Stormwater Management Report

For:

AnyFence Co.
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Holliston, MA 01746

Prepared by:

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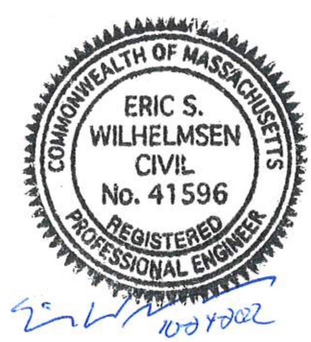
Report Preparation Date:

8/9/2022
Revised: October 12, 2022



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STORMWATER REPORT 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.

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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.

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[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

COMMONWEALTH OF MASSACHUSETTS
ERIC S. WILHELMSEN
CIVIL
No. 41596
REGISTERED PROFESSIONAL ENGINEER

8/10/2022
Signature and Date

Checklist

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

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

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

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

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

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

☐ is within the Zone II or Interim Wellhead Protection Area

☐ is near or to other critical areas

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

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

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

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

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☒ An Illicit Discharge Compliance Statement is attached;

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

REPORT SUMMARY

REPORT SUMMARY:

<u>Calculation Objectives</u>:
The objective of these calculations is to demonstrate design compliance with DEP's Stormwater Management regulations, the Town of Holliston, and the Massachusetts Stormwater Handbook requirements for water quantity and water quality objectives. Drainage area maps have been incorporated into this report to depict proposed watershed areas.

<u>Calculation Methods</u>:
- TR55/TR20 methodology utilizing HydroCAD software by Applied Microcomputer Systems
- DEP Stormwater Management Handbook for Water Quality Calculations / TSS Removal

<u>Sources of Data</u>:
- Technical Report No. 20
- Technical Report No. 55 and the Massachusetts Supplement for TR-55
- Technical Paper No. 40
- "Custom Soil Resource Report for, Nantucket County Massachusetts" by the Natural Resources Conservation Service (NRCS).
- "Massachusetts Stormwater Handbook" – Revised February 2008, by the Massachusetts Department of Environmental Protection (MADEP)
- NOAA atlas 14 point Precipitation Frequency Estimates
- "Stormwater Management and Land Disturbance Regulations" – Adopted on May 20, 2021, by Holliston Planning Board.

<u>Selection of Storm Events:</u>
The NOAA atlas 14 point rainfall data for the Type III, 24-hour storm events are as follow:

Frequency (Years)	Rainfall (Inches)
2	3.38
10	5.27
25	6.45
50	7.32
100	8.27

The time of concentration (Tc) for each watershed was calculated utilizing SCS TR-55 and the Massachusetts supplement. If the calculated Tc resulted in a time of less than 0.1 hours (6 minutes), then a direct entry of 6 minutes was used in the calculations.

Existing Conditions Overview:
The AnyFence Co. is located at 42°10'53.5" N and 71°26'50.7" W on the north side of Washington Street in Holliston, MA. The property is in the industrial zoning district and is encompassed by wetlands on the north and west, a vacant lot on the east, and Washington Street on the south.

The topography of the site consists mostly of shallow slopes, with steeper slopes along the wetland delineation. The surface runoff from the site flows directly to the wetlands.

Soil Descriptions:
Existing soil conditions have been characterized by the Middlesex County Soil Survey Report. The soils have been assigned a Hydrologic Soil Grouping (HSG) by NRCS. The soil boundaries depicted on the soil maps are as follows.

Map Unit	NRCS Soil Map Unit Description	Hydrologic Soil Group (HSG) Rating
73B	Whitman fine sandy loam, 0 to 3% slopes, extremely stony	D
106C	Narragansett-Hollis-Rock outcrop complex, 3 to 15% slopes	A
654	Udorthents, loamy	A*

The site is primarily within the 654 soil area, surrounded by the 106C soil area and a small portion of the 73B soil along the wetlands. The soil types in the general vicinity are in hydrological group A, which will be used for groundwater recharge and quality calculations. A soil test pit was conducted in the general area of the proposed undergrounds stormwater chambers, and confirmed the presence of a loamy sand, see the soil logs included with the soil maps.

Existing Subcatchments:
The existing site has been analyzed using two Analysis Points (DP-1e and DP-2e), located on the north and southwest of the site on the wetland, respectively. The site has been divided into three sub-watershed areas, as follows:

Subcatchments to DP-1e

E-1A: This watershed contains the rear left portion of the site. It consists of the gravel area adjacent to the building, the warehouse roof, and wooded area. Runoff from this area sheet flows directly to the wetlands.

E-1B: This watershed is comprised of the rear right area of the site. It consists of the roof of the front building, gravel area behind the building and wooded area along the north and east sides. Runoff from this area sheet flows north directly to the wetlands.

Subcatchment to DP-2e

E-2: This watershed contains the front area of the site. It consists of gravel, grassed and wooded areas, as well as the paved driveways. Runoff from this area sheet flows west directly to the wetlands.

Analysis Point	**Summary of Existing Stormwater Conditions (cfs)**				
Peak Flow	**2 Yr.**	**10 Yr.**	**25 Yr.**	**50 Yr.**	**100 Yr.**
DP-1e	1.1	2.5	3.4	4.0	4.8
DP-2e	1.0	2.2	3.0	3.5	4.2

Proposed Conditions Overview:

Under proposed conditions, a second story addition will be added to the front building and improvements will be made to the front parking pavement and driveways, including the removal of the gravel island and existing pavement, placement of a new bituminous concrete surface and stripping of parking spaces. A drainage system comprised of a water quality structure (Stormceptor) with grate as an inlet and underground chambers will be provided to mitigate the increase in imperviousness due to the removal of the gravel island and small grassed areas to accommodate the proposed entry radii of the driveways.

Proposed Subcatchments:

The proposed site analysis uses the same Analysis Points described under existing conditions (DP-1p and DP-2p). The contributing watershed areas have been broken down into multiple watersheds, designating individual flow areas draining to proposed stormwater controls or directly to the analysis point.

Subcatchments to DP-1p

P-1a: This watershed consists of the rear left portion of the site similar to the existing subcatchment E-1a.

P-1b: This watershed consists of the rear right portion of the site similar to the existing subcatchment E-1b.

Subcatchments to DP-2p

P-2a: This watershed sheet flows to the road, and then through the grass roadway shoulder and eventually directly to the wetland. It contains Washington Street, a portion of the gravel, and wooded areas.

P-2b: This watershed flows to the stormceptor that directs the water to the underground infiltration chambers. It is comprised of the parking pavement, with sections of gravel, grass, and small wooded areas.

Analysis Point	**Summary of Proposed Stormwater Conditions (cfs)**				
Peak Flow	**2 Yr.**	**10 Yr.**	**25 Yr.**	**50 Yr.**	**100 Yr.**
DP-1p	1.1	2.5	3.4	4.0	4.8
DP-2p	1.0	2.1	2.8	3.3	3.9

STORMWATER MANAGEMENT STANDARDS

STORMWATER MANAGEMENT STANDARDS

Project Narrative:

The subject project is comprised of a property currently owned by AnyFence located in Holliston, MA. The project includes the construction of a second story addition to the front building, removal and repaving of the existing front pavement and gravel island, as well as the installation of new drainage structures.

Developmental Measures:

The stormwater mitigation proposed is comprised of a water quality structure, underground infiltration chambers, two drain manholes, and an outlet structure, to capture the surface runoff from the impervious surfaces and infiltrate into the ground on-site. Runoff from the redeveloped site is less than or equal to existing conditions.

Standard #1: No New Untreated Discharges or Erosion to Wetlands

Developmental Measures:

The proposed storm water management system has been designed to collect runoff from paved areas and provide water quality treatment of storm water prior to infiltration or discharge into the wetland. Runoff from the redeveloped site is less than or equal to existing conditions.

Standard #2: Peak Rate Attenuation

Summary of Computations:

For all storms studied there is no increase in peak runoff rates at any analysis point under developed conditions. Reduction or maintenance of peak rates at the analysis points can be attributed to the direct mitigation provided by the proposed underground infiltration system. The following table summarizes the peak rates of runoff for all analyzed storm events at each design point for both existing and proposed conditions:

Design Point	**Summary of Peak Stormwater Conditions: (CFS)**									
Peak Flow	**2 Yr.**		**10 Yr.**		**25 Yr.**		**50 Yr.**		**100 Yr.**	
	Exist	Prop.	Exist	Prop.	Exist	Prop.	Exist	Prop.	Exist	Prop.
DP-1	1.1	1.1	2.5	2.5	3.4	3.4	4.0	4.0	4.8	4.8
DP-2	1.0	1.0	2.2	2.1	3.0	2.8	3.5	3.3	4.2	3.9

Standard #3: Recharge

At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions. The intent of this standard is to ensure that the infiltration volume of precipitation into the ground under post-development conditions is at least as much as the infiltration volume under pre-development conditions.

Required Recharge Volume:

R_V = (F) * (Proposed Impervious Area)
R_V = Required Recharge Volume, expressed in Ft^3, cubic yards, or acre-feet
F = 0.60-inch (100% group A soils), Target Depth Factor associated with each Hydrologic Soil Group

Post Construction Impervious Area (Parking Lot and Driveways) = 9,286 sq.ft.

Total Recharge = 0.60-Inch * 1/12 Ft/inch * 9,286 SF = 465 CF

Required Recharge Volume:

<u>Underground Infiltration Chambers (UGI)</u>
Outlet Grate Elevation = 261.10
Total Recharge Volume Provided to elevation 261.10 = 878 CF → (HydroCAD Report)

<u>Drawdown within 72 Hours</u>

$$Time_{drawdown} = \frac{Rv}{(K)(BottomArea)}$$

Rv = Storage Volume, maximum storage volume
K = Saturated Hydraulic Conductivity (2.41 in/hr)
Bottom Area = Bottom Area of Recharge Structure

$Time_{drawdown}$ UGI = 878 CF / (2.41 in/hr * 1/12 ft/in * 362 sq.ft.) = 12.1 hrs

<u>Standard #4: Water Quality</u>

Required Water Quality Volume:

V_{WQ} = (D_{WQ}/12 inches/foot) * (A_{IMP})
V_{WQ} = *Required Water Quality Volume* (in cubic feet)
D_{WQ} = Water Quality Depth: one-inch for discharges within a Zone II or Interim Wellhead Protection Area, to or near another critical area, runoff from a LUHPPL, or exfiltration to soils with infiltration rate greater than 2.4 inches/hour or greater; ½-inch for discharges near or to other areas.
A_{IMP} = Impervious Area (in square feet)

Total Impervious Area: 9,286 sq.ft.
Required WQV = 1.0-Inch * 1/12 Ft/inch * 9,286 SF = 774 CF

Required Retained Volume for Removal of Total Suspended Solids (TSS) and Total Phosphorus (TP) – Holliston Planning Board Stormwater Management and Land Disturbance Regulations (Redevelopment)

V_{TSS+TP} = 0.8-Inch * 1/12 Ft/Inch * Post-Construction Impervious Area
Post Construction Impervious Area (Parking Lot and Driveways) = 9,286 sq.ft.
V_{TSS+TP} = 0.8-Inch * 1/12 Ft/Inch * 9,286 = 619 CF
Required WQV= 774 CF > 619 CF

Per MassDEP Conversion of WQV to a Water Quality Peak Flow Rate:
WQF = (qu)(A)(WQV)
qu = unit peak discharge, in csm/in
A = impervious surface drainage area (in square miles)

qu = 774 csm/in (Based on Tc=0.1 hr)
A= 9,286 sq.ft. = 0.21 acres
WQF = (774 csm/in)(0.21 acres)(0.0015625 mi^2/acre)(1-in)
WQF = 0.26 cfs

Per the Brief Stormceptor Sizing Report, use one STC 450i, 90% TSS Removal.

Treatment Train
The runoff from the parking pavement, grass, and gravel areas is captured by stormceptor and then discharged to the underground infiltration system comprised of chambers. See TSS calculation sheet for the treatment train and percent removal efficiencies. The stormceptor is sized based on a flow rate, providing the required pretreatment of 44% TSS removal for soils with high infiltration rates, as well as the required Total Phosphorus (TP) and Total Suspended Solids (TSS) removal based on the Holliston Planning Board Stormwater Management and Land Disturbance Regulations for a Redevelopment.

Standard #5: Land Uses with Higher Potential Pollutant Loads
This project does not have a land use with a higher potential pollutant loads.

Standard #6: Critical Areas
This site is not a Zone II wellhead protection area as shown on the Massachusetts GIS maps. The open water portion of the wetland is designated as a potential vernal pool by NHESP, making the site to discharge to a potential critical area. A stormceptor is provided to meet at least 44% TSS removal prior to discharge to the infiltration structure, and it was sized based on a water quality flow rate conversion of the water quality depth of 1” required for soils with a rapid infiltration rate.

Standard #7: Redevelopment
This project is a redevelopment project of the existing pavement area and driveways. The proposed project meets all the stormwater standards. A Source Control and Pollution Prevention Plan, Construction Period Pollution Prevention and Erosion and Sedimentation

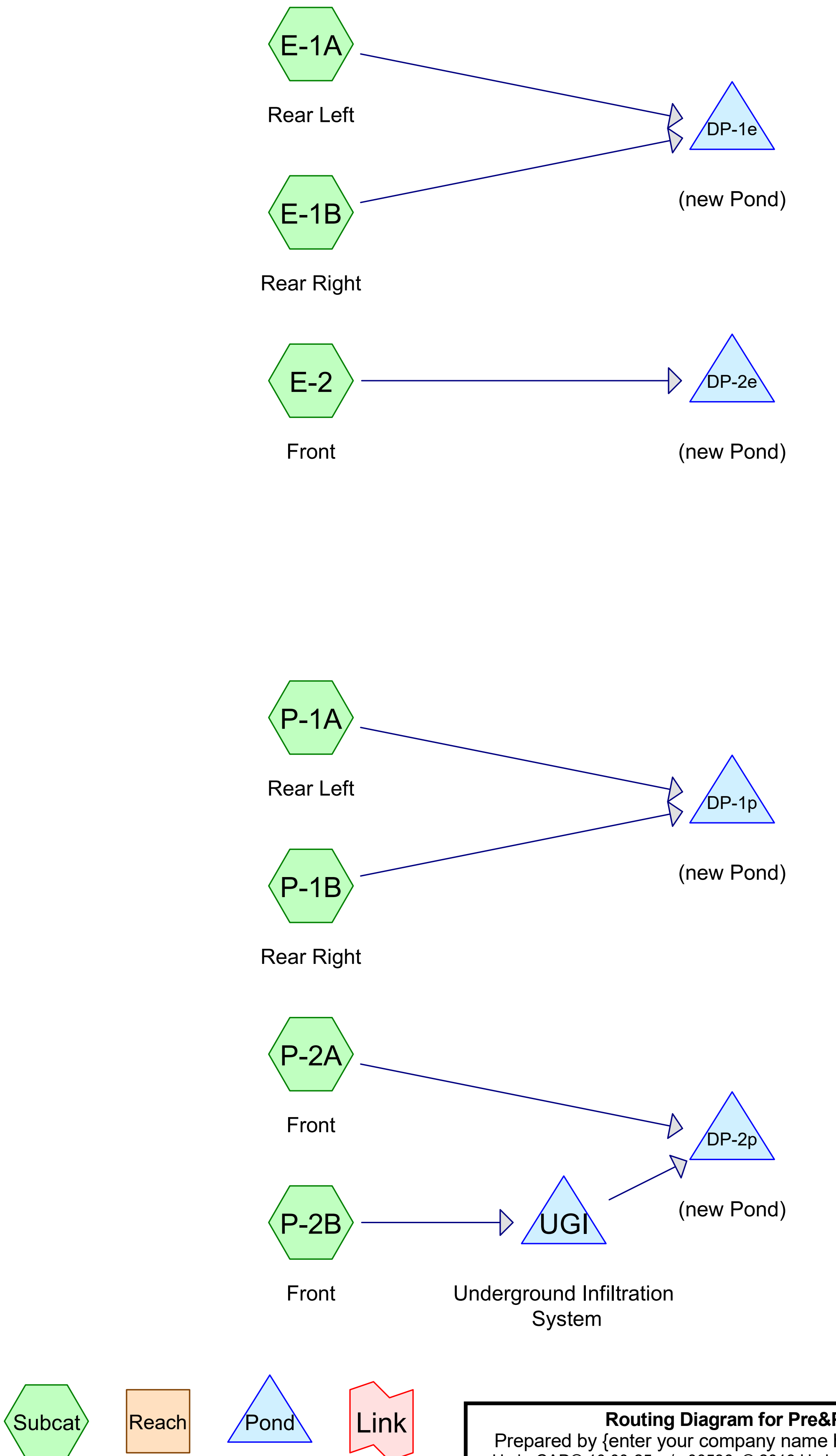
Control Plan, has been incorporated into this report. An Illicit Discharge Compliance Statement can be found in Standard 10.

Standard #8: Construction Period Pollution Prevention and Erosion and Sediment Control
A Construction Period Pollution Prevention and Sedimental Control Plan is provided on the site plans, including erosion control barrier locations and construction notes. A Long Term Pollution Prevention Plan is included in Attachment A.

Standard #9: Operation and Maintenance Plan
An Operations & Maintenance plan has been provided in Attachment B. The contractor(s) is responsible for stormwater system operation and maintenance during construction; and the owner, after acceptance of the installation, will be the party responsible for the storm water system operation and maintenance.

Standard #10: Illicit Discharges
A signed Illicit Discharge Compliance Statement is provided in Attachment C.

SUPPORTING CALCULATIONS



Routing Diagram for Pre&Post flow R3
Prepared by {enter your company name here}, Printed 10/21/2022

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.086	68	<50% Grass cover, Poor, HSG A (E-2, P-2A, P-2B)
0.786	96	Gravel surface, HSG A (E-1A, E-1B, E-2, P-1A, P-1B, P-2A, P-2B)
0.601	98	Paved parking, HSG A (E-2, P-2A, P-2B)
0.436	98	Roofs, HSG A (E-1A, E-1B, P-1A, P-1B)
0.885	36	Woods, Fair, HSG A (E-1A, E-1B, E-2, P-1A, P-1B, P-2A, P-2B)
2.794	**77**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
2.794	HSG A	E-1A, E-1B, E-2, P-1A, P-1B, P-2A, P-2B
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
2.794		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.086	0.000	0.000	0.000	0.000	0.086	<50% Grass cover, Poor	E-2, P-2A, P-2B
0.786	0.000	0.000	0.000	0.000	0.786	Gravel surface	E-1A, E-1B, E-2, P-1A, P-1B, P-2A, P-2B
0.601	0.000	0.000	0.000	0.000	0.601	Paved parking	E-2, P-2A, P-2B
0.436	0.000	0.000	0.000	0.000	0.436	Roofs	E-1A, E-1B, P-1A, P-1B
0.885	0.000	0.000	0.000	0.000	0.885	Woods, Fair	E-1A, E-1B, E-2, P-1A, P-1B, P-2A, P-2B
2.794	**0.000**	**0.000**	**0.000**	**0.000**	**2.794**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment E-1A: Rear Left Runoff Area=11,939 sf 58.84% Impervious Runoff Depth=1.54"
Tc=6.0 min CN=80 Runoff=0.5 cfs 0.035 af

Subcatchment E-1B: Rear Right Runoff Area=21,110 sf 11.67% Impervious Runoff Depth=1.16"
Tc=6.0 min CN=74 Runoff=0.6 cfs 0.047 af

Subcatchment E-2: Front Runoff Area=27,799 sf 43.96% Impervious Runoff Depth=1.41"
Tc=6.0 min CN=78 Runoff=1.0 cfs 0.075 af

Subcatchment P-1A: Rear Left Runoff Area=11,939 sf 58.84% Impervious Runoff Depth=1.54"
Tc=6.0 min CN=80 Runoff=0.5 cfs 0.035 af

Subcatchment P-1B: Rear Right Runoff Area=21,110 sf 11.67% Impervious Runoff Depth=1.16"
Tc=6.0 min CN=74 Runoff=0.6 cfs 0.047 af

Subcatchment P-2A: Front Runoff Area=14,503 sf 28.82% Impervious Runoff Depth=0.65"
Tc=6.0 min CN=64 Runoff=0.2 cfs 0.018 af

Subcatchment P-2B: Front Runoff Area=13,296 sf 73.71% Impervious Runoff Depth=2.62"
Tc=6.0 min CN=93 Runoff=0.9 cfs 0.067 af

Pond DP-1e: (new Pond) Inflow=1.1 cfs 0.082 af
Primary=1.1 cfs 0.082 af

Pond DP-1p: (new Pond) Inflow=1.1 cfs 0.082 af
Primary=1.1 cfs 0.082 af

Pond DP-2e: (new Pond) Inflow=1.0 cfs 0.075 af
Primary=1.0 cfs 0.075 af

Pond DP-2p: (new Pond) Inflow=1.0 cfs 0.035 af
Primary=1.0 cfs 0.035 af

Pond UGI: Underground Infiltration System Peak Elev=261.19' Storage=882 cf Inflow=0.9 cfs 0.067 af
Discarded=0.0 cfs 0.049 af Primary=0.8 cfs 0.017 af Outflow=0.9 cfs 0.066 af

Total Runoff Area = 2.794 ac Runoff Volume = 0.323 af Average Runoff Depth = 1.39"
62.88% Pervious = 1.757 ac 37.12% Impervious = 1.037 ac

Summary for Subcatchment E-1A: Rear Left

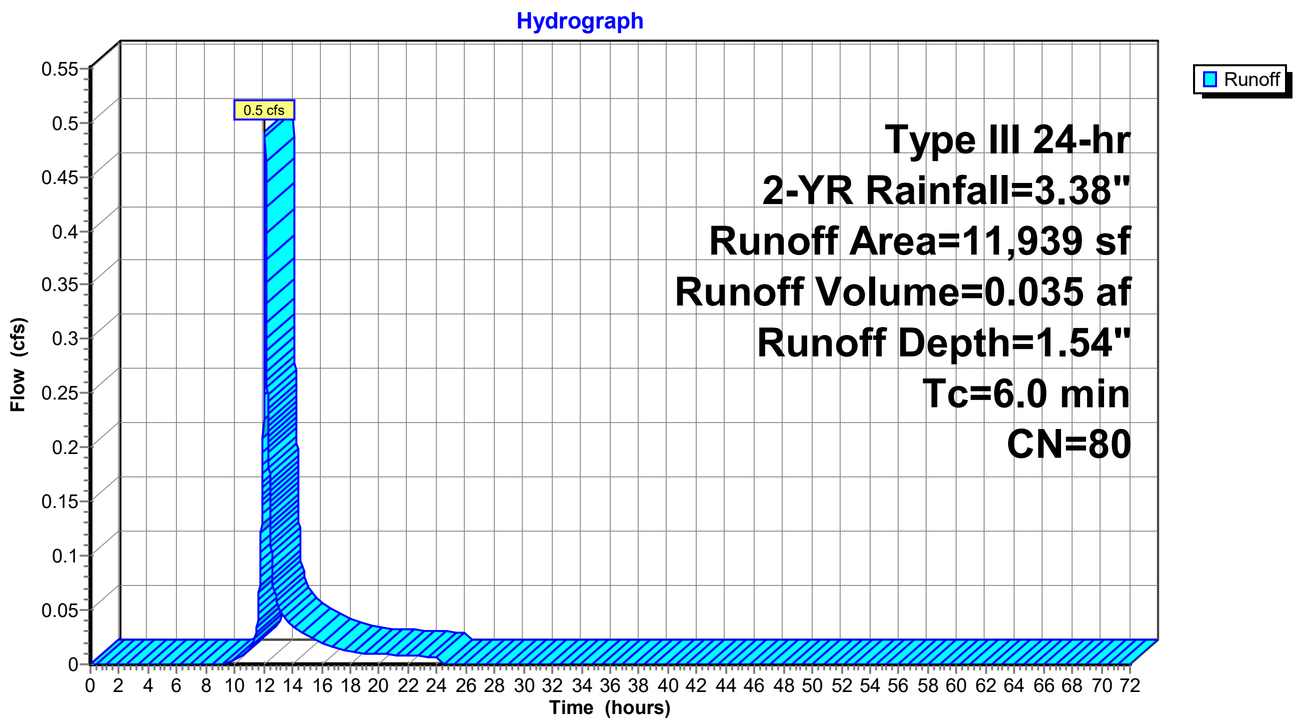
Runoff = 0.5 cfs @ 12.09 hrs, Volume= 0.035 af, Depth= 1.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-YR Rainfall=3.38"

Area (sf)	CN	Description
7,025	98	Roofs, HSG A
3,350	36	Woods, Fair, HSG A
1,564	96	Gravel surface, HSG A
11,939	80	Weighted Average
4,914		41.16% Pervious Area
7,025		58.84% Impervious Area

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

Subcatchment E-1A: Rear Left



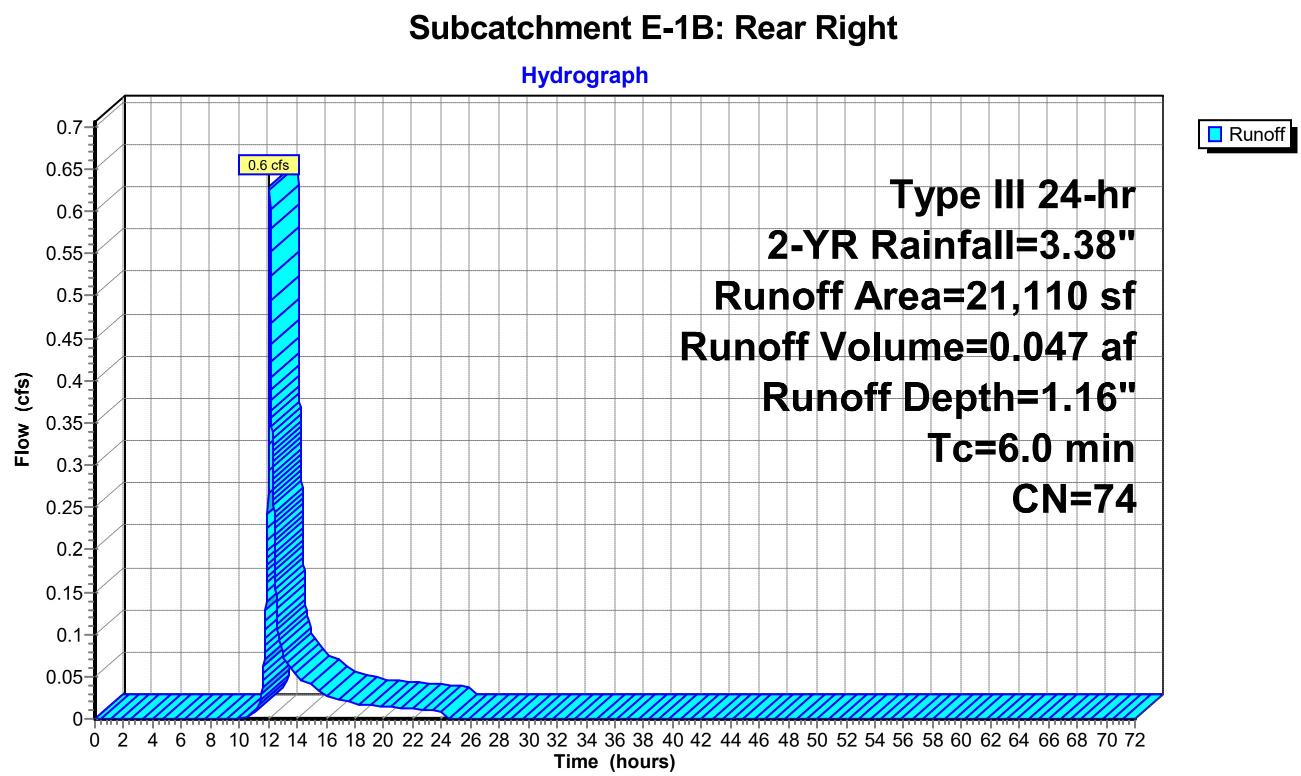
Summary for Subcatchment E-1B: Rear Right

Runoff = 0.6 cfs @ 12.09 hrs, Volume= 0.047 af, Depth= 1.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-YR Rainfall=3.38"

	Area (sf)	CN	Description
	2,463	98	Roofs, HSG A
	7,921	36	Woods, Fair, HSG A
	8,503	96	Gravel surface, HSG A
*	2,223	96	Gravel surface, HSG A
	21,110	74	Weighted Average
	18,647		88.33% Pervious Area
	2,463		11.67% Impervious Area

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



Summary for Subcatchment E-2: Front

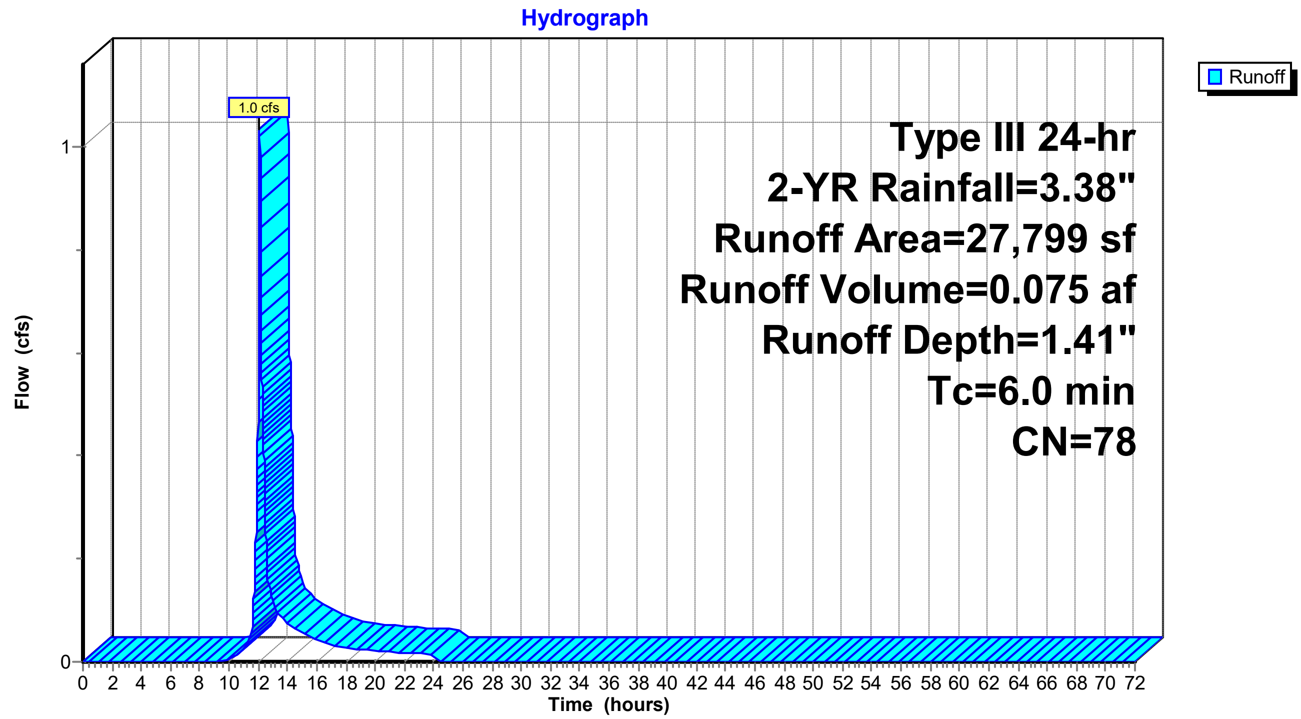
Runoff = 1.0 cfs @ 12.09 hrs, Volume= 0.075 af, Depth= 1.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-YR Rainfall=3.38"

	Area (sf)	CN	Description
	5,715	96	Gravel surface, HSG A
	12,220	98	Paved parking, HSG A
*	1,849	68	<50% Grass cover, Poor, HSG A
	8,015	36	Woods, Fair, HSG A
	27,799	78	Weighted Average
	15,579		56.04% Pervious Area
	12,220		43.96% Impervious Area

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

Subcatchment E-2: Front



Summary for Subcatchment P-1A: Rear Left

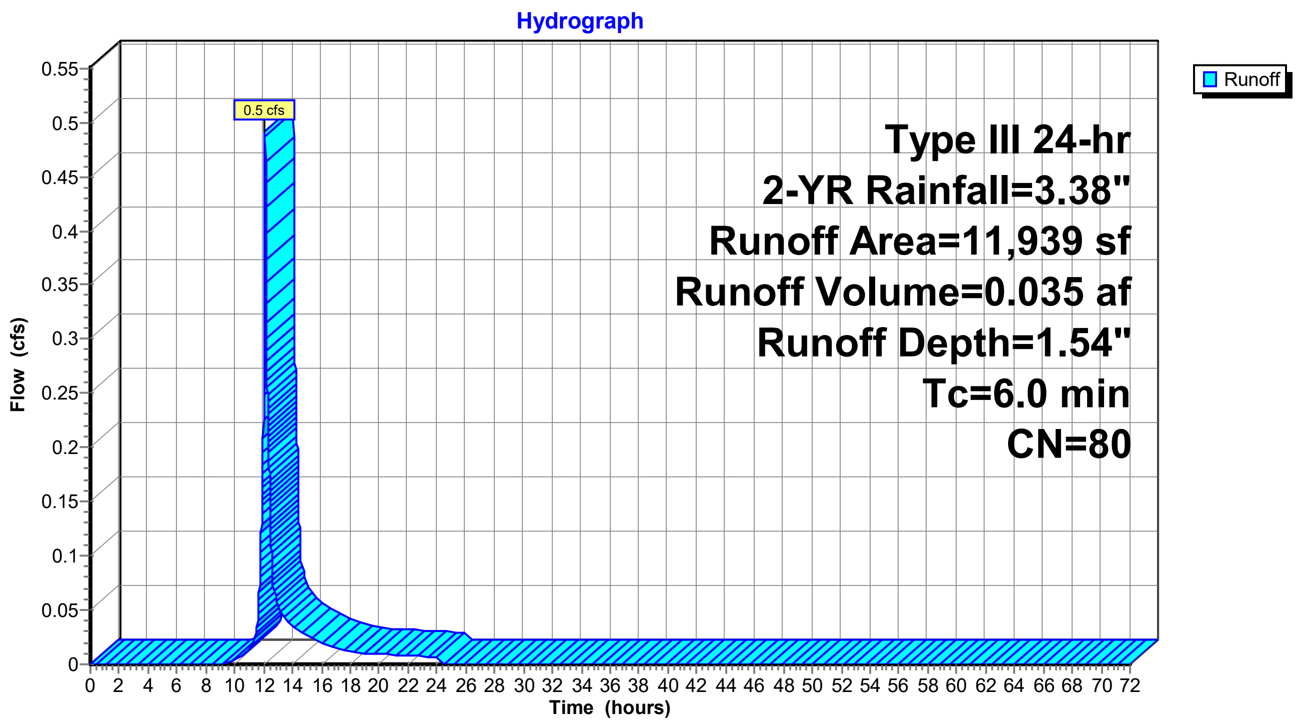
Runoff = 0.5 cfs @ 12.09 hrs, Volume= 0.035 af, Depth= 1.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-YR Rainfall=3.38"

Area (sf)	CN	Description
3,350	36	Woods, Fair, HSG A
1,564	96	Gravel surface, HSG A
7,025	98	Roofs, HSG A
11,939	80	Weighted Average
4,914		41.16% Pervious Area
7,025		58.84% Impervious Area

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

Subcatchment P-1A: Rear Left



Summary for Subcatchment P-1B: Rear Right

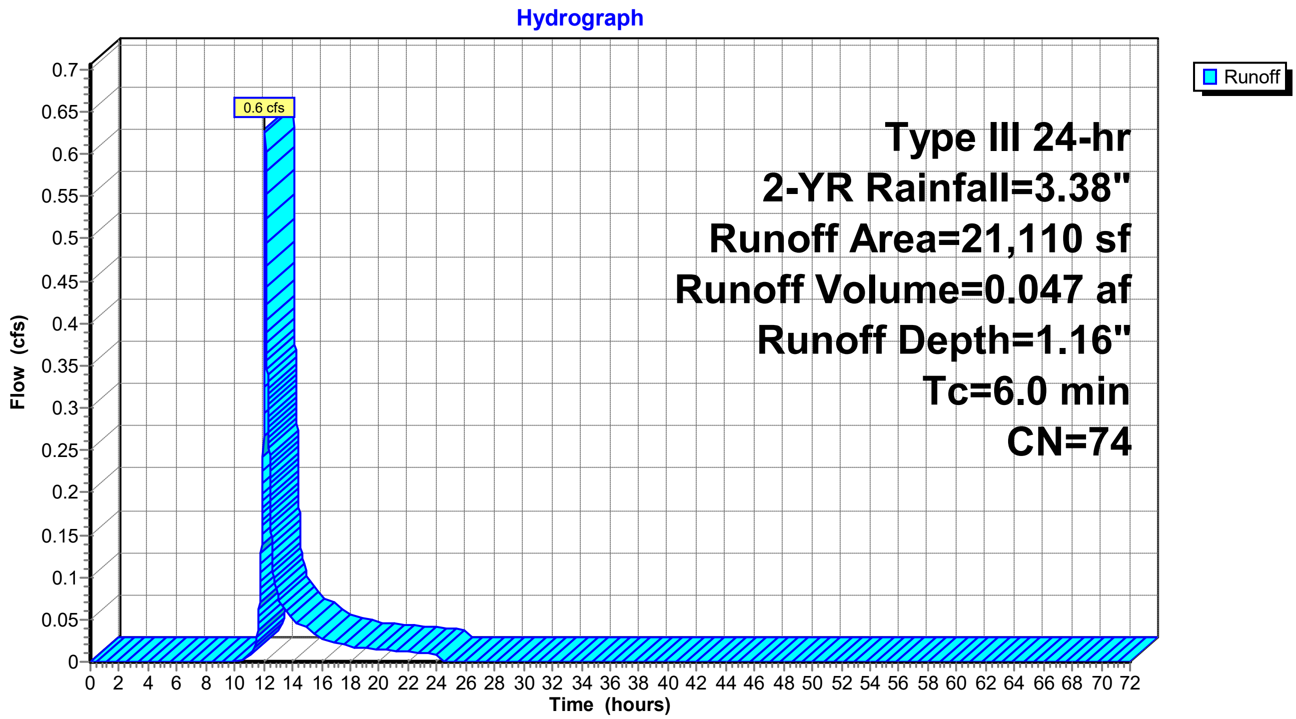
Runoff = 0.6 cfs @ 12.09 hrs, Volume= 0.047 af, Depth= 1.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-YR Rainfall=3.38"

	Area (sf)	CN	Description
	7,921	36	Woods, Fair, HSG A
	2,463	98	Roofs, HSG A
	8,503	96	Gravel surface, HSG A
*	2,223	96	Gravel surface, HSG A
	21,110	74	Weighted Average
	18,647		88.33% Pervious Area
	2,463		11.67% Impervious Area

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

Subcatchment P-1B: Rear Right



Summary for Subcatchment P-2A: Front

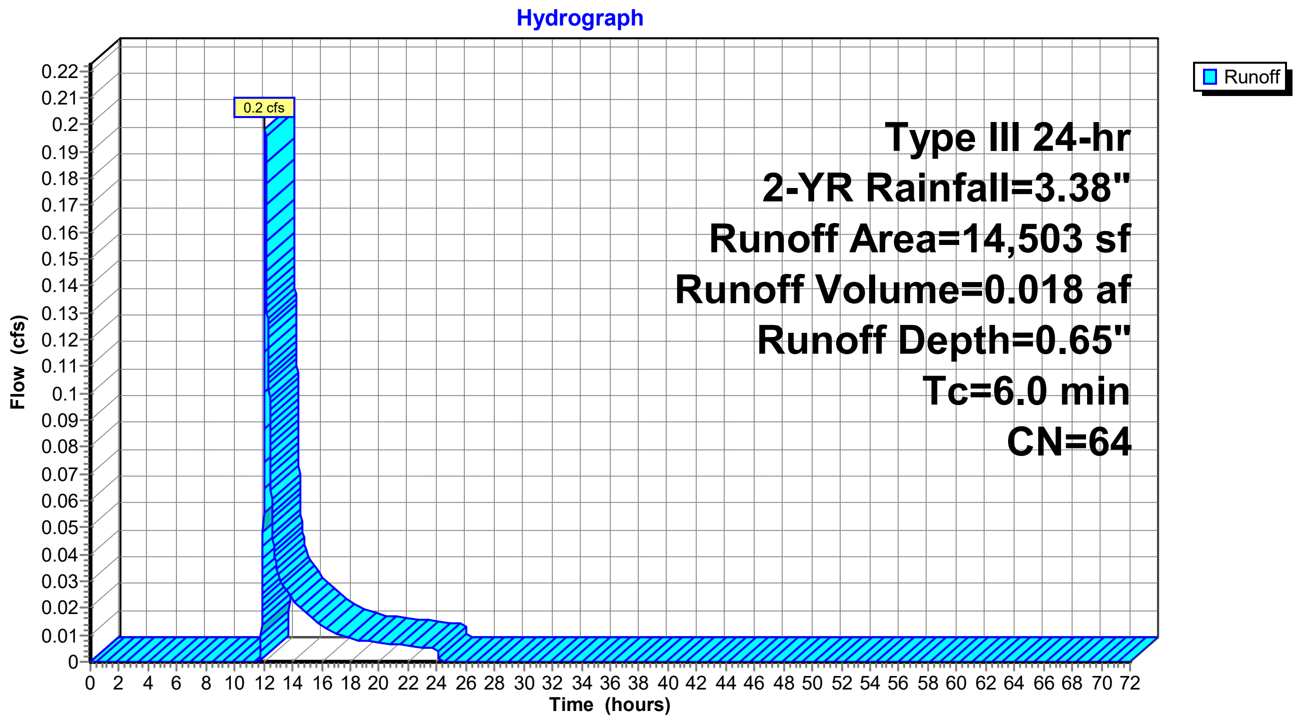
Runoff = 0.2 cfs @ 12.11 hrs, Volume= 0.018 af, Depth= 0.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-YR Rainfall=3.38"

Area (sf)	CN	Description
2,000	96	Gravel surface, HSG A
794	68	<50% Grass cover, Poor, HSG A
7,529	36	Woods, Fair, HSG A
4,180	98	Paved parking, HSG A
14,503	64	Weighted Average
10,323		71.18% Pervious Area
4,180		28.82% Impervious Area

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

Subcatchment P-2A: Front



Summary for Subcatchment P-2B: Front

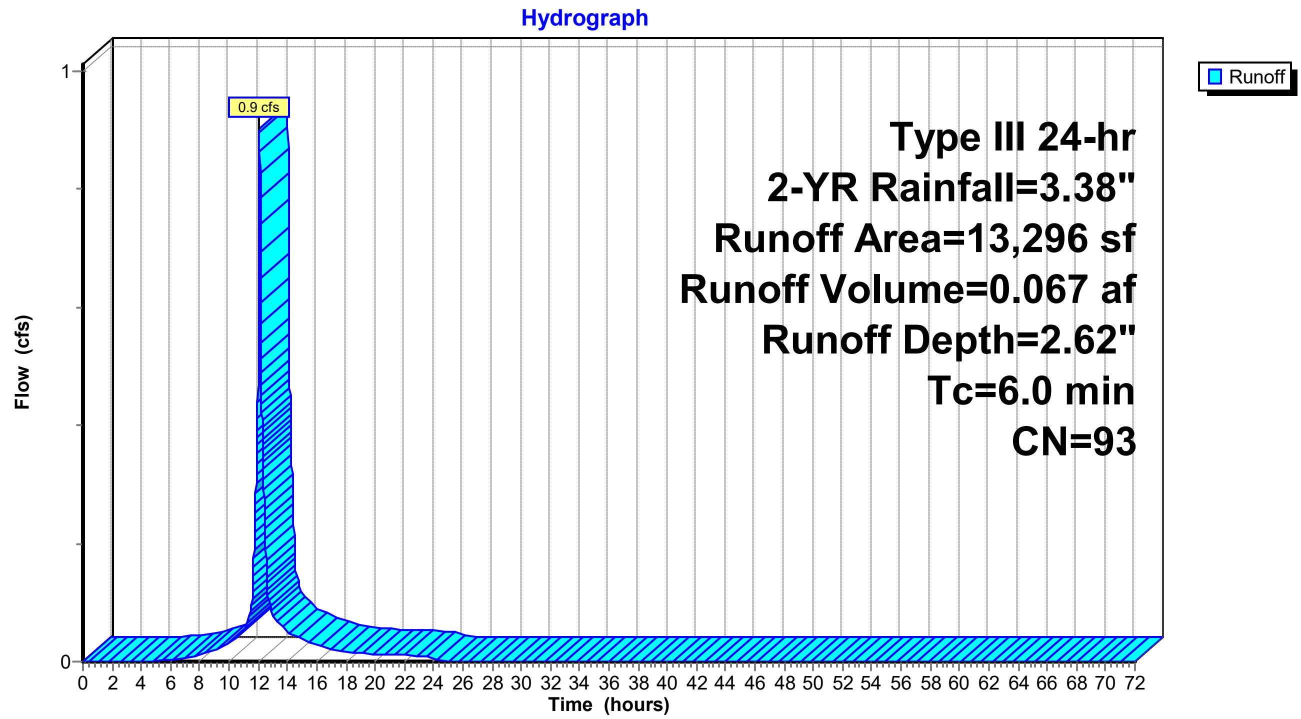
Runoff = 0.9 cfs @ 12.09 hrs, Volume= 0.067 af, Depth= 2.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-YR Rainfall=3.38"

	Area (sf)	CN	Description
	1,925	96	Gravel surface, HSG A
	1,086	68	<50% Grass cover, Poor, HSG A
	484	36	Woods, Fair, HSG A
	6,193	98	Paved parking, HSG A
*	3,608	98	Paved parking, HSG A
	13,296	93	Weighted Average
	3,495		26.29% Pervious Area
	9,801		73.71% Impervious Area

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

Subcatchment P-2B: Front



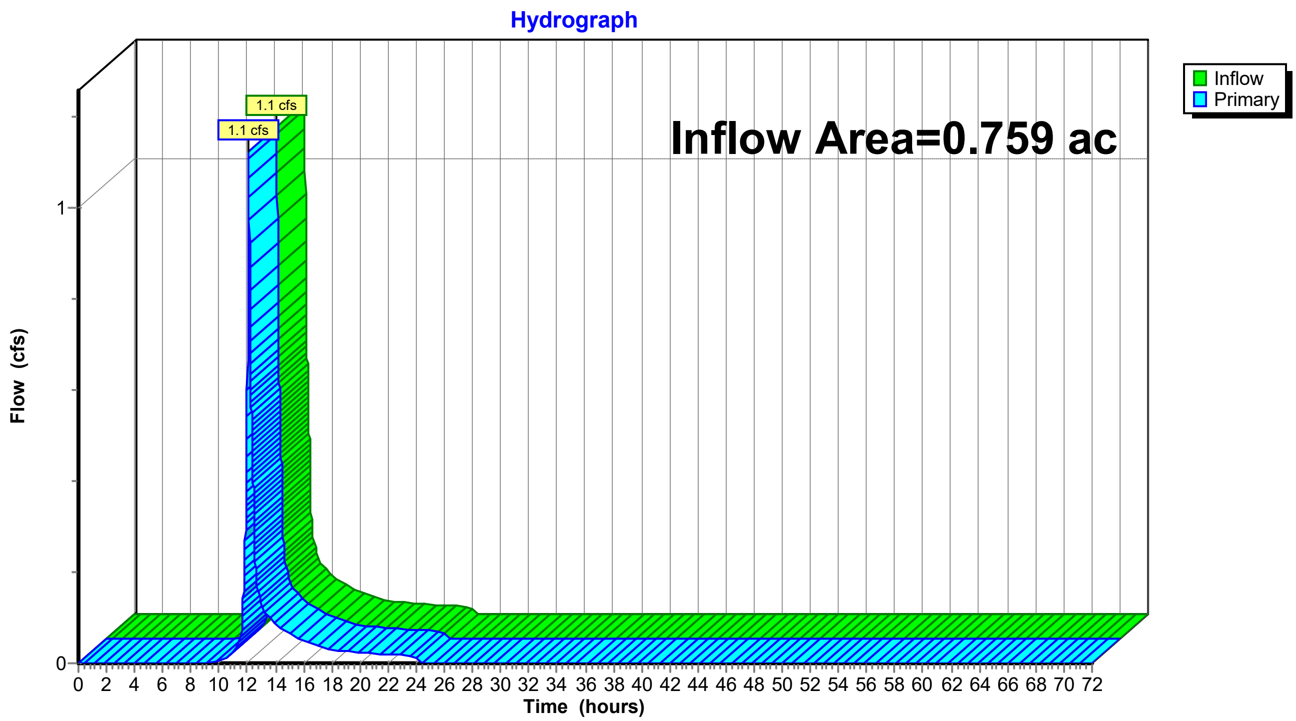
Summary for Pond DP-1e: (new Pond)

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

Inflow Area = 0.759 ac, 28.71% Impervious, Inflow Depth = 1.30" for 2-YR event
Inflow = 1.1 cfs @ 12.09 hrs, Volume= 0.082 af
Primary = 1.1 cfs @ 12.09 hrs, Volume= 0.082 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-1e: (new Pond)



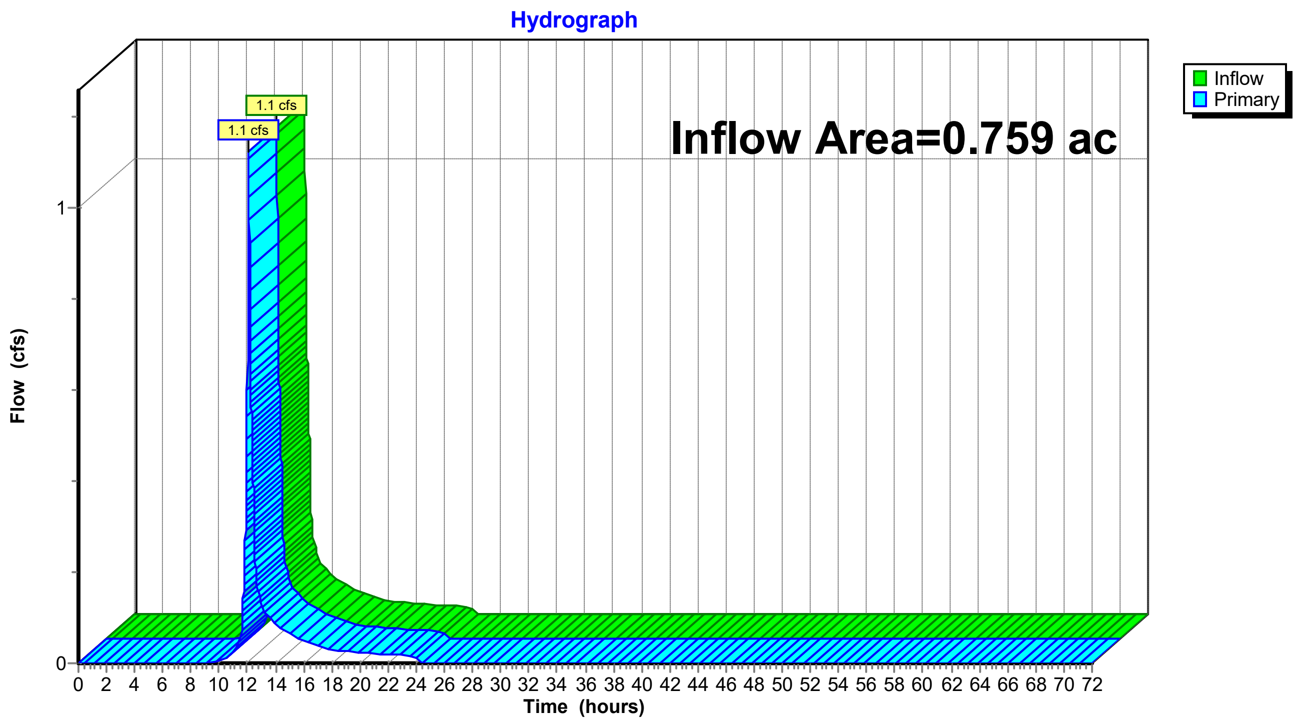
Summary for Pond DP-1p: (new Pond)

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

Inflow Area = 0.759 ac, 28.71% Impervious, Inflow Depth = 1.30" for 2-YR event
Inflow = 1.1 cfs @ 12.09 hrs, Volume= 0.082 af
Primary = 1.1 cfs @ 12.09 hrs, Volume= 0.082 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-1p: (new Pond)

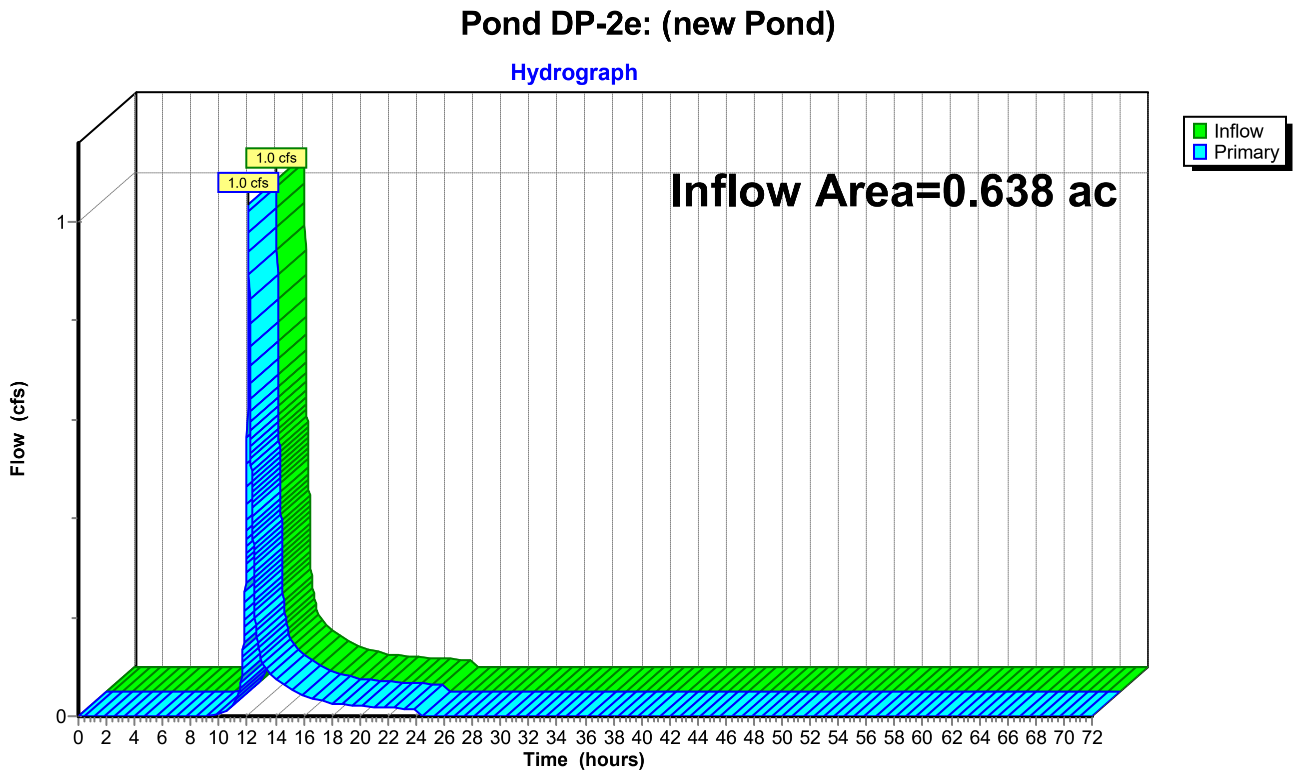


Summary for Pond DP-2e: (new Pond)

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

Inflow Area = 0.638 ac, 43.96% Impervious, Inflow Depth = 1.41" for 2-YR event
Inflow = 1.0 cfs @ 12.09 hrs, Volume= 0.075 af
Primary = 1.0 cfs @ 12.09 hrs, Volume= 0.075 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs



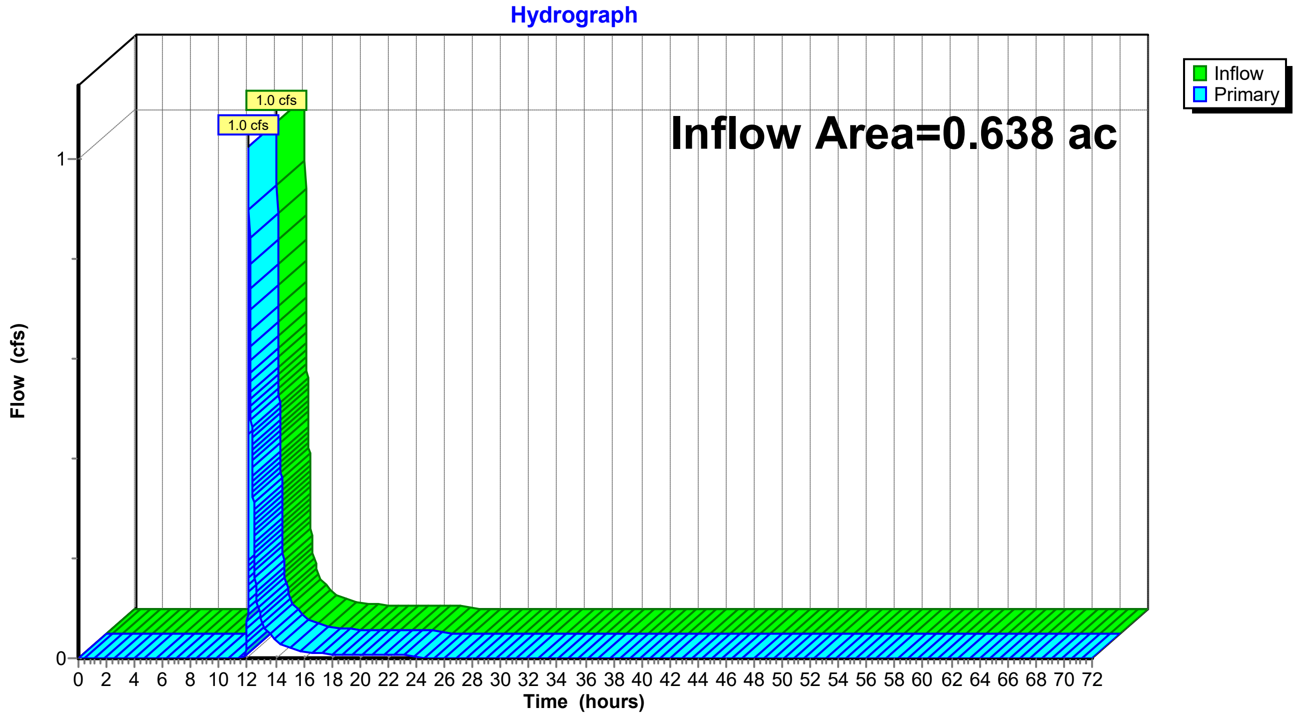
Summary for Pond DP-2p: (new Pond)

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

Inflow Area = 0.638 ac, 50.29% Impervious, Inflow Depth = 0.66" for 2-YR event
Inflow = 1.0 cfs @ 12.13 hrs, Volume= 0.035 af
Primary = 1.0 cfs @ 12.13 hrs, Volume= 0.035 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-2p: (new Pond)



Summary for Pond UGI: Underground Infiltration System

Inflow Area =	0.305 ac, 73.71% Impervious, Inflow Depth = 2.62" for 2-YR event			
Inflow =	0.9 cfs @	12.09 hrs, Volume=	0.067 af	
Outflow =	0.9 cfs @	12.13 hrs, Volume=	0.066 af,	Atten= 4%, Lag= 3.0 min
Discarded =	0.0 cfs @	12.13 hrs, Volume=	0.049 af	
Primary =	0.8 cfs @	12.13 hrs, Volume=	0.017 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 261.19' @ 12.13 hrs Surf.Area= 363 sf Storage= 882 cf

Plug-Flow detention time= 201.0 min calculated for 0.066 af (100% of inflow)
Center-of-Mass det. time= 199.2 min (990.0 - 790.8)

Volume	Invert	Avail.Storage	Storage Description
#1	259.60'	25 cf	**4.00'D x 2.00'H CB1** -Impervious
#2	259.60'	8 cf	**12.0" Round Pipe Storage** -Impervious L= 10.0' S= 0.0100 '/'
#3	257.79'	54 cf	**4.00'D x 4.30'H DMH1** -Impervious
#4	259.40'	3 cf	**12.0" Round Pipe Storage** -Impervious L= 4.0'
#5A	257.29'	325 cf	**11.33'W x 32.00'L x 3.21'H Field A** 1,164 cf Overall - 352 cf Embedded = 811 cf x 40.0% Voids
#6A	257.79'	352 cf	**Cultec R-280HD** x 8 Inside #5 Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap Row Length Adjustment= +1.00' x 6.07 sf x 2 rows
#7	257.79'	4 cf	**12.0" Round Pipe Storage** -Impervious L= 5.0'
#8	257.79'	58 cf	**4.00'D x 4.60'H DMH2** -Impervious
#9	257.22'	37 cf	**12.0" Round Pipe Storage** -Impervious L= 47.0' S= 0.0100 '/'
#10	257.22'	48 cf	**4.00'D x 3.78'H CB2** -Impervious
		913 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	257.29'	**2.410 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 1.00'
#2	Primary	261.60'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	261.10'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.0 cfs @ 12.13 hrs HW=261.19' (Free Discharge)
└─**1=Exfiltration** (Controls 0.0 cfs)

Primary OutFlow Max=0.7 cfs @ 12.13 hrs HW=261.19' (Free Discharge)
├─**2=Orifice/Grate** (Controls 0.0 cfs)
└─**3=Orifice/Grate** (Weir Controls 0.7 cfs @ 0.99 fps)

Pond UGI: Underground Infiltration System - Chamber Wizard Field A

Chamber Model = Cultec R-280HD (Cultec Recharger® 280HD)
Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf
Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap
Row Length Adjustment= +1.00' x 6.07 sf x 2 rows

47.0" Wide + 6.0" Spacing = 53.0" C-C Row Spacing

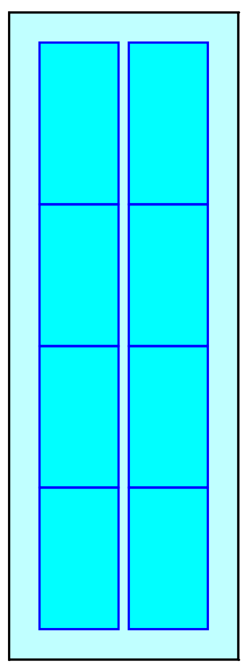
4 Chambers/Row x 7.00' Long +1.00' Row Adjustment = 29.00' Row Length +18.0" End Stone x 2 = 32.00' Base Length
2 Rows x 47.0" Wide + 6.0" Spacing x 1 + 18.0" Side Stone x 2 = 11.33' Base Width
6.0" Base + 26.5" Chamber Height + 6.0" Cover = 3.21' Field Height

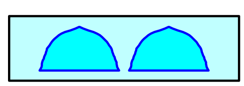
8 Chambers x 42.5 cf +1.00' Row Adjustment x 6.07 sf x 2 Rows = 352.2 cf Chamber Storage

1,163.6 cf Field - 352.2 cf Chambers = 811.4 cf Stone x 40.0% Voids = 324.6 cf Stone Storage

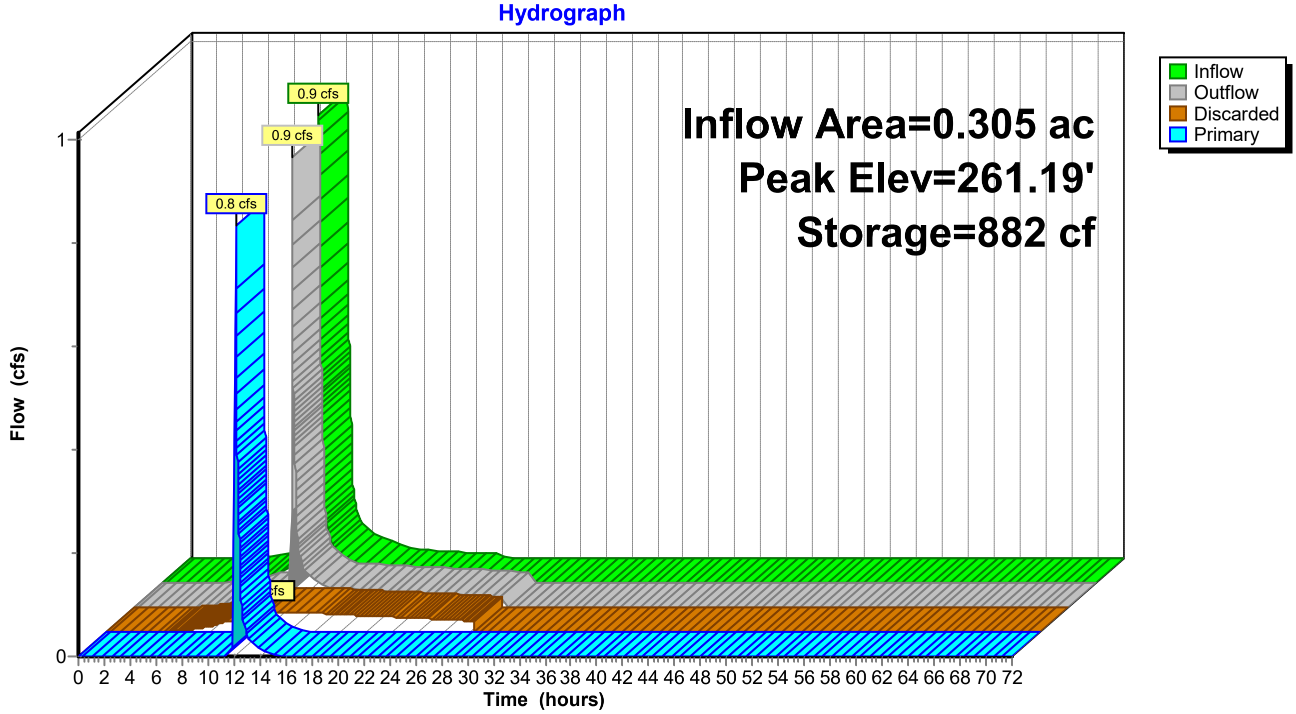
Chamber Storage + Stone Storage = 676.7 cf = 0.016 af
Overall Storage Efficiency = 58.2%
Overall System Size = 32.00' x 11.33' x 3.21'

8 Chambers
43.1 cy Field
30.1 cy Stone





Pond UGI: Underground Infiltration System



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment E-1A: Rear Left Runoff Area=11,939 sf 58.84% Impervious Runoff Depth=3.13"
Tc=6.0 min CN=80 Runoff=1.0 cfs 0.071 af

Subcatchment E-1B: Rear Right Runoff Area=21,110 sf 11.67% Impervious Runoff Depth=2.58"
Tc=6.0 min CN=74 Runoff=1.5 cfs 0.104 af

Subcatchment E-2: Front Runoff Area=27,799 sf 43.96% Impervious Runoff Depth=2.94"
Tc=6.0 min CN=78 Runoff=2.2 cfs 0.156 af

Subcatchment P-1A: Rear Left Runoff Area=11,939 sf 58.84% Impervious Runoff Depth=3.13"
Tc=6.0 min CN=80 Runoff=1.0 cfs 0.071 af

Subcatchment P-1B: Rear Right Runoff Area=21,110 sf 11.67% Impervious Runoff Depth=2.58"
Tc=6.0 min CN=74 Runoff=1.5 cfs 0.104 af

Subcatchment P-2A: Front Runoff Area=14,503 sf 28.82% Impervious Runoff Depth=1.76"
Tc=6.0 min CN=64 Runoff=0.7 cfs 0.049 af

Subcatchment P-2B: Front Runoff Area=13,296 sf 73.71% Impervious Runoff Depth=4.46"
Tc=6.0 min CN=93 Runoff=1.5 cfs 0.114 af

Pond DP-1e: (new Pond) Inflow=2.5 cfs 0.176 af
Primary=2.5 cfs 0.176 af

Pond DP-1p: (new Pond) Inflow=2.5 cfs 0.176 af
Primary=2.5 cfs 0.176 af

Pond DP-2e: (new Pond) Inflow=2.2 cfs 0.156 af
Primary=2.2 cfs 0.156 af

Pond DP-2p: (new Pond) Inflow=2.1 cfs 0.103 af
Primary=2.1 cfs 0.103 af

Pond UGI: Underground Infiltration System Peak Elev=261.25' Storage=884 cf Inflow=1.5 cfs 0.114 af
Discarded=0.0 cfs 0.059 af Primary=1.5 cfs 0.054 af Outflow=1.5 cfs 0.113 af

Total Runoff Area = 2.794 ac Runoff Volume = 0.670 af Average Runoff Depth = 2.88"
62.88% Pervious = 1.757 ac 37.12% Impervious = 1.037 ac

Summary for Subcatchment E-1A: Rear Left

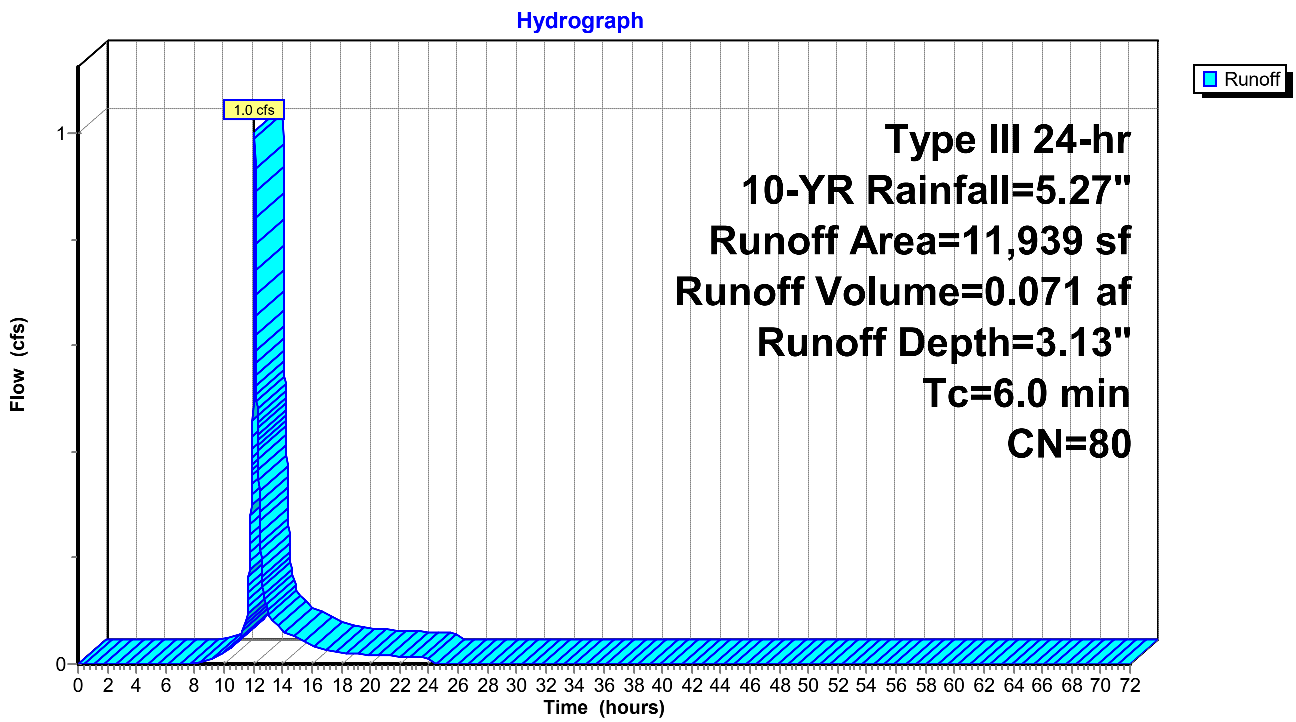
Runoff = 1.0 cfs @ 12.09 hrs, Volume= 0.071 af, Depth= 3.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-YR Rainfall=5.27"

Area (sf)	CN	Description
7,025	98	Roofs, HSG A
3,350	36	Woods, Fair, HSG A
1,564	96	Gravel surface, HSG A
11,939	80	Weighted Average
4,914		41.16% Pervious Area
7,025		58.84% Impervious Area

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

Subcatchment E-1A: Rear Left



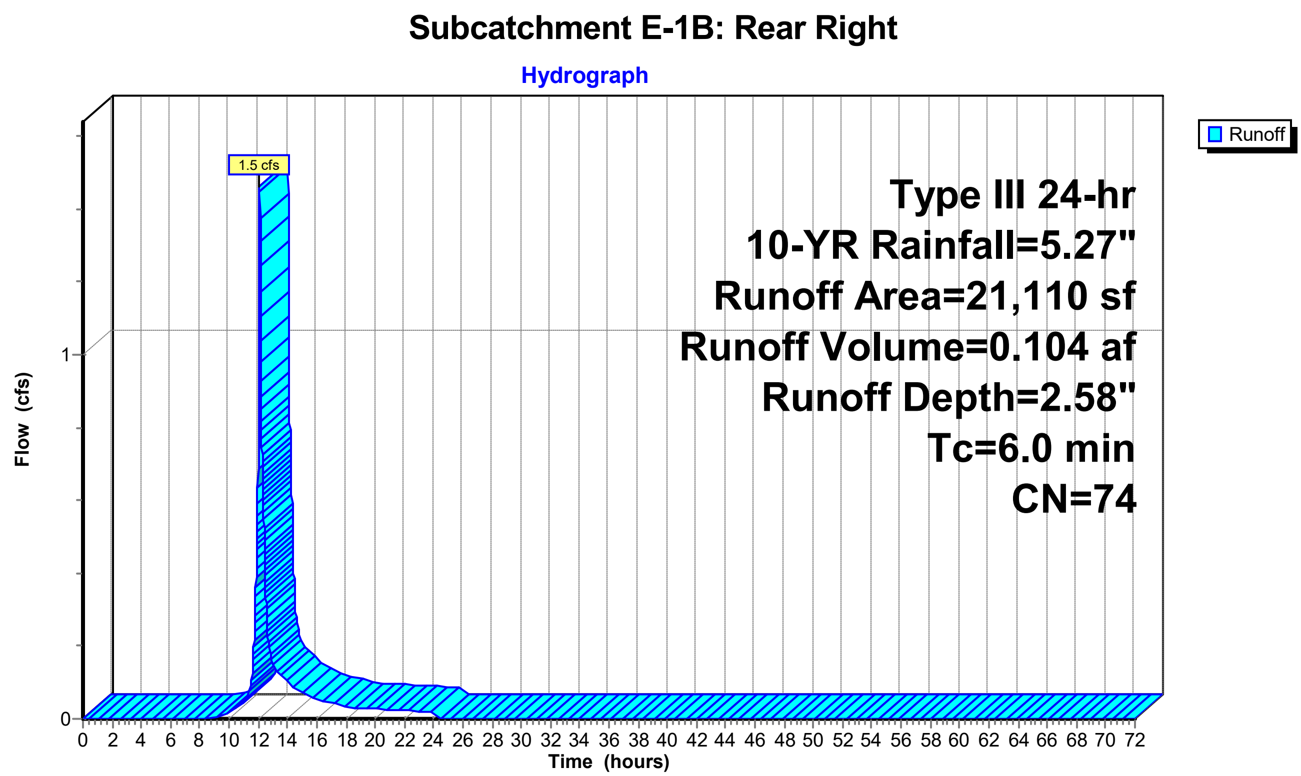
Summary for Subcatchment E-1B: Rear Right

Runoff = 1.5 cfs @ 12.09 hrs, Volume= 0.104 af, Depth= 2.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-YR Rainfall=5.27"

	Area (sf)	CN	Description
	2,463	98	Roofs, HSG A
	7,921	36	Woods, Fair, HSG A
	8,503	96	Gravel surface, HSG A
*	2,223	96	Gravel surface, HSG A
	21,110	74	Weighted Average
	18,647		88.33% Pervious Area
	2,463		11.67% Impervious Area

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



Summary for Subcatchment E-2: Front

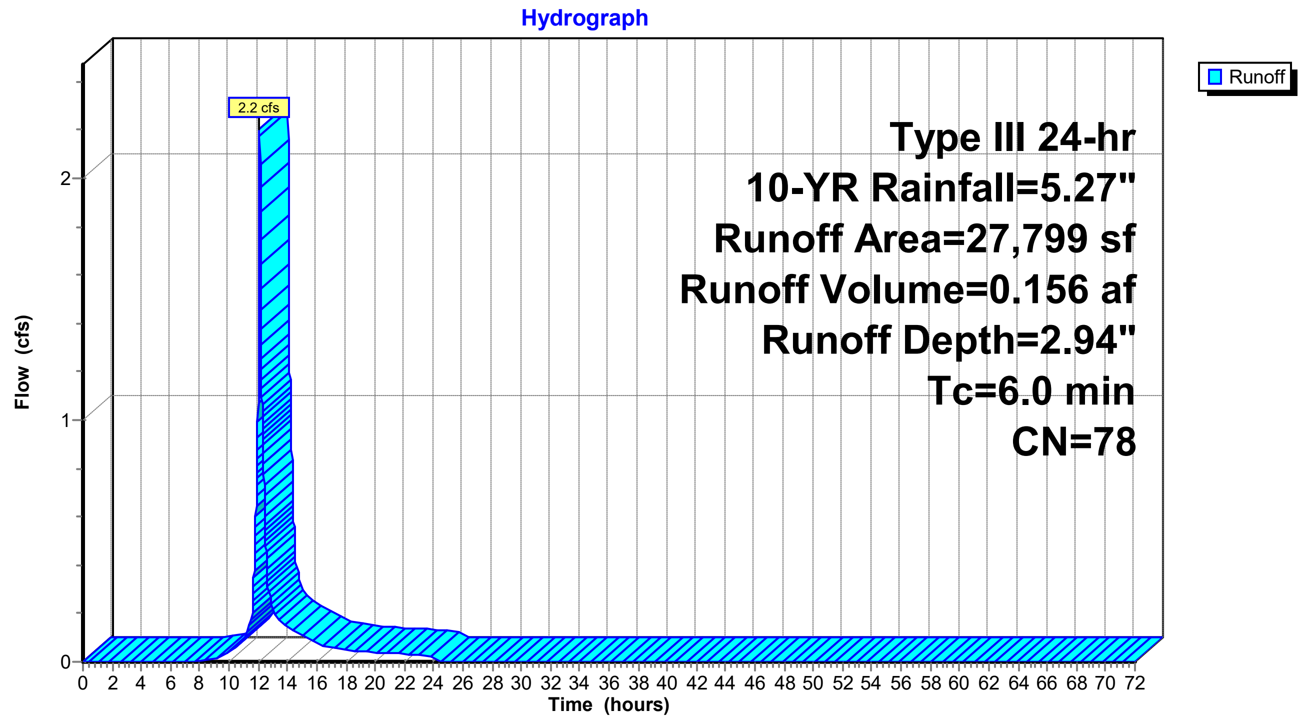
Runoff = 2.2 cfs @ 12.09 hrs, Volume= 0.156 af, Depth= 2.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-YR Rainfall=5.27"

	Area (sf)	CN	Description
	5,715	96	Gravel surface, HSG A
	12,220	98	Paved parking, HSG A
*	1,849	68	<50% Grass cover, Poor, HSG A
	8,015	36	Woods, Fair, HSG A
	27,799	78	Weighted Average
	15,579		56.04% Pervious Area
	12,220		43.96% Impervious Area

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

Subcatchment E-2: Front



Summary for Subcatchment P-1A: Rear Left

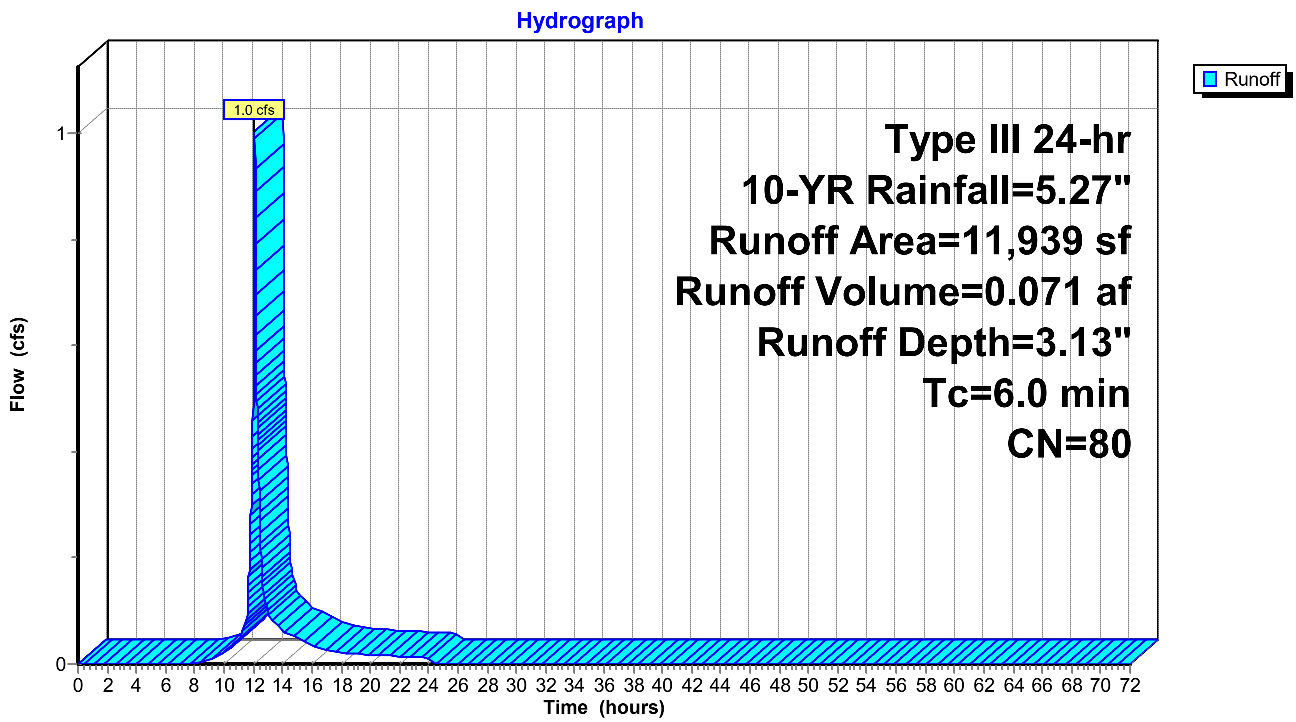
Runoff = 1.0 cfs @ 12.09 hrs, Volume= 0.071 af, Depth= 3.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-YR Rainfall=5.27"

Area (sf)	CN	Description
3,350	36	Woods, Fair, HSG A
1,564	96	Gravel surface, HSG A
7,025	98	Roofs, HSG A
11,939	80	Weighted Average
4,914		41.16% Pervious Area
7,025		58.84% Impervious Area

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

Subcatchment P-1A: Rear Left



Summary for Subcatchment P-1B: Rear Right

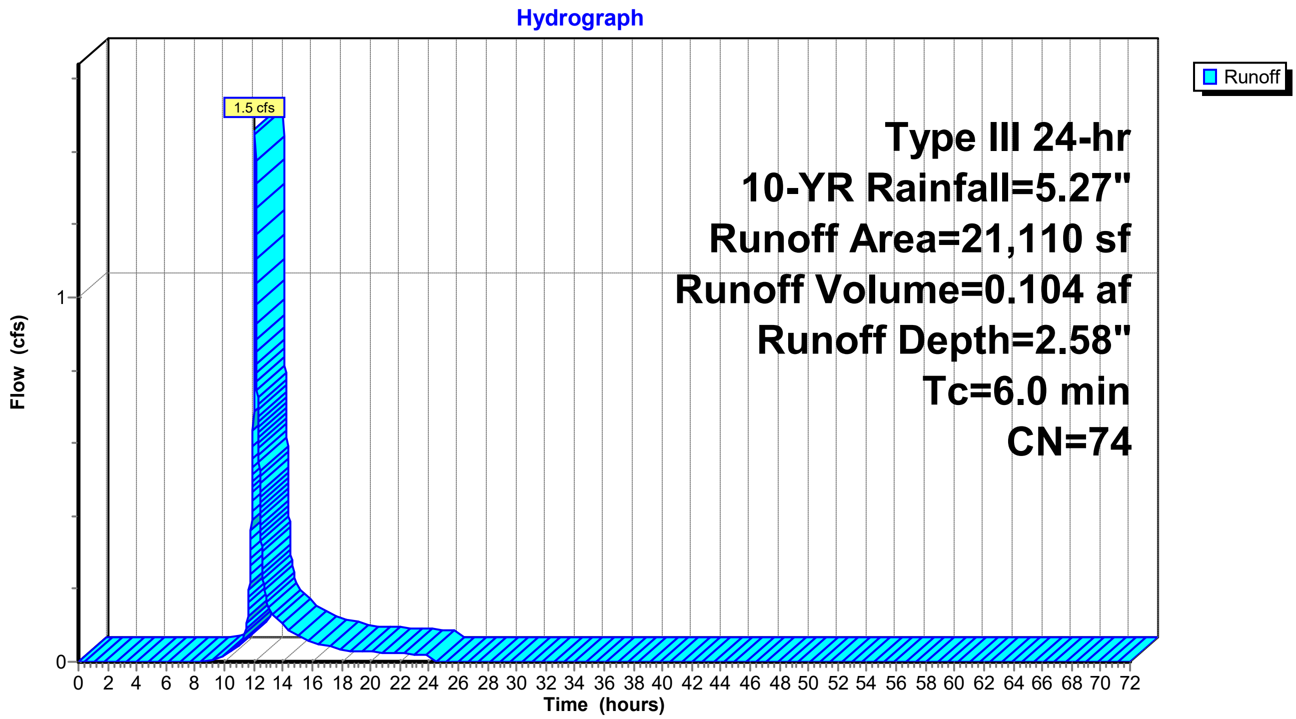
Runoff = 1.5 cfs @ 12.09 hrs, Volume= 0.104 af, Depth= 2.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-YR Rainfall=5.27"

	Area (sf)	CN	Description
	7,921	36	Woods, Fair, HSG A
	2,463	98	Roofs, HSG A
	8,503	96	Gravel surface, HSG A
*	2,223	96	Gravel surface, HSG A
	21,110	74	Weighted Average
	18,647		88.33% Pervious Area
	2,463		11.67% Impervious Area

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

Subcatchment P-1B: Rear Right



Summary for Subcatchment P-2A: Front

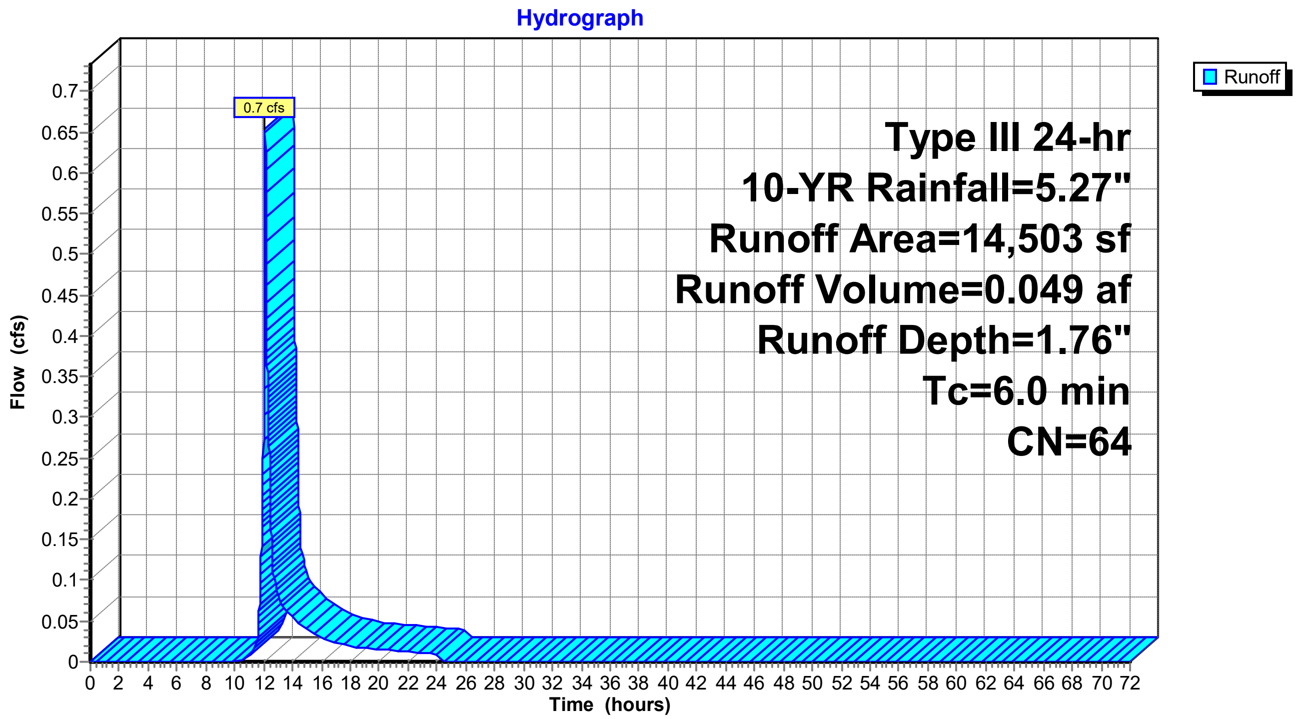
Runoff = 0.7 cfs @ 12.10 hrs, Volume= 0.049 af, Depth= 1.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-YR Rainfall=5.27"

Area (sf)	CN	Description
2,000	96	Gravel surface, HSG A
794	68	<50% Grass cover, Poor, HSG A
7,529	36	Woods, Fair, HSG A
4,180	98	Paved parking, HSG A
14,503	64	Weighted Average
10,323		71.18% Pervious Area
4,180		28.82% Impervious Area

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

Subcatchment P-2A: Front



Summary for Subcatchment P-2B: Front

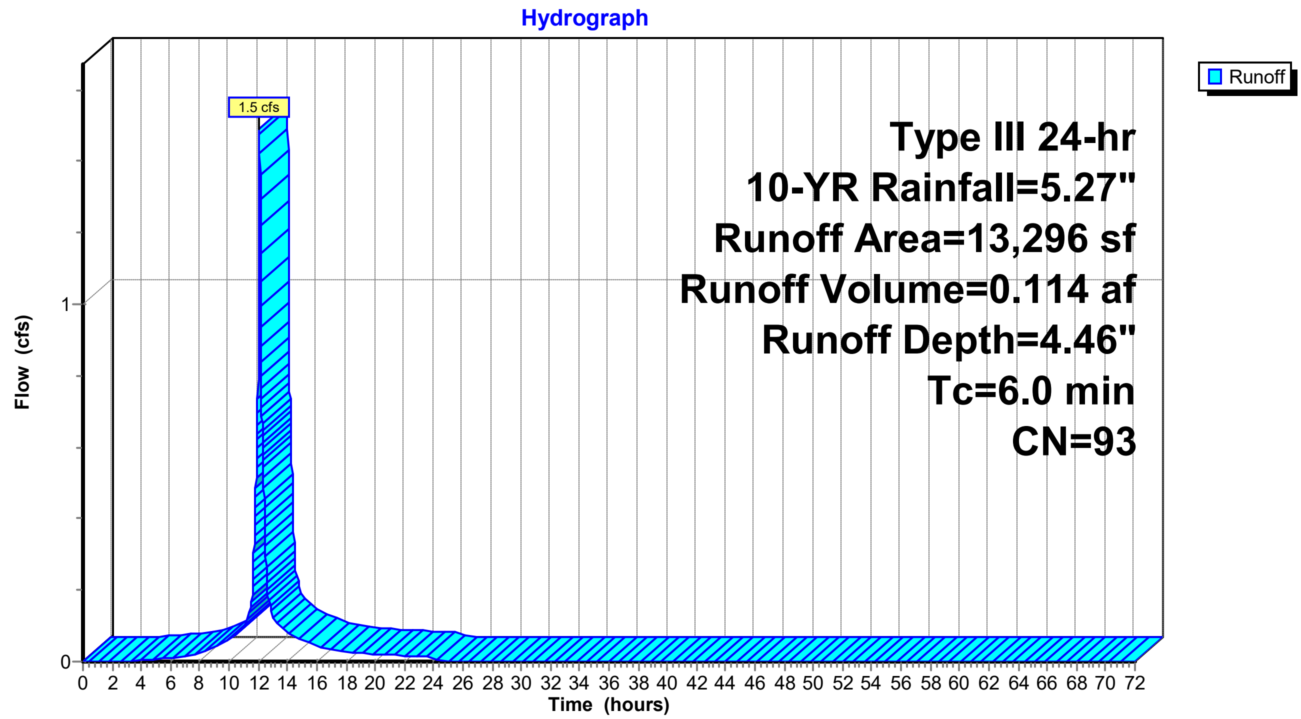
Runoff = 1.5 cfs @ 12.08 hrs, Volume= 0.114 af, Depth= 4.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-YR Rainfall=5.27"

	Area (sf)	CN	Description
	1,925	96	Gravel surface, HSG A
	1,086	68	<50% Grass cover, Poor, HSG A
	484	36	Woods, Fair, HSG A
	6,193	98	Paved parking, HSG A
*	3,608	98	Paved parking, HSG A
	13,296	93	Weighted Average
	3,495		26.29% Pervious Area
	9,801		73.71% Impervious Area

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

Subcatchment P-2B: Front



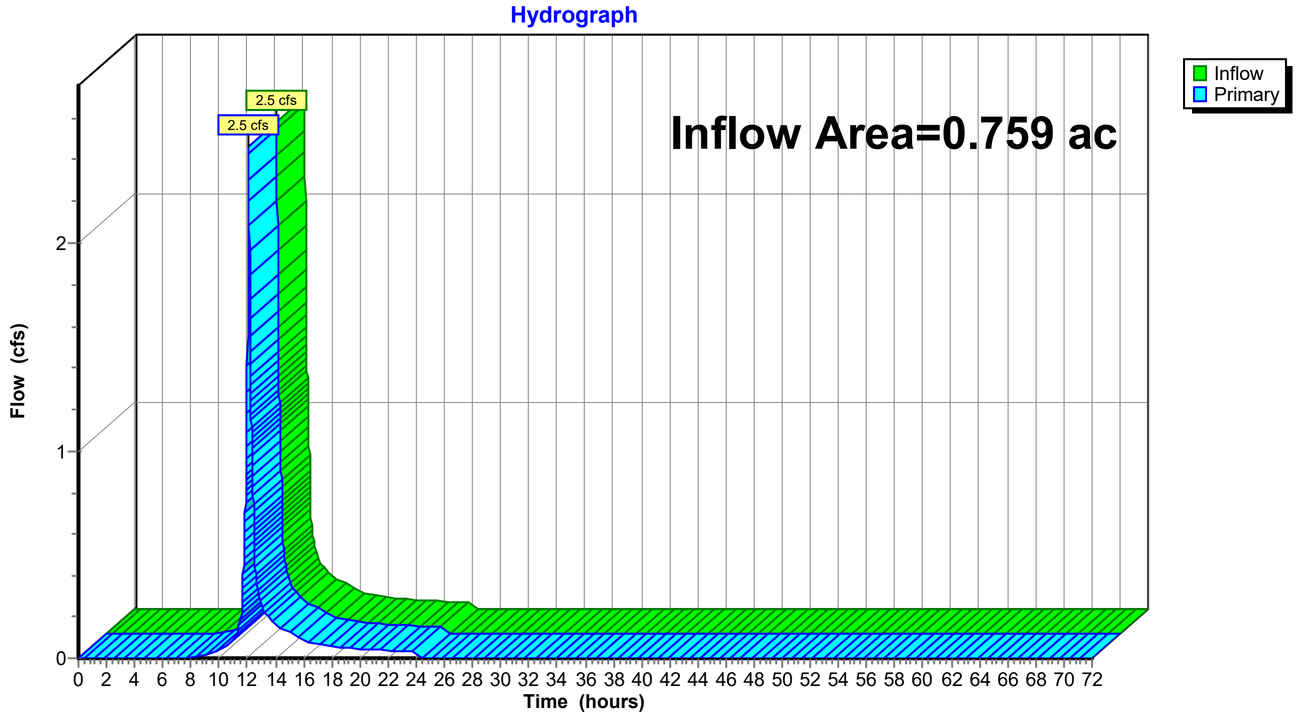
Summary for Pond DP-1e: (new Pond)

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

Inflow Area =	0.759 ac,	28.71% Impervious,	Inflow Depth = 2.78"	for 10-YR event
Inflow =	2.5 cfs @	12.09 hrs, Volume=	0.176 af	
Primary =	2.5 cfs @	12.09 hrs, Volume=	0.176 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-1e: (new Pond)



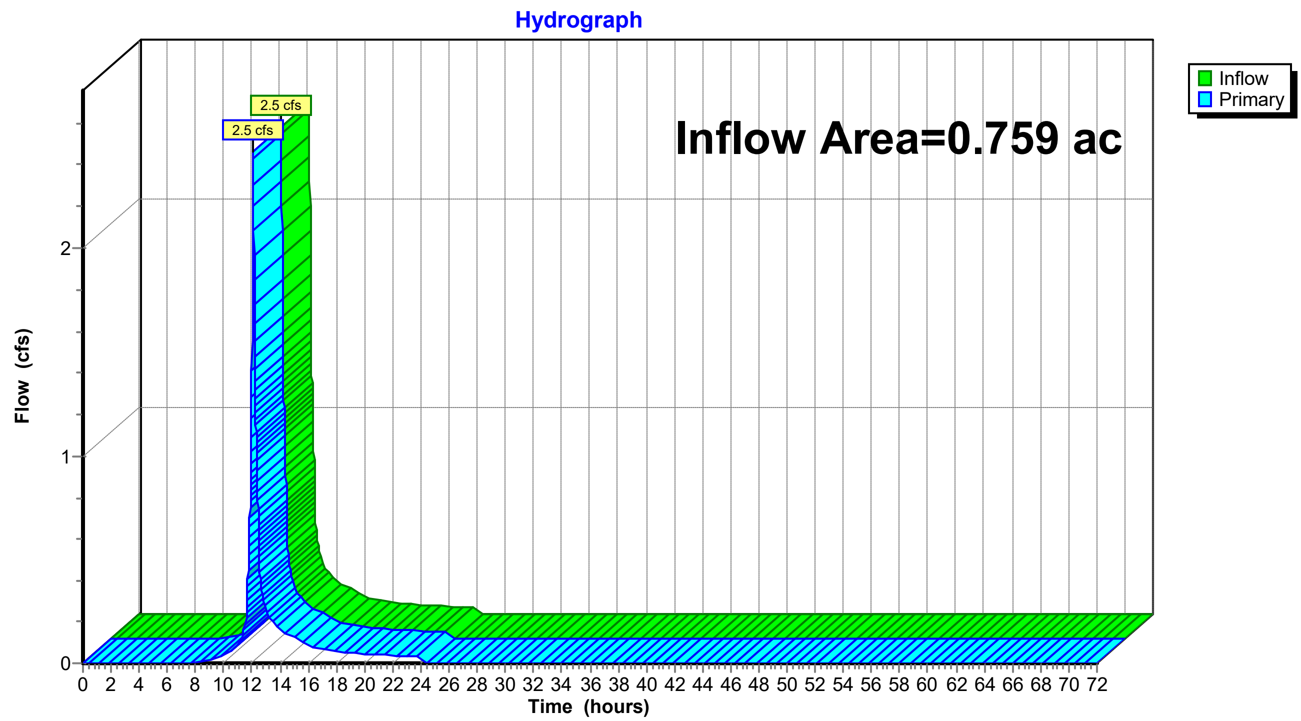
Summary for Pond DP-1p: (new Pond)

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

Inflow Area = 0.759 ac, 28.71% Impervious, Inflow Depth = 2.78" for 10-YR event
Inflow = 2.5 cfs @ 12.09 hrs, Volume= 0.176 af
Primary = 2.5 cfs @ 12.09 hrs, Volume= 0.176 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-1p: (new Pond)



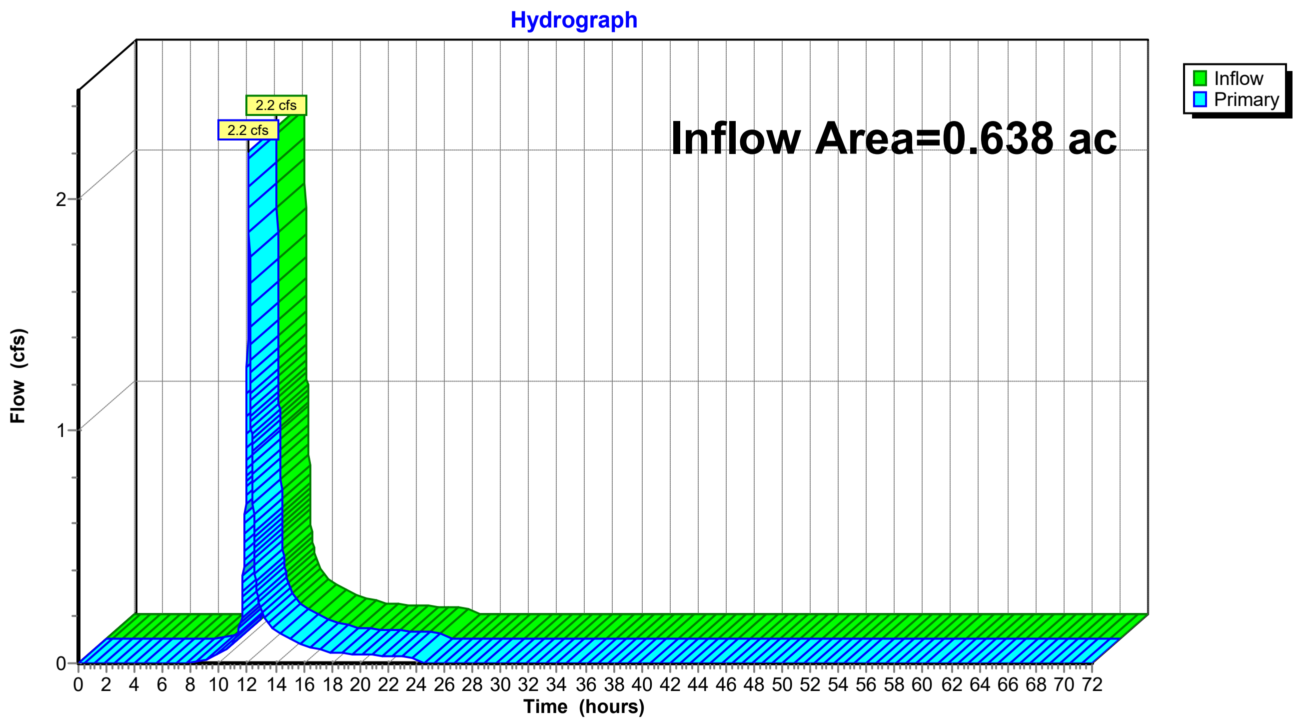
Summary for Pond DP-2e: (new Pond)

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

Inflow Area = 0.638 ac, 43.96% Impervious, Inflow Depth = 2.94" for 10-YR event
Inflow = 2.2 cfs @ 12.09 hrs, Volume= 0.156 af
Primary = 2.2 cfs @ 12.09 hrs, Volume= 0.156 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-2e: (new Pond)



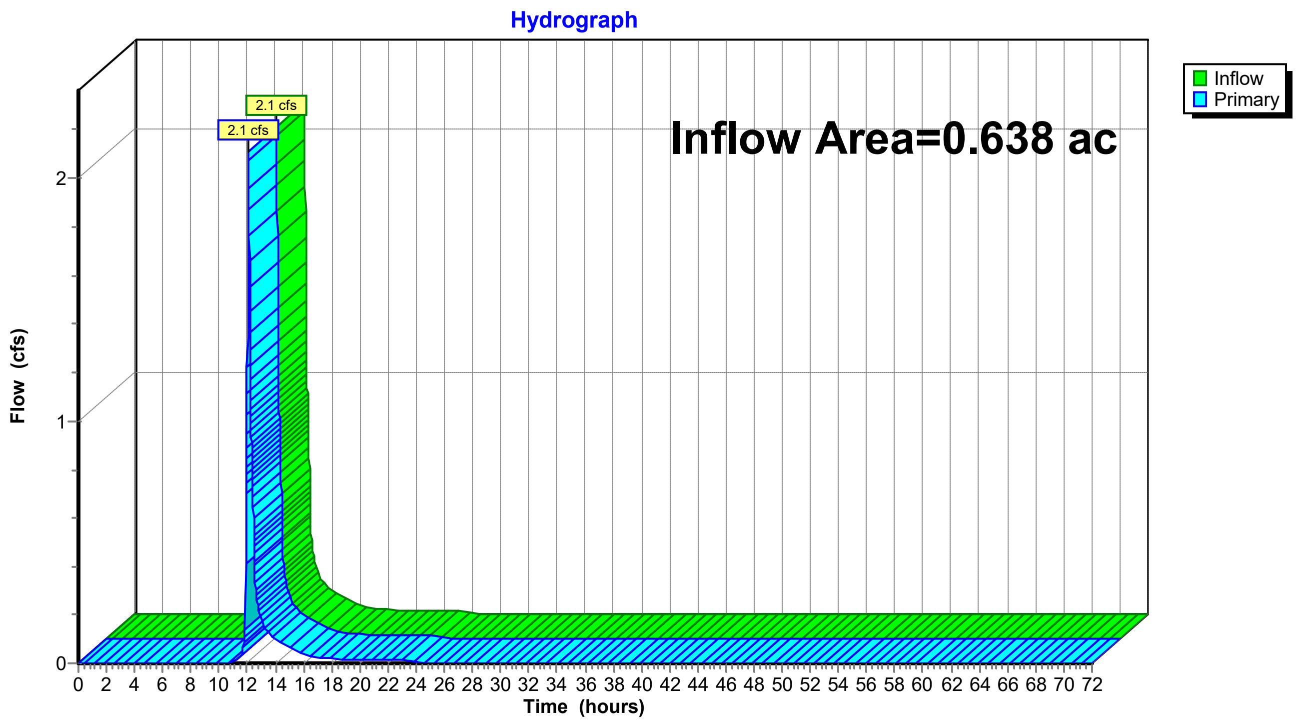
Summary for Pond DP-2p: (new Pond)

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

Inflow Area = 0.638 ac, 50.29% Impervious, Inflow Depth = 1.94" for 10-YR event
Inflow = 2.1 cfs @ 12.09 hrs, Volume= 0.103 af
Primary = 2.1 cfs @ 12.09 hrs, Volume= 0.103 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-2p: (new Pond)



Summary for Pond UGI: Underground Infiltration System

Inflow Area = 0.305 ac, 73.71% Impervious, Inflow Depth = 4.46" for 10-YR event
Inflow = 1.5 cfs @ 12.08 hrs, Volume= 0.114 af
Outflow = 1.5 cfs @ 12.08 hrs, Volume= 0.113 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.0 cfs @ 12.08 hrs, Volume= 0.059 af
Primary = 1.5 cfs @ 12.08 hrs, Volume= 0.054 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 261.25' @ 12.08 hrs Surf.Area= 363 sf Storage= 884 cf

Plug-Flow detention time= 147.3 min calculated for 0.113 af (100% of inflow)
Center-of-Mass det. time= 147.0 min (923.7 - 776.7)

Volume	Invert	Avail.Storage	Storage Description
#1	259.60'	25 cf	**4.00'D x 2.00'H CB1** -Impervious
#2	259.60'	8 cf	**12.0" Round Pipe Storage** -Impervious L= 10.0' S= 0.0100 '/'
#3	257.79'	54 cf	**4.00'D x 4.30'H DMH1** -Impervious
#4	259.40'	3 cf	**12.0" Round Pipe Storage** -Impervious L= 4.0'
#5A	257.29'	325 cf	**11.33'W x 32.00'L x 3.21'H Field A** 1,164 cf Overall - 352 cf Embedded = 811 cf x 40.0% Voids
#6A	257.79'	352 cf	**Cultec R-280HD** x 8 Inside #5 Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap Row Length Adjustment= +1.00' x 6.07 sf x 2 rows
#7	257.79'	4 cf	**12.0" Round Pipe Storage** -Impervious L= 5.0'
#8	257.79'	58 cf	**4.00'D x 4.60'H DMH2** -Impervious
#9	257.22'	37 cf	**12.0" Round Pipe Storage** -Impervious L= 47.0' S= 0.0100 '/'
#10	257.22'	48 cf	**4.00'D x 3.78'H CB2** -Impervious
		913 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	257.29'	**2.410 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 1.00'
#2	Primary	261.60'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	261.10'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.0 cfs @ 12.08 hrs HW=261.25' (Free Discharge)
└─**1=Exfiltration** (Controls 0.0 cfs)

Primary OutFlow Max=1.4 cfs @ 12.08 hrs HW=261.25' (Free Discharge)
├─**2=Orifice/Grate** (Controls 0.0 cfs)
└─**3=Orifice/Grate** (Weir Controls 1.4 cfs @ 1.25 fps)

Pond UGI: Underground Infiltration System - Chamber Wizard Field A

Chamber Model = Cultec R-280HD (Cultec Recharger® 280HD)
Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf
Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap
Row Length Adjustment= +1.00' x 6.07 sf x 2 rows

47.0" Wide + 6.0" Spacing = 53.0" C-C Row Spacing

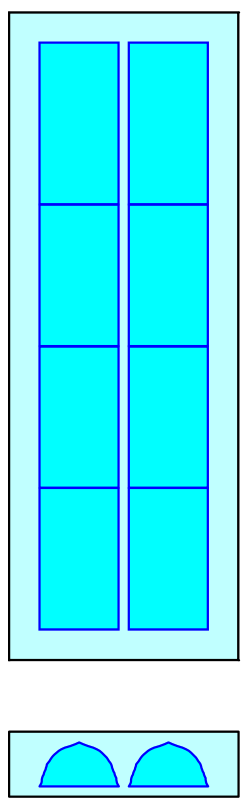
4 Chambers/Row x 7.00' Long +1.00' Row Adjustment = 29.00' Row Length +18.0" End Stone x 2 = 32.00' Base Length
2 Rows x 47.0" Wide + 6.0" Spacing x 1 + 18.0" Side Stone x 2 = 11.33' Base Width
6.0" Base + 26.5" Chamber Height + 6.0" Cover = 3.21' Field Height

8 Chambers x 42.5 cf +1.00' Row Adjustment x 6.07 sf x 2 Rows = 352.2 cf Chamber Storage

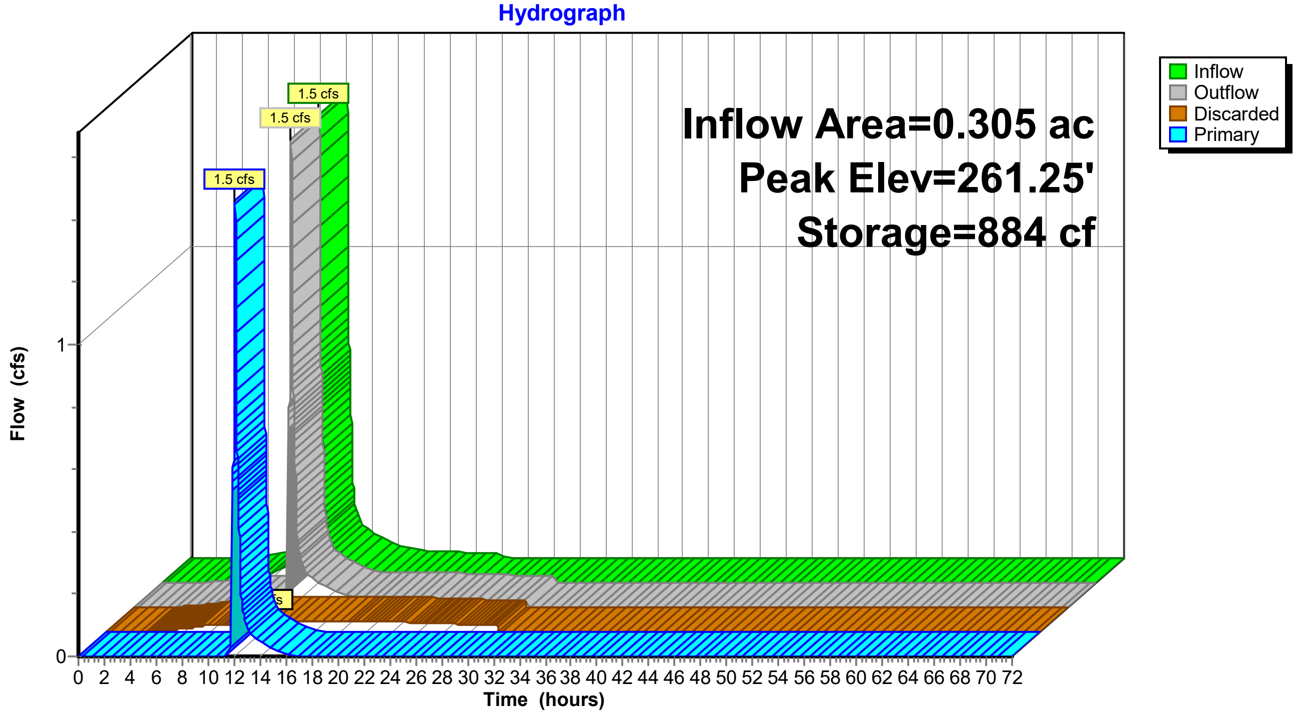
1,163.6 cf Field - 352.2 cf Chambers = 811.4 cf Stone x 40.0% Voids = 324.6 cf Stone Storage

Chamber Storage + Stone Storage = 676.7 cf = 0.016 af
Overall Storage Efficiency = 58.2%
Overall System Size = 32.00' x 11.33' x 3.21'

8 Chambers
43.1 cy Field
30.1 cy Stone



Pond UGI: Underground Infiltration System



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment E-1A: Rear Left Runoff Area=11,939 sf 58.84% Impervious Runoff Depth=4.19"
Tc=6.0 min CN=80 Runoff=1.3 cfs 0.096 af

Subcatchment E-1B: Rear Right Runoff Area=21,110 sf 11.67% Impervious Runoff Depth=3.57"
Tc=6.0 min CN=74 Runoff=2.0 cfs 0.144 af

Subcatchment E-2: Front Runoff Area=27,799 sf 43.96% Impervious Runoff Depth=3.98"
Tc=6.0 min CN=78 Runoff=3.0 cfs 0.212 af

Subcatchment P-1A: Rear Left Runoff Area=11,939 sf 58.84% Impervious Runoff Depth=4.19"
Tc=6.0 min CN=80 Runoff=1.3 cfs 0.096 af

Subcatchment P-1B: Rear Right Runoff Area=21,110 sf 11.67% Impervious Runoff Depth=3.57"
Tc=6.0 min CN=74 Runoff=2.0 cfs 0.144 af

Subcatchment P-2A: Front Runoff Area=14,503 sf 28.82% Impervious Runoff Depth=2.59"
Tc=6.0 min CN=64 Runoff=1.0 cfs 0.072 af

Subcatchment P-2B: Front Runoff Area=13,296 sf 73.71% Impervious Runoff Depth=5.63"
Tc=6.0 min CN=93 Runoff=1.9 cfs 0.143 af

Pond DP-1e: (new Pond) Inflow=3.4 cfs 0.240 af
Primary=3.4 cfs 0.240 af

Pond DP-1p: (new Pond) Inflow=3.4 cfs 0.240 af
Primary=3.4 cfs 0.240 af

Pond DP-2e: (new Pond) Inflow=3.0 cfs 0.212 af
Primary=3.0 cfs 0.212 af

Pond DP-2p: (new Pond) Inflow=2.8 cfs 0.151 af
Primary=2.8 cfs 0.151 af

Pond UGI: Underground Infiltration System Peak Elev=261.27' Storage=884 cf Inflow=1.9 cfs 0.143 af
Discarded=0.0 cfs 0.064 af Primary=1.8 cfs 0.079 af Outflow=1.9 cfs 0.143 af

Total Runoff Area = 2.794 ac Runoff Volume = 0.906 af Average Runoff Depth = 3.89"
62.88% Pervious = 1.757 ac 37.12% Impervious = 1.037 ac

Summary for Subcatchment E-1A: Rear Left

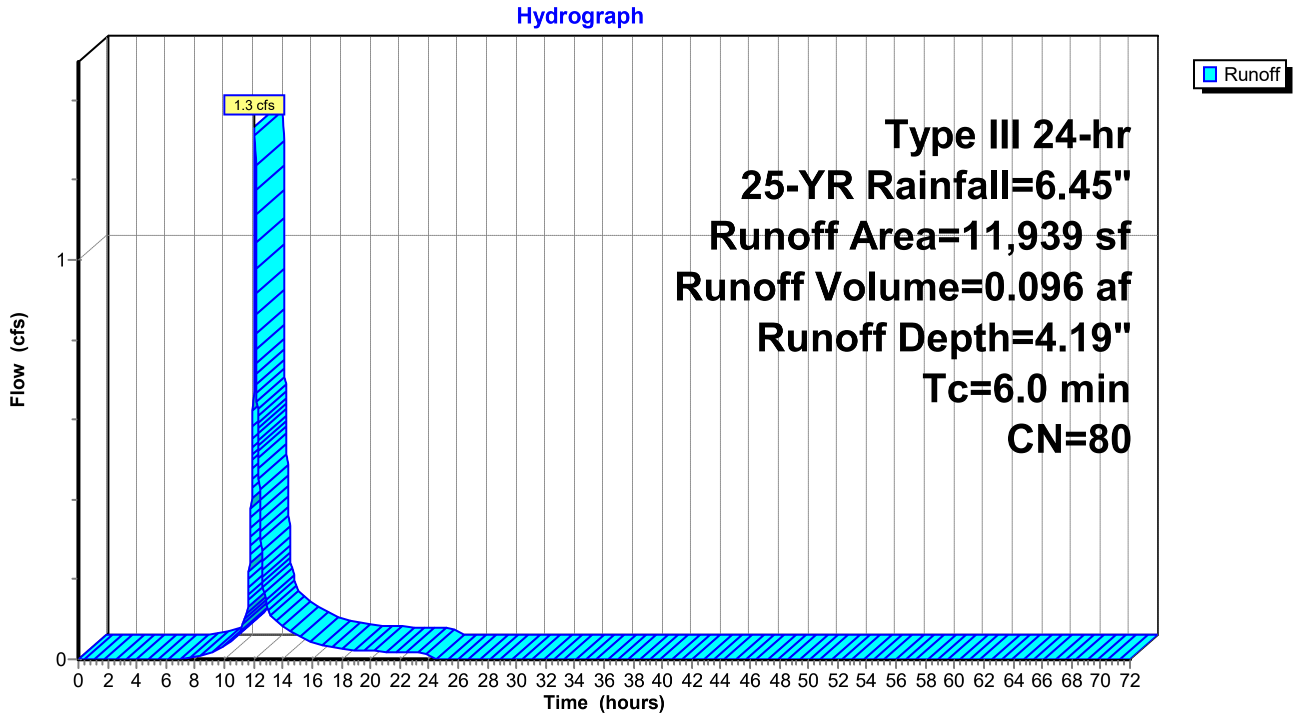
Runoff = 1.3 cfs @ 12.09 hrs, Volume= 0.096 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-YR Rainfall=6.45"

Area (sf)	CN	Description
7,025	98	Roofs, HSG A
3,350	36	Woods, Fair, HSG A
1,564	96	Gravel surface, HSG A
11,939	80	Weighted Average
4,914		41.16% Pervious Area
7,025		58.84% Impervious Area

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

Subcatchment E-1A: Rear Left



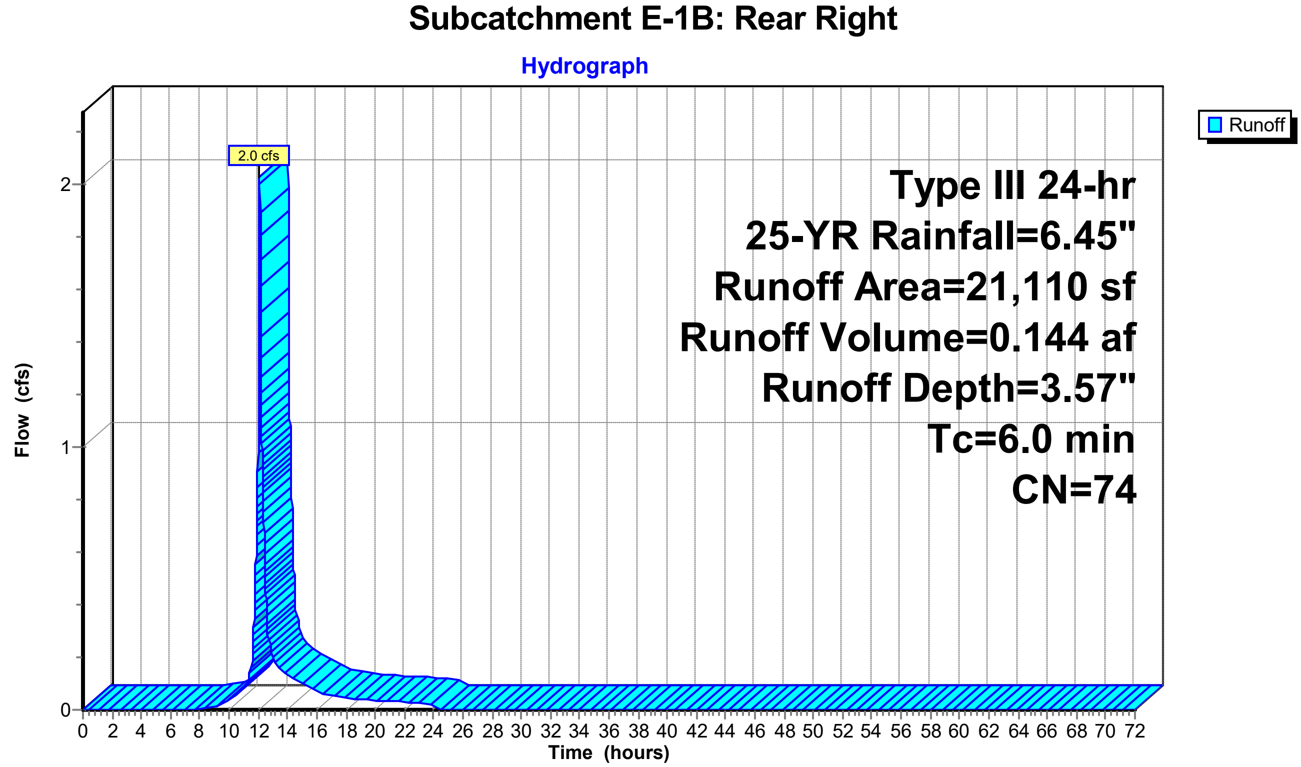
Summary for Subcatchment E-1B: Rear Right

Runoff = 2.0 cfs @ 12.09 hrs, Volume= 0.144 af, Depth= 3.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-YR Rainfall=6.45"

	Area (sf)	CN	Description
	2,463	98	Roofs, HSG A
	7,921	36	Woods, Fair, HSG A
	8,503	96	Gravel surface, HSG A
*	2,223	96	Gravel surface, HSG A
	21,110	74	Weighted Average
	18,647		88.33% Pervious Area
	2,463		11.67% Impervious Area

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



Summary for Subcatchment E-2: Front

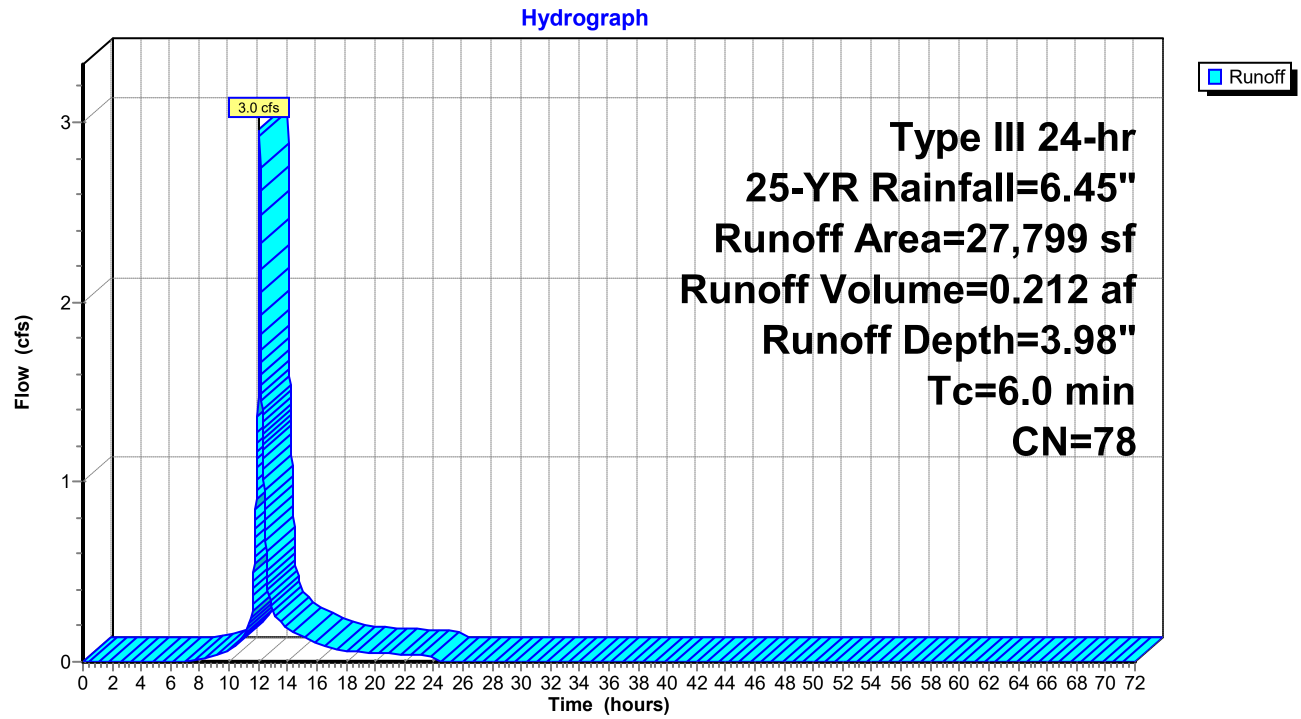
Runoff = 3.0 cfs @ 12.09 hrs, Volume= 0.212 af, Depth= 3.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-YR Rainfall=6.45"

	Area (sf)	CN	Description
	5,715	96	Gravel surface, HSG A
	12,220	98	Paved parking, HSG A
*	1,849	68	<50% Grass cover, Poor, HSG A
	8,015	36	Woods, Fair, HSG A
	27,799	78	Weighted Average
	15,579		56.04% Pervious Area
	12,220		43.96% Impervious Area

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

Subcatchment E-2: Front



Summary for Subcatchment P-1A: Rear Left

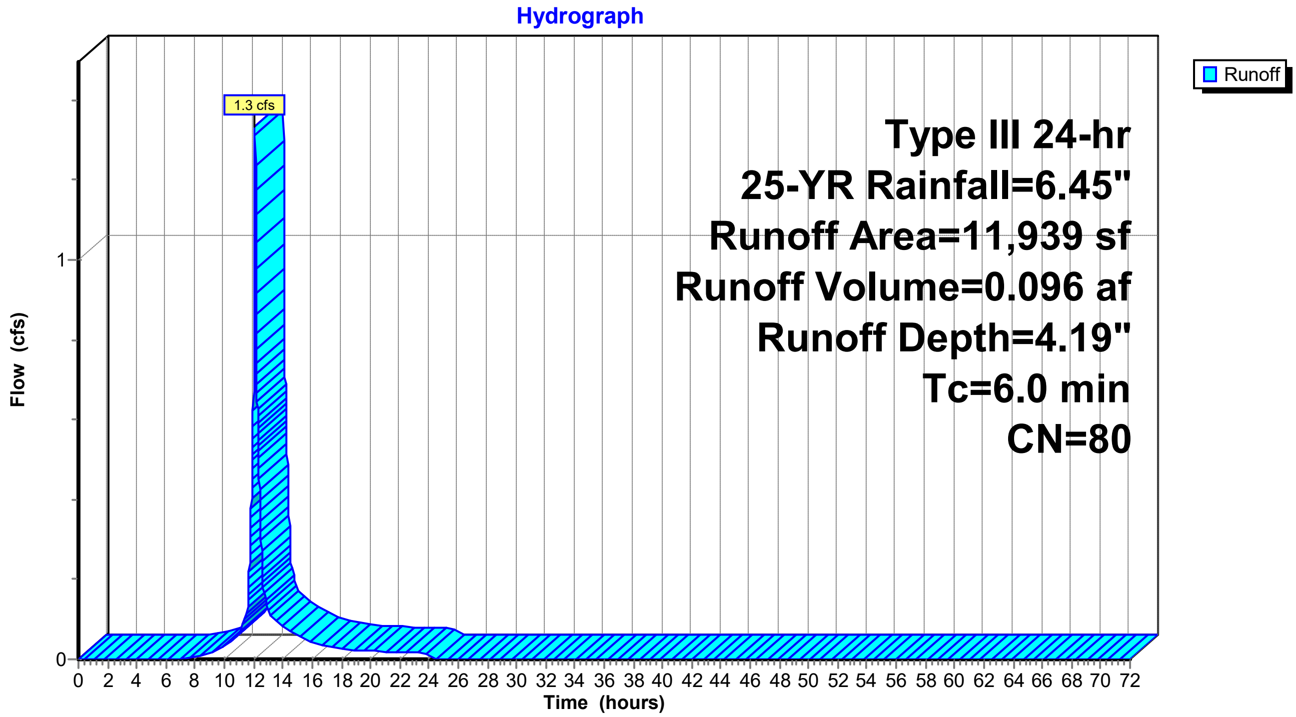
Runoff = 1.3 cfs @ 12.09 hrs, Volume= 0.096 af, Depth= 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-YR Rainfall=6.45"

Area (sf)	CN	Description
3,350	36	Woods, Fair, HSG A
1,564	96	Gravel surface, HSG A
7,025	98	Roofs, HSG A
11,939	80	Weighted Average
4,914		41.16% Pervious Area
7,025		58.84% Impervious Area

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

Subcatchment P-1A: Rear Left



Summary for Subcatchment P-1B: Rear Right

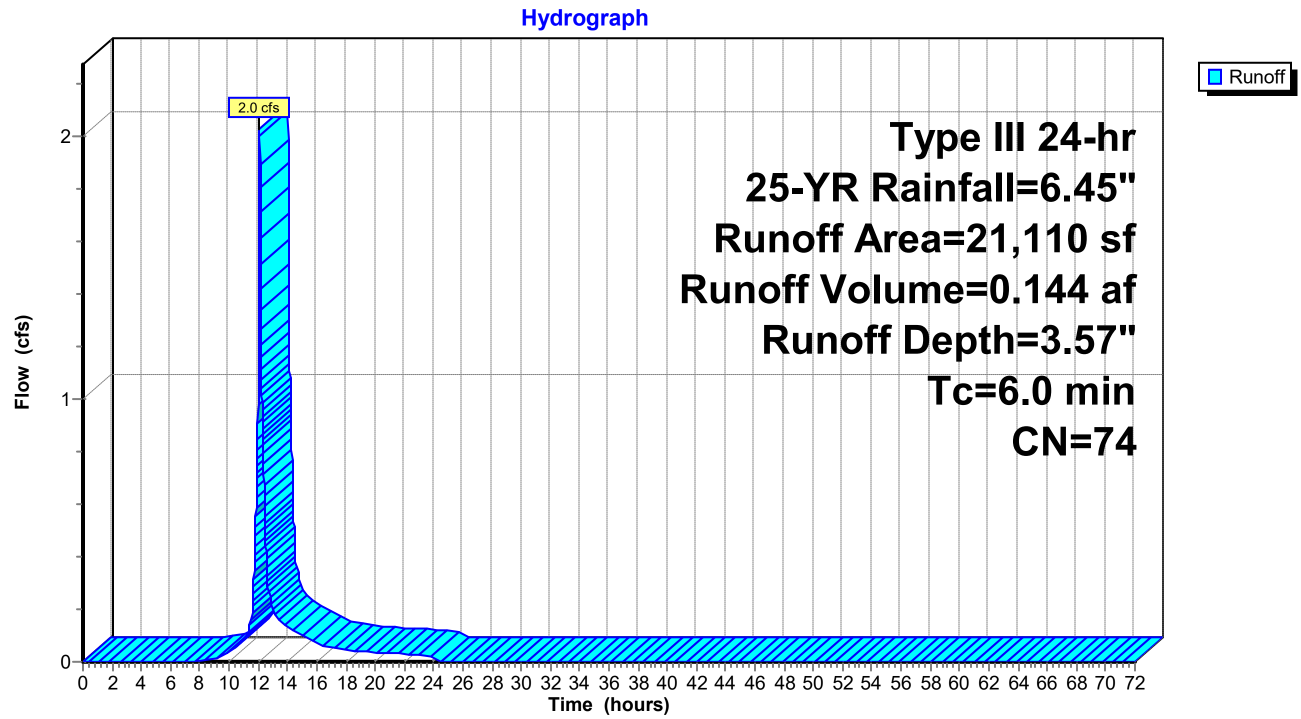
Runoff = 2.0 cfs @ 12.09 hrs, Volume= 0.144 af, Depth= 3.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-YR Rainfall=6.45"

	Area (sf)	CN	Description
	7,921	36	Woods, Fair, HSG A
	2,463	98	Roofs, HSG A
	8,503	96	Gravel surface, HSG A
*	2,223	96	Gravel surface, HSG A
	21,110	74	Weighted Average
	18,647		88.33% Pervious Area
	2,463		11.67% Impervious Area

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

Subcatchment P-1B: Rear Right



Summary for Subcatchment P-2A: Front

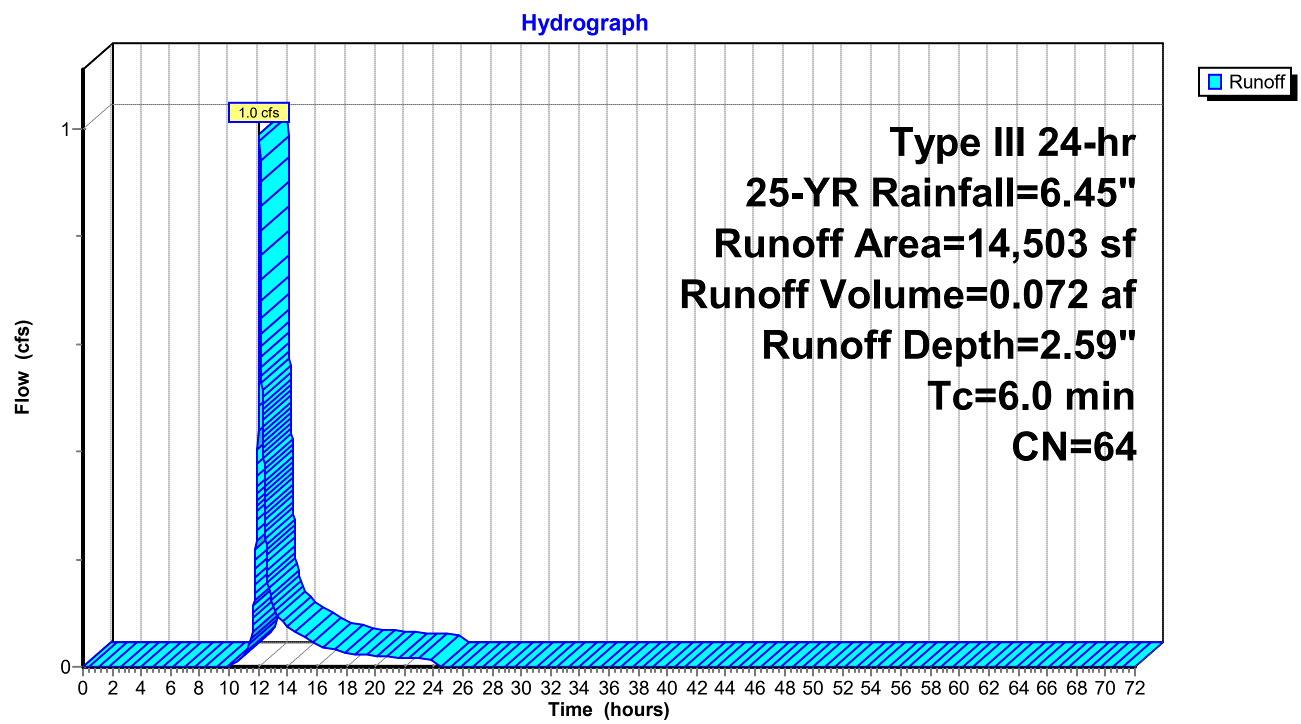
Runoff = 1.0 cfs @ 12.09 hrs, Volume= 0.072 af, Depth= 2.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-YR Rainfall=6.45"

Area (sf)	CN	Description
2,000	96	Gravel surface, HSG A
794	68	<50% Grass cover, Poor, HSG A
7,529	36	Woods, Fair, HSG A
4,180	98	Paved parking, HSG A
14,503	64	Weighted Average
10,323		71.18% Pervious Area
4,180		28.82% Impervious Area

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

Subcatchment P-2A: Front



Summary for Subcatchment P-2B: Front

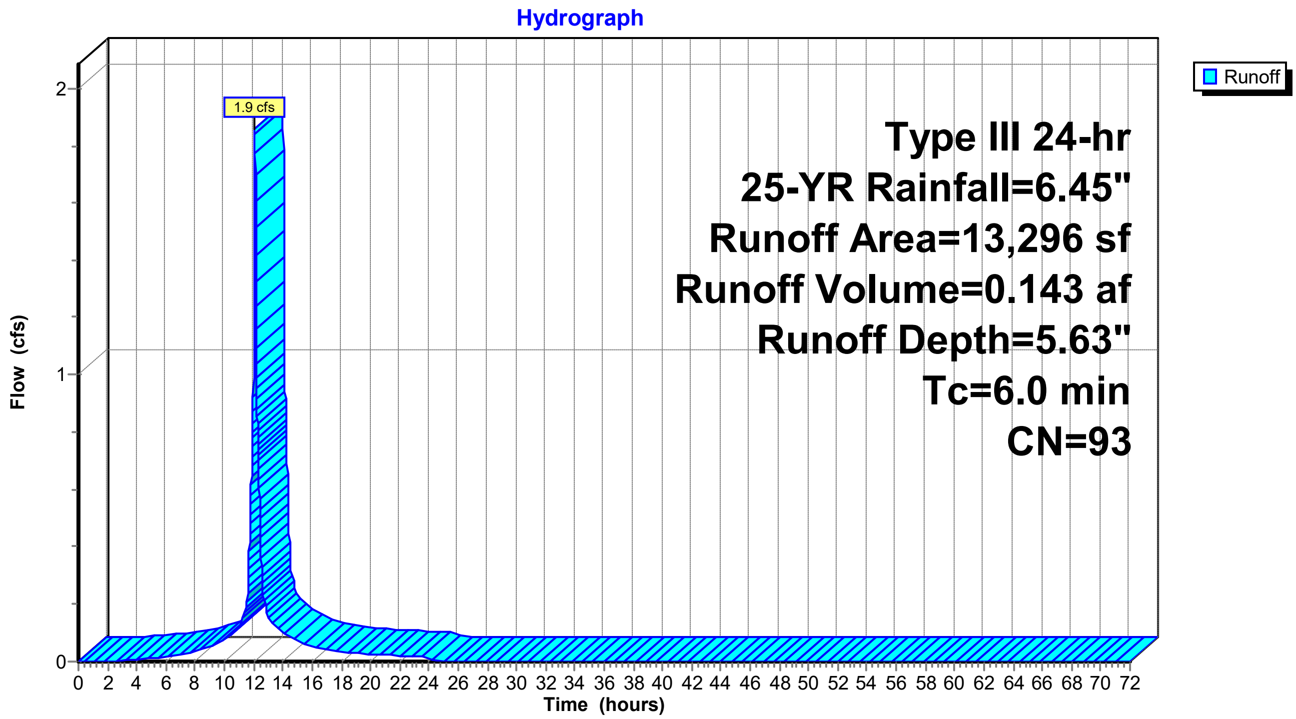
Runoff = 1.9 cfs @ 12.08 hrs, Volume= 0.143 af, Depth= 5.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-YR Rainfall=6.45"

	Area (sf)	CN	Description
	1,925	96	Gravel surface, HSG A
	1,086	68	<50% Grass cover, Poor, HSG A
	484	36	Woods, Fair, HSG A
	6,193	98	Paved parking, HSG A
*	3,608	98	Paved parking, HSG A
	13,296	93	Weighted Average
	3,495		26.29% Pervious Area
	9,801		73.71% Impervious Area

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

Subcatchment P-2B: Front



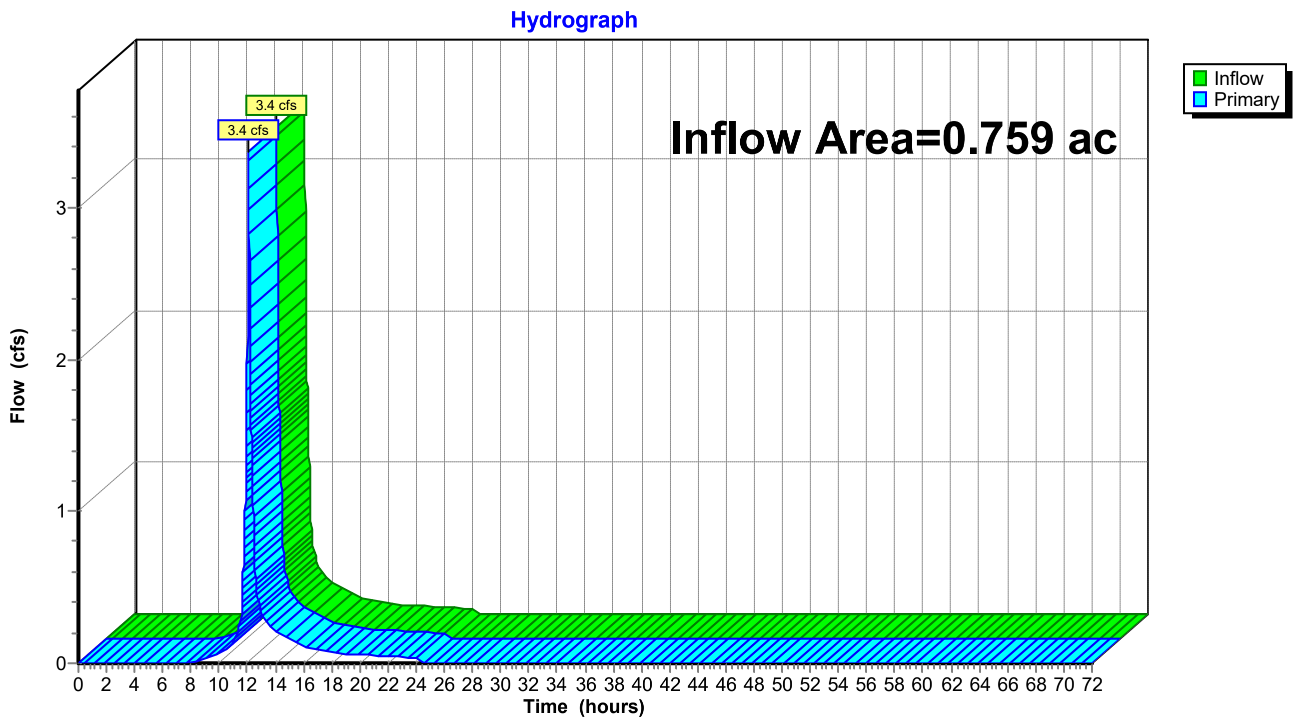
Summary for Pond DP-1e: (new Pond)

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

Inflow Area = 0.759 ac, 28.71% Impervious, Inflow Depth = 3.79" for 25-YR event
Inflow = 3.4 cfs @ 12.09 hrs, Volume= 0.240 af
Primary = 3.4 cfs @ 12.09 hrs, Volume= 0.240 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-1e: (new Pond)



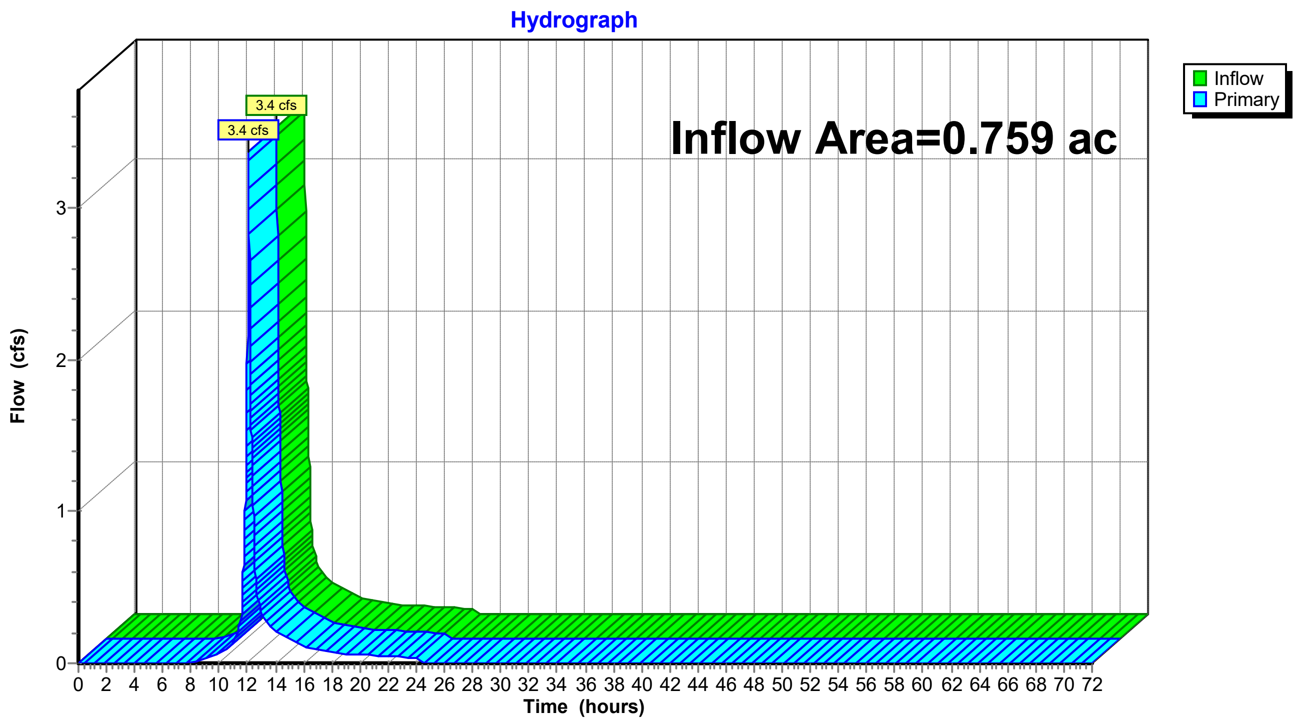
Summary for Pond DP-1p: (new Pond)

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

Inflow Area = 0.759 ac, 28.71% Impervious, Inflow Depth = 3.79" for 25-YR event
Inflow = 3.4 cfs @ 12.09 hrs, Volume= 0.240 af
Primary = 3.4 cfs @ 12.09 hrs, Volume= 0.240 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-1p: (new Pond)



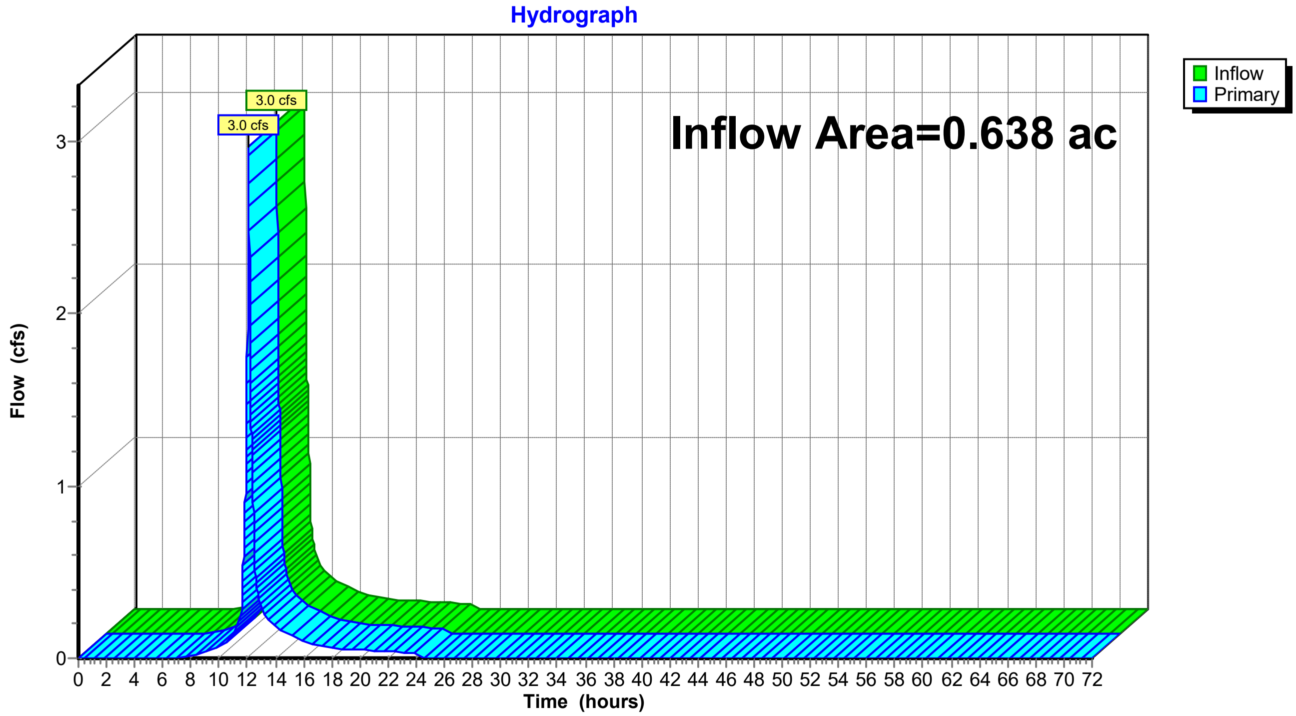
Summary for Pond DP-2e: (new Pond)

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

Inflow Area =	0.638 ac, 43.96% Impervious, Inflow Depth = 3.98" for 25-YR event			
Inflow =	3.0 cfs @	12.09 hrs, Volume=	0.212 af	
Primary =	3.0 cfs @	12.09 hrs, Volume=	0.212 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-2e: (new Pond)



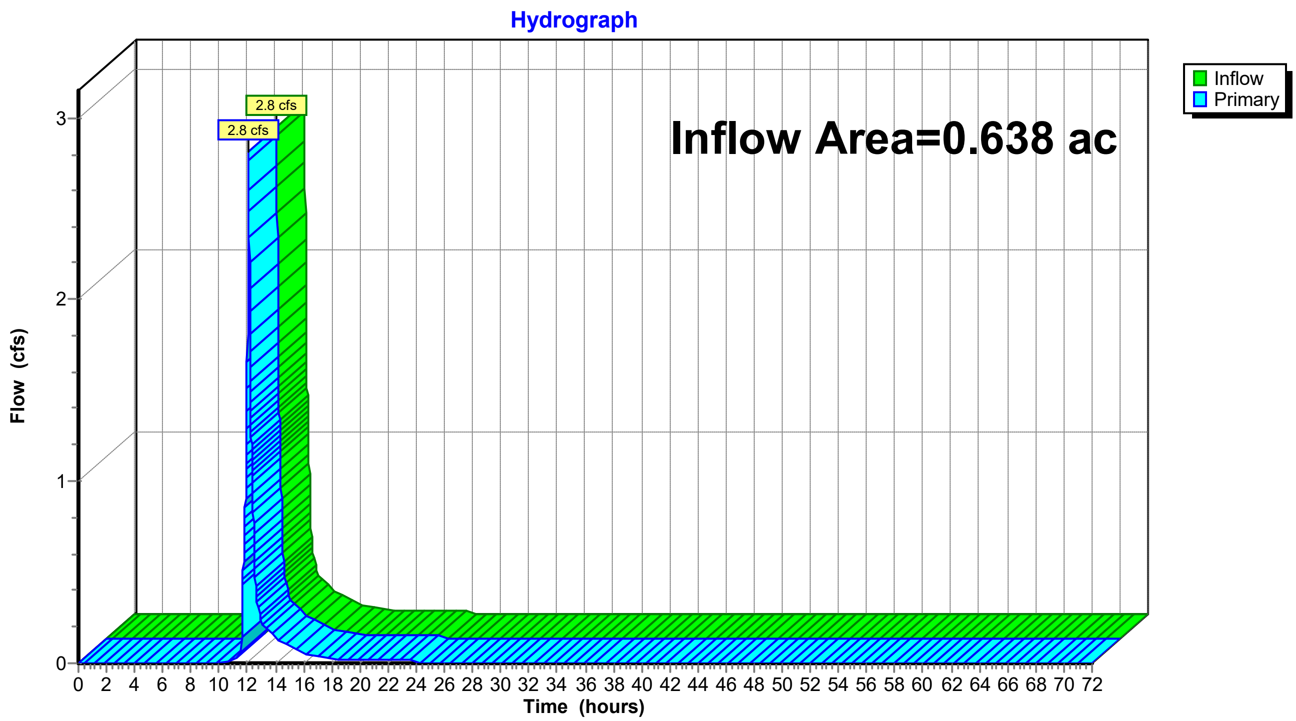
Summary for Pond DP-2p: (new Pond)

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

Inflow Area =	0.638 ac, 50.29% Impervious, Inflow Depth = 2.84"	for 25-YR event
Inflow =	2.8 cfs @ 12.09 hrs, Volume=	0.151 af
Primary =	2.8 cfs @ 12.09 hrs, Volume=	0.151 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-2p: (new Pond)



Summary for Pond UGI: Underground Infiltration System

Inflow Area = 0.305 ac, 73.71% Impervious, Inflow Depth = 5.63" for 25-YR event
Inflow = 1.9 cfs @ 12.08 hrs, Volume= 0.143 af
Outflow = 1.9 cfs @ 12.08 hrs, Volume= 0.143 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.0 cfs @ 12.08 hrs, Volume= 0.064 af
Primary = 1.8 cfs @ 12.08 hrs, Volume= 0.079 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 261.27' @ 12.08 hrs Surf.Area= 363 sf Storage= 884 cf

Plug-Flow detention time= 129.2 min calculated for 0.143 af (100% of inflow)
Center-of-Mass det. time= 129.4 min (900.4 - 771.0)

Volume	Invert	Avail.Storage	Storage Description
#1	259.60'	25 cf	**4.00'D x 2.00'H CB1** -Impervious
#2	259.60'	8 cf	**12.0" Round Pipe Storage** -Impervious L= 10.0' S= 0.0100 '/'
#3	257.79'	54 cf	**4.00'D x 4.30'H DMH1** -Impervious
#4	259.40'	3 cf	**12.0" Round Pipe Storage** -Impervious L= 4.0'
#5A	257.29'	325 cf	**11.33'W x 32.00'L x 3.21'H Field A** 1,164 cf Overall - 352 cf Embedded = 811 cf x 40.0% Voids
#6A	257.79'	352 cf	**Cultec R-280HD** x 8 Inside #5 Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap Row Length Adjustment= +1.00' x 6.07 sf x 2 rows
#7	257.79'	4 cf	**12.0" Round Pipe Storage** -Impervious L= 5.0'
#8	257.79'	58 cf	**4.00'D x 4.60'H DMH2** -Impervious
#9	257.22'	37 cf	**12.0" Round Pipe Storage** -Impervious L= 47.0' S= 0.0100 '/'
#10	257.22'	48 cf	**4.00'D x 3.78'H CB2** -Impervious
		913 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	257.29'	**2.410 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 1.00'
#2	Primary	261.60'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	261.10'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.0 cfs @ 12.08 hrs HW=261.27' (Free Discharge)
└─**1=Exfiltration** (Controls 0.0 cfs)

Primary OutFlow Max=1.8 cfs @ 12.08 hrs HW=261.27' (Free Discharge)
├─**2=Orifice/Grate** (Controls 0.0 cfs)
└─**3=Orifice/Grate** (Weir Controls 1.8 cfs @ 1.34 fps)

Pond UGI: Underground Infiltration System - Chamber Wizard Field A

Chamber Model = Cultec R-280HD (Cultec Recharger® 280HD)
Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf
Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap
Row Length Adjustment= +1.00' x 6.07 sf x 2 rows

47.0" Wide + 6.0" Spacing = 53.0" C-C Row Spacing

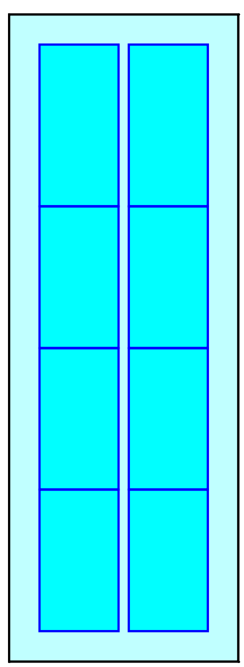
4 Chambers/Row x 7.00' Long +1.00' Row Adjustment = 29.00' Row Length +18.0" End Stone x 2 = 32.00' Base Length
2 Rows x 47.0" Wide + 6.0" Spacing x 1 + 18.0" Side Stone x 2 = 11.33' Base Width
6.0" Base + 26.5" Chamber Height + 6.0" Cover = 3.21' Field Height

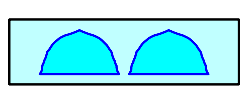
8 Chambers x 42.5 cf +1.00' Row Adjustment x 6.07 sf x 2 Rows = 352.2 cf Chamber Storage

1,163.6 cf Field - 352.2 cf Chambers = 811.4 cf Stone x 40.0% Voids = 324.6 cf Stone Storage

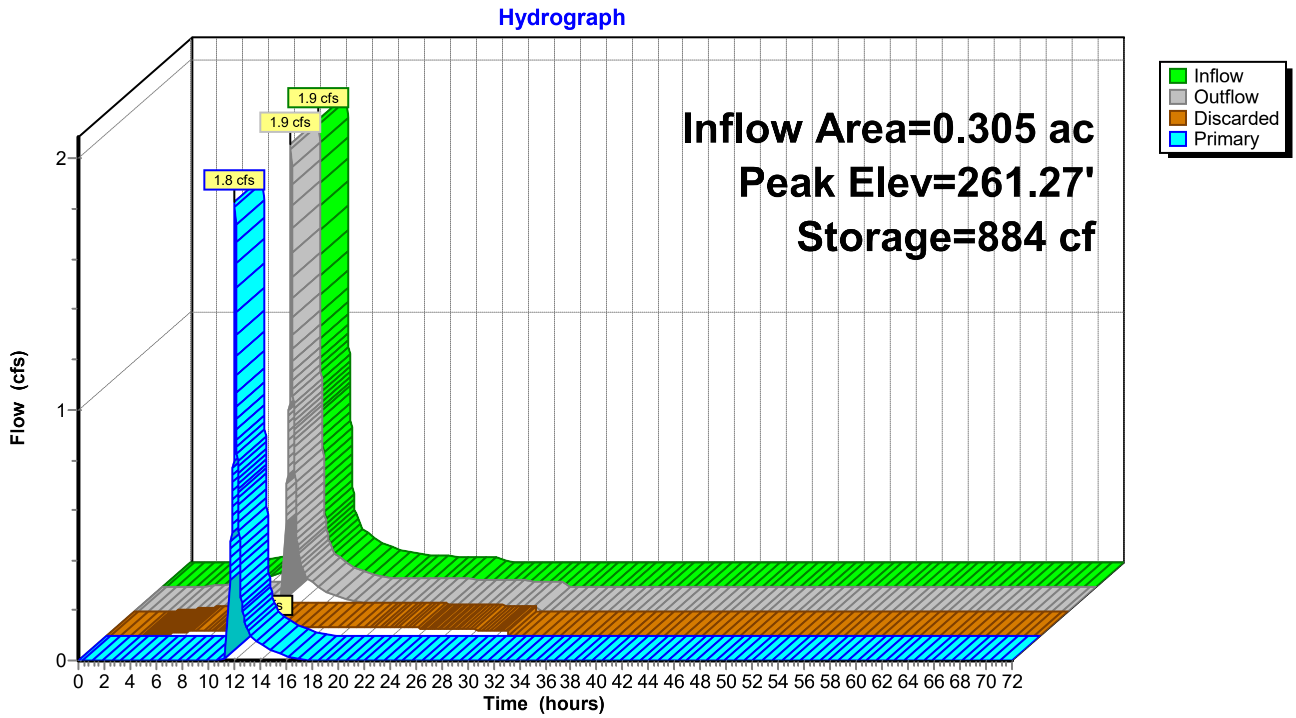
Chamber Storage + Stone Storage = 676.7 cf = 0.016 af
Overall Storage Efficiency = 58.2%
Overall System Size = 32.00' x 11.33' x 3.21'

8 Chambers
43.1 cy Field
30.1 cy Stone





Pond UGI: Underground Infiltration System



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment E-1A: Rear Left Runoff Area=11,939 sf 58.84% Impervious Runoff Depth=4.99"
Tc=6.0 min CN=80 Runoff=1.6 cfs 0.114 af

Subcatchment E-1B: Rear Right Runoff Area=21,110 sf 11.67% Impervious Runoff Depth=4.32"
Tc=6.0 min CN=74 Runoff=2.5 cfs 0.175 af

Subcatchment E-2: Front Runoff Area=27,799 sf 43.96% Impervious Runoff Depth=4.77"
Tc=6.0 min CN=78 Runoff=3.5 cfs 0.253 af

Subcatchment P-1A: Rear Left Runoff Area=11,939 sf 58.84% Impervious Runoff Depth=4.99"
Tc=6.0 min CN=80 Runoff=1.6 cfs 0.114 af

Subcatchment P-1B: Rear Right Runoff Area=21,110 sf 11.67% Impervious Runoff Depth=4.32"
Tc=6.0 min CN=74 Runoff=2.5 cfs 0.175 af

Subcatchment P-2A: Front Runoff Area=14,503 sf 28.82% Impervious Runoff Depth=3.25"
Tc=6.0 min CN=64 Runoff=1.3 cfs 0.090 af

Subcatchment P-2B: Front Runoff Area=13,296 sf 73.71% Impervious Runoff Depth=6.49"
Tc=6.0 min CN=93 Runoff=2.1 cfs 0.165 af

Pond DP-1e: (new Pond) Inflow=4.0 cfs 0.289 af
Primary=4.0 cfs 0.289 af

Pond DP-1p: (new Pond) Inflow=4.0 cfs 0.289 af
Primary=4.0 cfs 0.289 af

Pond DP-2e: (new Pond) Inflow=3.5 cfs 0.253 af
Primary=3.5 cfs 0.253 af

Pond DP-2p: (new Pond) Inflow=3.3 cfs 0.188 af
Primary=3.3 cfs 0.188 af

Pond UGI: Underground Infiltration System Peak Elev=261.28' Storage=885 cf Inflow=2.1 cfs 0.165 af
Discarded=0.0 cfs 0.067 af Primary=2.1 cfs 0.098 af Outflow=2.1 cfs 0.165 af

Total Runoff Area = 2.794 ac Runoff Volume = 1.086 af Average Runoff Depth = 4.66"
62.88% Pervious = 1.757 ac 37.12% Impervious = 1.037 ac

Summary for Subcatchment E-1A: Rear Left

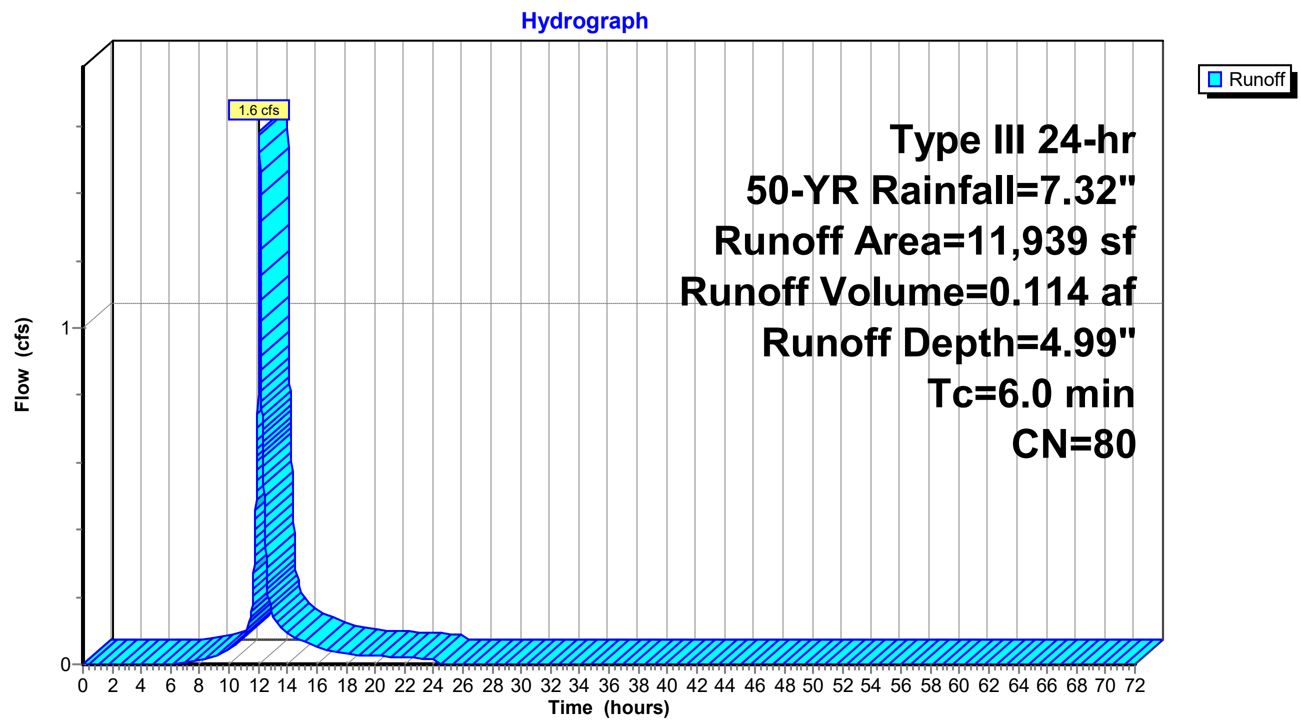
Runoff = 1.6 cfs @ 12.09 hrs, Volume= 0.114 af, Depth= 4.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-YR Rainfall=7.32"

Area (sf)	CN	Description
7,025	98	Roofs, HSG A
3,350	36	Woods, Fair, HSG A
1,564	96	Gravel surface, HSG A
11,939	80	Weighted Average
4,914		41.16% Pervious Area
7,025		58.84% Impervious Area

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

Subcatchment E-1A: Rear Left



Summary for Subcatchment E-1B: Rear Right

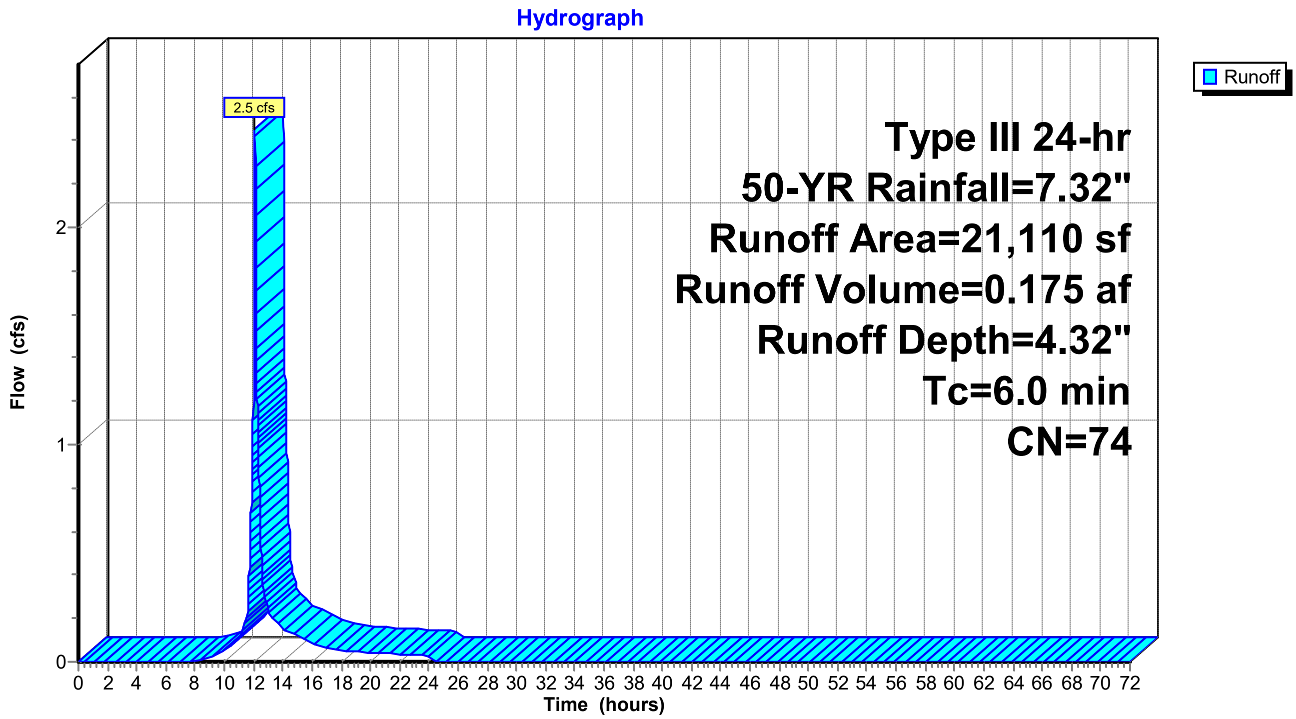
Runoff = 2.5 cfs @ 12.09 hrs, Volume= 0.175 af, Depth= 4.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-YR Rainfall=7.32"

	Area (sf)	CN	Description
	2,463	98	Roofs, HSG A
	7,921	36	Woods, Fair, HSG A
	8,503	96	Gravel surface, HSG A
*	2,223	96	Gravel surface, HSG A
	21,110	74	Weighted Average
	18,647		88.33% Pervious Area
	2,463		11.67% Impervious Area

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

Subcatchment E-1B: Rear Right



Summary for Subcatchment E-2: Front

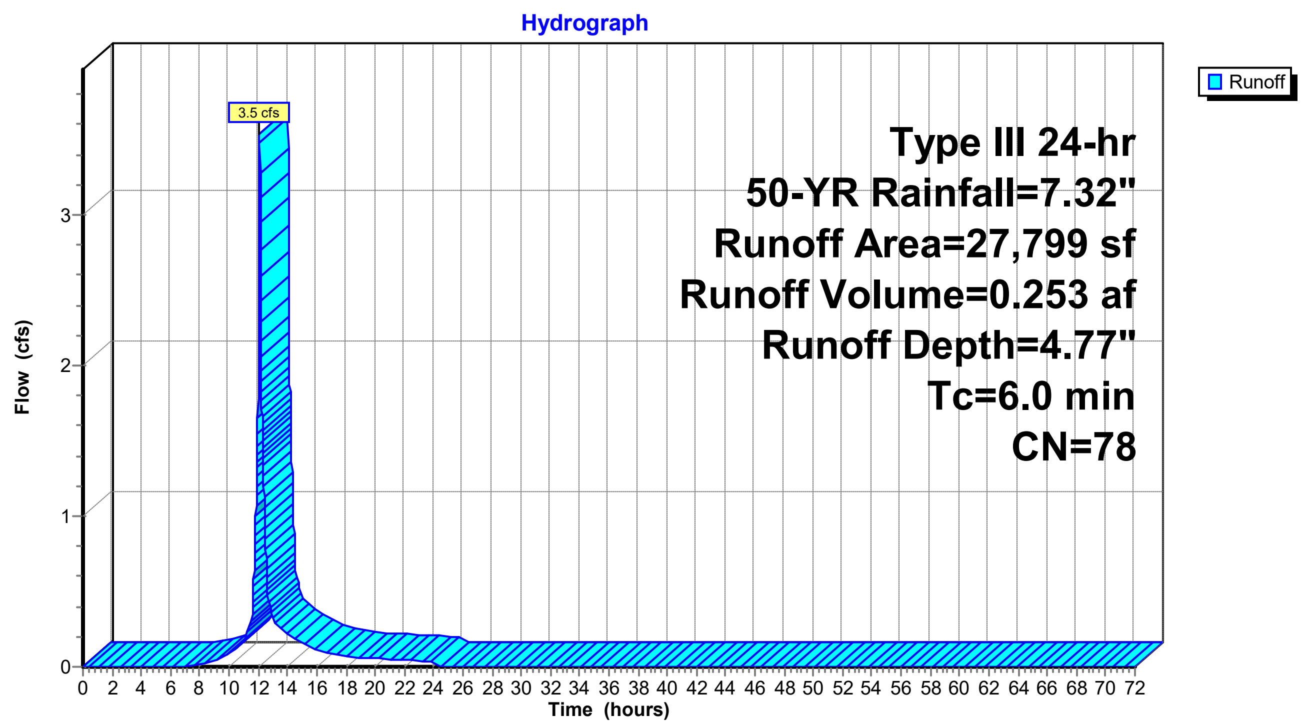
Runoff = 3.5 cfs @ 12.09 hrs, Volume= 0.253 af, Depth= 4.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-YR Rainfall=7.32"

	Area (sf)	CN	Description
	5,715	96	Gravel surface, HSG A
	12,220	98	Paved parking, HSG A
*	1,849	68	<50% Grass cover, Poor, HSG A
	8,015	36	Woods, Fair, HSG A
	27,799	78	Weighted Average
	15,579		56.04% Pervious Area
	12,220		43.96% Impervious Area

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

Subcatchment E-2: Front



Summary for Subcatchment P-1A: Rear Left

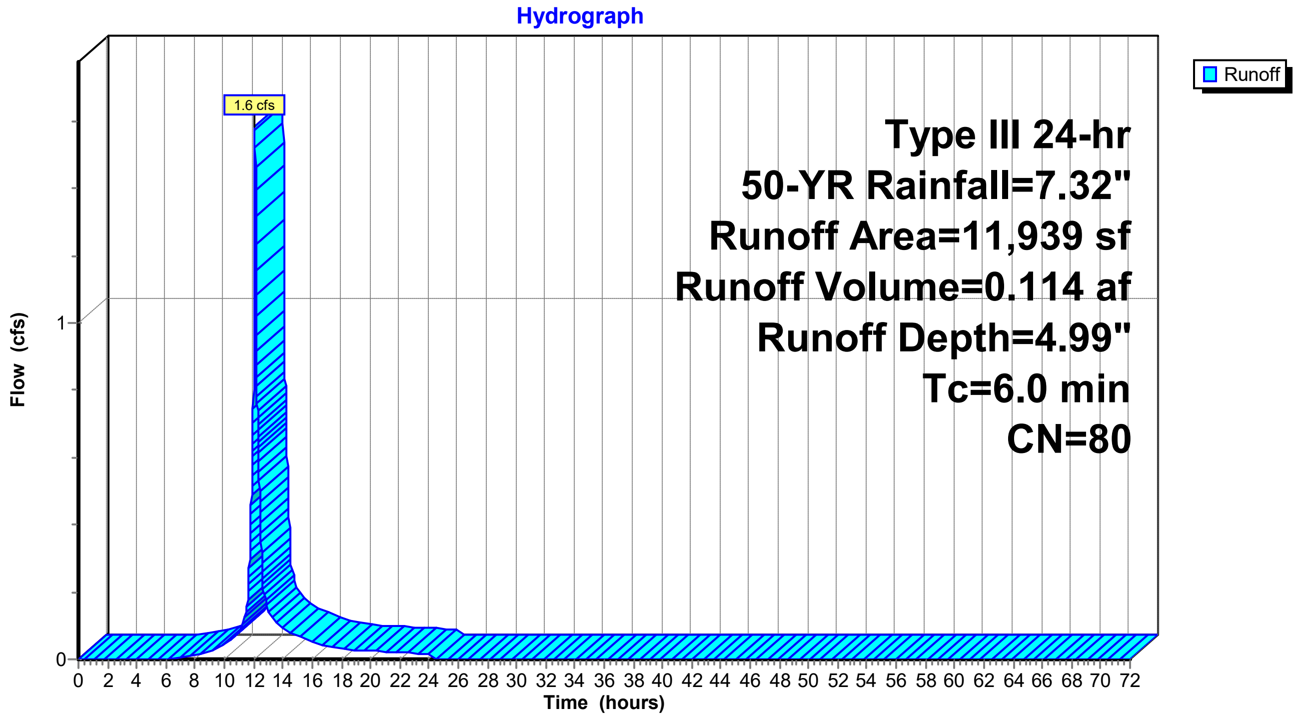
Runoff = 1.6 cfs @ 12.09 hrs, Volume= 0.114 af, Depth= 4.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-YR Rainfall=7.32"

Area (sf)	CN	Description
3,350	36	Woods, Fair, HSG A
1,564	96	Gravel surface, HSG A
7,025	98	Roofs, HSG A
11,939	80	Weighted Average
4,914		41.16% Pervious Area
7,025		58.84% Impervious Area

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

Subcatchment P-1A: Rear Left



Summary for Subcatchment P-1B: Rear Right

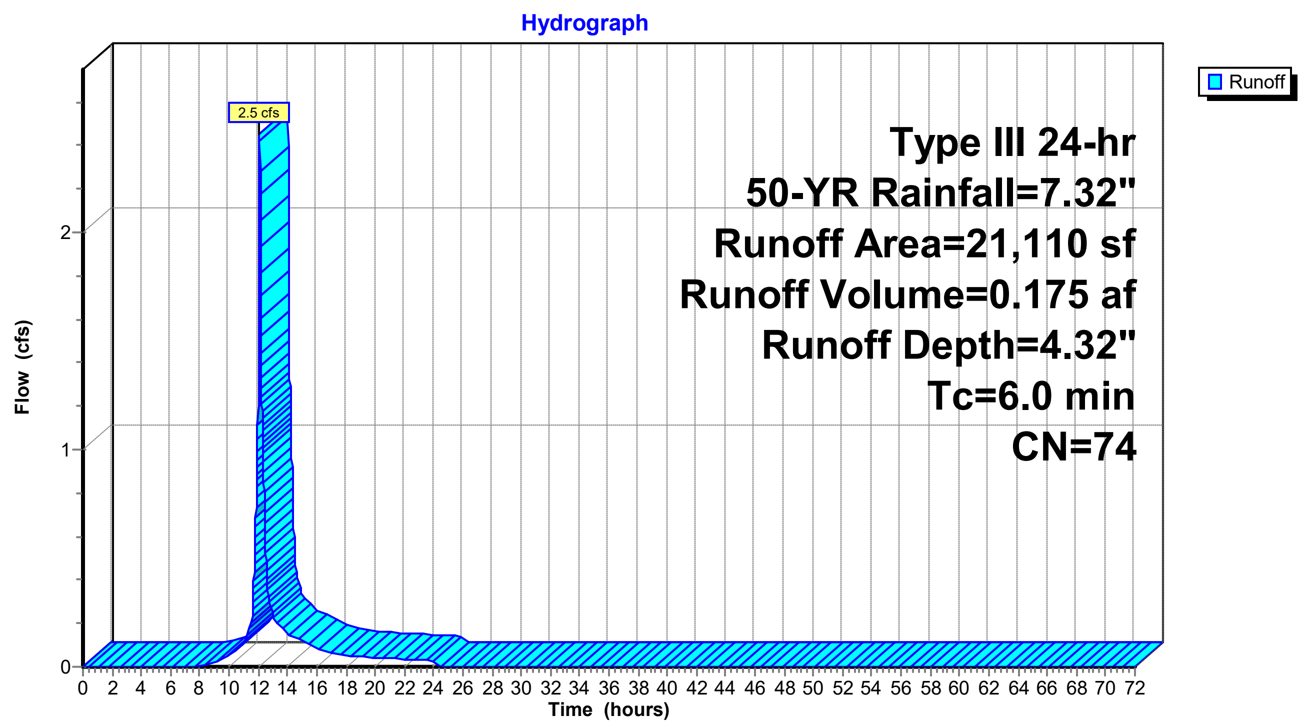
Runoff = 2.5 cfs @ 12.09 hrs, Volume= 0.175 af, Depth= 4.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-YR Rainfall=7.32"

	Area (sf)	CN	Description
	7,921	36	Woods, Fair, HSG A
	2,463	98	Roofs, HSG A
	8,503	96	Gravel surface, HSG A
*	2,223	96	Gravel surface, HSG A
	21,110	74	Weighted Average
	18,647		88.33% Pervious Area
	2,463		11.67% Impervious Area

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

Subcatchment P-1B: Rear Right



Summary for Subcatchment P-2A: Front

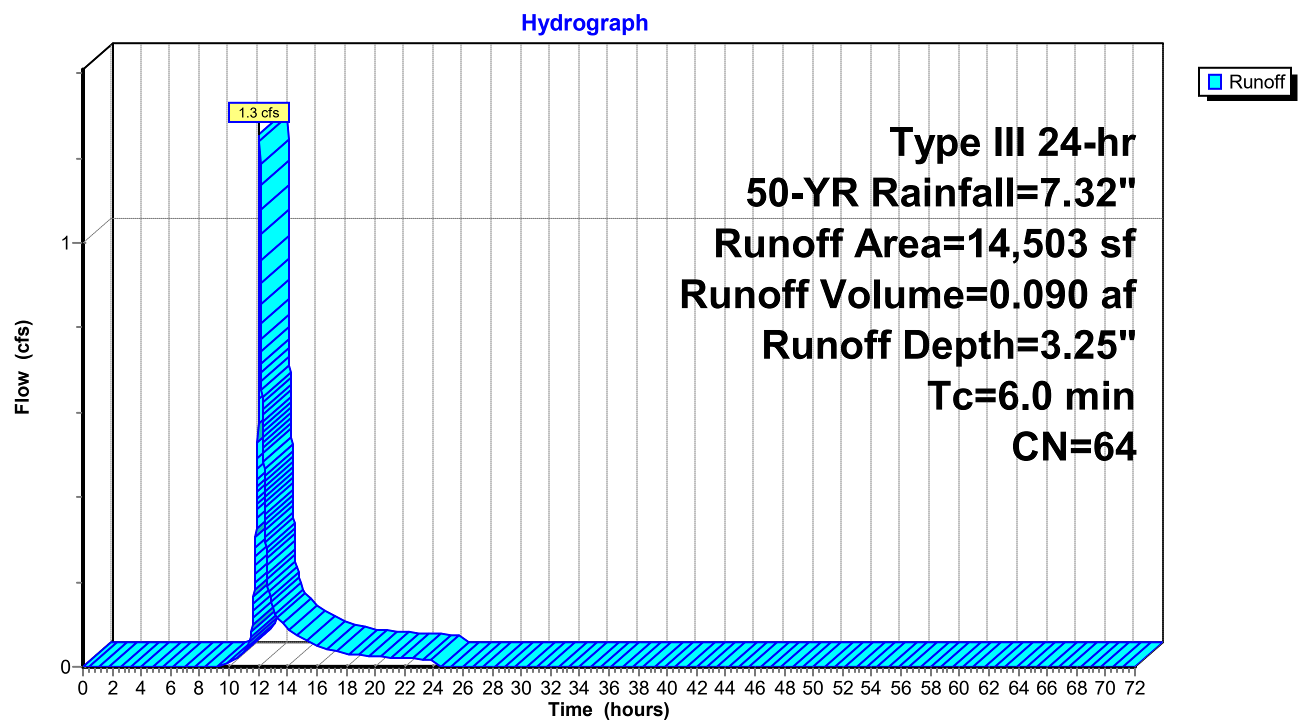
Runoff = 1.3 cfs @ 12.09 hrs, Volume= 0.090 af, Depth= 3.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-YR Rainfall=7.32"

Area (sf)	CN	Description
2,000	96	Gravel surface, HSG A
794	68	<50% Grass cover, Poor, HSG A
7,529	36	Woods, Fair, HSG A
4,180	98	Paved parking, HSG A
14,503	64	Weighted Average
10,323		71.18% Pervious Area
4,180		28.82% Impervious Area

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

Subcatchment P-2A: Front



Summary for Subcatchment P-2B: Front

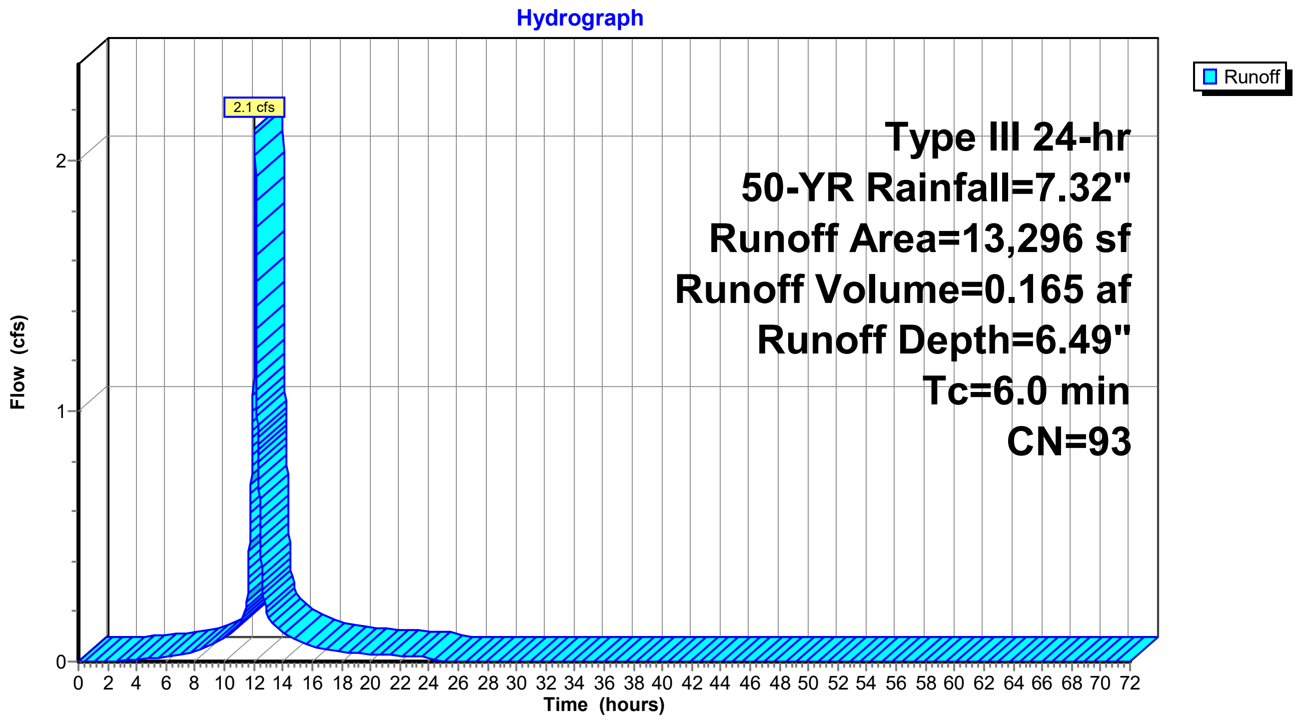
Runoff = 2.1 cfs @ 12.08 hrs, Volume= 0.165 af, Depth= 6.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-YR Rainfall=7.32"

	Area (sf)	CN	Description
	1,925	96	Gravel surface, HSG A
	1,086	68	<50% Grass cover, Poor, HSG A
	484	36	Woods, Fair, HSG A
	6,193	98	Paved parking, HSG A
*	3,608	98	Paved parking, HSG A
	13,296	93	Weighted Average
	3,495		26.29% Pervious Area
	9,801		73.71% Impervious Area

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

Subcatchment P-2B: Front

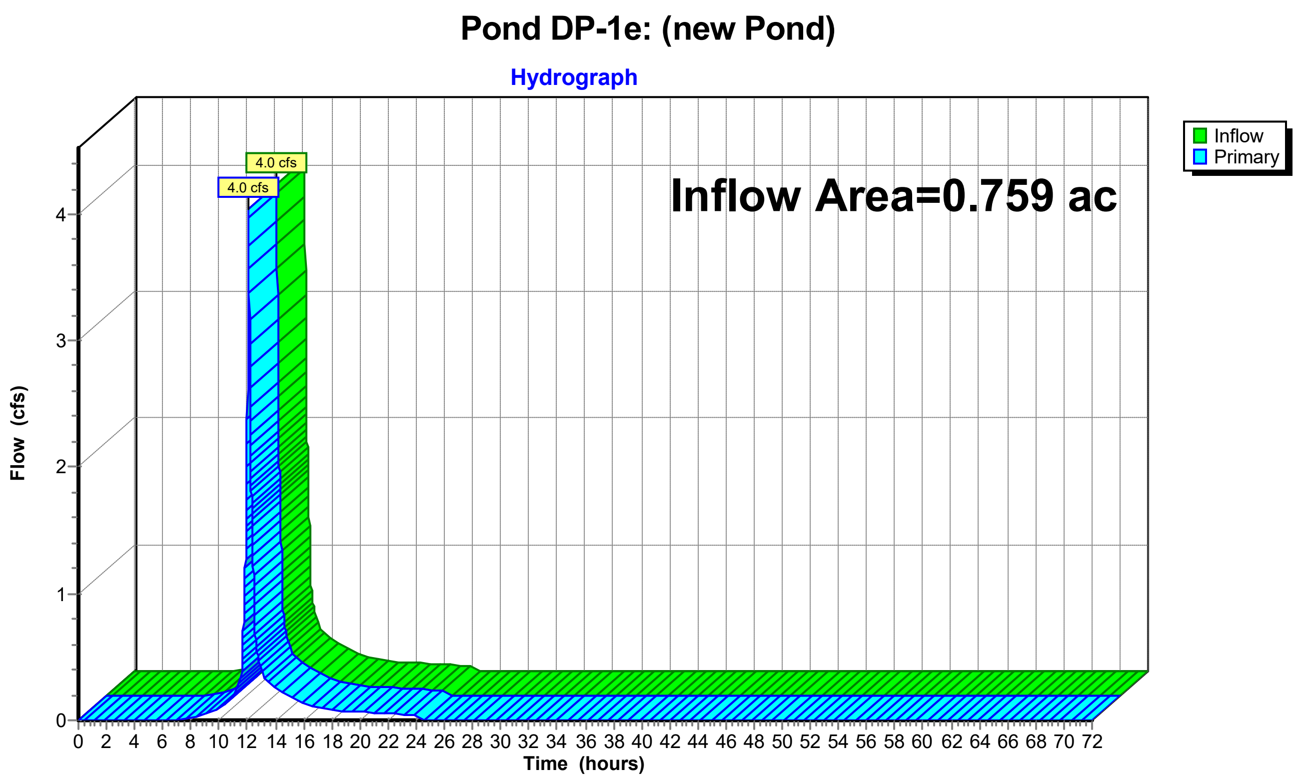


Summary for Pond DP-1e: (new Pond)

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

Inflow Area = 0.759 ac, 28.71% Impervious, Inflow Depth = 4.56" for 50-YR event
Inflow = 4.0 cfs @ 12.09 hrs, Volume= 0.289 af
Primary = 4.0 cfs @ 12.09 hrs, Volume= 0.289 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs



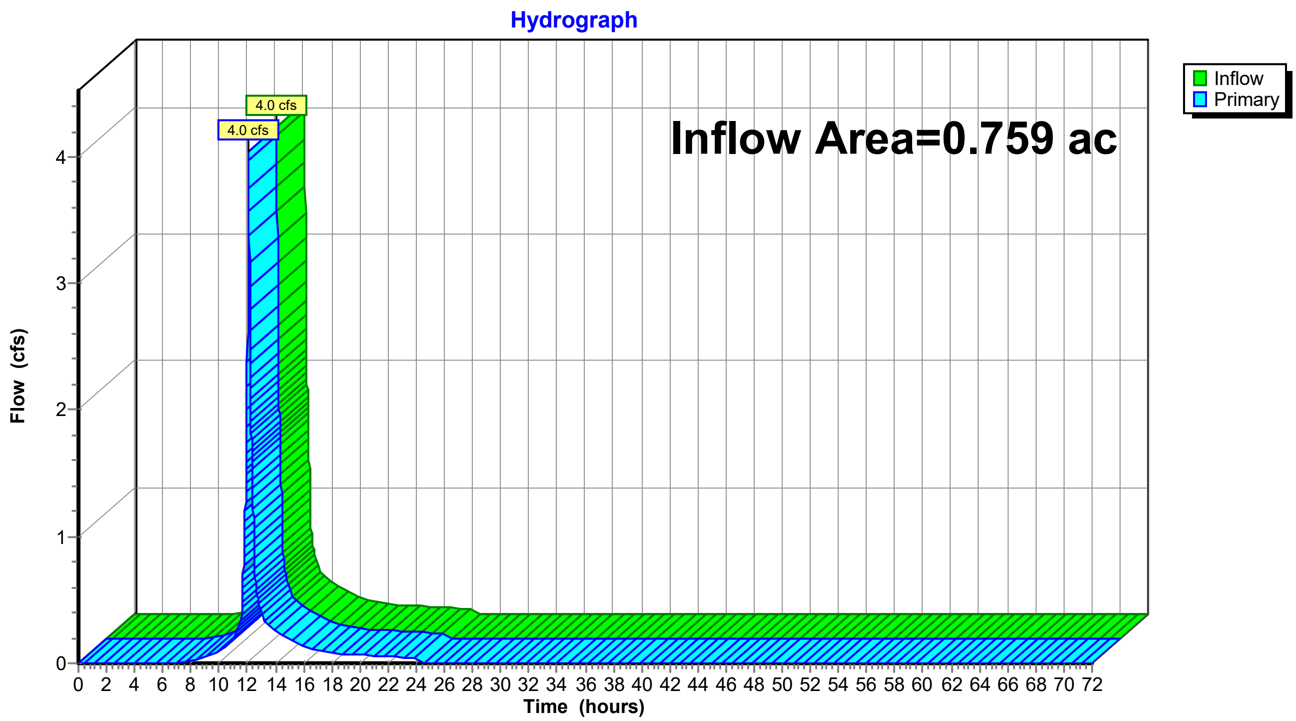
Summary for Pond DP-1p: (new Pond)

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

Inflow Area =	0.759 ac, 28.71% Impervious, Inflow Depth = 4.56" for 50-YR event			
Inflow =	4.0 cfs @	12.09 hrs, Volume=	0.289 af	
Primary =	4.0 cfs @	12.09 hrs, Volume=	0.289 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-1p: (new Pond)

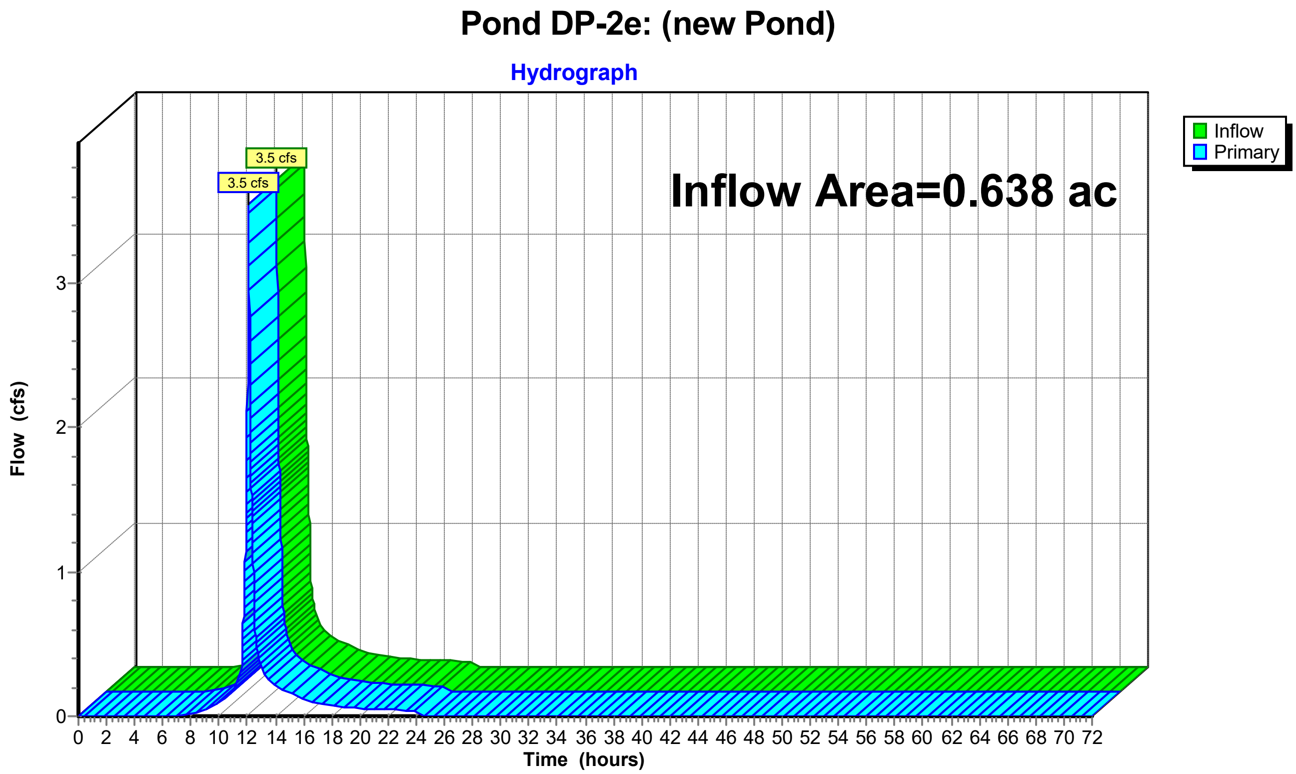


Summary for Pond DP-2e: (new Pond)

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

Inflow Area = 0.638 ac, 43.96% Impervious, Inflow Depth = 4.77" for 50-YR event
Inflow = 3.5 cfs @ 12.09 hrs, Volume= 0.253 af
Primary = 3.5 cfs @ 12.09 hrs, Volume= 0.253 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs



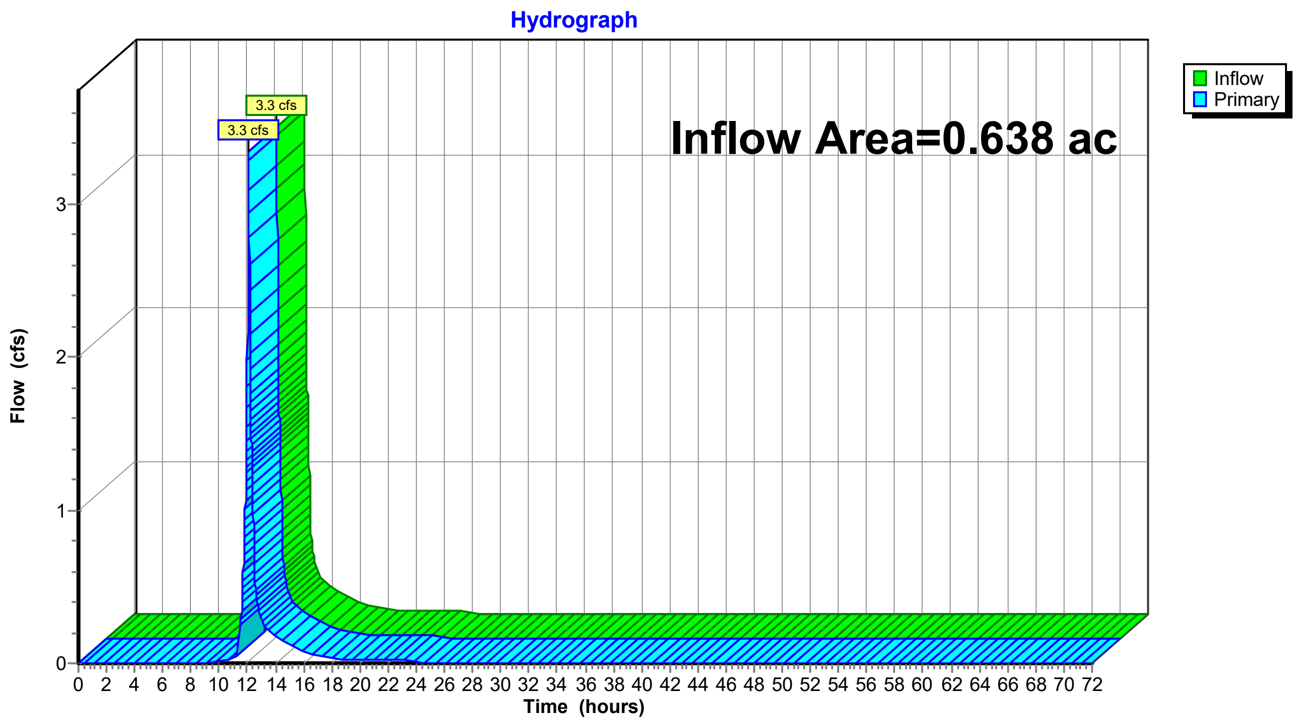
Summary for Pond DP-2p: (new Pond)

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

Inflow Area = 0.638 ac, 50.29% Impervious, Inflow Depth = 3.53" for 50-YR event
Inflow = 3.3 cfs @ 12.09 hrs, Volume= 0.188 af
Primary = 3.3 cfs @ 12.09 hrs, Volume= 0.188 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-2p: (new Pond)



Summary for Pond UGI: Underground Infiltration System

Inflow Area =	0.305 ac, 73.71% Impervious,	Inflow Depth = 6.49"	for 50-YR event
Inflow =	2.1 cfs @ 12.08 hrs,	Volume=	0.165 af
Outflow =	2.1 cfs @ 12.08 hrs,	Volume=	0.165 af, Atten= 0%, Lag= 0.0 min
Discarded =	0.0 cfs @ 12.08 hrs,	Volume=	0.067 af
Primary =	2.1 cfs @ 12.08 hrs,	Volume=	0.098 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 261.28' @ 12.08 hrs Surf.Area= 363 sf Storage= 885 cf

Plug-Flow detention time= 120.1 min calculated for 0.165 af (100% of inflow)
Center-of-Mass det. time= 120.0 min (887.6 - 767.6)

Volume	Invert	Avail.Storage	Storage Description
#1	259.60'	25 cf	**4.00'D x 2.00'H CB1** -Impervious
#2	259.60'	8 cf	**12.0" Round Pipe Storage** -Impervious L= 10.0' S= 0.0100 '/'
#3	257.79'	54 cf	**4.00'D x 4.30'H DMH1** -Impervious
#4	259.40'	3 cf	**12.0" Round Pipe Storage** -Impervious L= 4.0'
#5A	257.29'	325 cf	**11.33'W x 32.00'L x 3.21'H Field A** 1,164 cf Overall - 352 cf Embedded = 811 cf x 40.0% Voids
#6A	257.79'	352 cf	**Cultec R-280HD** x 8 Inside #5 Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap Row Length Adjustment= +1.00' x 6.07 sf x 2 rows
#7	257.79'	4 cf	**12.0" Round Pipe Storage** -Impervious L= 5.0'
#8	257.79'	58 cf	**4.00'D x 4.60'H DMH2** -Impervious
#9	257.22'	37 cf	**12.0" Round Pipe Storage** -Impervious L= 47.0' S= 0.0100 '/'
#10	257.22'	48 cf	**4.00'D x 3.78'H CB2** -Impervious
		913 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	257.29'	**2.410 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 1.00'
#2	Primary	261.60'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	261.10'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.0 cfs @ 12.08 hrs HW=261.28' (Free Discharge)
└─**1=Exfiltration** (Controls 0.0 cfs)

Primary OutFlow Max=2.1 cfs @ 12.08 hrs HW=261.28' (Free Discharge)
├─**2=Orifice/Grate** (Controls 0.0 cfs)
└─**3=Orifice/Grate** (Weir Controls 2.1 cfs @ 1.40 fps)

Pond UGI: Underground Infiltration System - Chamber Wizard Field A

Chamber Model = Cultec R-280HD (Cultec Recharger® 280HD)
Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf
Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap
Row Length Adjustment= +1.00' x 6.07 sf x 2 rows

47.0" Wide + 6.0" Spacing = 53.0" C-C Row Spacing

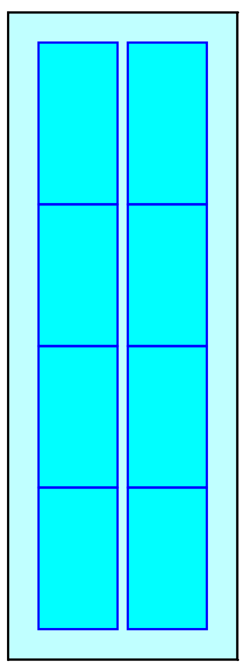
4 Chambers/Row x 7.00' Long +1.00' Row Adjustment = 29.00' Row Length +18.0" End Stone x 2 = 32.00' Base Length
2 Rows x 47.0" Wide + 6.0" Spacing x 1 + 18.0" Side Stone x 2 = 11.33' Base Width
6.0" Base + 26.5" Chamber Height + 6.0" Cover = 3.21' Field Height

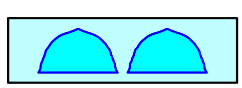
8 Chambers x 42.5 cf +1.00' Row Adjustment x 6.07 sf x 2 Rows = 352.2 cf Chamber Storage

1,163.6 cf Field - 352.2 cf Chambers = 811.4 cf Stone x 40.0% Voids = 324.6 cf Stone Storage

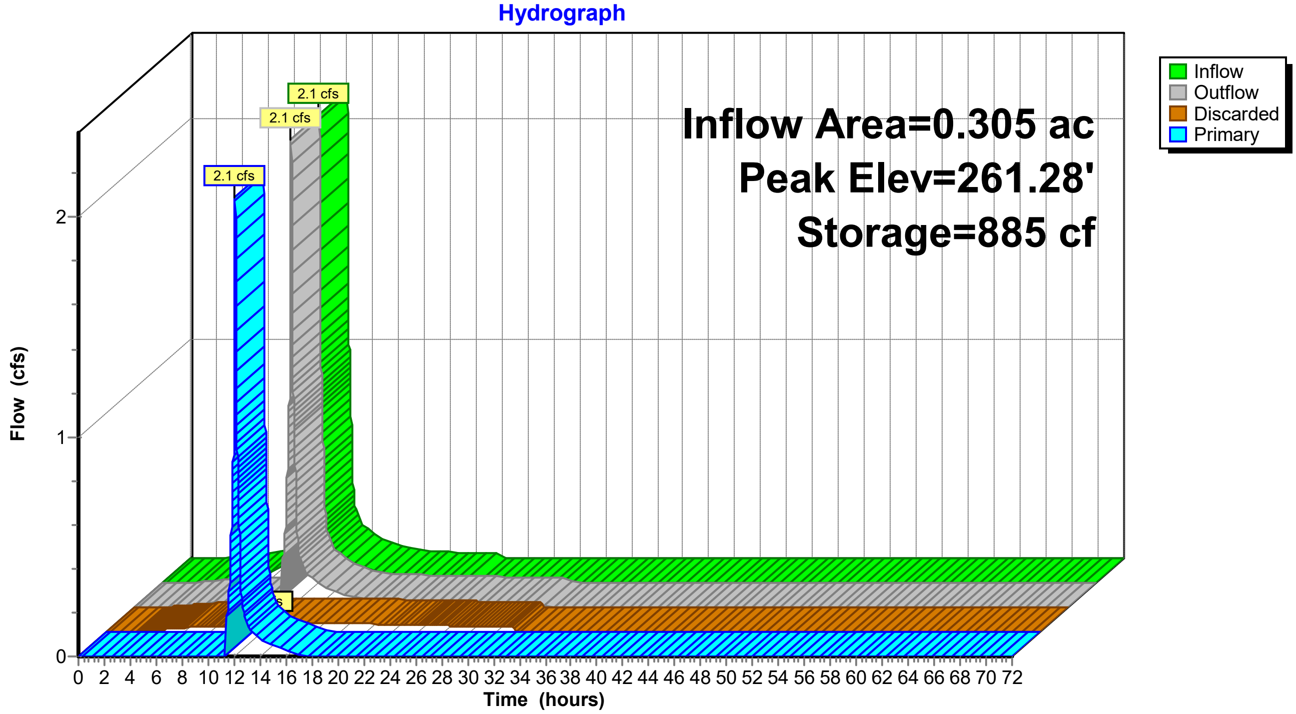
Chamber Storage + Stone Storage = 676.7 cf = 0.016 af
Overall Storage Efficiency = 58.2%
Overall System Size = 32.00' x 11.33' x 3.21'

8 Chambers
43.1 cy Field
30.1 cy Stone





Pond UGI: Underground Infiltration System



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment E-1A: Rear Left Runoff Area=11,939 sf 58.84% Impervious Runoff Depth=5.88"
Tc=6.0 min CN=80 Runoff=1.9 cfs 0.134 af

Subcatchment E-1B: Rear Right Runoff Area=21,110 sf 11.67% Impervious Runoff Depth=5.17"
Tc=6.0 min CN=74 Runoff=2.9 cfs 0.209 af

Subcatchment E-2: Front Runoff Area=27,799 sf 43.96% Impervious Runoff Depth=5.64"
Tc=6.0 min CN=78 Runoff=4.2 cfs 0.300 af

Subcatchment P-1A: Rear Left Runoff Area=11,939 sf 58.84% Impervious Runoff Depth=5.88"
Tc=6.0 min CN=80 Runoff=1.9 cfs 0.134 af

Subcatchment P-1B: Rear Right Runoff Area=21,110 sf 11.67% Impervious Runoff Depth=5.17"
Tc=6.0 min CN=74 Runoff=2.9 cfs 0.209 af

Subcatchment P-2A: Front Runoff Area=14,503 sf 28.82% Impervious Runoff Depth=4.00"
Tc=6.0 min CN=64 Runoff=1.6 cfs 0.111 af

Subcatchment P-2B: Front Runoff Area=13,296 sf 73.71% Impervious Runoff Depth=7.43"
Tc=6.0 min CN=93 Runoff=2.4 cfs 0.189 af

Pond DP-1e: (new Pond) Inflow=4.8 cfs 0.343 af
Primary=4.8 cfs 0.343 af

Pond DP-1p: (new Pond) Inflow=4.8 cfs 0.343 af
Primary=4.8 cfs 0.343 af

Pond DP-2e: (new Pond) Inflow=4.2 cfs 0.300 af
Primary=4.2 cfs 0.300 af

Pond DP-2p: (new Pond) Inflow=3.9 cfs 0.230 af
Primary=3.9 cfs 0.230 af

Pond UGI: Underground Infiltration System Peak Elev=261.30' Storage=886 cf Inflow=2.4 cfs 0.189 af
Discarded=0.0 cfs 0.070 af Primary=2.4 cfs 0.119 af Outflow=2.4 cfs 0.189 af

Total Runoff Area = 2.794 ac Runoff Volume = 1.286 af Average Runoff Depth = 5.52"
62.88% Pervious = 1.757 ac 37.12% Impervious = 1.037 ac

Summary for Subcatchment E-1A: Rear Left

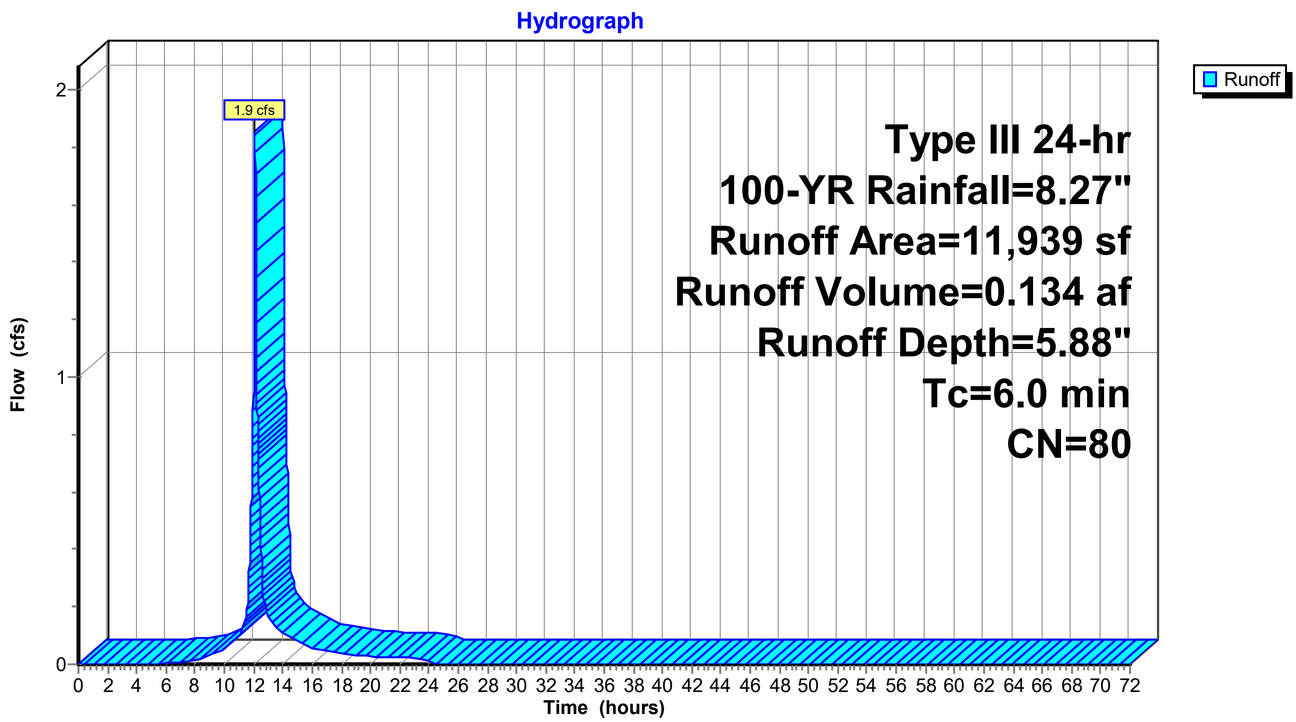
Runoff = 1.9 cfs @ 12.09 hrs, Volume= 0.134 af, Depth= 5.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-YR Rainfall=8.27"

Area (sf)	CN	Description
7,025	98	Roofs, HSG A
3,350	36	Woods, Fair, HSG A
1,564	96	Gravel surface, HSG A
11,939	80	Weighted Average
4,914		41.16% Pervious Area
7,025		58.84% Impervious Area

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

Subcatchment E-1A: Rear Left



Summary for Subcatchment E-1B: Rear Right

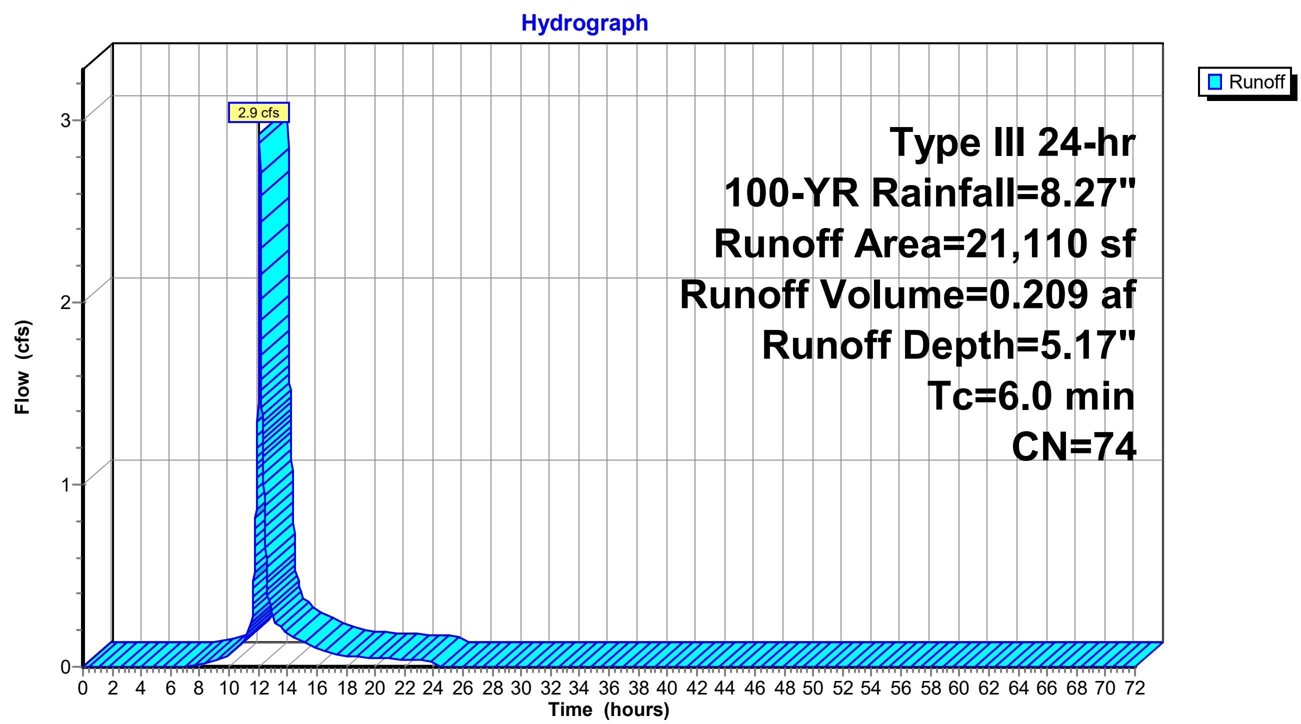
Runoff = 2.9 cfs @ 12.09 hrs, Volume= 0.209 af, Depth= 5.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-YR Rainfall=8.27"

	Area (sf)	CN	Description
	2,463	98	Roofs, HSG A
	7,921	36	Woods, Fair, HSG A
	8,503	96	Gravel surface, HSG A
*	2,223	96	Gravel surface, HSG A
	21,110	74	Weighted Average
	18,647		88.33% Pervious Area
	2,463		11.67% Impervious Area

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

Subcatchment E-1B: Rear Right



Summary for Subcatchment E-2: Front

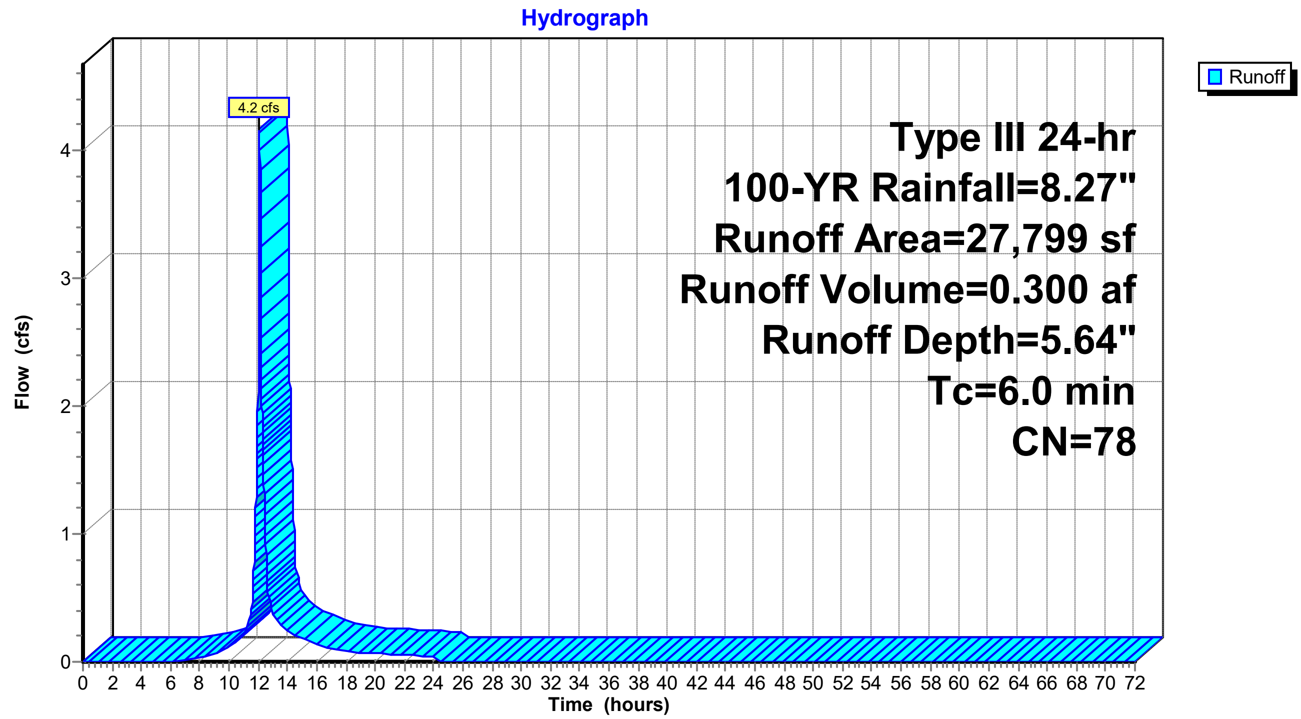
Runoff = 4.2 cfs @ 12.09 hrs, Volume= 0.300 af, Depth= 5.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-YR Rainfall=8.27"

	Area (sf)	CN	Description
	5,715	96	Gravel surface, HSG A
	12,220	98	Paved parking, HSG A
*	1,849	68	<50% Grass cover, Poor, HSG A
	8,015	36	Woods, Fair, HSG A
	27,799	78	Weighted Average
	15,579		56.04% Pervious Area
	12,220		43.96% Impervious Area

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

Subcatchment E-2: Front



Summary for Subcatchment P-1A: Rear Left

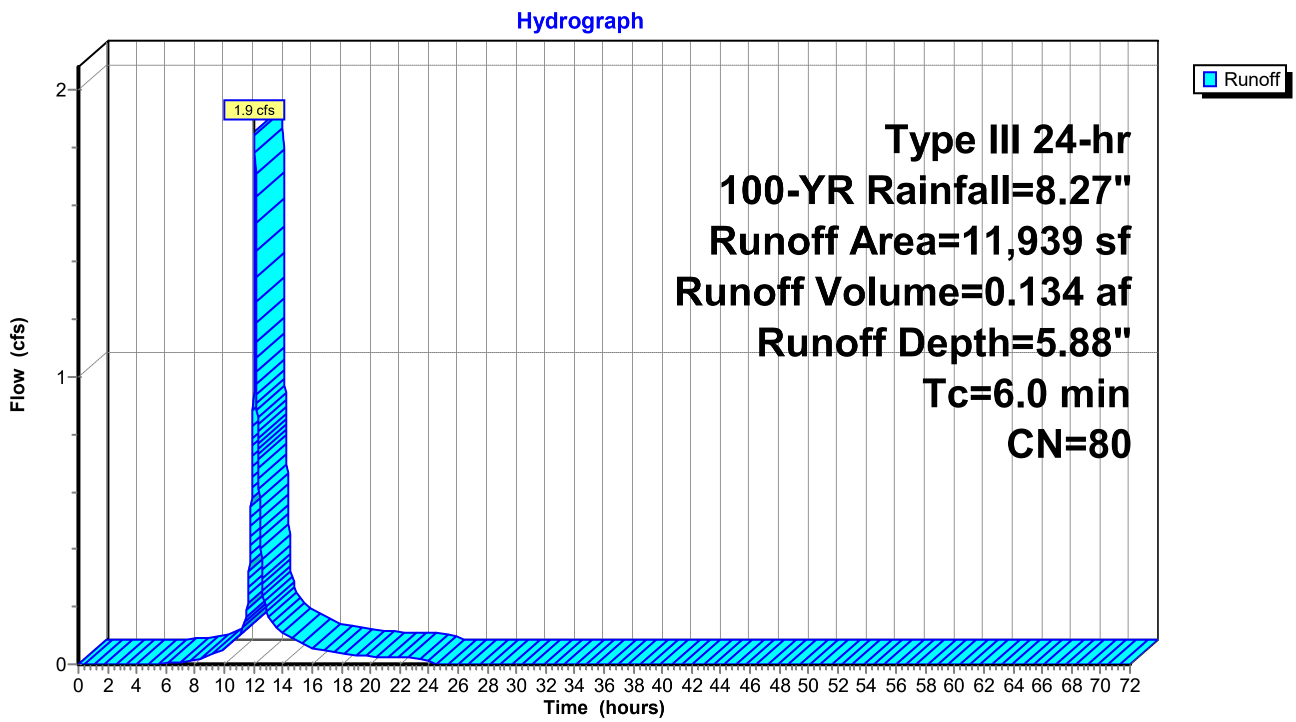
Runoff = 1.9 cfs @ 12.09 hrs, Volume= 0.134 af, Depth= 5.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-YR Rainfall=8.27"

Area (sf)	CN	Description
3,350	36	Woods, Fair, HSG A
1,564	96	Gravel surface, HSG A
7,025	98	Roofs, HSG A
11,939	80	Weighted Average
4,914		41.16% Pervious Area
7,025		58.84% Impervious Area

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

Subcatchment P-1A: Rear Left



Summary for Subcatchment P-1B: Rear Right

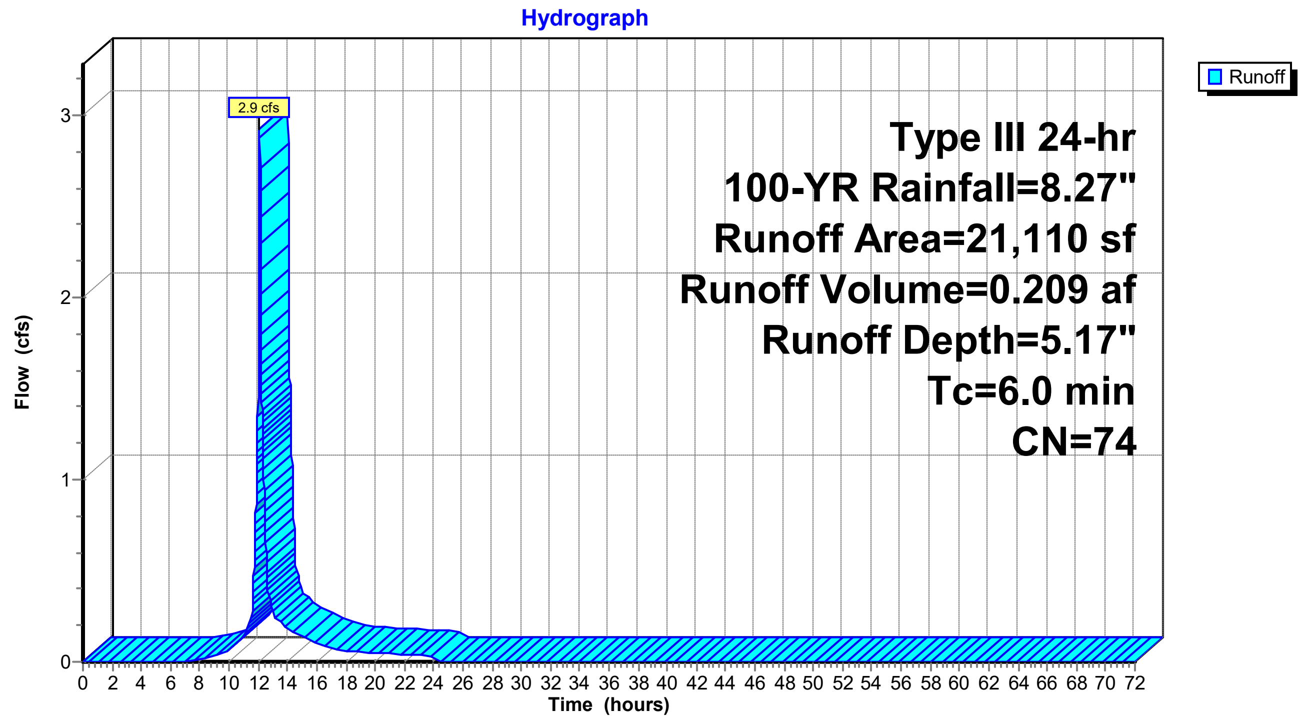
Runoff = 2.9 cfs @ 12.09 hrs, Volume= 0.209 af, Depth= 5.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-YR Rainfall=8.27"

	Area (sf)	CN	Description
	7,921	36	Woods, Fair, HSG A
	2,463	98	Roofs, HSG A
	8,503	96	Gravel surface, HSG A
*	2,223	96	Gravel surface, HSG A
	21,110	74	Weighted Average
	18,647		88.33% Pervious Area
	2,463		11.67% Impervious Area

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

Subcatchment P-1B: Rear Right



Summary for Subcatchment P-2A: Front

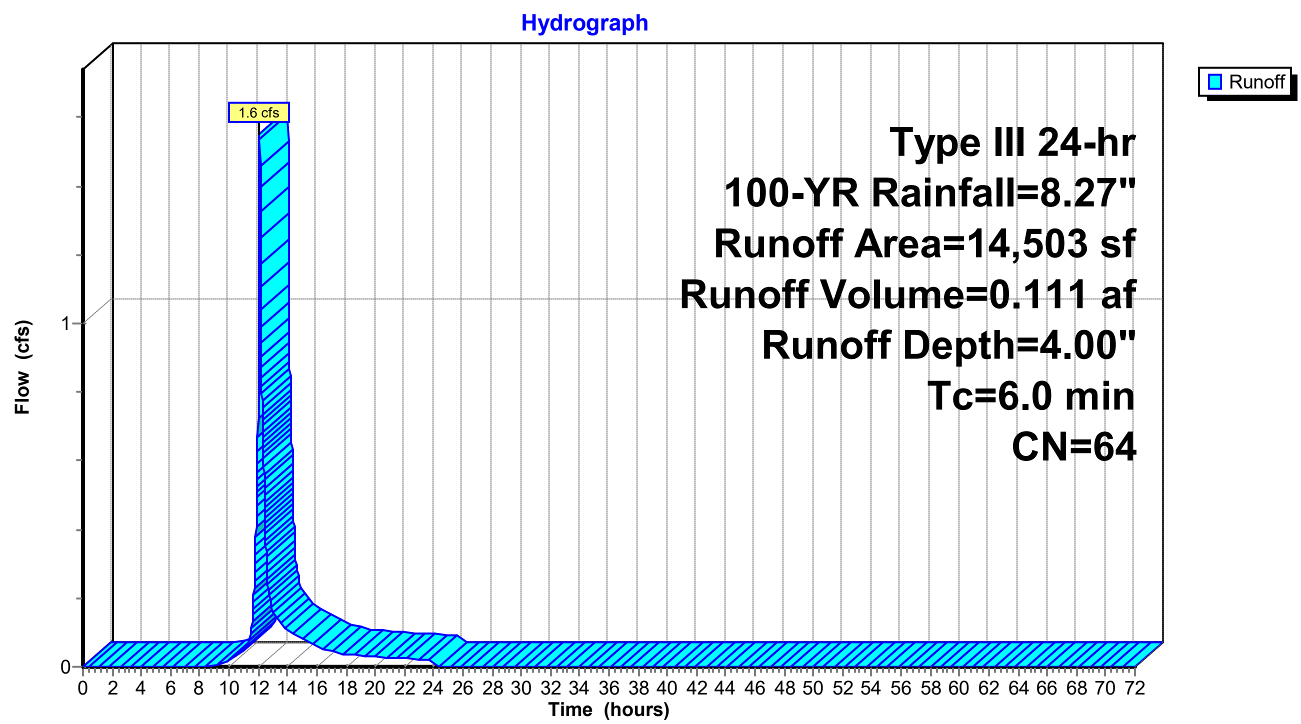
Runoff = 1.6 cfs @ 12.09 hrs, Volume= 0.111 af, Depth= 4.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-YR Rainfall=8.27"

Area (sf)	CN	Description
2,000	96	Gravel surface, HSG A
794	68	<50% Grass cover, Poor, HSG A
7,529	36	Woods, Fair, HSG A
4,180	98	Paved parking, HSG A
14,503	64	Weighted Average
10,323		71.18% Pervious Area
4,180		28.82% Impervious Area

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

Subcatchment P-2A: Front



Summary for Subcatchment P-2B: Front

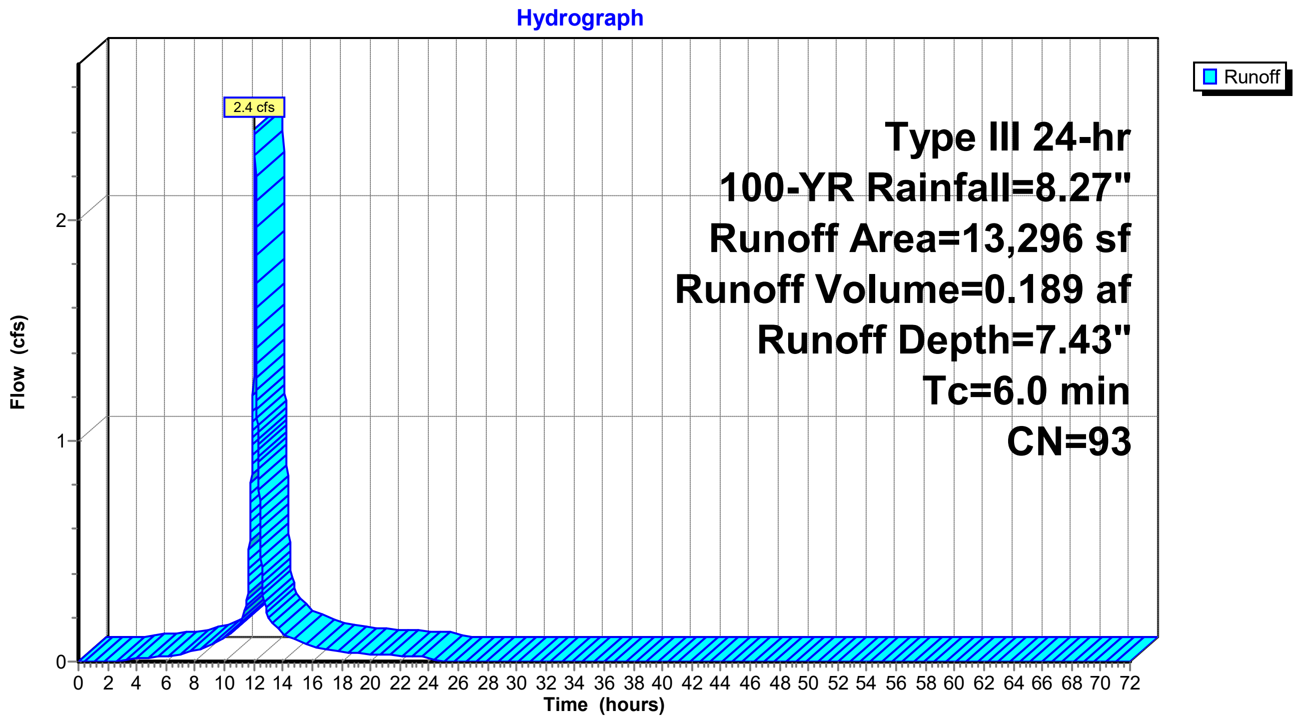
Runoff = 2.4 cfs @ 12.08 hrs, Volume= 0.189 af, Depth= 7.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-YR Rainfall=8.27"

	Area (sf)	CN	Description
	1,925	96	Gravel surface, HSG A
	1,086	68	<50% Grass cover, Poor, HSG A
	484	36	Woods, Fair, HSG A
	6,193	98	Paved parking, HSG A
*	3,608	98	Paved parking, HSG A
	13,296	93	Weighted Average
	3,495		26.29% Pervious Area
	9,801		73.71% Impervious Area

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

Subcatchment P-2B: Front



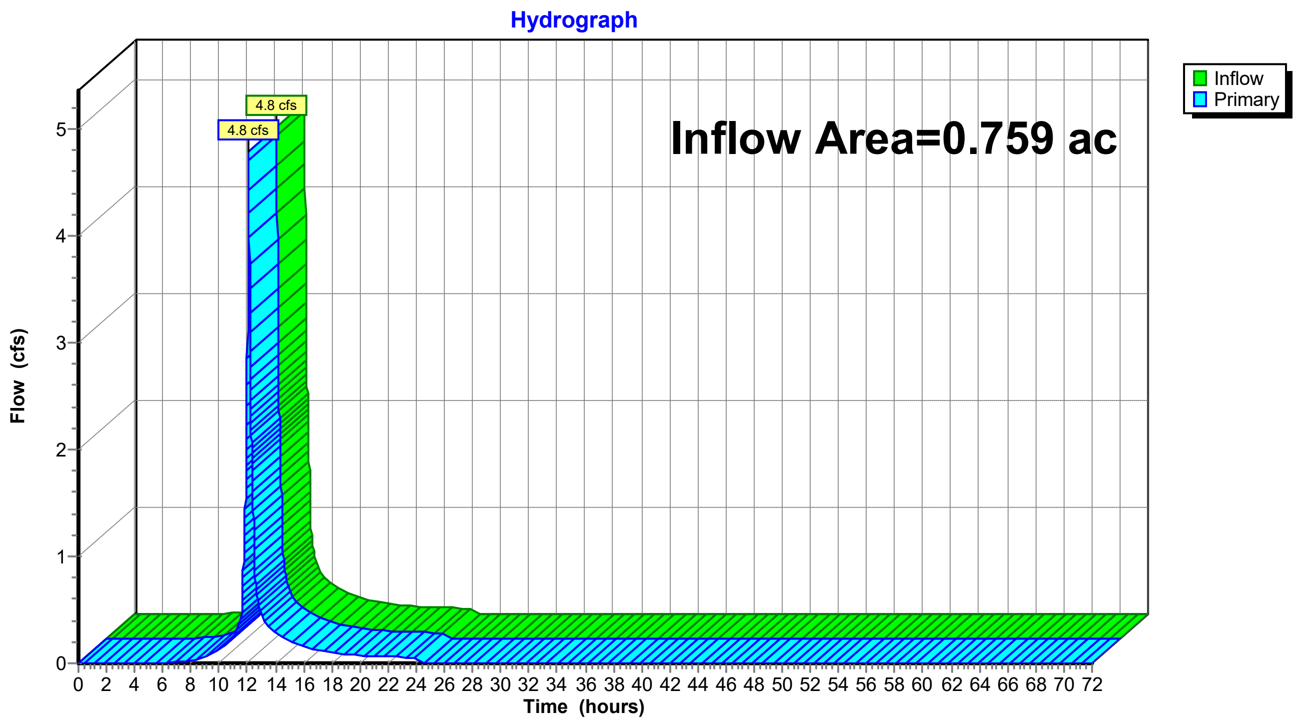
Summary for Pond DP-1e: (new Pond)

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

Inflow Area =	0.759 ac, 28.71% Impervious, Inflow Depth = 5.42"	for 100-YR event
Inflow =	4.8 cfs @ 12.09 hrs, Volume=	0.343 af
Primary =	4.8 cfs @ 12.09 hrs, Volume=	0.343 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-1e: (new Pond)

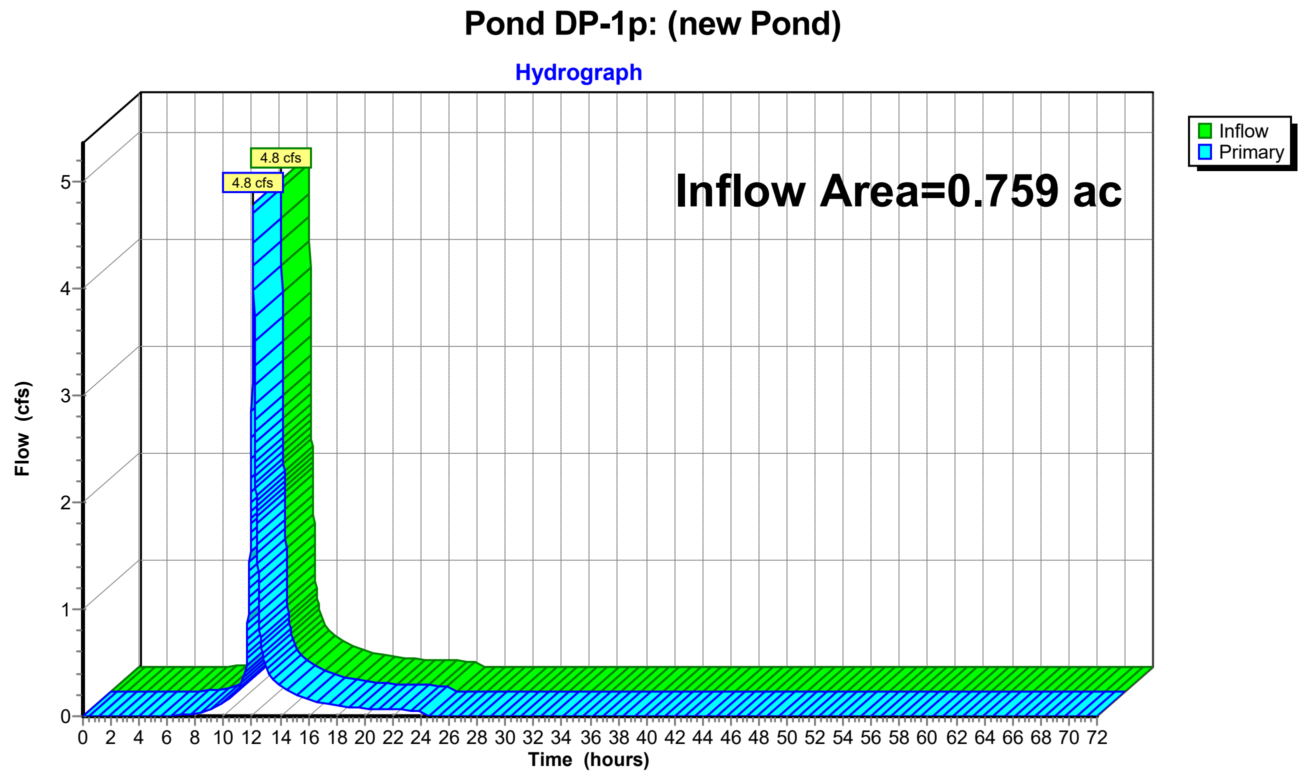


Summary for Pond DP-1p: (new Pond)

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

Inflow Area =	0.759 ac, 28.71% Impervious, Inflow Depth = 5.42" for 100-YR event			
Inflow =	4.8 cfs @	12.09 hrs, Volume=	0.343 af	
Primary =	4.8 cfs @	12.09 hrs, Volume=	0.343 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs



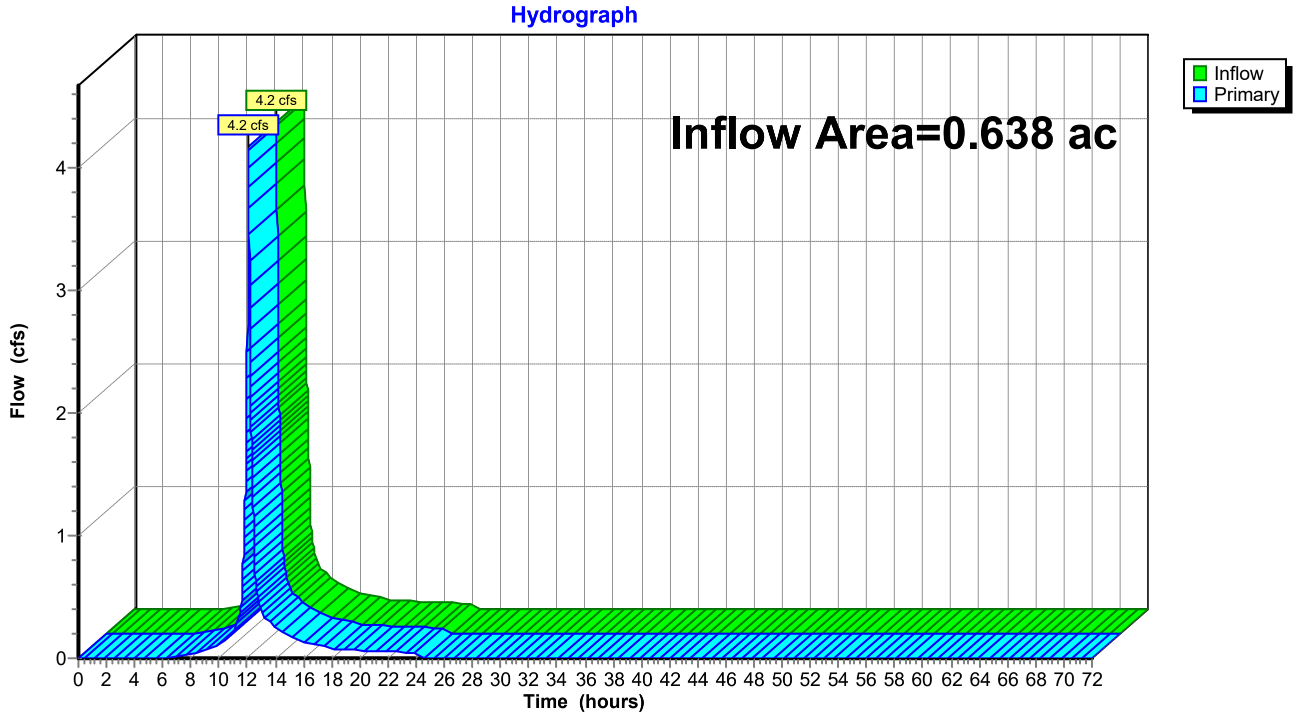
Summary for Pond DP-2e: (new Pond)

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

Inflow Area =	0.638 ac, 43.96% Impervious, Inflow Depth = 5.64"	for 100-YR event	
Inflow =	4.2 cfs @ 12.09 hrs, Volume=	0.300 af	
Primary =	4.2 cfs @ 12.09 hrs, Volume=	0.300 af, Atten= 0%, Lag= 0.0 min	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Pond DP-2e: (new Pond)

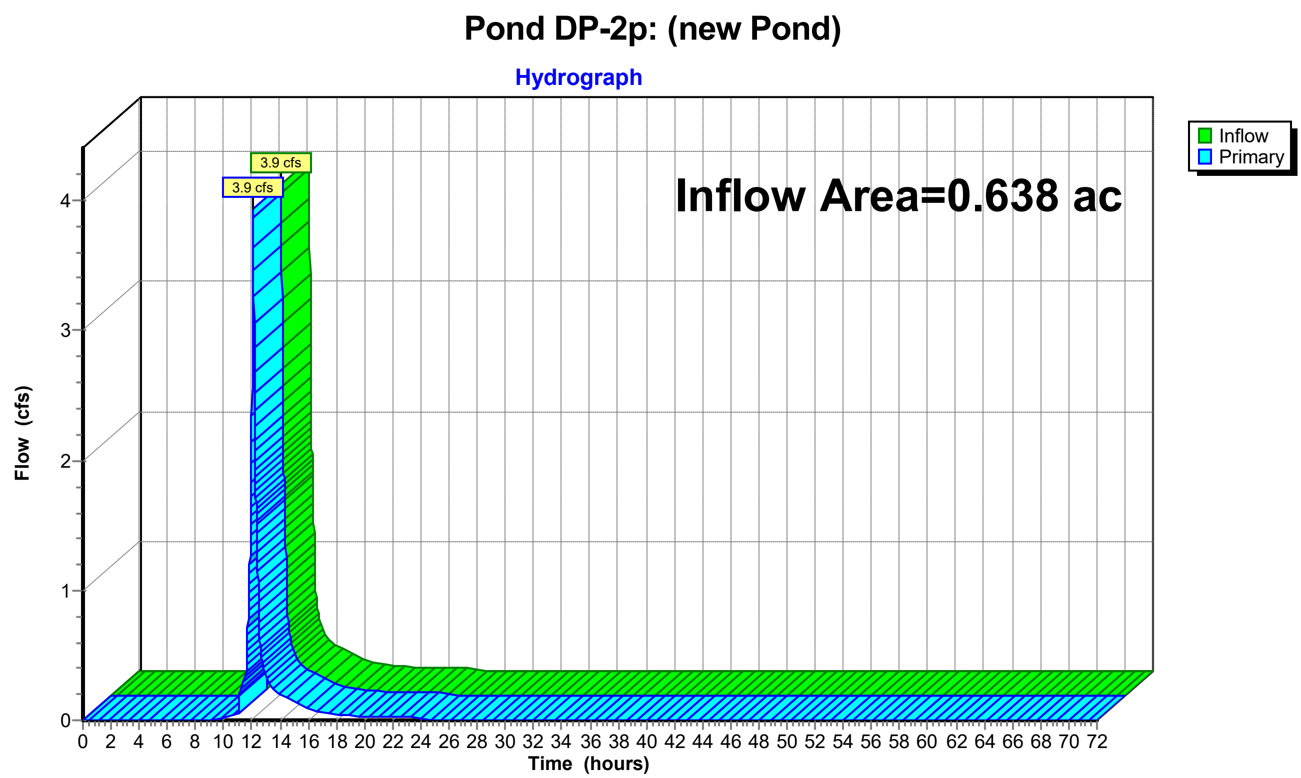


Summary for Pond DP-2p: (new Pond)

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

Inflow Area =	0.638 ac, 50.29% Impervious,	Inflow Depth = 4.32"	for 100-YR event	
Inflow =	3.9 cfs @	12.09 hrs, Volume=	0.230 af	
Primary =	3.9 cfs @	12.09 hrs, Volume=	0.230 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs



Summary for Pond UGI: Underground Infiltration System

Inflow Area = 0.305 ac, 73.71% Impervious, Inflow Depth = 7.43" for 100-YR event
Inflow = 2.4 cfs @ 12.08 hrs, Volume= 0.189 af
Outflow = 2.4 cfs @ 12.08 hrs, Volume= 0.189 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.0 cfs @ 12.08 hrs, Volume= 0.070 af
Primary = 2.4 cfs @ 12.08 hrs, Volume= 0.119 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 261.30' @ 12.08 hrs Surf.Area= 363 sf Storage= 886 cf

Plug-Flow detention time= 111.4 min calculated for 0.189 af (100% of inflow)
Center-of-Mass det. time= 111.4 min (875.9 - 764.5)

Volume	Invert	Avail.Storage	Storage Description
#1	259.60'	25 cf	**4.00'D x 2.00'H CB1** -Impervious
#2	259.60'	8 cf	**12.0" Round Pipe Storage** -Impervious L= 10.0' S= 0.0100 '/'
#3	257.79'	54 cf	**4.00'D x 4.30'H DMH1** -Impervious
#4	259.40'	3 cf	**12.0" Round Pipe Storage** -Impervious L= 4.0'
#5A	257.29'	325 cf	**11.33'W x 32.00'L x 3.21'H Field A** 1,164 cf Overall - 352 cf Embedded = 811 cf x 40.0% Voids
#6A	257.79'	352 cf	**Cultec R-280HD** x 8 Inside #5 Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap Row Length Adjustment= +1.00' x 6.07 sf x 2 rows
#7	257.79'	4 cf	**12.0" Round Pipe Storage** -Impervious L= 5.0'
#8	257.79'	58 cf	**4.00'D x 4.60'H DMH2** -Impervious
#9	257.22'	37 cf	**12.0" Round Pipe Storage** -Impervious L= 47.0' S= 0.0100 '/'
#10	257.22'	48 cf	**4.00'D x 3.78'H CB2** -Impervious
		913 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	257.29'	**2.410 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 1.00'
#2	Primary	261.60'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	261.10'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.0 cfs @ 12.08 hrs HW=261.30' (Free Discharge)
└**1=Exfiltration** (Controls 0.0 cfs)

Primary OutFlow Max=2.4 cfs @ 12.08 hrs HW=261.30' (Free Discharge)
├**2=Orifice/Grate** (Controls 0.0 cfs)
└**3=Orifice/Grate** (Weir Controls 2.4 cfs @ 1.47 fps)

Pond UGI: Underground Infiltration System - Chamber Wizard Field A

Chamber Model = Cultec R-280HD (Cultec Recharger® 280HD)
Effective Size= 46.9"W x 26.0"H => 6.07 sf x 7.00'L = 42.5 cf
Overall Size= 47.0"W x 26.5"H x 8.00'L with 1.00' Overlap
Row Length Adjustment= +1.00' x 6.07 sf x 2 rows

47.0" Wide + 6.0" Spacing = 53.0" C-C Row Spacing

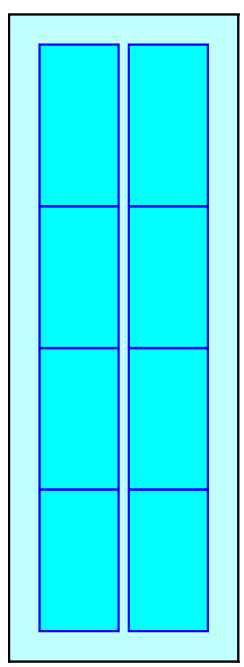
4 Chambers/Row x 7.00' Long +1.00' Row Adjustment = 29.00' Row Length +18.0" End Stone x 2 = 32.00' Base Length
2 Rows x 47.0" Wide + 6.0" Spacing x 1 + 18.0" Side Stone x 2 = 11.33' Base Width
6.0" Base + 26.5" Chamber Height + 6.0" Cover = 3.21' Field Height

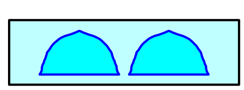
8 Chambers x 42.5 cf +1.00' Row Adjustment x 6.07 sf x 2 Rows = 352.2 cf Chamber Storage

1,163.6 cf Field - 352.2 cf Chambers = 811.4 cf Stone x 40.0% Voids = 324.6 cf Stone Storage

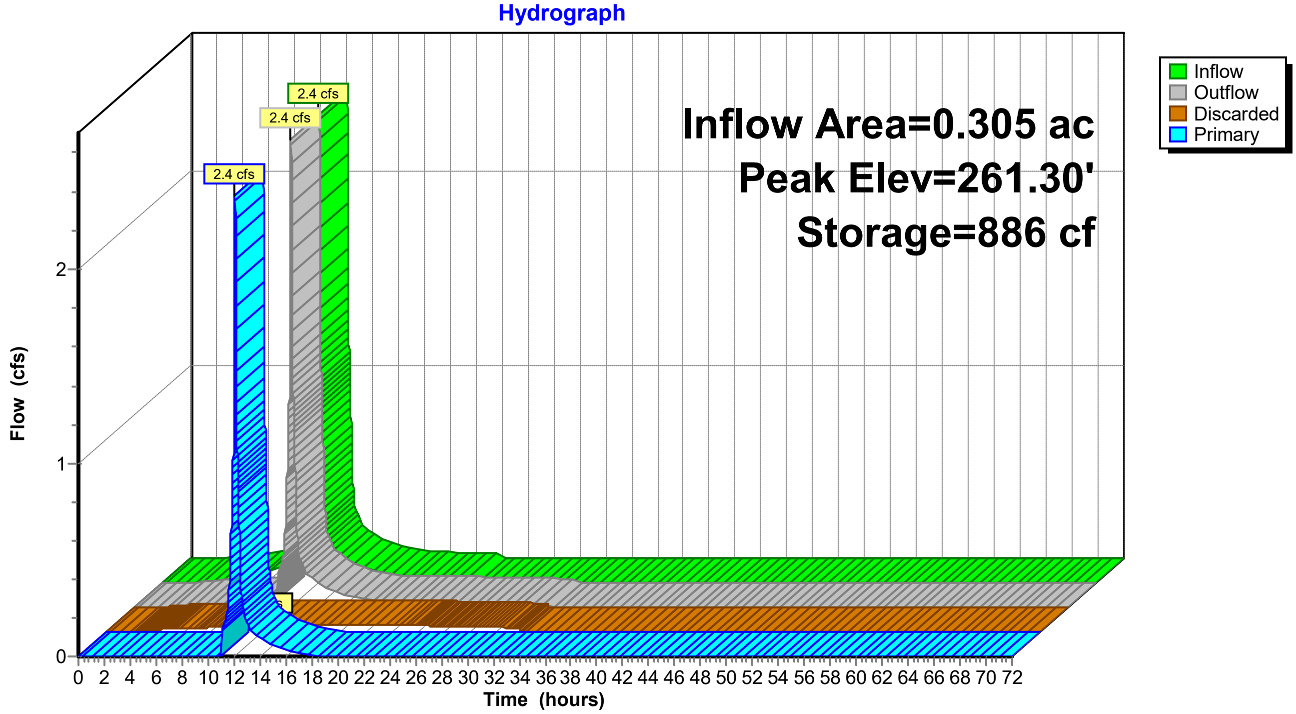
Chamber Storage + Stone Storage = 676.7 cf = 0.016 af
Overall Storage Efficiency = 58.2%
Overall System Size = 32.00' x 11.33' x 3.21'

8 Chambers
43.1 cy Field
30.1 cy Stone





Pond UGI: Underground Infiltration System



INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: Front Parking Lot Drainage System

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Stormceptor STC450i	**0.90**	**1.00**	**0.90**	**0.10**

Total TSS Removal = **90%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **AnyFence Co. Holliston**

Prepared By: **CDW**

Date: **8/9/2022**

*Equals remaining load from previous BMP (E) which enters the BMP

Stormceptor®

CONTECH ENGINEERED SOLUTIONS

Brief Stormceptor Sizing Report - AnyFence

Project Information & Location			
Project Name	AnyFence	**Project Number**	2008.0
City	Holliston	**State/ Province**	Massachusetts
Country	United States of America	**Date**	10/13/2022
Designer Information		**EOR Information (optional)**	
Name	Pietra Souza	**Name**	
Company	CDW Consultants	**Company**	
Phone #	508-875-2657	**Phone #**	
Email	psouza@cdwconsultants.com	**Email**	

Stormwater Treatment Recommendation

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

Site Name	
Target TSS Removal (%)	80
TSS Removal (%) Provided	90
Recommended Stormceptor Model	STC 450i

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

Stormceptor Sizing Summary

Stormceptor Model	% TSS Removal Provided
STC 450i	90
STC 900	94
STC 1200	94
STC 1800	94
STC 2400	96
STC 3600	96
STC 4800	97
STC 6000	97
STC 7200	98
STC 11000	99
STC 13000	99
STC 16000	99

Stormceptor®

CONTECH ENGINEERED SOLUTIONS

Sizing Details

Drainage Area	
Total Area (acres)	0.21
Imperviousness %	100.0

Rainfall	
Station Name	BLUE HILL
State/Province	Massachusetts
Station ID #	0736
Years of Records	58
Latitude	42°12'44"N
Longitude	71°6'53"W

Water Quality Objective	
TSS Removal (%)	80.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	1.70
Water Quality Flow Rate (CFS)	0.26

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

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cfs)	

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

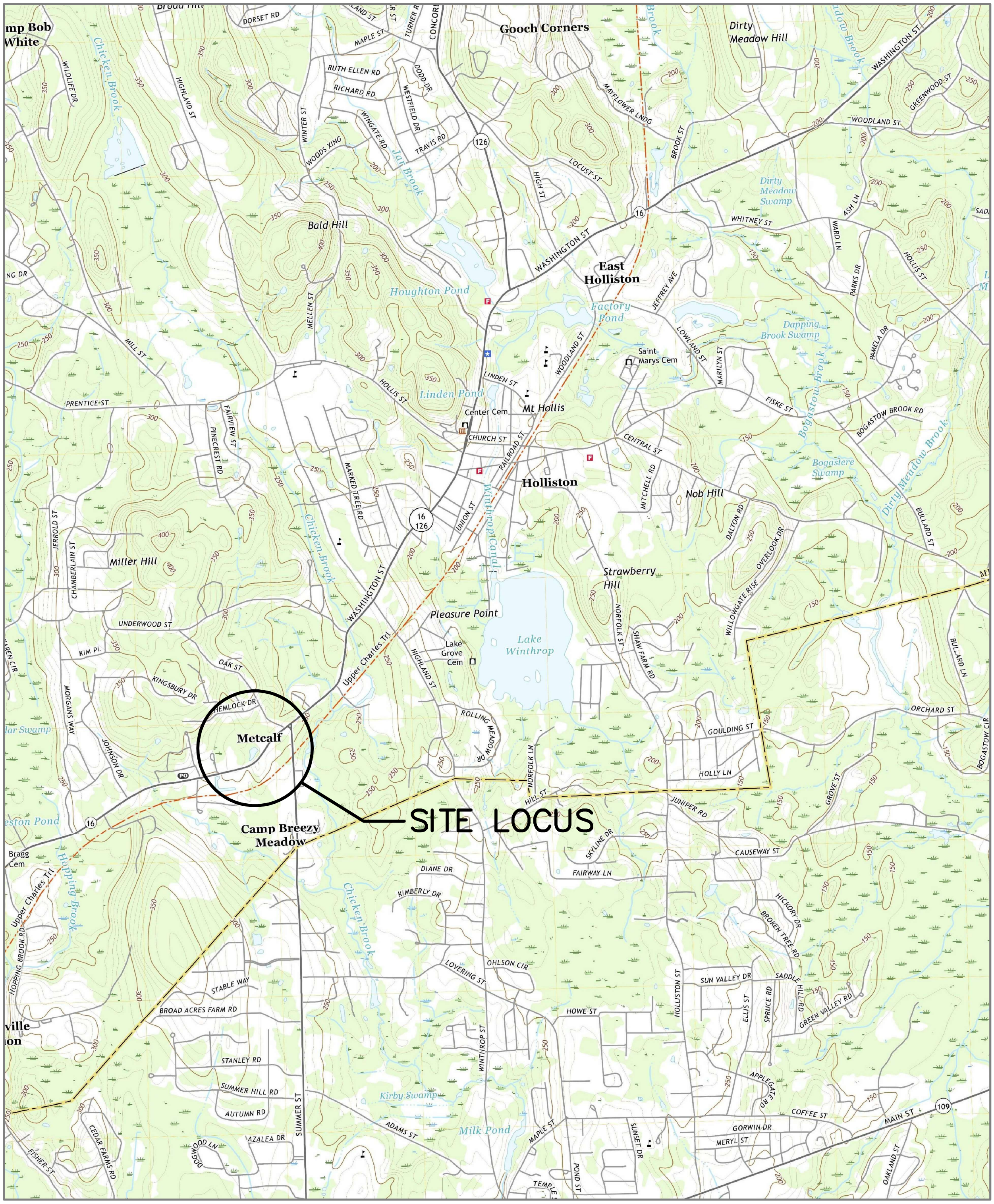
Fine Distribution		
Particle Diameter (microns)	Distribution %	Specific Gravity
20.0	20.0	1.30
60.0	20.0	1.80
150.0	20.0	2.20
400.0	20.0	2.65
2000.0	20.0	2.65

Notes

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

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

MAPS & PLANS



CDW CONSULTANTS, INC.

LOCUS MAP

ANYFENCE CO.

1485 WASHINGTON STREET

HOLLISTON, MA 01746

N

DATE:07/08/2022

PROJ NO.: 2008.00

SCALE: NTS

USDA 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

August 8, 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.

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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: 1:2,050 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 30, 60, 120, 180

Feet: 0, 50, 100, 200, 300

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

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

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 21, Sep 2, 2021

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

Date(s) aerial images were photographed: Aug 31, 2020—Oct 22, 2020

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
52A	Freetown muck, 0 to 1 percent slopes	0.1	0.5%
73B	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	2.6	13.0%
106C	Narragansett-Hollis-Rock outcrop complex, 3 to 15 percent slopes	11.3	55.4%
251B	Haven silt loam, 3 to 8 percent slopes	0.0	0.2%
422B	Canton fine sandy loam, 0 to 8 percent slopes, extremely stony	1.5	7.3%
654	Udorthents, loamy	4.7	23.3%
656	Udorthents-Urban land complex	0.1	0.3%
Totals for Area of Interest		**20.4**	**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

52A—Freetown muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2t2q9
Elevation: 0 to 1,110 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 and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freetown

Setting

Landform: Depressions, depressions, swamps, kettles, marshes, bogs
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

Whitman

Percent of map unit: 5 percent
Landform: Drainageways, depressions

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

Swansea

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

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

73B—Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2w695
Elevation: 0 to 1,580 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

Whitman, extremely stony, and similar soils: 81 percent
Minor components: 19 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Whitman, Extremely Stony

Setting

Landform: Drumlins, ground moraines, hills, drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Oi - 0 to 1 inches: peat
A - 1 to 10 inches: fine sandy loam
Bg - 10 to 17 inches: gravelly fine sandy loam
Cdg - 17 to 61 inches: fine sandy loam

Properties and qualities

Slope: 0 to 3 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 7 to 38 inches to densic material
Drainage class: Very poorly drained
Runoff class: Negligible
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 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY041MA - Very Wet Till Depressions
Hydric soil rating: Yes

Minor Components

Ridgebury, extremely stony

Percent of map unit: 10 percent
Landform: Drumlins, depressions, ground moraines, hills, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Scarboro

Percent of map unit: 5 percent
Landform: Drainageways, depressions, outwash terraces, outwash deltas
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Swansea

Percent of map unit: 3 percent
Landform: Marshes, bogs, swamps
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Woodbridge, 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: Concave
Across-slope shape: Linear
Hydric soil rating: No

106C—Narragansett-Hollis-Rock outcrop complex, 3 to 15 percent slopes

Map Unit Setting

National map unit symbol: 98yk
Elevation: 0 to 1,000 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

Narragansett and similar soils: 45 percent
Hollis and similar soils: 20 percent
Rock outcrop: 10 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Narragansett

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable silty eolian deposits and/or friable loamy eolian deposits over loose sandy glaciofluvial deposits derived from metamorphic rock and/or friable sandy basal till derived from metamorphic rock

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 7 inches: silt loam
Bw - 7 to 35 inches: silt loam
2C1 - 35 to 60 inches: very gravelly loamy sand
2C2 - 60 to 65 inches: very gravelly loamy sand

Properties and qualities

Slope: 3 to 15 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: 18 to 35 inches to strongly contrasting textural stratification
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 6.4 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: Ridges, hills
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Head slope, crest
Down-slope shape: Linear
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 15 percent
Surface area covered with cobbles, stones or boulders: 1.6 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 15 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: 9 percent
Landform: Hills
Landform position (two-dimensional): Backslope, toeslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Charlton

Percent of map unit: 6 percent
Landform: Hills, swales
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Scituate

Percent of map unit: 5 percent
Landform: Depressions, hillslopes
Landform position (two-dimensional): Toeslope, summit
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Unnamed

Percent of map unit: 5 percent

251B—Haven silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 990d
Elevation: 30 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Haven

Setting

Landform: Plains, terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over loose sandy glaciofluvial deposits

Typical profile

H1 - 0 to 2 inches: silt loam
H2 - 2 to 20 inches: silt loam
H3 - 20 to 32 inches: very fine sandy loam
H4 - 32 to 65 inches: stratified coarse sand to sand to fine sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 18 to 36 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: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Ecological site: F144AY023CT - Well Drained Outwash
Hydric soil rating: No

Minor Components

Merrimac

Percent of map unit: 9 percent
Landform: Terraces, plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Scio

Percent of map unit: 5 percent
Landform: Depressions, terraces
Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Unnamed
Percent of map unit: 1 percent

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): Side slope, crest, nose slope
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): Backslope, shoulder, summit
Landform position (three-dimensional): Crest, side slope
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): Footslope, backslope, summit
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): Backslope, shoulder, summit
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

654—Udorthents, loamy

Map Unit Setting

National map unit symbol: vr1l
Elevation: 0 to 3,000 feet
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 110 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Udorthents, Loamy

Setting

Parent material: Loamy alluvium and/or sandy glaciofluvial deposits and/or loamy glaciolacustrine deposits and/or loamy marine deposits and/or loamy basal till and/or loamy lodgment till

Properties and qualities

Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Minor Components

Udorthents, sandy

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

Urban land

Percent of map unit: 5 percent
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear

Udorthents, wet substratum

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

656—Udorthents-Urban land complex

Map Unit Setting

National map unit symbol: 995k
Elevation: 0 to 3,000 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

Udorthents and similar soils: 45 percent
Urban land: 35 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Setting

Parent material: Loamy alluvium and/or sandy glaciofluvial deposits and/or loamy glaciolacustrine deposits and/or loamy marine deposits and/or loamy basal till and/or loamy lodgment till

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

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

Canton

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope, toeslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent
Landform: Terraces, plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Paxton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex
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.

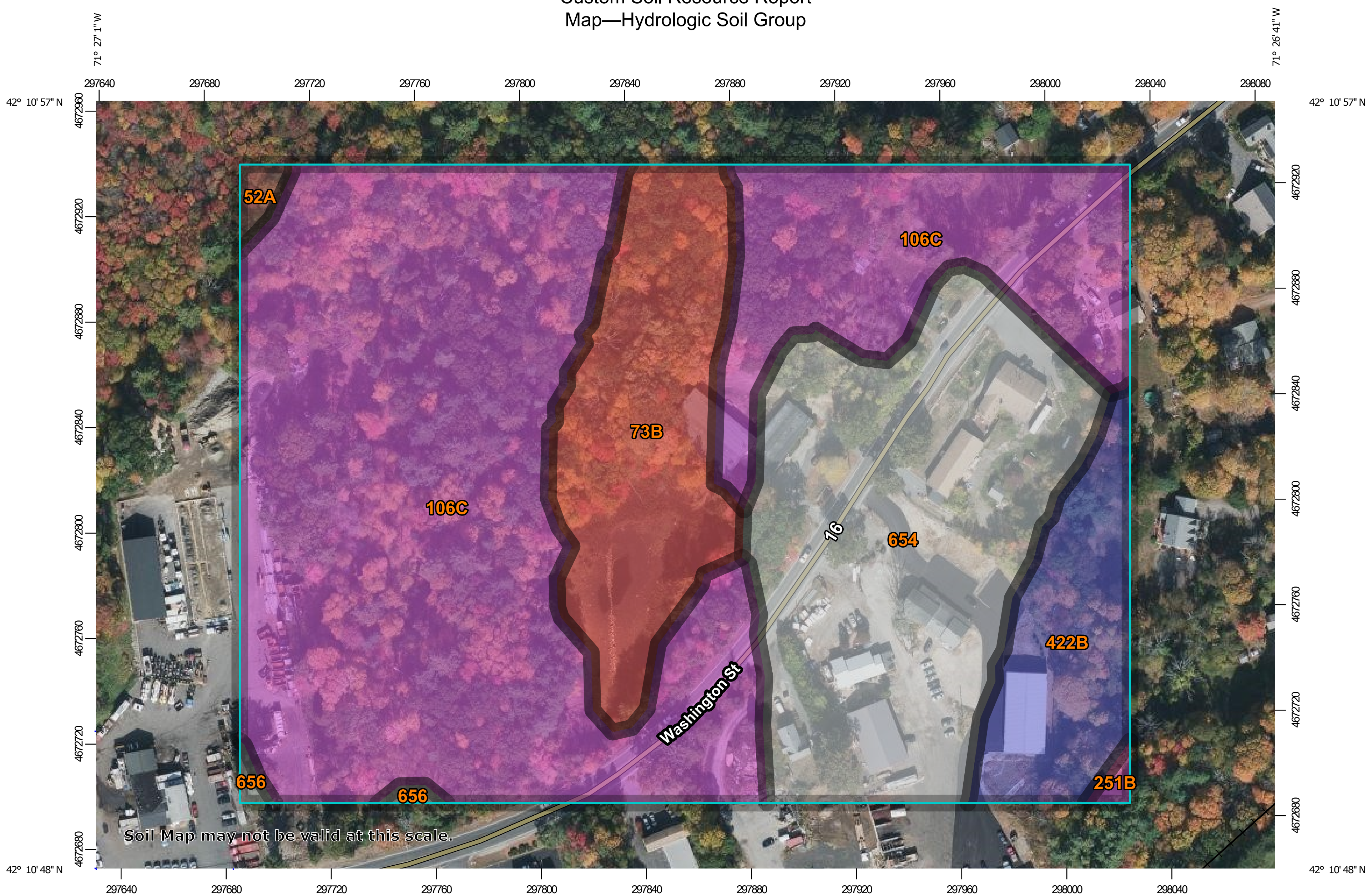
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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—Hydrologic Soil Group



Map Scale: 1:2,050 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 30, 60, 120, 180

Feet: 0, 50, 100, 200, 300

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil 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 21, Sep 2, 2021

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

Date(s) aerial images were photographed: Aug 31, 2020—Oct 22, 2020

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

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
52A	Freetown muck, 0 to 1 percent slopes	B/D	0.1	0.5%
73B	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	D	2.6	13.0%
106C	Narragansett-Hollis-Rock outcrop complex, 3 to 15 percent slopes	A	11.3	55.4%
251B	Haven silt loam, 3 to 8 percent slopes	A	0.0	0.2%
422B	Canton fine sandy loam, 0 to 8 percent slopes, extremely stony	B	1.5	7.3%
654	Udorthents, loamy		4.7	23.3%
656	Udorthents-Urban land complex		0.1	0.3%
Totals for Area of Interest			**20.4**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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Commonwealth of Massachusetts
City/Town of Holliston, 1485 Washington Street

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: 1 (Hole #) | 10/12/2022 (Date) | 9am (Time) | cloudy (Weather) | ______ (Latitude) | ______ (Longitude)

1. Land Use: parking lot (e.g., woodland, agricultural field, vacant lot, etc.) | none (Vegetation) | none (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 2% (Slope (%))

Description of Location: to the right side of the left most driveway entrance, just behind the existing stone wall, on the edge of the gravel parking area

2. Soil Parent Material: ______ | ______ (Landform) | ______ (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body 80 +/- feet | Drainage Way ______ feet | Wetlands 80 +/- feet
Property Line 10 feet | Drinking Water Well ______ feet | Other ______ feet

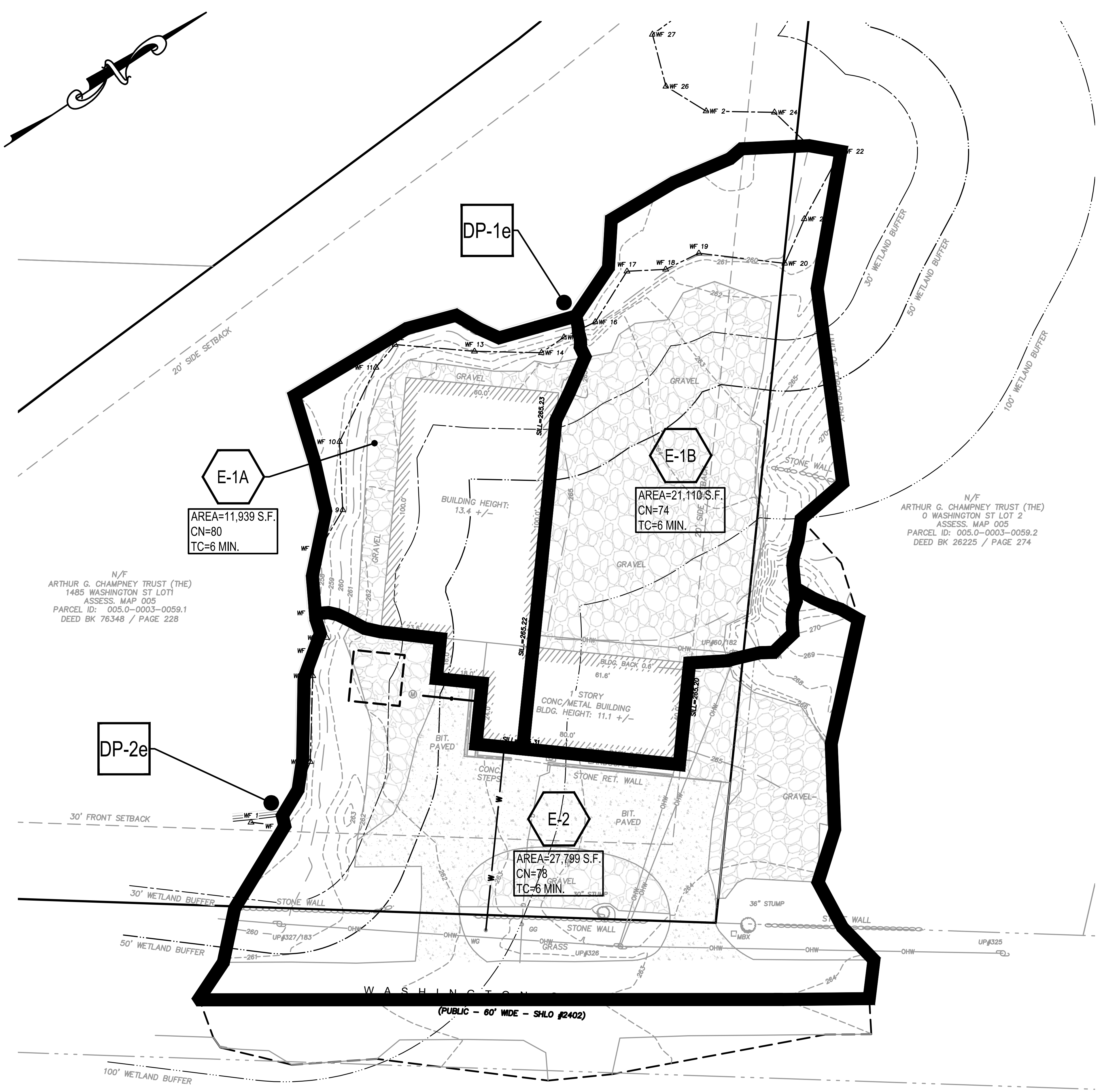
4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: NA Depth to Weeping in Hole NA Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-1"	A				Cnc : Dpl:						gravel parking surface
48"	C1	loamy sand		NA	Cnc : Dpl:		5%	5%	granular	dry	
104"	C2	loamy sand		NA	Cnc : Dpl:		10%	10%	granular	dry	
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes:
no mottles or weeping observed down to 104"



GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 INCH = 20 FT.

ABBREVIATIONS

BIT CONC	BITUMINOUS CONCRETE
CONC	CONCRETE
HDPE	HIGH-DENSITY POLYETHYLENE
EOP	EDGE OF PAVEMENT
VGC	VERTICAL GRANITE CURB
PCC	PRECAST CONCRETE CURB
CCB	CAPE COD BERM
PVC	POLYVINYL CHLORIDE
RCP	REINFORCED CONCRETE PIPE
RD	ROOF DRAIN
TYP	TYPICAL
CO	CLEAN OUT
RIM	RIM ELEVATION
INV	INVERT ELEVATION
R&D	REMOVE AND DISPOSE
R&R	REMOVE AND REPLACE
HC	HANDICAP RAMP
VE	VERTICAL ELLIPTICAL
TC/BC	TOP OF CURB/BOTTOM OF CURB
TW	TOP OF WALL
TOS	TOP OF STAIRS
BOS	BOTTOM OF STAIRS
BW	BOTTOM OF WALL (SURFACE GRADE)
BS	BACK OF SIDEWALK
SSD	SUB SOIL DRAIN
LA	LANDSCAPE ARCHITECT
UD	UNDER DRAIN / SUB DRAIN
UGI	UNDERGROUND INFILTRATION
VIF	VERIFY IN FIELD
OC	ON CENTER

LEGEND

EXISTING / PROPOSED

- GRANITE BOUND FOUND
- UTILITY POLE
- GUY WIRE
- GUY POLE
- SIGN
- POST
- BOLLARD
- DECIDUOUS TREE
- CONIFEROUS TREE
- UNDERGROUND GAS LINE
- UNDERGROUND WATER LINE
- UNDERGROUND ELECTRIC LINE
- UNDERGROUND SEWER LINE
- UNDERGROUND DRAIN LINE
- SEWER MANHOLE (SMH)
- SEWER CLEANOUT (CO)
- DRAIN MANHOLE (DMH)
- CATCH BASIN (CB)
- GAS/WATER GATE
- HYDRANT
- BUSH
- LOCUS PROPERTY LINE (±)
- ADJOINERS PROPERTY LINE (±)
- OVERHEAD WIRE
- TREELINE
- HISTORIC UTILITY LINE (G/W/E/S/D)
- MAJOR CONTOUR LINE
- MINOR CONTOUR LINE
- FENCE
- GUARD RAIL
- PRECAST CONCRETE CURB
- HANDICAP SPACE
- MAILBOX
- BORDERING VEGETATED WETLAND (BVW)
- WETLAND FLAG
- 100' WETLAND BUFFER
- MANHOLE

NO	DATE	REVISIONS
1	10/18/2022	CONCOM COMMENTS

SEAL

DATE : 08/09/2022
DRAWN : PS
SCALE : 1" = 20'

ANYFENCE CO.

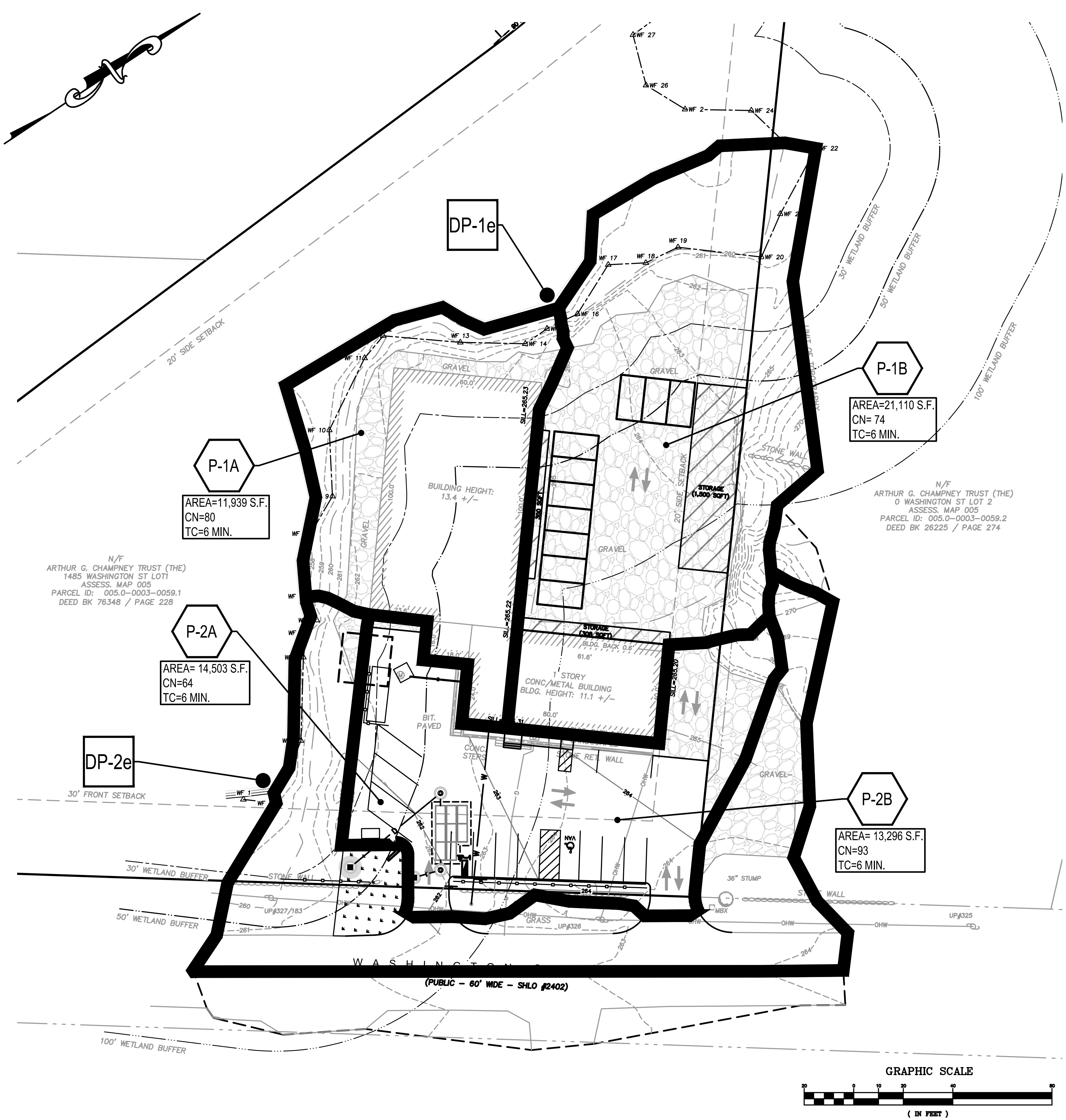
1485 WASHINGTON STREET
HOLLISTON, 01746 MA

CDW CONSULTANTS
Environmental and Civil Engineering

PRE DEVELOPMENT HYDROLOGY

PRE

SCALE: 1" = 20' | PRJ. NO: 2008.00



ABBREVIATIONS

BIT CONC	BITUMINOUS CONCRETE
CONC	CONCRETE
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LA	LANDSCAPE ARCHITECT
UD	UNDER DRAIN / SUB DRAIN
UGI	UNDERGROUND INFILTRATION
VIF	VERIFY IN FIELD
OC	ON CENTER

LEGEND

EXISTING / PROPOSED

- GRANITE BOUND FOUND
- UTILITY POLE
- GUY WIRE
- GUY POLE
- SIGN
- POST
- BOLLARD
- DECIDUOUS TREE
- CONIFEROUS TREE
- UNDERGROUND GAS LINE
- UNDERGROUND WATER LINE
- UNDERGROUND ELECTRIC LINE
- UNDERGROUND SEWER LINE
- UNDERGROUND DRAIN LINE
- SEWER MANHOLE (SMH)
- SEWER CLEANOUT (CO)
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- CATCH BASIN (CB)
- GAS/WATER GATE
- HYDRANT
- BUSH
- LOCUS PROPERTY LINE (±)
- ADJOINERS PROPERTY LINE (±)
- OVERHEAD WIRE
- TREELINE
- HISTORIC UTILITY LINE (G/W/E/S/D)
- MAJOR CONTOUR LINE
- MINOR CONTOUR LINE
- FENCE
- GUARD RAIL
- PRECAST CONCRETE CURB
- HANDICAP SPACE
- MAILBOX
- BORDERING VEGETATED WETLAND (BVW)
- WETLAND FLAG
- 100' WETLAND BUFFER
- MANHOLE

NO	DATE	REVISIONS
1	10/18/2022	CONCOM COMMENTS

SEAL

DATE : 08/09/2022
DRAWN : PS
SCALE : 1" = 20'

ANYFENCE CO.

1485 WASHINGTON STREET
HOLLISTON, 01746 MA

CDW CONSULTANTS
Environmental and Civil Engineering

POST DEVELOPMENT HYDROLOGY

POST

SCALE: 1" = 20' | PRJ. NO: 2008.00

ATTACHMENTS

ATTACHMENT A

LONG TERM POLLUTION PREVENTION PLAN

Long Term Pollution Prevention Plan

Standard #4 of the MA DEP Stormwater Management Handbook requires that a Long Term Pollution Prevention Plan (LTPPP) be prepared and incorporated into the long term operation and maintenance of the proposed stormwater management system. The purpose of the LTPPP is to identify potential sources of pollution that may affect the quality of stormwater discharges and to describe suggested practices to reduce pollutants in stormwater discharges.

Good housekeeping practices - The subject property owners are to keep the site in a neat and orderly condition so that pollutants are not conveyed to the storm drainage system. Materials swept, blown, or washed into the storm drains can decrease the system's effectiveness and could eventually be conveyed into the adjacent wetland resource area. Examples of good housekeeping practices are pavement sweeping, litter control, contained outdoor waste and proper cigarette disposal, and protected material storage areas. The property owners should assign responsibilities to personnel to keep the site in a neat and orderly condition.

Provisions for storing materials and waste products inside or under cover – The exterior storage areas shown on the plans, are limited to stockpiles of untreated cedar wood fencing materials for use by the owner. These materials are not anticipated to generate runoff pollutants. There are two dumpsters shown on the plans, a trash disposal company hired by the owner will pick up waste materials and properly dispose at a state approved disposal facility.

The stormwater drainage system has a catch basin with hooded outlet and deep sump designed to capture and retain trash, debris, and sediments prior to entering the underground detention system, which will also be installed with an isolated filter fabric wrapped chambers. The isolator/separator row which will further intercept any trash, debris, and sediments that might have entered the underground stormwater drainage system.

Requirements for routine inspections and maintenance of stormwater BMP's - Consistent with Standard 9 of the Massachusetts Stormwater Management Regulations, an Operation and Maintenance Plan has been provided in the Stormwater Management Report. The plan details routine inspection and maintenance of the stormwater BMP's along with associated record keeping forms.

Spill prevention and response plans – Sources of potential spill hazards include vehicle fluids and fuels, pesticides, paints, solvents, and liquid cleaning products. The majority of the spill hazards would likely occur within the building and would not enter the stormwater drainage system. However, there are spill hazards from vehicle fluids and fuels located outside of the buildings. These exterior spill hazards have the potential to enter the stormwater drainage system and are to be addressed as follows:

1) Spill hazards of pesticides, paints, and solvents shall be remediated using the Manufacturers' recommended spill cleanup protocol.
2) Vehicle fluid and fuel spills shall be remediated according to local and state regulations governing fuel spills.
3) The property owners shall have the following equipment and materials on hand to address a spill clean-up: brooms, dust-pans, mops, rags, gloves, trash bags, trash containers, and absorptive materials such as sand, sawdust, or kitty litter.
4) Spills of toxic or hazardous materials shall be reported to the Massachusetts Department of Environmental Protection at 1-888-304-1133.

Provisions for maintenance of lawns, garden, and other landscaped areas - It should be a general goal of the subject property owners to achieve a high quality of well-groomed and stable landscape that evolves throughout the changing seasons and overall condition of the property. All landscaped areas are to be maintained with dense vegetative growth or a layer of mulch so as to minimize sediment transport. Litter and waste are to be removed weekly from the landscaped areas and adjoining parking area and disposed of properly.

Requirements for storage and use of fertilizer, herbicides, and pesticides - Should use become necessary, application should be performed by a state licensed contractor in accordance with the manufacturer's label instruction and when environmental conditions are conducive to product application. Chemical controls should be used as a last resort to organic and biological control methods.

Pet waste management provisions – All pet waste is to be scooped up, sealed in a plastic bag, and disposed of properly in the garbage. Never deposit pet waste in the stormwater management system for it contains high level of fecal coliform bacteria.

Snow disposal and deicing chemicals – The property owner will be responsible for the clearing of the driveways and building entrances. The owners may be required to use a de-icing agent such as salt or potassium chloride to maintain a safe walking surface. De-icing agents should not be stored outside.

ATTACHMENT B

OPERATION & MAINTENANCE PLAN

Operation & Maintenance Plan

System Owner: AnyFence Co.
1485 Washington Street, Holliston, MA 01746
Brian Donoghue
(508)429-4000
anyfenceco@gmail.com

Signature: ____

Party Responsible for O&M: During construction, the property will be maintained by the site contractor selected to perform the work, yet to be determined. This includes the drainpipes and underground infiltration system. Maintenance of areas outside the contractor's scope of work will continued to be maintained by the AnyFence Co.

Following construction and acceptance of the site, the property will be fully maintained by the AnyFence Co. This includes the drainpipes and underground infiltration system.

Documentation: The Inspection and Maintenance Record Log will be kept for a period of 3 years by the Owner summarizing inspections, maintenance, repairs, and corrective actions taken. The logs will be made available to the Town of Holliston and/or the Commonwealth of Massachusetts upon request. The Town of Holliston is allowed to inspect each BMP to determine whether the owner is implementing the Operation and Maintenance Plan.

O&M Budget: The estimated annual operation and maintenance cost is $1,000 to $4,000.

Changes to O&M: Changes to the ownership or assignment of financial responsibility will be notified by the Owner to the Planning Board. Any amendments to the maintenance schedule will be in writing and signed by all responsible parties, including owner, persons with financial responsibility, and persons with operational responsibility.

Annual Certification: To ensure adequate long-term operation and maintenance of stormwater management practices, the Owner will submit a signed annual certification to the Conservation Commission and Planning Board documenting the work that has been done over the last 12 months to properly operate and maintain the stormwater controls.

The drainage system is to be operated and maintained in accordance with the following:

Part I: Construction Phase Controls

Construction Phasing: Construction shall proceed in the general following sequence:

1. Install Erosion Controls around project area Inspection and maintenance of these Erosion Controls and Construction Entrance is required throughout the project as detailed below.
2. Demolish existing site features and clear & grub areas only as needed.
3. Erosion Controls to be maintained until all disturbed areas are stabilized.
4. Construct new improvements and install all underground utilities.

The erosion controls are to be inspected daily and maintained throughout the duration of the construction phase and removed only when needed for site access. The siltation controls shall be maintained, and sediment removed as needed throughout construction.

Prior to turning the site over to the Owner for acceptance, the site shall be in a stable condition. The pavement areas shall be free of any debris and swept clean.

Part II: Post-Development Controls

1). Inspections. The catch basin, piping system, and underground chambers are to be inspected by the System Owner during the first year of operation on a quarterly basis. The inspection frequency can be reduced after the first year to annual inspections provided that the quarterly inspections do not indicate the need for more frequent inspections. If more frequent inspections become appropriate at any time, they should be implemented. Typical inspection forms have been provided at the end of this section.

Piping System. During each inspection, the piping is to be inspected for structural integrity, settlement, and sedimentation. Standing water in the piping indicates a lack of infiltration capacity or settlement. Sedimentation in the piping indicates the need for cleaning.

Catch basins. Remove the cover from the catch basin and visually inspect for corrosion and structural damage. Using a wooden pole, probe the sump to determine the depth of sediment. Accumulation greater than 16" indicates a clean-out should be performed. Cleaning should be by a vacuum truck or clamshell. Take care as to not damage the catch basin hood. If an oil layer is floating on the water surface, place an oil-absorbent pillow on surface, allow to soak and remove and replace. Repeat this process until the oil layer is removed. Alternatively, have the oil layer pumped out by a licensed disposal contractor and appropriately disposed of. The oil absorbent pillows must be drummed for disposal by a licensed disposal contractor.

Water Quality, Proprietary Separator. Inspect and clean these units in strict accordance with manufacturers' recommendations and requirements. Clean the units using the method specified by the manufacturer. Vactor trucks are typically used to clean these units. Clamshell buckets typically used for cleaning catch basins are almost never allowed by manufacturers. Sometimes it will be necessary to remove sediment manually. The manufacturer's O&M (Stormceptor, Model 450i, as proposed) is included at the end of this manual.

Pavement. Remove debris from the pavement as it accumulates, as part of normal site clean-up. Weekly patrolling for litter is recommended. Sand from ice control should be removed monthly via a street sweeper during the winter season. Significant oil leaks should be swept up and disposed of using oil-absorbent material as they are discovered. Any oil spills or leaks that reach the catch basins must be reported to the Massachusetts DEP oil spill hotline.

Subsurface Infiltration Structures, Chambers. Inspect the underground recharge structures after major storms to ensure proper function and stabilization. Record water levels over several days to check for the infiltration performance. After the first year, inspect the recharge structures annually for silt buildup or clogging. Remove trash and debris from the structures. Sediment at the inlet should be removed when it exceeds 6-inches in depth. After an extended period of dry weather inspect for standing water. The CULTEC's Operation and Maintenance Guidelines for CULTEC Stormwater System is included at the end of this manual.

TABLE 1: Construction Phase Inspection and Maintenance Procedures

Control	Inspection Frequency (1)	Maintenance Procedure
Construction Entrance	Weekly	a
Silt Fence	Weekly	a
Stormwater Basins	Weekly	a
Dust Control	Daily	b
Permanent Stabilization	Weekly	c

1. Inspection frequencies are a minimum. Site conditions may warrant more frequent review. All control shall be inspected after each storm event which exceeds 0.5 inches in 24-hours.

2. Maintenance Procedures shall be reviewed and revised as necessary to protect the environment.

   a. Remove accumulated debris and replace, as necessary.
   b. Water or calcium chloride shall be utilized to prevent the generation of dust.
   c. Disturbed areas shall either be paved or stabilized by permanent seeding.

Inspection forms are to be completed weekly and retained with project files.

INSPECTION AND MAINTENANCE REPORT FORM

TO BE COMPLETED EVERY 7 DAYS AND WITHIN 24 HOURS OF A RAINFALL EVENT OF 0.5 INCHES OR MORE

INSPECTOR: ____

DATE:____

INSPECTOR'S QUALIFICATIONS:

____

____

DAYS SINCE LAST RAINFALL:____

AMOUNT OF LAST RAINFALL:___________ INCHES

STABILIZATION MEASURES

Project Area	Date Since Last Disturbed	Date of Next Disturbance	Stabilized? (Yes/No)	Stabilized With	Condition
North					
East					
South					
West					

STABILIZATION REQUIRED:

____

____

____

____

____

____

____

TO BE PERFORMED BY:____________________ ON OR BEFORE__________________________

INSPECTION AND MAINTENANCE REPORT FORM

CONSTRUCTION ENTRANCE

Does Sediment Get Tracked onto the Road?	Is the Gravel Clean or is it Filled with Sediment?	Does All Traffic Use the Stabilized Exit to Leave the Site?

MAINTENANCE REQUIRED FOR ENTRANCE:
____
____
____
____
____
____
____

TO BE PERFORMED BY:____________________ ON OR BEFORE__________________________

INSPECTION AND MAINTENANCE REPORT FORM

Erosion Control Barriers

Location	Depth of Sediment Build-Up	Sediment Need Removal?	Need Replacement?
Eastern Side Southern Side Western Side Northern Side			

MAINTENANCE REQUIRED :

____
____
____
____
____
____
____

TO BE PERFORMED BY:____________________ ON OR BEFORE___________________________

INSPECTION AND MAINTENANCE REPORT FORM

INFILTRATION STRUCTURES

Location	Depth of Sediment Build-Up	Sediment Need Removal?	Need Replacement?
#1			
#2			
#3			
#4			

MAINTENANCE REQUIRED FOR BASIN:
____
____
____
____
____
____
____

TO BE PERFORMED BY:____________________ ON OR BEFORE__________________________

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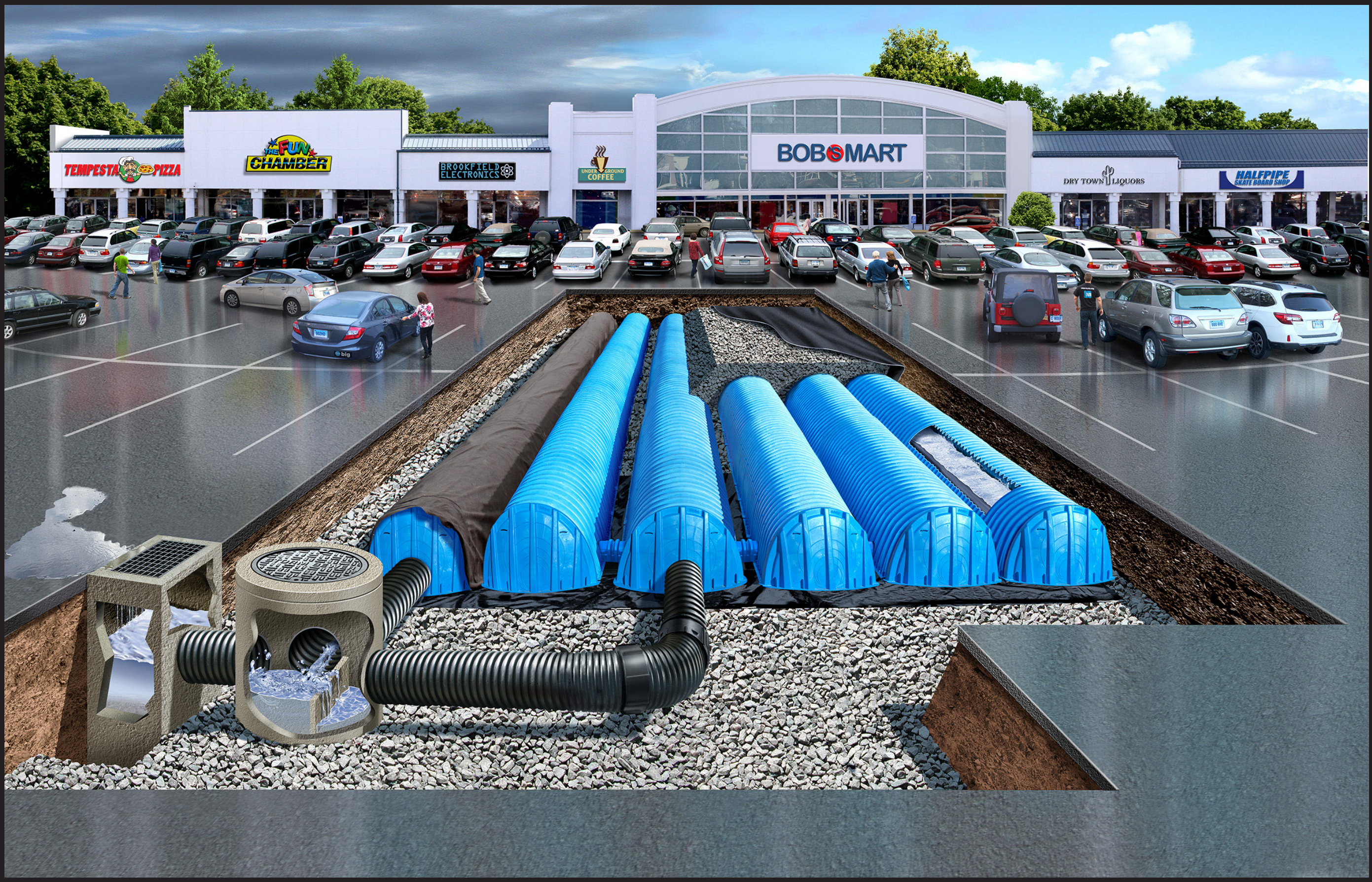
STORMWATER MANAGEMENT SOLUTIONS



OPERATION & MAINTENANCE GUIDELINES

FOR CULTEC STORMWATER MANAGEMENT SYSTEMS

CULTEC®

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www.cultec.com

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Contact Information:
For general information on our other products and services, please contact our offices within the United States at (800)428-5832, (203)775-4416 ext. 202, or e-mail us at custservice@cultec.com.

For technical support, please call (203)775-4416 ext. 203 or e-mail tech@cultec.com.

Visit www.cultec.com/downloads.html for Product Downloads and CAD details.

Doc ID: CLT057 01-20
January 2020

These instructions are for single-layer traffic applications only. For multi-layer applications, contact CULTEC.
All illustrations and photos shown herein are examples of typical situations. Be sure to follow the engineer's drawings.
Actual designs may vary.

This manual contains guidelines recommended by CULTEC, Inc. and may be used in conjunction with, but not to supersede, local regulations or regulatory authorities. OSHA Guidelines must be followed when inspecting or cleaning any structure.

Introduction

The CULTEC Subsurface Stormwater Management System is a high-density polyethylene (HDPE) chamber system arranged in parallel rows surrounded by washed stone. The CULTEC chambers create arch-shaped voids within the washed stone to provide stormwater detention, retention, infiltration, and reclamation. Filter fabric is placed between the native soil and stone interface to prevent the intrusion of fines into the system. In order to minimize the amount of sediment which may enter the CULTEC system, a sediment collection device (stormwater pretreatment device) is recommended upstream from the CULTEC chamber system. Examples of pretreatment devices include, but are not limited to, an appropriately sized catch basin with sump, pretreatment catchment device, oil grit separator, or baffled distribution box. Manufactured pretreatment devices may also be used in accordance with CULTEC chambers. Installation, operation, and maintenance of these devices shall be in accordance with manufacturer's recommendations. Almost all of the sediment entering the stormwater management system will be collected within the pretreatment device.

Best Management Practices allow for the maintenance of the preliminary collection systems prior to feeding the CULTEC chambers. The pretreatment structures shall be inspected for any debris that will restrict inlet flow rates. Outfall structures, if any, such as outlet control must also be inspected for any obstructions that would restrict outlet flow rates. OSHA Guidelines must be followed when inspecting or cleaning any structure.

Operation and Maintenance Requirements

I. Operation

CULTEC stormwater management systems shall be operated to receive only stormwater run-off in accordance with applicable local regulations. CULTEC subsurface stormwater management chambers operate at peak performance when installed in series with pretreatment. Pretreatment of suspended solids is superior to treatment of solids once they have been introduced into the system. The use of pretreatment is adequate as long as the structure is maintained and the site remains stable with finished impervious surfaces such as parking lots, walkways, and pervious areas are properly maintained. If there is to be an unstable condition, such as improvements to buildings or parking areas, all proper silt control measures shall be implemented according to local regulations.

II. Inspection and Maintenance Options

A. The CULTEC system may be equipped with an inspection port located on the inlet row. The inspection port is a circular cast box placed in a rectangular concrete collar. When the lid is removed, a 6-inch (150 mm) pipe with a screw-in plug will be exposed. Remove the plug. This will provide access to the CULTEC Chamber row below. From the surface, through this access, the sediment may be measured at this location. A stadia rod may be used to measure the depth of sediment if any in this row. If the depth of sediment is in excess of 3 inches (76 mm), then this row should be cleaned with high pressure water through a culvert cleaning nozzle. This would be carried out through an upstream manhole or through the CULTEC StormFilter Unit (or other pre-treatment device). CCTV inspection of this row can be deployed through this access port to deter mine if any sediment has accumulated in the inlet row.

B. If the CULTEC bed is not equipped with an inspection port, then access to the inlet row will be through an upstream manhole or the CULTEC StormFilter.

1. **Manhole Access**
This inspection should only be carried out by persons trained in confined space entry and sewer inspection services. After the manhole cover has been removed a gas detector must be lowered into the manhole to ensure that there are not high concentrations of toxic gases present. The inspector should be lowered into the manhole with the proper safety equipment as per OSHA requirements. The inspector may be able to observe sediment from this location. If this is not possible, the inspector will need to deploy a CCTV robot to permit viewing of the sediment.

2. **StormFilter Access**
Remove the manhole cover to allow access to the unit. Typically a 30-inch (750 mm) pipe is used as a riser from the StormFilter to the surface. As in the case with manhole access, this access point requires a technician trained in confined space entry with proper gas detection equipment. This individual must be equipped with the proper safety equipment for entry into the StormFilter. The technician will be lowered onto the StormFilter unit. The hatch on the unit must be removed. Inside the unit are two filters which may be removed according to StormFilter maintenance guidelines. Once these filters are removed the inspector can enter the StormFilter unit to launch the CCTV camera robot.

C. The inlet row of the CULTEC system is placed on a polyethylene liner to prevent scouring of the washed stone beneath this row. This also facilitates the flushing of this row with high pressure water through a culvert cleaning nozzle. The nozzle is deployed through a manhole or the StormFilter and extended to the end of the row. The water is turned on and the inlet row is back-flushed into the manhole or StormFilter. This water is to be removed from the manhole or StormFilter using a vacuum truck.

III. Maintenance Guidelines

The following guidelines shall be adhered to for the operation and maintenance of the CULTEC stormwater management system:

A. The owner shall keep a maintenance log which shall include details of any events which would have an effect on the system's operational capacity.

B. The operation and maintenance procedure shall be reviewed periodically and changed to meet site conditions.

C. Maintenance of the stormwater management system shall be performed by qualified workers and shall follow applicable occupational health and safety requirements.

D. Debris removed from the stormwater management system shall be disposed of in accordance with applicable laws and regulations.

IV. Suggested Maintenance Schedules

A. **Minor Maintenance**
The following suggested schedule shall be followed for routine maintenance during the regular operation of the stormwater system:

Frequency	Action
Monthly in first year	Check inlets and outlets for clogging and remove any debris, as required.
Spring and Fall	Check inlets and outlets for clogging and remove any debris, as required.
One year after commissioning and every third year following	Check inlets and outlets for clogging and remove any debris, as required.

B. **Major Maintenance**
The following suggested maintenance schedule shall be followed to maintain the performance of the CULTEC stormwater management chambers. Additional work may be necessary due to insufficient performance and other issues that might be found during the inspection of the stormwater management chambers. (See table on next page)

	Frequency	Action
Inlets and Outlets	Every 3 years	• Obtain documentation that the inlets, outlets and vents have been cleaned and will function as intended.
	Spring and Fall	• Check inlet and outlets for clogging and remove any debris as required.
CULTEC Stormwater Chambers	2 years after commissioning	• Inspect the interior of the stormwater management chambers through inspection port for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors will function as anticipated.
	9 years after commissioning every 9 years following	• Clean stormwater management chambers and feed connectors of any debris. • Inspect the interior of the stormwater management structures for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors have been cleaned and will function as intended.
	45 years after commissioning	• Clean stormwater management chambers and feed connectors of any debris. • Determine the remaining life expectancy of the stormwater management chambers and recommended schedule and actions to rehabilitate the stormwater management chambers as required. • Inspect the interior of the stormwater management chambers for deficiencies using CCTV or comparable technique. • Replace or restore the stormwater management chambers in accordance with the schedule determined at the 45-year inspection. • Attain the appropriate approvals as required. • Establish a new operation and maintenance schedule.
Surrounding Site	Monthly in 1st year	• Check for depressions in areas over and surrounding the stormwater management system.
	Spring and Fall	• Check for depressions in areas over and surrounding the stormwater management system.
	Yearly	• Confirm that no unauthorized modifications have been performed to the site.

For additional information concerning the maintenance of CULTEC Subsurface Stormwater Management Chambers, please contact CULTEC, Inc. at 1-800-428-5832.

WQMP
Operation & Maintenance (O&M) Plan

Project Name:____

Prepared for:

Project Name: ____

Address:____

City, State Zip:____

Prepared on:

Date:____

This O&M Plan describes the designated responsible party for implementation of this WQMP, including: operation and maintenance of all the structural BMP(s), conducting the training/educational program and duties, and any other necessary activities. The O&M Plan includes detailed inspection and maintenance requirements for all structural BMPs, including copies of any maintenance contract agreements, manufacturer's maintenance requirements, permits, etc.

8.1.1 Project Information

Project name	
Address	
City, State Zip	
Site size	
List of structural BMPs, number of each	
Other notes	

8.1.2 Responsible Party

The responsible party for implementation of this WQMP is:

Name of Person or HOA Property Manager	
Address	
City, State Zip	
Phone number	
24-Hour Emergency Contact number	
Email	

8.1.3 Record Keeping

Parties responsible for the O&M plan shall retain records for at least 5 years.

All training and educational activities and BMP operation and maintenance shall be documented to verify compliance with this O&M Plan. A sample Training Log and Inspection and Maintenance Log are included in this document.

8.1.4 Electronic Data Submittal

This document along with the Site Plan and Attachments shall be provided in PDF format. AutoCAD files and/or GIS coordinates of BMPs shall also be submitted to the City.

Appendix ___

BMP SITE PLAN

Site plan is preferred on minimum 11” by 17” colored sheets, as long as legible.

BMP OPERATION & MAINTENANCE LOG

Project Name: ______________________________

Today's Date: ______________________________

Name of Person Performing Activity (Printed): ______________________________

Signature: ______________________________

BMP Name (As Shown in O&M Plan)	Brief Description of Implementation, Maintenance, and Inspection Activity Performed

Minor Maintenance

Frequency		Action
Monthly in first year		Check inlets and outlets for clogging and remove any debris, as required.
		Notes
□ Month 1	Date:	
□ Month 2	Date:	
□ Month 3	Date:	
□ Month 4	Date	
□ Month 5	Date:	
□ Month 6	Date:	
□ Month 7	Date:	
□ Month 8	Date:	
□ Month 9	Date:	
□ Month 10	Date:	
□ Month 11	Date:	
□ Month 12	Date:	
Spring and Fall		Check inlets and outlets for clogging and remove any debris, as required.
		Notes
□ Spring	Date:	
□ Fall	Date:	
□ Spring	Date:	
□ Fall	Date:	
□ Spring	Date:	
□ Fall	Date:	
□ Spring	Date:	
□ Fall	Date:	
□ Spring	Date:	
□ Fall	Date:	
□ Spring	Date:	
□ Fall	Date:	
One year after commissioning and every third year following		Check inlets and outlets for clogging and remove any debris, as required.
		Notes
□ Year 1	Date:	
□ Year 4	Date:	
□ Year 7	Date:	
□ Year 10	Date:	
□ Year 13	Date:	
□ Year 16	Date:	
□ Year 19	Date:	
□ Year 22	Date:	

Major Maintenance

<table>
<tr><th></th><th colspan="2">Frequency</th><th>Action</th></tr>
<tr><td rowspan="22">Inlets and Outlets</td><td colspan="2" rowspan="2">Every 3 years</td><td>Obtain documentation that the inlets, outlets and vents have been cleaned and will function as intended.</td></tr>
<tr><td>Notes</td></tr>
<tr><td>□ Year 1</td><td>Date:</td><td></td></tr>
<tr><td>□ Year 4</td><td>Date:</td><td></td></tr>
<tr><td>□ Year 7</td><td>Date:</td><td></td></tr>
<tr><td>□ Year 10</td><td>Date:</td><td></td></tr>
<tr><td>□ Year 13</td><td>Date:</td><td></td></tr>
<tr><td>□ Year 16</td><td>Date:</td><td></td></tr>
<tr><td>□ Year 19</td><td>Date:</td><td></td></tr>
<tr><td>□ Year 22</td><td>Date:</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Spring and Fall</td><td>Check inlet and outlets for clogging and remove any debris, as required.</td></tr>
<tr><td>Notes</td></tr>
<tr><td>□ Spring</td><td>Date:</td><td></td></tr>
<tr><td>□ Fall</td><td>Date:</td><td></td></tr>
<tr><td>□ Spring</td><td>Date:</td><td></td></tr>
<tr><td>□ Fall</td><td>Date:</td><td></td></tr>
<tr><td>□ Spring</td><td>Date:</td><td></td></tr>
<tr><td>□ Fall</td><td>Date:</td><td></td></tr>
<tr><td>□ Spring</td><td>Date:</td><td></td></tr>
<tr><td>□ Fall</td><td>Date:</td><td></td></tr>
<tr><td>□ Spring</td><td>Date:</td><td></td></tr>
<tr><td>□ Fall</td><td>Date:</td><td></td></tr>
<tr><td>□ Spring</td><td>Date:</td><td></td></tr>
<tr><td>□ Fall</td><td>Date:</td><td></td></tr>
<tr><td rowspan="3">CULTEC Stormwater Chambers</td><td colspan="2" rowspan="2">2 years after commissioning</td><td>□ Inspect the interior of the stormwater management chambers through inspection port for deficiencies using CCTV or comparable technique.

□ Obtain documentation that the stormwater management chambers and feed connectors will function as anticipated.</td></tr>
<tr><td>Notes</td></tr>
<tr><td>□ Year 2</td><td>Date:</td><td></td></tr>
</table>

Major Maintenance

	Frequency		Action
CULTEC Stormwater Chambers	**9 years after commissioning every 9 years following**		◻ Clean stormwater management chambers and feed connectors of any debris. ◻ Inspect the interior of the stormwater management structures for deficiencies using CCTV or comparable technique. ◻ Obtain documentation that the stormwater management chambers and feed connectors have been cleaned and will function as intended.
			Notes
	◻ Year 9	Date:	
	◻ Year 18	Date:	
	◻ Year 27	Date:	
	◻ Year 36	Date:	
	45 years after commissioning		◻ Clean stormwater management chambers and feed connectors of any debris. ◻ Determine the remaining life expectancy of the stormwater management chambers and recommended schedule and actions to rehabilitate the stormwater management chambers as required. ◻ Inspect the interior of the stormwater management chambers for deficiencies using CCTV or comparable technique. ◻ Replace or restore the stormwater management chambers in accordance with the schedule determined at the 45-year inspection. ◻ Attain the appropriate approvals as required. ◻ Establish a new operation and maintenance schedule.
			Notes
	◻ Year 45	Date:	

Major Maintenance

	Frequency		Action
Surrounding Site	**Monthly in 1st year**		□ Check for depressions in areas over and surrounding the stormwater management system.
			Notes
	□ Month 1	Date:	
	□ Month 2	Date:	
	□ Month 3	Date:	
	□ Month 4	Date:	
	□ Month 5	Date:	
	□ Month 6	Date:	
	□ Month 7	Date:	
	□ Month 8	Date:	
	□ Month 9	Date:	
	□ Month 10	Date:	
	□ Month 11	Date:	
	□ Month 12	Date:	
	Spring and Fall		□ Check for depressions in areas over and surrounding the stormwater management system.
			Notes
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	Yearly		□ Confirm that no unauthorized modifications have been performed to the site.
			Notes
	□ Year 1	Date:	
	□ Year 2	Date:	
	□ Year 3	Date:	
	□ Year 4	Date:	
	□ Year 5	Date:	
	□ Year 6	Date:	
	□ Year 7	Date:	

CULTEC

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P: (203) 775-4416 • Toll Free: 1(800) 4-CULTEC • www.cultec.com

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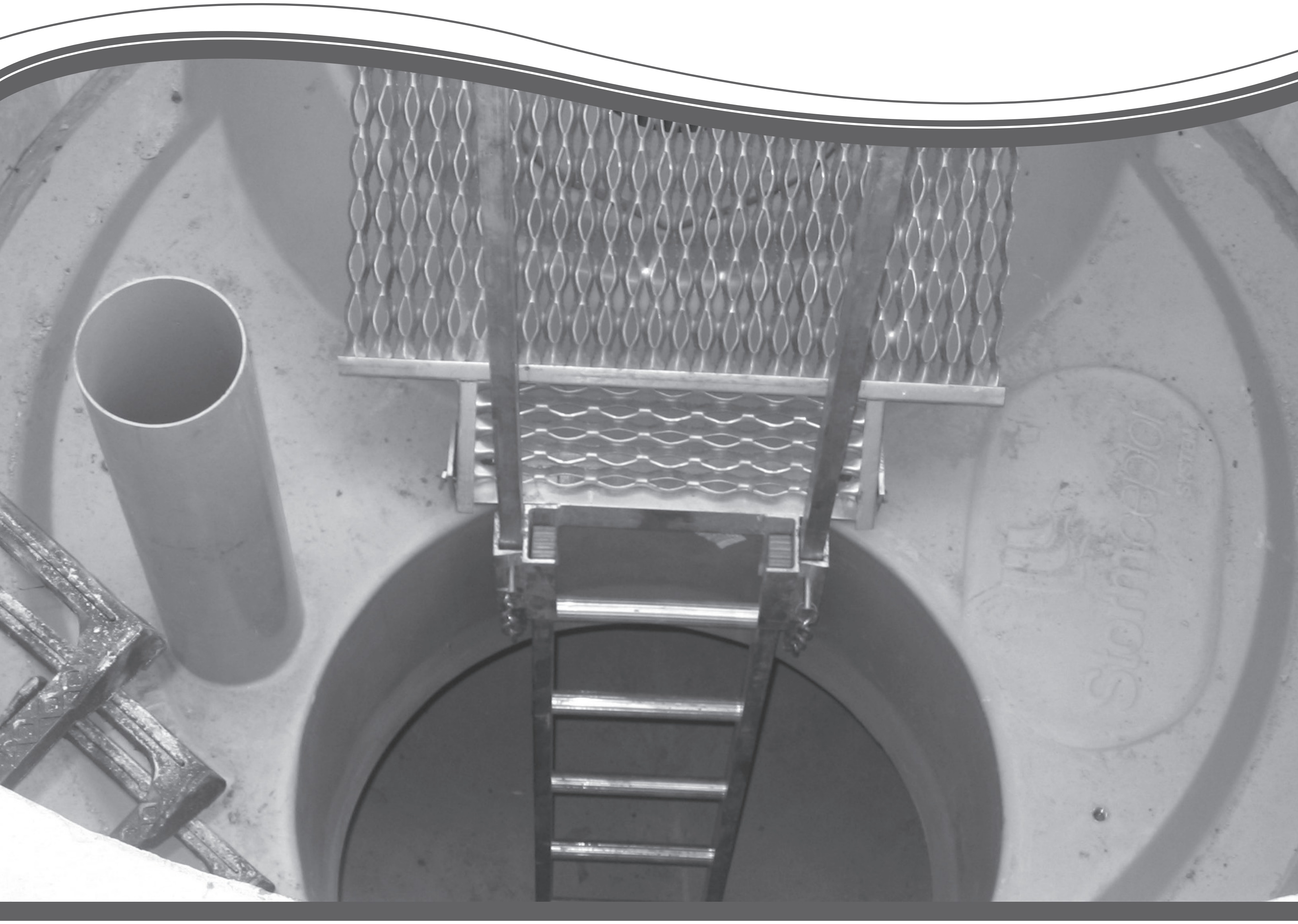
Stormceptor® STC
Operation and Maintenance Guide



Stormceptor® STC

Stormceptor Design Notes

- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.

Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences			
Inlet Pipe Configuration	STC 450i	STC 900 to STC 7200	STC 11000 to STC 16000
Single inlet pipe	3 in. (75 mm)	1 in. (25 mm)	3 in. (75 mm)
Multiple inlet pipes	3 in. (75 mm)	3 in. (75 mm)	Only one inlet pipe.

Maximum inlet and outlet pipe diameters:

Inlet/Outlet Configuration	Inlet Unit STC 450i	In-Line Unit STC 900 to STC 7200	Series* STC 11000 to STC 16000
Straight Through	24 inch (600 mm)	42 inch (1050 mm)	60 inch (1500 mm)
Bend (90 degrees)	18 inch (450 mm)	33 inch (825 mm)	33 inch (825 mm)

- The inlet and in-line Stormceptor units can accommodate turns to a maximum of 90 degrees.
- Minimum distance from top of grade to crown is 2 feet (0.6 m)
- Submerged conditions. A unit is submerged when the standing water elevation at the proposed location of the Stormceptor unit is greater than the outlet invert elevation during zero flow conditions. In these cases, please contact your local Stormceptor representative and provide the following information:
- Top of grade elevation
- Stormceptor inlet and outlet pipe diameters and invert elevations
- Standing water elevation
- Stormceptor head loss, K = 1.3 (for submerged condition, K = 4)

OPERATION AND MAINTENANCE GUIDE
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1. About Stormceptor

The Stormceptor® STC (Standard Treatment Cell) was developed by Imbrium™ Systems to address the growing need to remove and isolate pollution from the storm drain system before it enters the environment. The Stormceptor STC targets hydrocarbons and total suspended solids (TSS) in stormwater runoff. It improves water quality by removing contaminants through the gravitational settling of fine sediments and floatation of hydrocarbons while preventing the re-suspension or scour of previously captured pollutants.

The development of the Stormceptor STC revolutionized stormwater treatment, and created an entirely new category of environmental technology. Protecting thousands of waterways around the world, the Stormceptor System has set the standard for effective stormwater treatment.

1.1. Patent Information

The Stormceptor technology is protected by the following patents:

- Australia Patent No. 693,164 • 693,164 • 707,133 • 729,096 • 779401
- Austrian Patent No. 289647
- Canadian Patent No 2,009,208 •2,137,942 • 2,175,277 • 2,180,305 • 2,180,383 • 2,206,338 • 2,327,768 (Pending)
- China Patent No 1168439
- Denmark DK 711879
- German DE 69534021
- Indonesian Patent No 16688
- Japan Patent No 9-11476 (Pending)
- Korea 10-2000-0026101 (Pending)
- Malaysia Patent No PI9701737 (Pending)
- New Zealand Patent No 314646
- United States Patent No 4,985,148 • 5,498,331 • 5,725,760 • 5,753,115 • 5,849,181 • 6,068,765 • 6,371,690
- Stormceptor OSR Patent Pending • Stormceptor LCS Patent Pending

2. Stormceptor Design Overview

2.1. Design Philosophy

The patented Stormceptor System has been designed to focus on the environmental objective of providing long-term pollution control. The unique and innovative Stormceptor design allows for continuous positive treatment of runoff during all rainfall events, while ensuring that all captured pollutants are retained within the system, even during intense storm events.

An integral part of the Stormceptor design is PCSWMM for Stormceptor - sizing software developed in conjunction with Computational Hydraulics Inc. (CHI) and internationally acclaimed expert, Dr. Bill James. Using local historical rainfall data and continuous simulation modeling, this software allows a Stormceptor unit to be designed for each individual site and the corresponding water quality objectives.

By using PCSWMM for Stormceptor, the Stormceptor System can be designed to remove a wide range of particles (typically from 20 to 2,000 microns), and can also be customized to remove a specific particle size distribution (PSD). The specified PSD should accurately reflect what is in the stormwater runoff to ensure the device is achieving the desired water quality objective. Since stormwater runoff contains small particles (less than 75 microns), it is important to design a treatment system to remove smaller particles in addition to coarse particles.

2.2. Benefits

The Stormceptor System removes free oil and suspended solids from stormwater, preventing spills and non-point source pollution from entering downstream lakes and rivers. The key benefits, capabilities and applications of the Stormceptor System are as follows:

- Provides continuous positive treatment during all rainfall events
- Can be designed to remove over 80% of the annual sediment load
- Removes a wide range of particles
- Can be designed to remove a specific particle size distribution (PSD)
- Captures free oil from stormwater
- Prevents scouring or re-suspension of trapped pollutants
- Pre-treatment to reduce maintenance costs for downstream treatment measures (ponds, swales, detention basins, filters)
- Groundwater recharge protection
- Spills capture and mitigation
- Simple to design and specify
- Designed to your local watershed conditions
- Small footprint to allow for easy retrofit installations
- Easy to maintain (vacuum truck)
- Multiple inlets can connect to a single unit
- Suitable as a bend structure
- Pre-engineered for traffic loading (minimum AASHTO HS-20)
- Minimal elevation drop between inlet and outlet pipes
- Small head loss
- Additional protection provided by an 18” (457 mm) fiberglass skirt below the top of the insert, for the containment of hydrocarbons in the event of a spill.

2.3. Environmental Benefit

Freshwater resources are vital to the health and welfare of their surrounding communities. There is increasing public awareness, government regulations and corporate commitment to reducing the pollution entering our waterways. A major source of this pollution originates from stormwater runoff from urban areas. Rainfall runoff carries oils, sediment and other contaminants from roads and parking lots discharging directly into our streams, lakes and coastal waterways.

The Stormceptor System is designed to isolate contaminants from getting into the natural environment. The Stormceptor technology provides protection for the environment from spills that occur at service stations and vehicle accident sites, while also removing contaminated sediment in runoff that washes from roads and parking lots.

3. Key Operation Features

3.1. Scour Prevention

A key feature of the Stormceptor System is its patented scour prevention technology. This innovation ensures pollutants are captured and retained during all rainfall events, even extreme storms. The Stormceptor System provides continuous positive treatment for all rainfall events, including intense storms. Stormceptor slows incoming runoff, controlling and reducing velocities in the lower chamber to create a non-turbulent environment that promotes free oils and floatable debris to rise and sediment to settle.

The patented scour prevention technology, the fiberglass insert, regulates flows into the lower chamber through a combination of a weir and orifice while diverting high energy flows away through the upper chamber to prevent scouring. Laboratory testing demonstrated no scouring when tested up to 125% of the unit's operating rate, with the unit loaded to 100% sediment capacity (NJDEP, 2005). Second, the depth of the lower chamber ensures the sediment storage zone is adequately separated from the path of flow in the lower chamber to prevent scouring.

3.2. Operational Hydraulic Loading Rate

Designers and regulators need to evaluate the treatment capacity and performance of manufactured stormwater treatment systems. A commonly used parameter is the "operational hydraulic loading rate" which originated as a design methodology for wastewater treatment devices.

Operational hydraulic loading rate may be calculated by dividing the flow rate into a device by its settling area. This represents the critical settling velocity that is the prime determinant to quantify the influent particle size and density captured by the device. PCSWMM for Stormceptor uses a similar parameter that is calculated by dividing the hydraulic detention time in the device by the fall distance of the sediment.

$$v_{SC} = \frac{H}{6_H} = \frac{Q}{A_S}$$

Where:

v_{SC} = critical settling velocity, ft/s (m/s)

H = tank depth, ft (m)

$Ø_H$ = hydraulic detention time, ft/s (m/s)

Q = volumetric flow rate, ft3/s (m3/s)

A_S = surface area, ft^2 (m^2)

(Tchobanoglous, G. and Schroeder, E.D. 1987. Water Quality. Addison Wesley.)

Unlike designing typical wastewater devices, stormwater systems are designed for highly variable flow rates including intense peak flows. PCSWMM for Stormceptor incorporates all of the flows into its calculations, ensuring that the operational hydraulic loading rate is considered not only for one flow rate, but for all flows including extreme events.

3.3. Double Wall Containment

The Stormceptor System was conceived as a pollution identifier to assist with identifying illicit discharges. The fiberglass insert has a continuous skirt that lines the concrete barrel wall for a depth of 18 inches (457 mm) that provides double wall containment for hydrocarbons storage. This protective barrier ensures that toxic floatables do not migrate through the concrete wall into the surrounding soils.

4. Stormceptor Product Line

4.1. Stormceptor Models

A summary of Stormceptor models and capacities are listed in Table 1.

Table 1. Stormceptor Models

Stormceptor Model	Total Storage Volume U.S. Gal (L)	Hydrocarbon Storage Capacity U.S. Gal (L)	Maximum Sediment Capacity ft^3 (L)
STC 450i	470 (1,780)	86 (330)	46 (1,302)
STC 900	952 (3,600)	251 (950)	89 (2,520)
STC 1200	1,234 (4,670)	251 (950)	127 (3,596)
STC 1800	1,833 (6,940)	251 (950)	207 (5,861)
STC 2400	2,462 (9,320)	840 (3,180)	205 (5,805)
STC 3600	3,715 (1,406)	840 (3,180)	373 (10,562)
STC 4800	5,059 (1,950)	909 (3,440)	543 (15,376)
STC 6000	6,136 (23,230)	909 (3,440)	687 (19,453)
STC 7200	7,420 (28,090)	1,059 (4,010)	839 (23,757)
STC 11000	11,194 (42,370)	2,797 (10, 590)	1,086 (30,752)
STC 13000	13,348 (50,530)	2,797 (10, 590)	1,374 (38,907)
STC 16000	15,918 (60,260)	3,055 (11, 560)	1,677 (47,487)

NOTE: Storage volumes may vary slightly from region to region. For detailed information, contact your local Stormceptor representative.

4.2. Inline Stormceptor

The Inline Stormceptor, Figure 1, is the standard design for most stormwater treatment applications. The patented Stormceptor design allows the Inline unit to maintain continuous positive treatment of total suspended solids (TSS) year-round, regardless of flow rate. The Inline Stormceptor is composed of a precast concrete tank with a fiberglass insert situated at the invert of the storm sewer pipe, creating an upper chamber above the insert and a lower chamber below the insert.

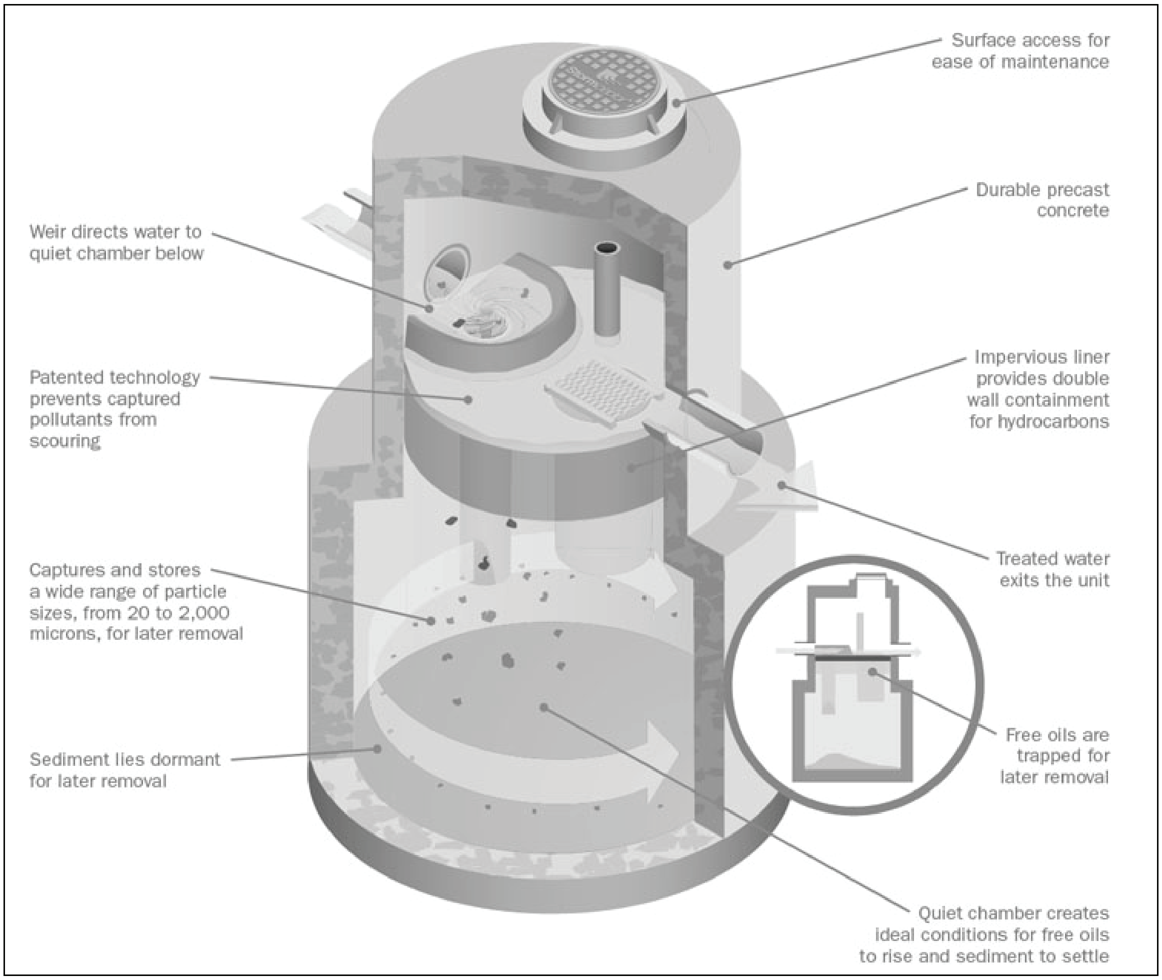

Figure 1. Inline Stormceptor

Operation

As water flows into the Stormceptor unit, it is slowed and directed to the lower chamber by a weir and drop tee. The stormwater enters the lower chamber, a non-turbulent environment, allowing free oils to rise and sediment to settle. The oil is captured underneath the fiberglass insert and shielded from exposure to the concrete walls by a fiberglass skirt. After the pollutants separate, treated water continues up a riser pipe, and exits the lower chamber on the downstream side of the weir before leaving the unit. During high flow events, the Stormceptor System's patented scour prevention technology ensures continuous pollutant removal and prevents re-suspension of previously captured pollutants.

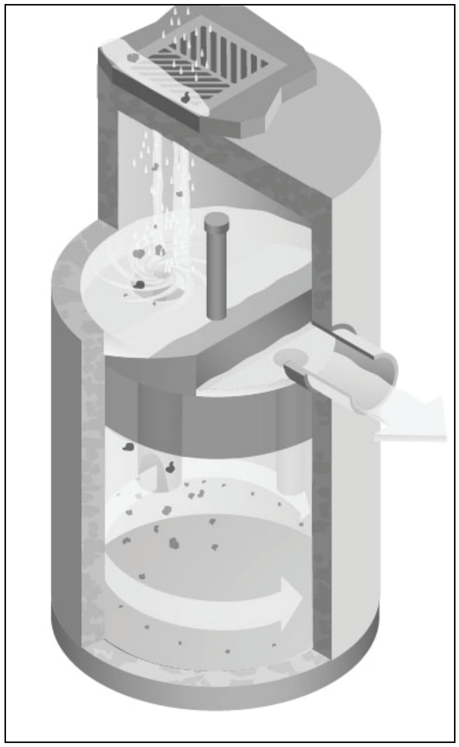

Figure 2. Inlet Stormceptor

4.3. Inlet Stormceptor

The Inlet Stormceptor System, Figure 2, was designed to provide protection for parking lots, loading bays, gas stations and other spill-prone areas. The Inlet Stormceptor is designed to remove sediment from stormwater introduced through a grated inlet, a storm sewer pipe, or both.

The Inlet Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

4.4. Series Stormceptor

Designed to treat larger drainage areas, the Series Stormceptor System, Figure 3, consists of two adjacent Stormceptor models that function in parallel. This design eliminates the need for additional structures and piping to reduce installation costs.

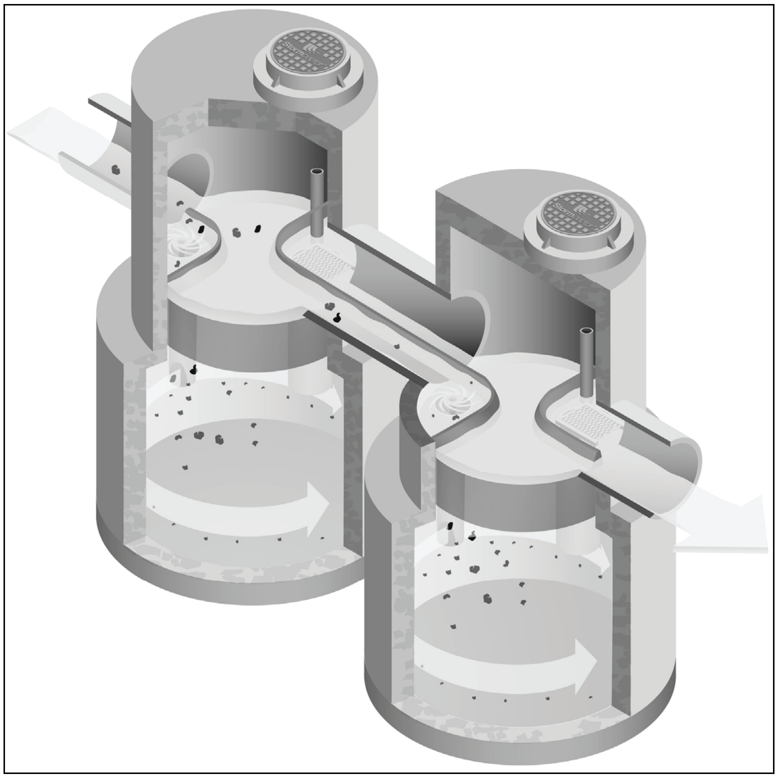

Figure 3. Series System

The Series Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

5. Sizing the Stormceptor System

The Stormceptor System is a versatile product that can be used for many different aspects of water quality improvement. While addressing these needs, there are conditions that the designer needs to be aware of in order to size the Stormceptor model to meet the demands of each individual site in an efficient and cost-effective manner.

PCSWMM for Stormceptor is the support tool used for identifying the appropriate Stormceptor model. In order to size a unit, it is recommended the user follow the seven design steps in the program. The steps are as follows:

STEP 1 – Project Details

The first step prior to sizing the Stormceptor System is to clearly identify the water quality objective for the development. It is recommended that a level of annual sediment (TSS) removal be identified and defined by a particle size distribution.

STEP 2 – Site Details

Identify the site development by the drainage area and the level of imperviousness. It is recommended that imperviousness be calculated based on the actual area of imperviousness based on paved surfaces, sidewalks and rooftops.

STEP 3 – Upstream Attenuation

The Stormceptor System is designed as a water quality device and is sometimes used in conjunction with onsite water quantity control devices such as ponds or underground detention systems. When possible, a greater benefit is typically achieved when installing a Stormceptor unit upstream of a detention facility. By placing the Stormceptor unit upstream of a detention structure, a benefit of less maintenance of the detention facility is realized.

STEP 4 – Particle Size Distribution

It is critical that the PSD be defined as part of the water quality objective. PSD is critical for the design of treatment system for a unit process of gravity settling and governs the size of a treatment system. A range of particle sizes has been provided and it is recommended that clays and silt-sized particles be considered in addition to sand and gravel-sized particles. Options and sample PSDs are provided in PCSWMM for Stormceptor. The default particle size distribution is the Fine Distribution, Table 2, option.

Table 2. Fine Distribution

Particle Size	Distribution	Specific Gravity
20	20%	1.3
60	20%	1.8
150	20%	2.2
400	20%	2.65
2000	20%	2.65

If the objective is the long-term removal of 80% of the total suspended solids on a given site, the PSD should be representative of the expected sediment on the site. For example, a system designed to remove 80% of coarse particles (greater than 75 microns) would provide relatively poor removal efficiency of finer particles that may be naturally prevalent in runoff from the site.

Since the small particle fraction contributes a disproportionately large amount of the total available particle surface area for pollutant adsorption, a system designed primarily for coarse particle capture will compromise water quality objectives.

STEP 5 – Rainfall Records

Local historical rainfall has been acquired from the U.S. National Oceanic and Atmospheric Administration, Environment Canada and regulatory agencies across North America. The rainfall data provided with PCSMM for Stormceptor provides an accurate estimation of small storm hydrology by modeling actual historical storm events including duration, intensities and peaks.

STEP 6 – Summary

At this point, the program may be executed to predict the level of TSS removal from the site. Once the simulation has completed, a table shall be generated identifying the TSS removal of each Stormceptor unit.

STEP 7 – Sizing Summary

Performance estimates of all Stormceptor units for the given site parameters will be displayed in a tabular format. The unit that meets the water quality objective, identified in Step 1, will be highlighted.

5.1. PCSWMM for Stormceptor

The Stormceptor System has been developed in conjunction with PCSWMM for Stormceptor as a technological solution to achieve water quality goals. Together, these two innovations model, simulate, predict and calculate the water quality objectives desired by a design engineer for TSS removal.

PCSWMM for Stormceptor is a proprietary sizing program which uses site specific inputs to a computer model to simulate sediment accumulation, hydrology and long-term total suspended solids removal. The model has been calibrated to field monitoring results from Stormceptor units that have been monitored in North America. The sizing methodology can be described by three processes:

1. Determination of real time hydrology
2. Buildup and wash off of TSS from impervious land areas
3. TSS transport through the Stormceptor (settling and discharge). The use of a calibrated model is the preferred method for sizing stormwater quality structures for the following reasons:
   - » The hydrology of the local area is properly and accurately incorporated in the sizing (distribution of flows, flow rate ranges and peaks, back-to-back storms, inter-event times)
   - » The distribution of TSS with the hydrology is properly and accurately considered in the sizing
   - » Particle size distribution is properly considered in the sizing
   - » The sizing can be optimized for TSS removal
   - » The cost benefit of alternate TSS removal criteria can be easily assessed
   - » The program assesses the performance of all Stormceptor models. Sizing may be selected based on a specific water quality outcome or based on the Maximum Extent Practicable

For more information regarding PCSWMM for Stormceptor, contact your local Stormceptor representative, or visit www.imbriumsystems.com to download a free copy of the program.

5.2. Sediment Loading Characteristics

The way in which sediment is transferred to stormwater can have a considerable effect on which type of system is implemented. On typical impervious surfaces (e.g. parking lots) sediment will build over time and wash off with the next rainfall. When rainfall patterns are examined, a short intense storm will have a higher concentration of sediment than a long slow drizzle. Together with rainfall data representing the site's typical rainfall patterns, sediment loading characteristics play a part in the correct sizing of a stormwater quality device.

Typical Sites

For standard site design of the Stormceptor System, PCSWMM for Stormceptor is utilized to accurately assess the unit's performance. As an integral part of the product's design, the program can be used to meet local requirements for total suspended solid removal. Typical installations of manufactured stormwater treatment devices would occur on areas such as paved parking lots or paved roads. These are considered "stable" surfaces which have non – erodible surfaces.

Unstable Sites

While standard sites consist of stable concrete or asphalt surfaces, sites such as gravel parking lots, or maintenance yards with stockpiles of sediment would be classified as "unstable". These types of sites do not exhibit first flush characteristics, are highly erodible and exhibit atypical sediment loading characteristics and must therefore be sized more carefully. Contact your local Stormceptor representative for assistance in selecting a proper unit sized for such unstable sites.

6. Spill Controls

When considering the removal of total petroleum hydrocarbons (TPH) from a storm sewer system there are two functions of the system: oil removal, and spill capture.

'Oil Removal' describes the capture of the minute volumes of free oil mobilized from impervious surfaces. In this instance relatively low concentrations, volumes and flow rates are considered. While the Stormceptor unit will still provide an appreciable oil removal function during higher flow events and/or with higher TPH concentrations, desired effluent limits may be exceeded under these conditions.

'Spill Capture' describes a manner of TPH removal more appropriate to recovery of a relatively high volume of a single phase deleterious liquid that is introduced to the storm sewer system over a relatively short duration. The two design criteria involved when considering this manner of introduction are overall volume and the specific gravity of the material. A standard Stormceptor unit will be able to capture and retain a maximum spill volume and a minimum specific gravity.

For spill characteristics that fall outside these limits, unit modifications are required. Contact your local Stormceptor Representative for more information.

One of the key features of the Stormceptor technology is its ability to capture and retain spills. While the standard Stormceptor System provides excellent protection for spill control, there are additional options to enhance spill protection if desired.

6.1. Oil Level Alarm

The oil level alarm is an electronic monitoring system designed to trigger a visual and audible alarm when a pre-set level of oil is reached within the lower chamber. As a standard, the oil

level alarm is designed to trigger at approximately 85% of the unit's available depth level for oil capture. The feature acts as a safeguard against spills caused by exceeding the oil storage capacity of the separator and eliminates the need for manual oil level inspection.

The oil level alarm installed on the Stormceptor insert is illustrated in Figure 4.

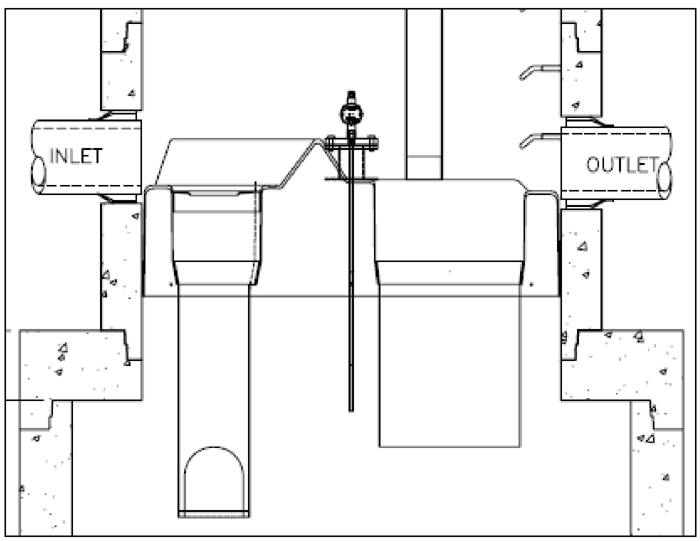

Figure 4. Oil level alarm

6.2. Increased Volume Storage Capacity

The Stormceptor unit may be modified to store a greater spill volume than is typically available. Under such a scenario, instead of installing a larger than required unit, modifications can be made to the recommended Stormceptor model to accommodate larger volumes. Contact your local Stormceptor representative for additional information and assistance for modifications.

7. Stormceptor Options

The Stormceptor System allows flexibility to incorporate to existing and new storm drainage infrastructure. The following section identifies considerations that should be reviewed when installing the system into a drainage network. For conditions that fall outside of the recommendations in this section, please contact your local Stormceptor representative for further guidance.

7.1. Installation Depth Minimum Cover

The minimum distance from the top of grade to the crown of the inlet pipe is 24 inches (600 mm). For situations that have a lower minimum distance, contact your local Stormceptor representative.

7.2. Maximum Inlet and Outlet Pipe Diameters

Maximum inlet and outlet pipe diameters are illustrated in Figure 5. Contact your local Stormceptor representative for larger pipe diameters

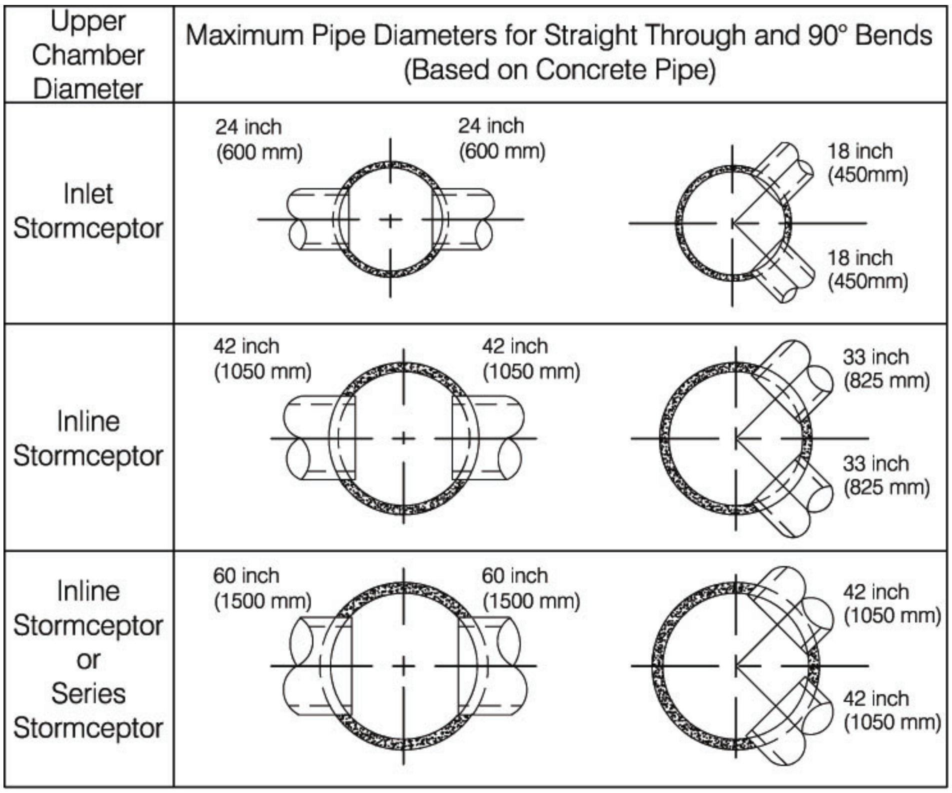

Figure 5. Maximum pipe diameters for straight through and bend applications

*The bend should only be incorporated into the second structure (downstream structure) of the Series Stormceptor System

7.3. Bends

The Stormceptor System can be used to change horizontal alignment in the storm drain network up to a maximum of 90 degrees. Figure 6 illustrates the typical bend situations of the Stormceptor System. Bends should only be applied to the second structure (downstream structure) of the Series Stormceptor System.

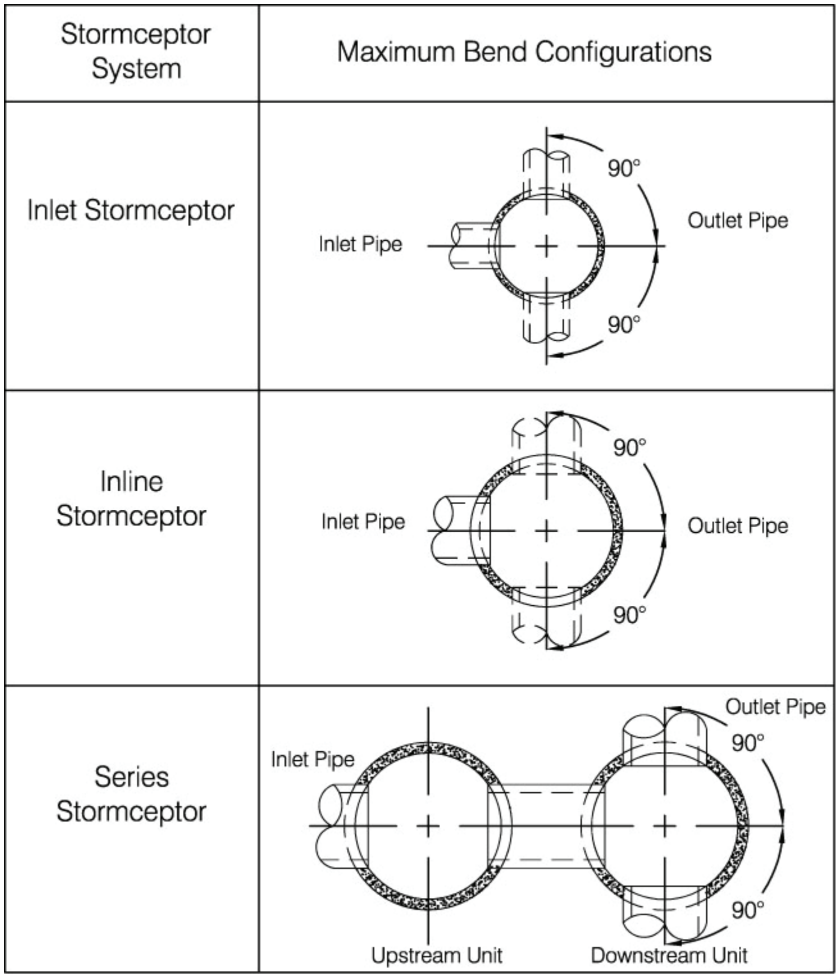

Figure 6. Maximum bend angles

7.4. Multiple Inlet Pipes

The Inlet and Inline Stormceptor System can accommodate two or more inlet pipes. The maximum number of inlet pipes that can be accommodated into a Stormceptor unit is a function of the number, alignment and diameter of the pipes and its effects on the structural integrity of the precast concrete. When multiple inlet pipes are used for new developments, each inlet pipe shall have an invert elevation 3 inches (75 mm) higher than the outlet pipe invert elevation.

7.5. Inlet/Outlet Pipe Invert Elevations

Recommended inlet and outlet pipe invert differences are listed in Table 3.

Table 3. Recommended Drops Between Inlet and Outlet Pipe Inverts

Number of Inlet Pipes	Inlet System	In-Line System	Series System
1	3 inches (75 mm)	1 inch (25 mm)	3 inches (75 mm)
>1	3 inches (75 mm)	3 inches (75 mm)	Not Applicable

7.6. Shallow Stormceptor

In cases where there may be restrictions to the depth of burial of storm sewer systems. In this situation, for selected Stormceptor models, the lower chamber components may be increased in diameter to reduce the overall depth of excavation required.

7.7. Customized Live Load

The Stormceptor system is typically designed for local highway truck loading (AASHTO HS- 20). When the project requires live loads greater than HS-20, the Stormceptor System may be customized structurally for a pre-specified live load. Contact your local Stormceptor representative for customized loading conditions.

7.8. Pre-treatment

The Stormceptor System may be sized to remove sediment and for spills control in conjunction with other stormwater BMPs to meet the water quality objective. For pretreatment applications, the Stormceptor System should be the first unit in a treatment train. The benefits of pre-treatment include the extension of the operational life (extension of maintenance frequency) of large stormwater management facilities, prevention of spills and lower total life- cycle maintenance cost.

7.9. Head loss

The head loss through the Stormceptor System is similar to a 60 degree bend at a manhole. The K value for calculating minor losses is approximately 1.3 (minor loss = k*1.3v2/2g).

However, when a Submerged modification is applied to a Stormceptor unit, the corresponding K value is 4.

7.10. Submerged

The Submerged modification, Figure 7, allows the Stormceptor System to operate in submerged or partially submerged storm sewers. This configuration can be installed on all models of the Stormceptor System by modifying the fiberglass insert. A customized weir height and a secondary drop tee are added.

Submerged instances are defined as standing water in the storm drain system during zero flow conditions. In these instances, the following information is necessary for the proper design and application of submerged modifications:

- Stormceptor top of grade elevation
- Stormceptor outlet pipe invert elevation
- Standing water elevation

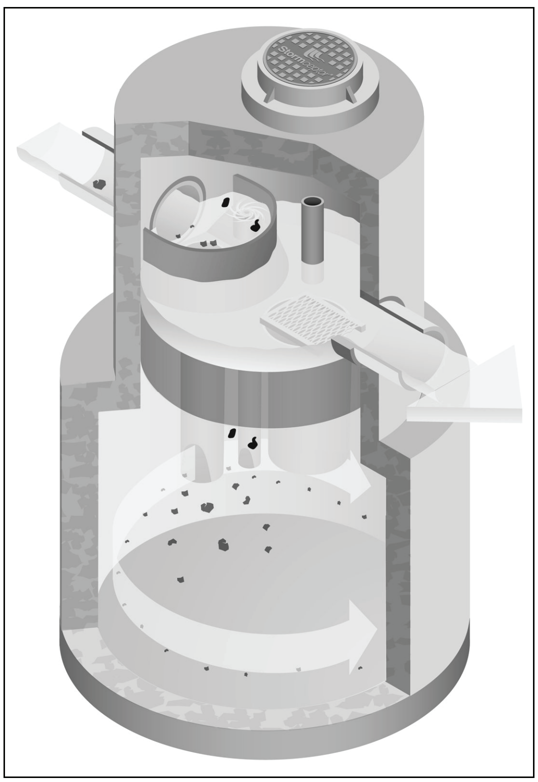

Figure 7. Submerged Stormceptor

8. Comparing Technologies

Designers have many choices available to achieve water quality goals in the treatment of stormwater runoff. Since many alternatives are available for use in stormwater quality treatment it is important to consider how to make an appropriate comparison between “approved alternatives”. The following is a guide to assist with the accurate comparison of differing technologies and performance claims.

8.1. Particle Size Distribution (PSD)

The most sensitive parameter to the design of a stormwater quality device is the selection of the design particle size. While it is recommended that the actual particle size distribution (PSD) for sites be measured prior to sizing, alternative values for particle size should be selected to represent what is likely to occur naturally on the site. A reasonable estimate of a particle size distribution likely to be found on parking lots or other impervious surfaces should consist of a wide range of particles such as 20 microns to 2,000 microns (Ontario MOE, 1994).

There is no absolute right particle size distribution or specific gravity and the user is cautioned to review the site location, characteristics, material handling practices and regulatory requirements when selecting a particle size distribution. When comparing technologies, designs using different PSDs will result in incomparable TSS removal efficiencies. The PSD of the TSS removed needs to be standard between two products to allow for an accurate comparison.

8.2. Scour Prevention

In order to accurately predict the performance of a manufactured treatment device, there must be confidence that it will perform under all conditions. Since rainfall patterns cannot be predicted, stormwater quality devices placed in storm sewer systems must be able to withstand extreme events, and ensure that all pollutants previously captured are retained in the system.

In order to have confidence in a system‘s performance under extreme conditions, independent validation of scour prevention is essential when examining different technologies. Lack of independent verification of scour prevention should make a designer wary of accepting any product’s performance claims.

8.3. Hydraulics

Full scale laboratory testing has been used to confirm the hydraulics of the Stormceptor System. Results of lab testing have been used to physically design the Stormceptor System and the sewer pipes entering and leaving the unit. Key benefits of Stormceptor are:

- Low head loss (typical k value of 1.3)
- Minimal inlet/outlet invert elevation drop across the structure
- Use as a bend structure
- Accommodates multiple inlets

The adaptability of the treatment device to the storm sewer design infrastructure can affect the overall performance and cost of the site.

8.4. Hydrology

Stormwater quality treatment technologies need to perform under varying climatic conditions. These can vary from long low intensity rainfall to short duration, high intensity storms. Since a treatment device is expected to perform under all these conditions, it makes sense that any system’s design should accommodate those conditions as well.

Long-term continuous simulation evaluates the performance of a technology under the varying conditions expected in the climate of the subject site. Single, peak event design does not provide this information and is not equivalent to long-term simulation. Designers should request long-term simulation performance to ensure the technology can meet the long-term water quality objective.

9. Testing

The Stormceptor System has been the most widely monitored stormwater treatment technology in the world. Performance verification and monitoring programs are completed to the strictest standards and integrity. Since its introduction in 1990, numerous independent field tests and studies detailing the effectiveness of the Stormceptor System have been completed.

- Coventry University, UK – 97% removal of oil, 83% removal of sand and 73% removal of peat
- National Water Research Institute, Canada, - scaled testing for the development of the Stormceptor System identifying both TSS removal and scour prevention.
- New Jersey TARP Program – full scale testing of an STC 900 demonstrating 75% TSS removal of particles from 1 to 1000 microns. Scour testing completed demonstrated that the system does not scour. The New Jersey Department of Environmental Protection was followed.
- City of Indianapolis – full scale testing of an STC 900 demonstrating over 80% TSS removal of particles from 50 microns to 300 microns at 130% of the unit's operating rate. Scour testing completed demonstrated that the system does not scour.
- Westwood Massachusetts (1997), demonstrated >80% TSS removal
- Como Park (1997), demonstrated 76% TSS removal
- Ontario MOE SWAMP Program – 57% removal of 1 to 25 micron particles
- Laval Quebec – 50% removal of 1 to 25 micron particles

10. Installation

The installation of the concrete Stormceptor should conform in general to state highway, or local specifications for the installation of manholes. Selected sections of a general specification that are applicable are summarized in the following sections.

10.1. Excavation

Excavation for the installation of the Stormceptor should conform to state highway, or local specifications. Topsoil removed during the excavation for the Stormceptor should be stockpiled in designated areas and should not be mixed with subsoil or other materials.

Topsoil stockpiles and the general site preparation for the installation of the Stormceptor should conform to state highway or local specifications.

The Stormceptor should not be installed on frozen ground. Excavation should extend a minimum of 12 inches (300 mm) from the precast concrete surfaces plus an allowance for shoring and bracing where required. If the bottom of the excavation provides an unsuitable foundation additional excavation may be required.

In areas with a high water table, continuous dewatering may be required to ensure that the excavation is stable and free of water.

10.2. Backfilling

Backfill material should conform to state highway or local specifications. Backfill material should be placed in uniform layers not exceeding 12 inches (300mm) in depth and compacted to state highway or local specifications.

11. Stormceptor Construction Sequence

The concrete Stormceptor is installed in sections in the following sequence:

1. Aggregate base
2. Base slab
3. Lower chamber sections
4. Upper chamber section with fiberglass insert
5. Connect inlet and outlet pipes
6. Assembly of fiberglass insert components (drop tee, riser pipe, oil cleanout port and orifice plate
7. Remainder of upper chamber
8. Frame and access cover

The precast base should be placed level at the specified grade. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with the precast concrete manufacturer's recommendations.

Adjustment of the Stormceptor can be performed by lifting the upper sections free of the excavated area, re-leveling the base and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary. Once the Stormceptor has been constructed, any lift holes must be plugged with mortar.

12. Maintenance

12.1. Health and Safety

The Stormceptor System has been designed considering safety first. It is recommended that confined space entry protocols be followed if entry to the unit is required. In addition, the fiberglass insert has the following health and safety features:

- Designed to withstand the weight of personnel
- A safety grate is located over the 24 inch (600 mm) riser pipe opening
- Ladder rungs can be provided for entry into the unit, if required

12.2. Maintenance Procedures

Maintenance of the Stormceptor system is performed using vacuum trucks. No entry into the unit is required for maintenance (in most cases). The vacuum service industry is a well- established sector of the service industry that cleans underground tanks, sewers and catch basins. Costs to clean a Stormceptor will vary based on the size of unit and transportation distances.

The need for maintenance can be determined easily by inspecting the unit from the surface. The depth of oil in the unit can be determined by inserting a dipstick in the oil inspection/cleanout port.

Similarly, the depth of sediment can be measured from the surface without entry into the Stormceptor via a dipstick tube equipped with a ball valve. This tube would be inserted through the riser pipe. Maintenance should be performed once the sediment depth exceeds the guideline values provided in the Table 4.

Table 4. Sediment Depths Indicating Required Servicing*

Particle Size	Specific Gravity
Model	Sediment Depth inches (mm)
450i	8 (200)
900	8 (200)
1200	10 (250)
1800	15 (381)
2400	12 (300)
3600	17 (430)
4800	15 (380)
6000	18 (460)
7200	15 (381)
11000	17 (380)
13000	20 (500)
16000	17 (380)
* based on 15% of the Stormceptor unit's total storage	

Although annual servicing is recommended, the frequency of maintenance may need to be increased or reduced based on local conditions (i.e. if the unit is filling up with sediment more quickly than projected, maintenance may be required semi-annually; conversely once the site has stabilized maintenance may only be required every two or three years).

Oil is removed through the oil inspection/cleanout port and sediment is removed through the riser pipe. Alternatively oil could be removed from the 24 inches (600 mm) opening if water is removed from the lower chamber to lower the oil level below the drop pipes.

The following procedures should be taken when cleaning out Stormceptor:

1. Check for oil through the oil cleanout port
2. Remove any oil separately using a small portable pump
3. Decant the water from the unit to the sanitary sewer, if permitted by the local regulating authority, or into a separate containment tank
4. Remove the sludge from the bottom of the unit using the vacuum truck
5. Re-fill Stormceptor with water where required by the local jurisdiction

12.3. Submerged Stormceptor

Careful attention should be paid to maintenance of the Submerged Stormceptor System. In cases where the storm drain system is submerged, there is a requirement to plug both the inlet and outlet pipes to economically clean out the unit.

12.4. Hydrocarbon Spills

The Stormceptor is often installed in areas where the potential for spills is great. The Stormceptor System should be cleaned immediately after a spill occurs by a licensed liquid waste hauler.

12.5. Disposal

Requirements for the disposal of material from the Stormceptor System are similar to that of any other stormwater Best Management Practice (BMP) where permitted. Disposal options for the sediment may range from disposal in a sanitary trunk sewer upstream of a sewage treatment plant, to disposal in a sanitary landfill site. Petroleum waste products collected in the Stormceptor (free oil/chemical/fuel spills) should be removed by a licensed waste management company.

12.6. Oil Sheens

With a steady influx of water with high concentrations of oil, a sheen may be noticeable at the Stormceptor outlet. This may occur because a rainbow or sheen can be seen at very small oil concentrations (<10 mg/L). Stormceptor will remove over 98% of all free oil spills from storm sewer systems for dry weather or frequently occurring runoff events.

The appearance of a sheen at the outlet with high influent oil concentrations does not mean the unit is not working to this level of removal. In addition, if the influent oil is emulsified the Stormceptor will not be able to remove it. The Stormceptor is designed for free oil removal and not emulsified conditions.

SUPPORT

Drawings and specifications are available at www.ContechES.com.

Site-specific design support is available from our engineers.

CONTECH® ENGINEERED SOLUTIONS
800-925-5240
www.ContechES.com

ATTACHMENT C

ILLICIT DISCHARGE STATEMENT

ILLICIT DISCHARGE COMPLIANCE STATEMENT

Responsibility: The Owner is responsible for ultimate compliance with all provisions of the Massachusetts Stormwater Management Policy, the USEPA NPDES Construction General Permit and responsible for identifying and eliminating illicit discharges (as defined by the USEPA).

PROPERTY LOCATION: 1485 Washington Street
Holliston, MA 01746

CURRENT OWNER NAME: AnyFence Co.

ADDRESS: 1485 Washington Street
Holliston, MA 01746

Engineer's Compliance Statement:
To the best of my knowledge, the attached plans, computations and specifications meet the requirements of Standard 10 of the Massachusetts Stormwater Handbook regarding illicit discharges to the stormwater management system and that no known illicit discharges exist on the site. All documents and attachments were prepared under my direction and qualified personnel properly gathered and evaluated the information submitted, to the best of my knowledge. Included with this statement are site plans, drawn to scale, that identify the location of systems for conveying stormwater on the site and show that these systems do not allow the entry of any illicit discharges into the stormwater management system. The plans also show any systems for conveying wastewater and/or groundwater on the site and show that there are no connections between the stormwater and wastewater systems.

Signature	Eric Wilhelmsen Print Name	8/9/2022 Date

Associate Principal Title	CDW Consultants, Inc. Company