Stormwater Management Report

Definitive Subdivision Plan of Maple Springs Road

0 Maple Springs Road,
0 Plymouth Road, and
99C Charge Pond Road
Wareham, Massachusetts

Prepared for:
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BEALS + THOMAS

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11/19/21

Matthew Cote, PE

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LIST OF ATTACHMENTS

1.0 INTRODUCTION

The proposed project includes a stormwater management system designed to mitigate potential impacts the proposed project could have on the existing watershed. Stormwater controls have been proposed to control peak runoff rates, provide water quality, promote groundwater recharge and sediment removal. The proposed system has been designed to comply with:

- The 2008 Massachusetts Department of Environmental Protection (DEP) Stormwater Management Handbook
- The Massachusetts Wetland Protection Act (310 CMR 10.00)
- Town of Wareham Rules & Regulations Governing the Subdivision of Land

The pre- and post-development hydrologic conditions were modeled using HydroCAD™ version 10.10 to demonstrate that post-development stormwater runoff rates will be less than or equal to the pre-development rates. Watershed maps with soil types as well as detailed analysis of the model results are also included. The following table summarizes the peak runoff rates for the pre- and post-development conditions.

Table 1: Pre- & Post-development Peak Runoff Rate Comparison, units are in cubic feet per second (cfs).

Storm Event	2 Year		10 Year		25 Year		50 Year		100 Year	
	Pre	Post	*Pre*	Post	*Pre*	Post	*Pre*	Post	*Pre*	Post
DP-1	*64.19*	64.19	*131.41*	131.41	*189.30*	189.30	*243.06*	243.06	*307.72*	307.72
DP-2	*17.77*	17.77	*39.23*	39.23	*57.56*	57.56	*75.08*	75.08	*96.33*	96.33
DP-3	*101.92*	101.92	*182.15*	182.15	*245.57*	245.57	*304.01*	304.01	*373.17*	373.17

2.0 PRE-DEVELOPMENT CONDITIONS

2.1 Site Conditions

The existing Site is developed and contains actively farmed cranberry bogs located off Maple Springs Road. A network of gravel and sand track roads exists throughout the Site and provides access between cranberry bogs and around the general area. Several reservoirs that are connected with the bog system are also present throughout the Site, as well as some wooded areas and minor facilities associated with the farming activity. There are no existing stormwater controls on the Site.

Runoff from the Site generally stays on site and drains to the several bogs and surface waters located throughout. A majority of the Site is comprised of cranberry bog area. Runoff from the existing gravel and dirt roads, and other areas throughout the Site, ultimately drains and infiltrates into the surrounding cranberry bogs. Due to the large scale of the overall Property, the hydrologic analysis focused on the eastern portion of the Property where work is proposed. The three design points (DP-1, DP-2, and DP-3) each represent a cranberry bog or surface water to which the surrounding tributary area and other interconnected cranberry bogs drain.

The site does not contain, nor is it tributary to any Critical Areas.

The site does not discharge to a surface water with a TMDL or draft TMDL.

2.2 Soil Description

The Natural Resources Conservation Service (NRCS) lists the majority of the on-site soils as Freetown muck, Freetown coarse sand, and Swansea coarse sand. NRCS classifies these soils as hydrologic class B/D. The site also contains Rainberry coarse sand, Carver loamy coarse sand, and Udipsamments. NRCS classifies these soils as hydrologic class A/D.

2.3 Hydrologic Analysis

Sub-catchment areas were delineated based on existing runoff patterns and topographic information. This information is shown on the *Pre-Development Conditions Hydrologic Areas Map* included in Attachment 2. Summaries of each area with respect to Curve Number and Time of Concentration calculations can be found in the model results also in Attachment 2.

3.0 POST-DEVELOPMENT CONDITIONS

3.1 Design Strategy

Given the location of existing cranberry bogs adjacent to Maple Springs Road, it is necessary to locate a portion of the proposed subdivision road within a cranberry bog. To mitigate this impact, new cranberry bog will be created by “squaring off” a portion of the impacted cranberry bog.

The subdivision roadway has been designed with the minimum impervious width required by the Town of Wareham, reducing the impact the project may have on the existing watershed.

A stormwater management system has been designed to provide treatment for stormwater runoff associated with the proposed impervious surfaces on site. All stormwater BMPs were designed to treat a minimum of the first 1.0 inch of runoff generated by the on-site impervious areas. Proprietary stormwater treatment systems were designed to treat the runoff rate associated with the water quality volume in accordance with the requirements of the DEP Stormwater Handbook. Stormwater BMP sizing worksheets and water quality sizing calculations are included in Attachment 5 of this report.

To mitigate increased stormwater flow rates associated with the proposed impervious area, a level spreader has been proposed. The level spreader will infiltrate stormwater into the surrounding native soils, consistent with the existing hydrology of the site.

3.2 Hydrologic Analysis

The established design points used in the pre-development conditions analysis were used in the post-development analysis for direct comparison. The tributary areas and flow paths were modified to reflect post-development conditions. See Attachment 3 for the *Post- Development Conditions Hydrologic Areas Map*. Summaries of each area with respect to Curve Number and Time of Concentration calculations can be found in the model results in Attachment 3.

3.3 Hydraulic Calculations

In compliance with Town of Wareham requirements, the proposed storm drain system was analyzed based on the 50-year storm event using the Rational Formula. A watershed map and detailed hydraulic analysis are provided in Attachment 4.

3.4 Compliance with DEP Stormwater Management Standards

The proposed stormwater management system was designed in compliance with the ten (10) DEP Stormwater Management Standards. The following summary provides key information related to the proposed stormwater management system, its design elements, and mitigation measures for potential impacts.

STANDARD 1: No new stormwater conveyance (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

There will be no direct discharge of untreated stormwater to nearby wetlands or waters of the Commonwealth. Runoff from all impervious areas of the site will be conveyed to stormwater management controls for infiltration, water quality treatment, and runoff rate attenuation prior to discharge to adjacent wetlands.

STANDARD 2: Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

The stormwater management design will control post-development peak discharge rates for the 2-, 10-, 25-, 50- and 100-year, 24-hour storms so as to maintain pre-development peak discharge rates. Refer to Section 1.0 Introduction for a summary of the peak runoff rates.

STANDARD 3: Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater management practices and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil types. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

The stormwater management system includes a level spreader that will effectively recharge groundwater on-site. Infiltration BMPs were sized using the static method based on the required recharge volume for the post-development site. As a result, annual recharge from the post-development site will approximate the annual recharge from the site under pre-development conditions. See Attachment 5 for stormwater BMP design worksheets and Groundwater Recharge Calculation.

STANDARD 4: Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).

The proposed project will meet the water quality requirements of Standard 4 using several on-site treatment trains that achieve 80% TSS removal. Refer to Attachment 5 for the TSS removal worksheets. Structural BMPs designed for water quality treatment, including the deep sump hooded catch basins and Contech® water quality treatment systems, were sized to capture and treat the flow rate associated with the first 1.0-inch of runoff from proposed impervious surfaces. All proposed stormwater management BMPs will be operated and maintained to ensure continued water quality treatment of runoff. The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards. The Manual outlines source control and pollution prevention measures and maintenance requirements of stormwater best management practices (BMPs) associated with the proposed development.

STANDARD 5: For land uses with higher potential pollutant loads (LUHPPLs), source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.

The proposed project is not associated with stormwater discharges from land uses with higher potential pollutant loads.

STANDARD 6: Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas. Critical areas are Outstanding Resource Waters, shellfish beds, swimming beaches, coldwater fisheries and recharge areas for public water supplies.

There are no stormwater discharges to critical areas associated with this project.

STANDARD 7: **Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. However, if it is not practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions.**

The proposed project is new development, and therefore this standard does not apply.

STANDARD 8: **A plan to control construction-related impacts during erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.**

A Stormwater Pollution Prevention Plan (SWPPP) will be developed prior to construction to comply with Section 3 of the NPDES Construction General Permit for Stormwater Discharges; therefore the requirements of Standard 8 are fulfilled.

STANDARD 9: **A Long-Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed.**

The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards. The Manual outlines source control and pollution prevention measures and maintenance requirements of the stormwater best management practices (BMPs) associated with the proposed development.

STANDARD 10: **All illicit discharges to the stormwater management system are prohibited.**

There will be no illicit discharges to the proposed stormwater management system associated with the proposed project. An Illicit Discharge Compliance Statement is provided on the following page.

3.5 Illicit Discharge Compliance Statement

An illicit discharge is any discharge to a stormwater management system that is not comprised entirely of stormwater, discharges from fire-fighting activities, and certain non-designated non-stormwater discharges.

To the best of my knowledge, no detectable illicit discharge exists on site. The site plans included with this report detail the storm sewers that convey stormwater on the site and demonstrate that these systems do not include the entry of an illicit discharge. A Site Owner's Manual is also included, which contains the Long Term Pollution Plan that outlines measures to prevent future illicit discharges. As the Site Owner, I will ultimately be responsible for implementing the Long Term Pollution Prevention Plan.

Signature: ______________________________

Owner's Name

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.

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.

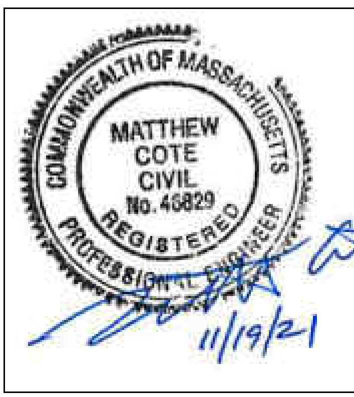
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



11/19/2021

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 (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): ____________________

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 (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 (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
- ☐ 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 (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 (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.

Attachment 1
Soil Data

Soil Map—Plymouth County, Massachusetts

Map Scale: 1:13,300 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 150 300 600 900

Feet: 0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 14, Sep 2, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Oct 9, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Water	6.8	1.4%
7A	Rainberry coarse sand, 0 to 3 percent slopes, sanded surface	14.6	3.1%
23A	Tihonet coarse sand, 0 to 3 percent slopes	14.9	3.1%
37A	Massasoit - Mashpee complex, 0 to 3 percent slopes	2.1	0.5%
52A	Freetown muck, 0 to 1 percent slopes	26.5	5.6%
53A	Freetown muck, ponded, 0 to 1 percent slopes	29.6	6.2%
55A	Freetown coarse sand, 0 to 3 percent slopes, sanded surface	121.6	25.6%
60A	Swansea coarse sand, 0 to 2 percent slopes	63.3	13.4%
252B	Carver coarse sand, 3 to 8 percent slopes	6.1	1.3%
252C	Carver coarse sand, 8 to 15 percent slopes	0.2	0.0%
255A	Windsor loamy sand, 0 to 3 percent slopes	24.5	5.2%
255B	Windsor loamy sand, 3 to 8 percent slopes	57.3	12.1%
256B	Deerfield loamy fine sand, 3 to 8 percent slopes	0.5	0.1%
259B	Carver loamy coarse sand, 3 to 8 percent slopes	11.4	2.4%
656B	Udorthents - Urban land complex, 0 to 8 percent slopes	3.4	0.7%
665B	Udipsamments, 0 to 8 percent slopes	14.2	3.0%
700A	Udipsamments, wet substratum, 0 to 3 percent slopes	2.5	0.5%
702C	Udipsamments, 8 to 15 percent slopes	74.7	15.8%
Totals for Area of Interest		**474.1**	**100.0%**

Attachment 2
Pre-Development Hydrologic Analysis

PRE-DEVELOPMENT CONDITIONS HYDROLOGIC ANALYSIS

OBJECTIVE

To determine the pre-development peak rates of runoff from the site for the 2-, 10-, 25-, 50-, and 100-year storm events.

CONCLUSION

Peak Runoff Rates

The following numbers represent the peak rates of runoff from the site under the pre-development conditions:

Storm Event	2 Year	10 Year	25 Year	50 Year	100 Year
	Pre (cfs)	*Pre (cfs)*	*Pre (cfs)*	*Pre (cfs)*	*Pre (cfs)*
DP-1	64.19	132.41	189.30	243.06	307.72
DP-2	17.77	39.23	57.56	75.08	96.33
DP-3	101.92	182.15	245.57	304.01	373.17

CALCULATION METHODS

1. Runoff curve numbers (CN), time-of-concentration (T_C), and runoff rates were calculated based on TR-55 methodology.
2. Autodesk Civil 3D 2019 computer program was utilized for digitizing ground cover areas.
3. Runoff rates computed using HydroCAD version 10.10.

ASSUMPTIONS

1. The ground cover types and boundaries were determined using the Topographic Plan, MassGIS aerial imagery, aerial imagery viewed on Google Earth, and hydrologic soil groups based on United States Department of Agriculture, NRCS Soil Survey map information
2. The subcatchment limits were truncated at the property line.
3. All runoff captured by the bogs within each subcatchment is assumed to drain to the same area designated by the design point.
4. This analysis only included portions of the Property where there are proposed impacts and lotting.
    a. All areas within the Property that are not included in the analysis will have no change in hydrology between pre-development and post-development conditions.
5. All bog areas are modeled as poor condition grass for this analysis.
6. To be conservative, all other areas outside of the bogs, building, gravel road, water, and wooded areas are modeled as dirt roads.
7. Soils identified by NRCS as HSG A/D or HSG B/D were modeled as HSG A or HSG B, respectively.

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	RFK	11/10/2021	KJP	11/12/2021	MC	11/17/2021

RFK/kjp/mc/189716CS001A

SOURCES OF DATA/ EQUATIONS

1. NRCS Soil Map for Plymouth County, downloaded from Web Soil Survey on 10/26/2021.
2. Topographic Plan, prepared by Northeast Survey Consultants and B+T, dated 11/19/2021.
3. Pre-Development Conditions Hydrologic Areas Map, prepared by B+T, dated 11/10/2021.
4. Proposed Site Plan Design File, B+T File No. 189716D011C.
5. TR-55 Urban Hydrology for Small Watersheds, SCS, 1986.
6. Massachusetts DEP Stormwater Management Handbook, February 2008.
7. Town of Wareham Rules & Regulations Governing the Subdivision of Land, March 2013.

LIST OF ATTACHMENTS

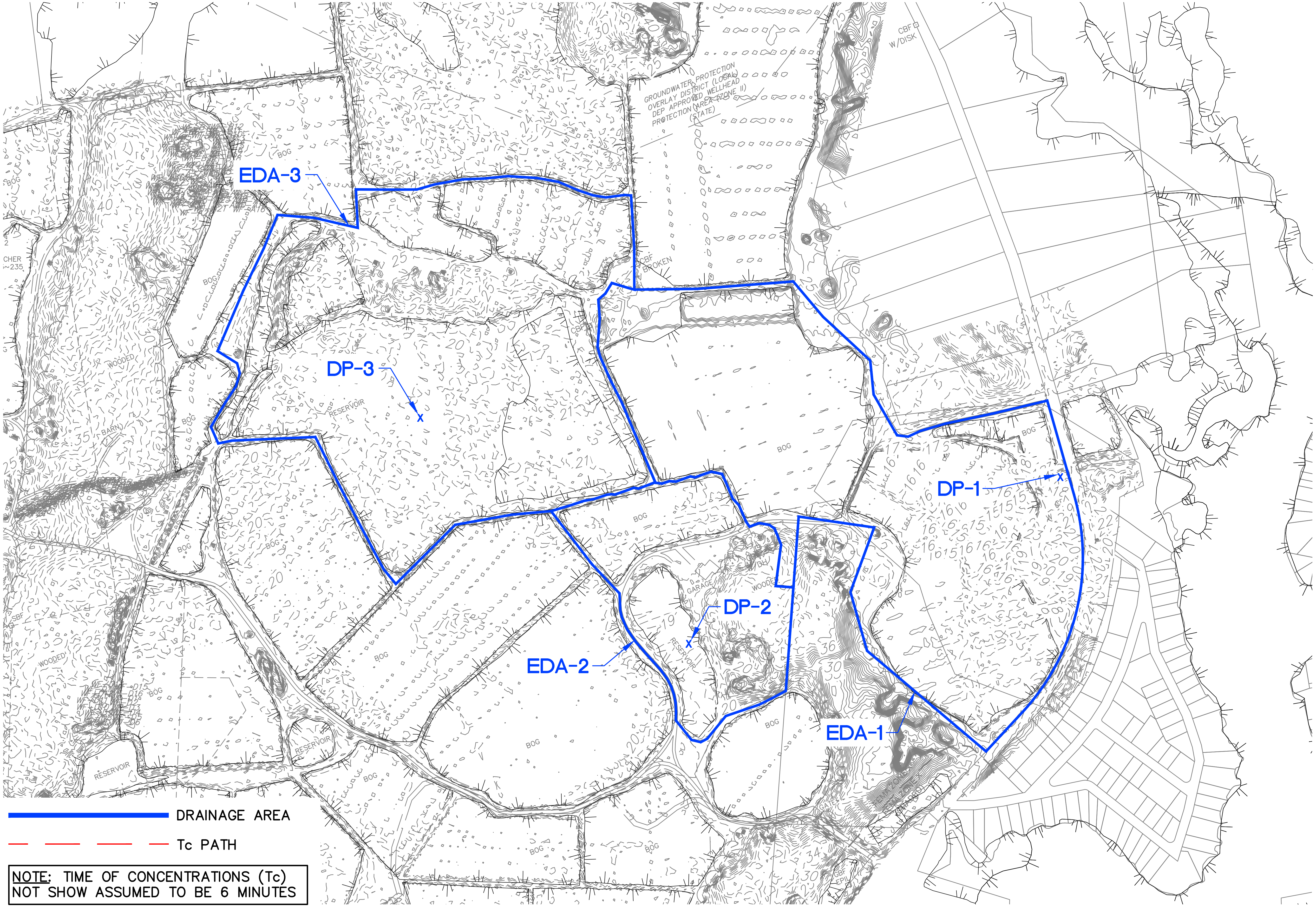
1. Pre-Development Conditions: Hydrologic Areas Map and HydroCAD Report

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	RFK	11/10/2021	KJP	11/12/2021	MC	11/17/2021

RFK/kjp/mc/189716CS001A

Attachment 1

Pre-Development Conditions:
Hydrologic Areas Map and HydroCAD Report



Pre-Development Conditions Hydrologic Areas Map

Figure Number 001

Scale: 1"=400'

Date: 11/10/2021

Plan No. 189716P068A-001

B+T Project No. 1897.16

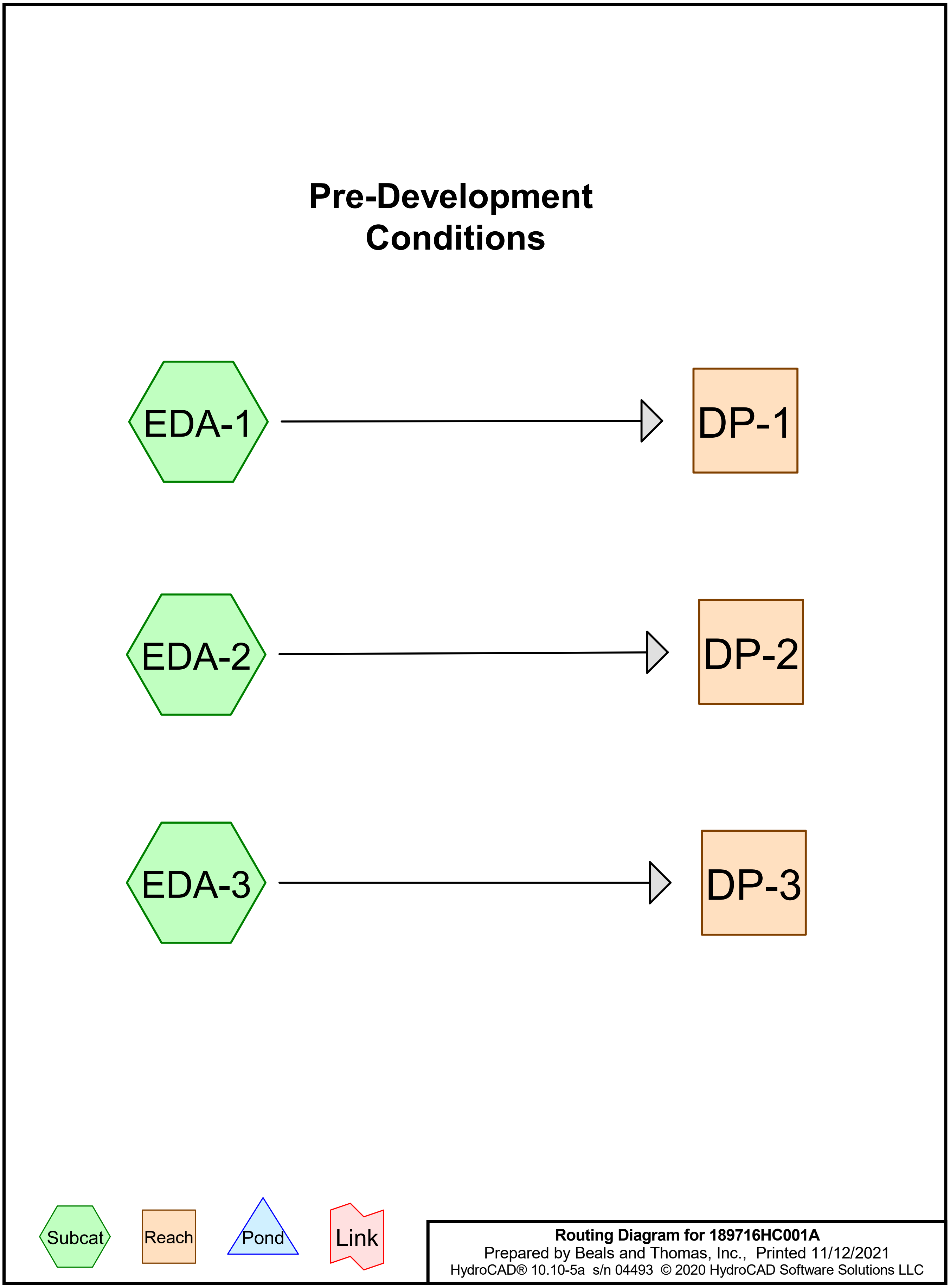
Definitive Subdivision Plan of Maple Springs Road

Wareham, Massachusetts

A.D. Makepeace Company

158 Tihonet Road
Wareham, Massachusetts

North Arrow



Routing Diagram for 189716HC001A
Prepared by Beals and Thomas, Inc., Printed 11/12/2021

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
9.255	68	<50% Grass cover, Poor, HSG A (EDA-1, EDA-3)
47.513	79	<50% Grass cover, Poor, HSG B (EDA-1, EDA-2, EDA-3)
19.811	72	Dirt roads, HSG A (EDA-1, EDA-2, EDA-3)
3.774	82	Dirt roads, HSG B (EDA-1, EDA-2, EDA-3)
0.946	76	Gravel roads, HSG A (EDA-1, EDA-2)
0.114	85	Gravel roads, HSG B (EDA-1, EDA-2)
0.106	98	Roofs, HSG A (EDA-2)
26.252	98	Water Surface, HSG A (EDA-1, EDA-2, EDA-3)
6.850	30	Woods, Good, HSG A (EDA-1, EDA-2, EDA-3)
0.194	55	Woods, Good, HSG B (EDA-3)
114.815	**78**	**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EDA-1: Runoff Area=47.930 ac 0.28% Impervious Runoff Depth>1.20"
Tc=6.0 min CN=75 Runoff=64.19 cfs 4.802 af

Subcatchment EDA-2: Runoff Area=15.953 ac 18.63% Impervious Runoff Depth>1.03"
Tc=6.0 min CN=72 Runoff=17.77 cfs 1.368 af

Subcatchment EDA-3: Runoff Area=50.932 ac 45.66% Impervious Runoff Depth>1.74"
Tc=6.0 min CN=83 Runoff=101.92 cfs 7.384 af

Reach DP-1: Inflow=64.19 cfs 4.802 af
Outflow=64.19 cfs 4.802 af

Reach DP-2: Inflow=17.77 cfs 1.368 af
Outflow=17.77 cfs 1.368 af

Reach DP-3: Inflow=101.92 cfs 7.384 af
Outflow=101.92 cfs 7.384 af

Total Runoff Area = 114.815 ac Runoff Volume = 13.555 af Average Runoff Depth = 1.42"
77.04% Pervious = 88.457 ac 22.96% Impervious = 26.358 ac

Summary for Subcatchment EDA-1:

Runoff = 64.19 cfs @ 12.10 hrs, Volume= 4.802 af, Depth> 1.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.36"

Area (ac)	CN	Description
8.723	68	<50% Grass cover, Poor, HSG A
27.234	79	<50% Grass cover, Poor, HSG B
10.117	72	Dirt roads, HSG A
0.705	82	Dirt roads, HSG B
0.573	76	Gravel roads, HSG A
0.089	85	Gravel roads, HSG B
0.357	30	Woods, Good, HSG A
0.132	98	Water Surface, HSG A
47.930	75	Weighted Average
47.798		99.72% Pervious Area
0.132		0.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment EDA-2:

Runoff = 17.77 cfs @ 12.10 hrs, Volume= 1.368 af, Depth> 1.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.36"

Area (ac)	CN	Description
4.154	79	<50% Grass cover, Poor, HSG B
4.840	72	Dirt roads, HSG A
0.698	82	Dirt roads, HSG B
0.373	76	Gravel roads, HSG A
0.025	85	Gravel roads, HSG B
2.891	30	Woods, Good, HSG A
0.106	98	Roofs, HSG A
2.866	98	Water Surface, HSG A
15.953	72	Weighted Average
12.981		81.37% Pervious Area
2.972		18.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment EDA-3:

Runoff = 101.92 cfs @ 12.09 hrs, Volume= 7.384 af, Depth> 1.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.36"

Area (ac)	CN	Description
0.532	68	<50% Grass cover, Poor, HSG A
16.125	79	<50% Grass cover, Poor, HSG B
4.854	72	Dirt roads, HSG A
2.371	82	Dirt roads, HSG B
3.602	30	Woods, Good, HSG A
0.194	55	Woods, Good, HSG B
23.254	98	Water Surface, HSG A
50.932	83	Weighted Average
27.678		54.34% Pervious Area
23.254		45.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Reach DP-1:

Inflow Area = 47.930 ac, 0.28% Impervious, Inflow Depth > 1.20" for Plymouth-002yr event
Inflow = 64.19 cfs @ 12.10 hrs, Volume= 4.802 af
Outflow = 64.19 cfs @ 12.10 hrs, Volume= 4.802 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2:

Inflow Area = 15.953 ac, 18.63% Impervious, Inflow Depth > 1.03" for Plymouth-002yr event
Inflow = 17.77 cfs @ 12.10 hrs, Volume= 1.368 af
Outflow = 17.77 cfs @ 12.10 hrs, Volume= 1.368 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3:

Inflow Area = 50.932 ac, 45.66% Impervious, Inflow Depth > 1.74" for Plymouth-002yr event
Inflow = 101.92 cfs @ 12.09 hrs, Volume= 7.384 af
Outflow = 101.92 cfs @ 12.09 hrs, Volume= 7.384 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EDA-1: Runoff Area=47.930 ac 0.28% Impervious Runoff Depth>2.41"
Tc=6.0 min CN=75 Runoff=132.41 cfs 9.612 af

Subcatchment EDA-2: Runoff Area=15.953 ac 18.63% Impervious Runoff Depth>2.16"
Tc=6.0 min CN=72 Runoff=39.23 cfs 2.868 af

Subcatchment EDA-3: Runoff Area=50.932 ac 45.66% Impervious Runoff Depth>3.13"
Tc=6.0 min CN=83 Runoff=182.15 cfs 13.269 af

Reach DP-1: Inflow=132.41 cfs 9.612 af
Outflow=132.41 cfs 9.612 af

Reach DP-2: Inflow=39.23 cfs 2.868 af
Outflow=39.23 cfs 2.868 af

Reach DP-3: Inflow=182.15 cfs 13.269 af
Outflow=182.15 cfs 13.269 af

Total Runoff Area = 114.815 ac Runoff Volume = 25.749 af Average Runoff Depth = 2.69"
77.04% Pervious = 88.457 ac 22.96% Impervious = 26.358 ac

Summary for Subcatchment EDA-1:

Runoff = 132.41 cfs @ 12.09 hrs, Volume= 9.612 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=4.95"

Area (ac)	CN	Description
8.723	68	<50% Grass cover, Poor, HSG A
27.234	79	<50% Grass cover, Poor, HSG B
10.117	72	Dirt roads, HSG A
0.705	82	Dirt roads, HSG B
0.573	76	Gravel roads, HSG A
0.089	85	Gravel roads, HSG B
0.357	30	Woods, Good, HSG A
0.132	98	Water Surface, HSG A
47.930	75	Weighted Average
47.798		99.72% Pervious Area
0.132		0.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment EDA-2:

Runoff = 39.23 cfs @ 12.10 hrs, Volume= 2.868 af, Depth> 2.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=4.95"

Area (ac)	CN	Description
4.154	79	<50% Grass cover, Poor, HSG B
4.840	72	Dirt roads, HSG A
0.698	82	Dirt roads, HSG B
0.373	76	Gravel roads, HSG A
0.025	85	Gravel roads, HSG B
2.891	30	Woods, Good, HSG A
0.106	98	Roofs, HSG A
2.866	98	Water Surface, HSG A
15.953	72	Weighted Average
12.981		81.37% Pervious Area
2.972		18.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment EDA-3:

Runoff = 182.15 cfs @ 12.09 hrs, Volume= 13.269 af, Depth> 3.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=4.95"

Area (ac)	CN	Description
0.532	68	<50% Grass cover, Poor, HSG A
16.125	79	<50% Grass cover, Poor, HSG B
4.854	72	Dirt roads, HSG A
2.371	82	Dirt roads, HSG B
3.602	30	Woods, Good, HSG A
0.194	55	Woods, Good, HSG B
23.254	98	Water Surface, HSG A
50.932	83	Weighted Average
27.678		54.34% Pervious Area
23.254		45.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Reach DP-1:

Inflow Area = 47.930 ac, 0.28% Impervious, Inflow Depth > 2.41" for Plymouth-010yr event
Inflow = 132.41 cfs @ 12.09 hrs, Volume= 9.612 af
Outflow = 132.41 cfs @ 12.09 hrs, Volume= 9.612 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2:

Inflow Area = 15.953 ac, 18.63% Impervious, Inflow Depth > 2.16" for Plymouth-010yr event
Inflow = 39.23 cfs @ 12.10 hrs, Volume= 2.868 af
Outflow = 39.23 cfs @ 12.10 hrs, Volume= 2.868 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3:

Inflow Area = 50.932 ac, 45.66% Impervious, Inflow Depth > 3.13" for Plymouth-010yr event
Inflow = 182.15 cfs @ 12.09 hrs, Volume= 13.269 af
Outflow = 182.15 cfs @ 12.09 hrs, Volume= 13.269 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EDA-1: Runoff Area=47.930 ac 0.28% Impervious Runoff Depth>3.43"
Tc=6.0 min CN=75 Runoff=189.30 cfs 13.712 af

Subcatchment EDA-2: Runoff Area=15.953 ac 18.63% Impervious Runoff Depth>3.14"
Tc=6.0 min CN=72 Runoff=57.56 cfs 4.172 af

Subcatchment EDA-3: Runoff Area=50.932 ac 45.66% Impervious Runoff Depth>4.26"
Tc=6.0 min CN=83 Runoff=245.57 cfs 18.061 af

Reach DP-1: Inflow=189.30 cfs 13.712 af
Outflow=189.30 cfs 13.712 af

Reach DP-2: Inflow=57.56 cfs 4.172 af
Outflow=57.56 cfs 4.172 af

Reach DP-3: Inflow=245.57 cfs 18.061 af
Outflow=245.57 cfs 18.061 af

Total Runoff Area = 114.815 ac Runoff Volume = 35.945 af Average Runoff Depth = 3.76"
77.04% Pervious = 88.457 ac 22.96% Impervious = 26.358 ac

Summary for Subcatchment EDA-1:

Runoff = 189.30 cfs @ 12.09 hrs, Volume= 13.712 af, Depth> 3.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.18"

Area (ac)	CN	Description
8.723	68	<50% Grass cover, Poor, HSG A
27.234	79	<50% Grass cover, Poor, HSG B
10.117	72	Dirt roads, HSG A
0.705	82	Dirt roads, HSG B
0.573	76	Gravel roads, HSG A
0.089	85	Gravel roads, HSG B
0.357	30	Woods, Good, HSG A
0.132	98	Water Surface, HSG A
47.930	75	Weighted Average
47.798		99.72% Pervious Area
0.132		0.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment EDA-2:

Runoff = 57.56 cfs @ 12.09 hrs, Volume= 4.172 af, Depth> 3.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.18"

Area (ac)	CN	Description
4.154	79	<50% Grass cover, Poor, HSG B
4.840	72	Dirt roads, HSG A
0.698	82	Dirt roads, HSG B
0.373	76	Gravel roads, HSG A
0.025	85	Gravel roads, HSG B
2.891	30	Woods, Good, HSG A
0.106	98	Roofs, HSG A
2.866	98	Water Surface, HSG A
15.953	72	Weighted Average
12.981		81.37% Pervious Area
2.972		18.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment EDA-3:

Runoff = 245.57 cfs @ 12.09 hrs, Volume= 18.061 af, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.18"

Area (ac)	CN	Description
0.532	68	<50% Grass cover, Poor, HSG A
16.125	79	<50% Grass cover, Poor, HSG B
4.854	72	Dirt roads, HSG A
2.371	82	Dirt roads, HSG B
3.602	30	Woods, Good, HSG A
0.194	55	Woods, Good, HSG B
23.254	98	Water Surface, HSG A
50.932	83	Weighted Average
27.678		54.34% Pervious Area
23.254		45.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Reach DP-1:

Inflow Area = 47.930 ac, 0.28% Impervious, Inflow Depth > 3.43" for Plymouth-025yr event
Inflow = 189.30 cfs @ 12.09 hrs, Volume= 13.712 af
Outflow = 189.30 cfs @ 12.09 hrs, Volume= 13.712 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2:

Inflow Area = 15.953 ac, 18.63% Impervious, Inflow Depth > 3.14" for Plymouth-025yr event
Inflow = 57.56 cfs @ 12.09 hrs, Volume= 4.172 af
Outflow = 57.56 cfs @ 12.09 hrs, Volume= 4.172 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3:

Inflow Area = 50.932 ac, 45.66% Impervious, Inflow Depth > 4.26" for Plymouth-025yr event
Inflow = 245.57 cfs @ 12.09 hrs, Volume= 18.061 af
Outflow = 245.57 cfs @ 12.09 hrs, Volume= 18.061 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EDA-1: Runoff Area=47.930 ac 0.28% Impervious Runoff Depth>4.42"
Tc=6.0 min CN=75 Runoff=243.06 cfs 17.654 af

Subcatchment EDA-2: Runoff Area=15.953 ac 18.63% Impervious Runoff Depth>4.09"
Tc=6.0 min CN=72 Runoff=75.08 cfs 5.439 af

Subcatchment EDA-3: Runoff Area=50.932 ac 45.66% Impervious Runoff Depth>5.32"
Tc=6.0 min CN=83 Runoff=304.01 cfs 22.567 af

Reach DP-1: Inflow=243.06 cfs 17.654 af
Outflow=243.06 cfs 17.654 af

Reach DP-2: Inflow=75.08 cfs 5.439 af
Outflow=75.08 cfs 5.439 af

Reach DP-3: Inflow=304.01 cfs 22.567 af
Outflow=304.01 cfs 22.567 af

Total Runoff Area = 114.815 ac Runoff Volume = 45.659 af Average Runoff Depth = 4.77"
77.04% Pervious = 88.457 ac 22.96% Impervious = 26.358 ac

Summary for Subcatchment EDA-1:

Runoff = 243.06 cfs @ 12.09 hrs, Volume= 17.654 af, Depth> 4.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-050yr Rainfall=7.31"

Area (ac)	CN	Description
8.723	68	<50% Grass cover, Poor, HSG A
27.234	79	<50% Grass cover, Poor, HSG B
10.117	72	Dirt roads, HSG A
0.705	82	Dirt roads, HSG B
0.573	76	Gravel roads, HSG A
0.089	85	Gravel roads, HSG B
0.357	30	Woods, Good, HSG A
0.132	98	Water Surface, HSG A
47.930	75	Weighted Average
47.798		99.72% Pervious Area
0.132		0.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment EDA-2:

Runoff = 75.08 cfs @ 12.09 hrs, Volume= 5.439 af, Depth> 4.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-050yr Rainfall=7.31"

Area (ac)	CN	Description
4.154	79	<50% Grass cover, Poor, HSG B
4.840	72	Dirt roads, HSG A
0.698	82	Dirt roads, HSG B
0.373	76	Gravel roads, HSG A
0.025	85	Gravel roads, HSG B
2.891	30	Woods, Good, HSG A
0.106	98	Roofs, HSG A
2.866	98	Water Surface, HSG A
15.953	72	Weighted Average
12.981		81.37% Pervious Area
2.972		18.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment EDA-3:

Runoff = 304.01 cfs @ 12.09 hrs, Volume= 22.567 af, Depth> 5.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-050yr Rainfall=7.31"

Area (ac)	CN	Description
0.532	68	<50% Grass cover, Poor, HSG A
16.125	79	<50% Grass cover, Poor, HSG B
4.854	72	Dirt roads, HSG A
2.371	82	Dirt roads, HSG B
3.602	30	Woods, Good, HSG A
0.194	55	Woods, Good, HSG B
23.254	98	Water Surface, HSG A
50.932	83	Weighted Average
27.678		54.34% Pervious Area
23.254		45.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Reach DP-1:

Inflow Area = 47.930 ac, 0.28% Impervious, Inflow Depth > 4.42" for Plymouth-050yr event
Inflow = 243.06 cfs @ 12.09 hrs, Volume= 17.654 af
Outflow = 243.06 cfs @ 12.09 hrs, Volume= 17.654 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2:

Inflow Area = 15.953 ac, 18.63% Impervious, Inflow Depth > 4.09" for Plymouth-050yr event
Inflow = 75.08 cfs @ 12.09 hrs, Volume= 5.439 af
Outflow = 75.08 cfs @ 12.09 hrs, Volume= 5.439 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3:

Inflow Area = 50.932 ac, 45.66% Impervious, Inflow Depth > 5.32" for Plymouth-050yr event
Inflow = 304.01 cfs @ 12.09 hrs, Volume= 22.567 af
Outflow = 304.01 cfs @ 12.09 hrs, Volume= 22.567 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EDA-1: Runoff Area=47.930 ac 0.28% Impervious Runoff Depth>5.63"
Tc=6.0 min CN=75 Runoff=307.72 cfs 22.476 af

Subcatchment EDA-2: Runoff Area=15.953 ac 18.63% Impervious Runoff Depth>5.26"
Tc=6.0 min CN=72 Runoff=96.33 cfs 6.999 af

Subcatchment EDA-3: Runoff Area=50.932 ac 45.66% Impervious Runoff Depth>6.60"
Tc=6.0 min CN=83 Runoff=373.17 cfs 27.992 af

Reach DP-1: Inflow=307.72 cfs 22.476 af
Outflow=307.72 cfs 22.476 af

Reach DP-2: Inflow=96.33 cfs 6.999 af
Outflow=96.33 cfs 6.999 af

Reach DP-3: Inflow=373.17 cfs 27.992 af
Outflow=373.17 cfs 27.992 af

Total Runoff Area = 114.815 ac Runoff Volume = 57.467 af Average Runoff Depth = 6.01"
77.04% Pervious = 88.457 ac 22.96% Impervious = 26.358 ac

Summary for Subcatchment EDA-1:

Runoff = 307.72 cfs @ 12.09 hrs, Volume= 22.476 af, Depth> 5.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=8.65"

Area (ac)	CN	Description
8.723	68	<50% Grass cover, Poor, HSG A
27.234	79	<50% Grass cover, Poor, HSG B
10.117	72	Dirt roads, HSG A
0.705	82	Dirt roads, HSG B
0.573	76	Gravel roads, HSG A
0.089	85	Gravel roads, HSG B
0.357	30	Woods, Good, HSG A
0.132	98	Water Surface, HSG A
47.930	75	Weighted Average
47.798		99.72% Pervious Area
0.132		0.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment EDA-2:

Runoff = 96.33 cfs @ 12.09 hrs, Volume= 6.999 af, Depth> 5.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=8.65"

Area (ac)	CN	Description
4.154	79	<50% Grass cover, Poor, HSG B
4.840	72	Dirt roads, HSG A
0.698	82	Dirt roads, HSG B
0.373	76	Gravel roads, HSG A
0.025	85	Gravel roads, HSG B
2.891	30	Woods, Good, HSG A
0.106	98	Roofs, HSG A
2.866	98	Water Surface, HSG A
15.953	72	Weighted Average
12.981		81.37% Pervious Area
2.972		18.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment EDA-3:

Runoff = 373.17 cfs @ 12.09 hrs, Volume= 27.992 af, Depth> 6.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=8.65"

Area (ac)	CN	Description
0.532	68	<50% Grass cover, Poor, HSG A
16.125	79	<50% Grass cover, Poor, HSG B
4.854	72	Dirt roads, HSG A
2.371	82	Dirt roads, HSG B
3.602	30	Woods, Good, HSG A
0.194	55	Woods, Good, HSG B
23.254	98	Water Surface, HSG A
50.932	83	Weighted Average
27.678		54.34% Pervious Area
23.254		45.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Reach DP-1:

Inflow Area = 47.930 ac, 0.28% Impervious, Inflow Depth > 5.63" for Plymouth-100yr event
Inflow = 307.72 cfs @ 12.09 hrs, Volume= 22.476 af
Outflow = 307.72 cfs @ 12.09 hrs, Volume= 22.476 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2:

Inflow Area = 15.953 ac, 18.63% Impervious, Inflow Depth > 5.26" for Plymouth-100yr event
Inflow = 96.33 cfs @ 12.09 hrs, Volume= 6.999 af
Outflow = 96.33 cfs @ 12.09 hrs, Volume= 6.999 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3:

Inflow Area = 50.932 ac, 45.66% Impervious, Inflow Depth > 6.60" for Plymouth-100yr event
Inflow = 373.17 cfs @ 12.09 hrs, Volume= 27.992 af
Outflow = 373.17 cfs @ 12.09 hrs, Volume= 27.992 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Attachment 3
Post-Development Hydrologic Analysis

POST-DEVELOPMENT CONDITIONS HYDROLOGIC ANALYSIS

OBJECTIVE

To determine the post-development peak rates of runoff from the site for the 2-, 10-, 25-, 50-, and 100-year storm events.

CONCLUSION

Peak Runoff Rates

The following numbers represent the peak rates of runoff from the site under the post-development conditions:

Storm Event	2 Year	10 Year	25 Year	50 Year	100 Year
	Post (cfs)	*Post (cfs)*	*Post (cfs)*	*Post (cfs)*	*Post (cfs)*
DP-1	64.19	132.41	189.30	243.06	307.72
DP-2	17.77	39.23	57.56	75.08	96.33
DP-3	101.92	182.15	245.57	304.01	373.17

In accordance with the MassDEP Stormwater Handbook, post-development peak runoff rates are equal to pre-development peak runoff rates under the 2-, 10-, 25-, 50-, and 100-year storm events.

CALCULATION METHODS

1. Runoff curve numbers (CN), time-of-concentration (T_C), and runoff rates were calculated based on TR-55 methodology.
2. Autodesk Civil 3D 2019 computer program was utilized for digitizing ground cover areas.
3. Runoff rates computed using HydroCAD version 10.10.

ASSUMPTIONS

1. The ground cover types and boundaries were determined using the Topographic Plan, MassGIS aerial imagery, aerial imagery viewed on Google Earth, and hydrologic soil groups based on United States Department of Agriculture, NRCS Soil Survey map information
2. The subcatchment limits were truncated at the property line.
3. All runoff captured by the bogs within each subcatchment is assumed to drain to the same area designated by the design point.
4. This analysis only included portions of the Property where there are proposed impacts and lotting.
   a. All areas within the Property that are not included in the analysis will have no change in hydrology between pre-development and post-development conditions.
5. All bog areas are modeled as poor condition grass for this analysis.

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	RFK	11/10/2021	KJP	11/12/2021	MC	11/17/2021

RFK/kjp/mc/189716CS002A

Corporate Office
144 Turnpike Road
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Regional Office
32 Court Street
Plymouth, MA 02360

6. To be conservative, all other areas outside of the bogs, building, gravel road, water, and wooded areas are modeled as dirt roads.
7. Soils identified by NRCS as HSG A/D or HSG B/D were modeled as HSG A or HSG B, respectively.

SOURCES OF DATA/ EQUATIONS

1. NRCS Soil Map for Plymouth County, downloaded from Web Soil Survey on 10/26/2021.
2. Topographic Plan, prepared by Northeast Survey Consultants and B+T, dated 11/12/2021.
3. Post-Development Conditions Hydrologic Areas Map, prepared by B+T, dated 11/10/2021.
4. Proposed Site Plan Design File, B+T File No. 189716D011C.
5. TR-55 Urban Hydrology for Small Watersheds, SCS, 1986.
6. Massachusetts DEP Stormwater Management Handbook, February 2008.
7. Town of Wareham Rules & Regulations Governing the Subdivision of Land, March 2013.

LIST OF ATTACHMENTS

1. Post-Development Conditions: Hydrologic Areas Map and HydroCAD Report

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	RFK	11/10/2021	KJP	11/12/2021	MC	11/17/2021

RFK/kjp/mc/189716CS002A

Attachment 1

Post-Development Conditions:
Hydrologic Areas Map and HydroCAD Report

Post-Development Conditions Hydrologic Areas Map

Figure Number 002

Scale: 1"=400'

Date: 11/10/2021

Plan No. 189716P068A-002

B+T Project No. 1897.16

Definitive Subdivision Plan of Maple Springs Road

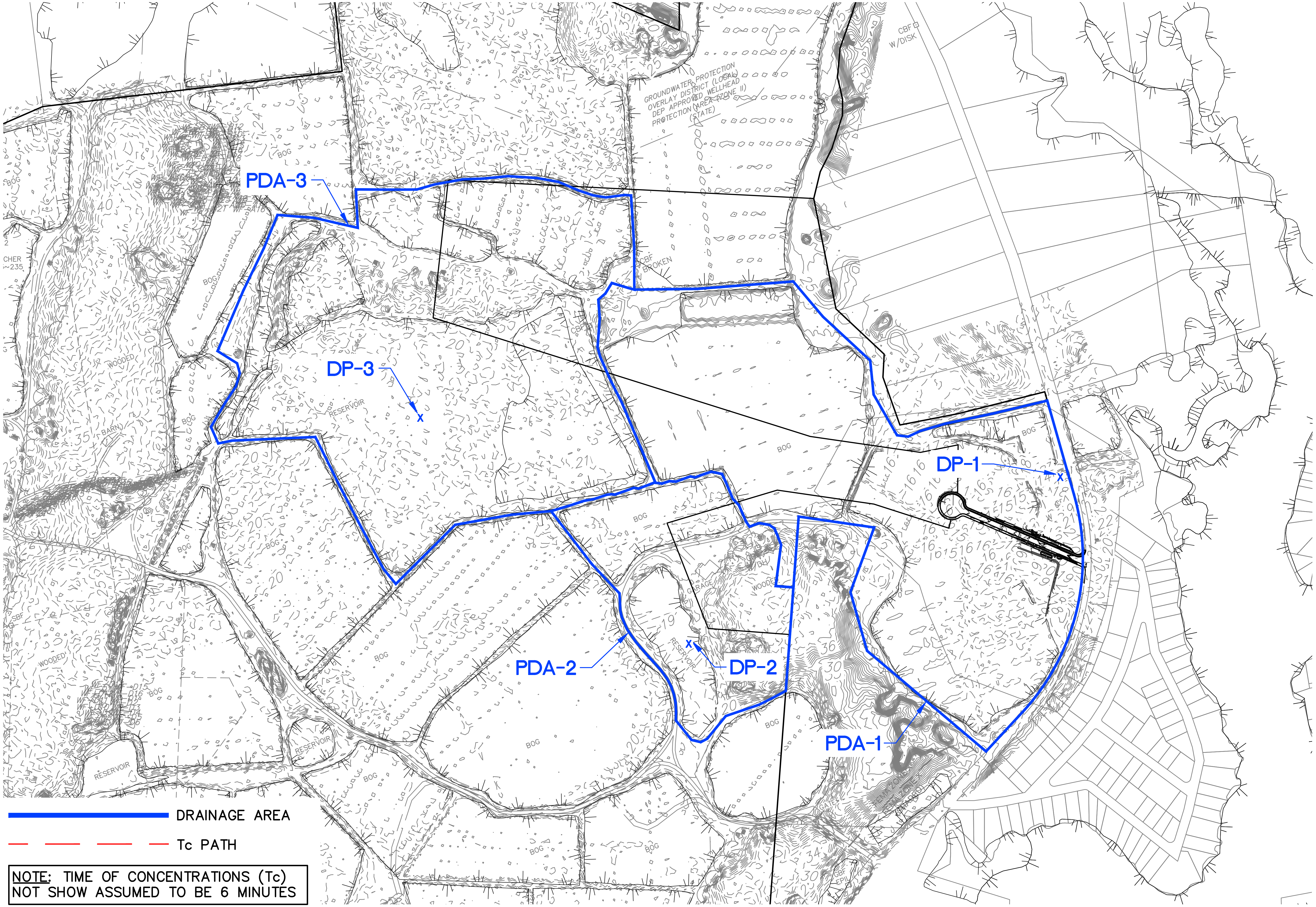
Wareham, Massachusetts

A.D. Makepeace Company

158 Tihonet Road

Wareham, Massachusetts

North Arrow

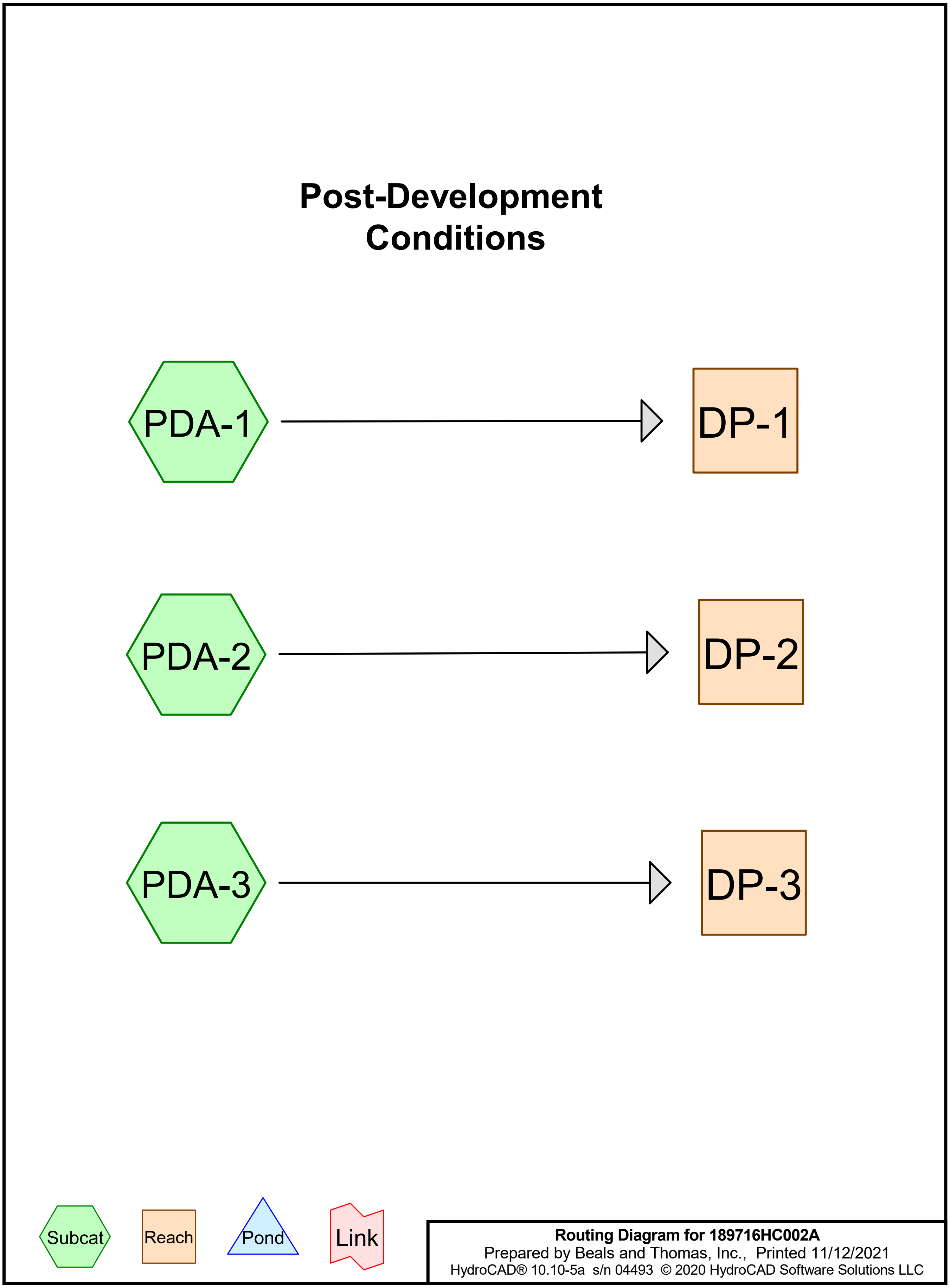


DRAINAGE AREA

Tc PATH

NOTE: TIME OF CONCENTRATIONS (Tc) NOT SHOW ASSUMED TO BE 6 MINUTES

BEALS+THOMAS



Routing Diagram for 189716HC002A
Prepared by Beals and Thomas, Inc., Printed 11/12/2021

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
8.791	68	<50% Grass cover, Poor, HSG A (PDA-1, PDA-3)
47.480	79	<50% Grass cover, Poor, HSG B (PDA-1, PDA-2, PDA-3)
1.491	39	>75% Grass cover, Good, HSG A (PDA-1)
0.015	61	>75% Grass cover, Good, HSG B (PDA-1)
18.258	72	Dirt roads, HSG A (PDA-1, PDA-2, PDA-3)
3.773	82	Dirt roads, HSG B (PDA-1, PDA-2, PDA-3)
0.946	76	Gravel roads, HSG A (PDA-1, PDA-2)
0.114	85	Gravel roads, HSG B (PDA-1, PDA-2)
0.527	98	Paved parking, HSG A (PDA-1)
0.018	98	Paved parking, HSG B (PDA-1)
0.106	98	Roofs, HSG A (PDA-2)
26.252	98	Water Surface, HSG A (PDA-1, PDA-2, PDA-3)
6.850	30	Woods, Good, HSG A (PDA-1, PDA-2, PDA-3)
0.194	55	Woods, Good, HSG B (PDA-3)
114.815	**78**	**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PDA-1: Runoff Area=47.930 ac 1.41% Impervious Runoff Depth>1.20"
Tc=6.0 min CN=75 Runoff=64.19 cfs 4.802 af

Subcatchment PDA-2: Runoff Area=15.953 ac 18.63% Impervious Runoff Depth>1.03"
Tc=6.0 min CN=72 Runoff=17.77 cfs 1.368 af

Subcatchment PDA-3: Runoff Area=50.932 ac 45.66% Impervious Runoff Depth>1.74"
Tc=6.0 min CN=83 Runoff=101.92 cfs 7.384 af

Reach DP-1: Inflow=64.19 cfs 4.802 af
Outflow=64.19 cfs 4.802 af

Reach DP-2: Inflow=17.77 cfs 1.368 af
Outflow=17.77 cfs 1.368 af

Reach DP-3: Inflow=101.92 cfs 7.384 af
Outflow=101.92 cfs 7.384 af

Total Runoff Area = 114.815 ac Runoff Volume = 13.555 af Average Runoff Depth = 1.42"
76.57% Pervious = 87.912 ac 23.43% Impervious = 26.903 ac

Summary for Subcatchment PDA-1:

Runoff = 64.19 cfs @ 12.10 hrs, Volume= 4.802 af, Depth> 1.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.36"

Area (ac)	CN	Description
8.259	68	<50% Grass cover, Poor, HSG A
27.201	79	<50% Grass cover, Poor, HSG B
1.491	39	>75% Grass cover, Good, HSG A
0.015	61	>75% Grass cover, Good, HSG B
8.564	72	Dirt roads, HSG A
0.704	82	Dirt roads, HSG B
0.573	76	Gravel roads, HSG A
0.089	85	Gravel roads, HSG B
0.357	30	Woods, Good, HSG A
0.527	98	Paved parking, HSG A
0.018	98	Paved parking, HSG B
0.132	98	Water Surface, HSG A
47.930	75	Weighted Average
47.253		98.59% Pervious Area
0.677		1.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment PDA-2:

Runoff = 17.77 cfs @ 12.10 hrs, Volume= 1.368 af, Depth> 1.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.36"

Area (ac)	CN	Description
4.154	79	<50% Grass cover, Poor, HSG B
4.840	72	Dirt roads, HSG A
0.698	82	Dirt roads, HSG B
0.373	76	Gravel roads, HSG A
0.025	85	Gravel roads, HSG B
2.891	30	Woods, Good, HSG A
0.106	98	Roofs, HSG A
2.866	98	Water Surface, HSG A
15.953	72	Weighted Average
12.981		81.37% Pervious Area
2.972		18.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment PDA-3:

Runoff = 101.92 cfs @ 12.09 hrs, Volume= 7.384 af, Depth> 1.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-002yr Rainfall=3.36"

Area (ac)	CN	Description
0.532	68	<50% Grass cover, Poor, HSG A
16.125	79	<50% Grass cover, Poor, HSG B
4.854	72	Dirt roads, HSG A
2.371	82	Dirt roads, HSG B
3.602	30	Woods, Good, HSG A
0.194	55	Woods, Good, HSG B
23.254	98	Water Surface, HSG A
50.932	83	Weighted Average
27.678		54.34% Pervious Area
23.254		45.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Reach DP-1:

Inflow Area = 47.930 ac, 1.41% Impervious, Inflow Depth > 1.20" for Plymouth-002yr event
Inflow = 64.19 cfs @ 12.10 hrs, Volume= 4.802 af
Outflow = 64.19 cfs @ 12.10 hrs, Volume= 4.802 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2:

Inflow Area = 15.953 ac, 18.63% Impervious, Inflow Depth > 1.03" for Plymouth-002yr event
Inflow = 17.77 cfs @ 12.10 hrs, Volume= 1.368 af
Outflow = 17.77 cfs @ 12.10 hrs, Volume= 1.368 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3:

Inflow Area = 50.932 ac, 45.66% Impervious, Inflow Depth > 1.74" for Plymouth-002yr event
Inflow = 101.92 cfs @ 12.09 hrs, Volume= 7.384 af
Outflow = 101.92 cfs @ 12.09 hrs, Volume= 7.384 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PDA-1: Runoff Area=47.930 ac 1.41% Impervious Runoff Depth>2.41"
Tc=6.0 min CN=75 Runoff=132.41 cfs 9.612 af

Subcatchment PDA-2: Runoff Area=15.953 ac 18.63% Impervious Runoff Depth>2.16"
Tc=6.0 min CN=72 Runoff=39.23 cfs 2.868 af

Subcatchment PDA-3: Runoff Area=50.932 ac 45.66% Impervious Runoff Depth>3.13"
Tc=6.0 min CN=83 Runoff=182.15 cfs 13.269 af

Reach DP-1: Inflow=132.41 cfs 9.612 af
Outflow=132.41 cfs 9.612 af

Reach DP-2: Inflow=39.23 cfs 2.868 af
Outflow=39.23 cfs 2.868 af

Reach DP-3: Inflow=182.15 cfs 13.269 af
Outflow=182.15 cfs 13.269 af

Total Runoff Area = 114.815 ac Runoff Volume = 25.749 af Average Runoff Depth = 2.69"
76.57% Pervious = 87.912 ac 23.43% Impervious = 26.903 ac

Summary for Subcatchment PDA-1:

Runoff = 132.41 cfs @ 12.09 hrs, Volume= 9.612 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=4.95"

Area (ac)	CN	Description
8.259	68	<50% Grass cover, Poor, HSG A
27.201	79	<50% Grass cover, Poor, HSG B
1.491	39	>75% Grass cover, Good, HSG A
0.015	61	>75% Grass cover, Good, HSG B
8.564	72	Dirt roads, HSG A
0.704	82	Dirt roads, HSG B
0.573	76	Gravel roads, HSG A
0.089	85	Gravel roads, HSG B
0.357	30	Woods, Good, HSG A
0.527	98	Paved parking, HSG A
0.018	98	Paved parking, HSG B
0.132	98	Water Surface, HSG A
47.930	75	Weighted Average
47.253		98.59% Pervious Area
0.677		1.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment PDA-2:

Runoff = 39.23 cfs @ 12.10 hrs, Volume= 2.868 af, Depth> 2.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=4.95"

Area (ac)	CN	Description
4.154	79	<50% Grass cover, Poor, HSG B
4.840	72	Dirt roads, HSG A
0.698	82	Dirt roads, HSG B
0.373	76	Gravel roads, HSG A
0.025	85	Gravel roads, HSG B
2.891	30	Woods, Good, HSG A
0.106	98	Roofs, HSG A
2.866	98	Water Surface, HSG A
15.953	72	Weighted Average
12.981		81.37% Pervious Area
2.972		18.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment PDA-3:

Runoff = 182.15 cfs @ 12.09 hrs, Volume= 13.269 af, Depth> 3.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-010yr Rainfall=4.95"

Area (ac)	CN	Description
0.532	68	<50% Grass cover, Poor, HSG A
16.125	79	<50% Grass cover, Poor, HSG B
4.854	72	Dirt roads, HSG A
2.371	82	Dirt roads, HSG B
3.602	30	Woods, Good, HSG A
0.194	55	Woods, Good, HSG B
23.254	98	Water Surface, HSG A
50.932	83	Weighted Average
27.678		54.34% Pervious Area
23.254		45.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Reach DP-1:

Inflow Area = 47.930 ac, 1.41% Impervious, Inflow Depth > 2.41" for Plymouth-010yr event
Inflow = 132.41 cfs @ 12.09 hrs, Volume= 9.612 af
Outflow = 132.41 cfs @ 12.09 hrs, Volume= 9.612 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2:

Inflow Area = 15.953 ac, 18.63% Impervious, Inflow Depth > 2.16" for Plymouth-010yr event
Inflow = 39.23 cfs @ 12.10 hrs, Volume= 2.868 af
Outflow = 39.23 cfs @ 12.10 hrs, Volume= 2.868 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3:

Inflow Area = 50.932 ac, 45.66% Impervious, Inflow Depth > 3.13" for Plymouth-010yr event
Inflow = 182.15 cfs @ 12.09 hrs, Volume= 13.269 af
Outflow = 182.15 cfs @ 12.09 hrs, Volume= 13.269 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PDA-1: Runoff Area=47.930 ac 1.41% Impervious Runoff Depth>3.43"
Tc=6.0 min CN=75 Runoff=189.30 cfs 13.712 af

Subcatchment PDA-2: Runoff Area=15.953 ac 18.63% Impervious Runoff Depth>3.14"
Tc=6.0 min CN=72 Runoff=57.56 cfs 4.172 af

Subcatchment PDA-3: Runoff Area=50.932 ac 45.66% Impervious Runoff Depth>4.26"
Tc=6.0 min CN=83 Runoff=245.57 cfs 18.061 af

Reach DP-1: Inflow=189.30 cfs 13.712 af
Outflow=189.30 cfs 13.712 af

Reach DP-2: Inflow=57.56 cfs 4.172 af
Outflow=57.56 cfs 4.172 af

Reach DP-3: Inflow=245.57 cfs 18.061 af
Outflow=245.57 cfs 18.061 af

Total Runoff Area = 114.815 ac Runoff Volume = 35.945 af Average Runoff Depth = 3.76"
76.57% Pervious = 87.912 ac 23.43% Impervious = 26.903 ac

Summary for Subcatchment PDA-1:

Runoff = 189.30 cfs @ 12.09 hrs, Volume= 13.712 af, Depth> 3.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.18"

Area (ac)	CN	Description
8.259	68	<50% Grass cover, Poor, HSG A
27.201	79	<50% Grass cover, Poor, HSG B
1.491	39	>75% Grass cover, Good, HSG A
0.015	61	>75% Grass cover, Good, HSG B
8.564	72	Dirt roads, HSG A
0.704	82	Dirt roads, HSG B
0.573	76	Gravel roads, HSG A
0.089	85	Gravel roads, HSG B
0.357	30	Woods, Good, HSG A
0.527	98	Paved parking, HSG A
0.018	98	Paved parking, HSG B
0.132	98	Water Surface, HSG A
47.930	75	Weighted Average
47.253		98.59% Pervious Area
0.677		1.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment PDA-2:

Runoff = 57.56 cfs @ 12.09 hrs, Volume= 4.172 af, Depth> 3.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.18"

Area (ac)	CN	Description
4.154	79	<50% Grass cover, Poor, HSG B
4.840	72	Dirt roads, HSG A
0.698	82	Dirt roads, HSG B
0.373	76	Gravel roads, HSG A
0.025	85	Gravel roads, HSG B
2.891	30	Woods, Good, HSG A
0.106	98	Roofs, HSG A
2.866	98	Water Surface, HSG A
15.953	72	Weighted Average
12.981		81.37% Pervious Area
2.972		18.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment PDA-3:

Runoff = 245.57 cfs @ 12.09 hrs, Volume= 18.061 af, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-025yr Rainfall=6.18"

Area (ac)	CN	Description
0.532	68	<50% Grass cover, Poor, HSG A
16.125	79	<50% Grass cover, Poor, HSG B
4.854	72	Dirt roads, HSG A
2.371	82	Dirt roads, HSG B
3.602	30	Woods, Good, HSG A
0.194	55	Woods, Good, HSG B
23.254	98	Water Surface, HSG A
50.932	83	Weighted Average
27.678		54.34% Pervious Area
23.254		45.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Reach DP-1:

Inflow Area = 47.930 ac, 1.41% Impervious, Inflow Depth > 3.43" for Plymouth-025yr event
Inflow = 189.30 cfs @ 12.09 hrs, Volume= 13.712 af
Outflow = 189.30 cfs @ 12.09 hrs, Volume= 13.712 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2:

Inflow Area = 15.953 ac, 18.63% Impervious, Inflow Depth > 3.14" for Plymouth-025yr event
Inflow = 57.56 cfs @ 12.09 hrs, Volume= 4.172 af
Outflow = 57.56 cfs @ 12.09 hrs, Volume= 4.172 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3:

Inflow Area = 50.932 ac, 45.66% Impervious, Inflow Depth > 4.26" for Plymouth-025yr event
Inflow = 245.57 cfs @ 12.09 hrs, Volume= 18.061 af
Outflow = 245.57 cfs @ 12.09 hrs, Volume= 18.061 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PDA-1: Runoff Area=47.930 ac 1.41% Impervious Runoff Depth>4.42"
Tc=6.0 min CN=75 Runoff=243.06 cfs 17.654 af

Subcatchment PDA-2: Runoff Area=15.953 ac 18.63% Impervious Runoff Depth>4.09"
Tc=6.0 min CN=72 Runoff=75.08 cfs 5.439 af

Subcatchment PDA-3: Runoff Area=50.932 ac 45.66% Impervious Runoff Depth>5.32"
Tc=6.0 min CN=83 Runoff=304.01 cfs 22.567 af

Reach DP-1: Inflow=243.06 cfs 17.654 af
Outflow=243.06 cfs 17.654 af

Reach DP-2: Inflow=75.08 cfs 5.439 af
Outflow=75.08 cfs 5.439 af

Reach DP-3: Inflow=304.01 cfs 22.567 af
Outflow=304.01 cfs 22.567 af

Total Runoff Area = 114.815 ac Runoff Volume = 45.659 af Average Runoff Depth = 4.77"
76.57% Pervious = 87.912 ac 23.43% Impervious = 26.903 ac

Summary for Subcatchment PDA-1:

Runoff = 243.06 cfs @ 12.09 hrs, Volume= 17.654 af, Depth> 4.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-050yr Rainfall=7.31"

Area (ac)	CN	Description
8.259	68	<50% Grass cover, Poor, HSG A
27.201	79	<50% Grass cover, Poor, HSG B
1.491	39	>75% Grass cover, Good, HSG A
0.015	61	>75% Grass cover, Good, HSG B
8.564	72	Dirt roads, HSG A
0.704	82	Dirt roads, HSG B
0.573	76	Gravel roads, HSG A
0.089	85	Gravel roads, HSG B
0.357	30	Woods, Good, HSG A
0.527	98	Paved parking, HSG A
0.018	98	Paved parking, HSG B
0.132	98	Water Surface, HSG A
47.930	75	Weighted Average
47.253		98.59% Pervious Area
0.677		1.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment PDA-2:

Runoff = 75.08 cfs @ 12.09 hrs, Volume= 5.439 af, Depth> 4.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-050yr Rainfall=7.31"

Area (ac)	CN	Description
4.154	79	<50% Grass cover, Poor, HSG B
4.840	72	Dirt roads, HSG A
0.698	82	Dirt roads, HSG B
0.373	76	Gravel roads, HSG A
0.025	85	Gravel roads, HSG B
2.891	30	Woods, Good, HSG A
0.106	98	Roofs, HSG A
2.866	98	Water Surface, HSG A
15.953	72	Weighted Average
12.981		81.37% Pervious Area
2.972		18.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment PDA-3:

Runoff = 304.01 cfs @ 12.09 hrs, Volume= 22.567 af, Depth> 5.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-050yr Rainfall=7.31"

Area (ac)	CN	Description
0.532	68	<50% Grass cover, Poor, HSG A
16.125	79	<50% Grass cover, Poor, HSG B
4.854	72	Dirt roads, HSG A
2.371	82	Dirt roads, HSG B
3.602	30	Woods, Good, HSG A
0.194	55	Woods, Good, HSG B
23.254	98	Water Surface, HSG A
50.932	83	Weighted Average
27.678		54.34% Pervious Area
23.254		45.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Reach DP-1:

Inflow Area = 47.930 ac, 1.41% Impervious, Inflow Depth > 4.42" for Plymouth-050yr event
Inflow = 243.06 cfs @ 12.09 hrs, Volume= 17.654 af
Outflow = 243.06 cfs @ 12.09 hrs, Volume= 17.654 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2:

Inflow Area = 15.953 ac, 18.63% Impervious, Inflow Depth > 4.09" for Plymouth-050yr event
Inflow = 75.08 cfs @ 12.09 hrs, Volume= 5.439 af
Outflow = 75.08 cfs @ 12.09 hrs, Volume= 5.439 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3:

Inflow Area = 50.932 ac, 45.66% Impervious, Inflow Depth > 5.32" for Plymouth-050yr event
Inflow = 304.01 cfs @ 12.09 hrs, Volume= 22.567 af
Outflow = 304.01 cfs @ 12.09 hrs, Volume= 22.567 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PDA-1: Runoff Area=47.930 ac 1.41% Impervious Runoff Depth>5.63"
Tc=6.0 min CN=75 Runoff=307.72 cfs 22.476 af

Subcatchment PDA-2: Runoff Area=15.953 ac 18.63% Impervious Runoff Depth>5.26"
Tc=6.0 min CN=72 Runoff=96.33 cfs 6.999 af

Subcatchment PDA-3: Runoff Area=50.932 ac 45.66% Impervious Runoff Depth>6.60"
Tc=6.0 min CN=83 Runoff=373.17 cfs 27.992 af

Reach DP-1: Inflow=307.72 cfs 22.476 af
Outflow=307.72 cfs 22.476 af

Reach DP-2: Inflow=96.33 cfs 6.999 af
Outflow=96.33 cfs 6.999 af

Reach DP-3: Inflow=373.17 cfs 27.992 af
Outflow=373.17 cfs 27.992 af

Total Runoff Area = 114.815 ac Runoff Volume = 57.467 af Average Runoff Depth = 6.01"
76.57% Pervious = 87.912 ac 23.43% Impervious = 26.903 ac

Summary for Subcatchment PDA-1:

Runoff = 307.72 cfs @ 12.09 hrs, Volume= 22.476 af, Depth> 5.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=8.65"

Area (ac)	CN	Description
8.259	68	<50% Grass cover, Poor, HSG A
27.201	79	<50% Grass cover, Poor, HSG B
1.491	39	>75% Grass cover, Good, HSG A
0.015	61	>75% Grass cover, Good, HSG B
8.564	72	Dirt roads, HSG A
0.704	82	Dirt roads, HSG B
0.573	76	Gravel roads, HSG A
0.089	85	Gravel roads, HSG B
0.357	30	Woods, Good, HSG A
0.527	98	Paved parking, HSG A
0.018	98	Paved parking, HSG B
0.132	98	Water Surface, HSG A
47.930	75	Weighted Average
47.253		98.59% Pervious Area
0.677		1.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment PDA-2:

Runoff = 96.33 cfs @ 12.09 hrs, Volume= 6.999 af, Depth> 5.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=8.65"

Area (ac)	CN	Description
4.154	79	<50% Grass cover, Poor, HSG B
4.840	72	Dirt roads, HSG A
0.698	82	Dirt roads, HSG B
0.373	76	Gravel roads, HSG A
0.025	85	Gravel roads, HSG B
2.891	30	Woods, Good, HSG A
0.106	98	Roofs, HSG A
2.866	98	Water Surface, HSG A
15.953	72	Weighted Average
12.981		81.37% Pervious Area
2.972		18.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Subcatchment PDA-3:

Runoff = 373.17 cfs @ 12.09 hrs, Volume= 27.992 af, Depth> 6.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr Plymouth-100yr Rainfall=8.65"

Area (ac)	CN	Description
0.532	68	<50% Grass cover, Poor, HSG A
16.125	79	<50% Grass cover, Poor, HSG B
4.854	72	Dirt roads, HSG A
2.371	82	Dirt roads, HSG B
3.602	30	Woods, Good, HSG A
0.194	55	Woods, Good, HSG B
23.254	98	Water Surface, HSG A
50.932	83	Weighted Average
27.678		54.34% Pervious Area
23.254		45.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Minimum**

Summary for Reach DP-1:

Inflow Area = 47.930 ac, 1.41% Impervious, Inflow Depth > 5.63" for Plymouth-100yr event
Inflow = 307.72 cfs @ 12.09 hrs, Volume= 22.476 af
Outflow = 307.72 cfs @ 12.09 hrs, Volume= 22.476 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-2:

Inflow Area = 15.953 ac, 18.63% Impervious, Inflow Depth > 5.26" for Plymouth-100yr event
Inflow = 96.33 cfs @ 12.09 hrs, Volume= 6.999 af
Outflow = 96.33 cfs @ 12.09 hrs, Volume= 6.999 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Reach DP-3:

Inflow Area = 50.932 ac, 45.66% Impervious, Inflow Depth > 6.60" for Plymouth-100yr event
Inflow = 373.17 cfs @ 12.09 hrs, Volume= 27.992 af
Outflow = 373.17 cfs @ 12.09 hrs, Volume= 27.992 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Attachment 4
Hydraulic Calculations

HYDRAULIC CALCULATIONS

OBJECTIVE

To size pipes to adequately convey flows from the proposed project and to meet the design standards of the Massachusetts DEP Stormwater Handbook for inlet capacity, pipe flow, and scour.

CONCLUSION

- The proposed pipes will adequately convey the 50-year storm event runoff rates.
- The proposed stormwater management design has been reviewed for compliance with the stormwater management standards described in the Massachusetts DEP Stormwater Management Handbook.

CALCULATION METHODS

- The pipes are designed using the Rational Formula, based on a 50-year storm event for the Town of Barnstable (see attached IDF curve).

ASSUMPTIONS

- Runoff coefficient C=0.3 for pervious areas and C=0.9 for impervious areas.
- Manning's n=0.012 for DI pipe.
- The times of concentration (T_C) for contributing subcatchments are approximately 6 minutes for flows to CB-1, CB-2, CB-3, and CB-4.
- The minimum full-flow (scour) velocity is 2 feet per second.
- The maximum full-flow (scour) velocity is 10 feet per second.

SOURCES OF DATA/ EQUATIONS

1. Rational Method (Q=CiA) was used to calculate peak runoff rates tributary to CB-1, CB-2, CB-3, and CB-4.
2. Manning's Equation was used to determine pipe capacities.
3. 50-year storm intensity obtained from the Intensity/Duration rainfall curve for Barnstable, MA in S.C.S Technical Report No. 40.
4. Massachusetts DEP Stormwater Management Handbook, February 2008.

REV	CALC. BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE
0	RFK	11/11/2021	KJP	11/12/2021	MC	11/17/2021

RFK/kjp/mc/189716CS003A

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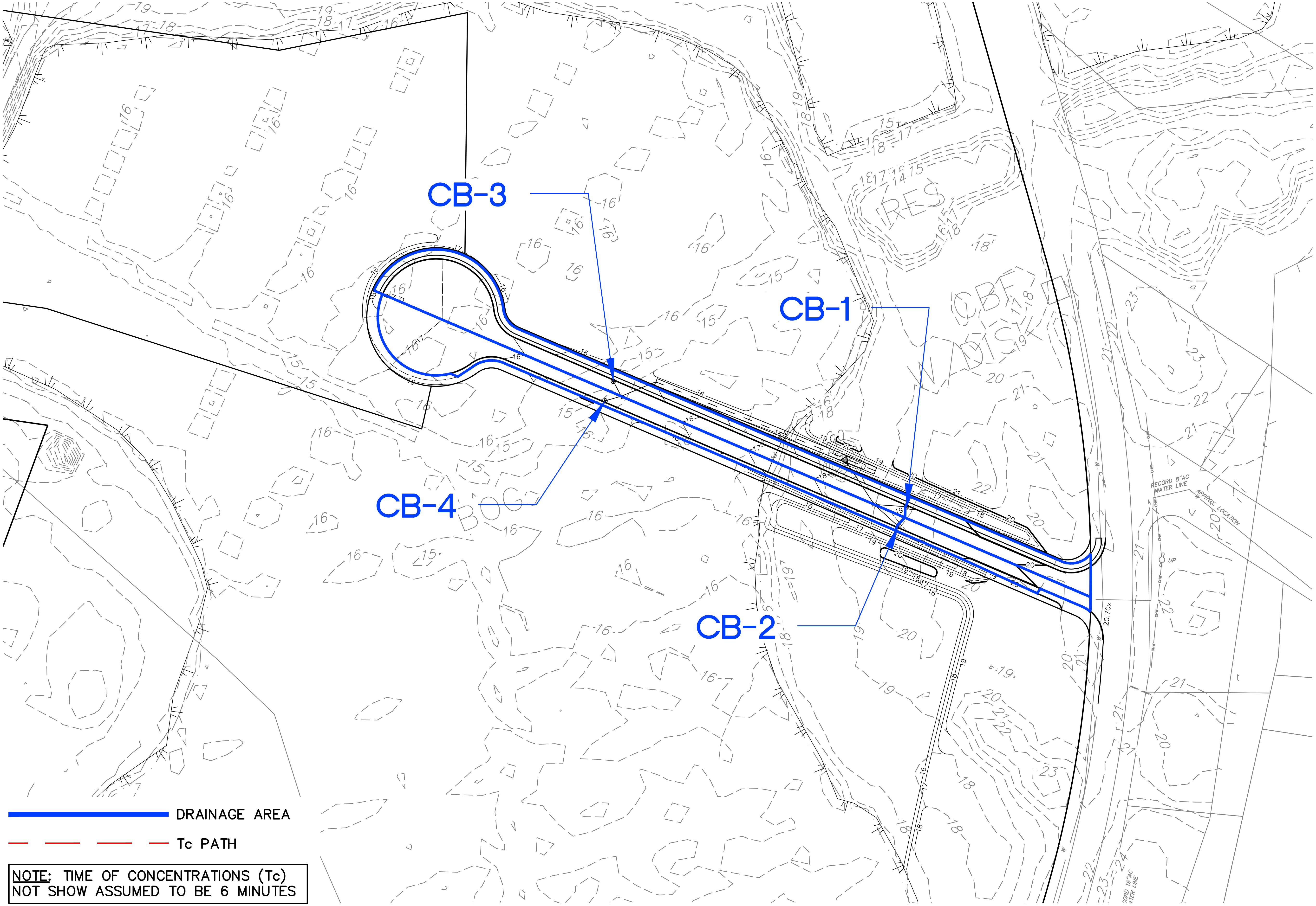


Hydraulic Areas Map
Figure Number 003

Scale: 1"=80'
Date: 11/11/2021
Plan No. 189716P068A-003
B+T Project No. 1897.16

Definitive Subdivision Plan of Maple Springs Road
Wareham, Massachusetts

A.D. Makepeace Company
158 Tihonet Road
Wareham, Massachusetts

North Arrow

BEALS+THOMAS

DA- CB-1

	AREA	C
PAVED	0.065	0.9
GRASSED	0.012	0.3

Tc=	6	MIN
TOTAL AREA=	0.077	ACRES
WEIGHTED C=	0.81	

DA- CB-2

	AREA	C
PAVED	0.043	0.9
GRASSED	0.011	0.3

Tc=	6	MIN
TOTAL AREA=	0.054	ACRES
WEIGHTED C=	0.78	

DA- CB-3

	AREA	C
PAVED	0.249	0.9
GRASSED	0.037	0.3

Tc=	6	MIN
TOTAL AREA=	0.286	ACRES
WEIGHTED C=	0.82	

DA- CB-4

	AREA	C
PAVED	0.187	0.9
GRASSED	0.029	0.3

Tc=	6	MIN
TOTAL AREA=	0.216	ACRES
WEIGHTED C=	0.82	

DA- WQS-1

	AREA	C
PAVED	0.108	0.9
GRASSED	0.023	0.3

Tc=	6	MIN
TOTAL AREA=	0.131	ACRES
WEIGHTED C=	0.79	

DA- WQS-2

	AREA	C
PAVED	0.436	0.9
GRASSED	0.066	0.3

Tc=	6	MIN
TOTAL AREA=	0.502	ACRES
WEIGHTED C=	0.82	

JOB NO.	1897.16	COMPUTED BY	RFK	CHECKED BY	KJP
FILE	Maple Springs Road	DATE	11/11/2021	DATE	11/12/2021

BEALS + THOMAS

Hydraulic Drainage Areas & Corresponding Rational Method Flows

Using the Rational Method:

$$Q = CiA$$

Where:

Q = flow (cfs)

C = Runoff Coefficient

i = Rainfall Intensity, 50-year storm (in/hr) (from Barnstable, MA IDF curve, see attachec

A = Contributing Area (acres)

Assumptions: - Coefficient of runoff for Gravel Surfaces = 0.9

- Coefficient of runoff for Pervious Surfaces = 0.3

Inlet	Contributing Area (Acres)	Weighted Average Rational Coefficients	Rainfall Intensity for Barnstable (in/hr)	Contributing Flow (cfs)
CB-1	0.077	0.81	6.60	0.41
CB-2	0.054	0.78	6.60	0.28
CB-3	0.286	0.82	6.60	1.55
CB-4	0.216	0.82	6.60	1.17
WQS-1	0.131	0.79	6.60	0.69
WQS-2	0.502	0.82	6.60	2.72

JOB NO. 1897.16 COMPUTED BY RFK CHECKED BY KJP

FILE Maple Springs Road DATE 11/11/2021 DATE 11/12/2021

BEALS + THOMAS

Hydraulic Pipe Sizing Calculations

Using the Manning Equation to Verify Pipe Capacities Versus Pipe Flows:

$$Q = \frac{1.49}{n} A\, R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Where:

Q = flow (cfs)
n = Manning's roughness coefficient
A = Cross Sectional Area (sf)
R = Hydraulic Radius (ft)
S = Pipe Slope

Assumptions: n = 0.012 for DI pipe
Pipe velocity shall be between 2.0 ft/sec and 10 ft/sec

Pipe Connection	Contributing Flow-50 Year Storm(cfs)	Proposed Pipe Size and Material	Proposed Pipe Slope (rise/run)	Full-Flow Capacity of Pipe from Manning Equation (cfs)	Adequate	Full Flow Velocity (ft/sec)
CB-1 to WQS-1	0.41	12" DI	0.005	2.74	OK	3.5
CB-2 to WQS-1	0.28	12" DI	0.005	2.74	OK	3.5
CB-3 to WQS-2	1.55	12" DI	0.005	2.74	OK	3.5
CB-4 to WQS-2	1.17	12" DI	0.005	2.74	OK	3.5
WQS-1 to FE-1	0.69	12" DI	0.005	2.74	OK	3.5
WQS-2 to LS	2.72	12" DI	0.005	2.74	OK	3.5

Note: LS = Level Spreader

JOB NO. 1897.16 COMPUTED BY RFK CHECKED BY KJP

FILE Maple Springs Road DATE 11/11/2021 DATE 11/12/2021

BEALS + THOMAS

Catchbasin Grate Sizing

CB #	50-YEAR STORM DESIGN FLOW (CFS)	HEAD (ft) Lebaron LF248-2 (Single grate)	HEAD (ft) Lebaron LV2448-2 (Double grate)	RECOMMENDED GRATE
		A= 1.5625 SF	A= 3.125 SF	
CB-1	0.41	0.002969883	0.0007425	Single
CB-2	0.28	0.001385121	0.0003463	Single
CB-3	1.55	0.042445825	0.0106115	Single
CB-4	1.17	0.024184845	0.0060462	Single

Note: Capacity based on Orifice Flow (ponded condition).

JOB NO. 1897.16 COMPUTED BY: RFK CHECKED BY: KJP

FILE: Maple Springs Road DATE: 11/11/21 DATE: 11/12/2021

Storm Data Detailed Report: Barnstable Rainfall

Element Details

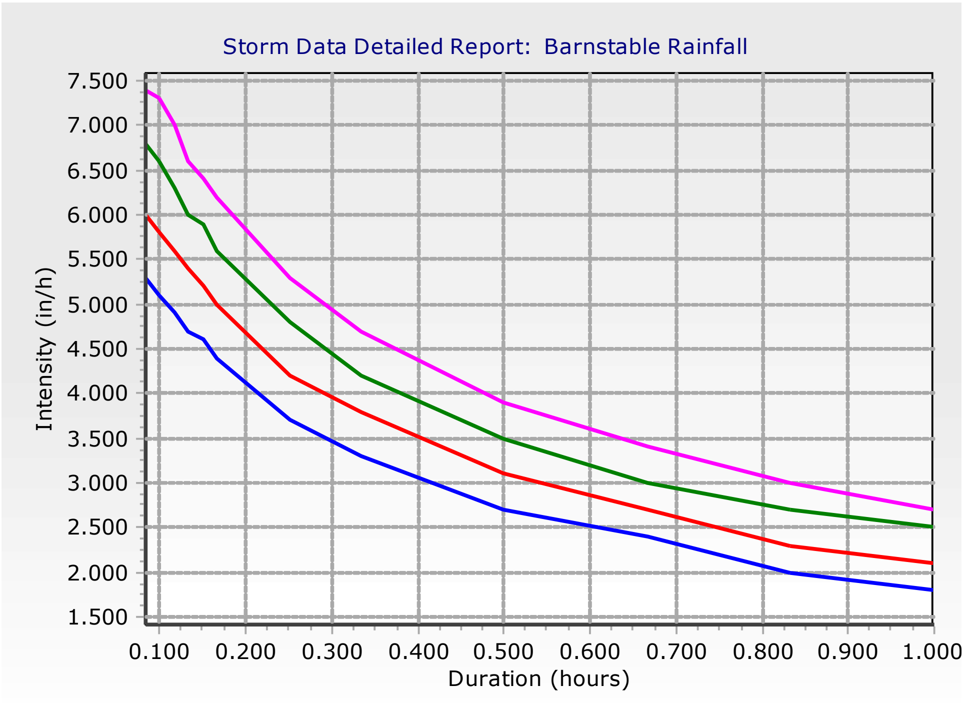
ID	30	Notes	
Label	Barnstable Rainfall		

Duration (hours)	10 Year (in/h)	25 Year (in/h)	50 Year (in/h)	100 Year (in/h)
0.083	5.300	6.000	6.800	7.400
0.100	5.100	5.800	6.600	7.300
0.117	4.900	5.600	6.300	7.000
0.133	4.700	5.400	6.000	6.600
0.150	4.600	5.200	5.900	6.400
0.167	4.400	5.000	5.600	6.200
0.250	3.700	4.200	4.800	5.300
0.333	3.300	3.800	4.200	4.700
0.500	2.700	3.100	3.500	3.900
0.667	2.400	2.700	3.000	3.400
0.833	2.000	2.300	2.700	3.000
1.000	1.800	2.100	2.500	2.700

Library Status Summary

	Synchronization Details
ID	30
Label	Barnstable Rainfall
Modified Date	6/25/2019 9:03:03 AM
Library Source	G:\Corp-Data\Qags\StormCAD\8 XM\Rainfall .xml
Library Modified Date	10/16/2008 3:19:18 PM
Synchronization Status	Synchronize to Library
Engineering Reference Guid	686ed606-a18a-4e03-9cab-f4a1ec6f02ac

Storm Data Detailed Report: Barnstable Rainfall



Attachment 5
Groundwater Recharge, Drawdown, Proprietary Water Quality Inlet Sizing, TSS Removal, and Riprap Apron Sizing.

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Standard 3: Groundwater Recharge

Groundwater Recharge Volume Required:

Rv = F x Impervious Area, where:

Rv = Required Recharge Volume [Ac-ft]

F = Target Depth Factor associated with each Hydrologic Soil Group (HSG) [in]

Impervious Area = Total Pavement and Rooftop Area under Post-development Conditions [Ac]

			Increased Impervious Area [Acres]	Required Recharge Volume [Ac-ft]	
HSG "A", use F =	0.6	in	0.527	0.026	
HSG "B", use F =	0.35	in	0.018	0.001	
HSG "C", use F =	0.25	in	0.000	0.000	
HSG "D", use F =	0.1	in	0.000	0.000	
Total Required Recharge Volume (Rv) =				**0.027**	**Ac-ft**

Capture Area Adjustment: (Ref: DEP Handbook V.3 Ch.1 P.27-28)

Total Increased Site Impervious Area (Total)=	0.545	Acres
Impervious Area Draining to Infiltrative BMPs (infil) =	0.436	Acres
Capture Area Adjustment Factor = (Total)/(Infil) = Ca =	1.25	
Adjusted Required Recharge Volume = Ca x Rv	**0.034**	**Ac-ft**

Groundwater Recharge Volume Provided :

BMP	Provided Recharge Volume [Ac-ft]	
Level Spreader	0.034	
Total Provided Recharge Volume =	**0.034**	**Ac-ft**

PROVIDED GROUNDWATER RECHARGE VOLUME IS GREATER THAN OR EQUAL TO THE REQUIRED RECHARGE VOLUME, THEREFORE PROPOSED STORMWATER MANAGEMENT DESIGN IS IN COMPLIANCE WITH STANDARD 3.

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B E A L S + T H O M A S

Standard 3: Drawdown

$$\text{Drawdown Time} = \frac{Rv}{(K)\,(\text{Bottom Area})}$$

where:

Rv = Total Provided Recharge Volume [Ac-ft]

K= Infiltration Rate [in/hr]

Bottom Area= Bottom Area of Recharge System [Ac]

Level Spreader

Rv =	0.034	Ac-ft	
K =	2.410	in/hr	
Bottom Area =	0.011	Acres	
Drawdown Time =	**14.995**	**Hours**	*< 72 Hours, Design is in compliance with the standard.*

Note:

1. The infiltration BMPs have been designed to fully drain within 72 hours, therefore the proposed stormwater management design is in compliance with Standard 3 .

2. Infiltration Rate based on Volume 3, Chapter 1, Table 2.3.3 *Rawls Rates* from the 2008 MA DEP Stormwater Management Handbook.

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JOB:	Maple Springs Road	DATE:	11/11/21	DATE:	11/12/2021

B E A L S + T H O M A S

Proprietary Water Quality Inlet Sizing

Step 1: Define Minimum Flow Rate per Water Quality Inlet to Treat Desired Water Quality Volume

Water quality inlets are sized based on flow rate; therefore expressing Water Quality Volume as a flow rate based on the percentage of cumulative average volume captured ensures systems are sized to achieve the desired Water Quality treatment level.

$Q = (q_u)(A)(WQV)$ where:

Q = peak flow rate associated with first 1.0-inch of runoff [CFS]

q_u = The Peak Discharge [CFS/mi^2/in] Massachusetts DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Practices

A = Contributing Drainage Area, Impervious Surface Only [Ac]

WQV = The Water Quality Treatment Depth [In]

WQI No.	A (Ac)	Tc (Min)	WQV (in)	q_u (csm/in)	Q (cfs)
WQS-1	0.109	6.0	1.0	774	0.13
WQS-2	0.436	6.0	1.0	774	0.53
Total	0.55	Acres			

Step 2: Size Water Quality Inlet as recommended by Manufacturer

See attached Sizing Report(s) for recommended model(s).

Step 3: Water Quality Volume Provided by WQI unit(s)

Total Impervious Area Treated by WQI unit(s): 0.55 Acres

23,740 SF

Treated Water Quality Depth : 1.0 inches

(accounted for by Average Water Quality Flow Rate)

Total Water Quality Volume provided by Water Quality Inlets 1,978 CF

JOB NO. 1897.16 COMPUTED BY: RFK CHECKED BY: PAT

JOB: Maple Springs Road DATE: 11/12/21 DATE: 11/12/2021

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

MAPLE SPRINGS ROAD SUBDIVISION
WAREHAM, MA

Area	**0.11 ac**	Unit Site Designation	**WQS-1**
Weighted C	**0.9**	Rainfall Station #	**66**
t_c	**6 min**		
CDS Model	**1515-3**	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.08	35.3%	35.3%	0.01	0.01	34.1
0.16	23.8%	59.1%	0.02	0.02	22.9
0.24	12.9%	72.0%	0.02	0.02	12.3
0.32	7.8%	79.8%	0.03	0.03	7.4
0.40	4.9%	84.7%	0.04	0.04	4.6
0.48	3.5%	88.3%	0.05	0.05	3.3
0.56	1.7%	90.0%	0.05	0.05	1.6
0.64	1.8%	91.8%	0.06	0.06	1.7
0.72	1.9%	93.7%	0.07	0.07	1.7
0.80	0.9%	94.6%	0.08	0.08	0.8
1.00	2.3%	96.9%	0.10	0.10	2.1
2.00	2.9%	99.8%	0.20	0.20	2.4
3.00	0.2%	100.0%	0.29	0.29	0.2
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					95.3

Removal Efficiency Adjustment[2] =	0.0%
Predicted % Annual Rainfall Treated =	100.0%
Predicted Net Annual Load Removal Efficiency =	**95.3%**

1 - Based on 14 years of 15 minute precipitation data from NCDC station 3821, Hyannis, in Barnstable County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

MAPLE SPRINGS ROAD SUBDIVISION
WAREHAM, MA

Area	0.44 ac	Unit Site Designation	WQS-2
Weighted C	0.9	Rainfall Station #	66
t_c	6 min		
CDS Model	1515-3	CDS Treatment Capacity	1.0 cfs

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.08	35.3%	35.3%	0.03	0.03	33.6
0.16	23.8%	59.1%	0.06	0.06	22.1
0.24	12.9%	72.0%	0.09	0.09	11.7
0.32	7.8%	79.8%	0.13	0.13	6.9
0.40	4.9%	84.7%	0.16	0.16	4.2
0.48	3.5%	88.3%	0.19	0.19	3.0
0.56	1.7%	90.0%	0.22	0.22	1.4
0.64	1.8%	91.8%	0.25	0.25	1.5
0.72	1.9%	93.7%	0.28	0.28	1.5
0.80	0.9%	94.6%	0.31	0.31	0.7
1.00	2.3%	96.9%	0.39	0.39	1.6
2.00	2.9%	99.8%	0.78	0.78	1.3
3.00	0.2%	100.0%	1.18	1.00	0.1
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					89.5
				Removal Efficiency Adjustment[2] =	0.0%
				Predicted % Annual Rainfall Treated =	100.0%
				Predicted Net Annual Load Removal Efficiency =	**89.5%**

1 - Based on 14 years of 15 minute precipitation data from NCDC station 3821, Hyannis, in Barnstable County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

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Riprap Apron Sizing

Median Stone Sizing:

$$D_{50} = 0.2D_0\left(\frac{Q}{\sqrt{g}D_0^{2.5}}\right)^{\frac{4}{3}}\left(\frac{D_0}{TW}\right)$$

Where:

D_0 = Maximum Inside Pipe Diameter (ft)

D_{50} = Median Riprap Diameter (ft)

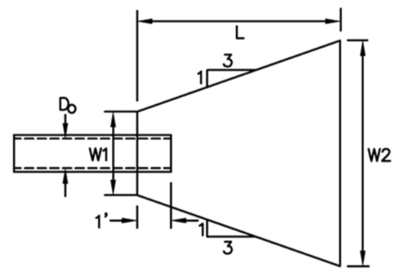
Q = Peak Discharge Rate from Hydraulic Design (cfs)

TW = Tailwater Depth (ft); (Use $0.4D_0$ if TW is unknown, max $1.0D_0$)

g = Gravitational Acceleration Constant = 32.2 ft/s^2

Apron Sizing:

D_{50} [In]	Apron Length (L) [ft}	Apron Depth [In]	Apron Width At Beginning	Apron Width At End
5	$4D_0$	$3.5D_{50}$	$3D_0$	$3D_0 + ⅔L$
6	$4D_0$	$3.3D_{50}$	$3D_0$	$3D_0 + ⅔L$
10	$5D_0$	$2.4D_{50}$	$3D_0$	$3D_0 + ⅔L$
14	$6D_0$	$2.2D_{50}$	$3D_0$	$3D_0 + ⅔L$
20	$7D_0$	$2.0D_{50}$	$3D_0$	$3D_0 + ⅔L$
22	$8D_0$	$2.0D_{50}$	$3D_0$	$3D_0 + ⅔L$



FLARED END SECTION	PIPE DIAMETER (D_0) (FEET)	50-YEAR STORM FLOW (Q) (CFS)	TAILWATER (TW) [ft]	MEDIAN STONE DIAMETER (D_{50}) (INCHES)	APRON LENGTH (L) (FEET)	APRON DEPTH [In]	APRON WIDTH AT BEGINING (W_1) [ft]	APRON WIDTH AT END (W_2) [ft]
FE-01	1.0	0.69	0.4	5	4.00	17.5	3.0	5.7

Notes

[1] Calculations performed in accordance with Hydraulic Engineering Circular No. 14, Third Edition; Hydraulic Design of Energy Dissipaters for Culverts and Channels, dated July 2006.

[2] Pipe shall extend 1 foot into riprap.

[3] For maximum pipe size of 60".

[4] FE-01 flow calculated using the Rational Method for the 50-year storm.

JOB NO. 1897.16 COMPUTED BY: RFK CHECKED BY: PAT

JOB: Maple Springs Road DATE: 11/11/21 DATE: 11/12/2021

Attachment 6
Site Owner's Manual

Site Owner's Manual

Definitive Subdivision Plan of Maple Springs Road

0 Maple Springs Road,
0 Plymouth Road, and
99C Charge Pond Road
Wareham, Massachusetts

Prepared for:
A.D. Makepeace Company
158 Tihonet Road
Wareham, MA 02571

Prepared by:

BEALS + THOMAS

November 19, 2021

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FIGURES

APPENDICES

1.0 INTRODUCTION

The Site Owner’s Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (DEP) Stormwater Handbook. The Manual outlines source control and pollution prevention measures and maintenance requirements of stormwater best management practices (BMPs) associated with the proposed development.

2.0 SITE OWNER'S AGREEMENT

2.1 Operation and Maintenance Compliance Statement

Site Owner: A.D. Makepeace Company
158 Tihonet Road
Wareham, MA 02571

Responsible Party: A.D. Makepeace Company

A.D. Makepeace Company or their successors shall maintain ownership of the on-site stormwater management system as well as the responsibility for operation and maintenance during the post-development stages of the project. The site has been inspected for erosion and appropriate measures have been taken to permanently stabilize any eroded areas. All aspects of stormwater best management practices (BMPs) have been inspected for damage, wear and malfunction, and appropriate steps have been taken to repair or replace the system or portions of the system so that the stormwater at the site may be managed in accordance with the Stormwater Management Standards. Future responsible parties shall be notified of their continuing legal responsibility to operate and maintain the BMPs. The operation and maintenance plan for the stormwater BMPs is being implemented.

______________________________ ____________
Responsible Party Signature Date

2.2 Stormwater Maintenance Easements

There are no off-site areas utilized for stormwater control, therefore no stormwater management easements are required. The Site Owner will have access to all stormwater practices for inspection and maintenance, including direct maintenance access by heavy equipment to structures requiring regular maintenance.

2.3 Record Keeping

The Site Owner shall maintain a rolling log in which all inspections and maintenance activities for the past three years shall be recorded. The Operation and Maintenance Log includes information pertaining to inspections, repairs, and disposal relevant to the project's stormwater management system. The Log is located in Appendix A.

The Operation and Maintenance Log shall be made available to the Conservation Commission and the DEP upon request. The Conservation Commission and the DEP shall be allowed to enter and inspect the premises to evaluate and ensure that the responsible party complies with the maintenance requirements for each BMP.

2.4 Training

Employees involved in grounds maintenance and emergency response will be educated on the general concepts of stormwater management and groundwater protection. The Site Owner's Manual will be reviewed with the maintenance staff. The staff will be trained on the proper course of action for specific events expected to be incurred during routine maintenance or emergency situations.

3.0 LONG-TERM POLLUTION PREVENTION PLAN

In compliance with Standard 4 of the 2008 DEP Stormwater Management Handbook, this section outlines source control and pollution prevention measures to be employed on-site after construction.

3.1 Storage of Materials and Waste

The site shall be kept clear of trash and debris at all times. Certain materials and waste products shall be stored inside or outside upon an impervious surface and covered, as required by local and state regulations.

3.2 Vehicle Washing

No commercial vehicle washing shall take place on site.

3.3 Routine Inspections and Maintenance of Stormwater BMPs

See Section 4.0 Long-Term Operation and Maintenance Plan, for routine inspection and maintenance requirements for all proposed stormwater BMPs.

3.4 Spill Prevention and Response

A contingency plan shall be implemented to address the spill or release of petroleum products and hazardous materials and will include the following measures:

1. Equipment necessary to quickly attend to inadvertent spills or leaks shall be stored on-site in a secure but accessible location. Such equipment shall include but not be limited to the following: safety goggles, chemically resistant gloves and overshoe boots, water and chemical fire extinguishers, sand and shovels, suitable absorbent materials, storage containers and first aid equipment (i.e. Indian Valley Industries, Inc. 55-gallon Spill Containment kit or approved equivalent).

2. Spills or leaks shall be treated properly according to material type, volume of spillage and location of spill. Mitigation shall include preventing further spillage, containing the spilled material in the smallest practical area, removing spilled material in a safe and environmentally-friendly manner, and remediation of any damage to the environment.

3. For large spills, Massachusetts DEP Hazardous Waste Incident Response Group shall be notified immediately at 888-304-1133 and an emergency response contractor shall be consulted.

3.5 Maintenance of Lawns, Gardens, and other Landscaped Areas

Lawns, gardens, and other landscaped areas shall be maintained regularly by the site owner. Vegetated and landscaped BMPs will be maintained as outlined in Section 4.0.

3.6 Storage and Use of Fertilizers, Herbicides, and Pesticides

All fertilizers, herbicides, and pesticides shall be stored in accordance with local, state, and federal regulations. The application rate and use of fertilizers, herbicides, and pesticides on the site shall at no time exceed local, state, or federal specifications.

3.7 Pet Waste Management

Pet owners shall be required to pick up after their animals and dispose of waste in the trash.

3.8 Snow and Deicing Chemical Management

Snow removal and use of deicing chemicals at the proposed development shall comply with the following requirements:

- Plowed snow shall be placed in the areas outside of wetland boundaries and stormwater best management practices. The following maintenance measures shall be undertaken at all snow disposal sites:
    - Debris shall be cleared from an area prior to using it for snow disposal.
    - Debris and accumulated sediments shall be cleared from the site and properly disposed of at the end of the snow season and no later than May 15.
- In accordance with the Massachusetts General Laws, Chapter 85, Section 7A, salt and other de-icing chemicals will be stored at an indoor location. Salt and other deicing chemicals shall be stored in accordance with Massachusetts General Law.
- Sand piles shall be contained and stabilized to prevent the discharge of sand to wetlands or water bodies, and, where feasible, covered.
- Salt storage piles shall be located outside of the 100-year floodplain.
- The application of salt on the proposed roadway shall at no time exceed state or local requirements.
- The use of deicing materials and sand shall not be used at the proposed project site to protect off-site areas.

4.0 LONG-TERM OPERATION AND MAINTENANCE PLAN

This section outlines the stormwater best management practices (BMPs) associated with the proposed stormwater management system and identifies the long-term inspection and maintenance requirements for each BMP.

4.1 Stormwater Management System Components

The following table outlines the type and quantity of the BMPs and their general location. All basins are accessible for maintenance from the development driveway.

BMP Type	Quantity	Location
Catch Basins	4	Throughout Cranberry Bog Drive.
Proprietary Separator/Water Quality Structure	2	Throughout Cranberry Bog Drive.
Level Spreader	1	Off of Cranberry Bog Drive.
Stormwater Outfall	1	Off of Cranberry Bog Drive.

4.2 Inspection and Maintenance Schedules

4.2.1 General Maintenance for Mosquito Control

If necessary to minimize mosquito breeding, a licensed pesticide applicator shall apply larvicides, such as Bacillus sphaericus (Bs) to all catch basins sumps, and water quality inlets. Larvicides shall be applied in compliance with all pesticide label requirements, and will be applied during or immediately after wet weather, unless the product used can withstand extended dry periods. Ensure all manhole covers, and inspection ports are secure to reduce the likelihood of mosquitoes laying eggs in standing water.

4.2.2 Deep Sump and Hooded Catch Basins

Catch basins shall be inspected four times per year, including after the foliage season. Other inspection and maintenance requirements include:

- Units shall be cleaned (organic material, sediment and hydrocarbons removed) four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.
    - Cleanout shall always occur after street sweeping.

- If any evidence of hydrocarbons is found during inspection, the material shall be immediately removed using absorbent pads or other suitable measures and disposed of legally.
- Remove other accumulated debris as necessary.
- Transport and disposal of accumulated sediment off-site shall be in accordance with applicable local, state and federal guidelines and regulations.

4.2.3 Proprietary Separators

Maintenance of proprietary separators shall be performed according the recommendations set forth by the manufacturer (see Appendix C. Proprietary Separator Technical Manual for complete installation, operation and maintenance procedures). Inspection and maintenance procedures for proprietary devices are provided below:

- Units shall be inspected post-construction, prior to being put into service.
- Units shall be inspected not less than twice per year following installation and no less than once per year thereafter.
- Units shall be inspected immediately after any oil, fuel or chemical spill.
- All inspections shall include checking the oil level and sediment depth in the unit.
- Removal of sediments/oils shall occur per manufacturer recommendations.
- A licensed waste management company shall remove captured petroleum waste products from any oil, chemical or fuel spills and dispose.
- OSHA confined space entry protocols shall be followed if entry into the unit is required.

4.2.4 Level Spreader

Inspections and preventative maintenance shall be performed at the level spreader after major storm events (rainfall totals greater than 2.5 inches in 24 hours) during the first three months of operation and twice a year thereafter. Additionally, all pretreatment BMPs shall be inspected in accordance with the minimal requirements specified for those practices and after major storm events. Inspections and maintenance activities shall include the following measures:

- Inlet and outlet pipes shall be inspected every 6 months and after major storm events for evidence of clogging.
- Accumulated sediment, trash, debris, leaves, and clippings from mowing shall be removed every 6 months and after major storm events.
- Tree seedlings shall be removed before they become firmly established.
- The level spreader shall be inspected 24 hours or several days after a rain event to look for ponded water. If there is ponded water at the surface of the level spreader, the following measures shall be employed to address surficial clogging:
    - Remove and replace topsoil or first layer of stone aggregate and the filter fabric.
- If there is ponded water inside the level spreader, the following measures shall be employed to address failure:
    - All accumulated sediments must be stripped from the bottom of the level spreader.
    - The bottom of the level spreader must be scarified and tilled to induce infiltration, and all of the stone aggregate and filter fabric or media shall be removed and replaced.

4.2.5 Stormwater Outfalls

Flared end sections and associated riprap spillways shall be inspected at least once per year and after major storm events (rainfall totals greater than 2.5 inches in 24 hours) to ensure that the stability of the outlet area is maintained. The outfall area shall be kept clear of debris such as trash, branches, and sediment. Repairs shall be made immediately if riprap displacement or downstream channel scour is observed.

4.3 Estimated Operation and Maintenance Budget

An operations and maintenance budget was prepared to approximate the annual cost of the inspections required in compliance with the DEP Stormwater Management Policy. The table below estimates the annual cost to inspect and maintain each proposed BMP, based on the requirements in Section 4.2.

BMP Type	# of BMPS	Annual O&M Cost (per BMP)[1]	Total Cost
Mosquito Control	6	$50-$100	$300-$600
Catch Basin	4	$200-$400	$800-$1600
Proprietary Separator	2	$100-$300	$200-$600
Level Spreader	1	$200-$400	$200-$400
Riprap Spillway	1	$50-$100	$50-$100
Flared End Pipe Outfall	1	$50-$100	$50-$100
		Total	**$1600-$3400**

4.4 Public Safety Features

Multiple safety measures are proposed to protect the public and prevent pollutant contamination of the stormwater management system and other water resources. Proposed curbing, sidewalk, and tree plantings along the access driveway will prevent cars from inadvertently detouring down steep side slopes and into adjacent wetlands or stormwater controls. The Site was designed to ensure protection to the public and prevent pollutant contamination of the stormwater management system.

[1] Annual maintenance cost is based on estimate of the cost to complete all inspection and maintenance measures outlined in Section 4.2. For BMPs that require sediment removal at regular intervals (i.e. every 5 or 10 years), the annual cost includes the annual percentage of that cost.

Figures

Refer to the Approved Definitive Subdivision Plans

Appendices

Appendix A

Operation and Maintenance Log

OPERATION AND MAINTENANCE LOG

This template is intended to comply with the operation and maintenance log requirements of the 2008 DEP Stormwater Management Handbook. Copies of this log should be made for all inspections and kept on file for three years from the inspection date.

Name/Company of Inspector:
Date/Time of Inspection:
Weather Conditions: (Note current weather and any recent precipitation events)

Stormwater BMP	Inspection Observations	Actions Required

Appendix B

List of Emergency Contacts

List of Emergency Contacts:

Massachusetts DEP Hazardous Waste Incident Response Group
Tel: (617) 792-7653

Wareham Fire Department
Emergencies: Dial 911
273 Main Street
Wareham, MA 02571
Tel: (508) 295-2973
Fire Chief: Matt Rowley

Wareham Police Department
Emergencies: Dial 911
2515 Cranberry Hwy
Wareham, MA 02571
Tel: (508) 295-1212
Fax: (508) 291-1001
Chief of Police: Walter Correia

Appendix C

Proprietary Separator Technical Manual

CONTECH
ENGINEERED SOLUTIONS

CDS Guide
Operation, Design, Performance and Maintenance

CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

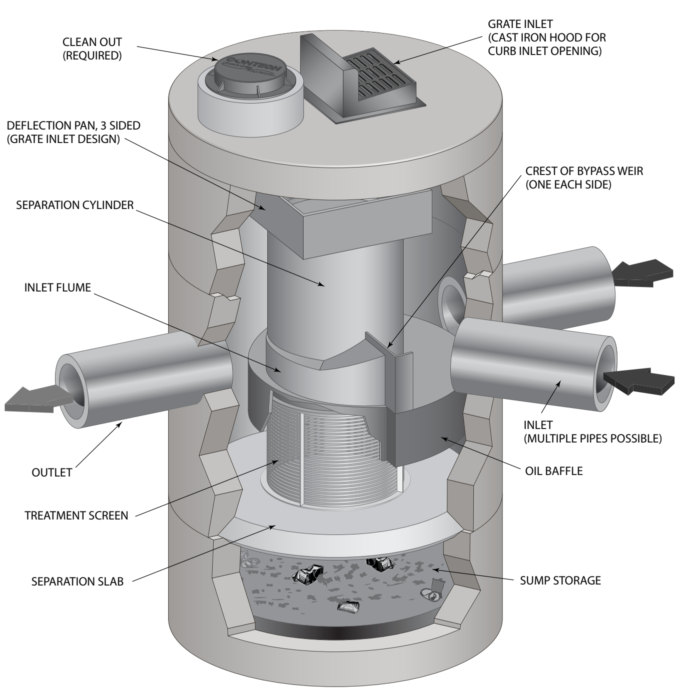
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

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Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

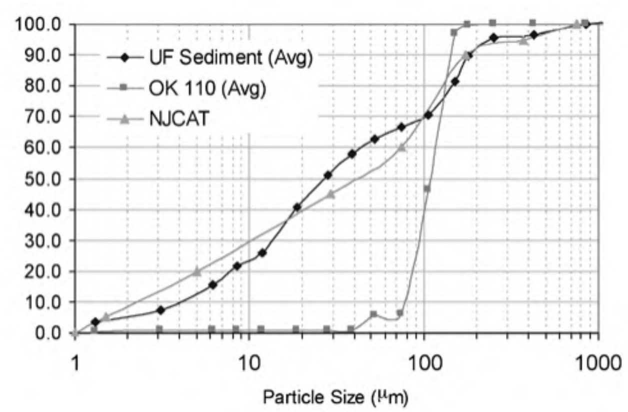


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

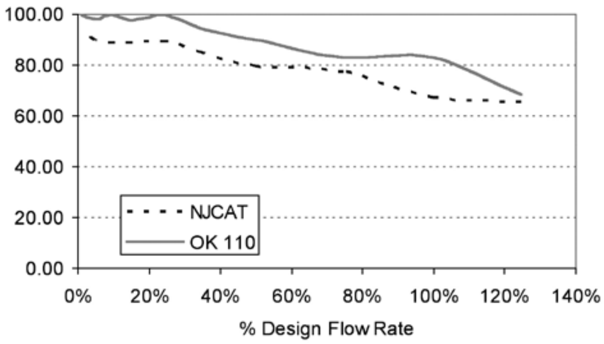


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μm).

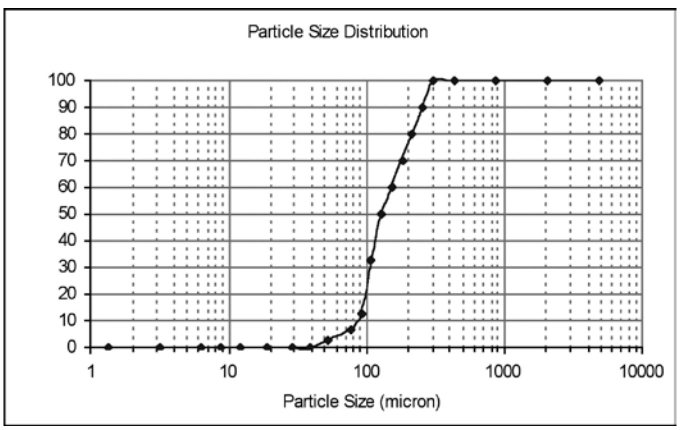


Figure 3. WASDOE PSD

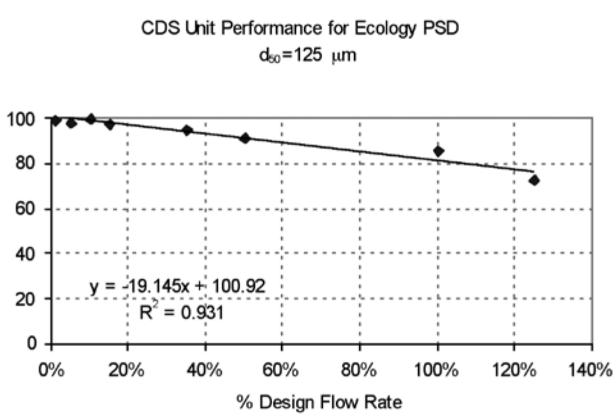


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified

during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

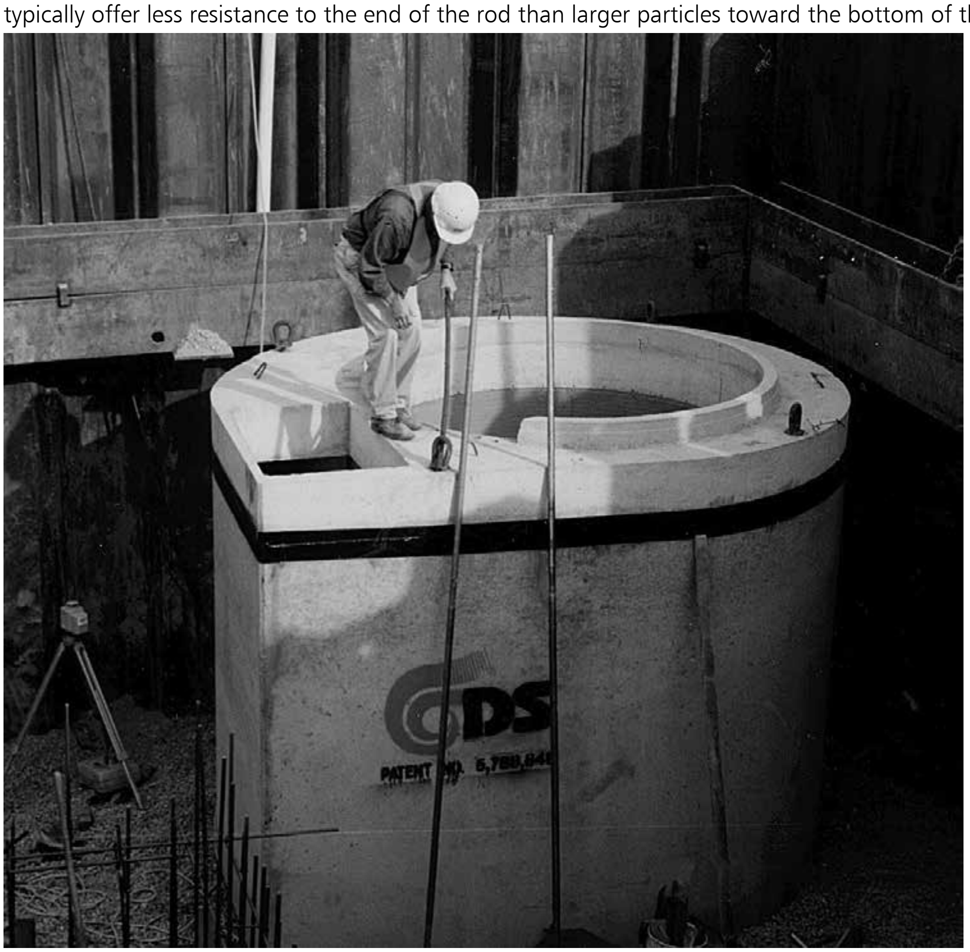
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y³	m³
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



CDS Inspection & Maintenance Log

CDS Model: ______________________ Location: ______________________

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile**.

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.

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