STORMWATER MANAGEMENT REPORT

PROPOSED RETAIL MOTOR FUEL OUTLET RE-DEVELOPMENT
MAP U45 LOTS 7, 7-B, 8-A & 11-0
254, 256 & 260 AYER ROAD (ROUTE 2A)
LITTLETON, MA

MAP 30 LOT 16
0 LITTLETON ROAD
AYER, MA

GPI

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Prepared For:

Energy North Group
2 International Way
Lawrence, MA 01843

February 8, 2023

Energy North Group
Proposed Retail Motor Fuel Outlet
Stormwater Management Report

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SECTION 1 EXECUTIVE SUMMARY

Greenman-Pedersen, Inc. (GPI) has prepared this analysis of the stormwater management system for the proposed retail motor fuel outlet re-development located at 254, 256 & 260 Ayer Road (Route 2A/110) in Littleton, Massachusetts and 0 Littleton Road in Ayer, Massachusetts. This analysis includes pre-development and post-development calculations or stormwater runoff rates from the project site. The analysis has been prepared in accordance with the Town of Ayer and Town of Littleton requirements and the Stormwater Management Standards of the Massachusetts Department of Environmental Protection (MassDEP) Massachusetts Stormwater Policy. The design is intended to interface with the improvements proposed as part of the MassDOT project #608443 which will reconstruct Route 2A along the site frontage.

The project site consists of five parcels total. Three parcels south of Ayer Road identified as Map U45 Lots 7-0, 7-B & 8-A (located in Littleton, MA) total approximately 2.79 acres and comprise the primary development area. Two parcels north of Ayer Road identified as Map U45 Lot 11-0 (located in Littleton, MA) and Map 30 Lot 16 (located in Ayer, MA) total approximately 0.52 acres and are ancillary to the primary development. The site south of Ayer Road is bounded by Ayer Road to the north, the intersection of Ayer Road and Bruce Street to the northeast, private residences along Bruce Street to the east, and wooded area to the south and west containing a campground.

The applicant, Energy North Group, proposes to redevelop the existing three parcels into a single development by demolishing the existing buildings and retail motor fuel outlet to construct a new retail motor fuel outlet. The re-development will include a 6,000 square foot convenience store, a new retail fuel canopy with five (5) dispensers (10 fueling positions), a new high-speed diesel fuel canopy with three (3) dispensers (2 fueling positions), three (3) new double-wall fiberglass underground fuel storage tanks, and an associated paved parking lot and driveways.

This project, which is considered a mix of redevelopment and new development under the DEP Stormwater Management Standards, provides on-site stormwater runoff management improvements over the existing site conditions.

In order to mitigate increases in peak discharge rates of stormwater runoff as a result of the new impervious surfaces, a new comprehensive stormwater management system has been designed that includes deep-sump, hooded catch basins, First Defense hydrodynamic separator units, an oil/water separator, two underground infiltration systems, a sediment forebay, an aboveground infiltration basin, and a bioretention area. The BMP's included in the proposed stormwater system are designed in accordance with the MassDEP Stormwater Management Standards to improve stormwater quality and quantity at the design points.

Based on site topography and discharge points, three design points are utilized for the purpose of this analysis. Design Point #1 represents Ayer Road. Design Point #2 represents the rear of the adjacent property to the east. Design Point #3 represents Willow Road.

The table below summarizes the comparative pre- and post-development peak rates of stormwater runoff at the design points.

TABLE 1: PEAK RATE ANALYSIS SUMMARY

Design Storm	Pre-Development (cfs)	Post-Development (cfs)	Change (cfs)
Design Point #1 – Ayer Road			
2-year	1.1	0.1	-1.0
10-year	3.0	0.8	-2.2
25-year	4.8	1.6	-3.2
100-year	8.6	4.7	-3.9
Design Point #2 – Adjacent Property (east)			
2-year	0.5	0.2	-0.3
10-year	1.4	0.6	-0.8
25-year	2.3	1.0	-1.3
100-year	4.1	1.7	-2.4
Design Point #3 – Willow Road			
2-year	1.2	0.0	-1.2
10-year	2.1	0.4	-1.7
25-year	2.8	1.0	-1.8
100-year	4.3	2.1	-2.2

(All values shown are peak rates in CFS)

In conclusion, by incorporating a new on-site drainage system that includes provisions for stormwater treatment, recharge and detention, there will be a reduction in peak rates of runoff at the Design Points as a result of the project during all storms analyzed.

Implementing the maintenance procedures outlined in the Operation and Maintenance Plan (O&M) will ensure the long-term performance of the system.

SECTION 2 EXISTING CONDITIONS

The project site consists of five parcels total. Three parcels south of Ayer Road identified as Map U45 Lots 7-0, 7-B & 8-A (located in Littleton, MA) total approximately 2.79 acres and comprise the primary development area. Two parcels north of Ayer Road identified as Map U45 Lot 11-0 (located in Littleton, MA) and Map 30 Lot 16 (located in Ayer, MA) total approximately 0.52 acres and are ancillary to the primary development. The site south of Ayer Road is bounded by Ayer Road to the north, the intersection of Ayer Road and Bruce Street to the northeast, private residences along Bruce Street to the east, and wooded area to the south and west containing a campground.

The site contains an existing retail motor fuel outlet with a 1,983 square foot convenience store, a retail fuel canopy with 4 dispensers, a diesel dispenser in the eastern portion of the site, and an associated paved parking lot. The rear (southern) portion of the site contains a 1,974 square foot building housing a tire recycling business. Parcel U45-8-A, which represents the western portion of the project site, is currently undeveloped and contains grassed and wooded areas throughout. Access is provided via two full-access driveways along Ayer Road.

Site topography generally slopes from south to north from a high elevation of 284 at the southern corner of the property to a low elevation of 253 at the northeast property corner along Ayer Road.

The two parcels north of Ayer Road consist of an existing paved parking area with wooded area to the north. Topography in that area slopes south to north from a high elevation of 254 along Ayer Road to a low elevation of 250 at the northern property corner.

Stormwater runoff from the existing development is either captured by one of several existing on-site catch basins or sheet flows over pavement uncontrolled into Ayer Road. It is unclear by survey and record plans where piped outlets from the on-site catch basins are directed, however, it is assumed that all flow eventually discharges into Ayer Road without treatment. Runoff from pervious areas flows over land to the north eventually into Ayer Road. Runoff from the southeastern portion of the site flows over land through woods to the east off-site to the rear of the abutting property. Currently, stormwater runoff receives no treatment or peak flow attenuation prior to discharging off-site eventually into the Ayer Road drainage system.

Stormwater runoff from the parcels north of Ayer Road flows uncontrolled over pavement and through woods to the northeast eventually to Willow Road.

The NRCS Web Soil Survey identifies on-site and surrounding soils as Canton-Charlton-Urban land complex and Hollis-Rock outcrop-Charlton complex with a Hydrologic Soil Group (HSG) classifications of ‘A’ and ‘D’ respectively. Refer to Appendix D for more information.

Test pits were performed by Greenman-Pedersen, Inc. (GPI) on December 15, 2022. The pits included several for drainage system design and others for septic system design. Test pits for drainage encountered sand and gravel as well as loamy sand overlain by fill (up to 5' thick). Test pits #2 - #4 were excavated to depths of nearly 10' with no redoximorphic features or refusal encountered. Test Pit #1 was performed on the property north of Ayer Road and encountered similar soil conditions with no redoximorphic features or refusal to 100" below ground.

There are no wetlands on or immediately adjacent to the site. The site is not located within a special flood hazard area (100-year flood) per insurance rate map number 25017C0216E, with an effective date of June 4, 2010.

SECTION 3 PROPOSED CONDITIONS

The applicant, Energy North Group, proposes to redevelop the existing three parcels into a single development by demolishing the existing buildings and retail motor fuel outlet to construct a new retail motor fuel outlet. The re-development will include a 6,000 square foot convenience store, a new retail fuel canopy with five (5) dispensers (10 fueling positions), a new high-speed diesel fuel canopy with three (3) dispensers (2 fueling positions), three (3) new double-wall fiberglass underground fuel storage tanks, and an associated paved parking lot and driveways.

To serve the redevelopment, the existing easterly driveway will remain and be slightly reconfigured to be an exit-only driveway. The existing driveway to the west will be closed and a new full-access driveway will be constructed further west with geometry to accommodate turning movements for WB-67 trucks.

The project will result in an increase in impervious area of approximately 45,700 square feet and is therefore considered a mix of redevelopment and new development under the DEP Stormwater Management Standards. The proposed design will provide on-site stormwater runoff management improvements over the existing site conditions.

In order to mitigate increases in peak discharge rates of stormwater runoff as a result of the new impervious surfaces, a new comprehensive stormwater management system has been designed that includes deep-sump, hooded catch basins, First Defense hydrodynamic separator units, an oil/water separator, two underground infiltration systems, a sediment forebay, an aboveground infiltration basin, and a bioretention area.

The BMP's included in the proposed stormwater system are designed in accordance with the MassDEP Stormwater Management Standards to improve stormwater quality and quantity at the design points. Underground drainage pipes have been sized to accommodate the 25-year storm event.

Runoff from the building roof, retail canopy, and diesel canopy will be directed through pipes to an underground infiltration system (UG-INF-2) consisting of Stormtech MC-3500 chambers surrounded by crushed stone. The volume of the system has been designed to maximize the amount of roof runoff recharge. A 6" HDPE outlet pipe is provided as an emergency overflow which is directed back into the on-site drainage system.

Runoff from paved surfaces in the southeastern, southern, and western portions of the site which do not have potential for fuel spills will be captured in deep sump catch basins with hooded outlets and directed through pipes to an underground infiltration system (UG-INF-1). This system consists of Stormtech MC-3500 chambers surrounded by crushed stone with manifold piping and an isolator row for additional pre-treatment prior to infiltration. Outlet control is provided via an outlet pipe and drain manhole to regulate flow rates from the infiltration system before

discharging into the closed drainage system downstream. The infiltration system volume has been designed to maximize the amount of on-site groundwater recharge in an effort to reduce the rate and volume of runoff ultimately leaving the site.

Paved surfaces in the northern and northeastern portions of the site including areas surrounding the dispensers and underground fuel tank pad have the potential for fuel spills and are considered land uses with a higher potential pollutant load (LUHPPL). Runoff from these areas will be captured in deep sump catch basins with hooded outlets and be directed through a First Defense hydrodynamic separator and an oil/water separator to remove floatables, fine particles, and provide storage for fuels/oils in the event of a spill. Runoff will then enter a sediment forebay with an impermeable liner and an aboveground infiltration system to provide treatment and groundwater recharge. An emergency overflow pipe will allow larger storm events to discharge into the closed drainage system within Ayer Road.

As part of the re-development, all existing on-site catch basins are to be removed, with the exception of one to remain in the driveway. The majority of stormwater runoff from the existing site, as described above, currently discharges into Ayer Road with no stormwater treatment, however, due to limited record information the exact pipe discharge points are not known. Accordingly, a new drain overflow connection to the Ayer Road drainage system is proposed to convey treated overflow from the site which is not otherwise infiltrated on-site.

The project will also improve the quantity and quality of the runoff from the two parcels north of Ayer Road by constructing a new bioretention area with rip rap apron to treat runoff from the paved parking area by filtering it through a designed media before infiltrating into the underlying soil or discharging off-site to Willow Road.

An Operation & Maintenance Plan (O&M) will be implemented to safeguard against future intrusion of contaminants and TSS and ensure proper maintenance and function of all drainage components.

To prevent erosion and sedimentation during construction, Best Management Practices including stabilized construction entrances, silt fence, catch basin inserts, and temporary and permanent seeding have been incorporated into the construction sequence.

The total area of disturbance related to the proposed construction on this property is approximately 122,000 square feet, therefore, the project is subject to a US EPA Construction General Permit under the NPDES program.

Stormwater Quality Controls:

1. **Street Sweeping** - to capture sediment prior to entering the drainage system. This would be done on a scheduled basis. TSS Removal Rate = 5%

2. **Catch Basins with Deep Sumps and Hooded Outlets** to capture, pretreat, and direct stormwater to the proposed treatment devices. TSS Removal Rate = 25%
3. **First Defense units** – to provide pretreatment and TSS removal of stormwater runoff prior to entering downstream BMPs. TSS removal rate = 70%
4. **Oil/Water Separator** – to provide additional pretreatment, as well sediment & oil storage capacity prior to discharge to the underground detention system. TSS Removal Rate = 25%
5. **Underground Infiltration Systems** - to recharge convenience store and canopy rooftop runoff & runoff from non-LUHPPL pavement areas. TSS removal rate = 80%
6. **Sediment Forebay** – to provide pretreatment through gravity settling of suspended solids. TSS removal rate = 25%
7. **Aboveground Infiltration Basin** - to recharge runoff from pavement areas. TSS removal rate = 80%
8. **Bioretention Area** – to provide treatment through filtration, microbe activity, and uptake by plants. TSS removal rate = 90%

Groundwater Recharge:

Groundwater recharge is provided in the underground infiltration systems, aboveground infiltration basin, and bioretention area.

Stormwater Quantity Controls:

The stormwater management system has been designed to convey stormwater runoff from the site during the 25-year storm event. Peak flow rates of stormwater runoff are reduced though the use of two underground infiltration systems, an aboveground infiltration basin, and a bioretention area.

Stormwater Management Standards:

Standard #1: Untreated Stormwater

Full compliance:

- No new untreated stormwater discharges directly to wetlands or waters of the Commonwealth are proposed.

Standard #2: Post Development Peak Discharge Rates

Full compliance:

- Implementing the stormwater management system will result in a decrease in post-development peak flow rates compared with pre-development rates for all storms analyzed. Refer to Table 1 in Section 1.

Standard #3: Groundwater Recharge

Full Compliance

On-site groundwater recharge is provided through the use of two underground infiltration systems and a bioretention area.

In accordance with Massachusetts Stormwater Policy, the required groundwater recharge volume (Rv) is based on a target depth factor (F) over impervious areas. The target depth factors for HSG-A & D soils is 0.60 and 0.10 inches respectively. The on-site impervious area = 54,758 sf for A soils and 34,553 sf for D soils.

Required Groundwater Recharge Volume:

$$R_v = F * A_{impervious}$$

$$R_v = 0.60\ inches\left(\frac{1\ in}{12\ ft}\right) * 54{,}758\ sf = \mathbf{2{,}738\ c.f.}$$

$$R_v = F * A_{impervious}$$

$$R_v = 0.10\ inches\left(\frac{1\ in}{12\ ft}\right) * 34{,}553\ sf = \mathbf{288\ c.f.}$$

The total required groundwater recharge volume is **3,026 cubic feet**. The recharge volume provided is the volume within the system below the lowest outlet elevation (measured statically). See summary table below.

Groundwater Recharge Volume Provided		
BMP	**Elevation**	**Volume Provided**
Underground Infiltration System #1	250.00-252.65	**5,373 c.f.**
Underground Infiltration System #2	249.50 – 253.02	**2,357 c.f.**
Aboveground Infiltration Basin	250.00-252.00	**2,433 c.f.**
Bioretention Area	248.00-251.50	**320 c.f.**

Total Annual Recharge Volume Provided = 10,483 c.f.
(See Appendix G for HydroCAD summaries)

Standard #4: TSS Removal

Full Compliance

Water Quality Volume Calculations:

The proposed infiltration practices are designed to store and infiltrate the water quality volume (V_{WQ}) from its contributing paved impervious surfaces. The water quality volume (V_{WQ}) is the volume of impervious surfaces times the water quality depth (D_{WQ}). A water quality depth of 1 inch is used due to the soils having an infiltration rate greater than 2.4 inches per hour and the use classified as a land use with higher potential pollutant loads (LUHPPL).

Underground Infiltration System #1:

The contributing impervious area to the Infiltration Basin is 31,701 sf.

$$V_{WQ} = D_{WQ} * A_{impervious}$$

$$V_{WQ} = 1\ in \left(\frac{1\ in}{12\ ft}\right) * 31{,}701\ sf = \mathbf{2{,}642\ c.f.}$$

The infiltration basin provides storage capacity for a treatment volume of 5,373 cf of runoff and exceeds the required volume of 2,642 cf.

Aboveground Infiltration #1:

The contributing impervious area to the Infiltration Basin is 27,769 sf.

$$V_{WQ} = D_{WQ} * A_{impervious}$$

$$V_{WQ} = 1\ in \left(\frac{1\ in}{12\ ft}\right) * 27{,}769\ sf = \mathbf{2{,}314\ c.f.}$$

The infiltration basin provides storage capacity for a treatment volume of 2,433 cf of runoff and exceeds the required volume of 2,314 cf.

First Defense Units:

The proposed First Defense units are sized by the manufacturer to provide treatment of the water quality flow rate for each contributing area. The water quality flow rates at DMH-8(FD) and CB-8(FD) during a 1-inch water quality storm are 0.27 cfs and 0.26 cfs respectively. The proposed First Defense FD-4HC unit is NJDEP certified to treat runoff up to 1.50 cfs. Refer to the product brochure included in Appendix G.

Oil/Water Separator:
Refer to the detail sheet for information on the oil/water separator design.

TSS Removal Rates Summary:

BMP	TSS Removal Rate
Street Sweeping	5%
Deep Sump Catch Basin	25%
Oil/Water Separator	25%
First Defense Unit	70%
Underground Infiltration Systems	80%
Sediment Forebay	25%
Aboveground Infiltration Basin	80%
Bioretention Basin	90%

Treatment Train 'A'
Beginning Load: 1.00 x Street Sweeping removal rate (0.05) = 0.05
Load Remaining = 1.00 – 0.05 = **0.95**
Remaining Load: 0.95 x Catch Basin w/ deep sump removal rate (0.25) = 0.24
Load Remaining = 0.95 – 0.24 = **0.71**
Remaining Load: 0.71 x Isolator Row removal rate (0.25) = 0.18
Load Remaining = 0.71 – 0.18 = **0.53**
Remaining Load: 0.53 x Underground Infiltration System removal rate (0.80) = 0.42
Load Remaining = 0.53 – 0.42 = **0.09**
TSS Removal Rate = (1.00 – 0.09) **= 91%**

Treatment Train 'B'
Beginning Load: 1.00 x Street Sweeping removal rate (0.05) = 0.05
Load Remaining = 1.00 – 0.05 = **0.95**
Remaining Load: 0.95 x Catch Basin w/ deep sump removal rate (0.25) = 0.24
Load Remaining = 0.95 – 0.24 = **0.71**
Remaining Load: 0.71 x First Defense removal rate (0.70) = 0.50
Load Remaining = 0.71 – 0.50 = **0.21**
Remaining Load: 0.21 x Oil/ Water Separator removal rate (0.25) = 0.05
Load Remaining = 0.21 – 0.05 = **0.16**
Remaining Load: 0.16 x Sediment forebay removal rate (0.25) = 0.04
Load Remaining = 0.16 – 0.04 = **0.12**
Remaining Load: 0.12 x Aboveground Infiltration Basin removal rate (0.80) = 0.10

Load Remaining = 0.12 – 0.10 = **0.02**
TSS Removal Rate = (1.00 – 0.02) **= 98%**

Treatment Train 'C'
Beginning Load: 1.00 x Street Sweeping removal rate (0.05) = 0.05
Load Remaining = 1.00 – 0.05 = **0.95**
Remaining Load: 0.95 x First Defense removal rate (0.70) = 0.67
Load Remaining = 0.95 – 0.67 = **0.28**
Remaining Load: 0.28 x Oil/ Water Separator removal rate (0.25) = 0.07
Load Remaining = 0.28 – 0.07 = **0.21**
Remaining Load: 0.21 x Sediment forebay removal rate (0.25) = 0.05
Load Remaining = 0.21 – 0.05 = **0.16**
Remaining Load: 0.16 x Aboveground Infiltration Basin removal rate (0.80) = 0.13
Load Remaining = 0.16– 0.13 = **0.03**
TSS Removal Rate = (1.00 – 0.03) **= 97%**

Treatment Train 'D'
Beginning Load: 1.00 x Street Sweeping removal rate (0.05) = 0.05
Load Remaining = 1.00 – 0.05 = **0.95**
Remaining Load: 0.95 x Bioretention Area removal rate (0.90) = 0.86
Load Remaining = 0.95 – 0.86 = **0.09**
TSS Removal Rate = (1.00 – 0.09) **= 91%**

Collectively, the BMPs designed achieve at least 80% removal of the average annual total suspended solids (TSS) from stormwater runoff.

Standard #5: Land Uses with Higher Potential Pollutant Loads (LUHPPL)

Pollution Prevention:

- The project is classified as a land use with higher potential pollutant loads as a gas station. BMPs capable of removing oil and grease have been selected to mitigate any risk associated with potential petroleum spills.
- The site is designed with a canopy structure covering the fuel dispensing islands.
- Spill containment grooves, positive limiting barriers (PLB's), surrounding the entire fueling area are designed to capture any potential spills at the dispensing islands.
- The long-term pollution plan includes good housekeeping practices, preventative maintenance procedures and regular inspections.

Standard #6: Protection of Critical Areas

The site is located within a Zone II of a public water supply. Source control and pollution prevention measures are identified in the Long-Term Pollution Prevention Plan within the Operation and Maintenance Plan (O&M). BMPs have been selected that are suitable for protection of these areas.

Standard #7: Redevelopment Projects

The site is a mix of redevelopment and new development. The redevelopment portion of the project and is subject to Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6 to the maximum extent practicable.

As shown in the standards above, the project fully complies with the Stormwater Management Standards.

Standard #8: Erosion and Sediment Control

Full compliance:

- Erosion and sediment controls are incorporated into the project design to prevent erosion. An Erosion & Sediment Control Plan is included in the site plan set.

Standard #9: Operation and Maintenance Plan

Full compliance:

- A long-term Operation and Maintenance Plan meeting the requirements of this standard has been prepared and is included as a separate document.

Standard #10: Illicit Discharges

Full compliance:

- To the best of our knowledge, the site does not contain any illicit discharges. An illicit discharge statement is included below.

February 8, 2023

Town of Littleton Planning Board
Littleton Town Hall
37 Shattuck Street, PO Box 1305
Littleton, MA 01460

Re: 254, 256 & 260 Ayer Road (Route 2A)
Map U45 Lots 7, 7-B, 8-A & 11-0
Sub: Illicit Discharge Statement
Standard #10

Dear Board Members:

On behalf of our client, Energy North Group, we hereby state that to the best of our knowledge, no illicit discharges exist on the above referenced site and none are proposed with the site re-development plans. Implementing the pollution prevention plan measures outlined in the site redevelopment plans will prevent illicit discharges to the stormwater management system, including wastewater discharges and discharges of stormwater contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances, oil, or grease. Refer to the Grading & Drainage Plan from the site plan set for additional information.

Sincerely,
Greenman-Pedersen, Inc.

Cory Mason, P.E.
Project Engineer

February 8, 2023

Town of Ayer Planning Board
Ayer Town Hall
1 Main Street
Ayer, MA 01432

Re: 0 Littleton Road
Map 30 Lot 16
Sub: Illicit Discharge Statement
Standard #10

Dear Board Members:

On behalf of our client, Energy North Group, we hereby state that to the best of our knowledge, no illicit discharges exist on the above referenced site and none are proposed with the site re-development plans. Implementing the pollution prevention plan measures outlined in the site redevelopment plans will prevent illicit discharges to the stormwater management system, including wastewater discharges and discharges of stormwater contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances, oil, or grease. Refer to the Grading & Drainage Plan from the site plan set for additional information.

Sincerely,
Greenman-Pedersen, Inc.

Cory Mason, P.E.
Project Engineer

SECTION 4 STORMWATER MODELING METHODOLOGY

The drainage system for this project was modeled using HydroCAD, a stormwater modeling computer program that analyzes the hydrology, and hydraulics of stormwater runoff. HydroCAD is based largely on the hydrology techniques developed by the Soil Conservation Service (SCS/NRCS), combined with other hydrology and hydraulics calculations. For a given rainfall event, these techniques are used to generate hydrographs throughout a watershed. This provides verification that a given drainage system is adequate for the area under consideration, or to predict where flooding or erosion is likely to occur.

In HydroCAD, each watershed is modeled as a Subcatchment, streams and culverts as a Reach (or Pond, depending on available storage capacity), and large wetlands and other natural or artificial storage areas as a Pond. SCS hydrograph generation and routing procedures were used to model both Pre-development and Post-development runoff conditions.

The Pre-development and Post-development watershed limits and the subcatchment characteristics were determined using both USGS and on-the-ground topographic survey information and through visual, on-site inspection. Conservative estimates were used at all times in estimating the hydrologic characteristics of each watershed or subcatchment.

APPENDIX A

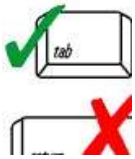
MassDEP Stormwater Checklist

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.

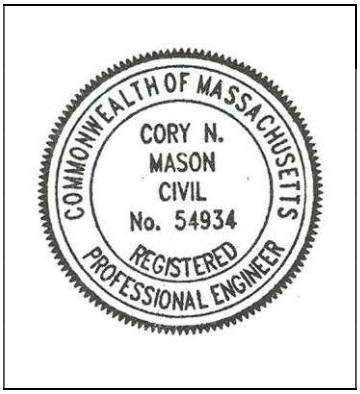
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



Cory Mason 2-8-2023

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

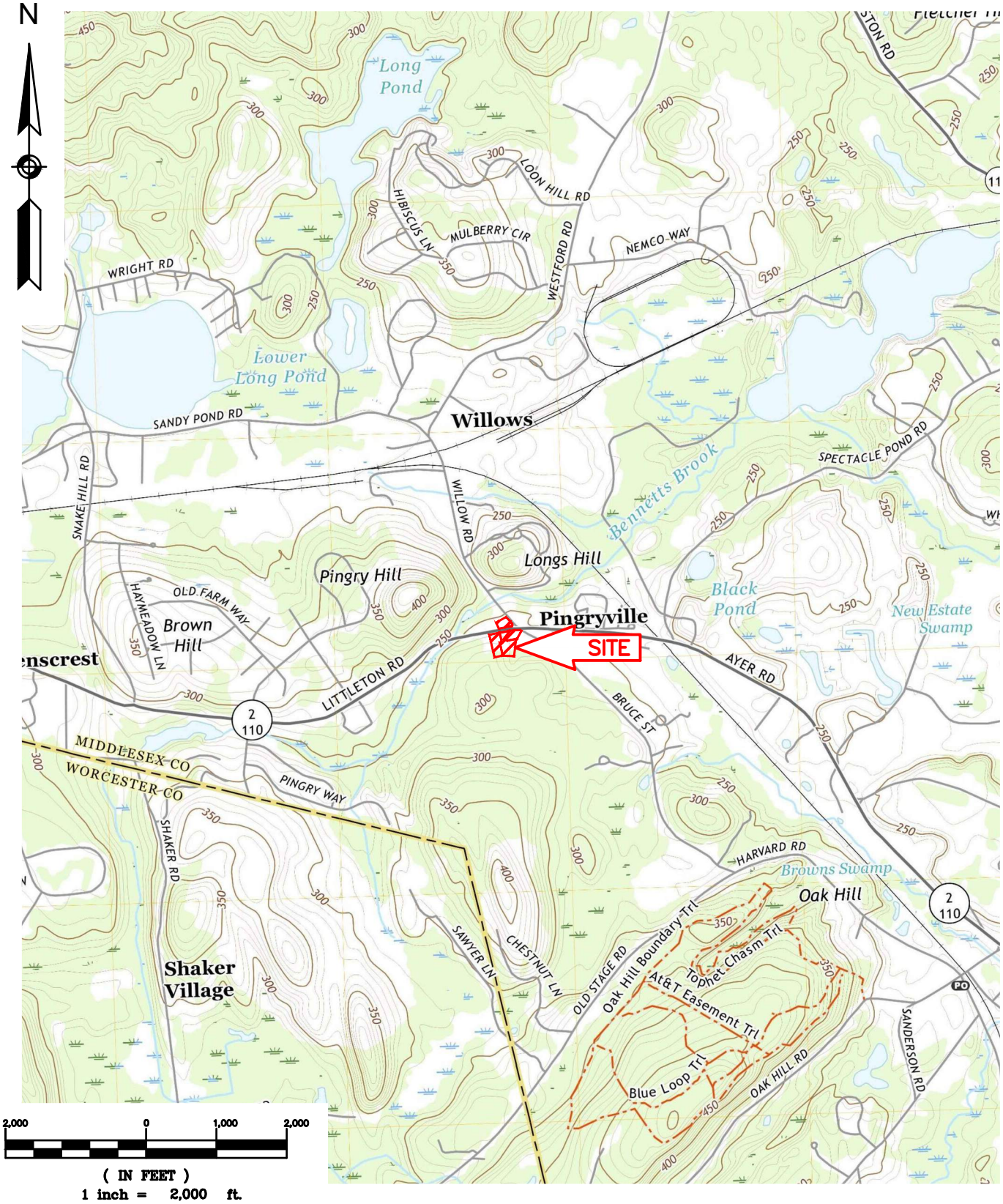
☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ 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

Figures



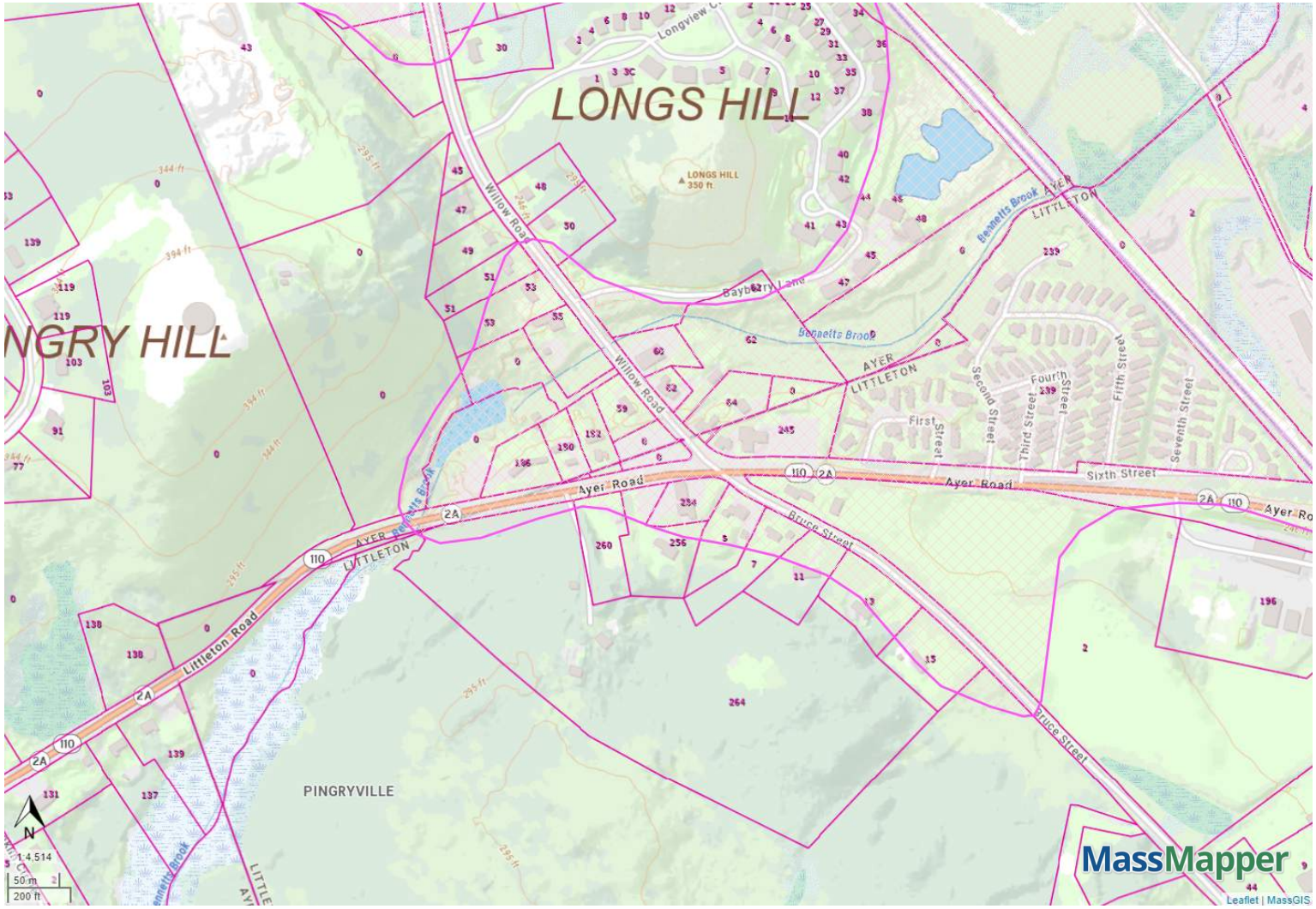
F:\Projects\NEX-2021267 - Littleton, MA - Energy North Goup\Drainage\Stormwater Report\Appendix B - Figures\21267 - USGS MAP.dwg USGS 2/01/23 3:54pm cmason

USGS MAP

ENERGY NORTH GROUP
254, 256 & 260 AYER ROAD
LITTLETON, MA
0 LITTLETON ROAD
AYER, MA

GPI Engineering Design Planning Construction Management
603.893.0720 GPINET.COM
Greenman-Pedersen, Inc.
44 Stiles Road, Suite One
Salem, NH 03079

DRAWN BY: CNM
PROJECT #: NEX-2021267
DATE: 2/8/2023
FIGURE 1



Areas of Critical Environmental Concern
ACECs

Zone IIs

Property Tax Parcels

APPENDIX C

NRCS Soil Information

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Middlesex County, Massachusetts

November 16, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:3,230 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 45 90 180 270

Feet: 0 150 300 600 900

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.

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: Middlesex County, Massachusetts
Survey Area Data: Version 22, Sep 9, 2022

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

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
53A	Freetown muck, ponded, 0 to 1 percent slopes	3.1	8.0%
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes	1.9	4.8%
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes	2.3	6.1%
104C	Hollis-Rock outcrop-Charlton complex, 0 to 15 percent slopes	13.7	35.4%
307E	Paxton fine sandy loam, 25 to 35 percent slopes, extremely stony	0.6	1.5%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	0.6	1.5%
422B	Canton fine sandy loam, 0 to 8 percent slopes, extremely stony	0.0	0.1%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	0.7	1.9%
629C	Canton-Charlton-Urban land complex, 3 to 15 percent slopes	15.7	40.6%
Totals for Area of Interest		**38.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion

of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Middlesex County, Massachusetts

53A—Freetown muck, ponded, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2t2qc
Elevation: 0 to 1,140 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Freetown, ponded, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freetown, Ponded

Setting

Landform: Kettles, marshes, depressions, depressions, bogs, swamps
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material

Typical profile

Oe - 0 to 2 inches: mucky peat
Oa - 2 to 79 inches: muck

Properties and qualities

Slope: 0 to 1 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 19.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: F144AY043MA - Acidic Organic Wetlands
Hydric soil rating: Yes

Minor Components

Swansea, ponded

Percent of map unit: 5 percent
Landform: Bogs, swamps, marshes, depressions, depressions, kettles

Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Whitman, ponded

Percent of map unit: 5 percent
Landform: Depressions on ground moraines
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Scarboro

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

103B—Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 98yc
Elevation: 0 to 1,490 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Charlton and similar soils: 50 percent
Hollis and similar soils: 25 percent
Rock outcrop: 15 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Charlton

Setting

Landform: Ground moraines, drumlins
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Convex
Across-slope shape: Convex

Parent material: Friable loamy eolian deposits over friable loamy basal till derived from granite and gneiss

Typical profile

H1 - 0 to 5 inches: fine sandy loam
H2 - 5 to 22 inches: sandy loam
H3 - 22 to 65 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Hollis

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable, shallow loamy basal till over granite and gneiss

Typical profile

H1 - 0 to 2 inches: fine sandy loam
H2 - 2 to 14 inches: fine sandy loam
H3 - 14 to 18 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D

Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Ledges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Granite and gneiss

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s

Minor Components

Canton

Percent of map unit: 2 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Head slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Narragansett

Percent of map unit: 2 percent
Landform: Hills, ridges
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Woodbridge

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder, toeslope
Landform position (three-dimensional): Head slope, nose slope, base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Scituate

Percent of map unit: 2 percent
Landform: Depressions, hillslopes
Landform position (two-dimensional): Summit, toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Montauk

Percent of map unit: 1 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Head slope, nose slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Unnamed

Percent of map unit: 1 percent

103C—Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2wzp1
Elevation: 0 to 1,390 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Charlton, extremely stony, and similar soils: 50 percent
Hollis, extremely stony, and similar soils: 20 percent
Rock outcrop: 10 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Charlton, Extremely Stony

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 4 inches: fine sandy loam
Bw - 4 to 27 inches: gravelly fine sandy loam
C - 27 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 8 to 15 percent

Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Hollis, Extremely Stony

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 7 inches: gravelly fine sandy loam
Bw - 7 to 16 inches: gravelly fine sandy loam
2R - 16 to 26 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 23 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
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): 7s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Ridges, hills
Parent material: Igneous and metamorphic rock

Typical profile

R - 0 to 79 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water supply, 0 to 60 inches: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Woodbridge, extremely stony

Percent of map unit: 8 percent
Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Canton, extremely stony

Percent of map unit: 5 percent
Landform: Moraines, hills, ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Chatfield, extremely stony

Percent of map unit: 5 percent
Landform: Ridges, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Ridgebury, extremely stony

Percent of map unit: 2 percent
Landform: Hills, drainageways, drumlins, depressions, ground moraines
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Head slope, base slope

Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

104C—Hollis-Rock outcrop-Charlton complex, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2w69p
Elevation: 0 to 1,270 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hollis, extremely stony, and similar soils: 35 percent
Rock outcrop: 25 percent
Charlton, extremely stony, and similar soils: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hollis, Extremely Stony

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 7 inches: gravelly fine sandy loam
Bw - 7 to 16 inches: gravelly fine sandy loam
2R - 16 to 26 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 23 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
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): 7s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Charlton, Extremely Stony

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 4 inches: fine sandy loam
Bw - 4 to 27 inches: gravelly fine sandy loam
C - 27 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 0 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Ridges, hills
Parent material: Igneous and metamorphic rock

Typical profile

R - 0 to 79 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water supply, 0 to 60 inches: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Canton, extremely stony

Percent of map unit: 7 percent
Landform: Moraines, hills, ridges
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Chatfield, extremely stony

Percent of map unit: 6 percent
Landform: Ridges, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Montauk, extremely stony

Percent of map unit: 1 percent
Landform: Hills, recessionial moraines, ground moraines, drumlins
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Scituate, extremely stony

Percent of map unit: 1 percent
Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

307E—Paxton fine sandy loam, 25 to 35 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2w67q
Elevation: 0 to 1,400 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Paxton, extremely stony, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Paxton, Extremely Stony

Setting

Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 10 inches: fine sandy loam
Bw1 - 10 to 17 inches: fine sandy loam
Bw2 - 17 to 28 inches: fine sandy loam
Cd - 28 to 67 inches: gravelly fine sandy loam

Properties and qualities

Slope: 25 to 35 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 20 to 43 inches to densic material
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Ecological site: F144AY007CT - Well Drained Dense Till Uplands
Hydric soil rating: No

Minor Components

Charlton, extremely stony

Percent of map unit: 8 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Woodbridge, extremely stony

Percent of map unit: 1 percent
Landform: Hills, drumlins, ground moraines
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Chatfield, extremely stony

Percent of map unit: 1 percent
Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

311B—Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony

Map Unit Setting

National map unit symbol: 2t2qr
Elevation: 0 to 1,440 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Woodbridge, very stony, and similar soils: 82 percent
Minor components: 18 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Woodbridge, Very Stony

Setting

Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 9 inches: fine sandy loam
Bw1 - 9 to 20 inches: fine sandy loam
Bw2 - 20 to 32 inches: fine sandy loam
Cd - 32 to 67 inches: gravelly fine sandy loam

Properties and qualities

Slope: 0 to 8 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: 20 to 43 inches to densic material
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 19 to 27 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: C/D
Ecological site: F144AY037MA - Moist Dense Till Uplands
Hydric soil rating: No

Minor Components

Paxton, very stony

Percent of map unit: 10 percent
Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Hydric soil rating: No

Ridgebury, very stony

Percent of map unit: 8 percent
Landform: Hills, drainageways, drumlins, depressions, ground moraines
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Concave

Across-slope shape: Concave
Hydric soil rating: Yes

422B—Canton fine sandy loam, 0 to 8 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2w818
Elevation: 0 to 1,180 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Canton, Extremely Stony

Setting

Landform: Moraines, hills, ridges
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy over sandy melt-out till derived from gneiss, granite, and/or schist

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 5 inches: fine sandy loam
Bw1 - 5 to 16 inches: fine sandy loam
Bw2 - 16 to 22 inches: gravelly fine sandy loam
2C - 22 to 67 inches: gravelly loamy sand

Properties and qualities

Slope: 0 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 19 to 39 inches to strongly contrasting textural stratification
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Charlton, extremely stony

Percent of map unit: 6 percent
Landform: Ridges, ground moraines, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Scituate, extremely stony

Percent of map unit: 6 percent
Landform: Hills, ground moraines, drumlins
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Montauk, extremely stony

Percent of map unit: 4 percent
Landform: Recessionial moraines, ground moraines, hills, drumlins
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Swansea

Percent of map unit: 4 percent
Landform: Marshes, depressions, bogs, swamps, kettles
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

626B—Merrimac-Urban land complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2tyr9
Elevation: 0 to 820 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F

Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Merrimac and similar soils: 45 percent
Urban land: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Merrimac

Setting

Landform: Outwash plains, outwash terraces, moraines, eskers, kames
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Crest, side slope, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam
Bw1 - 10 to 22 inches: fine sandy loam
Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand
2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline (0.0 to 1.4 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Description of Urban Land

Typical profile

M - 0 to 10 inches: cemented material

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 0 inches to manufactured layer

Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water supply, 0 to 60 inches: Very low (about 0.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: Unranked

Minor Components

Windsor
Percent of map unit: 5 percent
Landform: Outwash terraces, dunes, outwash plains, deltas
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Sudbury
Percent of map unit: 5 percent
Landform: Deltas, terraces, outwash plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Hinckley
Percent of map unit: 5 percent
Landform: Deltas, kames, eskers, outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Head slope, nose slope, crest, side slope, rise
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

629C—Canton-Charlton-Urban land complex, 3 to 15 percent slopes

Map Unit Setting
National map unit symbol: 9959
Elevation: 0 to 1,000 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Canton and similar soils: 40 percent
Charlton and similar soils: 30 percent
Urban land: 25 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Canton

Setting

Landform: Hills
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over friable sandy basal till derived from granite and gneiss

Typical profile

H1 - 0 to 8 inches: fine sandy loam
H2 - 8 to 21 inches: fine sandy loam
H3 - 21 to 65 inches: gravelly loamy sand

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: 18 to 30 inches to strongly contrasting textural stratification
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Charlton

Setting

Landform: Ground moraines, drumlins
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over friable loamy basal till derived from granite and gneiss

Typical profile

H1 - 0 to 5 inches: fine sandy loam
H2 - 5 to 22 inches: sandy loam

H3 - 22 to 65 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Minor Components

Montauk

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Head slope, nose slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Scituate

Percent of map unit: 2 percent
Landform: Hillslopes, depressions
Landform position (two-dimensional): Summit, toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Udorthents, loamy

Percent of map unit: 1 percent
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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:

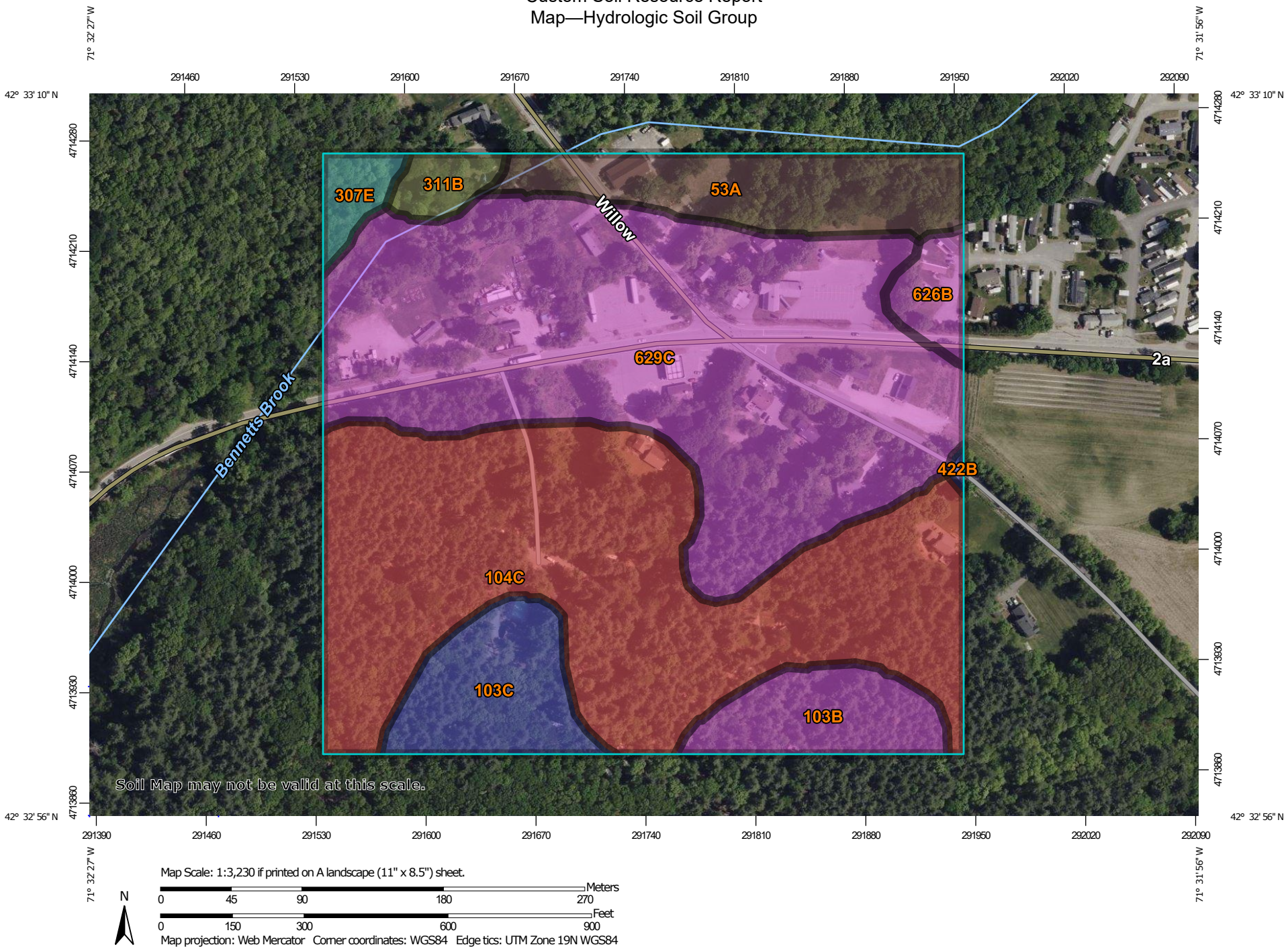
Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

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.



Map Scale: 1:3,230 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 45 90 180 270

Feet: 0 150 300 600 900

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: Middlesex County, Massachusetts
Survey Area Data: Version 22, Sep 9, 2022

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

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.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
53A	Freetown muck, ponded, 0 to 1 percent slopes	B/D	3.1	8.0%
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes	A	1.9	4.8%
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes	B	2.3	6.1%
104C	Hollis-Rock outcrop-Charlton complex, 0 to 15 percent slopes	D	13.7	35.4%
307E	Paxton fine sandy loam, 25 to 35 percent slopes, extremely stony	C	0.6	1.5%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	0.6	1.5%
422B	Canton fine sandy loam, 0 to 8 percent slopes, extremely stony	B	0.0	0.1%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	A	0.7	1.9%
629C	Canton-Charlton-Urban land complex, 3 to 15 percent slopes	A	15.7	40.6%
Totals for Area of Interest			**38.6**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

APPENDIX D

Test Pit Logs

TEST PIT DATA

Client: Energy North Group
Project Address: 254, 256, & 260 Ayer Road
Town, State: Littleton, MA
Job Number: NEX-2021267
Date: December 15, 2022
Performed by: Diane Pantermoller (SE#1835)

Test Pit No. 1 — SCS Soil: Canton-Charlton-Urban Land Complex
ESHWT: >100” — Standing Water: None
Refusal: >100” — Roots: None

Depth	Horizon	Soil Texture	Color	Consistence	Mottles; Quantity/Contrast
0-36”	Fill	Mixed Soils	Variable		
36-100”	C	Coarse Sand	2.5y 4/3	Loose	

Test Pit No. 2 — SCS Soil: Canton-Charlton-Urban Land Complex
ESHWT: >116” — Standing Water: None
Refusal: >116” — Roots: None

Depth	Horizon	Soil Texture	Color	Consistence	Mottles; Quantity/Contrast
0-36”	Fill	Mixed Soils	Variable		
36-48”	B	Loamy Sand	10yr 5/6	Friable	
48-116”	C	Sand & Gravel	2.5y 4/3	Loose	

Test Pit No. 3 — SCS Soil: Canton-Charlton-Urban Land Complex
ESHWT: >116” — Standing Water: None
Refusal: >116” — Roots: None

Depth	Horizon	Soil Texture	Color	Consistence	Mottles; Quantity/Contrast
0-22”	A/Fill	Loamy Sand	10yr 3/2	Friable	
22-36”	B	Loamy Sand	10yr 5/6	Friable	
36-116”	C	Sand & Gravel	2.5y 4/3	Loose	

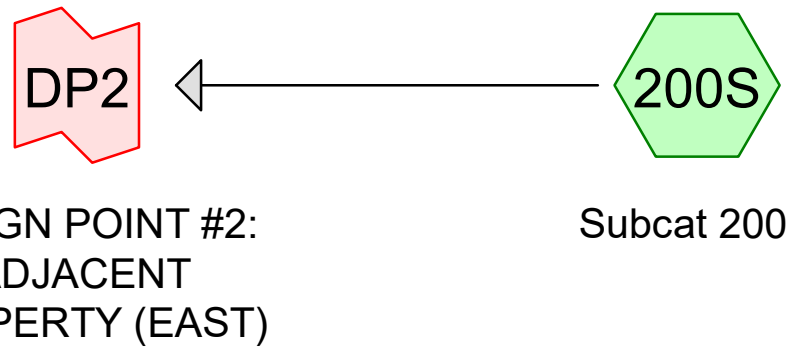
Test Pit No. 4 — SCS Soil: Canton-Charlton-Urban Land Complex
ESHWT: >120” — Standing Water: None
Refusal: >120” — Roots: None

Depth	Horizon	Soil Texture	Color	Consistence	Mottles; Quantity/Contrast
0-60”	Fill	Mixed Soils	Variable		
60-120”	C	Sand & Gravel	2.5y 4/3	Loose	

NOTES

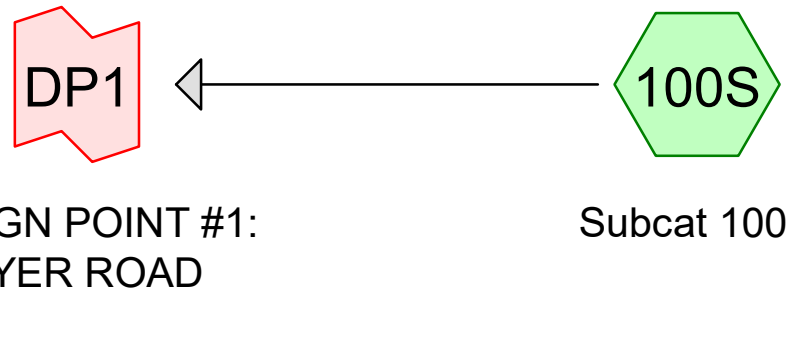
APPENDIX E

Pre-Development HydroCAD Computations



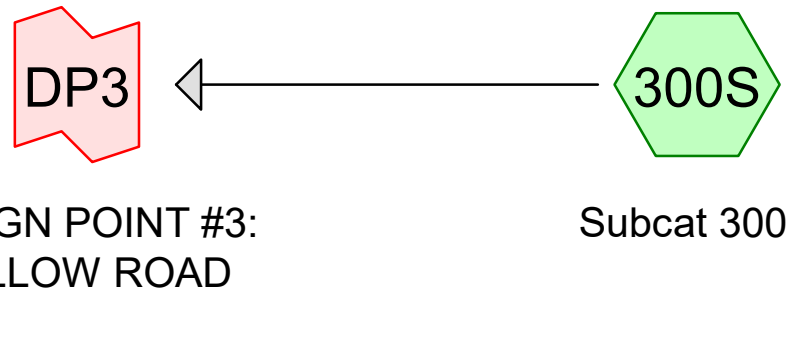
DESIGN POINT #2:
ADJACENT
PROPERTY (EAST)

Subcat 200S



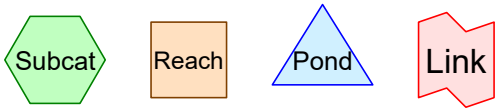
DESIGN POINT #1:
AYER ROAD

Subcat 100S



DESIGN POINT #3:
WILLOW ROAD

Subcat 300S



Routing Diagram for 21267_PRE
Prepared by Greenman-Pedersen, Inc, Printed 2/1/2023

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
14,167	39	>75% Grass cover, Good, HSG A (100S, 200S, 300S)
11,082	80	>75% Grass cover, Good, HSG D (100S, 200S)
11,779	30	Brush, Good, HSG A (100S)
13,448	73	Brush, Good, HSG D (100S)
36,949	98	Paved parking, HSG A (100S, 200S, 300S)
866	98	Paved parking, HSG D (100S, 200S)
3,840	98	Roofs, HSG A (100S)
1,994	98	Roofs, HSG D (100S, 200S)
16,036	30	Woods, Good, HSG A (100S, 200S, 300S)
34,422	77	Woods, Good, HSG D (100S, 200S)
144,584	**70**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
82,772	HSG A	100S, 200S, 300S
0	HSG B	
0	HSG C	
61,812	HSG D	100S, 200S
0	Other	
144,584		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Su Nu
14,167	0	0	11,082	0	25,249	>75% Grass cover, Good	
11,779	0	0	13,448	0	25,228	Brush, Good	
36,949	0	0	866	0	37,815	Paved parking	
3,840	0	0	1,994	0	5,834	Roofs	
16,036	0	0	34,422	0	50,458	Woods, Good	
82,772	**0**	**0**	**61,812**	**0**	**144,584**	**TOTAL AREA**	

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 100S: Subcat 100S Runoff Area=1.912 ac 28.57% Impervious Runoff Depth=0.64"
Flow Length=300' Tc=8.3 min CN=68 Runoff=1.08 cfs 4,421 cf

Subcatchment 200S: Subcat 200S Runoff Area=38,429 sf 3.58% Impervious Runoff Depth=0.64"
Flow Length=310' Slope=0.1000 '/' Tc=7.4 min CN=68 Runoff=0.52 cfs 2,040 cf

Subcatchment 300S: Subcat 300S Runoff Area=22,872 sf 80.77% Impervious Runoff Depth=1.61"
Flow Length=130' Tc=1.2 min CN=85 Runoff=1.17 cfs 3,059 cf

Link DP1: DESIGN POINT #1: AYER ROAD Inflow=1.08 cfs 4,421 cf
Primary=1.08 cfs 4,421 cf

Link DP2: DESIGN POINT #2: ADJACENT PROPERTY (EAST) Inflow=0.52 cfs 2,040 cf
Primary=0.52 cfs 2,040 cf

Link DP3: DESIGN POINT #3: WILLOW ROAD Inflow=1.17 cfs 3,059 cf
Primary=1.17 cfs 3,059 cf

Total Runoff Area = 144,584 sf Runoff Volume = 9,520 cf Average Runoff Depth = 0.79"
69.81% Pervious = 100,935 sf 30.19% Impervious = 43,649 sf

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 100S: Subcat 100S Runoff Area=1.912 ac 28.57% Impervious Runoff Depth=1.53"
Flow Length=300' Tc=8.3 min CN=68 Runoff=3.01 cfs 10,589 cf

Subcatchment 200S: Subcat 200S Runoff Area=38,429 sf 3.58% Impervious Runoff Depth=1.53"
Flow Length=310' Slope=0.1000 '/' Tc=7.4 min CN=68 Runoff=1.44 cfs 4,886 cf

Subcatchment 300S: Subcat 300S Runoff Area=22,872 sf 80.77% Impervious Runoff Depth=2.90"
Flow Length=130' Tc=1.2 min CN=85 Runoff=2.11 cfs 5,527 cf

Link DP1: DESIGN POINT #1: AYER ROAD Inflow=3.01 cfs 10,589 cf
Primary=3.01 cfs 10,589 cf

Link DP2: DESIGN POINT #2: ADJACENT PROPERTY (EAST) Inflow=1.44 cfs 4,886 cf
Primary=1.44 cfs 4,886 cf

Link DP3: DESIGN POINT #3: WILLOW ROAD Inflow=2.11 cfs 5,527 cf
Primary=2.11 cfs 5,527 cf

Total Runoff Area = 144,584 sf Runoff Volume = 21,002 cf Average Runoff Depth = 1.74"
69.81% Pervious = 100,935 sf 30.19% Impervious = 43,649 sf

Summary for Subcatchment 100S: Subcat 100S

Runoff = 3.01 cfs @ 12.13 hrs, Volume= 10,589 cf, Depth= 1.53"
Routed to Link DP1 : DESIGN POINT #1: AYER ROAD

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (ac)	CN	Description
0.234	39	>75% Grass cover, Good, HSG A
0.122	80	>75% Grass cover, Good, HSG D
0.270	30	Brush, Good, HSG A
0.309	73	Brush, Good, HSG D
0.424	98	Paved parking, HSG A
0.017	98	Paved parking, HSG D
0.088	98	Roofs, HSG A
0.017	98	Roofs, HSG D
0.143	30	Woods, Good, HSG A
0.287	77	Woods, Good, HSG D
1.912	68	Weighted Average
1.366		71.43% Pervious Area
0.546		28.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	30	0.0800	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.02"
0.6	50	0.0800	1.41		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	75	0.2400	2.45		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.4	145	0.0410	1.01		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
8.3	300	Total			

Summary for Subcatchment 200S: Subcat 200S

Runoff = 1.44 cfs @ 12.11 hrs, Volume= 4,886 cf, Depth= 1.53"
Routed to Link DP2 : DESIGN POINT #2: ADJACENT PROPERTY (EAST)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
3,900	39	>75% Grass cover, Good, HSG A
5,755	80	>75% Grass cover, Good, HSG D
0	98	Paved parking, HSG A
105	98	Paved parking, HSG D
1,271	98	Roofs, HSG D
5,493	30	Woods, Good, HSG A
21,905	77	Woods, Good, HSG D
38,429	68	Weighted Average
37,052		96.42% Pervious Area
1,377		3.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.4	30	0.1000	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.02"
3.0	280	0.1000	1.58		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
7.4	310	Total			

Summary for Subcatchment 300S: Subcat 300S

Runoff = 2.11 cfs @ 12.02 hrs, Volume= 5,527 cf, Depth= 2.90"
Routed to Link DP3 : DESIGN POINT #3: WILLOW ROAD

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
69	39	>75% Grass cover, Good, HSG A
18,474	98	Paved parking, HSG A
4,329	30	Woods, Good, HSG A
22,872	85	Weighted Average
4,398		19.23% Pervious Area
18,474		80.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	25	0.0175	0.96		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.02"
0.7	95	0.0175	2.13		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	10	0.2000	2.24		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.2	130	Total			

Summary for Link DP1: DESIGN POINT #1: AYER ROAD

Inflow Area = 83,283 sf, 28.57% Impervious, Inflow Depth = 1.53" for 10-yr event
Inflow = 3.01 cfs @ 12.13 hrs, Volume= 10,589 cf
Primary = 3.01 cfs @ 12.13 hrs, Volume= 10,589 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Summary for Link DP2: DESIGN POINT #2: ADJACENT PROPERTY (EAST)

Inflow Area = 38,429 sf, 3.58% Impervious, Inflow Depth = 1.53" for 10-yr event
Inflow = 1.44 cfs @ 12.11 hrs, Volume= 4,886 cf
Primary = 1.44 cfs @ 12.11 hrs, Volume= 4,886 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Summary for Link DP3: DESIGN POINT #3: WILLOW ROAD

Inflow Area = 22,872 sf, 80.77% Impervious, Inflow Depth = 2.90" for 10-yr event
Inflow = 2.11 cfs @ 12.02 hrs, Volume= 5,527 cf
Primary = 2.11 cfs @ 12.02 hrs, Volume= 5,527 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 100S: Subcat 100S Runoff Area=1.912 ac 28.57% Impervious Runoff Depth=2.34"
Flow Length=300' Tc=8.3 min CN=68 Runoff=4.76 cfs 16,241 cf

Subcatchment 200S: Subcat 200S Runoff Area=38,429 sf 3.58% Impervious Runoff Depth=2.34"
Flow Length=310' Slope=0.1000 '/' Tc=7.4 min CN=68 Runoff=2.27 cfs 7,494 cf

Subcatchment 300S: Subcat 300S Runoff Area=22,872 sf 80.77% Impervious Runoff Depth=3.95"
Flow Length=130' Tc=1.2 min CN=85 Runoff=2.84 cfs 7,537 cf

Link DP1: DESIGN POINT #1: AYER ROAD Inflow=4.76 cfs 16,241 cf
Primary=4.76 cfs 16,241 cf

Link DP2: DESIGN POINT #2: ADJACENT PROPERTY (EAST) Inflow=2.27 cfs 7,494 cf
Primary=2.27 cfs 7,494 cf

Link DP3: DESIGN POINT #3: WILLOW ROAD Inflow=2.84 cfs 7,537 cf
Primary=2.84 cfs 7,537 cf

Total Runoff Area = 144,584 sf Runoff Volume = 31,273 cf Average Runoff Depth = 2.60"
69.81% Pervious = 100,935 sf 30.19% Impervious = 43,649 sf

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 100S: Subcat 100S Runoff Area=1.912 ac 28.57% Impervious Runoff Depth=4.18"
Flow Length=300' Tc=8.3 min CN=68 Runoff=8.64 cfs 28,986 cf

Subcatchment 200S: Subcat 200S Runoff Area=38,429 sf 3.58% Impervious Runoff Depth=4.18"
Flow Length=310' Slope=0.1000 '/' Tc=7.4 min CN=68 Runoff=4.11 cfs 13,375 cf

Subcatchment 300S: Subcat 300S Runoff Area=22,872 sf 80.77% Impervious Runoff Depth=6.15"
Flow Length=130' Tc=1.2 min CN=85 Runoff=4.33 cfs 11,714 cf

Link DP1: DESIGN POINT #1: AYER ROAD Inflow=8.64 cfs 28,986 cf
Primary=8.64 cfs 28,986 cf

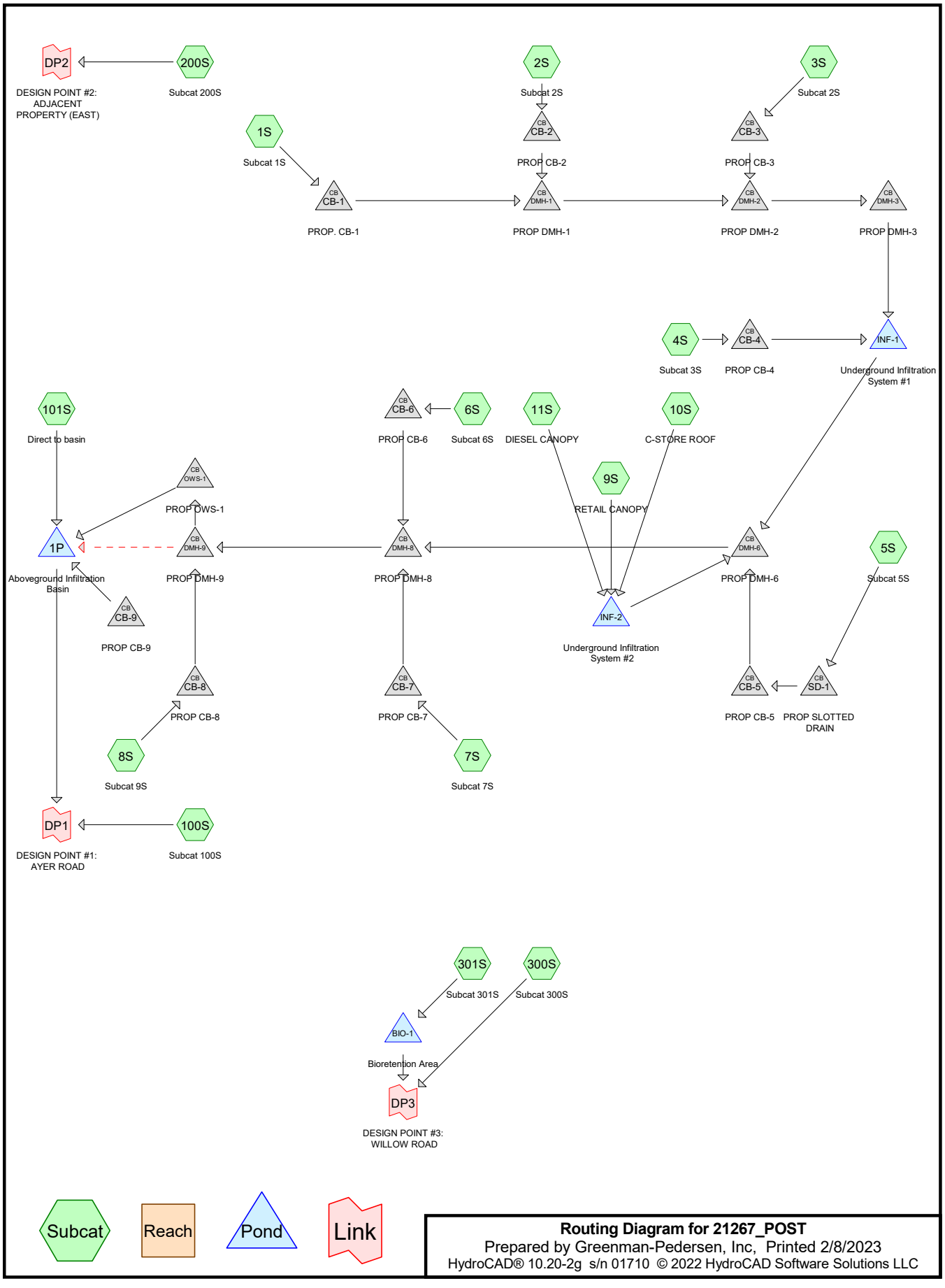
Link DP2: DESIGN POINT #2: ADJACENT PROPERTY (EAST) Inflow=4.11 cfs 13,375 cf
Primary=4.11 cfs 13,375 cf

Link DP3: DESIGN POINT #3: WILLOW ROAD Inflow=4.33 cfs 11,714 cf
Primary=4.33 cfs 11,714 cf

Total Runoff Area = 144,584 sf Runoff Volume = 54,075 cf Average Runoff Depth = 4.49"
69.81% Pervious = 100,935 sf 30.19% Impervious = 43,649 sf

APPENDIX F

Post-Development HydroCAD Computations



Routing Diagram for 21267_POST

Prepared by Greenman-Pedersen, Inc, Printed 2/8/2023

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
24,770	39	>75% Grass cover, Good, HSG A (4S, 5S, 6S, 8S, 100S, 101S, 200S, 300S, 301S)
19,439	80	>75% Grass cover, Good, HSG D (1S, 2S, 3S, 4S, 6S, 8S, 200S)
50,506	98	Paved parking, HSG A (1S, 4S, 5S, 6S, 7S, 8S, 100S, 101S, 300S, 301S)
28,553	98	Paved parking, HSG D (1S, 2S, 3S, 4S, 6S, 8S, 200S)
4,252	98	Roofs, HSG A (9S, 11S)
6,000	98	Roofs, HSG D (10S)
3,243	30	Woods, Good, HSG A (100S, 101S, 200S, 300S, 301S)
7,823	77	Woods, Good, HSG D (200S)
144,587	**83**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
82,772	HSG A	1S, 4S, 5S, 6S, 7S, 8S, 9S, 11S, 100S, 101S, 200S, 300S, 301S
0	HSG B	
0	HSG C	
61,815	HSG D	1S, 2S, 3S, 4S, 6S, 8S, 10S, 200S
0	Other	
144,587		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Su Nu
24,770	0	0	19,439	0	44,209	>75% Grass cover, Good	
50,506	0	0	28,553	0	79,059	Paved parking	
4,252	0	0	6,000	0	10,252	Roofs	
3,243	0	0	7,823	0	11,066	Woods, Good	
82,772	**0**	**0**	**61,815**	**0**	**144,587**	**TOTAL AREA**	

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	1P	252.00	248.00	31.0	0.1290	0.012	0.0	8.0	0.0
2	CB-1	253.45	252.70	109.0	0.0069	0.012	0.0	12.0	0.0
3	CB-2	254.20	254.00	11.0	0.0182	0.012	0.0	12.0	0.0
4	CB-3	253.20	253.00	11.0	0.0182	0.012	0.0	12.0	0.0
5	CB-4	252.85	252.80	12.0	0.0042	0.012	0.0	12.0	0.0
6	CB-5	252.85	252.55	19.0	0.0158	0.012	0.0	12.0	0.0
7	CB-6	252.40	251.75	67.0	0.0097	0.012	0.0	12.0	0.0
8	CB-7	252.80	252.35	11.0	0.0409	0.012	0.0	12.0	0.0
9	CB-8	251.80	251.70	11.0	0.0091	0.012	0.0	12.0	0.0
10	CB-9	251.00	250.00	37.0	0.0270	0.012	0.0	12.0	0.0
11	DMH-1	252.60	252.20	85.0	0.0047	0.012	0.0	12.0	0.0
12	DMH-2	251.95	251.65	41.0	0.0073	0.012	0.0	15.0	0.0
13	DMH-3	251.55	250.92	119.0	0.0053	0.012	0.0	15.0	0.0
14	DMH-6	252.35	251.65	153.0	0.0046	0.012	0.0	12.0	0.0
15	DMH-8	251.15	250.60	107.0	0.0051	0.012	0.0	18.0	0.0
16	DMH-9	250.60	250.50	5.0	0.0200	0.012	0.0	6.0	0.0
17	DMH-9	251.60	251.00	12.0	0.0500	0.012	0.0	18.0	0.0
18	INF-1	252.65	252.35	48.0	0.0063	0.012	0.0	12.0	0.0
19	INF-2	253.02	252.45	22.0	0.0259	0.012	0.0	6.0	0.0
20	OWS-1	250.25	250.00	8.0	0.0313	0.012	0.0	6.0	0.0
21	SD-1	253.85	253.80	5.0	0.0100	0.012	0.0	8.0	0.0

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Subcat 1S Runoff Area=8,273 sf 88.76% Impervious Runoff Depth=2.57"
Flow Length=105' Tc=3.8 min CN=96 Runoff=0.58 cfs 1,773 cf

Subcatchment 2S: Subcat 2S Runoff Area=8,626 sf 76.54% Impervious Runoff Depth=2.37"
Flow Length=115' Tc=1.7 min CN=94 Runoff=0.62 cfs 1,703 cf

Subcatchment 3S: Subcat 2S Runoff Area=17,131 sf 55.06% Impervious Runoff Depth=2.00"
Flow Length=155' Tc=1.6 min CN=90 Runoff=1.07 cfs 2,859 cf

Subcatchment 4S: Subcat 3S Runoff Area=14,990 sf 55.51% Impervious Runoff Depth=1.84"
Flow Length=215' Tc=2.1 min CN=88 Runoff=0.85 cfs 2,293 cf

Subcatchment 5S: Subcat 5S Runoff Area=6,531 sf 75.80% Impervious Runoff Depth=1.53"
Flow Length=75' Tc=1.3 min CN=84 Runoff=0.32 cfs 834 cf

Subcatchment 6S: Subcat 6S Runoff Area=5,068 sf 98.56% Impervious Runoff Depth=2.68"
Flow Length=108' Slope=0.0180 '/' Tc=0.9 min CN=97 Runoff=0.40 cfs 1,131 cf

Subcatchment 7S: Subcat 7S Runoff Area=5,589 sf 100.00% Impervious Runoff Depth=2.79"
Flow Length=112' Slope=0.0130 '/' Tc=1.1 min CN=98 Runoff=0.45 cfs 1,299 cf

Subcatchment 8S: Subcat 9S Runoff Area=12,740 sf 96.03% Impervious Runoff Depth=2.57"
Flow Length=150' Slope=0.0230 '/' Tc=1.0 min CN=96 Runoff=0.98 cfs 2,730 cf

Subcatchment 9S: RETAIL CANOPY Runoff Area=3,144 sf 100.00% Impervious Runoff Depth=2.79"
Tc=0.0 min CN=98 Runoff=0.26 cfs 731 cf

Subcatchment 10S: C-STORE ROOF Runoff Area=6,000 sf 100.00% Impervious Runoff Depth=2.79"
Tc=0.0 min CN=98 Runoff=0.49 cfs 1,394 cf

Subcatchment 11S: DIESEL CANOPY Runoff Area=1,108 sf 100.00% Impervious Runoff Depth=2.79"
Tc=0.0 min CN=98 Runoff=0.09 cfs 257 cf

Subcatchment 100S: Subcat 100S Runoff Area=12,676 sf 27.77% Impervious Runoff Depth=0.20"
Flow Length=30' Slope=0.0830 '/' Tc=2.2 min CN=55 Runoff=0.02 cfs 211 cf

Subcatchment 101S: Direct to basin Runoff Area=6,362 sf 0.02% Impervious Runoff Depth=0.00"
Tc=0.0 min CN=37 Runoff=0.00 cfs 0 cf

Subcatchment 200S: Subcat 200S Runoff Area=13,477 sf 0.01% Impervious Runoff Depth=0.68"
Flow Length=182' Tc=3.3 min CN=69 Runoff=0.23 cfs 764 cf

Subcatchment 300S: Subcat 300S Runoff Area=5,994 sf 37.25% Impervious Runoff Depth=0.34"
Flow Length=105' Slope=0.0260 '/' Tc=1.0 min CN=60 Runoff=0.03 cfs 170 cf

Subcatchment 301S: Subcat 301S Runoff Area=16,878 sf 81.98% Impervious Runoff Depth=1.76"
Flow Length=120' Slope=0.0175 '/' Tc=1.1 min CN=87 Runoff=0.95 cfs 2,471 cf

Pond 1P: Aboveground Infiltration Basin Peak Elev=252.15' Storage=2,778 cf Inflow=2.14 cfs 5,994 cf
Discarded=0.13 cfs 5,667 cf Primary=0.08 cfs 327 cf Outflow=0.21 cfs 5,994 cf

Pond BIO-1: Bioretention Area Peak Elev=251.40' Storage=257 cf Inflow=0.95 cfs 2,471 cf
Discarded=0.74 cfs 2,471 cf Primary=0.00 cfs 0 cf Outflow=0.74 cfs 2,471 cf

Pond CB-1: PROP. CB-1 Peak Elev=253.89' Inflow=0.58 cfs 1,773 cf
12.0" Round Culvert n=0.012 L=109.0' S=0.0069 '/' Outflow=0.58 cfs 1,773 cf

Pond CB-2: PROP CB-2 Peak Elev=254.60' Inflow=0.62 cfs 1,703 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0182 '/' Outflow=0.62 cfs 1,703 cf

Pond CB-3: PROP CB-3 Peak Elev=253.76' Inflow=1.07 cfs 2,859 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0182 '/' Outflow=1.07 cfs 2,859 cf

Pond CB-4: PROP CB-4 Peak Elev=253.43' Inflow=0.85 cfs 2,293 cf
12.0" Round Culvert n=0.012 L=12.0' S=0.0042 '/' Outflow=0.85 cfs 2,293 cf

Pond CB-5: PROP CB-5 Peak Elev=253.13' Inflow=0.32 cfs 834 cf
12.0" Round Culvert n=0.012 L=19.0' S=0.0158 '/' Outflow=0.32 cfs 834 cf

Pond CB-6: PROP CB-6 Peak Elev=252.74' Inflow=0.40 cfs 1,131 cf
12.0" Round Culvert n=0.012 L=67.0' S=0.0097 '/' Outflow=0.40 cfs 1,131 cf

Pond CB-7: PROP CB-7 Peak Elev=253.13' Inflow=0.45 cfs 1,299 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0409 '/' Outflow=0.45 cfs 1,299 cf

Pond CB-8: PROP CB-8 Peak Elev=252.40' Inflow=0.98 cfs 2,730 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0091 '/' Outflow=0.98 cfs 2,730 cf

Pond CB-9: PROP CB-9 Peak Elev=0.00'
12.0" Round Culvert n=0.012 L=37.0' S=0.0270 '/' Primary=0.00 cfs 0 cf

Pond DMH-1: PROP DMH-1 Peak Elev=253.28' Inflow=1.16 cfs 3,476 cf
12.0" Round Culvert n=0.012 L=85.0' S=0.0047 '/' Outflow=1.16 cfs 3,476 cf

Pond DMH-2: PROP DMH-2 Peak Elev=252.80' Inflow=2.22 cfs 6,335 cf
15.0" Round Culvert n=0.012 L=41.0' S=0.0073 '/' Outflow=2.22 cfs 6,335 cf

Pond DMH-3: PROP DMH-3 Peak Elev=252.37' Inflow=2.22 cfs 6,335 cf
15.0" Round Culvert n=0.012 L=119.0' S=0.0053 '/' Outflow=2.22 cfs 6,335 cf

Pond DMH-6: PROP DMH-6 Peak Elev=252.71' Inflow=0.32 cfs 834 cf
12.0" Round Culvert n=0.012 L=153.0' S=0.0046 '/' Outflow=0.32 cfs 834 cf

Pond DMH-8: PROP DMH-8 Peak Elev=252.24' Inflow=1.16 cfs 3,264 cf
18.0" Round Culvert n=0.012 L=107.0' S=0.0051 '/' Outflow=1.16 cfs 3,264 cf

Pond DMH-9: PROP DMH-9 Peak Elev=252.18' Inflow=2.14 cfs 5,994 cf
Primary=0.58 cfs 3,395 cf Secondary=1.62 cfs 2,599 cf Outflow=2.14 cfs 5,994 cf

Pond INF-1: Underground Infiltration Peak Elev=251.81' Storage=3,467 cf Inflow=3.07 cfs 8,628 cf
Discarded=0.23 cfs 8,628 cf Primary=0.00 cfs 0 cf Outflow=0.23 cfs 8,628 cf

Pond INF-2: Underground Infiltration System Peak Elev=250.92' Storage=834 cf Inflow=0.84 cfs 2,382 cf
Discarded=0.07 cfs 2,382 cf Primary=0.00 cfs 0 cf Outflow=0.07 cfs 2,382 cf

Pond OWS-1: PROP OWS-1 Peak Elev=252.15' Inflow=0.58 cfs 3,395 cf
6.0" Round Culvert n=0.012 L=8.0' S=0.0313 '/' Outflow=0.58 cfs 3,395 cf

Pond SD-1: PROP SLOTTED DRAIN Peak Elev=254.22' Inflow=0.32 cfs 834 cf
8.0" Round Culvert n=0.012 L=5.0' S=0.0100 '/' Outflow=0.32 cfs 834 cf

Link DP1: DESIGN POINT #1: AYER ROAD Inflow=0.09 cfs 538 cf
Primary=0.09 cfs 538 cf

Link DP2: DESIGN POINT #2: ADJACENT PROPERTY (EAST) Inflow=0.23 cfs 764 cf
Primary=0.23 cfs 764 cf

Link DP3: DESIGN POINT #3: WILLOW ROAD Inflow=0.03 cfs 170 cf
Primary=0.03 cfs 170 cf

Total Runoff Area = 144,587 sf Runoff Volume = 20,621 cf Average Runoff Depth = 1.71"
38.23% Pervious = 55,276 sf 61.77% Impervious = 89,311 sf

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Subcat 1S Runoff Area=8,273 sf 88.76% Impervious Runoff Depth=4.03"
Flow Length=105' Tc=3.8 min CN=96 Runoff=0.88 cfs 2,775 cf

Subcatchment 2S: Subcat 2S Runoff Area=8,626 sf 76.54% Impervious Runoff Depth=3.81"
Flow Length=115' Tc=1.7 min CN=94 Runoff=0.97 cfs 2,736 cf

Subcatchment 3S: Subcat 2S Runoff Area=17,131 sf 55.06% Impervious Runoff Depth=3.39"
Flow Length=155' Tc=1.6 min CN=90 Runoff=1.78 cfs 4,834 cf

Subcatchment 4S: Subcat 3S Runoff Area=14,990 sf 55.51% Impervious Runoff Depth=3.19"
Flow Length=215' Tc=2.1 min CN=88 Runoff=1.46 cfs 3,981 cf

Subcatchment 5S: Subcat 5S Runoff Area=6,531 sf 75.80% Impervious Runoff Depth=2.81"
Flow Length=75' Tc=1.3 min CN=84 Runoff=0.58 cfs 1,528 cf

Subcatchment 6S: Subcat 6S Runoff Area=5,068 sf 98.56% Impervious Runoff Depth=4.14"
Flow Length=108' Slope=0.0180 '/' Tc=0.9 min CN=97 Runoff=0.61 cfs 1,748 cf

Subcatchment 7S: Subcat 7S Runoff Area=5,589 sf 100.00% Impervious Runoff Depth=4.25"
Flow Length=112' Slope=0.0130 '/' Tc=1.1 min CN=98 Runoff=0.67 cfs 1,981 cf

Subcatchment 8S: Subcat 9S Runoff Area=12,740 sf 96.03% Impervious Runoff Depth=4.03"
Flow Length=150' Slope=0.0230 '/' Tc=1.0 min CN=96 Runoff=1.50 cfs 4,274 cf

Subcatchment 9S: RETAIL CANOPY Runoff Area=3,144 sf 100.00% Impervious Runoff Depth=4.25"
Tc=0.0 min CN=98 Runoff=0.39 cfs 1,115 cf

Subcatchment 10S: C-STORE ROOF Runoff Area=6,000 sf 100.00% Impervious Runoff Depth=4.25"
Tc=0.0 min CN=98 Runoff=0.74 cfs 2,127 cf

Subcatchment 11S: DIESEL CANOPY Runoff Area=1,108 sf 100.00% Impervious Runoff Depth=4.25"
Tc=0.0 min CN=98 Runoff=0.14 cfs 393 cf

Subcatchment 100S: Subcat 100S Runoff Area=12,676 sf 27.77% Impervious Runoff Depth=0.74"
Flow Length=30' Slope=0.0830 '/' Tc=2.2 min CN=55 Runoff=0.21 cfs 779 cf

Subcatchment 101S: Direct to basin Runoff Area=6,362 sf 0.02% Impervious Runoff Depth=0.06"
Tc=0.0 min CN=37 Runoff=0.00 cfs 34 cf

Subcatchment 200S: Subcat 200S Runoff Area=13,477 sf 0.01% Impervious Runoff Depth=1.60"
Flow Length=182' Tc=3.3 min CN=69 Runoff=0.62 cfs 1,792 cf

Subcatchment 300S: Subcat 300S Runoff Area=5,994 sf 37.25% Impervious Runoff Depth=1.01"
Flow Length=105' Slope=0.0260 '/' Tc=1.0 min CN=60 Runoff=0.17 cfs 507 cf

Subcatchment 301S: Subcat 301S Runoff Area=16,878 sf 81.98% Impervious Runoff Depth=3.09"
Flow Length=120' Slope=0.0175 '/' Tc=1.1 min CN=87 Runoff=1.65 cfs 4,345 cf

Pond 1P: Aboveground Infiltration Basin Peak Elev=252.55' Storage=3,782 cf Inflow=3.35 cfs 10,650 cf
Discarded=0.15 cfs 6,925 cf Primary=0.78 cfs 3,725 cf Outflow=0.93 cfs 10,650 cf

Pond BIO-1: Bioretention Area Peak Elev=251.57' Storage=371 cf Inflow=1.65 cfs 4,345 cf
Discarded=1.16 cfs 4,280 cf Primary=0.27 cfs 65 cf Outflow=1.43 cfs 4,346 cf

Pond CB-1: PROP. CB-1 Peak Elev=254.05' Inflow=0.88 cfs 2,775 cf
12.0" Round Culvert n=0.012 L=109.0' S=0.0069 '/' Outflow=0.88 cfs 2,775 cf

Pond CB-2: PROP CB-2 Peak Elev=254.72' Inflow=0.97 cfs 2,736 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0182 '/' Outflow=0.97 cfs 2,736 cf

Pond CB-3: PROP CB-3 Peak Elev=253.97' Inflow=1.78 cfs 4,834 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0182 '/' Outflow=1.78 cfs 4,834 cf

Pond CB-4: PROP CB-4 Peak Elev=253.64' Inflow=1.46 cfs 3,981 cf
12.0" Round Culvert n=0.012 L=12.0' S=0.0042 '/' Outflow=1.46 cfs 3,981 cf

Pond CB-5: PROP CB-5 Peak Elev=253.24' Inflow=0.58 cfs 1,528 cf
12.0" Round Culvert n=0.012 L=19.0' S=0.0158 '/' Outflow=0.58 cfs 1,528 cf

Pond CB-6: PROP CB-6 Peak Elev=252.88' Inflow=0.61 cfs 1,748 cf
12.0" Round Culvert n=0.012 L=67.0' S=0.0097 '/' Outflow=0.61 cfs 1,748 cf

Pond CB-7: PROP CB-7 Peak Elev=253.21' Inflow=0.67 cfs 1,981 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0409 '/' Outflow=0.67 cfs 1,981 cf

Pond CB-8: PROP CB-8 Peak Elev=252.70' Inflow=1.50 cfs 4,274 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0091 '/' Outflow=1.50 cfs 4,274 cf

Pond CB-9: PROP CB-9 Peak Elev=0.00'
12.0" Round Culvert n=0.012 L=37.0' S=0.0270 '/' Primary=0.00 cfs 0 cf

Pond DMH-1: PROP DMH-1 Peak Elev=253.57' Inflow=1.79 cfs 5,511 cf
12.0" Round Culvert n=0.012 L=85.0' S=0.0047 '/' Outflow=1.79 cfs 5,511 cf

Pond DMH-2: PROP DMH-2 Peak Elev=253.13' Inflow=3.55 cfs 10,345 cf
15.0" Round Culvert n=0.012 L=41.0' S=0.0073 '/' Outflow=3.55 cfs 10,345 cf

Pond DMH-3: PROP DMH-3 Peak Elev=253.00' Inflow=3.55 cfs 10,345 cf
15.0" Round Culvert n=0.012 L=119.0' S=0.0053 '/' Outflow=3.55 cfs 10,345 cf

Pond DMH-6: PROP DMH-6 Peak Elev=252.91' Inflow=0.58 cfs 2,612 cf
12.0" Round Culvert n=0.012 L=153.0' S=0.0046 '/' Outflow=0.58 cfs 2,612 cf

Pond DMH-8: PROP DMH-8 Peak Elev=252.61' Inflow=1.85 cfs 6,341 cf
18.0" Round Culvert n=0.012 L=107.0' S=0.0051 '/' Outflow=1.85 cfs 6,341 cf

Pond DMH-9: PROP DMH-9 Peak Elev=252.58' Inflow=3.35 cfs 10,616 cf
Primary=0.44 cfs 4,365 cf Secondary=2.93 cfs 6,250 cf Outflow=3.35 cfs 10,616 cf

Pond INF-1: Underground Infiltration Peak Elev=252.99' Storage=6,102 cf Inflow=5.00 cfs 14,326 cf
Discarded=0.27 cfs 13,242 cf Primary=0.28 cfs 1,084 cf Outflow=0.55 cfs 14,326 cf

Pond INF-2: Underground Infiltration Peak Elev=251.74' Storage=1,461 cf Inflow=1.26 cfs 3,634 cf
Discarded=0.07 cfs 3,634 cf Primary=0.00 cfs 0 cf Outflow=0.07 cfs 3,634 cf

Pond OWS-1: PROP OWS-1 Peak Elev=252.57' Inflow=0.44 cfs 4,365 cf
6.0" Round Culvert n=0.012 L=8.0' S=0.0313 '/' Outflow=0.44 cfs 4,365 cf

Pond SD-1: PROP SLOTTED DRAIN Peak Elev=254.39' Inflow=0.58 cfs 1,528 cf
8.0" Round Culvert n=0.012 L=5.0' S=0.0100 '/' Outflow=0.58 cfs 1,528 cf

Link DP1: DESIGN POINT #1: AYER ROAD Inflow=0.90 cfs 4,504 cf
Primary=0.90 cfs 4,504 cf

Link DP2: DESIGN POINT #2: ADJACENT PROPERTY (EAST) Inflow=0.62 cfs 1,792 cf
Primary=0.62 cfs 1,792 cf

Link DP3: DESIGN POINT #3: WILLOW ROAD Inflow=0.42 cfs 572 cf
Primary=0.42 cfs 572 cf

Total Runoff Area = 144,587 sf Runoff Volume = 34,950 cf Average Runoff Depth = 2.90"
38.23% Pervious = 55,276 sf 61.77% Impervious = 89,311 sf

Summary for Subcatchment 1S: Subcat 1S

Runoff = 0.88 cfs @ 12.05 hrs, Volume= 2,775 cf, Depth= 4.03"
Routed to Pond CB-1 : PROP. CB-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
929	80	>75% Grass cover, Good, HSG D
1,328	98	Paved parking, HSG A
6,015	98	Paved parking, HSG D
8,273	96	Weighted Average
929		11.24% Pervious Area
7,343		88.76% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	25	0.0200	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.02"
0.5	80	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
3.8	105	Total			

Summary for Subcatchment 2S: Subcat 2S

Runoff = 0.97 cfs @ 12.02 hrs, Volume= 2,736 cf, Depth= 3.81"
Routed to Pond CB-2 : PROP CB-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
2,023	80	>75% Grass cover, Good, HSG D
6,603	98	Paved parking, HSG D
8,626	94	Weighted Average
2,023		23.46% Pervious Area
6,603		76.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	30	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.02"
0.4	85	0.0300	3.52		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.7	115	Total			

Summary for Subcatchment 3S: Subcat 2S

Runoff = 1.78 cfs @ 12.02 hrs, Volume= 4,834 cf, Depth= 3.39"
Routed to Pond CB-3 : PROP CB-3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
7,699	80	>75% Grass cover, Good, HSG D
9,432	98	Paved parking, HSG D
17,131	90	Weighted Average
7,699		44.94% Pervious Area
9,432		55.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3000	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.02"
0.4	75	0.2100	3.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	60	0.0380	3.96		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.6	155	Total			

Summary for Subcatchment 4S: Subcat 3S

Runoff = 1.46 cfs @ 12.03 hrs, Volume= 3,981 cf, Depth= 3.19"
Routed to Pond CB-4 : PROP CB-4

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
889	39	>75% Grass cover, Good, HSG A
5,780	80	>75% Grass cover, Good, HSG D
2,875	98	Paved parking, HSG A
5,446	98	Paved parking, HSG D
14,990	88	Weighted Average
6,669		44.49% Pervious Area
8,321		55.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3000	0.35		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.02"
1.0	150	0.1200	2.42		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	45	0.0240	3.14		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.1	215	Total			

Summary for Subcatchment 5S: Subcat 5S

Runoff = 0.58 cfs @ 12.02 hrs, Volume= 1,528 cf, Depth= 2.81"
Routed to Pond SD-1 : PROP SLOTTED DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
1,580	39	>75% Grass cover, Good, HSG A
4,951	98	Paved parking, HSG A
6,531	84	Weighted Average
1,580		24.20% Pervious Area
4,951		75.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	20	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.02"
0.3	25	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	30	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.3	75	Total			

Summary for Subcatchment 6S: Subcat 6S

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.61 cfs @ 12.01 hrs, Volume= 1,748 cf, Depth= 4.14"
Routed to Pond CB-6 : PROP CB-6

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
31	39	>75% Grass cover, Good, HSG A
42	80	>75% Grass cover, Good, HSG D
3,973	98	Paved parking, HSG A
1,022	98	Paved parking, HSG D
5,068	97	Weighted Average
73		1.44% Pervious Area
4,995		98.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	20	0.0180	0.93		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.02"
0.5	88	0.0180	2.72		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.9	108	Total			

Summary for Subcatchment 7S: Subcat 7S

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.67 cfs @ 12.02 hrs, Volume= 1,981 cf, Depth= 4.25"
Routed to Pond CB-7 : PROP CB-7

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
5,589	98	Paved parking, HSG A
5,589		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	20	0.0130	0.82		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.02"
0.7	92	0.0130	2.31		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.1	112	Total			

Summary for Subcatchment 8S: Subcat 9S

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.50 cfs @ 12.01 hrs, Volume= 4,274 cf, Depth= 4.03"
Routed to Pond CB-8 : PROP CB-8

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
462	39	>75% Grass cover, Good, HSG A
44	80	>75% Grass cover, Good, HSG D
12,201	98	Paved parking, HSG A
34	98	Paved parking, HSG D
12,740	96	Weighted Average
505		3.97% Pervious Area
12,234		96.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	20	0.0230	1.02		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.02"
0.7	130	0.0230	3.08		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.0	150	Total			

Summary for Subcatchment 9S: RETAIL CANOPY

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.39 cfs @ 12.00 hrs, Volume= 1,115 cf, Depth= 4.25"
Routed to Pond INF-2 : Underground Infiltration System #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
3,144	98	Roofs, HSG A
3,144		100.00% Impervious Area

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

Summary for Subcatchment 10S: C-STORE ROOF

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.74 cfs @ 12.00 hrs, Volume= 2,127 cf, Depth= 4.25"
Routed to Pond INF-2 : Underground Infiltration System #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
6,000	98	Roofs, HSG D
6,000		100.00% Impervious Area

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

Summary for Subcatchment 11S: DIESEL CANOPY

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.14 cfs @ 12.00 hrs, Volume= 393 cf, Depth= 4.25"
Routed to Pond INF-2 : Underground Infiltration System #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
1,108	98	Roofs, HSG A
1,108		100.00% Impervious Area

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

Summary for Subcatchment 100S: Subcat 100S

Runoff = 0.21 cfs @ 12.05 hrs, Volume= 779 cf, Depth= 0.74"
Routed to Link DP1 : DESIGN POINT #1: AYER ROAD

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
9,110	39	>75% Grass cover, Good, HSG A
3,520	98	Paved parking, HSG A
45	30	Woods, Good, HSG A
12,676	55	Weighted Average
9,156		72.23% Pervious Area
3,520		27.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	30	0.0830	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.02"

Summary for Subcatchment 101S: Direct to basin

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.00 cfs @ 15.20 hrs, Volume= 34 cf, Depth= 0.06"
Routed to Pond 1P : Aboveground Infiltration Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
5,132	39	>75% Grass cover, Good, HSG A
1	98	Paved parking, HSG A
1,229	30	Woods, Good, HSG A
6,362	37	Weighted Average
6,361		99.98% Pervious Area
1		0.02% Impervious Area

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

Summary for Subcatchment 200S: Subcat 200S

Runoff = 0.62 cfs @ 12.06 hrs, Volume= 1,792 cf, Depth= 1.60"
Routed to Link DP2 : DESIGN POINT #2: ADJACENT PROPERTY (EAST)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
1,612	39	>75% Grass cover, Good, HSG A
2,921	80	>75% Grass cover, Good, HSG D
1	98	Paved parking, HSG D
1,119	30	Woods, Good, HSG A
7,823	77	Woods, Good, HSG D
13,477	69	Weighted Average
13,476		99.99% Pervious Area
1		0.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	25	0.1500	0.28		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.02"
0.6	67	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.2	90	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.3	182	Total			

Summary for Subcatchment 300S: Subcat 300S

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.17 cfs @ 12.02 hrs, Volume= 507 cf, Depth= 1.01"
Routed to Link DP3 : DESIGN POINT #3: WILLOW ROAD

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
2,957	39	>75% Grass cover, Good, HSG A
2,233	98	Paved parking, HSG A
804	30	Woods, Good, HSG A
5,994	60	Weighted Average
3,761		62.75% Pervious Area
2,233		37.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	25	0.0260	1.12		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.02"
0.5	75	0.0260	2.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	5	0.0260	0.81		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
1.0	105	Total			

Summary for Subcatchment 301S: Subcat 301S

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.65 cfs @ 12.02 hrs, Volume= 4,345 cf, Depth= 3.09"
Routed to Pond BIO-1 : Bioretention Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.49"

Area (sf)	CN	Description
2,997	39	>75% Grass cover, Good, HSG A
13,836	98	Paved parking, HSG A
45	30	Woods, Good, HSG A
16,878	87	Weighted Average
3,042		18.02% Pervious Area
13,836		81.98% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	25	0.0175	0.96		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.02"
0.7	95	0.0175	2.13		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.1	120	Total			

Summary for Pond 1P: Aboveground Infiltration Basin

[80] Warning: Exceeded Pond OWS-1 by 0.89' @ 24.10 hrs (0.76 cfs 1,698 cf)

Inflow Area = 95,562 sf, 72.96% Impervious, Inflow Depth = 1.34" for 10-yr event
Inflow = 3.35 cfs @ 12.02 hrs, Volume= 10,650 cf
Outflow = 0.93 cfs @ 12.29 hrs, Volume= 10,650 cf, Atten= 72%, Lag= 16.7 min
Discarded = 0.15 cfs @ 12.29 hrs, Volume= 6,925 cf
Primary = 0.78 cfs @ 12.29 hrs, Volume= 3,725 cf
Routed to Link DP1 : DESIGN POINT #1: AYER ROAD

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 252.55' @ 12.29 hrs Surf.Area= 2,665 sf Storage= 3,782 cf
Flood Elev= 254.00' Surf.Area= 4,033 sf Storage= 8,592 cf

Plug-Flow detention time= 171.2 min calculated for 10,650 cf (100% of inflow)
Center-of-Mass det. time= 171.2 min (938.4 - 767.2)

Volume	Invert	Avail.Storage	Storage Description
#1	250.00'	8,592 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
250.00	638	131.2	0	0	638
251.49	1,292	159.5	1,409	1,409	1,328
251.50	1,821	258.0	15	1,425	4,600
252.00	2,216	268.0	1,008	2,433	5,039
254.00	4,033	293.0	6,159	8,592	6,288

Device	Routing	Invert	Outlet Devices
#1	Discarded	250.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	252.00'	**8.0" Round Culvert** L= 31.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 252.00' / 248.00' S= 0.1290 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Primary	253.65'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.15 cfs @ 12.29 hrs HW=252.55' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.15 cfs)

Primary OutFlow Max=0.78 cfs @ 12.29 hrs HW=252.55' TW=0.00' (Dynamic Tailwater)
├**2=Culvert** (Inlet Controls 0.78 cfs @ 2.53 fps)
└**3=Orifice/Grate** (Controls 0.00 cfs)

Summary for Pond BIO-1: Bioretention Area

Inflow Area = 16,878 sf, 81.98% Impervious, Inflow Depth = 3.09" for 10-yr event
Inflow = 1.65 cfs @ 12.02 hrs, Volume= 4,345 cf
Outflow = 1.43 cfs @ 12.05 hrs, Volume= 4,346 cf, Atten= 14%, Lag= 1.8 min
Discarded = 1.16 cfs @ 12.05 hrs, Volume= 4,280 cf
Primary = 0.27 cfs @ 12.05 hrs, Volume= 65 cf
Routed to Link DP3 : DESIGN POINT #3: WILLOW ROAD

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 251.57' @ 12.05 hrs Surf.Area= 768 sf Storage= 371 cf
Flood Elev= 252.00' Surf.Area= 1,438 sf Storage= 837 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 12.8 min (813.5 - 800.7)

Volume	Invert	Avail.Storage	Storage Description
#1	248.00'	837 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
248.00	59	38.0	0.0	0	0	59
250.49	59	38.0	35.0	51	51	154
250.50	59	38.0	100.0	1	52	154
251.00	199	90.0	100.0	61	113	685
252.00	1,438	414.0	100.0	724	837	13,682

Device	Routing	Invert	Outlet Devices
#1	Discarded	248.00'	**8.270 in/hr Exfiltration over Wetted area**
#2	Primary	251.50'	**6.0' long x 5.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50
			Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=1.16 cfs @ 12.05 hrs HW=251.57' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 1.16 cfs)

Primary OutFlow Max=0.26 cfs @ 12.05 hrs HW=251.57' TW=0.00' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 0.26 cfs @ 0.62 fps)

Summary for Pond CB-1: PROP. CB-1

Inflow Area = 8,273 sf, 88.76% Impervious, Inflow Depth = 4.03" for 10-yr event
Inflow = 0.88 cfs @ 12.05 hrs, Volume= 2,775 cf
Outflow = 0.88 cfs @ 12.05 hrs, Volume= 2,775 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.88 cfs @ 12.05 hrs, Volume= 2,775 cf
Routed to Pond DMH-1 : PROP DMH-1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 254.05' @ 12.05 hrs
Flood Elev= 256.45'

Device	Routing	Invert	Outlet Devices
#1	Primary	253.45'	**12.0" Round Culvert** L= 109.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 253.45' / 252.70' S= 0.0069 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.90 cfs @ 12.05 hrs HW=254.05' TW=253.55' (Dynamic Tailwater)
1=Culvert (Outlet Controls 0.90 cfs @ 2.62 fps)

Summary for Pond CB-2: PROP CB-2

Inflow Area = 8,626 sf, 76.54% Impervious, Inflow Depth = 3.81" for 10-yr event
Inflow = 0.97 cfs @ 12.02 hrs, Volume= 2,736 cf
Outflow = 0.97 cfs @ 12.02 hrs, Volume= 2,736 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.97 cfs @ 12.02 hrs, Volume= 2,736 cf
Routed to Pond DMH-1 : PROP DMH-1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 254.72' @ 12.02 hrs
Flood Elev= 257.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	254.20'	**12.0" Round Culvert** L= 11.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 254.20' / 254.00' S= 0.0182 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.96 cfs @ 12.02 hrs HW=254.72' TW=253.54' (Dynamic Tailwater)
1=Culvert (Barrel Controls 0.96 cfs @ 3.37 fps)

Summary for Pond CB-3: PROP CB-3

Inflow Area = 17,131 sf, 55.06% Impervious, Inflow Depth = 3.39" for 10-yr event
Inflow = 1.78 cfs @ 12.02 hrs, Volume= 4,834 cf
Outflow = 1.78 cfs @ 12.02 hrs, Volume= 4,834 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.78 cfs @ 12.02 hrs, Volume= 4,834 cf
Routed to Pond DMH-2 : PROP DMH-2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 253.97' @ 12.02 hrs
Flood Elev= 257.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	253.20'	**12.0" Round Culvert** L= 11.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 253.20' / 253.00' S= 0.0182 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.77 cfs @ 12.02 hrs HW=253.97' TW=253.11' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 1.77 cfs @ 3.78 fps)

Summary for Pond CB-4: PROP CB-4

Inflow Area = 14,990 sf, 55.51% Impervious, Inflow Depth = 3.19" for 10-yr event
Inflow = 1.46 cfs @ 12.03 hrs, Volume= 3,981 cf
Outflow = 1.46 cfs @ 12.03 hrs, Volume= 3,981 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.46 cfs @ 12.03 hrs, Volume= 3,981 cf
Routed to Pond INF-1 : Underground Infiltration System #1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 253.64' @ 12.03 hrs
Flood Elev= 256.85'

Device	Routing	Invert	Outlet Devices
#1	Primary	252.85'	**12.0" Round Culvert** L= 12.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 252.85' / 252.80' S= 0.0042 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.45 cfs @ 12.03 hrs HW=253.64' TW=251.73' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 1.45 cfs @ 2.99 fps)

Summary for Pond CB-5: PROP CB-5

Inflow Area = 6,531 sf, 75.80% Impervious, Inflow Depth = 2.81" for 10-yr event
Inflow = 0.58 cfs @ 12.02 hrs, Volume= 1,528 cf
Outflow = 0.58 cfs @ 12.02 hrs, Volume= 1,528 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.58 cfs @ 12.02 hrs, Volume= 1,528 cf
Routed to Pond DMH-6 : PROP DMH-6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 253.24' @ 12.03 hrs
Flood Elev= 255.85'

Device	Routing	Invert	Outlet Devices
#1	Primary	252.85'	**12.0" Round Culvert** L= 19.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 252.85' / 252.55' S= 0.0158 '/' Cc= 0.900

n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.56 cfs @ 12.02 hrs HW=253.24' TW=252.90' (Dynamic Tailwater)
1=Culvert (Outlet Controls 0.56 cfs @ 3.00 fps)

Summary for Pond CB-6: PROP CB-6

Inflow Area = 5,068 sf, 98.56% Impervious, Inflow Depth = 4.14" for 10-yr event
Inflow = 0.61 cfs @ 12.01 hrs, Volume= 1,748 cf
Outflow = 0.61 cfs @ 12.01 hrs, Volume= 1,748 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.61 cfs @ 12.01 hrs, Volume= 1,748 cf
Routed to Pond DMH-8 : PROP DMH-8

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 252.88' @ 12.03 hrs
Flood Elev= 256.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	252.40'	**12.0" Round Culvert** L= 67.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 252.40' / 251.75' S= 0.0097 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.56 cfs @ 12.01 hrs HW=252.87' TW=252.56' (Dynamic Tailwater)
1=Culvert (Outlet Controls 0.56 cfs @ 2.24 fps)

Summary for Pond CB-7: PROP CB-7

Inflow Area = 5,589 sf,100.00% Impervious, Inflow Depth = 4.25" for 10-yr event
Inflow = 0.67 cfs @ 12.02 hrs, Volume= 1,981 cf
Outflow = 0.67 cfs @ 12.02 hrs, Volume= 1,981 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.67 cfs @ 12.02 hrs, Volume= 1,981 cf
Routed to Pond DMH-8 : PROP DMH-8

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 253.21' @ 12.02 hrs
Flood Elev= 255.80'

Device	Routing	Invert	Outlet Devices
#1	Primary	252.80'	**12.0" Round Culvert** L= 11.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 252.80' / 252.35' S= 0.0409 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.66 cfs @ 12.02 hrs HW=253.21' TW=252.58' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.66 cfs @ 2.18 fps)

Summary for Pond CB-8: PROP CB-8

Inflow Area = 12,740 sf, 96.03% Impervious, Inflow Depth = 4.03" for 10-yr event
Inflow = 1.50 cfs @ 12.01 hrs, Volume= 4,274 cf
Outflow = 1.50 cfs @ 12.01 hrs, Volume= 4,274 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.50 cfs @ 12.01 hrs, Volume= 4,274 cf
Routed to Pond DMH-9 : PROP DMH-9

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 252.70' @ 12.03 hrs
Flood Elev= 254.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	251.80'	**12.0" Round Culvert** L= 11.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 251.80' / 251.70' S= 0.0091 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.35 cfs @ 12.01 hrs HW=252.68' TW=252.52' (Dynamic Tailwater)
1=Culvert (Outlet Controls 1.35 cfs @ 2.44 fps)

Summary for Pond CB-9: PROP CB-9

[43] Hint: Has no inflow (Outflow=Zero)

Device	Routing	Invert	Outlet Devices
#1	Primary	251.00'	**12.0" Round Culvert** L= 37.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 251.00' / 250.00' S= 0.0270 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' TW=250.00' (Dynamic Tailwater)
1=Culvert (Controls 0.00 cfs)

Summary for Pond DMH-1: PROP DMH-1

Inflow Area = 16,899 sf, 82.53% Impervious, Inflow Depth = 3.91" for 10-yr event
Inflow = 1.79 cfs @ 12.04 hrs, Volume= 5,511 cf
Outflow = 1.79 cfs @ 12.04 hrs, Volume= 5,511 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.79 cfs @ 12.04 hrs, Volume= 5,511 cf
Routed to Pond DMH-2 : PROP DMH-2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 253.57' @ 12.04 hrs
Flood Elev= 257.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	252.60'	**12.0" Round Culvert** L= 85.0' CPP, square edge headwall, Ke= 0.500

Inlet / Outlet Invert= 252.60' / 252.20' S= 0.0047 '/' Cc= 0.900
n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.77 cfs @ 12.04 hrs HW=253.56' TW=253.13' (Dynamic Tailwater)
1=Culvert (Outlet Controls 1.77 cfs @ 2.92 fps)

Summary for Pond DMH-2: PROP DMH-2

Inflow Area = 34,030 sf, 68.70% Impervious, Inflow Depth = 3.65" for 10-yr event
Inflow = 3.55 cfs @ 12.03 hrs, Volume= 10,345 cf
Outflow = 3.55 cfs @ 12.03 hrs, Volume= 10,345 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.55 cfs @ 12.03 hrs, Volume= 10,345 cf
Routed to Pond DMH-3 : PROP DMH-3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 253.13' @ 12.03 hrs
Flood Elev= 257.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	251.95'	**15.0" Round Culvert**
			L= 41.0' CPP, square edge headwall, Ke= 0.500
			Inlet / Outlet Invert= 251.95' / 251.65' S= 0.0073 '/' Cc= 0.900
			n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=3.50 cfs @ 12.03 hrs HW=253.13' TW=252.65' (Dynamic Tailwater)
1=Culvert (Outlet Controls 3.50 cfs @ 3.78 fps)

Summary for Pond DMH-3: PROP DMH-3

Inflow Area = 34,030 sf, 68.70% Impervious, Inflow Depth = 3.65" for 10-yr event
Inflow = 3.55 cfs @ 12.03 hrs, Volume= 10,345 cf
Outflow = 3.55 cfs @ 12.03 hrs, Volume= 10,345 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.55 cfs @ 12.03 hrs, Volume= 10,345 cf
Routed to Pond INF-1 : Underground Infiltration System #1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 253.00' @ 12.58 hrs
Flood Elev= 258.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	251.55'	**15.0" Round Culvert**
			L= 119.0' CPP, square edge headwall, Ke= 0.500
			Inlet / Outlet Invert= 251.55' / 250.92' S= 0.0053 '/' Cc= 0.900
			n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=3.54 cfs @ 12.03 hrs HW=252.65' TW=251.71' (Dynamic Tailwater)
1=Culvert (Barrel Controls 3.54 cfs @ 4.12 fps)

Summary for Pond DMH-6: PROP DMH-6

[80] Warning: Exceeded Pond INF-1 by 1.46' @ 11.93 hrs (0.00 cfs 95 cf)

Inflow Area = 65,803 sf, 71.28% Impervious, Inflow Depth = 0.48" for 10-yr event
Inflow = 0.58 cfs @ 12.02 hrs, Volume= 2,612 cf
Outflow = 0.58 cfs @ 12.02 hrs, Volume= 2,612 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.58 cfs @ 12.02 hrs, Volume= 2,612 cf
Routed to Pond DMH-8 : PROP DMH-8

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 252.91' @ 12.03 hrs
Flood Elev= 256.25'

Device	Routing	Invert	Outlet Devices
#1	Primary	252.35'	**12.0" Round Culvert** L= 153.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 252.35' / 251.65' S= 0.0046 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.55 cfs @ 12.02 hrs HW=252.90' TW=252.59' (Dynamic Tailwater)
1=Culvert (Outlet Controls 0.55 cfs @ 1.78 fps)

Summary for Pond DMH-8: PROP DMH-8

Inflow Area = 76,460 sf, 75.18% Impervious, Inflow Depth = 1.00" for 10-yr event
Inflow = 1.85 cfs @ 12.02 hrs, Volume= 6,341 cf
Outflow = 1.85 cfs @ 12.02 hrs, Volume= 6,341 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.85 cfs @ 12.02 hrs, Volume= 6,341 cf
Routed to Pond DMH-9 : PROP DMH-9

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 252.61' @ 12.04 hrs
Flood Elev= 256.05'

Device	Routing	Invert	Outlet Devices
#1	Primary	251.15'	**18.0" Round Culvert** L= 107.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 251.15' / 250.60' S= 0.0051 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=1.43 cfs @ 12.02 hrs HW=252.58' TW=252.53' (Dynamic Tailwater)
1=Culvert (Outlet Controls 1.43 cfs @ 1.06 fps)

Summary for Pond DMH-9: PROP DMH-9

[80] Warning: Exceeded Pond DMH-8 by 0.01' @ 11.56 hrs (0.10 cfs 4 cf)

Inflow Area = 89,200 sf, 78.16% Impervious, Inflow Depth = 1.43" for 10-yr event
Inflow = 3.35 cfs @ 12.02 hrs, Volume= 10,616 cf
Outflow = 3.35 cfs @ 12.02 hrs, Volume= 10,616 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.44 cfs @ 11.62 hrs, Volume= 4,365 cf
Routed to Pond OWS-1 : PROP OWS-1
Secondary = 2.93 cfs @ 12.02 hrs, Volume= 6,250 cf
Routed to Pond 1P : Aboveground Infiltration Basin

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 252.58' @ 12.26 hrs
Flood Elev= 255.25'

Device	Routing	Invert	Outlet Devices
#1	Primary	250.60'	**6.0" Round Culvert** L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 250.60' / 250.50' S= 0.0200 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#2	Secondary	251.60'	**18.0" Round Culvert** L= 12.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 251.60' / 251.00' S= 0.0500 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=0.43 cfs @ 11.62 hrs HW=251.76' TW=251.56' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 0.43 cfs @ 2.18 fps)

Secondary OutFlow Max=2.72 cfs @ 12.02 hrs HW=252.53' TW=252.23' (Dynamic Tailwater)
↑—**2=Culvert** (Outlet Controls 2.72 cfs @ 3.39 fps)

Summary for Pond INF-1: Underground Infiltration System #1

Inflow Area = 49,020 sf, 64.67% Impervious, Inflow Depth = 3.51" for 10-yr event
Inflow = 5.00 cfs @ 12.03 hrs, Volume= 14,326 cf
Outflow = 0.55 cfs @ 12.62 hrs, Volume= 14,326 cf, Atten= 89%, Lag= 35.4 min
Discarded = 0.27 cfs @ 12.58 hrs, Volume= 13,242 cf
Primary = 0.28 cfs @ 12.62 hrs, Volume= 1,084 cf
Routed to Pond DMH-6 : PROP DMH-6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 252.99' @ 12.58 hrs Surf.Area= 3,037 sf Storage= 6,102 cf
Flood Elev= 255.50' Surf.Area= 3,037 sf Storage= 9,926 cf

Plug-Flow detention time= 194.7 min calculated for 14,326 cf (100% of inflow)
Center-of-Mass det. time= 194.7 min (978.5 - 783.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	250.00'	2,103 cf	**29.92'W x 48.72'L x 5.50'H Field A** 8,016 cf Overall - 2,758 cf Embedded = 5,258 cf x 40.0% Voids
#2A	250.75'	2,758 cf	**ADS_StormTech MC-3500 d +Cap** x 24 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 24 Chambers in 4 Rows Cap Storage= 14.9 cf x 2 x 4 rows = 119.2 cf
#3B	250.00'	804 cf	**8.42'W x 63.06'L x 5.50'H Field B** 2,919 cf Overall - 909 cf Embedded = 2,010 cf x 40.0% Voids
#4B	250.75'	909 cf	**ADS_StormTech MC-3500 d +Cap** x 8 Inside #3 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap Cap Storage= 14.9 cf x 2 x 1 rows = 29.8 cf
#5C	250.00'	715 cf	**8.42'W x 55.89'L x 5.50'H Field C** 2,587 cf Overall - 799 cf Embedded = 1,788 cf x 40.0% Voids
#6C	250.75'	799 cf	**ADS_StormTech MC-3500 d +Cap** x 7 Inside #5 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap Cap Storage= 14.9 cf x 2 x 1 rows = 29.8 cf
#7D	250.00'	538 cf	**8.42'W x 41.55'L x 5.50'H Field D** 1,923 cf Overall - 580 cf Embedded = 1,344 cf x 40.0% Voids
#8D	250.75'	580 cf	**ADS_StormTech MC-3500 d +Cap** x 5 Inside #7 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap Cap Storage= 14.9 cf x 2 x 1 rows = 29.8 cf
#9E	250.00'	360 cf	**8.42'W x 27.21'L x 5.50'H Field E** 1,260 cf Overall - 360 cf Embedded = 900 cf x 40.0% Voids
#10E	250.75'	360 cf	**ADS_StormTech MC-3500 d +Cap** x 3 Inside #9 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap Cap Storage= 14.9 cf x 2 x 1 rows = 29.8 cf
		9,926 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard
Storage Group C created with Chamber Wizard
Storage Group D created with Chamber Wizard
Storage Group E created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	250.00'	**2.410 in/hr Exfiltration over Wetted area** Phase-In= 0.01'
#2	Primary	252.65'	**12.0" Round Culvert** L= 48.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 252.65' / 252.35' S= 0.0063 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Discarded OutFlow Max=0.27 cfs @ 12.58 hrs HW=252.99' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.27 cfs)

Primary OutFlow Max=0.28 cfs @ 12.62 hrs HW=252.99' TW=252.79' (Dynamic Tailwater)
2=Culvert (Outlet Controls 0.28 cfs @ 1.78 fps)

Summary for Pond INF-2: Underground Infiltration System #2

Inflow Area = 10,252 sf,100.00% Impervious, Inflow Depth = 4.25" for 10-yr event
Inflow = 1.26 cfs @ 12.00 hrs, Volume= 3,634 cf
Outflow = 0.07 cfs @ 13.12 hrs, Volume= 3,634 cf, Atten= 94%, Lag= 67.3 min
Discarded = 0.07 cfs @ 13.12 hrs, Volume= 3,634 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond DMH-6 : PROP DMH-6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 251.74' @ 13.12 hrs Surf.Area= 983 sf Storage= 1,461 cf
Flood Elev= 255.00' Surf.Area= 983 sf Storage= 3,253 cf

Plug-Flow detention time= 160.2 min calculated for 3,634 cf (100% of inflow)
Center-of-Mass det. time= 160.2 min (904.5 - 744.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	249.50'	1,434 cf	**15.58'W x 63.06'L x 5.50'H Field A** 5,405 cf Overall - 1,819 cf Embedded = 3,586 cf x 40.0% Voids
#2A	250.25'	1,819 cf	**ADS_StormTech MC-3500 d +Cap** x 16 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 16 Chambers in 2 Rows Cap Storage= 14.9 cf x 2 x 2 rows = 59.6 cf
		3,253 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	249.50'	**2.410 in/hr Exfiltration over Wetted area** Phase-In= 0.01'
#2	Primary	253.02'	**6.0" Round Culvert** L= 22.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 253.02' / 252.45' S= 0.0259 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf

Discarded OutFlow Max=0.07 cfs @ 13.12 hrs HW=251.74' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=249.50' TW=252.35' (Dynamic Tailwater)
2=Culvert (Controls 0.00 cfs)

Summary for Pond OWS-1: PROP OWS-1

[80] Warning: Exceeded Pond DMH-9 by 0.08' @ 24.28 hrs (0.26 cfs 647 cf)

Inflow Area = 89,200 sf, 78.16% Impervious, Inflow Depth = 0.59" for 10-yr event
Inflow = 0.44 cfs @ 11.62 hrs, Volume= 4,365 cf
Outflow = 0.44 cfs @ 11.62 hrs, Volume= 4,365 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.44 cfs @ 11.62 hrs, Volume= 4,365 cf
Routed to Pond 1P : Aboveground Infiltration Basin

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 252.57' @ 12.28 hrs
Flood Elev= 254.95'

Device	Routing	Invert	Outlet Devices
#1	Primary	250.25'	**6.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 250.25' / 250.00' S= 0.0313 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf

Primary OutFlow Max=0.43 cfs @ 11.62 hrs HW=251.56' TW=251.35' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.43 cfs @ 2.18 fps)

Summary for Pond SD-1: PROP SLOTTED DRAIN

Inflow Area = 6,531 sf, 75.80% Impervious, Inflow Depth = 2.81" for 10-yr event
Inflow = 0.58 cfs @ 12.02 hrs, Volume= 1,528 cf
Outflow = 0.58 cfs @ 12.02 hrs, Volume= 1,528 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.58 cfs @ 12.02 hrs, Volume= 1,528 cf
Routed to Pond CB-5 : PROP CB-5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 254.39' @ 12.02 hrs
Flood Elev= 255.35'

Device	Routing	Invert	Outlet Devices
#1	Primary	253.85'	**8.0" Round Culvert** L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 253.85' / 253.80' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf

Primary OutFlow Max=0.58 cfs @ 12.02 hrs HW=254.39' TW=253.24' (Dynamic Tailwater)
1=Culvert (Barrel Controls 0.58 cfs @ 2.64 fps)

Summary for Link DP1: DESIGN POINT #1: AYER ROAD

Inflow Area = 108,238 sf, 67.67% Impervious, Inflow Depth = 0.50" for 10-yr event
Inflow = 0.90 cfs @ 12.27 hrs, Volume= 4,504 cf
Primary = 0.90 cfs @ 12.27 hrs, Volume= 4,504 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Summary for Link DP2: DESIGN POINT #2: ADJACENT PROPERTY (EAST)

Inflow Area = 13,477 sf, 0.01% Impervious, Inflow Depth = 1.60" for 10-yr event
Inflow = 0.62 cfs @ 12.06 hrs, Volume= 1,792 cf
Primary = 0.62 cfs @ 12.06 hrs, Volume= 1,792 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Summary for Link DP3: DESIGN POINT #3: WILLOW ROAD

Inflow Area = 22,872 sf, 70.26% Impervious, Inflow Depth = 0.30" for 10-yr event
Inflow = 0.42 cfs @ 12.05 hrs, Volume= 572 cf
Primary = 0.42 cfs @ 12.05 hrs, Volume= 572 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Subcat 1S Runoff Area=8,273 sf 88.76% Impervious Runoff Depth=5.16"
Flow Length=105' Tc=3.8 min CN=96 Runoff=1.12 cfs 3,557 cf

Subcatchment 2S: Subcat 2S Runoff Area=8,626 sf 76.54% Impervious Runoff Depth=4.93"
Flow Length=115' Tc=1.7 min CN=94 Runoff=1.23 cfs 3,544 cf

Subcatchment 3S: Subcat 2S Runoff Area=17,131 sf 55.06% Impervious Runoff Depth=4.49"
Flow Length=155' Tc=1.6 min CN=90 Runoff=2.32 cfs 6,404 cf

Subcatchment 4S: Subcat 3S Runoff Area=14,990 sf 55.51% Impervious Runoff Depth=4.27"
Flow Length=215' Tc=2.1 min CN=88 Runoff=1.92 cfs 5,334 cf

Subcatchment 5S: Subcat 5S Runoff Area=6,531 sf 75.80% Impervious Runoff Depth=3.85"
Flow Length=75' Tc=1.3 min CN=84 Runoff=0.79 cfs 2,096 cf

Subcatchment 6S: Subcat 6S Runoff Area=5,068 sf 98.56% Impervious Runoff Depth=5.28"
Flow Length=108' Slope=0.0180 '/' Tc=0.9 min CN=97 Runoff=0.76 cfs 2,228 cf

Subcatchment 7S: Subcat 7S Runoff Area=5,589 sf 100.00% Impervious Runoff Depth=5.39"
Flow Length=112' Slope=0.0130 '/' Tc=1.1 min CN=98 Runoff=0.84 cfs 2,512 cf

Subcatchment 8S: Subcat 9S Runoff Area=12,740 sf 96.03% Impervious Runoff Depth=5.16"
Flow Length=150' Slope=0.0230 '/' Tc=1.0 min CN=96 Runoff=1.90 cfs 5,477 cf

Subcatchment 9S: RETAIL CANOPY Runoff Area=3,144 sf 100.00% Impervious Runoff Depth=5.39"
Tc=0.0 min CN=98 Runoff=0.49 cfs 1,413 cf

Subcatchment 10S: C-STORE ROOF Runoff Area=6,000 sf 100.00% Impervious Runoff Depth=5.39"
Tc=0.0 min CN=98 Runoff=0.93 cfs 2,696 cf

Subcatchment 11S: DIESEL CANOPY Runoff Area=1,108 sf 100.00% Impervious Runoff Depth=5.39"
Tc=0.0 min CN=98 Runoff=0.17 cfs 498 cf

Subcatchment 100S: Subcat 100S Runoff Area=12,676 sf 27.77% Impervious Runoff Depth=1.31"
Flow Length=30' Slope=0.0830 '/' Tc=2.2 min CN=55 Runoff=0.44 cfs 1,384 cf

Subcatchment 101S: Direct to basin Runoff Area=6,362 sf 0.02% Impervious Runoff Depth=0.26"
Tc=0.0 min CN=37 Runoff=0.01 cfs 136 cf

Subcatchment 200S: Subcat 200S Runoff Area=13,477 sf 0.01% Impervious Runoff Depth=2.43"
Flow Length=182' Tc=3.3 min CN=69 Runoff=0.96 cfs 2,726 cf

Subcatchment 300S: Subcat 300S Runoff Area=5,994 sf 37.25% Impervious Runoff Depth=1.68"
Flow Length=105' Slope=0.0260 '/' Tc=1.0 min CN=60 Runoff=0.30 cfs 841 cf

Subcatchment 301S: Subcat 301S Runoff Area=16,878 sf 81.98% Impervious Runoff Depth=4.16"
Flow Length=120' Slope=0.0175 '/' Tc=1.1 min CN=87 Runoff=2.19 cfs 5,857 cf

Pond 1P: Aboveground Infiltration Basin Peak Elev=253.10' Storage=5,368 cf Inflow=4.28 cfs 16,504 cf
Discarded=0.18 cfs 7,741 cf Primary=1.47 cfs 8,682 cf Outflow=1.65 cfs 16,423 cf

Pond BIO-1: Bioretention Area Peak Elev=251.63' Storage=421 cf Inflow=2.19 cfs 5,857 cf
Discarded=1.33 cfs 5,618 cf Primary=0.68 cfs 239 cf Outflow=2.01 cfs 5,857 cf

Pond CB-1: PROP. CB-1 Peak Elev=254.35' Inflow=1.12 cfs 3,557 cf
12.0" Round Culvert n=0.012 L=109.0' S=0.0069 '/' Outflow=1.12 cfs 3,557 cf

Pond CB-2: PROP CB-2 Peak Elev=254.81' Inflow=1.23 cfs 3,544 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0182 '/' Outflow=1.23 cfs 3,544 cf

Pond CB-3: PROP CB-3 Peak Elev=254.12' Inflow=2.32 cfs 6,404 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0182 '/' Outflow=2.32 cfs 6,404 cf

Pond CB-4: PROP CB-4 Peak Elev=253.79' Inflow=1.92 cfs 5,334 cf
12.0" Round Culvert n=0.012 L=12.0' S=0.0042 '/' Outflow=1.92 cfs 5,334 cf

Pond CB-5: PROP CB-5 Peak Elev=253.45' Inflow=0.79 cfs 2,096 cf
12.0" Round Culvert n=0.012 L=19.0' S=0.0158 '/' Outflow=0.79 cfs 2,096 cf

Pond CB-6: PROP CB-6 Peak Elev=253.17' Inflow=0.76 cfs 2,228 cf
12.0" Round Culvert n=0.012 L=67.0' S=0.0097 '/' Outflow=0.76 cfs 2,228 cf

Pond CB-7: PROP CB-7 Peak Elev=253.27' Inflow=0.84 cfs 2,512 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0409 '/' Outflow=0.84 cfs 2,512 cf

Pond CB-8: PROP CB-8 Peak Elev=253.14' Inflow=1.90 cfs 5,477 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0091 '/' Outflow=1.90 cfs 5,477 cf

Pond CB-9: PROP CB-9 Peak Elev=0.00'
12.0" Round Culvert n=0.012 L=37.0' S=0.0270 '/' Primary=0.00 cfs 0 cf

Pond DMH-1: PROP DMH-1 Peak Elev=254.12' Inflow=2.28 cfs 7,101 cf
12.0" Round Culvert n=0.012 L=85.0' S=0.0047 '/' Outflow=2.28 cfs 7,101 cf

Pond DMH-2: PROP DMH-2 Peak Elev=253.68' Inflow=4.57 cfs 13,505 cf
15.0" Round Culvert n=0.012 L=41.0' S=0.0073 '/' Outflow=4.57 cfs 13,505 cf

Pond DMH-3: PROP DMH-3 Peak Elev=253.65' Inflow=4.57 cfs 13,505 cf
15.0" Round Culvert n=0.012 L=119.0' S=0.0053 '/' Outflow=4.57 cfs 13,505 cf

Pond DMH-6: PROP DMH-6 Peak Elev=253.44' Inflow=1.41 cfs 6,151 cf
12.0" Round Culvert n=0.012 L=153.0' S=0.0046 '/' Outflow=1.41 cfs 6,151 cf

Pond DMH-8: PROP DMH-8 Peak Elev=253.17' Inflow=2.39 cfs 10,890 cf
18.0" Round Culvert n=0.012 L=107.0' S=0.0051 '/' Outflow=2.39 cfs 10,890 cf

Pond DMH-9: PROP DMH-9 Peak Elev=253.13' Inflow=4.28 cfs 16,368 cf
Primary=0.40 cfs 5,076 cf Secondary=3.89 cfs 11,291 cf Outflow=4.28 cfs 16,368 cf

Pond INF-1: Underground Infiltration Peak Elev=253.60' Storage=7,322 cf Inflow=6.49 cfs 18,839 cf
Discarded=0.29 cfs 14,784 cf Primary=1.21 cfs 4,055 cf Outflow=1.50 cfs 18,839 cf

Pond INF-2: Underground Infiltration Peak Elev=252.48' Storage=2,002 cf Inflow=1.58 cfs 4,607 cf
Discarded=0.08 cfs 4,607 cf Primary=0.00 cfs 0 cf Outflow=0.08 cfs 4,607 cf

Pond OWS-1: PROP OWS-1 Peak Elev=253.12' Inflow=0.40 cfs 5,076 cf
6.0" Round Culvert n=0.012 L=8.0' S=0.0313 '/' Outflow=0.40 cfs 5,076 cf

Pond SD-1: PROP SLOTTED DRAIN Peak Elev=254.51' Inflow=0.79 cfs 2,096 cf
8.0" Round Culvert n=0.012 L=5.0' S=0.0100 '/' Outflow=0.79 cfs 2,096 cf

Link DP1: DESIGN POINT #1: AYER ROAD Inflow=1.60 cfs 10,065 cf
Primary=1.60 cfs 10,065 cf

Link DP2: DESIGN POINT #2: ADJACENT PROPERTY (EAST) Inflow=0.96 cfs 2,726 cf
Primary=0.96 cfs 2,726 cf

Link DP3: DESIGN POINT #3: WILLOW ROAD Inflow=0.97 cfs 1,080 cf
Primary=0.97 cfs 1,080 cf

Total Runoff Area = 144,587 sf Runoff Volume = 46,702 cf Average Runoff Depth = 3.88"
38.23% Pervious = 55,276 sf 61.77% Impervious = 89,311 sf

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Subcat 1S Runoff Area=8,273 sf 88.76% Impervious Runoff Depth=7.45"
Flow Length=105' Tc=3.8 min CN=96 Runoff=1.59 cfs 5,137 cf

Subcatchment 2S: Subcat 2S Runoff Area=8,626 sf 76.54% Impervious Runoff Depth=7.21"
Flow Length=115' Tc=1.7 min CN=94 Runoff=1.76 cfs 5,185 cf

Subcatchment 3S: Subcat 2S Runoff Area=17,131 sf 55.06% Impervious Runoff Depth=6.74"
Flow Length=155' Tc=1.6 min CN=90 Runoff=3.40 cfs 9,617 cf

Subcatchment 4S: Subcat 3S Runoff Area=14,990 sf 55.51% Impervious Runoff Depth=6.50"
Flow Length=215' Tc=2.1 min CN=88 Runoff=2.86 cfs 8,119 cf

Subcatchment 5S: Subcat 5S Runoff Area=6,531 sf 75.80% Impervious Runoff Depth=6.03"
Flow Length=75' Tc=1.3 min CN=84 Runoff=1.22 cfs 3,281 cf

Subcatchment 6S: Subcat 6S Runoff Area=5,068 sf 98.56% Impervious Runoff Depth=7.57"
Flow Length=108' Slope=0.0180 '/' Tc=0.9 min CN=97 Runoff=1.08 cfs 3,197 cf

Subcatchment 7S: Subcat 7S Runoff Area=5,589 sf 100.00% Impervious Runoff Depth=7.69"
Flow Length=112' Slope=0.0130 '/' Tc=1.1 min CN=98 Runoff=1.19 cfs 3,582 cf

Subcatchment 8S: Subcat 9S Runoff Area=12,740 sf 96.03% Impervious Runoff Depth=7.45"
Flow Length=150' Slope=0.0230 '/' Tc=1.0 min CN=96 Runoff=2.69 cfs 7,910 cf

Subcatchment 9S: RETAIL CANOPY Runoff Area=3,144 sf 100.00% Impervious Runoff Depth=7.69"
Tc=0.0 min CN=98 Runoff=0.69 cfs 2,015 cf

Subcatchment 10S: C-STORE ROOF Runoff Area=6,000 sf 100.00% Impervious Runoff Depth=7.69"
Tc=0.0 min CN=98 Runoff=1.31 cfs 3,845 cf

Subcatchment 11S: DIESEL CANOPY Runoff Area=1,108 sf 100.00% Impervious Runoff Depth=7.69"
Tc=0.0 min CN=98 Runoff=0.24 cfs 710 cf

Subcatchment 100S: Subcat 100S Runoff Area=12,676 sf 27.77% Impervious Runoff Depth=2.74"
Flow Length=30' Slope=0.0830 '/' Tc=2.2 min CN=55 Runoff=1.03 cfs 2,890 cf

Subcatchment 101S: Direct to basin Runoff Area=6,362 sf 0.02% Impervious Runoff Depth=0.95"
Tc=0.0 min CN=37 Runoff=0.10 cfs 504 cf

Subcatchment 200S: Subcat 200S Runoff Area=13,477 sf 0.01% Impervious Runoff Depth=4.29"
Flow Length=182' Tc=3.3 min CN=69 Runoff=1.72 cfs 4,818 cf

Subcatchment 300S: Subcat 300S Runoff Area=5,994 sf 37.25% Impervious Runoff Depth=3.28"
Flow Length=105' Slope=0.0260 '/' Tc=1.0 min CN=60 Runoff=0.62 cfs 1,639 cf

Subcatchment 301S: Subcat 301S Runoff Area=16,878 sf 81.98% Impervious Runoff Depth=6.38"
Flow Length=120' Slope=0.0175 '/' Tc=1.1 min CN=87 Runoff=3.29 cfs 8,976 cf

Pond 1P: Aboveground Infiltration Basin Peak Elev=253.84' Storage=7,970 cf Inflow=10.25 cfs 29,908 cf
Discarded=0.22 cfs 9,199 cf Primary=4.28 cfs 20,456 cf Outflow=4.50 cfs 29,655 cf

Pond BIO-1: Bioretention Area Peak Elev=251.72' Storage=503 cf Inflow=3.29 cfs 8,976 cf
Discarded=1.61 cfs 8,214 cf Primary=1.48 cfs 761 cf Outflow=3.09 cfs 8,976 cf

Pond CB-1: PROP. CB-1 Peak Elev=264.43' Inflow=1.59 cfs 5,137 cf
12.0" Round Culvert n=0.012 L=109.0' S=0.0069 '/' Outflow=1.59 cfs 5,137 cf

Pond CB-2: PROP CB-2 Peak Elev=264.41' Inflow=1.76 cfs 5,185 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0182 '/' Outflow=1.76 cfs 5,185 cf

Pond CB-3: PROP CB-3 Peak Elev=264.31' Inflow=3.40 cfs 9,617 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0182 '/' Outflow=3.40 cfs 9,617 cf

Pond CB-4: PROP CB-4 Peak Elev=263.76' Inflow=2.86 cfs 8,119 cf
12.0" Round Culvert n=0.012 L=12.0' S=0.0042 '/' Outflow=2.86 cfs 8,119 cf

Pond CB-5: PROP CB-5 Peak Elev=263.67' Inflow=1.22 cfs 3,281 cf
12.0" Round Culvert n=0.012 L=19.0' S=0.0158 '/' Outflow=1.22 cfs 3,281 cf

Pond CB-6: PROP CB-6 Peak Elev=255.02' Inflow=1.08 cfs 3,197 cf
12.0" Round Culvert n=0.012 L=67.0' S=0.0097 '/' Outflow=1.08 cfs 3,197 cf

Pond CB-7: PROP CB-7 Peak Elev=255.02' Inflow=1.19 cfs 3,582 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0409 '/' Outflow=1.19 cfs 3,582 cf

Pond CB-8: PROP CB-8 Peak Elev=254.78' Inflow=2.69 cfs 7,910 cf
12.0" Round Culvert n=0.012 L=11.0' S=0.0091 '/' Outflow=2.69 cfs 7,910 cf

Pond CB-9: PROP CB-9 Peak Elev=0.00'
12.0" Round Culvert n=0.012 L=37.0' S=0.0270 '/' Primary=0.00 cfs 0 cf

Pond DMH-1: PROP DMH-1 Peak Elev=264.38' Inflow=3.25 cfs 10,321 cf
12.0" Round Culvert n=0.012 L=85.0' S=0.0047 '/' Outflow=3.25 cfs 10,321 cf

Pond DMH-2: PROP DMH-2 Peak Elev=264.19' Inflow=6.61 cfs 19,938 cf
15.0" Round Culvert n=0.012 L=41.0' S=0.0073 '/' Outflow=6.61 cfs 19,938 cf

Pond DMH-3: PROP DMH-3 Peak Elev=263.98' Inflow=6.61 cfs 19,938 cf
15.0" Round Culvert n=0.012 L=119.0' S=0.0053 '/' Outflow=6.61 cfs 19,938 cf

Pond DMH-6: PROP DMH-6 Peak Elev=263.66' Inflow=8.25 cfs 14,715 cf
12.0" Round Culvert n=0.012 L=153.0' S=0.0046 '/' Outflow=8.25 cfs 14,715 cf

Pond DMH-8: PROP DMH-8 Peak Elev=255.01' Inflow=9.13 cfs 21,494 cf
18.0" Round Culvert n=0.012 L=107.0' S=0.0051 '/' Outflow=9.13 cfs 21,494 cf

Pond DMH-9: PROP DMH-9 Peak Elev=254.71' Inflow=10.17 cfs 29,405 cf
Primary=1.04 cfs 6,633 cf Secondary=9.13 cfs 22,772 cf Outflow=10.17 cfs 29,405 cf

Pond INF-1: Underground Infiltration Peak Elev=263.66' Storage=9,926 cf Inflow=9.47 cfs 28,058 cf
Discarded=0.35 cfs 17,433 cf Primary=7.76 cfs 10,625 cf Outflow=8.11 cfs 28,058 cf

Pond INF-2: Underground Infiltration Peak Elev=254.21' Storage=2,942 cf Inflow=2.24 cfs 6,570 cf
Discarded=0.10 cfs 5,760 cf Primary=0.36 cfs 810 cf Outflow=0.46 cfs 6,570 cf

Pond OWS-1: PROP OWS-1 Peak Elev=254.77' Inflow=1.04 cfs 6,633 cf
6.0" Round Culvert n=0.012 L=8.0' S=0.0313 '/' Outflow=1.04 cfs 6,633 cf

Pond SD-1: PROP SLOTTED DRAIN Peak Elev=263.75' Inflow=1.22 cfs 3,281 cf
8.0" Round Culvert n=0.012 L=5.0' S=0.0100 '/' Outflow=1.22 cfs 3,281 cf

Link DP1: DESIGN POINT #1: AYER ROAD Inflow=4.69 cfs 23,346 cf
Primary=4.69 cfs 23,346 cf

Link DP2: DESIGN POINT #2: ADJACENT PROPERTY (EAST) Inflow=1.72 cfs 4,818 cf
Primary=1.72 cfs 4,818 cf

Link DP3: DESIGN POINT #3: WILLOW ROAD Inflow=2.08 cfs 2,400 cf
Primary=2.08 cfs 2,400 cf

Total Runoff Area = 144,587 sf Runoff Volume = 71,425 cf Average Runoff Depth = 5.93"
38.23% Pervious = 55,276 sf 61.77% Impervious = 89,311 sf

APPENDIX G

Supplemental Calculations and Backup Data

Extreme Precipitation Tables

Northeast Regional Climate Center

Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

Smoothing	Yes
State	Massachusetts
Location	
Longitude	71.537 degrees West
Latitude	42.551 degrees North
Elevation	0 feet
Date/Time	Wed, 16 Nov 2022 15:05:21 -0500

Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.28	0.43	0.53	0.70	0.87	1.10	**1yr**	0.75	1.03	1.27	1.59	2.01	2.54	2.80	**1yr**	2.25	2.70	3.13	3.84	4.45	**1yr**
2yr	0.34	0.52	0.65	0.86	1.08	1.36	**2yr**	0.93	1.25	1.57	1.95	2.43	3.02	3.36	**2yr**	2.68	3.23	3.73	4.46	5.07	**2yr**
5yr	0.40	0.62	0.78	1.05	1.34	1.70	**5yr**	1.16	1.56	1.97	2.46	3.06	3.78	4.24	**5yr**	3.35	4.08	4.71	5.61	6.31	**5yr**
10yr	0.45	0.71	0.90	1.22	1.58	2.03	**10yr**	1.37	1.84	2.35	2.94	3.64	4.49	5.07	**10yr**	3.97	4.87	5.62	6.67	7.44	**10yr**
25yr	0.53	0.85	1.08	1.49	1.97	2.54	**25yr**	1.70	2.30	2.96	3.71	4.59	5.63	6.42	**25yr**	4.98	6.17	7.10	8.41	9.27	**25yr**
50yr	0.60	0.96	1.23	1.73	2.33	3.04	**50yr**	2.01	2.72	3.55	4.44	5.47	6.68	7.68	**50yr**	5.91	7.38	8.48	10.01	10.95	**50yr**
100yr	0.69	1.11	1.43	2.03	2.76	3.61	**100yr**	2.38	3.22	4.23	5.29	6.51	7.93	9.19	**100yr**	7.02	8.83	10.13	11.92	12.93	**100yr**
200yr	0.78	1.27	1.65	2.37	3.27	4.30	**200yr**	2.82	3.81	5.04	6.32	7.76	9.43	11.00	**200yr**	8.34	10.58	12.11	14.20	15.28	**200yr**
500yr	0.94	1.54	2.01	2.92	4.09	5.42	**500yr**	3.53	4.77	6.37	7.98	9.80	11.85	13.98	**500yr**	10.49	13.44	15.33	17.91	19.06	**500yr**

Lower Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.22	0.33	0.41	0.55	0.67	0.78	**1yr**	0.58	0.77	1.02	1.40	1.71	2.20	2.39	**1yr**	1.94	2.30	2.74	3.32	3.94	**1yr**
2yr	0.32	0.50	0.61	0.83	1.03	1.23	**2yr**	0.89	1.20	1.40	1.82	2.32	2.95	3.24	**2yr**	2.61	3.12	3.65	4.36	4.98	**2yr**
5yr	0.37	0.57	0.71	0.97	1.23	1.44	**5yr**	1.06	1.41	1.67	2.17	2.77	3.52	3.94	**5yr**	3.12	3.79	4.41	5.30	5.94	**5yr**
10yr	0.41	0.63	0.78	1.09	1.40	1.62	**10yr**	1.21	1.58	1.80	2.46	3.14	4.04	4.51	**10yr**	3.58	4.33	5.08	6.01	6.78	**10yr**
25yr	0.46	0.71	0.88	1.25	1.65	1.88	**25yr**	1.42	1.84	2.08	2.91	3.71	4.84	5.39	**25yr**	4.28	5.18	6.14	7.22	8.07	**25yr**
50yr	0.50	0.76	0.95	1.37	1.84	2.12	**50yr**	1.59	2.07	2.31	3.31	4.20	5.54	6.17	**50yr**	4.91	5.93	7.09	8.27	9.20	**50yr**
100yr	0.54	0.82	1.03	1.48	2.03	2.38	**100yr**	1.76	2.33	2.57	3.18	4.78	6.37	7.05	**100yr**	5.64	6.78	8.20	9.48	10.49	**100yr**
200yr	0.59	0.89	1.12	1.63	2.27	2.67	**200yr**	1.96	2.61	2.86	3.50	5.46	7.33	8.06	**200yr**	6.49	7.75	9.49	10.87	11.96	**200yr**
500yr	0.66	0.98	1.26	1.84	2.61	3.12	**500yr**	2.25	3.05	3.29	3.98	6.52	8.84	9.65	**500yr**	7.83	9.28	11.52	12.97	14.21	**500yr**

Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.32	0.49	0.60	0.80	0.99	1.18	**1yr**	0.85	1.15	1.33	1.74	2.18	2.74	3.04	**1yr**	2.42	2.92	3.42	4.30	4.85	**1yr**
2yr	0.36	0.56	0.69	0.94	1.15	1.35	**2yr**	1.00	1.32	1.54	2.01	2.56	3.10	3.52	**2yr**	2.74	3.38	3.84	4.60	5.19	**2yr**
5yr	0.44	0.68	0.84	1.15	1.46	1.76	**5yr**	1.26	1.72	1.96	2.50	3.15	4.05	4.51	**5yr**	3.58	4.34	4.99	5.93	6.73	**5yr**
10yr	0.52	0.80	0.99	1.38	1.78	2.16	**10yr**	1.54	2.11	2.48	3.01	3.76	4.95	5.52	**10yr**	4.38	5.31	6.11	7.26	8.19	**10yr**
25yr	0.66	1.00	1.25	1.78	2.34	2.84	**25yr**	2.02	2.77	3.27	3.83	4.75	6.46	7.22	**25yr**	5.71	6.94	8.01	9.46	10.66	**25yr**
50yr	0.79	1.20	1.49	2.14	2.88	3.50	**50yr**	2.49	3.42	4.04	4.61	5.66	7.90	8.86	**50yr**	6.99	8.52	9.83	11.57	13.03	**50yr**
100yr	0.94	1.43	1.79	2.58	3.54	4.30	**100yr**	3.06	4.21	5.00	6.41	6.76	9.66	10.85	**100yr**	8.55	10.44	12.07	14.15	15.94	**100yr**
200yr	1.13	1.70	2.16	3.13	4.36	5.30	**200yr**	3.76	5.18	6.17	7.88	8.07	11.83	13.29	**200yr**	10.47	12.78	14.82	17.30	19.53	**200yr**
500yr	1.45	2.16	2.78	4.04	5.74	6.95	**500yr**	4.95	6.79	8.17	10.41	10.19	15.44	17.45	**500yr**	13.67	16.78	19.44	22.61	25.57	**500yr**

Stage-Area-Storage for Pond 1P: Aboveground Infiltration Basin

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
250.00	638	0	250.51	836	375
250.01	642	6	250.52	840	383
250.02	645	13	250.53	844	392
250.03	649	19	250.54	849	400
250.04	653	26	250.55	853	409
250.05	656	32	250.56	857	417
250.06	660	39	250.57	861	426
250.07	664	46	250.58	865	434
250.08	667	52	250.59	870	443
250.09	671	59	250.60	874	452
250.10	675	66	250.61	878	460
250.11	678	72	250.62	882	469
250.12	682	79	250.63	887	478
250.13	686	86	250.64	891	487
250.14	690	93	250.65	895	496
250.15	694	100	250.66	900	505
250.16	697	107	250.67	904	514
250.17	701	114	250.68	908	523
250.18	705	121	250.69	912	532
250.19	709	128	250.70	917	541
250.20	713	135	250.71	921	550
250.21	716	142	250.72	926	560
250.22	720	149	250.73	930	569
250.23	724	157	250.74	934	578
250.24	728	164	250.75	939	588
250.25	732	171	250.76	943	597
250.26	736	178	250.77	947	606
250.27	740	186	250.78	952	616
250.28	743	193	250.79	956	626
250.29	747	201	250.80	961	635
250.30	751	208	250.81	965	645
250.31	755	216	250.82	970	654
250.32	759	223	250.83	974	664
250.33	763	231	250.84	979	674
250.34	767	239	250.85	983	684
250.35	771	246	250.86	988	694
250.36	775	254	250.87	992	703
250.37	779	262	250.88	997	713
250.38	783	270	250.89	1,001	723
250.39	787	277	250.90	1,006	733
250.40	791	285	250.91	1,010	744
250.41	795	293	250.92	1,015	754
250.42	799	301	250.93	1,019	764
250.43	803	309	250.94	1,024	774
250.44	807	317	250.95	1,029	784
250.45	811	325	250.96	1,033	795
250.46	816	333	250.97	1,038	805
250.47	820	342	250.98	1,042	815
250.48	824	350	250.99	1,047	826
250.49	828	358	251.00	1,052	836
250.50	832	366	251.01	1,056	847

Stage-Area-Storage for Pond 1P: Aboveground Infiltration Basin (continued)

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
251.02	1,061	857	251.53	1,844	1,480
251.03	1,066	868	251.54	1,851	1,498
251.04	1,070	879	251.55	1,859	1,517
251.05	1,075	889	251.56	1,866	1,536
251.06	1,080	900	251.57	1,874	1,554
251.07	1,085	911	251.58	1,882	1,573
251.08	1,089	922	251.59	1,889	1,592
251.09	1,094	933	251.60	1,897	1,611
251.10	1,099	944	251.61	1,905	1,630
251.11	1,104	955	251.62	1,912	1,649
251.12	1,108	966	251.63	1,920	1,668
251.13	1,113	977	251.64	1,928	1,687
251.14	1,118	988	251.65	1,935	1,707
251.15	1,123	999	251.66	1,943	1,726
251.16	1,127	1,011	251.67	1,951	1,746
251.17	1,132	1,022	251.68	1,959	1,765
251.18	1,137	1,033	251.69	1,967	1,785
251.19	1,142	1,045	251.70	1,974	1,804
251.20	1,147	1,056	251.71	1,982	1,824
251.21	1,152	1,068	251.72	1,990	1,844
251.22	1,157	1,079	251.73	1,998	1,864
251.23	1,161	1,091	251.74	2,006	1,884
251.24	1,166	1,102	251.75	2,014	1,904
251.25	1,171	1,114	251.76	2,022	1,924
251.26	1,176	1,126	251.77	2,029	1,945
251.27	1,181	1,138	251.78	2,037	1,965
251.28	1,186	1,149	251.79	2,045	1,985
251.29	1,191	1,161	251.80	2,053	2,006
251.30	1,196	1,173	251.81	2,061	2,026
251.31	1,201	1,185	251.82	2,069	2,047
251.32	1,206	1,197	251.83	2,077	2,068
251.33	1,211	1,209	251.84	2,085	2,089
251.34	1,216	1,221	251.85	2,093	2,109
251.35	1,221	1,234	251.86	2,101	2,130
251.36	1,226	1,246	251.87	2,110	2,151
251.37	1,231	1,258	251.88	2,118	2,173
251.38	1,236	1,270	251.89	2,126	2,194
251.39	1,241	1,283	251.90	2,134	2,215
251.40	1,246	1,295	251.91	2,142	2,237
251.41	1,251	1,308	251.92	2,150	2,258
251.42	1,256	1,320	251.93	2,158	2,280
251.43	1,261	1,333	251.94	2,167	2,301
251.44	1,266	1,346	251.95	2,175	2,323
251.45	1,271	1,358	251.96	2,183	2,345
251.46	1,277	1,371	251.97	2,191	2,367
251.47	1,282	1,384	251.98	2,199	2,388
251.48	1,287	1,397	251.99	2,208	2,411
251.49	1,292	1,409	252.00	2,216	2,433
251.50	1,821	1,425	252.01	2,224	2,455
251.51	1,829	1,443	252.02	2,231	2,477
251.52	1,836	1,462	252.03	2,239	2,499

Stage-Area-Storage for Pond 1P: Aboveground Infiltration Basin (continued)

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
252.04	2,247	2,522	252.55	2,662	3,772
252.05	2,255	2,544	252.56	2,670	3,799
252.06	2,263	2,567	252.57	2,679	3,826
252.07	2,270	2,590	252.58	2,687	3,852
252.08	2,278	2,612	252.59	2,696	3,879
252.09	2,286	2,635	252.60	2,704	3,906
252.10	2,294	2,658	252.61	2,713	3,933
252.11	2,302	2,681	252.62	2,722	3,961
252.12	2,310	2,704	252.63	2,730	3,988
252.13	2,318	2,727	252.64	2,739	4,015
252.14	2,326	2,751	252.65	2,747	4,043
252.15	2,334	2,774	252.66	2,756	4,070
252.16	2,341	2,797	252.67	2,765	4,098
252.17	2,349	2,821	252.68	2,773	4,125
252.18	2,357	2,844	252.69	2,782	4,153
252.19	2,365	2,868	252.70	2,791	4,181
252.20	2,373	2,891	252.71	2,799	4,209
252.21	2,381	2,915	252.72	2,808	4,237
252.22	2,389	2,939	252.73	2,817	4,265
252.23	2,397	2,963	252.74	2,825	4,293
252.24	2,406	2,987	252.75	2,834	4,322
252.25	2,414	3,011	252.76	2,843	4,350
252.26	2,422	3,035	252.77	2,852	4,379
252.27	2,430	3,060	252.78	2,860	4,407
252.28	2,438	3,084	252.79	2,869	4,436
252.29	2,446	3,108	252.80	2,878	4,464
252.30	2,454	3,133	252.81	2,887	4,493
252.31	2,462	3,157	252.82	2,896	4,522
252.32	2,470	3,182	252.83	2,905	4,551
252.33	2,479	3,207	252.84	2,913	4,580
252.34	2,487	3,232	252.85	2,922	4,609
252.35	2,495	3,257	252.86	2,931	4,639
252.36	2,503	3,282	252.87	2,940	4,668
252.37	2,511	3,307	252.88	2,949	4,698
252.38	2,520	3,332	252.89	2,958	4,727
252.39	2,528	3,357	252.90	2,967	4,757
252.40	2,536	3,382	252.91	2,976	4,786
252.41	2,544	3,408	252.92	2,985	4,816
252.42	2,553	3,433	252.93	2,994	4,846
252.43	2,561	3,459	252.94	3,003	4,876
252.44	2,569	3,484	252.95	3,012	4,906
252.45	2,578	3,510	252.96	3,021	4,936
252.46	2,586	3,536	252.97	3,030	4,967
252.47	2,594	3,562	252.98	3,039	4,997
252.48	2,603	3,588	252.99	3,048	5,027
252.49	2,611	3,614	253.00	3,057	5,058
252.50	2,620	3,640	253.01	3,066	5,088
252.51	2,628	3,666	253.02	3,075	5,119
252.52	2,636	3,693	253.03	3,084	5,150
252.53	2,645	3,719	253.04	3,093	5,181
252.54	2,653	3,746	253.05	3,103	5,212

Stage-Area-Storage for Pond 1P: Aboveground Infiltration Basin (continued)

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
253.06	3,112	5,243
253.07	3,121	5,274
253.08	3,130	5,305
253.09	3,139	5,337
253.10	3,149	5,368
253.11	3,158	5,400
253.12	3,167	5,431
253.13	3,176	5,463
253.14	3,186	5,495
253.15	3,195	5,527
253.16	3,204	5,559
253.17	3,213	5,591
253.18	3,223	5,623
253.19	3,232	5,655
253.20	3,241	5,688
253.21	3,251	5,720
253.22	3,260	5,753
253.23	3,270	5,785
253.24	3,279	5,818
253.25	3,288	5,851
253.26	3,298	5,884
253.27	3,307	5,917
253.28	3,317	5,950
253.29	3,326	5,983
253.30	3,336	6,016
253.31	3,345	6,050
253.32	3,355	6,083
253.33	3,364	6,117
253.34	3,374	6,151
253.35	3,383	6,184
253.36	3,393	6,218
253.37	3,402	6,252
253.38	3,412	6,286
253.39	3,422	6,321
253.40	3,431	6,355
253.41	3,441	6,389
253.42	3,450	6,424
253.43	3,460	6,458
253.44	3,470	6,493
253.45	3,479	6,528
253.46	3,489	6,562
253.47	3,499	6,597
253.48	3,509	6,632
253.49	3,518	6,668
253.50	3,528	6,703
253.51	3,538	6,738
253.52	3,548	6,774
253.53	3,557	6,809
253.54	3,567	6,845
253.55	3,577	6,880
253.56	3,587	6,916
253.57	3,597	6,952
253.58	3,607	6,988
253.59	3,617	7,024
253.60	3,626	7,060
253.61	3,636	7,097
253.62	3,646	7,133
253.63	3,656	7,170
253.64	3,666	7,206
253.65	3,676	7,243
253.66	3,686	7,280
253.67	3,696	7,317
253.68	3,706	7,354
253.69	3,716	7,391
253.70	3,726	7,428
253.71	3,736	7,465
253.72	3,746	7,503
253.73	3,756	7,540
253.74	3,766	7,578
253.75	3,776	7,616
253.76	3,786	7,653
253.77	3,797	7,691
253.78	3,807	7,729
253.79	3,817	7,767
253.80	3,827	7,806
253.81	3,837	7,844
253.82	3,847	7,882
253.83	3,858	7,921
253.84	3,868	7,960
253.85	3,878	7,998
253.86	3,888	8,037
253.87	3,898	8,076
253.88	3,909	8,115
253.89	3,919	8,154
253.90	3,929	8,194
253.91	3,940	8,233
253.92	3,950	8,272
253.93	3,960	8,312
253.94	3,971	8,352
253.95	3,981	8,391
253.96	3,991	8,431
253.97	4,002	8,471
253.98	4,012	8,511
253.99	4,023	8,551
254.00	**4,033**	**8,592**

Stage-Area-Storage for Pond BIO-1: Bioretention Area

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
248.00	59	59	0
248.01	59	59	0
248.02	59	60	0
248.03	59	60	1
248.04	59	61	1
248.05	59	61	1
248.06	59	61	1
248.07	59	62	1
248.08	59	62	2
248.09	59	62	2
248.10	59	63	2
248.11	59	63	2
248.12	59	64	2
248.13	59	64	3
248.14	59	64	3
248.15	59	65	3
248.16	59	65	3
248.17	59	65	4
248.18	59	66	4
248.19	59	66	4
248.20	59	67	4
248.21	59	67	4
248.22	59	67	5
248.23	59	68	5
248.24	59	68	5
248.25	59	69	5
248.26	59	69	5
248.27	59	69	6
248.28	59	70	6
248.29	59	70	6
248.30	59	70	6
248.31	59	71	6
248.32	59	71	7
248.33	59	72	7
248.34	59	72	7
248.35	59	72	7
248.36	59	73	7
248.37	59	73	8
248.38	59	73	8
248.39	59	74	8
248.40	59	74	8
248.41	59	75	8
248.42	59	75	9
248.43	59	75	9
248.44	59	76	9
248.45	59	76	9
248.46	59	76	9
248.47	59	77	10
248.48	59	77	10
248.49	59	78	10
248.50	59	78	10

Stage-Area-Storage for Pond BIO-1: Bioretention Area (continued)

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
248.51	59	78	11
248.52	59	79	11
248.53	59	79	11
248.54	59	80	11
248.55	59	80	11
248.56	59	80	12
248.57	59	81	12
248.58	59	81	12
248.59	59	81	12
248.60	59	82	12
248.61	59	82	13
248.62	59	83	13
248.63	59	83	13
248.64	59	83	13
248.65	59	84	13
248.66	59	84	14
248.67	59	84	14
248.68	59	85	14
248.69	59	85	14
248.70	59	86	14
248.71	59	86	15
248.72	59	86	15
248.73	59	87	15
248.74	59	87	15
248.75	59	88	15
248.76	59	88	16
248.77	59	88	16
248.78	59	89	16
248.79	59	89	16
248.80	59	89	17
248.81	59	90	17
248.82	59	90	17
248.83	59	91	17
248.84	59	91	17
248.85	59	91	18
248.86	59	92	18
248.87	59	92	18
248.88	59	92	18
248.89	59	93	18
248.90	59	93	19
248.91	59	94	19
248.92	59	94	19
248.93	59	94	19
248.94	59	95	19
248.95	59	95	20
248.96	59	95	20
248.97	59	96	20
248.98	59	96	20
248.99	59	97	20
249.00	59	97	21
249.01	59	97	21

Stage-Area-Storage for Pond BIO-1: Bioretention Area (continued)

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
249.02	59	98	21
249.03	59	98	21
249.04	59	99	21
249.05	59	99	22
249.06	59	99	22
249.07	59	100	22
249.08	59	100	22
249.09	59	100	23
249.10	59	101	23
249.11	59	101	23
249.12	59	102	23
249.13	59	102	23
249.14	59	102	24
249.15	59	103	24
249.16	59	103	24
249.17	59	103	24
249.18	59	104	24
249.19	59	104	25
249.20	59	105	25
249.21	59	105	25
249.22	59	105	25
249.23	59	106	25
249.24	59	106	26
249.25	59	107	26
249.26	59	107	26
249.27	59	107	26
249.28	59	108	26
249.29	59	108	27
249.30	59	108	27
249.31	59	109	27
249.32	59	109	27
249.33	59	110	27
249.34	59	110	28
249.35	59	110	28
249.36	59	111	28
249.37	59	111	28
249.38	59	111	28
249.39	59	112	29
249.40	59	112	29
249.41	59	113	29
249.42	59	113	29
249.43	59	113	30
249.44	59	114	30
249.45	59	114	30
249.46	59	114	30
249.47	59	115	30
249.48	59	115	31
249.49	59	116	31
249.50	59	116	31
249.51	59	116	31
249.52	59	117	31

Stage-Area-Storage for Pond BIO-1: Bioretention Area (continued)

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
249.53	59	117	32
249.54	59	118	32
249.55	59	118	32
249.56	59	118	32
249.57	59	119	32
249.58	59	119	33
249.59	59	119	33
249.60	59	120	33
249.61	59	120	33
249.62	59	121	33
249.63	59	121	34
249.64	59	121	34
249.65	59	122	34
249.66	59	122	34
249.67	59	122	34
249.68	59	123	35
249.69	59	123	35
249.70	59	124	35
249.71	59	124	35
249.72	59	124	36
249.73	59	125	36
249.74	59	125	36
249.75	59	126	36
249.76	59	126	36
249.77	59	126	37
249.78	59	127	37
249.79	59	127	37
249.80	59	127	37
249.81	59	128	37
249.82	59	128	38
249.83	59	129	38
249.84	59	129	38
249.85	59	129	38
249.86	59	130	38
249.87	59	130	39
249.88	59	130	39
249.89	59	131	39
249.90	59	131	39
249.91	59	132	39
249.92	59	132	40
249.93	59	132	40
249.94	59	133	40
249.95	59	133	40
249.96	59	133	40
249.97	59	134	41
249.98	59	134	41
249.99	59	135	41
250.00	59	135	41
250.01	59	135	42
250.02	59	136	42
250.03	59	136	42

Stage-Area-Storage for Pond BIO-1: Bioretention Area (continued)

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
250.04	59	137	42
250.05	59	137	42
250.06	59	137	43
250.07	59	138	43
250.08	59	138	43
250.09	59	138	43
250.10	59	139	43
250.11	59	139	44
250.12	59	140	44
250.13	59	140	44
250.14	59	140	44
250.15	59	141	44
250.16	59	141	45
250.17	59	141	45
250.18	59	142	45
250.19	59	142	45
250.20	59	143	45
250.21	59	143	46
250.22	59	143	46
250.23	59	144	46
250.24	59	144	46
250.25	59	145	46
250.26	59	145	47
250.27	59	145	47
250.28	59	146	47
250.29	59	146	47
250.30	59	146	47
250.31	59	147	48
250.32	59	147	48
250.33	59	148	48
250.34	59	148	48
250.35	59	148	49
250.36	59	149	49
250.37	59	149	49
250.38	59	149	49
250.39	59	150	49
250.40	59	150	50
250.41	59	151	50
250.42	59	151	50
250.43	59	151	50
250.44	59	152	50
250.45	59	152	51
250.46	59	152	51
250.47	59	153	51
250.48	59	153	51
250.49	59	154	51
250.50	59	154	52
250.51	61	160	53
250.52	63	167	53
250.53	65	174	54
250.54	67	181	55

Stage-Area-Storage for Pond BIO-1: Bioretention Area (continued)

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
250.55	69	188	55
250.56	71	195	56
250.57	74	202	57
250.58	76	210	57
250.59	78	218	58
250.60	80	226	59
250.61	83	234	60
250.62	85	242	61
250.63	87	250	61
250.64	90	259	62
250.65	92	268	63
250.66	95	277	64
250.67	97	286	65
250.68	100	295	66
250.69	102	305	67
250.70	105	315	68
250.71	108	324	69
250.72	110	334	70
250.73	113	345	71
250.74	116	355	73
250.75	119	365	74
250.76	121	376	75
250.77	124	387	76
250.78	127	398	77
250.79	130	409	79
250.80	133	421	80
250.81	136	432	81
250.82	139	444	83
250.83	142	456	84
250.84	145	468	86
250.85	148	480	87
250.86	151	493	89
250.87	155	505	90
250.88	158	518	92
250.89	161	531	93
250.90	164	544	95
250.91	168	557	97
250.92	171	571	98
250.93	174	584	100
250.94	178	598	102
250.95	181	612	104
250.96	185	626	105
250.97	188	641	107
250.98	192	655	109
250.99	195	670	111
251.00	199	685	113
251.01	206	732	115
251.02	213	781	117
251.03	220	831	119
251.04	227	884	122
251.05	234	938	124

Stage-Area-Storage for Pond BIO-1: Bioretention Area (continued)

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
251.06	241	993	126
251.07	249	1,051	129
251.08	256	1,109	131
251.09	264	1,170	134
251.10	272	1,232	137
251.11	280	1,296	139
251.12	288	1,362	142
251.13	296	1,429	145
251.14	304	1,498	148
251.15	313	1,569	151
251.16	321	1,641	154
251.17	330	1,715	158
251.18	338	1,791	161
251.19	347	1,868	164
251.20	356	1,947	168
251.21	365	2,028	171
251.22	374	2,110	175
251.23	384	2,194	179
251.24	393	2,280	183
251.25	402	2,367	187
251.26	412	2,456	191
251.27	422	2,547	195
251.28	432	2,639	199
251.29	442	2,733	204
251.30	452	2,829	208
251.31	462	2,927	213
251.32	472	3,026	217
251.33	482	3,126	222
251.34	493	3,229	227
251.35	504	3,333	232
251.36	514	3,439	237
251.37	525	3,546	242
251.38	536	3,655	248
251.39	547	3,766	253
251.40	558	3,878	259
251.41	570	3,992	264
251.42	581	4,108	270
251.43	593	4,226	276
251.44	604	4,345	282
251.45	616	4,465	288
251.46	628	4,588	294
251.47	640	4,712	300
251.48	652	4,838	307
251.49	664	4,965	313
251.50	677	5,094	320
251.51	689	5,225	327
251.52	702	5,358	334
251.53	714	5,492	341
251.54	727	5,628	348
251.55	740	5,765	356
251.56	753	5,904	363

Stage-Area-Storage for Pond BIO-1: Bioretention Area (continued)

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
251.57	766	6,045	371
251.58	779	6,188	378
251.59	793	6,332	386
251.60	806	6,478	394
251.61	820	6,625	402
251.62	834	6,774	411
251.63	847	6,925	419
251.64	861	7,078	428
251.65	875	7,232	436
251.66	889	7,388	445
251.67	904	7,545	454
251.68	918	7,705	463
251.69	933	7,865	472
251.70	947	8,028	482
251.71	962	8,192	491
251.72	977	8,358	501
251.73	992	8,526	511
251.74	1,007	8,695	521
251.75	1,022	8,866	531
251.76	1,037	9,038	541
251.77	1,053	9,213	552
251.78	1,068	9,389	562
251.79	1,084	9,566	573
251.80	1,099	9,745	584
251.81	1,115	9,926	595
251.82	1,131	10,109	606
251.83	1,147	10,293	618
251.84	1,164	10,479	629
251.85	1,180	10,667	641
251.86	1,196	10,856	653
251.87	1,213	11,047	665
251.88	1,229	11,240	677
251.89	1,246	11,434	690
251.90	1,263	11,630	702
251.91	1,280	11,828	715
251.92	1,297	12,027	728
251.93	1,314	12,228	741
251.94	1,332	12,431	754
251.95	1,349	12,635	767
251.96	1,367	12,841	781
251.97	1,384	13,049	795
251.98	1,402	13,258	809
251.99	1,420	13,469	823
252.00	**1,438**	**13,682**	**837**

Stage-Area-Storage for Pond INF-1: Underground Infiltration System #1

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
250.00	3,037	0	251.02	3,649	1,572
250.02	3,049	24	251.04	3,661	1,620
250.04	3,061	49	251.06	3,673	1,669
250.06	3,073	73	251.08	3,685	1,717
250.08	3,085	97	251.10	3,697	1,766
250.10	3,097	121	251.12	3,709	1,814
250.12	3,109	146	251.14	3,721	1,863
250.14	3,121	170	251.16	3,733	1,911
250.16	3,133	194	251.18	3,745	1,960
250.18	3,145	219	251.20	3,757	2,008
250.20	3,157	243	251.22	3,769	2,056
250.22	3,169	267	251.24	3,781	2,105
250.24	3,181	292	251.26	3,793	2,153
250.26	3,193	316	251.28	3,805	2,201
250.28	3,205	340	251.30	3,817	2,249
250.30	3,217	364	251.32	3,829	2,297
250.32	3,229	389	251.34	3,841	2,345
250.34	3,241	413	251.36	3,853	2,394
250.36	3,253	437	251.38	3,865	2,442
250.38	3,265	462	251.40	3,877	2,490
250.40	3,277	486	251.42	3,889	2,537
250.42	3,289	510	251.44	3,901	2,585
250.44	3,301	535	251.46	3,913	2,633
250.46	3,313	559	251.48	3,925	2,681
250.48	3,325	583	251.50	3,937	2,729
250.50	3,337	607	251.52	3,949	2,776
250.52	3,349	632	251.54	3,961	2,824
250.54	3,361	656	251.56	3,973	2,872
250.56	3,373	680	251.58	3,985	2,919
250.58	3,385	705	251.60	3,997	2,967
250.60	3,397	729	251.62	4,009	3,014
250.62	3,409	753	251.64	4,021	3,061
250.64	3,421	778	251.66	4,033	3,109
250.66	3,433	802	251.68	4,045	3,156
250.68	3,445	826	251.70	4,057	3,203
250.70	3,457	850	251.72	4,069	3,250
250.72	3,469	875	251.74	4,081	3,297
250.74	3,481	899	251.76	4,093	3,345
250.76	3,493	936	251.78	4,105	3,392
250.78	3,505	985	251.80	4,117	3,439
250.80	3,517	1,034	251.82	4,129	3,485
250.82	3,529	1,083	251.84	4,141	3,532
250.84	3,541	1,132	251.86	4,153	3,579
250.86	3,553	1,181	251.88	4,165	3,626
250.88	3,565	1,230	251.90	4,177	3,673
250.90	3,577	1,279	251.92	4,189	3,719
250.92	3,589	1,328	251.94	4,201	3,766
250.94	3,601	1,377	251.96	4,213	3,812
250.96	3,613	1,425	251.98	4,225	3,859
250.98	3,625	1,474	252.00	4,237	3,905
251.00	3,637	1,523	252.02	4,249	3,951

Stage-Area-Storage for Pond INF-1: Underground Infiltration System #1 (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
252.04	4,261	3,998
252.06	4,273	4,044
252.08	4,285	4,090
252.10	4,297	4,136
252.12	4,309	4,182
252.14	4,321	4,228
252.16	4,333	4,274
252.18	4,345	4,319
252.20	4,357	4,365
252.22	4,369	4,411
252.24	4,381	4,456
252.26	4,393	4,502
252.28	4,405	4,547
252.30	4,417	4,593
252.32	4,429	4,638
252.34	4,441	4,683
252.36	4,453	4,728
252.38	4,465	4,773
252.40	4,477	4,818
252.42	4,489	4,863
252.44	4,501	4,908
252.46	4,513	4,952
252.48	4,525	4,997
252.50	4,537	5,041
252.52	4,549	5,086
252.54	4,562	5,130
252.56	4,574	5,174
252.58	4,586	5,219
252.60	4,598	5,263
252.62	4,610	5,307
252.64	4,622	5,351
252.66	4,634	5,394
252.68	4,646	5,438
252.70	4,658	5,482
252.72	4,670	5,525
252.74	4,682	5,569
252.76	4,694	5,612
252.78	4,706	5,655
252.80	4,718	5,699
252.82	4,730	5,742
252.84	4,742	5,784
252.86	4,754	5,827
252.88	4,766	5,870
252.90	4,778	5,913
252.92	4,790	5,955
252.94	4,802	5,997
252.96	4,814	6,040
252.98	4,826	6,082
253.00	4,838	6,124
253.02	4,850	6,166
253.04	4,862	6,208
253.06	4,874	6,249
253.08	4,886	6,291
253.10	4,898	6,332
253.12	4,910	6,373
253.14	4,922	6,415
253.16	4,934	6,456
253.18	4,946	6,497
253.20	4,958	6,537
253.22	4,970	6,578
253.24	4,982	6,618
253.26	4,994	6,659
253.28	5,006	6,699
253.30	5,018	6,739
253.32	5,030	6,779
253.34	5,042	6,819
253.36	5,054	6,858
253.38	5,066	6,898
253.40	5,078	6,937
253.42	5,090	6,976
253.44	5,102	7,015
253.46	5,114	7,054
253.48	5,126	7,093
253.50	5,138	7,131
253.52	5,150	7,169
253.54	5,162	7,207
253.56	5,174	7,245
253.58	5,186	7,283
253.60	5,198	7,321
253.62	5,210	7,358
253.64	5,222	7,395
253.66	5,234	7,432
253.68	5,246	7,469
253.70	5,258	7,506
253.72	5,270	7,542
253.74	5,282	7,578
253.76	5,294	7,614
253.78	5,306	7,650
253.80	5,318	7,685
253.82	5,330	7,720
253.84	5,342	7,755
253.86	5,354	7,790
253.88	5,366	7,824
253.90	5,378	7,858
253.92	5,390	7,892
253.94	5,402	7,926
253.96	5,414	7,959
253.98	5,426	7,992
254.00	5,438	8,024
254.02	5,450	8,056
254.04	5,462	8,088
254.06	5,474	8,119

Stage-Area-Storage for Pond INF-1: Underground Infiltration System #1 (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
254.08	5,486	8,150	255.10	6,098	9,440
254.10	5,498	8,180	255.12	6,110	9,464
254.12	5,510	8,210	255.14	6,122	9,489
254.14	5,522	8,239	255.16	6,134	9,513
254.16	5,534	8,267	255.18	6,146	9,537
254.18	5,546	8,296	255.20	6,158	9,562
254.20	5,558	8,323	255.22	6,170	9,586
254.22	5,570	8,351	255.24	6,182	9,610
254.24	5,582	8,378	255.26	6,194	9,634
254.26	5,594	8,405	255.28	6,206	9,659
254.28	5,606	8,431	255.30	6,218	9,683
254.30	5,618	8,458	255.32	6,230	9,707
254.32	5,630	8,484	255.34	6,242	9,732
254.34	5,642	8,510	255.36	6,254	9,756
254.36	5,654	8,536	255.38	6,266	9,780
254.38	5,666	8,561	255.40	6,278	9,805
254.40	5,678	8,587	255.42	6,290	9,829
254.42	5,690	8,612	255.44	6,302	9,853
254.44	5,702	8,637	255.46	6,314	9,877
254.46	5,714	8,662	255.48	6,326	9,902
254.48	5,726	8,687	255.50	**6,338**	**9,926**
254.50	5,738	8,711	255.52	6,338	9,926
254.52	5,750	8,735	255.54	6,338	9,926
254.54	5,762	8,760	255.56	6,338	9,926
254.56	5,774	8,784	255.58	6,338	9,926
254.58	5,786	8,808	255.60	6,338	9,926
254.60	5,798	8,833	255.62	6,338	9,926
254.62	5,810	8,857	255.64	6,338	9,926
254.64	5,822	8,881	255.66	6,338	9,926
254.66	5,834	8,905	255.68	6,338	9,926
254.68	5,846	8,930	255.70	6,338	9,926
254.70	5,858	8,954	255.72	6,338	9,926
254.72	5,870	8,978	255.74	6,338	9,926
254.74	5,882	9,003	255.76	6,338	9,926
254.76	5,894	9,027	255.78	6,338	9,926
254.78	5,906	9,051	255.80	6,338	9,926
254.80	5,918	9,076	255.82	6,338	9,926
254.82	5,930	9,100	255.84	6,338	9,926
254.84	5,942	9,124	255.86	6,338	9,926
254.86	5,954	9,148	255.88	6,338	9,926
254.88	5,966	9,173	255.90	6,338	9,926
254.90	5,978	9,197	255.92	6,338	9,926
254.92	5,990	9,221	255.94	6,338	9,926
254.94	6,002	9,246	255.96	6,338	9,926
254.96	6,014	9,270	255.98	6,338	9,926
254.98	6,026	9,294	256.00	6,338	9,926
255.00	6,038	9,319	256.02	6,338	9,926
255.02	6,050	9,343	256.04	6,338	9,926
255.04	6,062	9,367	256.06	6,338	9,926
255.06	6,074	9,391	256.08	6,338	9,926
255.08	6,086	9,416	256.10	6,338	9,926

Stage-Area-Storage for Pond INF-1: Underground Infiltration System #1 (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
256.12	6,338	9,926	257.14	6,338	9,926
256.14	6,338	9,926	257.16	6,338	9,926
256.16	6,338	9,926	257.18	6,338	9,926
256.18	6,338	9,926	257.20	6,338	9,926
256.20	6,338	9,926	257.22	6,338	9,926
256.22	6,338	9,926	257.24	6,338	9,926
256.24	6,338	9,926	257.26	6,338	9,926
256.26	6,338	9,926	257.28	6,338	9,926
256.28	6,338	9,926	257.30	6,338	9,926
256.30	6,338	9,926	257.32	6,338	9,926
256.32	6,338	9,926	257.34	6,338	9,926
256.34	6,338	9,926	257.36	6,338	9,926
256.36	6,338	9,926	257.38	6,338	9,926
256.38	6,338	9,926	257.40	6,338	9,926
256.40	6,338	9,926	257.42	6,338	9,926
256.42	6,338	9,926	257.44	6,338	9,926
256.44	6,338	9,926	257.46	6,338	9,926
256.46	6,338	9,926	257.48	6,338	9,926
256.48	6,338	9,926	257.50	6,338	9,926
256.50	6,338	9,926	257.52	6,338	9,926
256.52	6,338	9,926	257.54	6,338	9,926
256.54	6,338	9,926	257.56	6,338	9,926
256.56	6,338	9,926	257.58	6,338	9,926
256.58	6,338	9,926	257.60	6,338	9,926
256.60	6,338	9,926	257.62	6,338	9,926
256.62	6,338	9,926	257.64	6,338	9,926
256.64	6,338	9,926	257.66	6,338	9,926
256.66	6,338	9,926	257.68	6,338	9,926
256.68	6,338	9,926	257.70	6,338	9,926
256.70	6,338	9,926	257.72	6,338	9,926
256.72	6,338	9,926	257.74	6,338	9,926
256.74	6,338	9,926	257.76	6,338	9,926
256.76	6,338	9,926	257.78	6,338	9,926
256.78	6,338	9,926	257.80	6,338	9,926
256.80	6,338	9,926	257.82	6,338	9,926
256.82	6,338	9,926	257.84	6,338	9,926
256.84	6,338	9,926	257.86	6,338	9,926
256.86	6,338	9,926	257.88	6,338	9,926
256.88	6,338	9,926	257.90	6,338	9,926
256.90	6,338	9,926	257.92	6,338	9,926
256.92	6,338	9,926	257.94	6,338	9,926
256.94	6,338	9,926	257.96	6,338	9,926
256.96	6,338	9,926	257.98	6,338	9,926
256.98	6,338	9,926	258.00	6,338	9,926
257.00	6,338	9,926	258.02	6,338	9,926
257.02	6,338	9,926	258.04	6,338	9,926
257.04	6,338	9,926	258.06	6,338	9,926
257.06	6,338	9,926	258.08	6,338	9,926
257.08	6,338	9,926	258.10	6,338	9,926
257.10	6,338	9,926	258.12	6,338	9,926
257.12	6,338	9,926	258.14	6,338	9,926

Stage-Area-Storage for Pond INF-1: Underground Infiltration System #1 (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
258.16	6,338	9,926	259.18	6,338	9,926
258.18	6,338	9,926	259.20	6,338	9,926
258.20	6,338	9,926	259.22	6,338	9,926
258.22	6,338	9,926	259.24	6,338	9,926
258.24	6,338	9,926	259.26	6,338	9,926
258.26	6,338	9,926	259.28	6,338	9,926
258.28	6,338	9,926	259.30	6,338	9,926
258.30	6,338	9,926	259.32	6,338	9,926
258.32	6,338	9,926	259.34	6,338	9,926
258.34	6,338	9,926	259.36	6,338	9,926
258.36	6,338	9,926	259.38	6,338	9,926
258.38	6,338	9,926	259.40	6,338	9,926
258.40	6,338	9,926	259.42	6,338	9,926
258.42	6,338	9,926	259.44	6,338	9,926
258.44	6,338	9,926	259.46	6,338	9,926
258.46	6,338	9,926	259.48	6,338	9,926
258.48	6,338	9,926	259.50	6,338	9,926
258.50	6,338	9,926	259.52	6,338	9,926
258.52	6,338	9,926	259.54	6,338	9,926
258.54	6,338	9,926	259.56	6,338	9,926
258.56	6,338	9,926	259.58	6,338	9,926
258.58	6,338	9,926	259.60	6,338	9,926
258.60	6,338	9,926	259.62	6,338	9,926
258.62	6,338	9,926	259.64	6,338	9,926
258.64	6,338	9,926	259.66	6,338	9,926
258.66	6,338	9,926	259.68	6,338	9,926
258.68	6,338	9,926	259.70	6,338	9,926
258.70	6,338	9,926	259.72	6,338	9,926
258.72	6,338	9,926	259.74	6,338	9,926
258.74	6,338	9,926	259.76	6,338	9,926
258.76	6,338	9,926	259.78	6,338	9,926
258.78	6,338	9,926	259.80	6,338	9,926
258.80	6,338	9,926	259.82	6,338	9,926
258.82	6,338	9,926	259.84	6,338	9,926
258.84	6,338	9,926	259.86	6,338	9,926
258.86	6,338	9,926	259.88	6,338	9,926
258.88	6,338	9,926	259.90	6,338	9,926
258.90	6,338	9,926	259.92	6,338	9,926
258.92	6,338	9,926	259.94	6,338	9,926
258.94	6,338	9,926	259.96	6,338	9,926
258.96	6,338	9,926	259.98	6,338	9,926
258.98	6,338	9,926	260.00	6,338	9,926
259.00	6,338	9,926	260.02	6,338	9,926
259.02	6,338	9,926	260.04	6,338	9,926
259.04	6,338	9,926	260.06	6,338	9,926
259.06	6,338	9,926	260.08	6,338	9,926
259.08	6,338	9,926	260.10	6,338	9,926
259.10	6,338	9,926	260.12	6,338	9,926
259.12	6,338	9,926	260.14	6,338	9,926
259.14	6,338	9,926	260.16	6,338	9,926
259.16	6,338	9,926	260.18	6,338	9,926

Stage-Area-Storage for Pond INF-1: Underground Infiltration System #1 (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
260.20	6,338	9,926	261.22	6,338	9,926
260.22	6,338	9,926	261.24	6,338	9,926
260.24	6,338	9,926	261.26	6,338	9,926
260.26	6,338	9,926	261.28	6,338	9,926
260.28	6,338	9,926	261.30	6,338	9,926
260.30	6,338	9,926	261.32	6,338	9,926
260.32	6,338	9,926	261.34	6,338	9,926
260.34	6,338	9,926	261.36	6,338	9,926
260.36	6,338	9,926	261.38	6,338	9,926
260.38	6,338	9,926	261.40	6,338	9,926
260.40	6,338	9,926	261.42	6,338	9,926
260.42	6,338	9,926	261.44	6,338	9,926
260.44	6,338	9,926	261.46	6,338	9,926
260.46	6,338	9,926	261.48	6,338	9,926
260.48	6,338	9,926	261.50	6,338	9,926
260.50	6,338	9,926	261.52	6,338	9,926
260.52	6,338	9,926	261.54	6,338	9,926
260.54	6,338	9,926	261.56	6,338	9,926
260.56	6,338	9,926	261.58	6,338	9,926
260.58	6,338	9,926	261.60	6,338	9,926
260.60	6,338	9,926	261.62	6,338	9,926
260.62	6,338	9,926	261.64	6,338	9,926
260.64	6,338	9,926	261.66	6,338	9,926
260.66	6,338	9,926	261.68	6,338	9,926
260.68	6,338	9,926	261.70	6,338	9,926
260.70	6,338	9,926	261.72	6,338	9,926
260.72	6,338	9,926	261.74	6,338	9,926
260.74	6,338	9,926	261.76	6,338	9,926
260.76	6,338	9,926	261.78	6,338	9,926
260.78	6,338	9,926	261.80	6,338	9,926
260.80	6,338	9,926	261.82	6,338	9,926
260.82	6,338	9,926	261.84	6,338	9,926
260.84	6,338	9,926	261.86	6,338	9,926
260.86	6,338	9,926	261.88	6,338	9,926
260.88	6,338	9,926	261.90	6,338	9,926
260.90	6,338	9,926	261.92	6,338	9,926
260.92	6,338	9,926	261.94	6,338	9,926
260.94	6,338	9,926	261.96	6,338	9,926
260.96	6,338	9,926	261.98	6,338	9,926
260.98	6,338	9,926	262.00	6,338	9,926
261.00	6,338	9,926	262.02	6,338	9,926
261.02	6,338	9,926	262.04	6,338	9,926
261.04	6,338	9,926	262.06	6,338	9,926
261.06	6,338	9,926	262.08	6,338	9,926
261.08	6,338	9,926	262.10	6,338	9,926
261.10	6,338	9,926	262.12	6,338	9,926
261.12	6,338	9,926	262.14	6,338	9,926
261.14	6,338	9,926	262.16	6,338	9,926
261.16	6,338	9,926	262.18	6,338	9,926
261.18	6,338	9,926	262.20	6,338	9,926
261.20	6,338	9,926	262.22	6,338	9,926

Stage-Area-Storage for Pond INF-1: Underground Infiltration System #1 (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
262.24	6,338	9,926
262.26	6,338	9,926
262.28	6,338	9,926
262.30	6,338	9,926
262.32	6,338	9,926
262.34	6,338	9,926
262.36	6,338	9,926
262.38	6,338	9,926
262.40	6,338	9,926
262.42	6,338	9,926
262.44	6,338	9,926
262.46	6,338	9,926
262.48	6,338	9,926
262.50	6,338	9,926
262.52	6,338	9,926
262.54	6,338	9,926
262.56	6,338	9,926
262.58	6,338	9,926
262.60	6,338	9,926
262.62	6,338	9,926
262.64	6,338	9,926
262.66	6,338	9,926
262.68	6,338	9,926
262.70	6,338	9,926
262.72	6,338	9,926
262.74	6,338	9,926
262.76	6,338	9,926
262.78	6,338	9,926
262.80	6,338	9,926
262.82	6,338	9,926
262.84	6,338	9,926
262.86	6,338	9,926
262.88	6,338	9,926
262.90	6,338	9,926
262.92	6,338	9,926
262.94	6,338	9,926
262.96	6,338	9,926
262.98	6,338	9,926
263.00	6,338	9,926
263.02	6,338	9,926
263.04	6,338	9,926
263.06	6,338	9,926
263.08	6,338	9,926
263.10	6,338	9,926
263.12	6,338	9,926
263.14	6,338	9,926
263.16	6,338	9,926
263.18	6,338	9,926
263.20	6,338	9,926
263.22	6,338	9,926
263.24	6,338	9,926
263.26	6,338	9,926
263.28	6,338	9,926
263.30	6,338	9,926
263.32	6,338	9,926
263.34	6,338	9,926
263.36	6,338	9,926
263.38	6,338	9,926
263.40	6,338	9,926
263.42	6,338	9,926
263.44	6,338	9,926
263.46	6,338	9,926
263.48	6,338	9,926
263.50	6,338	9,926
263.52	6,338	9,926
263.54	6,338	9,926
263.56	6,338	9,926
263.58	6,338	9,926
263.60	6,338	9,926
263.62	6,338	9,926
263.64	6,338	9,926
263.66	6,338	9,926
263.68	6,338	9,926
263.70	6,338	9,926
263.72	6,338	9,926
263.74	6,338	9,926

Stage-Area-Storage for Pond INF-2: Underground Infiltration System #2

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
249.50	983	0	250.01	1,063	200
249.51	984	4	250.02	1,064	204
249.52	986	8	250.03	1,066	208
249.53	987	12	250.04	1,068	212
249.54	989	16	250.05	1,069	216
249.55	991	20	250.06	1,071	220
249.56	992	24	250.07	1,072	224
249.57	994	28	250.08	1,074	228
249.58	995	31	250.09	1,075	232
249.59	997	35	250.10	1,077	236
249.60	998	39	250.11	1,079	240
249.61	1,000	43	250.12	1,080	244
249.62	1,002	47	250.13	1,082	248
249.63	1,003	51	250.14	1,083	252
249.64	1,005	55	250.15	1,085	255
249.65	1,006	59	250.16	1,086	259
249.66	1,008	63	250.17	1,088	263
249.67	1,009	67	250.18	1,090	267
249.68	1,011	71	250.19	1,091	271
249.69	1,013	75	250.20	1,093	275
249.70	1,014	79	250.21	1,094	279
249.71	1,016	83	250.22	1,096	283
249.72	1,017	86	250.23	1,098	287
249.73	1,019	90	250.24	1,099	291
249.74	1,020	94	250.25	1,101	295
249.75	1,022	98	250.26	1,102	303
249.76	1,024	102	250.27	1,104	311
249.77	1,025	106	250.28	1,105	319
249.78	1,027	110	250.29	1,107	327
249.79	1,028	114	250.30	1,109	335
249.80	1,030	118	250.31	1,110	343
249.81	1,031	122	250.32	1,112	352
249.82	1,033	126	250.33	1,113	360
249.83	1,035	130	250.34	1,115	368
249.84	1,036	134	250.35	1,116	376
249.85	1,038	138	250.36	1,118	384
249.86	1,039	142	250.37	1,120	392
249.87	1,041	145	250.38	1,121	400
249.88	1,042	149	250.39	1,123	408
249.89	1,044	153	250.40	1,124	416
249.90	1,046	157	250.41	1,126	424
249.91	1,047	161	250.42	1,127	432
249.92	1,049	165	250.43	1,129	440
249.93	1,050	169	250.44	1,131	448
249.94	1,052	173	250.45	1,132	456
249.95	1,053	177	250.46	1,134	464
249.96	1,055	181	250.47	1,135	473
249.97	1,057	185	250.48	1,137	481
249.98	1,058	189	250.49	1,138	489
249.99	1,060	193	250.50	1,140	497
250.00	1,061	197	250.51	1,142	505

Stage-Area-Storage for Pond INF-2: Underground Infiltration System #2 (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
250.52	1,143	513	251.03	1,223	918
250.53	1,145	521	251.04	1,225	926
250.54	1,146	529	251.05	1,226	934
250.55	1,148	537	251.06	1,228	942
250.56	1,149	545	251.07	1,230	949
250.57	1,151	553	251.08	1,231	957
250.58	1,153	561	251.09	1,233	965
250.59	1,154	569	251.10	1,234	973
250.60	1,156	577	251.11	1,236	981
250.61	1,157	585	251.12	1,237	989
250.62	1,159	593	251.13	1,239	996
250.63	1,160	601	251.14	1,241	1,004
250.64	1,162	609	251.15	1,242	1,012
250.65	1,164	617	251.16	1,244	1,020
250.66	1,165	625	251.17	1,245	1,028
250.67	1,167	633	251.18	1,247	1,035
250.68	1,168	641	251.19	1,248	1,043
250.69	1,170	649	251.20	1,250	1,051
250.70	1,171	657	251.21	1,252	1,059
250.71	1,173	665	251.22	1,253	1,067
250.72	1,175	673	251.23	1,255	1,074
250.73	1,176	681	251.24	1,256	1,082
250.74	1,178	689	251.25	1,258	1,090
250.75	1,179	697	251.26	1,260	1,098
250.76	1,181	705	251.27	1,261	1,105
250.77	1,182	713	251.28	1,263	1,113
250.78	1,184	720	251.29	1,264	1,121
250.79	1,186	728	251.30	1,266	1,129
250.80	1,187	736	251.31	1,267	1,136
250.81	1,189	744	251.32	1,269	1,144
250.82	1,190	752	251.33	1,271	1,152
250.83	1,192	760	251.34	1,272	1,160
250.84	1,193	768	251.35	1,274	1,167
250.85	1,195	776	251.36	1,275	1,175
250.86	1,197	784	251.37	1,277	1,183
250.87	1,198	792	251.38	1,278	1,190
250.88	1,200	800	251.39	1,280	1,198
250.89	1,201	808	251.40	1,282	1,206
250.90	1,203	816	251.41	1,283	1,213
250.91	1,204	824	251.42	1,285	1,221
250.92	1,206	831	251.43	1,286	1,229
250.93	1,208	839	251.44	1,288	1,236
250.94	1,209	847	251.45	1,289	1,244
250.95	1,211	855	251.46	1,291	1,252
250.96	1,212	863	251.47	1,293	1,259
250.97	1,214	871	251.48	1,294	1,267
250.98	1,215	879	251.49	1,296	1,275
250.99	1,217	887	251.50	1,297	1,282
251.00	1,219	894	251.51	1,299	1,290
251.01	1,220	902	251.52	1,300	1,298
251.02	1,222	910	251.53	1,302	1,305

Stage-Area-Storage for Pond INF-2: Underground Infiltration System #2 (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
251.54	1,304	1,313	252.05	1,384	1,693
251.55	1,305	1,321	252.06	1,385	1,701
251.56	1,307	1,328	252.07	1,387	1,708
251.57	1,308	1,336	252.08	1,388	1,715
251.58	1,310	1,343	252.09	1,390	1,723
251.59	1,311	1,351	252.10	1,392	1,730
251.60	1,313	1,359	252.11	1,393	1,737
251.61	1,315	1,366	252.12	1,395	1,744
251.62	1,316	1,374	252.13	1,396	1,752
251.63	1,318	1,381	252.14	1,398	1,759
251.64	1,319	1,389	252.15	1,399	1,766
251.65	1,321	1,396	252.16	1,401	1,773
251.66	1,322	1,404	252.17	1,403	1,780
251.67	1,324	1,411	252.18	1,404	1,788
251.68	1,326	1,419	252.19	1,406	1,795
251.69	1,327	1,427	252.20	1,407	1,802
251.70	1,329	1,434	252.21	1,409	1,809
251.71	1,330	1,442	252.22	1,411	1,816
251.72	1,332	1,449	252.23	1,412	1,823
251.73	1,333	1,457	252.24	1,414	1,831
251.74	1,335	1,464	252.25	1,415	1,838
251.75	1,337	1,472	252.26	1,417	1,845
251.76	1,338	1,479	252.27	1,418	1,852
251.77	1,340	1,487	252.28	1,420	1,859
251.78	1,341	1,494	252.29	1,422	1,866
251.79	1,343	1,502	252.30	1,423	1,873
251.80	1,344	1,509	252.31	1,425	1,880
251.81	1,346	1,516	252.32	1,426	1,887
251.82	1,348	1,524	252.33	1,428	1,894
251.83	1,349	1,531	252.34	1,429	1,902
251.84	1,351	1,539	252.35	1,431	1,909
251.85	1,352	1,546	252.36	1,433	1,916
251.86	1,354	1,554	252.37	1,434	1,923
251.87	1,355	1,561	252.38	1,436	1,930
251.88	1,357	1,568	252.39	1,437	1,937
251.89	1,359	1,576	252.40	1,439	1,944
251.90	1,360	1,583	252.41	1,440	1,951
251.91	1,362	1,591	252.42	1,442	1,958
251.92	1,363	1,598	252.43	1,444	1,965
251.93	1,365	1,605	252.44	1,445	1,972
251.94	1,366	1,613	252.45	1,447	1,979
251.95	1,368	1,620	252.46	1,448	1,986
251.96	1,370	1,628	252.47	1,450	1,992
251.97	1,371	1,635	252.48	1,451	1,999
251.98	1,373	1,642	252.49	1,453	2,006
251.99	1,374	1,650	252.50	1,455	2,013
252.00	1,376	1,657	252.51	1,456	2,020
252.01	1,377	1,664	252.52	1,458	2,027
252.02	1,379	1,672	252.53	1,459	2,034
252.03	1,381	1,679	252.54	1,461	2,041
252.04	1,382	1,686	252.55	1,462	2,048

Stage-Area-Storage for Pond INF-2: Underground Infiltration System #2 (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
252.56	1,464	2,054	253.07	1,544	2,388
252.57	1,466	2,061	253.08	1,546	2,394
252.58	1,467	2,068	253.09	1,547	2,400
252.59	1,469	2,075	253.10	1,549	2,406
252.60	1,470	2,082	253.11	1,550	2,413
252.61	1,472	2,089	253.12	1,552	2,419
252.62	1,473	2,095	253.13	1,554	2,425
252.63	1,475	2,102	253.14	1,555	2,431
252.64	1,477	2,109	253.15	1,557	2,437
252.65	1,478	2,116	253.16	1,558	2,443
252.66	1,480	2,122	253.17	1,560	2,449
252.67	1,481	2,129	253.18	1,561	2,455
252.68	1,483	2,136	253.19	1,563	2,461
252.69	1,484	2,142	253.20	1,565	2,467
252.70	1,486	2,149	253.21	1,566	2,473
252.71	1,488	2,156	253.22	1,568	2,479
252.72	1,489	2,163	253.23	1,569	2,485
252.73	1,491	2,169	253.24	1,571	2,491
252.74	1,492	2,176	253.25	1,573	2,497
252.75	1,494	2,182	253.26	1,574	2,503
252.76	1,495	2,189	253.27	1,576	2,508
252.77	1,497	2,196	253.28	1,577	2,514
252.78	1,499	2,202	253.29	1,579	2,520
252.79	1,500	2,209	253.30	1,580	2,526
252.80	1,502	2,215	253.31	1,582	2,532
252.81	1,503	2,222	253.32	1,584	2,537
252.82	1,505	2,229	253.33	1,585	2,543
252.83	1,506	2,235	253.34	1,587	2,549
252.84	1,508	2,242	253.35	1,588	2,555
252.85	1,510	2,248	253.36	1,590	2,560
252.86	1,511	2,255	253.37	1,591	2,566
252.87	1,513	2,261	253.38	1,593	2,572
252.88	1,514	2,268	253.39	1,595	2,577
252.89	1,516	2,274	253.40	1,596	2,583
252.90	1,517	2,281	253.41	1,598	2,588
252.91	1,519	2,287	253.42	1,599	2,594
252.92	1,521	2,293	253.43	1,601	2,599
252.93	1,522	2,300	253.44	1,602	2,605
252.94	1,524	2,306	253.45	1,604	2,610
252.95	1,525	2,313	253.46	1,606	2,616
252.96	1,527	2,319	253.47	1,607	2,621
252.97	1,528	2,325	253.48	1,609	2,626
252.98	1,530	2,332	253.49	1,610	2,632
252.99	1,532	2,338	253.50	1,612	2,637
253.00	1,533	2,344	253.51	1,613	2,642
253.01	1,535	2,351	253.52	1,615	2,647
253.02	1,536	2,357	253.53	1,617	2,653
253.03	1,538	2,363	253.54	1,618	2,658
253.04	1,539	2,369	253.55	1,620	2,663
253.05	1,541	2,376	253.56	1,621	2,668
253.06	1,543	2,382	253.57	1,623	2,673

Stage-Area-Storage for Pond INF-2: Underground Infiltration System #2 (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
253.58	1,624	2,678
253.59	1,626	2,683
253.60	1,628	2,688
253.61	1,629	2,693
253.62	1,631	2,697
253.63	1,632	2,702
253.64	1,634	2,707
253.65	1,635	2,712
253.66	1,637	2,716
253.67	1,639	2,721
253.68	1,640	2,725
253.69	1,642	2,730
253.70	1,643	2,734
253.71	1,645	2,739
253.72	1,646	2,743
253.73	1,648	2,748
253.74	1,650	2,752
253.75	1,651	2,756
253.76	1,653	2,761
253.77	1,654	2,765
253.78	1,656	2,769
253.79	1,657	2,774
253.80	1,659	2,778
253.81	1,661	2,782
253.82	1,662	2,787
253.83	1,664	2,791
253.84	1,665	2,795
253.85	1,667	2,799
253.86	1,668	2,803
253.87	1,670	2,808
253.88	1,672	2,812
253.89	1,673	2,816
253.90	1,675	2,820
253.91	1,676	2,824
253.92	1,678	2,828
253.93	1,679	2,832
253.94	1,681	2,836
253.95	1,683	2,840
253.96	1,684	2,844
253.97	1,686	2,848
253.98	1,687	2,852
253.99	1,689	2,856
254.00	1,690	2,860
254.01	1,692	2,864
254.02	1,694	2,868
254.03	1,695	2,872
254.04	1,697	2,876
254.05	1,698	2,880
254.06	1,700	2,884
254.07	1,701	2,888
254.08	1,703	2,892
254.09	1,705	2,896
254.10	1,706	2,899
254.11	1,708	2,903
254.12	1,709	2,907
254.13	1,711	2,911
254.14	1,712	2,915
254.15	1,714	2,919
254.16	1,716	2,923
254.17	1,717	2,927
254.18	1,719	2,931
254.19	1,720	2,935
254.20	1,722	2,939
254.21	1,724	2,943
254.22	1,725	2,947
254.23	1,727	2,951
254.24	1,728	2,954
254.25	1,730	2,958
254.26	1,731	2,962
254.27	1,733	2,966
254.28	1,735	2,970
254.29	1,736	2,974
254.30	1,738	2,978
254.31	1,739	2,982
254.32	1,741	2,986
254.33	1,742	2,990
254.34	1,744	2,994
254.35	1,746	2,998
254.36	1,747	3,002
254.37	1,749	3,006
254.38	1,750	3,009
254.39	1,752	3,013
254.40	1,753	3,017
254.41	1,755	3,021
254.42	1,757	3,025
254.43	1,758	3,029
254.44	1,760	3,033
254.45	1,761	3,037
254.46	1,763	3,041
254.47	1,764	3,045
254.48	1,766	3,049
254.49	1,768	3,053
254.50	1,769	3,057
254.51	1,771	3,061
254.52	1,772	3,065
254.53	1,774	3,068
254.54	1,775	3,072
254.55	1,777	3,076
254.56	1,779	3,080
254.57	1,780	3,084
254.58	1,782	3,088
254.59	1,783	3,092

Stage-Area-Storage for Pond INF-2: Underground Infiltration System #2 (continued)

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
254.60	1,785	3,096
254.61	1,786	3,100
254.62	1,788	3,104
254.63	1,790	3,108
254.64	1,791	3,112
254.65	1,793	3,116
254.66	1,794	3,120
254.67	1,796	3,123
254.68	1,797	3,127
254.69	1,799	3,131
254.70	1,801	3,135
254.71	1,802	3,139
254.72	1,804	3,143
254.73	1,805	3,147
254.74	1,807	3,151
254.75	1,808	3,155
254.76	1,810	3,159
254.77	1,812	3,163
254.78	1,813	3,167
254.79	1,815	3,171
254.80	1,816	3,175
254.81	1,818	3,179
254.82	1,819	3,182
254.83	1,821	3,186
254.84	1,823	3,190
254.85	1,824	3,194
254.86	1,826	3,198
254.87	1,827	3,202
254.88	1,829	3,206
254.89	1,830	3,210
254.90	1,832	3,214
254.91	1,834	3,218
254.92	1,835	3,222
254.93	1,837	3,226
254.94	1,838	3,230
254.95	1,840	3,234
254.96	1,841	3,237
254.97	1,843	3,241
254.98	1,845	3,245
254.99	1,846	3,249
255.00	**1,848**	**3,253**

Greenman-Pedersen, Inc.

GPI Project No.	NEX-2021267	**Sheet**	1 of 2
Project Description	254, 256 & 260 Ayer Road, Littleton, MA & 0 Littleton Road, Ayer, MA		
Task	Drawdown Calculations		
Calculated By	CNM	**Date**	02/08/23
Checked By		**Date**	

Drawdown within 72 hours Analysis for Static Method

Undergroud Infiltration System #1

Infiltration Rate: 8.27 inches/hour (From table 2.3.3: Rawls, Brakensiek, Saxton, 1982)

Design Infiltration Rate: 8.27 inches/hour

Volume Provided for Recharge: 5,373 cf

Basin bottom area: 3,038 sf

Time $_{drawdown}$ = (Required Recharge Volume in cubic feet as determined by the Static Method)(1/Design Infiltration Rate in inches per hour)(conversion for inches to feet)(1/bottom area in feet)

Time $_{drawdown}$ = (5,373 cf) (1 / 8.27 in/hr) (1ft/12 in.) (1 / 3,038 sf)

= 2.57 hours

Undergroud Infiltration System #2

Infiltration Rate: 8.27 inches/hour (From table 2.3.3: Rawls, Brakensiek, Saxton, 1982)

Design Infiltration Rate: 8.27 inches/hour

Volume Provided for Recharge: 2,357 cf

Basin bottom area: 982 sf

Time $_{drawdown}$ = (Required Recharge Volume in cubic feet as determined by the Static Method)(1/Design Infiltration Rate in inches per hour)(conversion for inches to feet)(1/bottom area in feet)

Time $_{drawdown}$ = (2,357 cf) (1 / 8.27 in/hr) (1ft/12 in.) (1 / 982 sf)

= 3.48 hours

Drawdown within 72 hours Analysis for Static Method

Bioretention Area

Infiltration Rate: 8.27 inches/hour (From table 2.3.3: Rawls, Brakensiek, Saxton, 1982)

Design Infiltration Rate: 8.27 inches/hour

Volume Provided for Recharge: 320 cf

Basin bottom area: 59 sf

Time $_{drawdown}$ = (Required Recharge Volume in cubic feet as determined by the Static Method)(1/Design Infiltration Rate in inches per hour)(conversion for inches to feet)(1/bottom area in feet)

Time $_{drawdown}$ = (320 cf) (1 / 8.27 in/hr) (1ft/12 in.) (1 / 59 sf)

= **7.87 hours**

Infiltration Basin

Infiltration Rate: 2.41 inches/hour (From table 2.3.3: Rawls, Brakensiek, Saxton, 1982)

Design Infiltration Rate: 2.41 inches/hour

Volume Provided for Recharge: 2,433 cf

Basin bottom area: 638 sf

Time $_{drawdown}$ = (Required Recharge Volume in cubic feet as determined by the Static Method)(1/Design Infiltration Rate in inches per hour)(conversion for inches to feet)(1/bottom area in feet)

Time $_{drawdown}$ = (2,433 cf) (1 / 2.41 in/hr) (1ft/12 in.) (1 / 638 sf)

= **18.99 hours**

Hydro International

First Defense® High Capacity

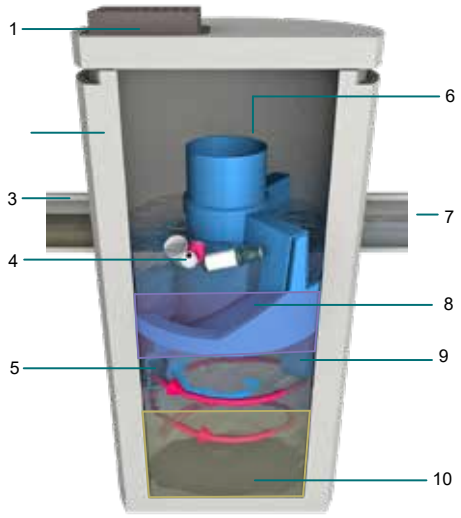
Advanced Hydrodynamic Separator

Product Summary

A Simple Solution for your Trickiest Sites

First Defense® High Capacity is a versatile stormwater separator with some of the highest approved flow rates in the United States, enabling engineers and contractors to save site space and projects costs by using the smallest possible footprint. It also works with single and multiple inlet pipes and inlet grates has an internal bypass to convey infrequent peak flows directly to the outlet.

Fig.1 The First Defense® High Capacity has internal components designed to efficiently capture pollutants and prevent washout at



Product Profile

1. Inlet Grate (optional)
2. Precast chamber
3. Inlet Pipe (optional)
4. Floatables Draw Off Slot (not pictured)
5. Inlet Chute
6. Internal Bypass
7. Outlet pipe
8. Oil and Floatables Storage
9. Outlet chute
10. Sediment Storage Sump

Applications

- Areas requiring a minimum of 50% TSS removal
- Stormwater treatment at the point of entry into the drainage line
- Sites constrained by space, topography or drainage profiles with limited slope and depth of cover
- Highways, car parks, industrial areas and urban developments
- Pre-treatment to ponds, storage systems, green infrastructure

How it Works

Highest Flow through the Smallest Footprint

Contaminated stormwater runoff enters the inlet chute from a surface grate and/or inlet pipe. The inlet chute introduces flow into the chamber tangentially to create a low energy vortex flow regime (magenta arrow) that directs sediment into the sump while oils, floating trash and debris rise to the surface.

Treated stormwater exits through a submerged outlet chute located opposite to the direction of the rotating flow (blue arrow). Enhanced vortex separation is provided by forcing the rotating flow within the vessel to follow the longest path possible rather than directly from inlet to outlet.

Higher flows bypass the treatment chamber to prevent turbulence and washout of captured pollutants. An internal bypass conveys infrequent peak flows directly to the outlet eliminating the need for, and expense of, external bypass control structures. A floatables draw off slot functions to convey floatables into the treatment chamber prior to bypass.

Benefits

Small & Simple

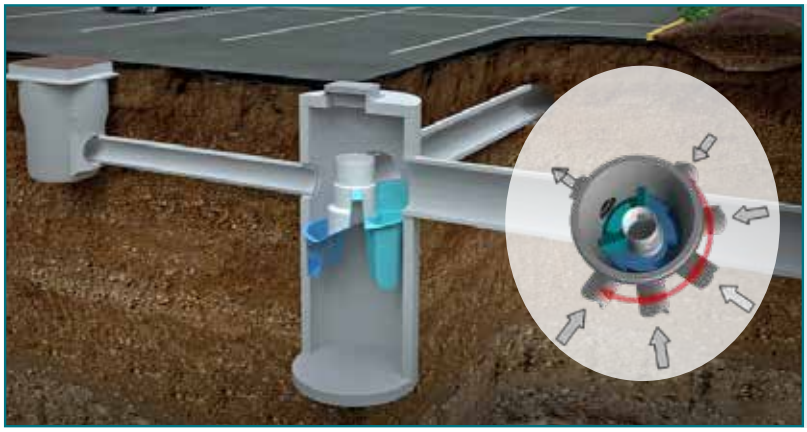
- Cut footprint size, cut costs: First Defense® provides space-saving, easy-to-install surface water treatment in standard sized chambers/ manholes.
- Adapt to site limitations: Variable configuratoins will help you effectively slip First Defense® into a tight spot. It also works well with large pipes, multiple inlet pipes and inlet grates.
- Save installation time: Every First Defense® unit is delivered to site pre-assembled and ready for installation – so installation is as easy as fitting any chamber/manhole.

Stormwater Solutions

→ hydro-int.com/firstdefense

Sizing & Design

This adaptable online treatment system works easily with large pipes, multiple inlet pipes, inlet grates and now, contains a high capacity bypass for the conveyance of large peak flows. Designed with site flexibility in mind, the First Defense® High Capacity allows engineers to maximize available site space without compromising treatment level.



Free Sizing Tool

This simple online tool will recommend the best separator, model size and online/offline arrangement based on site-specific data entered by the user.

Go to hydro-int.com/sizing to access the tool.

First Defense® High Capacity Model Number	Diameter	Typical TSS Treatment Flow Rates		Peak Online Flow Rate	Maximum Pipe Diameter[1]	Oil Storage Capacity	Typical Sediment Storage Capacity[2]	Minimum Distance from Outlet Invert to Top of Rim[3]	Standard Distance from Outlet Invert to Sump Floor
		NJDEP Certified	110µm						
	(ft / m)	(cfs / L/s)	(cfs / L/s)	(cfs / L/s)	(in / mm)	(gal / L)	(yd^3 / m^3)	(ft / m)	(ft / m)
FD-3HC	3 / 0.9	0.84 / 23.7	1.06 / 30.0	15 / 424	18 / 450	125 / 473	0.4 / 0.3	2.0 - 3.5 / 0.6 - 1.0	3.71 / 1.13
FD-4HC	4 / 1.2	1.50 / 42.4	1.88 / 53.2	18 / 510	24 / 600	191 / 723	0.7 / 0.5	2.3 - 3.9 / 0.7 - 1.2	4.97 / 1.5
FD-5HC	5 / 1.5	2.35 / 66.2	2.94 / 83.2	20 / 566	24 / 600	300 / 1135	1.1 / .84	2.5 - 4.5 / 0.7 - 1.3	5.19 / 1.5
FD-6HC	6 / 1.8	3.38 / 95.7	4.23 / 119.8	32 / 906	30 / 750	496 / 1,878	1.6 / 1.2	3.0 - 5.1 / 0.9 - 1.6	5.97 / 1.8
FD-8HC	8 / 2.4	6.00 / 169.9	7.52 / 212.9	50 / 1415	48 / 1200	1120 / 4239	2.8 / 2.1	3.0 - 6.0 / 0.9 -1.8	7.40 / 2.2
FD-10HC	10 / 3.0	9.38 / 265.6	11.75 / 332.7	50 / 1415	48 / 1200	1742 / 6594	4.4 / 3.3	6.5 -8.0 / 2.0 - 2.4	10.25 / 3.12

[1]Contact Hydro International when larger pipe sizes are required.
[2]Contact Hydro International when custom sediment storage capacity is required.
[3]Minimum distance for models depends on pipe diameter.

Maintenance

Easy vactor hose access through the center shaft of the system makes for quick, simple sump cleanout while trash and floatables can be fished out from the surface with a net.

Nobody maintains our systems better than we do. To ensure optimal, ongoing device performance, be sure to recommend Hydro International as a preferred service and maintenance provider to your clients.

Hydro International

Hydro International, 94 Hutchins Drive, Portland, ME 04102
Tel: (207) 756-6200
Email: stormwaterinquiry@hydro-int.com
Web: www.hydro-int.com/firstdefense

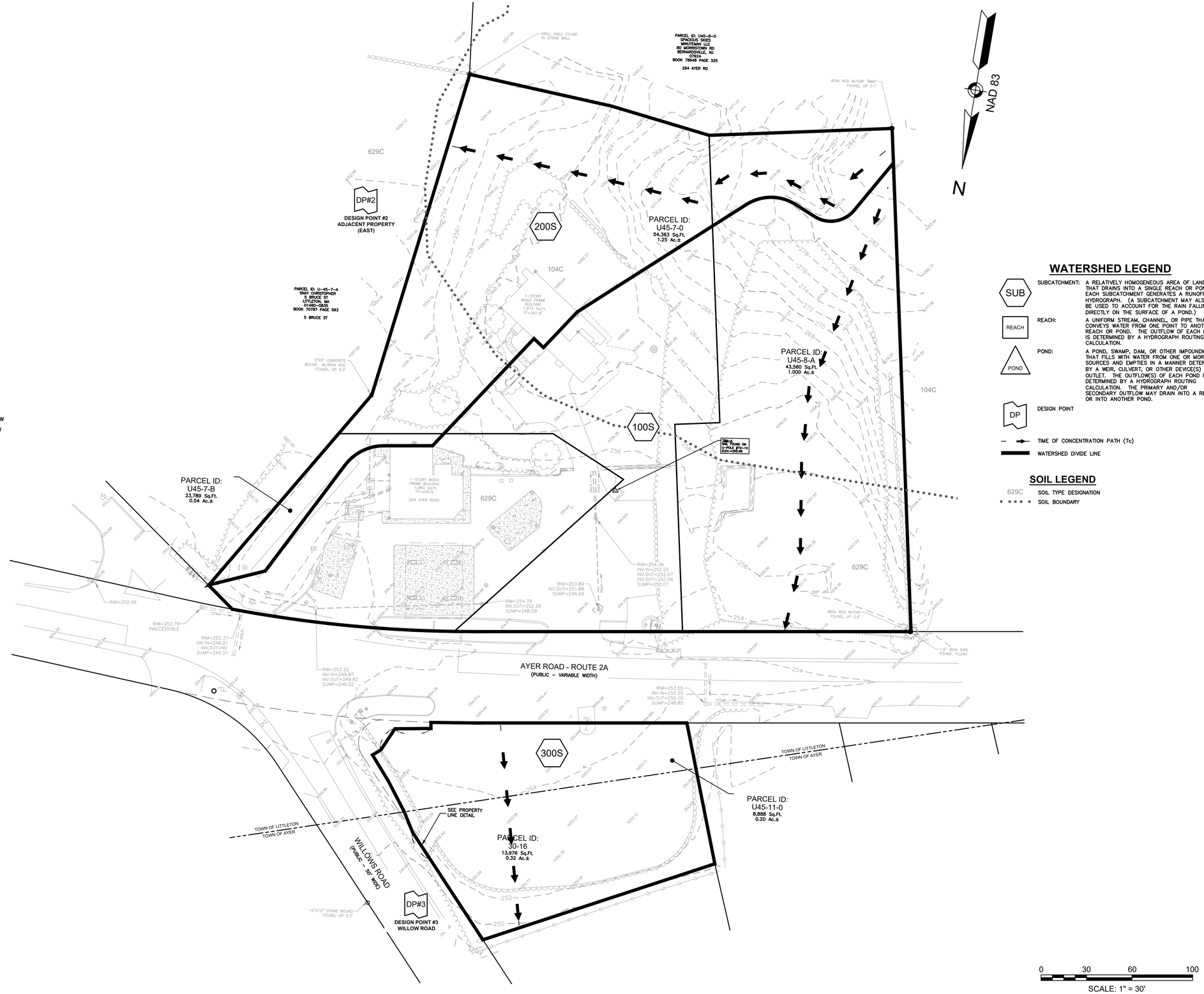
FD_SS_B_2105

Download Drawings!

→ hydro-int.com/fddrawings

Access the Operation & Maintenance Manual

→ hydro-int.com/fd-om



LEGEND

- SGC — SLOPED GRANITE CURB
- VGC — VERTICAL GRANITE CURB
- SCC — SLOPED CONCRETE CURB
- VCC — VERTICAL CONCRETE CURB
- CCB — CAPE COD BERM
- DSLY — DOUBLE SOLID LINE YELLOW
- DDLY — DOUBLE DASHED LINE YELLOW
- SDLY — SINGLE DASHED LINE YELLOW
- SSLY — SINGLE SOLID LINE YELLOW
- SSLW — SINGLE SOLID LINE WHITE
- SDLW — SINGLE DASHED LINE WHITE
- G — GAS LINE
- T — UNDERGROUND TELEPHONE
- W — WATER LINE
- E — UNDERGROUND ELECTRIC
- WOOD GUARDRAIL
- METAL GUARDRAIL
- CHAIN LINK FENCE
- STOCKADE FENCE
- POST & RAIL FENCE
- WIRE FENCE
- 90 — CONTOUR ELEVATION
- TREE
- UTILITY POLE
- GUY WIRE
- OVERHEAD WIRE
- TREELINE
- PB — PULL BOX
- SIGN
- SPOT ELEVATION
- DRAIN MANHOLE
- CATCH BASIN
- ROOF DRAIN
- CLEANOUT
- VENT
- S — SEWER MANHOLE
- T — TELEPHONE MANHOLE
- E — ELECTRIC MANHOLE
- W — WATER MANHOLE
- MH — MANHOLE
- GV — GAS VALVE
- GAS SHUT OFF
- WV — WATER VALVE
- WATER SHUT OFF
- FIRE HYDRANT
- BOLLARD
- GM — GAS METER
- EM — ELECTRIC METER
- MONITORING WELL
- LIGHT POLE
- BORING
- WETLAND LINE
- WATER FEATURE
- U/GAT — UNDERGROUND COMM
- DITCH LINE
- EASEMENT LINE
- PROPERTY LINE
- ABUTTER PROPERTY LINE
- BUILDING SETBACK
- SOIL TYPE LINE
- ZONE LINE
- FLOOD ZONE LINE

WATERSHED LEGEND

- SUB — SUBCATCHMENT: A RELATIVELY HOMOGENEOUS AREA OF LAND THAT DRAINS INTO A SINGLE REACH OR POND. EACH SUBCATCHMENT GENERATES A RUNOFF HYDROGRAPH. (A SUBCATCHMENT MAY ALSO BE USED TO ACCOUNT FOR THE RAIN FALLING DIRECTLY ON THE SURFACE OF A POND.)
- REACH — REACH: A UNIFORM STREAM, CHANNEL, OR PIPE THAT CONVEYS WATER FROM ONE POINT TO ANOTHER REACH OR POND. THE OUTFLOW OF EACH REACH IS DETERMINED BY A HYDROGRAPH ROUTING CALCULATION.
- POND — POND: A POND, SWAMP, DAM, OR OTHER IMPOUNDMENT THAT FILLS WITH WATER FROM ONE OR MORE SOURCES AND EMPTIES IN A MANNER DETERMINED BY A WEIR, CULVERT, OR OTHER DEVICE(S) AT ITS OUTLET. THE OUTFLOW(S) OF EACH POND IS DETERMINED BY A HYDROGRAPH ROUTING CALCULATION. THE PRIMARY AND/OR SECONDARY OUTFLOW MAY DRAIN INTO A REACH OR INTO ANOTHER POND.
- DP — DESIGN POINT
- TIME OF CONCENTRATION PATH (Tc)
- WATERSHED DIVIDE LINE

SOIL LEGEND

- 629C — SOIL TYPE DESIGNATION
- SOIL BOUNDARY

GPI
Engineering
Design
Planning
Construction Management
603.893.0720
GPINET.COM
Greenman-Pedersen, Inc.
44 Stiles Road, Suite One
Salem, NH 03079

PREPARED FOR
ENERGY NORTH GROUP
2 INTERNATIONAL WAY,
LAWRENCE, MA 01843

PARCEL ID: U45-7-B, PARCEL ID: U45-7-0
PARCEL ID: U45-8-A, PARCEL ID:U45-11-0
254, 256 & 260 AYER ROAD
LITTLETON, MASSACHUSETTS

PARCEL ID: 30-160
0 LITTLETON ROAD
AYER, MASSACHUSETTS

REVISIONS		
NO.	REVISION	DATE

FEBRUARY 8, 2023

DRAWN/DESIGN BY	CHECKED BY
SJB	CMT

PRE-DEVELOPMENT DRAINAGE AREA PLAN

SCALE: 1"=30'

NEX-2021267

1 OF 1

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LEGEND

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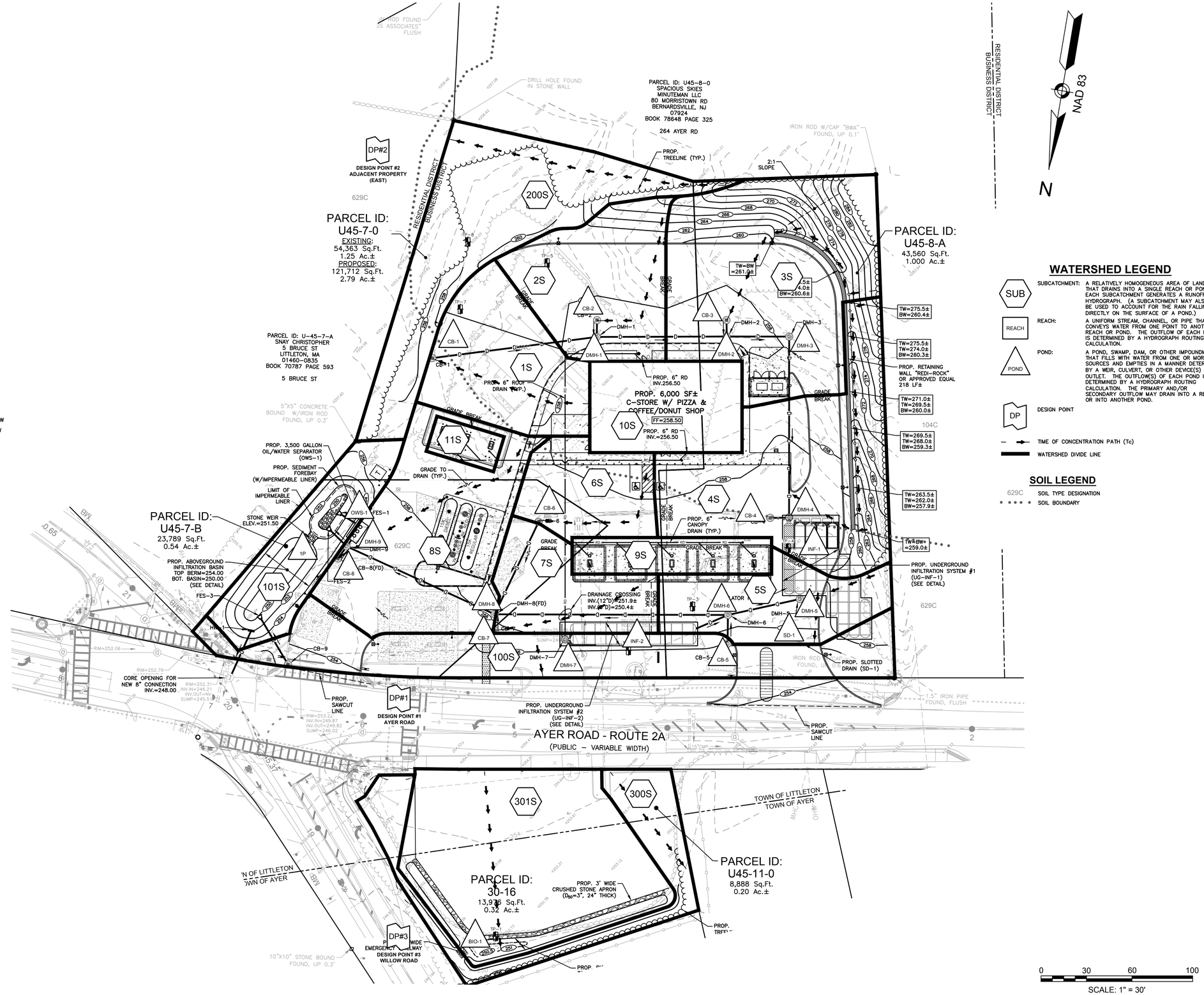
- E — ELECTRIC MANHOLE
- W — WATER MANHOLE
- MH — MANHOLE
- GV — GAS VALVE
- GAS SHUT OFF
- WV — WATER VALVE
- WATER SHUT OFF
- FIRE HYDRANT
- BOLLARD
- GM — GAS METER
- EM — ELECTRIC METER
- MONITORING WELL
- LIGHT POLE
- BORING
- WETLAND LINE
- WATER FEATURE
- U/GAT — UNDERGROUND COMM
- DITCH LINE
- EASEMENT LINE
- PROPERTY LINE
- ABUTTER PROPERTY LINE
- BUILDING SETBACK
- SOIL TYPE LINE
- ZONE LINE
- FLOOD ZONE LINE



WATERSHED LEGEND

- SUB — SUBCATCHMENT: A RELATIVELY HOMOGENEOUS AREA OF LAND THAT DRAINS INTO A SINGLE REACH OR POND. EACH SUBCATCHMENT GENERATES A RUNOFF HYDROGRAPH. (A SUBCATCHMENT MAY ALSO BE USED TO ACCOUNT FOR THE RAIN FALLING DIRECTLY ON THE SURFACE OF A POND.)
- REACH — REACH: A UNIFORM STREAM, CHANNEL, OR PIPE THAT CONVEYS WATER FROM ONE POINT TO ANOTHER REACH OR POND. THE OUTFLOW OF EACH REACH IS DETERMINED BY A HYDROGRAPH ROUTING CALCULATION.
- POND — POND: A POND, SWAMP, DAM, OR OTHER IMPOUNDMENT THAT FILLS WITH WATER FROM ONE OR MORE SOURCES AND EMPTIES IN A MANNER DETERMINED BY A WEIR, CULVERT, OR OTHER DEVICE(S) AT ITS OUTLET. THE OUTFLOW(S) OF EACH POND IS DETERMINED BY A HYDROGRAPH ROUTING CALCULATION. THE PRIMARY AND/OR SECONDARY OUTFLOW MAY DRAIN INTO A REACH OR INTO ANOTHER POND.
- DP — DESIGN POINT
- TIME OF CONCENTRATION PATH (Tc)
- WATERSHED DIVIDE LINE

SOIL LEGEND

- 629C — SOIL TYPE DESIGNATION
- SOIL BOUNDARY

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PREPARED FOR
ENERGY NORTH GROUP
2 INTERNATIONAL WAY,
LAWRENCE, MA 01843

PARCEL ID: U45-7-B, PARCEL ID: U45-7-0
PARCEL ID: U45-8-A, PARCEL ID:U45-11-0
254, 256 & 260 AYER ROAD
LITTLETON, MASSACHUSETTS

PARCEL ID: 30-160
0 LITTLETON ROAD
AYER, MASSACHUSETTS

REVISIONS		
NO.	REVISION	DATE

FEBRUARY 8, 2023

DRAWN/DESIGN BY	CHECKED BY
SJB	CMT

POST-DEVELOPMENT DRAINAGE AREA PLAN

SCALE: 1"=30'

NEX-2021267

1 OF 1

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OPERATION & MAINTENANCE PLAN
And
LONG TERM POLLUTION PREVENTION PLAN
For
STORMWATER MANAGEMENT SYSTEMS

PROPOSED RETAIL MOTOR FUEL OUTLET RE-DEVELOPMENT
MAP U45 LOTS 7, 7-B, 8-A & 11-0
254, 256 & 260 AYER ROAD (ROUTE 2A)
LITTLETON, MA

MAP 30 LOT 16
0 LITTLETON ROAD
AYER, MA

GPI

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Prepared For:

Energy North Group
2 International Way
Lawrence, MA 01843

February 8, 2023

Energy North Group
Proposed Retail Motor Fuel Outlet
Stormwater O&M and LTPPP

TABLE OF CONTENTS

SECTION 1 O & M DOCUMENTATION REQUIREMENTS

The property owner shall be responsible for the operation and maintenance of all stormwater management systems after construction in accordance with the below criteria. Logs of inspections and cleanings shall be maintained by the owner and annual BMP inspection forms shall be made available to the Town of Littleton and Town of Ayer upon request.

As required by the MassDEP Stormwater Management Handbook, which serves as guidance on the Massachusetts Stormwater Policy, and in accordance with Stormwater Standard #9, the following post construction operation and maintenance plan has been prepared.

Stormwater Management System Owner: Property owner

Party or Parties Responsible for Operation and Maintenance: Property owner

Documentation: A maintenance log shall be kept summarizing inspections, maintenance and any corrective actions taken. The log shall include the date on which each inspection or maintenance task was performed, a description of the inspection findings or maintenance completed, and the name of the inspector or maintenance personnel performing the task. If a maintenance task requires the clean out of any sediments or debris, the location where the sediment and debris was disposed after removal will be indicated. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations. The logs shall be made accessible to the Town of Littleton and Town of Ayer upon request.

All stormwater facilities associated with this redevelopment are identified on Figures 1A and 1B contained within Section 4 of this manual and listed individually on the log form included herein and shall be inspected and maintained in accordance with the procedures outlined in Section 2.

SECTION 2 BMP SPECIFIC O & M PROCEDURES

Driveway/Parking Lot Sweeping

Sweeping shall be done once in the early fall and then immediately following spring snowmelt to remove sand and other debris and when visual buildup of debris is apparent. Pavement surfaces shall be swept at other times such as in the fall after leaves have dropped to remove accumulated debris. Since contaminants typically accumulate within 12 inches of the curbline, street cleaning operations should concentrate in cleaning curb and gutter lines for maximum pollutant removal efficiency. Other areas shall also be swept periodically when visual buildup of debris is apparent. Once removed from paved surfaces, the sweeping must be handled and disposed of properly. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations.

Deep Sump Hooded Catch Basins/Slotted Drain

Inspect catch basins and slotted drain at least 4 times per year and at the end of the foliage and snow removal seasons (preferably in spring and fall) to ensure that the catch basins are working in their intended fashion and that they are free of debris. Sediment must also be removed 4 times per year of 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 the basin outlet is designed with a hood to trap floatable materials check to ensure watertight seal is working. At a minimum, remove floating debris and hydrocarbons at the time of the inspection. Sediment and debris can be removed by a clamshell bucket however, a vacuum truck is preferred. A vacuum truck must be used at a minimum of once per year for sediment removal. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations.

Oil/Water Separator

The system should initially be inspected within the first three months after completion of the site's construction and after any rainfall greater than 1-inch. The units should be inspected after every major storm but at least on a monthly basis. Cleaning of the units should be done at least twice a year and should include the following:

Removal of accumulated oil and grease and sediment by using a vacuum truck or similar catch basin cleaning device.
Visually inspect, and clean as needed, inlet and outlets including tees during each inspection.
At a minimum, remove any floating debris at the time of the inspection.

Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations.

Hydrodynamic Separator (First Defense Units)

Initial maintenance to be performed twice a year for the first year after the unit is online and operational. A vacuum truck must be used at a minimum of once per year for sediment removal. Refer to the attached First Defense Maintenance Guide for operation and maintenance procedures and schedules thereafter.

Stormtech Underground Infiltration Systems

Inspect and measure the level of sediment in the isolator rows via the inspection port and the sumps of the drainage manholes. If sediment is at, or above 3", jetvac the isolator row with a fixed culvert cleaning nozzle with rear facing spread of 45". Apply multiple passes of the jetvac until backflush water is clean. Vacuum connecting drain manhole structures.

In the first year, inspect the System every 6 months. After the first year, the inspection schedule should be adjusted based on previous observations of sediment accumulation and high water elevations; however, inspections should be performed once a year at a minimum. Refer to the attached Isolator Row O&M Manual for more information.

Infiltration Basin

Periodic mowings of the embankment shall be performed. Inspect slope and embankments at least twice annually. Woody vegetation shall be removed from fill embankments. Sediment and debris removal should be through the use of truck mounted vacuum equipment. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations.

The inlets of the basin should be checked periodically to ensure that flow structures are not blocked by debris. Spillways should be checked for debris that may obstruct flow.

Bioretention Area

The bioretention areas should initially be inspected within the first three months after completion of the site's construction and after any rainfall event exceeding 2.5 inches in a 24-hour period. The system should be inspected at least twice annually thereafter.

Preventative maintenance will aid in proper function of the bioretention area. Inspect for trash and debris on a month-to-month basis year-round. Additional mulch should be laid down on an annual basis, preferably in the springtime. Prune any plantings and remove dead vegetation on an annual basis in the spring or fall and any dead vegetation should be replanted in the springtime. At least annually, the system should be inspected for drawdown time. In the event the bioretention area needs to be replaced due to failure or other reasons, any vegetation & filter media should be replaced in either the late spring or early summer.

Stone Aprons/Outlet Weirs

Inspect at least once annually for damage and deterioration. Repair damage immediately.

Vegetated Areas

Inspect slopes and embankments early in the growing season to identify active or potential erosion problems. Replant bare areas or areas with sparse growth. Where rill erosion is evident, armor the area with an appropriate lining or divert the erosive flows to on-site areas able to withstand the concentrated flows. During the summer months, all landscape features are to be maintained with the minimum possible amount of fertilizers, pesticides or herbicides.

Winter Maintenance

Proposed snow storage is located along the edge of the driveways and parking areas. Any excess snow is to be trucked offsite. During the winter months all snow is to be stored such that snowmelt is controlled. Avoid disposing of snow on top of storm drain catch basins or in

stormwater drainage swales or ditches. The minimum amount of deicing chemicals needed is to be used.

For questions and additional information regarding snow storage or disposal, please contact the MassDEP's Central Regional Office in Worcester at 508-792-7650.

SECTION 3 LONG-TERM MAINTENANCE PLAN

The primary focus of the Long-Term Pollution Prevention Plan (LTPPP) is to establish procedures and controls for limiting the potential sources of pollutants, including nutrients that may contribute to excessive contaminant levels in the site's stormwater runoff. To this end the following source controls and procedures will be in place at the site:

- **Good House Keeping** – It shall be the responsibility of the property owner to keep the site clean at all times. Refuse disposal and pickup shall occur on a regular basis and all material shall be disposed of in the specified dumpster location area on the Site Development Plans.
- **Storing Material and waste products inside or under cover** – No material storage is to take place outside the proposed facility on either paved or lawn areas. All material stored on site will conform with all storage requirements of local, state and federal agencies.
- **Routine inspections and maintenance of stormwater BMP's** – Refer to the Operation and Maintenance procedures for each BMP as described in the O&M Plan as described herein.
- **Maintenance of lawns, gardens and other landscaped areas** – All landscaping and maintenance to be performed by an authorized company chosen by the property owner.
- **Storage and use of fertilizers, herbicides and pesticides** – All landscape maintenance will be conducted by an authorized company chosen by the property owner. Any application of herbicides or pesticides will be applied by a licensed applicator.
- **Proper management of deicing chemicals and snow** – Deicing chemicals and snow removal shall primarily be the responsibility of the property owner additional information can be found in the O&M Plan as described herein.
- **Nutrient management plan** - The goal of the nutrient management plan is to minimize the potential sources of excess nutrients on the site and the release of nutrients in the stormwater from the site. This minimization relates both to infiltrated water and runoff. In general, the nature of the site use will tend to reduce the nutrients in the stormwater. Further, procedures indicated above or in the O&M Plan related to deicing procedures, BMP maintenance procedures, and street sweeping will act to reduce the levels of nutrients in the stormwater, and the nutrients entering the adjacent wetland and the groundwater.

SECTION 4 LONG-TERM MAINTENANCE PLAN EXHIBIT

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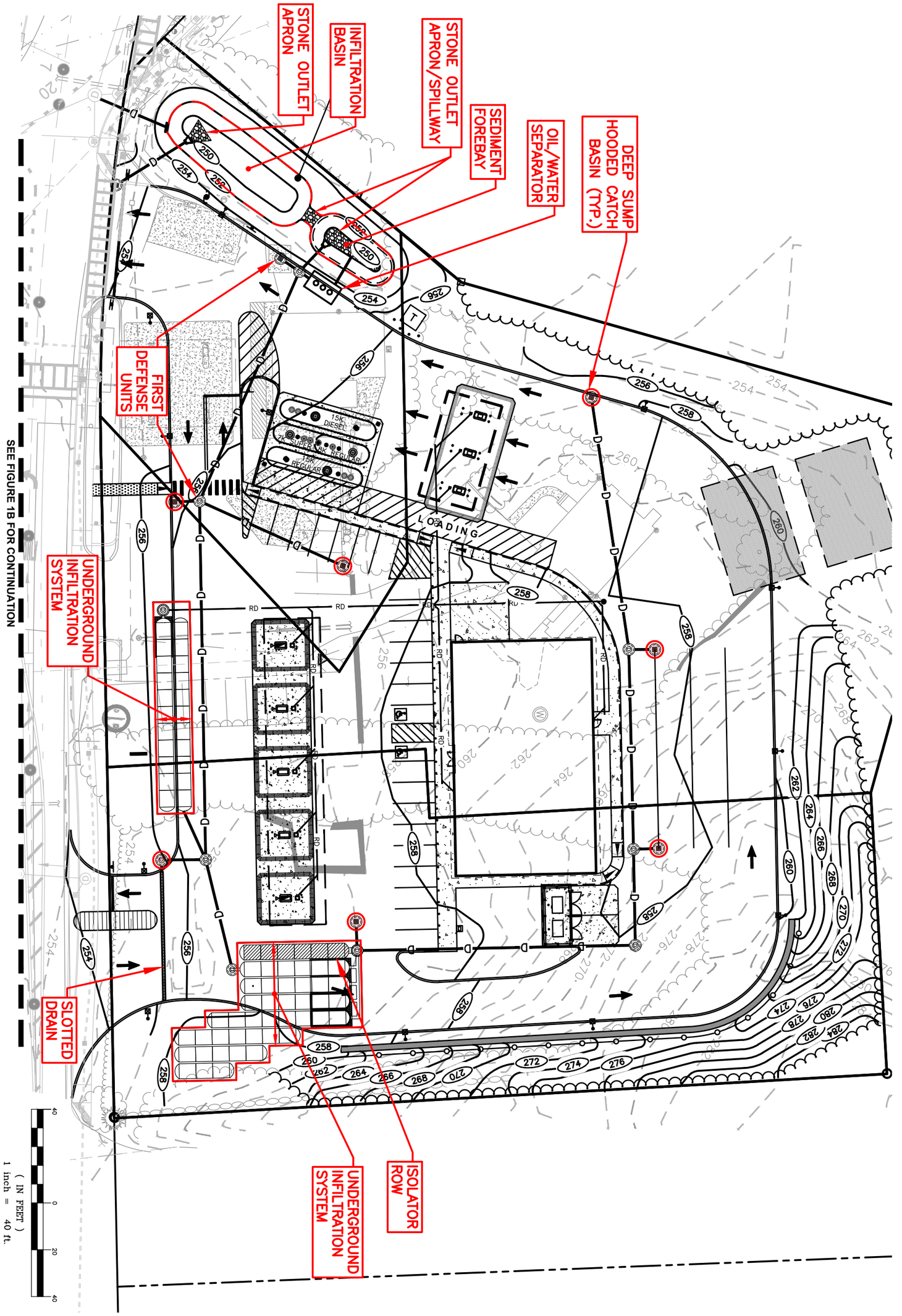

LONG TERM MAINTENANCE EXHIBIT

254, 256 & 260 AYER ROAD
LITTLETON, MASSACHUSETTS
0 LITTLETON ROAD
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DATE: 2/8/23
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FIGURE 1A

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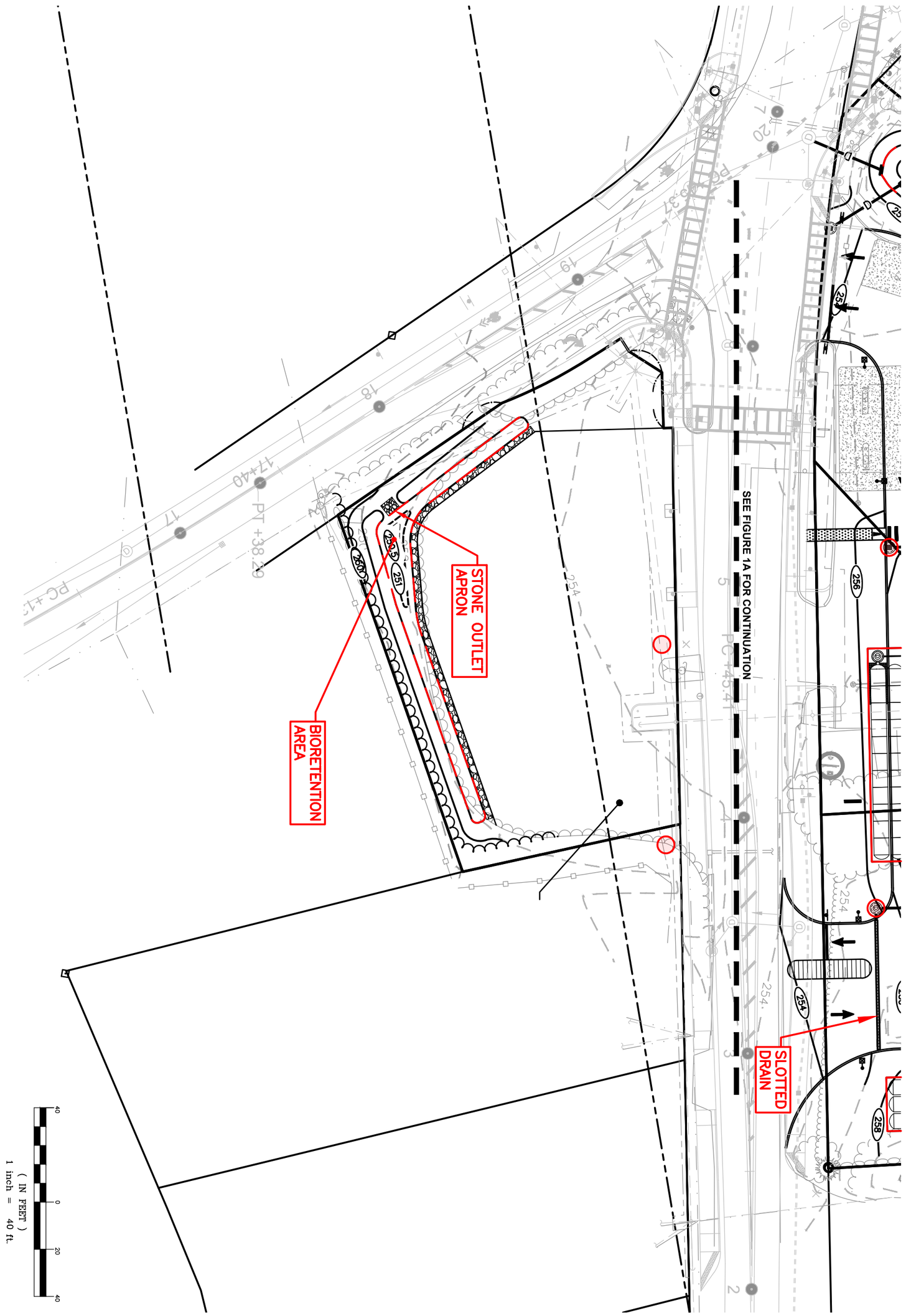

LONG TERM MAINTENANCE EXHIBIT

254, 256 & 260 AYER ROAD
LITTLETON, MASSACHUSETTS
0 LITTLETON ROAD
AYER, MASSACHUSETTS

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PROJECT #: 2021267
DATE: 2/8/23
REV.:

FIGURE 1B

SECTION 5 STORMWATER OPERATION & MAINTENANCE LOG

STORMWATER INSPECTION & MAINTENANCE LOG

254, 256 & 260 Ayer Road, Littleton, MA & 0 Littleton Road, Ayer, MA

General Information			
Project Name	Proposed Retail Motor Fuel Outlet	**Location**	Littleton & Ayer, MA
Date of Inspection		**Start/ End Time**	
Inspector's Name(s)			
Inspector's Title(s)			
Inspector's Contact Information			

	Site Specific BMP's	Maintenance Interval
1	Street Sweeping	6 months
2	Deep Sump Catch Basins/Slotted Drain	3 months
3	Hydrodynamic Separators (First Defense Unit)	1 Year (See separate maintenance log for First Defense Unit)
4	Oil/ Water Separator	6 months
5	Stormtech Underground Infiltration Systems	6 months (See separate maintenance log for Isolator Rows)
6	Infiltration Basin	6 months
7	Bioretention Area	6 months
8	Stone Outlet Aprons/Weirs	1 year

STORMWATER INSPECTION & MAINTENANCE LOG

254, 256 & 260 Ayer Road, Littleton, MA & 0 Littleton Road, Ayer, MA

BMP Description	Corrective Action Required?		Notes
Street Sweeping			
Evidence of debris accumulation	YES	NO	
Evidence of oil grease	YES	NO	
Other (specify)	YES	NO	
Deep Sump Catch Basins/Slotted Drain			
Grates clear of debris	YES	NO	
Inlet and outlet clear of debris	YES	NO	
Evidence of oil grease	YES	NO	
Observance of accumulated sediment	YES	NO	Sediment Depth =
Evidence of structural deterioration	YES	NO	
Evidence of flow bypassing facility	YES	NO	
Other (specify)	YES	NO	
Hydrodynamic Separators (First Defense Units)			
See separate maintenance log for First Defense Units			
Oil / Water Seperator			
Grates clear of debris	YES	NO	
Inlet and outlet clear of debris	YES	NO	
Observance of accumulated sediment	YES	NO	Sediment Depth =
Evidense of oil grease	YES	NO	
Evidence of flow bypassing facility	YES	NO	
Stormtech Underground Infiltration Systems			
Inlet and outlet clear of sediment/debris	YES	NO	
Chamber bottom clear of sediment/debris	YES	NO	
Outlet control structure clear of debris	YES	NO	
Observance of accumulated sediment	YES	NO	Sediment Depth =
Bottom dewaters within 72 hrs. of a storm event	YES	NO	
Other (specify)	YES	NO	
Infiltration Basin			
Inlet and outlet clear of debris	YES	NO	
Bottom surface clear of debris	YES	NO	
Evidence of rilling or gullying	YES	NO	
Observance of accumulated sediment	YES	NO	
Bottom dewaters between storms	YES	NO	
Standing water or wet spots	YES	NO	
Tree growth	YES	NO	
Other (specify)	YES	NO	
Bioretention Area			
Inlet and outlet clear of debris	YES	NO	
Bottom surface clear of debris	YES	NO	
Evidence of rilling or gullying	YES	NO	
Observance of accumulated sediment	YES	NO	

STORMWATER INSPECTION & MAINTENANCE LOG

254, 256 & 260 Ayer Road, Littleton, MA & 0 Littleton Road, Ayer, MA

Bottom dewaters between storms	YES	NO	
Standing water or wet spots	YES	NO	
Tree growth	YES	NO	
Other (specify)	YES	NO	
Stone Outlet Aprons/Weirs			
Inlet/ inflow pipe clear of debris	YES	NO	
Overflow spillway clear of debris	YES	NO	
Evidence of rilling or gullying	YES	NO	
Tree growth	YES	NO	
Other (specify)	YES	NO	

NOTE: Photos shall be provided with each inspection log and shall be sufficiently labeled to identify photo location.

SECTION 6 DE-ICING LOG

Deicing Log

Date Applied	Type of Deicing Material	Amount Applied

XERXES®

HydroChain™ Triton Chamber Main Header Row Manual

Operation & Maintenance

INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The Main Header Row™ is a patent pending technique to cost-effectively enhance total suspended solids removal and provide easy access for inspection and maintenance.

MAIN HEADER ROW™

The Main Header Row is comprised of a row of any chambers that sit upon the woven geotextile barrier (see **Figure 1**) or sediment floor is connected to a closely located manhole for easy access.

At the end of the Main Header Row there can be an optional Sump Basin Assembly (shown as item 3 in **Figure 2**) to help collect and contain any sediment that will be flushed out of the Main Header Row during a rain event or during a maintenance cleaning. The sump basin assembly can then be accessed from above via a manhole or up to a 33" diameter stand pipe.

The Main Header Row feeds the distribution rows (shown as item 4 in **Figure 2**) via a feed or distribution pipe. The Feed pipe is at an elevated invert height so the water in the Main Header Row has to rise to this invert height before flowing into the distribution rows thus capturing the sediments in the Main Header Row. The Main Header Row is then protecting the distribution chamber row storage areas of any sediment accumulation. This allows for preserving the infiltration rate of the area where the distribution rows are installed thus allowing the system to perform at the rate that the system was designed for. The geotextile barrier or sediment floor is designed to prevent scouring of the underlying stone and to collect sediments from infiltrating into the ground under the Main Header Row. The geotextile barrier or sediment floor is installed with the chambers so they will remain intact during very high flow events and during high pressure cleaning.

The Main Header Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow-rate basis. An upstream manhole not only provides access to the Main Header Row but typically includes a high flow outlet such that stormwater flow rates or volumes that exceed the capacity of the Main Header Row can overflow into the surrounding stone and/or discharge through a manifold to the other chambers.

The Main Header Row may also be part of a treatment train. By treating stormwater prior to entry into the Main Header Row system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pretreatment best management practices can be as simple as deep sump catch basins, oil-water separators

Figure 1.

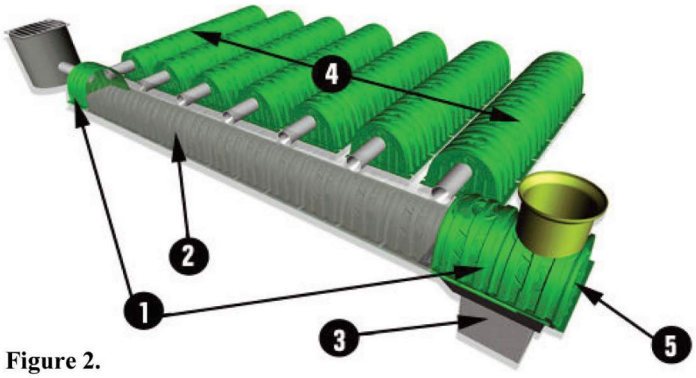


Figure 2.

or can be innovative stormwater treatment devices.

The design of the treatment train and selection of pretreatment devices by the design engineer are often driven by regulatory requirements. Whether pretreatment is used or not, the Main Header Row is recommended as an effective means to minimize maintenance requirements and maintenance costs.

TREATMENT TRAIN INSPECTION AND MAINTENANCE

We recommend treatment train inlet system has three tiers of treatment upstream of the chambers. It is recommended that inspection and maintenance (I&M) be initiated at the furthest upstream treatment tier and continue downstream as necessary. The following I&M procedures follow this approach providing I&M information in the following order:

Tier 1- Pretreatment (BMP)

Tier 2 - Main Header Row

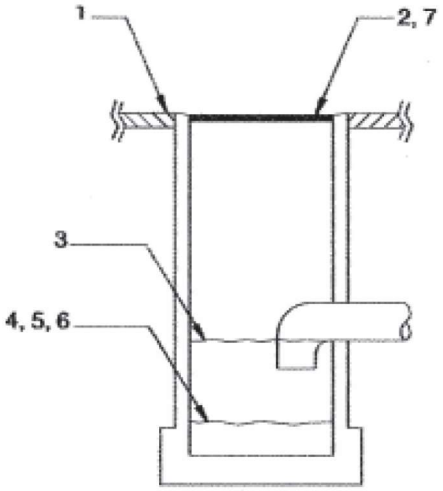
Tier 3 - Eccentric Pipe Header System – This option is not needed when using the chamber system because the Main Header Row eliminates the need for a pipe header system.

Catch Basin/Manholes I&M

Typically a stormwater system will have catch basins and manholes upstream of the detention/retention system. In some cases these may be the only pretreatment devices. Regular I&M of catch basins and manholes should be scheduled and performed as part of a site's routine maintenance plan.

Step-by-Step Maintenance Procedures

1). Inspect catch basins and manholes upstream of the chambers for sediment.
2). Remove grate or cover.
3). Skim off oils and floatables.
4). Using a stadia rod, measure the depth of sediment
5). If sediment is at a depth greater than 8" proceed to step 6. If not, proceed to step 7.
6). Vacuum or manually remove sediment .
7). Replace grate.
8). Record depth & date and schedule next inspection.



PreTreatment Device I&M

Manufacturer's I&M procedures should be followed for proprietary pretreatment devices such as baffle boxes, swirl concentrators, oil-water separators, and filtration units. Table below provides some general guidelines but is not a substitute for a manufacturer's specific instructions.

SEDIMENT CONTROL INSPECTION	INSPECTION*	MAINTENANCE**
Main Header Row	Annually	JetVac-Culvert Cleaning Nozzle or High-Pressure Hose
Sediment Basin	Bi-Annually or after large storm event	Excavate sediment
Catch Basin Sump	Bi-Annually	Excavate, pump or vacuum
Sediment Structure	Bi-Annually	Excavate, pump or vacuum
Catch Basin Filter Bags	After all storm events	Clean and/or replace filter bags
Porous Pavement	Quarterly	Sweep Pavement
Pipe Header Design	Quarterly	Excavate, pump or vacuum
Water Quality Inlet	Quarterly	Excavate, pump or vacuum
Filter Pucks	Bi-Annually	Clean and/or replace filter media in pucks

Main Header Row™ Inspection

The frequency of Inspection and maintenance varies by loca-tion. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc., all play a critical role in determining the actual frequency of inspection and maintenance practices.

At a minimum, we recommend annual inspections. The Main Header Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sedi-ment deposition.

The Main Header Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 8" inches in the bottom of the Sump Basin and or if there is 3" throughout the length of the Main Header Row, clean-out of the Sump Basin and Main Header Row should be performed.

Main Header Row™ Maintenance

The Main Header Row was designed to reduce the cost of periodic maintenance. By confining sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the Main Header Row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined-space entries. The inside dimensions of the Main Header Row Chambers are 34” tall by 48” wide.

Maintenance is accomplished by removing the sediment that has built up in the Sump Basin by using a standard vacuum truck as shown to the right. The Main Header Row sys-tem was designed to allow for easy access to the Sump Basin via a manhole/inspection port up to a 33” diameter pipe. There is no need for a special process to clean out the Sump Basin and the Main Header Row but they can be cleaned using a JetVac process or can be cleaned by using a water tank truck or fire truck equipped with a hose to flush the sediment to the Sump Basin if so desired. To use a water tanker or fire truck simply insert the hose into the upstream catch basin struc-ture and flush the sediment to the end of the main header row where the Sump Basin is located. If the Sump Basin is located close to the inlet, then vacuum out the sediment first and then back flush the Main Header Row back into the Sump Basin.

NOTE: The JetVac or high-pressure hose process shall only be performed on the Main Header Row where the woven geotextile barrier or sediment floor has been installed and only if there is 3” of sediment throughout the length of the Main Header Row.

XERXES HydroChain™ Triton Chamber Main Header Row O&M Manual

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Main Header Row™ Step-by-Step Maintenance Procedures

Step 1. Inspect Sump Basin and Main Header Row for Sediment

A. Inspection ports (if present)

- **i.** Remove lid from floor box frame.
- **ii.** Remove cap from inspection riser.
- **iii.** Using a flashlight and stadia rod, measure depth of sediment in the Sump Basin and record results on maintenance log.
- **iv.** If sediment is at or above 11-inch depth, proceed to Step 2. If not, proceed to step 3.

B. All Main Header Rows

- **i.** Remove cover from manhole at upstream end of Main Header Row.
- **ii.** Using a flashlight, inspect the Main Header Row through outlet pipe and through each distribution pipe that is connected in between the Main Header Row and the distribution row of chambers.
- **iii.** If sediment is at or above the 11" mark in the sump bin, proceed to Step 2.

1. Be sure to have proper footing when entering into Main Header Row.

2. Follow OSHA regulations for confined space entry if entering Main Header Row. If not, proceed to Step 3.

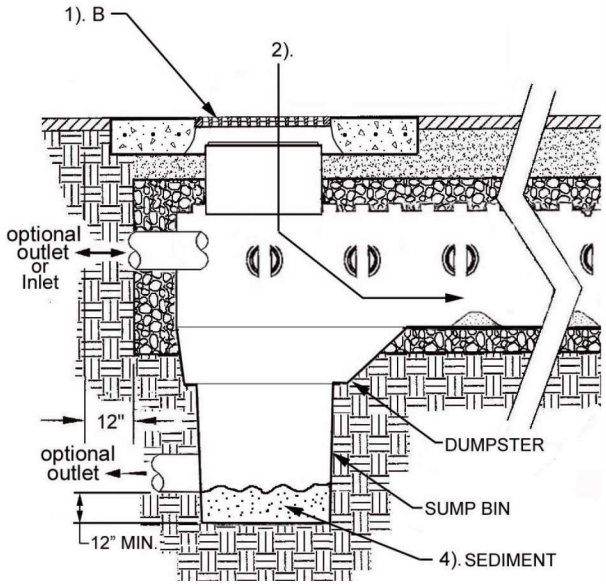
Step 2. Clean out the Sump Basin with a vacuum truck

A. Remove any secondary filtration media that may be installed in the sump basin.

B. Vacuum Sump Basin as required.

Step 3. Replace all caps, lids, and covers. Record observations and actions.

Step 4. Inspect & clean catch basins and manholes upstream of the chamber system.



Sample

Date	Stadia Rod Readings		Sediment Depth (1)-(2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to chamber top (2)			
4/11/2007	9.7 ft.	None		New installation. Fixed point is J1 frame at grade	KET
10/21/2007		9.6	0.1 ft.	Very little sediment in system - No maintenance required	GKT
4/11/2008		9.4	0.3 ft.	Very little sediment in system - No maintenance required	CMM
7/25/2009		9.1	0.6 ft.	Some debris/sediment is visible in sump basin assembly but not interfering with outlet	LEJ
7/20/2010		8.7	1.0 ft.	Some debris/sediment is visible in sump basin assembly - maintenance is due	DLC
8/20/2010	9.7 ft.		0	System has cleaned and vacuumed - very easy system to clean	NAT

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watersales@shawcor.com

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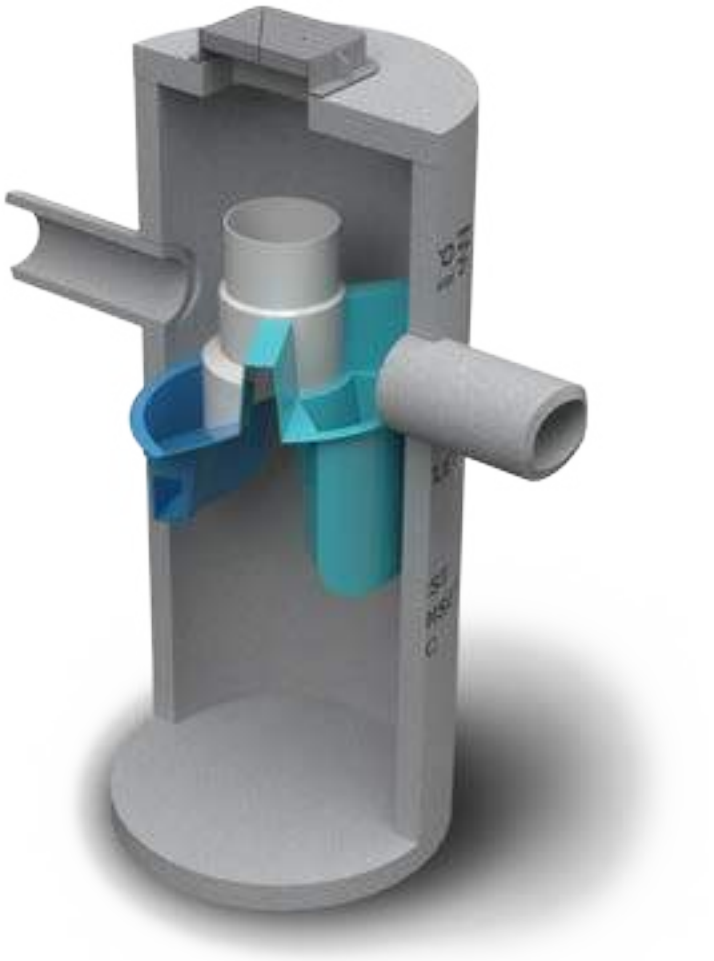
XERXES®

Hydro International



Operation and Maintenance Manual

First Defense® and First Defense® High Capacity

Vortex Separator for Stormwater Treatment

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Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Hydro Maintenance Services

Hydro International has been engineering stormwater treatment systems for over 30 years. We understand the mechanics of removing pollutants from stormwater and how to keep systems running at an optimal level.

Nobody Knows our Systems Better than we do

Avoid Service Negligence

Sanitation services providers not intimately familiar with stormwater treatment systems are at risk of the following:

- Inadvertently breaking parts or failing to clean/replace system components appropriately.
- Charging you for more frequent maintenance because they lacked the tools to service your system properly in the first place.
- Billing you for replacement parts that might have been covered under your Hydro warranty plan
- Charging for maintenance that may not yet have been required.

Leave the Dirty Work to us

Trash, sediment and polluted water is stored inside treatment systems until they are removed by our team with a vactor truck. Sometimes teams must physically enter the system chambers in order to prepare the system for maintenance and install any replacement parts. Services include but are not limited to:

- Solids removal
- Removal of liquid pollutants
- Replacement media installation (when applicable)

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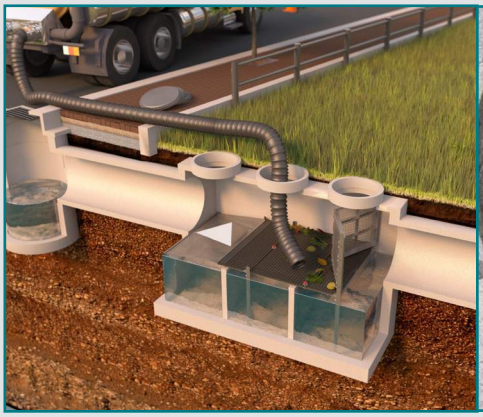
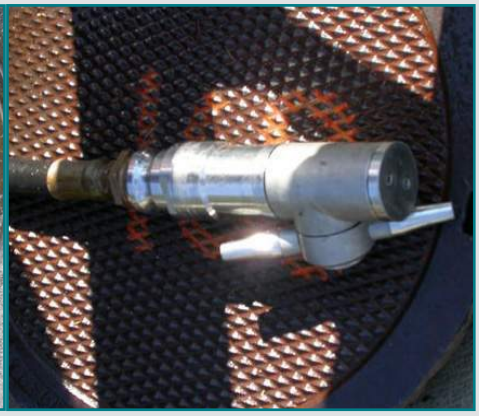
Better Tools, Better Results

Not all vactor trucks are created equal. Appropriate tools and suction power are needed to service stormwater systems appropriately. Companies who don't specialize in stormwater treatment won't have the tools to properly clean systems or install new parts.





Service Warranty

Make sure you're not paying for service that is covered under your warranty plan. Only Hydro International's service teams can identify tune-ups that should be on us, not you.

Treatment Systems Serviced by Hydro:

- Stormwwater filters
- Stormwater separators
- Baffle boxes
- Biofilters/biorention systems
- Storage structures
- Catch basins
- Stormwater ponds
- Permeable pavement

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I. First Defense® by Hydro International

Introduction

The First Defense® is an enhanced vortex separator that combines an effective and economical stormwater treatment chamber with an integral peak flow bypass. It efficiently removes total suspended solids (TSS), trash and hydrocarbons from stormwater runoff without washing out previously captured pollutants. The First Defense® is available in several model configurations (refer to *Section II. Model Sizes & Configurations*, page 4) to accommodate a wide range of pipe sizes, peak flows and depth constraints.

Operation

The First Defense® operates on simple fluid hydraulics. It is self-activating, has no moving parts, no external power requirement and is fabricated with durable non-corrosive components. No manual procedures are required to operate the unit and maintenance is limited to monitoring accumulations of stored pollutants and periodic clean-outs. The First Defense® has been designed to allow for easy and safe access for inspection, monitoring and clean-out procedures. Neither entry into the unit nor removal of the internal components is necessary for maintenance, thus safety concerns related to confined-space-entry are avoided.

Pollutant Capture and Retention

The internal components of the First Defense® have been designed to optimize pollutant capture. Sediment is captured and retained in the base of the unit, while oil and floatables are stored on the water surface in the inner volume (Fig.1).

The pollutant storage volumes are isolated from the built-in bypass chamber to prevent washout during high-flow storm events. The sump of the First Defense® retains a standing water level between storm events. This ensures a quiescent flow regime at the onset of a storm, preventing resuspension and washout of pollutants captured during previous events.

Accessories such as oil absorbent pads are available for enhanced oil removal and storage. Due to the separation of the oil and floatable storage volume from the outlet, the potential for washout of stored pollutants between clean-outs is minimized.

Applications

- Stormwater treatment at the point of entry into the drainage line
- Sites constrained by space, topography or drainage profiles with limited slope and depth of cover
- Retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line
- Pretreatment for filters, infiltration and storage

Advantages

- Inlet options include surface grate or multiple inlet pipes
- Integral high capacity bypass conveys large peak flows without the need for “offline” arrangements using separate junction manholes
- Proven to prevent pollutant washout at up to 500% of its treatment flow
- Long flow path through the device ensures a long residence time within the treatment chamber, enhancing pollutant settling
- Delivered to site pre-assembled and ready for installation

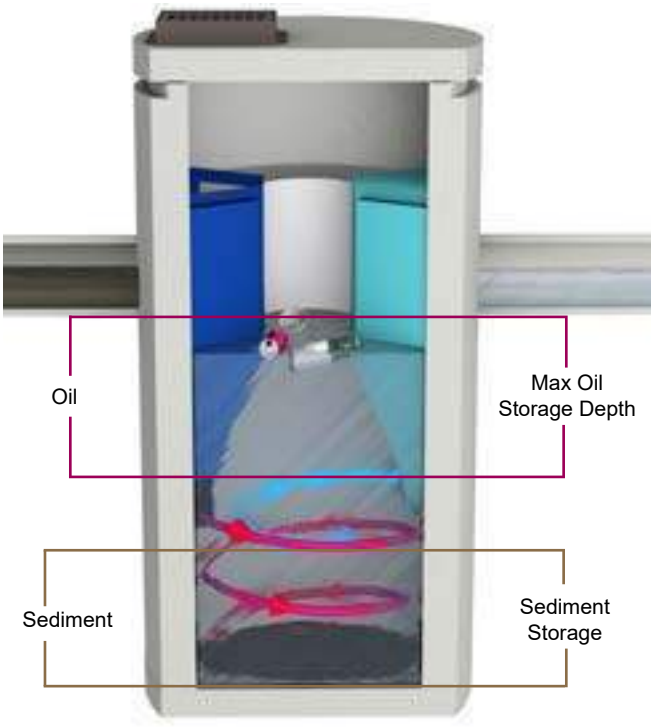

Fig.1 Pollutant storage volumes in the First Defense®.

II. Model Sizes & Configurations

The First Defense® inlet and internal bypass arrangements are available in several model sizes and configurations. The components of the First Defense®-4HC and First Defense®-6HC have modified geometries as to allow greater design flexibility needed to accommodate various site constraints.

All First Defense® models include the internal components that are designed to remove and retain total suspended solids (TSS), gross solids, floatable trash and hydrocarbons (Fig.2a - 2b). First Defense® model parameters and design criteria are shown in Table 1.

First Defense® Components

1. **Built-In Bypass**
2. **Inlet Pipe**
3. **Inlet Chute**
4. **Floatables Draw-off Port**
5. **Outlet Pipe**
6. **Floatables Storage**
7. **Sediment Storage**
8. **Inlet Grate or Cover**

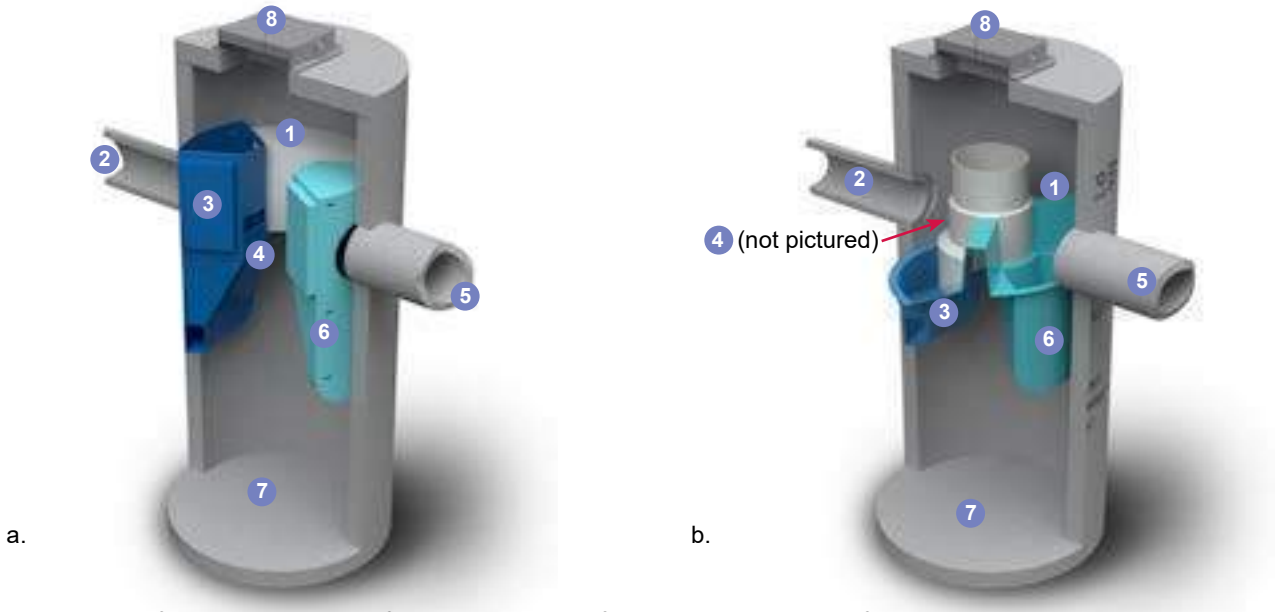

Fig.2a) First Defense®-4 and First Defense®-6; b) First Defense®-4HC and First Defense®-6HC, with higher capacity dual internal bypass and larger maximum pipe diameter.

First Defense® High Capacity Model Number	Diameter	Typical TSS Treatment Flow Rates		Peak Online Flow Rate	Maximum Pipe Diameter[1]	Oil Storage Capacity	Typical Sediment Storage Capacity[2]	Minimum Distance from Outlet Invert to Top of Rim[3]	Standard Distance from Outlet Invert to Sump Floor
		NJDEP Certified	106µm						
	(ft / m)	(cfs / L/s)	(cfs / L/s)	(cfs / L/s)	(in / mm)	(gal / L)	(yd^3 / m^3)	(ft / m)	(ft / m)
FD-3HC	3 / 0.9	0.84 / 23.7	1.60 / 45.3	15 / 424	18 / 457	125 / 473	0.4 / 0.3	2.0 - 3.5 / 0.6 - 1.0	3.71 / 1.13
FD-4HC	4 / 1.2	1.50 / 42.4	1.88 / 50.9	18 / 510	24 / 600	191 / 723	0.7 / 0.5	2.3 - 3.9 / 0.7 - 1.2	4.97 / 1.5
FD-5HC	5 / 1.5	2.34 / 66.2	2.94 / 82.1	20 / 566	24 / 609	300 / 1135	1.1 / .84	2.5 - 4.5 / 0.7 - 1.3	5.19 / 1.5
FD-6HC	6 / 1.8	3.38 / 95.7	4.73 / 133.9	32 / 906	30 / 750	496 / 1,878	1.6 / 1.2	3.0 - 5.1 / 0.9 - 1.6	5.97 / 1.8
FD-8HC	8 / 2.4	6.00 / 169.9	7.52 / 212.9	50 / 1,415	48 / 1219	1120 / 4239	2.8 / 2.1	3.0 - 6.0 / 0.9 -1.8	7.40 / 2.2

[1]Contact Hydro International when larger pipe sizes are required.
[2]Contact Hydro International when custom sediment storage capacity is required.
[3]Minimum distance for models depends on pipe diameter.

III. Maintenance

Overview

The First Defense® protects the environment by removing a wide range of pollutants from stormwater runoff. Periodic removal of these captured pollutants is essential to the continuous, long-term functioning of the First Defense®. The First Defense® will capture and retain sediment and oil until the sediment and oil storage volumes are full to capacity. When sediment and oil storage capacities are reached, the First Defense® will no longer be able to store removed sediment and oil. Maximum pollutant storage capacities are provided in Table 1.

The First Defense® allows for easy and safe inspection, monitoring and clean-out procedures. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables. Access ports are located in the top of the manhole.

Maintenance events may include Inspection, Oil & Floatables Removal, and Sediment Removal. Maintenance events do not require entry into the First Defense®, nor do they require the internal components of the First Defense® to be removed. In the case of inspection and floatables removal, a vactor truck is not required. However, a vactor truck is required if the maintenance event is to include oil removal and/or sediment removal.

Maintenance Equipment Considerations

The internal components of the First Defense®-HC have a centrally located circular shaft through which the sediment storage sump can be accessed with a sump vac hose. The open diameter of this access shaft is 15 inches in diameter (Fig.3). Therefore, the nozzle fitting of any vactor hose used for maintenance should be less than 15 inches in diameter.

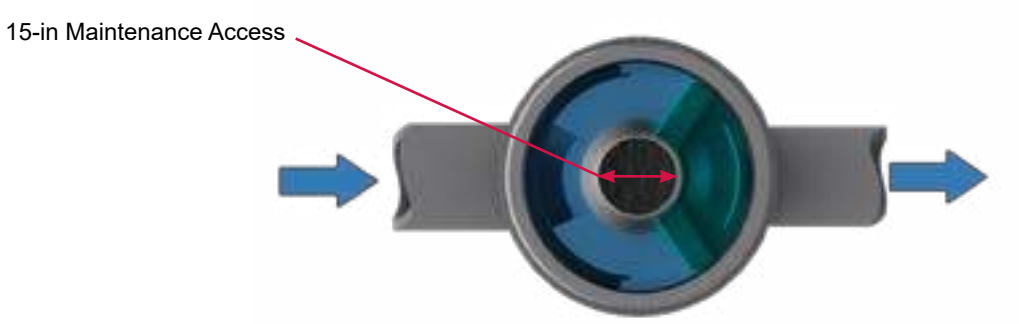

Fig.3 The central opening to the sump of the First Defense®-HC is 15 inches in diameter.

Determining Your Maintenance Schedule

The frequency of clean out is determined in the field after installation. During the first year of operation, the unit should be inspected every six months to determine the rate of sediment and floatables accumulation. A simple probe such as a Sludge-Judge® can be used to determine the level of accumulated solids stored in the sump. This information can be recorded in the maintenance log (see page 9) to establish a routine maintenance schedule.

The vactor procedure, including both sediment and oil / flotables removal, for a 6-ft First Defense® typically takes less than 30 minutes and removes a combined water/oil volume of about 765 gallons.

Inspection Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities. Fig.4 shows the standing water level that should be observed.

4. Without entering the vessel, use the pole with the skimmer net to remove floatables and loose debris from the components and water surface.

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel.

6. On the Maintenance Log (see page 9), record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components or blockages.

7. Securely replace the grate or lid.

8. Take down safety equipment.

9. Notify Hydro International of any irregularities noted during inspection.

Floatables and Sediment Clean Out

Floatables clean out is typically done in conjunction with sediment removal. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables (Fig.5).

Floatables and loose debris can also be netted with a skimmer and pole. The access port located at the top of the manhole provides unobstructed access for a vactor hose and skimmer pole to be lowered to the base of the sump.

Scheduling

- Floatables and sump clean out are typically conducted once a year during any season.

- Floatables and sump clean out should occur as soon as possible following a spill in the contributing drainage area.

Fig.4 Floatables are removed with a vactor hose (First Defense model FD-4, shown).

Recommended Equipment

- Safety Equipment (traffic cones, etc)
- Crow bar or other tool to remove grate or lid
- Pole with skimmer or net (if only floatables are being removed)
- Sediment probe (such as a Sludge Judge®)
- Vactor truck (flexible hose recommended)
- First Defense® Maintenance Log

Floatables and sediment Clean Out Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities.

4. Remove oil and floatables stored on the surface of the water with the vactor hose (Fig.5) or with the skimmer or net (not pictured).

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel and record it in the Maintenance Log (page 9).

6. Once all floatables have been removed, drop the vactor hose to the base of the sump. Vactor out the sediment and gross debris off the sump floor (Fig.5).

7. Retract the vactor hose from the vessel.

8. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components, blockages, or irregularly high or low water levels.

9. Securely replace the grate or lid.

Fig.5 Sediment is removed with a vactor hose (First Defense model FD-4, shown).

Maintenance at a Glance

Inspection	- Regularly during first year of installation - Every 6 months after the first year of installation
Oil and Floatables Removal	- Once per year, with sediment removal - Following a spill in the drainage area
Sediment Removal	- Once per year or as needed - Following a spill in the drainage area
NOTE: For most clean outs the entire volume of liquid does not need to be removed from the manhole. Only remove the first few inches of oils and floatables from the water surface to reduce the total volume of liquid removed during a clean out.	

First Defense® Installation Log

HYDRO INTERNATIONAL REFERENCE NUMBER:	
SITE NAME:	
SITE LOCATION:	
OWNER:	CONTRACTOR:
CONTACT NAME:	CONTACT NAME:
COMPANY NAME:	COMPANY NAME:
ADDRESS:	ADDRESS:
TELEPHONE:	TELEPHONE:
FAX:	FAX:

INSTALLATION DATE: / /

MODEL SIZE (CIRCLE ONE): **FD-4** **FD-4HC** **FD-6** **FD-6HC**

INLET (CIRCLE ALL THAT APPLY): **GRATED INLET (CATCH BASIN)** **INLET PIPE (FLOW THROUGH)**

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First Defense® Inspection and Maintenance Log

Date	Initials	Depth of Floatables and Oils	Sediment Depth Measured	Volume of Sediment Removed	Site Activity and Comments

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