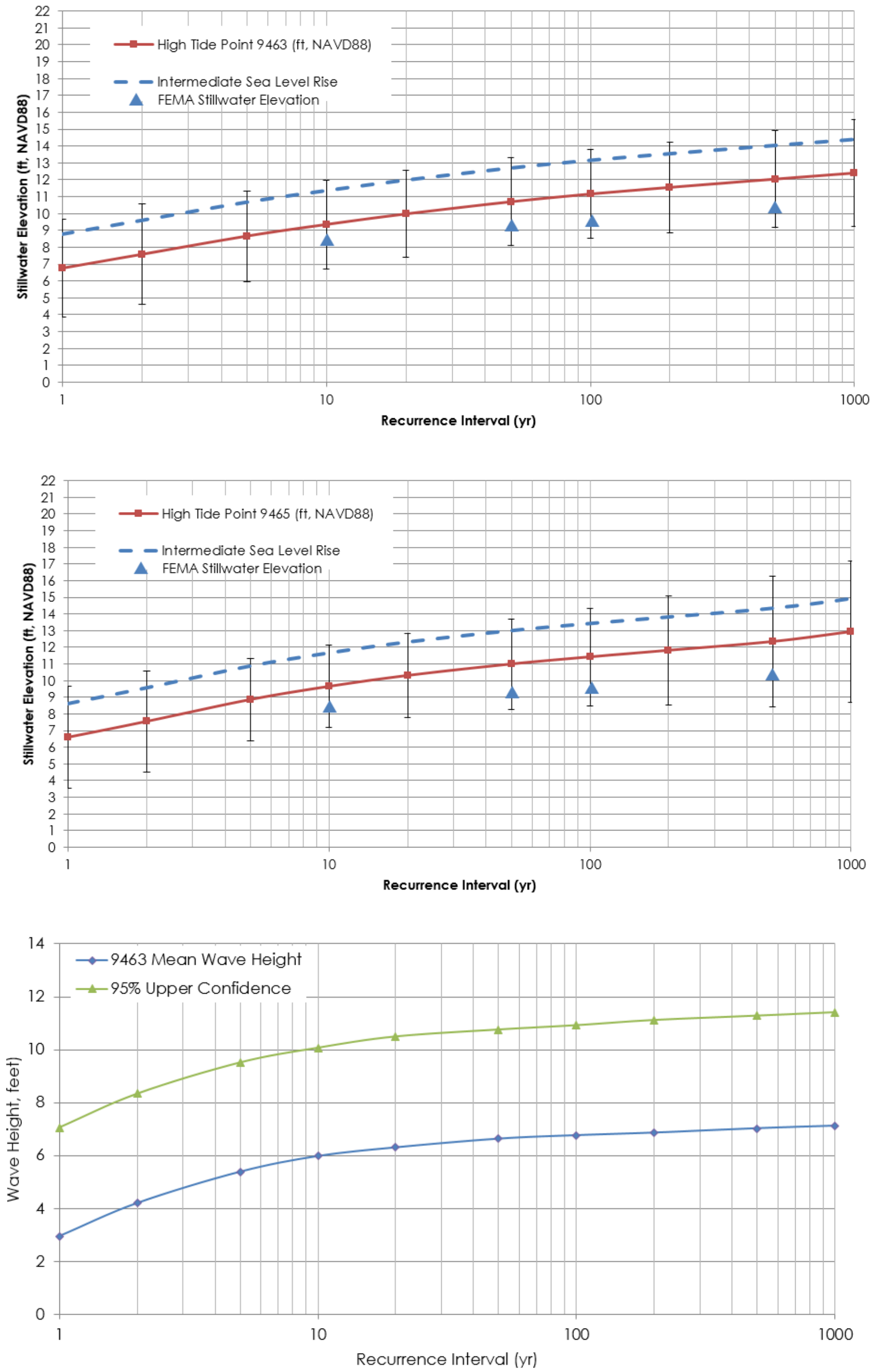


Figure 4-12: USACE NACCS Stillwater Flood-Probability (elevation, NAVD88) and Wave Height (Treatment Plant)

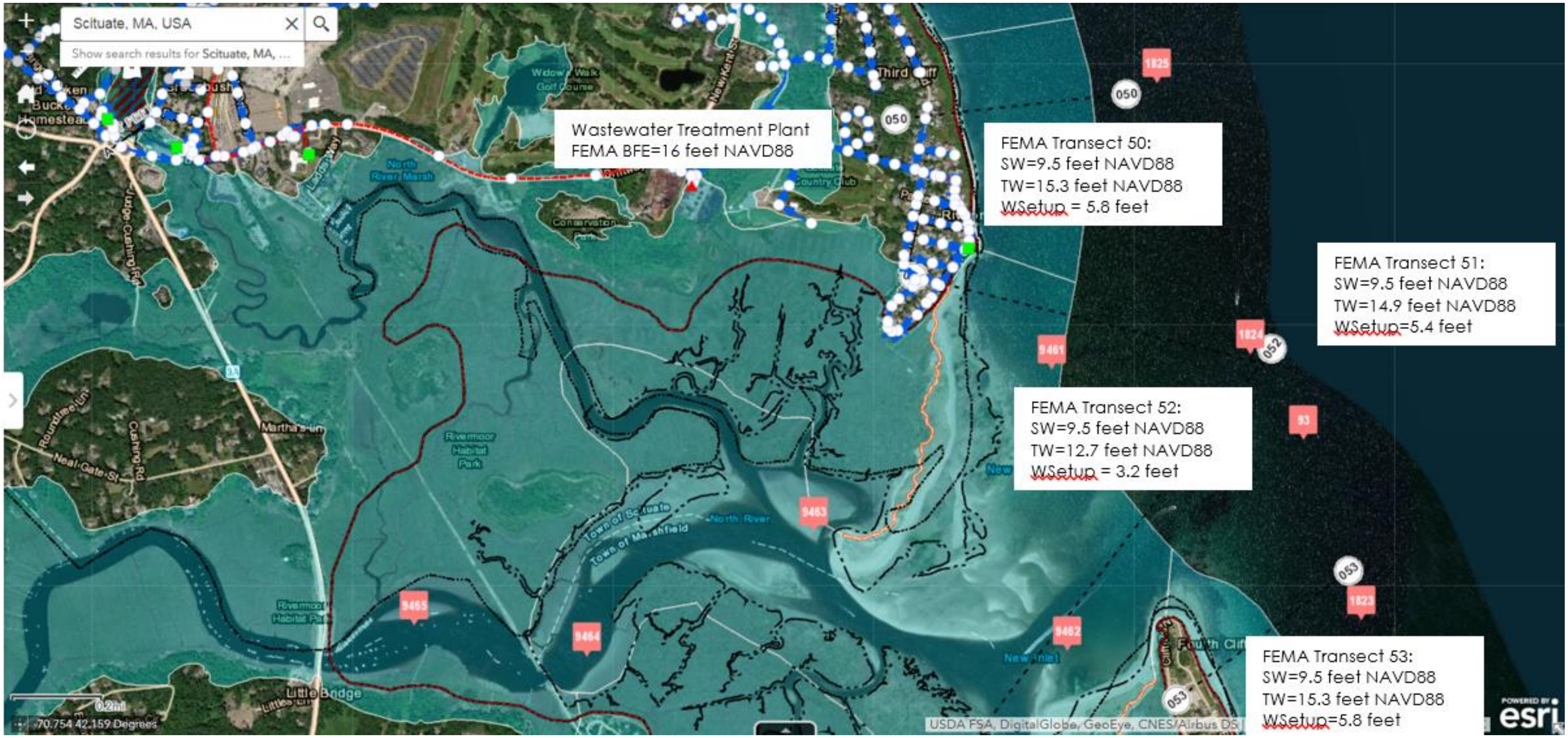


Figure 4-13: FEMA Flood Insurance Rate Map (FIRM) at Wastewater Treatment Plant

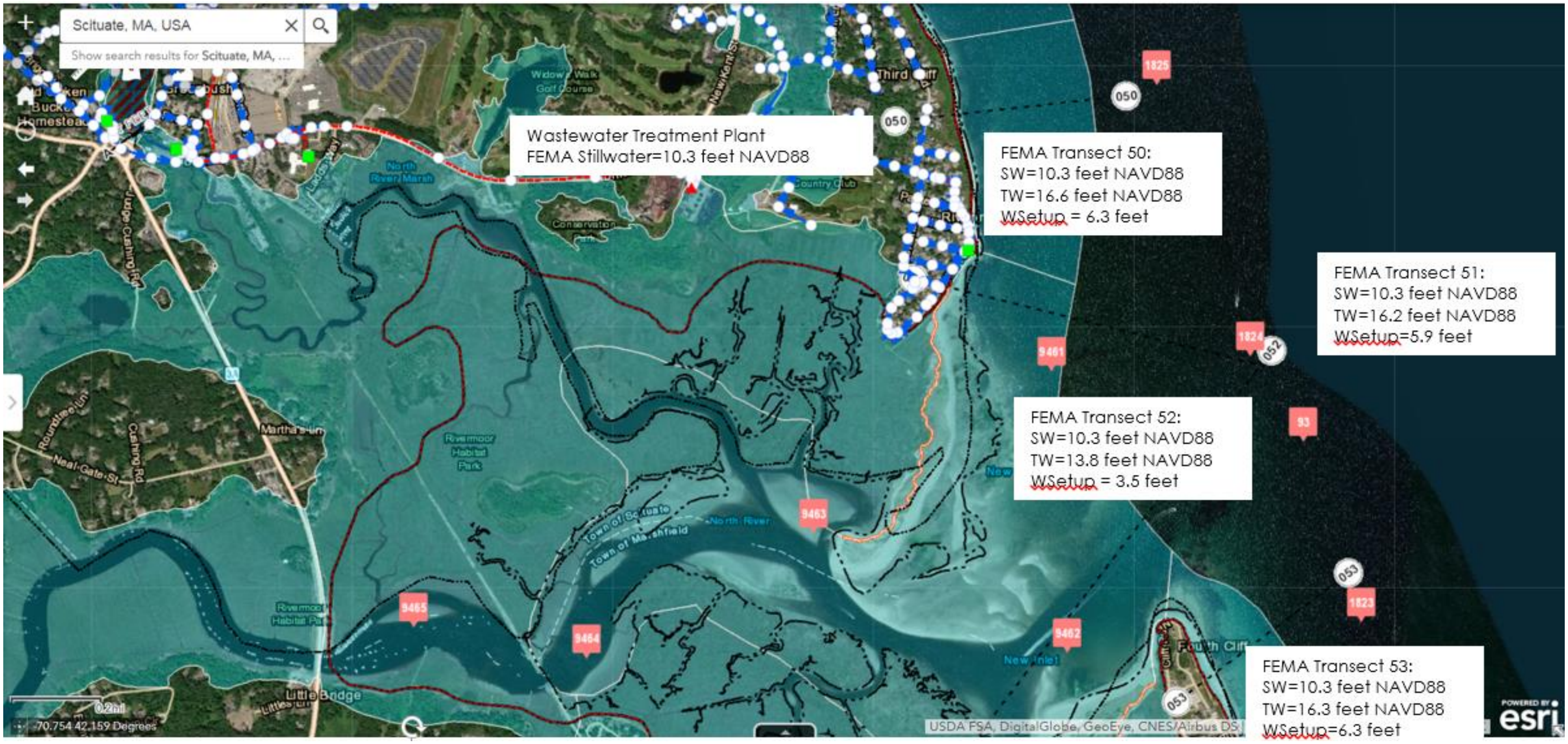


Figure 4-14: FEMA 500-year Recurrence Interval Stillwater Elevations

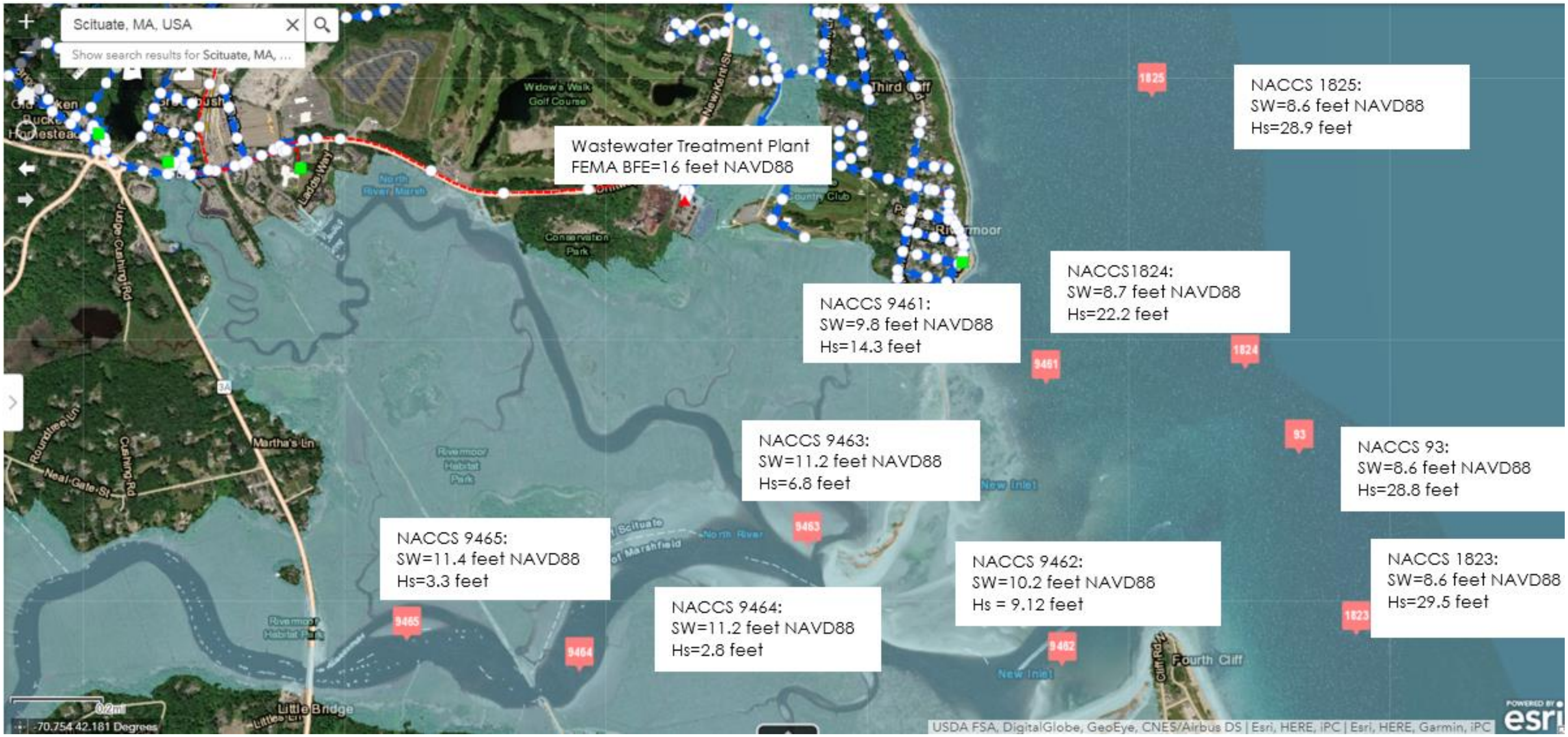


Figure 4-15: USACE NACCS 100-year Recurrence Interval Stillwater Elevations and Wave Heights

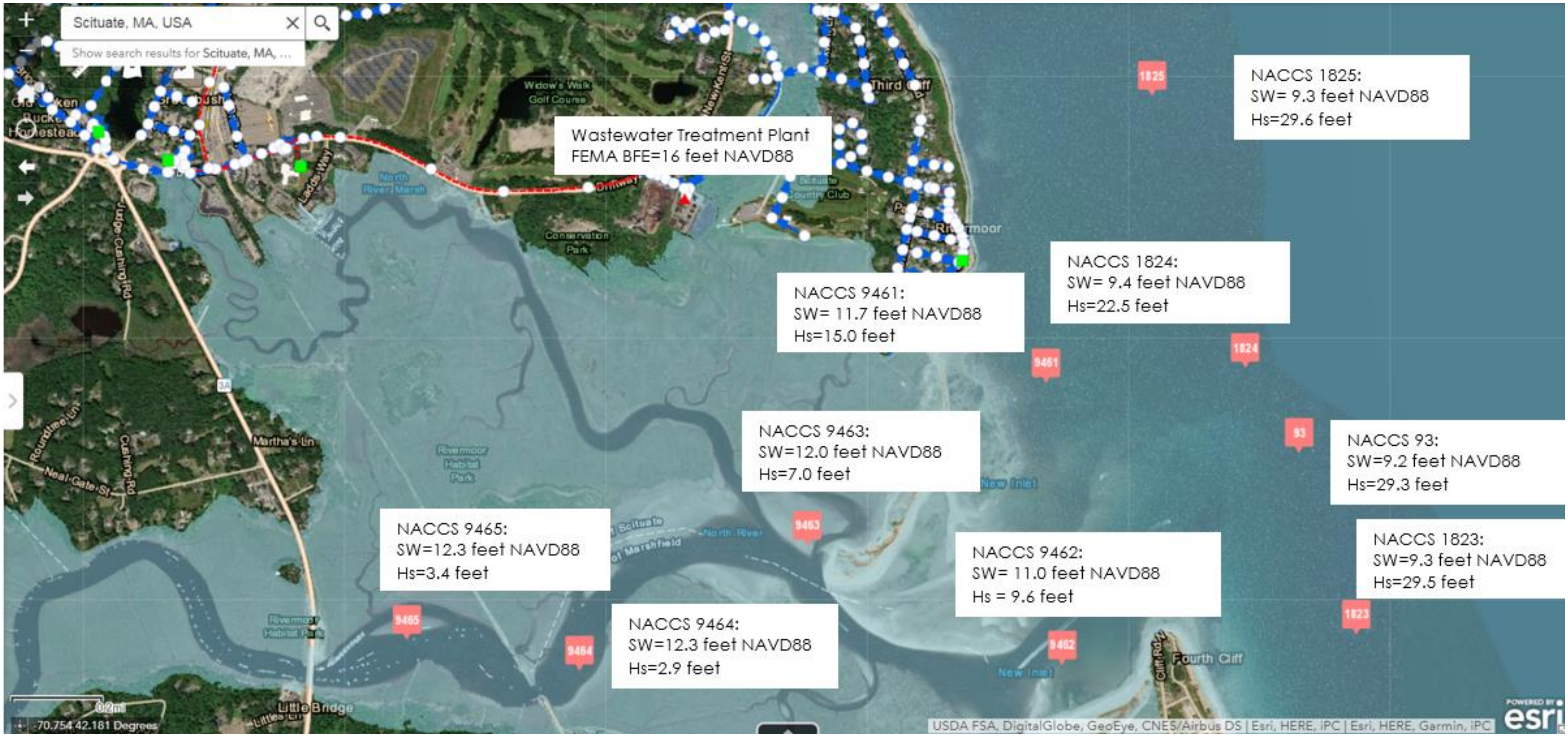


Figure 4-16: USACE NACCS 500-year Recurrence Interval Stillwater Elevations and Wave Heights

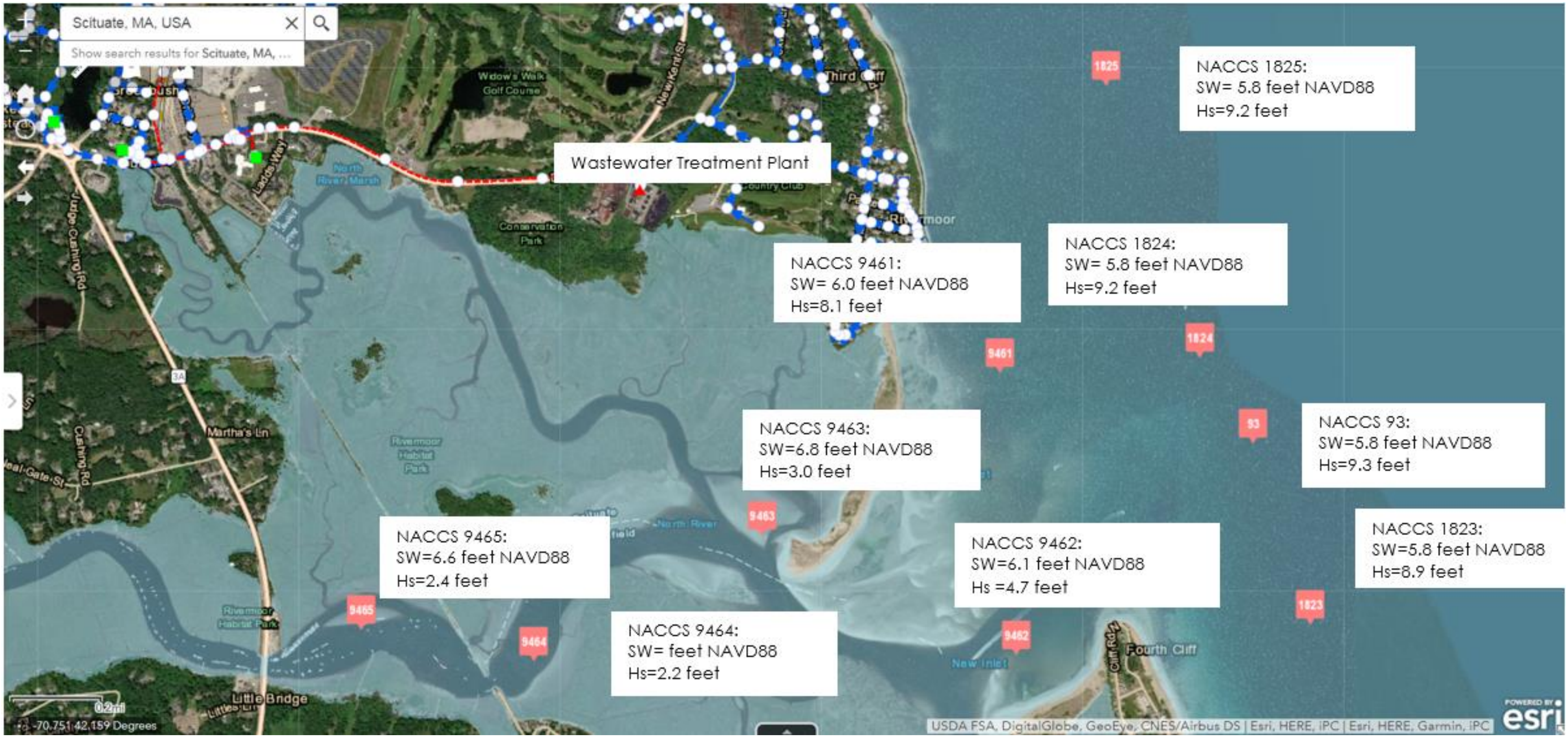


Figure 4-17: USACE NACCS 1-year Recurrence Interval Stillwater Elevations and Wave Heights (Stillwater = +/- 7 feet NAVD88)

Figure 4-18: Flood Inundation (Floodwater = 8 feet NAVD88)

Figure 4-19: Flood Inundation (Floodwater = 9 feet NAVD88)

Figure 4-20: Flood Inundation (Floodwater = 10 feet NAVD88)

Figure 4-21: Flood Inundation (Floodwater = 11 feet NAVD88)

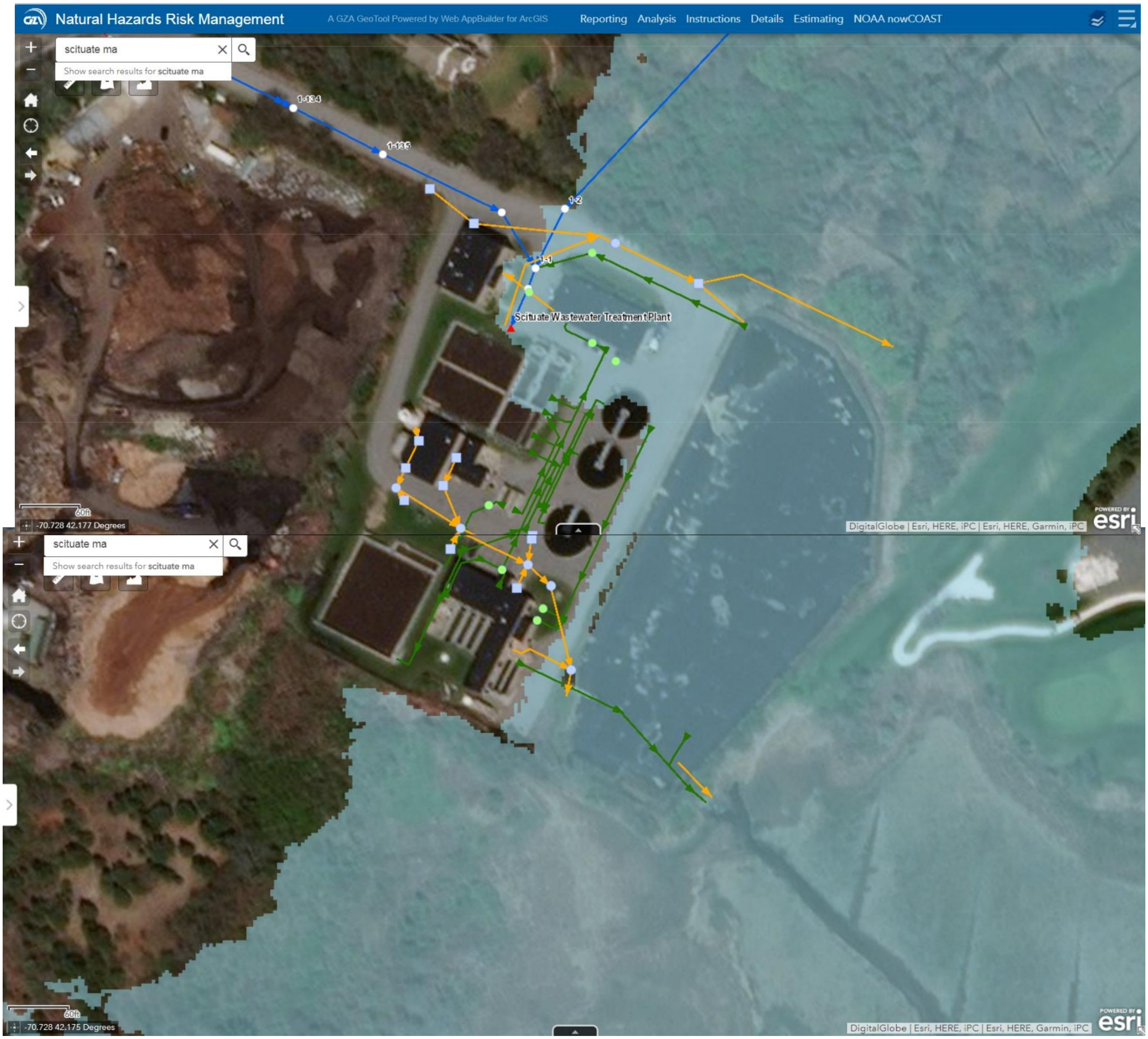


Figure 4-22: Flood Inundation (Floodwater = 12 feet NAVD88)

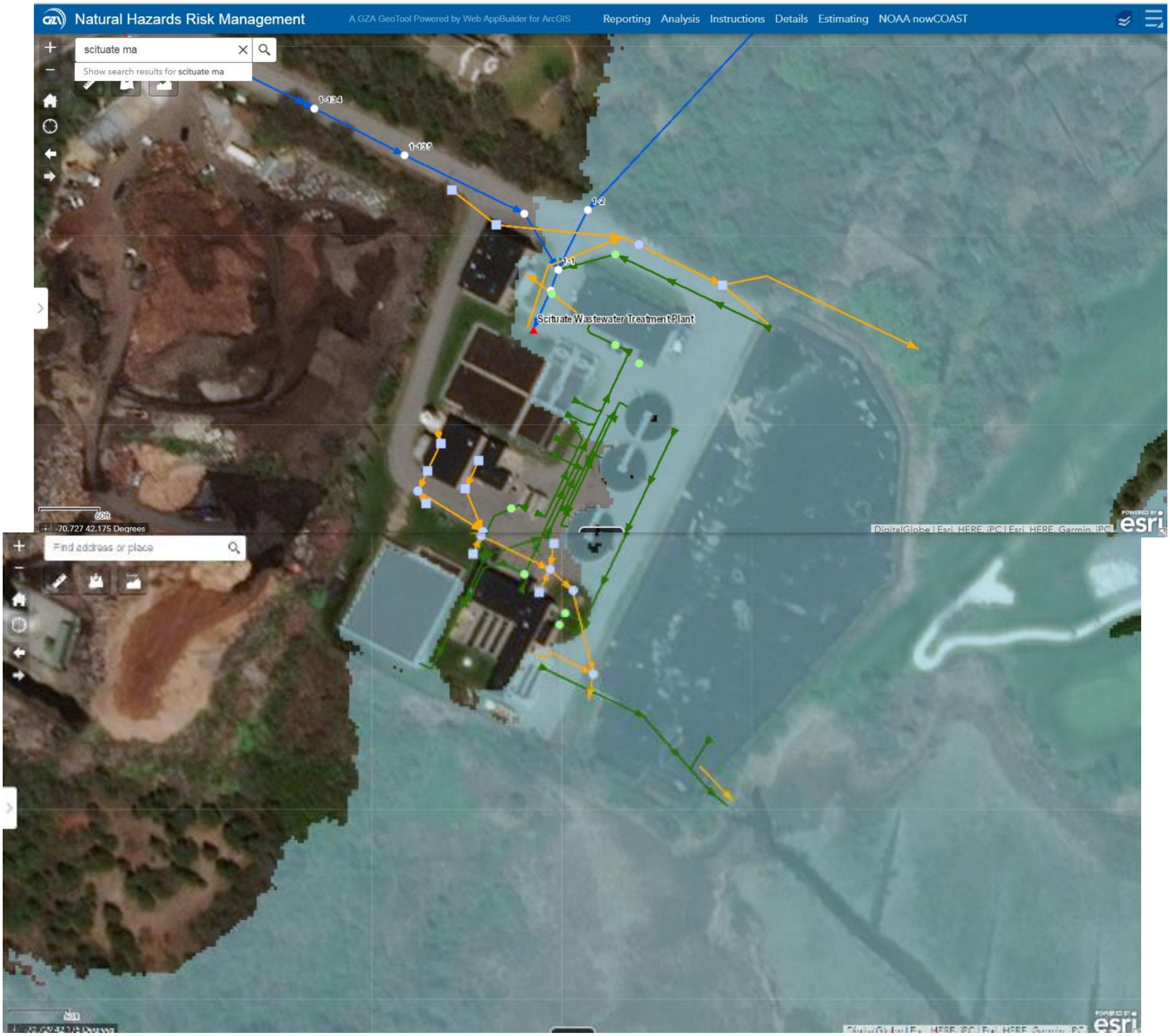


Figure 4-23: Flood Inundation (Floodwater = 13 feet NAVD88)

Figure 4-24: Flood Inundation (Floodwater = 14 feet NAVD88)

Figure 25: Flood Inundation (Floodwater = 15 feet NAVD88)

Figure 4-26: Flood Inundation (Floodwater = 16 feet NAVD88)

Stillwater Elevation (feet; NAVD88)	Depth-Limited Wave Height (feet)(1)	Est. Wave Set-up (feet)(4)	Est. Total Water Level (feet; NAVD88)	Est. Wave Crest Elevation (feet; NAVD88)(2)	Est. Mean Recurrence Interval (years)(3)			Flood Inundation due to Total Water Level	Wave Run-up and Overtopping(2)
					Current	2040	2070		
6	-	-	-	-	>1	>1		No	No
7	-	-	-	-	1	>1		No	No
8	<1	0	8	8	3	2	>1	No	Minor Run-up
9	1.5	0	9	10.1	7	5	1	No	Yes
10	2.5	0	10	11.8	20	10	2	Yes; Lined Basin Only	Yes
11	3.0	0.5	11.5	13.6	100	30	5	Yes; basin and Partial Plant	Yes
12	4.0	0.6	12.6	15.4	500	100	20	Yes; basin and Partial Plant	Yes
13	4.5	0.7	13.7	16.9	2,000	1,000	80	Yes	Yes
14	5.5	0.8	14.8	18.9	5,000	4,000	500	Yes	Yes
15	6.0	0.9	15.9	20.1	-	-	2,000	Yes	Yes

Notes:

1. Depth-limited wave height adjacent to lined basin dike (+/- Elevation 7 feet NAVD88).
2. At the location of lined basin dike (top of dike at +/- Elevation 10 feet NAVD88).
3. Based on NOAA 2017 Intermediate Sea Level Rise Projection.
4. Wave set-up estimated at 0.15 times depth-limited wave height.

Table 4-21: Coastal Flood Hazard Characteristics at Wastewater Treatment Plant

Collier Road Pump Station:

The Collier Road Pump Station is located along Collier Road near the intersection of Collier Road and Michael Avenue, about 100-feet inland from the shoreline. The ground surface at the Collier Road Pump Station is about 15.5 to 16 feet NAVD88. This stretch of shoreline is protected with a stone revetment which lies along the base of Third Cliff. A stone seawall is located further to the south. Based on the FEMA FIRM and ground surface elevation, the pump station is located just outside of the effective FEMA Flood Hazard Zone. Coastal flooding in the vicinity of the Collier Road Pump Station includes the following components:

- stillwater flood inundation due to storm surge and tide. Stillwater flooding initially overtops the beach to the south of the revetment. As the stillwater flood elevation increases, flooding inundates areas to the north. If the stillwater elevation increases enough, it overtops the beach, dune and revetment and directly floods the area of the pump station.
- The beach to the east of the pump station is fronted by a barrier beach with a primary dune at Elevation +/- 10 feet NAVD88 and a revetment (assumed crest elevation 16 feet NAVD88). During coastal storms, large waves break seaward of the dune. Wave set-up increases the total water elevation (stillwater plus set-up) within the wave break zone.
- Wave run-up, erosion and overtopping of the primary dune causes additional flooding.
- At floodwater elevation +/-15 feet NAVD88, the area of the pump station is flooded.

The coastal flood hazard in the vicinity of the wastewater treatment plant is characterized by:

- FEMA Flood Insurance Study (FIS) and Flood Insurance rate Map (FIRM):
    - Coastal Transects 51Stillwater Elevations, Wave Set-up and Total Water Elevations
    - FEMA FIRM BFE at Pump Station: Zone AE Elevation 16 feet
- NACCS Save Points: 9463; 9461
- NOAA 2017 Intermediate Sea Level Rise

Figure 4-27 presents the FEMA FIRM flood hazard zones in the vicinity of the pump station. **Figure 4-28** represents the applicable stillwater flood-frequency curves. The predicted flood-frequency with sea level rise (Intermediate SLR projection by the year 2070) is also shown. **Figures 4-29** through **4-31** show inundation limits for representative stillwater elevations.

Based on the available flood hazard data and engineering judgement, **Table 4-22** summarizes the estimated coastal flood hazard characteristics at the Collier Road Pump Station.

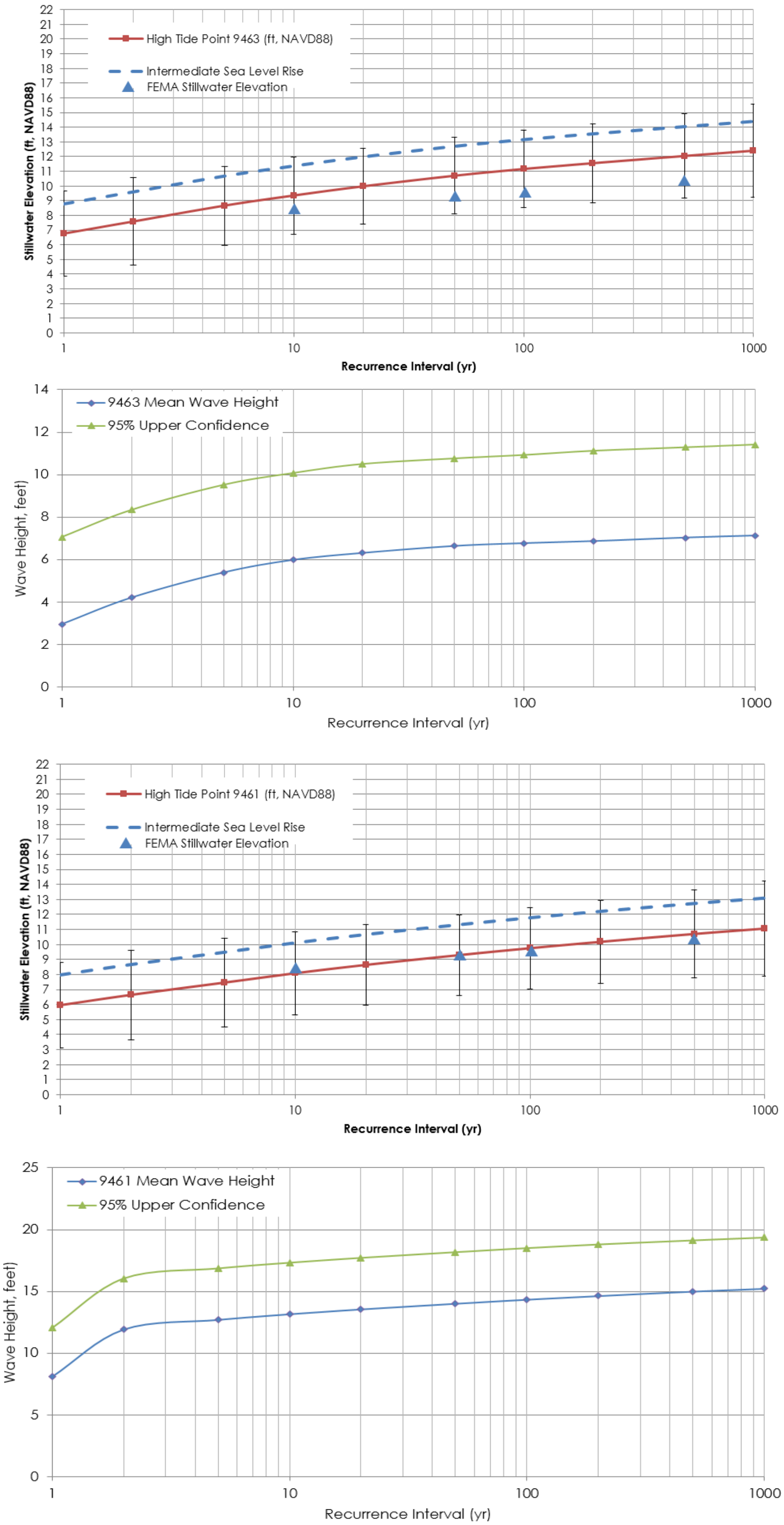


Figure 4-27: USACE NACCS Stillwater Flood-Probability (elevation, NAVD88) and Wave Height (Collier Road Pump Station)

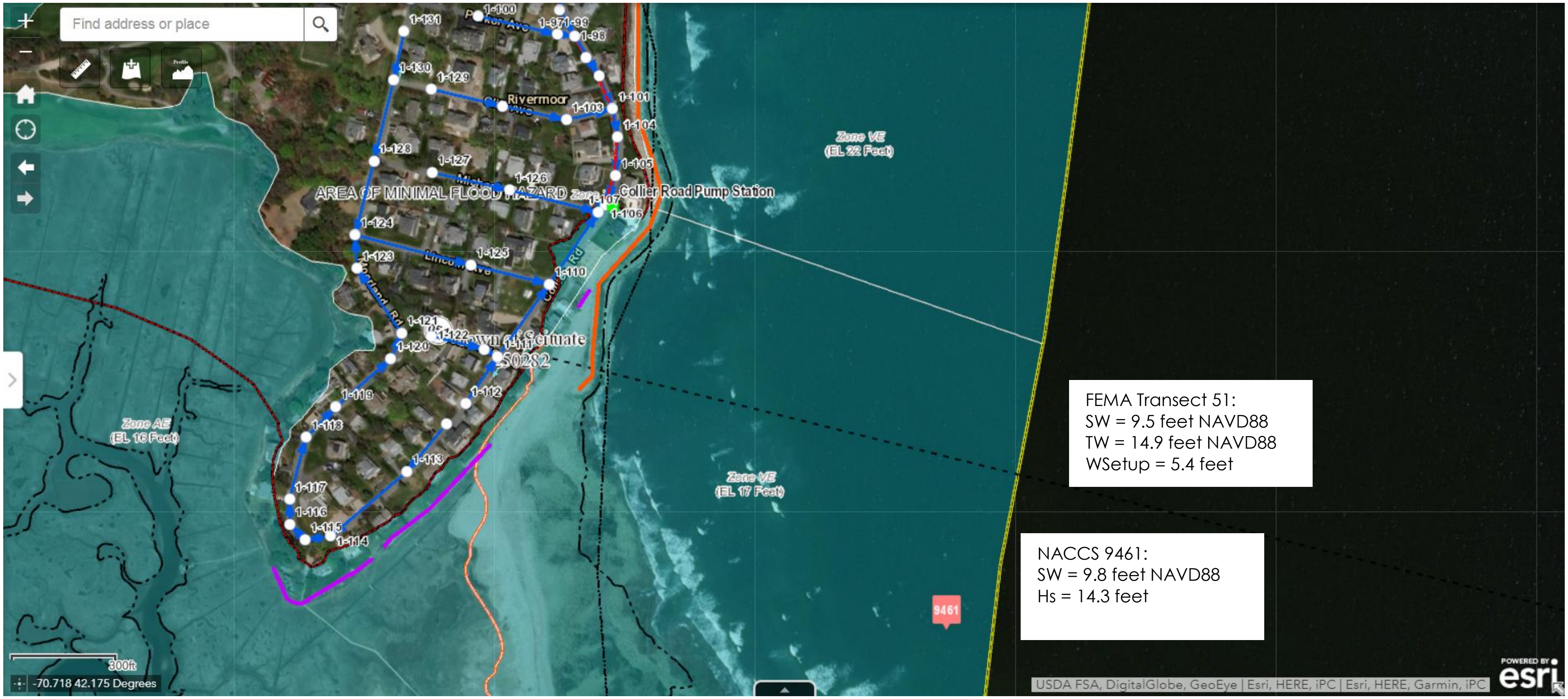


Figure 4-28: FEMA Flood Insurance Rate Map (FIRM) at Collier Road Pump Station

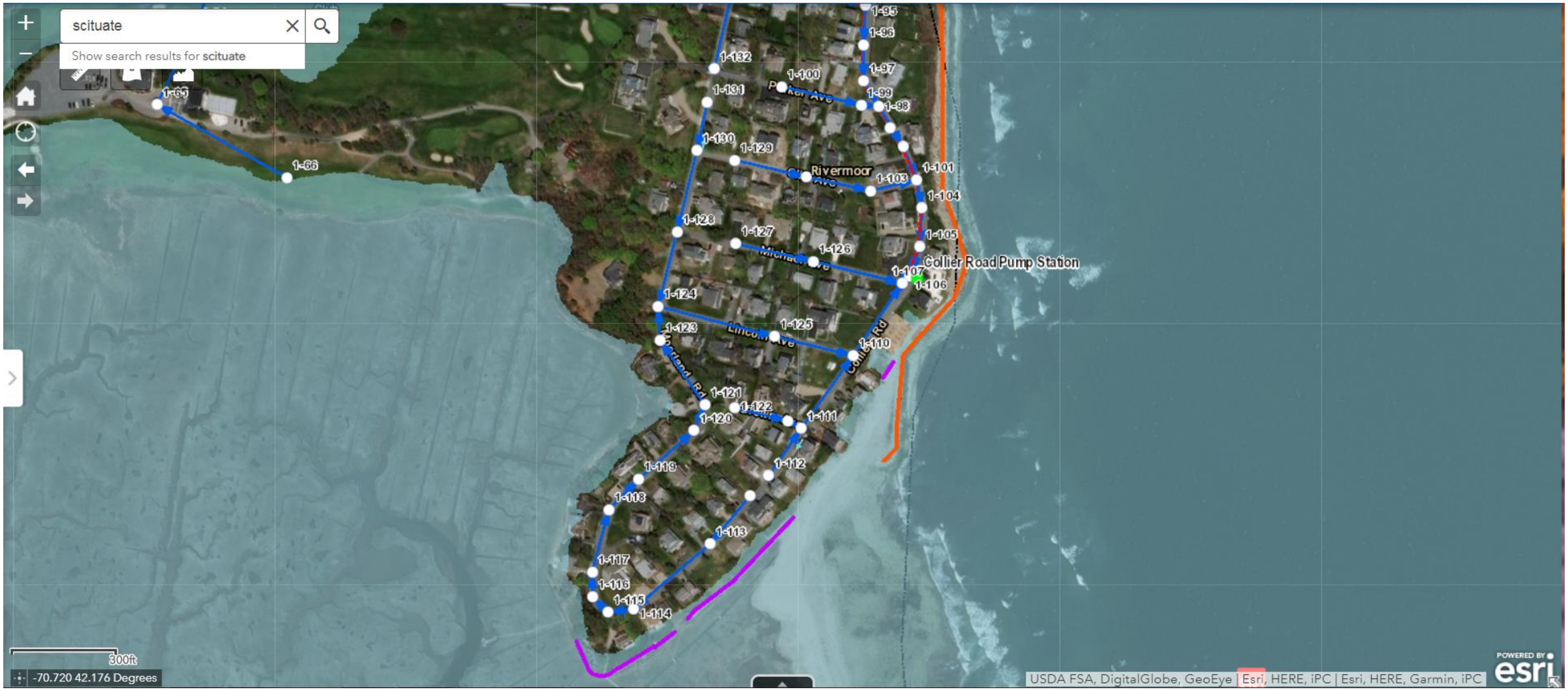


Figure 4-29: Flood Inundation (Floodwater = 12 feet NAVD88)

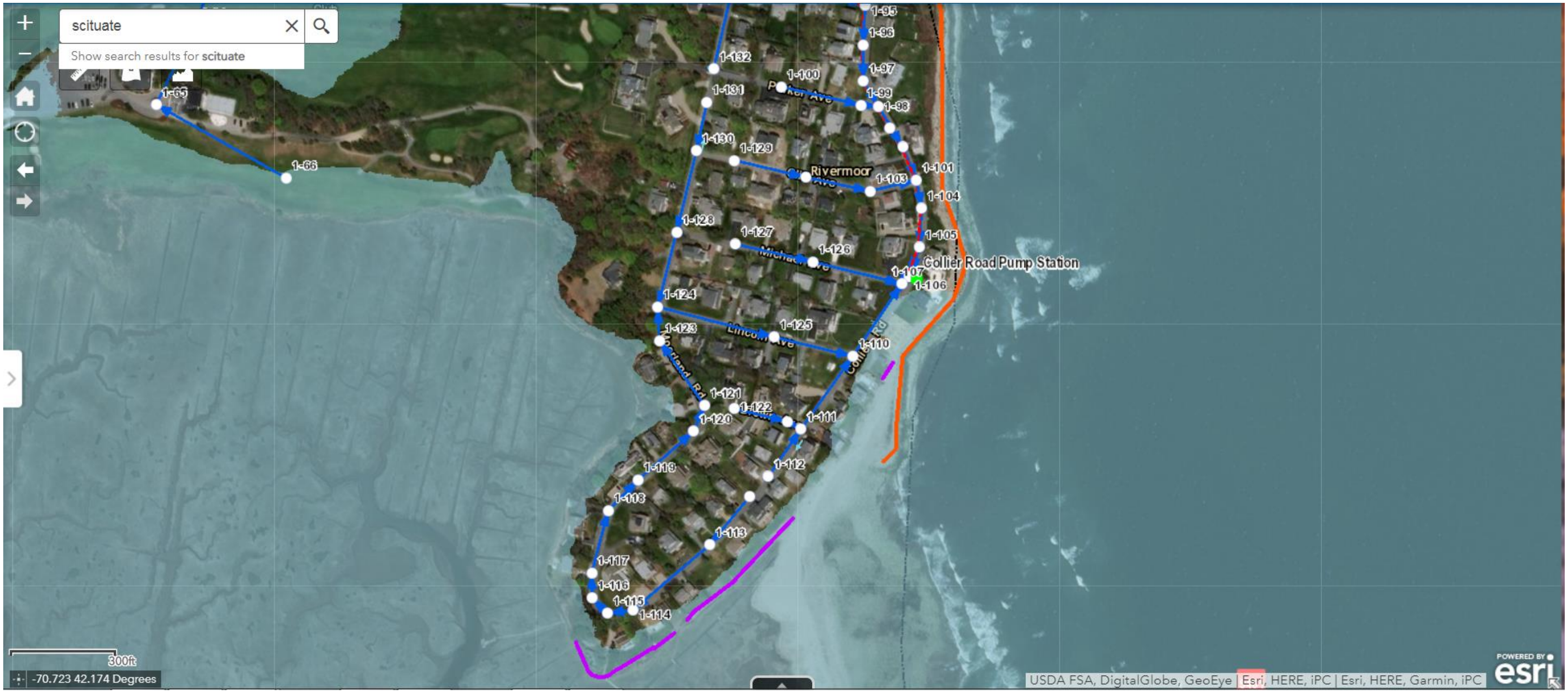


Figure 4-30: Flood Inundation (Floodwater = 14 feet NAVD88)

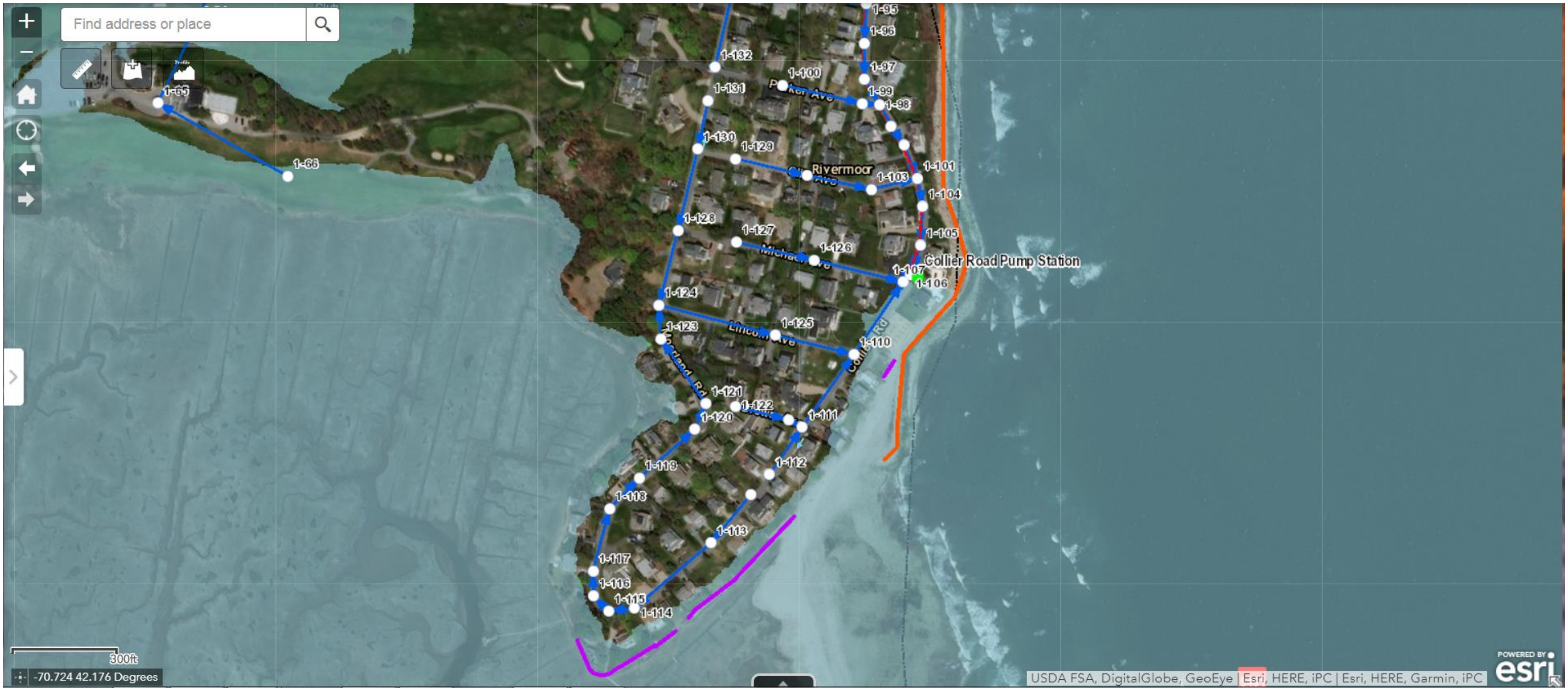


Figure 4-31: Flood Inundation (Floodwater = 15 feet NAVD88)

Stillwater Elevation (feet; NAVD88)	Depth-Limited Wave Height (feet)[1]	Est. Wave Set-up (feet)[4]	Est. Total Water Level (feet; NAVD88)	Est. Wave Crest Elevation (feet; NAVD88)[2]	Est. Mean Recurrence Interval (years)[3]			Flood Inundation due to Total Water Level	Wave Run-up and Overtopping[4]
					Current	2040	2070		
6	-	-	-	-	>1	>1		No	No
7	-	-	-	-	1	>1		No	No
8	-	0	8	8	3	2	>1	No	No
9	-	0	9	9	7	5	1	No	No
10	-	0	10	10	20	10	2	No	No
11	-	0	11	11	100	30	5	No	Yes
12	-	0	12	12	500	100	20	No	Yes
13	-	0	13	13	2,000	1,000	80	No	Yes
14	-	0	14	14	5,000	4,000	500	No	Yes
15	-	0	15	15	-	-	2,000		

Notes:

1. Depth-limited wave height at Collier Road Pump Station (+/- Ground surface elevation 15 to 16 feet NAVD88).

2. At Collier Road Pump Station (+/- Ground surface elevation 15 to 16 feet NAVD88).

3. Based on NOAA 2017 Intermediate Sea Level Rise Projection.

4. Wave run-up from ocean waves may encroach on the area of Collier Road Pump Station based on FEMA BFE=16 feet NAVD88.

Table 4-22: Coastal Flood Hazard Characteristics at Collier Road Pump Station

Herring Brook Pump Station:

The Herring Brook Pump Station is located off of New Driftway Road, adjacent to First Herring Brook. The ground surface elevation at the Herring Brook Pump Station is about 9 to 10 feet NAVD88. The Herring Brook Pump Station and vicinity is vulnerable to coastal flooding. First Herring Brook is hydraulically connected to the North River tidal marsh via a culvert beneath New Driftway Road. Flooding of the North River Tidal Marsh has been discussed previously.

The coastal flood hazard in the vicinity of the pump station is characterized by:

- FEMA Flood Insurance Study (FIS) and Flood Insurance rate Map (FIRM):
  - Coastal Transects 51and 52 Stillwater Elevations, Wave Set-up and Total Water Elevations
  - FEMA FIRM BFE at Pump Station: Zone AE Elevation 16 feet
- NACCS Save Points: 9463; 9465
- NOAA 2017 Intermediate Sea Level Rise

Figure 4-12 represents the applicable stillwater flood-frequency curves. **Figure 4-32** presents the FEMA FIRM flood hazard zones in the vicinity of the pump station. The predicted flood-frequency with sea level rise (Intermediate SLR projection by the year 2070) is also shown. **Figures 4-33** through **4-35** show inundation limits for representative floodwater elevations. When the tidal marsh floodwater elevation increases to about 9 feet NAVD88, flooding of the Herring Brook Pump Station may start to occur via the culvert under Driftway Road. As the tidal marsh floodwater elevation increases to above the elevation of New Driftway Road (+/-12 feet NAVD88), the floodwaters overtop the roadway and inundate the area.

Based on the available flood hazard data and engineering judgement, **Table 4-23** summarizes the estimated coastal flood hazard characteristics at the Herring Brook Pump Station.

Figure 4-32: FEMA Flood Insurance Rate Map (FIRM) at Herring Brook Pump Station

Figure 4-33: Flood Inundation (Floodwater = 12 feet NAVD88)
Note:
Flooding of Herring Brook Pump Station area via the culvert beneath Driftway Road may occur at flood elevations greater than +/-9 feet NAVD88. That flooding is not shown here.

Figure 4-34: Flood Inundation (Floodwater = 13 feet NAVD88)

Figure 4-35: Flood Stillwater Inundation (Stillwater = 15 feet NAVD88)

Stillwater Elevation (feet; NAVD88)	Depth-Limited Wave Height (feet)[1]	Est. Wave Set-up (feet)[1,4]	Est. Total Water Level (feet; NAVD88)	Est. Wave Crest Elevation (feet; NAVD88)[2]	Est. Mean Recurrence Interval (years)[3]			Flood Inundation due to Total Water Level	Wave Run-up and Overtopping[2]
					Current	2040	2070		
6	-	-	-	-	>1	>1		No	No
7	-	-	-	-	1	>1		No	No
8	-	0	8	-	3	2	>1	No	No
9	-	0	9	-	7	5	1	No	No
10	-	0	10	-	20	10	2	Yes	Yes
11	<1	0	11.5	-	100	30	5	Yes	Yes
12	1.5	0.2	12.2	13.3	500	100	20	Yes	Yes
13	2.5	0.4	13.4	15.2	2,000	1,000	80	Yes	Yes
14	3.0	0.5	14.5	16.6	5,000	4,000	500	Yes	Yes
15	4.0	0.6	15.6	18.4	-	-	2,000	Yes	Yes

Notes:

1. Depth-limited wave height adjacent to south side of Driftway Road (+/- Elevation 10 feet NAVD88).

2. Adjacent to south side of Driftway Road (+/- Elevation 10 feet NAVD88).

3. Based on NOAA 2017 Intermediate Sea Level Rise Projection.

4. Wave set-up estimated at 0.15 times depth-limited wave height.

Table 4-23: Coastal Flood Hazard Characteristics at Herring Brook Pump Station

Peggotty Beach Pump Station:

The Peggotty Beach Pump Station is located on Peggotty Beach Road, about 650 feet inland from Peggotty Beach. The pump station is vulnerable to coastal flooding. Ground surface elevation at the pump station is about 9 to 10 feet NAVD88. **Figure 4-36** presents the FEMA FIRM flood hazard zones in the vicinity of the pump station. The pump station is located within a FEMA VE zone with a BFE of 17 feet NAVD88.

Peggotty Beach is a narrow barrier beach separating the Atlantic Ocean from the Scituate Harbor tidal marsh. The beach is relatively flat with an intermittent dune (crest at +/- Elevation 15 feet NAVD88). The Massachusetts Shoreline Change Project indicates that Peggotty Beach is eroding (**Figure 4-37**). Coastal flooding in the vicinity of the Peggotty Beach Pump Station includes the following components:

- stillwater flood inundation due to storm surge and tide. Wave run-up, erosion and overtopping of the primary dune along Peggotty Beach causes additional flooding.
- As the stillwater flood and wave elevations increase, flooding inundates the Scituate Harbor marshes and adjacent areas. If the stillwater elevation increases enough, it overtops the beach and dune and directly floods the area of the pump station.
- During coastal storms, large waves break seaward of the dune. Wave set-up increases the total water elevation (stillwater plus set-up) within the wave break zone.
- At floodwater elevations of +/-9 to 10 feet NAVD88, the area of the pump station is flooded.

Figure 4-38 represents the applicable stillwater flood-frequency and wave height-frequency curves. The predicted flood-frequency with sea level rise (Intermediate SLR projection by the year 2070) is also shown. **Figures 4-39** through **4-41** show inundation limits for representative stillwater elevations.

Based on the available flood hazard data and engineering judgement, **Table 4-24** summarizes the estimated coastal flood hazard characteristics at the Peggotty Beach Pump Station.

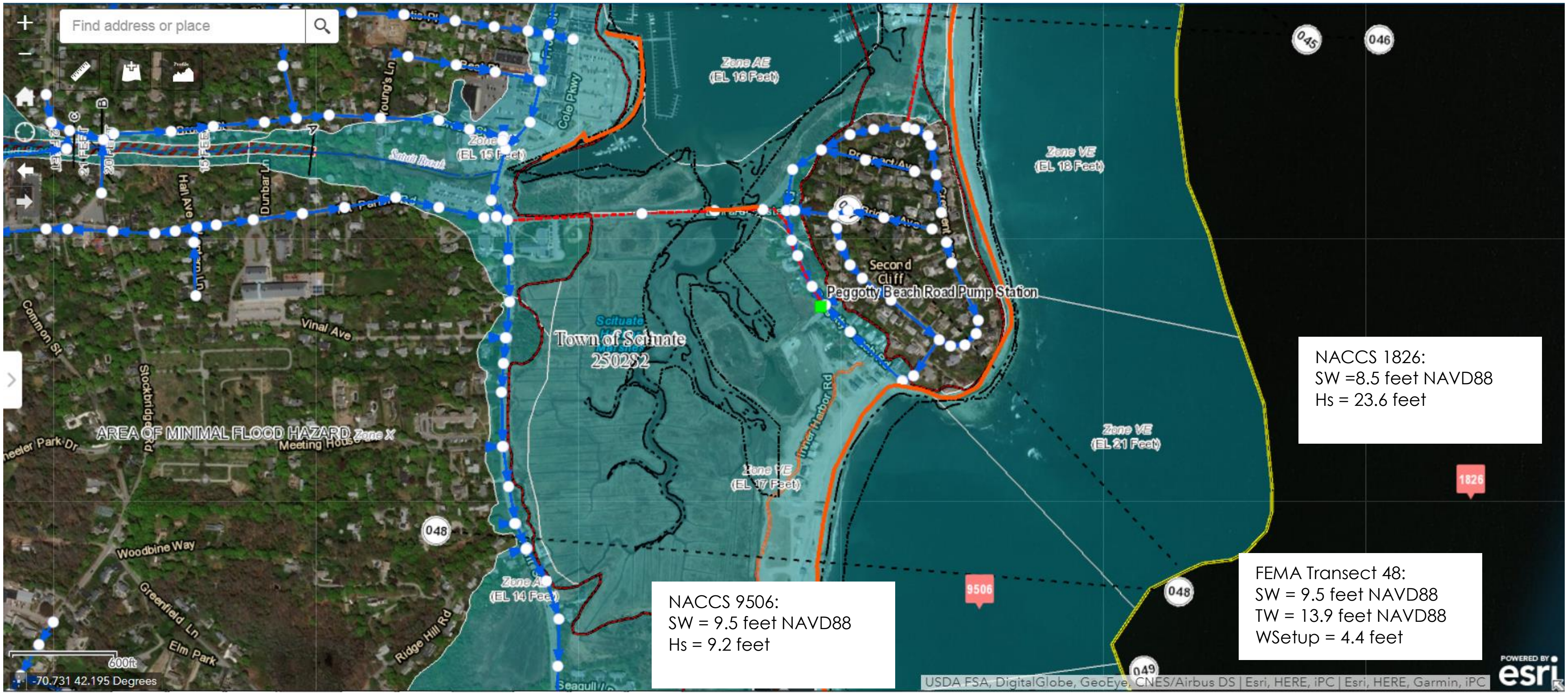


Figure 4-36: FEMA Flood Insurance Rate Map (FIRM) at Peggotty Beach Pump Station

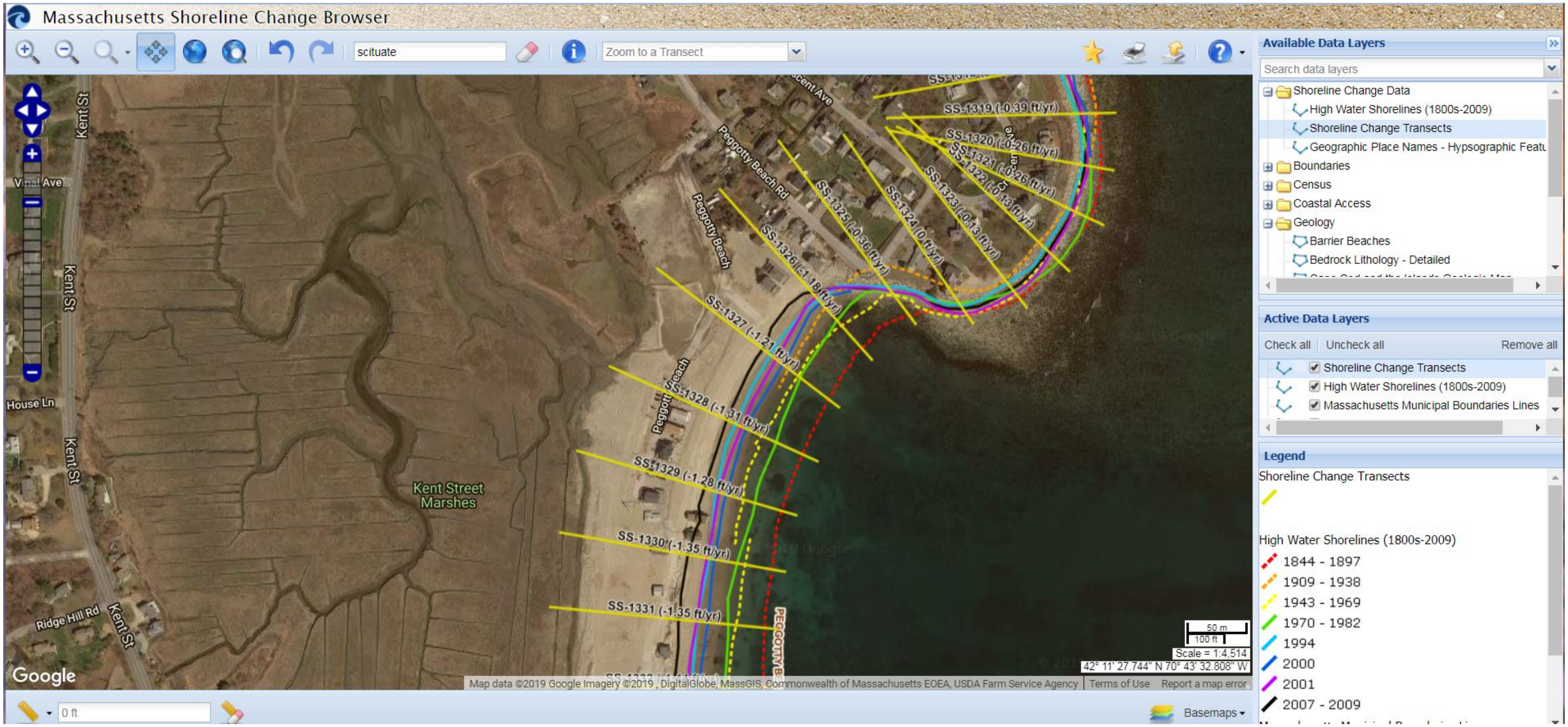
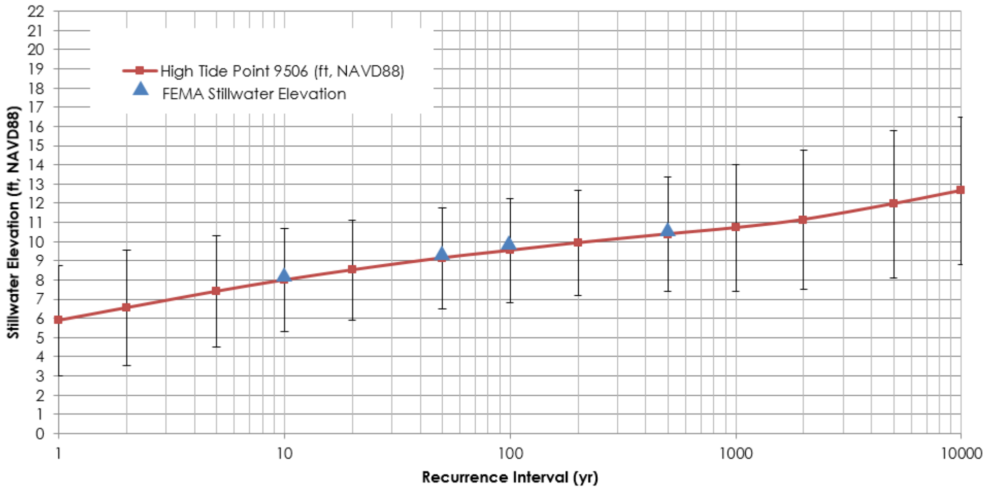
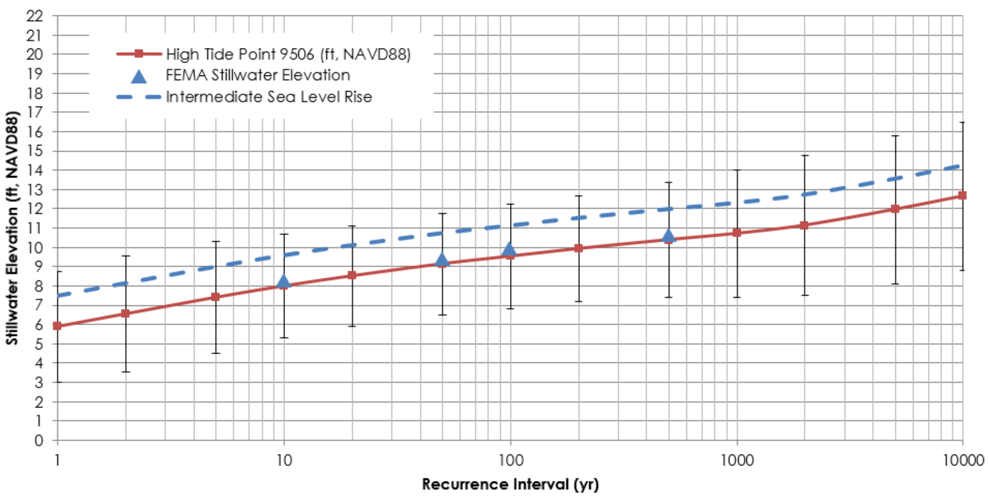


Figure 4-37: Long Term Shoreline Change at Peggotty Beach





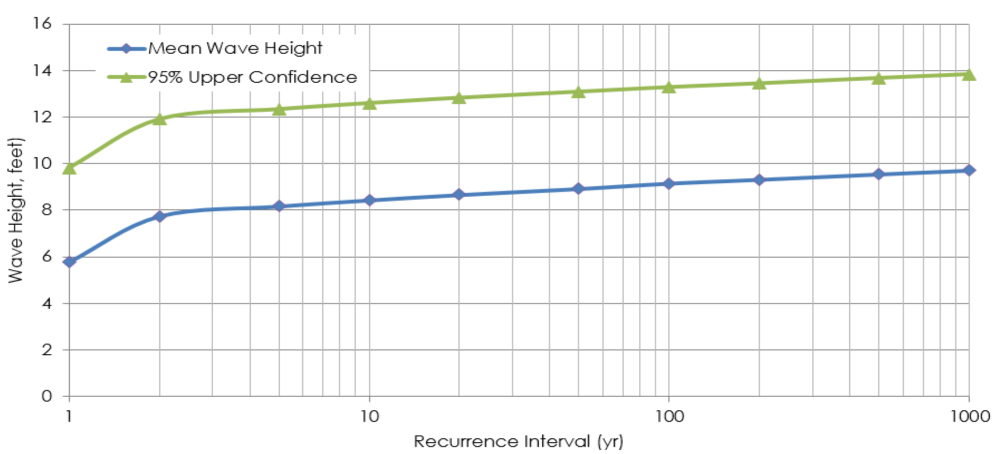


Figure 4-38: USACE NACCS Stillwater Flood-Probability (elevation, NAVD88) and Wave Height (Peggotty Beach Pump Station)

Figure 4-39: Flood Inundation at Peggotty Beach Pump Station (Floodwater = 9 feet NAVD88)

Figure 4-40: Flood Inundation at Peggotty Beach Pump Station (Floodwater = 11 feet NAVD88)

Figure 4-41: Flood Inundation at Peggotty Beach Pump Station (Floodwater = 14 feet NAVD88)

Stillwater Elevation (feet; NAVD88)	Depth-Limited Wave Height (feet)[1]	Est. Wave Set-up (feet)[1,4]	Est. Total Water Level (feet; NAVD88)	Est. Wave Crest Elevation (feet; NAVD88)[2]	Est. Mean Recurrence Interval (years)[3]			Flood Inundation due to Total Water Level	Wave Run-up and Overtopping[2]
					Current	2040	2070		
6	-	-	-	-	1	>1	>1	No	No
7	-	-	-	-	3	>1	>1	No	No
8	-	0	8	-	10	5	2	No	No
9	-	0	9	-	50	20	5	Yes	Yes
10	<1	0	10	-	200	50	20	Yes	Yes
11	1.5	0.3	11.3	-	500	500	60	Yes	Yes
12	2.5	0.4	12.4	14.2	-	2,000	500	Yes	Yes
13	3.0	0.5	13.5	15.6	-	-	2,000	Yes	Yes
14	4.0	0.6	14.6	17.4	-	-	-	Yes	Yes
15	5.0	0.8	15.8	19.3	-	-	-	Yes	Yes

Notes:

1. Depth-limited wave height adjacent to south side of pump station (+/- Elevation 9 feet NAVD88).

2. Adjacent to south side of pump station (+/- Elevation 9 feet NAVD88). Wave run-up from broken ocean waves may occur within the area of the pump station.

3. Based on NOAA 2017 Intermediate Sea Level Rise Projection.

4. Wave set-up estimated at 0.15 times depth-limited wave height.

Table 4-24: Coastal Flood Hazard Characteristics at Peggotty Beach Pump Station

Edward Foster Road Pump Station:

The Edward Foster Road Pump Station is located off of Edward Foster Road, about 250 feet inland from the ocean shoreline, about 250 feet from the Scituate Harbor tidal marsh. The ground elevation at the pump station is around 9 to 10 feet NAVD88. The pump station is located on a short, narrow barrier beach separating the Atlantic Ocean from the Scituate Harbor and tidal marsh. The beach is relatively flat with an intermittent dune (crest at +/- Elevation 10 to 15 feet NAVD88) and a concrete seawall with a partial revetment.

The pump station is vulnerable to coastal flooding. **Figure 4-42** presents the FEMA FIRM flood hazard zones in the vicinity of the pump station. The pump station is located in a FEMA AE zone with a BFE of Elevation 16 feet NAVD88.

Coastal flooding in the vicinity of the Edward Foster Road Pump Station includes the following components:

- stillwater flood inundation due to storm surge and tide. Stillwater flooding initially floods both the ocean shoreline and Scituate Harbor. If the stillwater elevation increases enough, it overtops the beach and dune and directly floods the area of the pump station.
- Flooding due to storm surge (i.e., stillwater elevation) is higher within Scituate Harbor than along the ocean coast due to hydrodynamic effects.
- During coastal storms, large ocean waves break along the barrier beach. Wave set-up increases the total water elevation (stillwater plus set-up) within the wave break zone.
- Wave run-up, erosion and overtopping of the primary dune and seawall causes additional flooding.
- At floodwater elevation +/-9 to 10 feet NAVD88, the area of the pump station is flooded.

Figure 4-43 represents the applicable stillwater flood-frequency and wave height-frequency curves. The predicted flood-frequency with sea level rise (Intermediate SLR projection by the year 2070) is also shown. **Figures 4-44** through **48** show inundation limits for representative stillwater elevations.

Based on the available flood hazard data and engineering judgement, **Table 4-24** summarizes the estimated coastal flood hazard characteristics at the Edward Foster Road Pump Station.

Figure 4-42: FEMA Flood Insurance Rate Map (FIRM) at Edward Foster Pump Station

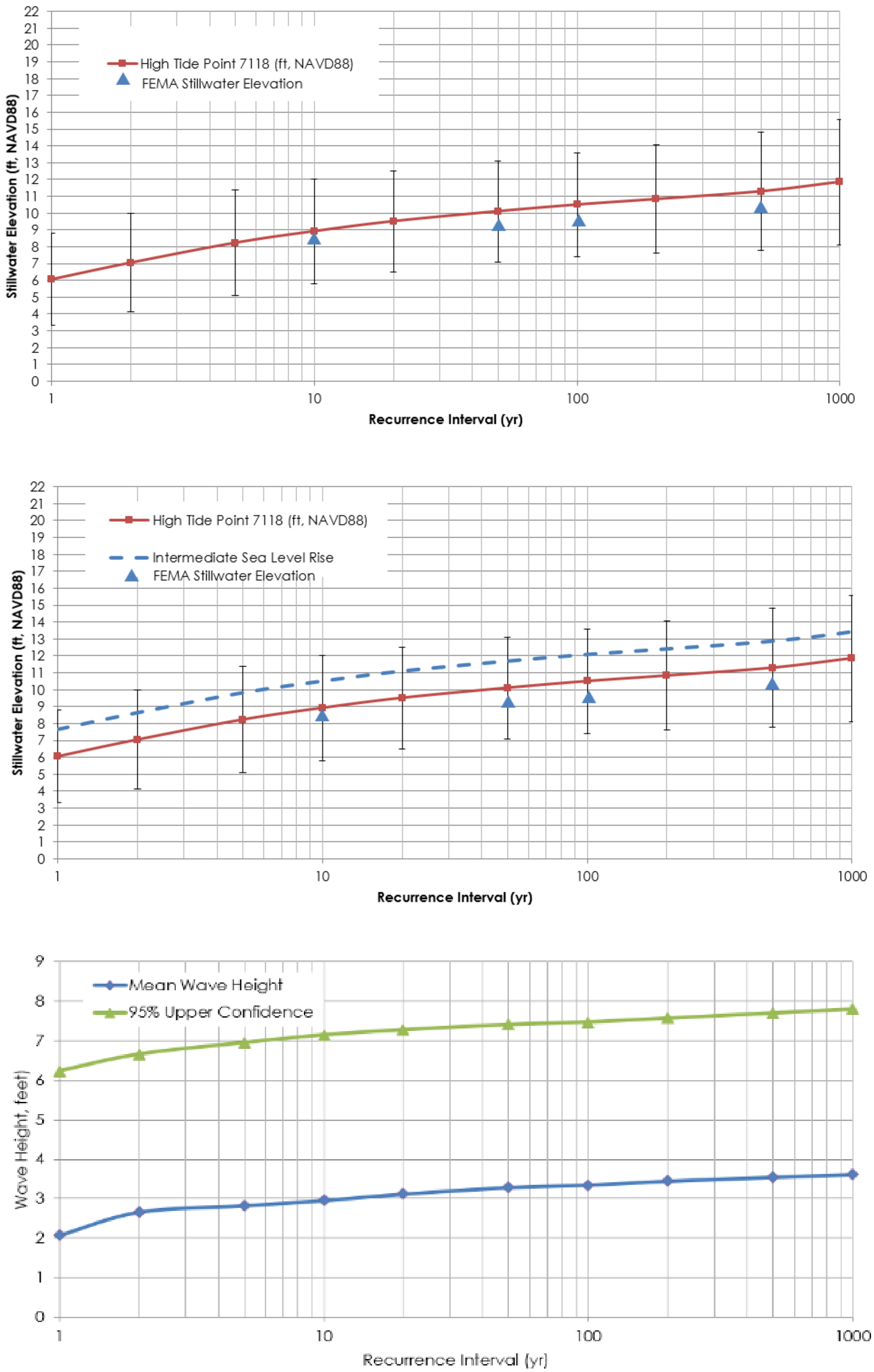


Figure 4-43: USACE NACCS Stillwater Flood-Probability (elevation, NAVD88) and Wave Height (feet) (Edward Foster Road Pump Station)

Figure 4-44: Flood Inundation (Floodwater = 9 feet NAVD88)

Figure 4-45: Flood Inundation (Floodwater = 10 feet NAVD88)

Stillwater Elevation (feet; NAVD88)	Depth-Limited Wave Height (feet)(1)	Est. Wave Set-up (feet)(1,4)	Est. Total Water Level (feet; NAVD88)	Est. Wave Crest Elevation (feet; NAVD88)(2)	Est. Mean Recurrence Interval (years)(3)			Flood Inundation due to Total Water Level	Wave Run-up and Overtopping(2)
					Current	2040	2070		
6	-	-	-	-	1	>1	>1	No	No
7	-	-	-	-	2	1	>1	No	No
8	-	0	8	-	4	2	1	No	No
9	-	0	9	-	10	5	2.5	Yes	Yes
10	<1	0	10	-	50	20	6	Yes	Yes
11	1.5	0.3	11.3	12.4	200	50	20	Yes	Yes
12	2.5	0.4	12.4	14.2	1,000	500	80	Yes	Yes
13	3.0	0.5	13.5	15.6	-	1,500	500	Yes	Yes
14	4.0	0.6	14.6	18.3	-	-	-	Yes	Yes
15	5.0	0.8	15.8	19.2	-	-	-	Yes	Yes

Notes:

1. Depth-limited wave height adjacent to south side of pump station (+/- Elevation 9 feet NAVD88).

2. Adjacent to south side of pump station (+/- Elevation 9 feet NAVD88). Wave run-up from broken ocean waves may occur within the area of the pump station.

3. Based on NOAA 2017 Intermediate Sea Level Rise Projection.

4. Wave set-up estimated at 0.15 times depth-limited wave height.

Table 4-25: Coastal Flood Hazard Characteristics at Edward Foster Road Pump Station

Chain Pond Pump Station:

The Chain Pond Pump Station is located off of Hatherly Road, about 500 feet inland from the ocean shoreline (Egypt Beach). The ground elevation at the pump station is around 11 to 12 feet NAVD88. The beach has an intermittent dune (crest at +/- Elevation 15 feet NAVD88).

The pump station is vulnerable to coastal flooding. **Figure 4-46** presents the FEMA FIRM flood hazard zones in the vicinity of the pump station. The pump station is located in a FEMA AE zone with a BFE of Elevation 14 feet NAVD88.

Coastal flooding in the vicinity of the Chain Pond Pump Station includes the following components:

- stillwater flood inundation due to storm surge and tide. Stillwater flooding initially floods both the ocean shoreline and Musquashcut Brook, marsh and pond. If the stillwater elevation increases enough, it overtops the beach and dune and directly floods the area of the pump station.
- During coastal storms, large waves break seaward of the dune. Wave set-up increases the total water elevation (stillwater plus set-up) within the wave break zone.
- Wave run-up, erosion and overtopping of the primary dune causes additional flooding.
- At floodwater elevation +/-9 to 10 feet NAVD88, the area of the pump station is flooded.

Figure 4-47 represents the applicable stillwater flood-frequency and wave height-frequency curves. The predicted flood-frequency with sea level rise (Intermediate SLR projection by the year 2070) is also shown. **Figures 4-48** through **4-51** show inundation limits for representative stillwater elevations.

Based on the available flood hazard data and engineering judgement, **Table 4-25** summarizes the estimated coastal flood hazard characteristics at the Chain Pond Pump Station.

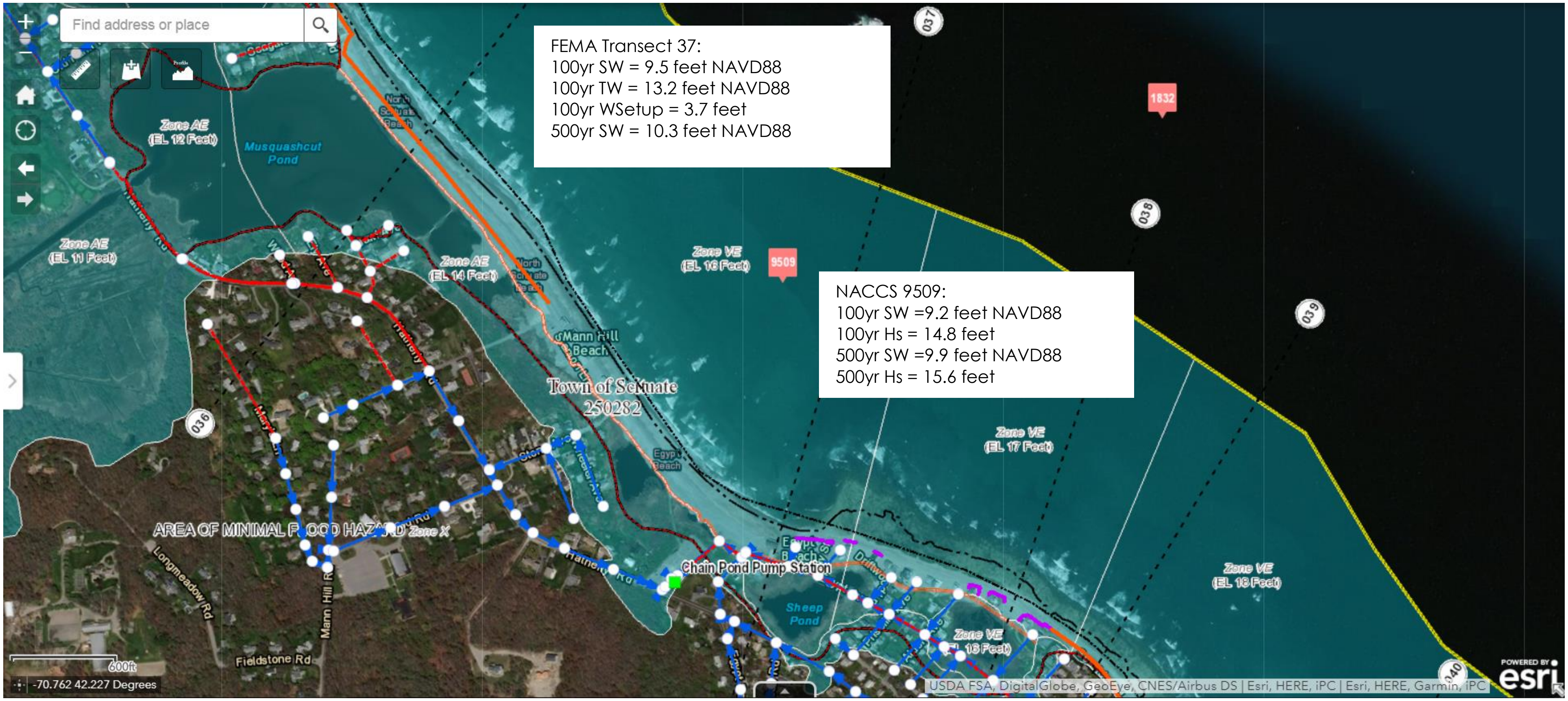
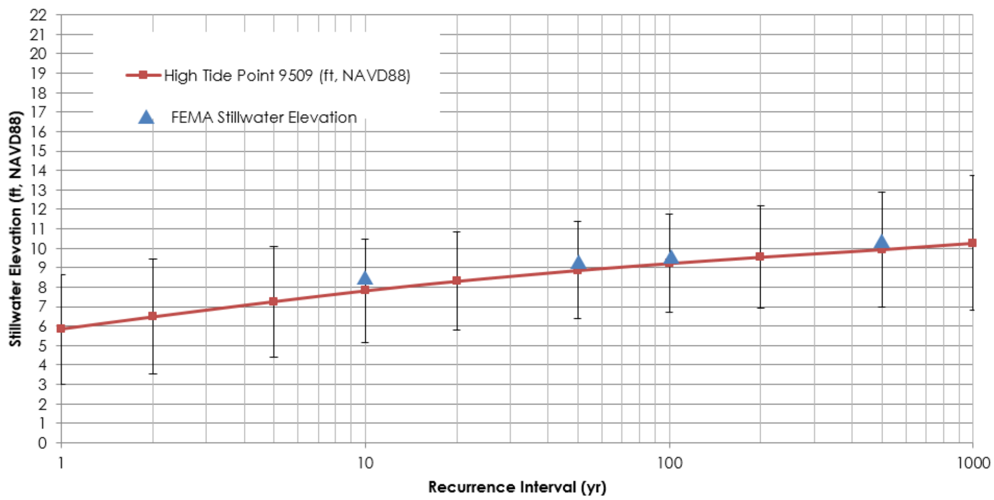
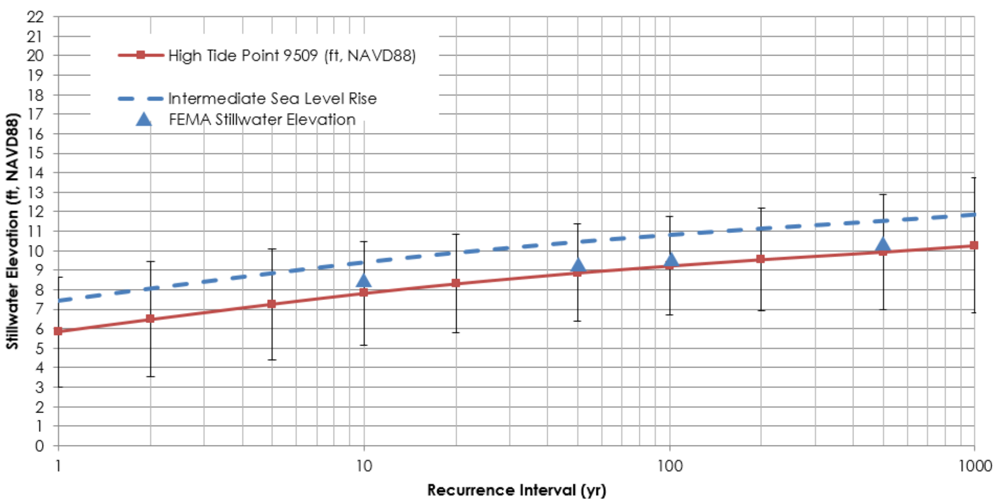


Figure 4-46: FEMA Flood Insurance Rate Map (FIRM) at Chain Pond Pump Station





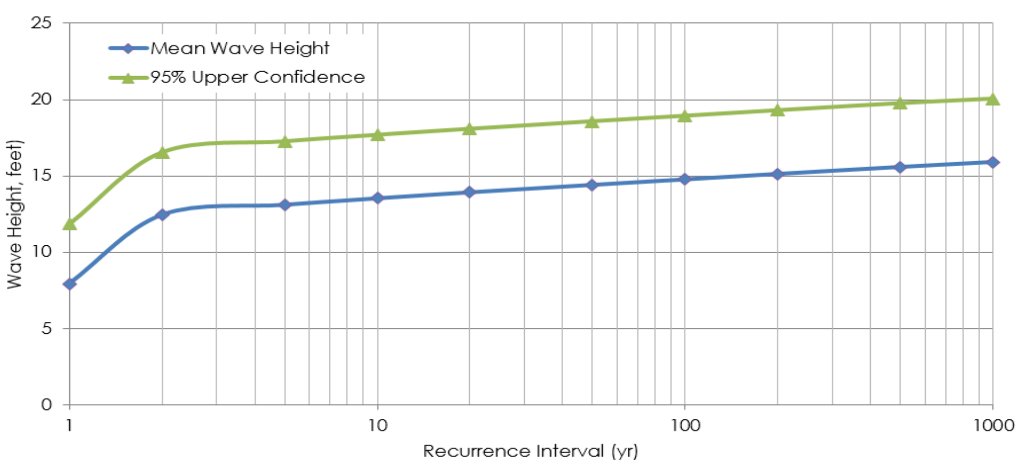


Figure 4-47: USACE NACCS Stillwater Flood-Probability (elevation, NAVD88) and Wave Height (feet)(Chain Pond Pump Station)

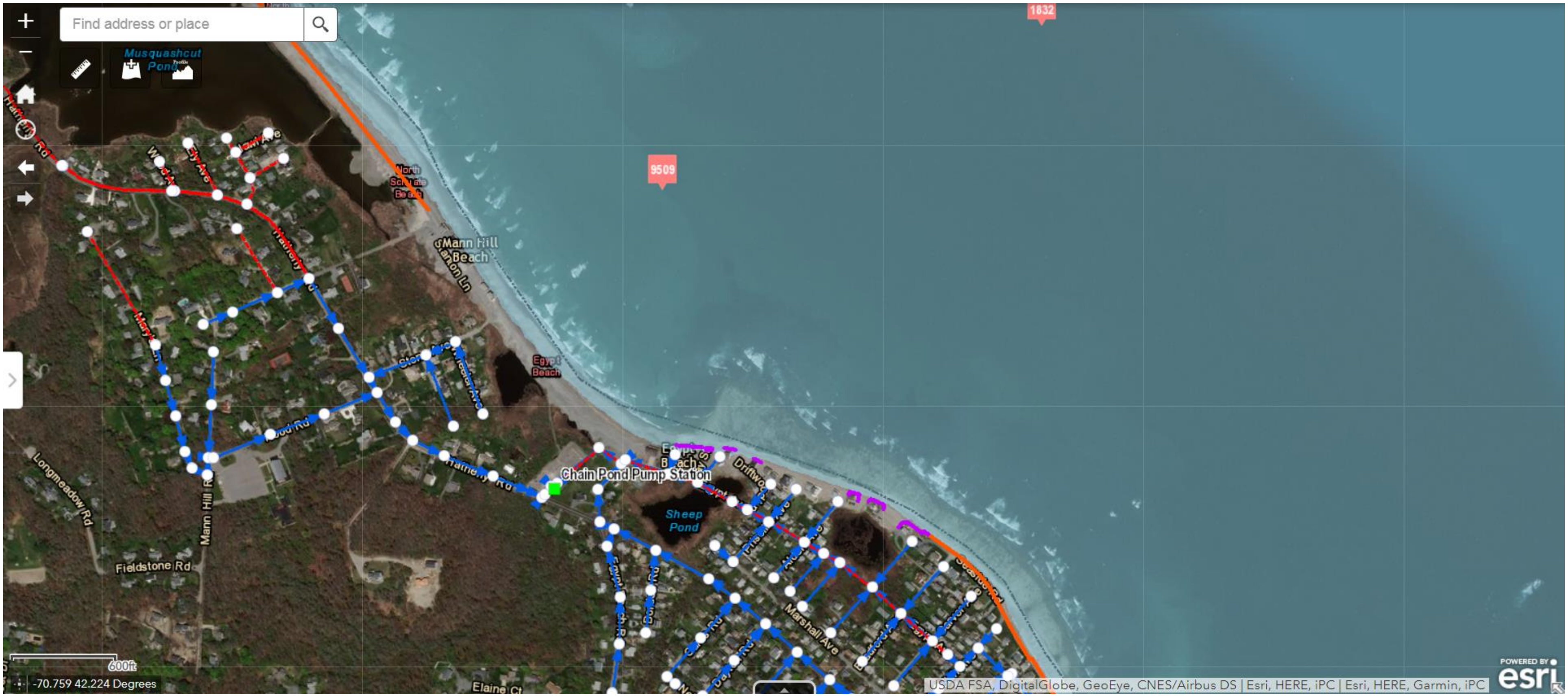


Figure 4-48: Flood Inundation at Chain Pond Pump Station (Floodwater = 9 feet NAVD88)

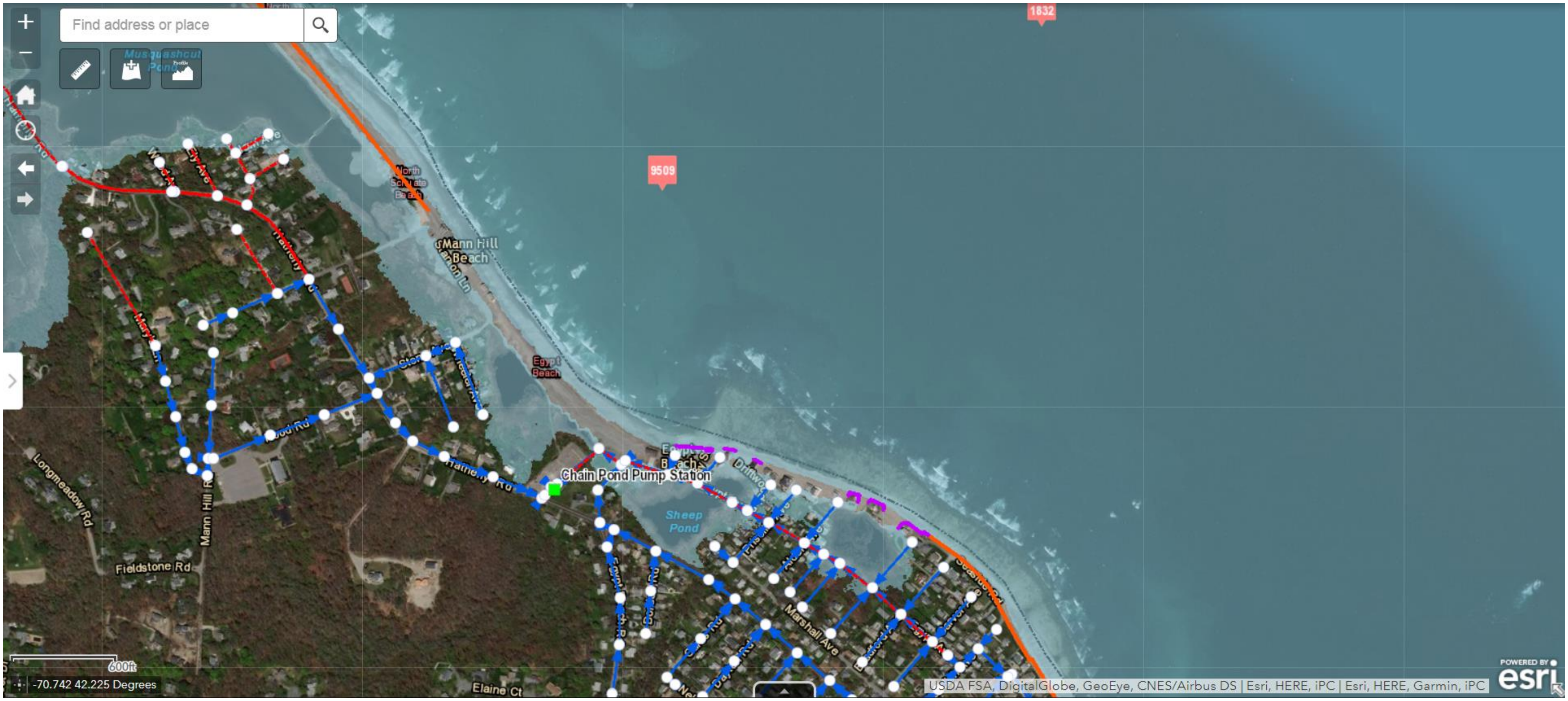


Figure 4-49: Flood Inundation at Chain Pond Pump Station (Floodwater = 10 feet NAVD88)

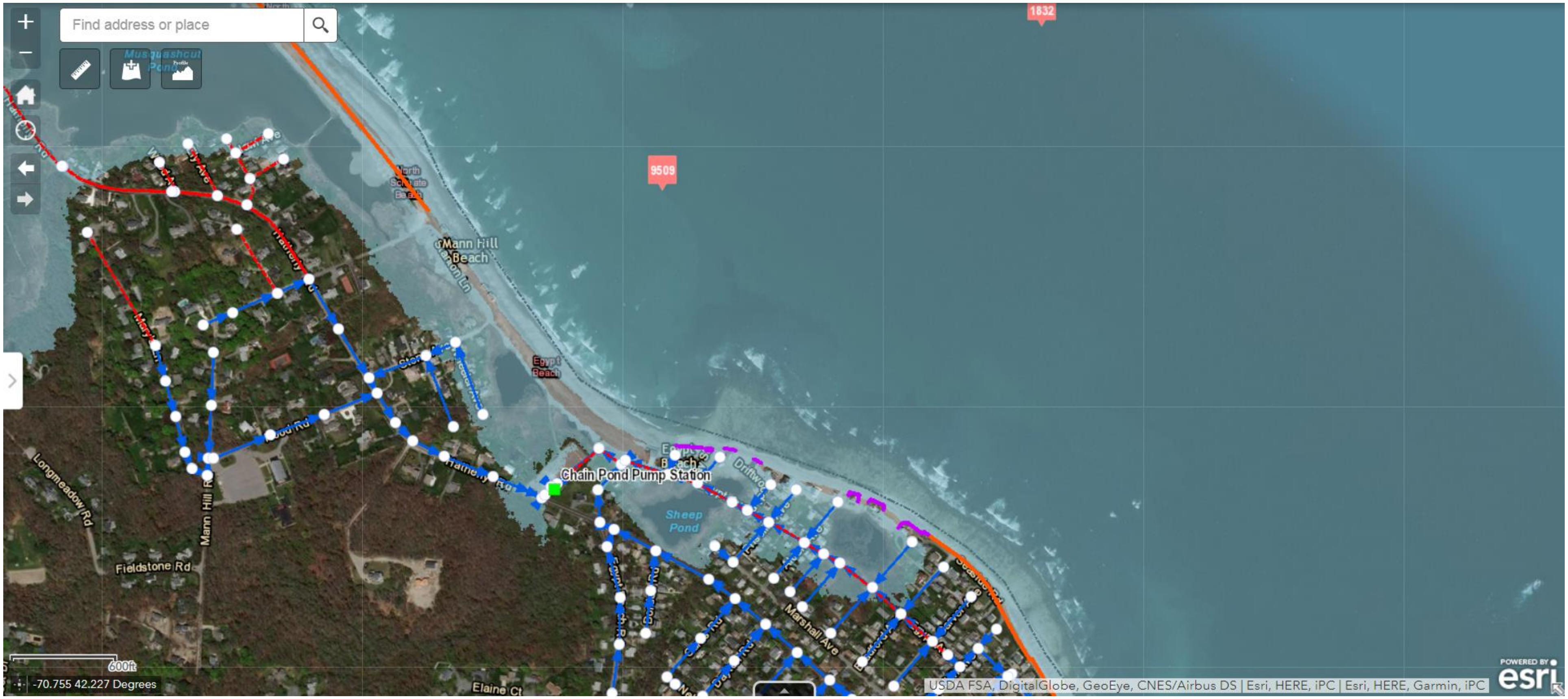


Figure 4-50: Flood Inundation at Chain Pond Pump Station (Floodwater = 12 feet NAVD88)

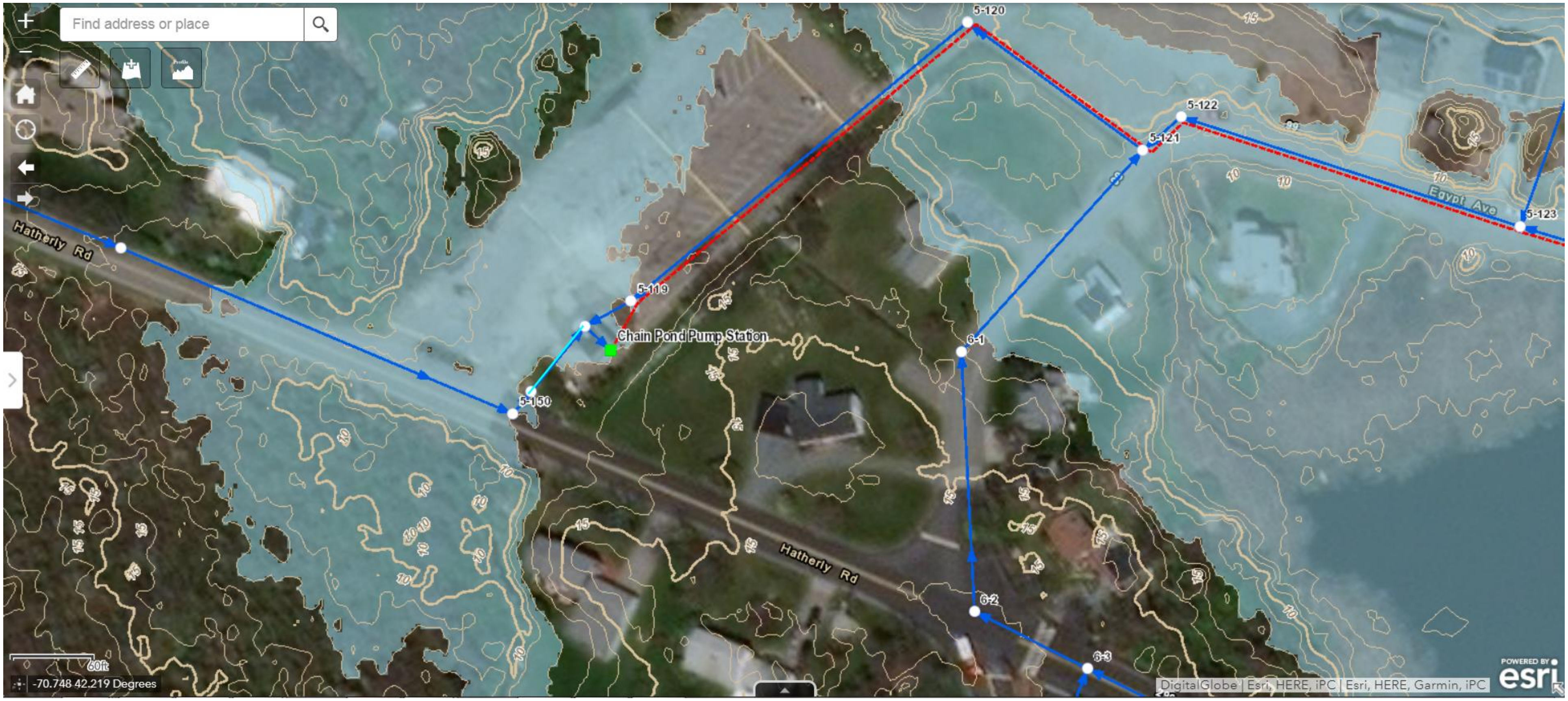


Figure 4-51: Flood Inundation at Chain Pond Pump Station (Floodwater = 12 feet NAVD88)

Stillwater Elevation (feet; NAVD88)	Depth-Limited Wave Height (feet)(1)	Est. Wave Set-up (feet)(1,4)	Est. Total Water Level (feet; NAVD88)	Est. Wave Crest Elevation (feet; NAVD88)(2)	Est. Mean Recurrence Interval (years)(3)			Flood Inundation due to Total Water Level	Wave Run-up and Overtopping(2)
					Current	2040	2070		
6	-	-	-	-	>1	>1	>1	No	No
7	-	-	-	-	3	2	>1	No	No
8	-	-	-	-	10	5	1	No	No
9	-	-	-	-	100	20	3	No	Yes
10	-	-	-	-	500	100	10	No	Yes
11	-	-	-	-	-	500	50	Yes	Yes
12	0	-	-	-	-	2,000	500	Yes	Yes
13	1.5	0.3	-	-	-		-	Yes	Yes
14	2.5	0.4	14.4	16.2	-	-	-	Yes	Yes
15	3.0	0.5	15.5	17.6	-	-	-	Yes	Yes

Notes:

1. Depth-limited wave height adjacent to pump station (+/- Elevation 11 to 12 feet NAVD88).

2. Adjacent to pump station (+/- Elevation 11 feet NAVD88). Wave run-up from broken ocean waves may occur within the area of the pump station.

3. Based on NOAA 2017 Intermediate Sea Level Rise Projection.

4. Wave set-up estimated at 0.15 times depth-limited wave height.

Table 4-26: Coastal Flood Hazard Characteristics at Chain Pond Pump Station

Sands Hill Pump Station:

The Sands Hill Pump Station is located off of Otis Road and Scituate Avenue, about 500 feet inland from the ocean shoreline (Sands Hill Beach). It is also located in a filled area within an unnamed marsh and tidal creek. The ground elevation at the pump station is around 5 to 7 feet NAVD88. The beach has a concrete and stone seawall with top elevation at about 10 to 15 feet NAVD88.

The pump station is vulnerable to coastal flooding. **Figure 4-52** presents the FEMA FIRM flood hazard zones in the vicinity of the pump station. The pump station is located in a FEMA AE zone with a BFE of Elevation 15 feet NAVD88.

Coastal flooding in the vicinity of the Sands Hill Pump Station includes the following components:

- stillwater flood inundation due to storm surge and tide. Stillwater flooding appears to initially flood the pump station area within a low-lying area (about Elevation 9 feet NAVD88) adjacent to the Scituate Harbor (about 900 feet to the east of the pump station near the tidal creek outfall).
- During coastal storms, large waves break seaward of the Sands Hill seawall. Wave set-up increases the total water elevation (stillwater plus set-up) within the wave break zone.
- If the stillwater elevation increases enough, it overtops the beach and seawall and directly floods the area of the pump station.
- Wave run-up, erosion and overtopping of the primary dune causes additional flooding.
- At floodwater elevation +/-9 to 10 feet NAVD88, the area of the pump station is flooded.
- The area may flood at lower elevations (+/- 5 feet NAVD88) due to surcharging at the tidal creek outfall; however, details are not available for the outfall to confirm that condition .

Figure 4-53 represents the applicable stillwater flood-frequency and wave height-frequency curves. The predicted flood-frequency with sea level rise (Intermediate SLR projection by the year 2070) is also shown. **Figures 4-54** and **4-55** show inundation limits for representative stillwater elevations.

Based on the available flood hazard data and engineering judgement, **Table 4-27** summarizes the estimated coastal flood hazard characteristics at the Chain Pond Pump Station.

Figure 4-52: FEMA Flood Insurance Rate Map (FIRM) at Sands Hill Pond Pump Station

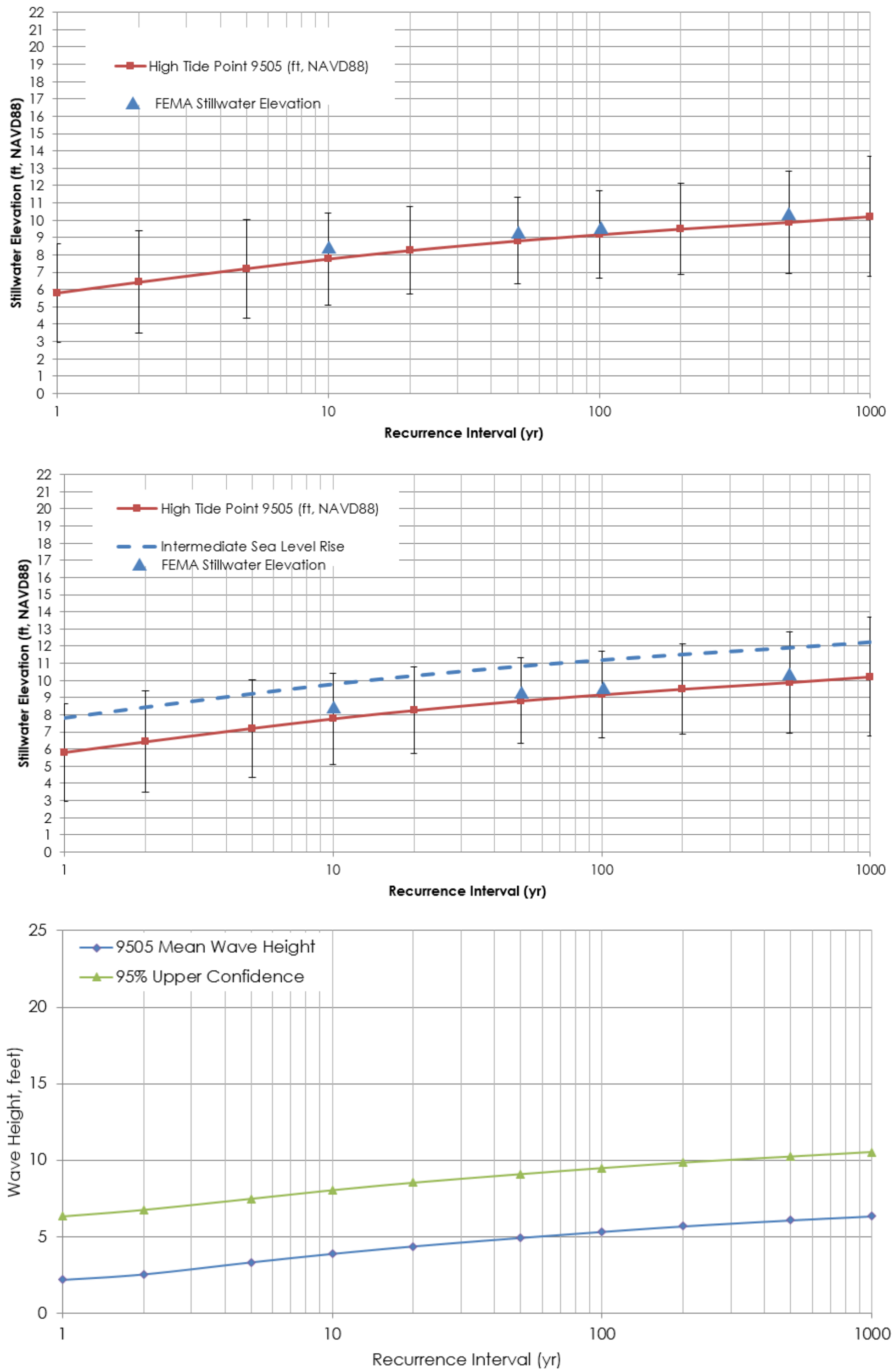


Figure 4-53: USACE NACCS Stillwater Flood-Probability (elevation, NAVD88) and Wave Height (feet) (Sands Hill Pump Station)

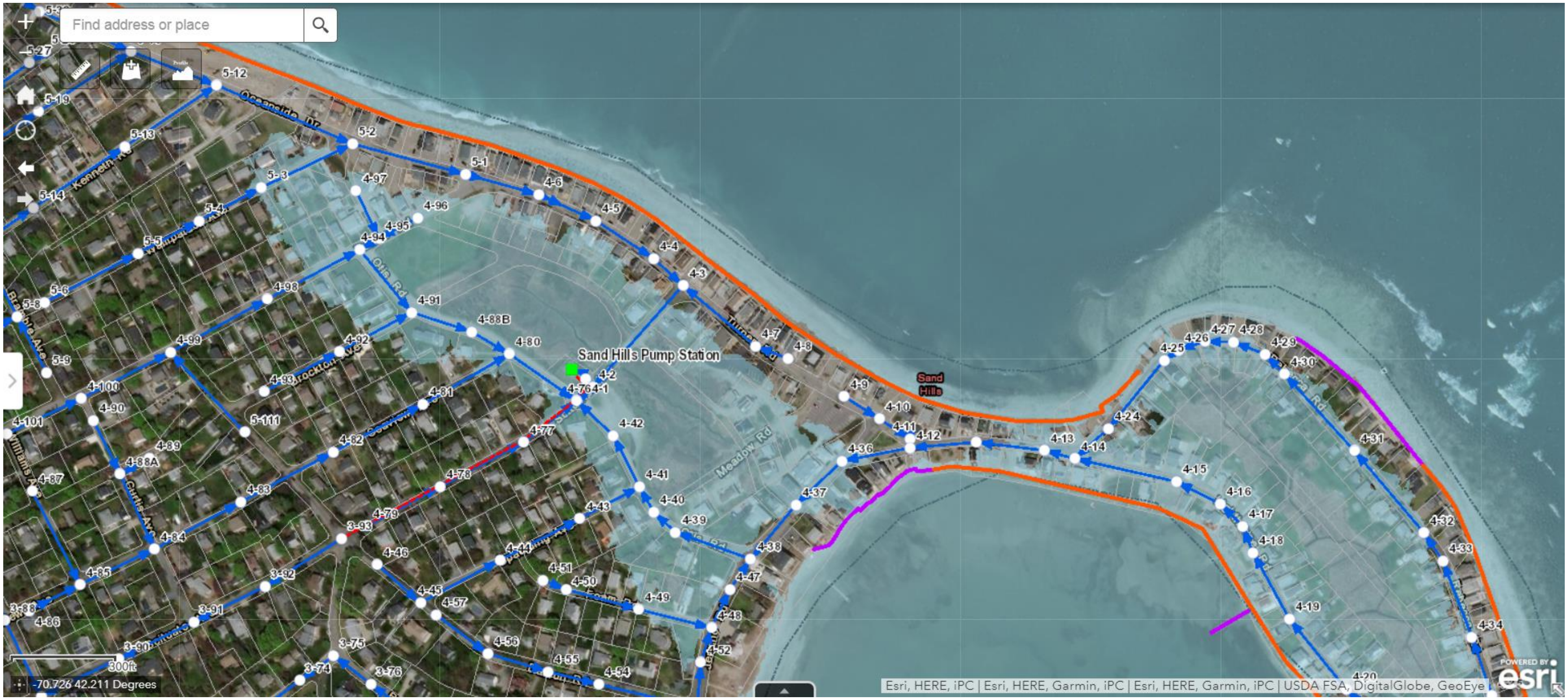


Figure 4-54: Flood Inundation at Sands Hill Pump Station (Floodwater = 10 feet NAVD88)

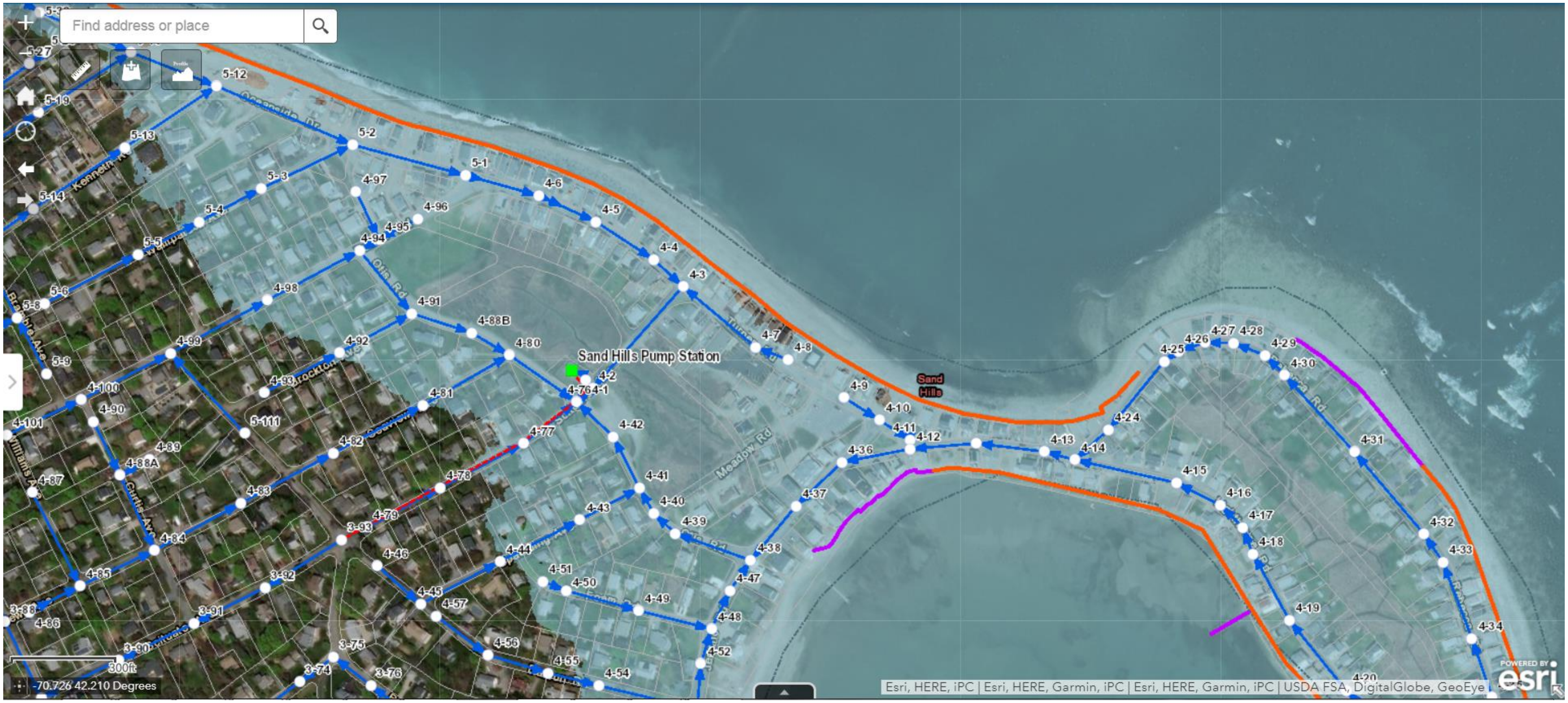


Figure 4-55: Flood Inundation at Sands Hill Pump Station (Floodwater = 15 feet NAVD88)

Stillwater Elevation (feet; NAVD88)	Depth-Limited Wave Height (feet)(1)	Est. Wave Set-up (feet)(1,4)	Est. Total Water Level (feet; NAVD88)	Est. Wave Crest Elevation (feet; NAVD88)(2)	Est. Mean Recurrence Interval (years)(3)			Flood Inundation due to Total Water Level	Wave Run-up and Overtopping(2)
					Current	2040	2070		
6	-	-	6	-	1	>1	>1	Yes	No
7	1.5	-	7	8.1	4	2	>1	Yes	No
8	2.5	0.4	8.4	10.2	10	5	1	Yes	No
9	3.0	0.5	9.5	11.6	50	20	3	Yes	No
10	4.0	-	10.5	12.6	500	100	10	Yes	Yes
11	4.7	-	11.5	13.6	2,000	1,000	50	Yes	Yes
12	5.5	-	12.5	14.6	-	2,000	500	Yes	Yes
13	6.2	-	13.5	15.6	-	-	-	Yes	Yes
14	7.0	-	14.5	16.6	-	-	-	Yes	Yes
15	7.8	-	15.5	17.6	-	-	-	Yes	Yes

Notes:

1. Depth-limited wave height adjacent to pump station (+/- Elevation 5 to 7 feet NAVD88). Note that wind fetch within flooded area is small and that depth-limited waves of about >3 feet will not be achieved.

2. Adjacent to pump station (+/- Elevation 5 feet NAVD88). Wave run-up from broken Sand Hill Beach ocean waves may occur within the area of the pump station.

3. Based on NOAA 2017 Intermediate Sea Level Rise Projection.

4. Wave set-up estimated at 0.15 times depth-limited wave height.

Table 4-27: Coastal Flood Hazard Characteristics at Sands Hill Pump Station

Musquashcut Pond Pump Station:

The Musquashcut Pond Pump Station is located off of Hatherly Road and Musquashcut Avenue, adjacent to Musquashcut Pond and about 1,600 feet from North Scituate Beach. There is a concrete seawall located along North Scituate Beach. The ground elevation at the pump station is around 7 feet NAVD88.

The pump station is vulnerable to coastal flooding. **Figure 4-56** presents the FEMA FIRM flood hazard zones in the vicinity of the pump station. The pump station is located in a FEMA AE zone with a BFE of Elevation 13 feet NAVD88.

Coastal flooding in the vicinity of the Musquashcut Pond Pump Station includes the following components:

- stillwater flood inundation due to storm surge and tide. Stillwater flooding initially floods (at about Elevation 9 feet NAVD88) both the ocean shoreline at a low-lying area along Egypt Beach and along Musquashcut Brook, marsh and pond. If the stillwater elevation increases enough, it overtops the beach and dune and directly floods the area of the pump station.
- During coastal storms, large waves break seaward of the North Scituate Beach. Wave set-up increases the total water elevation (stillwater plus set-up) within the wave break zone.
- Wave run-up, erosion and overtopping of the seawall causes additional flooding.
- At floodwater elevation +/-9 to 10 feet NAVD88, the area of the pump station is flooded.

Figure 4-57 represents the applicable stillwater flood-frequency and wave height-frequency curves. The predicted flood-frequency with sea level rise (Intermediate SLR projection by the year 2070) is also shown. **Figures 4-58** show inundation limits for representative stillwater elevations.

Based on the available flood hazard data and engineering judgement, **Table 4-28** summarizes the estimated coastal flood hazard characteristics at the Musquashcut Pond Pump Station.

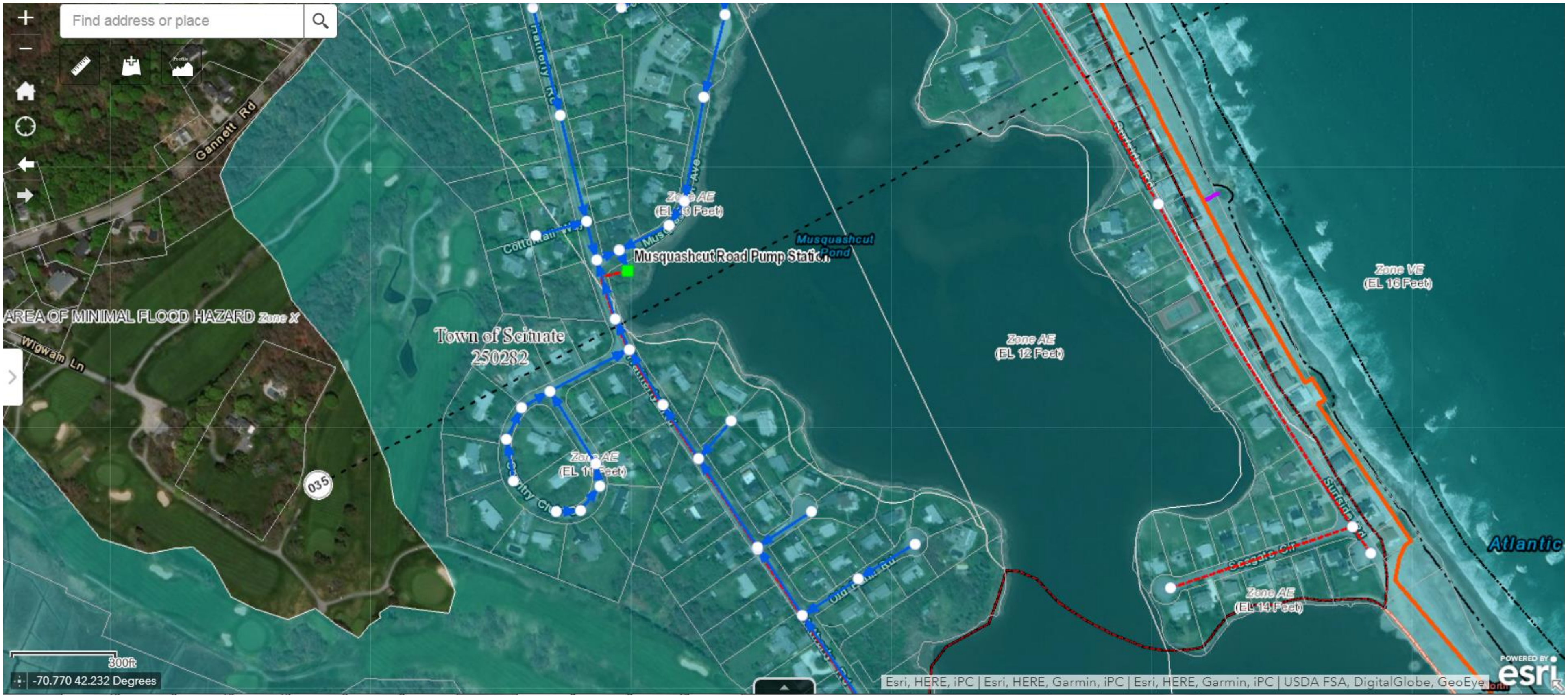


Figure 4-56: FEMA Flood Insurance Rate Map (FIRM) at Musquashcut Pond Pump Station

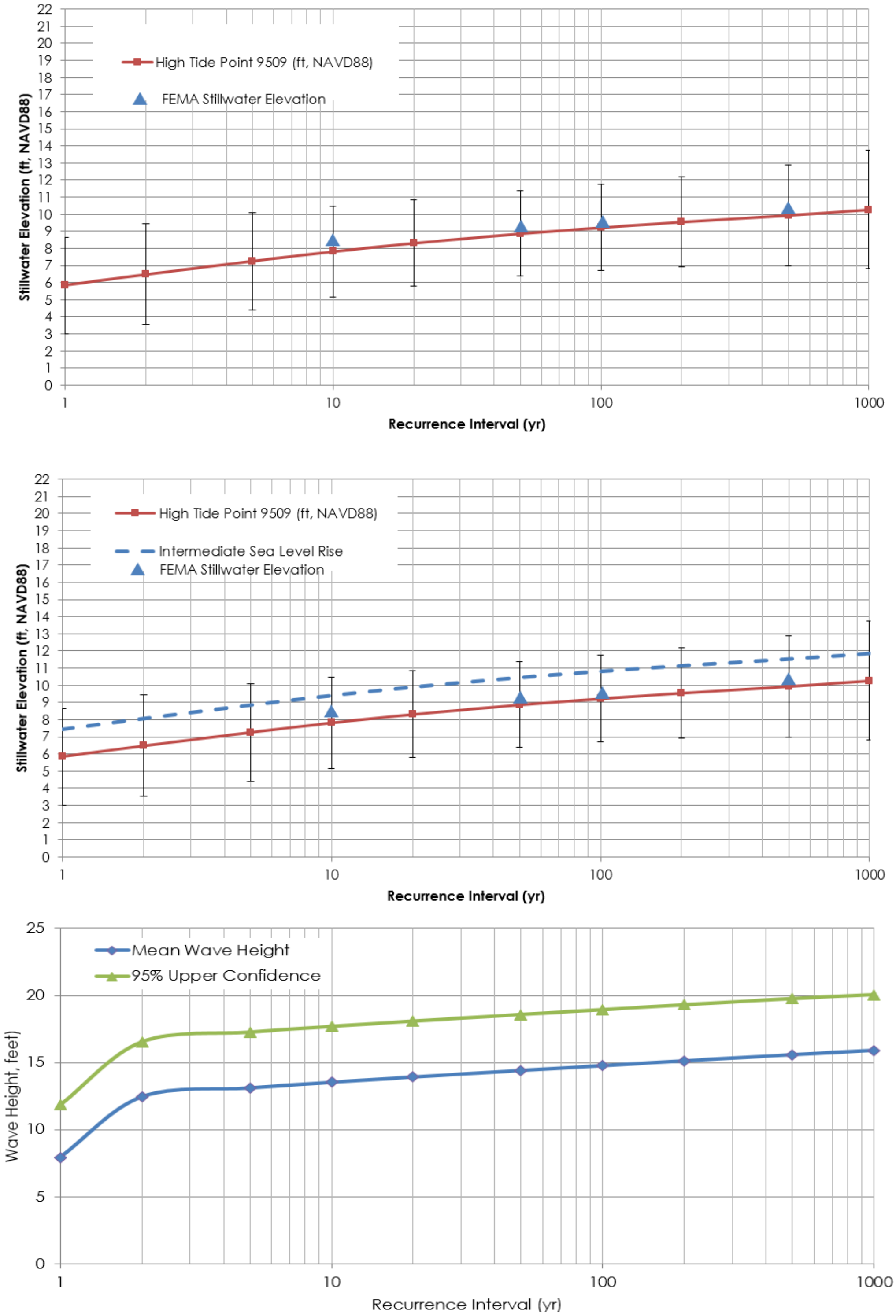


Figure 4-57: USACE NACCS Stillwater Flood-Probability (elevation, NAVD88) and Waves (feet) (Musquashcut Pond Pump Station)

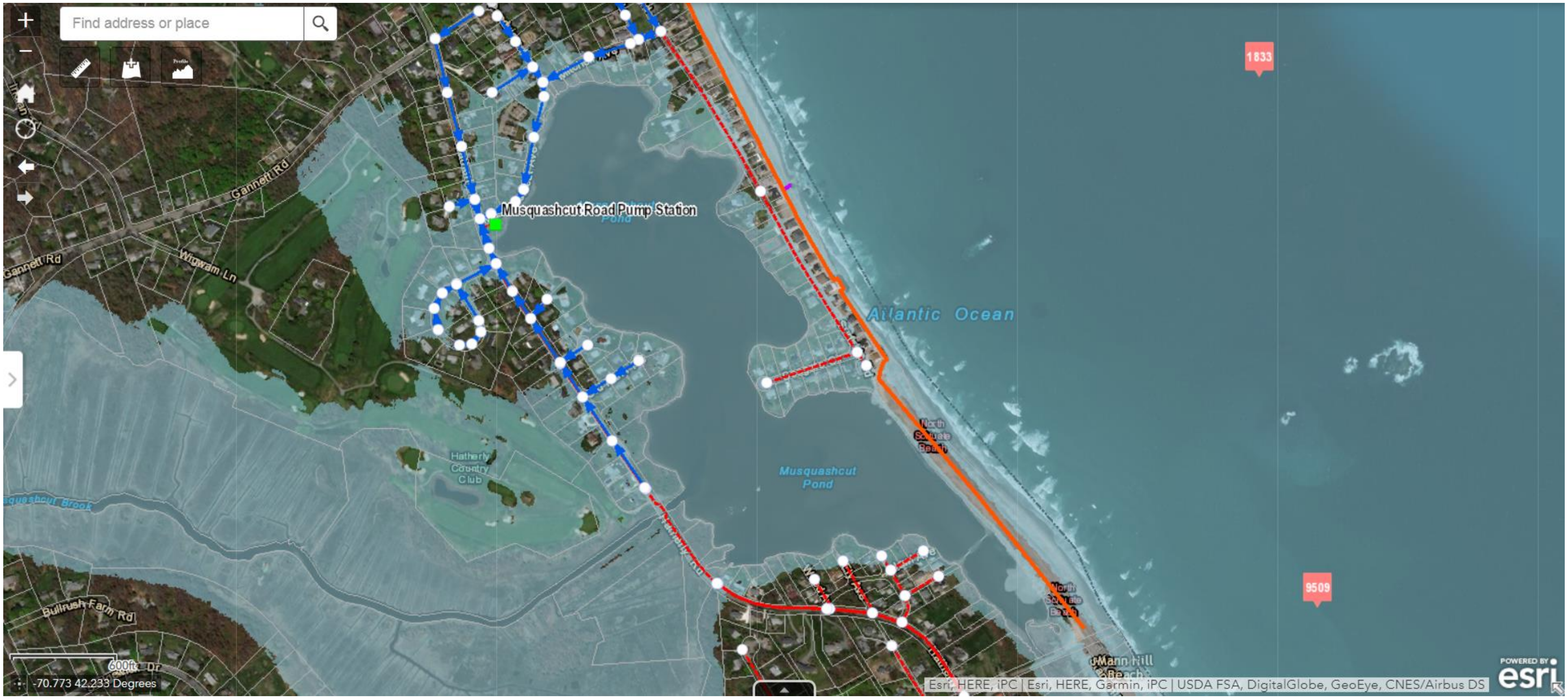


Figure 4-58: Flood Inundation at Musquashcut Pond Pump Station (Floodwater = 10 feet NAVD88)

Stillwater Elevation (feet; NAVD88)	Depth-Limited Wave Height (feet)[1]	Est. Wave Set-up (feet)[1,4]	Est. Total Water Level (feet; NAVD88)	Est. Wave Crest Elevation (feet; NAVD88)[2]	Est. Mean Recurrence Interval (years)[3]			Flood Inundation due to Total Water Level	Wave Run-up and Overtopping[2]
					Current	2040	2070		
6	-	-	-	-	1	>1	>1	No	No
7	-	-	7	7	4	2	>1	No	No
8	-	-	8	8	10	5	1	No	No
9	1.5	-	9	9	100	20	3	Yes	No
10	2.5	0.4	10.4	12.2	500	100	10	Yes	Yes
11	3.0	0.5	11.5	13.6	2,000	1,000	50	Yes	Yes
12	4.0	-	12.5	14.6	-	2,000	500	Yes	Yes
13	4.7	-	13.5	15.6	-	-	-	Yes	Yes
14	5.5	-	14.5	16.6	-	-	-	Yes	Yes
15	6.2	-	15.5	17.6	-	-	-	Yes	Yes

Notes:

1. Depth-limited wave height adjacent to pump station (+/- Elevation 7 feet NAVD88). Note that wind fetch within flooded area is small and that depth-limited waves of about >3 feet will not be achieved.

2. Adjacent to pump station (+/- Elevation 7 feet NAVD88). Wave run-up from broken North Scituate Beach ocean waves may occur within the area of the pump station.

3. Based on NOAA 2017 Intermediate Sea Level Rise Projection.

4. Wave set-up estimated at 0.15 times depth-limited wave height.

Table 4-28: Coastal Flood Hazard Characteristics at Musquashcut Pond Pump Station

March 1-3, 2018 Nor’easter

The Sewer Division estimates that on average each year, the Town experiences coastal flood-related damage to the wastewater infrastructure. While the Sewer Division has managed to maintain wastewater treatment plant operations during major coastal storms; extreme high tides combined with sewer system extreme-storm infiltration and tidal inflows have resulted in sewerage surcharges and overflows. These situations will become increasingly prevalent, and challenging in the future due to accelerating impacts from climate change.

The March 1-3, 2018 nor’easter (Winter Storm Riley) resulted in documented damage. Winter Storm Riley became an intense nor'easter after undergoing bombogenesis off the New England coast March 2-3, producing damaging winds and coastal flooding from New York and New England to North Carolina. Coastal flooding occurred over multiple tide cycles, yielding the third highest tide on record in Boston. Wind gusts of 80 mph or greater were observed in Scituate. Flood inundation within coastal Massachusetts occurred during the first high tide cycle late in the morning on March 2, and a second period of higher tide occurred late that night with moderate flooding.

Figure 4-59 shows the verified flood hydrograph at the NOAA Boston tide gage during the storm. The peak elevation at the Boston gage was 9.2 feet NAVD88.

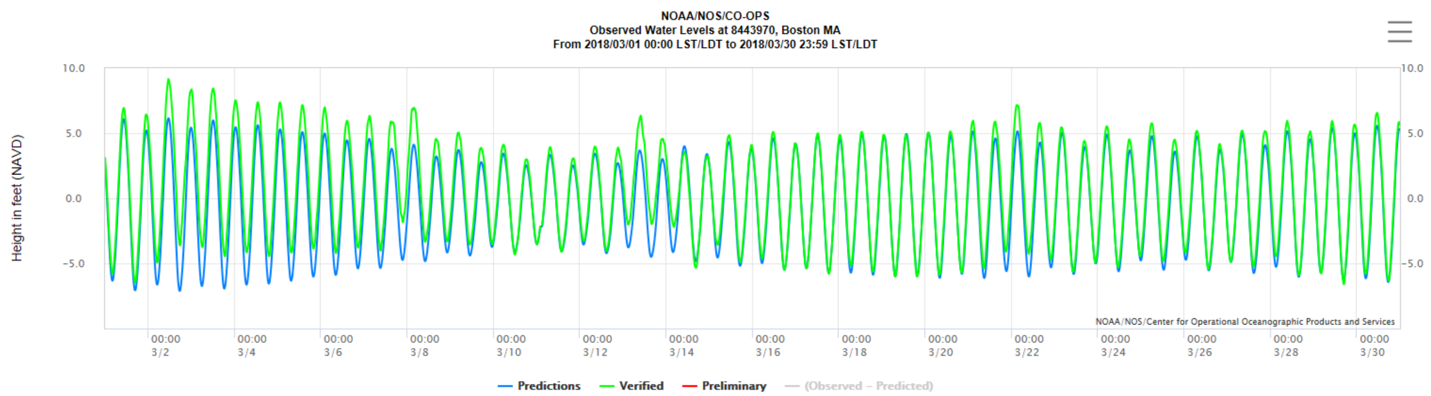


Figure 4-59: Winter Storm Riley (March1-3, 2018) Coastal Flood Elevations at the NOAA Boston Tide Gage

The March 1-3, 2018 nor’easter was a powerful storm that adversely impacted the operations of some components of the sewer system in Scituate. The Sewer Division estimated the economic impacts from the nor’easter exceeded $200,000 in storm-related damages caused primarily by coastal flooding. The impacts from the March 2018 nor’easter resulted in extensive flooding that inundated: 1) the Sand Hills Pump Station on Scituate Avenue (see **Figure 60** below); 2) the parking lot and portions of the Chain Pond Pump Station; and 3) sewer collection areas (see **Figure 61** on the following page) providing access to sewer pumping stations and supporting wastewater infrastructure.

Figure 4-60: Scituate Police Divers guide Sewer Department Supervisor William Branton along Scituate Ave. to activate emergency pumps at the Sand Hills Pump Station towards the end of March 2, 2018 nor’easter (“Winter Storm Riley”).

Figure 4-61: Image of inundated roadways in the vicinity of Cedar Point

Even though the Waste Water Pollution Control Plant (WWPCF) did not experience direct flooding impacts from the March 2018 nor'easter to facilities, an outfall hydraulically connected to the marsh surcharged through a standpipe into the overflow area. This resulted in additional stress on the WPCF capability to process excess seawater that drained back into the sewer processing system.

The damages resulted in the need for the Sewer division to increase resources and replace several sewer system operational components including but not limited to the following:

1) replace critical operational components at the Sand Hills and Chain Pond pumping stations;
2) increase in resources (e.g. gas for emergency generators, larger amounts of soda-ash, methanol, MetClear, and SoliSep, standby pumps, etc.) needed to support the function of the overall sewer system during the event;
3) overtime of Sewer Division staff time to support the operations before, during and after the nor'easter event; and
4) replacement of additional sewer system operational components damaged including various types of pumps, manhole covers and frames, motors, and other components.

A detailed breakdown of costs (which totaled $204,400) is presented below:

- Overtime: See payroll, been putting all storm related overtime work into payroll system. Hours to date: 220.25 cost to date: $8,793.67
- Gas: Emergency generators: $5,880
- Soda-Ash: Extra use to maintain treatment: $3,500
- Methanol: Extra Use to maintain treatment: $2,200
- MetClear: Extra Use to maintain treatment: $1,355
- SoliSep: Extra Use to maintain treatment: $1,225
- Sand Hills Pump Station:
    - Standby Pump: Impeller, Bearing, Seal: $18,500
    - Lag Pump: Bearing: $5,500
    - Wet well level sensor: $2,300

    - Heating System: Replace: $45,000
- Influent Standby Pump: Bearing, Seal, Impeller: $18,500
- Intermediate Standby Pump: Impeller, Bearing, Seal, Motor: $22,400
- UV System: Wiper Assembly and sleeve x2 : $1,500
- Trash Pump: Pump + hoses: $2,200
- Feed Pump: motor, gearbox, shaft, seals: $33,000
- Chain Pond Pump Station:
    - Transfer Switch: $5,160
    - Back flow preventer: $4,611
- Return Pumps: Motor: $3,400
- Truck 5-1: Bearing, breaks: $1,172.70
- Penn Valley Pumps: 2 rebuilds $3,600
- Damaged Manhole Covers and Frames: $4,272
- Mixer Motor: $9,800
- Misc tools/parts: $493.09

This storm also resulted in significant pipe leakage resulting in excessive wastewater flows. The average, capacity and March 2018 peak daily flows are summarized below:

Pump Station	Dry Average (GPD)	Wet Average (GPD)	Design Capacity (GPM)	March 2108 Peak (GPD)
Musquashcut	10,000	13,000	600	55,000[1]
Peggotty Beach	10,000	25,000	280	108,000
Herring Brook	35,000	70,000	1,000	120,000[2]
Country Way	6,500	15,000	260	14,000
Chain Pond	200,000	250,000	1,200	525,000
Sand Hills	600,000	1,000,000	1,600	2,250,000

Notes:

1. During this event the drywell became submerged and flow metering was lost. This value was the highest value captured during the event before the meter was lost.
2. The values for March at this station seemed low and could have been a calibration issue. This value was the highest daily flow observed in April 2018.

Table 4-29: Pump Station Design and Observed Flow Data

Flood inundation in the area of the wet well at the Musquashcut pump station caused significant leakage via the wet well hatch cover. Excess wastewater flow within the Sand Hills pump station caused back-up and overflow within the pump well and also pump failure. Electrical “brown outs” caused failure of the treatment plant return pumps.

Consistent with coastal flood events, flow was manually reduced (throttled) at the treatment plant and at Sand Hills pump station.

Additional nor’easters hit Massachusetts a few days later during March 6 to 7, March 12 to 14, and March 20 to 22, 2018. Excessive flows at the treatment plant continued for several days after the storm. See **Figure 4-62**. The March, 2018 data indicates that coastal flood elevations on the order of 6 feet NAVD88 will result in I/I flows causing the treatment plant to operate at near full capacity.

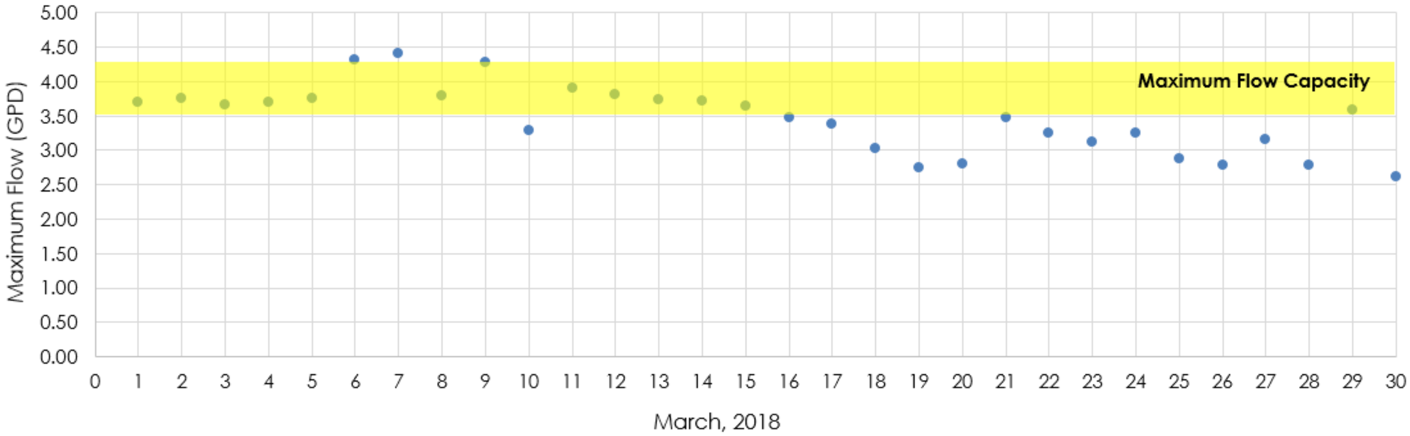


Figure 4-62: Maximum Flow rate (GPD) at Treatment Plant during March, 2018

Attachment 5
Coastal Flood Vulnerability Assessment (Collection System and Pump Stations)

Collection System and Pump Station Flood Vulnerability

The following provides an overview of the potential collection system and pump station vulnerability to external flooding by floodwater elevation. The attached **Tables 5-1** through **5-7** identify vulnerable components and possible water entryways at each pumping station. The collection system vulnerability is also presented.

Pump Station External Flood Vulnerability Overview:

Flood Elevation 10 feet NAVD88:

Inundated Structures and Systems and Entryways:

- **Collier Road Pumping Station:** None
- **Chain Pond Pumping Station:** None
- **Edward Foster Road Pumping Station:** Outside Gas Pressure Regulator, Wet Well Manhole/Hatch
- **Musquashcut Pond Pumping Station:** Exterior Stairs, Outside Gas Pressure Regulator, Wet Well Manhole/Hatch
- **Peggotty Beach Road Pumping Station:** Outside Gas Pressure regulator
- **Sand Hills Pumping Station:** Exterior Stairs, Gas Connection, Roof Drain
- **Herring Brook Pumping Station:** Wet Well Manhole/Hatch, Generator Skid

At a water elevation of 10 feet (NAVD88). The exterior stairs at Musquashcut Avenue and Sand Hills Pump Stations are partially flooded and access to these stations will be limited. While no vital systems at Peggotty Beach Road or Edward Foster Road Pump Stations are inundated, nearby roadways will likely be flooded possibly, limiting access to these pump stations. No components at Collier Road or Chain Pond Pump Stations are inundated at this water level; however, access to these pump stations may be difficult due to nearby roadway flooding. Components at Herring Brook Pump Station are not housed inside a structure, instead most of its components sit at ground level and are not shielded from the elements. At the 10-foot floodwater elevation the Herring Brook Pump Station is mostly inundated. Wet well manholes/hatches are submerged at Edward Foster, Musquashcut Ave and Herring Brook pump stations. During GZA's inspection these wet well covers did not appear to be watertight, indicating that leakage to the wet well from surface flooding is likely. Gas Pressure regulators are submerged at some pump stations; however, these appear to be sealed to prevent water intrusion.

Flood Elevation 11 feet NAVD88:

Additional Inundated Structures, Systems and Entryways:

- **Collier Road Pumping Station:** None
- **Chain Pond Pumping Station:** None
- **Edward Foster Road Pumping Station:** Personnel Entryway, Gas Connection, Inside Generator Skid
- **Musquashcut Pond Pumping Station:** Outside Electric Meter Panel
- **Peggotty Beach Road Pumping Station:** Personnel Entryway, Wet Well Manhole
- **Sand Hills Pumping Station:** No additional
- **Herring Brook Pumping Station:** Outside Gas Pressure Regulator

At a water elevation of 11 feet (NAVD88), water threshold elevations for personnel entryways at Edward Foster Road and Peggotty Beach Road Pump Stations are inundated, likely flooding the interiors of both pump stations. The wet well manhole cover/hatch at Edward Foster Road Pump Station is also inundated. At Musquashcut, the electric meter panel is partially submerged. No components at Collier Road or Chain Pond pump stations are inundated at this water level.

Flood Elevation 12 feet NAVD88:

Additional Inundated Structures, Systems and Entryways:

- **Collier Road Pumping Station:** None
- **Chain Pond Pumping Station:** Pipe Wall Penetrations, Exterior Stairs, Outside Gas Pressure Regulator, Wet Well Manhole/Hatch
- **Edward Foster Road Pumping Station:** Vent 2, Vent 4, Wet Well Vent Pipe
- **Musquashcut Pond Pumping Station:** Personnel Entryway, Wet Well Vent Pipe
- **Peggotty Beach Road Pumping Station:** Vent 4, Gas Connection, Inside Generator Skid
- **Sand Hills Pumping Station:** Personnel Entryway 1 and 2, Vents 1, 4, 5, 6, and 7.
- **Herring Brook Pumping Station:** No additional

At a water elevation of 12 feet (NAVD88), personnel entryways and several air vents at the Sand Hills Pump Station are submerged above their threshold elevations likely flooding the pump stations floors. Water will also likely flood the interior of Musquashcut Ave Pump Station through its doorway. Pipe Wall Penetrations, Exterior Stairs, and the Outside Gas Pressure Regulator at Chain Pond Pump Station are inundated at this water level; however, water is not expected to reach the structure's free floor elevation**.**

Elevation 13 feet NAVD88:

Additional Inundated Structures, Systems and Entryways:

- **Collier Road Pumping Station:** None
- **Chain Pond Pumping Station:** No additional
- **Edward Foster Road Pumping Station:** Outside Electric Meter
- **Musquashcut Pond Pumping Station:** Vent 4, Gas Connection, Inside Generator Skid
- **Peggotty Beach Road Pumping Station:** Vent 2, Wet Well Vent Pipe
- **Sand Hills Pumping Station:** Outside Electric Meter Panel
- **Herring Brook Pumping Station:** Outside Electric Meter Panel, Wet Well Vent Pipe

At a water elevation of 13 feet (NAVD88) electric meter panels are partially submerged at Edward Foster Road, Sand Hills and Herring Brook Pump Stations. At the Musquashcut Pond Pump Station the water will be above the inside emergency generator's skid elevation.

Flood Elevation 14 feet NAVD88:

Additional Inundated Structures, Systems and Entryways:

- **Collier Road Pumping Station:** None
- **Chain Pond Pumping Station:** No additional
- **Edward Foster Road Pumping Station:** No additional
- **Musquashcut Ave Pumping Station:** Vent 2
- **Peggotty Beach Road Pumping Station:** No additional
- **Sand Hills Pumping Station:** Vent 7
- **Herring Brook Pumping Station:** No additional

At a water elevation of 14 feet (NAVD88) additional vents at Musquashcut Ave and Sand Hills Pump Stations are inundated.

Flood Elevation 15 feet NAVD88:

Additional Inundated Structures, Systems and Entryways:

- **Collier Road Pumping Station:** Outside Gas Pressure Regulator, Gas Connection
- **Chain Pond Pumping Station:** No additional
- **Edward Foster Road Pumping Station:** None
- **Musquashcut Ave Pumping Station:** None
- **Peggotty Beach Road Pumping Station:** Outside Electric Meter Panel
- **Sand Hills Pumping Station:** No additional
- **Herring Brook Pumping Station:** No additional

At a water elevation of 15 feet (NAVD88) Water begins to reach components at Collier Road Pump Station including the gas pressure regulator and its pipe connection. The outside electric meter at Peggotty Beach Road Pump Station is partially submerged.

Flood Elevation 16 feet NAVD88:

Additional Inundated Structures, Systems and Entryways:

- **Collier Road Pumping Station:** Personnel Entryway, Wet Well Manhole/Hatch, Inside Generator Skid
- **Chain Pond Pumping Station:** Personnel Entryway, Outside Electric Meter Panel, Inside Generator Skid
- **Edward Foster Road Pumping Station:** None
- **Musquashcut Ave Pumping Station:** No additional
- **Peggotty Beach Road Pumping Station:** No additional
- **Sand Hills Pumping Station:** Vent 2 and 3, Electric Conduit Wall Penetration
- **Herring Brook Pumping Station:** No additional

At a water elevation of 16 feet (NAVD88), personnel entryways at Collier Road and Chain Pond Pump Stations are submerged above their threshold elevations flooding the interiors of both pump stations. Additional components inundated at the Sand Hills Pump Station are Vents 2 and 3, and an electric conduit wall penetration.

Flood Elevation 17 feet NAVD88:

Additional Inundated Structures, Systems and Entryways:

- **Collier Road Pumping Station:** None
- **Chain Pond Pumping Station:** No additional
- **Edward Foster Road Pumping Station:** Vent 1 and 3,
- **Musquashcut Ave Pumping Station:** No additional
- **Peggotty Beach Road Pumping Station:** Vent 1
- **Sand Hills Pumping Station:** No additional
- **Herring Brook Pumping Station:** Generator Exhaust

At a water elevation of 17 feet (NAVD88) air vents at Edward Foster Road and Peggotty Beach Road pump stations are inundated. The emergency generator's exhaust pipe at Herring Brook Pond is inundated.

Combined Pump Station Vulnerabilities

Table 5-8 presents a summary external flood vulnerability overview by pump station and flood water elevation. The vulnerability is characterized as follows:

- Green – indicates minor to no impact expected.
- Yellow – indicates flood impact, with minor damage expected and/or unlikely pump station disruption. Includes gas connector flooded, potential leakage into wet wells.
- Red – indicates significant impact is expected (e.g., door threshold flooded; vents and other major penetrations flooded; emergency generator pad flooded; and/or potential for internal flooding due to high flood depth [+3 feet] above wet well).

As shown in **Table 8**, the external flood vulnerability varies by location. At flood water elevation of 16 feet (and above), effectively all the pump stations are inoperable and likely to experience significant damage.

Collection System Internal Flood Vulnerability:

In addition to the vulnerability of the pump stations to external flooding, the collection infrastructure (e.g., pipes, manholes, etc.) contributes to the overall treatment system vulnerability due to excess infiltration and inflow (I/I) into the infrastructure. Excess I/I into the collection system has been observed during dry conditions, during precipitation events and during coastal flood events.

The Town retained CDM Smith during 2016 to perform a system flow monitoring program and I/I analyses. The results were presented in a memorandum dated August 10, 2016.

As defined in that memorandum:

Infiltration is non-effluent water that enters the sewer system through pipelines (structural defects, faulty joints, and service connections), manholes and other structures, including:

- Base Infiltration is groundwater which enters the sewer system and is observed at an increased rate during winter and early spring when the groundwater is highest due to ground thaw, snow melt and rainfall.
- Tidal Infiltration is a secondary source of infiltration from the ocean that is observed at an increased rate during high tide. Where present, tidal infiltration can occur year round. Inflow in a sewer system is the total flow from direct and indirect sources as defined below. Inflow is present throughout the year.

Inflow is water that enters into the system through source connections, including:

- Direct inflow enters the sewer system through direct connections to the collection system such as catch basins and roof leaders. The primary source of inflow is storm water, including rainfall runoff, and if it is a significant source, can be observed during rainfall events year round.
- Indirect, or delayed inflow enters the sewer system through connections to sources such as building sump pumps and foundation drains. Its primary source is the wet weather (rainfall) influence on groundwater and may be prevalent for extended periods during the late winter and early spring and for shorter periods following rainfall events year round.

RDII, or Rain-Derived Infiltration and Inflow, is the increased portion of water flow in a sanitary sewer system that occurs during and after a rainfall event. Extraneous water enters the sewer system during wet weather periods through cracks and open joints in sewer mains, manholes and building laterals, as well as through direct connections between storm drains and sanitary sewer and from illegal drainage connections on private property.

Wet weather flow is the metered flow data during and after the wet weather period (generally over several days).

Dry weather flow is the metered flow data during a dry weather period (typically at least four days following a rain event and anytime thereafter until the next rain event).

The results of the CDM Smith study concluded that:

- the treatment system is susceptible to both infiltration and inflow;
- during high tide and especially during periods of seasonally high groundwater elevations, portions of the sewer system are submerged in groundwater/tidal waters;
- The majority of inflow entering the sewer system during a rainfall event is indirect inflow (82 percent indirect inflow vs. 18 percent direct inflow). Based on the high groundwater levels and tidal influence on groundwater (wastewater flows increase and decrease in unison with high tide and low tide), many of the sub-areas experience rainfall-derived inflow and infiltration (RDII) following a rainfall event;
- The inflow results indicate that while the sewer system is susceptible to direct inflow connections (roof leaders, driveway drains, etc.), it is more susceptible to groundwater/tide and indirect inflow sources (sump pumps, foundation drains, etc.); and
- Sub-areas 4-1, 4-2, 5-1 and 6-1 are considered high priority and sub-areas 1-1, 2-1, 5-2 and 7-2 are considered low priority (see **Figure 5-1** for subdrainage area locations). These areas correspond to Chain Pond Pump and Sand Hill Pump Stations. Note that Musquashcut Pump Station drainage areas were not part of the CDM Smith study.

The CDM Smith study identified I/I factors but their study period did not include a coastal flood event. Coastal flood events are expected to significantly increase the gross and net infiltration (and possibly direct inflow) relative to that observed during the study.

In addition to rainfall, coastal flood contributions to I/I include: 1) direct inflow via non-watertight sewer manholes and pump station wet wells located within flood inundation areas: 2) indirect inflow to infrastructure (e.g., building sump pumps and foundation drains) located within flood inundation areas; and 3) significantly higher tidal inflow due to flood-related increases in groundwater within system areas located close enough to the shoreline to be tidally influenced. For example, during the CDM Smith study period (March 14, 2016 to March 21, 2016), tidal elevations ranged from 7.7 feet to 11.8 feet MLLW (high tide) and -2.3 to 1.7 feet MLLW (low tide), which reflect no to minor (<1 foot) storm surge. In comparison, the March, 2018 flood events resulted in much higher tidal elevations (due to storm surge) as well as flood-inundated areas due to storm surge and waves. During March 2018, tidal elevations were as high as about Elevation 14 to 15 feet NAVD88 for several high tide cycles (+/- 25% to 100% higher peak elevations than occurred during the CDM Smith study period). The effect of this storm (see **Attachment 4**) was significantly increased net and gross flow observed in certain pump stations.

The effect of system I/I represents a coastal storm vulnerability due to the potential to: 1) exceed the capacity of individual pump stations pump capacities resulting in operation disruption; 2) exceed the capacity of the treatment plant pump and treat capacity resulting in operational disruption; 3) result in internal flooding within a pump station and/or the treatment plant resulting in both damage and operation disruption; and 4) temporary loss of storage within the collection system, resulting in operational disruption. Exceedance of the overall system capacity can also result in a controlled or uncontrolled release at the system outfall to the estuary.

Table 5-1: Summary of Water Entry Points – Collier Road Pump Station

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Floodwater Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:		None Observed													
Doors (Personnel and Public):															
Personnel entryway		Door Threshold elev.	16.3±	15.5±											
Vents:															
18'' x 24'' Fresh Air Intake	Vent 1	Bottom of Vent	22.3±	21.5±											
24'' x 36'' Fresh Air Intake	Vent 2	Bottom of Vent	18.1±	17.3±											
20'' x 20" Fresh Air Intake	Vent 3	Bottom of Vent	23.0±	22.2±											
24'' x 30'' Exhaust Louver	Vent 4	Bottom of Vent	17.3±	16.5±											
20'' x 20'' Muffler Vent	Vent 5	Bottom of Vent	23.3±	22.5±											
Other:															
Outside Electric Meter Panel		Lowest Elevation	20.6±	19.8±											
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed													
Exterior Stairs		None Observed													
Electrical Conduit Wall Penetrations:		None Observed													
Outside Gas Pressure Regulator		Lowest Elevation	15.8±	15.0±											
Gas Connection		Wall Penetration	17.0±	16.2±											
Generator Exhaust		Invert of Pipe	24.2±	23.4±											
Wet Well Manhole/Hatch Rim		Hatch/Rim Elevation	16.1±	15.3±											
Wet Well Vent Pipe		Pipe Outlet	19.3±	18.5±											
Critical Interior Components															
Inside Generator Skid Top Elev.		Lowest Elevation	16.8±	16.0±											
Wall Mounted Electrical Equipment		Lowest Elevation	Unknown	Unknown											
Non-Critical Interior Components															
Gas Fired Unit Heater		Lowest Elevation	16.3±	15.5±											
Electric Water Heater		Lowest Elevation	16.3±	15.5±											

Table 5-2: Summary of Water Entry Points – Chain Pond Pump Station

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:		None Observed													
Doors (Personnel and Public):															
Personnel entryway		Door Threshold elev.	16.3±	15.5±											
Vents:															
72'' x 36'' Vent	Vent 1	Bottom of Vent	19.4±	18.6±											
15'' x 8'' Vent	Vent 2	Bottom of Vent	18.6±	17.8±											
Other:															
Outside Electric Meter Panel		Lowest Elevation	16.7±	15.9±											
Pipe Wall Penetrations to daylight or unsealed vaults/manholes	Manhole	Inlet Threshold Elevation	12.6±	11.8±											
Exterior Stairs		Bottom of Step	12.7±	11.9±											
Electrical Conduit North Wall Penetrations		Wall Penetration	18.5±	17.7±											
Electrical Conduit East Wall Penetrations		Wall Penetration	18.2±	17.4±											
Outside Gas Pressure Regulator		Lowest Elevation	12.8±	12.0±											
Gas Connection		Wall Penetration	18.4±	17.6±											
Generator Exhaust		Invert of Pipe	24.8±	24.0±											
Roof Drain		Invert of Pipe	13.7±	12.9±											
Wet Well Manhole/Hatch Rim		Hatch/Rim Elevation	12.8±	12.0±											
Wet Well Vent Pipe		Pipe Outlet	19.5±	18.7±											
Critical Interior Components															
Inside Generator Skid Top Elev.		Lowest Elevation	16.8±	16.0±											
Lowest Control Panel		Lowest Elevation	19.8±	19.0±											
Circuit Breaker		Lowest Elevation	20.0±	19.2±											
Non-Critical Interior Components															
Water Meter		Lowest Elevation	17.8±	17.0±											
Electric Meter		Lowest Elevation	18.0±	17.2±											
Water Heater		Lowest Elevation	16.8±	16.0±											

Table 5-3: Summary of Water Entry Points – Edward Foster Road PS

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:		None Observed													
Doors (Personnel and Public):															
Personnel entryway		Door Threshold elev.	10.9±	10.1±											
Vents:															
18'' x 24 Fresh Air Intake	Vent 1	Bottom of Vent	16.9±	16.1±											
24'' x 36'' Fresh Air Intake	Vent 2	Bottom of Vent	12.7±	11.9±											
20'' x 20 Fresh Air Intake	Vent 3	Bottom of Vent	17.6±	16.8±											
24'' x 30'' Exhaust Louver	Vent 4	Bottom of Vent	11.9±	11.1±											
20'' x 20 Muffler Vent	Vent 5	Bottom of Vent	17.9±	17.1±											
Other:															
Outside Electric Meter Panel		Lowest Elevation	13.2±	12.4±											
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed													
Exterior Stairs		None Observed													
Electrical Conduit Wall Penetrations:		None Observed													
Outside Gas Pressure Regulator		Lowest Elevation	10.0±	9.2±											
Gas Connection		Wall Penetration	11.4±	10.6±											
Generator Exhaust		Invert of Pipe	18.8±	18.0±											
Wet Well Manhole/Hatch Rim		Hatch/Rim Elevation	9.9±	9.1±											
Wet Well Vent Pipe		Pipe Outlet	12.6±	11.8±											
Critical Interior Components															
Inside Generator Skid Top Elev.		Lowest Elevation	11.4±	10.6±											
Wall Mounted Electrical Equipment		Lowest Elevation	Unknown	Unknown											
Non-Critical Interior Components															
Gas Fired Unit Heater		Lowest Elevation	10.9±	10.1±											
Electric Water Heater		Lowest Elevation	10.9±	10.1±											

Table 5-4: Summary of Water Entry Points – Musquashicut Ave PS

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:		None Observed													
Doors (Personnel and Public):															
Personnel entryway		Door Threshold elev.	12.4±	11.6±											
Vents:															
18'' x 24 Fresh Air Intake	Vent 1	Bottom of Vent	18.4±	17.6±											
24'' x 36'' Fresh Air Intake	Vent 2	Bottom of Vent	14.2±	13.4±											
20'' x 20 Fresh Air Intake	Vent 3	Bottom of Vent	19.1±	18.3±											
24'' x 30'' Exhaust Louver	Vent 4	Bottom of Vent	13.4±	12.6±											
20'' x 20 Muffler Vent	Vent 5	Bottom of Vent	19.4±	18.6±											
Other:															
Outside Electric Meter Panel		Lowest Elevation	11.2±	10.4±											
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed													
Exterior Stairs		Bottom Step	7.9±	7.1±											
Electrical Conduit Wall Penetrations:		None Observed													
Outside Gas Pressure Regulator		Lowest Elevation	7.9±	7.1±											
Gas Connection		Wall Penetration	13.2±	12.4±											
Generator Exhaust		Invert of Pipe	19.5±	18.7±											
Wet Well Manhole/Hatch Rim		Hatch/Rim Elevation	7.9±	7.1±											
Wet Well Vent Pipe		Pipe Outlet	12.7±	11.9±											
Critical Interior Components															
Inside Generator Skid Top Elev.			12.9±	12.1±											
Wall Mounted Electrical Equipment			Unknown	Unknown											
Non-Critical Interior Components															
Gas Fired Unit Heater			12.4±	11.6±											
Electric Water Heater			12.4±	11.6±											

Table 5-5: Summary of Water Entry Points – Peggotty Beach Road PS

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:		None Observed													
Doors (Personnel and Public):															
Personnel entryway		Door Threshold elev.	11.5±	10.7±											
Vents:															
18'' x 24 Fresh Air Intake	Vent 1	Bottom of Vent	17.5±	16.7±											
24'' x 36'' Fresh Air Intake	Vent 2	Bottom of Vent	13.3±	12.5±											
20'' x 20 Fresh Air Intake	Vent 3	Bottom of Vent	18.2±	17.4±											
24'' x 30'' Exhaust Louver	Vent 4	Bottom of Vent	12.5±	11.7±											
20'' x 20 Muffler Vent	Vent 5	Bottom of Vent	18.5±	17.7±											
Other:															
Outside Electric Meter Panel		Lowest Elevation	14.4±	13.6±											
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed													
Exterior Stairs		None Observed													
Electrical Conduit Wall Penetrations:		None Observed													
Outside Gas Pressure Regulator		Lowest Elevation	10.5±	9.7±											
Gas Connection		Wall Penetration	12.2±	11.4±											
Generator Exhaust		Invert of Pipe	19.4±	18.6±											
Wet Well Manhole/Hatch Rim		Hatch/Rim Elevation	11.3±	10.5±											
Wet Well Vent Pipe		Pipe Outlet	13.0±	12.2±											
Critical Interior Components															
Inside Generator Skid Top Elev.		Lowest Elevation	12.0±	11.2±											
Wall Mounted Electrical Equipment		Lowest Elevation	Unknown	Unknown											
Non-Critical Interior Components															
Gas Fired Unit Heater		Lowest Elevation	11.5±	10.7±											
Electric Water Heater		Lowest Elevation	11.5±	10.7±											

Table 5-6: Summary of Water Entry Points – Sand Hills PS

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:		None Observed													
Doors (Personnel and Public):															
Personnel entryway	1	Door Threshold elev.	12.2±	11.4±											
Personnel entryway	2	Door Threshold elev.	12.2±	11.4±											
Vents:															
18'' x 88'' Vent	Vent 1	Bottom of Vent	12.2±	11.4±											
28'' x 40'' Vent	Vent 2	Bottom of Vent	16.7±	15.9±											
28'' x 40'' Vent	Vent 3	Bottom of Vent	16.7±	15.9±											
28'' x 88'' Vent	Vent 4	Bottom of Vent	12.2±	11.4±											
28'' x 88'' Vent	Vent 5	Bottom of Vent	12.2±	11.4±											
8'' x 8'' Vent	Vent 6	Bottom of Vent	12.4±	11.6±											
8'' x 8'' Vent	Vent 7	Bottom of Vent	14.0±	13.2±											
Other															
Outside Electric Meter Panel		Lowest Elevation	13.9±	13.1±											
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed													
Exterior Stairs		Bottom of Step	8.1±	7.3±											
Electrical Conduit North Wall Penetrations		Wall Penetration	19.3±	18.5±											
Electrical Conduit East Wall Penetrations		Wall Penetration	16.1±	15.3±											
Outside Gas Pressure Regulator		Lowest Elevation	8.2±	7.4±											
Gas Connection		Wall Penetration	8.8±	8.0±											
Generator Exhaust		Invert of Pipe	18.8±	18.0±											
Roof Drain		Invert of Pipe	8.8±	8.0±											
Wet Well Manhole/Hatch Rim		None Observed													
Wet Well Vent Pipe		None Observed													
Critical Interior Components															
Inside Generator Skid Top Elev.		Lowest Elevation	12.7±	11.9±											
Floor Mounted Control Panel		Lowest Elevation	12.2±	11.4±											
Circuit Breaker		Lowest Elevation	16.7±	15.9±											
Pump Motors		Lowest Elevation	12.5±	11.7±											

Non-Critical Interior Components															
Boiler		Lowest Elevation	2.7±	1.9±											
Water Heater		Lowest Elevation	12.7±	11.9±											
Comminutor Motor		Lowest Elevation	12.5±	11.7±											

Table 5-7: Summary of Water Entry Points – Herring Brook PS

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:		None Observed													
Doors (Personnel and Public):		None Observed													
Vents:		None Observed													
Other:															
Outside Electric Meter Panel		Lowest Elevation	13.8±	13.0±											
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed													
Exterior Stairs		None Observed													
Electrical Conduit Wall Penetrations:		None Observed													
Outside Gas Pressure Regulator		Lowest Elevation	11.8±	11.0±											
Gas Connection		None Observed													
Generator Exhaust		Invert of Pipe	17.8±	17.0±											
Wet Well Manhole/Hatch Rim		Hatch/Rim Elevation	10.6±	9.8±											
Wet Well Vent Pipe		Pipe Outlet	13.8±	13.0±											
Critical Interior Components															
Generator Skid Top Elev.		Lowest Elevation	10.7±	9.9±											
Outside Electric Control Panel		Lowest Elevation	13.8±	13.0±											
Non-Critical Interior Components		None Observed													

Pump Station	Flood Elevation, feet NAVD88										
	7	8	9	10	11	12	13	14	15	16	17
Collier Road Pumping Station											
Chain Pond Pumping Station											
Edward Foster Road Pumping Station											
Musquashcut Ave Pumping Station											
Peggotty Beach Road Pumping Station											
Sands Hill Pump Station											
Herring Brook Pumping Station											

Notes:

Green – indicates minor to no impact expected.
Yellow – indicates flood impact, with minor damage expected and/or unlikely pump station disruption. Includes gas connector flooded, potential leakage into wet wells.
Red – indicates significant impact is expected (e.g., door threshold flooded; vents and other major penetrations flooded; emergency generator pad flooded; and/or potential for internal flooding due to high flood depth [+3 feet] above wet well).

Table 5-8: External Coastal Flood Vulnerability relative to Flood Elevation NAVD88 – All Pump Stations

Figure 5-1: I/I Priority Subdrainage Areas (from CDM Smith memorandum dated August 10, 2016)

Attachment 6
CDM Smith Memorandum: Flow Monitoring Program and I/I Analysis Memorandum

Memorandum

To: *William Branton, Interim Supervisor, Sewer Division*

From: *Shawn Syde, P.E.*
Chad Kershaw, P.E.

Date: *August 10, 2016 (Revised October 2, 2017)*

Subject: *Flow Monitoring Program and I/I Analysis Memorandum*

Introduction

Purpose

The purpose of the flow monitoring program is to develop estimates of infiltration/inflow (I/I) contribution from drainage sub-areas within the Town of Scituate's (Town) sewer system. The program will identify the general location and extent of I/I entering the sewer system. The findings provide the basis for recommending diagnostic investigations required to develop an effective remediation program to reduce the levels of extraneous flow within the sewer system to acceptable limits. The flow monitoring program was completed in spring 2016 in order to determine I/I during the high groundwater period.

The purpose of this technical memorandum is to provide a summary of the analysis, results, conclusions and recommendations from the flow monitoring field program. Work under the flow monitoring program was completed in accordance with the Massachusetts Department of Environmental Protection (MassDEP) I/I guidelines.

Definitions

- *Infiltration* enters the sewer system through pipelines (structural defects, faulty joints, and service connections), manholes and other structures.

- *Base Infiltration* is groundwater which enters the sewer system and is observed at an increased rate during winter and early spring when the groundwater is highest due to ground thaw, snow melt and rainfall.

- *Tidal Infiltration* is a secondary source of infiltration from the ocean that is observed at an increased rate during high tide. Where present, tidal infiltration can occur year round.

- *Inflow* in a sewer system is the total flow from direct and indirect sources as defined below. Inflow is present throughout the year.

- *Direct inflow* enters the sewer system through direct connections to the collection system such as catch basins and roof leaders. The primary source of inflow is storm water, including rainfall runoff, and, if it is a significant source, can be observed during rainfall events year round.

- *Indirect, or delayed inflow* enters the sewer system through connections to sources such as building sump pumps and foundation drains. Its primary source is the wet weather (rainfall) influence on groundwater and may be prevalent for extended periods during the late winter and early spring and for shorter periods following rainfall events year round.

- RDII, or Rain-Derived Infiltration and Inflow, is the increased portion of water flow in a sanitary sewer system that occurs during and after a rainfall event. Extraneous water enters the sewer system during wet weather periods through cracks and open joints in sewer mains, manholes and building laterals, as well as through direct connections between storm drains and sanitary sewer and from illegal drainage connections on private property.

- *Wet weather flow* is the metered flow data during and after the wet weather period (generally over several days).

- *Dry weather flow* is the metered flow data during a dry weather period (typically at least four days following a rain event and anytime thereafter until the next rain event).

I/I Remediation Program

The I/I remediation program is structured in three phases that provide a logical sequence for locating, identifying and removing extraneous flow sources. A phased approach is important in a comprehensive I/I remediation program to avoid "chasing" flows that could result in little to no effectiveness and reduction of extraneous flows. A phased approach allows the Town to target the areas of the collection system which have the most severe I/I.

- *Phase I – Flow Monitoring.* Identify the general extent and location of I/I severity and determine specific drainage sub-areas where second phase investigations should be conducted (***completed in 2016***).

- *Phase II – Sewer System Evaluation Survey (SSES).* An SSES consists of field investigations such as smoke testing, flow isolation and television inspection of pipelines. The objective of this phase is to identify individual I/I sources so that remediation recommendations can be developed and implemented under the third phase.

- *Phase III – I/I Remediation.* Construction projects consisting of sewer system improvements to remove I/I.

Flow Monitoring Data and Analysis

Summary of Field Program and Data Collection

The spring flow monitoring field program was conducted between February 23 and April 19, 2016 by Flow Assessment Service Inc. under the supervision of CDM Smith. Continuous flow monitoring data (5-minute interval data), flow data reports, flow hydrographs, flow summary reports, rain reports and sub-area site sketches are included in Flow Assessment's report titled, *Scituate, MA, Flow Monitoring Report, February – May 2016* (electronic copy in **Appendix A**). The following summarizes the field programs and data collection activities:

- The Town's sanitary sewer system was separated into 12 drainage sub-areas. Where possible, the drainage sub-areas were limited to no more than 20,000 linear feet of sewer pipe. The 12 drainage sub-areas and meter locations are mapped in **Figure 1** (in map pocket).

- The flow monitoring program included nine area velocity flow meters and three level meters with a Palmer-Bowlus Flume to capture wastewater flows from each sub-area. Also two continuous recording rain gauges and six groundwater gauges were installed in order to correlate wastewater flows to rainfall and groundwater levels. Rain Gauge No. 1 was installed at the WWTP and Rain Gauge No. 2 was installed at the Sand Hills Pumping Station.

- During the field program, there were seven rainfall events which totaled at least 0.5 inches of rainfall with varying peak rainfall intensities. The largest rainfall event occurred on March 14th and 15th (approximately 1.4 inches of rainfall). Note that many of the rainfall events included snow and/or occurred within four days of a previous rainfall event.

- A successful flow monitoring program is contingent upon having optimum groundwater elevations. Groundwater gauges were installed in six manholes where a flow meter was installed. The groundwater gauges were installed in manhole 1-1, 2-1, 2-2, 4-1, 6-1 and 7-1. **Figure 2** shows the groundwater depth below the ground surface during the metering period vs. the downstream sewer pipe invert. For nearly all readings, the groundwater was higher than the downstream sewer pipe invert. At manholes 1-1, 4-1, 6-1 and 7-1, the groundwater was at least 5 feet higher than the pipe invert during the entire metering period.

- Given the proximity of the Town's sewer system to the ocean, CDM Smith collected tidal data from the US Harbors Tide Chart. During the flow monitoring field program, the tide chart indicates that the high tide elevation fluctuated between 7.7 feet and 11.8 feet and the low tide elevation fluctuated between -2.3 feet and 1.7 feet.

- Prior to the start of flow gauging, an inventory of the Scituate collection system was conducted. The inventory consisted of a review of existing engineering drawings, reports, and records, GIS data, and discussions and field investigations with Town personnel. This information was used to delineate the tributary areas and determine each meter location.

Town of Scituate Massachusetts

Figure 1
Flow Meter Plan

Updated:
July 2016

Legend

- Meter Station
- Rain Gauge
- WWTP Wastewater Treatment Plant
- Pumping Station
- Sewer Manhole
- Force Main

Sewer Main

- 8 inch
- 10 inch
- 12 inch
- 14 inch
- 15 inch
- 18 inch
- 24 inch
- 27 inch
- 30 inch
- 36 inch
- Sub Area

0 1,500 3,000 4,500 6,000 Feet

1 inch = 1,200 feet

N W E S

CDM Smith

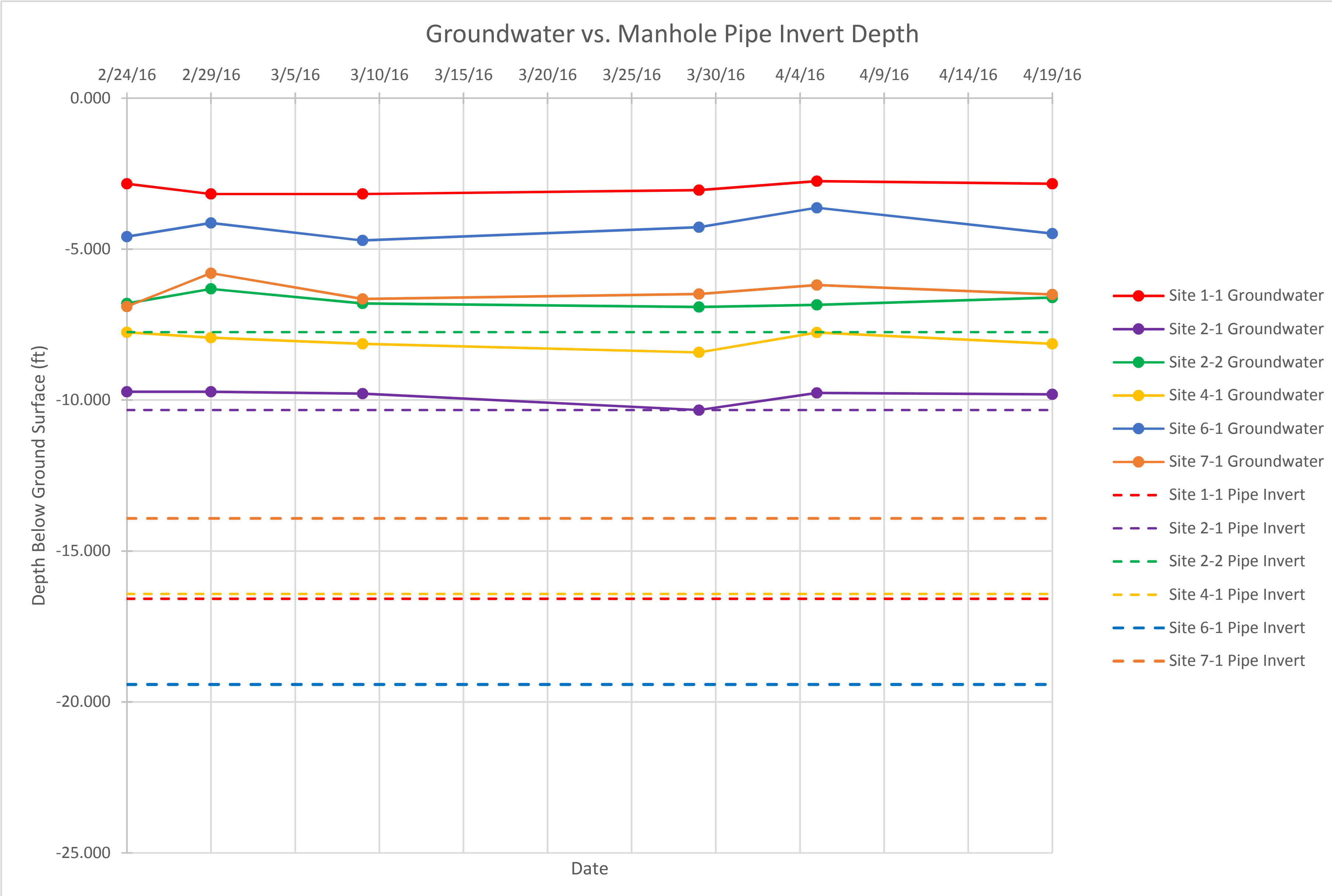


FIGURE 2
TOWN OF SCITUATE
FLOW MONITORING PROGRAM AND I/I ANALYSIS MEMO
GROUNDWATER ELEVATIONS VS. PIPE INVERT ELEVATIONS

Dry Weather Analysis

Prior to beginning the analysis, typical dry weather flow curves need to be developed to establish a baseline to then determine the extent and severity of infiltration and inflow. Dry weather is metered flow data during a dry weather period and includes sanitary flow, base infiltration from groundwater and tidal infiltration from the ocean. The following summarizes the dry weather flow analysis:

- For the purposes of this analysis, dry weather flow is defined as a period of time with no rain or a period of time where the system is no longer under influence of a prior rainfall event. This period of time is typically four to five days following a rainfall event when system flows return to pre-storm conditions. It is important to avoid including storm related flow impacts in the dry weather flows as it would result in under- and over-estimating I/I rates.

- The flow monitoring period included a number of rainfall events, many of which were smaller in duration and intensity. In addition, several of these include snow. Although rainfall is appropriate for a spring metering period to maintain elevated groundwater conditions, the characteristics of the rainfall event are also critical (i.e, duration and intensity) as well as proximity to each other. Given the number of smaller events, and that many were close together (i.e., many were less than the optimum 4 days apart), proper selection of dry weather days was more critical to avoid storm related influences.

- Based on Town records, there were no night time users or heavy industrial users that would impact the results of the flow monitoring program.

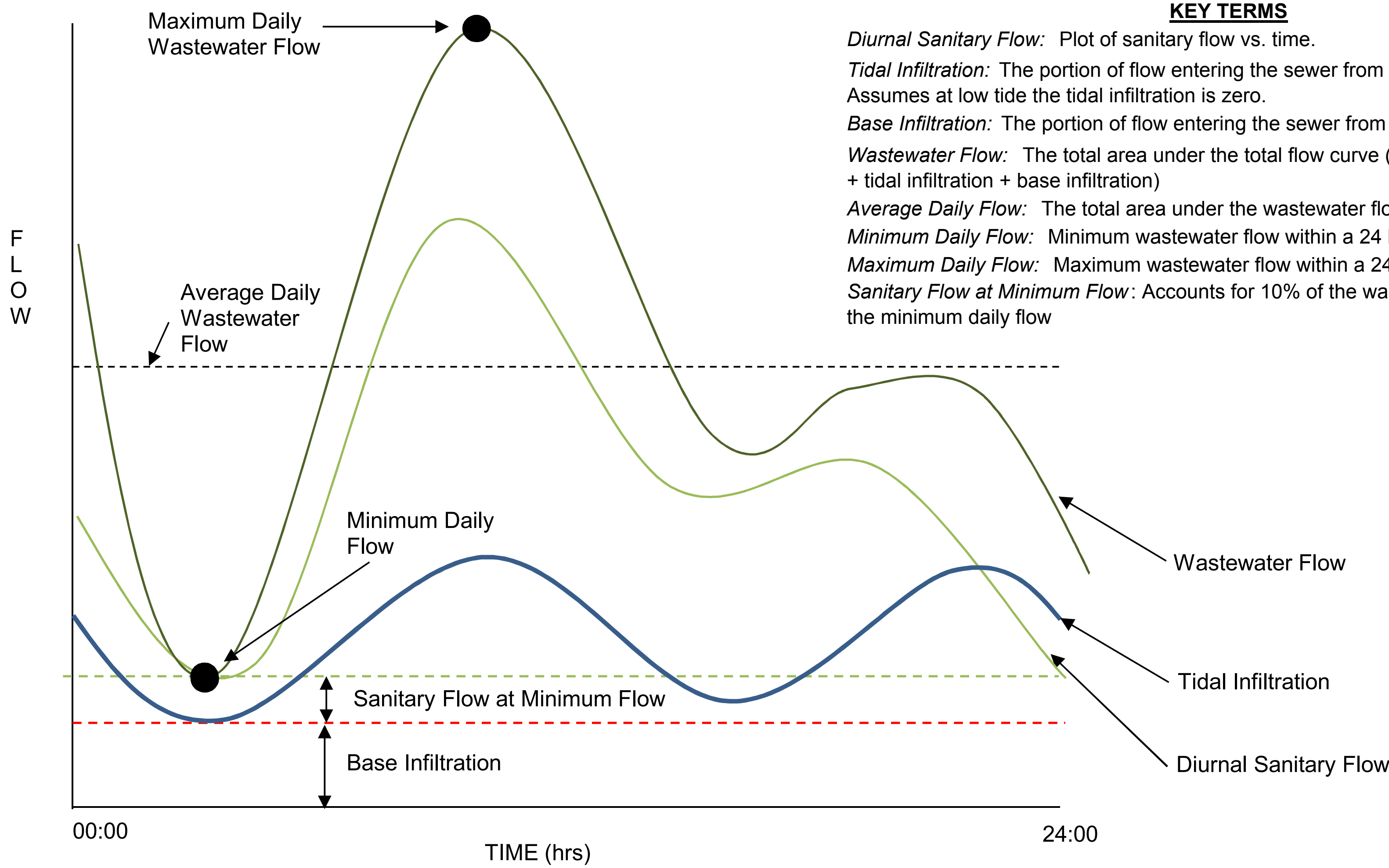
- Daily dry weather flow curves were developed for all sub-areas and can be found in **Appendix B**. The orange curve represents dry weather sanitary flow with base infiltration and tidal infiltration, the green curve represents dry weather sanitary flow with base infiltration and without tidal infiltration, and the blue curve represents the tide elevation, for reference.

- The effects of base infiltration and tidal infiltration on a diurnal flow curve can be seen in **Figure 3**. The developed dry weather flow curves were used for the inflow and infiltration analyses.

Inflow Analysis

Inflow typically occurs during and immediately following a rainfall event. Inflow enters a sewer system through direct connections such as roof leaders or catch basins – more commonly termed direct inflow or other sources such as sump pumps or foundation drains – more commonly termed delayed or indirect inflow. In addition to the indirect sources, inflow can also occur as a result of temporary elevated groundwater elevations from rainfall or tidal influences. This impact is commonly referred to as RDII.

DIURNAL FLOW CURVE
SHOWING THE EFFECTS OF INFILTRATION



KEY TERMS

Diurnal Sanitary Flow: Plot of sanitary flow vs. time.

Tidal Infiltration: The portion of flow entering the sewer from the tide. Assumes at low tide the tidal infiltration is zero.

Base Infiltration: The portion of flow entering the sewer from groundwater

Wastewater Flow: The total area under the total flow curve (sanitary flow + tidal infiltration + base infiltration)

Average Daily Flow: The total area under the wastewater flow curve

Minimum Daily Flow: Minimum wastewater flow within a 24 hour period.

Maximum Daily Flow: Maximum wastewater flow within a 24 hour period

Sanitary Flow at Minimum Flow: Accounts for 10% of the wastewater at the minimum daily flow

FIGURE 3
TOWN OF SCITUATE
FLOW MONITORING PROGRAM AND I/I ANALYSIS MEMO
DIURNAL FLOW CURVE

The following summarizes the inflow analysis:

- **Figure 4** is a hydrograph for sub-area 6-1 that shows an example of a direct inflow response and a long recovery. The data presented in the hydrograph is defined by the following:

  - *Rainfall* is captured in order to determine the variation in the size and intensity of storm events and develop reasonable relationships between rainfall and peak wastewater flows.

  - *Wet Weather Gross Flow (Q)* is the total flow in the sewer system within a particular sub-area and all upstream sub-areas.

  - *Gross I/I* is the total flow entering the system from infiltration and inflow sources within a particular sub-area and all upstream sub-areas.

  - *Net I/*I is the total flow entering the system from infiltration and inflow sources tributary to a specific sub-area only. The I/I tributary to a particular sub-area is computed by subtracting the Net I/I of all upstream sub-areas from the Gross I/I for that sub-area.

  - *Dry Weather Flow* is adjusted up or down to compensate for flow conditions immediately preceding the storm event. The curve is adjusted using a pre-composition period. The pre-composition period is an arbitrary amount of time (usually 24 hours) before the storm start time that is used to adjust the average flow of the dry day diurnal curve. The dry day diurnal curve used to calculate the inflow are thus raised or lowered to reflect the differences between the diurnal curve and metered flows. The tidal infiltration flow was added to the dry day diurnal curve and shifted in order to match the actual high tide and low tide time periods.

- The March 14th and 15th rainfall event was used for the inflow analysis. This rainfall event contributed approximately 1.4 inches of rainfall with a maximum peak hourly intensity of 0.18 inches per hour.

- Many of the storm events showed response during rainfall events indicating the presence of some direct inflow sources; however, the majority of the response was observed following the rainfall event, correlated to influences in both elevated groundwater elevations from rainfall and tide.

- The total inflow volume from this rainfall event was 2.08 million gallons (MG) (0.37 MG of direct inflow and 1.71 MG of indirect inflow). Note that this total inflow volume does not include base infiltration from groundwater and tidal infiltration from the ocean but does include any indirect inflow from an increase in groundwater levels resulting from a high tide or rainfall event.

- MassDEP inflow guidelines recommend further investigation in sub-areas that comprise 80% of the total inflow volume. **Table 1** shows a ranking of the inflow severity and identifies the

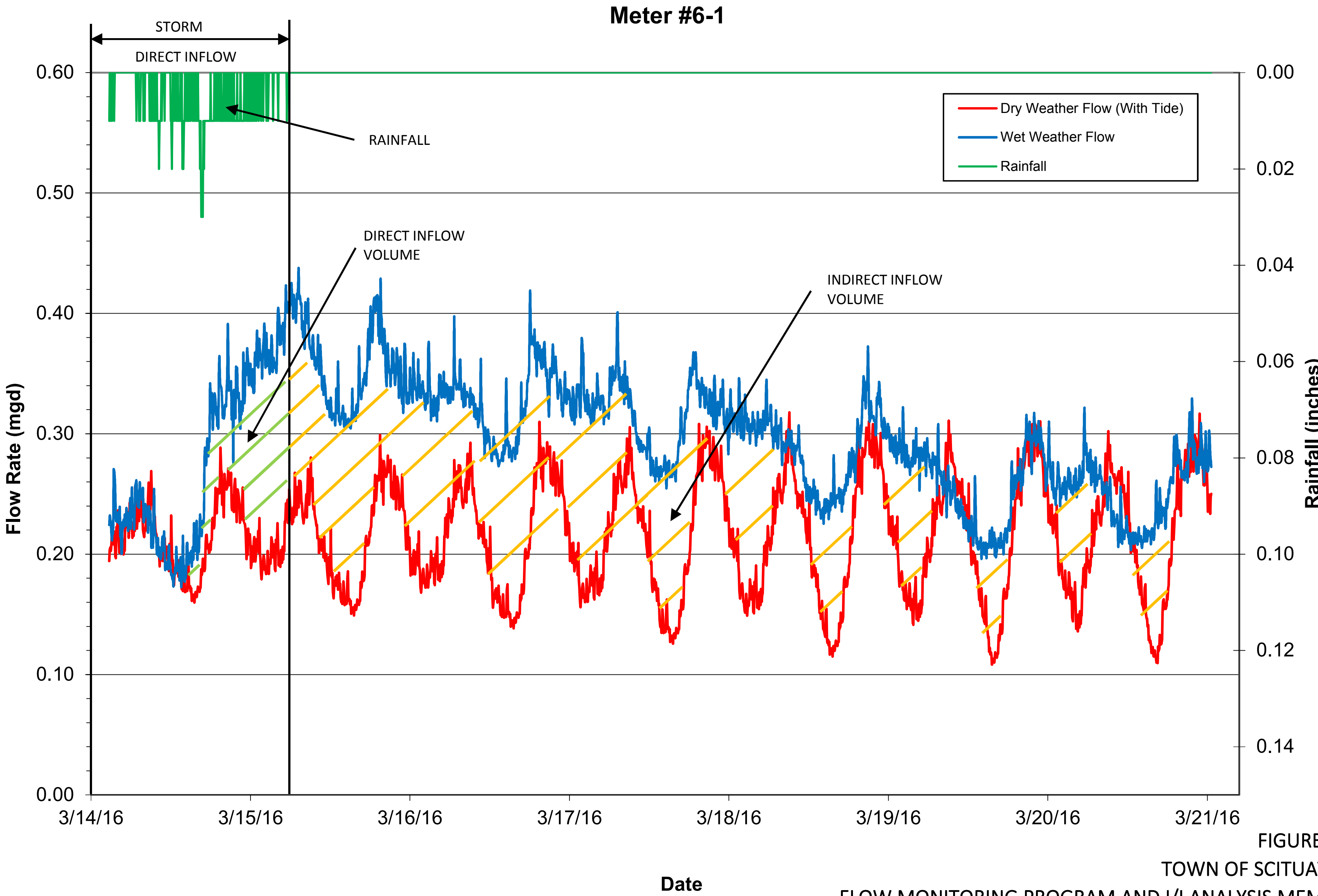


FIGURE 4
TOWN OF SCITUATE
FLOW MONITORING PROGRAM AND I/I ANALYSIS MEMO
DIURNAL FLOW CURVE
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 6-1

CDM Smith

Inflow Subarea Rank	Sub Area	Volume Event Net Inflow (gal)	Volume Event Direct Net Inflow (gal)	Volume Event Indirect Net Inflow (gal)	Inch-Miles (in-mi)	Inflow Severity (g/in-mi)	Cumulative Inflow Volume Event (gal)	Cumulative Inflow Volume Event (%)
1	4-2	185,290	38,985	146,305	7.56	24,516	185,290	9%
2	6-1	332,670	43,162	289,508	32.10	10,364	517,960	25%
3	5-1	210,670	6,648	204,022	21.28	9,898	728,629	35%
4	4-1	201,348	5,113	196,236	23.01	8,751	929,978	45%
5	5-2	258,964	30,618	228,346	31.64	8,184	1,188,942	57%
6	1-1	391,158	77,789	313,369	77.25	5,064	1,580,100	76%
7	7-2	139,867	26,672	113,196	30.59	4,572	1,719,967	83%
8	2-1	214,212	36,356	177,856	47.74	4,487	1,934,179	93%
9	3-1	102,209	85,342	16,867	49.54	2,063	2,036,388	98%
10	7-1	23,948	4,795	19,152	14.09	1,700	2,060,335	99%
11	2-2	10,412	5,063	5,348	7.60	1,370	2,070,747	99%
12	8-1	10,923	5,871	5,052	14.98	729	2,081,670	100%

System Total	2,081,670	366,413	1,715,257
		17.60%	82.40%

Notes:

Shading denotes areas recommended for further evaluation.

TABLE 1
TOWN OF SCITUATE
FLOW MONITORING PROGRAM AND I/I ANALYSIS MEMO
INFLOW RANKING FOR MARCH 14 AND 15, 2016 STORM BY SUB-AREA

seven sub-areas that qualify for additional investigation. These seven sub-areas (1-1, 4-1, 4-2, 5-1, 5-2, 6-1, 7-2) comprise approximately 65 percent of the total piped sewer system but approximately 83 percent of the total inflow volume.

- Two storm hydrographs of each sub-area for the March 14th and 15th rainfall event are included in **Appendix C**. One storm hydrograph includes rainfall in order to determine the relationship between rainfall and peak wastewater flows. The other storm hydrograph includes the tide elevation in order to determine the relationship between tidal infiltration and peak wastewater flows.

Infiltration Analysis

Infiltration primarily consists of groundwater entering the sewer through cracks in the sewer pipe, offset pipe joints and defects in manholes. Infiltration can occur 24 hours a day throughout the year. The extent of infiltration will vary depending on the level of the local groundwater table and the severity of pipe and manhole defects. Infiltration rates increase during a rainfall event as the ground becomes saturated; typically called rain-dependent infiltration. Base infiltration is estimated by selecting a dry weather day that occurs at least 4-5 days following a rain event. The following summarizes the infiltration analysis:

- The infiltration (base infiltration and tidal infiltration) for each dry weather day during the metering program was averaged for each meter. For meters with other drainage areas located upstream, the net flow was calculated for the basin as the difference between the upstream and downstream meters. These values were used to estimate the net base infiltration for a drainage sub-area. The average net base infiltration for the entire sewer system was calculated to be 1.01 million gallons per day (mgd). The average net infiltration quantities and severity rankings for each sub-area are shown in **Table 2**.

- Also, the infiltration during high tide (base infiltration and high tide infiltration) and infiltration during low tide (assumed base infiltration only) was calculated for each drainage sub-area. The total net base infiltration during high tide and low tide was calculated to be 1.03 mgd and 0.88 mgd, respectively. Note that the high tide infiltration calculations were taken from the March 1st dry weather data and the low tide infiltration calculations were taken from the March 9th dry weather data. The net infiltration quantities and severity rankings for each sub-area during high tide and low tide are shown in **Table 3** and **Table 4**, respectively.

- MassDEP infiltration guidelines recommend further investigations in the drainage sub-areas with infiltration rates greater than 4,000 gallons per day per inch diameter mile of sewer (gpd/in-mi).

    - Based on the average infiltration analysis (entire flow metering program), five sub-areas exceeded the 4,000 gpd/in-mi threshold (2-1, 4-1, 4-2, 5-1, 6-1). The infiltration rate for the entire sewer system was 2,830 gpd/in-mi.

Infiltration Subarea Rank	Subarea	Length (LF)	Inch-Miles (in-mi)	Gross Infiltration (gpd)	Net Infiltration (gpd)	Infiltration Severity (gpd/in-mi)
1	5-1	9,223	21.28	423,904	203,279	9,551
2	4-2	4,724	7.56	49,439	49,439	6,541
3	6-1	21,068	32.10	173,964	173,964	5,420
4	4-1	14,735	23.01	164,085	114,647	4,983
5	2-1	19,424	47.74	207,443	199,652	4,182
6	3-1	18,930	49.54	669,981	81,991	1,655
7	5-2	15,999	31.64	220,625	46,662	1,475
8	7-1	9,298	14.09	19,039	19,039	1,351
9	1-1	29,971	77.25	959,768	81,977	1,061
10	7-2	20,190	30.59	31,368	31,368	1,025
11	2-2	5,015	7.60	7,791	7,791	1,025
12	8-1	9,889	14.98	368	368	25

SYSTEM TOTAL = 1,010,174 gpd

Notes:

Shading denotes areas recommended for further evaluation.

The net infiltration results are calculated from all dry weather days during the metering program.

TABLE 2
TOWN OF SCITUATE
FLOW MONITORING PROGRAM AND I/I ANALYSIS MEMO
INFILTRATION QUANTITIES AND SEVERITY RANKING (AVERAGE)

Infiltration Subarea Rank	Subarea	Length (LF)	Inch-Miles (in-mi)	Gross Infiltration (gpd)	Net Infiltration (gpd)	Infiltration Severity (gpd/in-mi)
1	5-1	9223	21.3	503,608	228,499	10,736
2	4-1	10852	20.4	206,722	171,587	7,457
3	6-1	21068	32.1	218,310	218,310	6,801
4	4-2	10072	15.7	35,135	35,135	4,649
5	2-1	19424	47.7	209,030	206,603	4,328
6	5-2	15,999	31.6	275,108	56,798	1,795
7	7-1	9,298	14.1	16,001	16,001	1,136
8	7-2	20,190	30.6	34,689	34,689	1,134
9	3-1	17,465	44.0	745,232	34,902	704
10	2-2	5,015	7.6	2,426	2,426	319
11	1-1	29,971	77.2	978,152	23,360	302
12	8-1	9,889	15.0	531	531	35

SYSTEM TOTAL = 1,028,841 gpd

Notes:

Shading denotes areas recommended for further evaluation.

The net infiltration results are calculated from the dry weather day (March 1st) which the high tide occurred between 2:00AM and 5:00AM.

TABLE 3
TOWN OF SCITUATE
FLOW MONITORING PROGRAM AND I/I ANALYSIS MEMO
INFILTRATION QUANTITIES AND SEVERITY RANKING (HIGH TIDE)

Infiltration Subarea Rank	Subarea	Length (LF)	Inch-Miles (in-mi)	Gross Infiltration (gpd)	Net Infiltration (gpd)	Infiltration Severity (gpd/in-mi)
1	5-1	9,223	21.3	403,899	210,856	9,907
2	4-2	10,072	15.7	42,726	42,726	5,653
3	4-1	10,852	20.4	159,890	117,165	5,092
4	6-1	21,068	32.1	156,497	156,497	4,876
5	2-1	19,424	47.7	191,328	186,489	3,907
6	3-1	17,465	44.0	621,309	57,519	1,161
7	5-2	15,999	31.6	193,044	36,546	1,155
8	7-1	9,298	14.1	15,225	15,225	1,081
9	7-2	20,190	30.6	25,761	25,761	842
10	2-2	5,015	7.6	4,839	4,839	637
11	1-1	29,971	77.2	840,814	28,058	363
12	8-1	9,889	15.0	119	119	8

SYSTEM TOTAL = 881,800 gpd

Notes:

Shading denotes areas recommended for further evaluation.

The net infiltration results are calculated from the dry weather day (March 9th) which the low tide occurred between 2:00AM and 5:00AM.

TABLE 4
TOWN OF SCITUATE
FLOW MONITORING PROGRAM AND I/I ANALYSIS MEMO
INFILTRATION QUANTITIES AND SEVERITY RANKING (LOW TIDE)

  - Based on the high tide infiltration analysis (March 1st), the same five sub-areas exceeded the 4,000 gpd/in-mi threshold (2-1, 4-1, 4-2, 5-1, 6-1). The infiltration rate for the entire sewer system was 2,880 gpd/in-mi.

  - Based on the low tide infiltration analysis (March 9th), four sub-areas exceeded the 4,000 gpd/in-mi threshold (4-1, 4-2, 5-1, 6-1) and sub-area 2-1 was close to the threshold (3,907 gpd/in-mi). The infiltration rate for the entire sewer system was 2,470 gpd/in-mi.

- Based on high tide and low tide wastewater flows, it appears that sub-areas 6-1, 4-1, 5-2 and 2-1 are most susceptible to tidal infiltration (largest delta between high tide infiltration and low tide infiltration). Also, note that based on the location and depth of the sewer mains in sub-area 4-2, it is believed that the low tide elevation is higher than the majority of the sewer pipes in the sub-area, resulting in constant tidal infiltration.

- Pumping station metered data was analyzed in an attempt to correlate pumping station flow rates with groundwater and rainfall events. However, due to errors and missing data, along with changes in wastewater patterns due to seasonal residents, a proper correlation could not be made.

Conclusions and Recommendations

Conclusions

The data obtained during the spring 2016 wet season is adequate for initial I/I analysis of the Scituate sewer system. Although the type and spacing of rainfall events were not optimum for analysis of infiltration and inflow, an additional flow monitoring program in spring 2017 will not be necessary and CDM Smith recommends moving directly to the Phase II (Sewer System Analysis).

The flow monitoring program indicted that infiltration and inflow in several of the drainage areas contributes to increased flows at the wastewater treatment plant, as well as taking up collection system capacity. On an overall basis, however, I/I does not contribute large volumes of extraneous flow to warrant a complete system wide evaluation.

- The findings of the flow monitoring program show that the Scituate sewer system is susceptible to both infiltration and inflow.

- During high tide (year round) and especially during the high groundwater season, portions of the sewer system is submerged in groundwater/tidal waters.

- The majority of inflow entering the sewer system from a rainfall event is indirect inflow (82 percent indirect inflow vs. 18 percent direct inflow). Based on the high groundwater levels and tidal influence on groundwater (wastewater flows increase and decrease in unison with high tide and low tide), many of the sub-areas experience rainfall-derived inflow and infiltration (RDII) following a rainfall event.

- The inflow results indicate the sewer system is susceptible to direct inflow connections (roof leaders, driveway drains, etc.), but more susceptible to groundwater/tide and indirect inflow sources (sump pumps, foundation drains, etc.).
- Based on MassDEP guidelines, seven sub-areas exceed the inflow threshold and five sub-areas exceed the infiltration threshold. Of these sub-areas, four exceed both the infiltration and inflow thresholds (4-1, 4-2, 5-1, 6-1) and four sub-areas exceed either the infiltration or inflow thresholds (1-1, 2-1, 5-2, 7-2).
- As a result, sub-areas 4-1, 4-2, 5-1 and 6-1 are considered high priority and sub-areas 1-1, 2-1, 5-2 and 7-2 are considered low priority.
- Sub-areas with previously repaired sewers such as sub-area 4-2 and 6-1 still exhibit excessive I/I. The previously completed rehabilitation work may not have been as effective as planned and/or I/I is entering the sewer system from private sources or defective sewer service connections may be contributing to excessive flows.

Recommendations

The next step in the Town's I/I program is to begin to investigate and locate the sources of infiltration and inflow in the areas identified as contributing excessive flow. These activities are more commonly referred to as a Sewer System Evaluation Survey or SSES. The field activities included in a traditional SSES program are structured such that less costly programs are conducted first to narrow down those locations that require more intensive investigations. The results of the SSES program will provide the Town with a roadmap for implementation of I/I removal and capital improvements program. **Figure 5** (in map pocket) shows the drainage sub-areas recommended for the next phase (Phase II) of the I/I remediation program categorized into high and low priority sub-areas.

The following are recommendations for future Phase II SSES work to locate and identify sources of extraneous flow and to properly provide rehabilitation recommendations:

- *Task 1: Flow Isolation and CCTV Inspection of Sewers* for high priority sub-areas (4-1, 4-2, 5-1, 6-1) and low priority sub-areas exceeding the infiltration threshold (2-1). This task is divided into two parts:
    - Flow Isolation – Flow isolation is used to document the extent of infiltration entering the sewer system on a reach to reach basis. This work is typically performed in those locations where infiltration was determined to be considered excessive. This work is performed during the night time hours (11:00 pm to 6:00 am) when sanitary flows are typically at their lowest and during dry weather (i.e., no rainfall) to gain an understanding as to the extent of infiltration entering a sewer pipe. The results of the program will help determine those sewer reaches that should be further evaluated under a CCTV inspection program.

Town of Scituate Massachusetts

Figure 5
I/I Priority Areas

Updated:
July 2016

Legend

- High Priority Remediation Area
- Low Priority Remediation Area
- Meter Station
- Rain Gauge
- WWTP Wastewater Treatment Plant
- Pumping Station
- Sewer Manhole
- 8 inch
- 10 inch
- 12 inch
- 14 inch
- 15 inch
- 18 inch
- 24 inch
- 27 inch
- 30 inch
- 36 inch
- Sub Area

0 1,500 3,000 4,500 6,000 Feet

1 inch = 1,200 feet

N W E S

CDM Smith

  - CCTV Inspection – CCTV inspection includes cleaning and follow-up televising to gain visual documentation of sewer pipe defects that might contribute excessive flows. Given the potential for RDII influenced flows in certain areas, it is recommended that, in addition to a traditional program, that certain areas be CCTV inspected during rainfall events and/or during periods of high tide to document the presence of RDII and I/I from private sources. If available, the Town can utilize their equipment (vactor trucks, jetting trucks, CCTV truck, etc.) to minimize follow-up investigations costs.

- *Task 2: Manhole Inspection Program* for high priority sub-areas (4-1, 4-2, 5-1, 6-1) and low priority sub-areas (1-1, 2-1, 5-2, 7-2). The inspections shall include visually identifying and quantifying sources of extraneous flow entering through defects such as pipe connections, defective shelves, or leaking walls.

- *Task 3: Smoke Testing Program* for high priority sub-areas (4-1, 4-2, 5-1, 6-1) and low priority sub-areas exceeding the inflow threshold (1-1, 5-2, 7-2) shall occur during the summer/fall to help locate potential inflow sources and to aid in the further stages of inflow removal. This smoke testing will help target where to implement inflow remediation programs and identification programs such as dye testing, CCTV inspection of sewer service connections, and house-to-house programs.

- *Task 4: Multi Sensor Inspection (MSI)* for approximately 13,400 linear feet of the 18-inch to 36-inch diameter reinforced concrete (RC) main interceptor. In addition to identifying sources of I/I, the MSI will determine the structural condition of the interceptor and help measure the potential pipe deterioration from hydrogen sulfide. The interceptor is located in sub-areas 1-1 and 3-1 and runs from the Sand Hills pumping station force main discharge location to the WWTP.

- *Task 5: Community Relations Program* for high priority sub-areas (4-1, 4-2, 5-1, 6-1) and low priority sub-areas (1-1, 2-1, 5-2, 7-2). The program includes public outreach by providing notifications for affected homeowners prior to commencement of the field work.

- *Task 6: SSES Report.* Using the data from these investigations, the final SSES report with rehabilitation recommendations will be generated.

The traditional SSES program outlined above can be implemented in a number of ways. Traditionally, a community would begin work in the spring with flow isolation followed immediately by CCTV activities. During the summer months, smoke testing would occur to locate private inflow sources and to help target where to implement inflow remediation programs and identification programs such as dye testing, CCTV inspection of sewer service connections, and house-to-house programs. Once all field investigations are completed, an SSES with rehabilitation recommendations can be generated.

The following summarizes potential options for implementation of the SSES program:

Option 1 – Proceed on a basin by basin basis: Proceeding on a basin by basin basis will allow the town to minimize field activities and expedite sewer repairs which is the goal. With this approach, the Town would immediately proceed in the highest priority area first, completing an SSES program including both infiltration and inflow investigations in the spring and summer months, followed by system repairs the following spring. This will allow the Town to establish budgets annually on a basin by basin basis for investigations and repairs and allow for targeting the worst areas first. A downside to this program is that it will extend the implementation of the completed program over a longer period of time and increase program costs due to economy of scale for investigations and construction related activities. See **Table 5** for a summary of estimated costs for an SSES program and follow-up rehabilitation for each basin. Note that the required rehabilitation will not be known until the SSES program is completed. As a result, a range of costs for rehabilitation construction are provided.

Option 2 – Proceed on a traditional approach: Under Option 2, the town would proceed as described above on a more traditional approach. The SSES program, in lieu of the expedited schedule noted above, could be implemented over the period of 3 to 4 years to minimize sewer expenditures. This program, at the completion of work, will provide the town with a complete roadmap of sewer repairs moving forward allowing to budget for a sewer rehabilitation program. A downside to this option is that no or very little sewer rehabilitation work will take place during the SSES program as the various program will take time to implement and analyze. **Figure 6** shows the Phase II SSES program schedule divided into the six investigation tasks listed above to be implemented over a period of 3 to 4 years.

In an effort to help the Town minimize sewer expenditures on the SSES program going forward, and expedite the implementation of sewer system repairs in high priority areas, it is recommended that the Town proceed on less-traditional path – Option 1. This option will provide the fastest path for mitigating extraneous flows and allowing the town to budget small "chunks" of monies annually toward the program vs. committing to a larger program upfront.

- CDM Smith recommends that a budgetary amount of $355,000-$400,000 be allocated for the Phase II work. Note that the cost provided is an estimate only and will be refined once an option is chosen and prior to work commencing. This cost includes subcontractor and engineering cost for Tasks 1 through 6, summarized above.

- Once the Phase II work is completed, additional follow-up investigations such as house-to-house inspections and dye testing to identify illicit connections, manhole inspections of non-priority areas, CCTV inspection (mainline) of low priority areas and CCTV inspection (sewer services) of high priority areas may be recommended. Note that the above budgetary cost does not include follow-up investigations.

- The SSES program will provide the framework for a value-effective rehabilitation program, tailored to fit within available Town funding. Also, the rehabilitation program can be

I/I Programs Cost Summary

Option 1 - Basin-by-Basin Approach

Meter	Priority	Priority Ranking[1]	Length (ft)	I/I Investigations[2]	Construction Range[3,4,5,6]	
				Total	Total Low Cost	Total High Cost
4-2	High	1	4,724	$ 20,000	$ 700,000	$ 1,700,000[7]
5-1	High	2	9,223	$ 25,000	$ 1,400,000	$ 1,900,000
6-1	High	3	21,068	$ 55,000	$ 3,000,000	$ 4,200,000
4-1	High	4	14,735	$ 40,000	$ 2,100,000	$ 3,000,000
		Subtotal	***49,750***	***$ 140,000***	***$ 7,200,000***	***$ 9,100,000***
5-2	Low	5	15,999	$ 40,000	$ 1,900,000	$ 2,800,000
2-1	Low	6	19,424	$ 45,000	$ 2,300,000	$ 3,500,000
1-1	Low	7	29,971	$ 115,000	$ 3,000,000	$ 4,600,000
7-2	Low	8	20,190	$ 55,000	$ 2,300,000	$ 3,500,000
		Subtotal	***85,584***	***$ 255,000***	***$ 9,500,000***	***$ 14,400,000***

Notes

1. Priority ranking based on the subarea's total I/I divided by the inch-miles. Based on MassDEP guidelines, subareas 2,2 3-1, 7-1 and 8-1 were not recommended for further inspection.
2. I/I Investigations cost includes flow isolation, cleaning and CCTV inspection, smoke testing, manhole inspections, and multi-sensor inspection of the main interceptor (where applicable). Cost does not include follow-up investigations such as house-to-house inspections and dye testing.
3. High priority subareas assumes 10%-15% of mainline sewer will need to be open cut replaced and 50%-70% will need to be cured-in-place pipe (CIPP) lined. Also assumes that 50%-70% of the manholes will need to be rehabilitated and 50%-70% of sewer services will need to be open cut replaced.
4. Low priority subareas assumes 7.5%-12.5% of mainline sewer will need to be open cut replaced and 40%-60% will need to be cured-in-place pipe (CIPP) lined. Also assumes that 40%-60% of the manholes will need to be rehabilitated and 40%-60% of sewer services will need to be open cut replaced.
5. Cost does not include main interceptor rehabilitation. This cost should not be estimated until a multi-sensor inspection is completed.
6. Construction cost includes construction contingency, engineering and permitting, bidding, construction services and police. Costs are in August 2016 dollars.
7. High cost for subarea 4-2 includes replacement of existing gravity system with new low pressure sewers and grinder pumps.

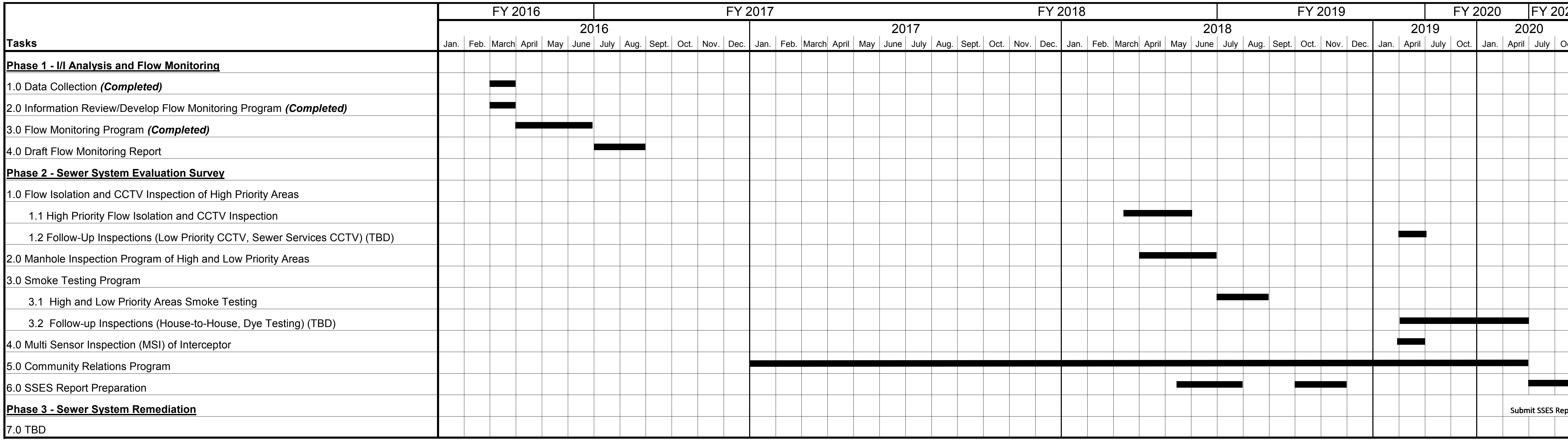


FIGURE 6
TOWN OF SCITUATE
FLOW MONITORING PROGRAM AND I/I ANALYSIS MEMO
OPTION 2 - SCHEDULE OF TASKS

prioritized and scheduled to be constructed in conjunction with pending water and roadway work and adjacent planned developments.

cc: Daniel Smith, P.E., Town of Scituate

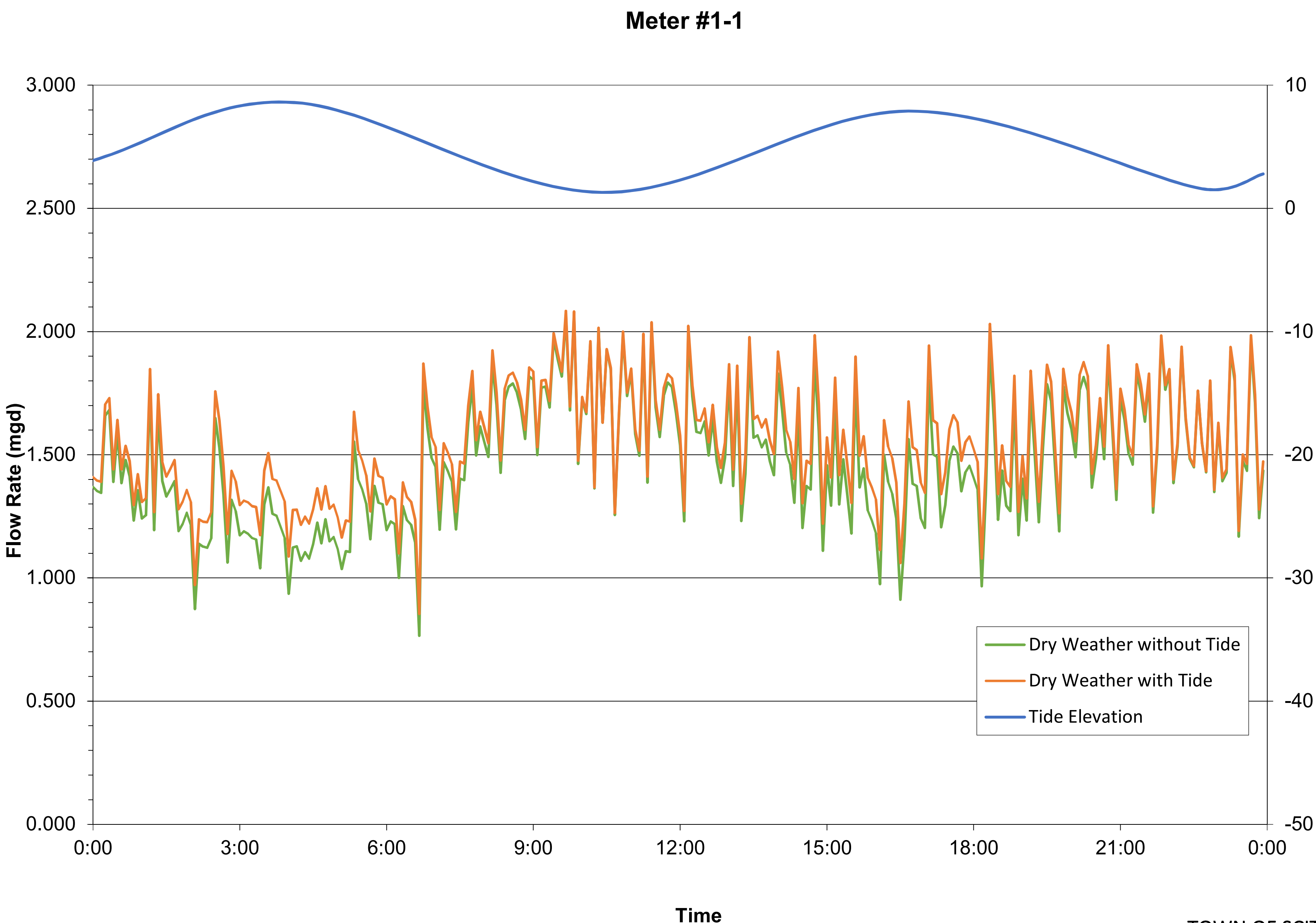
Appendix A

Flow Assessment's

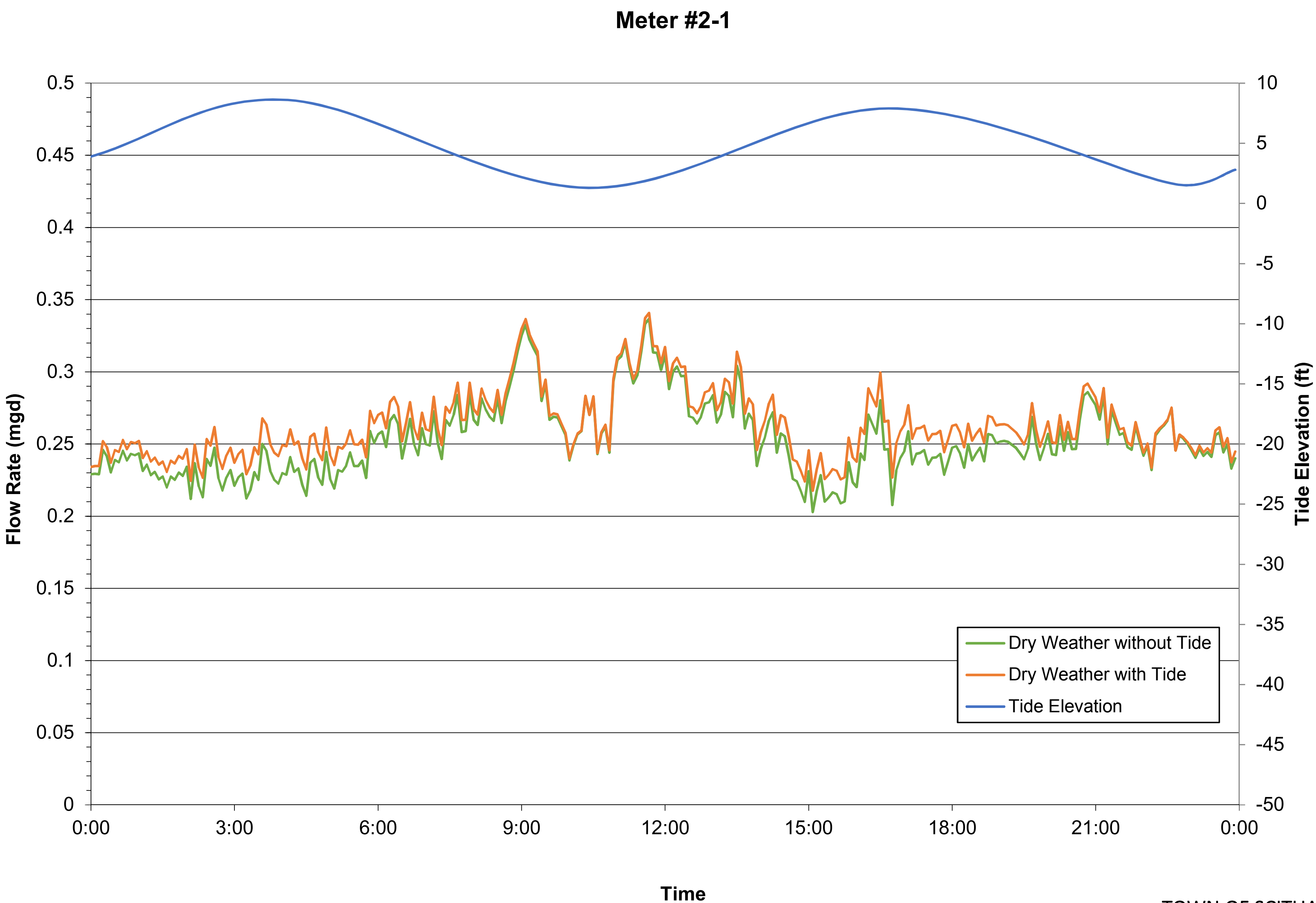
Scituate, MA, Flow Monitoring Report, February – May 2016

Electronic copy of Flow Assessment report to be included in separate file.

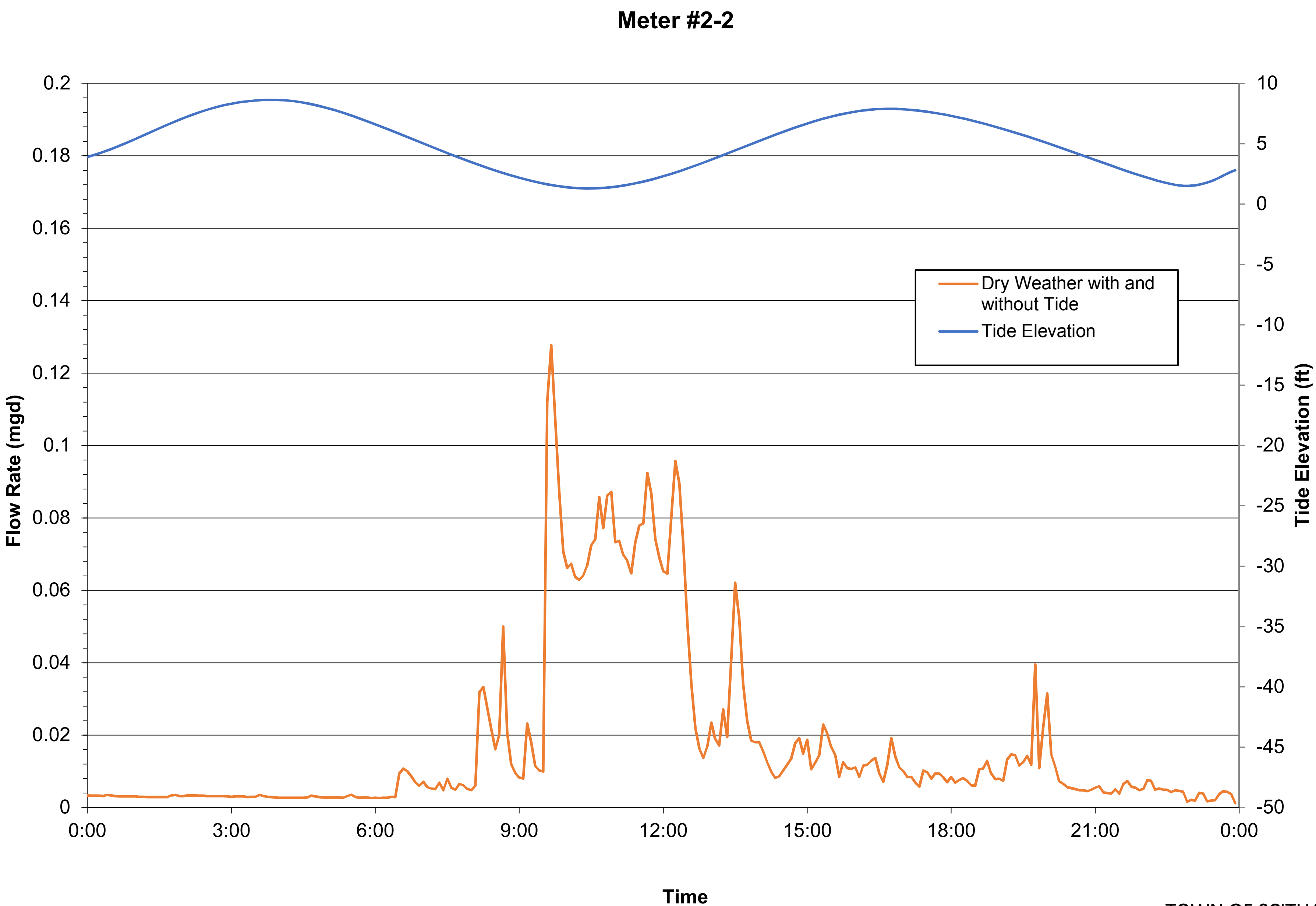
APPENDIX B
DRY WEATHER FLOW CURVES



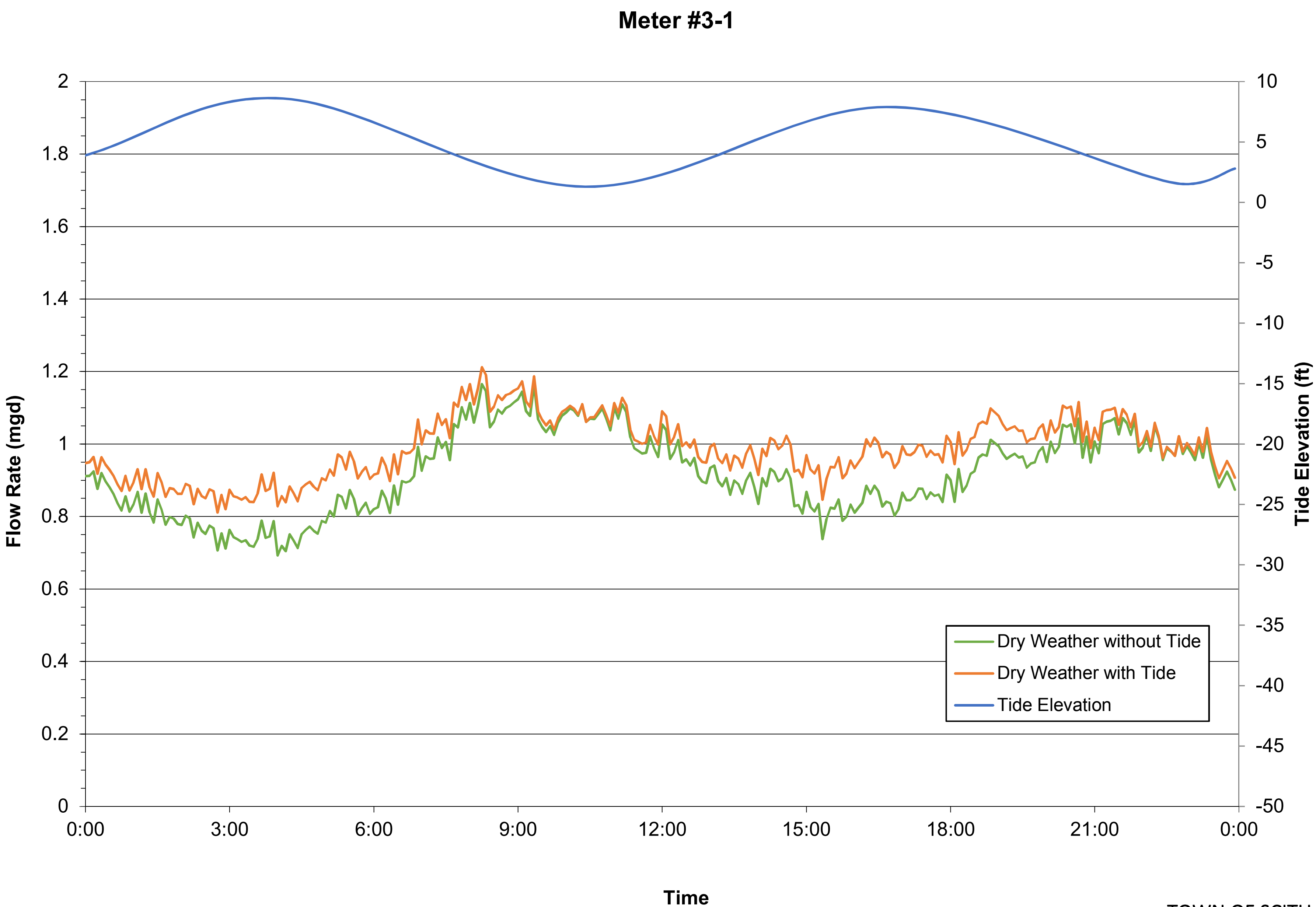
TOWN OF SCITUATE
FLOW MONITORING SUMMARY REPORT
ADJUSTED DRY WEATHER FLOW
SUB-AREA 1-1



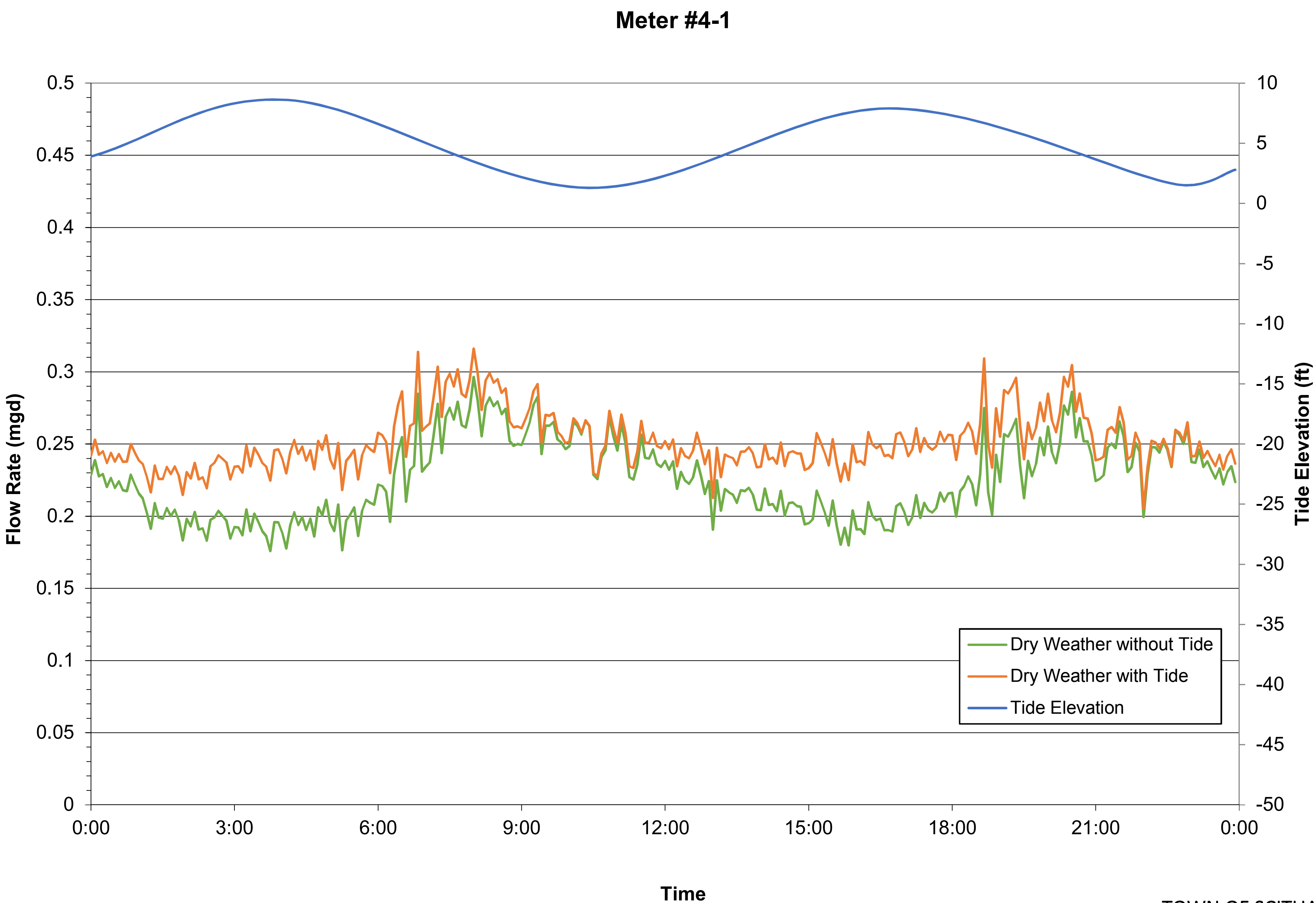
TOWN OF SCITUATE
FLOW MONITORING SUMMARY REPORT
ADJUSTED DRY WEATHER FLOW
SUB-AREA 2-1



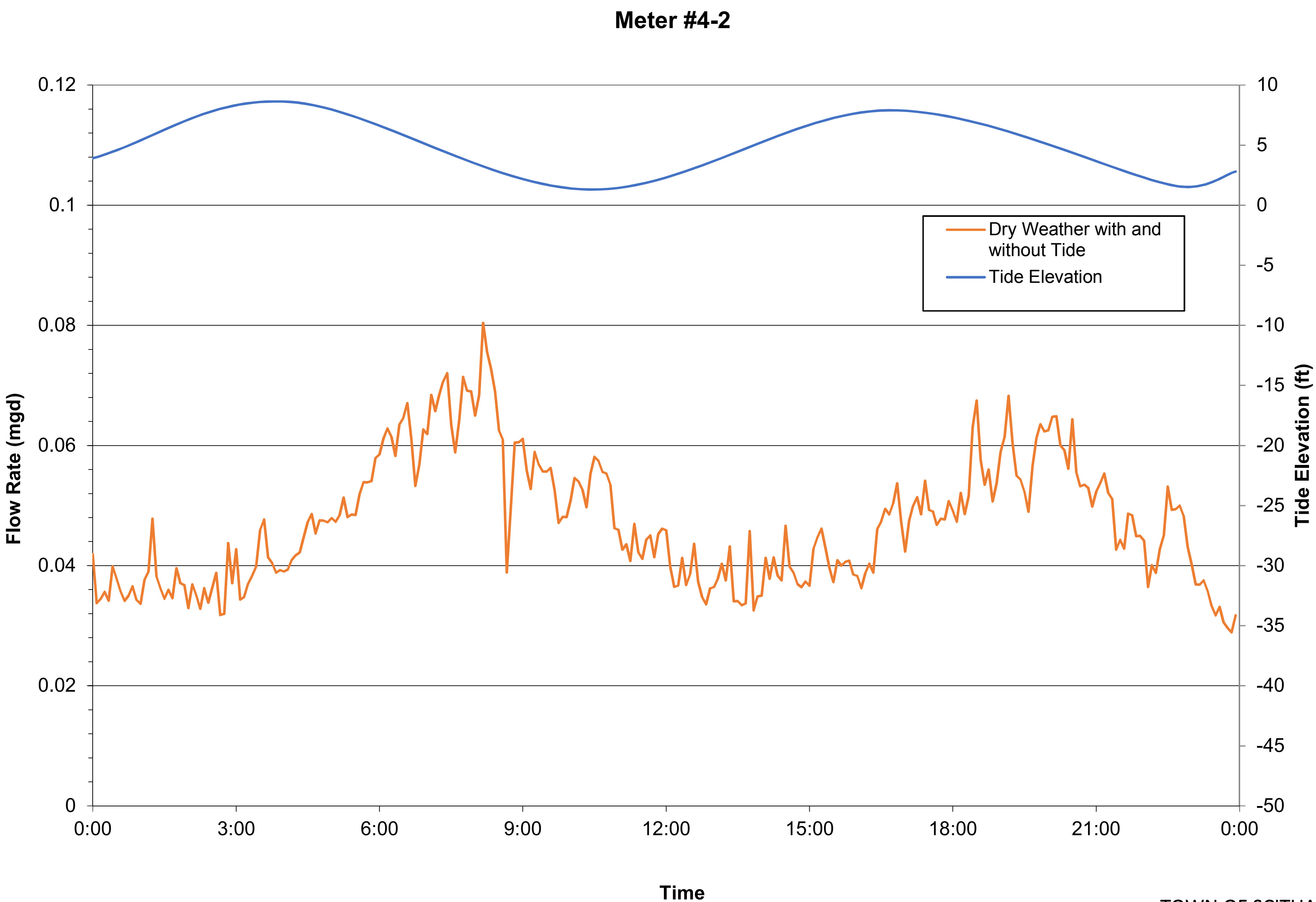
TOWN OF SCITUATE
FLOW MONITORING SUMMARY REPORT
ADJUSTED DRY WEATHER FLOW
SUB-AREA 2-2



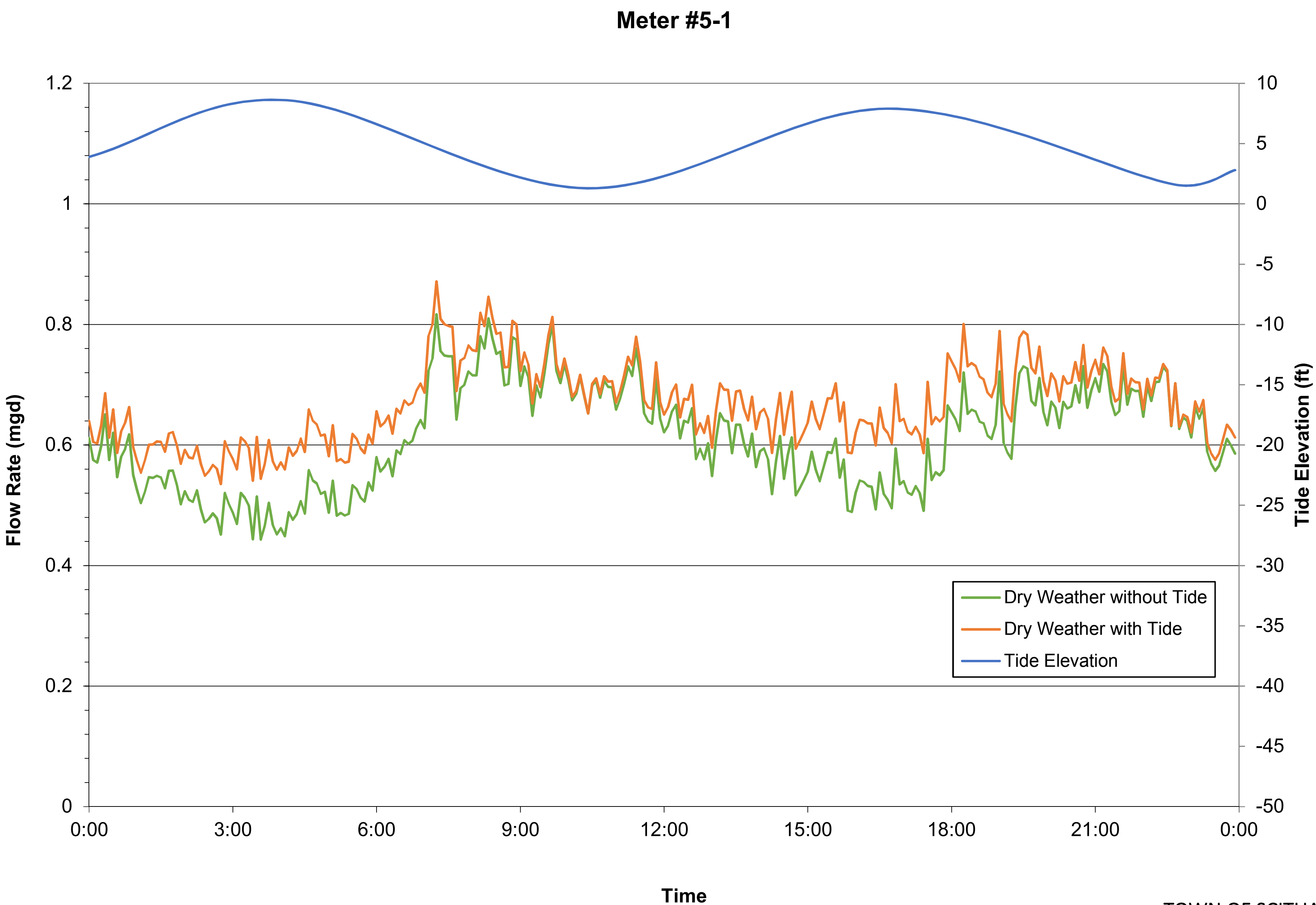
TOWN OF SCITUATE
FLOW MONITORING SUMMARY REPORT
ADJUSTED DRY WEATHER FLOW
SUB-AREA 3-1



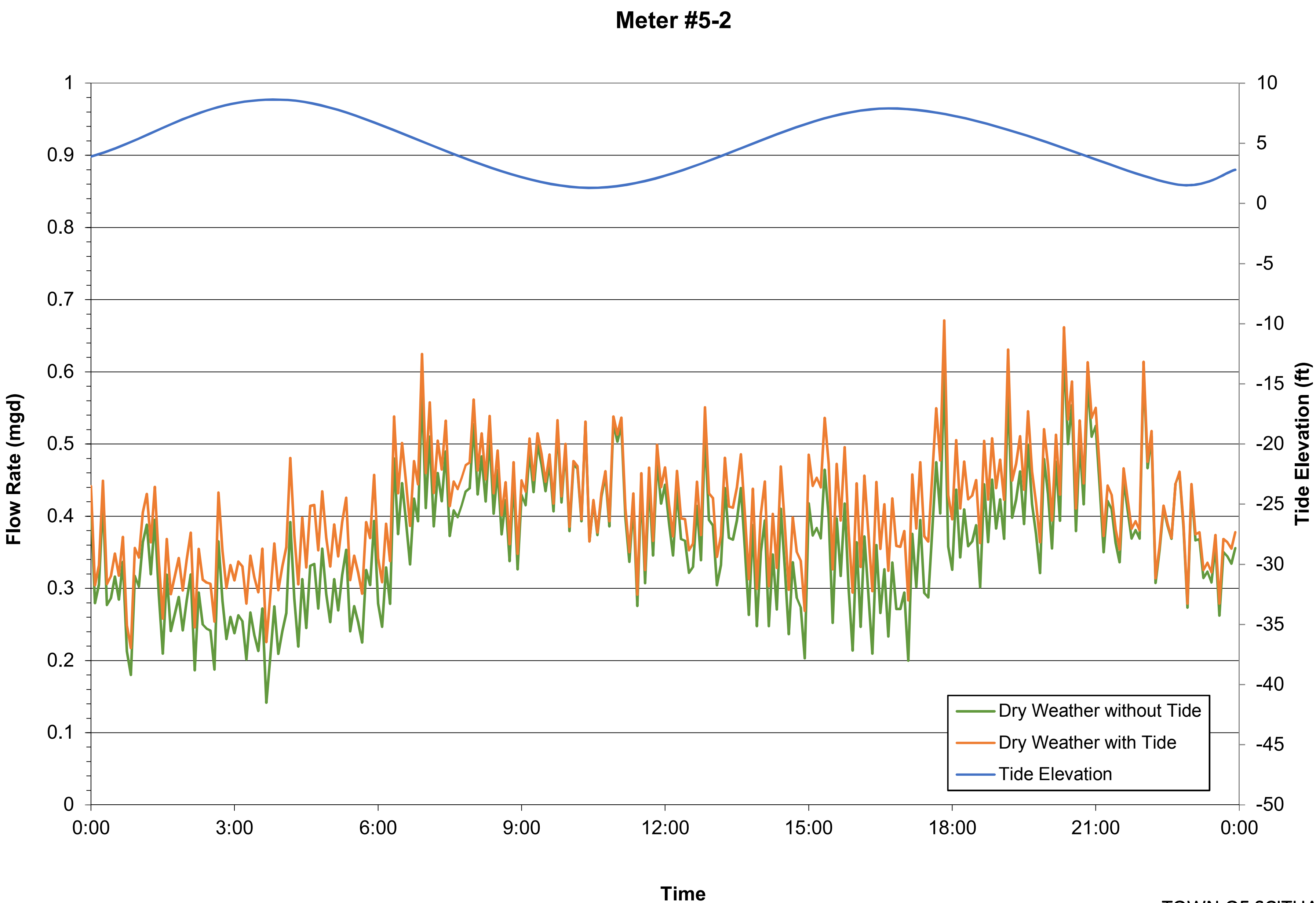
TOWN OF SCITUATE
FLOW MONITORING SUMMARY REPORT
ADJUSTED DRY WEATHER FLOW
SUB-AREA 4-1



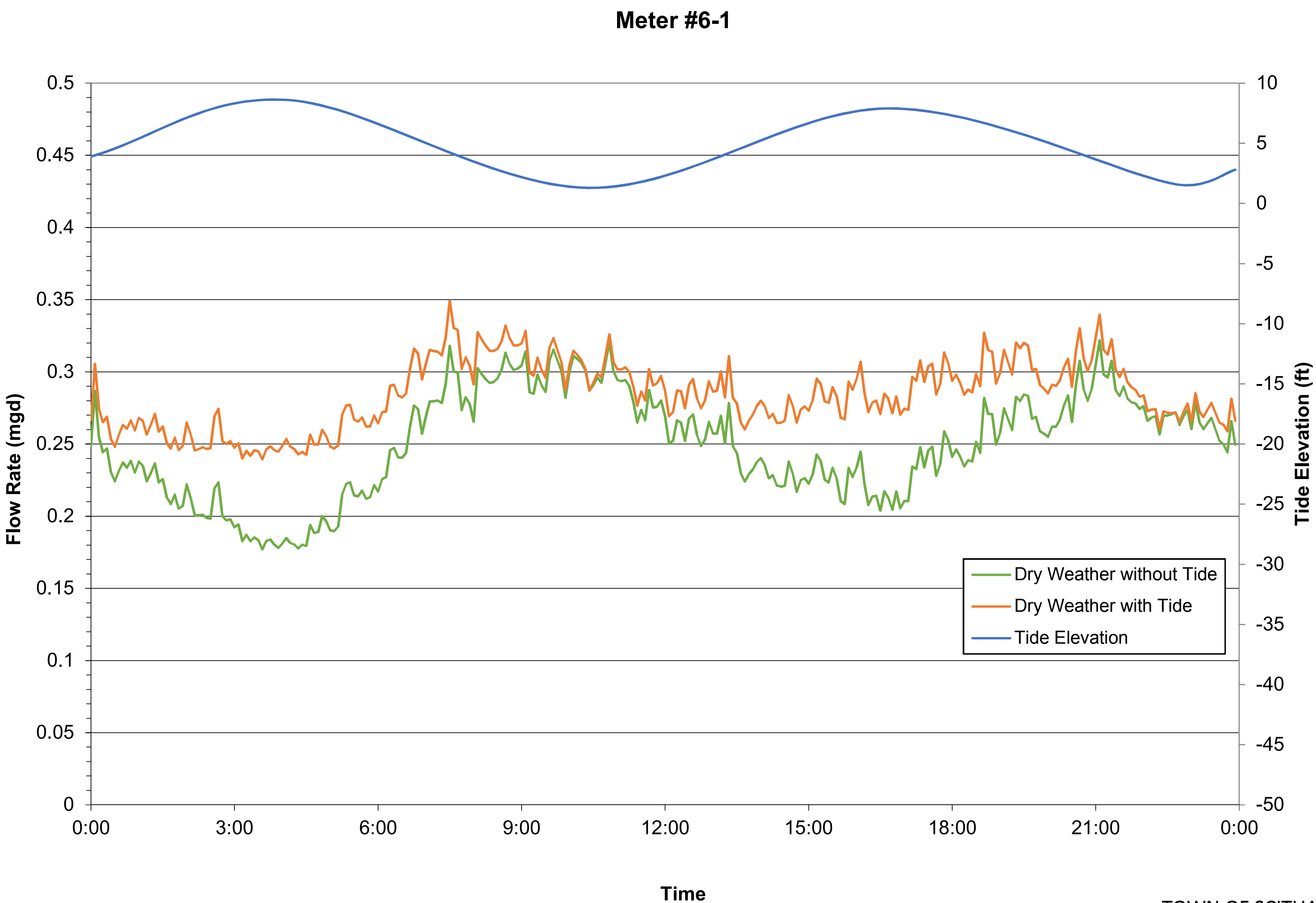
TOWN OF SCITUATE
FLOW MONITORING SUMMARY REPORT
ADJUSTED DRY WEATHER FLOW
SUB-AREA 4-2



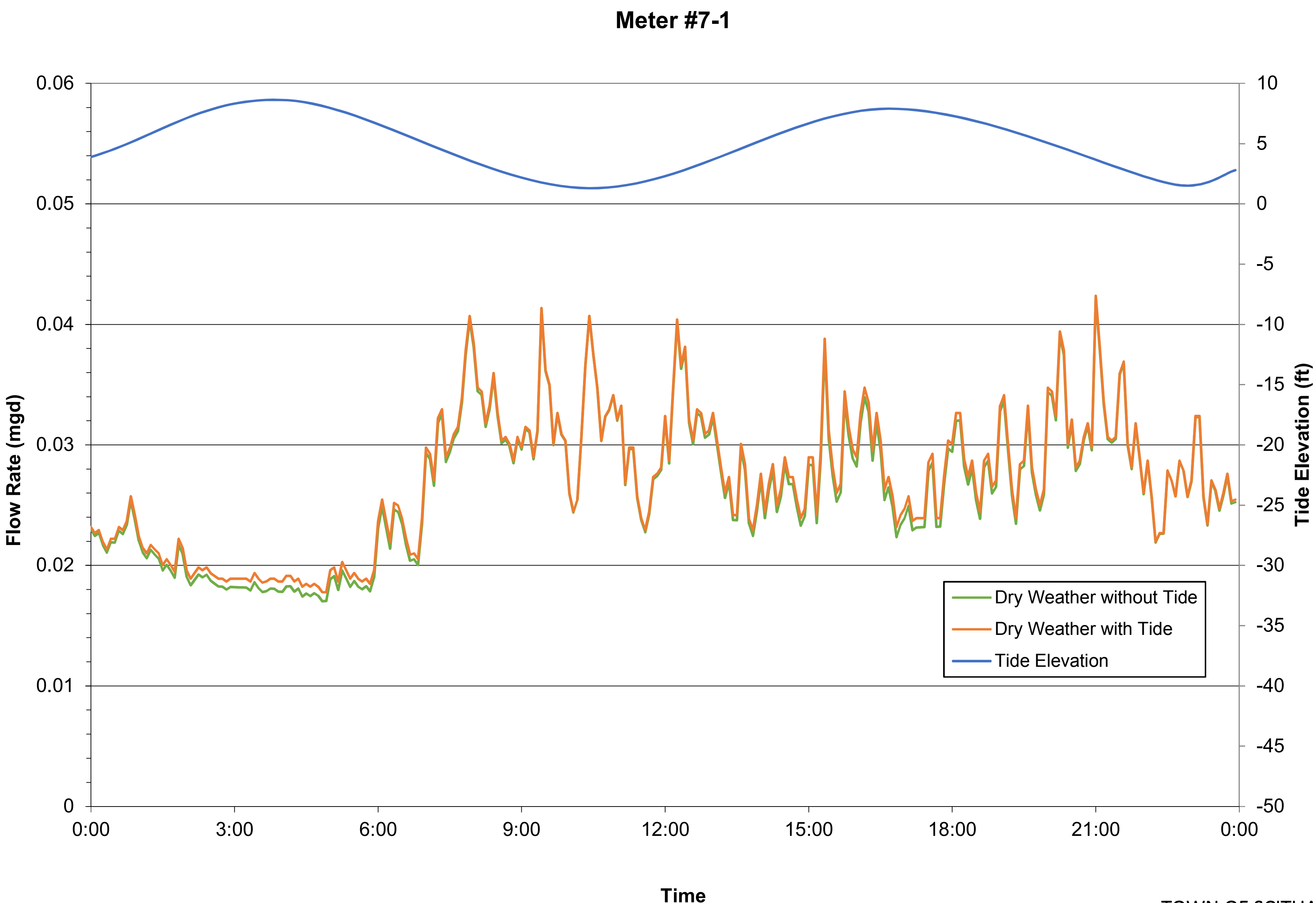
TOWN OF SCITUATE
FLOW MONITORING SUMMARY REPORT
ADJUSTED DRY WEATHER FLOW
SUB-AREA 5-1



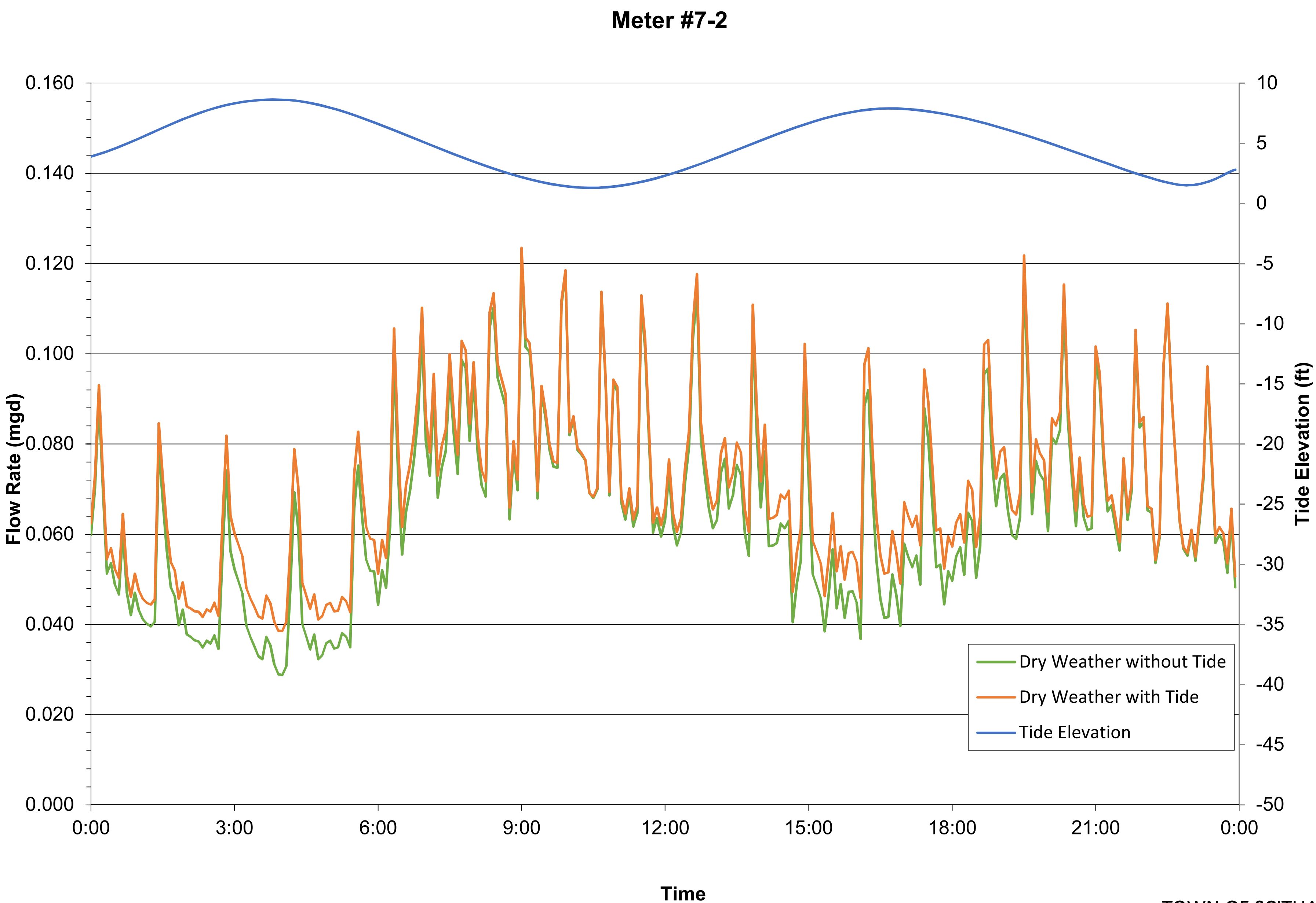
TOWN OF SCITUATE
FLOW MONITORING SUMMARY REPORT
ADJUSTED DRY WEATHER FLOW
SUB-AREA 5-2



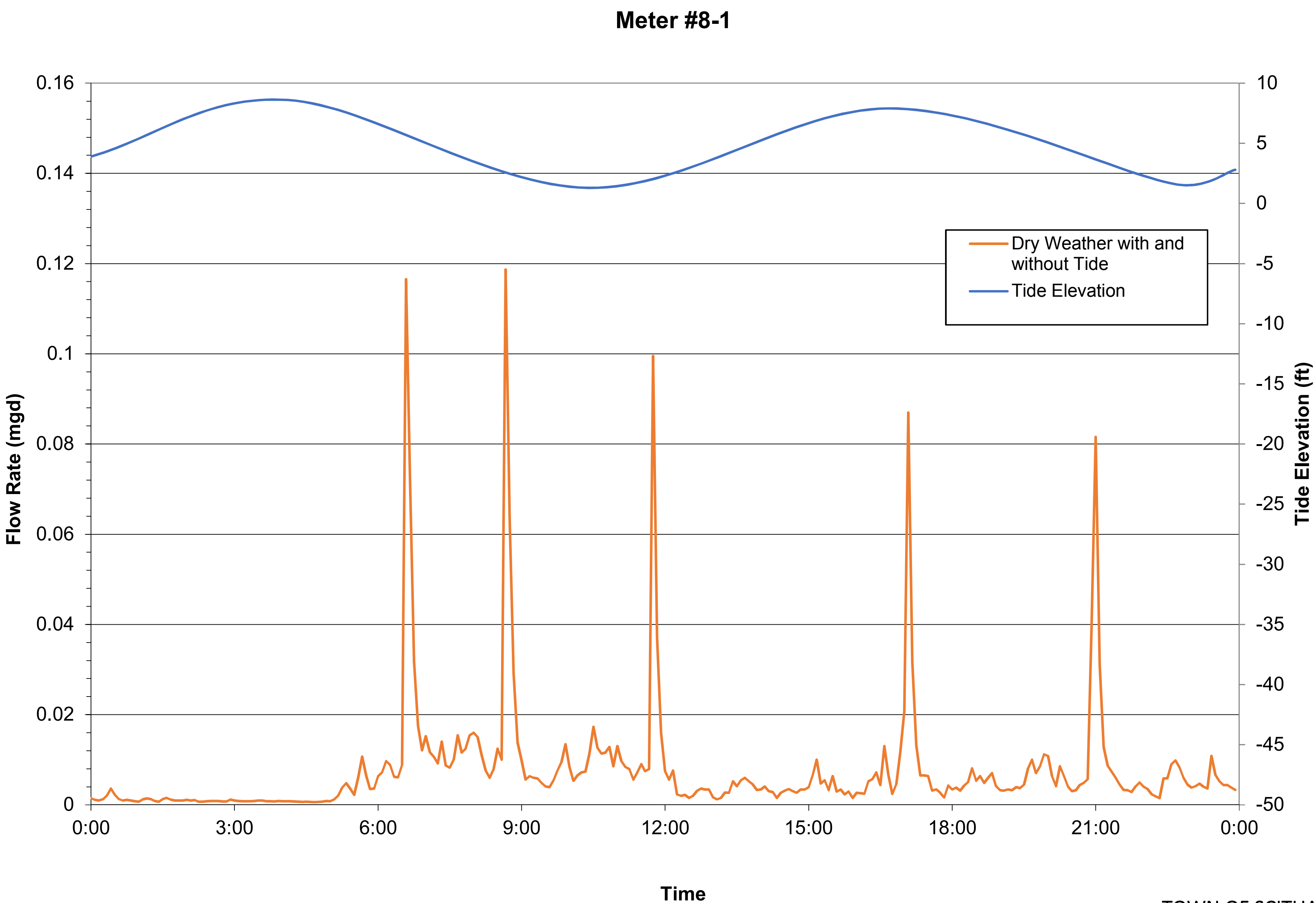
TOWN OF SCITUATE
FLOW MONITORING SUMMARY REPORT
ADJUSTED DRY WEATHER FLOW
SUB-AREA 6-1



TOWN OF SCITUATE
FLOW MONITORING SUMMARY REPORT
ADJUSTED DRY WEATHER FLOW
SUB-AREA 7-1



Meter #7-2
Flow Rate (mgd)
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Tide Elevation (ft)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time
Dry Weather without Tide
Dry Weather with Tide
Tide Elevation



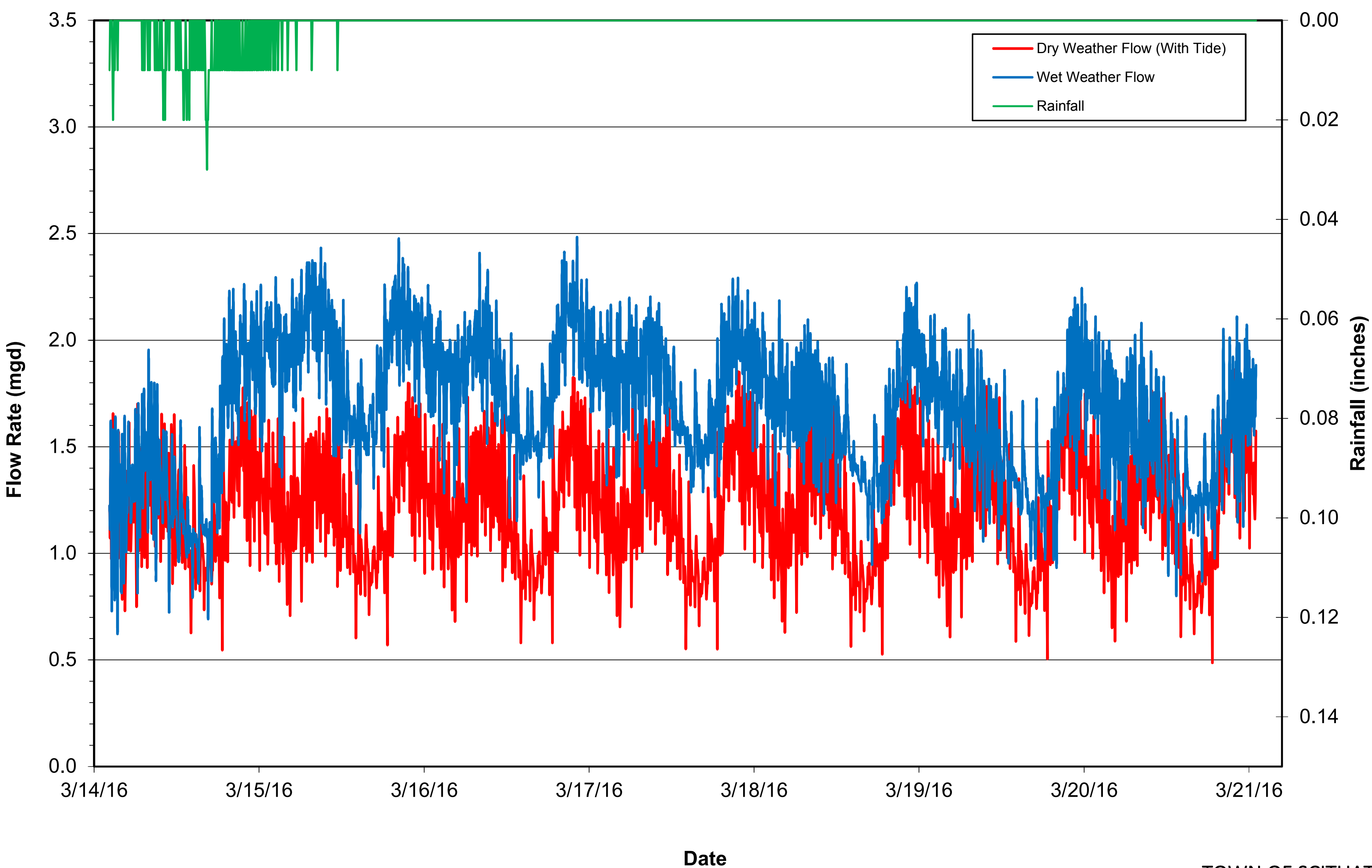
TOWN OF SCITUATE
FLOW MONITORING SUMMARY REPORT
ADJUSTED DRY WEATHER FLOW
SUB-AREA 8-1

APPENDIX C

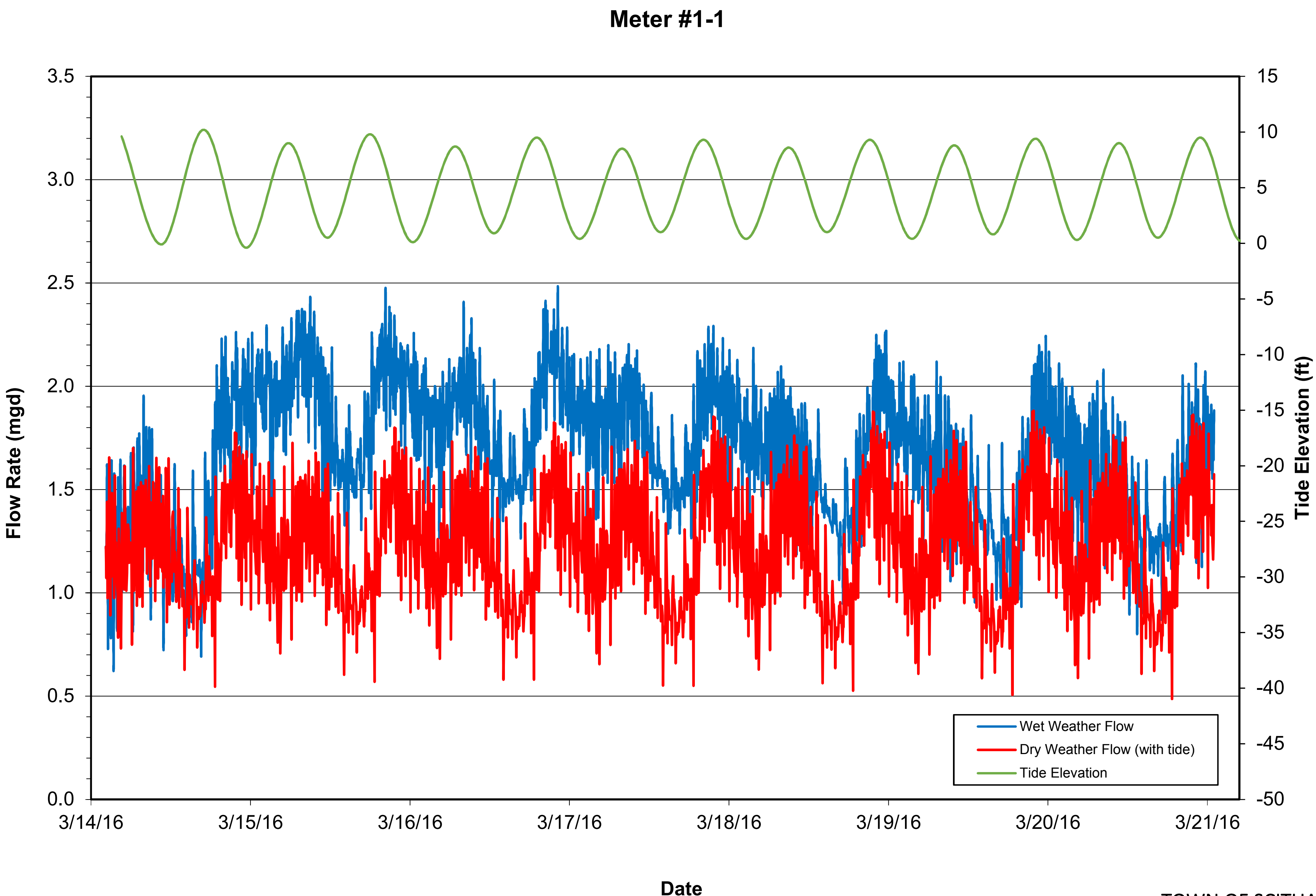
STORM HYDROGRAPHS

MARCH 14 AND 15, 2016 RAINFALL EVENT

Meter #1-1

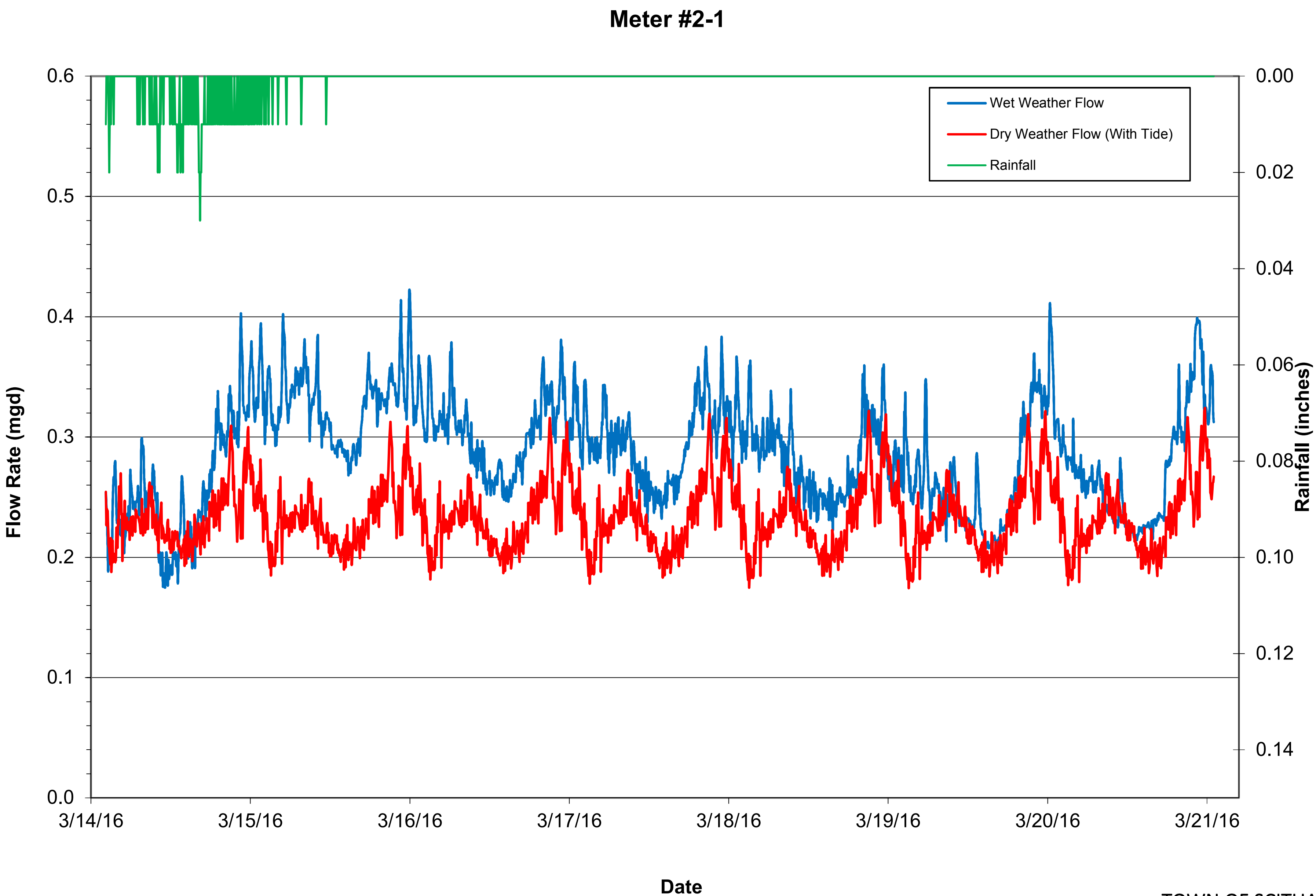


TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 1-1

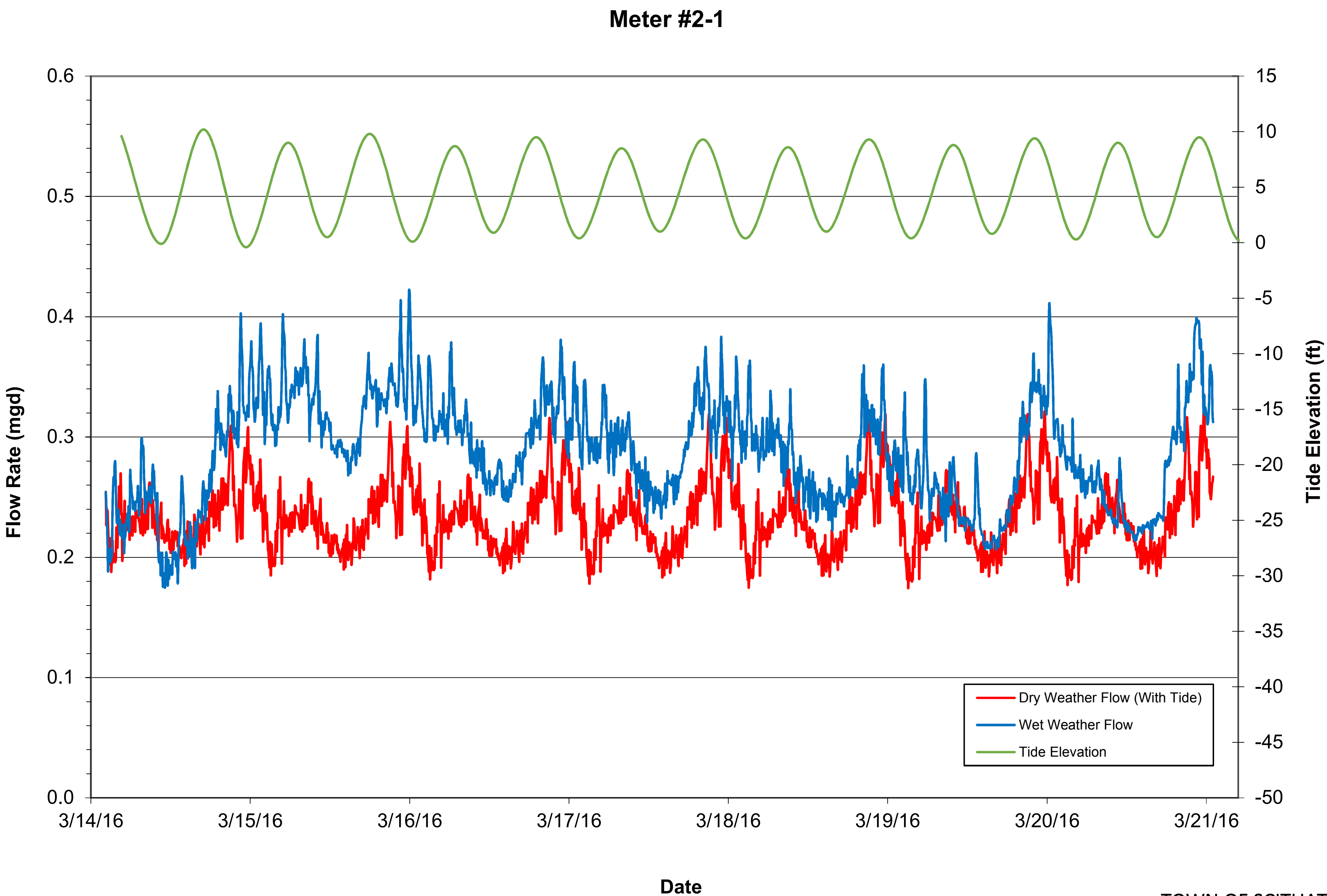


TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM WITH TIDE CURVE
METER 1-1

CDM Smith



TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 2-1



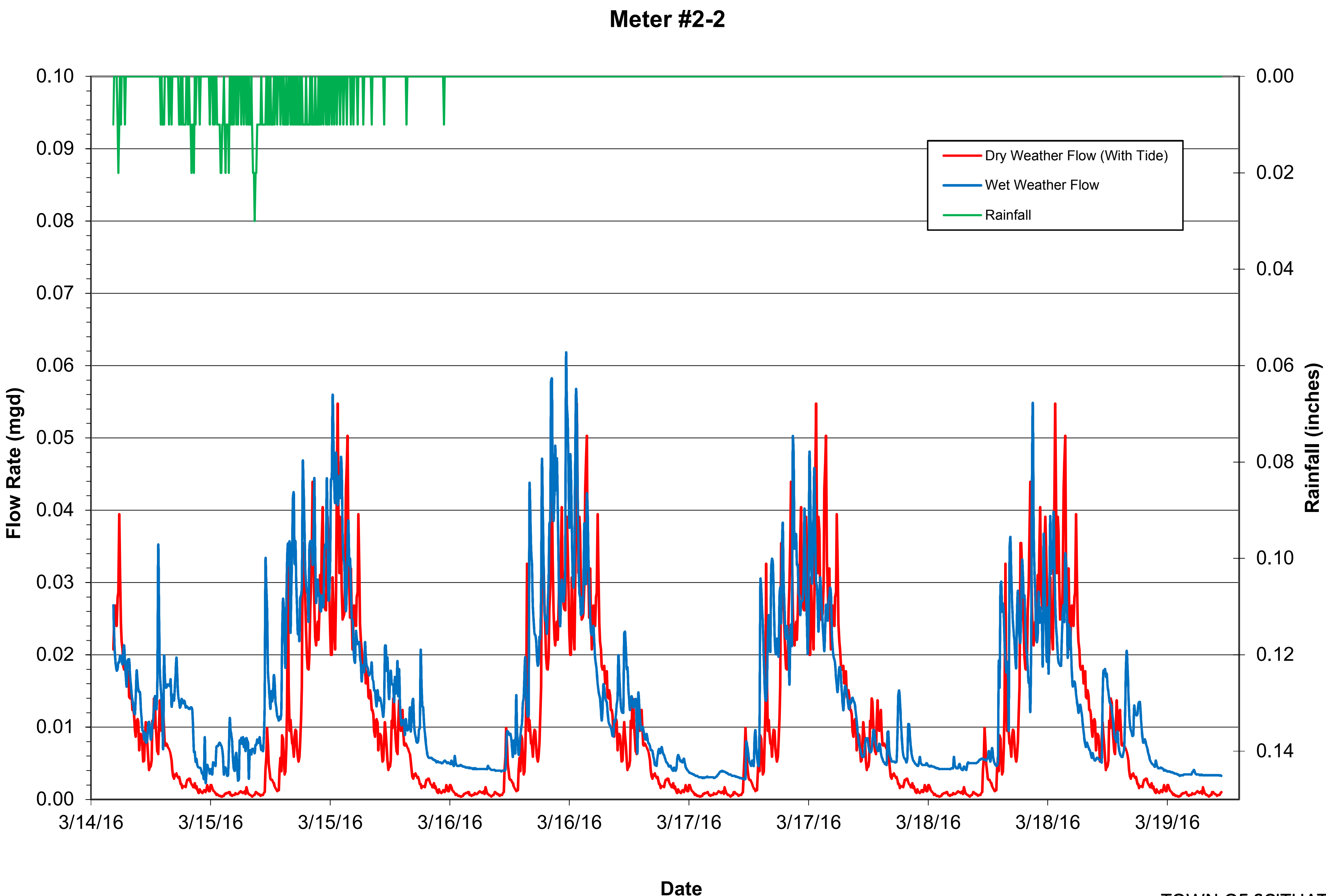
TOWN OF SCITUATE

FLOW MONITORING SUMMARY

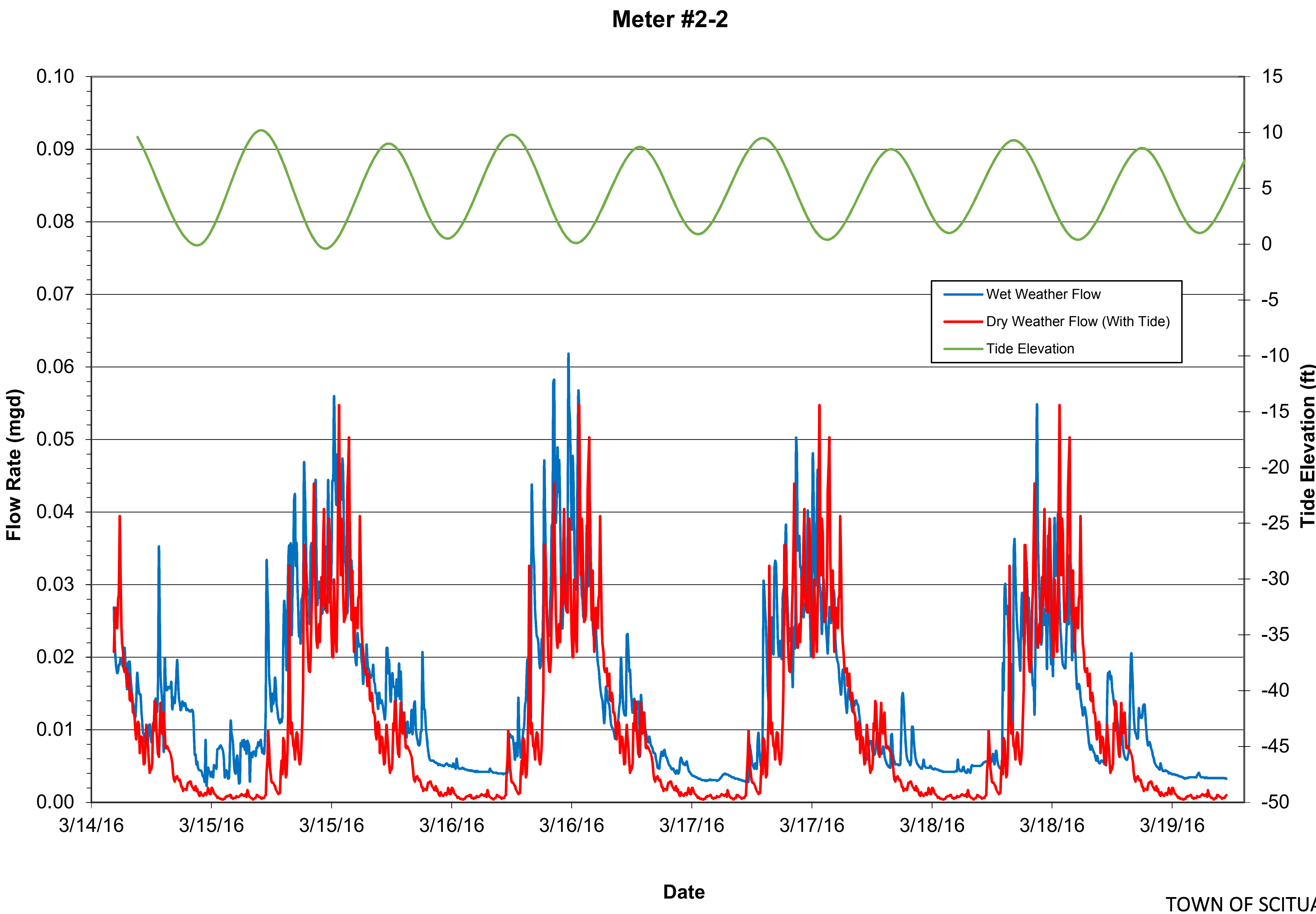
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM WITH TIDE CURVE

METER 2-1

CDM Smith



TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-22, 2016 STORM
METER 2-2



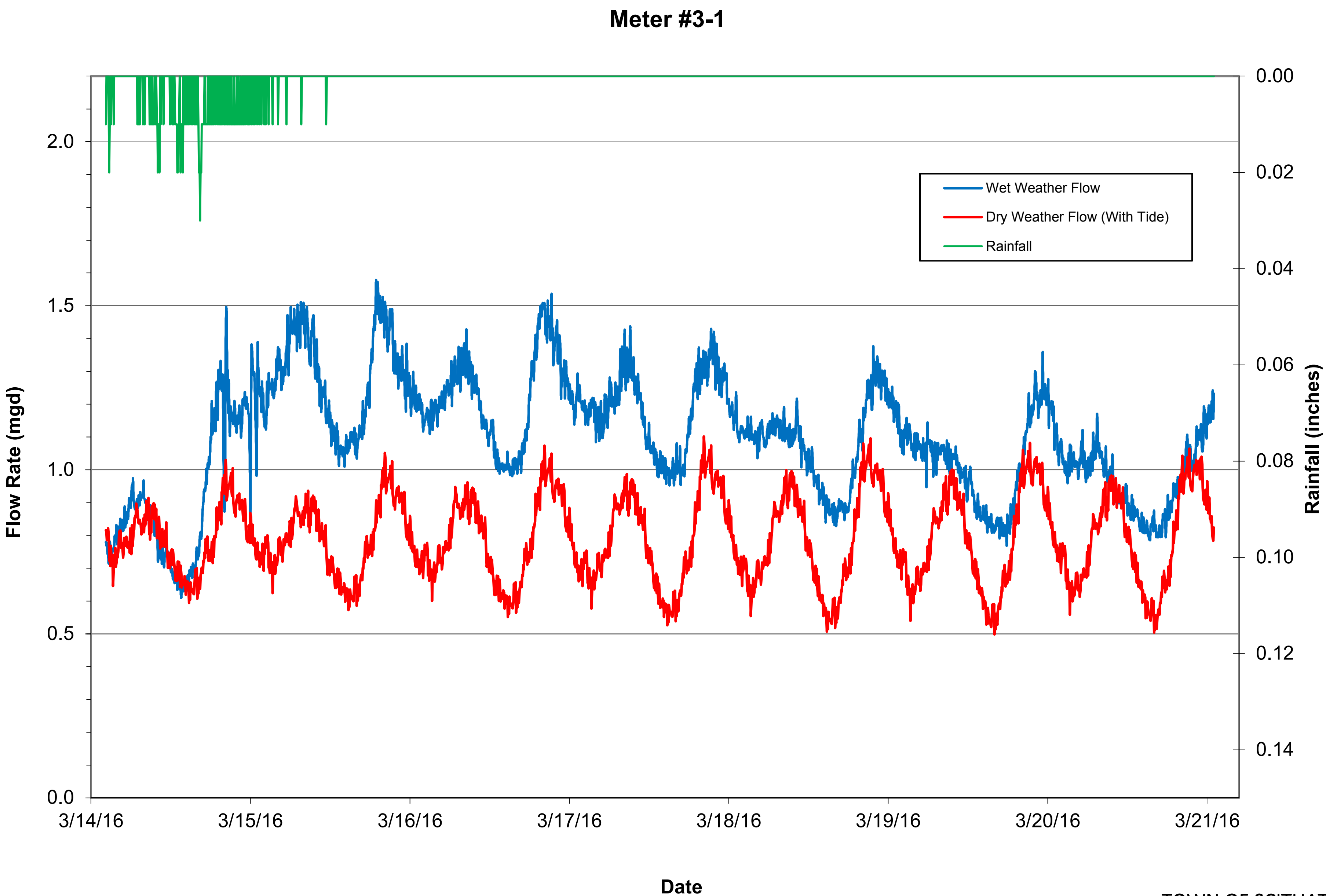
TOWN OF SCITUATE

FLOW MONITORING SUMMARY

FLOW VS. TIME GRAPH - MARCH 14-22, 2016 STORM WITH TIDE CURVE

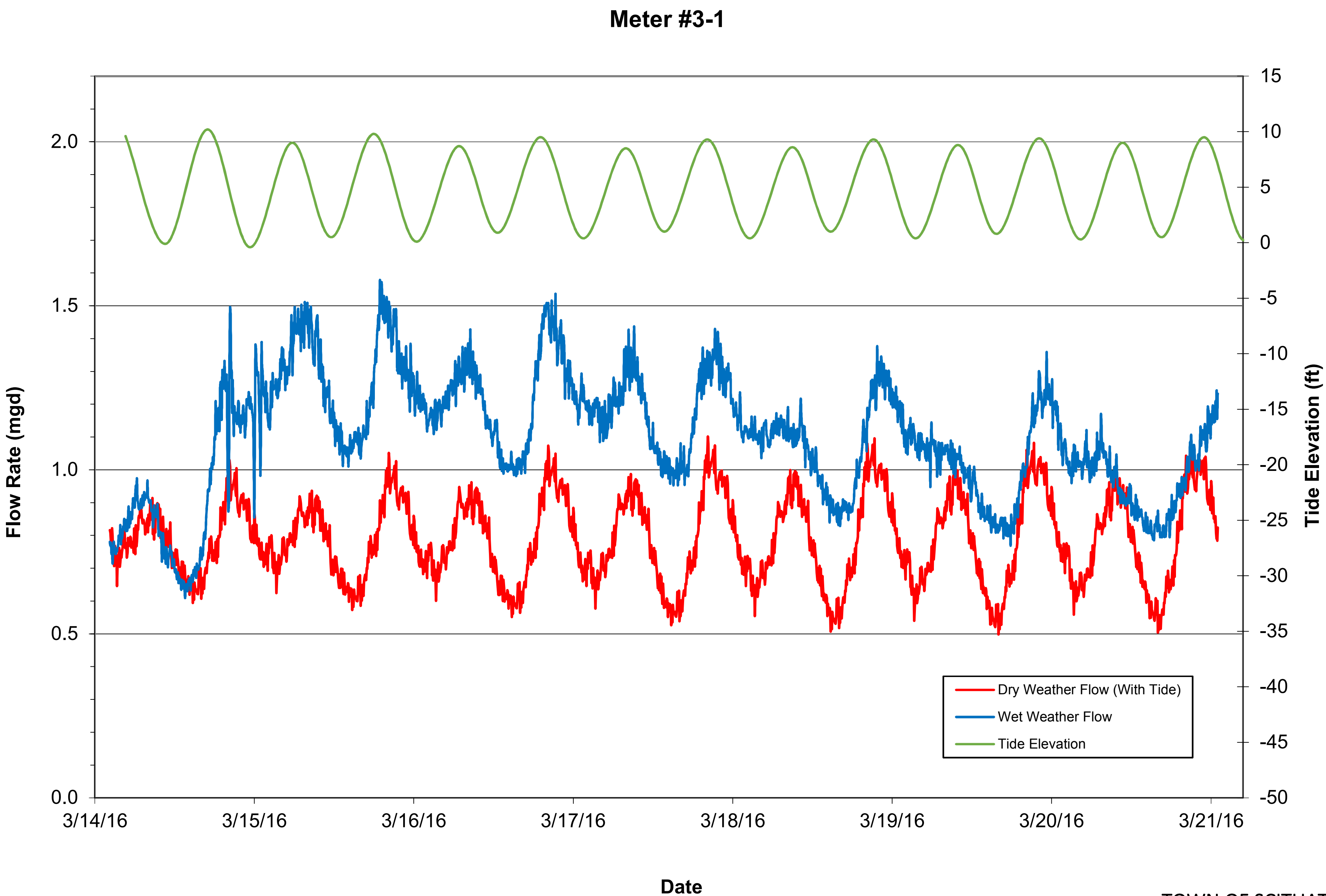
METER 2-2

CDM Smith

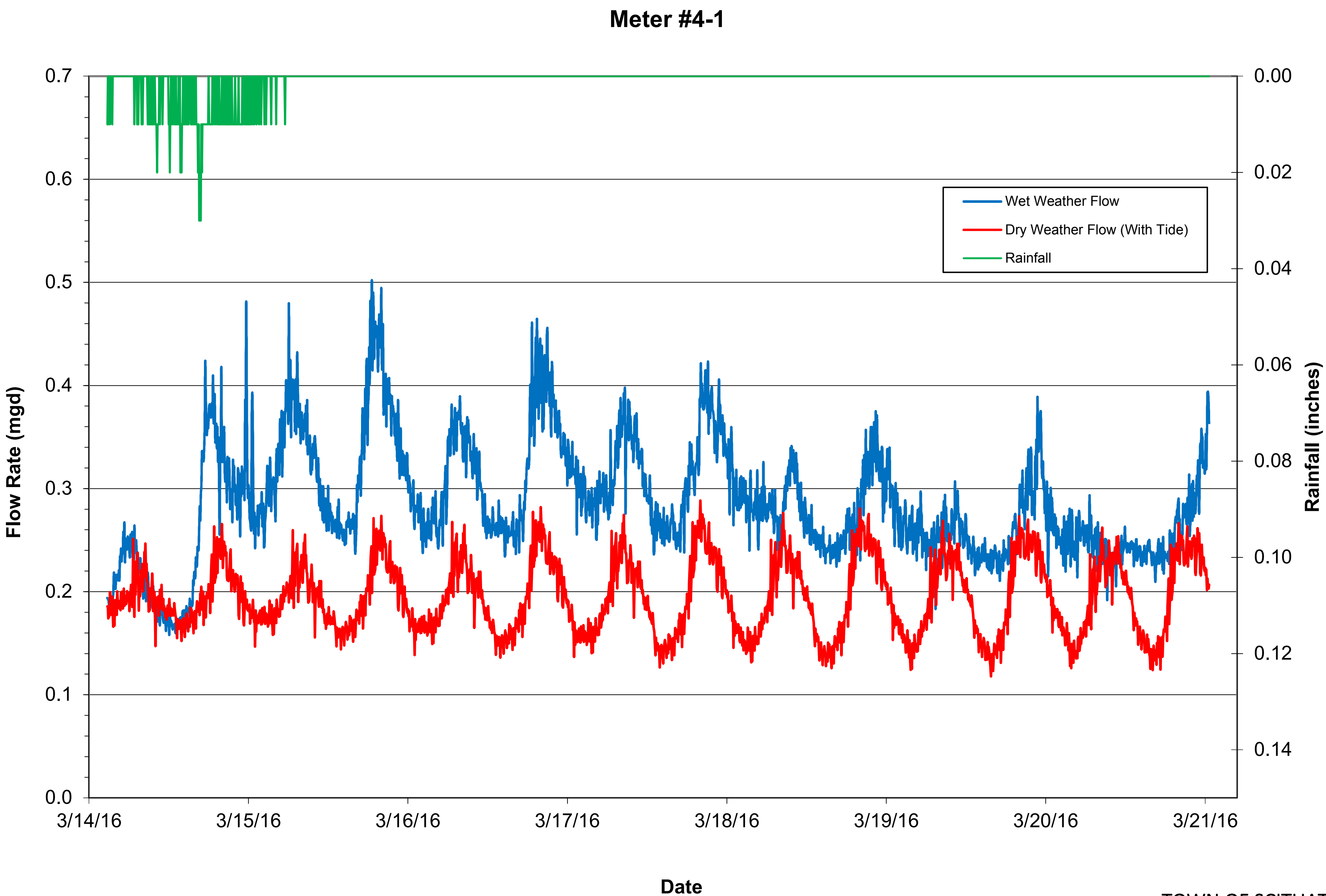


TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 3-1

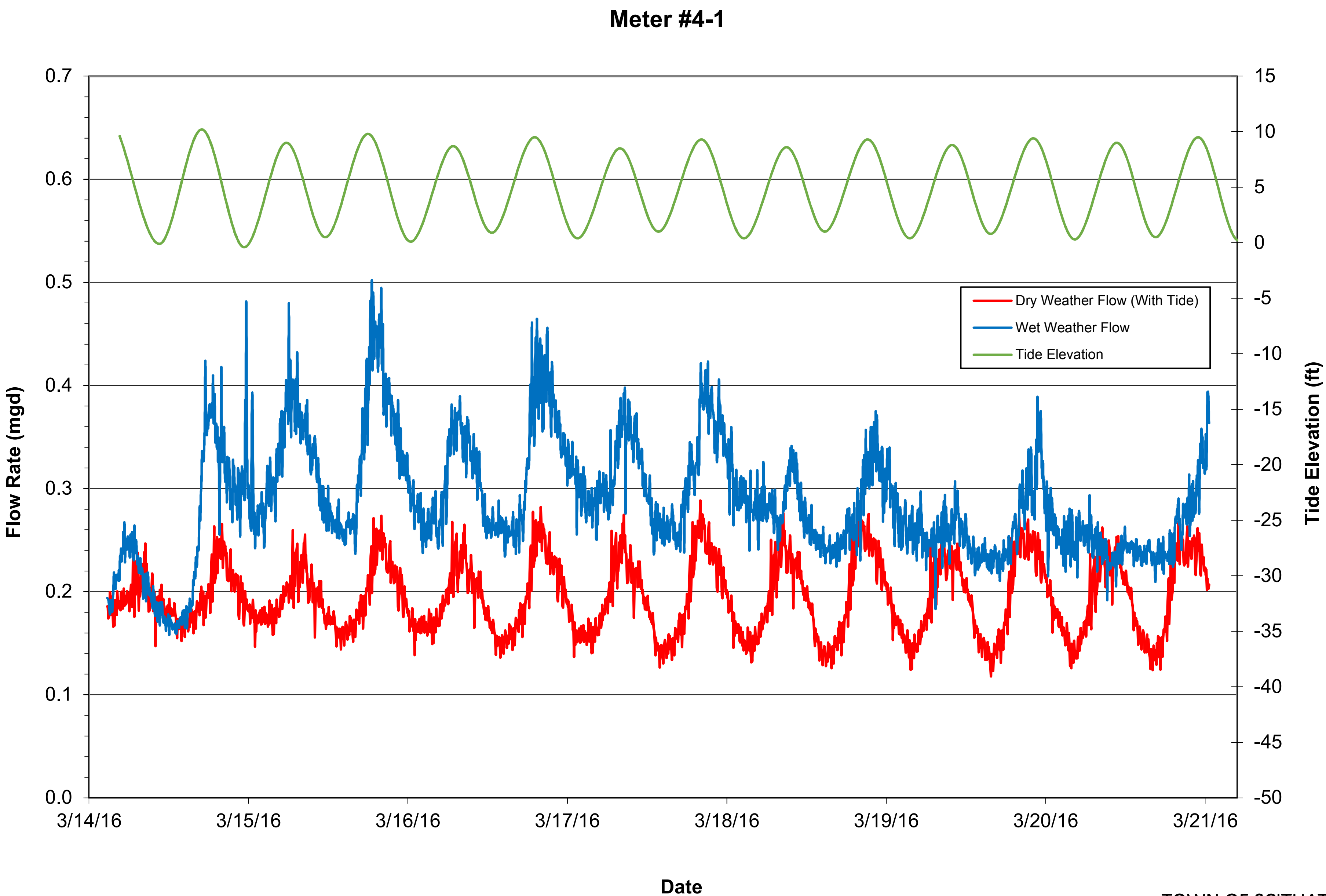
CDM Smith



TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM WITH TIDE CURVE
METER 3-1

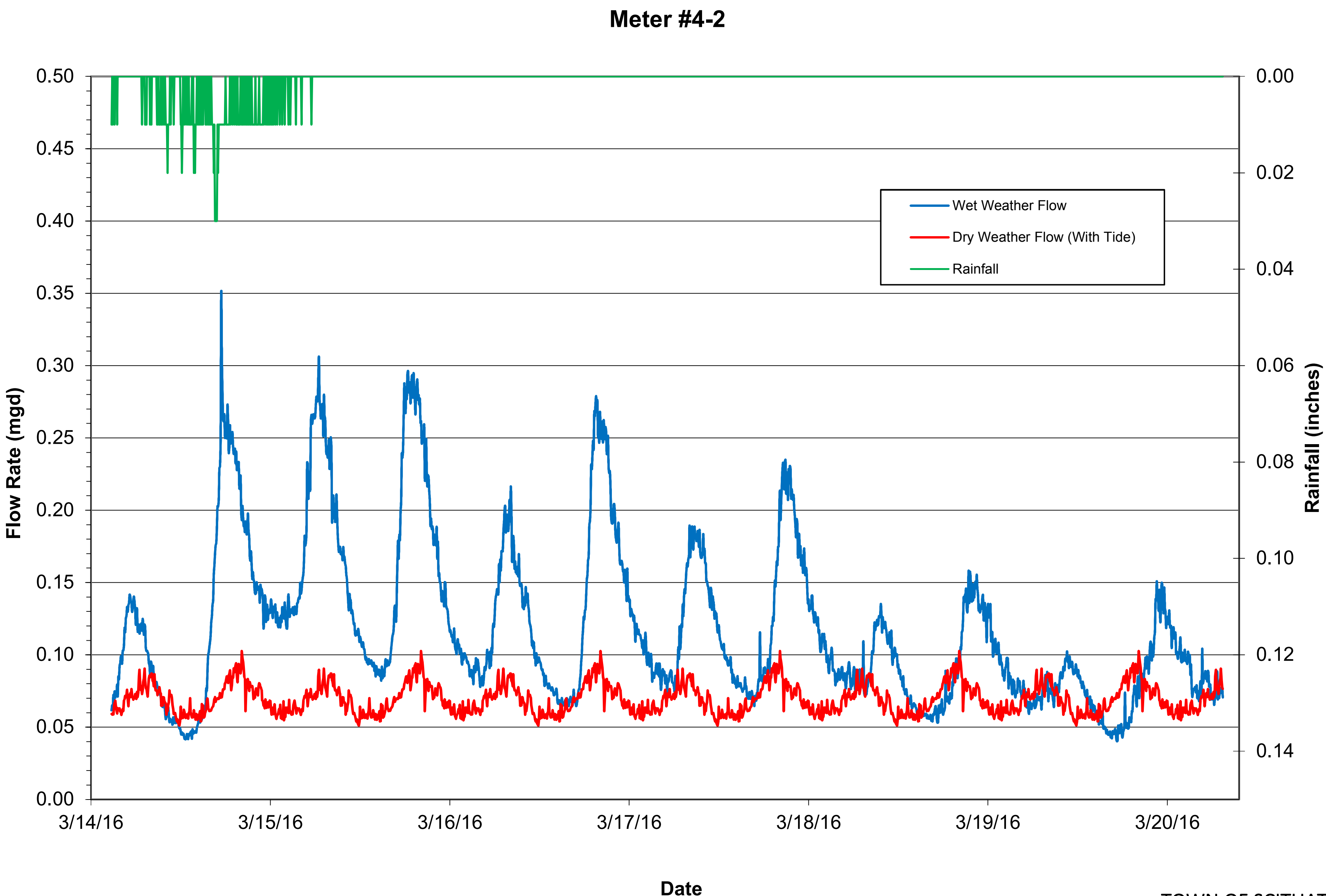


TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 4-1



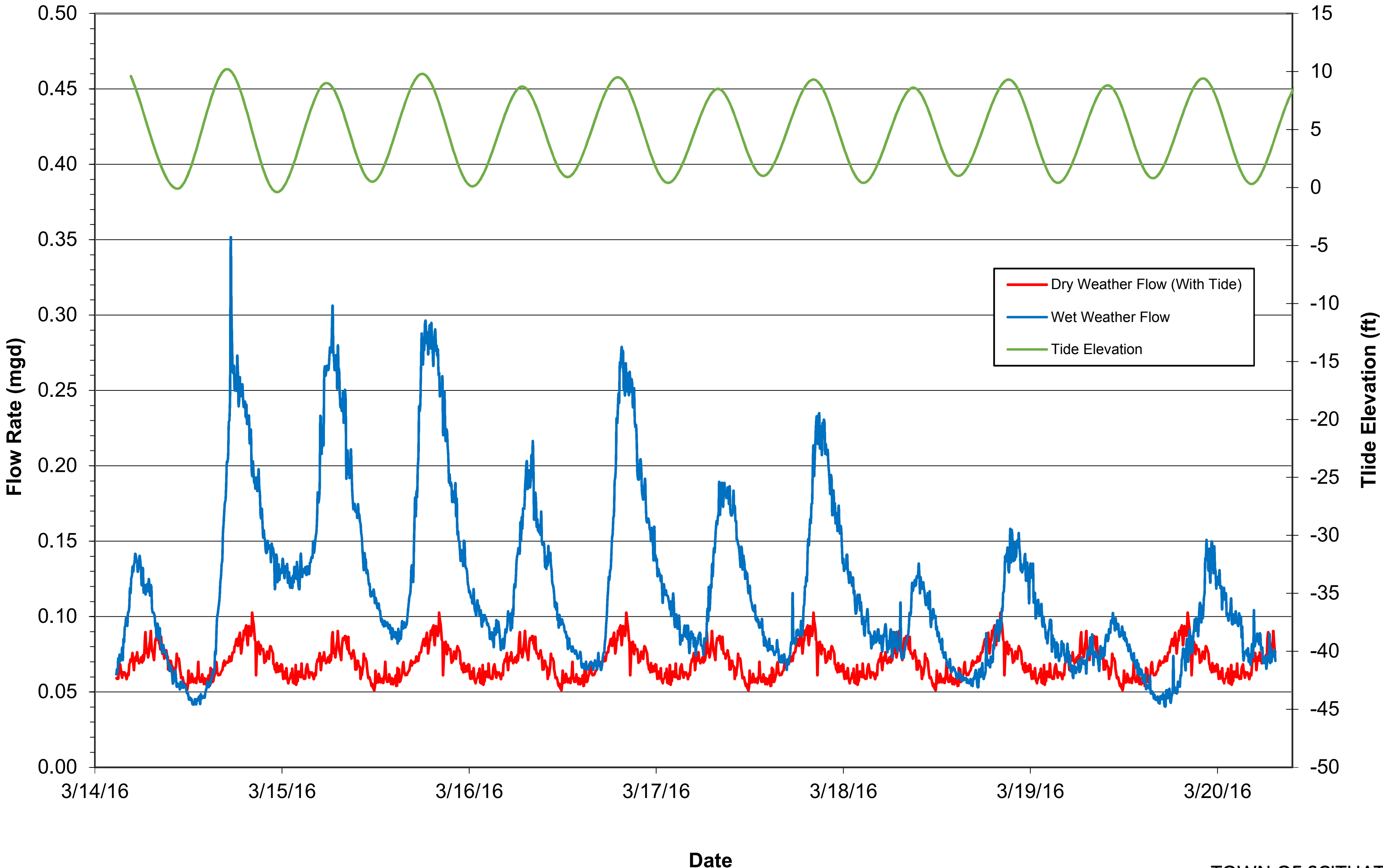
TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM WITH TIDE CURVE
METER 4-1

CDM Smith



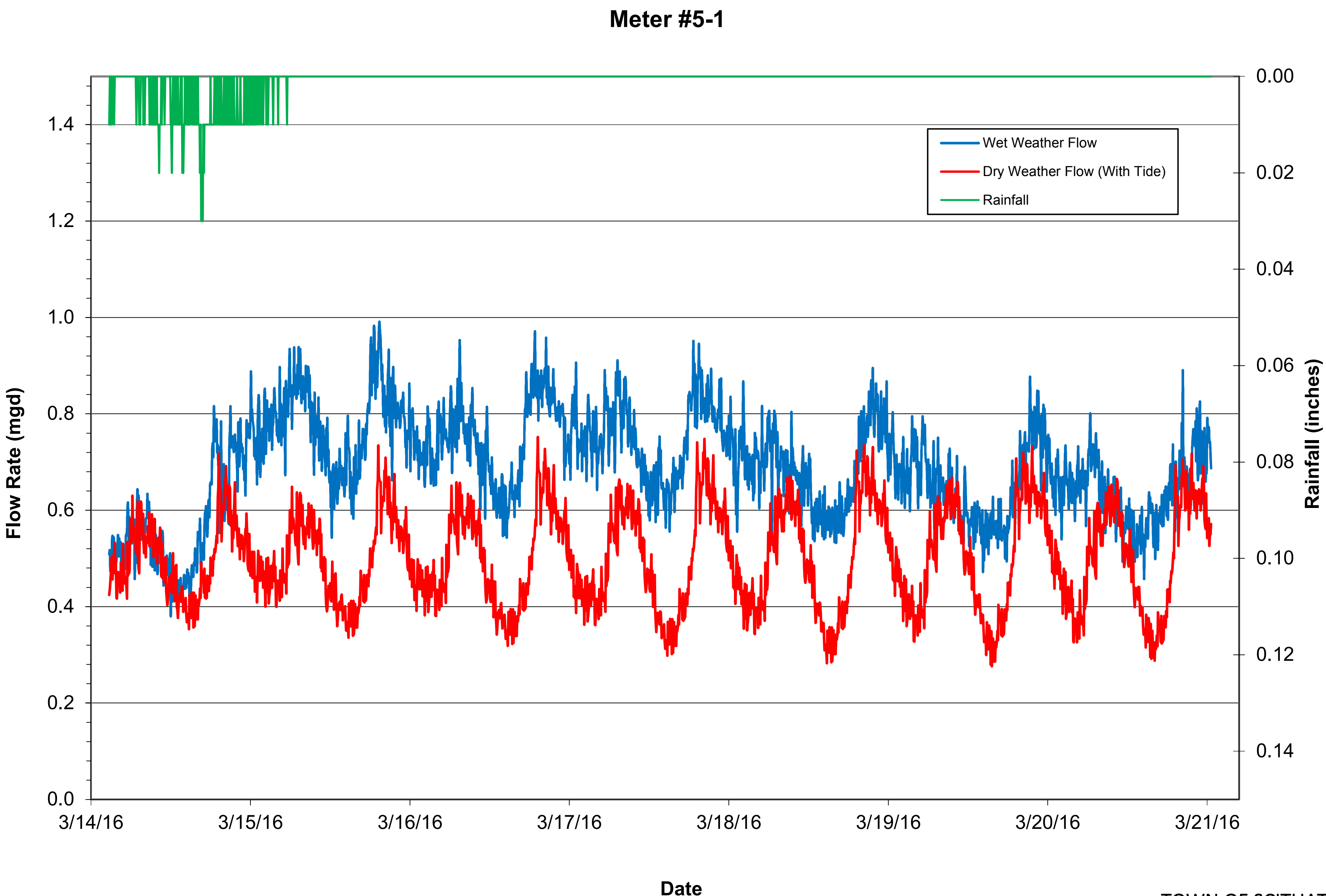
TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 4-2

Meter #4-2



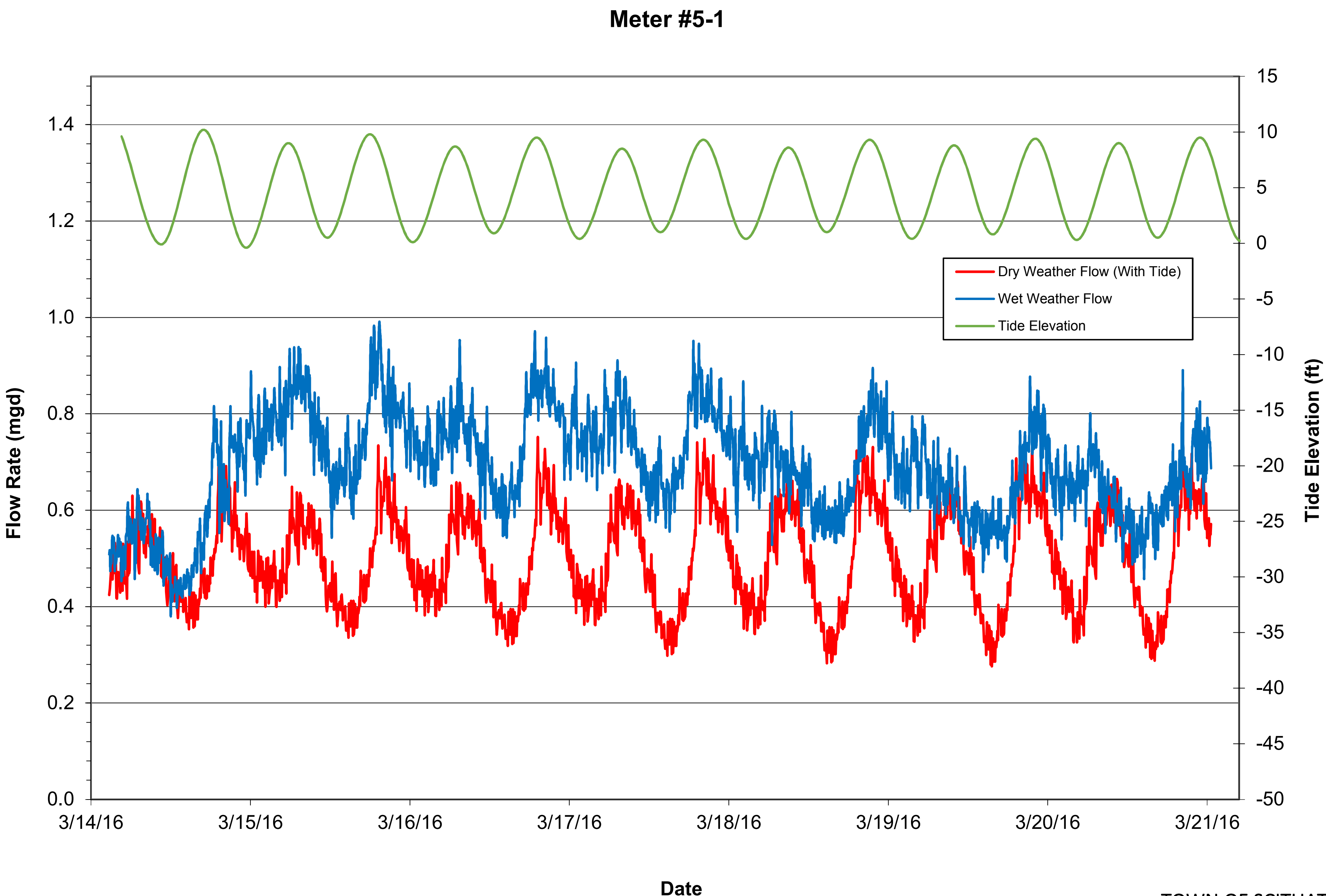
TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM WITH TIDE CURVE
METER 4-2

CDM Smith



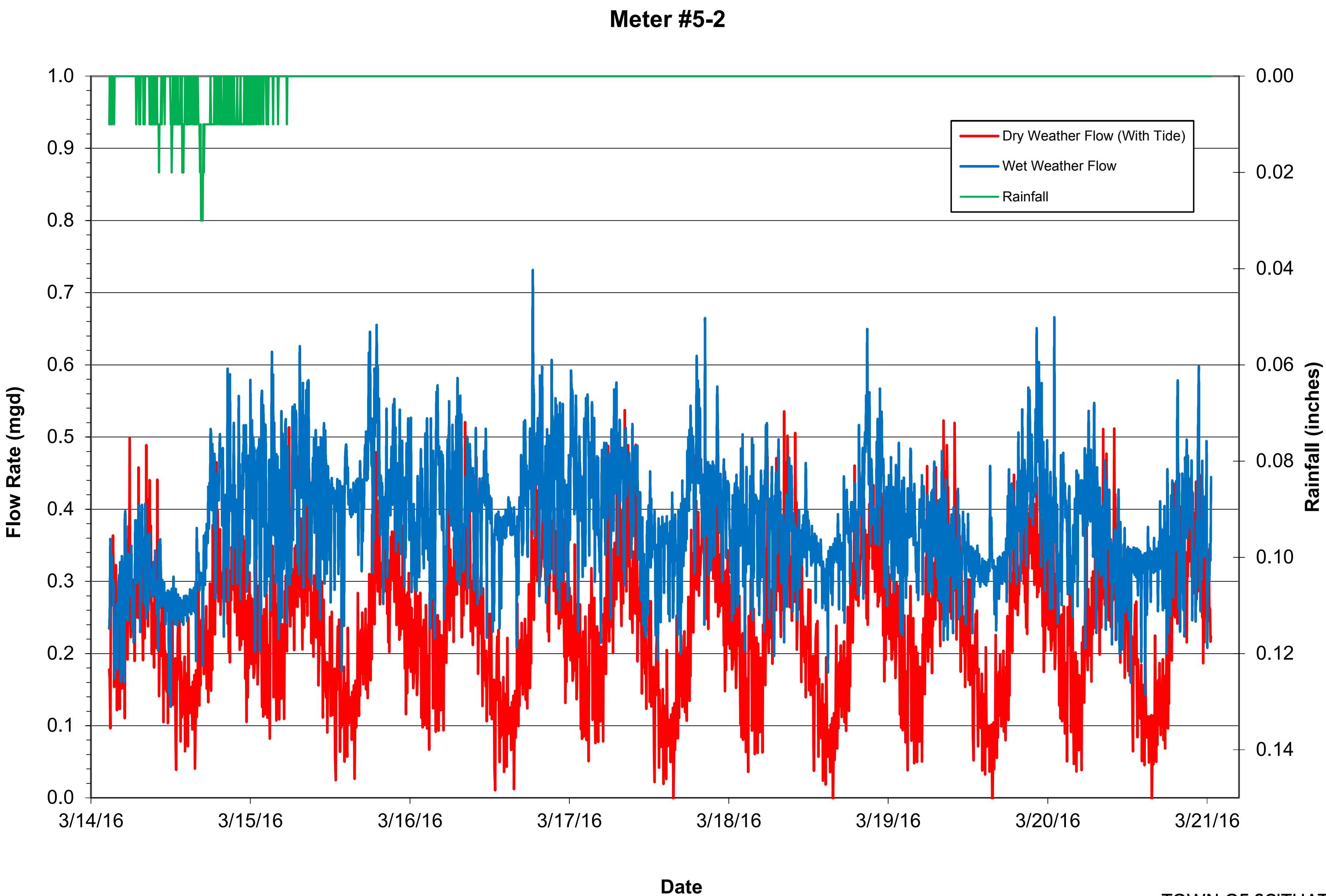
TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 5-1

CDM Smith



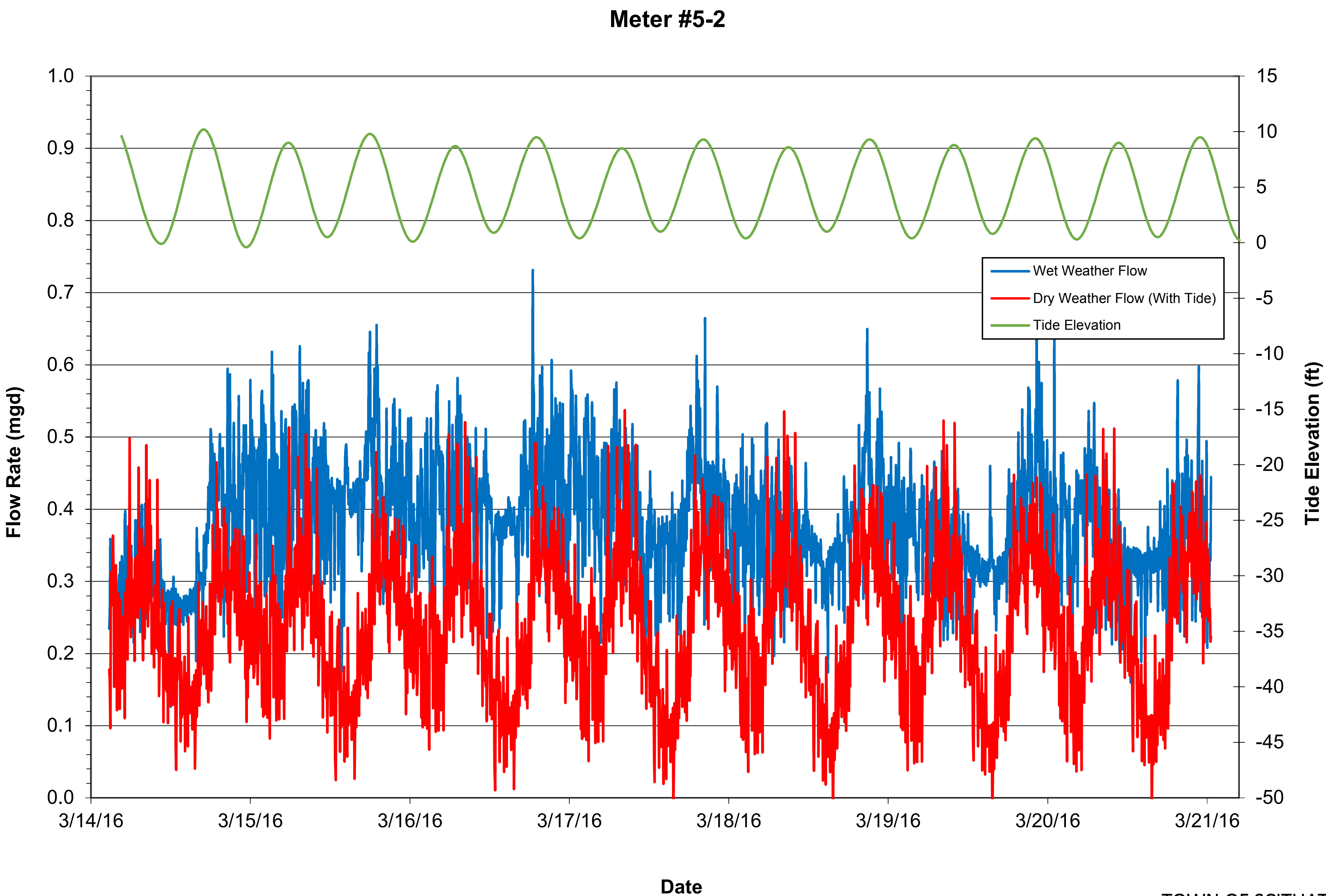
TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 5-1 WITH TIDE CURVE

CDM Smith

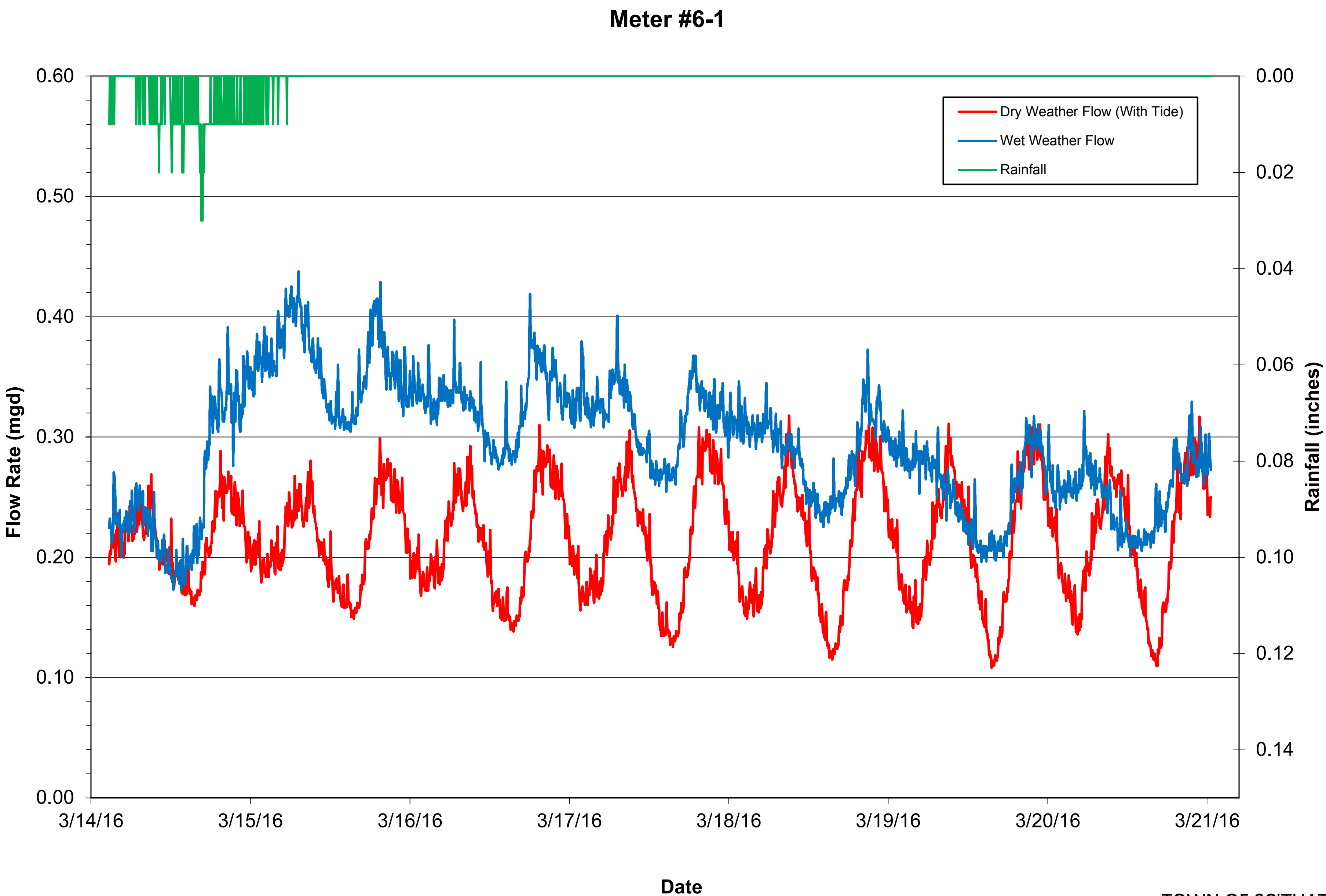


TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 5-2

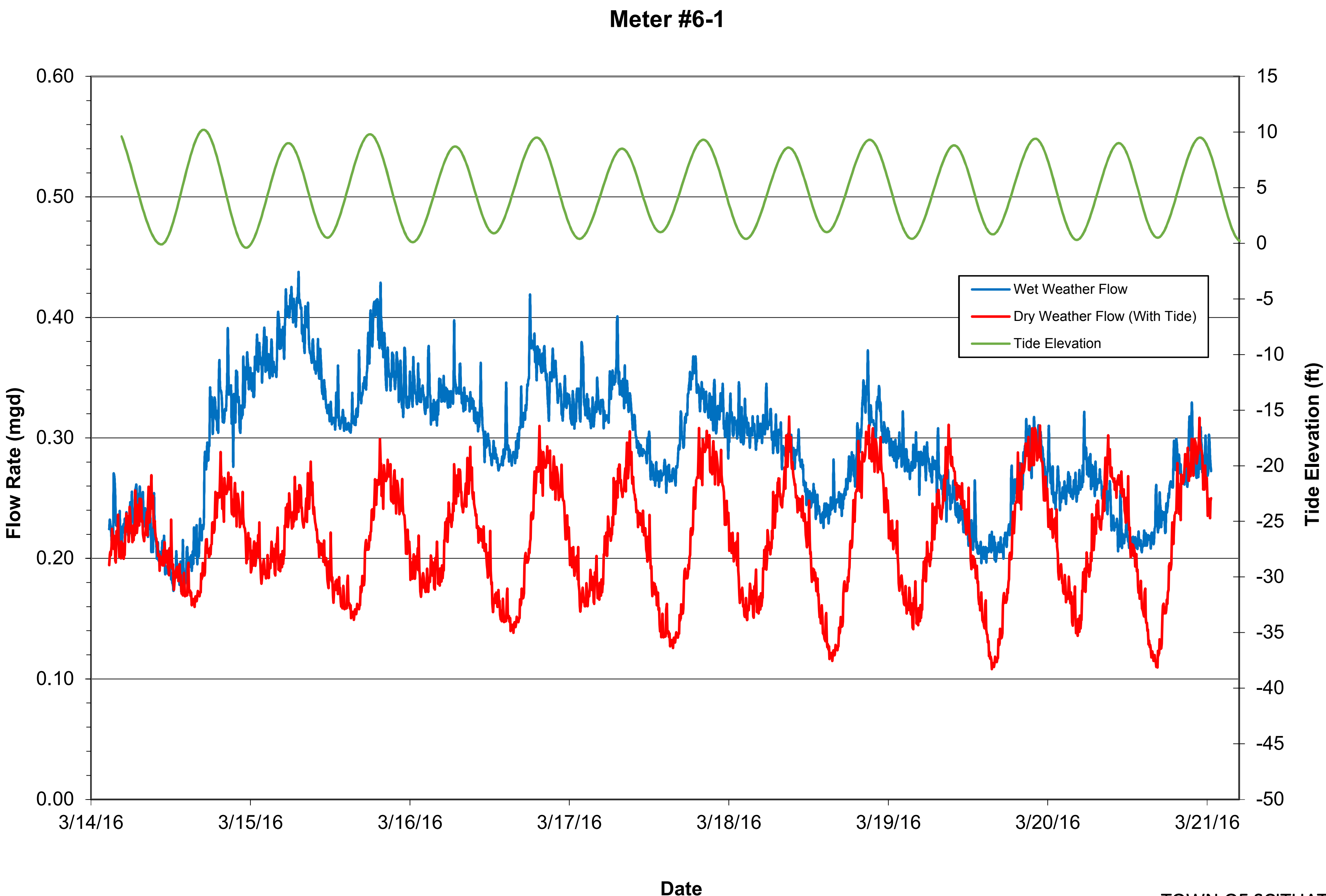
CDM Smith



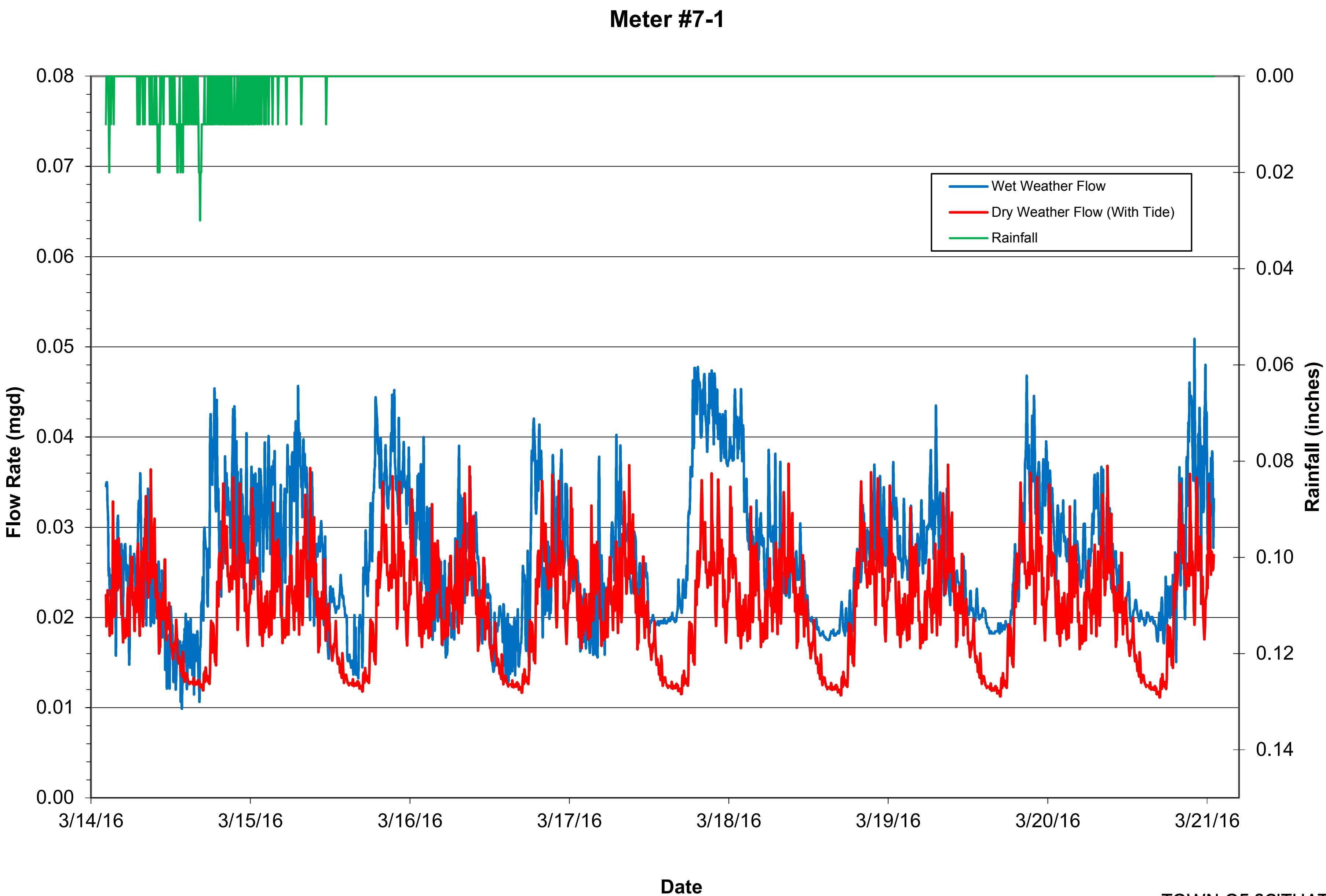
TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 5-2



TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 6-1

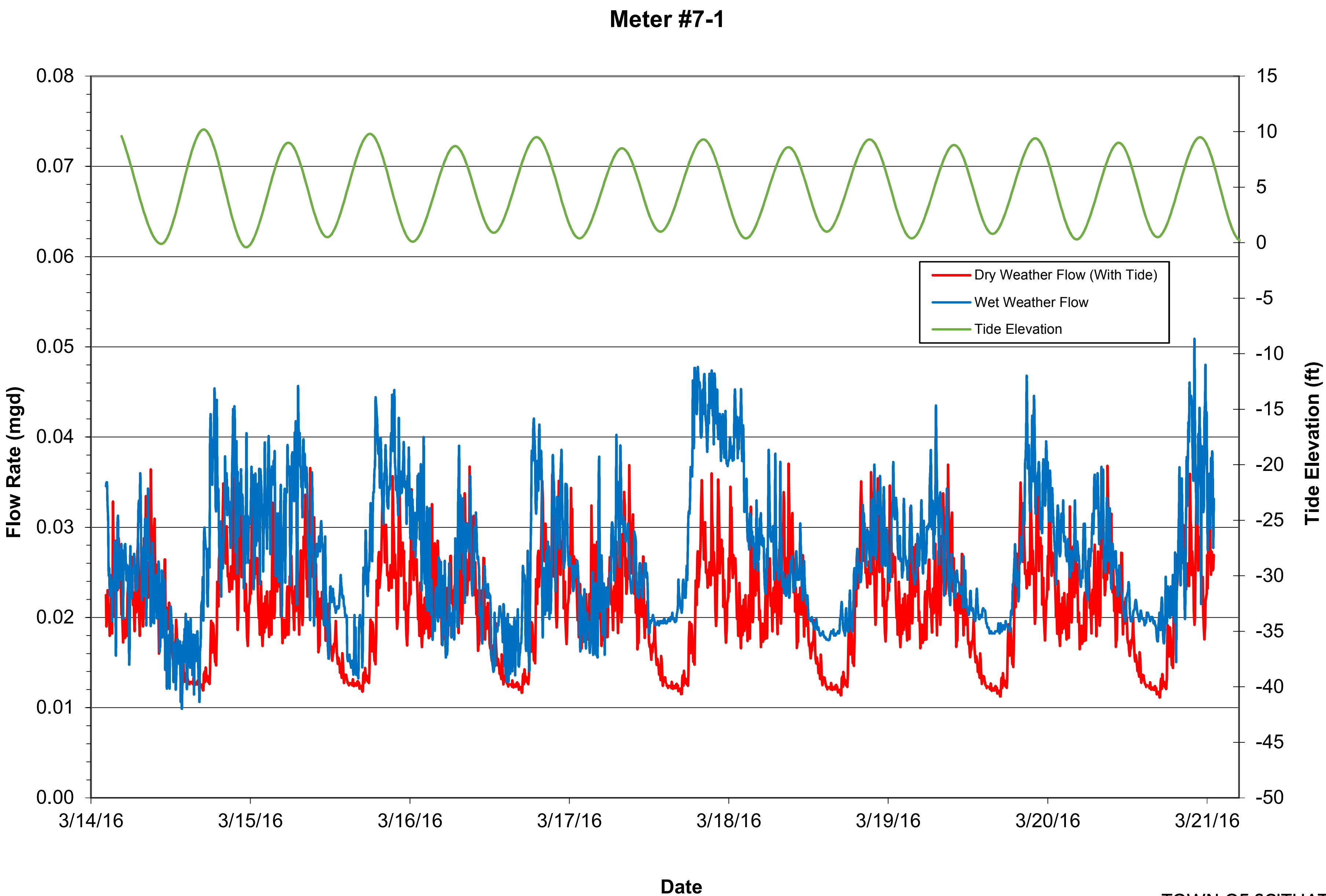


TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM WITH TIDE CURVE
METER 6-1

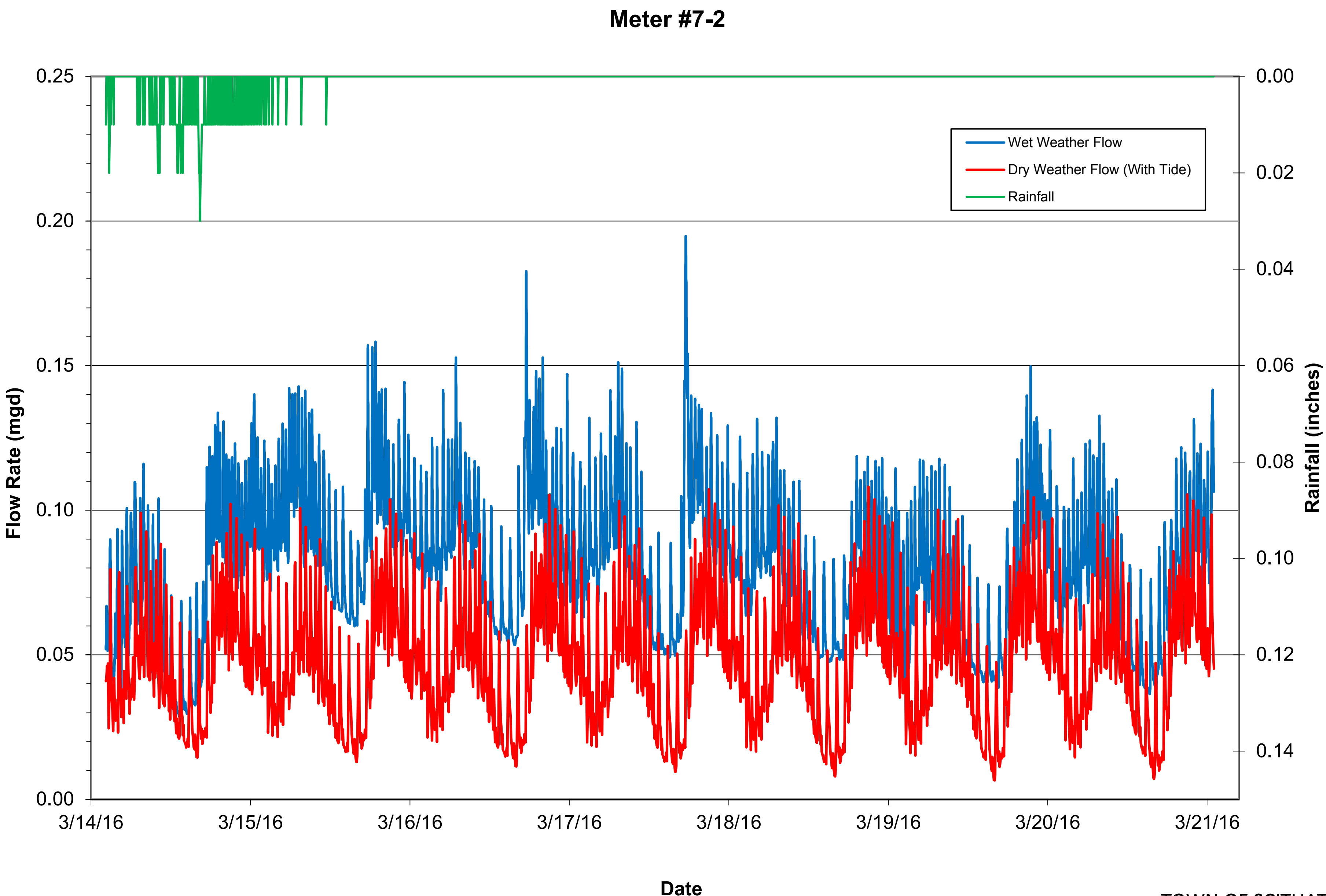


TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 7-1

CDM Smith



TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM WITH TIDE CURVE
METER 7-1

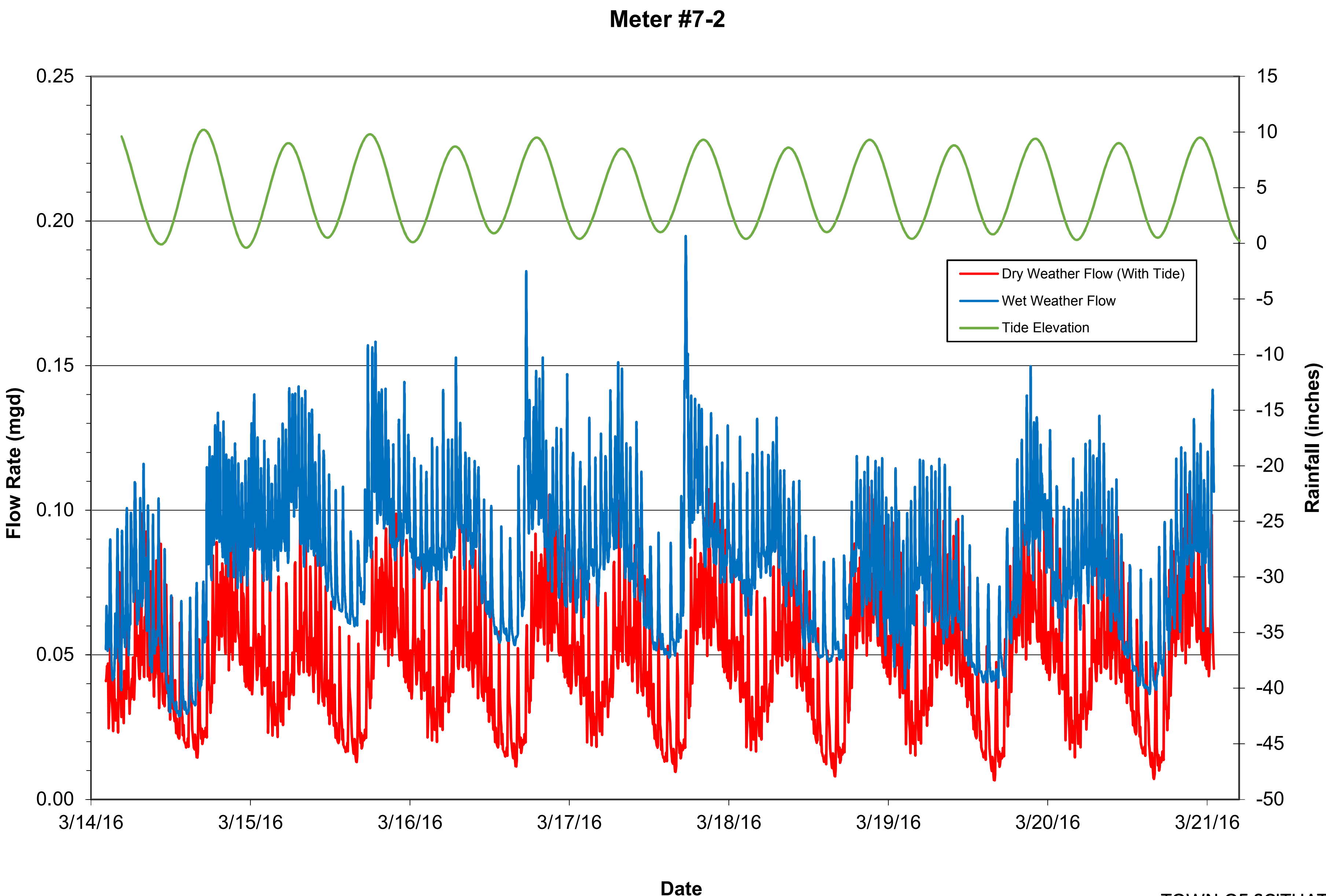


TOWN OF SCITUATE

FLOW MONITORING SUMMARY

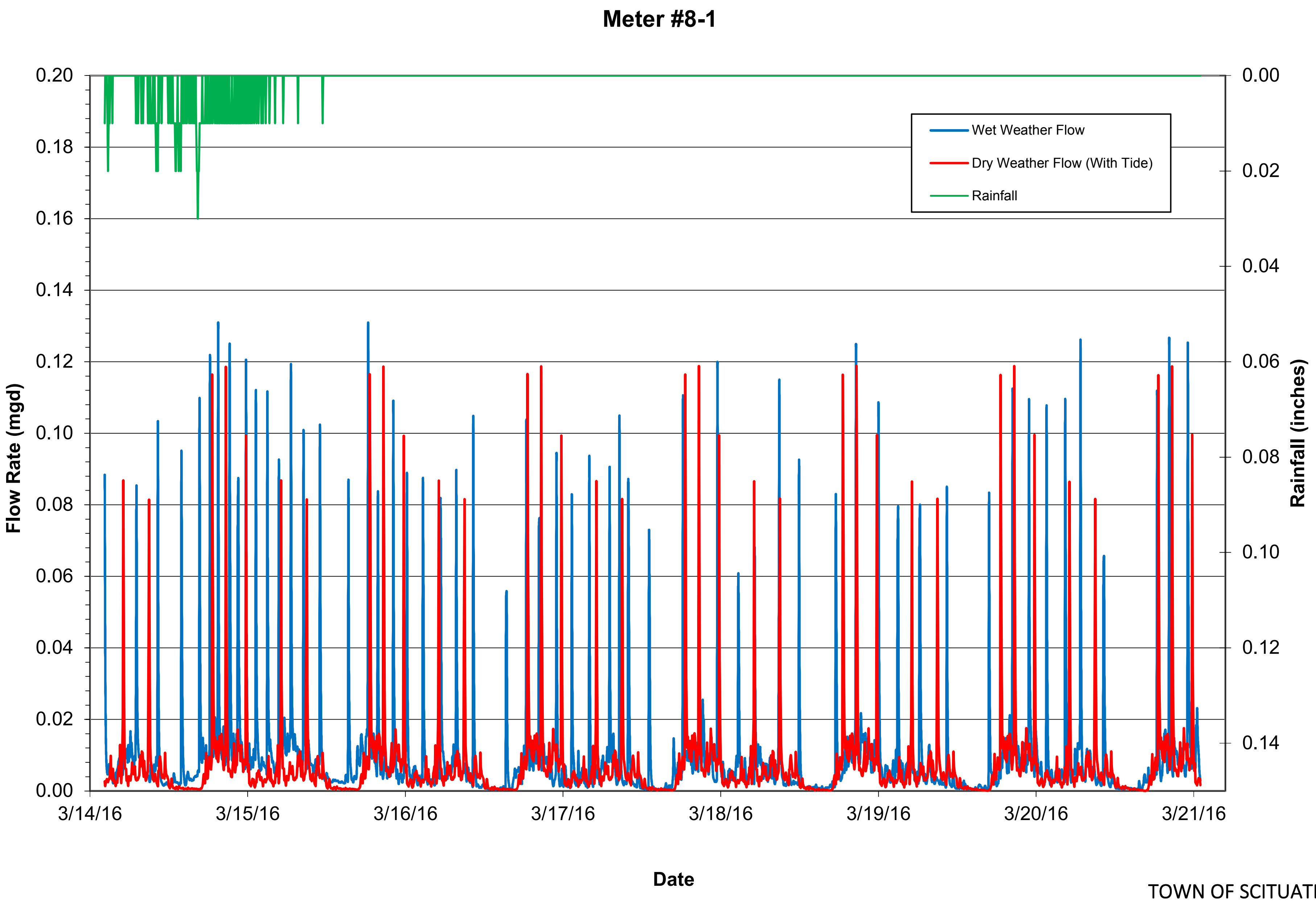
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM

METER 7-2



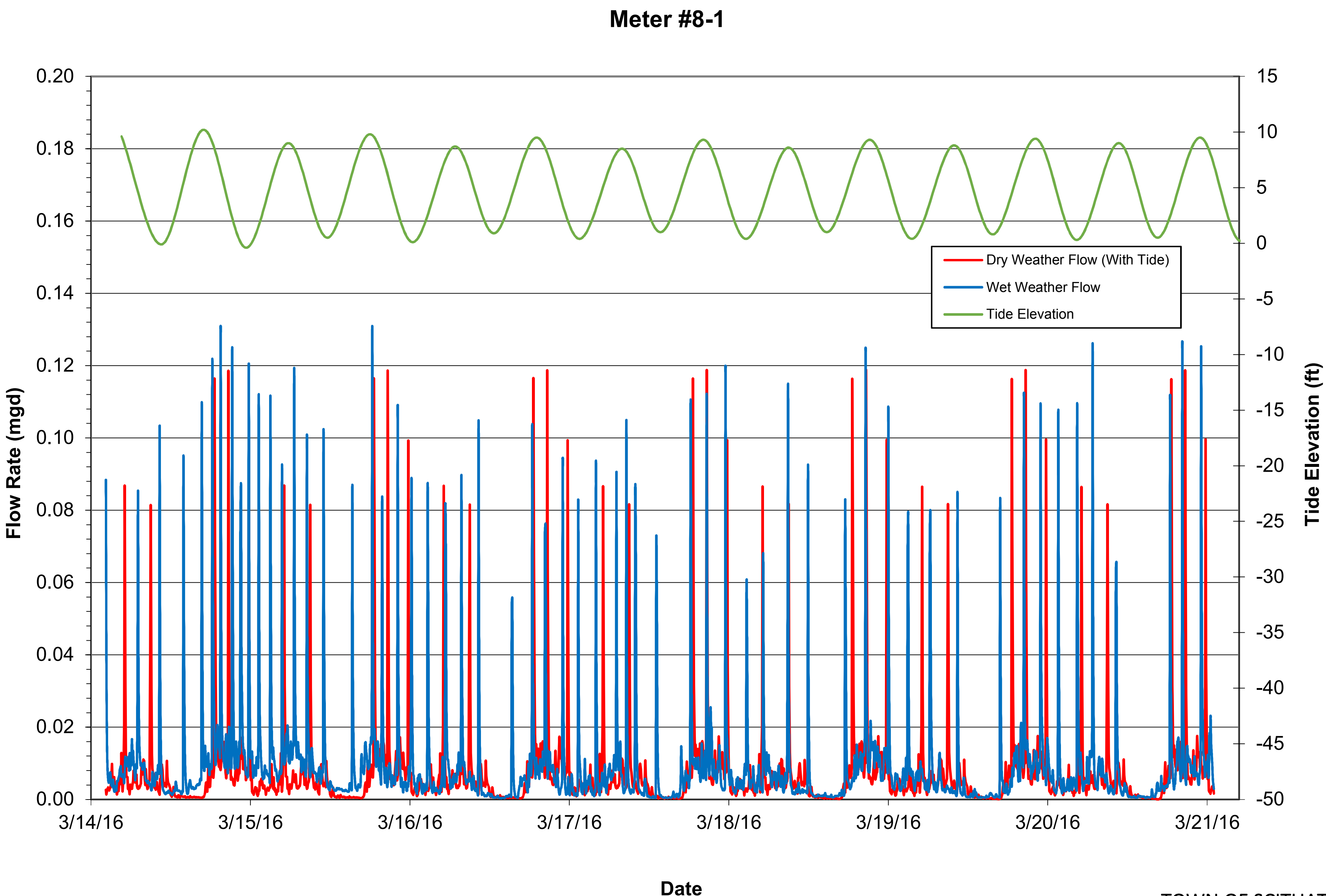
TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM WITH TIDE CURVE
METER 7-2

CDM Smith



TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM
METER 8-1

CDM Smith



TOWN OF SCITUATE
FLOW MONITORING SUMMARY
FLOW VS. TIME GRAPH - MARCH 14-21, 2016 STORM WITH TIDE CURVE
METER 8-1

CDM Smith

Attachment 7
Coastal Flood Vulnerability Assessment (Wastewater Treatment Plant)

Wastewater Treatment Plant Flood Vulnerability

The Wastewater Treatment Plant is vulnerable to both external flooding and internal flooding. External flooding includes: 1) inundation of floodwaters, resulting in flooding of treatment plant structures, systems and components (SSCs); 2) flooding of underground power and communications conduits and manholes; and 3) flooding of stormwater outfalls resulting in surcharging of the stormwater system, flow out of catch basins and manholes and reduction or loss of system drainage capacity. Internal flooding includes wastewater flooding of internal building spaces due to surcharging of the treatment system due to excess leakage and flow in the collection system and/or backwater effects within the treatment system due to elevated flood water levels at the effluent discharge outfalls.

Attachment 3 provides the treatment plant details. The following provides an overview of the potential Wastewater Treatment Plant external flood vulnerability by floodwater elevation. The following tables identify the potential external flood vulnerability at the buildings and major wastewater treatment plant system and components.

External Flood Vulnerability Overview

Flood Elevation 10 feet NAVD88:

Inundated treatment plant SSCs and other features:

- **Catch Basin 6**
- **Lagoon Riser**
- **Lagoon Overflow outlet to Marsh**
- **Emergency Storage Drain Pipe Outlet**
- **Emergency Storage Drain Pipe Riser**
- **Parshall Flume Outlet**

At a water elevation of 10 feet NAVD88, the Lagoon Overflow Outlet is submerged and water may begin to overtop the dike through wave action. Catch Basin No. 6 located on the northeast side of the treatment plant is also inundated which may reduce the effectiveness of the plant to handle on-site storm water runoff and causing pooling at the northeast corner of the plant. At this water level the plant is unlikely to be compromised due to external flooding.

Flood Elevation 11 feet NAVD88:

Additional inundated treatment plant SSCs and other features:

- **Instrumentation Manhole 4 (I4)**
- **Sewer Manholes 5, 6, 7 and 8 (MH 5, MH 6, MH 7, MH 8))**
- **Stormceptor 2**

At a water elevation of 11 feet NAVD88, flood water begins to pool around the Operations Building. Although water entry points (e.g., doors) to Operations Building are at elevations higher than 11 feet, accessing the building may be difficult in this scenario. Sewer manholes 5, 6, 7, and 8 (located around the Operations Building) are also inundated, infiltration through these manholes will likely affect the sludge pipes that enter and leave the Operations Building. Flood water is also likely to overtop most of the dike possibly causing structural damage to the dike through erosion.

Flood Elevation 12 feet NAVD88:

Additional inundated treatment plant SSCs and other features:

- **Stairwells 1 and 2 of Sludge Dewater Building**
- **Dewater Building Roof Drains**
- **All Windows, Doorways and Other Entryways to Operations Building**

- **Manhole 7 (MH 7)**

At a water elevation of 12 feet NAVD88 all Operation Building entryways and windows are inundated above their threshold elevation, potentially flooding the building's first floor. Portions of the east stairwells to the Sludge Dewatering Building will be submerged making entry to the building from the east side difficult. The weir elevation of the Post Aeration Tank is 11.68 feet NAVD88; a water elevation greater than this may affect the plant's ability to discharge treated effluent, possibly resulting in plant shutdown. Accessing the plant from the north via New Kent Street may also be difficult due to roadway flooding.

Flood Elevation 13 feet NAVD88:

Additional inundated treatment plant SSCs and other features:

- **Personnel Entryway (Door 6) of Filter Building**
- **East Stairwell 1 and 2 of Filter Building**
- **Stormwater Manhole 4 (MH 4)**

At a water elevation of 13 feet NAVD88 water partially submerges the east stairwells 1 and 2 of the Filter Building and Door 6 of the Filter Building. Under these conditions, access to the east side of the Filter Building will be difficult as well as access to the Methane Storage Tank. Accessing the plant from the north via New Kent Street and from the South via Drift way may be restricted due to roadway flooding, possibly cutting off the treatment plant from road access.

Flood Elevation 14 feet NAVD88:

Additional inundated treatment plant SSCs and other features:

- **Methane Building Outside Storage Closet**
- **Settling Tanks 1 & 2**
- **Catch Basin 2 and 3 (CB 2 and CB 3)**
- **Stormceptor 1**
- **Sewer Manhole 6 and 9 (MH 6 and MH 9)**

At a water elevation of 14 feet NAVD88 water will overtop settling tanks 1 and 2 likely compromising the treatment plant. Water will also reach the Methane Building's storage closet and several sewer manholes and catch basins.

Flood Elevation 15 feet NAVD88:

Additional inundated treatment plant SSCs and other features:

- **Personnel Entryway (Door 4) of Sludge Dewater Building**
- **Garage Entryway (Door 3) of Sludge Dewater Building**
- **Sodium Hydroxide Fill Line of at Sludge Dewater Building**
- **Sewage Effluent Pipes at Wall of Operations Building**
- **Outside Gas Pressure Regulator at Operations Building**
- **Window 3 and 4 of Filter building**
- **Public and Personnel Entryway (Door 1) of Filter Building**
- **Personnel Entryway (Door 2) of Filter Building**
- **Garage Entryway (Door 5) of Filter Building**
- **South Stairwell of Filter Building**
- **Wet Well Manholes outside Filter Building**

- **Outside Gas Pressure Regulator at Filter Building**
- **Settling Tank 3**
- **Electrical Manholes 2 and 3 (E2 and E3)**
- **Catch Basin 5 (CB 5)**
- **Inlet 5**
- **Stormwater Manholes 2 and 3 (MH 2 and MH 3)**
- **Sewer Manhole 2A (MH 2A)**

At a water elevation of 15 feet NAVD88, flood water will surround the Filter Building limiting access and flood the building's first floor though several entryways and windows. Water will also start to enter the Sludge Dewater Building though personnel entryways Door Nos. 3 and 4. Settling tank No. 3 is also overtopped. Electrical manholes 2 and 3 will be under water possibly resulting in loss of some electrical systems.

Flood Elevation 16 feet NAVD88:

Additional inundated treatment plant SSCs and other features:

- **Personnel Entryways (Door 1, Door 2, and Door 3) of Blower Building**
- **Outside Air Conditioning units at Blower Building**
- **Concrete Pad on West Side of Filter building**
- **East and West Stairwells of Generator Building**
- **Methane Fill Line at Methane Storage Tank**
- **Aeration Tanks 1, 2, and 3**
- **Post Aeration Tank**
- **Aerobic Digester 3**
- **Electrical Manholes 1, 4 and 5 (E1, E4 and E5)**
- **Instrumentation Manholes (I1, I2, and I3)**
- **Transformer Base Elevation**
- **Catch Basin 1 and 4 (CB1 and CB4)**
- **Inlet 1, 2, 3 and 4**
- **Stormwater Manhole 1 (MH 1)**

At a water elevation of 16 feet NAVD88 the northwest corner of the treatment plant becomes inundated making access to the plant via the main entrance dangerous. Water will reach Blower Building entryways flooding the building's first floor. Aeration tanks 1, 2, and 3 are overtopped as well as the post aeration tanks. All sewer, Electrical and instrumentation manholes will be under water as well as all catch basins.

Flood Elevation 17 feet NAVD88:

Additional inundated treatment plant SSCs and other features:

- **Septage Tank Concrete Pad**
- **Roof Drains at Septage Building**
- **Electrical Conduit Wall Penetrations at Septage building**
- **Personnel Entryway (Door 4) at Filter Building**

- **Fire Pipe Connection at Filter Building**
- **Electrical Conduit Wall Penetration at Filter building**
- **Control Panel at Filter building**
- **Aerobic Digesters 1 and 2**
- **Soda Ash Silo Base Concrete Pad**
- **Personnel Entryway (Door 1) at Soda Ash Silo**

At a water elevation of 17 feet NAVD88 water will inundate the Soda Ash Silo and Aerobic Digester 1 and 2 are overtopped. Effectively, the entire treatment plant will be inundated at this water elevation. Accessing any treatment system or building under these conditions will be restricted and dangerous.

Internal Flood Vulnerability Overview

Internal building flood vulnerabilities include: 1) effluent flow into the treatment plant exceeding the treatment plant capacity, resulting in overflow of internal wet wells; and 2) increased water elevations at the treatment system outfall, negatively impacting the system hydraulic gradient. GZA has not done an analysis of the treatment system hydraulic gradient; however, as indicated in **Attachment 3**, it appears that the system pump capacities can operationally support external water levels at the outfall of at least Elevation 9.6 feet NAVD88 (10.4 feet NGVD29). Coastal floods resulting in higher water levels at the outfall may exceed the internal pump capacities to maintain the design hydraulic gradient, resulting in system failure and internal flooding.

Table 7-1: Summary of Water Entry Points – WWTP Sludge Dewatering Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:															
East Windows		Sill Elevation	22.5±	21.7±											
South Windows		Sill Elevation	22.5±	21.7±											
Doors (Personnel and Public):															
East Personnel Entryway	Door 1	Door Threshold elev.	18.5±	17.7±											
East Personnel Entryway	Door 2	Door Threshold elev.	18.5±	17.7±											
North Personnel Entryway	Door 4	Door Threshold elev.	15.6±	14.8±											
North Personnel Entryway	Door 5	Door Threshold elev.	18.5±	17.7±											
West Personnel Entryway	Door 6	Door Threshold elev.	18.5±	17.7±											
Doors (Garage and Overhead):															
Garage Entryway	Door 3	Door Threshold elev.	15±	14.2±											
Outside Air Conditioning Units															
		None Observed													
Brick/Block Vents:															
North Side Louvered Vent		Sill Elevation	18.4±	17.6±											
South Side Air Vents		Sill Elevation	19.3±	18.5±											
Pipe Vents:															
South Side Pipe Vents		Pipe Invert	18.4±	17.6±											
Exterior Depressed Stairwell:															
East Stairwell 1		Bottom of Step	12.1±	11.3±											
East Stairwell 2		Bottom of Step	12.3±	11.5±											
Other:															
Roof Drains		Invert of pipe at wall	12.8±	12.0±											
Pipe Wall Penetrations to daylight		None Observed													
Electrical Conduit Wall Penetrations:		None Observed													
Chemical Fill Line Connections															
Sodium Hydroxide Fill Line		Invert of pipe at wall	15.4±	14.6±											
Outside Gas Pressure Regulator Elev.		None Observed													

Table 7-2: Summary of Water Entry Points – WWTP Operations Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:															
East Window		Sill Elevation	12.5±	11.7±											
South Windows		Sill Elevation	12.5±	11.7±											
North Windows		Sill Elevation	12.5±	11.7±											
Doors (Personnel and Public):															
East Personnel Entryway	Door 1	Door Threshold elev.	12.5±	11.7±											
East Personnel Entryway	Door 2	Door Threshold elev.	12.5±	11.7±											
South Personnel Entryway	Door 3	Door Threshold elev.	12.5±	11.7±											
South Personnel Entryway	Door 4	Door Threshold elev.	12.5±	11.7±											
North Personnel Entryway	Door 6	Door Threshold elev.	12.5±	11.7±											
Doors (Garage and Overhead):															
West Garage Entryway	Door 5	Door Threshold elev.	12.5±	11.7±											
Outside Air Conditioning Units		None Observed													
Other:															
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed													
Electrical Conduit Wall Penetrations:		None Observed													
Chemical Fill Line Connections		None Observed													
East Side Sewage Effluent Pipe		Invert of pipe at wall	15.5±	14.7±											
South Side Sewage Effluent Pipe		Invert of pipe at wall	15.5±	14.7±											
Outside Gas Pressure Regulator Elev.		Lowest Elevation	12.3±	11.5±											

Table 7-3: Summary of Water Entry Points – WWTP Septage Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:															
East window	W1	Sill Elevation	20.1±	19.3±											
Doors (Personnel and Public):															
Personnel Entryway	Door 1	Door Threshold elev.	18.5±	17.7±											
Doors (Garage and Overhead):		None Observed													
Outside Air Conditioning Units		None Observed													
Pipe Vents:															
South Side Pipe Vents		Pipe Invert	21.3±	20.5±											
Exterior Depressed Stairwell:		None Observed													
Other:															
Septage Tank Pad		Top of concrete pad	17.3±	16.5±											
Roof Drains		Pipe Invert	16.8±	16.0±											
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed													
Electrical Conduit Wall Penetrations:		Wall penetration	17.8±	17.0±											
Chemical Fill Line Connections		None Observed													
Outside Gas Pressure Regulator Elev.		None Observed													

Table 7-4: Summary of Water Entry Points – WWTP Blower Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:															
South Windows		Sill Elevation													
North Windows		Sill Elevation													
Doors (Personnel and Public):															
South Personnel Entryway	Door 1	Door Threshold elev.	16.4±	15.6±											
South Personnel Entryway	Door 2	Door Threshold elev.	16.4±	15.6±											
North Personnel Entryway	Door 3	Door Threshold elev.	16.4±	15.6±											
Doors (Garage and Overhead):		None Observed													
Outside Air Conditioning Units		Pad Elevation	16.2±	15.4±											
Pipe Vents:															
West Side Pipe Vent		Pipe Invert	26.4±	25.6±											
Other:															
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed													
Electrical Conduit Wall Penetrations:		Wall penetration	17.9±	17.1±											
Chemical Fill Line Connections		None Observed													
Outside Gas Pressure Regulator Elev.		None Observed													

Table 7-5: Summary of Water Entry Points – WWTP Generator Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:		None Observed													
Doors (Personnel and Public):															
East Personnel Entryway	Door 1	Door Threshold elev.	19.2±	18.4±											
West Personnel Entryway	Door 2	Door Threshold elev.	19.2±	18.4±											
Doors (Garage and Overhead):		None Observed													
Outside Air Conditioning Units		None Observed													
Pipe Vents:		None Observed													
Exterior Depressed Stairwell:															
East Stairwell		Bottom of Step	16.2±	15.4±											
West Stairwell		Bottom of Step	16.2±	15.4±											
Other:															
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed													
Electrical Conduit Wall Penetrations:		None Observed													
Chemical Fill Line Connections		None Observed													
Outside Gas Pressure Regulator Elev.		None Observed													

Table 7-6: Summary of Water Entry Points – WWTP Filter Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Windows:															
Window 1	W1	Sill Elevation	18.8±	18.0±											
Window 2	W2	Sill Elevation	18.8±	18.0±											
Window 3	W3	Sill Elevation	15.5±	14.7±											
Window 4	W4	Sill Elevation	15.5±	14.7±											
Window 5	W5	Sill Elevation	18.8±	18.0±											
Window 6	W6	Sill Elevation	18.8±	18.0±											
Window 7	W7	Sill Elevation	18.8±	18.0±											
Doors (Personnel and Public):															
Main Public and Personnel Entryway	Door 1	Door Threshold elev.	15.5±	14.7±											
Personnel Entryway	Door 2	Door Threshold elev.	15.5±	14.7±											
Personnel Entryway	Door 3	Door Threshold elev.	21.5±	20.7±											
Personnel Entryway	Door 4	Door Threshold elev.	17.5±	16.7±											
Personnel Entryway	Door 6	Door Threshold elev.	13.0±	12.2±											
Doors (Garage and Overhead):															
Garage Entryway	Door 5	Door Threshold elev.	15.5±	14.7±											
Outside Air Conditioning Units		None Observed													
Pipe Vents:		None Observed													
Exterior Depressed Stairwell:															
West Stairwell		Bottom of Step	15.5±	14.7±											
East Stairwell 1		Bottom of Step	13.5±	12.7±											
East Stairwell 2		Bottom of Step	13.5±	12.7±											
Other:															
Fire Pipe Connection		Invert of pipe at wall	17.8±	17.0±											
Concrete Pad		Lowest Point	16.2±	15.4±											
Top Filter Beds		Lowest Point	21.3±	20.5±											
Wet Well Manhole covers		Rim elevation	15.7±	14.9±											
Outside Gas Pressure Regulator Elev.		Lowest Elevation	15.8±	15.0±											
Electrical Conduit Wall Penetrations:		Wall Penetration	17.5±	16.7±											
Chemical Fill Line Connections		None Observed													
Control Panel		Lowest Elevation	17.8±	17.0±											
Electric Meter		Lowest Elevation	18.3±	17.5±											

Table 7-7: Summary of Water Entry Points – WWTP Methane Building

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Outside Storage Closet	Door 1	Door Threshold elev.	14.2±	13.4±											
Pipe Wall Penetrations to daylight or unsealed vaults/manholes		None Observed													
Electrical Conduit Wall Penetrations:		None Observed													
Chemical Fill Line Connections															
Methane Fill Line		Pipe Invert	16.3±	15.5±											

Table 6-8: Summary of Water Entry Points – WWTP Aeration Tanks

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Top of Lowest Wall															
Aeration Tank 1	1	Lowest Point	16.2±	15.4±											
Aeration Tank 2	2	Lowest Point	16.2±	15.4±											
Aeration Tank 3	3	Lowest Point	16.2±	15.4±											
Aeration Tank 4	4	Lowest Point	20.6±	19.8±											
Post Aeration Tank		Lowest Point	16.0±	15.2±											

Table 7-9: Summary of Water Entry Points – WWTP Aerobic Digestors

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Top of Lowest Wall															
Aerobic Digester 1	1	Lowest Point	17.3±	16.5±											
Aerobic Digester 2	2	Lowest Point	17.3±	16.5±											
Aerobic Digester 3	3	Lowest Point	16.2±	15.4±											

Table 7-10: Summary of Water Entry Points – Soda Ash Silo

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Concrete Base Pad		Concrete Pad	17.7±	16.9±											
Personnel entryway	Door 1	Door Threshold elev.	17.8±	17.0±											
Control Panel		Lowest Elevation	21.3±	20.5±											
Electric Conduit Wall Penetration		Wall Penetration	24.8±	24.0±											

Table 7-11: Summary of Water Entry Points – WWTP Settling Tanks

Water Entry Points	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Top of Lowest Point on Settling Tank Wall															
Settling Tank 1	1	Lowest Point	14.7±	13.9±											
Settling Tank 2	2	Lowest Point	14.6±	13.8±											
Settling Tank 3	3	Lowest Point	15.7±	14.5±											

Table 7-12: Summary of Water Entry Points – North River WWTP Site - Electrical & Instrumentation

Water Entry Points	ID	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
				7	8	9	10	11	12	13	14	15	16	17
Electrical														
Manhole/Hatch Rim	E1	16.1±	15.3±											
Manhole/Hatch Rim	E2	14.9±	14.1±											
Manhole/Hatch Rim	E3	15.0±	14.2±											
Manhole/Hatch Rim	E4	16.1±	15.3±											
Manhole/Hatch Rim	E5	16.0±	15.2±											
Instrumentation														
Manhole/Hatch Rim	I1	15.9±	15.1±											
Manhole/Hatch Rim	I2	14.9±	14.1±											
Manhole/Hatch Rim	I3	15.1±	14.3±											
Manhole/Hatch Rim	I4	11.7±	10.9±											
Other														
Transformer Base Elev.		16.0±	15.2±											

Table 7-13: Summary of Water Entry Points – North River WWTP Site – Stormwater and Sewer Structures

Water Entry Points	ID	Inv. Elevation (feet, NGVD29)	Inv. Elevation (feet, NAVD88)	Rim Elevation (feet, NGVD29)	Rim Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
						7	8	9	10	11	12	13	14	15	16	17
Stormwater																
Catch Basin Rim	CB 1	12.9±	12.1±	16.1±	15.3±											
Catch Basin Rim	CB 2	12.0±	11.2±	14.5±	13.7±											
Catch Basin Rim	CB 3	11.6±	10.8±	14.8±	14.0±											
Catch Basin Rim	CB 4	11.8±	11.0±	17.3±	16.5±											
Catch Basin Rim	CB 5	9.6±	8.8±	15.1±	14.3±											
Catch Basin Rim	CB 6	6.3±	5.5±	9.5±	8.7±											
Inlet	Inlet 1	13.3±	12.5±	16.2±	15.4±											
Inlet	Inlet 2	12.9±	12.1±	16.2±	15.4±											
Inlet	Inlet 3	13.0±	12.2±	16.2±	15.4±											
Inlet	Inlet 4	12.8±	12.0±	16.2±	15.4±											
Inlet	Inlet 5	12.0±	11.2±	15.3±	14.5±											
Drain Manhole Rim	MH 1	16.2±	15.4± (out)	16.1±	15.3±											
Drain Manhole Rim	MH 2	11.5±	10.7± (out)	15.7±	14.9±											
Drain Manhole Rim	MH 3	9.8±	9.0± (out)	15.0±	14.2±											
Drain Manhole Rim	MH 4	9.8±	9.0± (out)	12.9±	12.1±											
Stormceptor	1	NA	NA	14.4±	13.6±											
Stormceptor	2	NA	NA	11.6±	10.8±											
Sewer																
Sewer Manhole Rim	MH 2A	-1.8±	-2.6± (out)	15.2±	14.4±											
Sewer Manhole Rim	MH 5	6.1±	5.3± (out)	11.5±	10.7±											
Sewer Manhole Rim	MH 6	-7.1±	-7.9± (out)	11.8±	11.0±											
Sewer Manhole Rim	MH 7	-6.4±	-7.2± (out)	12.1±	11.3±											
Sewer Manhole Rim	MH 6	NA	NA	14.4±	13.6±											
Sewer Manhole Rim	MH 7	NA	NA	11.7±	10.9±											
Sewer Manhole Rim	MH 8	NA	NA	11.8±	11.0±											
Sewer Manhole Rim	MH 9	NA	NA	15.5±	14.7±											

Other	ID	Description Critical Elevation	Elevation (feet, NGVD29)	Elevation (feet, NAVD88)	Flood Elevation, feet NAVD88										
					7	8	9	10	11	12	13	14	15	16	17
Lagoon Riser		Pipe Inver	10.0±	9.2±											
Lagoon Overflow Outlet to Marsh		Pipe Invert	10.0±	9.2±											
Top of Lagoon Levee (low point)		Top of Dike	11.5±	10.7±											
Drain Pipe Outlet		Pipe Invert	6.6±	5.8±											
Drain Pipe Riser		Pipe Invert	7.1±	6.3±											
Top of Parshall Flume		Top of Structure	13.5±	12.7±											
Parshall Flume		Outlet to Lagoon	8.3±	7.5±											

Table 7-13 cont.

Treatment Plant SSCs	Flood Elevation, feet NAVD88										
	7	8	9	10	11	12	13	14	15	16	17
Sludge Dewatering Building											
Operations Building											
Septage Building											
Blower Building											
Generator Building											
Filter Building											
Methane Building											
Aeration Tanks											
Aerobic Digesters											
Soda Ash Silo											
Settling Tanks											
Electrical											
Instrumentation											
Transformer											
Stormwater Infrastructure											
Sewer Infrastructure											
Lagoon Levee (Dike Crest)											
Lagoon Overflow Outlet											
Discharge Pipe Outlet											
Parshall Flume Outlet											

Notes:

Green indicates No Impact.
Red indicates Some to Significant Impact.
Bold SSC indicates that structure is critical to complete treatment plant failure.

Table 7-14: Summary of Treatment SSC Vulnerability

Attachment 8
Collection and Treatment System Vulnerability

Collection and Treatment System Vulnerability

The Scituate Collection system was divided into 14 collection sub-areas as shown in **Figure 8-1**. **Figure 8-2** is a simplified flow chart showing how collection sub-areas are connected and the path effluent takes to reach the Wastewater Treatment Plant.

Elevations of critical components were collected for each pump station (seen in **Attachment 2**) as well as at the Wastewater Treatment Plant (WWTP) (seen in **Attachment 3**). This data was used to estimate flood water elevations that would likely cause damage to the pump stations and the WWTP. Two threshold elevations were chosen, one where limited damage is expected and one where total disruption is expected. At the limited damage elevation, some components of the pump station or WWTP may become damaged; however, the system may still be able to operate, and total loss is not expected. At the total disruption elevation, flood water would likely cause major damage to critical components and cause the pump station or WWTP to completely fail. This critical flood elevation was estimated based on the lowest elevation of vital components such as a generator or major control panel. When a pump station fails, pump stations and collection sub-areas located upstream of the compromised station are impacted as well. Any system upstream of the failure may experience backups; however, pump stations downstream of the failure may still function normally. For the WWTP total failure is expected to occur when flood waters reach about 14 feet NAVD88.

Flood elevations were estimated at each pump station under the 2-year, 10-year, 50-year and 100-year flood recurrence interval for current (2019) climate conditions based on GZA's interpretation of multiple data sources. Potential impacts using the FEMA estimated 100-year BFE for 2019 were also estimated. **Table 8-1** shows each pump station's estimated disruption elevations as well as the estimated flood elevation during each flood recurrence interval. **Figures 8-3 through 8-7** show impacted pump stations and the resulting system impacts during different flood events. These figures demonstrate how the disruption of one pump station can impact collection sub-areas and pump stations located upstream of the failed pump station. Note that the Hatherly School, First Parish Road and Country Way pump stations are not located within FEMA flood zones and vulnerability was not assessed for these pump stations.

During the 2-year recurrence interval flood no pump stations are expected to fail due to internal flooding of components, thus no impacts are shown in **Figure 8-4**. During the 10-year recurrence interval flood, lower levels of the Sand Hills Pump Station are at risk of being flooded possibly causing some damage; however, the pump station may still function. In the event the Sand Hills Pump Station fails, collection areas that feed into the pump station will likely experience backups and other failures. The failure of the Sand Hills Pump Station may affect the performance of the Chain Pond, Musquashicut and Hatherly Brook pump stations.

During the 50-year recurrence interval flood limited damage is expected at Herring Brook, Sand Hills, Musquashicut and Edward Foster pump stations as well as the WWTP. If the WWTP experiences a failure the effects would be felt across the entire collection system. Major backups and uncontrolled discharges of untreated effluent would likely occur until the system is brought back online.

During the 100-year recurrence interval flood the Sand Hills, Musquashicut and Edward Foster pump stations are expected to experience limited damage while the Herring Brook Pump station and the WWTP are likely to experience major component failure. The WWTP is likely to fail at this flood elevation with portions of the plant being completely inundated. The high flood waters will make accessing portions of the plant dangerous affecting the ability of crews to make repairs.

For the FEMA Base Flood Elevation (100-year recurrence interval flood as determined by FEMA), major damage and component failure is expected for all major systems except for the Chain Pond Pump Station where only limited damage is expected.

Tables 8-2 through 8-6 summarize the estimate damage costs, labor costs to make repairs and loss of service costs. The number of serviced properties impacted for each flood event and assumed component asset values are also shown.

Table 8-1: Flood Elevation Impact Summary

Pump Station	Total Disruption Elev. (ft, NAVD88)	Limited Damage Elev. (ft, NAVD88)	Finished Floor Elev. (ft, NAVD88)	Existing Grade Elev. (ft, NAVD88)	2019 Wave Crest Elevation (ft, NAVD88) 2-year	10-year	50-year	100-year	2019 FEMA BFE (ft, NAVD88) 100-year
Musquashicut Ave	10.0	8.0	11.6	7.1	6.5	8.0	8.8	9.0	13.0
Chain Pond	16.0	13.0	15.5	11.9	6.5	8.0	8.5	9.0	14.0
Sand Hills	12.0	8.0	11.4	7.3	6.5	10.2	11.2	11.6	15.0
Edward Foster	11.0	10.0	10.1	9.1	7.0	9.0	10.0	10.8	16.0
Peggotty Beach	11.0	10.0	10.7	10.5	6.5	8.0	9.0	9.5	17.0
Herring Brook	11.0	10.8	10.8	10.6	7.5	9.5	10.8	11.5	16.0
Collier	16.0	15.5	15.5	15.5	7.5	9.5	10.5	11.0	16.0
Hatherly School	NA	NA	NA	40	NA	NA	NA	NA	NA
First Parish Road	NA	NA	NA	64	NA	NA	NA	NA	NA
Country Way	NA	NA	NA	57	NA	NA	NA	NA	NA
Treatment Plant	13.0	11.0	varies	varies	7.0	10.8	12.5	13.6	16.0

Orange denotes limited damage expected with possibility of system failure.

Red denotes major damage expected with high likelihood of system failure.

Table 8-2: 2-year Flood Estimated Damage Costs

Pump Station	No. of Buildings Impacted	Est. Damage Loss ($)	Asset Value
Musquashicut Ave	0	$ -	$ 1,040,400
Chain Pond	0	$ -	$ 1,139,481
Sand Hills	0	$ -	$ 1,367,961
Edward Foster	0	$ -	$ 1,040,400
Peggotty Beach	0	$ -	$ 1,040,400
Herring Brook	0	$ -	$ 1,020,000
Collier Road	0	$ -	$ 1,020,000
Hatherly School	0	$ -	$ 1,200,000
First Parish Road	0	$ -	$ 872,344
Country Way	0	$ -	$ 1,020,000
Treatment Plant	0	$ -	$ 25,000,000
Total	0		
	Est. Damage Loss	$ -	
	Labor Costs	$ -	
	Loss of Service	$ -	
	Total Loss	$ -	

Table 8-3: 10-year Flood Estimated Damage Costs

Pump Station	No. of Buildings Impacted	Est. Damage Loss ($)	Asset Value
Musquashicut Ave	343	$ 9,363.60	$ 1,040,400
Chain Pond	342	$ -	$ 1,139,481
Sand Hills	300	$ 64,294.17	$ 1,367,961
Edward Foster	0	$ -	$ 1,040,400
Peggotty Beach	0	$ -	$ 1,040,400
Herring Brook	0	$ -	$ 1,020,000
Collier Road	0	$ -	$ 1,020,000
Hatherly School	269	$ -	$ 1,200,000
First Parish Road	0	$ -	$ 872,344
Country Way	0	$ -	$ 1,020,000
Treatment Plant	0	$ -	$ 25,000,000
Total	1254		
	Est. Damage Loss	$ 73,657.77	
	Labor Costs	$ 7,365.78	
	Loss of Service	$ 28,215.00	
	Total Loss	$ 109,238.54	

Table 8-4: 50-year Flood Estimated Damage Costs

Pump Station	No. of Buildings Impacted	Est. Damage Loss ($)	Asset Value
Musquashicut Ave	343	$ 17,687	$ 1,040,400
Chain Pond	342	$ -	$ 1,139,481
Sand Hills	300	$ 191,515	$ 1,367,961
Edward Foster	82	$ 9,364	$ 1,040,400
Peggotty Beach	80	$ -	$ 1,040,400
Herring Brook	250	$ 2,040	$ 1,020,000
Collier Road	380	$ -	$ 1,020,000
Hatherly School	269	$ -	$ 1,200,000
First Parish Road	393	$ -	$ 872,344
Country Way	253	$ -	$ 1,020,000
Treatment Plant	705	$ -	$ 25,000,000
Total	3397		
	Est. Damage Loss	$ 220,605	
	Labor Costs	$ 22,060	
	Loss of Service	$ 76,433	
	Total Loss	$ 319,098	

Table 8-5: 100-year Flood Estimated Damage Costs

Pump Station	No. of Buildings Impacted	Est. Damage Loss ($)	Asset Value
Musquashicut Ave	343	$ 19,768	$ 1,040,400
Chain Pond	342	$ -	$ 1,139,481
Sand Hills	300	$ 266,752	$ 1,367,961
Edward Foster	82	$ 17,687	$ 1,040,400
Peggotty Beach	80	$ -	$ 1,040,400
Herring Brook	250	$ 9,180	$ 1,020,000
Collier Road	380	$ -	$ 1,020,000
Hatherly School	269	$ -	$ 1,200,000
First Parish Road	393	$ -	$ 872,344
Country Way	253	$ -	$ 1,020,000
Treatment Plant	705	$ -	$ 25,000,000
Total	3397		
	Est. Damage Loss	$ 313,387	
	Labor Costs	$ 31,339	
	Loss of Service	$ 76,433	
	Total Loss	$ 421,158	

Table 8-6: FEMA BFE 100-year Flood Estimated Damage Costs

Pump Station	No. of Buildings Impacted	Est. Damage Loss ($)	Asset Value
Musquashicut Ave	343	$ 446,332	$ 1,040,400
Chain Pond	342	$ 28,829	$ 1,139,481
Sand Hills	300	$ 601,903	$ 1,367,961
Edward Foster	82	$ 457,776	$ 1,040,400
Peggotty Beach	80	$ 457,776	$ 1,040,400
Herring Brook	250	$ 381,480	$ 1,020,000
Collier Road	380	$ 5,610	$ 1,020,000
Hatherly School	269	$ -	$ 1,200,000
First Parish Road	393	$ -	$ 872,344
Country Way	253	$ -	$ 1,020,000
Treatment Plant	705	$ 1,375,000	$ 25,000,000
Total	3397		
	Est. Damage Loss	$ 3,754,705	
	Labor Costs	$ 375,471	
	Loss of Service	$ 76,433	
	Total Loss	$ 4,206,608	

▲ Scituate Wastewater Treatment Plant

■ Pump Station

Figure 8-1: Scituate Wastewater Collections System Sub Areas

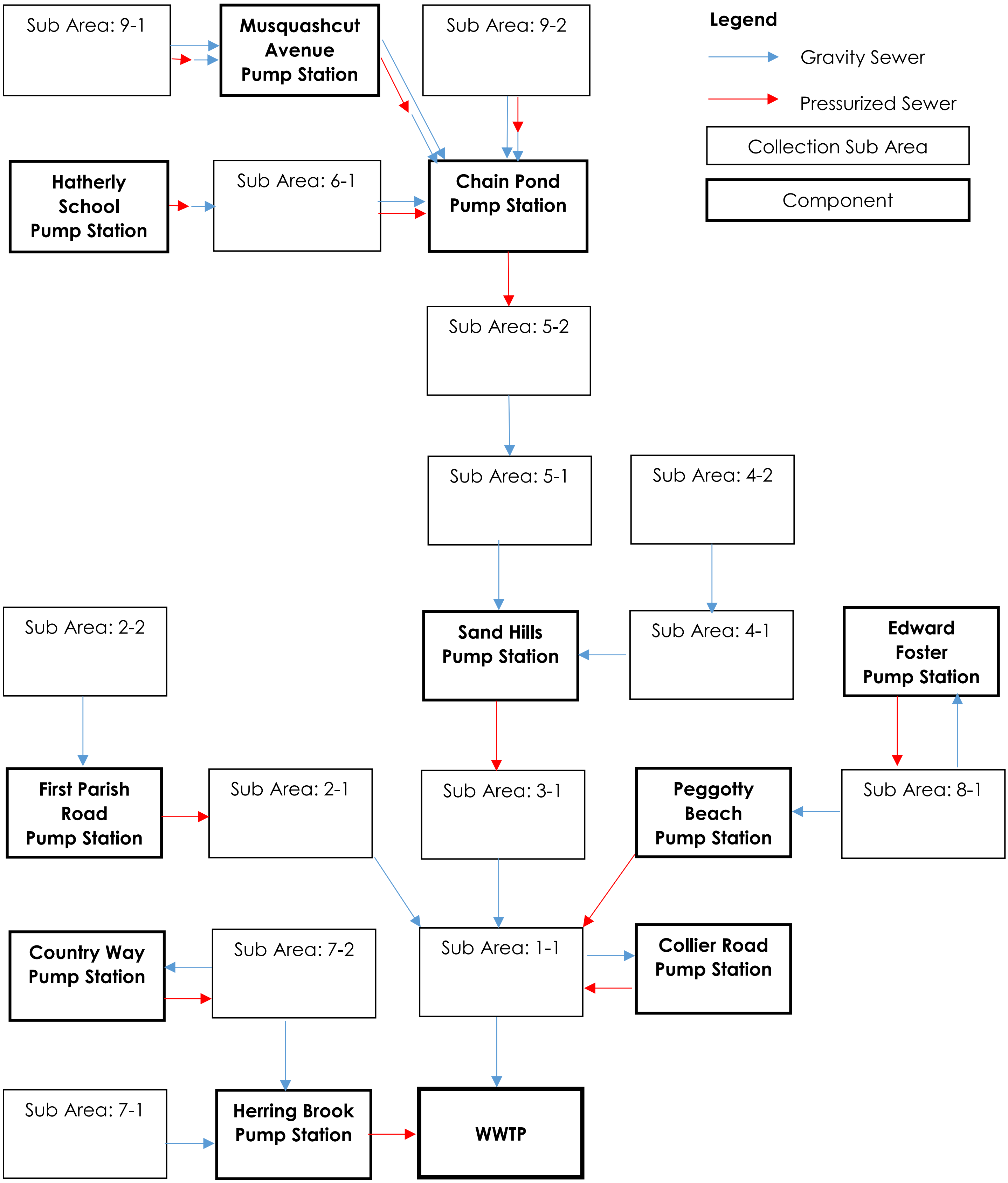


Figure 8-2: Schematic Chart of Scituate Wastewater Collections System

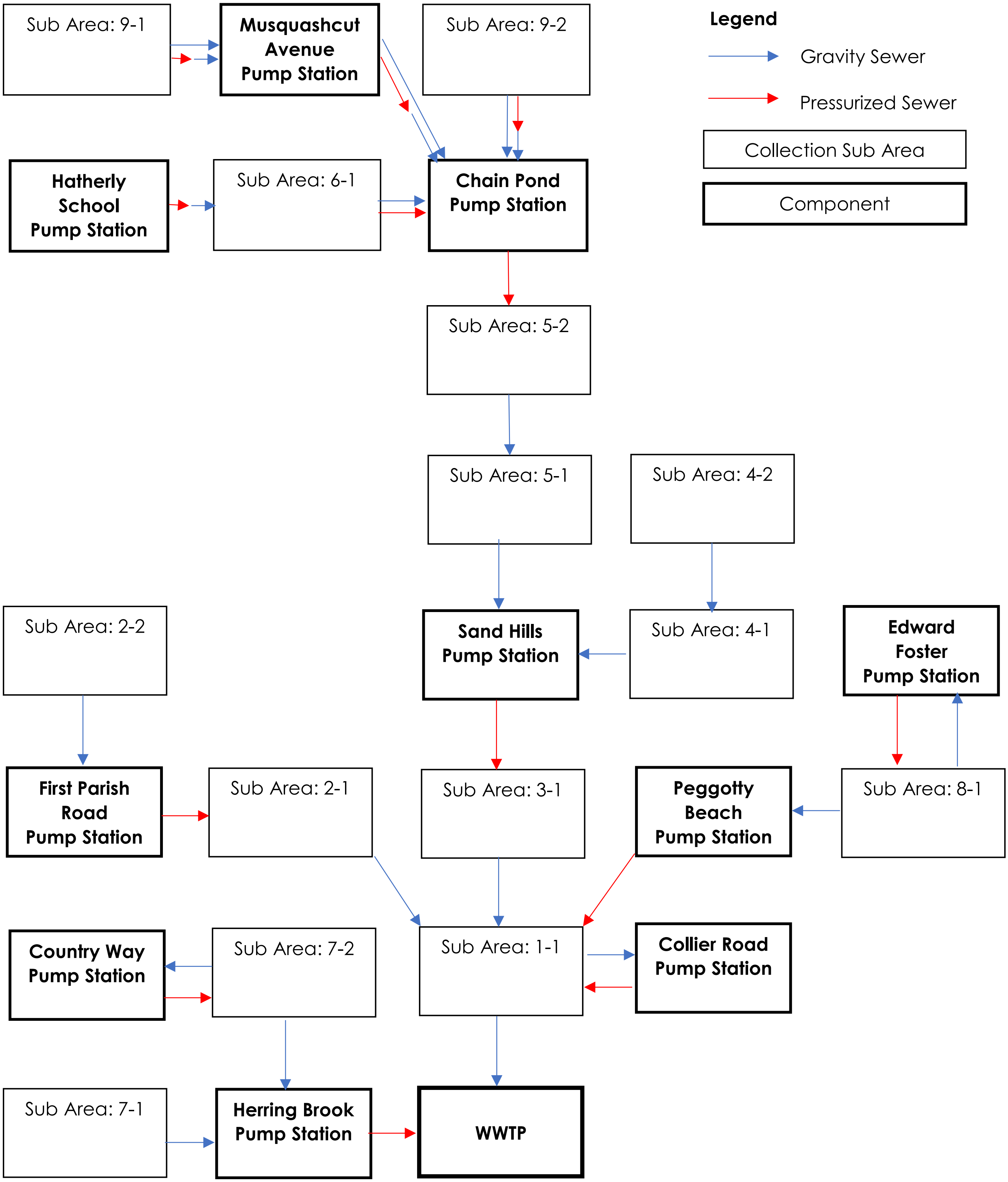


Figure 8-3: Schematic Chart of Scituate Wastewater Collections System: 2 -year recurrence interval (2019)

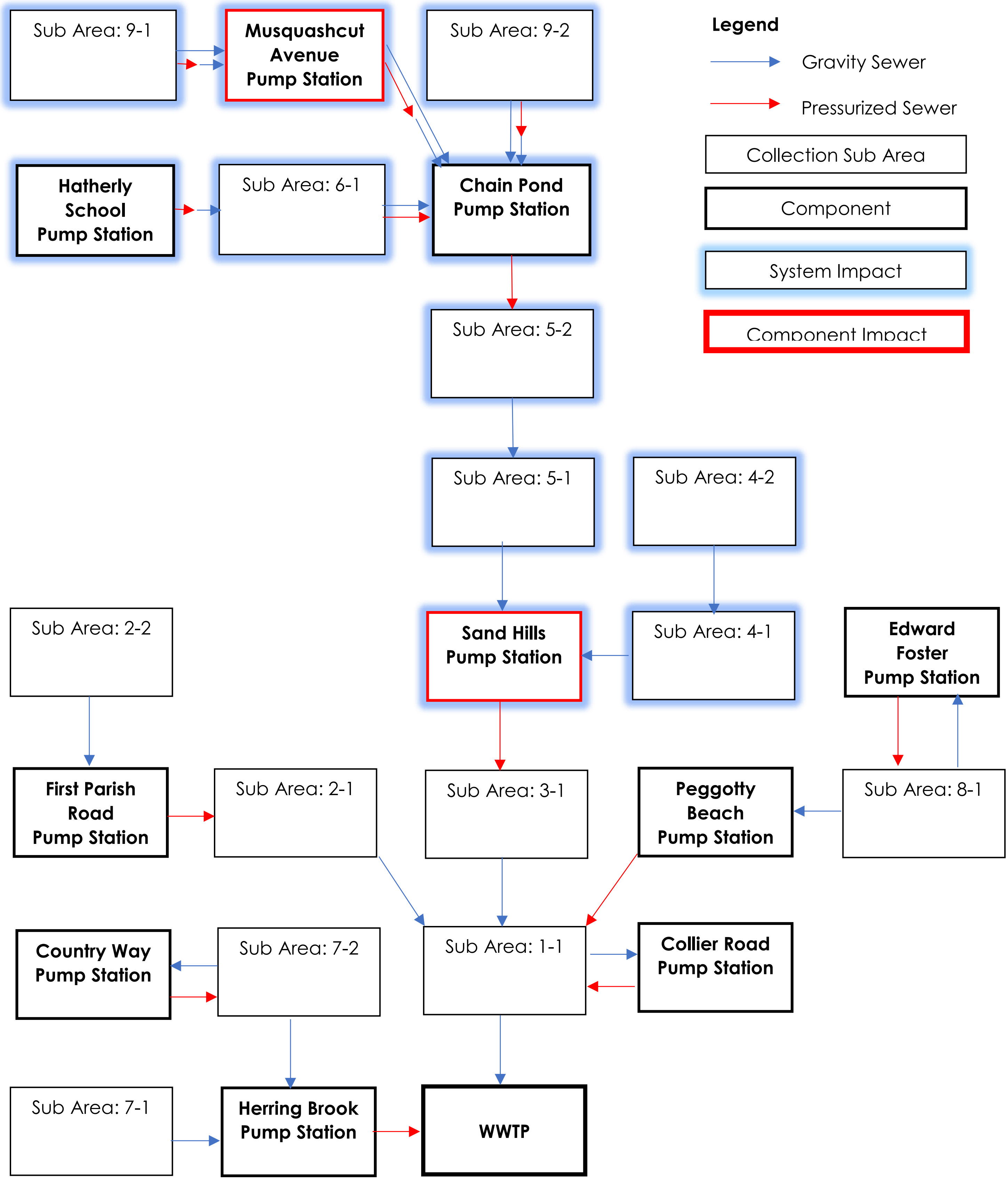


Figure 8-4: Schematic Chart of Scituate Wastewater Collections System: 10-year recurrence interval (2019)

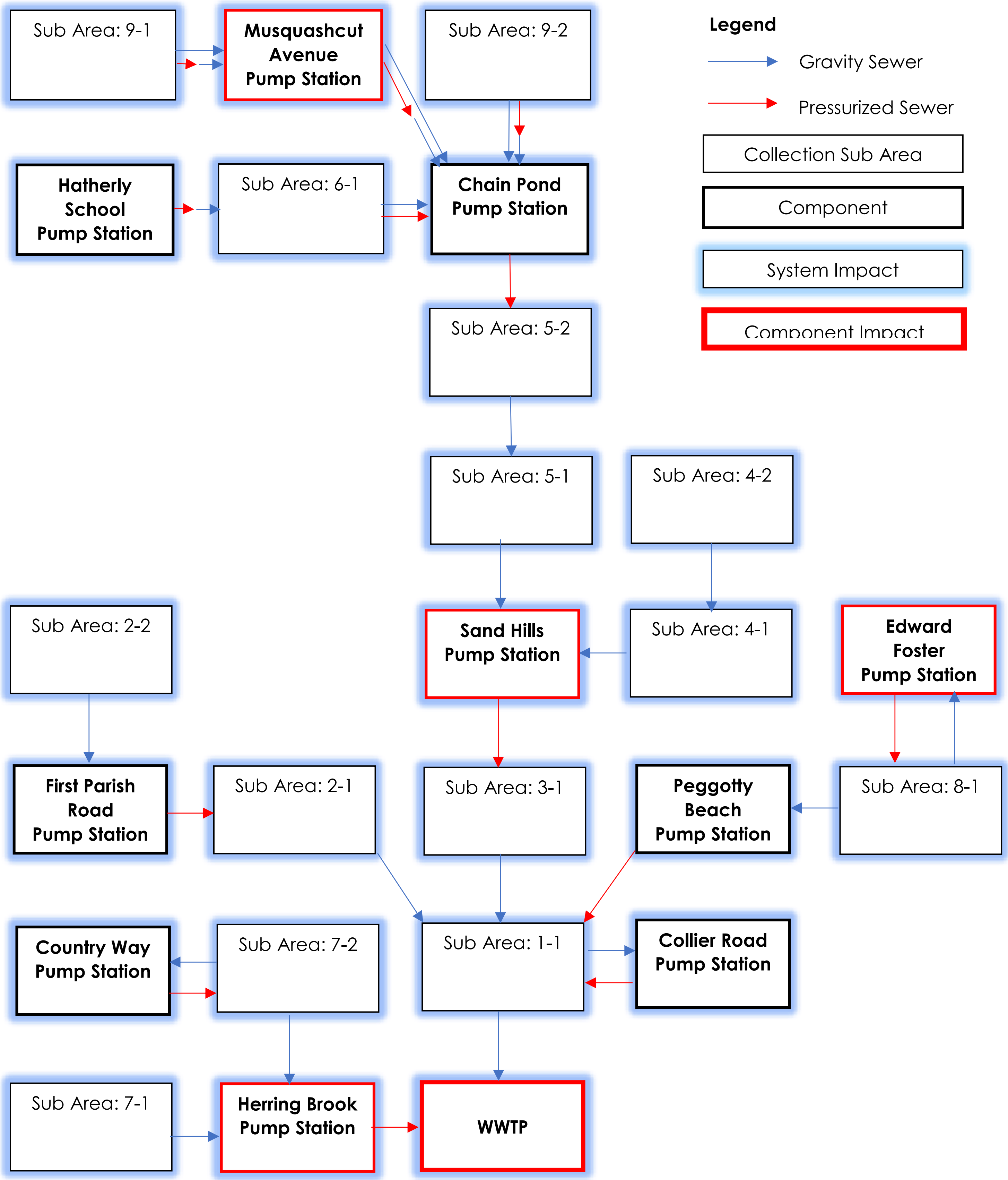


Figure 8-5: Schematic Chart of Scituate Wastewater Collections System: 50-year recurrence interval (2019)

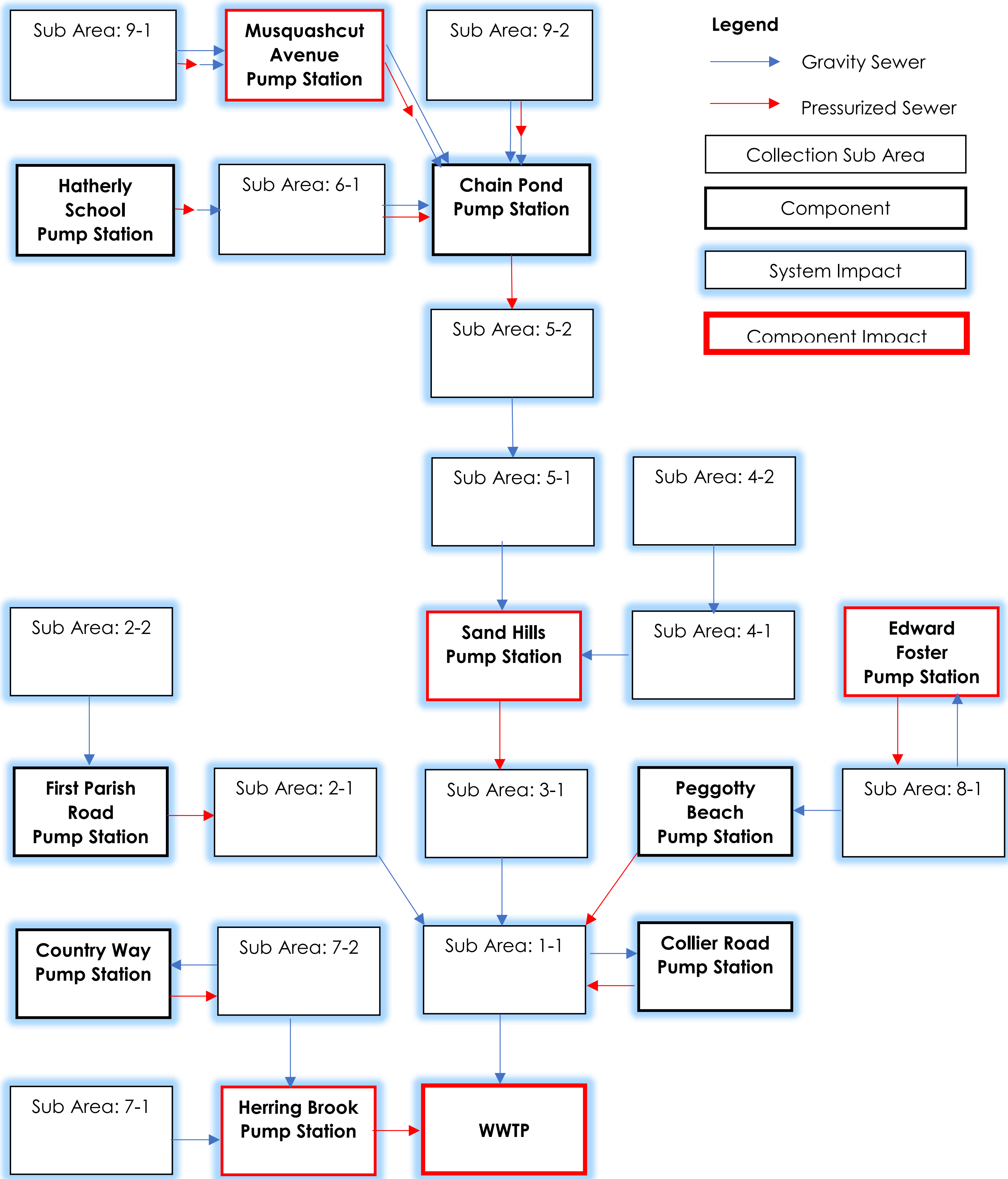


Figure 8-6: Schematic Chart of Scituate Wastewater Collections System: 100-year recurrence interval (2019)

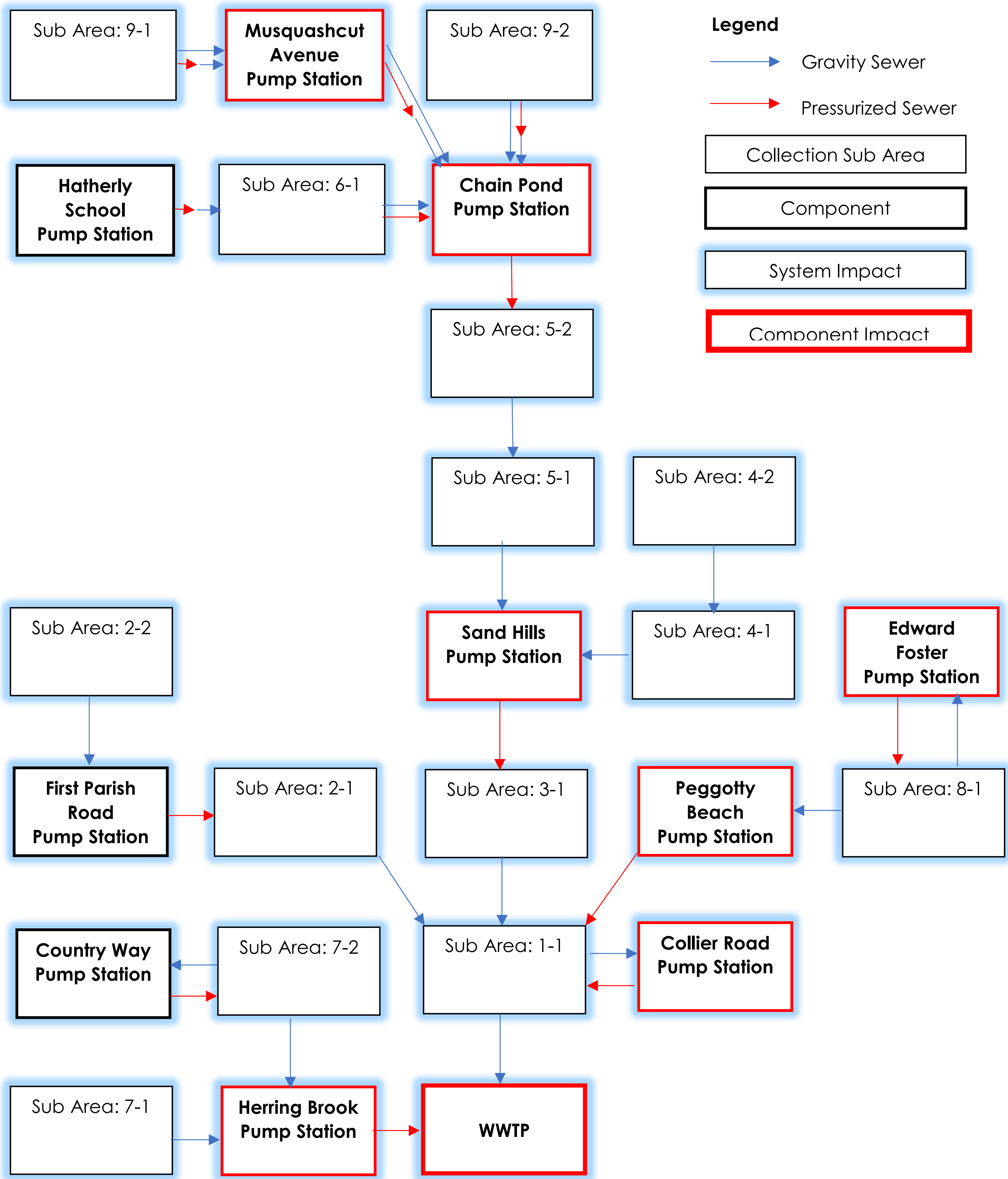


Figure 8-7: Schematic Chart of Scituate Wastewater Collections System: FEMA BFE 100-year recurrence interval (2019)

Attachment 9
Pump Station and Treatment Plant Flood Mitigation Measures

Pump Station and Treatment Plant Flood Mitigation Measures

The following summarizes proposed flood protection measures and approximate costs at the pump stations and treatment plant. These are presented for planning purposes only. Additional evaluation, engineering, design and final cost estimation will be required in future project phases to develop final measures and costs.

Appendix A to this attachment presents an itemized breakdown of measures by pump station and component. Appendix B to this attachment presents an itemized breakdown of measures by treatment plant system and component.

Treatment Plant Measures

Figure 9-1 presents the approximate location and extent of a deployable flood wall system. The purpose of a deployable system is to reduce the flood risk, over the near term, associated with high probability flooding. This system meets the general goals of TR-16 for existing plants but does not meet the explicit flood protection goals of TR-16. An aluminum stop log system is considered the most appropriate deployable system at this time based on: 1) cost; 2) ease of installation; and 3) the capability of the system to be semi-permanently deployed, leaving openings for access (e.g., for snow plowing). Deployable systems applied around individual components was also considered, but a semi-perimeter layout such as shown in **Figure 9-1** is considered: 1) more cost effective; and 2) less disruptive to operations.

Figure 9-2 presents the locations of outfall and instrumentation manholes recommended for flood protection, including backflow prevention (outfalls) and watertight manhole covers. Watertight manhole covers may not be required assuming the deployable flood wall is utilized. However, the Town has indicated that these need replacement regardless due to condition issues.

Figure 9-3 presents preliminary details for liner replacement. The purpose of the lined lagoon is to provide, over the near term, overflow capacity for temporary storage of untreated wastewater during coastal flood events. Based on conversations with the Town, we understand that due to the significant amount of I/I into the system, the wastewater is substantially cleaner than non-storm conditions. The need for temporary overflow storage will diminish with construction of the proposed measures to reduce I/I. A detailed condition survey was not performed as part of this study. However, the existing liner is beyond a typical liner service life. The lined lagoon is not currently utilized for overflow storage. The existing perimeter dike is adequate to support the liner edge but (apparently based on available documentation) was not designed or constructed as a flood levee. The dike crest is at approximately Elevation 10 feet NAVD88. Clearing and grubbing of the dike area and regrading of the dike will be required as part of the liner replacement. Pending additional investigation and design, minor increase in the crest elevation (+/- 1 to 2 feet) may be achievable within a complete dike reconstruction. Any work performed at this time should be compatible with future construction of a permanent perimeter flood wall/levee.

Figure 9-4 presents the approximate location and extent of a permanent flood wall/levee system. The purpose of a permanent flood wall/levee system is to achieve compliance with the explicit flood protection goals of TR-16, which is effectively: 1) the 100-year recurrence interval flood level + 3 feet for critical equipment; and 2) the 100-year recurrence interval flood elevation water level for all first floors, tank walls and structural openings. The FEMA Base Flood Elevation, increased for projected service life sea level rise, should be used to establish flood protection levels. The current FEMA Base Flood Elevation at the treatment plant is Elevation 16 feet NAVD88. Additional analysis is required to establish a future Base Flood Elevation that incorporates sea level rise. For preliminary planning purposes, an 8-foot high flood wall/levee (approximately Elevation 18 feet NAVD88, is assumed. A sheetpile flood wall and earthen levee is considered the most appropriate permanent coastal flood protection system at this time based on: 1) cost; 2) ease of installation; and 3) limited disturbance of adjacent wetlands. The flood wall portion would be utilized adjacent to existing wetlands (effectively, the limits of the existing lined lagoon) and would grade into a new earthen levee within non-wetland areas.

Figure 9.5 presents the existing design hydraulic profile representing the existing treatment lift capacity. The system design is based on a hydraulic head at the effluent outfall of Elevation 9.5 feet NAVD88 (which was originally based on the 100-year recurrence interval flood at the time of design). The current and future flood hazard will result in a greater hydraulic head at the effluent outfall, potentially reducing the system flow management and increasing the risk of internal flooding. Per TR-16, the plant hydraulic design should allow for peak hourly flows, including associated sidestream flows, to be passed through the plant with the largest of longest flow path of each unit process removed from service and with the receiving water at the 100-year recurrence interval flood elevation (including considerations of climate change). Additional analysis is required to establish a future Base Flood Elevation (100-year recurrence interval flood elevation), that incorporates sea level rise, at the effluent outfall. Pending additional hydraulic capacity analysis, a new pump station may be warranted to manage flow (see **Figure 9.6**) and is assumed in this study for planning purposes.

As noted above, the purpose of the lined lagoon is to provide, over the near term, overflow capacity for temporary storage of untreated wastewater during coastal flood events. The need for temporary overflow storage will diminish with construction of the proposed measures to reduce I/I. However long term expansion of the system may warrant a new approach to wastewater treatment. One opportunity may be the integration of a constructed wetlands into the treatment process, as a standalone feature or integrated with existing tidal marsh system. Constructed wetlands are treatment systems that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to assist or partially treat effluent. While there are significant regulatory (e.g., Clean Water Act, requiring an individual CWA Section 404 permit for construction outside of the existing lined lagoon and within the waters of the U.S. and Section 402 permits for discharge to waters of the U.S.) and technical challenges to utilizing this approach, there are a number of significant advantages that warrant further evaluation. These advantages include: 1) the location of the effluent outfall within a large and substantial tidal wetlands system; 2) potentially reduced cost of system expansion relative to traditional treatment; 3) the fact that a constructed wetland system could include earthen flood levees that would provide perimeter plant flood protection in lieu of a flood wall; and 4) this approach has aesthetic and ecological benefit. The study recommends additional evaluation of this alternative as part of comprehensive long term planning for the Town's wastewater treatment. Costs for this alternative have not been included in this study. **Figure 9.7** presents a typical schematic of a constructed wetland.

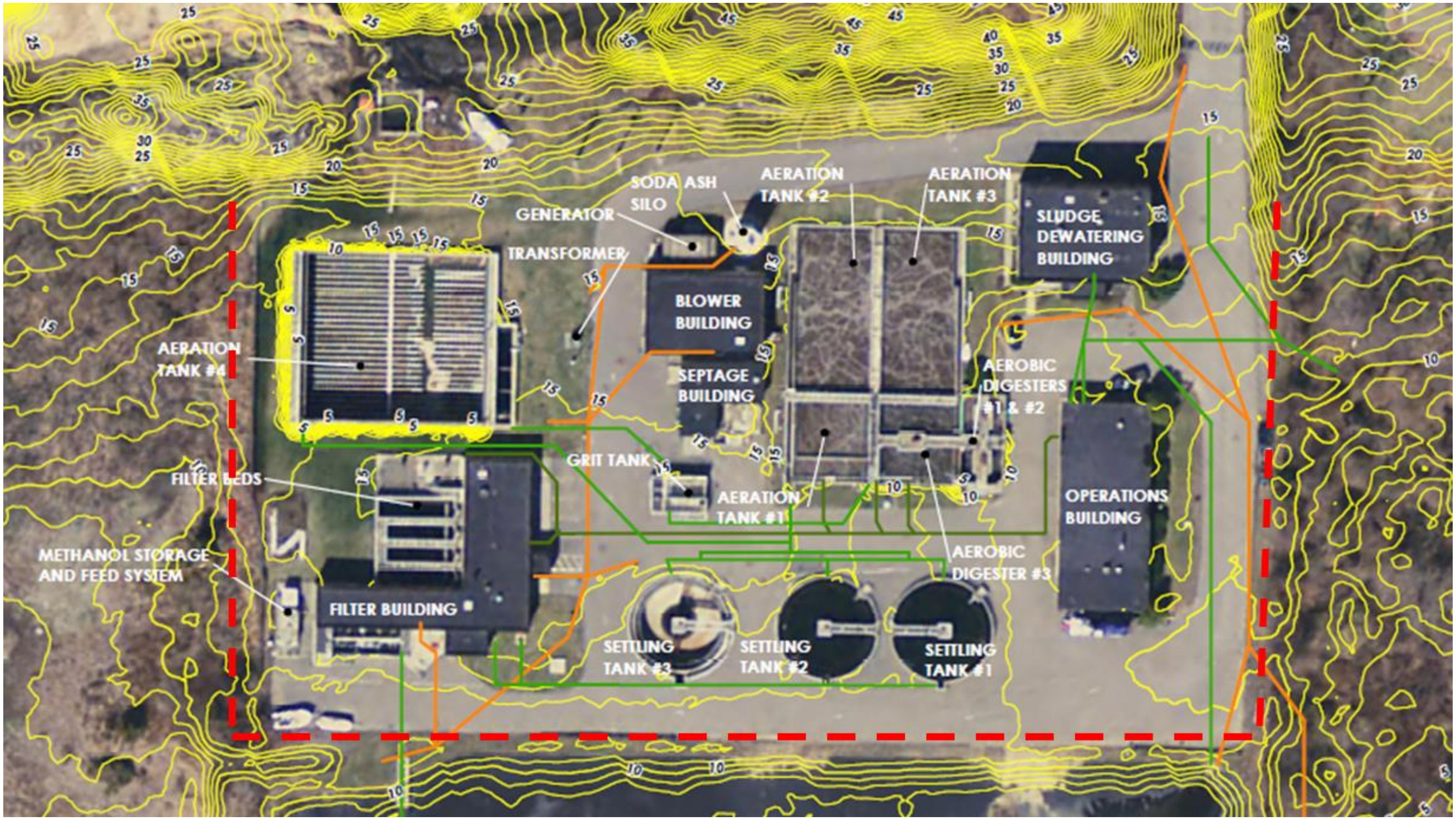
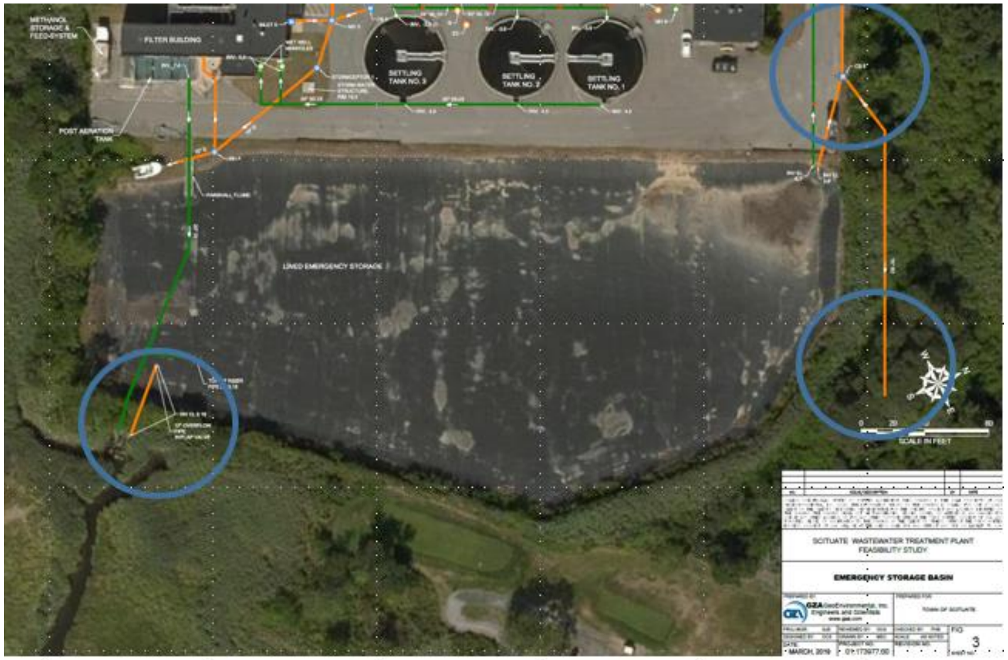


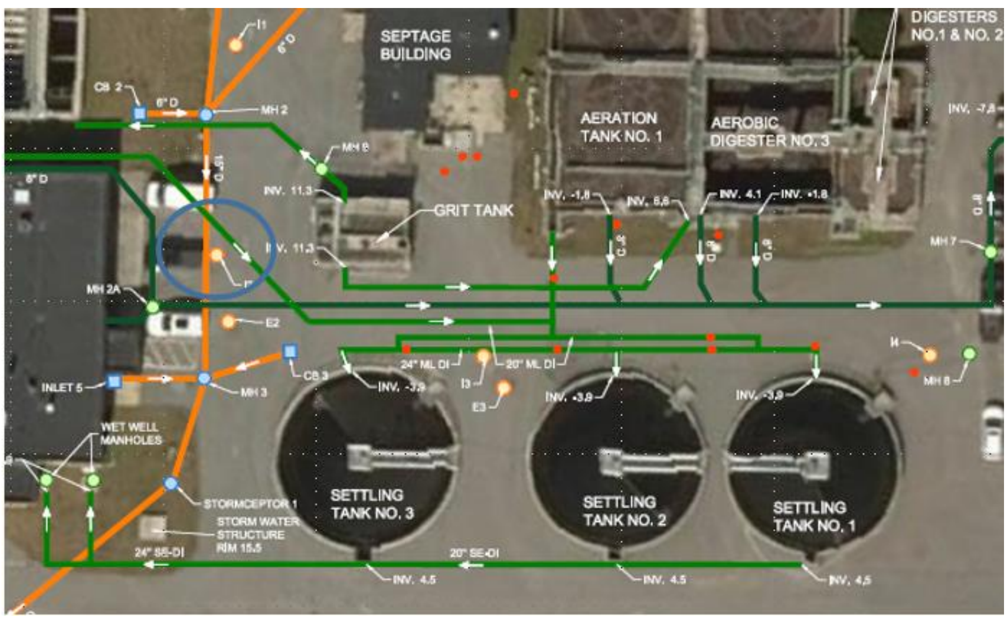
Figure 9-1: Proposed location of the deployable flood wall around the wastewater treatment plant

Description:

Wall Type: Aluminum Stop Logs
Wall Height: +/- 5 feet (Elev. 16 feet NAVD88)
Wall Length: 1,000 l.f.
Est. Cost: $750/l.f. x 1,000 l.f. = $750,000



Stormwater Outfall Gates: about 2 to 3 locations
Effluent gate Valve: 1 locations



Electrical/Instrumentation Manholes: about 10 locations

Figure 9-2: Outfall and Instrumentation Flood Protection Locations

Figure 9-3: Liner/Lagoon Replacement/Restoration

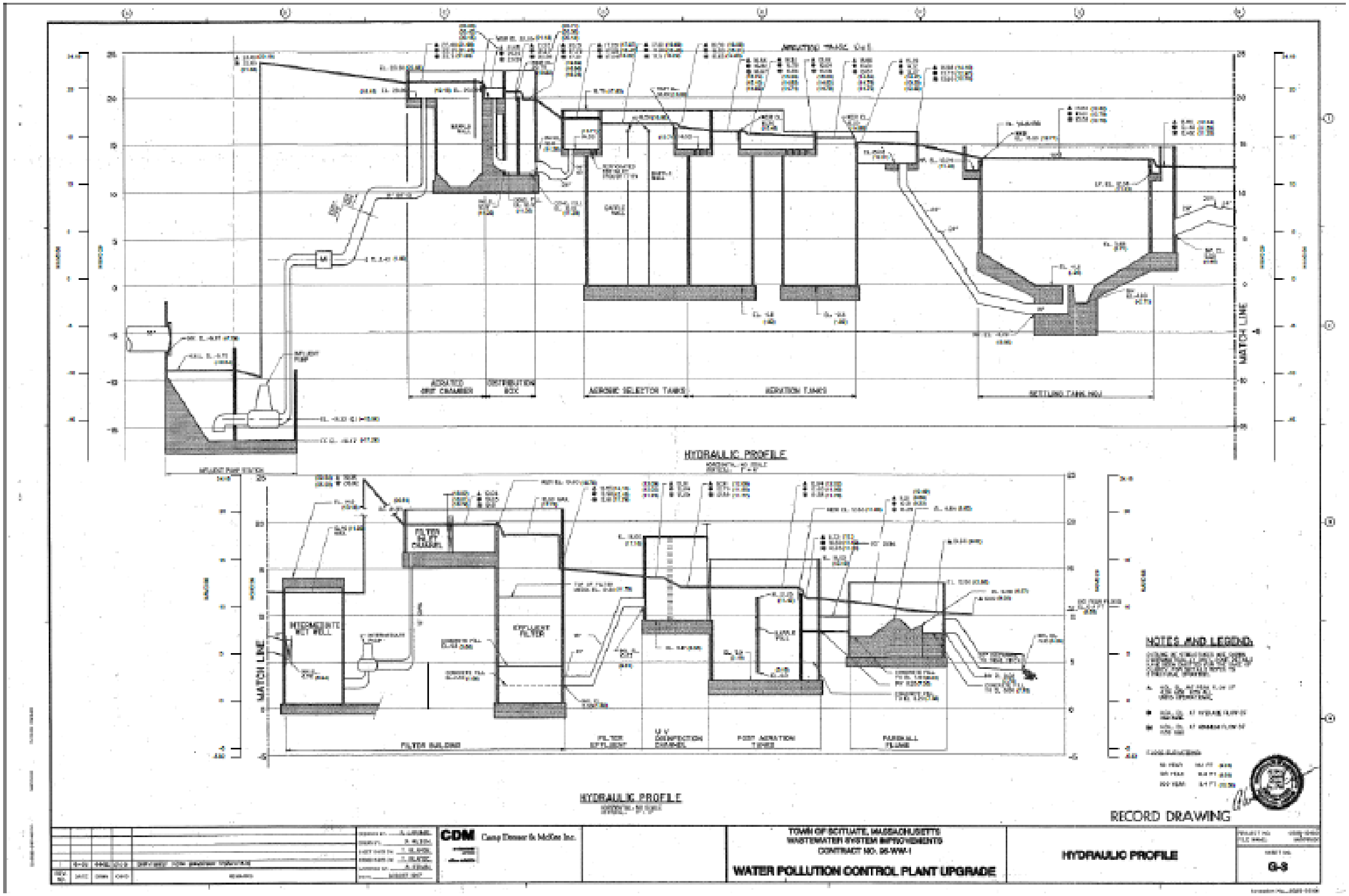
Description:

Existing Volume: 240,000+/- c.f. (1.8M gal)
Required Capacity: TBD
Holding Time: TBD (60 days+/-)
Liner Area: +/- 80,000 s.f.
Liner Replacement Cost: $10/s.f. = $800,000
Dike restoration/elevation: l.f x $

Description:

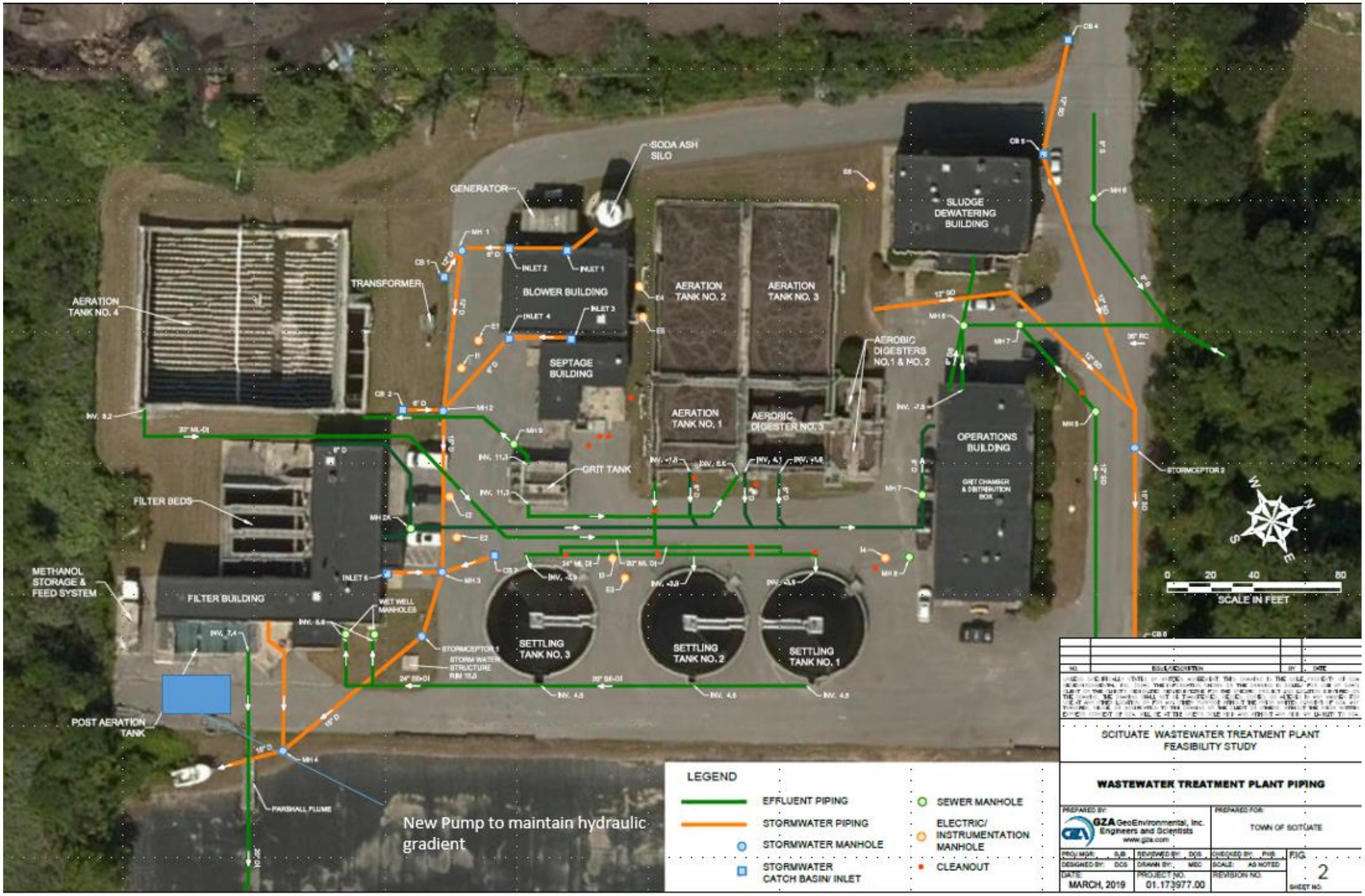
Wall Type: Partial Levee/Steel Sheetpile
Wall Height: +/- 8 feet (Elev. 18 feet NAVD88)
Wall Length:
Est. Cost: \$2,000/l.f. x 1,370 l.f. = \$2.5M

Figure 9-4: Proposed location of the partial levee and sheet pile flood wall around the lagoon and plant



Description: Allow for peak hourly flows to be passed through the plant with the receiving water at the 100-year recurrence interval flood elevation (including considerations of climate change): Current Design Flood Level at Outlet: El. 9.5 NAVD88

Figure 9-5: Existing design hydraulic profile within treatment system



Description:

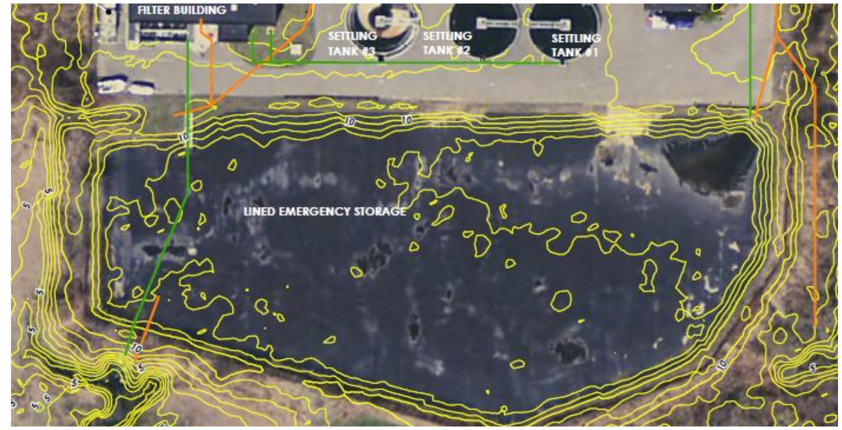
Capacity: TBD
Pump Cost: $250,000
(w/generator upgrade)

Figure 9-6: Proposed location of the new pump station (need pending additional study)

Description:

Existing Volume: 240,000+/- c.f. (1.8M gal)
Required Capacity: TBD
Holding Time: TBD (60 days+/-)
Liner Area: +/- 80,000 s.f.
Liner Replacement Cost: $10/s.f. = $800,000
Constructed Wetland Cost: $50/s.f. = $4M
Preliminary Treatment Structures (costs TBD):

- Bar Screen
- Grit Chambers



Constructed Wetland Location: Existing Lined Lagoon

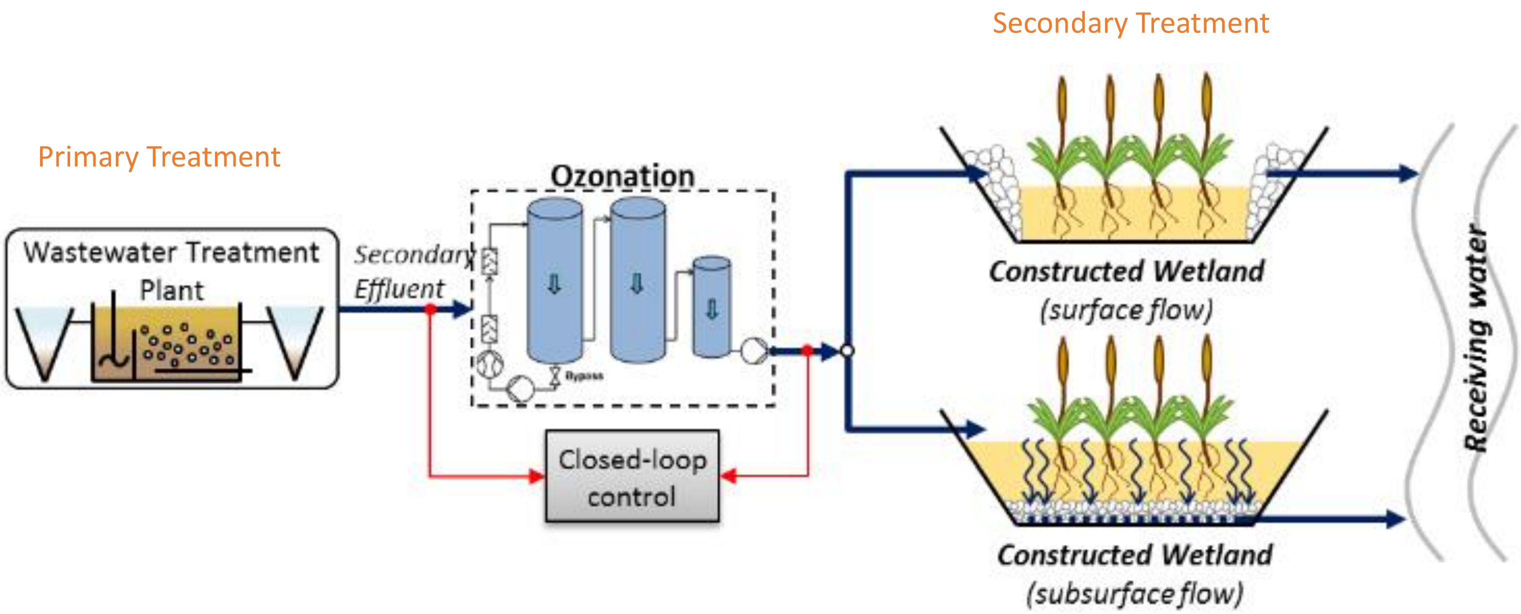


Figure 9-7: Image of a constructed wetland for storm wastewater overflow management and treatment

Appendix A
Pump Station Flood Protection Measures

Wastewater Treatment System Flood Mitigation Measures: Collier Road Pump Station

	System, Structure, Component (SSC)	Flood Protection Measure	Quantity	units	unit cost	Installation cost	Total Cost
Near-term							
Building	-						
	Wet Well and Dry Well Hatch Covers	Replace hatches with watertight hatches	2	EA	$2,500	$7,500	$20,000
	Personnel entryway	Install Full Flood Door	1	EA	$3,600	$1,200	$4,800
	Wall Penetrations	Flood proof any structural/wall penetrations	1	LS	$1,200	(included)	$1,200
Pumps and Mechanical Components	-						
Electrical Components:	-						
Power	-						
Other	-						
	Gas Meter	Provide shielding to protect the gas meter components from debris collision in the event of projected maximum flooding	1	LS	$3,000		$3,000
					Near Term Subtotal		$29,000
Long-term							
Building							
Pumps and Mechanical Components	-						
Electrical Components:							
	Control Panels	Relocate or elevate electrical components	1	LS	$50,000	(included)	$50,000
Power							
	Gas Generator	Raise generator above maximum flood elevation	1	LS	$150,000	(included)	$150,000
Other							
	Gas Meter	Relocate the gas meter assembly above the anticipated flood elevation .	1	LS	$5,000		$5,000
					Long Term Subtotal		$205,000

Flood Wall Protection Options	Not Recommended
100-year FEMA BFE Elev.	16' NAVD88
Finished Floor Elev.	15.5' NVAD88
Ground Elev.	15.3' NAVD88
Pump Station Age	11 years
Pump Station Replacment:	Recommend Future Pump Station Replacement Benefit-Cost Analysis and Feasibility Study

Wastewater Treatment System Flood Mitigation Measures: Chain Pond Pump Station

	System, Structure, Component (SSC)	Flood Protection Measure	Quantity	units	unit cost	Installation cost	Cost
Near-term							
Building							
	Wall Penetrations	Flood proof any structural/wall penetrations	1	LS	$1,200	(included)	$1,200
	Wet Well and Dry Well Hatch Covers	Replace hatches with watertight hatches	2	EA	$5,000	$7,500	$25,000
	Personnel entryway	Install full flood door	1	EA	$4,000		$4,000
Pumps and Mechanical Components	-						
Electrical Components:	-						
Power	-						
Other	-						
	Gas Meter	Provide shielding to protect the gas meter components from debris collision in the event of projected maximum flooding	1	LS	$3,000		$3,000
					Near Term Subtotal		$33,200
Long-term							
Building							
Pumps and Mechanical Components	-						
Electrical Components:							
	Electric Meter	Relocate the Electric meter assembly above the anticipated flood elevation	1	LS	$5,000		$5,000
Power							
	Gas Generator	Raise generator above maximum flood elevation	1	LS	$150,000	(included)	$150,000
Other							
	Gas Meter	Relocate the gas meter assembly above the anticipated flood elevation	1	LS	$5,000		$5,000
					Long Term Subtotal		$160,000

Flood Wall Protection Options	Not Recommended
100-year FEMA BFE Elev.	14' NAVD88
Finished Floor Elev.	15.5' NAVD88
Ground Elev.	12.0' NAVD88
Pump Station Age	45 years
Pump Station Replacment:	Recommend Future Pump Station Replacement Benefit-Cost Analysis and Feasibility Study

Wastewater Treatment System Flood Mitigation Measures: Edward Foster Pump Station

	System, Structure, Component (SSC)	Flood Protection Measure	Quantity	units	unit cost	Installation cost	Total Cost
Near-term							
Building							
	Wall Penetrations	Flood proof any structural/wall penetrations	1	LS	$1,200	(included)	$1,200
	Wet Well and Dry Well Hatch Covers	Replace hatches with watertight hatches	2	EA	$2,500	$7,500	$20,000
	Wet Well Vent	Raise Wet Well Vent Pipe above flood elevation	1	LS	$1,000	(included)	$1,000
	Personnel entryway	Install full flood door	1	EA	$3,600	$1,200	$4,800
	Air and Exhaust Vents	Raising and/or extension of ventilation ducts that are below or at the maximum flood elevation	1	LS	$1,200	(included)	$1,200
Pumps and Mechanical Components	-						
Electrical Components:	-						
Power	-						
Other							
	Gas Meter	Provide shielding to protect the gas meter components from debris collision in the event of projected maximum flooding	1	LS	$3,000		$3,000
	Gas Meter	Relocate the gas meter assembly above the anticipated flood elevation	1	LS	$5,000		$5,000
					Near Term Subtotal		$36,200
Long-term							
Building							
Pumps and Mechanical Components	-						
Electrical Components:							
	Control Panels	Relocate or elevate electrical components	1	LS	$50,000	(included)	$50,000
	Electric Meter	Relocate the Electric meter assembly above the anticipated flood elevation	1	LS	$5,000	(included)	$5,000
Power							
	Gas Generator	Raise generator above maximum flood elevation	1	LS	$150,000	(included)	$150,000
Other	-						
					Long Term Subtotal		$205,000
Flood Wall Protection Options							
Option 1	7 ft. high AquaFence w/ concrete pad	Semi-Permanent Flood Wall Protection	125	LF	$650	$75,000	$156,250
Option 2	7 ft. high Stop-Logs w/ concrete pad	Semi-Permanent Flood Wall Protection	125	LF	$700	$75,000	$162,500
Option 3	8 ft. high Sheet piling Flood Wall w/ concrete pad	Permanent Flood Wall Protection	110	LF	$2,000	(included)	$220,000
	Stop Log Gate		15	LF	$800		$12,000
Option 3 Total							$232,000

100-year FEMA BFE Elev.	16' NAVD88
Finished Floor Elev.	10.1' NVAD88
Ground Elev.	9.1' NAVD88
Pump Station Age	9 years
Pump Station Replacment:	Recommend Future Pump Station Replacement Benefit-Cost Analysis and Feasibility Study

Wastewater Treatment System Flood Mitigation Measures: Musquashicut Avenue Pump Station

	System, Structure, Component (SSC)	Flood Protection Measure	Quantity	units	unit cost	Installation cost	Total Cost
Near-term							
Building							
	Wet Well and Dry Well Hatch Covers	Replace hatches with watertight hatches	2	EA	$2,500	$7,500	$20,000
	Air and Exhaust Vents	Raising and/or extension of ventilation ducts that are below or at the maximum flood elevation	1	LS	$1,200	(included)	$1,200
	Wet Well Vent	Raise Wet Well Vent Pipe above flood elevation	1	LS	$1,000	(included)	$1,000
	Personnel entryway	Install full flood door	1	EA	$3,600	$1,200	$4,800
Pumps and Mechanical Components	-						
Electrical Components:	-						
Power	-						
Other							
	Gas Meter	Provide shielding to protect the gas meter components from debris collision in the event of projected maximum flooding	1	LS	$3,000		$3,000
	Gas Meter	Relocate the gas meter assembly above the anticipated flood elevation	1	LS	$5,000		$5,000
					Near Term Subtotal		$35,000
Long-term							
Building							
Pumps and Mechanical Components	-						
Electrical Components:							
	Control Panels	Relocate or elevate electrical components	1	LS	$50,000	(included)	$50,000
	Electric Meter	Relocate the Electric meter assembly above the anticipated flood elevation	1	LS	$5,000	(included)	$5,000
Power							
	Gas Generator	Raise generator above maximum flood elevation	1	LS	$150,000	(included)	$150,000
Other	-						
					Long Term Subtotal		$205,000
Flood Wall Protection Options							
Option 1	6 ft. high AquaFence w/ concrete pad	Semi-Permanent Flood Wall Protection	125	LF	$575	$75,000	$146,875
Option 2	7 ft. high Stop-Logs w/ concrete pad	Semi-Permanent Flood Wall Protection	125	LF	$700	$75,000	$162,500
Option 3	8 ft. high Sheet piling Flood Wall w/ concrete pad	Permanent Flood Wall Protection	110	LF	$2,000	(included)	$220,000
	Stop Log Gate		15	LF	$800		$12,000
Option 3 Total							$232,000

100-year FEMA BFE Elev.	13' NAVD88
Finished Floor Elev.	11.6' NAVD88
Ground Elev.	7.1' NAVD88
Pump Station Age	9 years
Pump Station Replacment:	Recommend Future Pump Station Replacement Benefit-Cost Analysis and Feasibility Study

Wastewater Treatment System Flood Mitigation Measures: Peggotty Beach Road Pump Station

	System, Structure, Component (SSC)	Flood Protection Measure	Quantity	units	unit cost	Installation cost	Total Cost
Near-term							
Building							
	Air and Exhaust Vents	Raising and/or extension of ventilation ducts that are below or at the maximum flood elevation	1	LS	$1,200	(included)	$1,200
	Wet Well Vent	Raise Wet Well Vent Pipe above flood elevation	1	LS	$1,000	(included)	$1,000
	Wall Penetrations	Flood proof any structural/wall penetrations	1	LS	$1,200	(included)	$1,200
	Wet Well and Dry Well Hatch Covers	Replace hatches with watertight hatches	2	EA	$2,500	7500	$20,000
	Personnel entryway	Install full flood door	1	EA	$3,600	$1,200	$4,800
Pumps and Mechanical Components	-						
Electrical Components:	-						
Power	-						
Other							
	Gas Meter	Provide shielding to protect the gas meter components from debris collision in the event of projected maximum flooding	1	LS	$3,000		$3,000
	Gas Meter	Relocate the gas meter assembly above the anticipated flood elevation	1	LS	$5,000		$5,000
					Near Term Subtotal		$36,200
Long-term							
Building							
Pumps and Mechanical Components	-						
Electrical Components:							
	Control Panels	Relocate or elevate electrical components	1	LS	$50,000	(included)	$50,000
	Electric Meter	Relocate the Electric meter assembly above the anticipated flood elevation	1	LS	$5,000	(included)	$5,000
Power							
	Gas Generator	Raise generator above maximum flood elevation	1	LS	$150,000	(included)	$150,000
Other	-						
					Long Term Subtotal		$205,000
Flood Wall Protection Options							
Option 1	7 ft. high AquaFence w/ concrete pad	Semi-Permanent Flood Wall Protection	125	LF	$650	$75,000	$156,250
Option 2	7 ft. high Stop-Logs w/ concrete pad	Semi-Permanent Flood Wall Protection	125	LF	$700	$75,000	$162,500
Option 3	8 ft. high Sheet piling Flood Wall w/ concrete pad	Permanent Flood Wall Protection	110	LF	$2,000	(included)	$220,000
	Stop Log Gate		15	LF	$800		$12,000
Total Option 3							$232,000

100-year FEMA BFE Elev.	17' NAVD88
Finished Floor Elev.	10.7' NVAD88
Ground Elev.	10.5' NAVD88
Pump Station Age	9 years
Pump Station Replacment:	Recommend Future Pump Station Replacement Benefit-Cost Analysis and Feasibility Study

Wastewater Treatment System Flood Mitigation Measures: Sand Hills Pump Station

	System, Structure, Component (SSC)	Flood Protection Measure	Quantity	units	unit cost	Installation cost	Total Cost
Near-term							
Building							
	Wall Penetrations	Flood proof any structural/wall penetrations	1	LS	$1,200	(included)	$1,200
	Personnel entryway	Install full flood door	2	EA	$3,600	$1,200	$9,600
	Air and Exhaust Vents	Raising and/or extension of ventilation ducts that are below or at the maximum flood elevation	1	LS	$5,000	(included)	$5,000
	Air and Exhaust Vents	Raising and/or extension of ventilation ducts that are below or at the maximum flood elevation	1	LS	$1,200	(included)	$1,200
Pumps and Mechanical Components	-						
Electrical Components:	-						
Primary Power	-						
Back-Up Power	-						
Other							
	Gas Meter	Provide shielding to protect the gas meter components from debris collision in the event of projected maximum flooding	1	LS	$3,000		$3,000
	Gas Meter	Relocate the gas meter assembly above the anticipated flood elevation	1	LS	$5,000		$5,000
					Near Term Subtotal		$25,000
Long-term							
Building							
Pumps and Mechanical Components							
	Pump Motors	Elevate Pump Motors	1	LS	$20,000	(included)	$20,000
Electrical Components:							
	Control Panels	Relocate or elevate electrical components	1	LS	$50,000	(included)	$50,000
	Electric Meter	Relocate the Electric meter assembly above the anticipated flood elevation	1	LS	$5,000		$5,000
Power							
	Gas Generator	Raise generator above maximum flood elevation	1	LS	$150,000	(included)	$150,000
Other	-						
					Long Term Subtotal		$225,000
Flood Wall Protection Options							
Option 1	8 ft. high AquaFence w/ concrete pad	Semi-Permanent Flood Wall Protection	200	LF	$750	$75,000	$225,000
Option 2	8 ft. high Stop-Logs w/ concrete pad	Semi-Permanent Flood Wall Protection	200	LF	$800	$75,000	$235,000
Option 3	8 ft. high Sheet piling Flood Wall w/ concrete pad	Permanent Flood Wall Protection	185	LF	$2,000	(included)	$370,000
	Stop Log Gate		15	LF	$800		$12,000
Option 3 Total							$382,000

100-year FEMA BFE Elev.	15' NAVD88
Finished Floor Elev.	11.4' NAVD88
Ground Elev.	7.3' NAVD88
Pump Station Age	53 years
Pump Station Replacment:	Recommend Future Pump Station Replacement Benefit-Cost Analysis and Feasibility Study

Wastewater Treatment System Flood Mitigation Measures: Herring Brook Pump Station

	System, Structure, Component (SSC)	Flood Protection Measure	Quantity	units	unit cost	Installation cost	Total Cost
Near-term							
Building							
	Wet Well and Dry Well Hatch Covers	Replace hatches with watertight hatches	2	EA	$2,500	$7,500	$20,000
	Gas Generator	Raise generator above maximum flood elevation	1	LS	$75,000	(included)	$75,000
	Wet Well Vent	Raise Wet Well Vent Pipe above flood elevation	1	LS	$1,000	(included)	$1,000
Pumps and Mechanical Components	-						
Electrical Components:	-						
Power	-						
Other							
	Gas Meter	Provide shielding to protect the gas meter components from debris collision in the event of projected maximum flooding	1	LS	$3,000		$3,000
	Gas Meter	Relocate the gas meter assembly above the anticipated flood elevation	1	LS	$5,000		$5,000
					Near Term Subtotal		$104,000
Long-term							
Building							
Pumps and Mechanical Components	-						
Electrical Components:							
	Control Panels	Relocate or elevate electrical components	1	LS	$50,000	(included)	$50,000
	Electric Meter	Relocate the Electric meter assembly above the anticipated flood elevation	1	LS	$5,000	(included)	$5,000
Power							
Other	-						
					Long Term Subtotal		$55,000
Flood Wall Protection Options							
Option 1	7 ft. high AquaFence w/ concrete pad	Semi-Permanent Flood Wall Protection	125	LF	$650	$75,000	$156,250
Option 2	7 ft. high Stop-Logs w/ concrete pad	Semi-Permanent Flood Wall Protection	125	LF	$700	$75,000	$162,500
Option 3	8 ft. high Sheet piling Flood Wall w/ concrete pad	Permanent Flood Wall Protection	110	LF	$2,000	(included)	$220,000
Option 3 Total			15	LF	$800		$12,000
							$232,000

100-year FEMA BFE Elev.	16' NAVD88
Finished Floor Elev.	-
Ground Elev.	9.8' NAVD88
Pump Station Age	9 years
Pump Station Replacment:	Recommend Future Pump Station Replacement Benefit-Cost Analysis and Feasibility Study

Appendix B
Wastewater Treatment Plant Flood Protection Measures

Wastewater Treatment System Flood Mitigation Measures: Wastewater Treatment Plant

	System, Structure, Component (SSC)	Flood Protection Measure	Quantity	units	unit cost	Installation cost	Total Cost
Short-term							
Building							
Pumps and Mechanical Components	-						
Electrical Components:	-						
	Electric/Instrumentation Manholes		10	LS	$10,000	(included)	$100,000
Power	-						
Other							
	Effluent Outfall 20" Pipe	Install backflow prevention (e.g., 20 " duckbill valve)	1	LS	$17,000		$17,000
	Stormwater Outfall 15" Pipe	Install backflow prevention (e.g., 15 " duckbill valve)	2	LS	$12,500		$25,000
	Stormwater Outfall 6" Pipe	Install backflow prevention (e.g., 6 " duckbill valve)	1	LS	$5,000		$5,000
	Lined Emergency Storage Lagoon	Liner Lagoon Restoration	80,000	LS	$10	(included)	$800,000
							$947,000
Deployable Perimeter Flood Protection							
Option 1	Perimeter Protection	AquaFence System	1000	LF	$875	75000	$950,000
				Option 1 Short Term Subtotal			**$1,897,000**
Option 2	Perimeter Protection	Stop Logs System	1000	LF	$700	75000	$775,000
				Option 2 Short Term Subtotal			**$1,722,000**
Long-term							
Building							
Pumps and Mechanical Components	-						
	Pump Station	New pump station with generator upgrade to manage hydraulic head	1	LS	$400,000	(included)	$400,000
Electrical Components:							
Power							
Other	-						
Permanent Flood Wall Protection Options							
Option 1	8 ft. high Sheet piling Flood Wall w/ concrete pad	Permanent Flood Wall Protection	1000	LF	$2,000	(included)	$2,000,000
				Option 1 Long Term Subtotal			**$2,400,000**
Option 2	8 ft. high Sheet piling Flood Wall w/ concrete pad	Permanent Flood Wall Protection	1370	LF	$2,000	(included)	$2,740,000
				Option 2 Long Term Subtotal			**$3,140,000**
100-year FEMA BFE Elev.	16' NAVD88						
Ground Elev.	10' NAVD88						

GZA GeoEnvironmental, Inc.