STORMWATER MANAGEMENT REPORT

Herring River Boat Ramp - Harwich, MA

November 2023

Cape Cod Boat Ramp Stormwater Retrofit Project

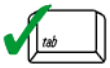
Partner: Association to Preserve Cape Cod
Owner/Operator: Town of Harwich

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

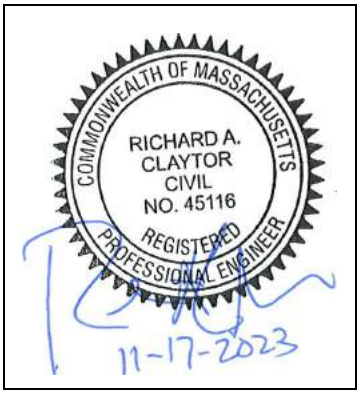
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



11/17/23

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☐ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☒ Reduced Impervious Area (Redevelopment Only)
- ☒ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☒ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☒ Other (describe): Pervious Pavers for Site Stabilization and Public Education Signage

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☒ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☐ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☐ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

☐ Site is comprised solely of C and D soils and/or bedrock at the land surface

☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000

☐ Solid Waste Landfill pursuant to 310 CMR 19.000

☒ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☐ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

☐ is within the Zone II or Interim Wellhead Protection Area

☒ is near or to other critical areas MEP -Retrofit Project

☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)

☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☒ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☒ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☒ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

☐ Limited Project

☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.

☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area

☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff

☐ Bike Path and/or Foot Path

☒ Redevelopment Project

☐ Redevelopment portion of mix of new and redevelopment.

☒ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☒ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☐ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☒ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

STORMWATER MANAGEMENT REPORT

HERRING RIVER BOAT RAMP
CAPE COD BOAT RAMP STORMWATER RETROFIT PROJECT
HARWICH, MA

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EXECUTIVE SUMMARY

The purpose of this report is to describe existing and proposed site drainage conditions at the Herring River Boat Ramp, as well as measures to prevent stormwater pollution during and after construction. This project is part of a regional effort led by the Association to Preserve Cape Cod (APCC) to improve water quality at public boat ramps on Cape Cod by implementing green stormwater infrastructure (GSI) retrofits. The main goal for this site is to better manage and treat stormwater runoff from the parking lot and boat ramp access road prior to entering Herring River. The goal of the proposed drainage conditions is to improve the site's resilience to storms and climate change. By designing the parking lot to be "floodable" through the use of pervious pavers, green stormwater control measures planted with salt-tolerant plants and other improvements, the site can continue to function as a parking lot and boat ramp while reducing the amount of sediment and other pollutants entering the salt marsh and Herring River. The project also aims to provide public outreach on the benefits of GSI and overarching watershed issues using interpretive signage.

The project includes the following structural and non-structural stormwater control measures (SCMs):

- Sediment Forebays for Pretreatment
- Wet Bioretention Areas for Treatment
- Pervious Pavers for Stabilization
- Pavement Reduction/Buffer Planting
- Public Educational Signage

Since the proposed stormwater management system is a retrofit project undertaken solely to improve water quality at the site, it falls under the redevelopment category in accordance with the Massachusetts Stormwater Management Standards (MASMS), as described in Massachusetts Stormwater Handbook, Volume 1 Chapter 1. As a redevelopment project, the design is required to meet the MASMS to the maximum extent practicable (MEP) and improve existing conditions.

As shown in **Table 1,** the proposed project meets each standard**,** except the recharge and water quality standard, which are met to the MEP. In addition, a waiver for the water quantity standard will be requested as the site is within the 100-year coastal flood plain. Each of the proposed treatment SCMs (wet bioretentions) are designed to capture and treat only the 1/2 inch of runoff of their contributing drainage areas and a small portion of the site could not be captured due to site constraints (the boat ramp area). Due to the tidal range in this location, it is not feasible to provide recharge. However, this project reduces impervious cover, stabilizes the parking lot, and provides additional native vegetation along the limit of work. Overall, this project will significantly improve conditions at the Herring River Boat Ramp and reduce on-going impacts to Herring River and downstream resources.

Table 1. Project MASMS Compliance Summary

	Minimum Standard	Type	Compliance	Report Reference(s)
1	**New Stormwater Conveyances**	Narrative	Yes	Section 3.2
2	**Water Quantity**	Calculation	Waived	Section 4.3
3	**Recharge**	Calculation	MEP	Section 4.2/Table 5
4	**Water Quality**	Calculation	MEP	Section 4.1/Table 3/Table 4 /Appendix B
5	**Land Uses with Higher Potential Pollutant Loading**	Narrative	Not Applicable	Section 2.0
6	**Critical Areas**	Narrative	Yes	Section 4.1
7	**Redevelopment**	Narrative	Yes	Section 4.0
8	**Erosion Control**	Narrative	Yes	Section 4.4/Appendix G
9	**Operation and Maintenance**	Narrative	Yes	Section 4.5/Appendix E
10	**Illicit Discharges**	Narrative	Yes	Section 4.6

1.0 INTRODUCTION

This report provides a summary of the stormwater management systems proposed for the Herring River Boat Ramp in Harwich, MA, a Town-owned and operated boat ramp (**Figure 1**). The Harwich Department of Natural Resources and Department of Engineering are proposing this project in collaboration with the Association to Preserve Cape Cod (APCC) as a part of a regional effort (Cape Cod Boat Ramp Stormwater Retrofit Project) to improve water quality at public boat ramps across Cape Cod. The proposed project has been designed to retrofit existing impervious areas for water quality improvements and improving overall site conditions. This report describes the existing and proposed site conditions and the practices to be implemented to reduce stormwater discharges and pollutants during and after construction. As required for retrofit projects, the stormwater system for the project has been designed to conform to the requirements of the Massachusetts Stormwater Standards (MASMS) to the maximum extent practicable.

1.1 Background

Freshwater ponds and coastal embayments across Cape Cod are significantly degraded by nutrient and bacteria impairment. Land uses, including stormwater runoff and fertilizer use, contribute on average 20% of the controllable nitrogen load within our coastal watersheds (Cape Cod Commission 208 Plan, 2015) and bacterial contamination, including cyanobacteria, regularly causes closures of beaches. In report (APCC's 2022 State of the Waters), 90% of the coastal embayments and 39% of the freshwater ponds assessed received unacceptable water quality scores. These high nutrient loads are of concern for the environment, our coastal economy, and public health as they negatively impact habitat for fish and shellfish and can result in unsafe conditions for swimming, fishing and boating. Public boats ramps are a common source of pollution in areas of high recreational use. As such, these locations have been targeted by APCC's regional project.

As part of an EPA Southeast New England Program (SNEP) Watershed Grant, APCC and partners first identified 20 public boat ramps across 10 Cape Cod towns in need of improved stormwater management. Concept designs for each of these twenty sites were ranked based on various criteria

including potential pollutant removal (i.e., load and drainage area), water quality status of the associated waterbody, construction cost and feasibility, and additional human use and resource benefits (restored shellfish and anadromous fish habitat, proximity to environmental justice communities, improved climate resiliency, opportunity for public education, etc.). With additional funding from a CZM FY23 Coastal Habitat and Water Quality Grant, 25% and 75% designs were developed for seven high-ranking priority sites, including this one at the tidally influenced Herring River, which discharges to Nantucket Sound. Throughout the project, the team has been working closely with the Town of Harwich's Engineering, Conservation, Harbormaster, Natural Resources, and the Water Departments to discuss and review plans for this site.

As a separate project, the Town is also undergoing efforts to plan, permit, and install a new watermain line along the Route 28 corridor close to the project site. A section of the watermain is proposed to be located on the project site, so coordination between the two projects will continue to occur with the goal of the watermain to be installed prior to the stormwater improvements project at the boat ramp site.

1.2 Project Goals

The purpose of this project is to improve water quality in Herring River and downstream waters by reducing or eliminating pollutant loads from stormwater runoff at the public boat ramp using green stormwater infrastructure (GSI) stormwater control measures (SCMs). Specifically, the project aims to maximize pollutant removal (% bacteria, nitrogen and phosphorus) and water quality volume treated. Over time, we hope this work leads to a reduction in nutrients and improvements to the shellfish and Herring River herring run.

1.3 Design Methodology

The design was completed by the following tasks:

- Preliminary field assessment of the site and contributing drainage area to identify usage, physical and environmental constraints and opportunities, and long-term operation and maintenance concerns
- Determination of drainage areas and land coverage within the project area
- Selection of structural and non-structural SCMs best suited to site conditions and project goals
- Structural SCM sizing and performance estimates (described further below)
- Hydrologic/Hydraulic Modeling (described further below)
- Grading and layout of site plan
- Erosion control plan development
- Operation and maintenance (O&M) plan development

SCM Performance Estimates

The proposed SCMs were selected and sized to maximize pollutant load removals. Since the waterbody this site drains to has water quality impairments and is subject to a TMDL, the SCMs were chosen to

maximize not only total suspended solids (TSS) removal, but total phosphorus (TP), total nitrogen (TN), and bacteria load reductions as well. MASMS was used as a reference for TSS removal estimates for bioretentions, but the more recently developed pollutant load removal curves (USEPA 2021 & Paradigm Environmental 2019) were used for TP, TN, and bacteria.[1]

Hydrologic/Hydraulic Modeling

Existing and proposed conditions for the project area were modeled using HydroCAD software, which combines USDA Soil Conservation Service hydrology and hydraulic techniques (commonly known as SCS TR-55 and TR-20) to generate hydrographs. Conditions were evaluated for the water quality event (storm that produces 1 inch of runoff, or a roughly 1.2-inch rain event).

2.0 Existing Conditions

The Herring River boat ramp is a popular water access point on the south end of Herring River, accessed by Route 28. This land use is not classified as a land use with higher potential pollutant loads (LUHPPL) and thus, is not subject to MASMS **Standard 5**.

The project site includes a large gravel parking area, paved entrance and exit driveways, a concrete boat ramp, and associated amenities such as dinghy storage and various signage (**Figure 2**). The parking area is a large open lot with no parking space delineation, but it is sized to provide approximately four regular parking spaces and six trailer parking spaces. The existing gravel lot at the site is in need of constant maintenance and areas of erosion are evident. The paved driveways are crumbling at the edges. Salt marsh is located in close proximity to the parking area (**Figure 3**). There is no existing stormwater management infrastructure nor other utilities at this site. The site is low lying at a tidally-influenced river. In 2011, tidal data was collected at or near the site as part of the Massachusetts Estuaries Project study for the Herring River; the data indicates the site experiences a mean high water of 2.66 feet and mean low water of -0.80 feet[2]. At mean high water, part of the parking lot is flooded. Town staff also provided anecdotal evidence that the parking lot floods during King Tide events.

2.1 Receiving Water and Watershed

Herring River boat ramp discharges stormwater into Herring River, a tidal river that provides habitat for shellfish and serves as an important herring run. However, it is listed (Category 4a – TMDL completed) as impaired for estuarine bioassessments, fecal coliform, total nitrogen, and nutrient/eutrophication biological indicators by the most recent Massachusetts DEP 303(d) – 2018/2020 Integrated list of Waters (MA96-22) **(Figure 4)**, and APCC's State of the Waters Report lists it as unacceptable for nitrogen.

[1] It is important to note that these curves have a crosswalk to help users determine which specific curve to reference: for wet bioretentions, the appropriate curve is the Wet Pond Performance Curve.
[2] Elevations are given relative to NAVD88. The MEP study is available at: https://www.harwich-ma.gov/sites/g/files/vyhlif7091/f/file/file/mep_herring_river_draft-10mb.pdf.

Herring River is located in the Herring River Watershed, which is located in the Towns of Harwich, Dennis, and Brewster. Total maximum daily load documents (TMDLs) have been developed for total nitrogen and pathogens for Herring River[3].

2.2 Drainage Area

The boat ramp's existing contributing drainage area is approximately 0.38 acres. As there is no runoff from the state-owned Route 28 coming onto the site, the drainage area to the boat ramp is the entrance/exit driveways and parking area, with 0.23 acres (61% of total drainage area) of impervious cover. Based on existing topography and flow paths, the total drainage area was divided into two separate drainage areas: DA1 (West Parking Lot and Driveway/Boat Ramp) draining to Study Point 1 (SP1 – Herring River) and DA2 (East Parking Lot and Driveway) draining to Study Point 2 (SP2 – Herring Salt Marsh). See the existing conditions drainage area map and a detailed breakdown of land cover in **Appendix A,** as well as the existing HydroCAD model report in **Appendix B.**

2.3 Resource Areas

HW wetland biologists delineated several resource areas at the site in December 2022. A full description of these resource areas is included in **Appendix C**, and their locations and associated buffers are shown on the plans in **Appendix G**. The wetland resource areas include Salt Marsh; Coastal Bank; Bordering Vegetated Wetland (BVW); Riverfront Area; Land Subject to Coastal Storm Flowage (LSCSF); and the 50-foot No Disturb and 100-foot Buffer Zones to Salt Marsh, Coastal Bank, and BVW. Additional resource areas present adjacent to the site include Land Under Waterbodies and Waterways (LUW) and Banks of or Land Under the Ocean, Ponds, Streams, Rivers, Lakes, or Creeks that Underlie an Anadromous/ Catadromous Fish Run ("Fish Run").

According to the most recent version of the *Massachusetts Natural Heritage Atlas* (15th Edition, August 1, 2021), there are no areas of *Estimated Habitat of Rare Wildlife and Certified Vernal Pools* (EH 377) and/or *Priority Habitat of Rare Species* (PH 280) as designated by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) located at the site (**Figure 3**). The majority of the site is located within a Special Flood Hazard Area, Zone AE (1% annual chance of flooding, with base flood elevations of 11 feet) with the remainder of the site, closer to the Herring River located within a Special Flood Hazard Area, Zone AE (1% annual chance of flooding, with base flood elevations of 13 feet), as shown in the wetland memo (**Appendix C**). Since the site discharges to a shell fishing area, it is considered a critical area and subject to MASMS **Standard 6**.

2.4 Soils

Soils data from the Natural Resources Conservation Service (NRCS) indicate that the soils within the drainage areas to the site are composed of Udipsamments, 0-3% slopes. The entire drainage area (0.38 acres) is within this one soil type and is classified as hydrologic soil group (HSG) "null" due to the urban

[3] TMDL documents available at: https://www.mass.gov/doc/final-tmdl-for-total-nitrogen-for-the-herring-river/download & https://www.mass.gov/doc/final-pathogen-tmdl-report-for-the-cape-cod-watershed/download.

fill in this area (**Figure 5)**. Given the proximity to salt marsh and HSG of neighboring land to the south, the site's HSG was assumed as D for this project.

Three test pits (TP) were conducted at the site on January 24, 2023 to evaluate subsurface conditions. The test pits were witnessed and logged by an HW Massachusetts Title 5 Approved Soil Evaluator; results are shown in **Table 2** below.

Test pits were conducted in three areas: the northwest corner of the parking lot (TP-1), eastern edge of the parking lot (TP-2), and the southern edge of the parking lot (TP-3). The parent material of the soil unit, human transported material, is sandy excavated or filled land. See **Appendix D** for soil test pit logs. No redoximorphic staining was observed in the test pits. Water was observed in the test pits. There is a shallow depth to groundwater at the site. The groundwater at this site is influenced by the tides so when the tide is high, groundwater rises. The current tide elevation during the time of the test pits was not recorded by HW, however, based on historical tide data for the region, the site was experiencing low tide during the timeframe the test pits were being evaluated[4]. Given this information, the water observed in the test pits is likely shallower during high tides.

Table 2. Test Pit (TP) Results

Test Pit ID	Surface Elevation at TP (ft)	Pit Bottom Elevation (ft)	Soil Texture(s)	Notes
TP-1	2.8	-1.4	Loamy medium sand	Water observed at 24" depth
TP-2	2.6	-1.6	Loamy medium sand to fine sand	Water observed at 21" depth
TP- 3	2.8	-4.2	Loamy medium sand	Water observed at 44" depth

3.0 Proposed Conditions

The goal of the design improvements is to improve the site's resilience to storms and climate change. By designing the parking lot to be "floodable" through the use of pervious pavers and GSI planted with salt-tolerant plants, the site can continue to function as a parking lot and boat ramp and reduce or minimize the amount of sediment and other pollutants entering the salt marsh and Herring River. The proposed project consists of the following stormwater and related site development improvements:

- Resurfaced entrance/exit driveways and parking lot to better direct runoff while maintaining current parking spaces, adequate drive aisle and required parking space dimensions, traffic flow, and stabilization of the parking lot surface;
- GSI including wet bioretention areas;
- Reduction in overall impervious cover; and

[4] Historic tide information was reviewed at: https://www.usharbors.com/harbor/massachusetts/harwich-port-ma/tides/?tide=2023-02#monthly-tide-chart. In addition, plans for a project nearby the site along the Herring River shows mean high water elevation at 1.4 feet (October 2022).

- Revegetation and protection of salt marsh areas to promote regrowth.

The proposed GSI system is designed to meet the following major objectives:

- Capture and treat runoff to the maximum extent practicable;
- Reduce pollutant source by stabilizing parking lot surface; and
- Engage the community with interpretive signage.

3.1 Drainage Areas

The boat ramp's contributing drainage area (DA) under proposed conditions is very similar to existing, with a total of approximately 0.38 acres. While the project is proposing increased paved surfaces, total impervious cover would be reduced by roughly 1,020 square feet, dropping the site to just below 55% impervious for the entire drainage area. DA1 (West Parking Lot and Driveway/Boat Ramp) and DA2 (East Parking Lot and Driveway) were subdivided for the proposed conditions in order to model flows to the proposed SCMs. The proposed DA1 drainage areas are DA1A (To BIO 1) and DA1B (To West). The proposed DA2 drainage areas are DA2A (To BIO 2) and DA2B (To East). The proposed SCMs were added as "ponds" in the HydroCAD model. The site will continue to discharge runoff to Study Point 1 (SP1-Herring River) and Study Point 2 (SP2-Herring Salt Marsh), as in existing conditions.

See the proposed conditions drainage area map and a detailed breakdown of land cover in **Appendix A,** as well as the proposed HydroCAD model report in **Appendix B.**

3.2 Structural Stormwater Control Measures (SCMs)

The proposed stormwater management includes a GSI approach to capture, treat, infiltrate (if possible), and detain runoff by using the following SCMs. There are three stormwater GSI practices proposed throughout the site - two of the practices are wet bioretention areas and one is a permeable paver system. Pretreatment will be provided with sediment forebays, and overflows from extreme events will flow over spillways. The stormwater management systems were designed to meet **Standard 1**, so that no new untreated stormwater runoff will be directed to any off-site areas or resource areas. Runoff from contributing impervious areas will be treated by the proposed practices.

Sediment Forebays

Porous sediment forebays are provided for pretreatment of the runoff from the paved surfaces to allow for sediment and other debris to settle out prior to conveyance into the wet bioretention areas.

Wet Bioretention Areas (BIO)

A wet bioretention area (BIO) is a shallow depression used to treat stormwater runoff using a specific planting soil and plants to filter runoff when possible, but also to provide storage when inundated (regular tidal inundation is expected at this site). The method combines settling, physical filtering, and adsorption with bio-geochemical processes to remove pollutants. During periods of low groundwater and/or no tidal inundation, these systems will act like a typical bioretention, and runoff will be filtered through the media. During periods of high groundwater and/or tidal inundation, these systems will act

as a wet practice with no filtering in the media. The system consists of an inflow component, a pretreatment element, a shallow ponding area planted with appropriate native plant species (i.e., native salt marsh species), and an overflow weir.

The wet bioretention areas are proposed at key locations around the parking lot to manage runoff from the entrance/exit driveways and the parking lot. These BIOs capture, treat, and infiltrate the first inch of runoff from the contributing drainage areas. Runoff from storms larger than the 0.5 inch will flow over the overflow weirs. Given the location of the site in the 100-year floodplain several feet above the parking lot grade (11 & 13 ft elevation compared to the parking lot elevation of 4 ft), the proposed SCMs will be completely submerged during large storm events.

Pervious Pavers

Interlocking pervious pavers are proposed to be used for the surface of the parking area. The pervious paver system is designed to provide a stable parking area for vehicles and trailers, while minimizing gravel and fine sediment runoff that an unstabilized surface generates (pollutant source). The pervious paver product specified considers current and future tidal inundation and the mechanical and chemical weathering that entails.

While the pervious paver surface is designed to promote water infiltration through joints in the pavers and/or the block material itself, the parking area was modeled with a curve number of 96 (represents a highly impervious surface). During small storms, and when groundwater and tides are low, the pervious paver surface will accept and infiltrate runoff. However, if groundwater and/or tide is high, the paver system will accept little to no runoff, and will instead act as though it were impermeable. For this reason, all paved surfaces are considered impervious for modeling purposes.

3.3 Non-structural SCMs

The non-structural SCMs proposed at the site include pavement reduction (~1,020 sf) and associated buffer plantings and public educational signage. Excess pavement/compacted gravel was reduced slightly with the proposed design, reducing overall runoff volume and pollution source. In addition, an interpretive sign is proposed overlooking wet bioretention area 1 (BIO1) next to the parking lot edge at the boat ramp. This sign will explain the GSI at the site as a part of the larger watershed issues discussed above and encourage GSI actions at home.

4.0 Stormwater Design Components

The proposed SCMs were designed to meet a variety of goals and regulatory requirements as discussed above. As a retrofit project for managing existing impervious cover, this design must specifically comply with the redevelopment standard (MASMS **Standard 7)** by meeting all standards to the maximum extent practicable and improve existing conditions. The project fully meets this standard, as described in detail below.

4.1 Water Quality

The main purpose of this retrofit project is to improve water quality. This section describes the treatment volumes and pollutant load reductions achieved by the proposed design and how they compare to the MASMS standards.

Treatment Volume

Per **Standard 4 and 6** of MASMS, the stormwater management system for a new development site discharging to a critical area must be sized to treat the first one inch of runoff (water quality volume (WQV)) and remove 80% or more of the annual post-construction load of total suspended solids (TSS). As a retrofit (falls under **Standard 7** - Redevelopment), the project is only required to meet this to the maximum extent practicable. The proposed wet bioretention areas were sized to be as large as possible given the proximity to resource areas, with only a small portion of the site's impervious area (IA) that could not be captured and treated (DA1B). The proposed HydroCAD model results are included in **Appendix B** and summarized below in **Table 3**.

Table 3. Compliance with Water Quality Volume Requirements

DA ID	SCM ID	IA (ac)	WQv Goal (ac-ft)	WQv Provided (ac-ft)*	% WQv Provided	Meets Reqt?	Notes
DA1A	P1	0.07	0.006	0.004	67%	MEP	No infiltration - 'HSG D'
DA1B	N/A	0.03	0.002	0	0	N/A	
DA2A	P2	0.09	0.008	0.004	50%	MEP	No infiltration - 'HSG D'
DA2B	N/A	0.00	N/A	N/A	N/A	N/A	
TOTAL SITE:		**0.20**	**0.016**	**0.008**	**50%**	**MEP**	**Retrofit Project**

**From HydroCAD results – see Appendix B for "pond" storage volume*

Pollutant Load Reductions

The wet bioretentions are expected to exceed the MASMS requirements for TSS removal and provide removals of the other pollutants of concern. Estimated TSS, phosphorus (TP), nitrogen (TN), and bacteria removals for the proposed project are provided in **Table 4.** The proposed O&M Guide in **Appendix E** was developed to ensure that the stormwater system continues to function as it was designed into the future to maintain these levels of pollutant removal.

Table 4. Compliance with Water Quality Pollutant Load Reduction Requirements

DA ID	SCM ID	IA (ac)	WQv Provided (ac-ft)*	Runoff Depth Treated (in)	TSS Removal (%)**	TP Removal (%)***	TN Removal (%)***	Bacteria Removal (%)****	Meets Reqt?	Notes
DA1A	P1	0.07	0.004	0.64	58%	44%	28%	50%	MEP	
DA1B	N/A	0.03	0	0	0%	0%	0%	0%	N/A	
DA2A	P2	0.09	0.004	0.51	46%	41%	26%	45%	MEP	
DA2B	N/A	0.00	N/A	0	0	0	0	0	N/A	
TOTAL SITE:		**0.20**	**0.008**	**0.49**	**44%**	**37%**	**23%**	**41%**	**MEP**	**Retrofit Project**

**From HydroCAD results – see Appendix B for pond storage volume*
***From MASMS*
****From MS4 NPDES Permit Appendix F Attachment 3 (USEPA 2021)*
*****From Paradigm Environmental (2019)*

Long-term Pollution Prevention Plan

Source control is important to ensure long-term functionality of the proposed SCMs and protect downstream resources and habitat. A long-term pollution prevention plan specific to this site is provided as a part of the O&M Guide in **Appendix E**.

4.2 Recharge

For new development projects, the MASMS requires a specific annual "recharge" volume (Rev) based on the HSG of the soil covered by new impervious surfaces. However, infiltrating treated runoff is not a goal of this project because the site is very close to groundwater and tidally influenced, and we are assuming these urban soils are classified as HSG D with a poor infiltration rate as stated above. While we are not taking credit for recharge at this site due to these constraints to be conservative in our estimates, we do expect that there will be infiltration at low tide conditions from the permeable pavers and the wet bioretentions. In addition, removing impervious area (1,020 sf) and replanting with native vegetation will also improve recharge. In these ways, the proposed project is improving existing conditions with regards to recharge.

Table 5. Compliance with Recharge Requirements

DA ID	SCM ID	IA (ac)	Soil HSG	Required Recharge Depth (in)	Rev Goal (ac-ft)	Rev Provided (ac-ft)	% Rev Provided	Draw-down Time (hrs)	Notes
DA1A	P1	0.07	D	0.1	0.001	0	0%	N/A	Wet practice
DA1B	N/A	0.03	D	0.1	0.000	0	N/A	N/A	
DA2A	P2	0.09	D	0.1	0.001	0	0%	N/A	Wet practice
DA2B	N/A	0.00	D	0.1	0.000	0	N/A	N/A	
TOTAL SITE:		**0.20**			**0.00**	**0.00**	**0%**		

4.3 Water Quantity

The main goal of this project is to improve water quality. Since the site is located within the 100-year floodplain and designated as land subject to coastal storm flowage, as well as subject to daily tidal influence, the requirements of **Standard 2** of the MASMS may be waived. During these large storm events, the parking lot itself will be impacted by coastal flooding. Thus, HydroCAD calculations for the proposed wet bioretentions for the 2-, 10-, and 100-year storms are not provided.

4.4 Erosion Control

Controlling erosion and sedimentation from the construction site is important to meet the overall water quality goals of this retrofit project, as well as to meet MASMS **Standard 8**. Given this site's size (< 1 acre of disturbance), a NPDES Construction General Permit Stormwater Pollution Plan (SWPPP) is not required. However, an ESC Plan is included in the design plans (**Appendix G**), along with a detailed sequence of construction activities and ESC notes. Silt socks are proposed along the downgradient edges of the area of disturbance. A construction entrance will be installed to minimize tracking onto Main Street. Disturbed areas will be stabilized as soon as possible to minimize erosion and sedimentation with pavement, seeding and/or erosion control blankets, if necessary. A Pollutant Controls During Construction guide is also included in **Appendix F** that discusses these controls in more detail. With these layered ESCs implemented throughout the site, discharge of sediment-laden runoff during construction should be minimized to the maximum extent practicable.

This site, particularly the parking area and proposed wet bioretention areas, is subject to regular tidal inundation. Particular attention should be paid to the tide times when deciding how construction should be sequenced and times, and erosion and sedimentation controls installed and maintained, such that damage to unstabilized or partially-constructed stormwater areas is prevented.

The contractor will be required to place erosion controls prior to beginning any other project-related work. The ESC Plan will also establish the limit of work, beyond which the contractor will not be allowed to perform any work. It is the contractor's responsibility to monitor and correct erosion control practices throughout the duration of the project. Erosion control measures will not be removed until the project reaches completion as directed by the project engineer or landscape architect.

4.5 Operation and Maintenance

Ongoing maintenance is vital for long-term success at the site. The SCMs were designed to be low-maintenance in nature. These SCMs will be operated and maintained appropriately during construction and post-construction as required on the construction drawings and O&M Guide per MASMS **Standard 9** (**Appendix E and G**).

4.6 Illicit Discharges

There will be no illicit discharges to the existing system by the proposed project per MASMS **Standard 10**. The Long-Term Pollution Prevention Plan in the O&M Guide (**Appendix E**) includes measures to prevent future illicit discharges.

5.0 REFERENCES

Association to Preserve Cape Cod. 2022. State of the Waters: Cape Cod Report.

Cape Cod Commission. 2015. 208 Plan – Cape Cod's Area Wide Water Quality Management Plan Updated.

Massachusetts Department of Environmental Protection (MADEP). 2008. Massachusetts Stormwater Standards Manual.

MADEP. 2019. See their homepage at www.state.ma.gov/dep.

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USEPA (United States Environmental Protection Agency). 2019. National Pollutant Discharge Elimination System (NPDES). See their homepage at: http://cfpub.epa.gov/NPDES/.

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FIGURES

Horsley Witten Group
Sustainable Environmental Solutions

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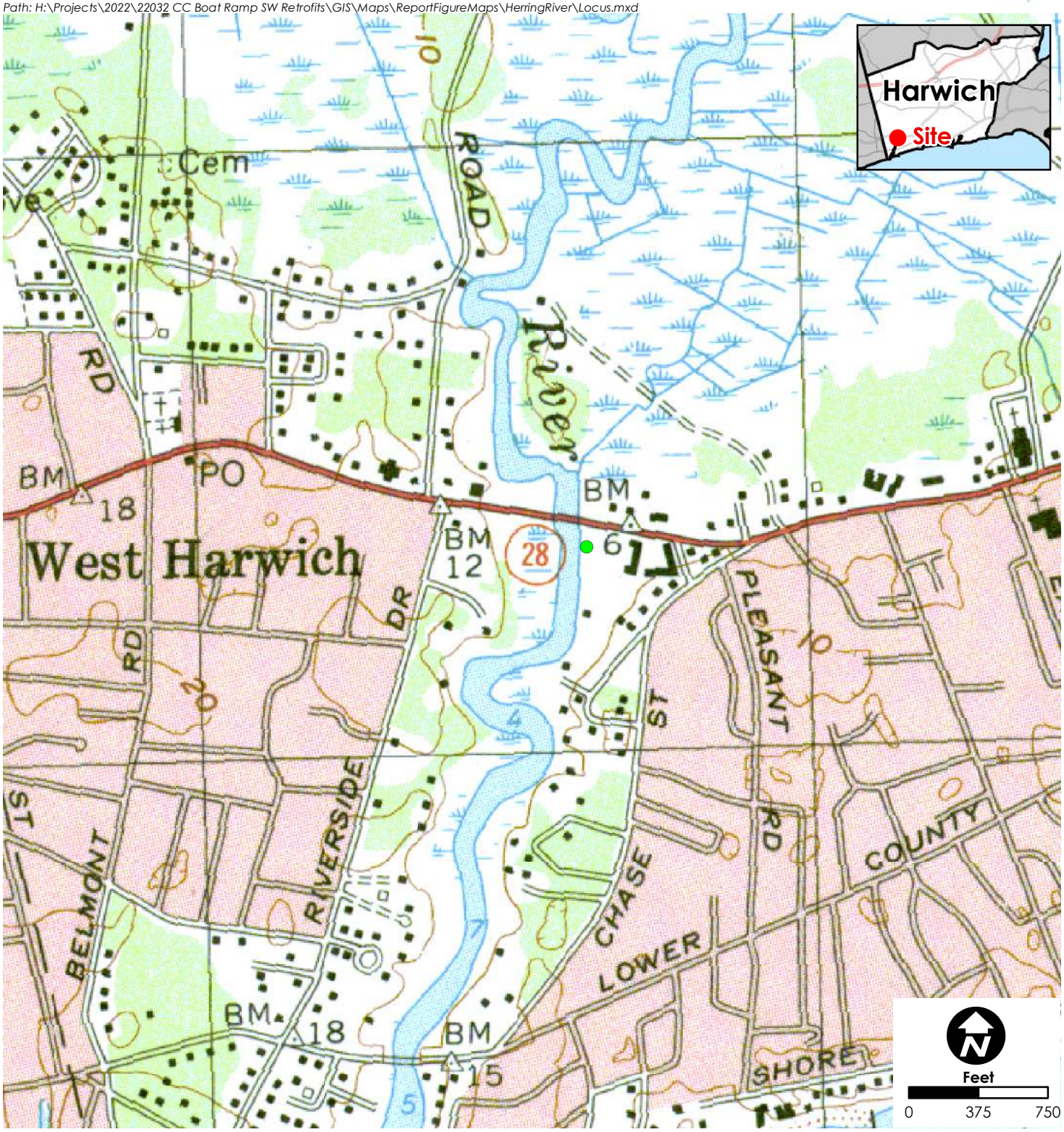

Date: 8/17/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

● Herring River Boat Ramp

HERRING RIVER Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Harwich, MA

Figure 1
Locus Map

Horsley Witten Group
Sustainable Environmental Solutions

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Date: 8/17/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

- Herring River Boat Ramp
- Town Parcels

HERRING RIVER Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Harwich, MA

Figure 2
Aerial

Horsley Witten Group
Sustainable Environmental Solutions

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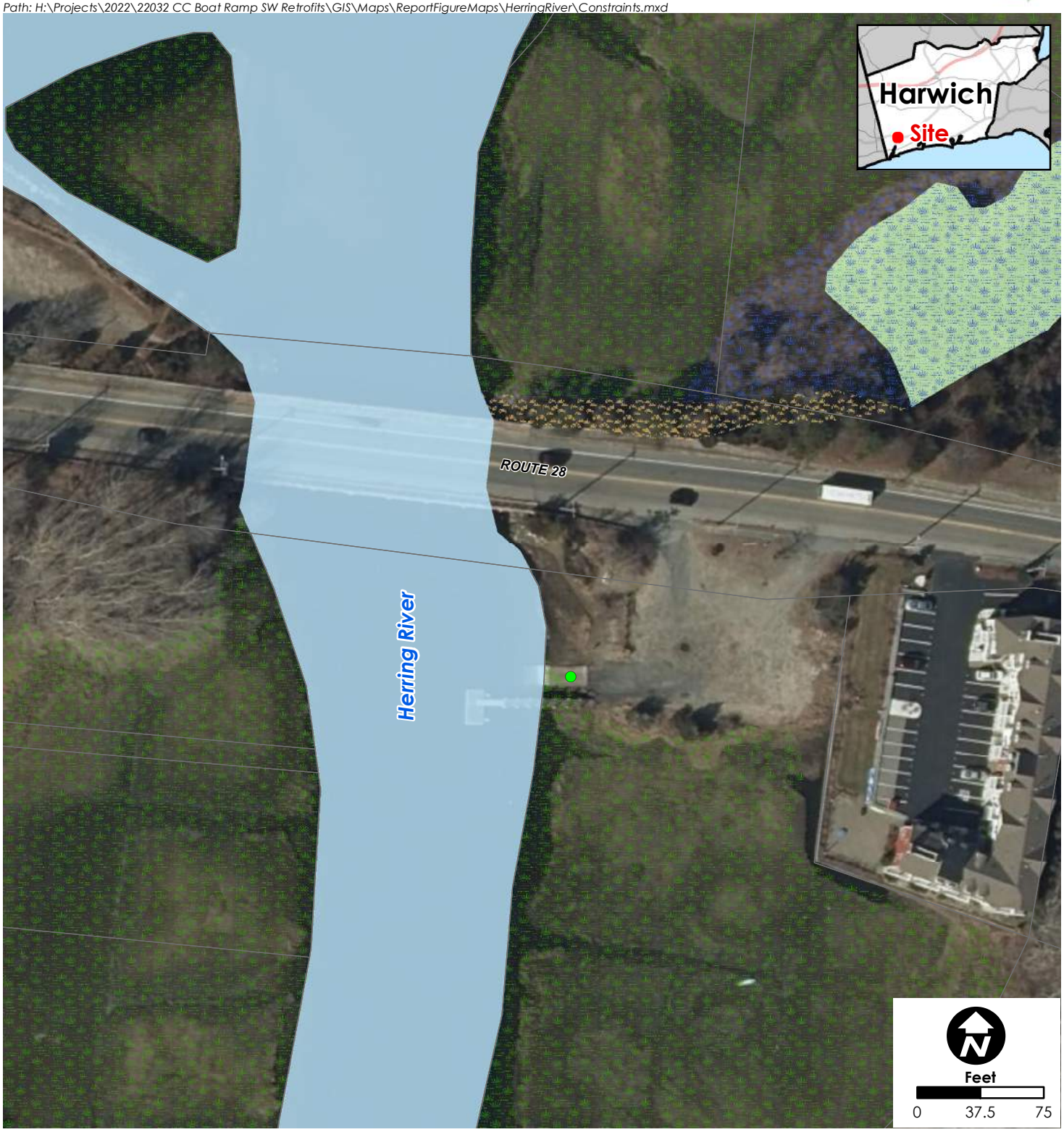

Date: 8/17/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

- Herring River Boat Ramp
- Town Parcels
- Marsh/Bog
- Wooded marsh
- Salt Marsh
- Open Water
- Beach/Dune

HERRING RIVER Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Harwich, MA

Figure 3
Constraints

Horsley Witten Group
Sustainable Environmental Solutions

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Date: 9/5/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

- Herring River Boat Ramp

2018/2020 Integrated List Data

- 4A - Impaired - TMDL is completed
- Municipal Boundary

HERRING RIVER Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Harwich, MA

Figure 4
Impaired Waters

Horsley Witten Group
Sustainable Environmental Solutions

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Date: 8/17/2023
Data Sources: Bureau of Geographic Information (MassGIS), ESRI

This map is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

- Herring River Boat Ramp
- Town Parcels

Hydrologic Soil Group

- <Null>
- A
- A/D

HERRING RIVER Boat Ramp
Cape Cod Boat Ramp Stormwater Retrofit Project
Harwich, MA

Figure 5
Soils

APPENDIX A – Drainage Areas

- Existing and Proposed Drainage Areas Maps
- Land Coverage Summaries

LEGEND

- DRAINAGE AREA BOUNDARY
- IMP. AREA / TOTAL AREA (SQUARE FEET)
- WOODS
- WATER
- ROOFTOP
- GRASS
- PAVEMENT
- DA1 — DRAINAGE AREA
- SP1 — STUDY POINT
- SOIL BOUNDARY
- 5' MAJOR CONTOUR
- 1' MINOR CONTOUR

SOIL TYPES

607	WATER, SALINE (NO HSG)
665	UDIPSAMMENTS (NO HSG)

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90 Route 6A Sandwich, MA 02563
horsleywittengroup.com

Scale: 8/30/23
Design By: -
Drawn By: MCL
Checked By: MW

Plan Set:
CAPE COD BOAT RAMP STORMWATER RETROFIT PROJECT - PERMITTING PLANS
HERRING RIVER
HARWICH, MA

Plan Title:
EXISTING DRAINAGE MAP

Prepared For:
Town of Harwich
732 Main Steet
Harwich, MA
Phone:(508) 430-7514

Project Number:
22032

Sheet Number:
1 of 2

LEGEND

DRAINAGE AREA BOUNDARY

IMP. AREA
TOTAL AREA
(SQUARE FEET)

PAVEMENT *5,000* **15,000**

WOODS
WATER
ROOFTOP
GRASS
PAVERS

DA1 DRAINAGE AREA

SP1 STUDY POINT

P1 POND

SOIL BOUNDARY

5' MAJOR CONTOUR

1' MINOR CONTOUR

SOIL TYPES

607 WATER, SALINE (NO HSG)

665 UDIPSAMMENTS (NO HSG)

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A Sandwich, MA 02563
horsleywittengroup.com

Date: 8/30/23
Design By: ,
Drawn By: MCL
Checked By: MW

Plan Set:
HERRING RIVER
CAPE COD BOAT RAMP STORMWATER
RETROFIT PROJECT - PERMITTING PLANS
HARWICH, MA

Plan Title:
PROPOSED DRAINAGE MAP

Prepared For:
Town of Harwich
732 Main Street
Harwich, MA
Phone:(508) 430-7514

Project Number:
22032

Sheet Number:
2 of 2

CAPE COD BOAT RAMP RETROFITS HARWICH, MASSACHUSETTS	Calc'd by:	MCL
	Checked by:	MW
Existing Drainage Conditions	Date:	9/18/2023

DRAINAGE AREAS	
DA1	**West**
DA2	**East**

NOAA 14+ 24-hr Type III (inches)	
WQv	1.21
1-yr	3.03
2-yr	3.57
5-yr	4.46
10-yr	5.23
25-yr	6.47
100-yr	8.50
500-yr	11.34

DA1	**West**		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	4,491	0.103	including grave
Permeable	0	0.000	
Roof	0	0.000	
Water	0	0.000	
Woods	813	0.019	
Grass	2,659	0.061	
TOTAL	7,963	0.183	

Impervious		
Area, ft^2	Area, *ac*	Percent
4,491	0.103	56

DA2	**East**		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	5,570	0.128	
Permeable	0	0.000	
Roof	0	0.000	
Water	0	0.000	
Woods	893	0.021	
Grass	2,105	0.048	
TOTAL	8,568	0.197	

Impervious		
Area, ft^2	Area, *ac*	Percent
5,570	0.128	65

ALL	***ALL EXISTING DRAINAGE AREAS COMBINED***					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	10,061	0.231				
Permeable	0	0.000				
Roof	0	0.000				
Water	0	0.000				
Woods	1,706	0.039		**Impervious**		
Grass	4,764	0.109		Area, ft^2	Area, *ac*	Percent
TOTAL	16,531	0.379		10,061	0.231	61

CAPE COD BOAT RAMP RETROFITS **HARWICH, MASSACHUSETTS**	Calc'd by:	MCL
	Checked by:	MW
Proposed Drainage Conditions	Date:	9/18/2023

DRAINAGE AREAS	
DA1A	**TO BIO 1**
DA1B	**TO WEST**
DA2A	**TO BIO 2**
DA2B	**TO EAST**

NOAA 14+ 24-hr Type III (inches)	
WQv	1.21
1-yr	3.03
2-yr	3.57
5-yr	4.46
10-yr	5.23
25-yr	6.47
100-yr	8.50
500-yr	11.34

DA1A	**TO BIO 1**		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	1,803	0.041	
Permeable	1,460	0.034	
Roof	0	0.000	
Water	219	0.005	
Woods	700	0.016	
Grass	1,613	0.037	
TOTAL	5,795	0.133	

Impervious		
Area, ft^2	Area, *ac*	Percent
3,263	0.075	56

DA1B	**TO WEST**		
Cover type	Area, ft^2	Area, *ac*	Note
Paved	0	0.000	
Permeable	1,116	0.026	
Roof	0	0.000	
Water	0	0.000	
Woods	25	0.001	
Grass	1,697	0.039	
TOTAL	2,838	0.065	

Impervious		
Area, ft^2	Area, *ac*	Percent
1,116	0.026	39

DA2A	TO BIO 2					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	1,859	0.043				
Permeable	2,264	0.052				
Roof	0	0.000				
Water	177	0.004				
Woods	0	0.000		**Impervious**		
Grass	1,726	0.040		Area, ft^2	Area, *ac*	Percent
TOTAL	6,026	0.138		4,123	0.095	68

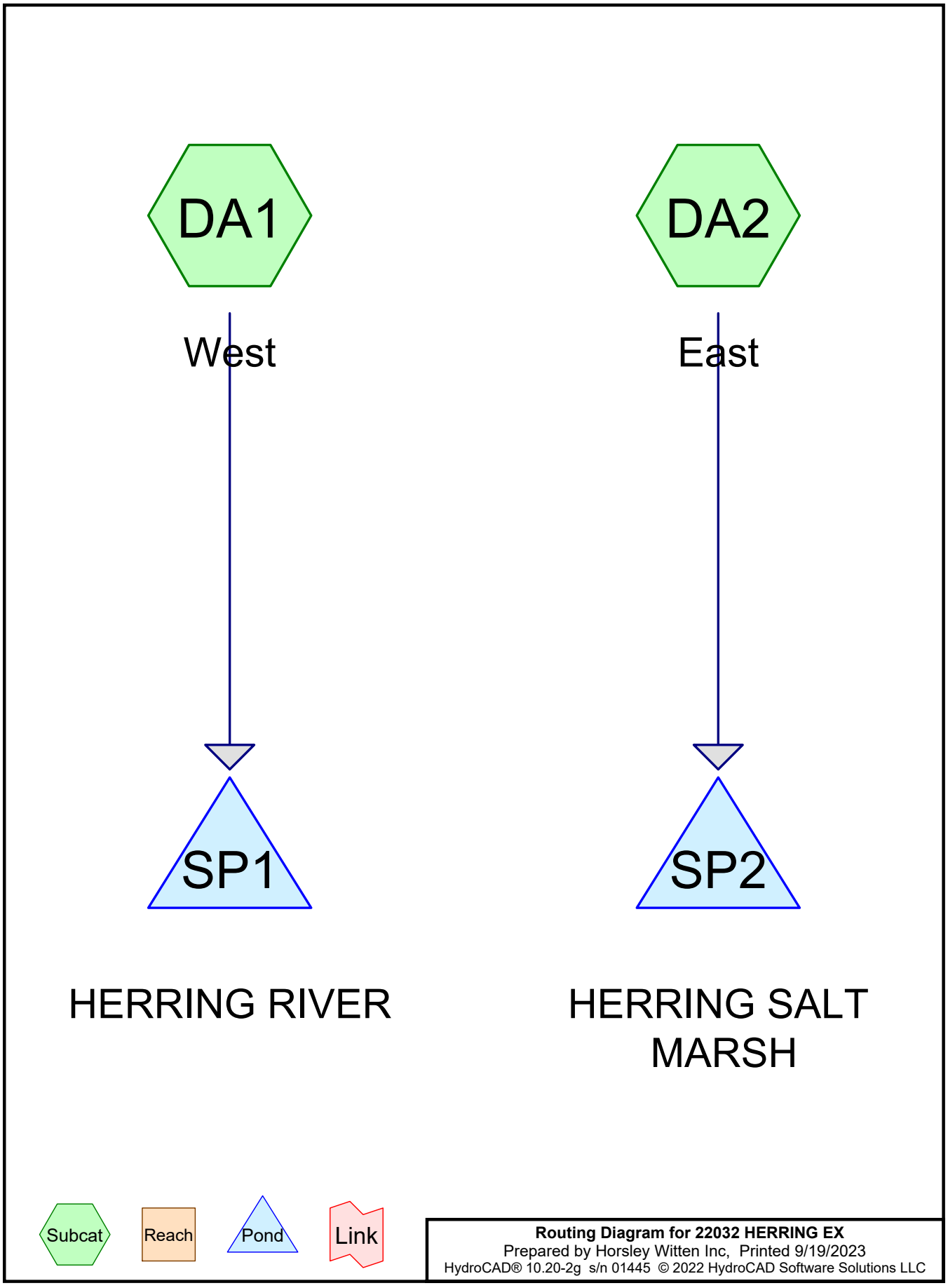
DA2B	TO EAST					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	0	0.000				
Permeable	0	0.000				
Roof	0	0.000				
Water	0	0.000				
Woods	894	0.021		**Impervious**		
Grass	921	0.021		Area, ft^2	Area, *ac*	Percent
TOTAL	1,815	0.042		0	0.000	0

ALL	***ALL PROPOSED DRAINAGE AREAS COMBINED***					
Cover type	Area, ft^2	Area, *ac*	Note			
Paved	3,662	0.084				
Permeable	4,840	0.111				
Roof	0	0.000				
Water	396	0.009				
Woods	1,619	0.037		**Impervious**		
Grass	5,957	0.137		Area, ft^2	Area, *ac*	Percent
TOTAL	16,474	0.378		8,898	0.204	54

APPENDIX B – Hydrologic/Hydraulic Model Results

HydroCAD® Results

- Existing
- Proposed



Routing Diagram for 22032 HERRING EX
Prepared by Horsley Witten Inc, Printed 9/19/2023

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	WQV	Type III 24-hr		Default	24.00	1	1.21	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
3,552	80	>75% Grass cover, Good, HSG D (DA1, DA2)
10,061	98	Paved parking, HSG D (DA1, DA2)
2,918	77	Woods, Good, HSG D (DA1, DA2)
16,531	**90**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
0	HSG C	
16,531	HSG D	DA1, DA2
0	Other	
16,531		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Sub Num
0	0	0	3,552	0	3,552	>75% Grass cover, Good	
0	0	0	10,061	0	10,061	Paved parking	
0	0	0	2,918	0	2,918	Woods, Good	
0	**0**	**0**	**16,531**	**0**	**16,531**	**TOTAL AREA**	

Time span=1.00-48.00 hrs, dt=0.02 hrs, 2351 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: West Runoff Area=7,963 sf 56.40% Impervious Runoff Depth=0.62"
Tc=5.0 min CN=79/98 Runoff=0.12 cfs 412 cf

Subcatchment DA2: East Runoff Area=8,568 sf 65.01% Impervious Runoff Depth=0.69"
Tc=5.0 min CN=78/98 Runoff=0.15 cfs 492 cf

Pond SP1: HERRING RIVER Inflow=0.12 cfs 412 cf
Primary=0.12 cfs 412 cf

Pond SP2: HERRING SALT MARSH Inflow=0.15 cfs 492 cf
Primary=0.15 cfs 492 cf

Total Runoff Area = 16,531 sf Runoff Volume = 905 cf Average Runoff Depth = 0.66"
39.14% Pervious = 6,470 sf 60.86% Impervious = 10,061 sf

Summary for Subcatchment DA1: West

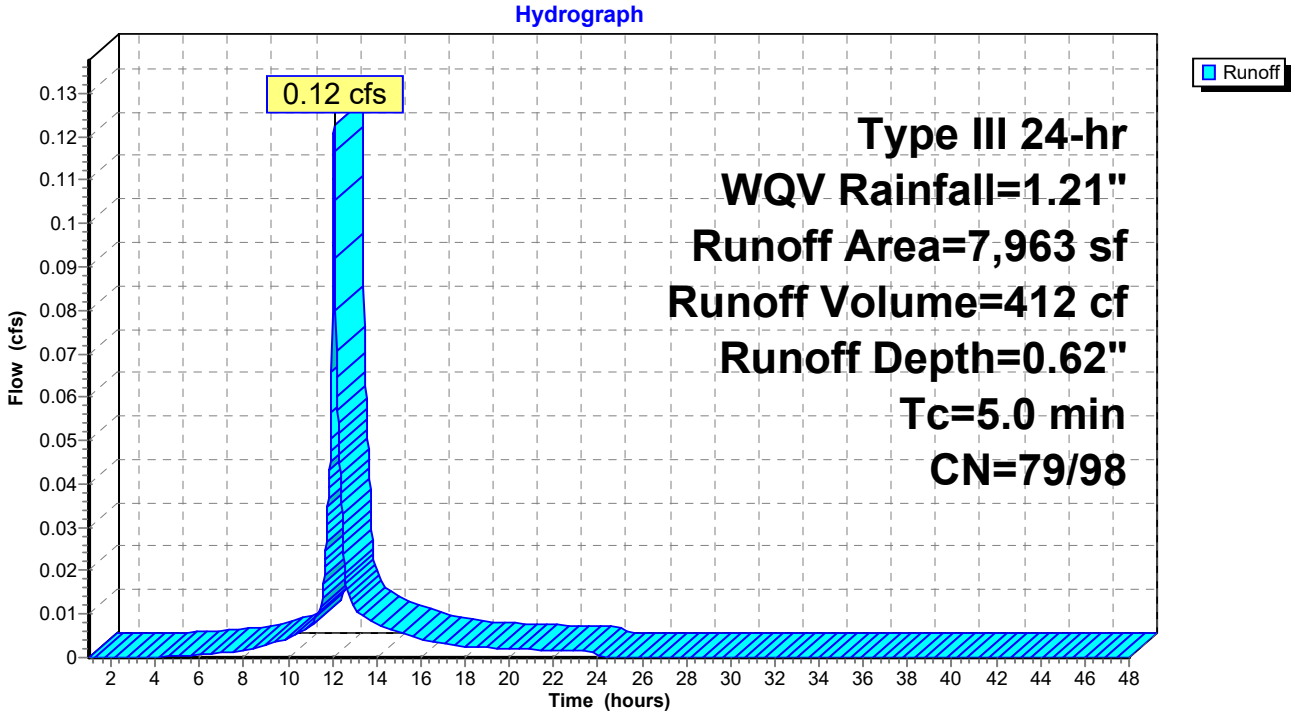
Runoff = 0.12 cfs @ 12.07 hrs, Volume= 412 cf, Depth= 0.62"
Routed to Pond SP1 : HERRING RIVER

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr WQV Rainfall=1.21"

Area (sf)	CN	Description
4,491	98	Paved parking, HSG D
813	77	Woods, Good, HSG D
2,659	80	>75% Grass cover, Good, HSG D
7,963	90	Weighted Average
3,472	79	43.60% Pervious Area
4,491	98	56.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 MIN**

Subcatchment DA1: West



Summary for Subcatchment DA2: East

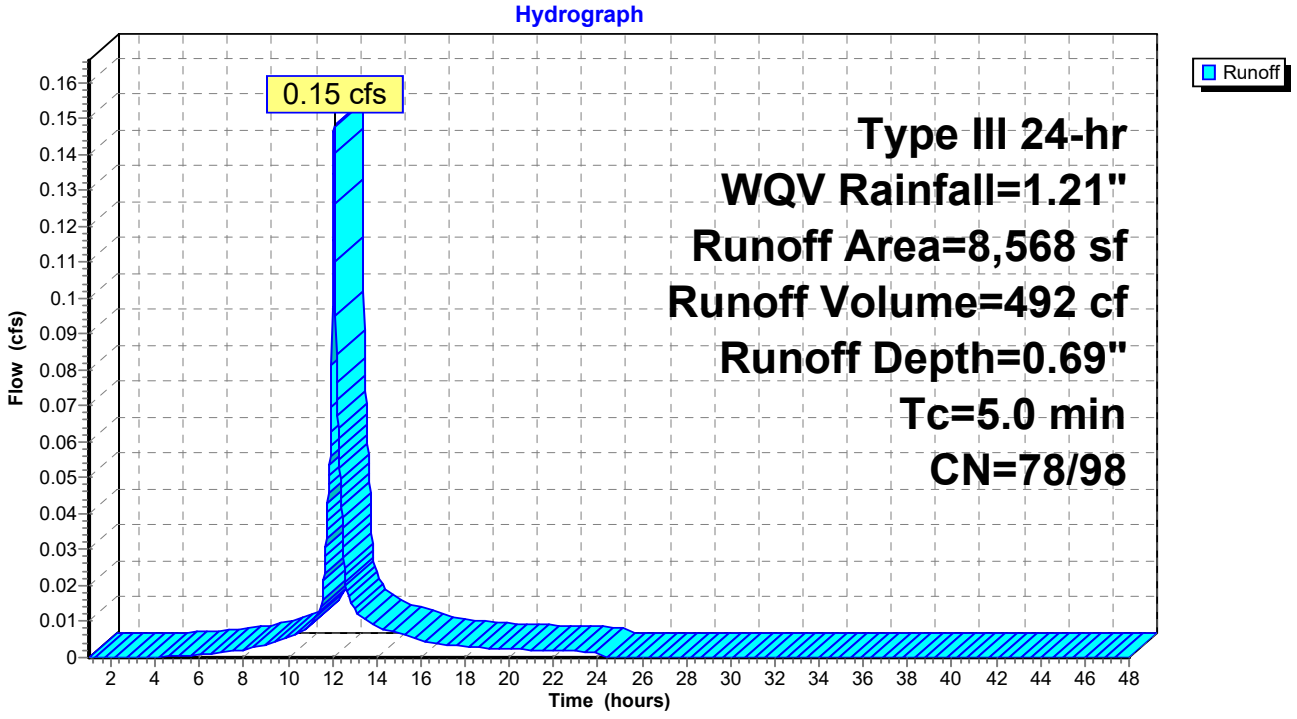
Runoff = 0.15 cfs @ 12.07 hrs, Volume= 492 cf, Depth= 0.69"
Routed to Pond SP2 : HERRING SALT MARSH

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr WQV Rainfall=1.21"

Area (sf)	CN	Description
5,570	98	Paved parking, HSG D
893	80	>75% Grass cover, Good, HSG D
2,105	77	Woods, Good, HSG D
8,568	91	Weighted Average
2,998	78	34.99% Pervious Area
5,570	98	65.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 MIN DIRECT**

Subcatchment DA2: East



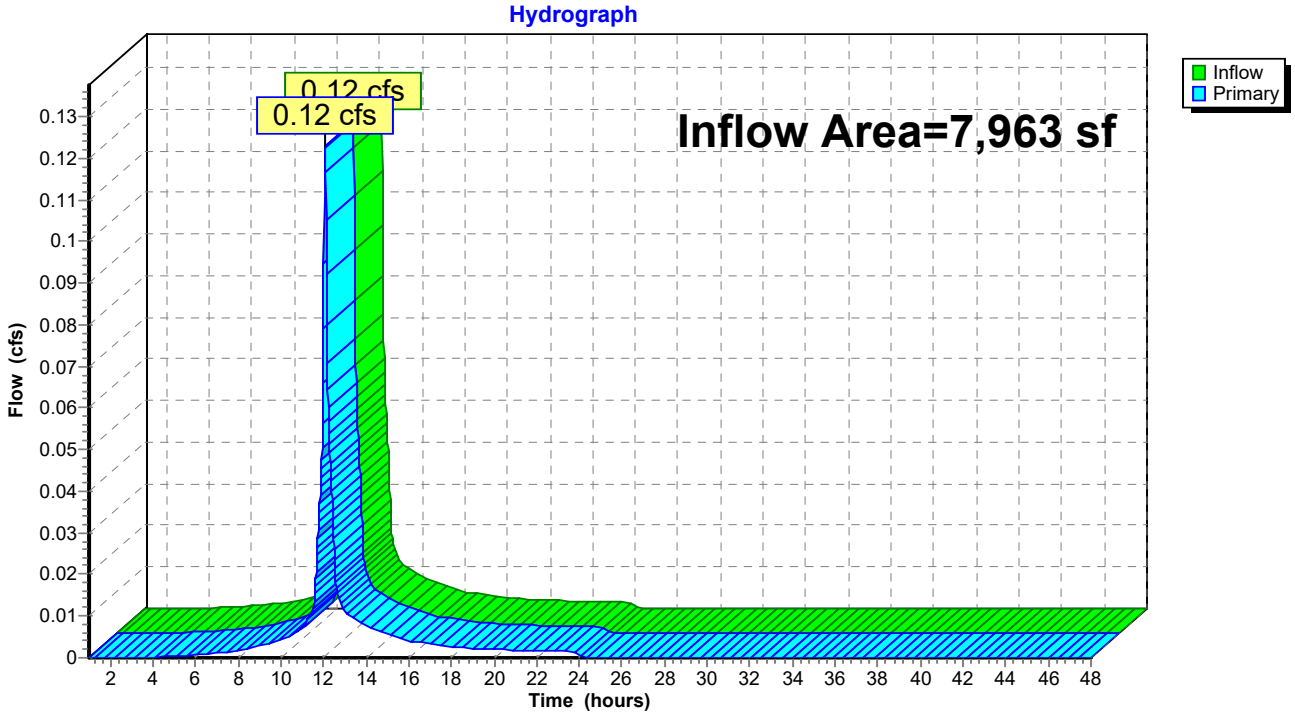
Summary for Pond SP1: HERRING RIVER

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 7,963 sf, 56.40% Impervious, Inflow Depth = 0.62" for WQV event
Inflow = 0.12 cfs @ 12.07 hrs, Volume= 412 cf
Primary = 0.12 cfs @ 12.07 hrs, Volume= 412 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: HERRING RIVER



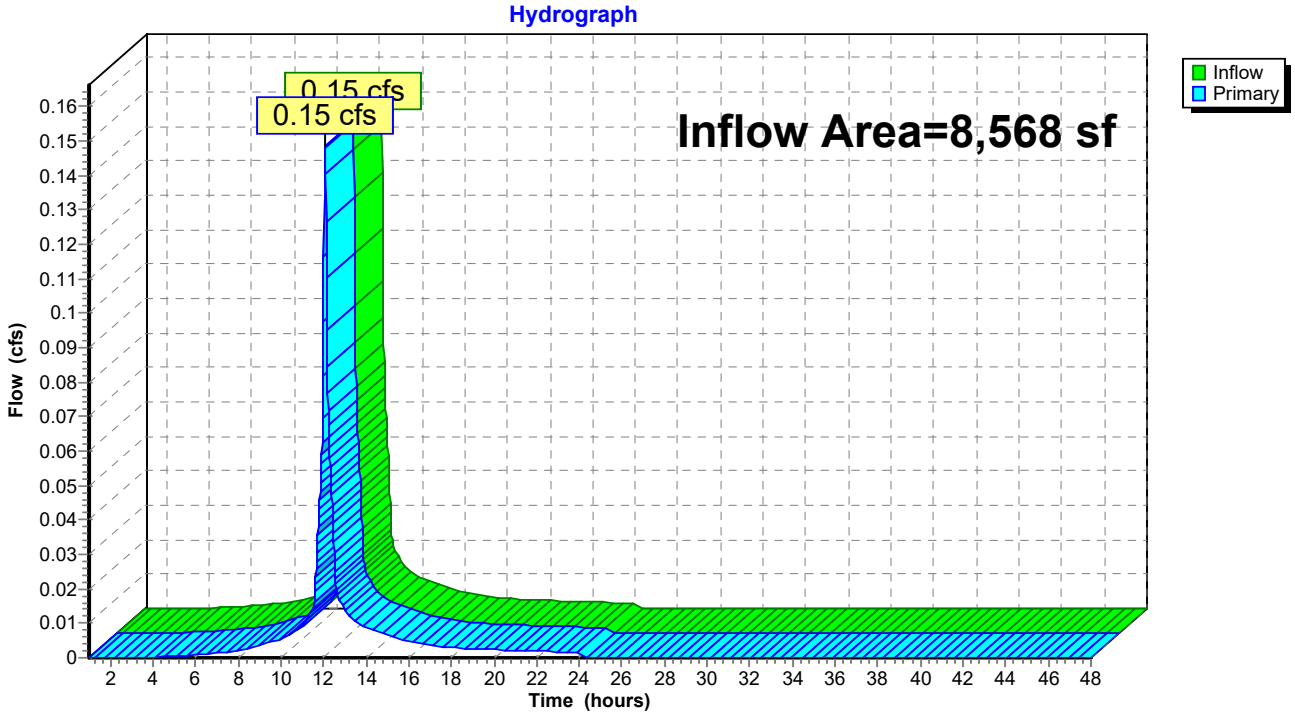
Summary for Pond SP2: HERRING SALT MARSH

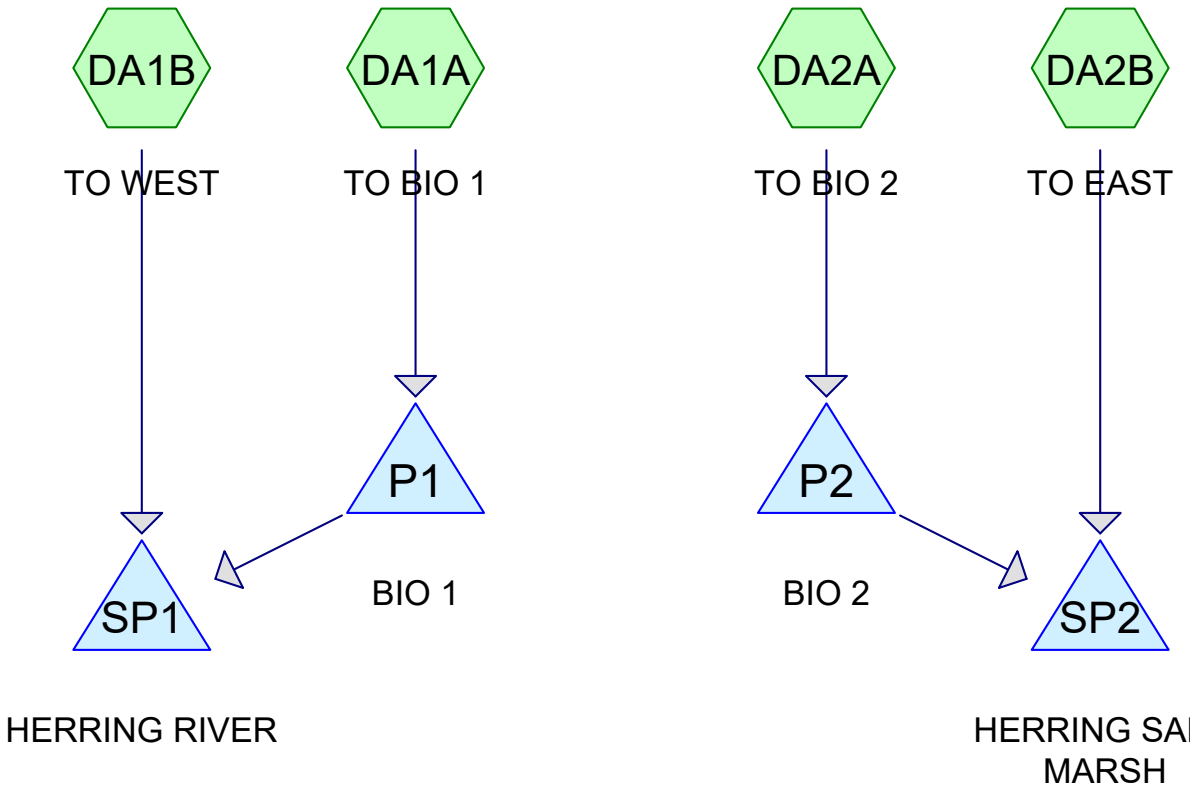
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 8,568 sf, 65.01% Impervious, Inflow Depth = 0.69" for WQV event
Inflow = 0.15 cfs @ 12.07 hrs, Volume= 492 cf
Primary = 0.15 cfs @ 12.07 hrs, Volume= 492 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.02 hrs

Pond SP2: HERRING SALT MARSH





Subcat Reach Pond Link

Routing Diagram for 22032 HERRING PR
Prepared by Horsley Witten Inc, Printed 11/17/2023

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	WQV	Type III 24-hr		Default	24.00	1	1.21	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
5,957	80	>75% Grass cover, Good, HSG D (DA1A, DA1B, DA2A, DA2B)
4,840	96	Gravel surface, HSG D (DA1A, DA1B, DA2A)
3,662	98	Paved parking, HSG D (DA1A, DA2A)
396	98	Water Surface, HSG D (DA1A, DA2A)
1,619	77	Woods, Good, HSG D (DA1A, DA1B, DA2B)
16,474	**89**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
0	HSG C	
16,474	HSG D	DA1A, DA1B, DA2A, DA2B
0	Other	
16,474		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Sub Num
0	0	0	5,957	0	5,957	>75% Grass cover, Good	
0	0	0	4,840	0	4,840	Gravel surface	
0	0	0	3,662	0	3,662	Paved parking	
0	0	0	396	0	396	Water Surface	
0	0	0	1,619	0	1,619	Woods, Good	
0	**0**	**0**	**16,474**	**0**	**16,474**	**TOTAL AREA**	

Time span=1.00-48.00 hrs, dt=0.02 hrs, 2351 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1A: TO BIO 1 Runoff Area=5,795 sf 34.89% Impervious Runoff Depth=0.55"
Tc=5.0 min CN=86/98 Runoff=0.08 cfs 266 cf

Subcatchment DA1B: TO WEST Runoff Area=2,838 sf 0.00% Impervious Runoff Depth=0.31"
Tc=5.0 min CN=86/0 Runoff=0.02 cfs 74 cf

Subcatchment DA2A: TO BIO 2 Runoff Area=6,026 sf 33.79% Impervious Runoff Depth=0.62"
Tc=5.0 min CN=89/98 Runoff=0.10 cfs 309 cf

Subcatchment DA2B: TO EAST Runoff Area=1,815 sf 0.00% Impervious Runoff Depth=0.14"
Tc=5.0 min CN=79/0 Runoff=0.00 cfs 21 cf

Pond P1: BIO 1 Peak Elev=2.75' Storage=185 cf Inflow=0.08 cfs 266 cf
Outflow=0.01 cfs 82 cf

Pond P2: BIO 2 Peak Elev=2.76' Storage=183 cf Inflow=0.10 cfs 309 cf
Outflow=0.01 cfs 129 cf

Pond SP1: HERRING RIVER Inflow=0.02 cfs 156 cf
Primary=0.02 cfs 156 cf

Pond SP2: HERRING SALT MARSH Inflow=0.01 cfs 149 cf
Primary=0.01 cfs 149 cf

Total Runoff Area = 16,474 sf Runoff Volume = 669 cf Average Runoff Depth = 0.49"
75.37% Pervious = 12,416 sf 24.63% Impervious = 4,058 sf

Summary for Subcatchment DA1A: TO BIO 1

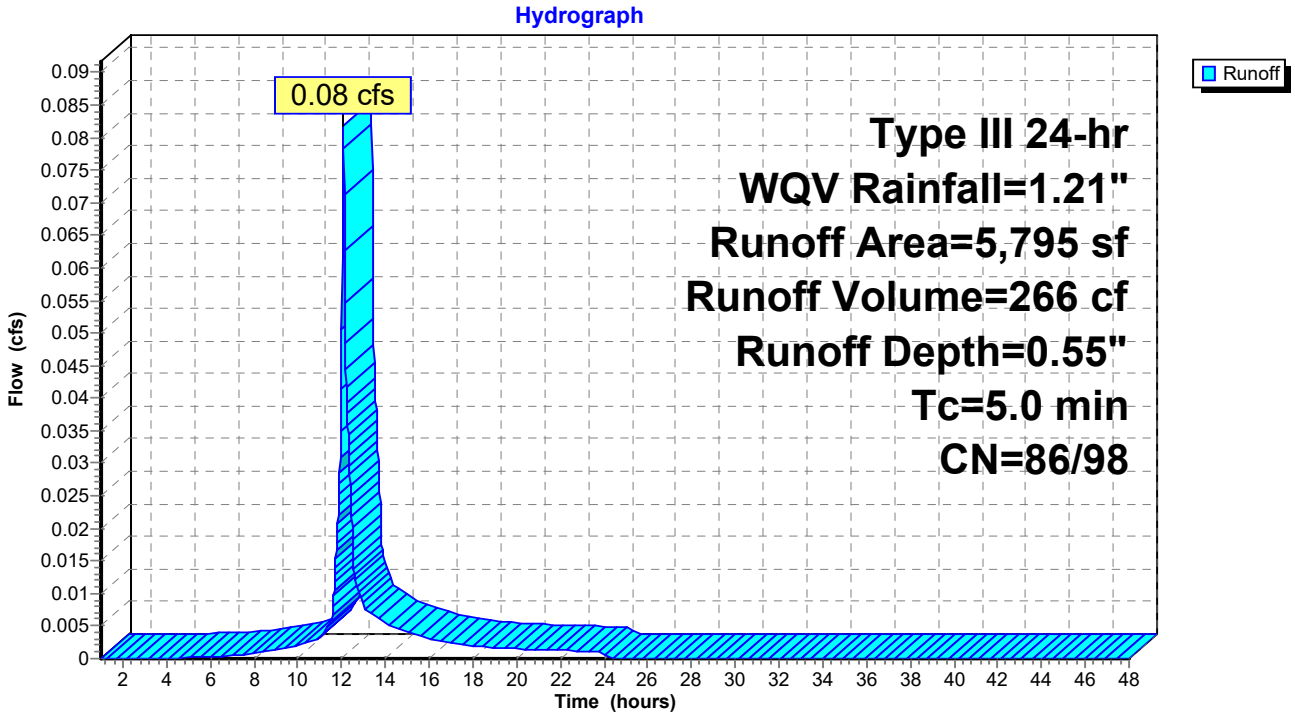
Runoff = 0.08 cfs @ 12.08 hrs, Volume= 266 cf, Depth= 0.55"
Routed to Pond P1 : BIO 1

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr WQV Rainfall=1.21"

Area (sf)	CN	Description
1,803	98	Paved parking, HSG D
1,460	96	Gravel surface, HSG D
219	98	Water Surface, HSG D
700	77	Woods, Good, HSG D
1,613	80	>75% Grass cover, Good, HSG D
5,795	90	Weighted Average
3,773	86	65.11% Pervious Area
2,022	98	34.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 MIN**

Subcatchment DA1A: TO BIO 1



Summary for Subcatchment DA1B: TO WEST

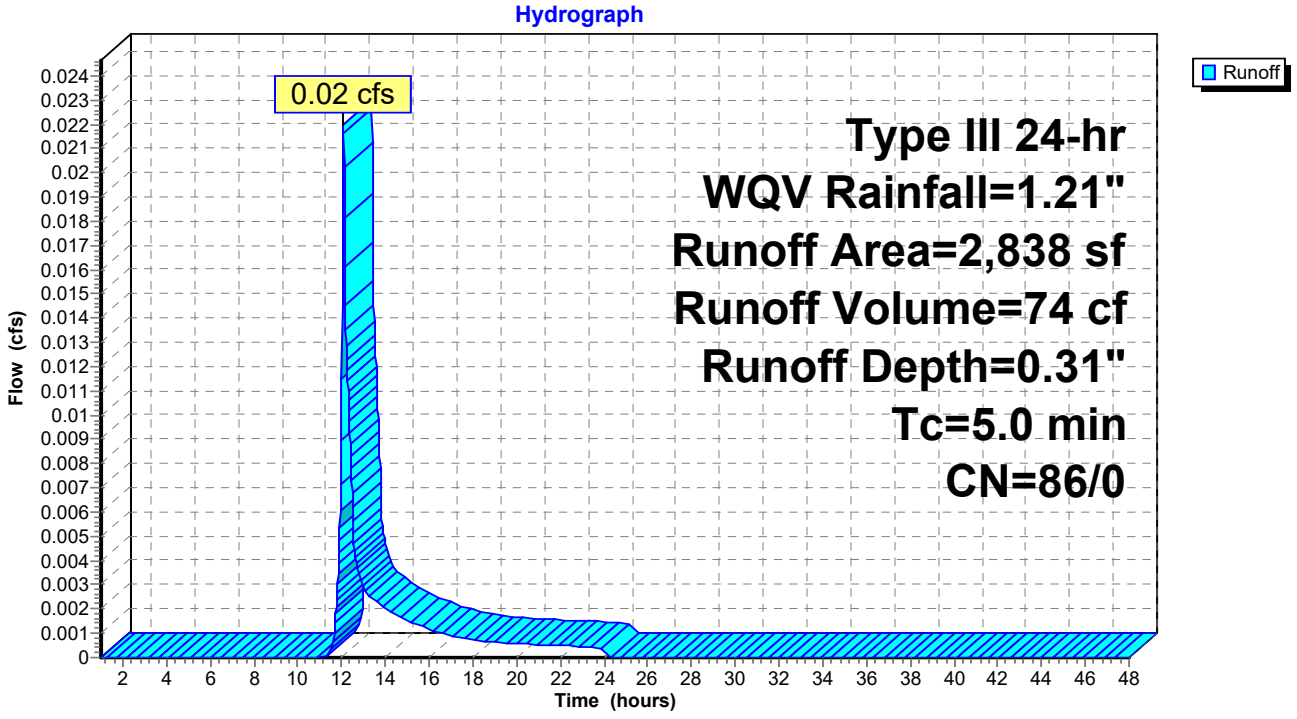
Runoff = 0.02 cfs @ 12.09 hrs, Volume= 74 cf, Depth= 0.31"
Routed to Pond SP1 : HERRING RIVER

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr WQV Rainfall=1.21"

Area (sf)	CN	Description
0	98	Paved parking, HSG D
1,116	96	Gravel surface, HSG D
25	77	Woods, Good, HSG D
1,697	80	>75% Grass cover, Good, HSG D
2,838	86	Weighted Average
2,838	86	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 MIN**

Subcatchment DA1B: TO WEST



Summary for Subcatchment DA2A: TO BIO 2

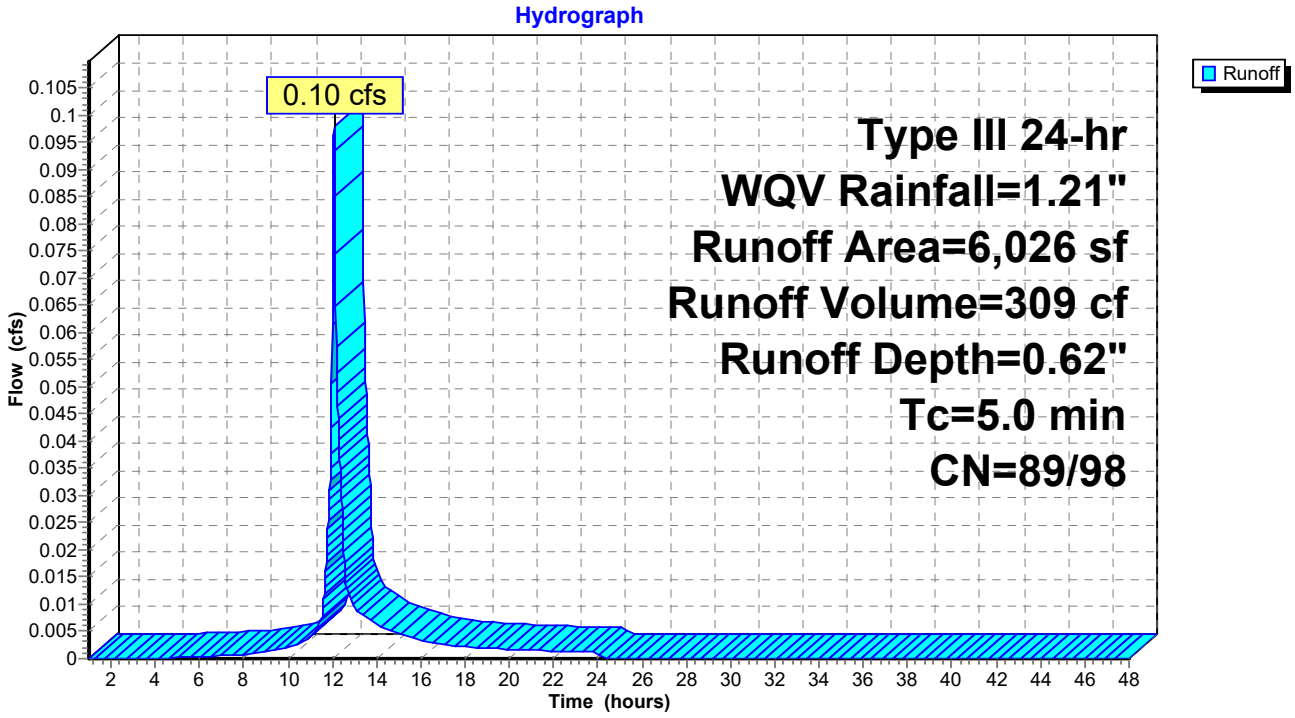
Runoff = 0.10 cfs @ 12.08 hrs, Volume= 309 cf, Depth= 0.62"
Routed to Pond P2 : BIO 2

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr WQV Rainfall=1.21"

Area (sf)	CN	Description
1,859	98	Paved parking, HSG D
2,264	96	Gravel surface, HSG D
177	98	Water Surface, HSG D
0	77	Woods, Good, HSG D
1,726	80	>75% Grass cover, Good, HSG D
6,026	92	Weighted Average
3,990	89	66.21% Pervious Area
2,036	98	33.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 MIN DIRECT**

Subcatchment DA2A: TO BIO 2



Summary for Subcatchment DA2B: TO EAST

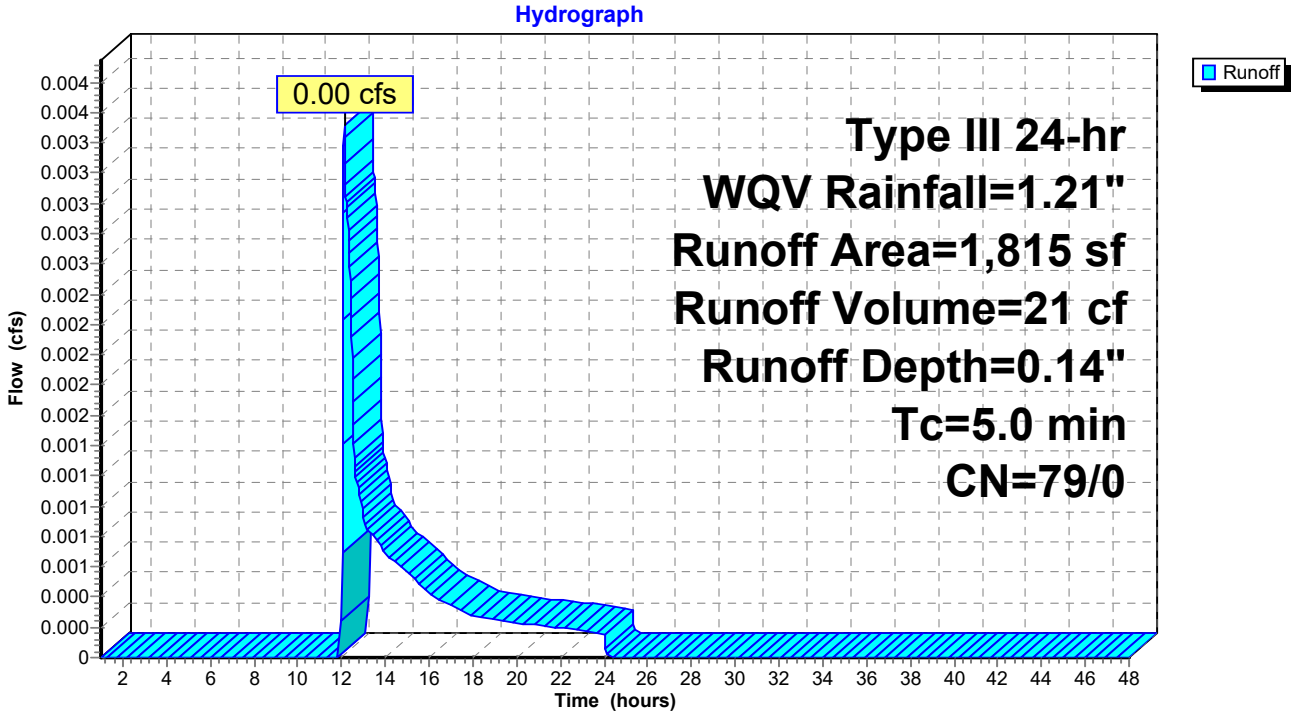
Runoff = 0.00 cfs @ 12.12 hrs, Volume= 21 cf, Depth= 0.14"
Routed to Pond SP2 : HERRING SALT MARSH

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 1.00-48.00 hrs, dt= 0.02 hrs
Type III 24-hr WQV Rainfall=1.21"

Area (sf)	CN	Description
0	98	Paved parking, HSG D
921	80	>75% Grass cover, Good, HSG D
894	77	Woods, Good, HSG D
0	96	Gravel surface, HSG D
1,815	79	Weighted Average
1,815	79	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5 MIN DIRECT**

Subcatchment DA2B: TO EAST



Summary for Pond P1: BIO 1

Inflow Area = 5,795 sf, 34.89% Impervious, Inflow Depth = 0.55" for WQV event
Inflow = 0.08 cfs @ 12.08 hrs, Volume= 266 cf
Outflow = 0.01 cfs @ 14.03 hrs, Volume= 82 cf, Atten= 93%, Lag= 117.1 min
Primary = 0.01 cfs @ 14.03 hrs, Volume= 82 cf
Routed to Pond SP1 : HERRING RIVER

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 2.75' @ 14.03 hrs Surf.Area= 315 sf Storage= 185 cf

Plug-Flow detention time= 386.3 min calculated for 82 cf (31% of inflow)
Center-of-Mass det. time= 233.9 min (1,049.5 - 815.6)

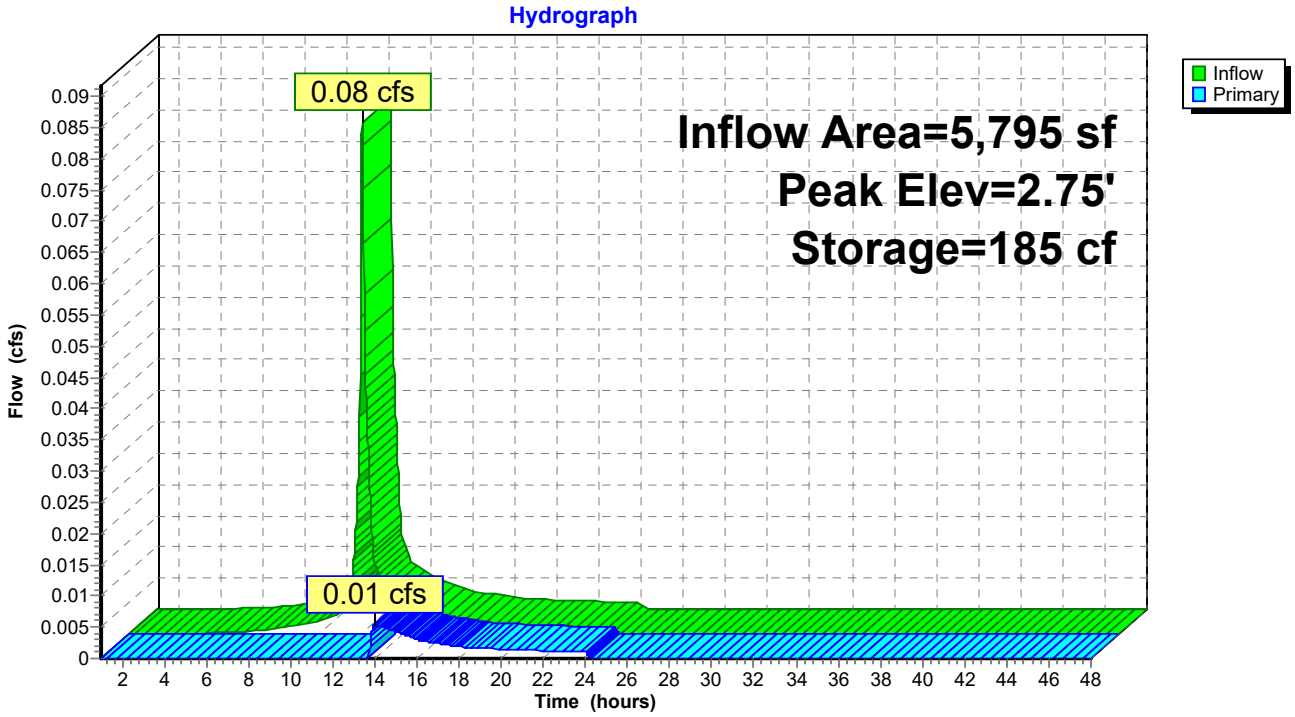
Volume	Invert	Avail.Storage	Storage Description
#1	2.00'	268 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2.00	175	0	0
3.00	360	268	268

Device	Routing	Invert	Outlet Devices
#1	Primary	2.75'	**5.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 14.03 hrs HW=2.75' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 0.00 cfs @ 0.16 fps)

Pond P1: BIO 1


Hydrograph
Inflow
Primary
0.08 cfs
0.01 cfs
Inflow Area=5,795 sf
Peak Elev=2.75'
Storage=185 cf
Flow (cfs)
0.09
0.085
0.08
0.075
0.07
0.065
0.06
0.055
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Time (hours)

Summary for Pond P2: BIO 2

Inflow Area = 6,026 sf, 33.79% Impervious, Inflow Depth = 0.62" for WQV event
Inflow = 0.10 cfs @ 12.08 hrs, Volume= 309 cf
Outflow = 0.01 cfs @ 12.90 hrs, Volume= 129 cf, Atten= 89%, Lag= 49.5 min
Primary = 0.01 cfs @ 12.90 hrs, Volume= 129 cf
Routed to Pond SP2 : HERRING SALT MARSH

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.02 hrs
Peak Elev= 2.76' @ 12.90 hrs Surf.Area= 323 sf Storage= 183 cf

Plug-Flow detention time= 296.8 min calculated for 129 cf (42% of inflow)
Center-of-Mass det. time= 165.4 min (980.6 - 815.2)

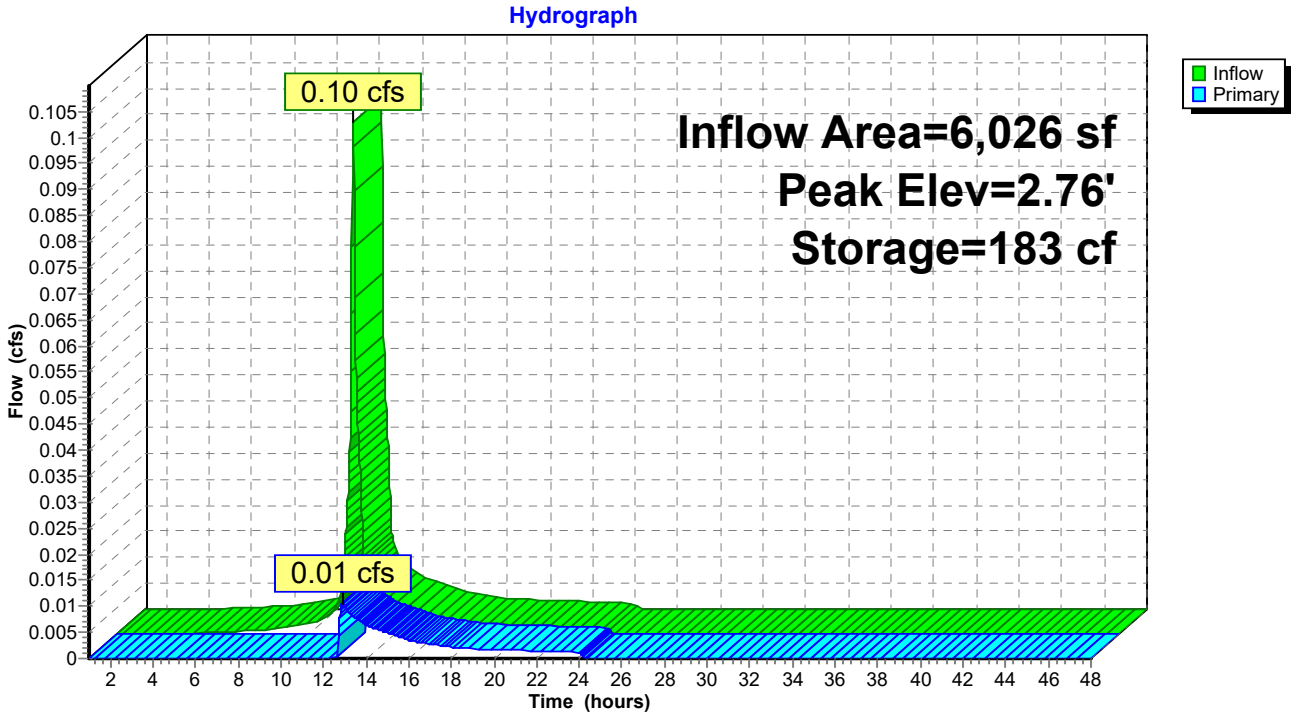
Volume	Invert	Avail.Storage	Storage Description
#1	2.00'	268 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2.00	160	0	0
3.00	375	268	268

Device	Routing	Invert	Outlet Devices
#1	Primary	2.75'	**5.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.01 cfs @ 12.90 hrs HW=2.76' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 0.01 cfs @ 0.23 fps)

Pond P2: BIO 2


Hydrograph
0.10 cfs
0.01 cfs
Inflow Area=6,026 sf
Peak Elev=2.76'
Storage=183 cf
Inflow
Primary
Flow (cfs)
0.105
0.1
0.095
0.09
0.085
0.08
0.075
0.07
0.065
0.06
0.055
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Time (hours)

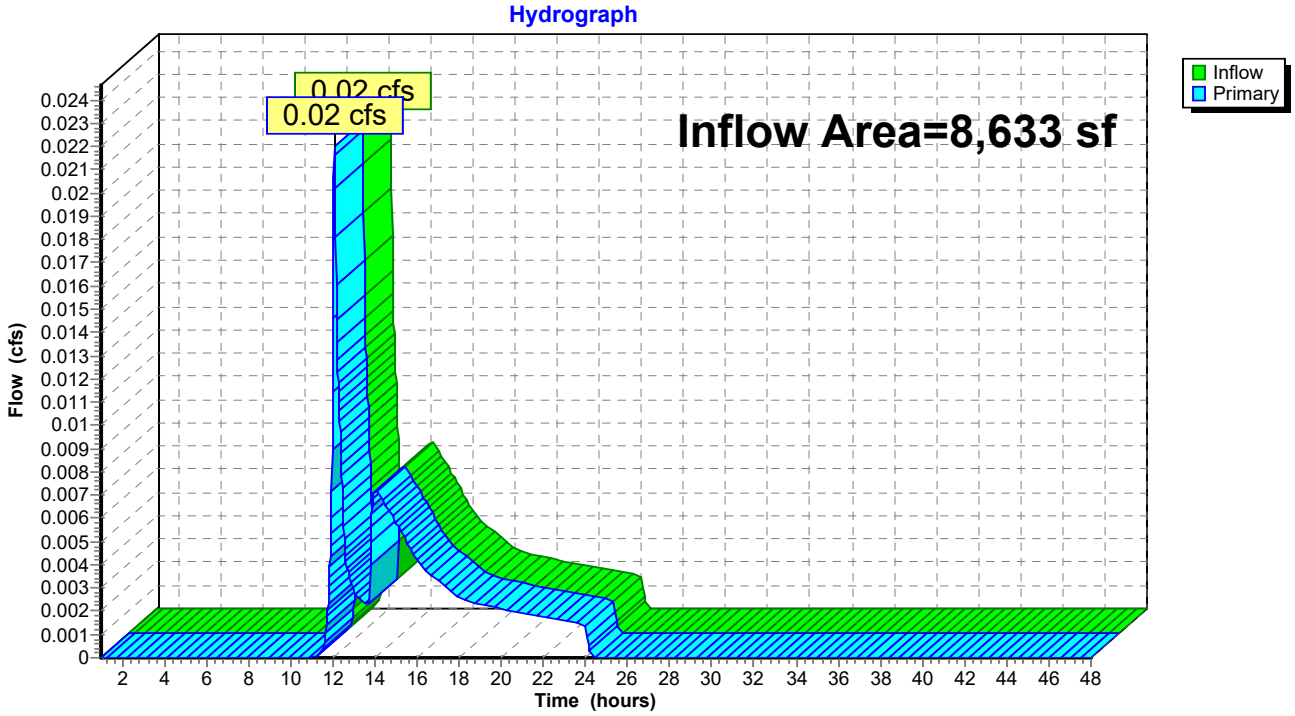
Summary for Pond SP1: HERRING RIVER

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 8,633 sf, 23.42% Impervious, Inflow Depth = 0.22" for WQV event
Inflow = 0.02 cfs @ 12.09 hrs, Volume= 156 cf
Primary = 0.02 cfs @ 12.09 hrs, Volume= 156 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.02 hrs

Pond SP1: HERRING RIVER



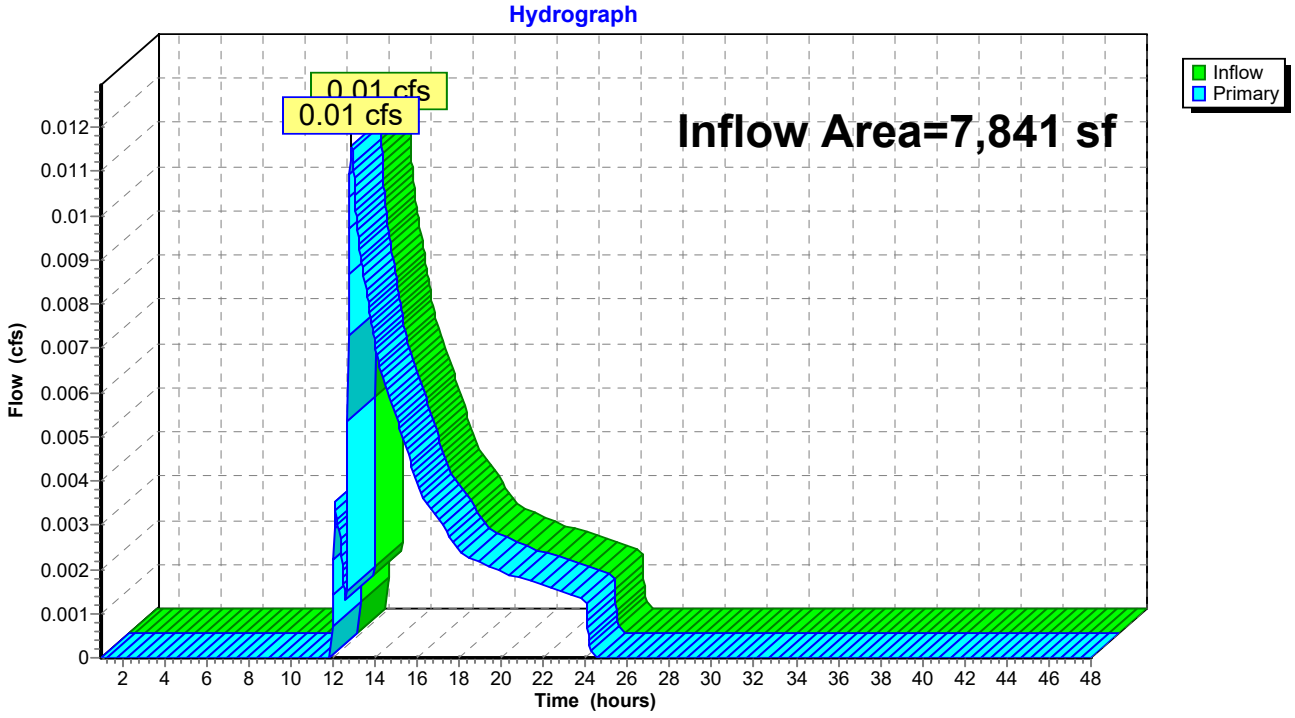
Summary for Pond SP2: HERRING SALT MARSH

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 7,841 sf, 25.97% Impervious, Inflow Depth = 0.23" for WQV event
Inflow = 0.01 cfs @ 12.90 hrs, Volume= 149 cf
Primary = 0.01 cfs @ 12.90 hrs, Volume= 149 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.02 hrs

Pond SP2: HERRING SALT MARSH



APPENDIX C – Wetland Resources Summary Memo

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Unit 1 • Sandwich, MA 02563
508-833-6600 • horsleywitten.com

MEMORANDUM

To: Jordan Mora, APCC

From: Ben Wollman, Wetland Scientist

Date: March 15, 2023

Re: Wetland Resources – Herring River Boat Ramp Stormwater Retrofit Site, Harwich, MA

HW has prepared the following memo and site figures to document the wetland resource areas at the referenced site and to provide regulatory context for future work at this site.

General Site Description

The site is located along the east side of Herring River off Route 28 in Harwich, Massachusetts, and is focused on stormwater management improvements to the parking adjacent to the public boat ramp in this location.

FEMA Designation

According to the FEMA National Flood Hazard Map (Community Panel No. 25001C0611J, effective July 16, 2014), the majority of the site is located within a Special Flood Hazard Area, Zone AE (1% annual chance of flooding, with base flood elevations of 11 feet) with additional portions, closer to the Herring River located within a Special Flood Hazard Area, Zone AE (1% annual chance of flooding, with base flood elevations of 13 feet) (**Figure 1**).

Figure 1. Excerpt from Federal Emergency Management Agency (FEMA) FIRMette for the subject site.

State-listed Rare Species Habitat and Open Space

According to the most recent version of the *Massachusetts Natural Heritage Atlas* (15th Edition, August 1, 2021), there are no areas of *Estimated Habitat of Rare Wildlife and Certified Vernal Pools* or *Priority Habitat of Rare Species* located at the site, as designated by the Massachusetts Natural Heritage and Endangered Species Program (NHESP).

Wetland Resource Areas

The site supports both freshwater and coastal wetland resource areas, as defined under the Massachusetts *Wetlands Protection Act* (M.G.L. Ch. 131 § 40) and the Town of Harwich Wetlands Protection By-law (Chapter 310) and their respective regulations. Horsley Witten Group, Inc. (HW) wetland biologists identified and delineated these resource areas during a site visit on December 28, 2022. Jurisdictional areas identified on or adjacent to the site include Salt Marsh; Coastal Bank; Bordering Vegetated Wetland (BVW); Riverfront Area; Land Subject to Coastal Storm Flowage (LSCSF); and the 50-foot No Disturb and 100-foot Buffer Zones to Salt Marsh, Coastal Bank, and BVW. Additional resource areas present adjacent to the site include Land Under Waterbodies and Waterways (LUW) and Banks of or Land Under the Ocean, Ponds, Streams, Rivers, Lakes, or Creeks that Underlie an Anadromous/Catadromous Fish Run ("Fish Run").

HW followed wetland resource area identification and on-site delineation procedure guidelines described in the Massachusetts Department of Environmental Protection (MassDEP) handbook, entitled *Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act* (March, 1995), Massachusetts Wetlands Protection Act (M.G.L. Ch. 131 § 40), and its implementing Regulations (310 CMR 10.00), and the Town of Harwich *Wetlands Protection By-law* (Chapter 310) and associated Town of Harwich Conservation Commission Wetland Protection Regulations. Coastal Bank determinations were made following the DEP Program Policy 92-1: Coastal Banks (March 1992).

Prior to conducting field delineations, HW reviewed existing source data, including USGS Geological Survey 7.5 minute topographic maps, Massachusetts Department of Environmental Protection (MassDEP) wetlands source data available through the Massachusetts Geographic Information System (MassGIS), USDA Natural Resources Conservation Service (NRCS) soils survey, U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps, and other source data to identify the presence of jurisdictional wetlands and waters of the United States within the site. This information was used to compile base mapping to assist in the understanding of the hydrologic variables, soils conditions, and vegetation communities (where applicable).

A brief description of the regulatory definitions and the observed resources areas is provided below.

Salt Marsh

Salt Marsh is defined at 310 CMR 10.32(2) as *"a coastal wetland that extends landward up to the highest high tide line, that is, the highest spring tide of the year, and is characterized by plants that are well adapted to or prefer living in, saline soils. Dominant plants within salt*

marshes are salt meadow cord grass (Spartina patens) and/or saltmarsh cordgrass (Spartina alterniflora). A salt marsh may contain tidal creeks, ditches and pools."

The site supports Salt Marsh areas on the south and west edges of the parking lot/boat ramp area. Salt Marsh is also present adjacent to the site on the north side of Route 28. These Salt Marshes are associated with the tidal Herring River that exists to the west of the site. Common species observed within the Salt Marsh areas include smooth cordgrass (*Spartina alterniflora*), maritime marsh-elder (*Iva frutescens*), salt meadow cordgrass (*Spartina patens*), saltgrass (*Distichlis spicata*), eastern false willow (*Baccharis halimifolia*), and sea-lavender (*Limonium carolinianum*). Additional species observed at the upper edges of the Salt Marsh include eastern red cedar (*Juniperus virginiana*) and tick quack grass (*Thinopyrum pycnantum*).

HW delineated the landward boundary of the Salt Marsh with a series of consecutively numbered blue flagging stations labeled SM 1 – SM 12 (south of Rt. 28, adjacent to the parking lot) and SM 101 – SM 105 (north of Rt. 28). The Salt Marsh boundary extends further to the northeast beyond the SM 105 flagging station; however the landward-most wetland resource area becomes BVW to the east of this location.

Photo 1. View of the Salt Marsh south of the parking area.

Photo 2. View of the Salt Marsh present along the west side of the parking area.

Photo 3. View of the Salt Marsh boundary north of Rt. 28.

Coastal Bank

Coastal Bank is defined at 310 CMR 10.30(2) as "*the seaward face or side of any elevated landform, other than a coastal dune, which lies at the landward edge of a coastal beach, land subject to tidal action, or other wetland.*" The Town of Harwich Wetlands Protection Bylaw (Chapter 310) defines Coastal Bank similarly.

Coastal Bank is present at the site along the northern side of the parking lot, where the slope rises from the parking lot to meet Route 28. Coastal Bank is also present just north of the site where a steep slope exists between the road and the Salt Marsh and BVW, along the north side of Route 28. The Coastal Bank between the parking lot and Route 28 is vegetated with a mix of native and non-native trees, shrubs, and vines at the northeastern and northwestern corners of the parking lot and is comprised of lawn with a few smaller, spaced-out trees in between the two parking lot entrance driveways from the road. The Coastal Bank on the north side of Route 28 is vegetated with a mix of native trees and grass ground cover. Common plant species observed on the vegetated Coastal Bank at the site include eastern red cedar, black oak (*Quercus velutina*), pitch pine (*Pinus rigida*), and black cherry (*Prunus serotina*), with additional species present in smaller quantities that include multiflora rose (*Rosa multiflora*), seaside goldenrod (*Solidago sempervirens*), rugosa rose (*Rosa rugosa*), switchgrass (*Panicum virgatum*), Asiatic bittersweet (*Celastrus orbiculatus*), Virginia rose (*Rosa virginiana*), autumn olive (*Elaeagnus umbellata*), and American sycamore (*Platanus occidentalis*).

To determine the regulatory limits of the Coastal Bank, HW established three transects along the face of the Coastal Bank (with white flagging stations) on the southern side of Route 28 (T1, T2, & T3) and two transects along the face of the Coastal Bank on northern side of Route 28 (T4 & T5) in accordance with the DEP Program Policy 92-1. All transects (T1 – T5) conform to Figure 4 of the DEP's Program Policy 92-1.

Photo 4. View of the Coastal Bank present along the northwestern corner of the parking lot area.

Photo 5. View of the Coastal Bank present at the northeast corner of the parking lot area.

Photo 6. View of the Coastal Bank present along the north side of Route 28.

Bordering Vegetated Wetland

Bordering Vegetated Wetland (BVW) is defined at 310 CMR 10.55(2)(a) as "*freshwater wetlands that border on creeks, rivers, streams, ponds and lakes. The types of freshwater wetlands are wet meadows, marshes, swamps and bogs. Bordering Vegetated Wetlands are areas where the soils are saturated and/or inundated such that they support a predominance of wetland indicator plants. The boundary of Bordering Vegetated Wetland is defined at 310 CMR 10.55 (2)(c) as the line within which 50% or more of the vegetational community consists of wetland indicator plants and saturated or inundated conditions exist.*"

Adjacent to the site, north of Route 28, there is a section of BVW present between the Coastal Bank and Salt Marsh. Closer to the Route 28 bridge the landward Salt Marsh boundary meets directly with the lower boundary of the Coastal Bank. The Coastal Bank and Salt Marsh share the same boundary in this location for approximately 100 feet along Route 28, from the bridge moving east. At this point the landward Salt Marsh boundary shifts to the northeast away from the lower Coastal Bank boundary and the area between the Salt Marsh and Coastal Bank becomes BVW. Moving further east, the landward boundary of the BVW also shifts away from the lower boundary of the Coastal Bank where upland is then present between the Coastal Bank and the BVW. The resource area boundaries noted above are present within LSCSF. Closer to the Salt Marsh boundary, the BVW resembles a freshwater emergent marsh wetland community, with the predominant species being common reed (*Phragmites australis*), but also includes small amounts of salt marsh rush (*Juncus gerardii*), eastern false willow, and eastern red cedar. Transitioning further landward from the Salt Marsh, the BVW resembles a scrub-shrub swamp wetland, with common species including bayberry (*Morella caroliniensis*), eastern shadbush (*Amelanchier canadensis*), eastern false willow, common wrinkle-leaved goldenrod (*Solidago rugosa*), switchgrass, and eastern red cedar.

HW delineated the landward boundary of the BVW with a series of consecutively numbered pink flagging stations labeled BVW 1 – BVW 13.

HW noted that a significant section of the upland area between the BVW and the Coastal Bank contained saturated soils and even standing water in some locations; however, the predominant plant species in this area was an upland species (mostly mature eastern red cedars) and the soils were not indicative of wetland hydrology. Although the saturated soils and standing water were present, the delineation was performed outside of the growing season and should not be used as indicators of wetland hydrology. HW emphasized plants and soils as indicators for the delineation of the landward boundary of the BVW.

Photo 7. View towards the east at the boundary between the Salt Marsh and emergent marsh BVW, where the Salt Marsh boundary line shifts in a northeast direction and BVW is present between the Coastal Bank and Salt Marsh.

Photo 8. Scrub-shrub BVW present landward of the Salt Marsh.

Riverfront Area

Riverfront Area is defined at 310 CMR 10.58(2)(a)3 as "*the area of land between a river's mean annual high-water line measured horizontally outward from the river and a parallel line located 200 feet away* (…)"

2. Mean Annual High-water Line of a river is the line that is apparent from visible markings or changes in the character of soils or vegetation due to the prolonged presence of water and that distinguishes between predominantly aquatic and predominantly terrestrial land. (…)

> *c. In tidal rivers, the mean annual high-water line is coincident with the mean high water line determined under 310 CMR 10.23:*

Mean High Water Line means the line where the arithmetic mean of the high water heights observed over a specific 19-year metonic cycle (the National Tidal Datum Epoch) meets the shore and shall be determined using hydrographic survey data of the National Ocean Survey of the U.S. Department of Commerce. As this site, the Mean High Water Line is at elevation 4 feet.

The Riverfront Area extends landward 200 feet from the Mean High Water (MHW) Line of the Herring River, and encompasses the entire site and all of the associate resource areas present.

Land Subject to Coastal Storm Flowage

Land Subject to Coastal Storm Flowage is defined at 310 CMR 10.04 as "*land subject to any inundation caused by coastal storms up to and including that caused by the 100-year storm, surge of record or storm of record, which ever is greater.*"

The majority of the site is located within a Special Flood Hazard Area, Zone AE (1% annual chance of flooding, with base flood elevations of 11 feet) with additional portions, closer to the Herring River located within a Special Flood Hazard Area, Zone AE (1% annual chance of flooding, with base flood elevations of 13 feet) (see **Figure 1** above).

Invasive Species

Invasive plants (as defined by the Massachusetts Invasive Plant Advisory Group) were present at or near the site, primarily on the Coastal Bank at the northwest corner of the parking lot, with species present including Asiatic bittersweet, autumn olive, and multiflora rose. The Massachusetts Invasive Plant Advisory Group identifies invasive plant species as "non-native species that have spread into native or minimally managed plant systems in Massachusetts," and which "cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems." For future planning purposes, the Town may wish to develop a management plan for reducing or eliminating these plants at this site to allow for the establishment of naturally vegetated protective buffers to the wetland resource areas.

If you have any questions regarding our findings, or if HW may be of further assistance, please do not hesitate to contact me directly at bwollman@horsleywitten.com or at (508) 833-6600.

APPENDIX D – Soil Test Pit Logs

Commonwealth of Massachusetts

City/Town of Harwich

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review

Deep Observation Hole Number: 1 (Hole #) | 1/24/23 (Date) | 8:40 (Time) | 35F, Cloudy (Weather) | 41°40'07.0"N (Latitude) | 70°06'31.8"W (Longitude)

1. Land Use: Edge of parking lot (e.g. woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | Few (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | 3-5% (Slope (%))

Description of Location: Northwest corner of parking, near dinghy storage

2. Soil Parent Material: Sandy Fill | Summit (Landform) | Toeslope (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body 50 feet | Drainage Way feet | Wetlands feet | Property Line 25 feet | Drinking Water Well feet | Other feet

4. Unsuitable Materials Present: ☑ Yes ☐ No If Yes: ☐ Disturbed Soil ☑ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☑ Yes ☐ No If Yes: 24" Depth weeping from pit | 30" Depth standing water in hole (after 1 hour)

Soil Log

Depth (in)	Soil Horizon/ Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles/Stones			
0-44	HTM	MLS		-	-	-	-	-	-	-	Brick @ 36"
44-50+	C	MS	10 YR 4/2	-	-	-	-	-	SG	L	

Additional Notes: Sheen visible, walls caving, standing surface water in dinghy storage area adjacent to TP 1. Water flowing into pit from uphill side

Commonwealth of Massachusetts

City/Town of Harwich

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review

Deep Observation Hole Number: 2 (Hole #) | 1/24/23 (Date) | 8:56 AM (Time) | 35F, Cloudy (Weather) | 41°40'06.3"N (Latitude) | 70°06'30.6"W (Longitude)

1. Land Use: Parking Lot (e.g. woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | Few (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | <2% (Slope (%))

Description of Location: West side of parking area

2. Soil Parent Material: Sandy Fill | Summit (Landform) | Toeslope (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body 100 feet | Drainage Way feet | Wetlands 10 feet | Property Line 10 feet | Drinking Water Well feet | Other feet

4. Unsuitable Materials Present: ☑ Yes ☐ No If Yes: ☐ Disturbed Soil ☑ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☑ Yes ☐ No If Yes: 21 Depth weeping from pit | 22 Depth standing water in hole (after 40 min)

Soil Log

Depth (in)	Soil Horizon/ Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles/Stones			
0-12	HTM	MLS		-	-	-	-	-	-	-	
12-16	C1	MS	10 YR 5/2	-	-	-	-	-	SG	L	
12-36+	C2	Fs	2.5 Y 5/1	-	-	-	-	-	SG	L	heavy seep, caving

Additional Notes: Strong seep, caving. Standing water in wetland 75 ft away.

Commonwealth of Massachusetts

City/Town of Harwich

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review

Deep Observation Hole Number: 3 (Hole #) | 1/24/23 (Date) | 9:11 AM (Time) | 35F, Cloudy (Weather) | 41°40'06.4"N (Latitude) | 70°06'31.5"W (Longitude)

1. Land Use: Parking Lot (e.g. woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | Few (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | <2% (Slope (%))

Description of Location: South side of parking, along edge of marsh

2. Soil Parent Material: Sandy Fill | Summit (Landform) | Toeslope (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body 75 feet | Drainage Way feet | Wetlands 10 feet | Property Line 10 feet | Drinking Water Well feet | Other feet

4. Unsuitable Materials Present: ☑ Yes ☐ No If Yes: ☐ Disturbed Soil ☑ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☑ Yes ☐ No If Yes: 44 Depth weeping from pit | N/A Depth standing water in hole

Soil Log

Depth (in)	Soil Horizon/ Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles/Stones			
0-84	HTM	MLS		-	-	-	-	-	-	-	Debris, large wood beams starting at 24"

Additional Notes: Lots of timber, shingles. Fill still present at 80"

APPENDIX E – Operation and Maintenance Guide

Stormwater Operations & Maintenance Guide

Herring River Boat Ramp

Table of Contents

APPENDICES

1. INTRODUCTION

This document provides a general description along with the operation and maintenance requirements for the Herring River Boat Ramp Stormwater Retrofit project at Route 28, Harwich, MA. The responsible parties are required to inspect and maintain all measures as outlined in this maintenance guide throughout the year. Site maintenance is divided into three categories as outlined below.

1. Green Stormwater Infrastructure
    - Structural Components
    - Structural Maintenance Schedule
    - Planting
    - Landscape Maintenance Schedule
    - Weed Guide

2. General Site Maintenance
    - Trash & Debris
    - Pet Waste
    - Pavement Sweeping
    - Contributing Drainage Areas
    - Snow Removal
    - De-icing

3. Long-Term Pollution Prevention Measures

2. RESPONSIBLE PARTIES AND BUDGET

The estimated average annual O&M budget for the proposed system is shown below:

- **Wet Bioretentions (2):** **$1,000**
  ($500/Bio)
- **Porous Pavement/Pavers:** **$1,500**
  ($1,500/cleaning)

Owner and operator contact information is provided below:

Owner:	**Town of Harwich**
Contact:	**Harbormaster**
	John Rendon
	715 Main Street, Harwich Port, MA 02646
	Harwich, MA
	jrendon@town.harwich.ma.us
	508-430-7532

Owner - Signature:_____Date:_____

3. GREEN STORMWATER INFRASTRUCTURE

3.1. How Does Green Infrastructure Work?

Green Stormwater Infrastructure (GSI) is a nature-based approach to stormwater treatment and management. These stormwater practices or "treatment areas" are designed to mimic nature and use the natural filtration properties of soil and plants to remove pollutants from stormwater runoff prior to discharging to the municipal drainage system or waterbodies.

GSI relies on the following basic steps to function properly. Structural components of the practices facilitate the functioning of the steps. If one of these steps, or components, does not work properly, the entire system can be compromised and the GSI practice itself could be contributing to maintenance problems. This can lead to landscape nuisances, more frequent maintenance and costly repairs/improvement. The steps are:

1. ***Collect*** (Inlets)
2. ***Move Water*** (Conveyance) if needed, can come after capturing sediment
3. ***Capture Sediment*** (Pretreatment)

4. ***Treat and Manage*** (Filter, Infiltrate or Store)
5. ***Overflow*** (Structures and Spillways)

3.2. What is required for Maintenance?

As these are nature-based systems that rely on plant upkeep, the maintenance for GSI typically falls under landscape and general site maintenance services. Proper operation and maintenance (O&M) are vital to its long-term viability. Regularly scheduled maintenance can prevent system failures due to sediment build-up, damage, or deterioration. The maintenance requirements, outlined in this guide, are critical to ensure proper treatment, maintain storage capacity and preserve the visual integrity.

General maintenance includes the following:

1. Removing sediment from the pretreatment practices used to capture sediment.
2. Maintaining the proper drainage function and pollutant removal capacity of the systems.
3. Maintaining healthy and native, trees, plants, and vegetative cover as well as the removal of unwanted weeds and invasive species.

It is recommended that all practices be maintained regularly as part of the routine landscape maintenance or at a minimum four times per year and after major rain events:

- **Early Spring**: during spring cleanup
- **Summer:** during lawn mowing and other routine site maintenance
- **Early Fall:** when leaves begin to fall
- **Late Fall/Early Winter:** after all the leaves have fallen during leaf removal
- **After major storm events**: 2" of rain or greater.

The following sections describe the general function and landscape maintenance of each practice on the site. Included in the appendices is a specific Inspection Report for each practice type (**Appendix A**) along with a plan showing the location of the items to be inspected and maintained (**Appendix B**).

3.3. What practices are used at this site?

The following practices are present at this site:

a. Wet Bioretention Areas: A wet bioretention area is a stormwater management practice to manage and treat stormwater runoff using a conditioned planting soil bed or "filter" media and plants to filter runoff captured in a shallow depression. The method combines physical filtering and adsorption with bio-geochemical processes to remove pollutants.

b. Porous Pavers: Porous pavers are designed to capture and infiltrate runoff, but also help stabilize the site during periods of tidal inundation. The areas of porous pavers have been placed to ensure they do not collect runoff from the traditional impervious pavement, as this can clog the pervious pavement. Regular maintenance is critical to the success of this practice.

The maintenance for the green infrastructure is divided into two categories:

a. The **Structural Components** that make up the basic steps of a functioning system.

b. The **Plantings** that are the landscape and filtration element.

Each category is further described in the sections below.

4. STRUCTURAL COMPONENTS: WET BIORETENTION AREAS

Structural Components

1. ***Collect***: Stormwater runoff is directed to paved flume inlets(s) and/or grass channel where stormwater enters the wet bioretention area.

2. ***Capture Sediment***: Sand and debris settle out within sediment forebays.

3. ***Move Water:*** The stormwater discharges directly to the wet bioretention area via a check dam weir.

4. ***Treat and Manage***: Stormwater overtops the forebay check dam and flows through the planted wet bioretention area. Plants slow the water down, and the soil media and plant roots filter the runoff, removing nutrients and bacteria. The plants are tolerant to both wet and dry periods as well as other site conditions such as wind, salt, and shade. The treated water then infiltrates into the soil below or overflows as described below.

5. ***Overflow***: During larger rain events, the water level will rise and overflow either into the outlet structure or back out the paved flume.

MAINTENANCE SCHEDULE: WET BIORETENTION AREAS

A site inspection of the wet bioretention components shall be conducted at least twice a year in the Spring and Fall, and after major storm events (2" of rain or greater). Debris and trash should be removed monthly from April to November and sediment removal should occur during the two site inspections and during the monthly debris and trash inspections as needed. See the calendar below and the Inspection Report in **Appendix A** for more information.

Wet Bioretention General Maintenance Schedule												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Task	**Frequency & Time of the Year**											
Site Inspection				**X**							**X**	
Debris & Trash Removal				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Sediment Removal				**X**	x	x	x	x	x	x	**X**	

should **also** be completed after major storm events

X required inspection

x as needed

- When removing trash and debris during monthly inspections look for:
  - If sediment is > 3" in paver lined sediment forebays. Ensure sediment does not cause blockage of inlet weirs. If it is, remove sediment.
  - If standing water does not drain after 48 hours. See Inspection Report for action items.
- After rain event look for:
  - If standing water does not drain after 48 hours. See Inspection Report for action items.

Use a shovel to clear stone and sediment from the inlets.

See Plantings section for information on plantings maintenance of the wet bioretention area. Use the plantings maintenance calendar to combine maintenance efforts.

5. STRUCTURAL COMPONENTS: POROUS PAVERS

A Pervious Pavers
B Edging *(Per Manufacturer)*
C Bedding Course
D Filter Fabric *(Sidewalls Only)*
E Gravel Reservoir
F Approved Subsoil

Structural Components

1. ***Collect***: Stormwater runoff is absorbed directly into the pervious surface when it rains.
2. ***Capture Sediment***: Porous pavers are designed for minimal run-on from permeable surfaces (like lawn areas) and no runoff from impervious pavement, so sediment should be minimal. Sediment will filter into the porous pavement and will eventually clog.
3. ***Move Water:*** The stormwater filters through the surface material and choker courses.
4. ***Treat and Manage***: The stormwater is treated as it flows through the filter course into the underlying native soils.
5. ***Overflow***: During larger rain events, once the porous pavement and gravel below are saturated, additional runoff will flow downgradient to the wet bioretention and then down to the boat ramp and out to the pond.

MAINTENANCE SCHEDULE: POROUS PAVERS

A site inspection of the porous pavement shall be conducted at least twice a year in the Spring and Fall, and after major storm events (2" of rain or greater). See the calendar below.

Pervious Pavement and Pavers General Maintenance Schedule												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Task	**Frequency & Time of the Year**											
Site Inspection				**X**				**X**				
Debris & Trash Removal				**X**	x	x	x	x	x	x	**X**	
Sediment Removal	x	x	x	**X**	x	x	x	x	x	x	**X**	x

should **also** be completed after major storm events

X required inspection

x as needed

Frequent cleaning and maintenance is critical to prevent clogging of porous surfaces. To keep the surface clean, sweep the porous pavement using vacuum sweepers at least twice a year.

No sanding or de-icing is permitted. Full porous pavement replacement will be conducted every 10-20 years or as determined necessary due to field conditions.

6. PLANTINGS

6.1. Plantings

The planting design for the site consists of three landscape maintenance areas. The “mow” area which consists of turf, the “no mow” areas (two wet bioretention areas), and the natural buffer. The plantings maintenance checklist is included in **Appendix A**, and the full planting plan is available in **Appendix C**.

“Mow” Areas

No “Mow” Area (Wet Bioretentions)

Natural Buffer

PLANTINGS: "MOW" AREAS MAINTENANCE

There is an area of the site that is allowed to be maintained as "mowed" lawn as necessary. Landscape maintenance of "mowed" lawn areas includes the following:

Seeding

Loam and reseed bare spots with a seed mix that matches existing species.

Mowing/Weed Whacking

Cut only 1/3 of vegetation. Do not mow during drought periods or when excessively wet. Depending on height of grasses and the time of year, grass cuttings/stalks may need to be raked and removed from site.

Watering

Allowing the lawn areas to "brown" is desired. Water only during drought conditions or during reseeding establishment period.

Fertilizing

No fertilizer shall be used.

Weeding

Weeding should be limited to invasive and weedy species (see section 3.6 Weed Identification below and the Weed Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf). Non-chemical methods (hand pulling and hoeing) are required; chemical herbicides should be avoided. Properly remove and dispose of all invasive species off site as to prevent colonization elsewhere, this includes disposal on land beyond the project area.

Monitoring

During the establishment period, walk the mow areas monthly during the first year to look for invasive species, bare spots and identify potential pest or disease problems. Properly remove and dispose of all invasive species as to prevent colonization elsewhere, this includes disposal on land beyond the project area.

Debris & Trash

Remove and properly dispose litter from all areas prior to mowing.

PLANTINGS: NO "MOW" AREA MAINTENANCE (WET BIORETENTION AREAS)

By design, plants in wet bioretention areas are meant to flourish throughout the growing season leaving dry standing stalks during the dormant months. Plants do not require fertilizers or watering (except during drought or establishment period). This area is designated as "no mow." Frequent mowing would eliminate selected meadow species, may promote the growth of undesirable plants, and require additional maintenance and watering. It is recommended this area be cut back no more than one time per year and only as necessary. Remove and replace vegetation as necessary, using the appropriate species as shown on the Planting Plan. The best time to plant is in early to mid-fall or early to mid-spring. Specific maintenance activities of the "no mow" area include:

Seeding

Loam and reseed bare spots with the specified seed mix as shown on the Planting Plan.

Cutting Back

Recommend cutting with shears a maximum of once a year in early spring. Otherwise, allow areas to grow to their natural heights (12" to 36") to maintain a meadow appearance. Do NOT cut area lower than 6" – maintain sporadic wooden stakes on site at 6" height to provide visual cues during cutting. Depending on height of grasses and the time of year, grass cuttings/stalks may need to be raked and removed from site so as not to clog the wet bioretention. Use a leaf blower as needed to assist in clean-up.

Pruning

Prune trees and shrubs to remove deadwood and low hanging branches.

Watering

Water only during drought conditions or during reseeding establishment period.

Fertilizing

No fertilizer shall be used.

Weeding

Weeding should be limited to invasive and weedy species (see section on Weed Identification below and the Weed Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf). Non-chemical methods (hand pulling and hoeing) are required; chemical herbicides should be avoided. Properly remove and dispose off site all invasive species as to prevent colonization elsewhere; this includes disposal on land beyond the project area.

Monitoring

During the establishment period, walk the "no mow" areas monthly without the intent to cut, but to look for invasive species, bare spots and identify potential pest or disease problems.

Debris & Trash

Remove and properly dispose of litter from all areas.

PLANTINGS: NATURAL BUFFER AREAS MAINTENANCE

This area is intended to increase the natural buffer to the adjacent pond and is not to be disturbed. Maintenance of natural buffer areas includes the following:

Monitoring

Walk the buffers to look for potential invasive species and identify potential disease.

Weeding

Weeding should be limited to invasive and weedy species (see section 3.6 Weed Identification below and the Weed Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf). Non-chemical methods (hand pulling and hoeing) are required; chemical herbicides should be avoided. Properly remove and dispose of all invasive species as to prevent colonization elsewhere; this includes disposal on land beyond the project area.

Watering

Water only during drought conditions or during the plant establishment period.

Debris & Trash

Remove and properly dispose litter from all natural areas.

PLANTINGS: REPLACEMENTS

The plants that thrive in wet bioretention areas are typically quite drought tolerant due to the filter profile having a top layer of planting soil and sandy soil media below. They need to be able to withstand periods of inundation after storm events; however, when it doesn't rain, there will be less water held naturally in the sand than in other soil types for the plants to use, so they need to tolerate dry periods as well.

Specifying plants native to the area increases the ecosystem benefits by helping to support native wildlife like pollinators.

If replacements are needed, use the planting plan as a guide (see **Appendix C**). However, if all the plants of a certain species have not done well in the bioretention area or other locations on the site, do not replace with that same species. Rather, replant with one or more of the other species that has thrived under the conditions or have a plant professional choose a different species based on current photos of the site.

Site specific considerations for plants in bioretention areas should be:

- Salt marsh species (preferably native)
- Tolerant of occasional fresh water and regular salt water inundation
- Size constraints:
    - taller perennials at the bottom of the bioretention
    - shorter perennials on the side slopes
- A mix of different types of plants that will create a resilient plant community: cold & warm season grasses, perennials, groundcovers in all areas.

PLANTINGS: MAINTENANCE SCHEDULE

By design, plants in the bioretention area are meant to help filter the stormwater as it passes through and flourish throughout the growing season. The plants do not require fertilizers or mulch, and, after establishment, only need water during periods of drought. Remove and replace vegetation as necessary, using the appropriate species as discussed in the no-mow section above. Weeding should occur quarterly during the growing season as well as monitoring for invasive species. An annual spring "clean up" includes cutting last season's growth of the perennials and pruning as needed. See the calendar below, the Plantings Maintenance Checklist in **Appendix A**, the Weed Identification section, and the Weed Identification Guide at https://web.uri.edu/riss/files/In-the-Weeds.pdf for more information.

Bioretention Landscape Maintenance Schedule												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Task	**Frequency & Time of the Year**											
Cutting				**X**								
Mowing				x	**X**	x	x	x	x	x	x	x	**X**	x	x	
Weeding				**X**			**X**				**X**				**X**	
Monitoring				**X**			**X**				**X**				**X**	
Watering						x		x		x		x				
Seeding				x	x									x	x	
Plant Replacement				x	x									x	x	

"Mow" Areas
No "Mow" Areas (Bioretention Areas)
All areas

X required
x as needed

- Trash and debris are removed during monthly structural component inspections but can also be completed during landscape maintenance visits for weeding and monitoring.

Yellow Toadflax *(Linaris vulgaris)*

Redroot Pigweed- (*Amaranthus retroflexus)*

Smartweed *(Polygonum lapathifolium)*

Dandelion *(Taraxacum officinale)*

Fireweed *(Erechtites hieracifolia)*

Spotted Spurge (Euphorbia maculata)

Crabgrass *(Digitaria ischaemum)*

Crabgrass with seedheads

Ragweed (*Ambrosia artemisiifolia*)

Japanese Knotweed (Polygonum cuspidatum)

Ragweed (*Ambrosia artemisiifolia*)

Oriental Bittersweet (*Celastrus orbiculatus*)

Green Foxtail (Setaria viridis)

Norway Maple Tree Seedling (Acer platanoides)

Catalpa Tree Seedling (Catalpa speciosa)

Purple Loosestrife (*Lythrum salicaria*)

Field Bindweed (*Convolvulus arvensis*)

Black Swallow-wort (*Cynanchum louisea*)

7. GENERAL SITE MAINTENANCE

General site maintenance includes the following requirements:

Trash & Debris

Remove and properly dispose of all trash and debris.

Pet Waste

Visitors to the site are encouraged to pick up after their pets. Remove and properly dispose of all pet waste left behind. Pet waste should be picked up and disposed of properly to reduce bacteria and nutrient levels in stormwater.

Pavement Sweeping

Paved roadways should be mechanically swept, at a minimum of once per year in early spring, to remove accumulated sand and sediment debris. Porous pavement/pavers should be swept using a vacuum sweeper at least twice a year.

Snow Removal

Due to the potential for plant damage, snow piling and or removal is NOT recommended in the bioretention areas.

De-Icing

When de-icing compounds are necessary for areas draining to the green stormwater infrastructure, the least harmful chemicals should be used. Excessive salting should be avoided. Use of large amounts of sand should also be avoided, since it may obstruct the conveyance system. Ice removal is NOT permitted in the bioretention areas or porous pavement.

8. LONG-TERM POLLUTION PREVENTION MEASURES

Long-term pollution prevention measures implemented at the site reduce pollutants in stormwater discharges. The following precautions will be employed on an on-going basis.

Spill Prevention & Control Measures

To minimize the risk of spills or other accidental exposure of materials and substances to stormwater runoff, the following material management is to be used when working on site.

- Any materials stored on-site will be stored in a neat, orderly manner in their appropriate containers.
- Products will be kept in their original containers with the original manufacturer's label.
- Substances will not be mixed with one another unless recommended by the manufacturer.
- Manufacturers' recommendations for proper use and disposal will be followed.
- The contractor's supervisor will be issued this Guide to ensure proper use and disposal of materials.

Materials or substances listed below may be present on-site for maintenance and care should be taken to avoid spills:

  - Petroleum Based Products

The following product-specific measures will be followed on-site:

- *Petroleum Products* - All on-site vehicles will be monitored for leaks and receive preventative maintenance to reduce the chance of leakage.
- *Grass Clipping, Leaf Litter and Plant Debris* – are to be removed from the property and not disposed on site.

APPENDIX A – Maintenance Checklist

- Bioretention Areas
- Porous Pavement/Pavers
- Landscaping

Operation and Maintenance Checklist
Herring River Boat Ramp

Date:

Time:

Inspector:

Maintenance Item	Description	Maintenance (Y/N)
1, 2 & 3. Inlet Flumes, Sediment Forebays, and Check Dams		
Debris Cleanout	Remove all trash, leaf litter and debris from the inlet flumes, grass channel and forebays.	
Sediment/Organic Debris Removal	Check for clogging and sediment accumulation that impacts inflow and outflow. Remove and properly dispose of when sediment is >3" in forebays. Remove/cut any vegetation that sprouts through voids in stone, pavement, or pavers.	
Erosion	Check for areas of erosion (gullies, animal burrowing, or overtopping), particularly near check dam weirs, perimeter, and guard rail posts. Repair as necessary and return to design grades.	
Actions to be taken:		
4 & 5. Bioretention Areas, Overflow Spillways		
Debris Cleanout	Remove trash and debris from the surface.	
Erosion	Signs of erosion gullies, animal burrowing, or overtopping are observed. Repair as necessary.	
Sediment/Organic Debris Removal	Remove sediment accumulation and properly dispose when accumulation is greater than or equal to 3 inches.*	
Water Draining properly	Check for leaf litter, debris, and sediment accumulation in overflow spillway.	
Actions to be taken:		
6. Porous/Permeable Pavement/Pavers		
Debris Removal	Remove trash from paved and perimeter areas. Sweep surface.	
Vacuum	Vacuum surface to clean pores of debris and sediment with a commercial vacuum system.	
Structure	Repair cracking or other structural issues as found during inspection.	
Actions to be taken:		

Operation and Maintenance Checklist
Herring River Boat Ramp

Maintenance Item	Description	Maintenance (Y/N)
General Site Maintenance		
Debris Removal	Remove trash from perimeter areas.	
Pet Waste Removal	Remove any pet waste from perimeter areas.	
Pavement Sweeping	Sweep road minimum once a year after spring thaw.	
Contributing drainage area	Confirm that contributing drainage area stabilized – stabilize as necessary.	
Snow Removal	Ensure snow piles do no block inlet structures and are not placed in the green stormwater infrastructure.	
De-Icing	Do not remove ice in the bioretention areas. If needed on road, use de-icing compounds with the least harmful chemicals. Avoid excessive salting or large amounts of sand.	
Actions to be taken:		

*Sediment shall be disposed of offsite in a pre-approved location.

Plantings Maintenance Checklist
Herring River Boat Ramp

Location:

Date:

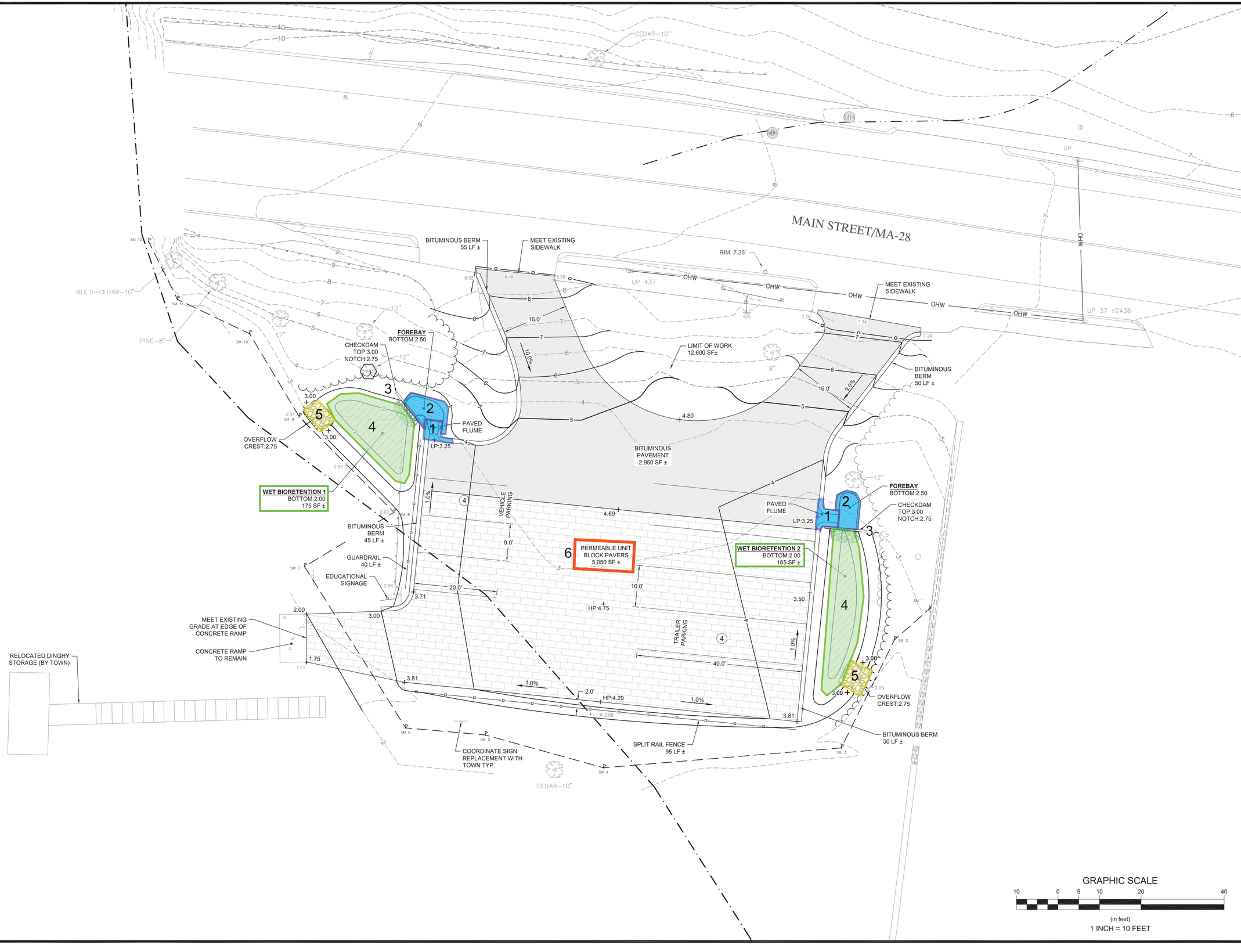
Inspector:

Task	Description	Complete (Y/N)
Cutting	• Cut with shears once a year in the early spring. • Do not cut lower than 6". • Blow out leaves and cuttings for easy removal. • Remove cuttings so the bioretention area does not clog.	
Mowing	• Mow twice a year or more frequently as needed with a mulching mower or weed whacker depending on the frequency of cutting. • Bag clippings as needed and dispose of off site. • Maintain a cutting height of 3" or greater. • Leave the grass taller in the warmer months. • Trim edges when necessary.	
Weeding	• Weeding should be limited to invasive and exotic species, which can overwhelm the desired plant community.* • Non-chemical methods including hand pulling and hoeing are recommended. • Chemical herbicides are not allowed.	
Monitoring	• Look for potential invasive species and identify potential disease. Remove and dispose of all invasive species.* (see weeding)	
Watering	• During establishment or drought conditions, plants should be watered a minimum of once every seven to ten days.	
Seeding	• Loam and re-seed bare spots with the specified seed mix as shown on the Planting Plan.	
Plant Replacement	• Replace/replant diseases, unhealthy or dead plans to maintain a healthy plant community	
Fertilizing	NONE	
Mulch	NONE	
Actions to be taken:		

*Invasive species shall be disposed of offsite in a pre-approved location.

"Mowed" Areas
No "Mow" Areas (Bioretention Areas)
All areas

APPENDIX B – Overall SCM Location Plan



GRAPHIC SCALE

10 0 5 10 20 40

(in feet)

1 INCH = 10 FEET

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Revisions

Rev.	Date	By	Appr.	Description

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Designed By: EHH
Date: JUNE 2023

Plan Set: HERRING RIVER
CAPE COD BOAT RAMP STORMWATER
RETROFIT PROJECT - PERMITTING PLANS
HARWICH, MA

Plan Title: SITE AND GRADING PLAN

Prepared For:
Town of Harwich
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Dated: FEBRUARY 7, 2023

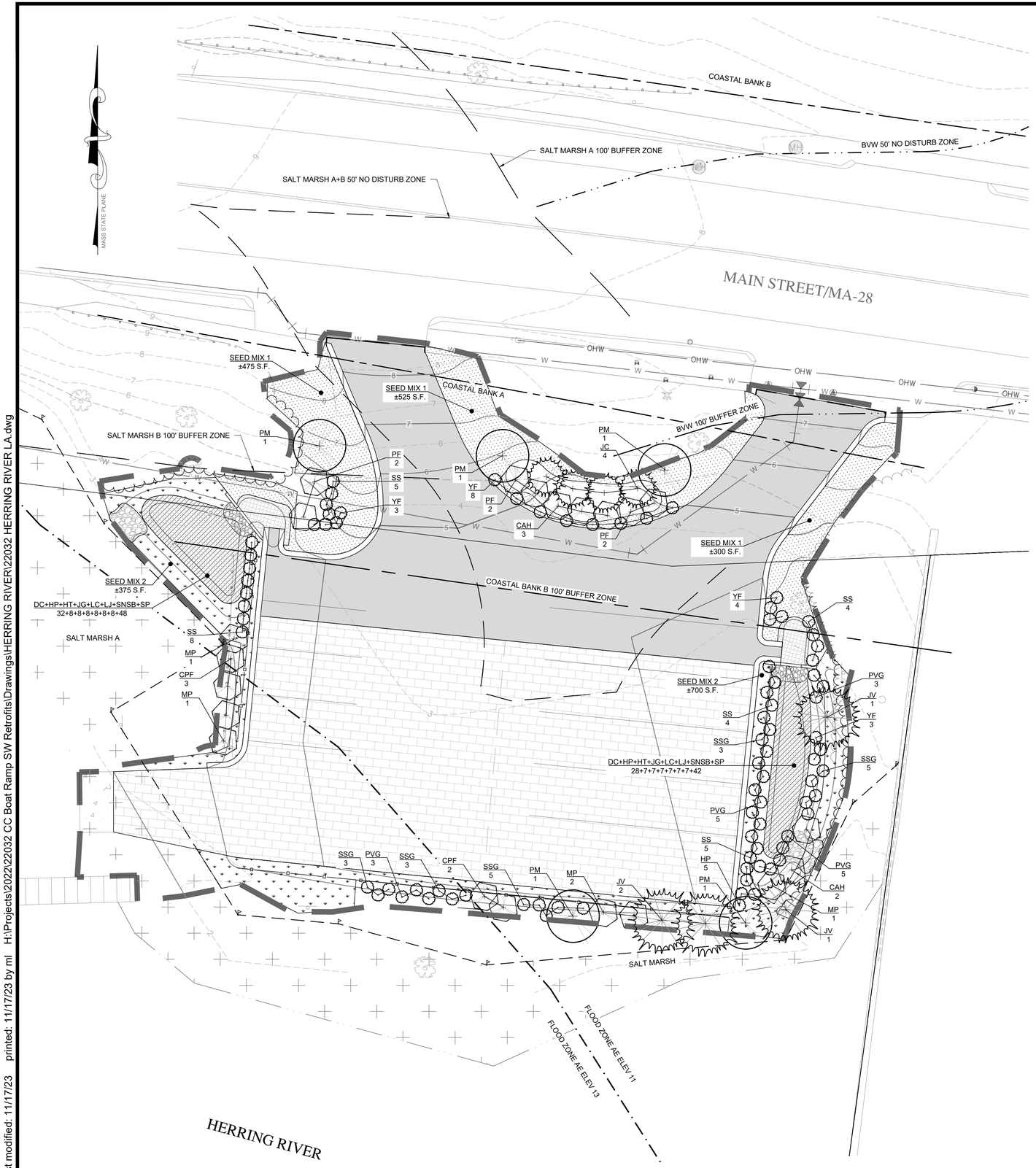
Registration:

DRAFT
NOT FOR
CONSTRUCTION

Project Number: 22032
Sheet : 4 of 7

Sheet Number: C - 4

APPENDIX C – Planting Plan



KEY

- DECIDUOUS TREE
- EVERGREEN TREE
- EVERGREEN SHRUB
- DECIDUOUS SHRUB
- PERENNIAL
- BIORETENTION PLANTING
- SEED MIX #1
- SEED MIX #2

Master Plant List

Key		Botanical Name	Common Name	Size	Spacing
		Trees			
PM	5	*Prunus maritima*	Beach Plum	6/7' B&B	As Shown
		Evergreen Shrubs			
JC	4	*Juniperus communis*	Common Juniper	6/7' B&B	As Shown
JV	4	*Juniperus virginiana*	Eastern Red Cedar	6/7' B&B	As Shown
		Deciduous Shrubs			
CAH	5	*Clethra alnifolia* 'Hummingbird'	Hummingbird Summer Sweet	#3	As Shown
CPF	5	*Comptonia peregrina*	Sweet Fern	4" pot	As Shown
MP	5	*Myrica pensylvanica*	Northern Bayberry	#5	As Shown
PF	6	*Potentilla fruticosa*	Potentilla/ Shrubby cinquefoil	#3	As Shown
		Groundcovers/Grasses/Perennials			
DC	60	*Distichlis spicata*	Saltgrass	plugs	12" O.C.
HP	5	*Honckenya peploides*	Seabeach Sandwort	#1	18" O.C.
HT	15	*Hudsonia tomentosa*	Hudsonia	#1	18" O.C.
JG	15	*Juncus gerardi*	Black Grass	#1	12" O.C.
LJ	15	*Lathyrus japonicus*	Beach Pea	#1	24" O.C.
LC	15	*Limonium carolinanum*	Sea Lavender	#1	18" O.C.
PVG	16	*Panicum virgatum*	Switch Grass	#1	18" O.C.
SS	26	*Schizachyrium scoparium*	Little Bluestem	#1	18" O.C.
SSG	19	*Solidago sempervirens*	Seaside Goldenrod	#1	18" O.C.
SNSB	15	*Sorghastrum nutans* 'Sioux Blue'	Sioux Blue Indian Grass	#1	18" O.C.
SP	90	*Spartina patens*	Saltmeadow cordgrass	plugs	18" O.C.
YF	18	*Yucca filamentosa*	Adams Needle Yucca	#3	24" O.C.
		Seed Mixes			
1,300 SF		**SEED MIX #1: Harmony Seed Mix**			
		Deschampsia flexuosa	Coastal/Wavy Hair Grass		
		festuca ovina	Sheep Fescue		
		Festuca x glauca	Blue X Hard Fescue		
		Festuca glauca	Blue Fescue		
		Festuca ovina var. duriuscula	Hard Fescue		
1,075 SF		**SEED MIX #2: New England Wetland Plants Coastal Salt Tolerant Grass Mix**			
		Elymus Canadensis	Canada Wild Rye		
		Festuca rubra	Red Fescue		
		Panicum amarum	Atlantic Coastal Panic Grass		
		Andropogon gerardii	Big Bluestem		
		Sorghastrum nutans	Indian Grass		
		Panicum virgatum	Switch Grass		
		Juncus tenuis	Path Rush		

PLANTING LAYOUT NOTES

1. FOR AREAS WITH MIXED GROUNDCOVERS / GRASSES AND/OR PERENNIALS (SHOWN AS HATCHED AREAS ON PLANS), DO NOT PLANT IN A PATTERN OR WITH LARGE AREAS OF THE SAME SPECIES. RANDOMLY PLANT AS INDICATED ON THE PLANTING PLANS INTO SMALL GROUPINGS OF THE SAME SPECIES TO CREATE A MORE NATURALISTIC APPEARANCE. PLANT THE SAME PLANT SPECIES IN GROUPS OF 3-7 AND NOT LARGER THAN 7, DEPENDING ON THE OVERALL NUMBER OF PLANTINGS.
2. ALL BIORETENTION BASIN PLANTINGS SHALL BE PLANTED WITH A MIX OF GROUNDCOVERS / GRASSES / PERENNIALS AT SPACING SPECIFIED IN THE PLANT LIST.

GRAPHIC SCALE

10 0 5 10 20 40

(in feet)

1 INCH = 10 FEET

Revisions

Rev.	Date	By	Appr.	Description

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Drawn By: AJH/EE
Designed By: AJH/EE
Date: NOVEMBER 2023

Plan Set: CAPE COD BOAT RAMP STORMWATER RETROFIT PROJECT - PERMITTING PLANS
HERRING RIVER
HARWICH, MA

Plan Title: PLANTING PLAN

Prepared For:
Town of Harwich
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Registration:

Project Number: 22032
Sheet : 6 of 7

Sheet Number: C - 6

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APPENDIX F – Pollutant Controls During Construction

POLLUTANT CONTROLS DURING CONSTRUCTION

1.1 Structural Practices

The following are the structural practices that will be implemented as part of the construction activity.

- Sediment Silt Sock Barrier will be installed prior to commencement of construction. The silt sock will be used on the downgradient portions of the limit of work to allow water to flow through it while keeping sediment on site. The Town will be informed upon their installation so that they may inspect this barrier prior to construction. Portions of the barrier will be replaced and/or repaired as necessary. The barrier will be installed parallel to contour at the perimeter of the work site, as shown on the Plans. Details are provided in the Plans.

- Sediment Traps/Basins. The bioretention area(s) will be graded to within one foot of design elevations until site is fully stabilized to capture sediment during construction. Heavy equipment will not be allowed to operate on the surface location where the systems are planned because soil compaction can adversely impact their long-term performance. Light earth-moving equipment will be used for excavation and construction of the systems. All excavated materials from the area will be removed and disposed of in an approved location. All sediment traps/basins will be inspected at least once every seven calendar days and immediately after storm events by the Construction Manager.

- Construction Entrance will be installed following pavement removal. All construction vehicles must use this access point to ensure sediment is not tracked off site.

- Slope Stabilization will occur immediately upon obtaining final grades as shown on the project site plans. Areas that fail to stabilize will be re-graded to final grade and stabilized as necessary. Amount of land disturbed will be minimized to reduce potential for erosion and sedimentation. Stabilization measures shall be initiated within 14 days following the end of construction at each portion of the site and as soon as practicable.

The entire stormwater management system will be inspected upon completion of construction. Sediment will be removed from all elements of the stormwater management system. All control measures must be installed and maintained in accordance with manufacturer's specifications, good engineering practices, and in accordance with this report (every seven calendar days and after storm events). If inspections show that a control has failed or been installed incorrectly, the Operator must replace or modify it within 24 hours.

1.2 Stabilization Practices

The amount of land disturbed during construction will be minimized to reduce the potential for erosion and sedimentation. Prompt surface stabilization will be provided to control erosion in areas where disturbances cannot be avoided during construction. Stabilization measures shall be initiated within 14

days following the end of construction at each portion of the site. Exceptions to this requirement are allowable when snow cover prevents the initiation of stabilization within 14 days, in which case such measures shall be undertaken as soon as possible.

Stabilization measures that will be, or may be, used during construction are described below:

- Temporary Seeding – Temporary seeding of disturbed surfaces with fast-growing grasses (annual rye) to provide greater resistance to stormwater runoff and/or wind erosion for areas where construction has temporarily ceased.

- Permanent Seeding – Permanent seeding of surfaces with vegetation, including but not limited to grass, trees, bushes, and shrubs, to stabilize the soil. Establishing a permanent and sustainable ground cover at a site stabilizes the soil while reducing the sediment content in runoff.

- Permanent Planting –establish all planting as required at the completion of the project.

- Erosion Control Blankets - install erosion control blankets along all slopes greater than 3:1.

- Mulching – materials, including but not limited to hay, grass, woodchips, straw, and gravel will be placed on the soil surface to cover and hold in place disturbed soils.

Temporary seeding or other soil stabilization measures will be provided where construction activities have ceased at the site. Topsoil stockpiles will be temporarily seeded or covered to prevent erosion and will be surrounded with silt fence or silt sock. When the site's final grade has been established, permanent vegetation will be planted on the disturbed areas. The vegetation will consist of grass, shrubs, bushes, and trees in the locations indicated on the plans.

1.3 Other Types of Controls

Additional controls/practices will be undertaken to reduce pollution in stormwater runoff flows which include, but are not limited to, control of off-site mud tracking from construction site, dust suppression, proper sanitary waste disposal, earthwork procedures timed and conducted in manners aimed to minimize erosion and sedimentation, snow removal plans, proper management of waste materials, proper management of hazardous waste, proper material stockpiling, and spill prevention and control measures.

- Dust Suppression – Water sprays shall be used to control dust during extended dry periods during construction.

- Earthwork – The exposure of disturbed surfaces to stormwater and potential stormwater erosion will be minimized by well-organized earthwork procedures. Stabilization procedures shall be undertaken in accordance with this report. Grubbing during wet seasons will be avoided if feasible.

- Snow Removal Plan – Plowed snow collected from the roadway and parking areas will be deposited onto free draining, pervious surfaces, away from the sites drainage conveyance structures to maximize infiltration.

- Waste Materials – Dumpsters rented from a licensed solid waste management company will be used to store solid waste and debris that cannot be recycled, reused or salvaged. The dumpsters will meet all local and state solid waste management regulations. Dumpsters will be covered when refuse is not being directly deposited or withdrawn from them. Potentially hazardous wastes will be separated from normal wastes, including segregation of storage areas and proper labeling of containers. Removal of all waste from the site will be performed by licensed contractors in accordance with applicable regulatory requirements and disposed of at either locally- or regionally approved facilities. Waste materials will not be buried on-site. All site personnel will be instructed regarding the correct procedures for waste disposal. Notices stating these procedures will be posted at the site. Solvents and flushing materials used during construction and pre-operational cleaning will be provided, handled, managed, and removed by the contractor for appropriate off-site disposal.

- Hazardous Waste Materials – Any disposal of hazardous materials will be completed using the required paperwork. Copies will be provided to the Engineer and to the city.

- Spill Prevention and Control Measures – To minimize the risk of spills or other accidental exposure of materials and substances to stormwater runoff, the following material management practices will be used throughout the project:

    - An effort will be made to store only enough products required to do the job.

    - All materials stored on-site will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure.

    - Products will be kept in their original containers with the original manufacturer's label.

    - Substances will not be mixed with one another unless recommended by the manufacturer.

    - Whenever possible, the maximum amount of a product will be used before disposing of the container.

    - Manufacturers' recommendations for proper use and disposal will be followed.

    - The site superintendent will conduct daily inspections to ensure proper use and disposal of materials.

    To reduce the risk associated with hazardous materials used on the site, the following practices will be used:

        - Products will be kept in original containers unless they are not resealable.

- Original labels and material safety data sheets will be retained and kept on-site; they contain important product information.
- If surplus product must be disposed of, manufacturers' or local and state recommended methods for proper disposal will be followed.

- Materials List - Materials or substances listed below are expected to be present on-site during construction:

- Concrete	- Fertilizers
- Asphalt	- Petroleum Based Products
- Paints (enamel and latex)	- Cleaning Solvents
- Metal Studs	- Wood
- Concrete	- Tar
- Sealants	- Adhesives

The following product-specific practices will be followed on-site:

Petroleum Products - All on-site vehicles will be monitored for leaks and receive preventative maintenance to reduce the chance of leakage. Petroleum products will be stored in tightly sealed containers which area clearly labeled. Any asphalt substances used on-site will be applied according to the manufacturers' recommendations.

Paints – All containers will be tightly sealed and stored indoors when not required for use. Excess paint will not be discharged to the storm sewer system but will be properly disposed of according to the manufacturers' instructions or state and local regulations.

Concrete Trucks – Concrete trucks will not be allowed to wash out or discharge surplus concrete or drum wash water on the site.

In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup:

- Manufacturers' recommended methods for spill cleanup will be clearly posted, and site personnel will be made aware of the procedures and location of the information and cleanup supplies.
- Materials and equipment necessary for spill cleanup will be kept in the material storage area on-site. Equipment and materials will include, but not be limited to, brooms, dust pans, mops, rags, gloves, goggles, speedi-dry, sand, sawdust, and plastic and metal trash containers specifically for this purpose.

- All spills will be cleaned up immediately after discovery. Spills large enough to reach the storm water system will be reported to the National Response Center at 1-800-424-8802.
- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.
- Spills of toxic or hazardous material will be reported to the appropriate state or local government agency, regardless of the size.
- The site superintendent responsible for the day-to-day site operations will be the spill prevention and clean-up coordinator. He will designate at least three other site personnel who will receive spill prevention and cleanup training. These individuals will each become responsible for a particular phase of prevention and cleanup. The names of responsible spill personnel will be posted in the material storage area and in the on-site office trailer.

APPENDIX G – Site Plans