STORMWATER MANAGEMENT REPORT
SITE PLAN MODIFICATION

CENTRAL MA CRANE SERVICE, INC.
112 HUNTOON MEMORIAL HIGHWAY
ROCHDALE, MA 01542

Prepared for:
Central MA Crane Service, Inc.
112 Huntoon Memorial Highway
Rochdale, MA 01542

August 25, 2021

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Section I - Introduction

A. Scope of Analysis

This 2021 Stormwater Management Report provides the required analysis for the proposed gravel parking lot expansion and associated site work at Central MA Crane Service, Inc. located at 112 Huntoon Memorial Highway, Rochdale, MA (Site). This report also documents compliance with the Town of Leicester Planning Board Zoning Bylaws requirements for Site Plan Review, and the Massachusetts 310 CMR 10.00 Wetland Protection Regulations as promulgated by the Commissioner of the Massachusetts Department of Environmental Protection (MassDEP) pursuant to the authority granted under the Wetland Protection Act, M.G.L. c. 131 § 40 (WPA). The analysis includes pre- and post- conditions hydrologic modeling, and hydraulic sizing of the conveyance systems, sizing and analysis of Stormwater Best Management Practices (BMPs) of structural or non-structural techniques for managing stormwater to prevent or reduce non-point source pollutants from entering surface waters or ground waters. This report will demonstrate that the stormwater management system as designed and laid out for the site expansion at Central MA Crane Service, Inc. located at 112 Huntoon Memorial Highway, Rochdale, MA, complies with the referenced regulations.

A Stormwater Checklist is included as **Appendix A**.

B. Site Description

112 Huntoon Memorial Highway, Rochdale, MA, known as assessor's parcel numbers 44-A-10, and 46-A-1.2 is home to Central Mass Crane and is comprised of approximately 9.85 acres +/-. The site is currently home to an existing commercial building and associated asphalt parking and gravel storage areas, located at the corner of Stafford Street and Huntoon Memorial Highway (Route 56). The Site is located in the Highway Business-Industrial 2 zoning district. The original site plan was developed and approved in 2014, designed by JH Engineering Group LLC. A stormwater drainage analysis was performed at the time, resulting in a design of a stormwater management system consisting of a catch basin and manhole pipe network, two rain gardens, two water quality Stormceptor™ units, and an underground detention system.

A wetland resource area delineation was performed by EcoTec, Inc. in November 2012. The original site plan included a wetland crossing for the Site's driveway on Huntoon Memorial Highway, as well as an associated wetland replication area.

A Site Locus Map is included as **Appendix B**.

C. Proposed Construction

The Applicant's intent of this proposed site plan modification is to expand the existing gravel parking and storage area on site as detailed on the "Site Plan Modification" plans prepared by McClure Engineering, Inc. The expansion of this parking area requires some modifications to the existing stormwater management system and the two existing rain gardens. Stormwater runoff from the proposed gravel parking expansion area will be conveyed via a bituminous concrete drainage channel to a new proposed Stormceptor™ catch basin. The Stormceptor™ catch basin will discharge treated stormwater to a proposed manhole and then to Rain Garden 2 for further treatment and peak flow attenuation. Both rain gardens will need to be slightly modified by way of grading and adjusting outlets to maintain compliance with peak flow attenuation standards.

See "Site Plan Modification" 112 Huntoon Memorial Highway, Rochdale, MA date 8/20/21, prepared by McClure Engineering, Inc.

Section II - Hydrologic Analysis

A. Purpose

The purpose of this analysis is to determine the peak rate of stormwater runoff discharging from the Site (Analysis Point #1 (On site wetland), #2 (Route 56), #3 (Abutting Parcel 44-A-9 – 108 Huntoon Memorial Highway)) and to analyze the existing stormwater management system, and to design additional measure as needed, to ensure prevention of an increase in rate of runoff due to development of this area, compared to pre-development conditions. MassDEP Stormwater Management Policy, Standard No. 2, requires that post-development peak stormwater discharge rates shall not exceed pre- development levels.

B. Methodology

The pre- and post-development stormwater runoff has been analyzed using HydroCAD 10.00, a stormwater modeling computer program. HydroCAD is a collection of techniques for the generation and routing of hydrographs, including Soil Conservation Service (SCS) Technical Release No. 20 (TR-20) and SCS Technical Release 55 (TR-55), *Urban Hydrology for Small Watersheds.* The analysis routes completely through one node at a time determining each outflow hydrograph before considering the next node.

Drainage areas are modeled as three components, or nodes: subcatchments, reaches and ponds. A subcatchment is a relatively homogeneous area of land, which produces runoff that drains to a single reach or a pond. A reach is generally a uniform stream, pipe, or other concentrated stormwater flows that conveys water from one point to another reach or pond. A pond is defined as a pond, swamp or other impoundment receiving water from one or more sources.

The subcatchments have been modeled using SCS methods. Curve numbers, which are based upon the type of development and soil classifications, coupled with the time of concentration have been used to generate the peak storm flow for each area. The detailed information and results are provided in this report.

C. Selection of Storm Events

The intensity for each storm event was determined from the NOAA Atlas 14, Volume 10, Version 3, Point Precipitation Frequency Estimates for Leicester, MA (see **Appendix C**).

Rainfall frequency and intensity used in this analysis are as follows:

Design Storm Event	**Rainfall Intensity**
2 year	3.18 inches
10 year	4.95 inches
25 year	6.05 inches
100 year	7.76 inches

D. Soils Classification

Site soils classifications were obtained from the following sources:

1.) Advanced soil mapping performed by the U.S. Department of Agriculture's SCS, "Soil Survey of Worcester County, Massachusetts, Southern Part."

(See **Appendix C** for detailed soil information).

The soils descriptions are mapped as follows:

315A – Scituate fine sandy loam, 0 to 3 percent slopes – HSG C, estimated depth to water table 17"-36"

Appendix C provides a copy of the NRCS soil mapping and respective hydrologic Soil Group (HSG).

Soil Permeability (k):

Site subsurface soils are classified as a "sandy loam" Type C soils.

Design permeability (k) value:

***k* = 0.17 in / hr** (Rawls Rate: Sandy Loam)

E. Pre-Development Model Summary

The pre-development hydrologic model analysis consists of three analysis points and subcatchments. Subcatchment DA-E1, DA-E2, DA-E3. DA-E1 is the subcatchment and analysis point for runoff to the wetland at the corner of Stafford Street and Route 56. This subcatchment is the same subcatchment named DA-3-L in the 2014 JH Engineering stormwater report. This subcatchment analyzed the runoff to the wetland prior to the existing development being constructed. Subcatchment DA-E2 analyzes current existing flows to Route 56. Subcatchment DA-E3 analyzes the current existing flows to the abutter located at Parcel 44-A-9 (108 Huntoon Memorial Highway). The graphical presentation of the pre-development model is shown in two figures as provided in **Appendix D**. The pre-development model is nearly identical to that which was used by Cuoco and Cormier, however on site soils have been analyzed as HSG C per NRCS mapping, whereas Cuoco and Cormier had originally modeled the site with HSG B soils.

F. Post-Development Model Summary

The post development model is shown in the figure as provided in **Appendix E**. The post development model includes three analysis points and five sub-catchment areas consisting of:

- P1, P2, and P3 which drain to the on-site rain gardens and the wetland at the corner of Route 56 and Stafford Street, analysis point DA-P1.
- DA-P2 is the analysis point for runoff to Route 56.
- DA-P3 is the analysis point for runoff to the abutter at 108 Huntoon Memorial Highway.

G. Summary of Peak Stormwater Discharge Rates

The following summary table present results for the pre- and post-development analysis for the 2, 10, 25 and 100 year, 24-hr storm events at the analysis point 1 as considered.

Flows to Analysis Point 1 – Wetland	Pre-Development (cfs)	Post-Development (cfs)	Net Change (cfs)
2 Year Storm	5.22	5.07	-0.15
10 Year Storm	10.46	8.82	-1.64
25 Year Storm	13.82	11.76	-2.06
100 Year Storm	19.09	19.02	-0.07

Flows to Analysis Point 2 – Route 56	Pre-Development (cfs)	Post-Development (cfs)	Net Change (cfs)
2 Year Storm	0.50	0.31	-0.19
10 Year Storm	1.35	0.86	-0.49
10 Year Storm	1.95	1.24	-0.71
100 Year Storm	2.95	1.86	-1.09

Flows to Analysis Point 3 – 108 Huntoon Memorial Highway	Pre-Development (cfs)	Post-Development (cfs)	Net Change (cfs)
2 Year Storm	0.33	0.16	-0.17
10 Year Storm	0.90	0.39	-0.51
10 Year Storm	1.30	0.55	-0.75
100 Year Storm	1.96	0.80	-1.16

Section III – Storm Sewer Drainage System Pipe Design

A. Methodology

The site drainage system has been designed from calculations based upon the 100-year design storm event using the peak flows predicted by the HydroCAD 10 Dynamic Modelling Program.

The Manning's Equation has been used to size the drainage system pipe runs.

Manning's Equation: $Q = A\ 1.486\ R^{2/3}\ S^{1/2} / n$

Where:
Q = Flow Discharge, cfs
A = Cross Sectional Area of Wetted Perimeter
n = Manning Coefficient of Channel Roughness
R = Hydraulic Radius (A/WP)
WP = Wetted Perimeter
S = Slope of Energy Gradient

B. Drainage Systems Computations

Summary of these results are provided in **Appendix F**.

Section IV – Stormwater Standards

A. Standard 1 – No New Untreated Discharges

The proposed expansion of the developed site, along with the proposed additional stormwater management features, will not produce any new untreated discharges. All stormwater runoff from the proposed gravel parking area expansion is proposed to be treated via a Stormceptor™ water quality unit prior to being discharged to the on-site rain gardens for peak flow attenuation. Velocities of stormwater in proposed storm drain piping are proposed to be far less than maximum allowable velocities (see **Appendix F**).

B. Standard 2 – Peak Rate Attenuation

The peak rate attenuation analyses and summaries have been reported in hydrologic analysis provided in **Appendix D & E** of this report. Flood Insurance Rate Map (FIRM) #25027C0784E was reviewed for this site, as provided in **Appendix B**. This mapping does not show any flood zones mapped on this site. The analysis as submitted indicates that there will be no increase in rate of runoff that would cause an increase of the flood elevation downstream.

C. Standard 3 – Recharge

As stated in the original 2014 stormwater management report by JH Engineering, due to the on-site soil conditions, soil types (fine sandy loam), hydrologic soil group C and associated Rawls Rate (0.17 inches/hour), and depth to seasonal high groundwater, the Site is not conducive to groundwater recharge. Original soil testing done in 2014 resulted in seasonal high groundwater between 20" and 33" and therefore a 24" groundwater separation is unachievable. Due to these conditions, groundwater recharge unfortunately cannot be provided per the standards. Stormwater is proposed to be conveyed to the existing rain gardens which currently are not designed to provide groundwater recharge due to these reasons, although they likely do provide for recharge at times of low groundwater conditions.

D. Standard 4 – Water Quality

Water Quality Treatment Volume for the additional impervious area proposed is calculated by:

V_{wq} = (D_{wq}/12 inches/ft) x (A_{imp})

The additional gravel parking area proposed is a total of 29,755 s.f. All of the runoff from this expanded area is proposed to the conveyed to a proposed Stormceptor 450i water quality unit. A 1" water quality depth will be used as the site is a potential LUHPPL.

V_{wq} = (1")/12"/ft x 29,755 s.f. = 2,480 c.f.

5,553 c.f. of stormwater is directed through the Stormceptor unit during a 2 year storm event.

The proposed Stormceptor 450i unit is rated for 81% TSS removal according to the Contech Stormceptor PCSWMM Sizing Program. Because all proposed impervious area is conveyed through this unit, 81% TSS removal will be provided prior to discharge to the existing rain gardens, where additional treatment beyond the required 80% will be achieved. *(See Stormceptor Sizing Report Summary – **Appendix F**).*

E. Standard 5 – Land Uses with Higher Potential Pollutant Loads

The site is considered a potential LUHPPL due to fleet storage of vehicles as well as some outside vehicle maintenance which takes place on site. Therefore the water quality depth used to calculate the water quality volume is 1".

F. Standard 6 – Critical Areas

Not applicable – the Site does not discharge to critical areas.

G. Standard 7 - Redevelopment

A portion of the project could be considered a redevelopment project, however, all applicable standards will be met with the exception of groundwater recharge as stated in Standard 3.

H. Standard 8 – Construction Period Controls

The construction period erosion and sedimentation control plan has been outlined on the referenced amended site plans along with the sequence for implementation. The construction period erosion and sedimentation control are shown on the referenced plans and consists of perimeter filter tube. A draft Construction Site Inspection Report is included in **Appendix G**.

Construction of the proposed site improvements does not fall under the overall Site's NPDES Construction General Permit as the project will not disturb greater than 1 Acre (approximately 40,000 s.f. disturbance).

I. Standard 9 – Operation and Maintenance Plan

The additional stormwater structures for the proposed gravel parking lot expansion are already outlined in the original Long Term Operation and Maintenance Plan for the Stormwater Management System provided with the original report by JH Engineering. This original O&M Plan is provided in **Appendix H**.

J. Standard 10 – Illicit Discharges to Drainage System

All illicit discharges to the stormwater management system are prohibited. To the best of our knowledge, there are no existing discharges from the Site other than from the existing stormwater management system. There are no direct connections between sources containing wastewater, hazardous substances, oils, greases, and the existing/ proposed stormwater management system. The Long Term Operation and Maintenance Plan provided in **Appendix H** addresses illicit discharges to drainage system. An Illicit Discharge Compliance Statement is provided in **Appendix H**.

APPENDIX A

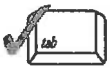
MassDEP STORMWATER CHECKLIST

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

8-25-21

Signature and Date

Checklist

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

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☐ Required Recharge Volume calculation provided.

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

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

☐ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

☐ Solid Waste Landfill pursuant to 310 CMR 19.000

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☒ involves runoff from land uses with higher potential pollutant loads.

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☒ Redevelopment portion of mix of new and redevelopment.

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

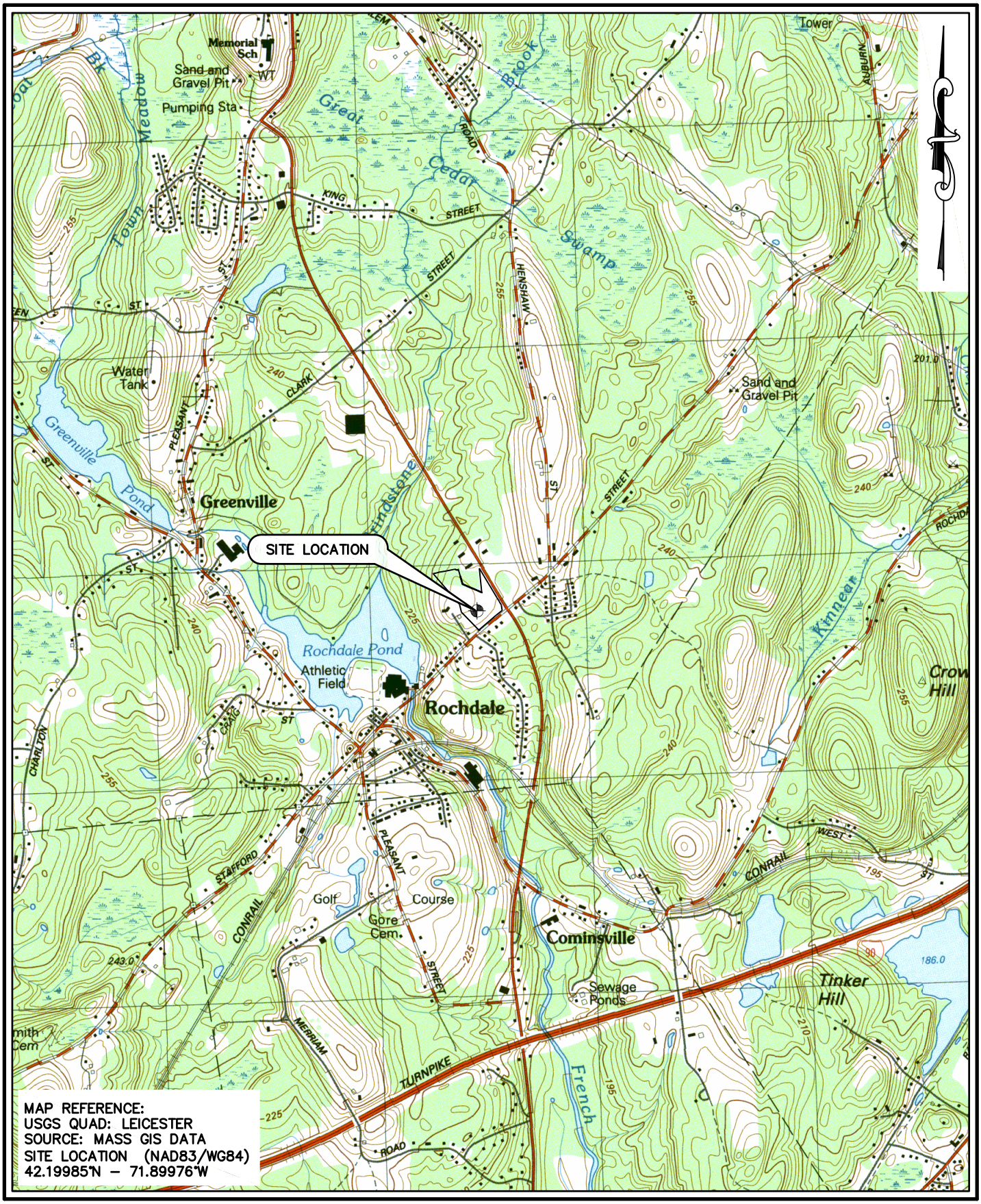
☒ An Illicit Discharge Compliance Statement is attached;

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

APPENDIX B

USGS LOCUS – FIGURE 1

FEMA MAP



DATE:	8/19/2021
DRAWN BY:	MM
APPROVED BY:	CPM
SCALE:	
HORZ:	1"=2000'
VERT:	

0 1000' 2000'

McCLURE
ENGINEERING, INC
119 Worcester Road
Charlton, MA 01507
Tel: (508) 248-2005
Fax (508) 248-4887
Email: chris@mcclureengineers.com

USGS SITE LOCATION
112 HUNTOON MEMORIAL HIGHWAY
ROCHDALE, MA 01542
PREPARED FOR
HUNTOON HIGHWAY, LLC

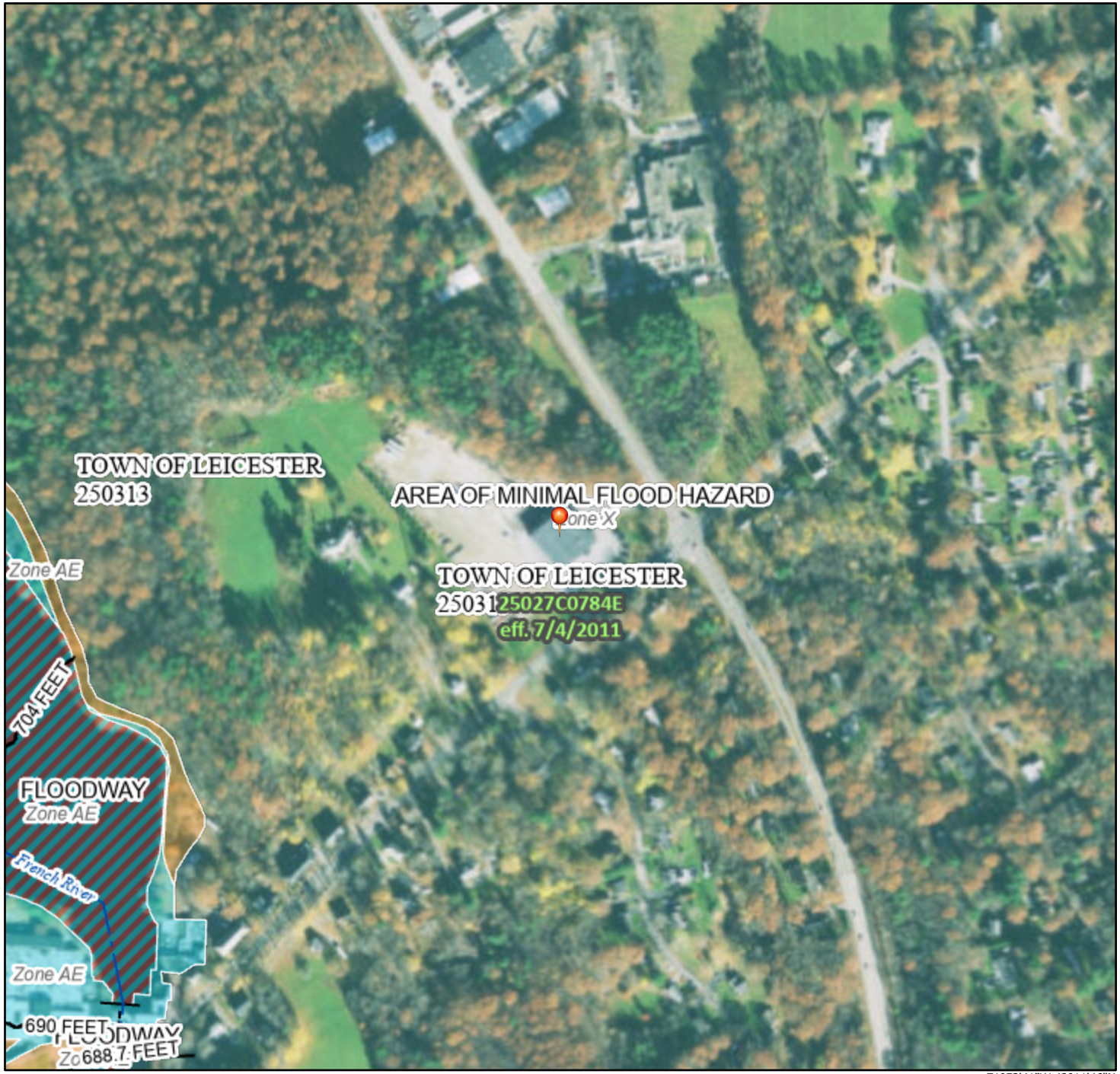
PROJ. NO.	135-2415-M
DWG.	GIS

FIG 1

National Flood Hazard Layer FIRMette

FEMA

71°54'18"W 42°12'12"N



71°53'41"W 42°11'46"N

0 250 500 1,000 1,500 2,000 Feet 1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/18/2021 at 1:01 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

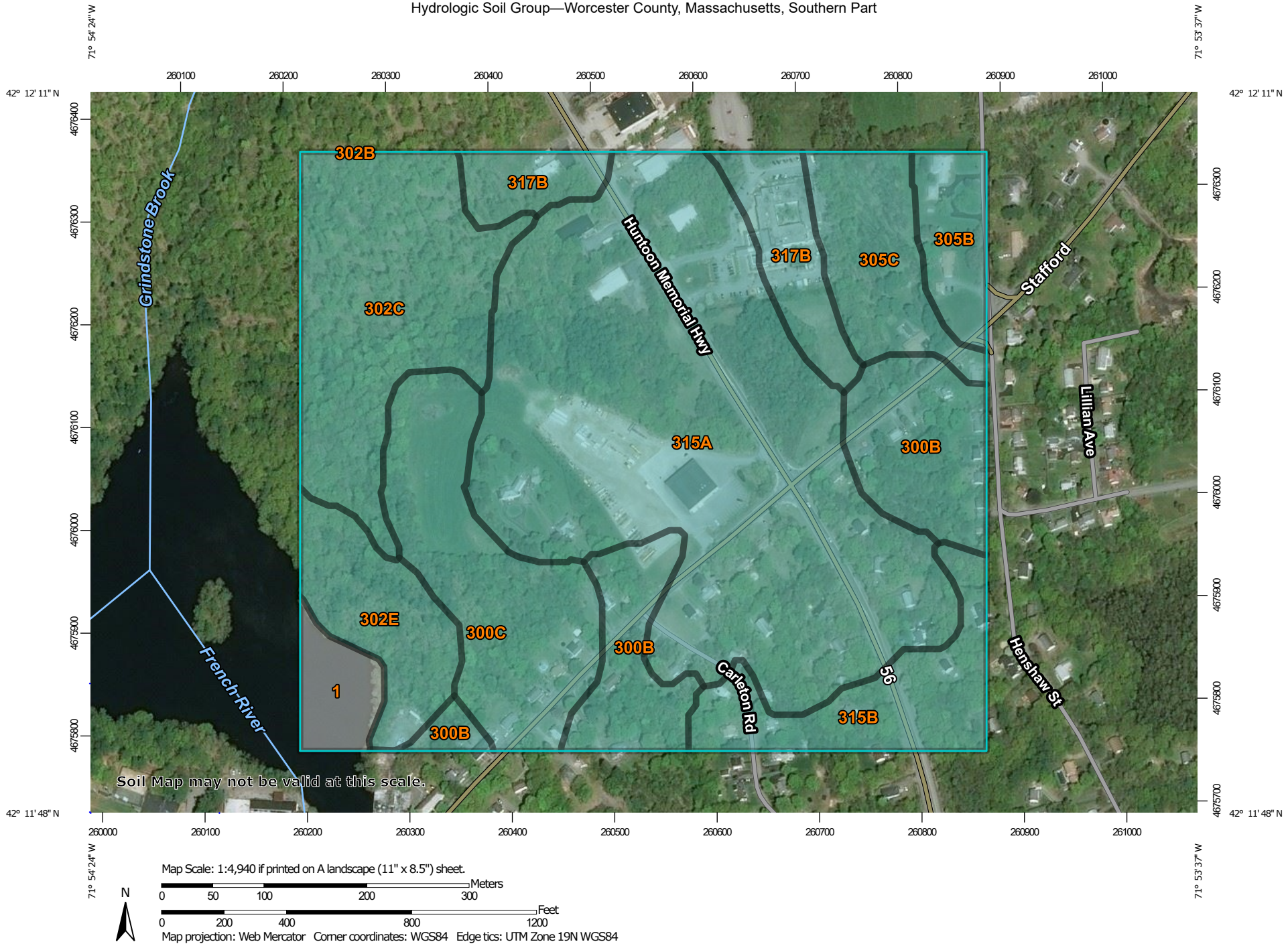
APPENDIX C

NCRS SOIL MAPPING

SOIL BORING LOGS (2004)

PRECIPITATION DATA FROM NAOO

RAWLS TABLE


71° 54' 24" W
71° 53' 37" W
42° 12' 11" N
42° 11' 48" N
260100
260200
260300
260400
260500
260600
260700
260800
260900
261000
4676400
4676300
4676200
4676100
4676000
4675900
4675800
4675700
302B
317B
317B
305B
305C
302C
315A
300B
302E
300C
300B
1
300B
315B
Grindstone Brook
French River
Huntoon Memorial Hwy
Stafford
Lillian Ave
Henshaw St
Carleton Rd
56
Soil Map may not be valid at this scale.
Map Scale: 1:4,940 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0 50 100 200 300
Feet
0 200 400 800 1200
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 Rating Polygons

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Lines

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Points

A
A/D
B
B/D
C
C/D
D
Not rated or not available

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 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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: Worcester County, Massachusetts, Southern Part
Survey Area Data: Version 13, Jun 11, 2020

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

Date(s) aerial images were photographed: May 18, 2019—Jul 9, 2019

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Water		2.1	2.2%
300B	Montauk fine sandy loam, 3 to 8 percent slopes	C	10.0	10.3%
300C	Montauk fine sandy loam, 8 to 15 percent slopes	C	10.0	10.4%
302B	Montauk fine sandy loam, 0 to 8 percent slopes, extremely stony	C	0.0	0.0%
302C	Montauk fine sandy loam, 8 to 15 percent slopes, extremely stony	C	12.9	13.3%
302E	Montauk fine sandy loam, 15 to 35 percent slopes, extremely stony	C	5.1	5.2%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	C	2.9	3.0%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	C	5.2	5.4%
315A	Scituate fine sandy loam, 0 to 3 percent slopes	C	37.3	38.4%
315B	Scituate fine sandy loam, 3 to 8 percent slopes	C	6.0	6.1%
317B	Scituate fine sandy loam, 3 to 8 percent slopes, extremely stony	C	5.5	5.7%
Totals for Area of Interest			**97.0**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

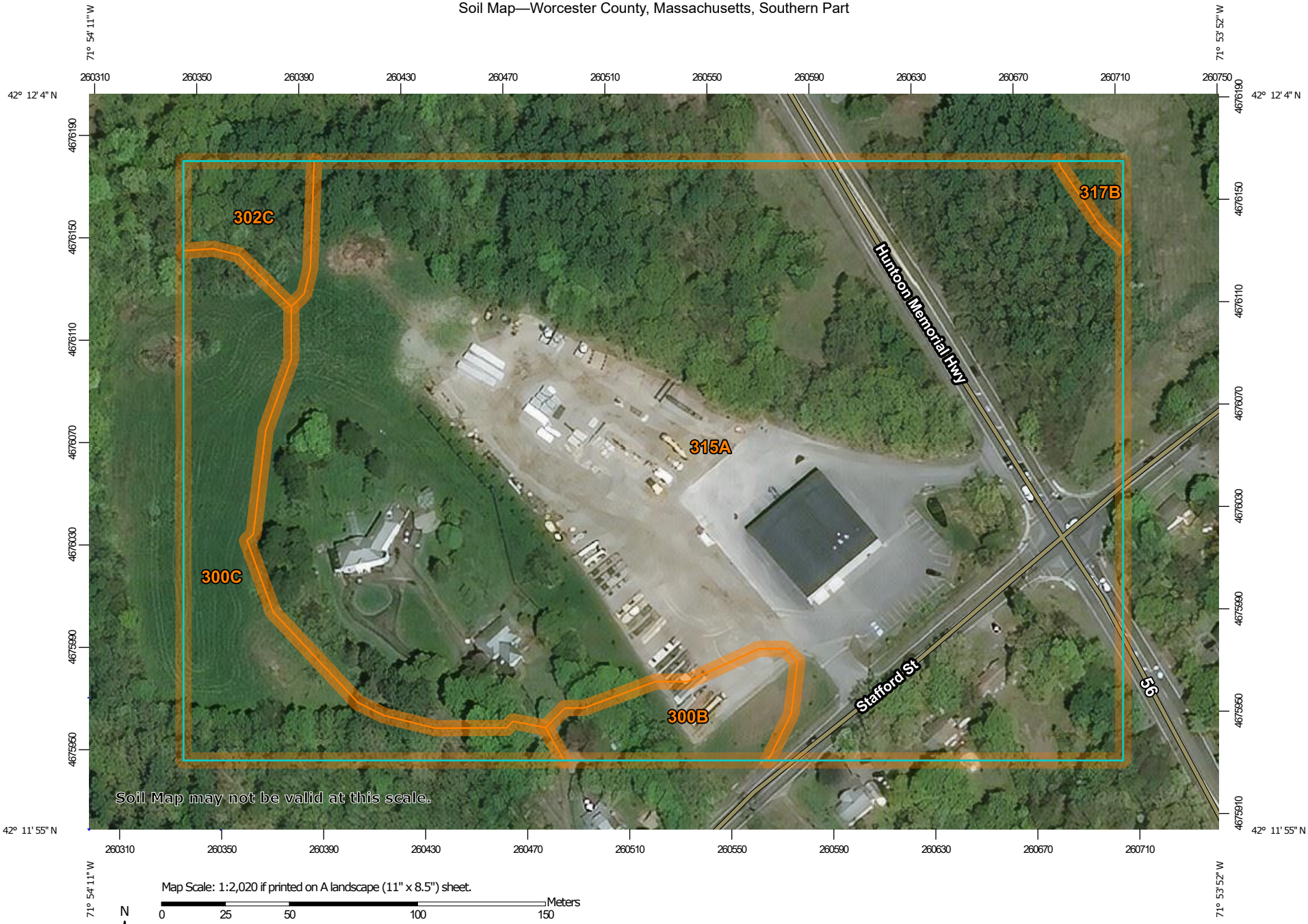
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



Map Scale: 1:2,020 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

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 1:25,000.

Warning: Soil Map may not be valid at this scale.

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Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

Soil Survey Area: Worcester County, Massachusetts, Southern Part
Survey Area Data: Version 13, Jun 11, 2020

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

Date(s) aerial images were photographed: May 18, 2019—Jul 9, 2019

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
300B	Montauk fine sandy loam, 3 to 8 percent slopes	0.7	3.3%
300C	Montauk fine sandy loam, 8 to 15 percent slopes	2.3	10.7%
302C	Montauk fine sandy loam, 8 to 15 percent slopes, extremely stony	0.5	2.5%
315A	Scituate fine sandy loam, 0 to 3 percent slopes	17.8	83.0%
317B	Scituate fine sandy loam, 3 to 8 percent slopes, extremely stony	0.1	0.6%
Totals for Area of Interest		**21.4**	**100.0%**

Worcester County, Massachusetts, Southern Part

315A—Scituate fine sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 9bc8
Elevation: 280 to 930 feet
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 145 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Scituate and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Scituate

Setting

Landform: Till plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Friable coarse-loamy eolian deposits over dense sandy lodgment till derived from granite and gneiss

Typical profile

H1 - 0 to 4 inches: sandy loam
H2 - 4 to 16 inches: gravelly sandy loam
H3 - 16 to 30 inches: loamy sand
H4 - 30 to 65 inches: gravelly loamy sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 20 to 30 inches to densic material
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 17 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C
Ecological site: F144AY037MA - Moist Dense Till Uplands

Hydric soil rating: No

Minor Components

Montauk

Percent of map unit: 10 percent
Hydric soil rating: No

Whitman

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Ridgebury

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Worcester County, Massachusetts, Southern Part
Survey Area Data: Version 13, Jun 11, 2020

SOIL TESTING
DECEMBER 5, 2012
PERFORMED BY SHELLEY HAMMOND
WITNESSED BY KEVIN QUINN

DH-1
DEPTH=107"
ESHGW @ 20"
NO REFUSAL

DH-2
DEPTH = 92"
ESHGW @ 23"
NO REFUSAL

DH-3
DEPTH = 71"
ESHGW @ 22"

DH-4
DEPTH = 112"
ESHGW @ 31"
NO REFUSAL

DH-5
DEPTH = 118"
ESHGW @ 31"
NO REFUSAL

DH-6
DEPTH = 46"
ESHGW @ 32"
REFUSAL @ 46"

DH-7
DEPTH = 58"
ESHGW @ 31"
REFUSAL RANGES FROM 25"-58"

DH-8
DEPTH = 82"
ESHGW @ 33"
REFUSAL @ 82"

NOAA Atlas 14, Volume 10, Version 3
Location name: Rochdale, Massachusetts, USA*
Latitude: 42.1999°, Longitude: -71.8992°
Elevation: 805.96 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.341** (0.273-0.420)	**0.401** (0.321-0.495)	**0.499** (0.398-0.618)	**0.581** (0.460-0.726)	**0.694** (0.529-0.911)	**0.780** (0.580-1.05)	**0.868** (0.623-1.22)	**0.964** (0.656-1.40)	**1.10** (0.715-1.66)	**1.21** (0.763-1.87)
10-min	**0.482** (0.387-0.595)	**0.568** (0.454-0.701)	**0.708** (0.564-0.877)	**0.824** (0.652-1.03)	**0.983** (0.750-1.29)	**1.10** (0.822-1.49)	**1.23** (0.883-1.72)	**1.37** (0.928-1.98)	**1.56** (1.01-2.36)	**1.71** (1.08-2.65)
15-min	**0.568** (0.455-0.700)	**0.668** (0.535-0.825)	**0.832** (0.663-1.03)	**0.969** (0.767-1.21)	**1.16** (0.882-1.52)	**1.30** (0.967-1.75)	**1.45** (1.04-2.03)	**1.61** (1.09-2.33)	**1.83** (1.19-2.77)	**2.01** (1.27-3.12)
30-min	**0.775** (0.621-0.955)	**0.912** (0.730-1.13)	**1.14** (0.907-1.41)	**1.32** (1.05-1.65)	**1.58** (1.21-2.08)	**1.78** (1.32-2.39)	**1.98** (1.42-2.78)	**2.20** (1.49-3.19)	**2.50** (1.63-3.79)	**2.75** (1.74-4.27)
60-min	**0.982** (0.787-1.21)	**1.16** (0.926-1.43)	**1.44** (1.15-1.79)	**1.68** (1.33-2.10)	**2.01** (1.53-2.63)	**2.25** (1.68-3.03)	**2.51** (1.80-3.52)	**2.79** (1.89-4.05)	**3.18** (2.07-4.81)	**3.49** (2.21-5.42)
2-hr	**1.25** (1.01-1.53)	**1.48** (1.19-1.81)	**1.85** (1.49-2.28)	**2.17** (1.73-2.68)	**2.59** (1.99-3.39)	**2.91** (2.19-3.91)	**3.25** (2.36-4.57)	**3.65** (2.48-5.26)	**4.22** (2.76-6.36)	**4.71** (2.99-7.26)
3-hr	**1.43** (1.16-1.75)	**1.70** (1.38-2.08)	**2.14** (1.73-2.63)	**2.51** (2.01-3.09)	**3.01** (2.33-3.93)	**3.38** (2.56-4.54)	**3.79** (2.77-5.33)	**4.26** (2.91-6.14)	**4.98** (3.26-7.47)	**5.59** (3.56-8.59)
6-hr	**1.78** (1.46-2.16)	**2.14** (1.75-2.60)	**2.73** (2.21-3.32)	**3.21** (2.59-3.94)	**3.88** (3.02-5.04)	**4.38** (3.33-5.85)	**4.92** (3.62-6.90)	**5.57** (3.82-7.96)	**6.57** (4.30-9.79)	**7.42** (4.73-11.3)
12-hr	**2.18** (1.80-2.63)	**2.66** (2.18-3.20)	**3.43** (2.80-4.15)	**4.07** (3.31-4.96)	**4.95** (3.88-6.40)	**5.61** (4.29-7.44)	**6.31** (4.68-8.81)	**7.18** (4.94-10.2)	**8.49** (5.58-12.6)	**9.62** (6.16-14.6)
24-hr	**2.59** (2.15-3.10)	**3.18** (2.63-3.81)	**4.15** (3.42-4.99)	**4.95** (4.05-5.99)	**6.05** (4.77-7.77)	**6.87** (5.29-9.07)	**7.76** (5.79-10.8)	**8.84** (6.11-12.5)	**10.5** (6.93-15.5)	**11.9** (7.66-18.0)
2-day	**2.98** (2.49-3.54)	**3.68** (3.06-4.37)	**4.82** (4.00-5.74)	**5.76** (4.75-6.92)	**7.06** (5.60-9.01)	**8.02** (6.22-10.5)	**9.06** (6.81-12.5)	**10.4** (7.18-14.5)	**12.4** (8.19-18.1)	**14.1** (9.09-21.1)
3-day	**3.25** (2.72-3.84)	**4.00** (3.35-4.73)	**5.23** (4.36-6.22)	**6.26** (5.18-7.49)	**7.67** (6.11-9.75)	**8.70** (6.77-11.4)	**9.84** (7.42-13.6)	**11.3** (7.82-15.7)	**13.5** (8.93-19.6)	**15.4** (9.92-22.9)
4-day	**3.48** (2.93-4.10)	**4.28** (3.59-5.05)	**5.58** (4.66-6.61)	**6.66** (5.53-7.95)	**8.15** (6.51-10.3)	**9.24** (7.21-12.1)	**10.4** (7.89-14.3)	**11.9** (8.31-16.6)	**14.3** (9.48-20.7)	**16.3** (10.5-24.2)
7-day	**4.14** (3.51-4.86)	**5.02** (4.24-5.89)	**6.46** (5.43-7.61)	**7.65** (6.38-9.07)	**9.29** (7.46-11.7)	**10.5** (8.22-13.6)	**11.8** (8.95-16.1)	**13.4** (9.40-18.6)	**15.9** (10.6-23.0)	**18.1** (11.7-26.7)
10-day	**4.81** (4.08-5.61)	**5.73** (4.86-6.70)	**7.24** (6.11-8.50)	**8.49** (7.11-10.0)	**10.2** (8.22-12.8)	**11.5** (9.01-14.8)	**12.9** (9.74-17.4)	**14.5** (10.2-20.0)	**17.0** (11.4-24.5)	**19.2** (12.4-28.2)
20-day	**6.88** (5.89-7.97)	**7.86** (6.71-9.12)	**9.46** (8.04-11.0)	**10.8** (9.11-12.7)	**12.6** (10.2-15.6)	**14.0** (11.0-17.7)	**15.4** (11.6-20.4)	**17.0** (12.0-23.2)	**19.2** (12.9-27.4)	**21.0** (13.7-30.7)
30-day	**8.62** (7.40-9.94)	**9.62** (8.26-11.1)	**11.3** (9.62-13.1)	**12.6** (10.7-14.8)	**14.5** (11.7-17.7)	**16.0** (12.5-20.0)	**17.4** (13.1-22.6)	**18.9** (13.4-25.6)	**20.8** (14.0-29.5)	**22.3** (14.5-32.4)
45-day	**10.8** (9.29-12.4)	**11.8** (10.2-13.6)	**13.5** (11.6-15.6)	**14.9** (12.7-17.3)	**16.8** (13.7-20.4)	**18.4** (14.4-22.8)	**19.8** (14.8-25.5)	**21.2** (15.1-28.6)	**22.9** (15.5-32.2)	**24.0** (15.7-34.8)
60-day	**12.6** (10.9-14.4)	**13.6** (11.8-15.6)	**15.4** (13.2-17.7)	**16.8** (14.3-19.5)	**18.8** (15.3-22.7)	**20.4** (16.1-25.1)	**21.8** (16.4-27.9)	**23.1** (16.5-31.1)	**24.7** (16.7-34.6)	**25.6** (16.8-37.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

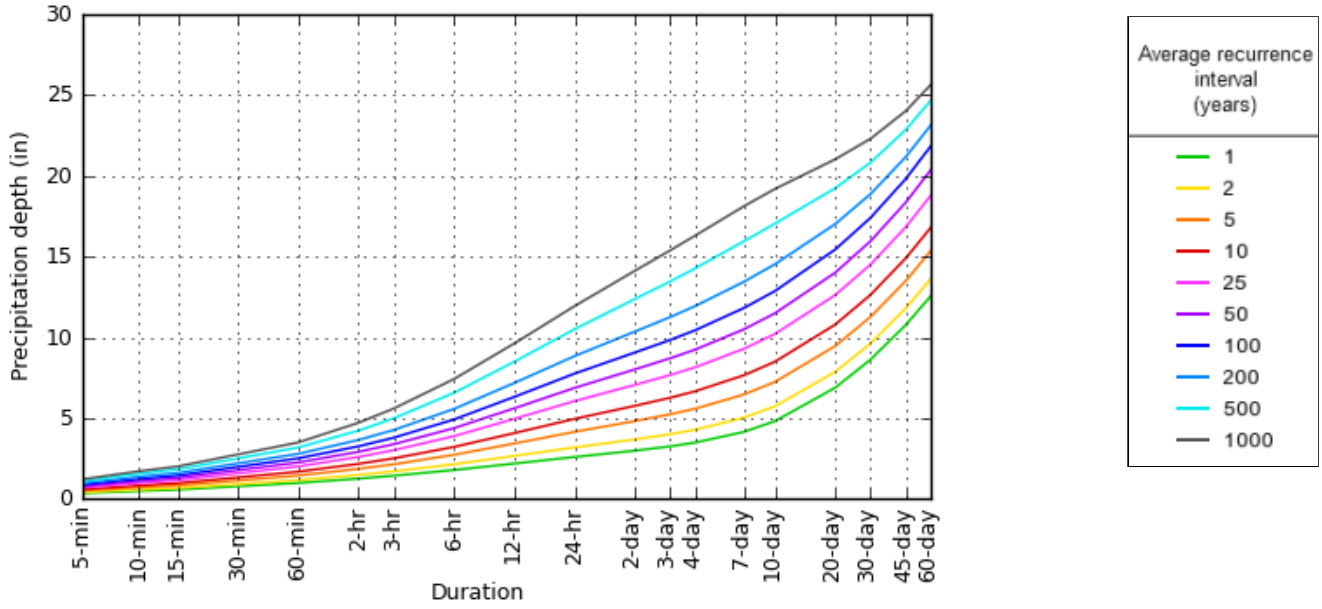
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

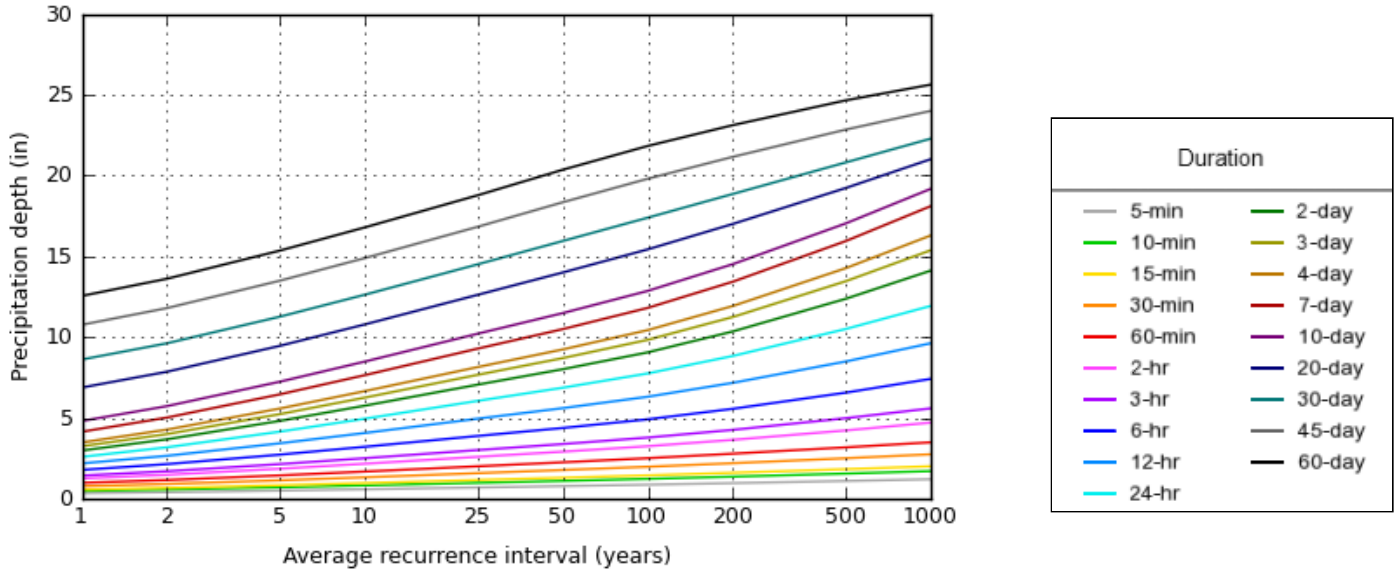
Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 42.1999°, Longitude: -71.8992°





NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Wed Jul 7 20:24:25 2021

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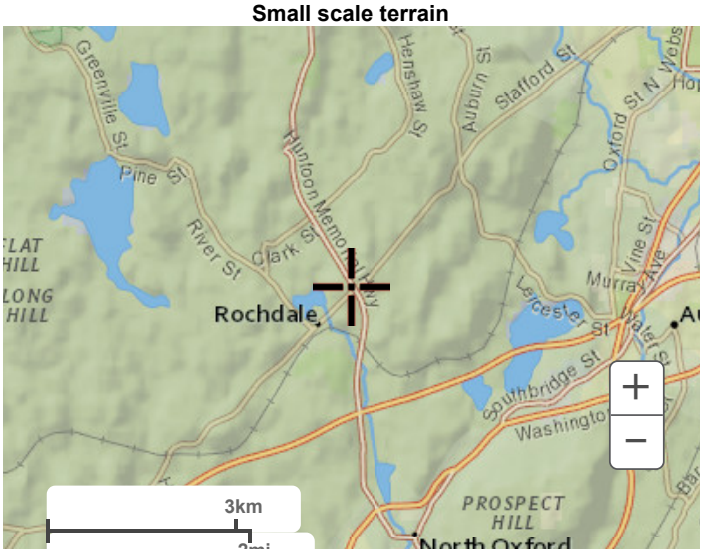
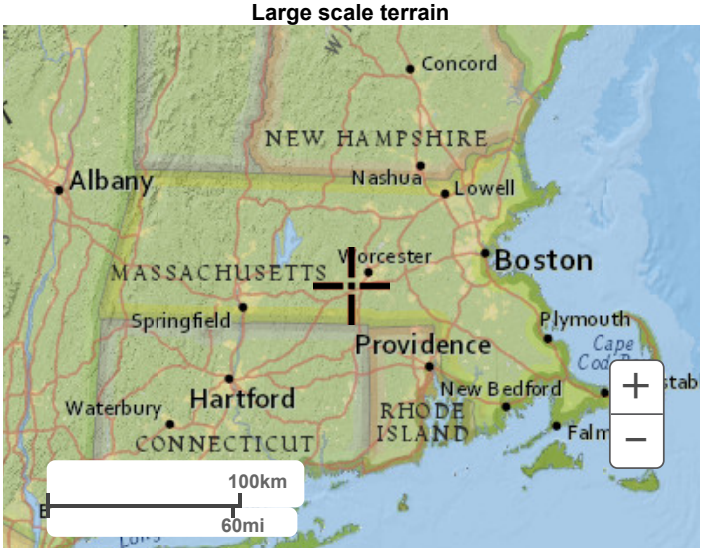
Maps & aerials

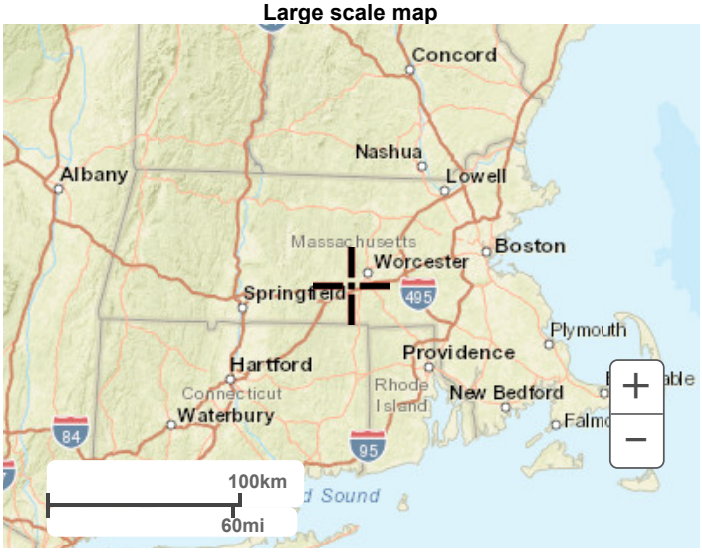
Small scale terrain



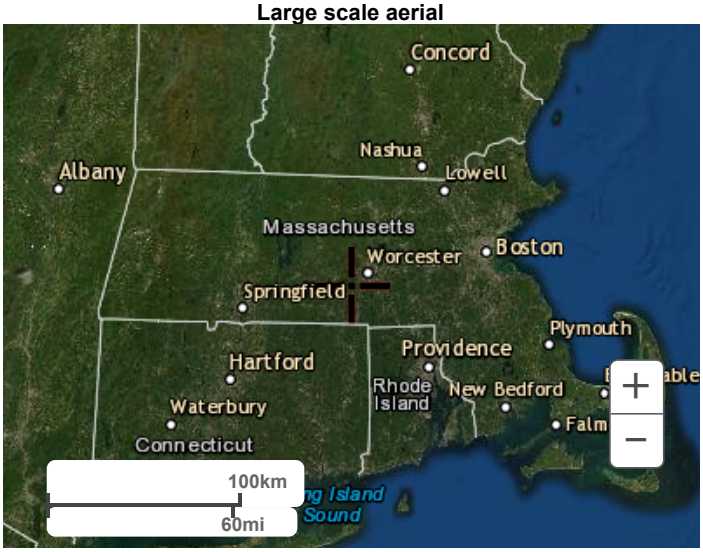
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Table 2.3.3. 1982 Rawls Rates[18]

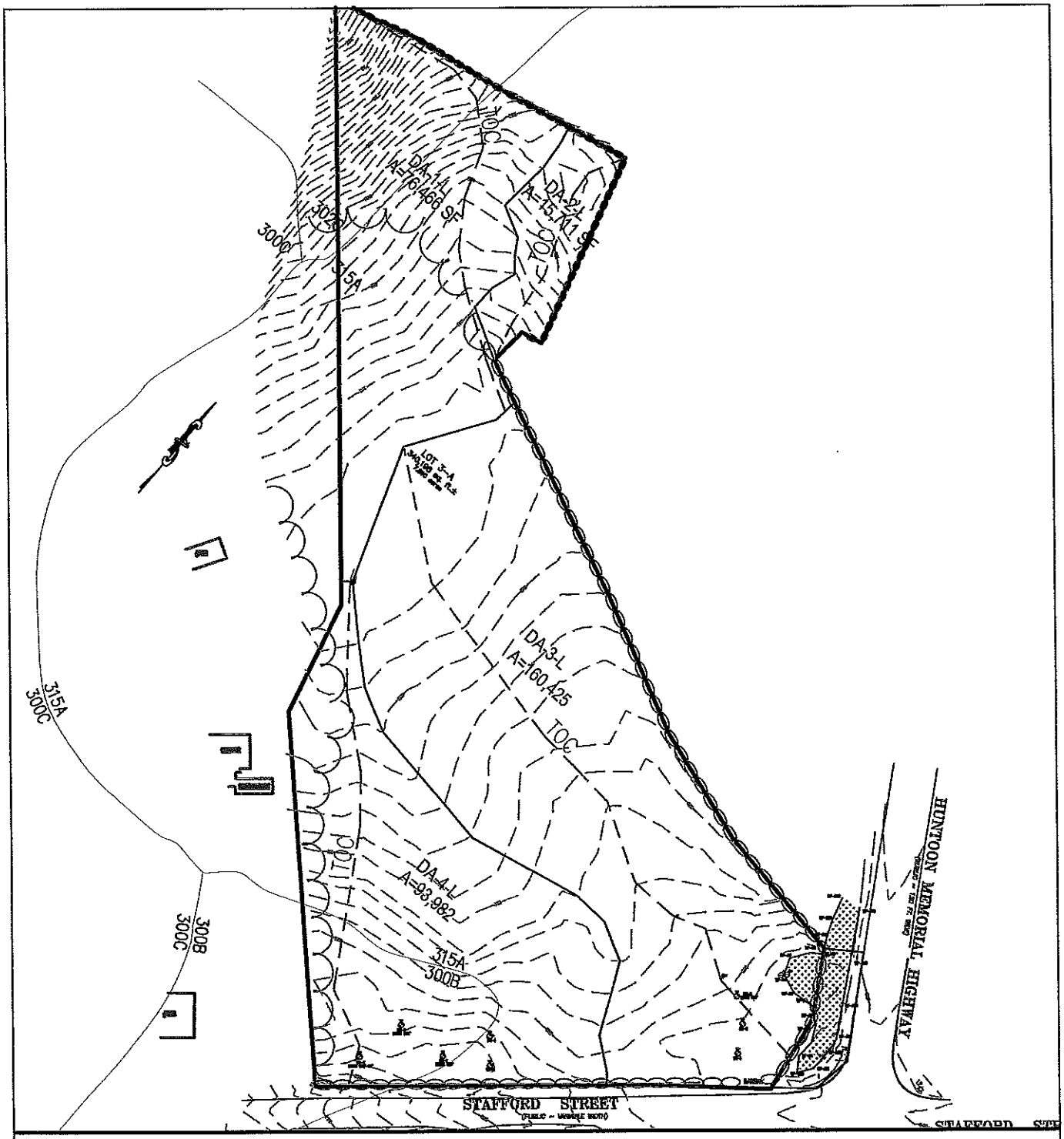
Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate Inches/Hour
Sand	A	8.27
Loamy Sand	A	2.41
Sandy Loam	B	1.02
Loam	B	0.52
Silt Loam	C	0.27
Sandy Clay Loam	C	0.17
Clay Loam	D	0.09
Silty Clay Loam	D	0.06
Sandy Clay	D	0.05
Silty Clay	D	0.04
Clay	D	0.02

[18] Rawls, Brakensiek and Saxton, 1982

APPENDIX D

PRE-DEVELOPMENT SUBCATCHMENT MODEL

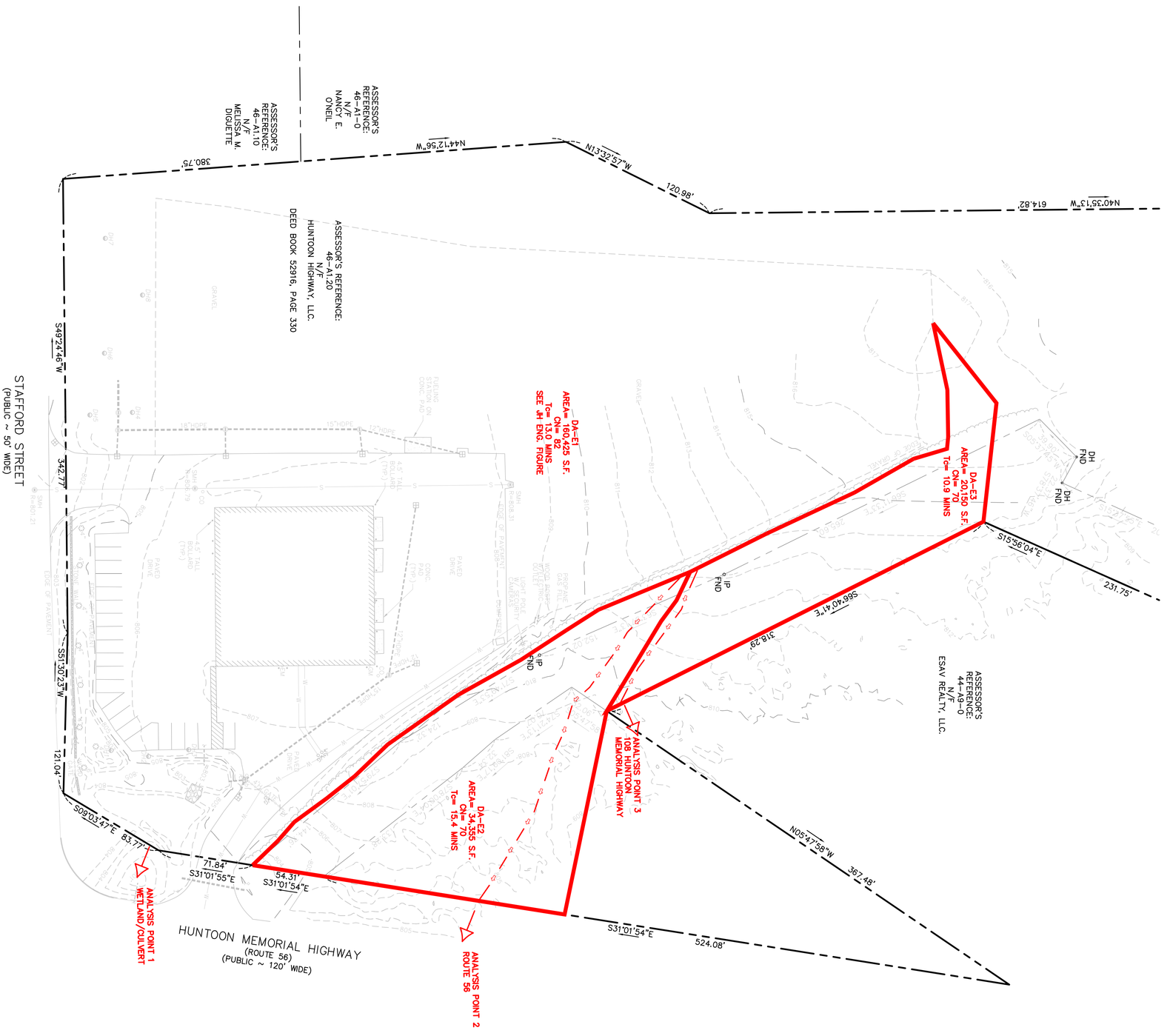
PRE-DEVELOPMENT HYDROCAD DRAINAGE CALCULATIONS



PRE-DEVELOPMENT
DRAINAGE AREAS
CENTRAL MASS CRANE SERVICE
980 STAFFORD STREET, LLC

J Engineering Group LLC
PO BOX 1198
WORCESTER, MA 01613
TEL (508)752-1130

JOB NO.:	DESIGNED/DRAWN BY:	CHECKED BY:
C0048	JWH/SEH	JWH
SCALE: 1"=150'	DATE: 3/25/14 REV: 5/22/14	SHEET: 1 OF 1



PRE-DEVELOPMENT

DRAWN BY:	WCN
DATE:	8/20/2021
SCALE:	1"=40'
PROJ. NO.	152-2415-M

WATERSHED ANALYSIS PLAN
HUNTOON HIGHWAY, LLC.
112 HUNTOON MEMORIAL HIGHWAY
ROCHDALE, MA
PREPARED FOR
HUNTOON HIGHWAY, LLC.
112 HUNTOON MEMORIAL HIGHWAY
ROCHDALE, MA 01542-0338

McCLURE ENGINEERING, INC
119 Worcester Road
Charlton, MA 01507
Tel: (508) 248-2005
Fax (508) 248-4887
Email: pengle@mcclureengineers.com

PETER C. ENGLE, P.E.
PROFESSIONAL ENGINEER
MA LIC. NO. 53736

HOR. SCALE IN FEET: 1"=40'
40 0 40 80 120

REVISIONS

REV	DATE	DESCRIPTION	MADE	APV'D

Subcat Reach Pond Link

Routing Diagram for Pre-Development_PE_7.7.21
Prepared by Microsoft, Printed 8/20/2021

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
10,513	74	>75% Grass cover, Good, HSG C (DA-E1)
4,467	83	Brush, Poor, HSG D (DA-E1)
145,445	82	Row crops, SR + CR, Good, HSG C (DA-E1)
54,505	70	Woods, Good, HSG C (DA-E2, DA-E3)
214,930	**79**	**TOTAL AREA**

Summary for Subcatchment DA-E1: Wetland/ Culvert - From Original Analysis DA-3-L

Runoff = 5.22 cfs @ 12.18 hrs, Volume= 20,348 cf, Depth= 1.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YearMass Rainfall=3.18"

Area (sf)	CN	Description
145,445	82	Row crops, SR + CR, Good, HSG C
10,513	74	>75% Grass cover, Good, HSG C
4,467	83	Brush, Poor, HSG D
160,425	82	Weighted Average
160,425		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0100	0.23		**Sheet Flow,** Cultivated: Residue<=20% n= 0.060 P2= 3.00"
9.3	708	0.0200	1.27		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
13.0	758	Total			

Summary for Subcatchment DA-E2: East to Huntoon Highway

Runoff = 0.50 cfs @ 12.24 hrs, Volume= 2,337 cf, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YearMass Rainfall=3.18"

Area (sf)	CN	Description
34,355	70	Woods, Good, HSG C
34,355		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
4.6	240	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.4	290	Total			

Summary for Subcatchment DA-E3: East to Parcel 44-A9

Runoff = 0.33 cfs @ 12.17 hrs, Volume= 1,371 cf, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YearMass Rainfall=3.18"

Area (sf)	CN	Description
20,150	70	Woods, Good, HSG C
20,150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.7	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.2	70	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.9	120	Total			

Summary for Subcatchment DA-E1: Wetland/ Culvert - From Original Analysis DA-3-L

Runoff = 10.46 cfs @ 12.18 hrs, Volume= 40,566 cf, Depth= 3.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YearMass Rainfall=4.95"

Area (sf)	CN	Description
145,445	82	Row crops, SR + CR, Good, HSG C
10,513	74	>75% Grass cover, Good, HSG C
4,467	83	Brush, Poor, HSG D
160,425	82	Weighted Average
160,425		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0100	0.23		**Sheet Flow,** Cultivated: Residue<=20% n= 0.060 P2= 3.00"
9.3	708	0.0200	1.27		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
13.0	758	Total			

Summary for Subcatchment DA-E2: East to Huntoon Highway

Runoff = 1.35 cfs @ 12.22 hrs, Volume= 5,724 cf, Depth= 2.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YearMass Rainfall=4.95"

Area (sf)	CN	Description
34,355	70	Woods, Good, HSG C
34,355		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
4.6	240	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.4	290	Total			

Summary for Subcatchment DA-E3: East to Parcel 44-A9

Runoff = 0.90 cfs @ 12.16 hrs, Volume= 3,357 cf, Depth= 2.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YearMass Rainfall=4.95"

Area (sf)	CN	Description
20,150	70	Woods, Good, HSG C
20,150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.7	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.2	70	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.9	120	Total			

Summary for Subcatchment DA-E1: Wetland/ Culvert - From Original Analysis DA-3-L

Runoff = 13.82 cfs @ 12.18 hrs, Volume= 53,918 cf, Depth= 4.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YearMass Rainfall=6.05"

Area (sf)	CN	Description
145,445	82	Row crops, SR + CR, Good, HSG C
10,513	74	>75% Grass cover, Good, HSG C
4,467	83	Brush, Poor, HSG D
160,425	82	Weighted Average
160,425		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0100	0.23		**Sheet Flow,** Cultivated: Residue<=20% n= 0.060 P2= 3.00"
9.3	708	0.0200	1.27		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
13.0	758	Total			

Summary for Subcatchment DA-E2: East to Huntoon Highway

Runoff = 1.95 cfs @ 12.22 hrs, Volume= 8,145 cf, Depth= 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YearMass Rainfall=6.05"

Area (sf)	CN	Description
34,355	70	Woods, Good, HSG C
34,355		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
4.6	240	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.4	290	Total			

Summary for Subcatchment DA-E3: East to Parcel 44-A9

Runoff = 1.30 cfs @ 12.15 hrs, Volume= 4,777 cf, Depth= 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YearMass Rainfall=6.05"

Area (sf)	CN	Description
20,150	70	Woods, Good, HSG C
20,150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.7	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.2	70	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.9	120	Total			

Summary for Subcatchment DA-E1: Wetland/ Culvert - From Original Analysis DA-3-L

Runoff = 19.09 cfs @ 12.18 hrs, Volume= 75,296 cf, Depth= 5.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YearMass Rainfall=7.76"

Area (sf)	CN	Description
145,445	82	Row crops, SR + CR, Good, HSG C
10,513	74	>75% Grass cover, Good, HSG C
4,467	83	Brush, Poor, HSG D
160,425	82	Weighted Average
160,425		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0100	0.23		**Sheet Flow,** Cultivated: Residue<=20% n= 0.060 P2= 3.00"
9.3	708	0.0200	1.27		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
13.0	758	Total			

Summary for Subcatchment DA-E2: East to Huntoon Highway

Runoff = 2.95 cfs @ 12.21 hrs, Volume= 12,192 cf, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YearMass Rainfall=7.76"

Area (sf)	CN	Description
34,355	70	Woods, Good, HSG C
34,355		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
4.6	240	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.4	290	Total			

Summary for Subcatchment DA-E3: East to Parcel 44-A9

Runoff = 1.96 cfs @ 12.15 hrs, Volume= 7,151 cf, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YearMass Rainfall=7.76"

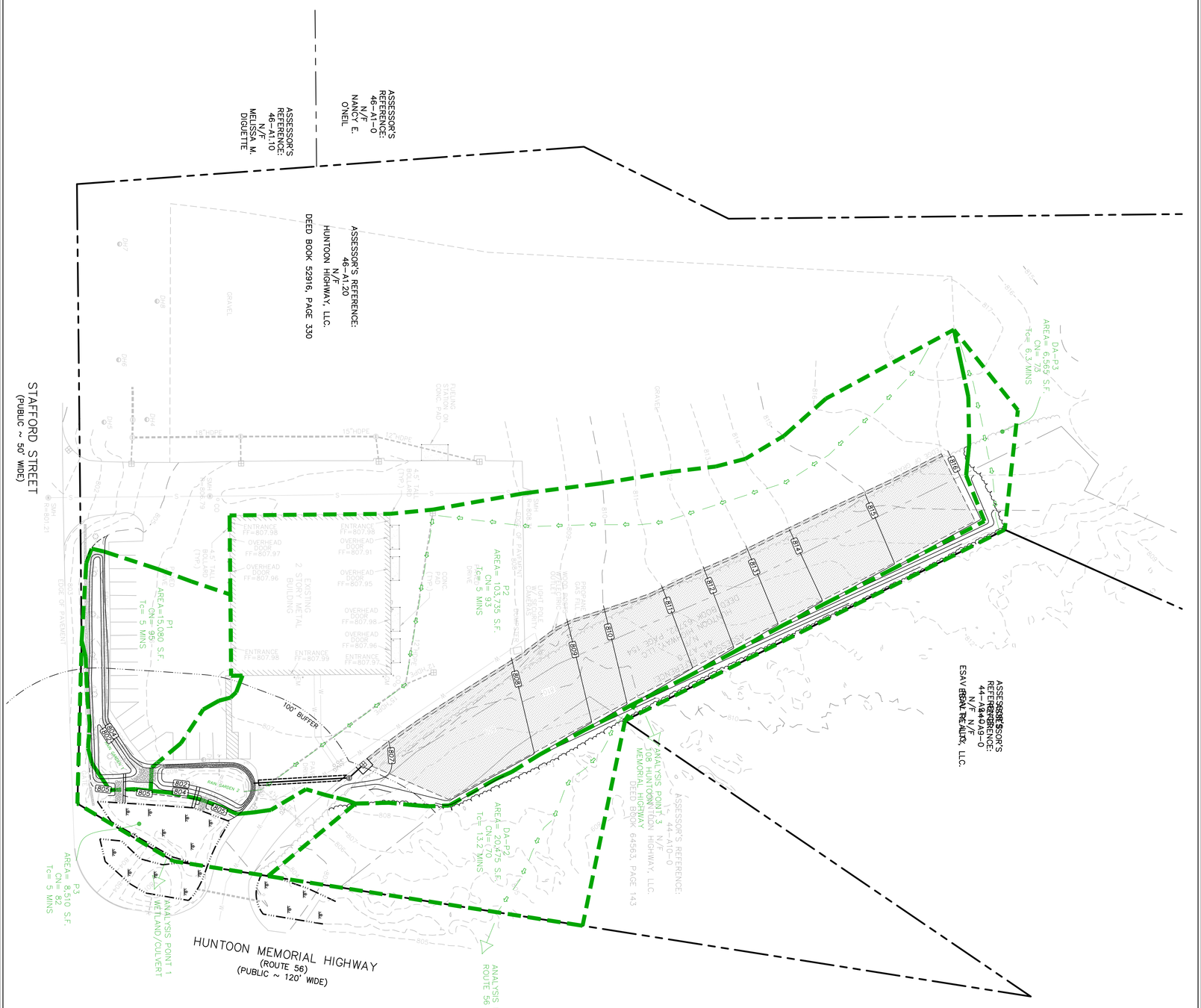
Area (sf)	CN	Description
20,150	70	Woods, Good, HSG C
20,150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.7	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
1.2	70	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.9	120	Total			

APPENDIX E

POST-DEVELOPMENT SUBCATCHMENT MODEL

POST-DEVELOPMENT HYDROCAD DRAINAGE CALCULATIONS



POST-DEVELOPMENT

DRAWN BY:	WCN
DATE:	8/20/2025
SCALE:	1"=40'
PROJ. NO.	152-2415-M

SITE PLAN MODIFICATION
112 HUNTOON MEMORIAL HIGHWAY
ROCHDALE, MA

PREPARED FOR
HUNTOON HIGHWAY, LLC.
112 HUNTOON MEMORIAL HIGHWAY
ROCHDALE, MA 01542-0338

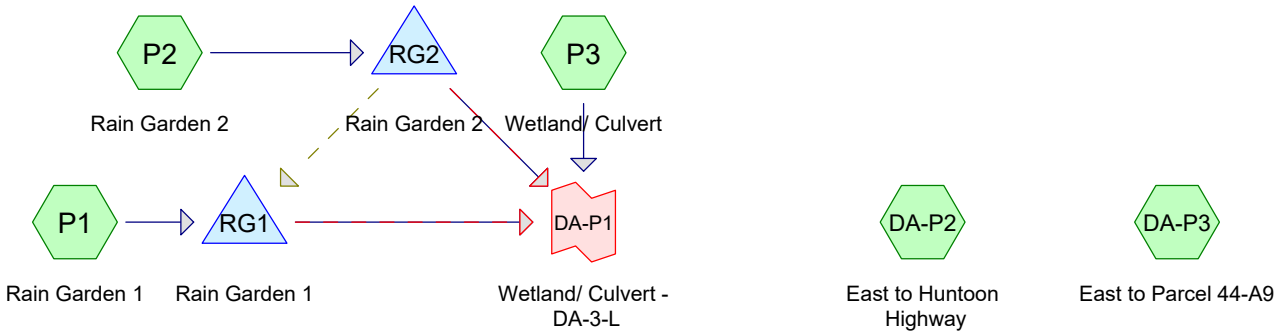
McCLURE ENGINEERING, INC
119 Worcester Road
Charlton, MA 01507
Tel: (508) 248-2005
Fax (508) 248-4887
Email: pengle@mcclureengineers.com

PETER C. ENGLE, P.E.
PROFESSIONAL ENGINEER
MA LIC. NO. 53736

HOR. SCALE IN FEET: 1"=40'
40 0 40 80 120

REVISIONS

REV	DATE	DESCRIPTION	MADE	APV'D



Subcat Reach Pond Link

Routing Diagram for Post-Development_PE_7.7.21
Prepared by Microsoft, Printed 8/20/2021

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
16,270	74	>75% Grass cover, Good, HSG C (DA-P2, DA-P3, P1, P2, P3)
2,750	83	Brush, Poor, HSG D (P3)
56,890	91	Gravel surface, HSG C (P2)
37,835	98	Paved parking, HSG C (P1, P2, P3)
14,400	98	Roof, HSG C (P2)
4,230	98	Water Surface, HSG C (P1, P2)
21,990	70	Woods, Good, HSG C (DA-P2, DA-P3, P3)
154,365	**89**	**TOTAL AREA**

Summary for Subcatchment DA-P2: East to Huntoon Highway

Runoff = 0.31 cfs @ 12.20 hrs, Volume= 1,393 cf, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YearMass Rainfall=3.18"

Area (sf)	CN	Description
19,315	70	Woods, Good, HSG C
1,160	74	>75% Grass cover, Good, HSG C
20,475	70	Weighted Average
20,475		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
2.4	125	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
13.2	175	Total			

Summary for Subcatchment DA-P3: East to Parcel 44-A9

Runoff = 0.16 cfs @ 12.10 hrs, Volume= 531 cf, Depth= 0.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YearMass Rainfall=3.18"

Area (sf)	CN	Description
2,005	70	Woods, Good, HSG C
4,560	74	>75% Grass cover, Good, HSG C
6,565	73	Weighted Average
6,565		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	50	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
1.4	85	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.3	135	Total			

Summary for Subcatchment P1: Rain Garden 1

Runoff = 1.04 cfs @ 12.07 hrs, Volume= 3,299 cf, Depth= 2.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YearMass Rainfall=3.18"

Area (sf)	CN	Description
2,485	98	Water Surface, HSG C
1,710	74	>75% Grass cover, Good, HSG C
10,885	98	Paved parking, HSG C
15,080	95	Weighted Average
1,710		11.34% Pervious Area
13,370		88.66% Impervious Area

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

Summary for Subcatchment P2: Rain Garden 2

Runoff = 6.80 cfs @ 12.07 hrs, Volume= 20,977 cf, Depth= 2.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YearMass Rainfall=3.18"

	Area (sf)	CN	Description
	5,750	74	>75% Grass cover, Good, HSG C
	1,745	98	Water Surface, HSG C
	24,950	98	Paved parking, HSG C
*	56,890	91	Gravel surface, HSG C
*	14,400	98	Roof, HSG C
	103,735	93	Weighted Average
	62,640		60.38% Pervious Area
	41,095		39.62% Impervious Area

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

Summary for Subcatchment P3: Wetland/ Culvert

Runoff = 0.36 cfs @ 12.08 hrs, Volume= 1,079 cf, Depth= 1.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YearMass Rainfall=3.18"

Area (sf)	CN	Description
2,000	98	Paved parking, HSG C
3,090	74	>75% Grass cover, Good, HSG C
2,750	83	Brush, Poor, HSG D
670	70	Woods, Good, HSG C
8,510	82	Weighted Average
6,510		76.50% Pervious Area
2,000		23.50% Impervious Area

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

Summary for Pond RG1: Rain Garden 1

Inflow Area = 15,080 sf, 88.66% Impervious, Inflow Depth = 2.91" for 2YearMass event
Inflow = 2.18 cfs @ 12.11 hrs, Volume= 3,655 cf
Outflow = 0.02 cfs @ 18.14 hrs, Volume= 351 cf, Atten= 99%, Lag= 361.8 min
Primary = 0.02 cfs @ 18.14 hrs, Volume= 351 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 802.06' @ 18.14 hrs Surf.Area= 5,325 sf Storage= 3,337 cf

Plug-Flow detention time= 731.6 min calculated for 350 cf (10% of inflow)
Center-of-Mass det. time= 472.0 min (1,247.1 - 775.1)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	6,115 cf	**Ponding (Irregular)** Listed below (Recalc)
#2	801.75'	298 cf	**Mulch (Irregular)** Listed below (Recalc) 596 cf Overall x 50.0% Voids
#3	798.60'	3,005 cf	**Soil Media and Gravel (Irregular)** Listed below (Recalc) 7,513 cf Overall x 40.0% Voids
		9,418 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	500	105.0	0	0	500
803.00	1,690	370.0	1,036	1,036	10,520
804.00	2,485	385.0	2,075	3,111	11,497
805.00	3,555	420.0	3,004	6,115	13,775

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.75	2,385	380.0	0	0	2,385
802.00	2,385	380.0	596	596	2,480

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
798.60	2,385	380.0	0	0	2,385
801.75	2,385	380.0	7,513	7,513	3,582

Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**4.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf
#2	Primary	802.00'	**12.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500

			Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900
			n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Secondary	803.50'	**5.0' long x 10.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.02 cfs @ 18.14 hrs HW=802.06' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.01 cfs @ 0.78 fps)
└─**2=Culvert** (Barrel Controls 0.01 cfs @ 0.81 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=798.60' TW=0.00' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond RG2: Rain Garden 2

Inflow Area = 103,735 sf, 39.62% Impervious, Inflow Depth = 2.43" for 2YearMass event
Inflow = 6.80 cfs @ 12.07 hrs, Volume= 20,977 cf
Outflow = 5.99 cfs @ 12.11 hrs, Volume= 18,552 cf, Atten= 12%, Lag= 2.5 min
Primary = 4.11 cfs @ 12.11 hrs, Volume= 18,017 cf
Secondary = 0.63 cfs @ 12.11 hrs, Volume= 178 cf
Tertiary = 1.25 cfs @ 12.11 hrs, Volume= 356 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 803.64' @ 12.11 hrs Surf.Area= 5,127 sf Storage= 4,694 cf

Plug-Flow detention time= 97.8 min calculated for 18,552 cf (88% of inflow)
Center-of-Mass det. time= 44.0 min (836.0 - 792.0)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	4,920 cf	**Ponding (Irregular)** Listed below (Recalc)
#2	801.75'	218 cf	**Mulch (Irregular)** Listed below (Recalc) 436 cf Overall x 50.0% Voids
#3	798.60'	2,199 cf	**Soil Media and Gravel (Irregular)** Listed below (Recalc) 5,497 cf Overall x 40.0% Voids
		7,337 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	1,140	165.0	0	0	1,140
803.00	1,455	175.0	1,294	1,294	1,460
804.00	1,745	185.0	1,598	2,892	1,798
805.00	2,325	205.0	2,028	4,920	2,448

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.75	1,745	185.0	0	0	1,745
802.00	1,745	185.0	436	436	1,791

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
798.60	1,745	185.0	0	0	1,745
801.75	1,745	185.0	5,497	5,497	2,328

Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**4.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf
#2	Primary	802.00'	**12.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Secondary	803.50'	**5.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#4	Tertiary	803.50'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=4.11 cfs @ 12.11 hrs HW=803.64' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Barrel Controls 0.40 cfs @ 4.63 fps)
- **2=Culvert** (Barrel Controls 3.71 cfs @ 4.72 fps)

Secondary OutFlow Max=0.62 cfs @ 12.11 hrs HW=803.64' TW=0.00' (Dynamic Tailwater)
- **3=Broad-Crested Rectangular Weir** (Weir Controls 0.62 cfs @ 0.92 fps)

Tertiary OutFlow Max=1.24 cfs @ 12.11 hrs HW=803.64' TW=800.32' (Dynamic Tailwater)
- **4=Broad-Crested Rectangular Weir** (Weir Controls 1.24 cfs @ 0.92 fps)

Summary for Link DA-P1: Wetland/ Culvert - DA-3-L

Inflow Area = 127,325 sf, 44.35% Impervious, Inflow Depth = 1.85" for 2YearMass event
Inflow = 5.07 cfs @ 12.11 hrs, Volume= 19,625 cf
Primary = 5.07 cfs @ 12.11 hrs, Volume= 19,625 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Subcatchment DA-P2: East to Huntoon Highway

Runoff = 0.86 cfs @ 12.19 hrs, Volume= 3,411 cf, Depth= 2.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YearMass Rainfall=4.95"

Area (sf)	CN	Description
19,315	70	Woods, Good, HSG C
1,160	74	>75% Grass cover, Good, HSG C
20,475	70	Weighted Average
20,475		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
2.4	125	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
13.2	175	Total			

Summary for Subcatchment DA-P3: East to Parcel 44-A9

Runoff = 0.39 cfs @ 12.10 hrs, Volume= 1,226 cf, Depth= 2.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YearMass Rainfall=4.95"

Area (sf)	CN	Description
2,005	70	Woods, Good, HSG C
4,560	74	>75% Grass cover, Good, HSG C
6,565	73	Weighted Average
6,565		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	50	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
1.4	85	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.3	135	Total			

Summary for Subcatchment P1: Rain Garden 1

Runoff = 1.69 cfs @ 12.07 hrs, Volume= 5,492 cf, Depth= 4.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YearMass Rainfall=4.95"

Area (sf)	CN	Description
2,485	98	Water Surface, HSG C
1,710	74	>75% Grass cover, Good, HSG C
10,885	98	Paved parking, HSG C
15,080	95	Weighted Average
1,710		11.34% Pervious Area
13,370		88.66% Impervious Area

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

Summary for Subcatchment P2: Rain Garden 2

Runoff = 11.29 cfs @ 12.07 hrs, Volume= 35,865 cf, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YearMass Rainfall=4.95"

	Area (sf)	CN	Description
	5,750	74	>75% Grass cover, Good, HSG C
	1,745	98	Water Surface, HSG C
	24,950	98	Paved parking, HSG C
*	56,890	91	Gravel surface, HSG C
*	14,400	98	Roof, HSG C
	103,735	93	Weighted Average
	62,640		60.38% Pervious Area
	41,095		39.62% Impervious Area

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

Summary for Subcatchment P3: Wetland/ Culvert

Runoff = 0.72 cfs @ 12.07 hrs, Volume= 2,152 cf, Depth= 3.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YearMass Rainfall=4.95"

Area (sf)	CN	Description
2,000	98	Paved parking, HSG C
3,090	74	>75% Grass cover, Good, HSG C
2,750	83	Brush, Poor, HSG D
670	70	Woods, Good, HSG C
8,510	82	Weighted Average
6,510		76.50% Pervious Area
2,000		23.50% Impervious Area

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

Summary for Pond RG1: Rain Garden 1

Inflow Area = 15,080 sf, 88.66% Impervious, Inflow Depth = 6.40" for 10YearMass event
Inflow = 6.03 cfs @ 12.08 hrs, Volume= 8,049 cf
Outflow = 2.54 cfs @ 12.19 hrs, Volume= 4,744 cf, Atten= 58%, Lag= 6.3 min
Primary = 2.54 cfs @ 12.19 hrs, Volume= 4,744 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 803.04' @ 12.19 hrs Surf.Area= 6,486 sf Storage= 4,401 cf

Plug-Flow detention time= 151.5 min calculated for 4,742 cf (59% of inflow)
Center-of-Mass det. time= 77.7 min (832.4 - 754.6)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	6,115 cf	**Ponding (Irregular)** Listed below (Recalc)
#2	801.75'	298 cf	**Mulch (Irregular)** Listed below (Recalc) 596 cf Overall x 50.0% Voids
#3	798.60'	3,005 cf	**Soil Media and Gravel (Irregular)** Listed below (Recalc) 7,513 cf Overall x 40.0% Voids
		9,418 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	500	105.0	0	0	500
803.00	1,690	370.0	1,036	1,036	10,520
804.00	2,485	385.0	2,075	3,111	11,497
805.00	3,555	420.0	3,004	6,115	13,775

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.75	2,385	380.0	0	0	2,385
802.00	2,385	380.0	596	596	2,480

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
798.60	2,385	380.0	0	0	2,385
801.75	2,385	380.0	7,513	7,513	3,582

Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**4.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf
#2	Primary	802.00'	**12.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500

			Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Secondary	803.50'	**5.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=2.54 cfs @ 12.19 hrs HW=803.04' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.31 cfs @ 3.50 fps)
└─**2=Culvert** (Barrel Controls 2.23 cfs @ 3.41 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=798.60' TW=0.00' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond RG2: Rain Garden 2

Inflow Area = 103,735 sf, 39.62% Impervious, Inflow Depth = 4.15" for 10YearMass event
Inflow = 11.29 cfs @ 12.07 hrs, Volume= 35,865 cf
Outflow = 11.10 cfs @ 12.08 hrs, Volume= 33,440 cf, Atten= 2%, Lag= 0.8 min
Primary = 4.55 cfs @ 12.08 hrs, Volume= 29,604 cf
Secondary = 2.18 cfs @ 12.08 hrs, Volume= 1,279 cf
Tertiary = 4.37 cfs @ 12.08 hrs, Volume= 2,557 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 803.81' @ 12.08 hrs Surf.Area= 5,178 sf Storage= 4,983 cf

Plug-Flow detention time= 71.2 min calculated for 33,440 cf (93% of inflow)
Center-of-Mass det. time= 34.8 min (812.5 - 777.7)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	4,920 cf	**Ponding (Irregular)** Listed below (Recalc)
#2	801.75'	218 cf	**Mulch (Irregular)** Listed below (Recalc) 436 cf Overall x 50.0% Voids
#3	798.60'	2,199 cf	**Soil Media and Gravel (Irregular)** Listed below (Recalc) 5,497 cf Overall x 40.0% Voids
		7,337 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	1,140	165.0	0	0	1,140
803.00	1,455	175.0	1,294	1,294	1,460
804.00	1,745	185.0	1,598	2,892	1,798
805.00	2,325	205.0	2,028	4,920	2,448

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.75	1,745	185.0	0	0	1,745
802.00	1,745	185.0	436	436	1,791

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
798.60	1,745	185.0	0	0	1,745
801.75	1,745	185.0	5,497	5,497	2,328

Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**4.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf
#2	Primary	802.00'	**12.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Secondary	803.50'	**5.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#4	Tertiary	803.50'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=4.55 cfs @ 12.08 hrs HW=803.81' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Barrel Controls 0.43 cfs @ 4.91 fps)
- **2=Culvert** (Barrel Controls 4.12 cfs @ 5.25 fps)

Secondary OutFlow Max=2.18 cfs @ 12.08 hrs HW=803.81' TW=0.00' (Dynamic Tailwater)
- **3=Broad-Crested Rectangular Weir** (Weir Controls 2.18 cfs @ 1.41 fps)

Tertiary OutFlow Max=4.35 cfs @ 12.08 hrs HW=803.81' TW=802.27' (Dynamic Tailwater)
- **4=Broad-Crested Rectangular Weir** (Weir Controls 4.35 cfs @ 1.41 fps)

Summary for Link DA-P1: Wetland/ Culvert - DA-3-L

Inflow Area = 127,325 sf, 44.35% Impervious, Inflow Depth = 3.56" for 10YearMass event
Inflow = 8.82 cfs @ 12.13 hrs, Volume= 37,778 cf
Primary = 8.82 cfs @ 12.13 hrs, Volume= 37,778 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Subcatchment DA-P2: East to Huntoon Highway

Runoff = 1.24 cfs @ 12.19 hrs, Volume= 4,854 cf, Depth= 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YearMass Rainfall=6.05"

Area (sf)	CN	Description
19,315	70	Woods, Good, HSG C
1,160	74	>75% Grass cover, Good, HSG C
20,475	70	Weighted Average
20,475		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
2.4	125	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
13.2	175	Total			

Summary for Subcatchment DA-P3: East to Parcel 44-A9

Runoff = 0.55 cfs @ 12.09 hrs, Volume= 1,712 cf, Depth= 3.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YearMass Rainfall=6.05"

Area (sf)	CN	Description
2,005	70	Woods, Good, HSG C
4,560	74	>75% Grass cover, Good, HSG C
6,565	73	Weighted Average
6,565		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	50	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
1.4	85	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.3	135	Total			

Summary for Subcatchment P1: Rain Garden 1

Runoff = 2.08 cfs @ 12.07 hrs, Volume= 6,863 cf, Depth= 5.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YearMass Rainfall=6.05"

Area (sf)	CN	Description
2,485	98	Water Surface, HSG C
1,710	74	>75% Grass cover, Good, HSG C
10,885	98	Paved parking, HSG C
15,080	95	Weighted Average
1,710		11.34% Pervious Area
13,370		88.66% Impervious Area

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

Summary for Subcatchment P2: Rain Garden 2

Runoff = 14.05 cfs @ 12.07 hrs, Volume= 45,228 cf, Depth= 5.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YearMass Rainfall=6.05"

	Area (sf)	CN	Description
	5,750	74	>75% Grass cover, Good, HSG C
	1,745	98	Water Surface, HSG C
	24,950	98	Paved parking, HSG C
*	56,890	91	Gravel surface, HSG C
*	14,400	98	Roof, HSG C
	103,735	93	Weighted Average
	62,640		60.38% Pervious Area
	41,095		39.62% Impervious Area

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

Summary for Subcatchment P3: Wetland/ Culvert

Runoff = 0.95 cfs @ 12.07 hrs, Volume= 2,860 cf, Depth= 4.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YearMass Rainfall=6.05"

Area (sf)	CN	Description
2,000	98	Paved parking, HSG C
3,090	74	>75% Grass cover, Good, HSG C
2,750	83	Brush, Poor, HSG D
670	70	Woods, Good, HSG C
8,510	82	Weighted Average
6,510		76.50% Pervious Area
2,000		23.50% Impervious Area

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

Summary for Pond RG1: Rain Garden 1

Inflow Area = 15,080 sf, 88.66% Impervious, Inflow Depth = 8.91" for 25YearMass event
Inflow = 8.15 cfs @ 12.08 hrs, Volume= 11,202 cf
Outflow = 4.34 cfs @ 12.17 hrs, Volume= 7,897 cf, Atten= 47%, Lag= 5.1 min
Primary = 3.99 cfs @ 12.17 hrs, Volume= 7,824 cf
Secondary = 0.34 cfs @ 12.17 hrs, Volume= 74 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 803.59' @ 12.17 hrs Surf.Area= 6,912 sf Storage= 5,470 cf

Plug-Flow detention time= 117.1 min calculated for 7,897 cf (70% of inflow)
Center-of-Mass det. time= 57.7 min (806.3 - 748.6)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	6,115 cf	**Ponding (Irregular)** Listed below (Recalc)
#2	801.75'	298 cf	**Mulch (Irregular)** Listed below (Recalc) 596 cf Overall x 50.0% Voids
#3	798.60'	3,005 cf	**Soil Media and Gravel (Irregular)** Listed below (Recalc) 7,513 cf Overall x 40.0% Voids
		9,418 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	500	105.0	0	0	500
803.00	1,690	370.0	1,036	1,036	10,520
804.00	2,485	385.0	2,075	3,111	11,497
805.00	3,555	420.0	3,004	6,115	13,775

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.75	2,385	380.0	0	0	2,385
802.00	2,385	380.0	596	596	2,480

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
798.60	2,385	380.0	0	0	2,385
801.75	2,385	380.0	7,513	7,513	3,582

Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**4.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf
#2	Primary	802.00'	**12.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500

			Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900
			n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Secondary	803.50'	**5.0' long x 10.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=3.99 cfs @ 12.17 hrs HW=803.59' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.40 cfs @ 4.55 fps)
└─**2=Culvert** (Barrel Controls 3.59 cfs @ 4.57 fps)

Secondary OutFlow Max=0.34 cfs @ 12.17 hrs HW=803.59' TW=0.00' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Weir Controls 0.34 cfs @ 0.75 fps)

Summary for Pond RG2: Rain Garden 2

Inflow Area = 103,735 sf, 39.62% Impervious, Inflow Depth = 5.23" for 25YearMass event
Inflow = 14.05 cfs @ 12.07 hrs, Volume= 45,228 cf
Outflow = 13.86 cfs @ 12.08 hrs, Volume= 42,803 cf, Atten= 1%, Lag= 0.7 min
Primary = 4.73 cfs @ 12.08 hrs, Volume= 36,263 cf
Secondary = 3.04 cfs @ 12.08 hrs, Volume= 2,200 cf
Tertiary = 6.09 cfs @ 12.08 hrs, Volume= 4,339 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 803.88' @ 12.08 hrs Surf.Area= 5,200 sf Storage= 5,109 cf

Plug-Flow detention time= 61.6 min calculated for 42,803 cf (95% of inflow)
Center-of-Mass det. time= 31.3 min (803.1 - 771.8)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	4,920 cf	**Ponding (Irregular)** Listed below (Recalc)
#2	801.75'	218 cf	**Mulch (Irregular)** Listed below (Recalc) 436 cf Overall x 50.0% Voids
#3	798.60'	2,199 cf	**Soil Media and Gravel (Irregular)** Listed below (Recalc) 5,497 cf Overall x 40.0% Voids
		7,337 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	1,140	165.0	0	0	1,140
803.00	1,455	175.0	1,294	1,294	1,460
804.00	1,745	185.0	1,598	2,892	1,798
805.00	2,325	205.0	2,028	4,920	2,448

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.75	1,745	185.0	0	0	1,745
802.00	1,745	185.0	436	436	1,791

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
798.60	1,745	185.0	0	0	1,745
801.75	1,745	185.0	5,497	5,497	2,328

Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**4.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf
#2	Primary	802.00'	**12.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Secondary	803.50'	**5.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#4	Tertiary	803.50'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=4.72 cfs @ 12.08 hrs HW=803.88' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Barrel Controls 0.44 cfs @ 5.02 fps)
- **2=Culvert** (Barrel Controls 4.29 cfs @ 5.46 fps)

Secondary OutFlow Max=3.04 cfs @ 12.08 hrs HW=803.88' TW=0.00' (Dynamic Tailwater)
- **3=Broad-Crested Rectangular Weir** (Weir Controls 3.04 cfs @ 1.58 fps)

Tertiary OutFlow Max=6.07 cfs @ 12.08 hrs HW=803.88' TW=803.16' (Dynamic Tailwater)
- **4=Broad-Crested Rectangular Weir** (Weir Controls 6.07 cfs @ 1.58 fps)

Summary for Link DA-P1: Wetland/ Culvert - DA-3-L

Inflow Area = 127,325 sf, 44.35% Impervious, Inflow Depth = 4.64" for 25YearMass event
Inflow = 11.76 cfs @ 12.10 hrs, Volume= 49,221 cf
Primary = 11.76 cfs @ 12.10 hrs, Volume= 49,221 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Subcatchment DA-P2: East to Huntoon Highway

Runoff = 1.86 cfs @ 12.18 hrs, Volume= 7,267 cf, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YearMass Rainfall=7.76"

Area (sf)	CN	Description
19,315	70	Woods, Good, HSG C
1,160	74	>75% Grass cover, Good, HSG C
20,475	70	Weighted Average
20,475		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.00"
2.4	125	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
13.2	175	Total			

Summary for Subcatchment DA-P3: East to Parcel 44-A9

Runoff = 0.80 cfs @ 12.09 hrs, Volume= 2,515 cf, Depth= 4.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YearMass Rainfall=7.76"

Area (sf)	CN	Description
2,005	70	Woods, Good, HSG C
4,560	74	>75% Grass cover, Good, HSG C
6,565	73	Weighted Average
6,565		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	50	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.00"
1.4	85	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.3	135	Total			

Summary for Subcatchment P1: Rain Garden 1

Runoff = 2.70 cfs @ 12.07 hrs, Volume= 9,001 cf, Depth= 7.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YearMass Rainfall=7.76"

Area (sf)	CN	Description
2,485	98	Water Surface, HSG C
1,710	74	>75% Grass cover, Good, HSG C
10,885	98	Paved parking, HSG C
15,080	95	Weighted Average
1,710		11.34% Pervious Area
13,370		88.66% Impervious Area

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

Summary for Subcatchment P2: Rain Garden 2

Runoff = 18.30 cfs @ 12.07 hrs, Volume= 59,860 cf, Depth= 6.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YearMass Rainfall=7.76"

	Area (sf)	CN	Description
	5,750	74	>75% Grass cover, Good, HSG C
	1,745	98	Water Surface, HSG C
	24,950	98	Paved parking, HSG C
*	56,890	91	Gravel surface, HSG C
*	14,400	98	Roof, HSG C
	103,735	93	Weighted Average
	62,640		60.38% Pervious Area
	41,095		39.62% Impervious Area

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

Summary for Subcatchment P3: Wetland/ Culvert

Runoff = 1.31 cfs @ 12.07 hrs, Volume= 3,994 cf, Depth= 5.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YearMass Rainfall=7.76"

Area (sf)	CN	Description
2,000	98	Paved parking, HSG C
3,090	74	>75% Grass cover, Good, HSG C
2,750	83	Brush, Poor, HSG D
670	70	Woods, Good, HSG C
8,510	82	Weighted Average
6,510		76.50% Pervious Area
2,000		23.50% Impervious Area

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

Summary for Pond RG1: Rain Garden 1

Inflow Area = 15,080 sf, 88.66% Impervious, Inflow Depth = 12.72" for 100YearMass event
Inflow = 11.07 cfs @ 12.07 hrs, Volume= 15,979 cf
Outflow = 8.11 cfs @ 12.12 hrs, Volume= 12,674 cf, Atten= 27%, Lag= 3.3 min
Primary = 4.78 cfs @ 12.12 hrs, Volume= 11,191 cf
Secondary = 3.34 cfs @ 12.12 hrs, Volume= 1,483 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 803.91' @ 12.12 hrs Surf.Area= 7,175 sf Storage= 6,188 cf

Plug-Flow detention time= 96.3 min calculated for 12,670 cf (79% of inflow)
Center-of-Mass det. time= 46.8 min (790.3 - 743.5)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	6,115 cf	**Ponding (Irregular)** Listed below (Recalc)
#2	801.75'	298 cf	**Mulch (Irregular)** Listed below (Recalc) 596 cf Overall x 50.0% Voids
#3	798.60'	3,005 cf	**Soil Media and Gravel (Irregular)** Listed below (Recalc) 7,513 cf Overall x 40.0% Voids
		9,418 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	500	105.0	0	0	500
803.00	1,690	370.0	1,036	1,036	10,520
804.00	2,485	385.0	2,075	3,111	11,497
805.00	3,555	420.0	3,004	6,115	13,775

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.75	2,385	380.0	0	0	2,385
802.00	2,385	380.0	596	596	2,480

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
798.60	2,385	380.0	0	0	2,385
801.75	2,385	380.0	7,513	7,513	3,582

Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**4.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf
#2	Primary	802.00'	**12.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500

			Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900
			n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Secondary	803.50'	**5.0' long x 10.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60
			Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=4.78 cfs @ 12.12 hrs HW=803.91' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.44 cfs @ 5.06 fps)
└─**2=Culvert** (Barrel Controls 4.34 cfs @ 5.52 fps)

Secondary OutFlow Max=3.33 cfs @ 12.12 hrs HW=803.91' TW=0.00' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Weir Controls 3.33 cfs @ 1.64 fps)

Summary for Pond RG2: Rain Garden 2

Inflow Area = 103,735 sf, 39.62% Impervious, Inflow Depth = 6.92" for 100YearMass event
Inflow = 18.30 cfs @ 12.07 hrs, Volume= 59,860 cf
Outflow = 17.67 cfs @ 12.07 hrs, Volume= 57,434 cf, Atten= 3%, Lag= 0.1 min
Primary = 5.01 cfs @ 12.11 hrs, Volume= 46,171 cf
Secondary = 4.82 cfs @ 12.11 hrs, Volume= 4,285 cf
Tertiary = 8.38 cfs @ 12.07 hrs, Volume= 6,978 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 804.01' @ 12.11 hrs Surf.Area= 5,241 sf Storage= 5,329 cf

Plug-Flow detention time= 51.3 min calculated for 57,434 cf (96% of inflow)
Center-of-Mass det. time= 27.4 min (792.5 - 765.2)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	4,920 cf	**Ponding (Irregular)** Listed below (Recalc)
#2	801.75'	218 cf	**Mulch (Irregular)** Listed below (Recalc) 436 cf Overall x 50.0% Voids
#3	798.60'	2,199 cf	**Soil Media and Gravel (Irregular)** Listed below (Recalc) 5,497 cf Overall x 40.0% Voids
		7,337 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	1,140	165.0	0	0	1,140
803.00	1,455	175.0	1,294	1,294	1,460
804.00	1,745	185.0	1,598	2,892	1,798
805.00	2,325	205.0	2,028	4,920	2,448

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.75	1,745	185.0	0	0	1,745
802.00	1,745	185.0	436	436	1,791

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
798.60	1,745	185.0	0	0	1,745
801.75	1,745	185.0	5,497	5,497	2,328

Device	Routing	Invert	Outlet Devices
#1	Primary	802.00'	**4.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.09 sf
#2	Primary	802.00'	**12.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 802.00' / 801.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Secondary	803.50'	**5.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#4	Tertiary	803.50'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=5.01 cfs @ 12.11 hrs HW=804.01' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Barrel Controls 0.45 cfs @ 5.21 fps)
- **2=Culvert** (Barrel Controls 4.55 cfs @ 5.80 fps)

Secondary OutFlow Max=4.81 cfs @ 12.11 hrs HW=804.01' TW=0.00' (Dynamic Tailwater)
- **3=Broad-Crested Rectangular Weir** (Weir Controls 4.81 cfs @ 1.88 fps)

Tertiary OutFlow Max=7.81 cfs @ 12.07 hrs HW=803.98' TW=803.67' (Dynamic Tailwater)
- **4=Broad-Crested Rectangular Weir** (Weir Controls 7.81 cfs @ 1.64 fps)

Summary for Link DA-P1: Wetland/ Culvert - DA-3-L

Inflow Area = 127,325 sf, 44.35% Impervious, Inflow Depth = 6.33" for 100YearMass event
Inflow = 19.02 cfs @ 12.11 hrs, Volume= 67,124 cf
Primary = 19.02 cfs @ 12.11 hrs, Volume= 67,124 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

APPENDIX F

ADDITIONAL DRAINAGE CALCULATION WORKSHEETS

Central Mass Crane
112 Huntoon Memorial Highway
Leicester, MA

PIPE SIZING CALCULATIONS

McClure Engineering, Inc.
8/20/21

From	To	Q100, cfs Hydrocadd	pipe D, in	pipe L, ft	Rim El, ft	invert out	Downstream Invert	Design pipe slope	Pipe Full V, f/s	Manning Q, cfs (n=.013)
STC450i	DMH	5.16	12	10	806.75	804.95	804.7	0.025	7.19	5.65
DMH	RG2	5.16	15	70	807.00	804.60	804.15	0.006	4.23	5.19
Note:	HDPE Pipe, Use n=		0.013							

Brief Stormceptor Sizing Report - Rain Garden 2

Project Information & Location			
Project Name	Central Crane	**Project Number**	39142
City	Leicester	**State/ Province**	Massachusetts
Country	United States of America	**Date**	7/14/2021
Designer Information		**EOR Information (optional)**	
Name	Peter Engle	**Name**	
Company	McClure Engineering Inc	**Company**	
Phone #	508-248-2005	**Phone #**	
Email	pengle@mcclureengineers.com	**Email**	

Stormwater Treatment Recommendation
The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	Rain Garden 2
Target TSS Removal (%)	80
TSS Removal (%) Provided	81
Recommended Stormceptor Model	STC 450i

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	81
STC 900	88
STC 1200	88
STC 1800	88
STC 2400	91
STC 3600	91
STC 4800	93
STC 6000	93
STC 7200	95
STC 11000	96
STC 13000	96
STC 16000	97

Sizing Details

Drainage Area

Total Area (acres)	0.7
Imperviousness %	98.0

Rainfall

Station Name	EAST BRIMFIELD LAKE
State/Province	Massachusetts
Station ID #	2107
Years of Records	45
Latitude	42°7'0"N
Longitude	72°8'0"W

Water Quality Objective

TSS Removal (%)	80.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	9.90
Water Quality Flow Rate (CFS)	

Up Stream Storage

Storage (ac-ft)	Discharge (cfs)
0.000	0.000

Up Stream Flow Diversion

Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD)
The selected PSD defines TSS removal

Fine Distribution

Particle Diameter (microns)	Distribution %	Specific Gravity
20.0	20.0	1.30
60.0	20.0	1.80
150.0	20.0	2.20
400.0	20.0	2.65
2000.0	20.0	2.65

Notes

• Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
• Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
• For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX

APPENDIX G

CONSTRUCTION PERIOD INSPECTION REPORT

Weekly Stormwater Construction Site Inspection Report

General Information			
Project Name			
MassDEP File Number:			
Date of Inspection		**Start/End Time**	
Inspector's Name(s) & Contact Information			

Type of Inspection:
❑ Regular ❑ Pre-storm event ❑ During storm event ❑ Post-storm event

Weather Information

Has there been a storm event since the last inspection? ❑Yes ❑No
If yes, provide:
Storm Start Date & Time: Storm Duration (hrs): Approximate Amount of Precipitation (in):

Weather at time of this inspection?
❑ Clear ❑Cloudy ❑ Rain ❑ Sleet ❑ Fog ❑ Snowing ❑ High Winds
❑ Other: Temperature:

Have any discharges occurred since the last inspection? ❑Yes ❑No
If yes, describe:

Are there any discharges at the time of inspection? ❑Yes ❑No
If yes, describe:

	Site – Specific BMPs	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
1	Erosion Control Barrier	❑Yes ❑No	❑Yes ❑No	
2	Catch Basin Inlet Protection	❑Yes ❑No	❑Yes ❑No	
3	Temporary Soil Stabilization	❑Yes ❑No	❑Yes ❑No	
4	Stormwater System	❑Yes ❑No	❑Yes ❑No	

CERTIFICATION STATEMENT

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Print name and title: _____

Signature:_____ **Date:**_____

Overall Site Issues

Below are some general site issues that should be assessed during inspections. Customize this list as needed for conditions at your site.

	BMP/activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
1	**Slopes** and disturbed areas not actively being worked properly stabilized?	❑Yes ❑No	❑Yes ❑No	
2	**Natural Resource** areas (e.g., streams, wetlands, mature trees, etc.) protected with barriers or similar BMPs?	❑Yes ❑No	❑Yes ❑No	
3	**Perimeter Controls** and sediment barriers adequately installed (keyed into substrate) and maintained?	❑Yes ❑No	❑Yes ❑No	*Surround Stockpiles w/ straw bales if > 1 week
4	**Discharge Points** and receiving waters free of any sediment deposits?	❑Yes ❑No	❑Yes ❑No	
5	**Storm Drain Inlets** properly protected?	❑Yes ❑No	❑Yes ❑No	
6	**Construction exit** preventing sediment from being tracked into the street?	❑Yes ❑No	❑Yes ❑No	
7	**Trash / Litter** from work areas collected and placed in covered dumpsters?	❑Yes ❑No	❑Yes ❑No	
8	**Washout Facilities** (e.g., paint, stucco, concrete) available, clearly marked, and maintained?	❑Yes ❑No	❑Yes ❑No	
9	**Vehicle and Equipment Fueling,** cleaning, and maintenance areas free of spills, leaks, or any other deleterious material?	❑Yes ❑No	❑Yes ❑No	
10	**Materials** that are potential stormwater contaminants stored inside or under cover?	❑Yes ❑No	❑Yes ❑No	
11	**Non-stormwater discharges** (wash water, dewatering) properly controlled?	❑Yes ❑No	❑Yes ❑No	

APPENDIX H

STORMWATER MANAGEMENT SYSTEM
LONG-TERM OPERATION & MAINTENANCE (O & M) PLAN

ILLICIT DISCHARGE COMPLIANCE STATEMENT

CENTRAL MASS CRANE SERVICE

STAFFORD STREET & HUNTOON MEMORIAL HIGHWAY
ROCHDALE, MA 01542

STORMWATER COLLECTION AND TREATMENT SYSTEM

OPERATION AND MAINTENANCE PLAN

This long-term Operation and Maintenance Plan outlines the efforts necessary to ensure that the stormwater collection and treatment system of this site operates in accordance with Massachusetts Department of Environmental Protection Stormwater Management Policy (MSMP) and as designed and approved. In the event that the system performance becomes inadequate, adjustments in the Plan may become necessary to improve the performance.

It is noted that the following restrictions on the use of this property are recommended, for the protection of groundwater:

1. Use of salt on driveway, parking areas and sidewalks is to be minimized. Under any conditions where sand or other non-toxic materials are suitable, they are to be used.

2. Use of pesticides, herbicides and fertilizers should be restricted

3. Pet waste should be collected by the pet owner and disposed of properly.

4. Proper storage, use, and disposal of commercial/industrial/retail hazardous chemicals, tires, yard waste, paint and solvents, automobile fluids, and propane tanks is encouraged.

STORMWATER OWNERSHIP AND OPERATION RESPONSIBILITIES

Plan Approval:
Upon approval of the plans, the applicant shall provide a one-time deposit of funds to be placed in escrow under the owner/applicants name or a trust for the same. The amount shall be sufficient to cover the estimated cost of maintenance of the basins over a twenty-year period once the site has been constructed.

During Construction:
Construction, maintenance, oversight, and proper operation of the basin and the appurtenant stormwater management system, and construction period erosion and sedimentation controls throughout the construction period shall be the responsibility of the contractor. Until final sign off by the Town, the developer shall provide the Planning Board and Conservation Commission with monthly written reports of inspections performed.

Post construction:
The property owner shall be responsible for the inspection and maintenance of the drainage network and facilities upon acceptance and approval of the final construction.

SCHEDULE OF INSPECTIONAND MAINTENANCE TASKS

Onsite Drainage Areas. Areas that drain into the collection system from onsite must be inspected to verify that soil surfaces are stable and that erosion of soils into the collection system is not occurring. In the event that erosion of onsite soils is occurring, the soils must be stabilized against further erosion. Permanently finish the surface against erosion, by placing stable vegetation such as loam and grass seed, or by armoring the surface against erosion with rip-rap placed on a filter fabric blanket.

Asphalt Surfaces. Inspect asphalt surfaces for accumulation of sand, litter, eroded soils or other deleterious materials. Verify that no hazardous materials, such as fuel oil, motor oils or other material has occurred. Pick up all litter, junk, trash, or any other deleterious materials left on the surface. Upon detecting accumulation of sand, sediment or other materials, the asphalt surface must be swept to remove all such materials. All sweepings collected must be disposed of in accordance with current Massachusetts Department of Environmental Protection standards for such waste disposal. Any material deposits deemed to be hazardous must be removed and disposed of by a licensed contractor.

Deep Sump Catch Basins. Inspect units four times per year. Clean units 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. Regular maintenance is essential. Deep sump catch basins remain effective at removing pollutants only if they are cleaned out frequently. One study found that once 50% of the sump volume is filled, the catch basin is not able to retain additional sediments. Inspect or clean deep sump basins at least four times per year and at the end of the foliage and snow removal seasons. Sediments must also be 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. If handling runoff from land uses with higher potential pollutant loads or discharging runoff near or to a critical area, more frequent cleaning may be necessary. Clamshell buckets are typically used to remove sediment, however, vacuum

trucks are preferable, because they remove more trapped sediment and supernatant than clamshells. Vacuuming is also a speedier process and is less likely to snap the cast iron hood within the deep sump catch basin.

ADS StormTech Chambers. Periodic inspections of the inlet and outlet areas to ascertain correct operation of system and to clean materials trapped on grates protecting catch basins and inlet area should be required monthly. Routine sweeping and cleaning of impervious drainage areas will reduce floatables and sediment loading to underground stormwater storage chambers. The primary maintenance concerns are removal of floatables that become trapped and removal of accumulating sediments within the system; this should be done at least on an annual basis. Proprietary traps and filters associated with stormwater storage units should be maintained as recommended by the manufacturer. Sediments are best removed mechanically rather than flushing. If flushing is the only option then great care must be taken not to flush sediments downstream to off-site drainage systems. Generally, the chambers should be cleaned per manufacturer's recommendations. Any structural repairs required to inlet and outlet areas should be addressed in a timely manner on an as needed basis.

Rain Garden. Until the plant material has taken root, water the rain garden on a daily basis. In addition, water the rain garden during drought conditions. Inspect the soil and repair eroded areas of the rain garden monthly. Re-mulch void areas as needed. Remove litter and debris monthly. Treat diseased vegetation as needed. Remove and replace dead vegetation twice per year (spring and fall). Remove invasive species including weeds as needed to prevent these species from spreading into the rain garden. Replace mulch every two years, in the early spring. Upon failure, excavate rain garden area, scarify the bottom and sides, replace soil, replant, and mulch.

Grass Channels. Remove sediment from grass channel annually. Mow once a month during growing season. Repair areas of erosion and re-vegetate as needed, but no less than once a year.

Mowing Set the mower blades no lower than 3 to 4 inches above the ground. Do not mow beneath the depth of the design flow during the storm associated with the water quality event (e.g., if the design flow is no more than 4 inches, do not cut the grass shorter than 4 inches). Mow on an as-needed basis during the growing season so that the grass height does not exceed 6 inches.

Inspection: Inspect semi-annually the first year, and at least once a year thereafter. Inspect the grass for growth and the side slopes for signs of erosion and formation of rills and gullies. Plant an alternative grass species if the original grass cover is not successfully established. If grass growth is impaired by winter road salt or other deicer use, re-establish the grass in the spring.

Trash/Debris Removal: Remove accumulated trash and debris prior to mowing.

Sediment Removal: Check on a yearly basis and clean as needed. Use hand methods (i.e., a person with a shovel) when cleaning to minimize disturbance to vegetation and underlying soils.

Sediment build-up in the grass channel reduces its capacity to treat and convey the water quality event, 2-year and 10-year 24-hour storm.

Stormceptor Unit. Stormceptor unit shall be maintained per the manufacturer's recommendations attached.

RECORDKEEPING

It is necessary that record of each inspection and maintenance activity be kept. The record keeping shall be kept on the O&M Maintenance Log for issued by DEP. Such information should include the following:

- Person Performing the activity
- The date of the activity, and the weather conditions
- The preceding weather conditions
- The site conditions (dry, heavy snow cover, saturated conditions, etc.)
- The specific activity (inspection, cleaning, etc)
- The facility inspected
- The conditions of the facility
- The results of the activity

Stormceptor®

Inspection and Maintenance. Easy. Convenient.

When it rains, oils, sediment and other contaminants are captured and contained by over 20,000 Stormceptor units operating worldwide. While Stormceptor's patented scour prevention technology ensures captured pollutants remain in the unit during all rainfall events, the accumulated pollutants must eventually be removed as part of a regular maintenance program.

If neglected, oil and sediment gradually build up and diminish any BMP's efficiency, harming the environment and leaving owners and operators vulnerable to fines, surcharges and bad publicity.

Maintenance is a must

Ease, frequency and cost of maintenance are often overlooked by specifiers when considering the merits of a stormwater treatment system. In reality, maintenance is fundamental to the long-term performance of any stormwater quality treatment device.

While regular maintenance is crucial, it shouldn't be complicated. An ongoing maintenance program with Stormceptor is convenient and practically effortless. With virtually no disruptions, you can concentrate on your core business.

Quick inspections

Inspections are easily carried out above ground from any standard surface access cover through a visual inspection of the orifice and drop tee components. A sludge judge and oil dip-stick are all that are needed for sediment and oil depth measurements.

Easy unit access

Maintenance is typically conducted from the same surface access cover, eliminating the need for confined space entry into the unit. Your site remains undisturbed, saving you time and money.

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No muss, no fuss and fast

Maintenance is performed quickly and inexpensively with a standard vacuum truck. Servicing usually takes less than two hours, with no disruption to your site.

A complete stormwater management plan for Stormceptor extends beyond installation and performance to regular maintenance. It's the smart, cost-effective way to ensure your unit continues to remove more pollutants than any other separator for decades to come.

Stormceptor maintenance recommendations

- Units should be inspected post-construction, prior to being put into service.
- Inspect every six months for the first year of operation to determine the oil and sediment accumulation rate.
- In subsequent years, inspections can be based on first-year observations or local requirements.
- Cleaning is required once the sediment depth reaches 15% of storage capacity, (generally taking one year or longer). Local regulations for maintenance frequency may vary.
- Inspect the unit immediately after an oil, fuel or chemical spill.
- A licensed waste management company should remove captured petroleum waste products from any oil, chemical or fuel spills and dispose responsibly.

With over 20,000 units operating worldwide, Stormceptor performs and protects every day, in every storm.

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www.imbriumsystems.com

USA: (888) 279 8826
CANADA: (800) 565 4801

Illicit Discharge Compliance Statement
Site Stormwater Management System

Property Owner/Responsible Party: **Central Mass Crane Service, Inc.**
112 Huntoon Memorial Highway
Leicester, MA 01542
Phone: (781) 697-5861

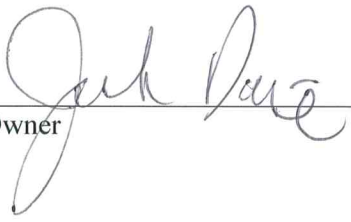
Storm water Management System Owner: **(same as above)**

Site subject to Wetlands Protection Act: **Yes**

The above listed Responsible Party is responsible for implementation of the "Long-Term Operation and Maintenance Plan" and certifies that:

- The site has been inspected for erosion and appropriate steps have been taken to permanently stabilize any eroded areas.
- All aspects of storm water 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 storm water at the site may be managed in accordance with the Stormwater Management Standards, revise date January 2, 2008.
- There is no record or knowledge of existing illicit discharges to the on-site stormwater management system.
- All "future property owners" must be notified of their continuing legal responsibility to operate and maintain the existing stormwater management system structures.
- The "Long-Term Operation and Maintenance Plan" for the storm water BMPs is being implemented.

Signature of Responsible Party:



Owner

8/25/2021
Date