DRAINAGE REPORT

For

SDG Development, LLC

PROPOSED

Self-Storage Facility

108 Old Church Street
Pembroke, Massachusetts
Plymouth County

Prepared by:

BOHLER ENGINEERING
352 Turnpike Road
Southborough, MA 01772
(508) 480-9900 TEL.

Joshua G. Swerling
Massachusetts P.E. Lic. #41697

BOHLER

January 25, 2022
#MAA220228

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I. EXECUTIVE SUMMARY

This report examines the changes in drainage that can be expected as the result of the development of a proposed self storage facility located on the northern side of Old Church Street in the Town of Pembroke, Massachusetts. The site, which contains approximately 1.98 acres of land, contains undeveloped wooded and grass areas.

The proposed project includes the construction of a new 26,050 SF floor (104,200 SF total) freestanding self-storage facility along with new paved parking areas, landscaping, storm water management components and associated utilities. This report addresses a comparative analysis of the pre- and post-development site runoff conditions. Additionally, this report provides calculations documenting the design of the proposed stormwater conveyance/management system as illustrated within the accompanying Site Development Plans prepared by Bohler. The project will also provide erosion and sedimentation controls during the demolition and construction periods, as well as long term stabilization of the site.

For the purposes of this analysis the pre- and post-development drainage conditions were analyzed at one (1) "design point" where stormwater runoff currently drains to under existing conditions. These design points are described in further detail in **Section II** below. A summary of the existing and proposed conditions peak runoff rates for the 2-, 10-, 25-, and 100-year storms can be found in **Table 1.1** below. In addition, the project has been designed to meet or exceed the Stormwater Management Standards as detailed herein.

Table 1.1: Design Point Peak Runoff Rate Summary

Point of Analysis	2-Year Storm			10-Year Storm			25-Year Storm			100-Year Storm		
	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
DP1	0.57	0.41	**-0.16**	1.90	1.18	**-0.72**	3.04	1.85	**-1.19**	5.03	4.73	**-0.30**

**Flows are represented in cubic feet per second (cfs)*

II. EXISTING SITE CONDITIONS

Existing Site Description

The site consists of approximately 1.98 acres of land located along the norther side of Old Church Street in the Town of Pembroke, Massachusetts. The site contains undeveloped wooded and grass areas.

On-Site Soil Information

Soils within the analyzed area consist of the following as classified by the Natural Resource Conservation Service (NRCS):

Table 2.1: Existing Soil Information

Soil Unit Symbol	Soil Name / Description	Hydrologic Soil Group (HSG)
254A	Merrimac fine sandy	A
259B	Carver loamy coarse	A
320A	Birchwood sand	B/D
320B	Birchwood sand	B/D
634B	Birchwood – Urban land	B/D
636B	Montauk – Urban land	C
665B	Udipsamments	A
702C	Udipsamments	A

Onsite soil testing was performed by MacArdle Gannon Associates, Inc. on January 6th, 2023. Refer to **Appendix C** for additional information. Based off the soil testing results, the entirety of the site was modeled as HSG B with an infiltration rate of 1.02 inches/hour.

Existing Collection and Conveyance

The entirety of the undeveloped site drains towards the eastern side of the site in the wooded area. Part of this wooded area is considered a small wetland per the Pembroke Conservation. Slopes on the site range from 1%-16% with on-site elevations ranging from 86 at the westerly side of the property to 99 at the easterly portion of the property.

Existing Watersheds and Design Point Information

For the purposes of this analysis, the pre- and post-development drainage conditions were analyzed at one (1) "design point" as described below where stormwater runoff currently drains to under existing conditions. The existing site was subdivided into one (1) sub catchment, as described below, to analyze existing and proposed flow rates at each design point. The calculated time of concentration for all proposed areas is calculated as 8.4 minutes (0.14 hr).

Design Point #1 (DP1) is the low point on the western side of the property in the wooded area. Under existing conditions, this design point receives stormwater flows from approximately 1.98 acres of land, designated as watershed "EX-#1". Refer to Table 2.1 below for additional detail.

Table 2.1: Existing Sub-Catchment Summary

Sub-catchment Name	Total Area (acres)	Cover Description	Curve Number (CN)	Time of Concentration (Tc, minutes)
EX-#1	1.98±	Grass area, wooded area	59	8.4

Refer to **Table 1.1 and 6.1** for the existing conditions peak rates of runoff. Refer to **Appendix D** and the Drainage Area Maps in the appendices of this report for a graphical representation of the existing drainage areas.

III. PROPOSED SITE CONDITIONS

Proposed Development Description

The proposed project includes the construction of a new 26,050 SF freestanding self-storage facility along with new paved parking areas, landscaping, storm water management components and associated utilities. The site, including the proposed parking areas, has been designed to drain to deep-sump, hooded catch basins. The catch basins will capture and convey stormwater runoff, via an underground pipe system, to a proposed underground infiltration system. The proposed underground infiltration system includes an outlet control structure that has been designed to control discharge out of the system. Pretreatment of stormwater runoff will be provided by a combination of the deep-sump, hooded catch basins and an isolator row prior to discharge into the proposed infiltration system. Rooftop runoff has been designed to flow to the infiltration system as well.

Proposed Development Collection and Conveyance

Deep sump hooded catch basins are proposed to collect and route runoff from the paved parking areas to the proposed underground infiltration system. Pipes have been designed for the 25-year storm using Storm Sewers by Hydraflow Software/Rational Method. Pipe, inlet, and outlet protection sizing calculations are included in **Appendix F**.

The best management practices (BMPs) incorporated into the proposed stormwater management system have been designed to meets, or exceeds, the standards set forth in the Massachusetts Department of Environmental Protection Stormwater Handbook standards. Refer to **Section V** for additional information.

Proposed Watersheds and Design Point Information

The project has been designed to maintain existing drainage watersheds to the greatest extent possible, with the same design points described in **Section II** above. The site was subdivided into five (5) separate sub catchments for the proposed conditions as described below. The minimum time of concentration for all proposed areas is calculated as 6 minutes (0.1 hr).

Under proposed conditions DP#1 receives stormwater flows from approximately 1.98 acres of land, designated as watershed “PR-#1”, “PR-#2”, “PR-#3”, “PR-#4”, and “PR-#5”. Refer to Table 3.1 below for additional detail.

Table 3.1: Proposed Sub-catchment Summary

Sub-catchment Name	Total Area (acres)	Cover Description	Curve Number (CN)	Time of Concentration (Tc, minutes)	Hydrologic Routing
PR-#1	0.60±	Rooftop	98	6.0	Basin #1 / DP#1
PR-#2	0.14±	Paved parking, grass area	87	6.0	Basin #1 / DP#1
PR-#3	0.21±	Paved parking, grass area	86	6.0	Basin #1 / DP#1
PR-#4	0.93±	Paved parking, grass area, wooded area	58	6.0	DP#1
PR-#5	0.10±	Paved parking	98	6.0	Basin #1 / DP#1

Refer to **Tables 1.1 and 6.1** for the calculated proposed conditions peak rates of runoff. For additional hydrologic information, refer to **Appendix D** and the Drainage Area Maps in the appendices of this report for a graphical representation of the proposed drainage areas.

IV. METHODOLOGY

Peak Flow Calculations

Methodology utilized to design the proposed stormwater management system includes compliance with the guidelines set forth in the latest edition of the Massachusetts DEP Stormwater Handbook. The pre- and post-development runoff rates being discharged from the site were computed using the HydroCAD computer program. The drainage area and outlet information were entered into the program, which routes storm flows based on NRCS TR-20 and TR-55 methods. The other components of the model were determined following standard NRCS procedures for Curve Numbers (CNs) and times of concentrations documented in the appendices of this report. The rainfall data utilized and listed below in table 4.1 below for stormwater calculations is based on Technical Paper-40. Refer to **Appendix F** for more information.

Table 4.1: Mass DEP TP-40

Frequency	2 year	10 year	25 year	100 year
Rainfall* (inches)	3.4	4.7	5.6	7.0

*Values derived from Mass DEP (TP-40 Maps)

The proposed stormwater management as designed will provide a decrease in peak rates of runoff from the proposed facility for the 2-, 10-, 25- and 100-year design storm events. Additionally, the proposed project meets, or exceeds, the MADEP Stormwater Management standards. Compliance with these standards is described further below.

V. STORMWATER MANAGEMENT STANDARDS

Standard #1: No New Untreated Discharges

The project has been designed so that the majority of proposed impervious areas (including the building roof and paved parking/driveway areas) shall be collected and passed through the proposed drainage system for treatment prior to discharge.

Standard #2: Peak Rate Attenuation

As outlined in **Table 1.1** and **Table 6.1**, the development of the site and the proposed stormwater management system, have been designed so that post-development peak rates of runoff are below pre-development conditions for the 2-, 10-, 25- and 100-year storm events at all design points.

Standard #3: Recharge

The stormwater runoff from the project will be collected and diverted to a proposed underground infiltration system. The project as proposed will involve the creation of 41,513 square feet of new impervious area and is required to infiltrate 1,211 cubic feet of stormwater as defined in Stormwater Standard 3. The proposed infiltration basin will provide 2,679 cubic feet of volume below the lowest outlet for groundwater recharge. Refer to **Appendix F** of this report for calculations documenting required and provided recharge volumes.

The DEP Stormwater Standards require that the infiltration BMP drains completely within 72 hours of the end of the storm event. Calculations showing that the proposed infiltration basin will drain within 7.1 hours are included in **Appendix F** of this report.

A groundwater mounding analysis has been provided in **Appendix F** of this report. The analysis shows that the groundwater mound will have no effect on the proposed system.

Standard #4: Water Quality

Water quality treatment is provided via deep sump catch basins, an infiltration basin, and a flared end section with rip rap apron. TSS removal calculations are included in **Appendix F** of this report. The project as proposed will involve the creation of 41,513 square feet of new impervious area and is required to treat 1,730 cubic feet of water quality volume as defined in Stormwater Standard 4. The proposed infiltration basin provides 2,679 cubic feet of water quality volume below the lowest outlet for water quality treatment. Refer to **Appendix F** of this report for calculations documenting required and provided water quality volumes.

Standard #5: Land Use with Higher Potential Pollutant Loads

Not Applicable for this project.

Standard #6: Critical Areas

Not Applicable for this project.

Standard #7: Redevelopment

Not Applicable for this project.

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

The proposed project will provide construction period erosion and sedimentation controls as indicated within the site plan set provided for this project. This includes a proposed construction exit, protection for stormwater inlets, protection around temporary material stock piles and various other techniques as outlined on the erosion and sediment control sheets. Additionally, the project is required to file a Notice of Intent with the US EPA and implement a Stormwater Pollution Prevention Plan (SWPPP) during the construction period. The SWPPP will be prepared prior to the start of construction and will be implemented by the site contractor under the guidance and responsibility of the project's proponent. Refer to **Appendix H**.

Standard #9: Operation and Maintenance Plan (O&M Plan)

An Operation and Maintenance (O&M) Plan for this site has been prepared and is included in **Appendix G** of this report. The O&M Plan outlines procedures and time tables for the long term operation and maintenance of the proposed site stormwater management system, including initial inspections upon completion of construction, and periodic monitoring of the system components, in accordance with established practices and the manufacturer's recommendations. The O&M Plan includes a list of responsible parties and an estimated budget for inspections and maintenance.

Standard #10: Prohibition of Illicit Discharges

The proposed stormwater system will only convey allowable non-stormwater discharges (firefighting waters, irrigation, air conditioning condensates, etc.) and will not contain any illicit discharges from prohibited sources. An Illicit Discharge Statement is included in **Appendix G** of this report.

VI. SUMMARY

In summary, the proposed stormwater management system illustrated on the drawings prepared by Bohler results in a reduction in peak rates of runoff from the subject site when compared to pre-development conditions for the 2-, 10-, 25- and 100-year storm frequencies. In addition, the proposed best management practices will result in an effective removal of total suspended solids from the post-development runoff. The pre-development versus post-development stormwater discharge comparisons are contained in **Table 6.1**.

Table 6.1: Design Point Peak Runoff Rate Summary

Point of Analysis	2-Year Storm			10-Year Storm			25-Year Storm			100-Year Storm		
	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
DP1	0.57	0.41	**-0.16**	1.90	1.18	**-0.72**	3.04	1.85	**-1.19**	5.03	4.73	**-0.30**

**Flows are represented in cubic feet per second (cfs)*

As outlined in the table above, the proposed stormwater management system as designed will provide a decrease in peak rates of runoff from the proposed facility for the 2-, 10-, 25- and 100-year storm events. Additionally, the project meets or exceeds the MADEP Stormwater Management Standards as described further herein.

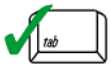
APPENDIX A: MASSACHUSETTS STORMWATER MANAGEMENT CHECKLIST

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

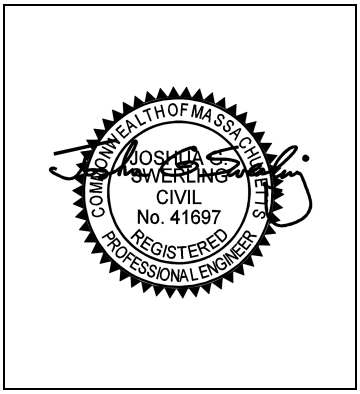
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



01/25/2023

Signature and Date

Checklist

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

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

☒ No disturbance to any Wetland Resource Areas

☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)

☐ Reduced Impervious Area (Redevelopment Only)

☐ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

- ☐ Credit 1
- ☐ Credit 2
- ☐ Credit 3

☐ Use of "country drainage" versus curb and gutter conveyance and pipe

☐ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☒ Other (describe): Underground Infiltration Basin and Isolator Row

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☒ An Illicit Discharge Compliance Statement is attached;

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

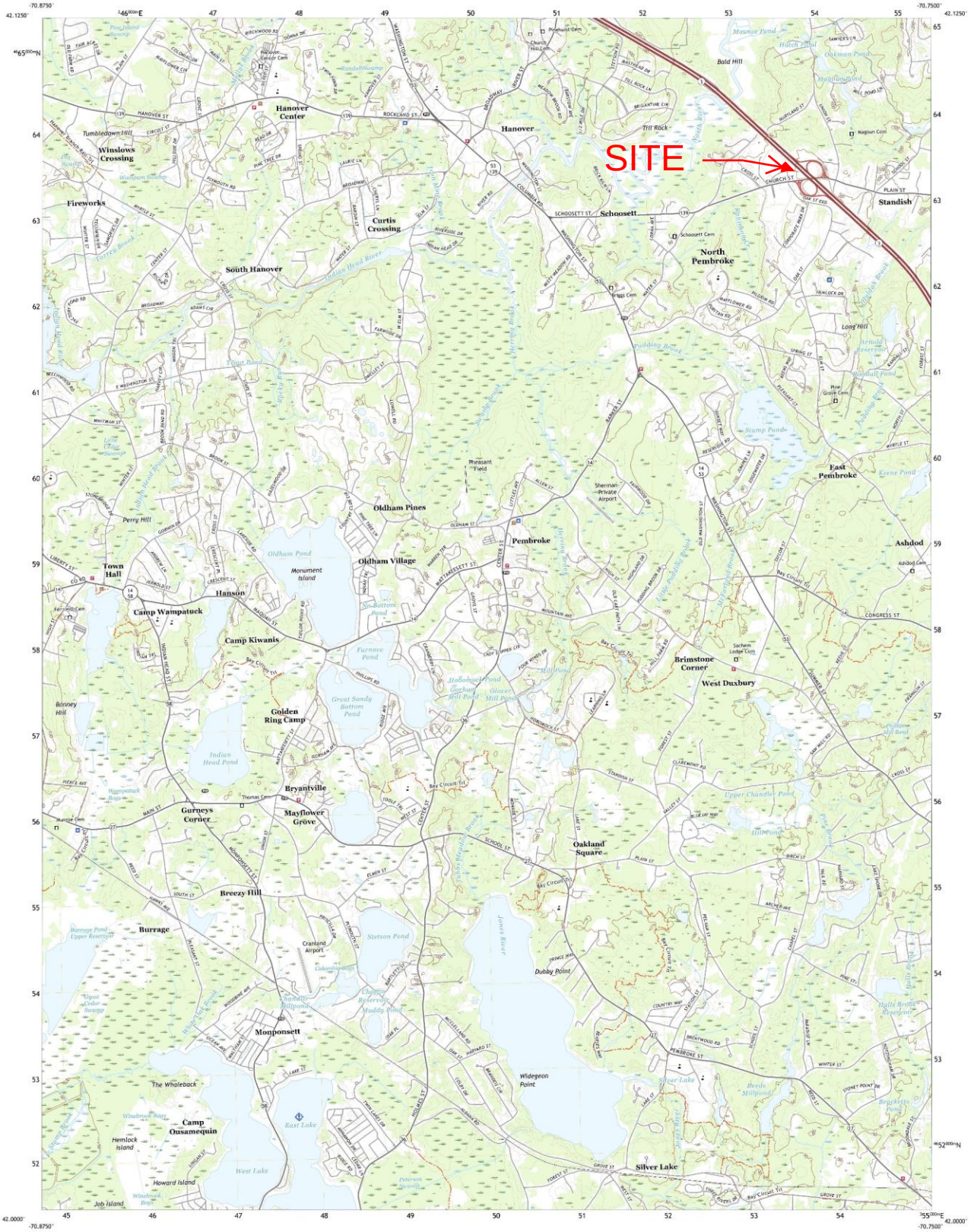
APPENDIX B: PROJECT LOCATION MAPS

- *USGS MAP*
- *FEMA FIRMETTE*

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

The National Map
US Topo

HANOVER QUADRANGLE
MASSACHUSETTS - PLYMOUTH COUNTY
7.5-MINUTE SERIES



Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000 meter grid:Universal Transverse Mercator, Zone 19T
This map is not a legal document. Boundaries may be
generalized for this map scale. Private lands within government
reservations may not be shown. Obtain permission before
entering private lands.

Imagery.....NAIP, September 2018
Roads.....U.S. Census Bureau, 2018
Names.....GNIS, 1974 - 2020
Hydrography.....National Hydrography Dataset, 1899 - 2019
Contours.....National Elevation Dataset, 2012 - 2019
Boundaries.....Multiple sources; see metadata file 2018 - 2019

Wetlands.....FWS National Wetlands Inventory 1992 - 2011

UTM GRID AND 2015 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

SCALE 1:24 000
1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

This map was produced to conform with the
National Geospatial Program US Topo Product Standard.

ADJOINING QUADRANGLES
1 Weymouth
2 Cohasset
3 Scituate
4 Whitman
5 Duxbury
6 Bridgewater
7 Plympton
8 Plymouth

ROAD CLASSIFICATION
Expressway
Secondary Hwy
Ramp
Local Connector
Local Road
4WD
Interstate Route
US Route
State Route

HANOVER, MA
2021

NSN 7643013619225
NGA REF NO. USGSX24K19225

National Flood Hazard Layer FIRMette

FEMA

70°46'30"W 42°6'46"N

70°45'53"W 42°6'19"N

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

1:6,000

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

Legend

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

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

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

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

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

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

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

N

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

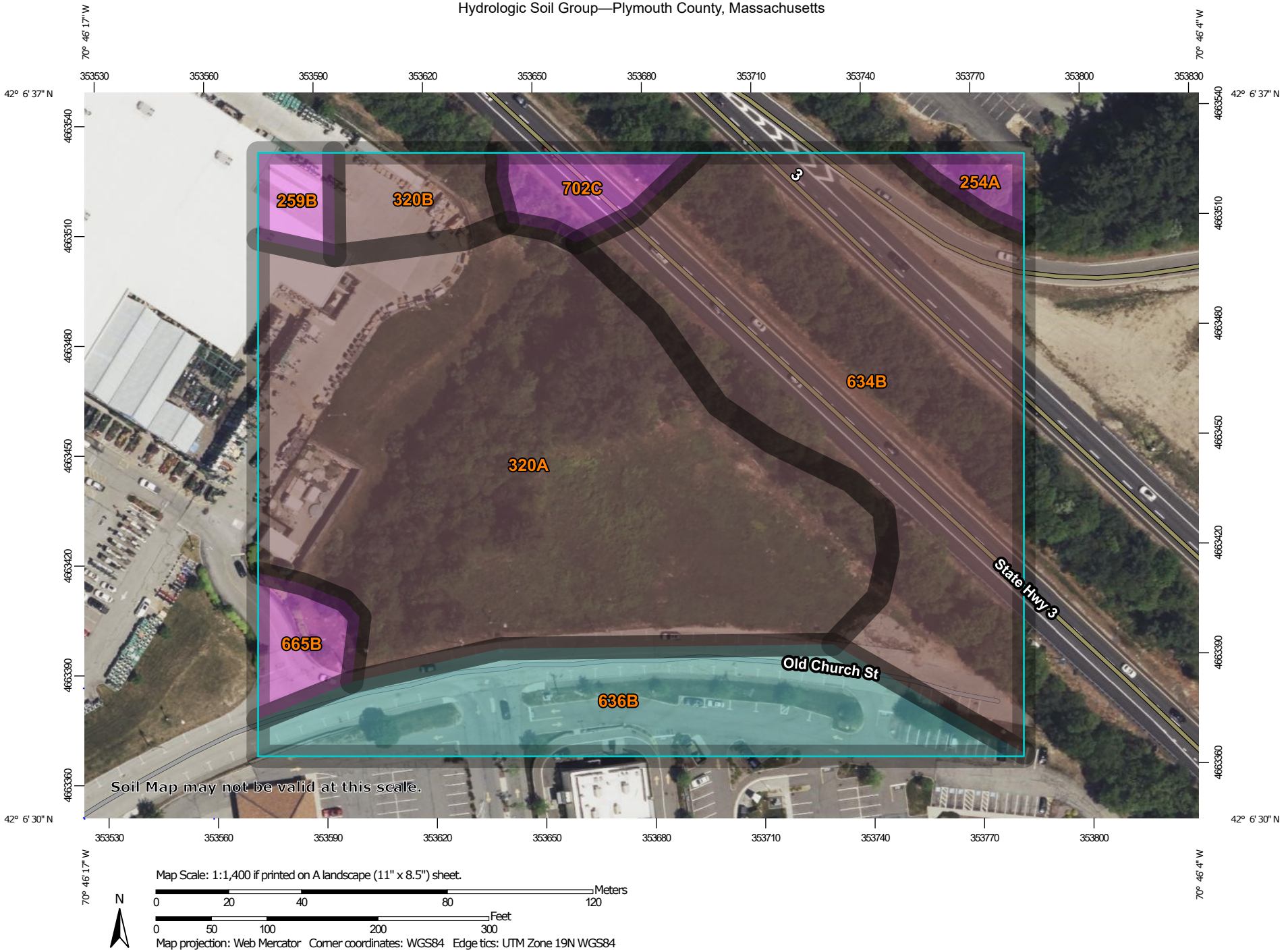
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/16/2023 at 9:39 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

APPENDIX C: SOIL AND WETLAND INFORMATION

- *USDA SOIL MAP*
- *SOIL TESTING*


70° 46' 17" W
70° 46' 4" W
353530
353560
353590
353620
353650
353680
353710
353740
353770
353800
353830
42° 6' 37" N
42° 6' 30" N
4663540
4663510
4663480
4663450
4663420
4663390
4663360
259B
320B
702C
3
254A
634B
320A
State Hwy 3
665B
Old Church St
636B
Soil Map may not be valid at this scale.
Map Scale: 1:1,400 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0 20 40 80 120
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 1:12,000.

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: Plymouth County, Massachusetts
Survey Area Data: Version 15, Sep 9, 2022

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

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

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
254A	Merrimac fine sandy loam, 0 to 3 percent slopes	A	0.1	1.2%
259B	Carver loamy coarse sand, 3 to 8 percent slopes	A	0.1	1.6%
320A	Birchwood sand, 0 to 3 percent slopes	B/D	3.8	43.9%
320B	Birchwood sand, 3 to 8 percent slopes	B/D	0.3	3.3%
634B	Birchwood - Urban land complex, 0 to 8 percent slopes	B/D	2.6	30.7%
636B	Montauk-Urban land complex, 0 to 8 percent slopes	C	1.2	14.3%
665B	Udipsamments, 0 to 8 percent slopes	A	0.2	2.4%
702C	Udipsamments, 8 to 15 percent slopes	A	0.2	2.7%
Totals for Area of Interest			**8.6**	**100.0%**

Description

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

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

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

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

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

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

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

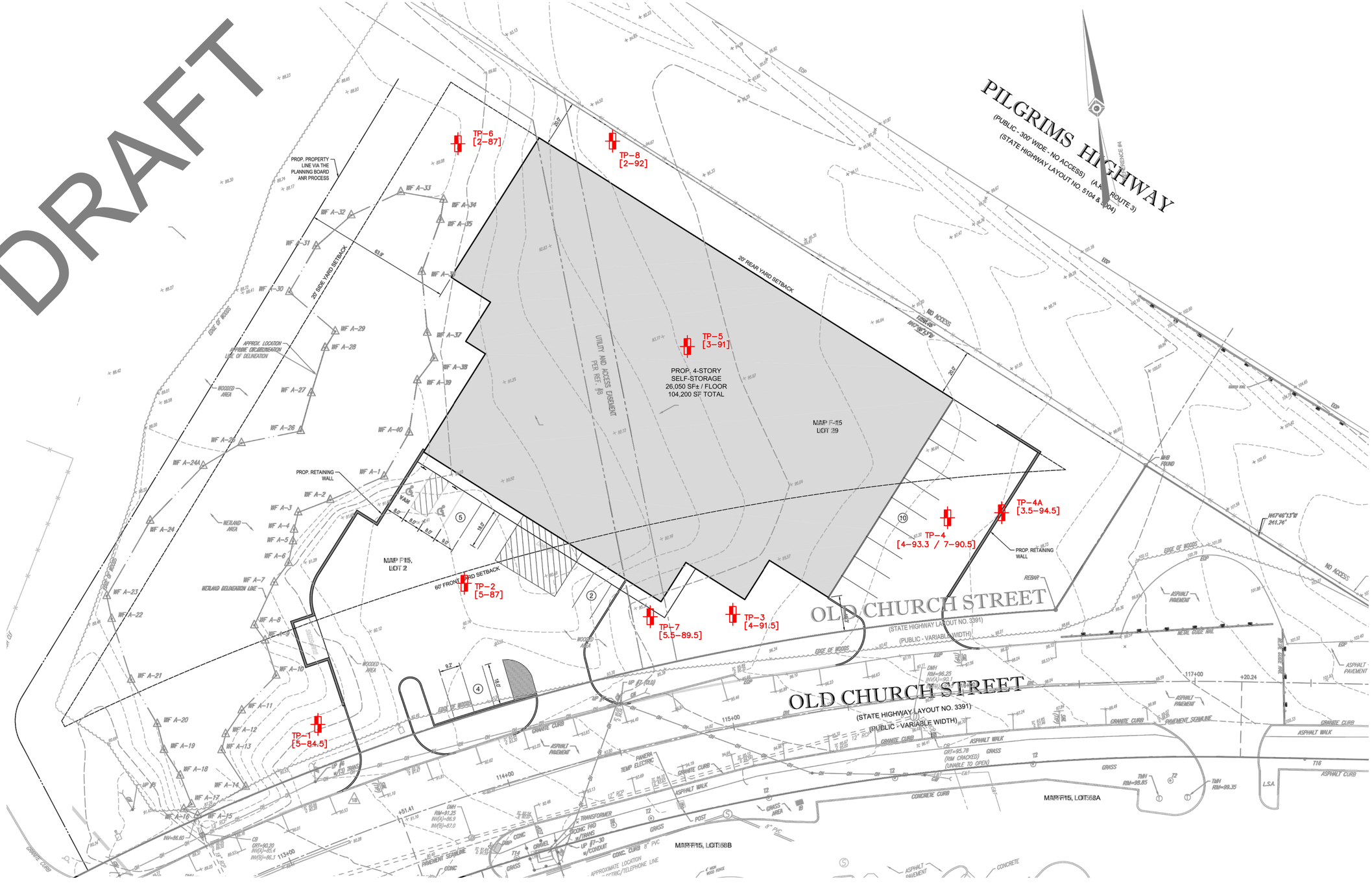
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

DRAFT



LEGEND:

TP-1 — TEST PITS PERFORMED BY SLT CONSTRUCTION CORP. OF CARVER, MASSACHUSETTS ON JANUARY 6, 2023.

[2–7] — INDICATES APPROXIMATE DEPTH–ELEVATION (IN FEET) OF BOTTOM OF EXISTING FILL/TOPSOIL/SUBSOIL AT EXPLORATION LOCATION.

NOTES:

1. BASE PLAN DEVELOPED FROM A PLANW ENTITLED "PARTIAL TOPOGRAPHY SURVEY," SHEET 2 OF 4, REVISION 2, DATED NOVEMBER 7, 2022, AND "ZBA SITE PLAN," SHEET CB–01, DATED DECEMBER 12, 2022, BY BOHLER ENGINEERING, LLC.
2. EXPLORATION LOCATIONS WERE LOCATED USING A HANDHELD GPS TRACKER AND SURVEY POINTS PROVIDED BY BOHLER ENGINEERING. MGA LOCATED TEST PITS TP–4A, TP–7, AND TP–8 BY TAPE MEASUREMENT AND LINE OF SIGHT FROM GPS LOCATED EXPLORATIONS. THE EXPLORATION LOCATIONS ARE APPROXIMATE.
3. MGA OBSERVED AND LOGGED THE EXPLORATIONS SHOWN.

GRAPHIC SCALE

20 0 10 20 40 60

(IN FEET)
1 inch = 20 ft.

REVISIONS

DRAWN BY: RED

DESIGNED BY: RED

CHECKED BY: SLH

McArdle Gannon Associates, Inc.
Engineers & Consultants
300 Oak Street, Suite 460
Pembroke, MA 02359
781.826.0040 phone
781.735.0418 fax

EXPLORATION LOCATION PLAN

PROPOSED STORAGE FACILITY

OLD CHURCH STREET, PEMBROKE, MASSACHUSETTS

JANUARY 2023

SCALE: 1" = 20'

JOB No. W0963

FIG No. 2

SHEET 1 OF 1

Commonwealth of Massachusetts
City/Town of Pembroke, Massachusetts

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

W0963 - Proposed Self Storage Building, Old Church Street, Pembroke, Massachusetts

C. On-Site Review (continued)

Deep Observation Hole Number: TP-1 Ground Surface Elevation (ft): 89.5±

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	Ap Fill	-	-	-	-	-	-	-	-	-	
6-36	Fill	-	-	-	-	-	-	-	-	-	
36-60	Ap	10YR 3/2	-	-	-	Sandy Loam	0	0	Massive	V. Friabe	
60-120	C1	10YR 7/1	78	2.5YR 4/6	40	Silt Loam	5	0	Massive	V. Friable	
120-144	C2	10YR 5/2	-	-	-	Silt Loam	15-20	10-15	Massive	Firm	

Additional Notes:

Groundwater seeping quickly at 36 inches.

Sample collected from 60 to 72 inches.

McArdle Gannon Associates, Inc.
Engineers & Consultants

300 Oak Street, Suite 460 Phone: 781.826.0040
Pembroke, MA 02359 Fax: 781.735.0418

Engineer: Robert E. Drown, P.E. #SE13855
Operator: Dale Whitbeck
Equipment: Caterpillar 313F Excavator
Date: 1/6/2023

Commonwealth of Massachusetts
City/Town of Pembroke, Massachusetts

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

W0963 - Proposed Self Storage Building, Old Church Street, Pembroke, Massachusetts

C. On-Site Review (continued)

Deep Observation Hole Number: TP-2 Ground Surface Elevation (ft): 92±

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	Ap Fill	-	-	-	-	-	-	-	-	-	
6-42	Fill	-	-	-	-	-	-	-	-	-	
42-60	Ap	10YR 3/2	-	-	-	Loamy Sand	0	0	Massive	V. Friable	
60-90	C1	10YR 5/3	72	2.5YR 4/6	40	Sandy Loam	5	0	Massive	V. Friable	
90-156	C2	10YR 5/2	-	-	-	Silt Loam	15-20	10-15	Massive	Firm	

Additional Notes:

Groundwater seeping quickly at 54 inches.

Sample collected from 48 to 60 inches.

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Operator: Dale Whitbeck
Equipment: Caterpillar 313F Excavator
Date: 1/6/2023

Commonwealth of Massachusetts
City/Town of Pembroke, Massachusetts

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

W0963 - Proposed Self Storage Building, Old Church Street, Pembroke, Massachusetts

C. On-Site Review (continued)

Deep Observation Hole Number: TP-3 Ground Surface Elevation (ft): 95.5±

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	Ap Fill	-	-	-	-	-	-	-	-	-	
6-30	Fill	-	-	-	-	-	-	-	-	-	
30-48	Ap	10YR 3/2	-	-	-	Sandy Loam	0	0	Massive	V. Friable	(1)
48-156	C1	10YR 5/2	48	2.5YR 4/6	30	Sandy Loam	15-20	10-15	Massive	Firm	

Additional Notes:

Groundwater seeping quickly at 48 inches.

Sample collected from 48 to 60 inches.

(1) Stumps observed in topsoil layer.

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Pembroke, MA 02359 Fax: 781.735.0418

Engineer: Robert E. Drown, P.E. #SE13855
Operator: Dale Whitbeck
Equipment: Caterpillar 313F Excavator
Date: 1/6/2023

Commonwealth of Massachusetts
City/Town of Pembroke, Massachusetts

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

W0963 - Proposed Self Storage Building, Old Church Street, Pembroke, Massachusetts

C. On-Site Review (continued)

Deep Observation Hole Number: TP-4 Ground Surface Elevation (ft): 97.5±

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-48	Fill	-	-	-	-	-	-	-	-		South Side
48-108	C1	10YR 5/2	51	2.5YR 4/6	20	Silt Loam	15-20	10-15	Massive	Firm	South Side
0-84	Fill	-	-	-	-	-	-	-	-	-	North Side
84-108	C1	10YR 5/2	-	-	-	Silt Loam	15-20	10-15	Massive	Firm	North Side

Additional Notes:

Groundwater seeping slowly at 48 inches.

Former building foundation walls uncovered at the northern and southern sides of test pit. Each foundation wall was approximately 10 inches thick and terminated at 4 and 7 feet below ground surface on the southern and northern sides respectively.

MGA McArdle Gannon Associates, Inc.
Engineers & Consultants

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Pembroke, MA 02359 Fax: 781.735.0418

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Operator: Dale Whitbeck
Equipment: Caterpillar 313F Excavator
Date: 1/6/2023

Commonwealth of Massachusetts
City/Town of Pembroke, Massachusetts

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

W0963 - Proposed Self Storage Building, Old Church Street, Pembroke, Massachusetts

C. On-Site Review (continued)

Deep Observation Hole Number: TP-4A Ground Surface Elevation (ft): 98±

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	Ap Fill	-	-	-	-	-	-	-	-	-	
6-24	Fill	-	-	-	-	-	-	-	-	-	
24-42	Ap	10YR 3/2	-	-	-	Sandy Loam	0	0	Massive	V. Friable	
42-120	C1	10YR 5/2	48	2.5YR 4/6	20	Loamy Sand	15-20	10-15	Massive	Firm	

Additional Notes:

Groundwater seeping slowly at 42 inches.

Sample collected from 48 to 60 inches.

Probable septic tank located along north side of test pit, bottom of tank and stone at 6.5 feet below ground surface

Test pit TP-4A located approximately 10 feet east of test pit TP-4.

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

W0963 - Proposed Self Storage Building, Old Church Street, Pembroke, Massachusetts

C. On-Site Review (continued)

Deep Observation Hole Number: TP-5 Ground Surface Elevation (ft): 94±

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	Ap Fill	-	-	-	-	-	-	-	-	-	
6-18	Fill	-	-	-	-	-	-	-	-	-	
18-36	Fill	-	-	-	-	-	-	-	-	-	(1)
36-180	C1	10YR 5/2	60	2.5YR 4/6	15	Sandy Loam	15-20	10-15	Massive	Firm	
			120	2.5YR 4/6	50						

Additional Notes:

Groundwater seeping slowly at 36 inches.

Sample collected from 60 to 96 inches.

(1) Old septic field uncovered at test pit from 18 to 36 inches below ground surface.

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Operator: Dale Whitbeck
Equipment: Caterpillar 313F Excavator
Date: 1/6/2023

Commonwealth of Massachusetts
City/Town of Pembroke, Massachusetts

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

W0963 - Proposed Self Storage Building, Old Church Street, Pembroke, Massachusetts

C. On-Site Review (continued)

Deep Observation Hole Number: TP-6 Ground Surface Elevation (ft): 89±

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-12	Ap	10YR 3/2	-	-	-	Sandy Loam	0	0	Massive	V. Friable	
12-24	Bw	10YR 5/8	-	-	-	Sandy Loam	0-5	0	Massive	V. Friable	
24-90	C1	10YR 5/3	48	2.5YR 4/6	30	Sand	5-10	0	Single Grain	Loose	
90-120	C2	10YR /2	-	-	-	Silt Loam	15-20	10-15	Massive	Firm	

Additional Notes:

Groundwater seeping quickly at 60 inches.

Sample collected from 48 to 60 inches.

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

W0963 - Proposed Self Storage Building, Old Church Street, Pembroke, Massachusetts

C. On-Site Review (continued)

Deep Observation Hole Number: TP-7 Ground Surface Elevation (ft): 95±

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	Ap Fill	-	-	-	-	-	-	-	-	-	
6-24	Fill	-	-	-	-	-	-	-	-	-	-
24-42	Ap	10YR 3/2	-	-	-	Sandy Loam	0	0	Massive	V. Friable	(1)
42-66	C1	10YR 5/2	48	2.5YR 4/6	15	Silt Loam	15-20	10-15	Massive	Firm	(2)

Additional Notes:

Groundwater seeping quickly at 42 inches.

(1) Stumps observed in topsoil layer.

(2) Uncovered 4 inch diameter PVC sewer force main at center of test pit. Top of force main located 5 feet below existing ground surface. Force main surrounded by 6 inches of crushed stone on three side and 12 inches of stone on top.

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Operator: Dale Whitbeck
Equipment: Caterpillar 313F Excavator
Date: 1/6/2023

Commonwealth of Massachusetts
City/Town of Pembroke, Massachusetts

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

W0963 - Proposed Self Storage Building, Old Church Street, Pembroke, Massachusetts

C. On-Site Review (continued)

Deep Observation Hole Number: TP-8 Ground Surface Elevation (ft): 94±

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-9	Ap	10YR 3/2	-	-	-	Sandy Loam	0	0	Massive	V. Friable	
9-24	Bw	10YR 5/8	-	-	-	Sandy Loam	0-5	0	Massive	V. Friable	
24-60	C1	10YR 5/3	48	2.5YR 4/6	15	Sand	5-10	0	Single Grain	Loose	
60-120	C1	10YR 5/2	-	-	-	Silt Loam	15-20	10-15	Massive	Firm	

Additional Notes:

Groundwater seeping quickly at 60 inches.

Sample collected from 36 to 48 inches.

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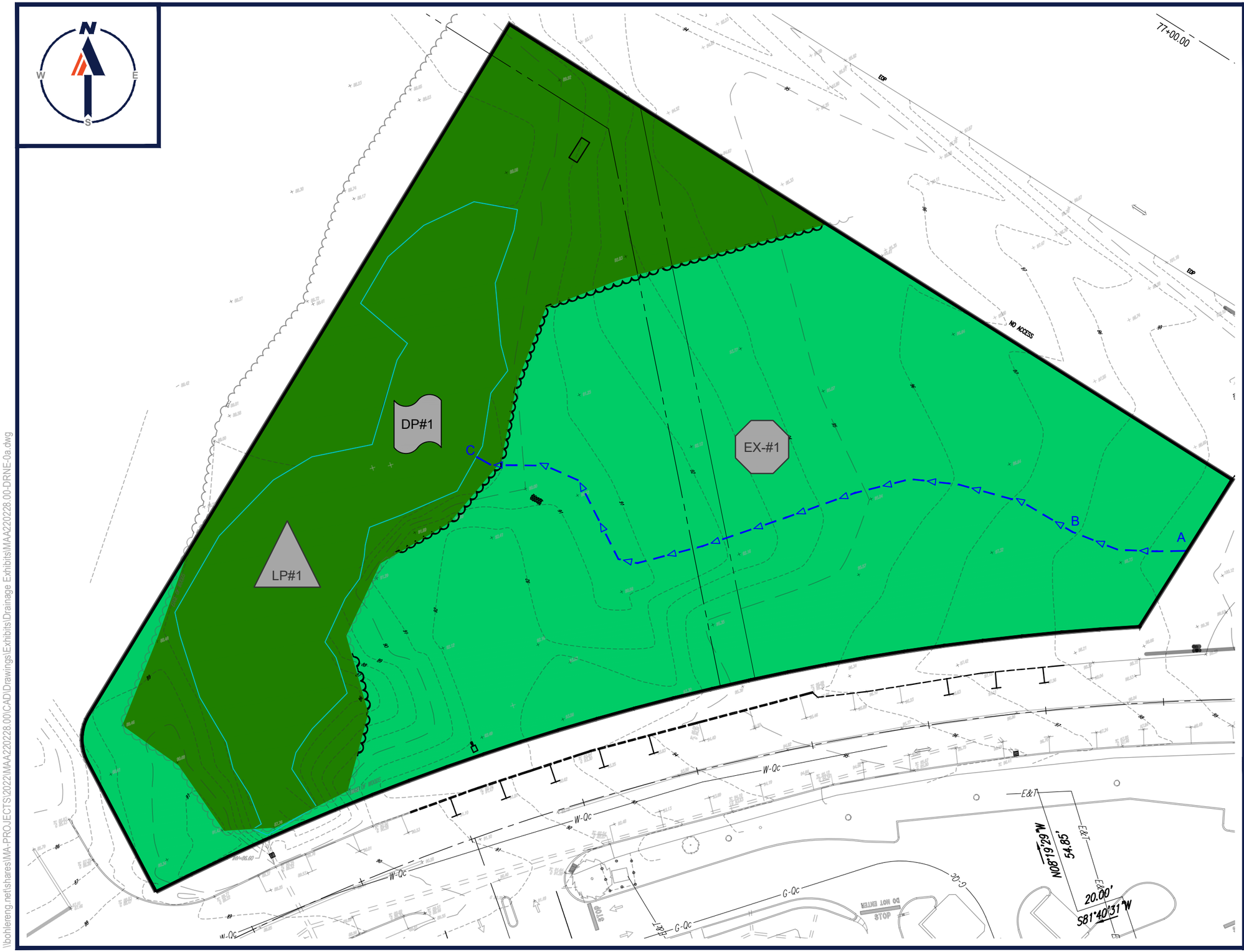
Date: 1/6/2023

APPENDIX D: EXISTING CONDITIONS HYDROLOGIC ANALYSIS

- *EXISTING CONDITIONS DRAINAGE MAP*
- *EXISTING CONDITIONS HYDROCAD COMPUTATIONS*



LEGEND

- DP# — DESIGN POINT
- EX-# — EXISTING SUBCATCHMENT
- XX# — BASIN OR MODELED DRAINAGE STRUCTURE
- A/B/C/D — HYDROLOGIC SOIL GROUP RATING
- UNIT — NRCS SOIL MAP UNIT
- X-# — SWALE OR MODELED JUNCTION
- OVERALL ANALYSIS BOUNDARY
- SUBCATCHMENT BOUNDARY
- NRCS SOIL BOUNDARY
- TIME OF CONCENTRATION
- CONCRETE OR PAVEMENT
- ROOF
- SURFACE WATER (IMPERVIOUS)
- GRASS OR LANDSCAPED AREA
- UNIT PAVER OR GRAVEL (PERVIOUS)
- WOODS OR UNDEVELOPED AREA

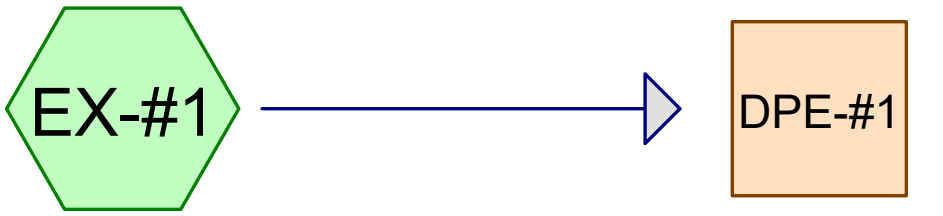
EXISTING CONDITIONS DRAINAGE AREA MAP

PROJECT ADDRESS
CITY/TOWN, STATE

PREPARED BY
BOHLER

SCALE:1"=40' DATE: 01/25/2023

\\bohlereng.net\shares\MA-PROJECTS\2022\MAA220228.00\CADD\Drawings\Exhibits\Drainage Exhibits\MAA220228.00-DRNE-0a.dwg



Subcatchment 1

Wetlands

Subcat Reach Pond Link

Routing Diagram for MAA220228-REV0
Prepared by {enter your company name here}, Printed 1/24/2023

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.241	61	>75% Grass cover, Good, HSG B (EX-#1)
0.737	55	Woods, Good, HSG B (EX-#1)
1.978	**59**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
1.978	HSG B	EX-#1
0.000	HSG C	
0.000	HSG D	
0.000	Other	
1.978		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	1.241	0.000	0.000	0.000	1.241	>75% Grass cover, Good	EX-#1
0.000	0.737	0.000	0.000	0.000	0.737	Woods, Good	EX-#1
0.000	**1.978**	**0.000**	**0.000**	**0.000**	**1.978**	**TOTAL AREA**	

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-#1: Subcatchment 1 Runoff Area=86,145 sf 0.00% Impervious Runoff Depth=0.45"
Flow Length=336' Tc=8.4 min CN=59 Runoff=0.57 cfs 0.074 af

Reach DPE-#1: Wetlands Inflow=0.57 cfs 0.074 af
Outflow=0.57 cfs 0.074 af

Total Runoff Area = 1.978 ac Runoff Volume = 0.074 af Average Runoff Depth = 0.45"
100.00% Pervious = 1.978 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment EX-#1: Subcatchment 1

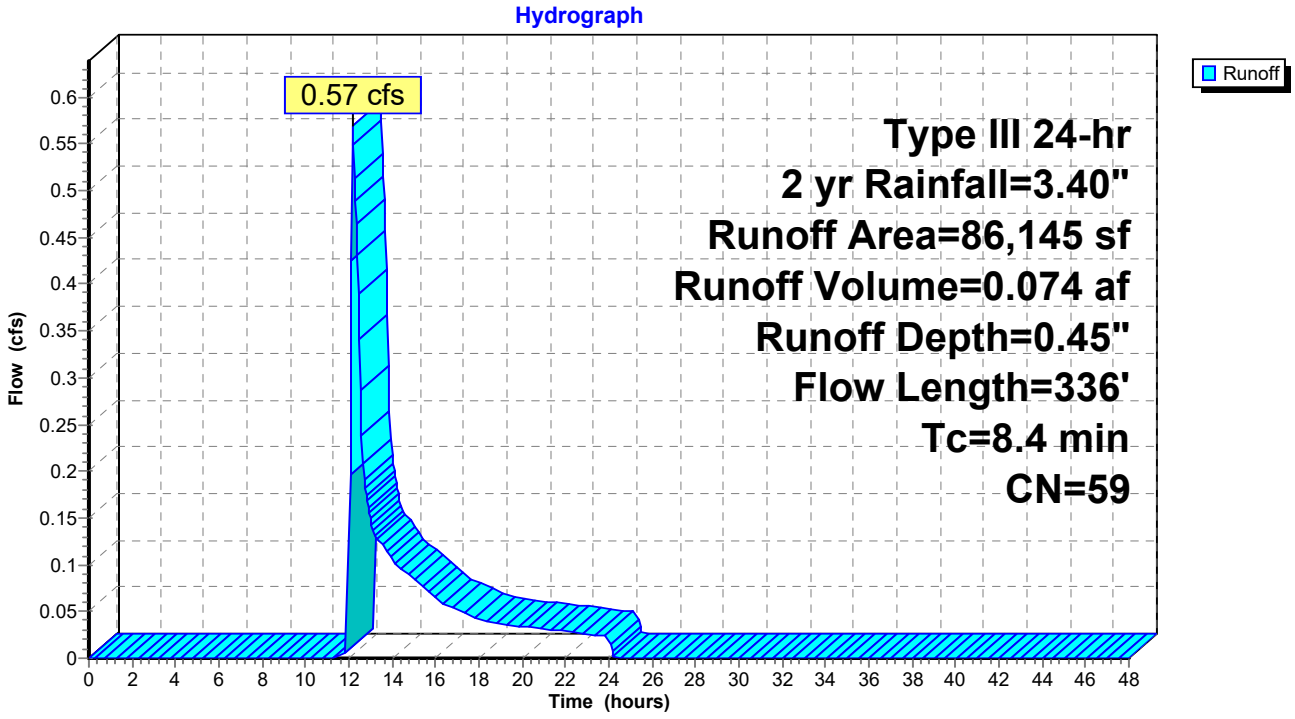
Runoff = 0.57 cfs @ 12.17 hrs, Volume= 0.074 af, Depth= 0.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.40"

Area (sf)	CN	Description
54,038	61	>75% Grass cover, Good, HSG B
32,107	55	Woods, Good, HSG B
86,145	59	Weighted Average
86,145		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.7	50	0.0360	0.12		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.00"
1.7	286	0.0350	2.81		**Shallow Concentrated Flow, B-C** Grassed Waterway Kv= 15.0 fps
8.4	336	Total			

Subcatchment EX-#1: Subcatchment 1



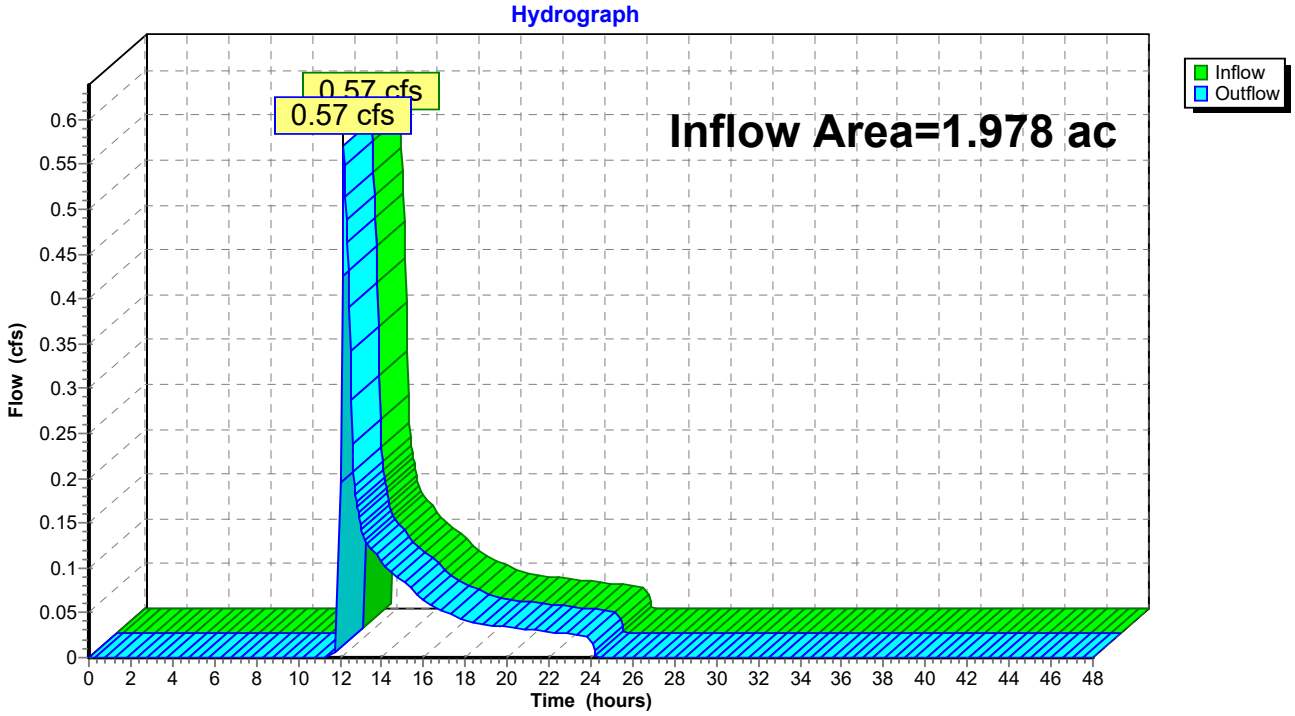
Summary for Reach DPE-#1: Wetlands

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

Inflow Area = 1.978 ac, 0.00% Impervious, Inflow Depth = 0.45" for 2 yr event
Inflow = 0.57 cfs @ 12.17 hrs, Volume= 0.074 af
Outflow = 0.57 cfs @ 12.17 hrs, Volume= 0.074 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DPE-#1: Wetlands



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-#1: Subcatchment 1 Runoff Area=86,145 sf 0.00% Impervious Runoff Depth=1.07"
Flow Length=336' Tc=8.4 min CN=59 Runoff=1.90 cfs 0.176 af

Reach DPE-#1: Wetlands Inflow=1.90 cfs 0.176 af
Outflow=1.90 cfs 0.176 af

Total Runoff Area = 1.978 ac Runoff Volume = 0.176 af Average Runoff Depth = 1.07"
100.00% Pervious = 1.978 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment EX-#1: Subcatchment 1

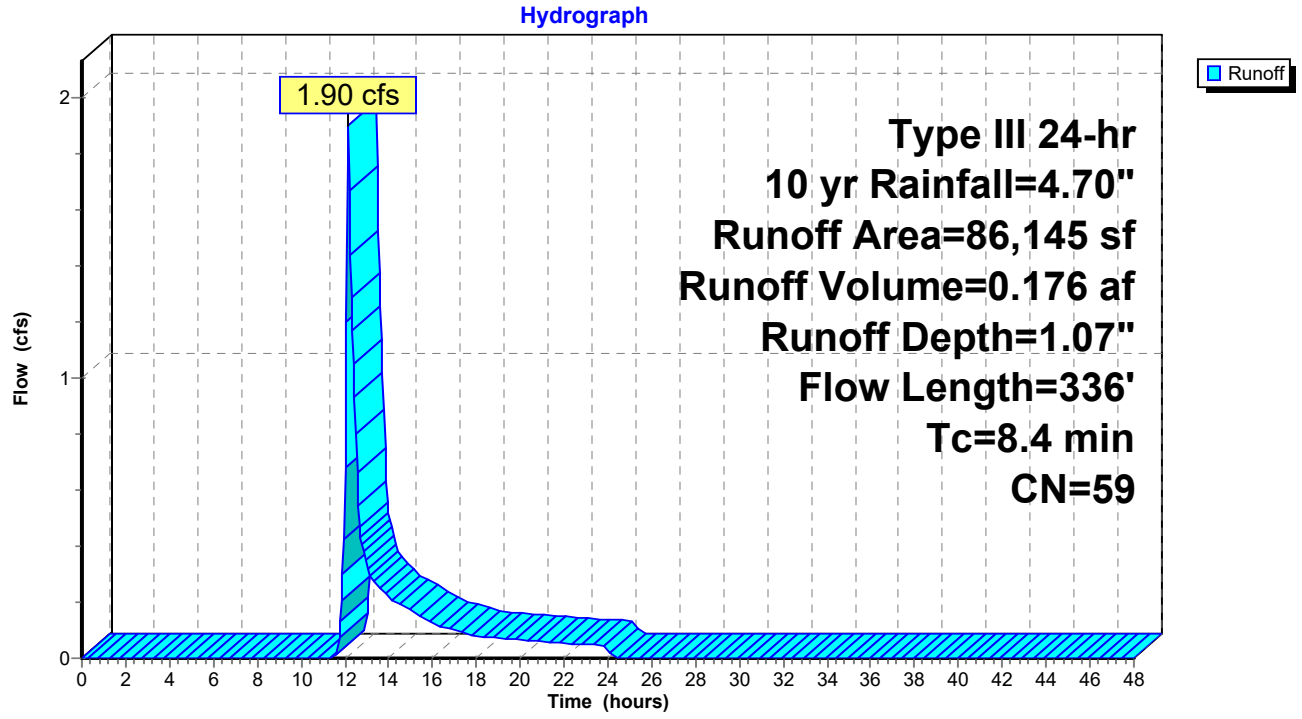
Runoff = 1.90 cfs @ 12.14 hrs, Volume= 0.176 af, Depth= 1.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
54,038	61	>75% Grass cover, Good, HSG B
32,107	55	Woods, Good, HSG B
86,145	59	Weighted Average
86,145		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.7	50	0.0360	0.12		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.00"
1.7	286	0.0350	2.81		**Shallow Concentrated Flow, B-C** Grassed Waterway Kv= 15.0 fps
8.4	336	Total			

Subcatchment EX-#1: Subcatchment 1



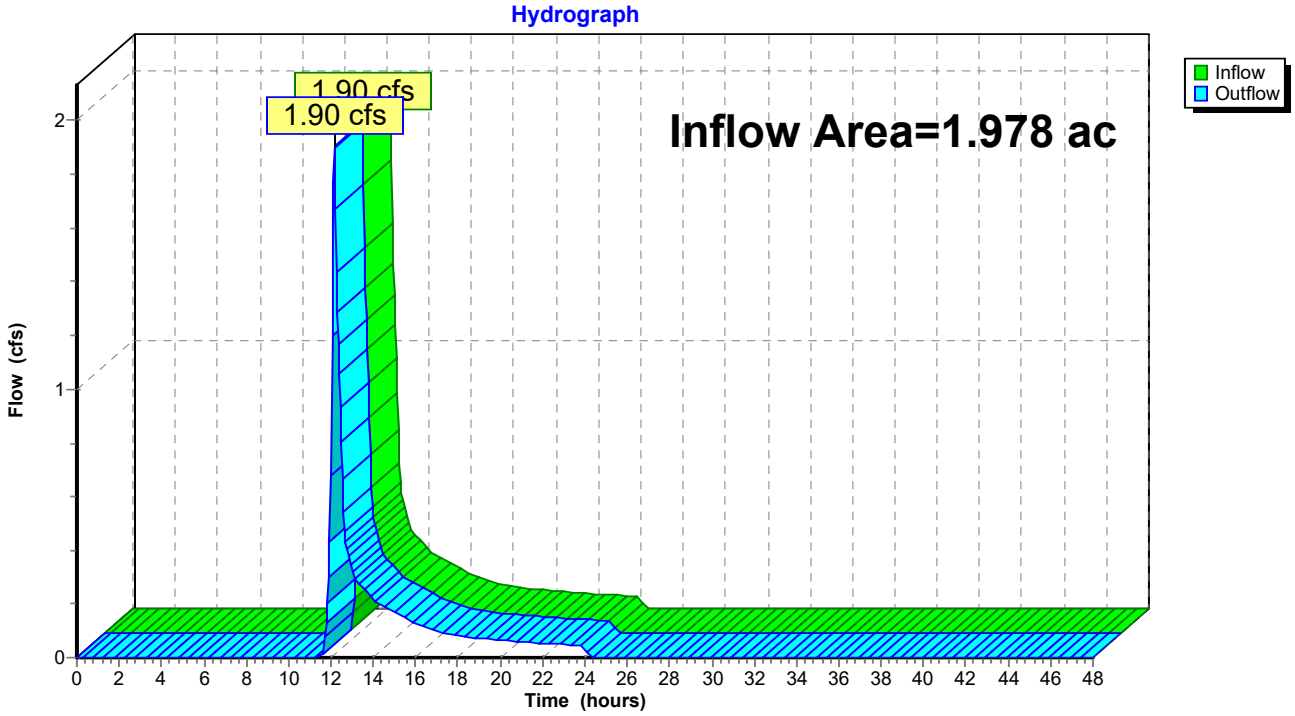
Summary for Reach DPE-#1: Wetlands

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

Inflow Area = 1.978 ac, 0.00% Impervious, Inflow Depth = 1.07" for 10 yr event
Inflow = 1.90 cfs @ 12.14 hrs, Volume= 0.176 af
Outflow = 1.90 cfs @ 12.14 hrs, Volume= 0.176 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DPE-#1: Wetlands



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-#1: Subcatchment 1 Runoff Area=86,145 sf 0.00% Impervious Runoff Depth=1.59"
Flow Length=336' Tc=8.4 min CN=59 Runoff=3.04 cfs 0.262 af

Reach DPE-#1: Wetlands Inflow=3.04 cfs 0.262 af
Outflow=3.04 cfs 0.262 af

Total Runoff Area = 1.978 ac Runoff Volume = 0.262 af Average Runoff Depth = 1.59"
100.00% Pervious = 1.978 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment EX-#1: Subcatchment 1

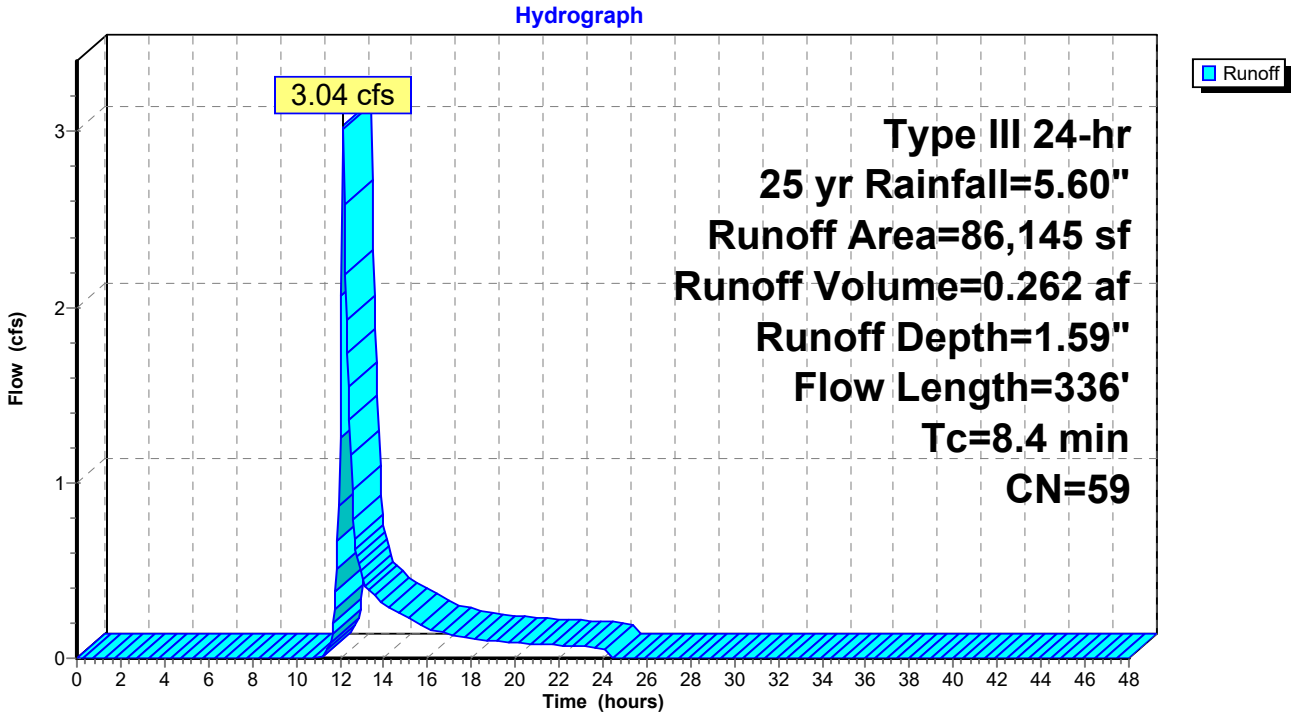
Runoff = 3.04 cfs @ 12.14 hrs, Volume= 0.262 af, Depth= 1.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
54,038	61	>75% Grass cover, Good, HSG B
32,107	55	Woods, Good, HSG B
86,145	59	Weighted Average
86,145		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.7	50	0.0360	0.12		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.00"
1.7	286	0.0350	2.81		**Shallow Concentrated Flow, B-C** Grassed Waterway Kv= 15.0 fps
8.4	336	Total			

Subcatchment EX-#1: Subcatchment 1



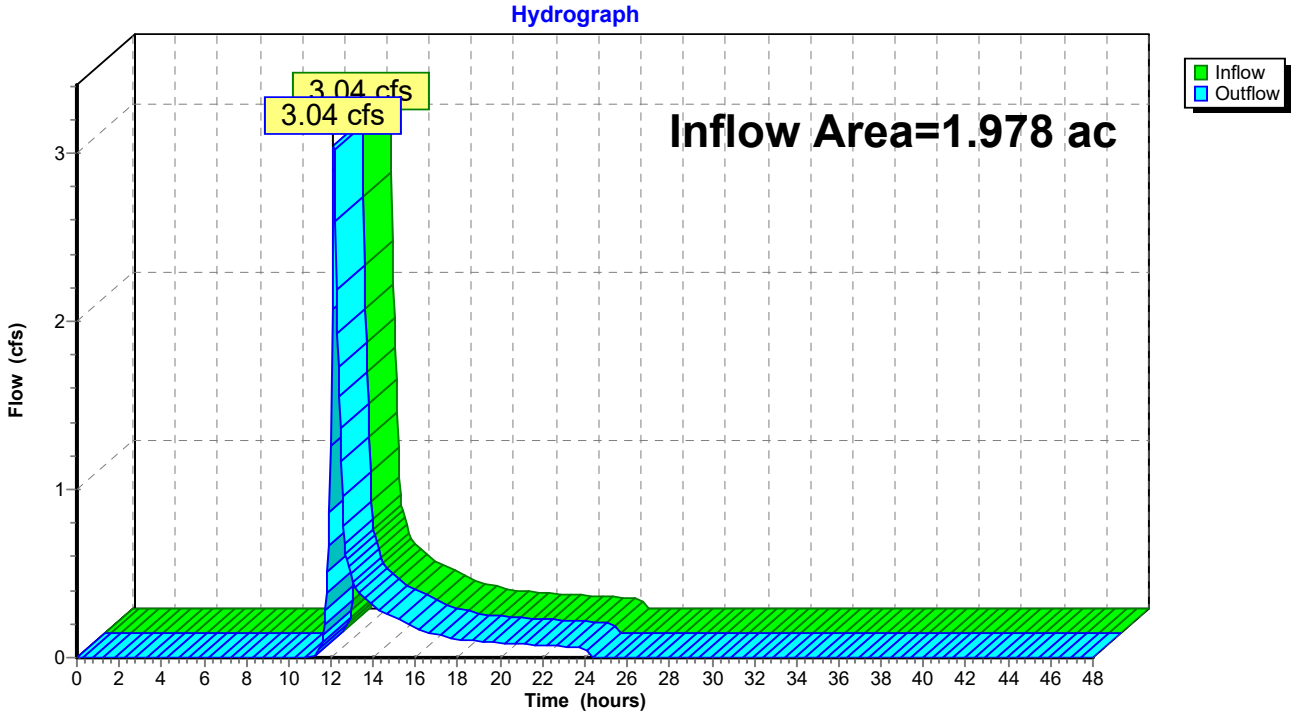
Summary for Reach DPE-#1: Wetlands

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

Inflow Area = 1.978 ac, 0.00% Impervious, Inflow Depth = 1.59" for 25 yr event
Inflow = 3.04 cfs @ 12.14 hrs, Volume= 0.262 af
Outflow = 3.04 cfs @ 12.14 hrs, Volume= 0.262 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DPE-#1: Wetlands



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-#1: Subcatchment 1 Runoff Area=86,145 sf 0.00% Impervious Runoff Depth=2.51"
Flow Length=336' Tc=8.4 min CN=59 Runoff=5.03 cfs 0.413 af

Reach DPE-#1: Wetlands Inflow=5.03 cfs 0.413 af
Outflow=5.03 cfs 0.413 af

Total Runoff Area = 1.978 ac Runoff Volume = 0.413 af Average Runoff Depth = 2.51"
100.00% Pervious = 1.978 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment EX-#1: Subcatchment 1

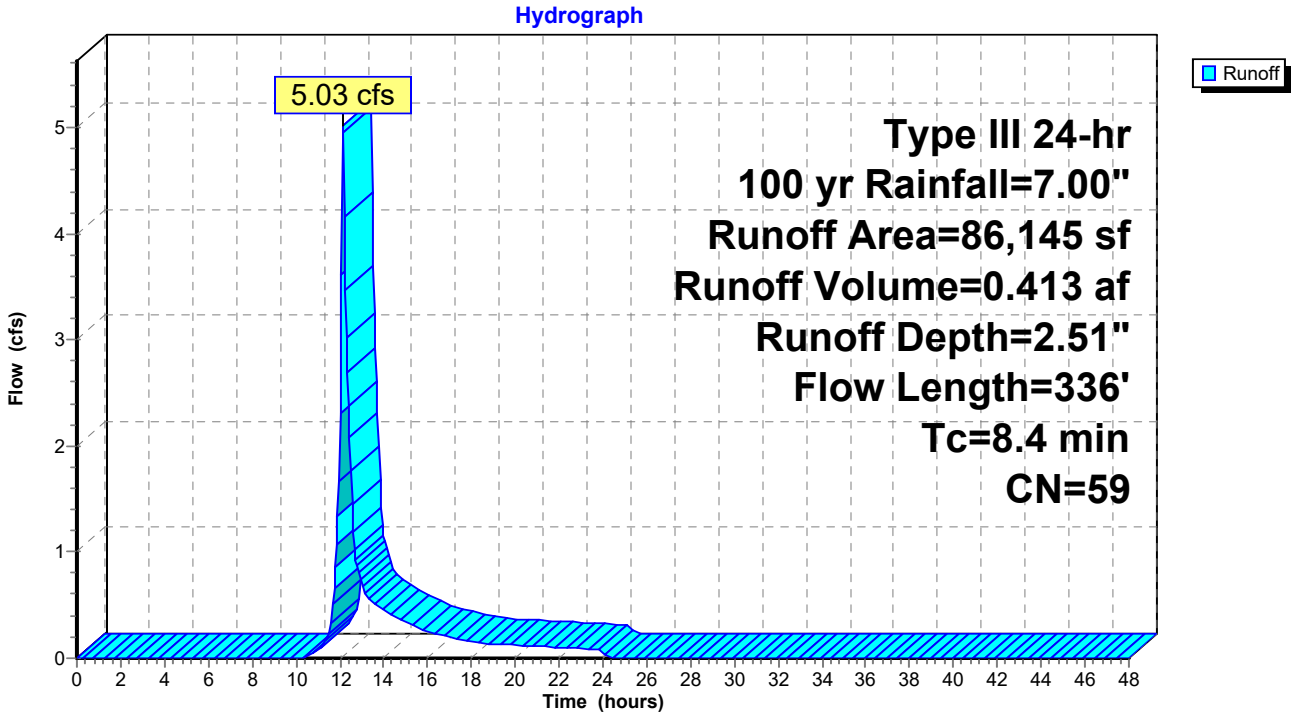
Runoff = 5.03 cfs @ 12.13 hrs, Volume= 0.413 af, Depth= 2.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (sf)	CN	Description
54,038	61	>75% Grass cover, Good, HSG B
32,107	55	Woods, Good, HSG B
86,145	59	Weighted Average
86,145		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.7	50	0.0360	0.12		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.00"
1.7	286	0.0350	2.81		**Shallow Concentrated Flow, B-C** Grassed Waterway Kv= 15.0 fps
8.4	336	Total			

Subcatchment EX-#1: Subcatchment 1



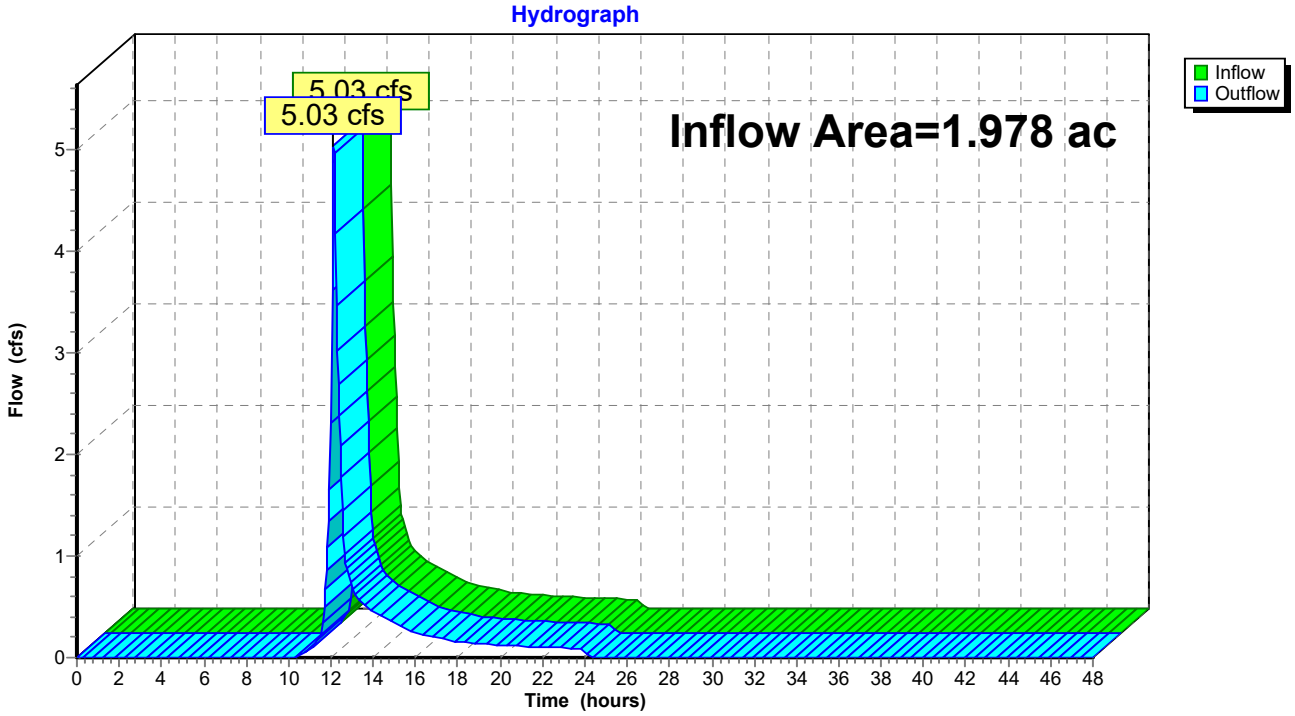
Summary for Reach DPE-#1: Wetlands

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

Inflow Area = 1.978 ac, 0.00% Impervious, Inflow Depth = 2.51" for 100 yr event
Inflow = 5.03 cfs @ 12.13 hrs, Volume= 0.413 af
Outflow = 5.03 cfs @ 12.13 hrs, Volume= 0.413 af, Atten= 0%, Lag= 0.0 min

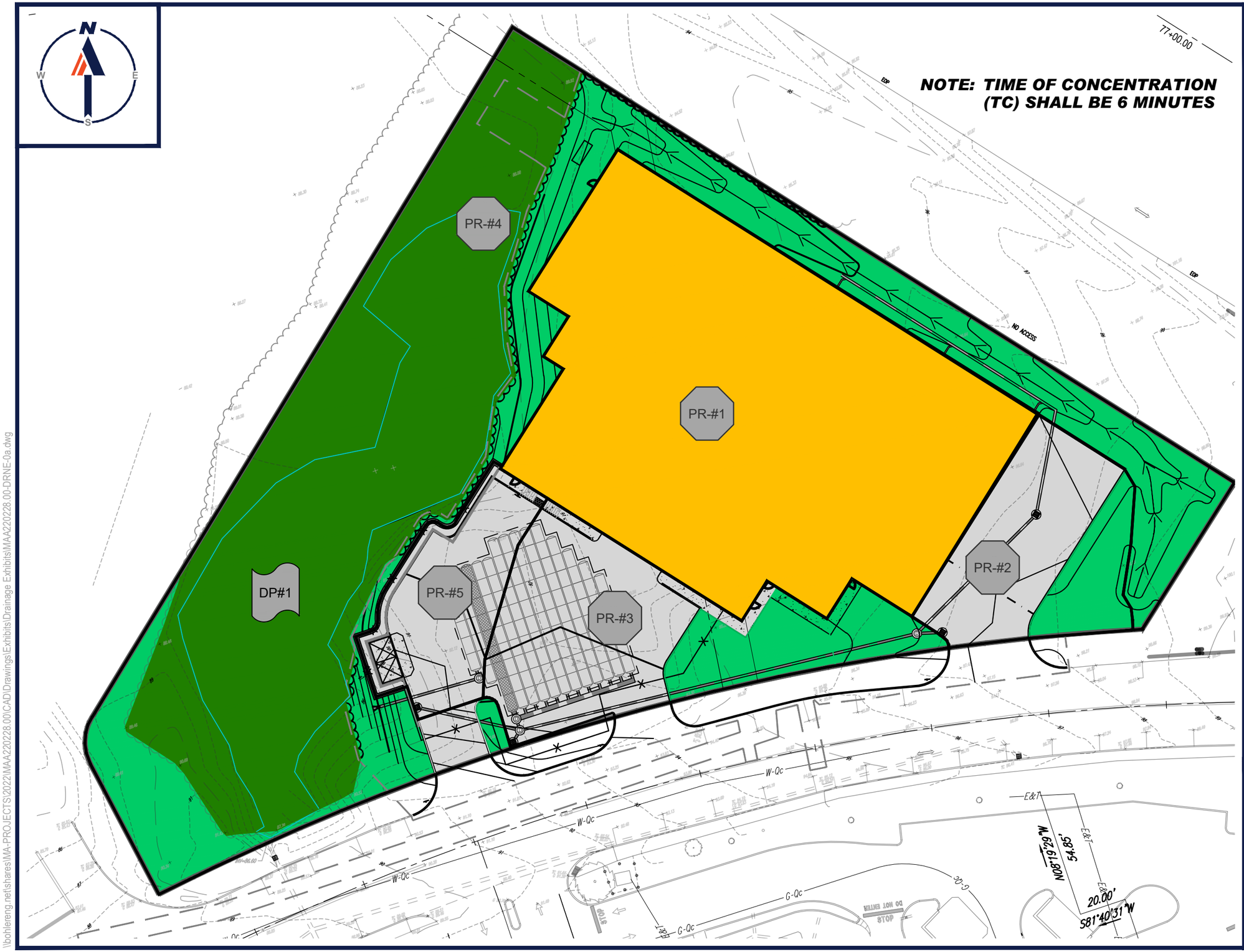
Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DPE-#1: Wetlands



APPENDIX E: PROPOSED CONDITIONS HYDROLOGIC ANALYSIS

- *PROPOSED CONDITIONS DRAINAGE MAP*
- *PROPOSED CONDITIONS HYDROCAD CALCULATIONS*



LEGEND

- DP# — DESIGN POINT
- EX-# — EXISTING SUBCATCHMENT
- XX# — BASIN OR MODELED DRAINAGE STRUCTURE
- A/B/C/D — HYDROLOGIC SOIL GROUP RATING
- UNIT — NRCS SOIL MAP UNIT
- X-# — SWALE OR MODELED JUNCTION
- OVERALL ANALYSIS BOUNDARY
- SUBCATCHMENT BOUNDARY
- NRCS SOIL BOUNDARY
- TIME OF CONCENTRATION
- CONCRETE OR PAVEMENT
- ROOF
- SURFACE WATER (IMPERVIOUS)
- GRASS OR LANDSCAPED AREA
- UNIT PAVER OR GRAVEL (PERVIOUS)
- WOODS OR UNDEVELOPED AREA

PROPOSED CONDITIONS DRAINAGE AREA MAP

PROJECT ADDRESS
CITY/TOWN, STATE

PREPARED BY
BOHLER

SCALE:1"=40' DATE: 01/25/2023

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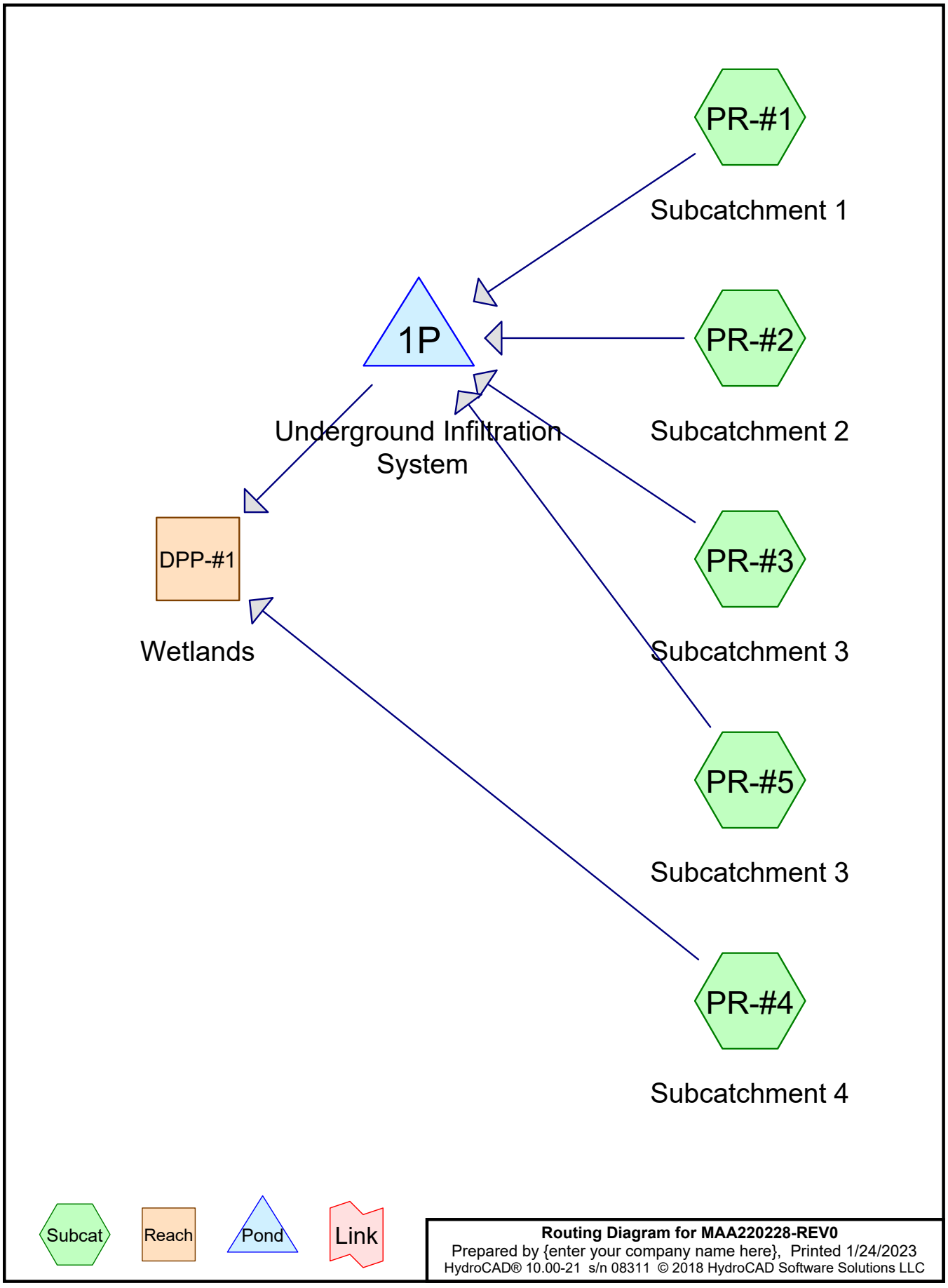


Routing Diagram for MAA220228-REV0
Prepared by {enter your company name here}, Printed 1/24/2023

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.463	61	>75% Grass cover, Good, HSG B (PR-#2, PR-#3, PR-#4)
0.097	98	Paved parking, HSG A (PR-#2)
0.258	98	Paved parking, HSG B (PR-#3, PR-#4, PR-#5)
0.598	98	Roofs, HSG A (PR-#1)
0.562	55	Woods, Good, HSG B (PR-#4)
1.978	**77**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.695	HSG A	PR-#1, PR-#2
1.283	HSG B	PR-#2, PR-#3, PR-#4, PR-#5
0.000	HSG C	
0.000	HSG D	
0.000	Other	
1.978		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.463	0.000	0.000	0.000	0.463	>75% Grass cover, Good	PR-#2, PR-#3, PR-#4
0.097	0.258	0.000	0.000	0.000	0.355	Paved parking	PR-#2, PR-#3, PR-#4, PR-#5
0.598	0.000	0.000	0.000	0.000	0.598	Roofs	PR-#1
0.000	0.562	0.000	0.000	0.000	0.562	Woods, Good	PR-#4
0.695	**1.283**	**0.000**	**0.000**	**0.000**	**1.978**	**TOTAL AREA**	

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-#1: Subcatchment 1 Runoff Area=26,041 sf 100.00% Impervious Runoff Depth=3.17"
Tc=6.0 min CN=98 Runoff=1.93 cfs 0.158 af

Subcatchment PR-#2: Subcatchment 2 Runoff Area=5,918 sf 71.26% Impervious Runoff Depth=2.09"
Tc=6.0 min CN=87 Runoff=0.33 cfs 0.024 af

Subcatchment PR-#3: Subcatchment 3 Runoff Area=9,353 sf 67.63% Impervious Runoff Depth=2.01"
Tc=6.0 min CN=86 Runoff=0.50 cfs 0.036 af

Subcatchment PR-#4: Subcatchment 4 Runoff Area=40,505 sf 1.46% Impervious Runoff Depth=0.41"
Tc=6.0 min CN=58 Runoff=0.24 cfs 0.032 af

Subcatchment PR-#5: Subcatchment 3 Runoff Area=4,328 sf 100.00% Impervious Runoff Depth=3.17"
Tc=6.0 min CN=98 Runoff=0.32 cfs 0.026 af

Reach DPP-#1: Wetlands Inflow=0.41 cfs 0.096 af
Outflow=0.41 cfs 0.096 af

Pond 1P: Underground Infiltration System Peak Elev=91.05' Storage=4,581 cf Inflow=3.07 cfs 0.244 af
Discarded=0.10 cfs 0.180 af Primary=0.26 cfs 0.064 af Outflow=0.36 cfs 0.244 af

Total Runoff Area = 1.978 ac Runoff Volume = 0.276 af Average Runoff Depth = 1.67"
51.82% Pervious = 1.025 ac 48.18% Impervious = 0.953 ac

Summary for Subcatchment PR-#1: Subcatchment 1

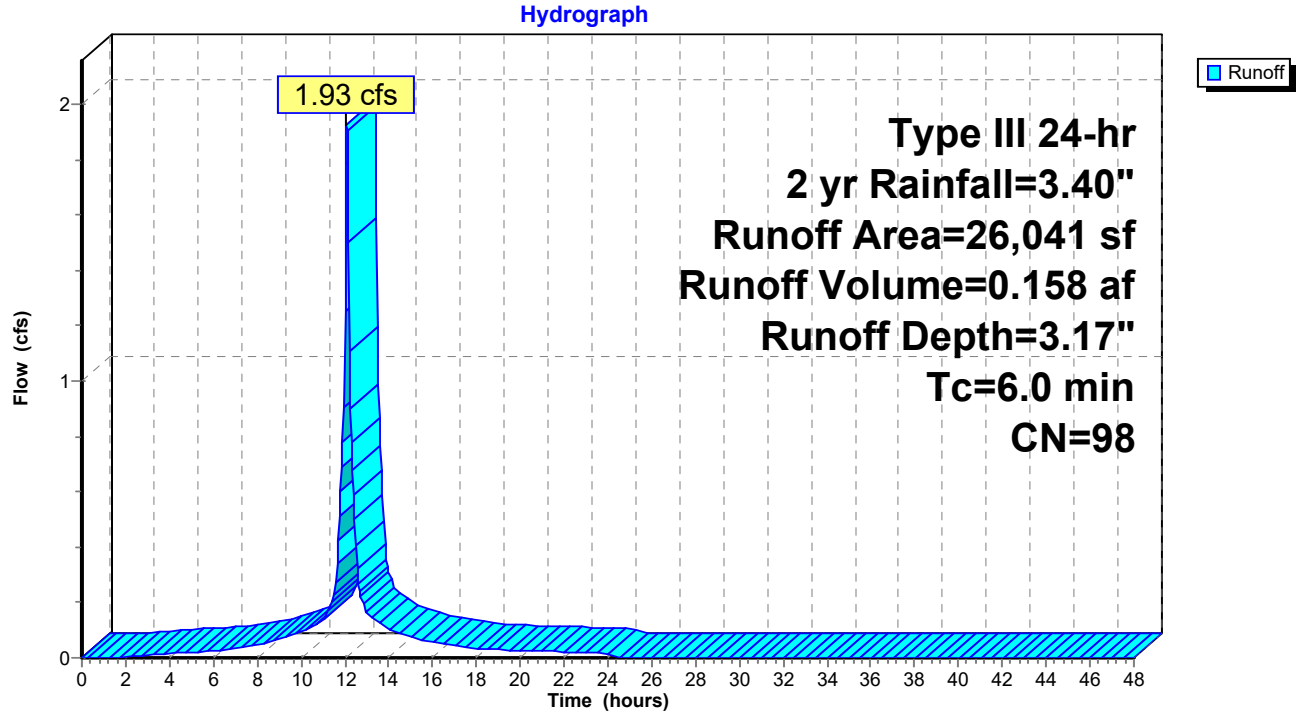
Runoff = 1.93 cfs @ 12.09 hrs, Volume= 0.158 af, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.40"

Area (sf)	CN	Description
26,041	98	Roofs, HSG A
26,041		100.00% Impervious Area

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

Subcatchment PR-#1: Subcatchment 1



Summary for Subcatchment PR-#2: Subcatchment 2

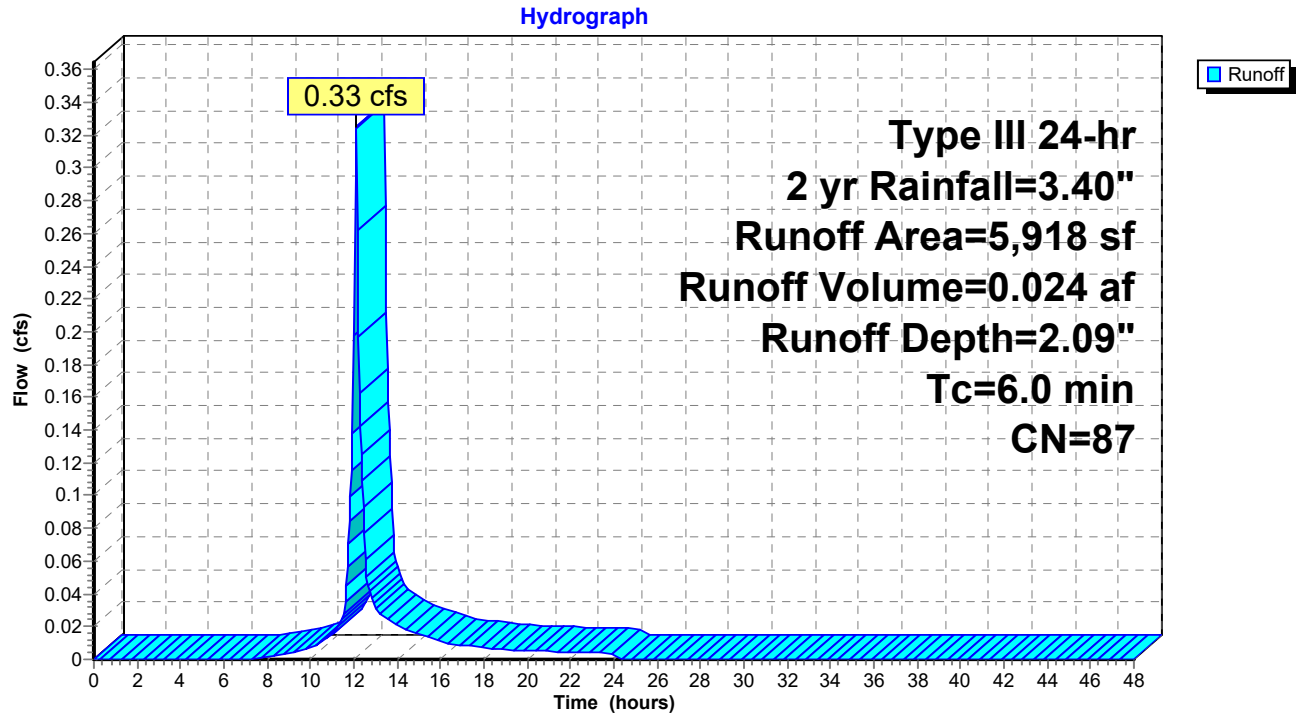
Runoff = 0.33 cfs @ 12.09 hrs, Volume= 0.024 af, Depth= 2.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.40"

Area (sf)	CN	Description
4,217	98	Paved parking, HSG A
1,701	61	>75% Grass cover, Good, HSG B
5,918	87	Weighted Average
1,701		28.74% Pervious Area
4,217		71.26% Impervious Area

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

Subcatchment PR-#2: Subcatchment 2



Summary for Subcatchment PR-#3: Subcatchment 3

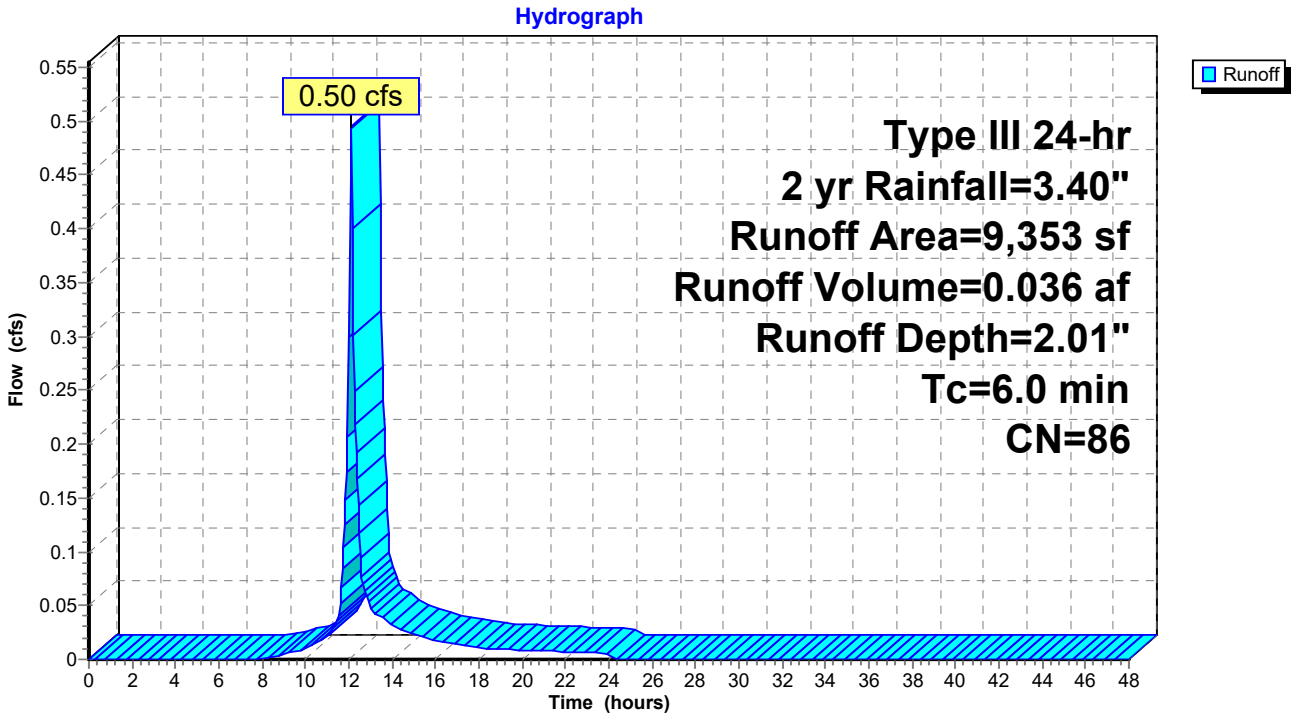
Runoff = 0.50 cfs @ 12.09 hrs, Volume= 0.036 af, Depth= 2.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.40"

Area (sf)	CN	Description
3,028	61	>75% Grass cover, Good, HSG B
6,325	98	Paved parking, HSG B
9,353	86	Weighted Average
3,028		32.37% Pervious Area
6,325		67.63% Impervious Area

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

Subcatchment PR-#3: Subcatchment 3



Summary for Subcatchment PR-#4: Subcatchment 4

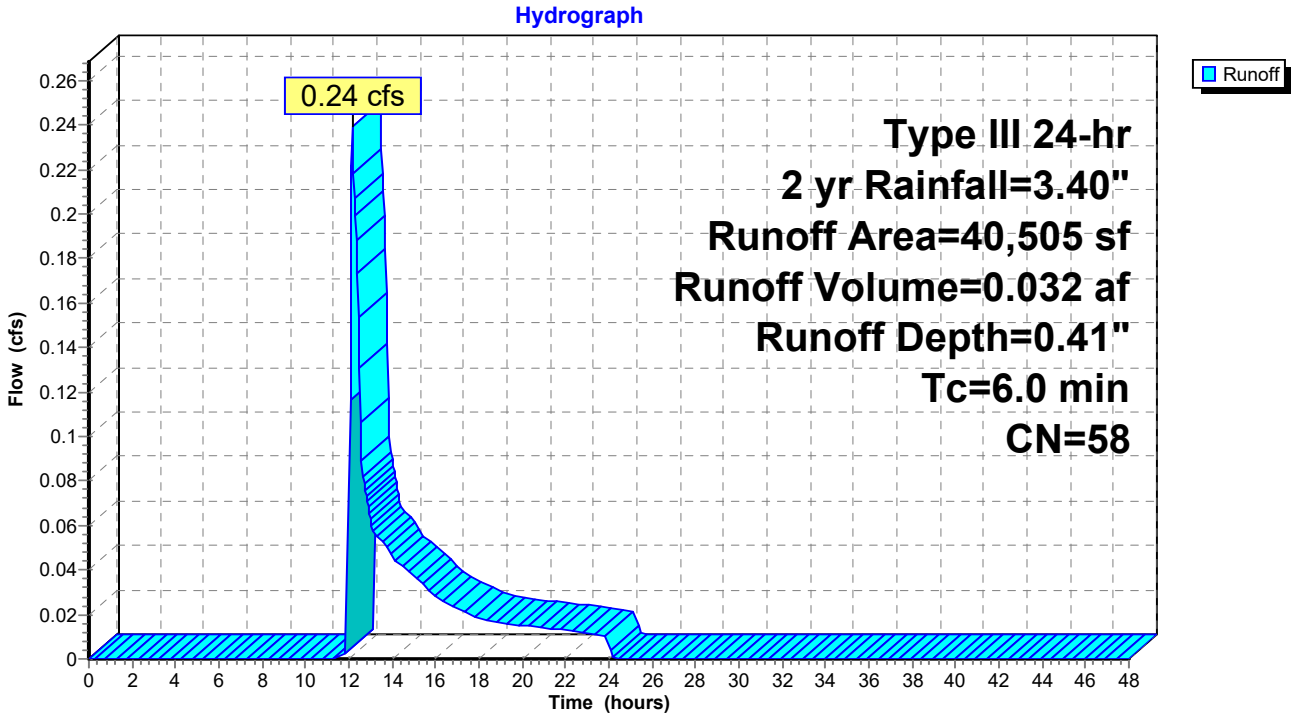
Runoff = 0.24 cfs @ 12.15 hrs, Volume= 0.032 af, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.40"

Area (sf)	CN	Description
15,432	61	>75% Grass cover, Good, HSG B
590	98	Paved parking, HSG B
24,483	55	Woods, Good, HSG B
40,505	58	Weighted Average
39,915		98.54% Pervious Area
590		1.46% Impervious Area

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

Subcatchment PR-#4: Subcatchment 4



Summary for Subcatchment PR-#5: Subcatchment 3

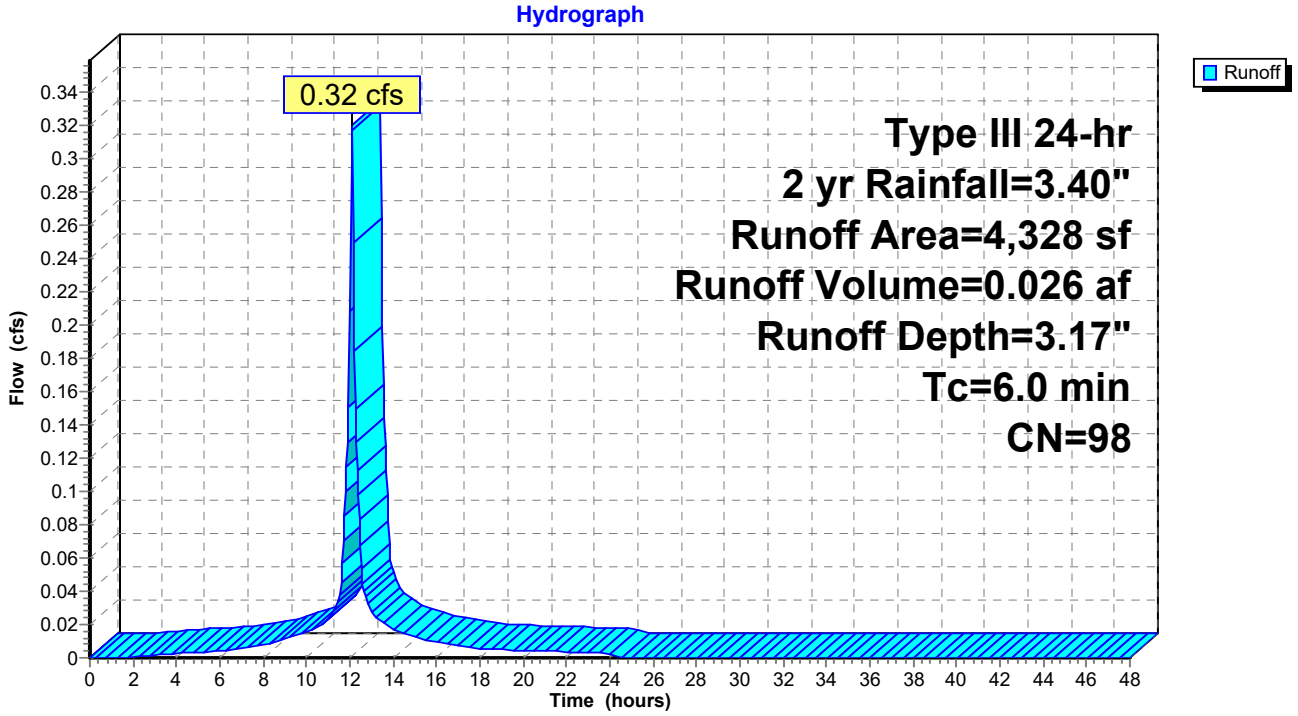
Runoff = 0.32 cfs @ 12.09 hrs, Volume= 0.026 af, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.40"

Area (sf)	CN	Description
4,328	98	Paved parking, HSG B
4,328		100.00% Impervious Area

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

Subcatchment PR-#5: Subcatchment 3



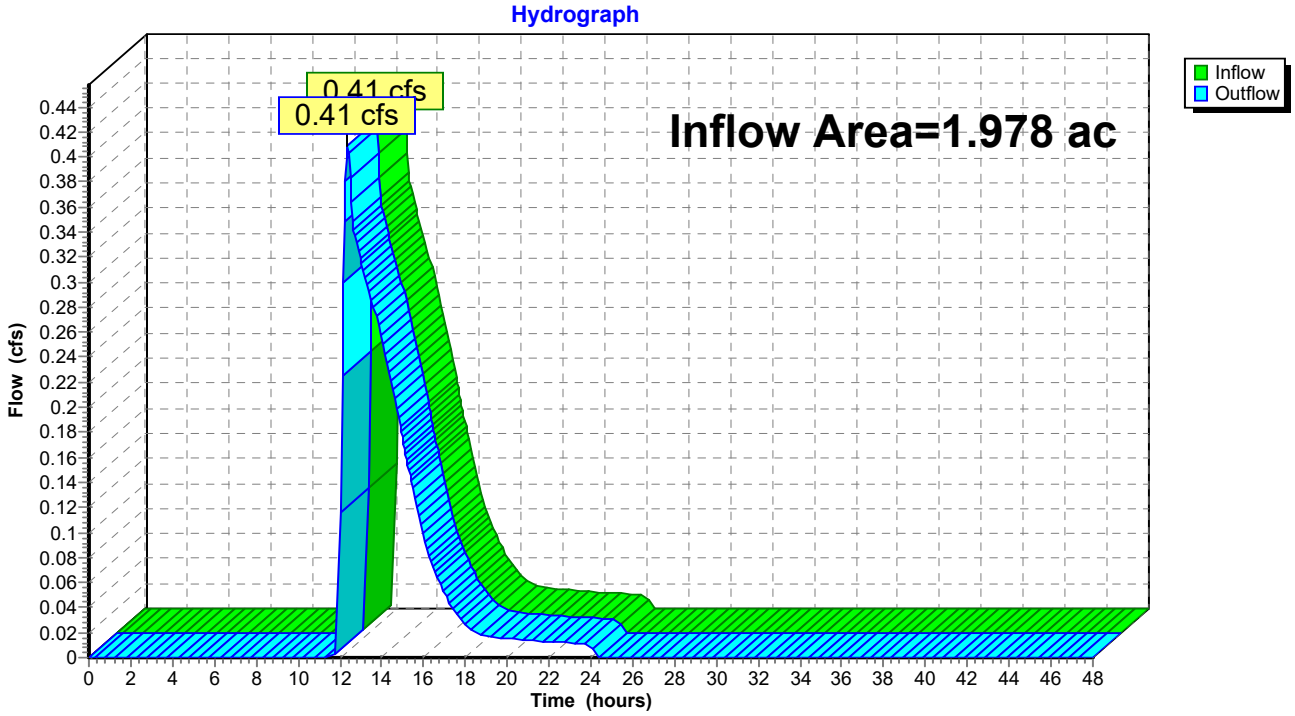
Summary for Reach DPP-#1: Wetlands

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

Inflow Area = 1.978 ac, 48.18% Impervious, Inflow Depth = 0.58" for 2 yr event
Inflow = 0.41 cfs @ 12.37 hrs, Volume= 0.096 af
Outflow = 0.41 cfs @ 12.37 hrs, Volume= 0.096 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DPP-#1: Wetlands



Summary for Pond 1P: Underground Infiltration System

Inflow Area = 1.048 ac, 89.64% Impervious, Inflow Depth = 2.79" for 2 yr event
Inflow = 3.07 cfs @ 12.09 hrs, Volume= 0.244 af
Outflow = 0.36 cfs @ 12.72 hrs, Volume= 0.244 af, Atten= 88%, Lag= 37.8 min
Discarded = 0.10 cfs @ 9.65 hrs, Volume= 0.180 af
Primary = 0.26 cfs @ 12.72 hrs, Volume= 0.064 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 91.05' @ 12.72 hrs Surf.Area= 4,364 sf Storage= 4,581 cf

Plug-Flow detention time= 224.0 min calculated for 0.243 af (100% of inflow)
Center-of-Mass det. time= 224.0 min (994.7 - 770.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	89.50'	3,904 cf	**49.00'W x 89.06'L x 3.50'H Field A** 15,273 cf Overall - 5,513 cf Embedded = 9,760 cf x 40.0% Voids
#2A	90.00'	5,513 cf	**ADS_StormTech SC-740 +Cap** x 120 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 10 Rows of 12 Chambers
		9,417 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	89.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	92.60'	**5.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	90.50'	**4.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.10 cfs @ 9.65 hrs HW=89.54' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.10 cfs)

Primary OutFlow Max=0.26 cfs @ 12.72 hrs HW=91.05' (Free Discharge)
├**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
└**3=Orifice/Grate** (Orifice Controls 0.26 cfs @ 2.98 fps)

Pond 1P: Underground Infiltration System - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

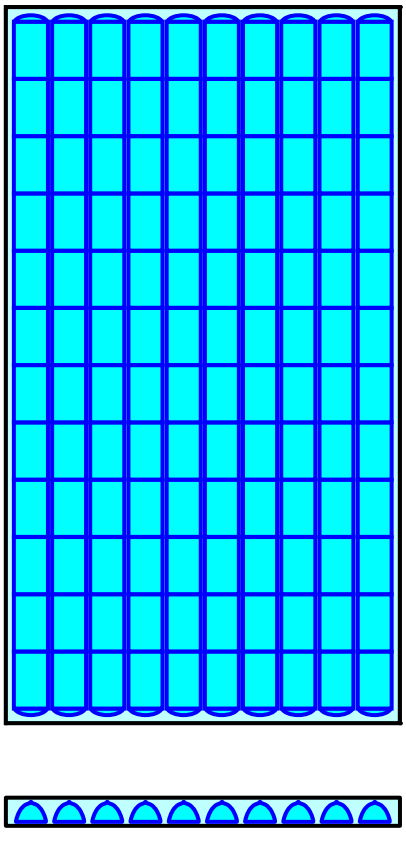
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +12.0" End Stone x 2 = 89.06' Base Length
10 Rows x 51.0" Wide + 6.0" Spacing x 9 + 12.0" Side Stone x 2 = 49.00' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

120 Chambers x 45.9 cf = 5,512.8 cf Chamber Storage

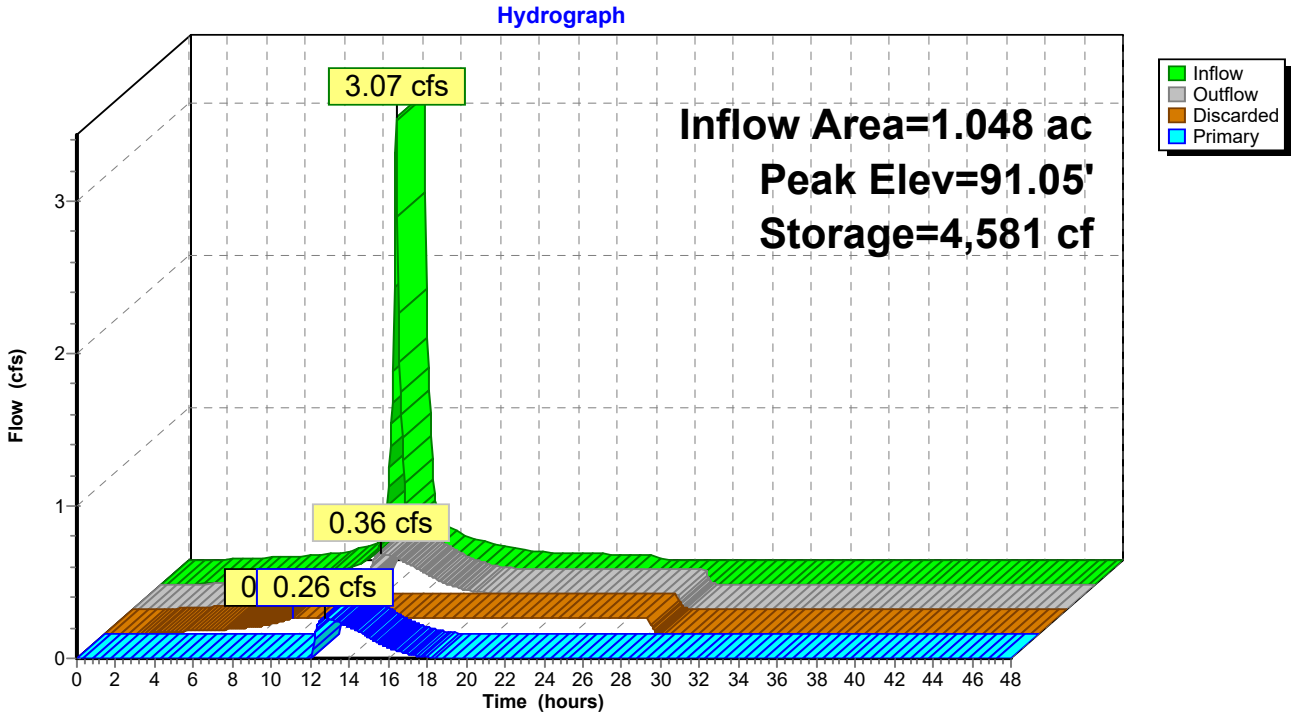
15,273.2 cf Field - 5,512.8 cf Chambers = 9,760.4 cf Stone x 40.0% Voids = 3,904.2 cf Stone Storage

Chamber Storage + Stone Storage = 9,417.0 cf = 0.216 af
Overall Storage Efficiency = 61.7%
Overall System Size = 89.06' x 49.00' x 3.50'

120 Chambers
565.7 cy Field
361.5 cy Stone



Pond 1P: Underground Infiltration System



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-#1: Subcatchment 1 Runoff Area=26,041 sf 100.00% Impervious Runoff Depth=4.46"
Tc=6.0 min CN=98 Runoff=2.68 cfs 0.222 af

Subcatchment PR-#2: Subcatchment 2 Runoff Area=5,918 sf 71.26% Impervious Runoff Depth=3.29"
Tc=6.0 min CN=87 Runoff=0.50 cfs 0.037 af

Subcatchment PR-#3: Subcatchment 3 Runoff Area=9,353 sf 67.63% Impervious Runoff Depth=3.19"
Tc=6.0 min CN=86 Runoff=0.78 cfs 0.057 af

Subcatchment PR-#4: Subcatchment 4 Runoff Area=40,505 sf 1.46% Impervious Runoff Depth=1.01"
Tc=6.0 min CN=58 Runoff=0.91 cfs 0.078 af

Subcatchment PR-#5: Subcatchment 3 Runoff Area=4,328 sf 100.00% Impervious Runoff Depth=4.46"
Tc=6.0 min CN=98 Runoff=0.45 cfs 0.037 af

Reach DPP-#1: Wetlands Inflow=1.18 cfs 0.228 af
Outflow=1.18 cfs 0.228 af

Pond 1P: Underground Infiltration System Peak Elev=91.81' Storage=6,947 cf Inflow=4.41 cfs 0.354 af
Discarded=0.10 cfs 0.204 af Primary=0.45 cfs 0.149 af Outflow=0.55 cfs 0.354 af

Total Runoff Area = 1.978 ac Runoff Volume = 0.432 af Average Runoff Depth = 2.62"
51.82% Pervious = 1.025 ac 48.18% Impervious = 0.953 ac

Summary for Subcatchment PR-#1: Subcatchment 1

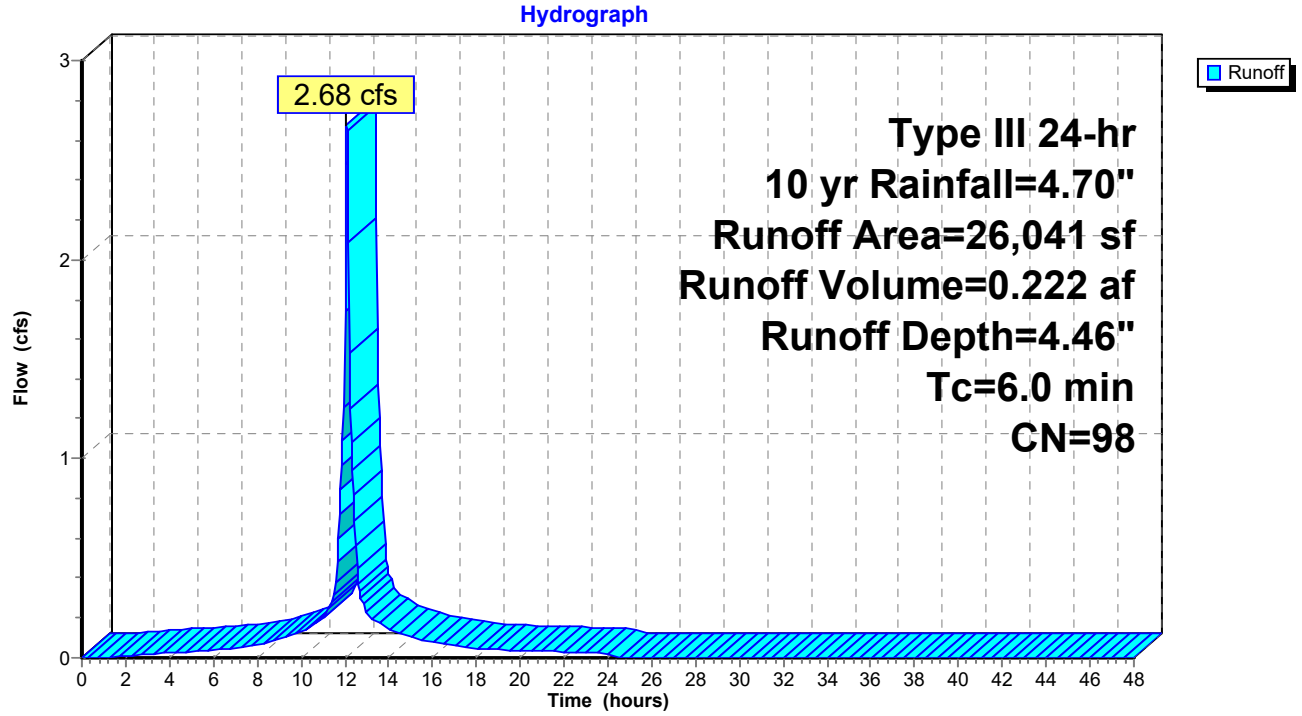
Runoff = 2.68 cfs @ 12.09 hrs, Volume= 0.222 af, Depth= 4.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
26,041	98	Roofs, HSG A
26,041		100.00% Impervious Area

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

Subcatchment PR-#1: Subcatchment 1



Summary for Subcatchment PR-#2: Subcatchment 2

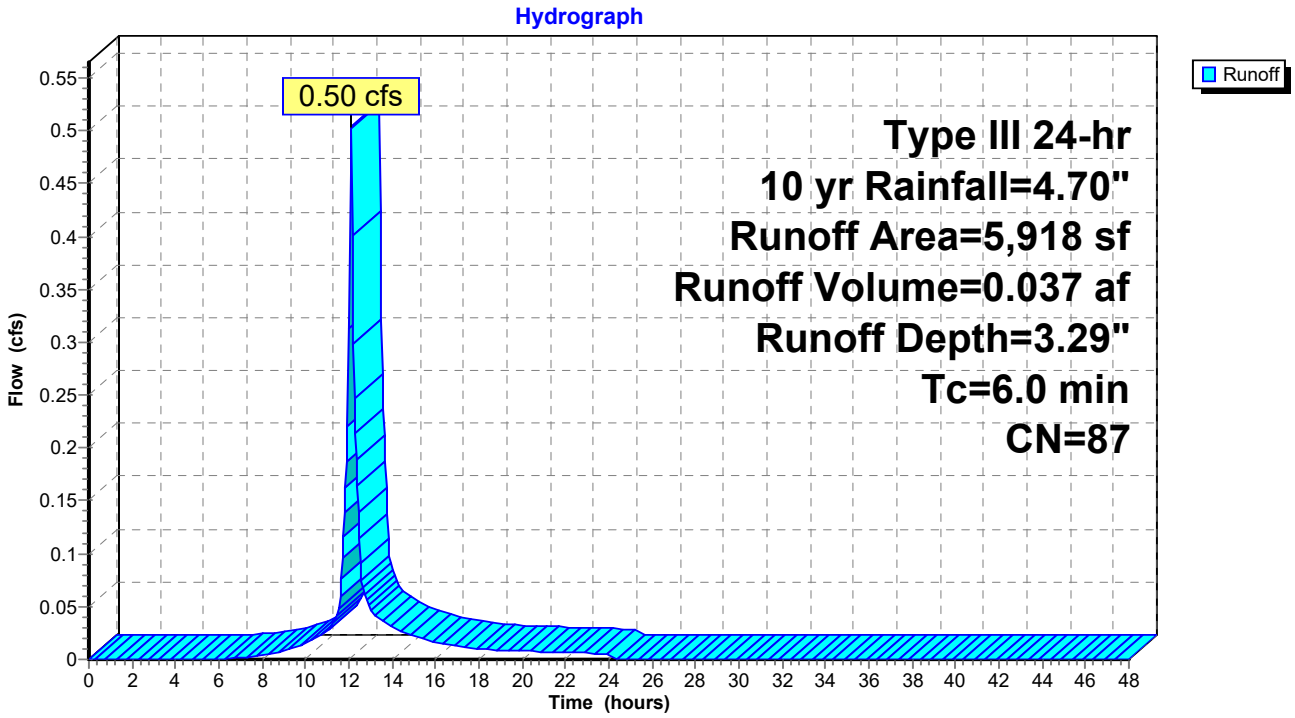
Runoff = 0.50 cfs @ 12.09 hrs, Volume= 0.037 af, Depth= 3.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
4,217	98	Paved parking, HSG A
1,701	61	>75% Grass cover, Good, HSG B
5,918	87	Weighted Average
1,701		28.74% Pervious Area
4,217		71.26% Impervious Area

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

Subcatchment PR-#2: Subcatchment 2



Summary for Subcatchment PR-#3: Subcatchment 3

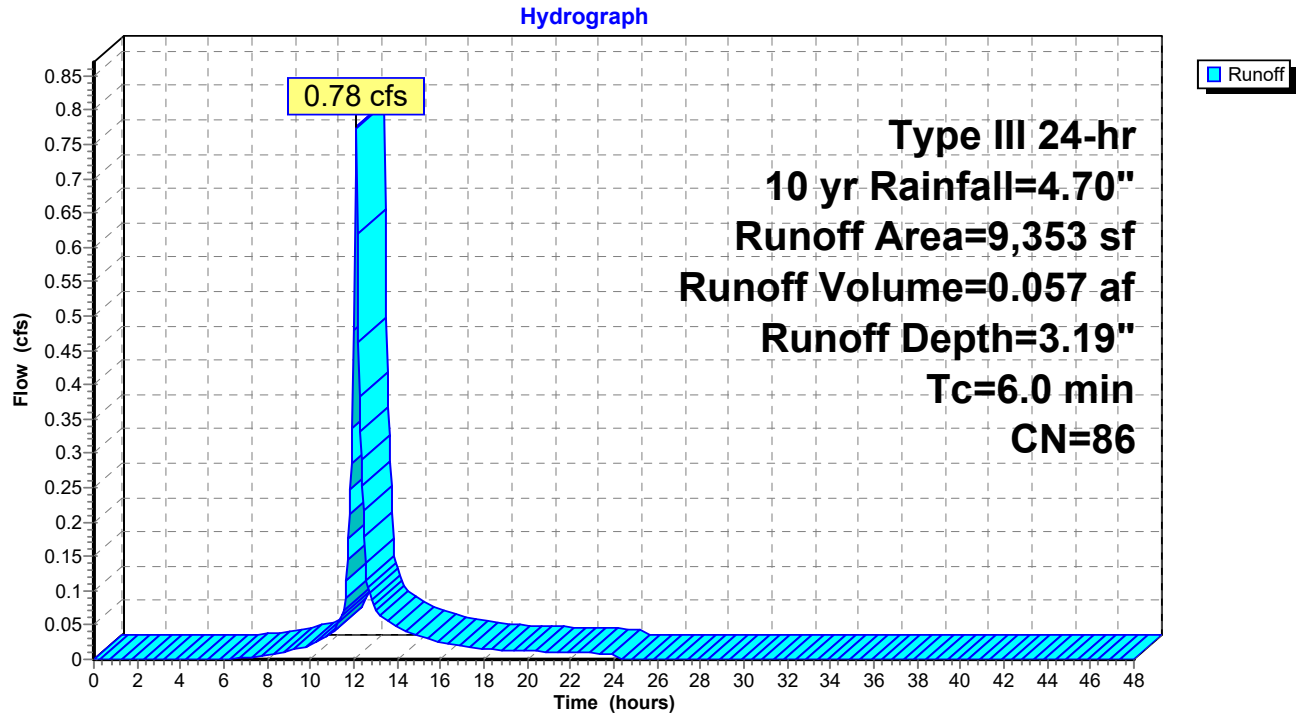
Runoff = 0.78 cfs @ 12.09 hrs, Volume= 0.057 af, Depth= 3.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
3,028	61	>75% Grass cover, Good, HSG B
6,325	98	Paved parking, HSG B
9,353	86	Weighted Average
3,028		32.37% Pervious Area
6,325		67.63% Impervious Area

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

Subcatchment PR-#3: Subcatchment 3



Summary for Subcatchment PR-#4: Subcatchment 4

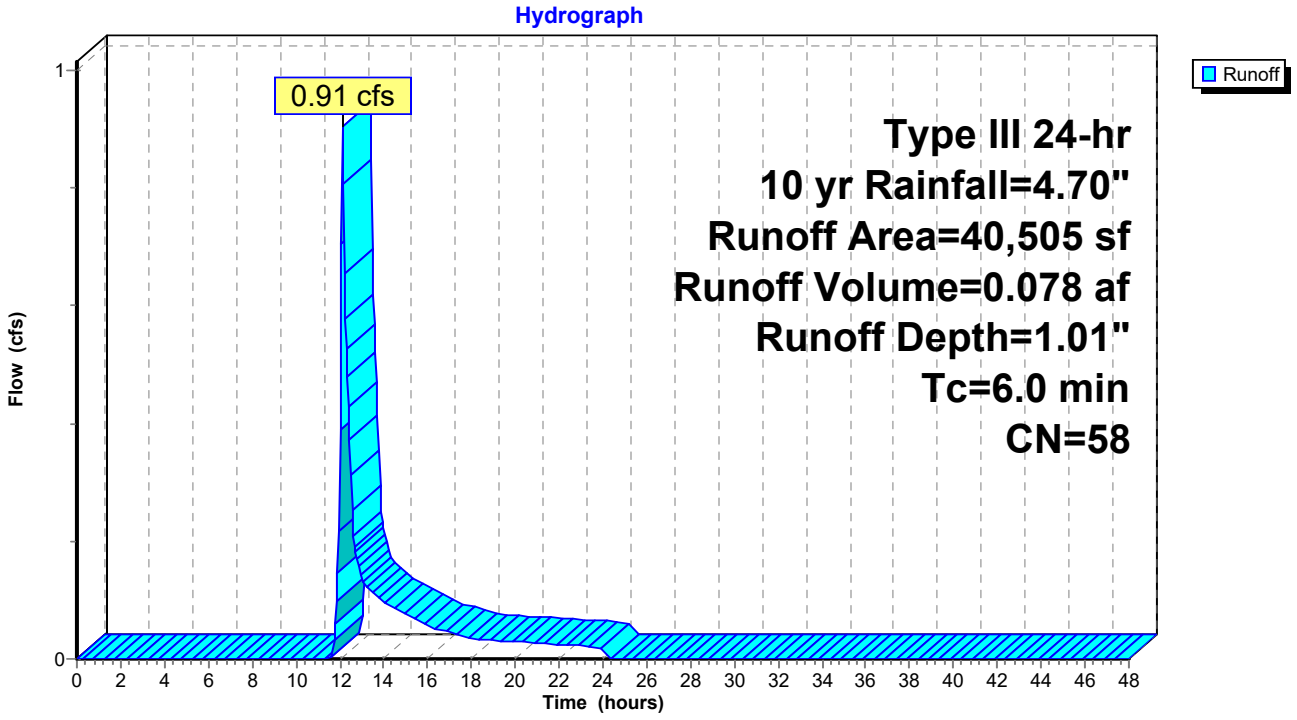
Runoff = 0.91 cfs @ 12.11 hrs, Volume= 0.078 af, Depth= 1.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
15,432	61	>75% Grass cover, Good, HSG B
590	98	Paved parking, HSG B
24,483	55	Woods, Good, HSG B
40,505	58	Weighted Average
39,915		98.54% Pervious Area
590		1.46% Impervious Area

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

Subcatchment PR-#4: Subcatchment 4



Summary for Subcatchment PR-#5: Subcatchment 3

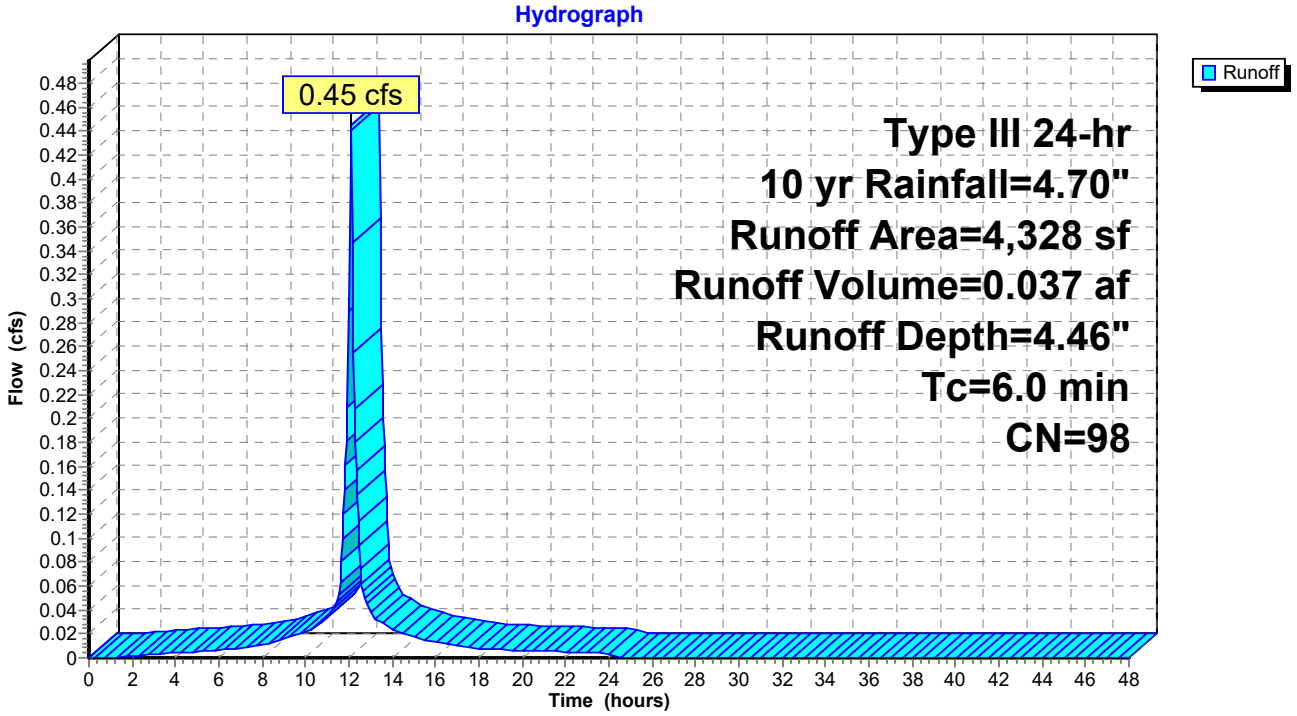
Runoff = 0.45 cfs @ 12.09 hrs, Volume= 0.037 af, Depth= 4.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.70"

Area (sf)	CN	Description
4,328	98	Paved parking, HSG B
4,328		100.00% Impervious Area

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

Subcatchment PR-#5: Subcatchment 3



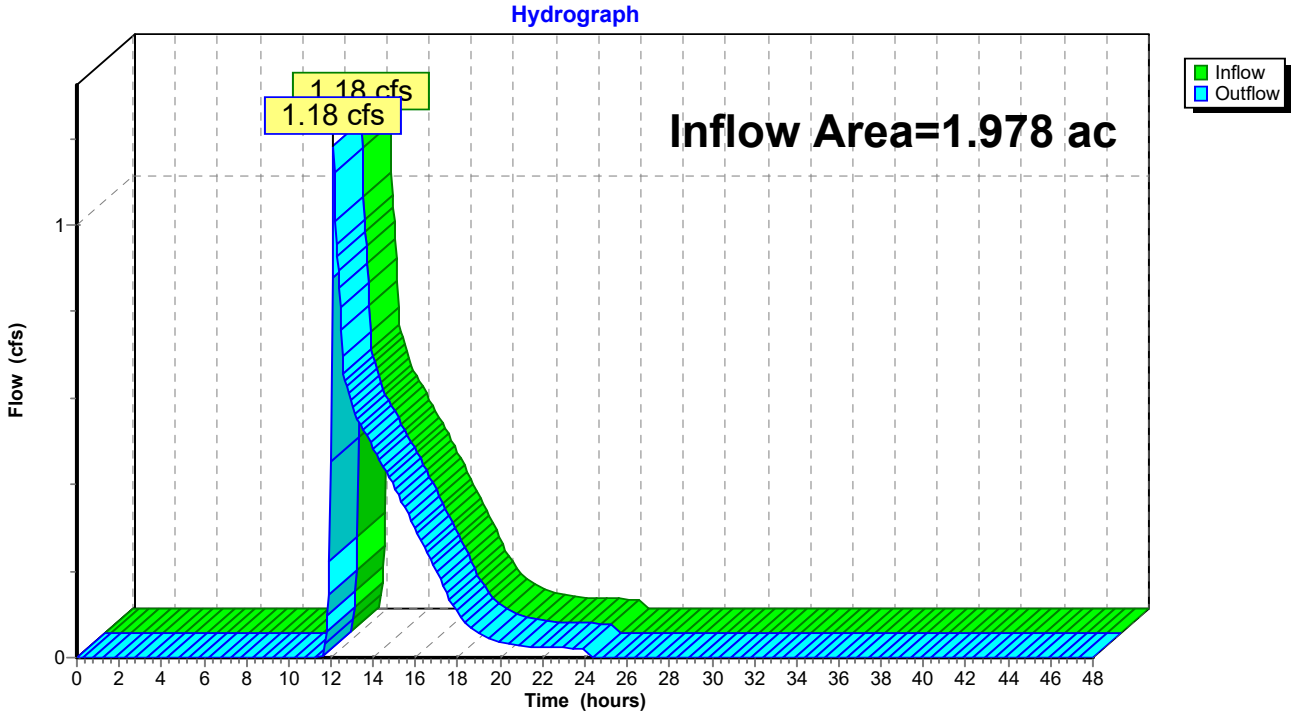
Summary for Reach DPP-#1: Wetlands

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

Inflow Area = 1.978 ac, 48.18% Impervious, Inflow Depth = 1.38" for 10 yr event
Inflow = 1.18 cfs @ 12.12 hrs, Volume= 0.228 af
Outflow = 1.18 cfs @ 12.12 hrs, Volume= 0.228 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DPP-#1: Wetlands



Summary for Pond 1P: Underground Infiltration System

Inflow Area = 1.048 ac, 89.64% Impervious, Inflow Depth = 4.05" for 10 yr event
Inflow = 4.41 cfs @ 12.09 hrs, Volume= 0.354 af
Outflow = 0.55 cfs @ 12.66 hrs, Volume= 0.354 af, Atten= 87%, Lag= 34.5 min
Discarded = 0.10 cfs @ 8.60 hrs, Volume= 0.204 af
Primary = 0.45 cfs @ 12.66 hrs, Volume= 0.149 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 91.81' @ 12.66 hrs Surf.Area= 4,364 sf Storage= 6,947 cf

Plug-Flow detention time= 215.6 min calculated for 0.353 af (100% of inflow)
Center-of-Mass det. time= 215.8 min (979.9 - 764.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	89.50'	3,904 cf	**49.00'W x 89.06'L x 3.50'H Field A** 15,273 cf Overall - 5,513 cf Embedded = 9,760 cf x 40.0% Voids
#2A	90.00'	5,513 cf	**ADS_StormTech SC-740 +Cap** x 120 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 10 Rows of 12 Chambers
		9,417 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	89.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	92.60'	**5.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	90.50'	**4.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.10 cfs @ 8.60 hrs HW=89.54' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.10 cfs)

Primary OutFlow Max=0.45 cfs @ 12.66 hrs HW=91.81' (Free Discharge)
├**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
└**3=Orifice/Grate** (Orifice Controls 0.45 cfs @ 5.15 fps)

Pond 1P: Underground Infiltration System - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

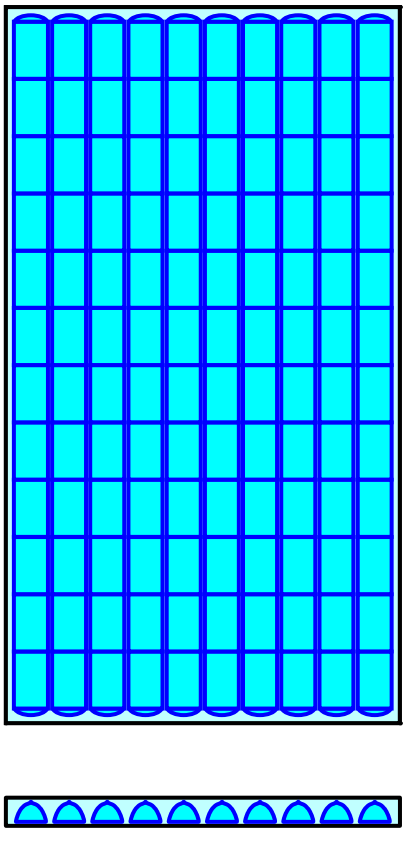
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +12.0" End Stone x 2 = 89.06' Base Length
10 Rows x 51.0" Wide + 6.0" Spacing x 9 + 12.0" Side Stone x 2 = 49.00' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

120 Chambers x 45.9 cf = 5,512.8 cf Chamber Storage

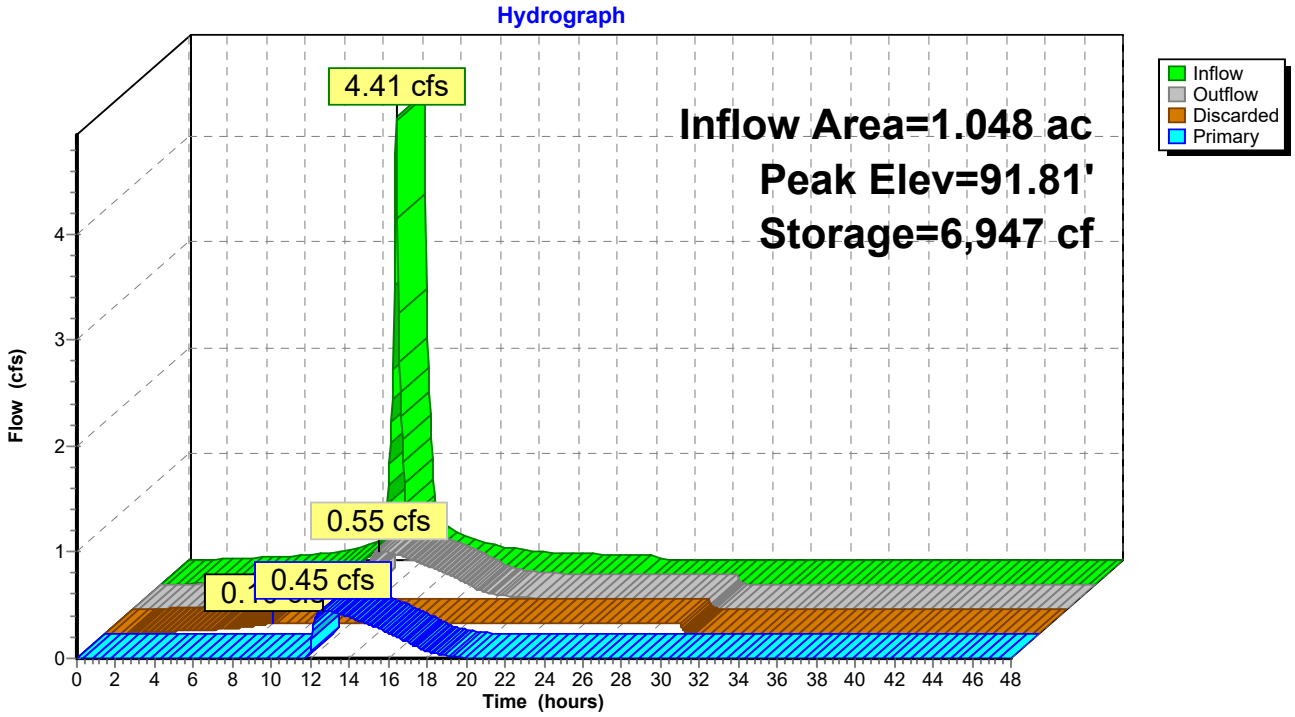
15,273.2 cf Field - 5,512.8 cf Chambers = 9,760.4 cf Stone x 40.0% Voids = 3,904.2 cf Stone Storage

Chamber Storage + Stone Storage = 9,417.0 cf = 0.216 af
Overall Storage Efficiency = 61.7%
Overall System Size = 89.06' x 49.00' x 3.50'

120 Chambers
565.7 cy Field
361.5 cy Stone



Pond 1P: Underground Infiltration System



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-#1: Subcatchment 1 Runoff Area=26,041 sf 100.00% Impervious Runoff Depth=5.36"
Tc=6.0 min CN=98 Runoff=3.20 cfs 0.267 af

Subcatchment PR-#2: Subcatchment 2 Runoff Area=5,918 sf 71.26% Impervious Runoff Depth=4.14"
Tc=6.0 min CN=87 Runoff=0.63 cfs 0.047 af

Subcatchment PR-#3: Subcatchment 3 Runoff Area=9,353 sf 67.63% Impervious Runoff Depth=4.03"
Tc=6.0 min CN=86 Runoff=0.97 cfs 0.072 af

Subcatchment PR-#4: Subcatchment 4 Runoff Area=40,505 sf 1.46% Impervious Runoff Depth=1.51"
Tc=6.0 min CN=58 Runoff=1.47 cfs 0.117 af

Subcatchment PR-#5: Subcatchment 3 Runoff Area=4,328 sf 100.00% Impervious Runoff Depth=5.36"
Tc=6.0 min CN=98 Runoff=0.53 cfs 0.044 af

Reach DPP-#1: Wetlands Inflow=1.85 cfs 0.331 af
Outflow=1.85 cfs 0.331 af

Pond 1P: Underground Infiltration System Peak Elev=92.56' Storage=8,657 cf Inflow=5.33 cfs 0.430 af
Discarded=0.10 cfs 0.217 af Primary=0.58 cfs 0.213 af Outflow=0.68 cfs 0.430 af

Total Runoff Area = 1.978 ac Runoff Volume = 0.548 af Average Runoff Depth = 3.32"
51.82% Pervious = 1.025 ac 48.18% Impervious = 0.953 ac

Summary for Subcatchment PR-#1: Subcatchment 1

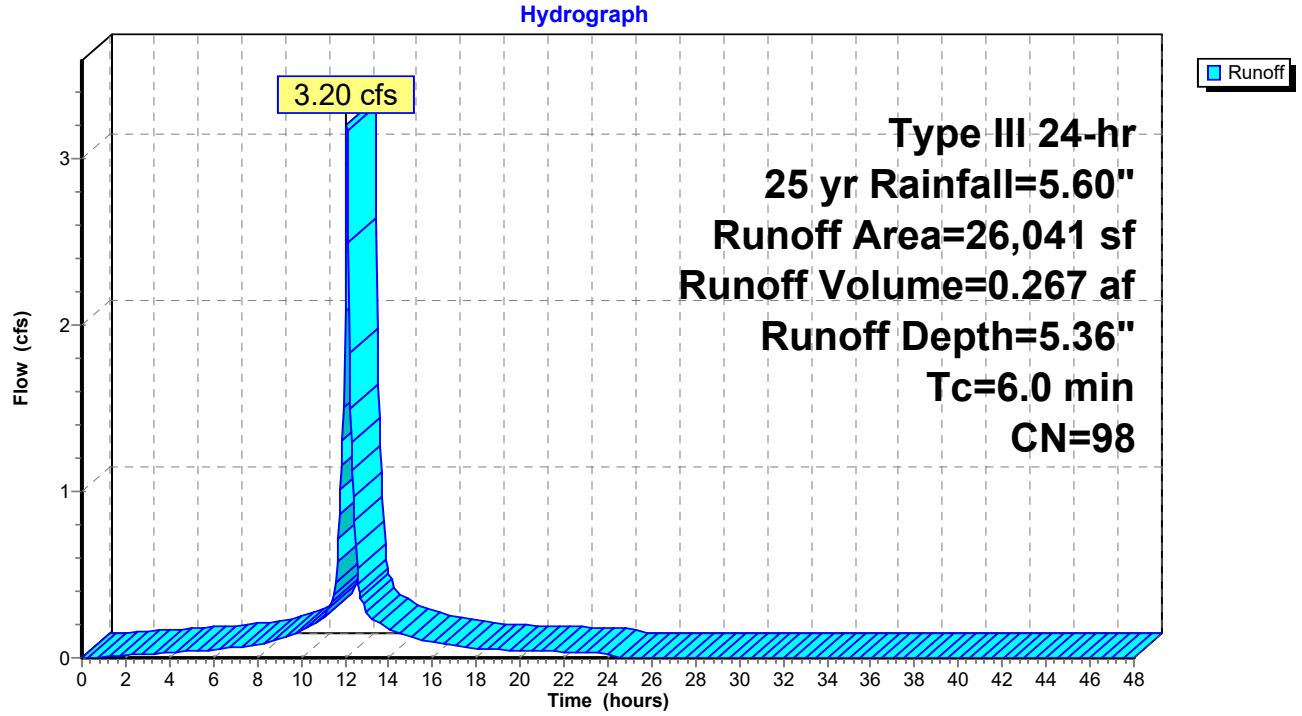
Runoff = 3.20 cfs @ 12.09 hrs, Volume= 0.267 af, Depth= 5.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
26,041	98	Roofs, HSG A
26,041		100.00% Impervious Area

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

Subcatchment PR-#1: Subcatchment 1



Summary for Subcatchment PR-#2: Subcatchment 2

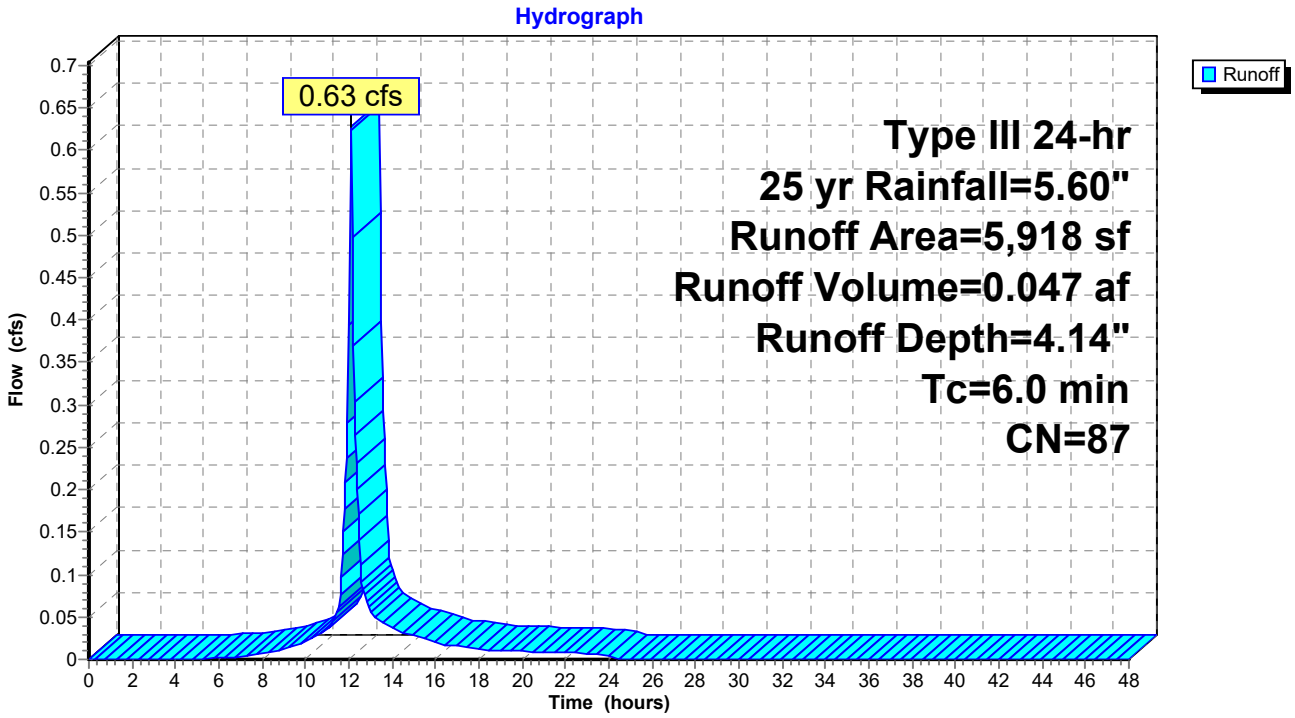
Runoff = 0.63 cfs @ 12.09 hrs, Volume= 0.047 af, Depth= 4.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
4,217	98	Paved parking, HSG A
1,701	61	>75% Grass cover, Good, HSG B
5,918	87	Weighted Average
1,701		28.74% Pervious Area
4,217		71.26% Impervious Area

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

Subcatchment PR-#2: Subcatchment 2



Summary for Subcatchment PR-#3: Subcatchment 3

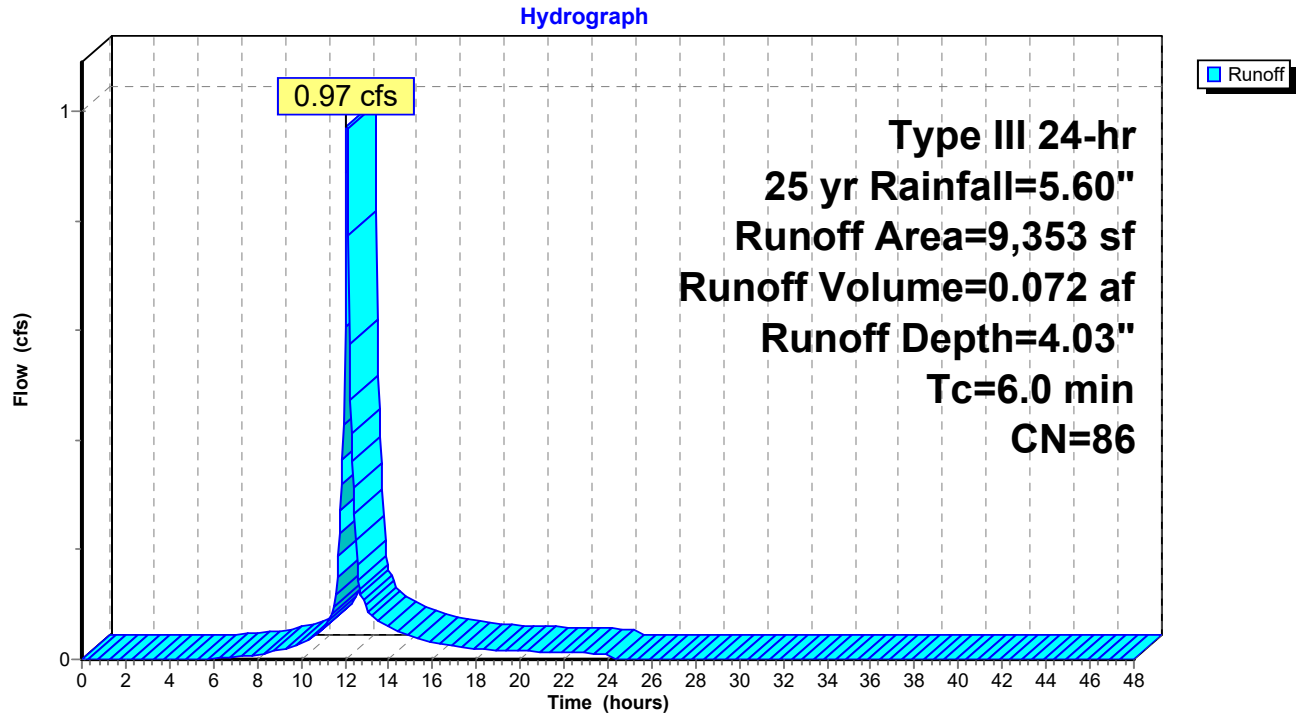
Runoff = 0.97 cfs @ 12.09 hrs, Volume= 0.072 af, Depth= 4.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
3,028	61	>75% Grass cover, Good, HSG B
6,325	98	Paved parking, HSG B
9,353	86	Weighted Average
3,028		32.37% Pervious Area
6,325		67.63% Impervious Area

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

Subcatchment PR-#3: Subcatchment 3



Summary for Subcatchment PR-#4: Subcatchment 4

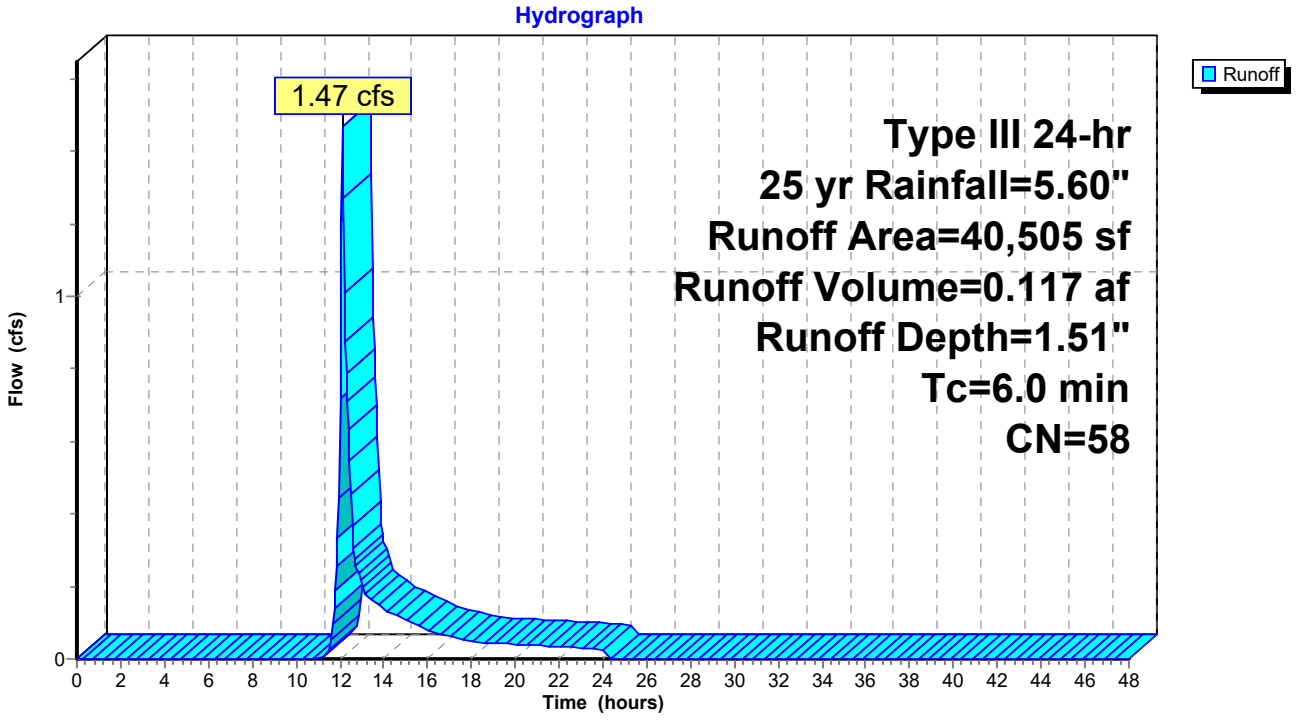
Runoff = 1.47 cfs @ 12.10 hrs, Volume= 0.117 af, Depth= 1.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
15,432	61	>75% Grass cover, Good, HSG B
590	98	Paved parking, HSG B
24,483	55	Woods, Good, HSG B
40,505	58	Weighted Average
39,915		98.54% Pervious Area
590		1.46% Impervious Area

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

Subcatchment PR-#4: Subcatchment 4



Summary for Subcatchment PR-#5: Subcatchment 3

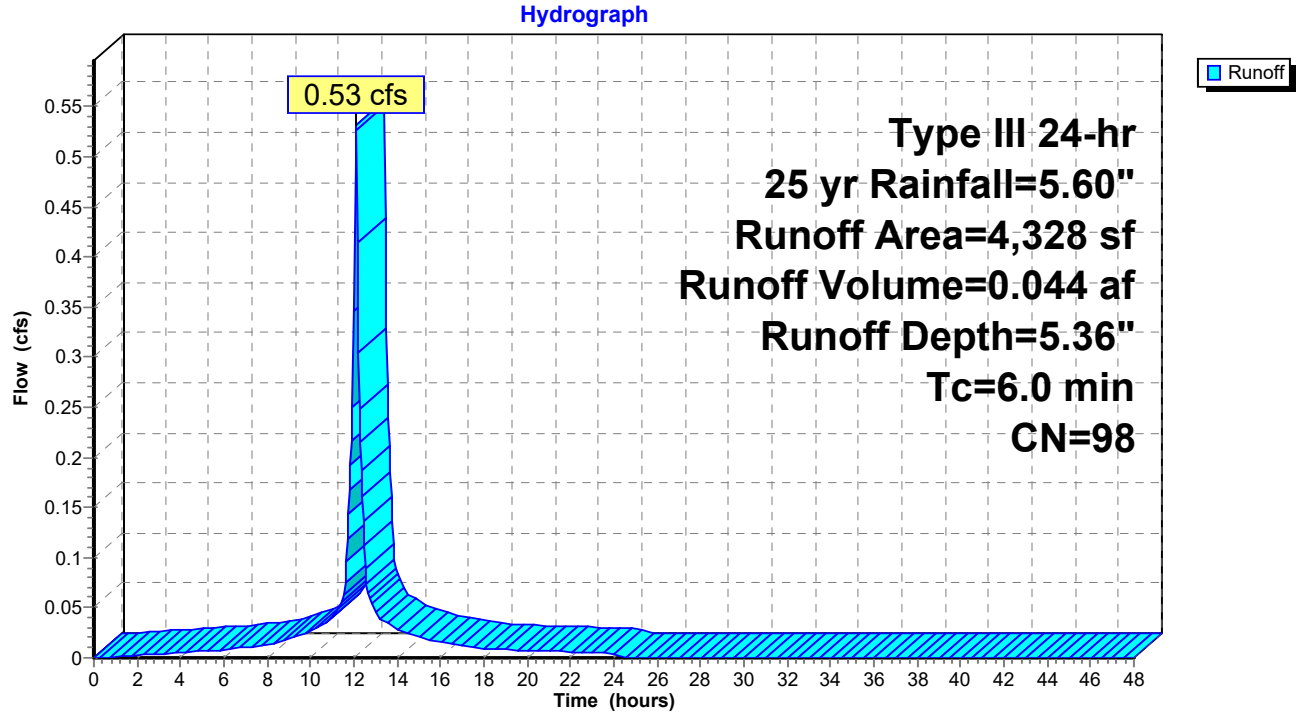
Runoff = 0.53 cfs @ 12.09 hrs, Volume= 0.044 af, Depth= 5.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.60"

Area (sf)	CN	Description
4,328	98	Paved parking, HSG B
4,328		100.00% Impervious Area

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

Subcatchment PR-#5: Subcatchment 3



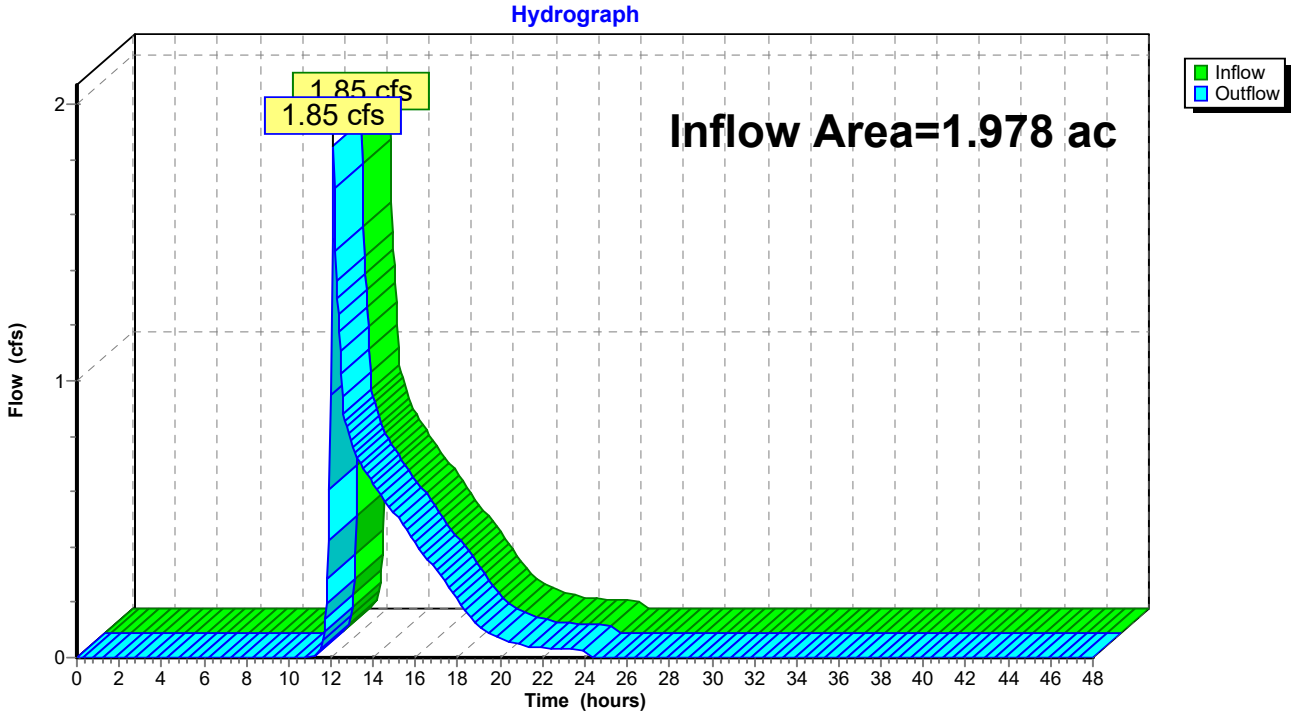
Summary for Reach DPP-#1: Wetlands

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

Inflow Area = 1.978 ac, 48.18% Impervious, Inflow Depth = 2.01" for 25 yr event
Inflow = 1.85 cfs @ 12.11 hrs, Volume= 0.331 af
Outflow = 1.85 cfs @ 12.11 hrs, Volume= 0.331 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DPP-#1: Wetlands



Summary for Pond 1P: Underground Infiltration System

Inflow Area = 1.048 ac, 89.64% Impervious, Inflow Depth = 4.93" for 25 yr event
Inflow = 5.33 cfs @ 12.09 hrs, Volume= 0.430 af
Outflow = 0.68 cfs @ 12.65 hrs, Volume= 0.430 af, Atten= 87%, Lag= 33.6 min
Discarded = 0.10 cfs @ 8.00 hrs, Volume= 0.217 af
Primary = 0.58 cfs @ 12.65 hrs, Volume= 0.213 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 92.56' @ 12.65 hrs Surf.Area= 4,364 sf Storage= 8,657 cf

Plug-Flow detention time= 214.9 min calculated for 0.430 af (100% of inflow)
Center-of-Mass det. time= 214.8 min (975.6 - 760.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	89.50'	3,904 cf	**49.00'W x 89.06'L x 3.50'H Field A** 15,273 cf Overall - 5,513 cf Embedded = 9,760 cf x 40.0% Voids
#2A	90.00'	5,513 cf	**ADS_StormTech SC-740 +Cap** x 120 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 10 Rows of 12 Chambers
		9,417 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	89.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	92.60'	**5.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	90.50'	**4.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.10 cfs @ 8.00 hrs HW=89.54' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.10 cfs)

Primary OutFlow Max=0.58 cfs @ 12.65 hrs HW=92.56' (Free Discharge)
├**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
└**3=Orifice/Grate** (Orifice Controls 0.58 cfs @ 6.63 fps)

Pond 1P: Underground Infiltration System - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

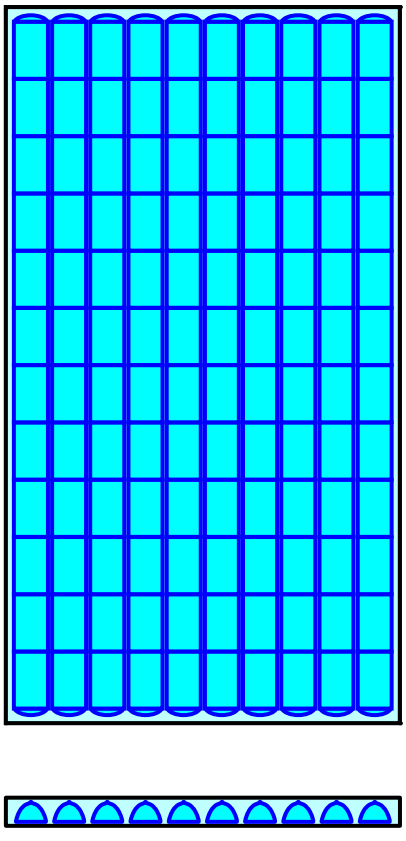
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +12.0" End Stone x 2 = 89.06' Base Length
10 Rows x 51.0" Wide + 6.0" Spacing x 9 + 12.0" Side Stone x 2 = 49.00' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

120 Chambers x 45.9 cf = 5,512.8 cf Chamber Storage

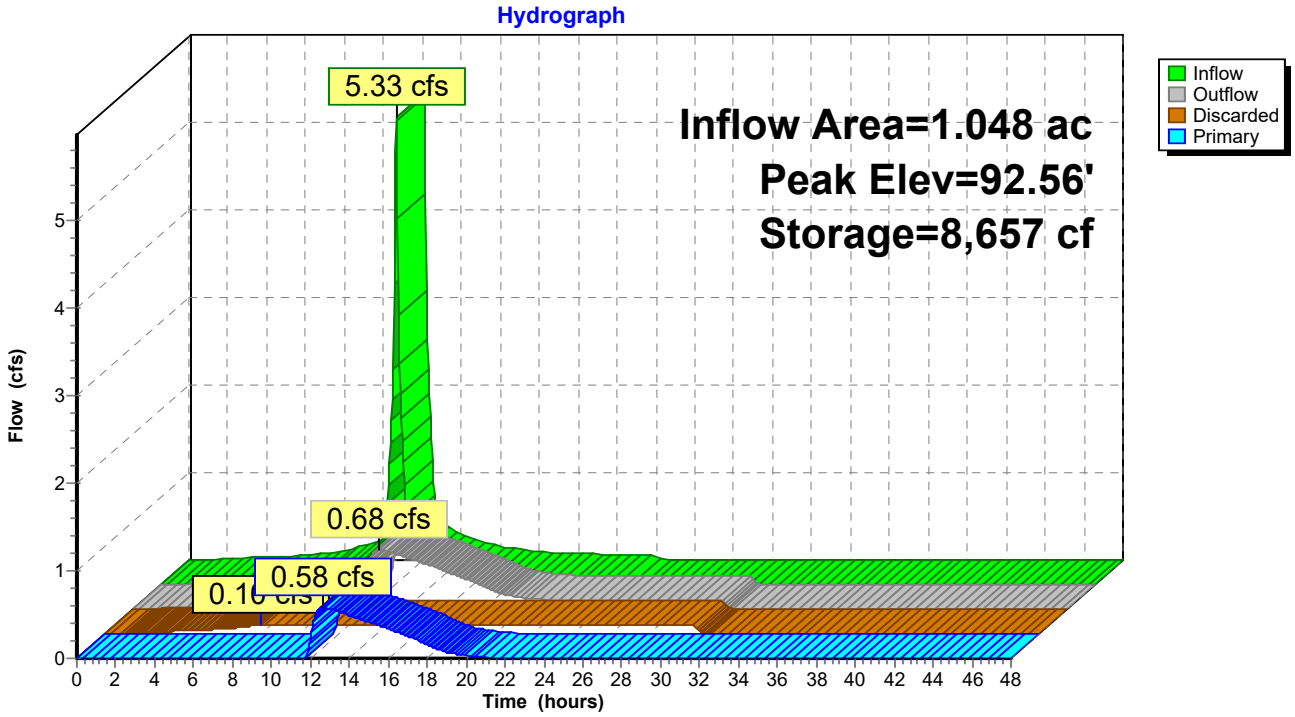
15,273.2 cf Field - 5,512.8 cf Chambers = 9,760.4 cf Stone x 40.0% Voids = 3,904.2 cf Stone Storage

Chamber Storage + Stone Storage = 9,417.0 cf = 0.216 af
Overall Storage Efficiency = 61.7%
Overall System Size = 89.06' x 49.00' x 3.50'

120 Chambers
565.7 cy Field
361.5 cy Stone



Pond 1P: Underground Infiltration System



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-#1: Subcatchment 1 Runoff Area=26,041 sf 100.00% Impervious Runoff Depth=6.76"
Tc=6.0 min CN=98 Runoff=4.01 cfs 0.337 af

Subcatchment PR-#2: Subcatchment 2 Runoff Area=5,918 sf 71.26% Impervious Runoff Depth=5.48"
Tc=6.0 min CN=87 Runoff=0.82 cfs 0.062 af

Subcatchment PR-#3: Subcatchment 3 Runoff Area=9,353 sf 67.63% Impervious Runoff Depth=5.37"
Tc=6.0 min CN=86 Runoff=1.28 cfs 0.096 af

Subcatchment PR-#4: Subcatchment 4 Runoff Area=40,505 sf 1.46% Impervious Runoff Depth=2.41"
Tc=6.0 min CN=58 Runoff=2.48 cfs 0.187 af

Subcatchment PR-#5: Subcatchment 3 Runoff Area=4,328 sf 100.00% Impervious Runoff Depth=6.76"
Tc=6.0 min CN=98 Runoff=0.67 cfs 0.056 af

Reach DPP-#1: Wetlands Inflow=4.73 cfs 0.506 af
Outflow=4.73 cfs 0.506 af

Pond 1P: Underground Infiltration System Peak Elev=92.93' Storage=9,290 cf Inflow=6.77 cfs 0.551 af
Discarded=0.10 cfs 0.231 af Primary=3.32 cfs 0.319 af Outflow=3.43 cfs 0.551 af

Total Runoff Area = 1.978 ac Runoff Volume = 0.738 af Average Runoff Depth = 4.48"
51.82% Pervious = 1.025 ac 48.18% Impervious = 0.953 ac

Summary for Subcatchment PR-#1: Subcatchment 1

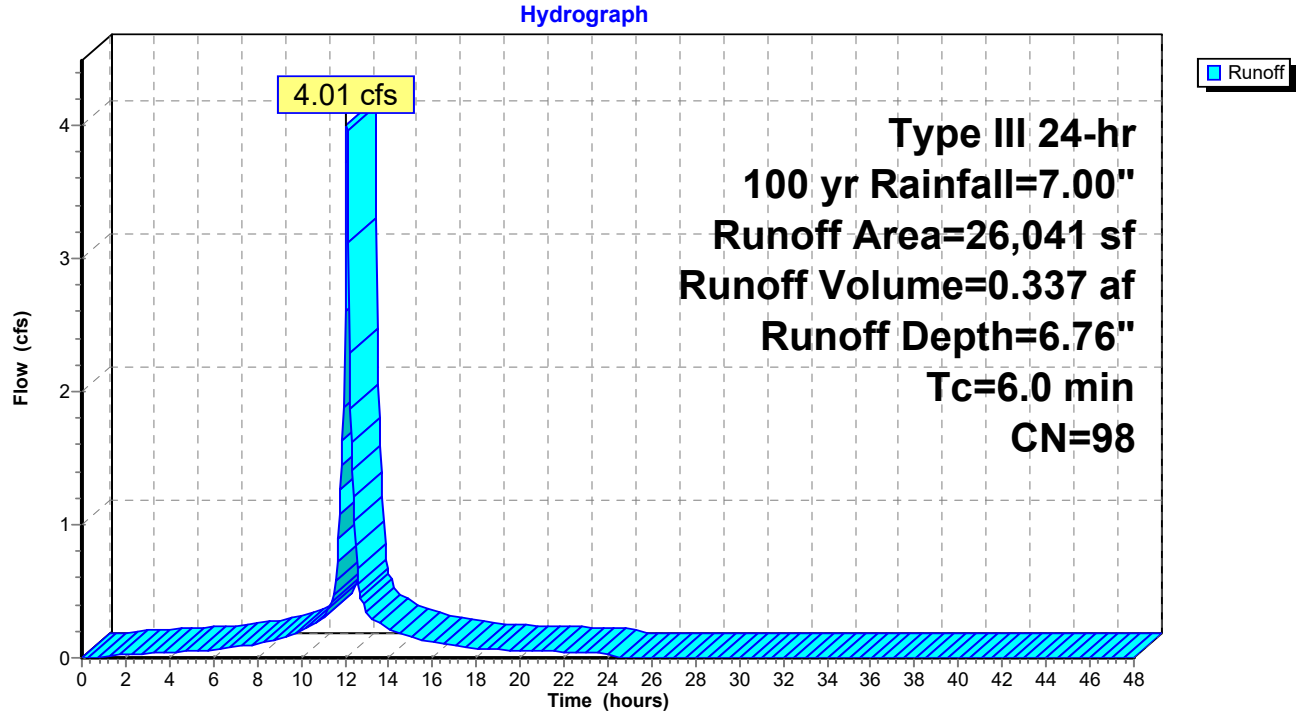
Runoff = 4.01 cfs @ 12.09 hrs, Volume= 0.337 af, Depth= 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (sf)	CN	Description
26,041	98	Roofs, HSG A
26,041		100.00% Impervious Area

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

Subcatchment PR-#1: Subcatchment 1



Summary for Subcatchment PR-#2: Subcatchment 2

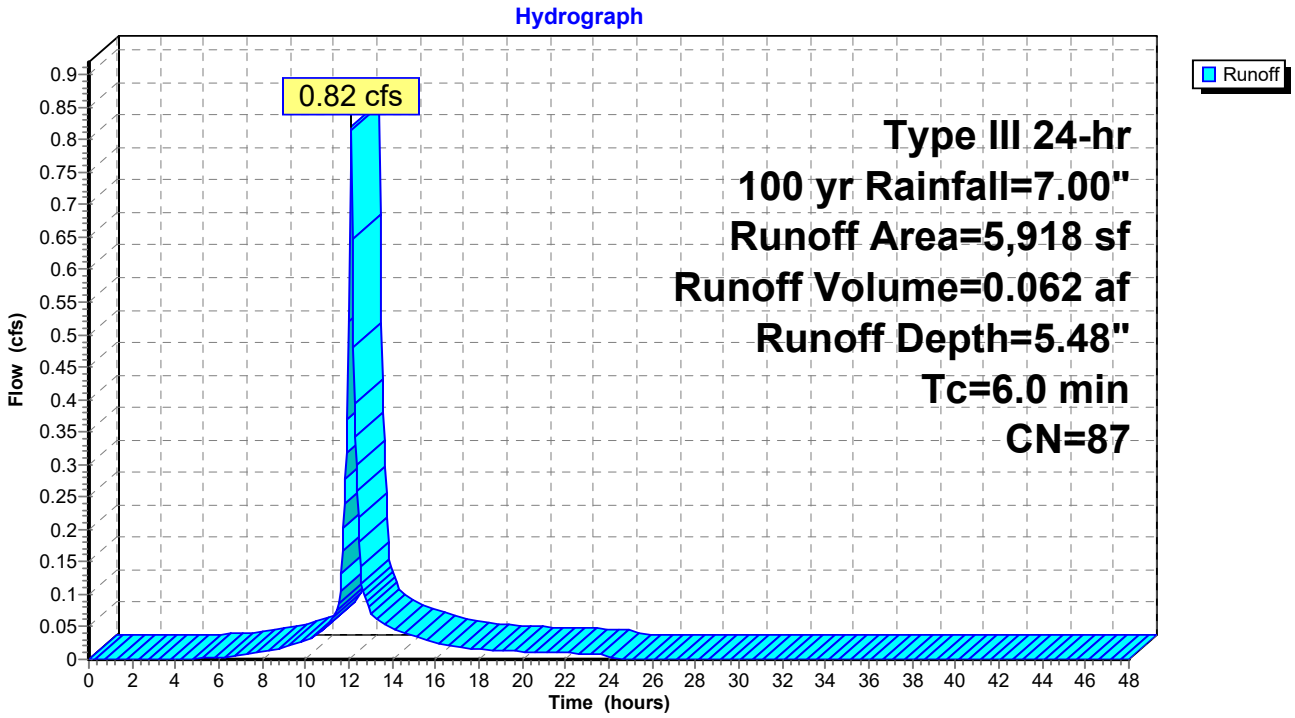
Runoff = 0.82 cfs @ 12.09 hrs, Volume= 0.062 af, Depth= 5.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (sf)	CN	Description
4,217	98	Paved parking, HSG A
1,701	61	>75% Grass cover, Good, HSG B
5,918	87	Weighted Average
1,701		28.74% Pervious Area
4,217		71.26% Impervious Area

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

Subcatchment PR-#2: Subcatchment 2



Summary for Subcatchment PR-#3: Subcatchment 3

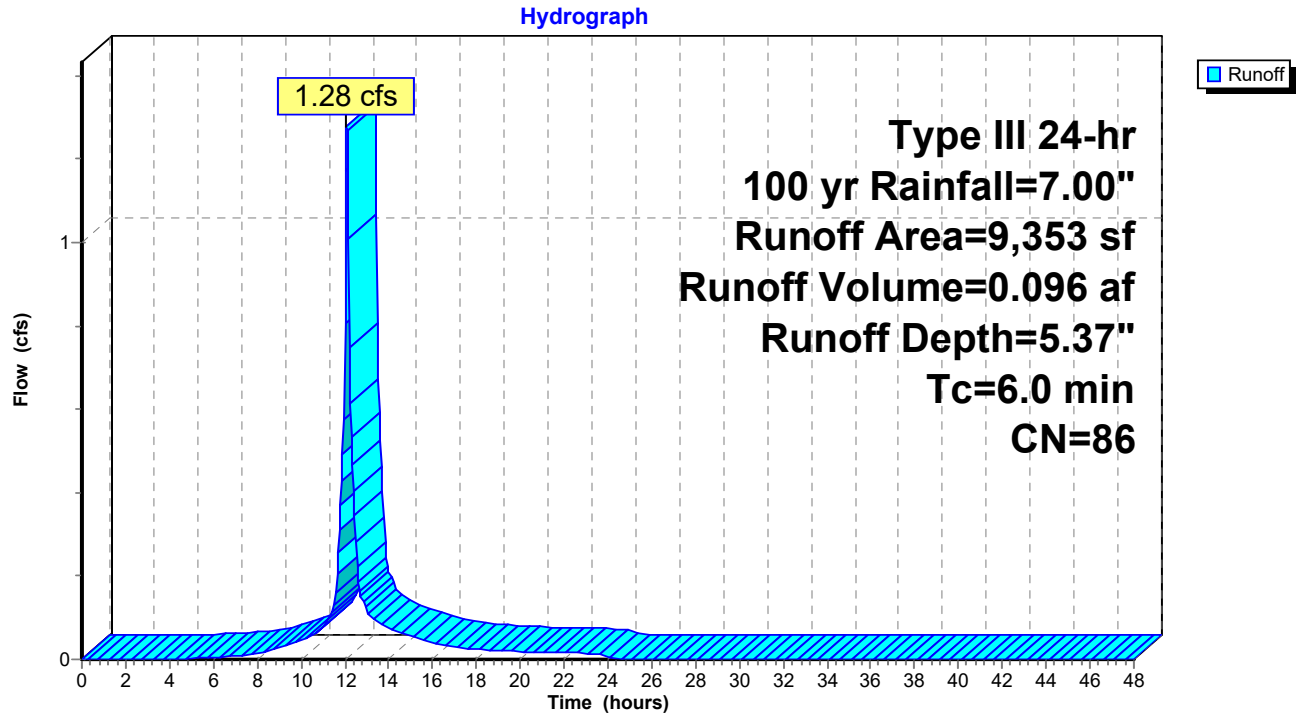
Runoff = 1.28 cfs @ 12.09 hrs, Volume= 0.096 af, Depth= 5.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (sf)	CN	Description
3,028	61	>75% Grass cover, Good, HSG B
6,325	98	Paved parking, HSG B
9,353	86	Weighted Average
3,028		32.37% Pervious Area
6,325		67.63% Impervious Area

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

Subcatchment PR-#3: Subcatchment 3



Summary for Subcatchment PR-#4: Subcatchment 4

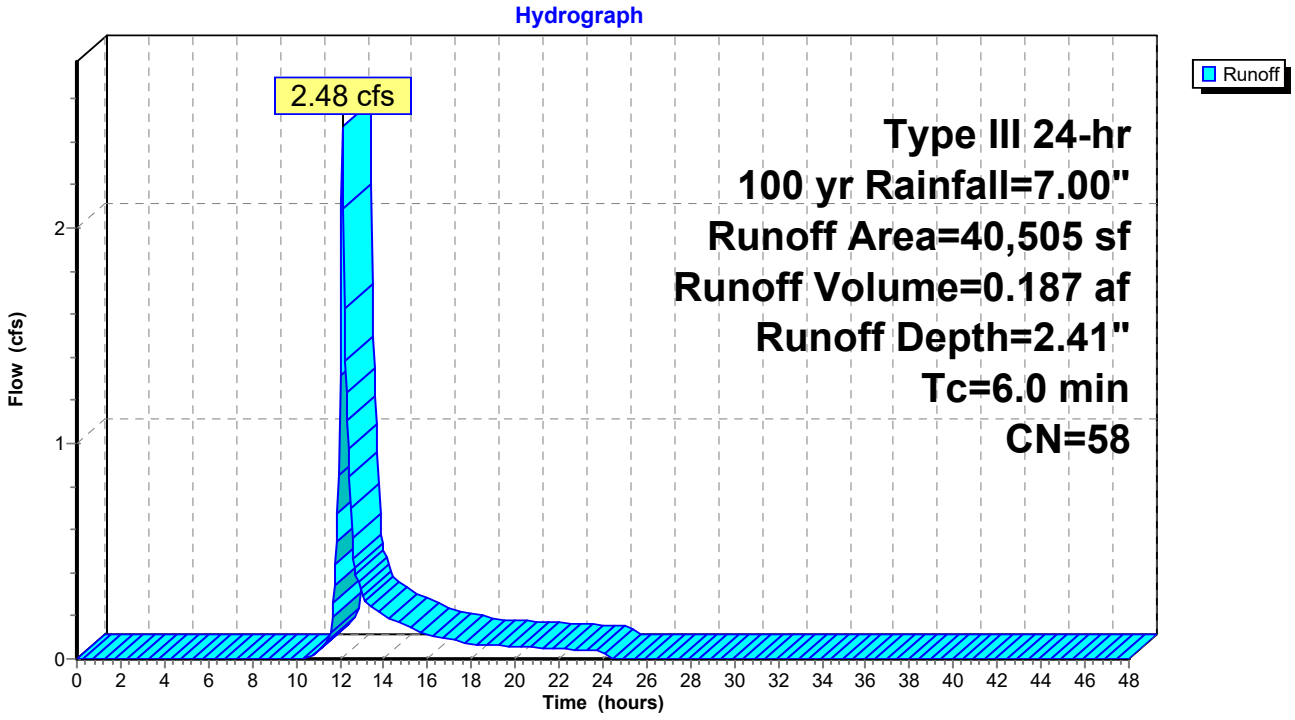
Runoff = 2.48 cfs @ 12.10 hrs, Volume= 0.187 af, Depth= 2.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (sf)	CN	Description
15,432	61	>75% Grass cover, Good, HSG B
590	98	Paved parking, HSG B
24,483	55	Woods, Good, HSG B
40,505	58	Weighted Average
39,915		98.54% Pervious Area
590		1.46% Impervious Area

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

Subcatchment PR-#4: Subcatchment 4



Summary for Subcatchment PR-#5: Subcatchment 3

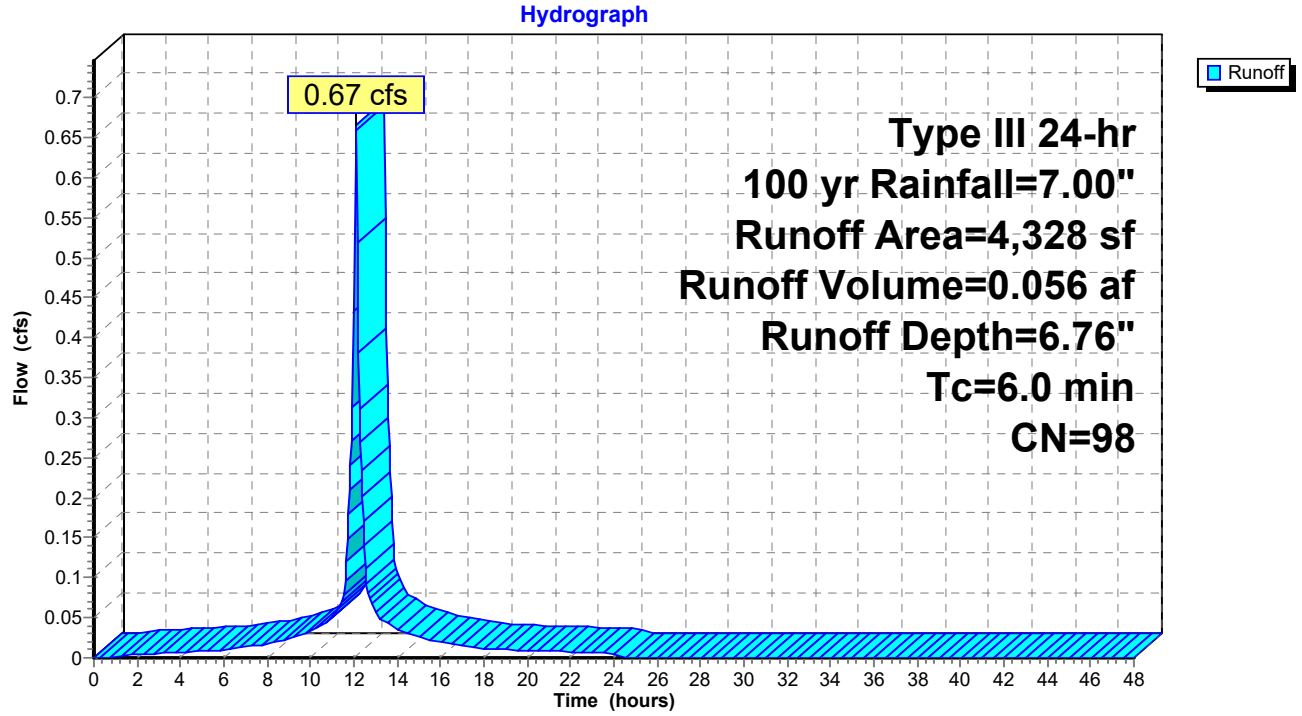
Runoff = 0.67 cfs @ 12.09 hrs, Volume= 0.056 af, Depth= 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (sf)	CN	Description
4,328	98	Paved parking, HSG B
4,328		100.00% Impervious Area

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

Subcatchment PR-#5: Subcatchment 3



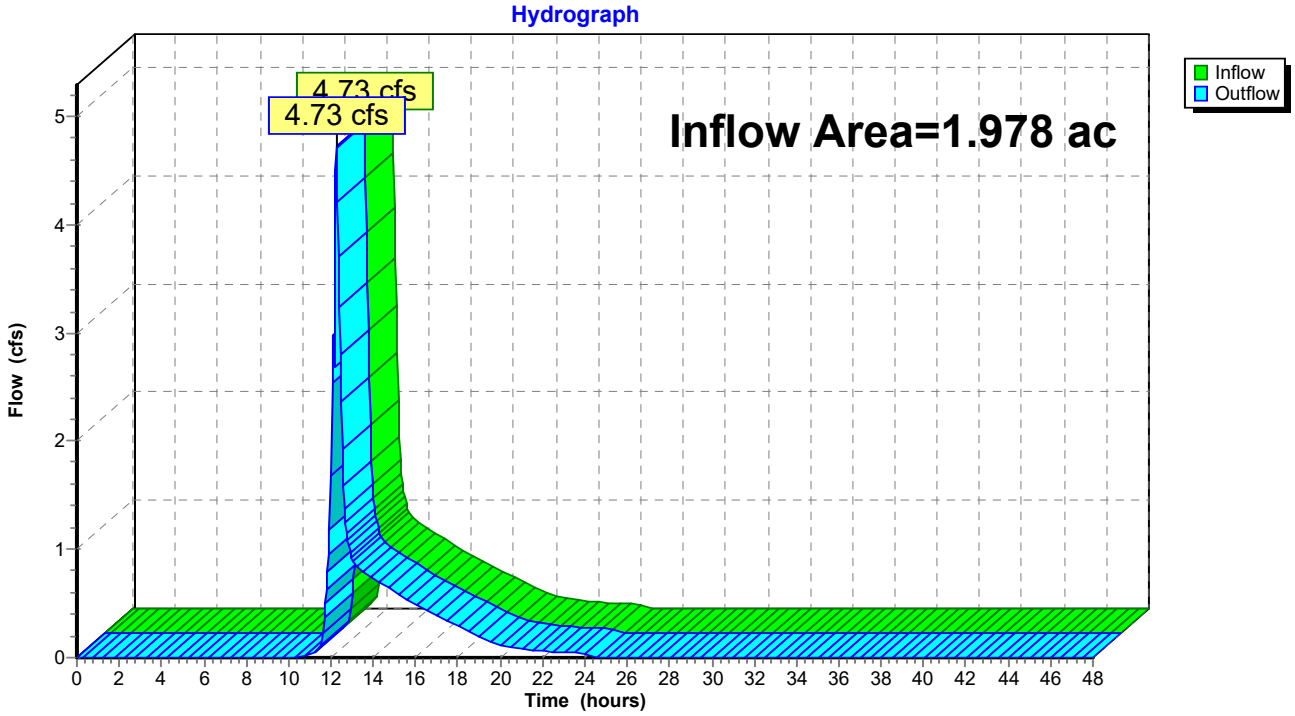
Summary for Reach DPP-#1: Wetlands

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

Inflow Area = 1.978 ac, 48.18% Impervious, Inflow Depth = 3.07" for 100 yr event
Inflow = 4.73 cfs @ 12.24 hrs, Volume= 0.506 af
Outflow = 4.73 cfs @ 12.24 hrs, Volume= 0.506 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DPP-#1: Wetlands



Summary for Pond 1P: Underground Infiltration System

Inflow Area = 1.048 ac, 89.64% Impervious, Inflow Depth = 6.31" for 100 yr event
Inflow = 6.77 cfs @ 12.09 hrs, Volume= 0.551 af
Outflow = 3.43 cfs @ 12.25 hrs, Volume= 0.551 af, Atten= 49%, Lag= 9.9 min
Discarded = 0.10 cfs @ 7.00 hrs, Volume= 0.231 af
Primary = 3.32 cfs @ 12.25 hrs, Volume= 0.319 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 92.93' @ 12.25 hrs Surf.Area= 4,364 sf Storage= 9,290 cf

Plug-Flow detention time= 189.7 min calculated for 0.550 af (100% of inflow)
Center-of-Mass det. time= 190.0 min (946.8 - 756.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	89.50'	3,904 cf	**49.00'W x 89.06'L x 3.50'H Field A** 15,273 cf Overall - 5,513 cf Embedded = 9,760 cf x 40.0% Voids
#2A	90.00'	5,513 cf	**ADS_StormTech SC-740 +Cap** x 120 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 10 Rows of 12 Chambers
		9,417 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	89.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	92.60'	**5.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	90.50'	**4.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.10 cfs @ 7.00 hrs HW=89.54' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.10 cfs)

Primary OutFlow Max=3.30 cfs @ 12.25 hrs HW=92.93' (Free Discharge)
├**2=Broad-Crested Rectangular Weir** (Weir Controls 2.67 cfs @ 1.64 fps)
└**3=Orifice/Grate** (Orifice Controls 0.63 cfs @ 7.24 fps)

Pond 1P: Underground Infiltration System - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

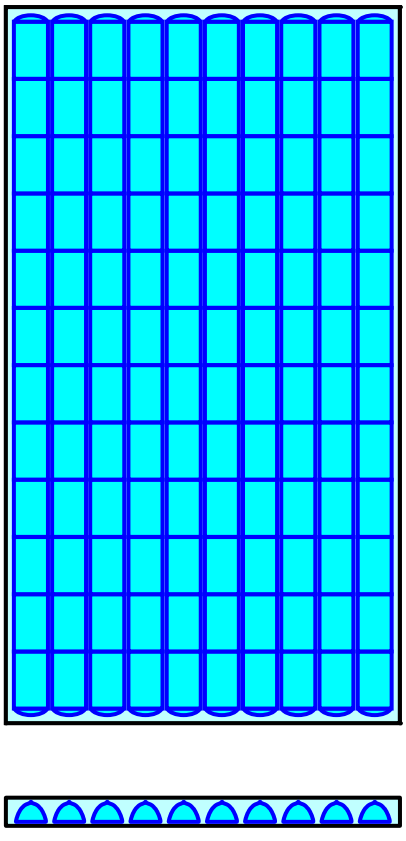
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +12.0" End Stone x 2 = 89.06' Base Length
10 Rows x 51.0" Wide + 6.0" Spacing x 9 + 12.0" Side Stone x 2 = 49.00' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

120 Chambers x 45.9 cf = 5,512.8 cf Chamber Storage

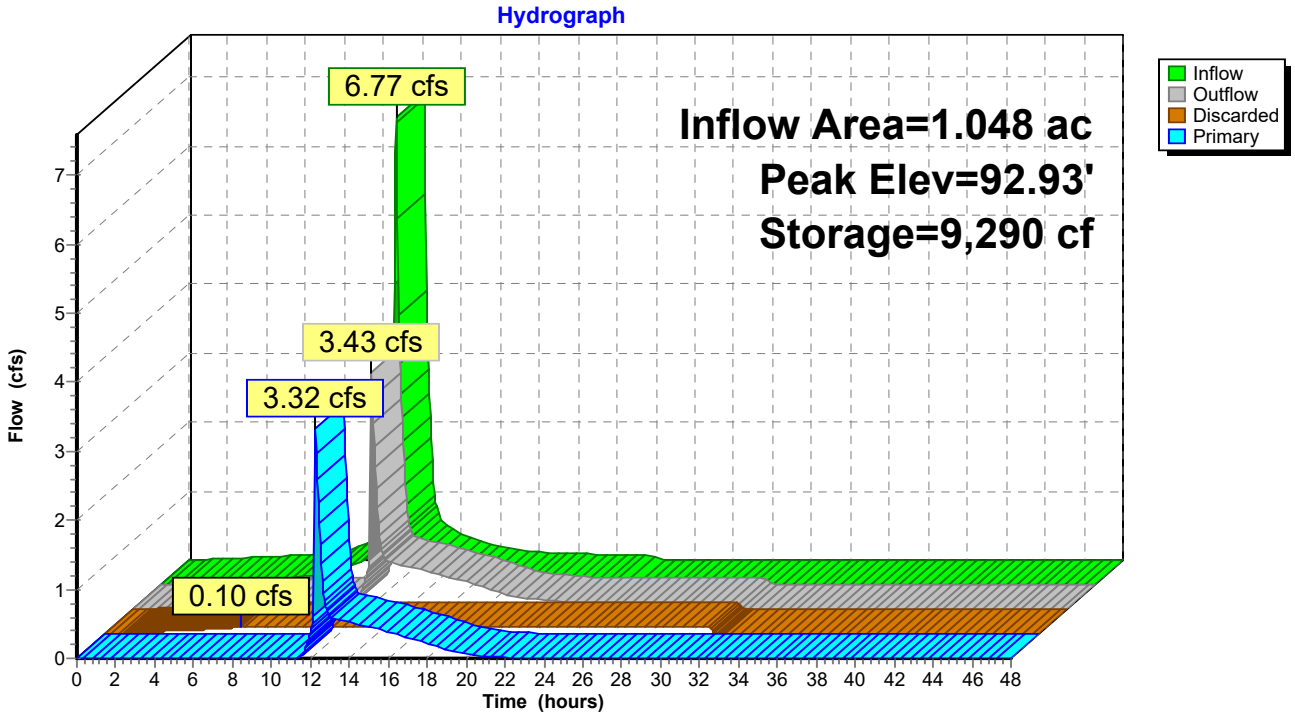
15,273.2 cf Field - 5,512.8 cf Chambers = 9,760.4 cf Stone x 40.0% Voids = 3,904.2 cf Stone Storage

Chamber Storage + Stone Storage = 9,417.0 cf = 0.216 af
Overall Storage Efficiency = 61.7%
Overall System Size = 89.06' x 49.00' x 3.50'

120 Chambers
565.7 cy Field
361.5 cy Stone



Pond 1P: Underground Infiltration System



APPENDIX F: STORMWATER CALCULATIONS

- *MA STANDARD #3 – RECHARGE AND DRAWDOWN TIME*
- *MA STANDARD #4 – WATER QUALITY AND TSS REMOVAL*
- *TP40 RAINFALL DATA*
- *PIPE SIZING*
- *RIP RAP SIZING*
- *MOUNDING ANALYSIS*

Self-Storage Development
108 Old Church Street
Pembroke, MA
Bohler Job Number: MAA220228
January 24, 2023

MA DEP Standard 3: Recharge Volume Calculations

Required Recharge Volume - A Soils (0.60 in.)	
Existing Site Impervious Area (ac)	0.000
Proposed Site Impervious Area (ac)	0.000
Proposed Increase in Site Impervious Area (ac)	0.000
Recharge Volume Required (cf)	**0**

Required Recharge Volume - B Soils (0.35 in.)	
Existing Site Impervious Area (ac)	0.000
Proposed Site Impervious Area (ac)	0.953
Proposed Increase in Site Impervious Area (ac)	0.953
Recharge Volume Required (cf)	**1,211**

Required Recharge Volume - C Soils (0.25 in.)	
Existing Site Impervious Area (ac)	0.000
Proposed Site Impervious Area (ac)	0.000
Proposed Increase in Site Impervious Area (ac)	0.000
Recharge Volume Required (cf)	**0**

Required Recharge Volume - D Soils (0.10 in.)	
Existing Site Impervious Area (ac)	0.000
Proposed Site Impervious Area (ac)	0.000
Proposed Increase in Site Impervious Area (ac)	0.000
Recharge Volume Required (cf)	**0**

Total Recharge Volume Required (cf)	**1,211**

Recharge Volume Adjustment Factor	
Impervious Area Directed to Infiltration BMP (ac)	**0.000**
%Impervious Directed to Infiltration BMP	
Adjustment Factor	
Adjusted Total Recharge Volume Required (cf)	

Provided Recharge Volume*	
Underground Infiltration System	2,679
Total Recharge Volume Provided (cf)	**2,679**

Input Required

*Volume provided below lowest outlet in cubic feet (cf)

Prepared By:
BOHLER
352 Turnpike Road
Southborough, MA 01772
(508) 480-9900

Self-Storage Development
108 Old Church Street
Pembroke, MA
Bohler Job Number: MAA220228
January 24, 2023

MA DEP Standard 3: Drawdown Time Calculations

Drawdown Time - Underground Infiltration System	
Volume below outlet pipe (Rv) (cf)	2,679
Soil Type	Sandy Loam - B
Infiltration rate (K)*	1.02
Bottom Area (sf)	4,411
Drawdown time (Hours)*	**7.1**

*Infiltration Rates taken from Rawls Table
**Drawdown time = Rv / (K) x (bottom area)

Prepared By:
BOHLER
352 Turnpike Road
Southborough, MA 01772
(508) 480-9900

Stage-Area-Storage for Pond 1P: Underground Infiltration System

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
89.50	**4,364**	0
89.55	4,364	87
89.60	4,364	175
89.65	4,364	262
89.70	4,364	349
89.75	4,364	436
89.80	4,364	524
89.85	4,364	611
89.90	4,364	698
89.95	4,364	785
90.00	4,364	873
90.05	4,364	1,055
90.10	4,364	1,238
90.15	4,364	1,420
90.20	4,364	1,602
90.25	4,364	1,783
90.30	4,364	1,964
90.35	4,364	2,144
90.40	4,364	2,323
90.45	4,364	2,501
90.50	4,364	2,679
90.55	4,364	2,857
90.60	4,364	3,033
90.65	4,364	3,208
90.70	4,364	3,383
90.75	4,364	3,557
90.80	4,364	3,729
90.85	4,364	3,901
90.90	4,364	4,072
90.95	4,364	4,242
91.00	4,364	4,411
91.05	4,364	4,579
91.10	4,364	4,745
91.15	4,364	4,910
91.20	4,364	5,074
91.25	4,364	5,237
91.30	4,364	5,398
91.35	4,364	5,558
91.40	4,364	5,716
91.45	4,364	5,872
91.50	4,364	6,028
91.55	4,364	6,181
91.60	4,364	6,333
91.65	4,364	6,483
91.70	4,364	6,630
91.75	4,364	6,775
91.80	4,364	6,918
91.85	4,364	7,058
91.90	4,364	7,197
91.95	4,364	7,332
92.00	4,364	7,465
92.05	4,364	7,594
92.10	4,364	7,720
92.15	4,364	7,841
92.20	4,364	7,958
92.25	4,364	8,068
92.30	4,364	8,171
92.35	4,364	8,269
92.40	4,364	8,364
92.45	4,364	8,455
92.50	4,364	8,544
92.55	4,364	8,631
92.60	4,364	8,719
92.65	4,364	8,806
92.70	4,364	8,893
92.75	4,364	8,981
92.80	4,364	9,068
92.85	4,364	9,155
92.90	4,364	9,242
92.95	4,364	9,330
93.00	4,364	**9,417**

@ Underground Infiltration Basin lowest outlet elevation 4" orifice = 90.50
2,679 CF of storage/water quality volume provided

Self-Storage Development
108 Old Church Street
Pembroke, MA
Bohler Job Number: MAA220228
January 24, 2023

MA DEP Standard 4: Water Quality Volume Calculations

Water Quality Volume Required	
Water Quality Volume runoff (in.)*	0.5
Total Post Development Impervious Area (sf)	41,513
Required Water Quality Volume (cf)	**1,730**
*Water Quality volume runoff is equal to 0.5 or 1.0 inches of runoff times the total impervious area of the post development project site.	

Water Quality Volume Provided*	
Underground Infiltration System	2,679
Total Provided Water Quality Volume (cf)	**2,679**

Required Recharge Provided

*Volume provided below lowest outlet pipe in cubic feet (cf)

Prepared By:
BOHLER
352 Turnpike Road
Southborough, MA 01772
(508) 480-9900

Self-Storage Development
108 Old Church Street
Pembroke, MA
Bohler Job Number: MAA220228
January 24, 2023

MA DEP Standard 4: TSS Removal Calculation Worksheet

BMP Treatment Train: to Underground Infiltration System

A BMP	B TSS Removal Rate	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Isolator Row	**0.80**	**0.75**	**0.60**	**0.15**
		Total TSS Removal =	**85%**	

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

Prepared By:
BOHLER
352 Turnpike Road
Southborough, MA 01772
(508) 480-9900

F-1. Rainfall Data for Massachusetts from *Rainfall Frequency Atlas of the United States* (TP-40)

■ Users of this Handbook should note that current MA DEP written guidance (see DEP Waterlines newsletter -- Fall 2000) requires the use of TP-40 Rainfall Data for calculations under the Wetlands Protection Regulations and the Stormwater Management Policy. More stringent design storms may be used under a local bylaw or ordinance. However, DEP will continue to require the use of TP-40 in any case it reviews under the Wetlands Protection Act and Stormwater Management Policy.

Adjusted Technical Paper 40 Design Storms for 24-hour Event by County

County Name	1-yr 24-hr	2-yr 24-hr	5-yr 24-hr	10-yr 24-hr	25-yr 24-hr	50-yr 24-hr	100-yr 24-hr
Barnstable	2.5	3.6	4.5	4.8	5.7	6.4	7.1
Berkshire	2.5	2.9	3.8	4.4	5.1	5.9	6.4
Bristol	2.5	3.4	4.3	4.8	5.6	6.3	7.0
Dukes	2.5	3.6	4.6	4.9	5.8	6.5	7.2
Essex	2.5	3.1	3.9	4.5	5.4	5.9	6.5
Franklin	2.5	2.9	3.8	4.3	5.1	5.8	6.2
Hampden	2.5	3.0	4.0	4.6	5.3	6.0	6.5
Hampshire	2.5	3.0	3.9	4.5	5.2	5.9	6.4
Middlesex	2.5	3.1	4.0	4.5	5.3	5.9	6.5
Nantucket	2.5	3.6	4.6	4.9	5.8	6.5	7.2
Norfolk	2.5	3.2	4.1	4.7	5.5	6.1	6.7
Plymouth	2.5	3.4	4.3	4.7	5.6	6.2	7.0
Suffolk	2.5	3.2	4.0	4.6	5.5	6.0	6.6
Worcester	2.5	3.0	4.0	4.5	5.3	5.9	6.5

Self-Storage Development
108 Old Church Street
Pembroke, MA
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January 24, 2023

Rational Pipe Sizing Calculations

Design Period Storm:		25	Year	Design Period Intensity*			5.6	in/hr									
LOCATION		IMPERVIOUS			OTHER			SUM CA	Tc (min)	I (in/hr)	Q (cfs)	D (in)	S (ft/ft)	Material	n	Q Full (cfs)	V Full (fps)
FROM	TO	A	C	CA	A	C	CA										
ROOF	CB-4	0.60	0.95	0.57	0.00	0.30	0.00	0.57	6	5.6	3.19	15	0.005	HDPE	0.012	4.95	4.03
CB-4	DMH-2	0.67	0.95	0.64	0.04	0.30	0.01	0.65	6	5.6	3.63	15	0.005	HDPE	0.012	4.95	4.03
CB-3	DMH-2	0.02	0.95	0.02	0.00	0.30	0.00	0.02	6	5.6	0.11	12	0.040	HDPE	0.012	7.72	9.83
DMH-2	DMH-1	0.69	0.95	0.66	0.04	0.30	0.01	0.67	6	5.6	3.74	15	0.005	HDPE	0.012	4.95	4.03
CB-2	DMH-1	0.15	0.95	0.14	0.07	0.30	0.02	0.16	6	5.6	0.92	12	0.040	HDPE	0.012	7.72	9.83
CB-1	DMH-1	0.10	0.95	0.10	0.00	0.30	0.00	0.10	6	5.6	0.53	12	0.005	HDPE	0.012	2.73	3.47
DMH-1	ICS-1	0.94	0.95	0.89	0.11	0.30	0.03	0.93	6	5.6	5.19	15	0.010	HDPE	0.012	7.00	5.70
OCS-1	FES-1	–	–	–	–	–	–	–	–	–	0.58	12	0.011	HDPE	0.012	4.05	5.15

*Rainfall intensity provided by TR55 Exhibit X-XX or Cornell University's NRCC Atlas of Precipitation Extremes for the North Eastern United States and Canada or NOAA Atlas 14, Volume 10, Version 2 on DATE

Prepared By:
BOHLER
352 Turnpike Road
Southborough, MA 01772
(508) 480-9900

Self-Storage Development
108 Old Church Street
Pembroke, MA
Bohler Job Number: MAA220228
January 24, 2023

Rip Rap Sizing Calculations

Design Period Storm: 25 **Year**

Rip Rap Apron Sizing Calculations

Location	Pipe Size (in.)	Pipe Size (ft.)	Q (cfs)	TW (ft.)	V (fps)	W1 (ft.)	La (ft.)	W2 (ft.)	W3 (ft.)	Apron Type	Rip Rap Type
FES-1	12	1.0	0.58	0.20	5.15	3.00	10	10	NA	A	Modified

Based ConnDOT Drainage Manual - Type A, B, and C Riprap Aprons

Prepared By: Bohler
BOHLER
352 Turnpike Road
Southborough, MA 01772
(508) 480-9900

MOUNDING ANALYSIS

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
2.0400	*R*	**Recharge (infiltration) rate (feet/day)**
0.350	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
20.40	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
37.400	x	**1/2 length of basin (x direction, in feet)**
34.000	y	**1/2 width of basin (y direction, in feet)**
1.000	t	**duration of infiltration period (days)**
50.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

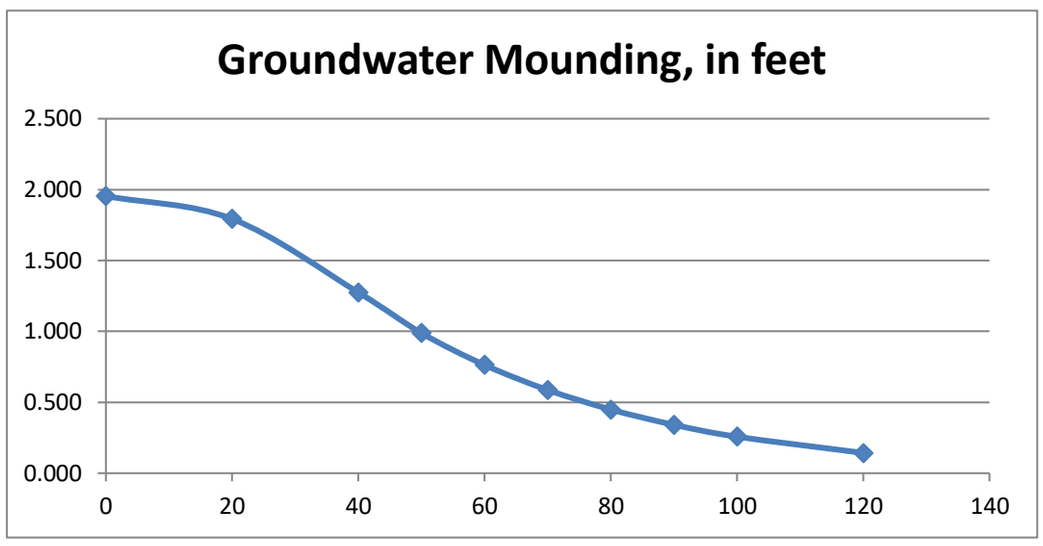
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

51.954	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
1.954	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
1.954	0
1.793	20
1.274	40
0.988	50
0.763	60
0.587	70
0.449	80
0.341	90
0.257	100
0.143	120

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

APPENDIX G: OPERATION AND MAINTENANCE

- *STORMWATER OPERATION AND MAINTENANCE PLAN*
- *ISOLATOR ROW OPERATION AND MAINTENANCE MANUAL*

STORMWATER OPERATION AND MAINTENANCE PLAN

SDG Development, LLC
108 Old Church Street
Pembroke, MA

RESPONSIBLE PARTY DURING CONSTRUCTION:

SDG Development, LLC
108 Old Church Street
Pembroke, MA

RESPONSIBLE PARTY POST CONSTRUCTION:

SDG Development, LLC
108 Old Church Street
Pembroke, MA

Construction Phase

During the construction phase, all erosion control devices and measures shall be maintained in accordance with the final record plans, local/state approvals and conditions, the EPA Construction General Permit and the Stormwater Pollution Prevention Plan (SWPPP) if applicable. Additionally, the maintenance of all erosion / siltation control measures during construction shall be the responsibility of the general contractor. Contact information of the OWNER and CONTRACTOR shall be listed in the SWPPP for this site. The SWPPP also includes information regarding construction period allowable and illicit discharges, housekeeping and emergency response procedures. Upon proper notice to the property owner, the Town/City or its authorized designee shall be allowed to enter the property at a reasonable time and in a reasonable manner for the purposes of inspection.

Post Development Controls

Once construction is completed, the post development stormwater controls are to be operated and maintained in compliance with the following permanent procedures (note that the continued implementation of these procedures shall be the responsibility of the Owner or its assignee):

1. Parking lots: Sweep at least four (4) times per year and on a more frequent basis depending on sanding. All resulting sweepings shall be collected and properly disposed of offsite in accordance with MADEP and other applicable requirements.

   Approximate Maintenance Budget: $1,000/year

2. Catch basins, yard drains, trench drains, manholes and piping: Inspect four (4) times per year and at the end of foliage and snow-removal seasons. These features shall be cleaned four (4) times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the catch basin or underground system. Accumulated sediment and hydrocarbons present must be removed and properly disposed of off-site in accordance with MADEP and other applicable requirements.

Approximate Maintenance Budget: $500/year per structure.

3. Riprap apron / Scour Hole: Riprap and scour holes should be checked at least annually and after every major storm event (generally equal or greater to 3.0 inches in 24 hours) for displaced stones, slumping, and erosion at edges, especially downstream or downslope. If the riprap is damaged, it should be repaired before further damage can take place. Note and repair any erosion, stone displacement or low spots in the areas. Woody vegetation should be removed from the riprap annually.

   Approximate Maintenance Budget: $250/year per location.

4. Underground Infiltration Basins: Preventative maintenance after every major storm event during the first three (3) months of operation and at least twice per year thereafter. Inspect structure and pretreatment BMP to ensure proper operation after every major storm event (generally equal or greater to 3.0 inches in 24 hours) for the first three months. The outlet of the basin, if any, shall be inspected for erosion and sedimentation, and rip-rap shall be promptly repaired in the case of erosion. Sediment collecting in the bottom of the basin shall be inspected twice annually, and removal shall commence any time the sediment reaches a depth of six inches anywhere in the basin. Any sediment removed shall be disposed of in accordance with MADEP and other applicable requirements.

   Approximate Maintenance Budget: Cleaning - $1,000/year, Inspection - $200/year

STORMWATER MANAGEMENT SYSTEM

POST-CONSTRUCTION INSPECTION REPORT

LOCATION:

SDG Development, LLC
108 Old Church Street
Pembroke, MA

RESPONSIBLE PARTY:

SDG Development, LLC
108 Old Church Street
Pembroke, MA

NAME OF INSPECTOR:	INSPECTION DATE:
Note Condition of the Following (sediment depth, debris, standing water, damage, etc.):	
Catch Basins:	
Flared End Sections / Rip Rap:	
Underground Infiltration System:	
Other:	
Other:	

Note Recommended Actions to be taken on the Following (sediment and/or debris removal, repairs, etc.):
Catch Basins:
Flared End Sections / Rip Rap:
Underground Infiltration System:
Other:
Other:
Comments:

STORMWATER INSPECTION AND MAINTENANCE LOG FORM

SDG Development, LLC
108 Old Church Street - Pembroke, MA

Stormwater Management Practice	Responsible Party	Date	Maintenance Activity Performed

LONG-TERM POLLUTION PREVENTION PLAN

SDG Development, LLC
108 Old Church Street
Pembroke, MA

RESPONSIBLE PARTY DURING CONSTRUCTION:

SDG Development, LLC
108 Old Church Street
Pembroke, MA

RESPONSIBLE PARTY POST CONSTRUCTION:

SDG Development, LLC
108 Old Church Street
Pembroke, MA

For this site, the Long-Term Pollution Prevention Plan will consist of the following:

- The property owner shall be responsible for "good housekeeping" including proper periodic maintenance of building and pavement areas, curbing, landscaping, etc.
- Proper storage and removal of solid waste (dumpsters).
- Sweeping of parking lots, drive aisles and access aisles a minimum of twice per year with a commercial cleaning unit. Any sediment removed shall be disposed of in accordance with applicable local and state requirements.
- Sweeping of roadways a minimum of twice per year with a commercial cleaning unit. Any sediment removed shall be disposed of in accordance with applicable local and state requirements.
- Regular inspections and maintenance of Stormwater Management System as noted in the "O&M Plan".
- Snow removal shall be the responsibility of the property owner. Snow shall not be plowed, dumped and/or placed in forebays, infiltration basins or similar stormwater controls. Salting and/or sanding of pavement / walkway areas during winter conditions shall only be done in accordance with all state/local requirements and approvals.

OPERATON AND MAINTENANCE TRAINING PROGRAM

The Owner will coordinate an annual in-house training session to discuss the Operations and Maintenance Plan, the Long-Term Pollution Prevention Plan, and the Spill Prevention Plan and response procedures. Annual training will include the following:

Discuss the Operations and Maintenance Plan

- Explain the general operations of the stormwater management system and its BMPs
- Identify potential sources of stormwater pollution and measures / methods of reducing or eliminating that pollution
- Emphasize good housekeeping measures

Discuss the Spill Prevention and Response Procedures

- Explain the process in the event of a spill
- Identify potential sources of spills and procedures for cleanup and /or reporting and notification
- Complete a yearly inventory or Materials Safety Data sheets of all tenants and confirm that no potentially harmful chemicals are in use.

ILLICIT DISCHARGE STATEMENT

Certain types of non-stormwater discharges are allowed under the U.S. Environmental Protection Agency Construction General Permit. These types of discharges will be allowed under the conditions that no pollutants will be allowed to come in contact with the water prior to or after its discharge. The control measures which have been outlined previously in this LTPPP will be strictly followed to ensure that no contamination of these non-storm water discharges takes place. Any existing illicit discharges, if discovered during the course of the work, will be reported to MassDEP and the local DPW, as applicable, to be addressed in accordance with their respective policies. No illicit discharges will be allowed in conjunction with the proposed improvements.

Duly Acknowledged:

_____

Name & Title Date

SPILL PREVENTION AND RESPONSE PROCEDURES (POST CONSTRUCTION)

In order to prevent or minimize the potential for a spill of Hazardous Substances or Oil or come into contact with stormwater, the following steps will be implemented:

1. All Hazardous Substances or Oil (such as pesticides, petroleum products, fertilizers, detergents, acids, paints, paint solvents, cleaning solvents, etc.) will be stored in a secure location, with their lids on, preferably under cover, when not in use.

2. The minimum practical quantity of all such materials will be kept on site.

3. A spill control and containment kit (containing, for example, absorbent materials, acid neutralizing powder, brooms, dust pans, mops, rags, gloves, goggles, plastic and metal trash containers, etc.) will be provided on site.

4. Manufacturer's recommended methods for spill cleanup will be clearly posted and site personnel will be trained regarding these procedures and the location of the information and cleanup supplies.

5. It is the OWNER's responsibility to ensure that all Hazardous Waste on site is disposed of properly by a licensed hazardous material disposal company. The OWNER is responsible for not exceeding Hazardous Waste storage requirements mandated by the EPA or state and local authorities.

In the event of a spill of Hazardous Substances or Oil, the following procedures should be followed:

1. All measures should be taken to contain and abate the spill and to prevent the discharge of the Hazardous Substance or Oil to stormwater or off-site. (The spill area should be kept well ventilated and personnel should wear appropriate protective clothing to prevent injury from contact with the Hazardous Substances.)

2. For spills of less than five (5) gallons of material, proceed with source control and containment, clean-up with absorbent materials or other applicable means unless an imminent hazard or other circumstances dictate that the spill should be treated by a professional emergency response contractor.

3. For spills greater than five (5) gallons of material immediately contact the MADEP at the toll-free 24-hour statewide emergency number: **1-888-304-1133**, the local fire department (**9-1-1**) and an approved emergency response contractor. Provide information on the type of material spilled, the location of the spill, the quantity spilled, and the time of the spill to the emergency response contractor or coordinator, and proceed with prevention, containment and/or clean-up if so desired. (Use the form provided, or similar).

4. If there is a Reportable Quantity (RQ) release, then the National Response Center should be notified immediately at (800) 424-8802; within 14 days a report should be submitted to the EPA regional office describing the release, the date and circumstances of the release and the steps taken to prevent another release. This Pollution Prevention Plan should be updated to reflect any such steps or actions taken and measures to prevent the same from reoccurring.

SPILL PREVENTION CONTROL AND COUNTERMEASURE FORM

SDG Development, LLC
108 Old Church Street
Pembroke, MA

Where a release containing a hazardous substance occurs, the following steps shall be taken by the facility manager and/or supervisor:

1. Immediately notify The Town Fire Department (at **9-1-1**)

2. All measures must be taken to contain and abate the spill and to prevent the discharge of the pollutant(s) to off-site locations, receiving waters, wetlands and/or resource areas.

3. Notify the Town Health Department at (781) 293-2718 and the Town Conservation Commission at (781) 293-4674.

4. Provide documentation from licensed contractor showing disposal and cleanup procedures were completed as well as details on chemicals that were spilled to the Town Health Department and Conservation Commission.

Date of spill:_____ Time:_____ Reported By:_____

Weather Conditions:_____

Material Spilled	**Location of Spill**	**Approximate Quantity of Spill (in gallons)**	**Agency(s) Notified**	**Date of Notification**

Cause of Spill: _____

_____

Measures Taken to Clean up Spill: _____

_____

Type of equipment: _____ Make: _____ Size: _____

License or S/N: _____

Location and Method of Disposal _____

_____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring: _____

_____

_____

Additional Contact Numbers:

- DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP) EMERGENCY PHONE: 1-888-304-1133
- NATIONAL RESPONSE CENTER PHONE: (800) 424-8802
- U.S. ENVIRONMENTAL PROTECTION AGENCY PHONE: (888) 372-7341

StormTech®

Detention • Retention • Water Quality

A division of ADS

Save Valuable Land and Protect Water Resources

Isolator® Row O&M Manual

StormTech® Chamber System for Stormwater Management

1.0 The Isolator® Row

1.1 INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patented technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

1.2 THE ISOLATOR ROW

The Isolator Row is a row of StormTech chambers, either SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-4500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC-310-3 and SC-740 models) allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

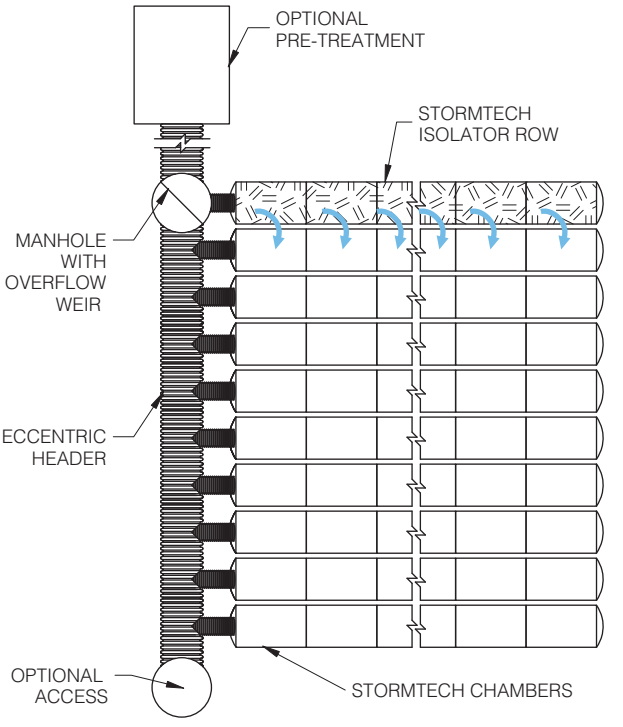
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

StormTech Isolator Row with Overflow Spillway
(not to scale)



2.0 Isolator Row Inspection/Maintenance

2.1 INSPECTION

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

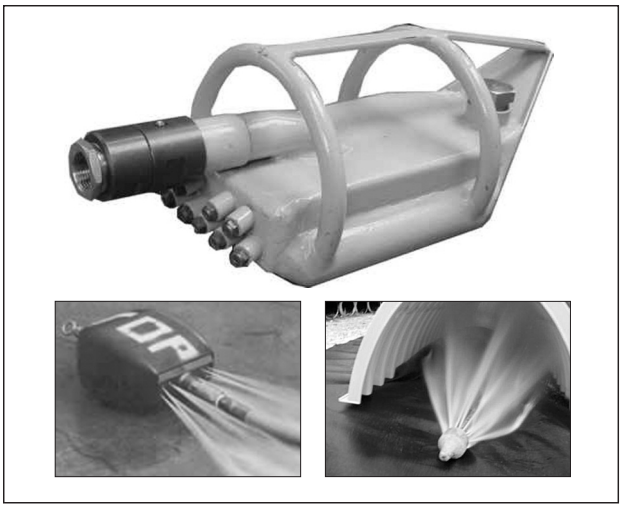
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

2.2 MAINTENANCE

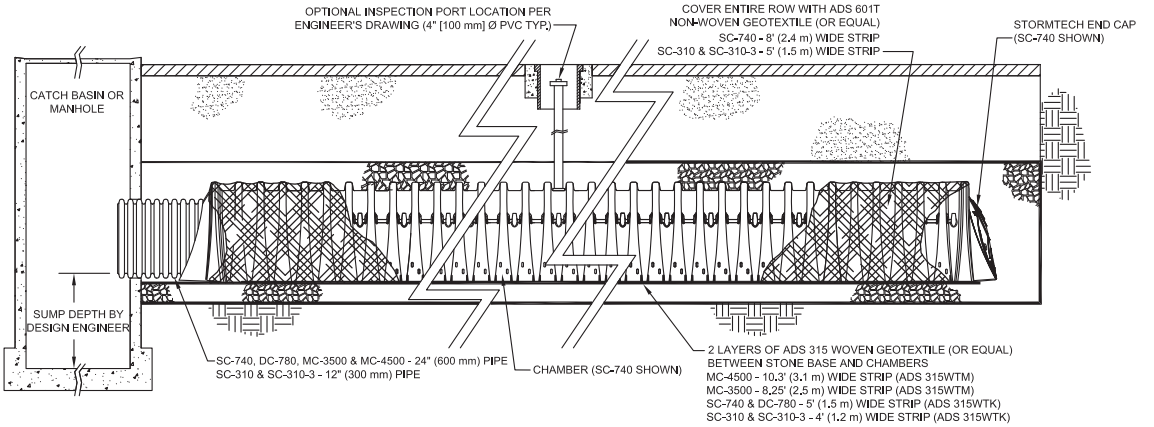
The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.



Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)



NOTE: NON-WOVEN FABRIC IS ONLY REQUIRED OVER THE INLET PIPE CONNECTION INTO THE END CAP FOR DC-780, MC-3500 AND MC-4500 CHAMBER MODELS AND IS NOT REQUIRED OVER THE ENTIRE ISOLATOR ROW.

3.0 Isolator Row Step By Step Maintenance Procedures

Step 1) Inspect Isolator Row for sediment

A) Inspection ports (if present)

i. Remove lid from floor box frame

ii. Remove cap from inspection riser

iii. Using a flashlight and stadia rod, measure depth of sediment and record results on maintenance log.

iv. If sediment is at, or above, 3 inch depth proceed to Step 2. If not proceed to step 3.

B) All Isolator Rows

i. Remove cover from manhole at upstream end of Isolator Row

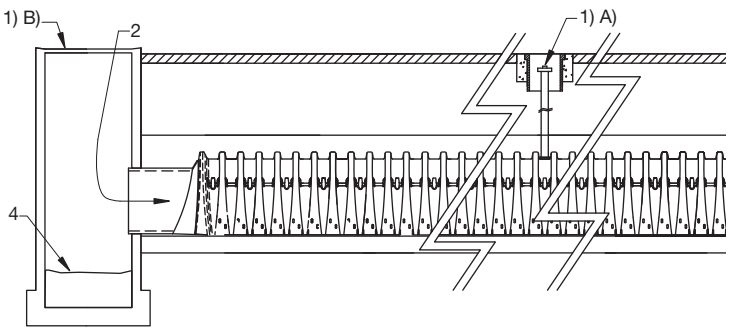
ii. Using a flashlight, inspect down Isolator Row through outlet pipe

1. Mirrors on poles or cameras may be used to avoid a confined space entry

2. Follow OSHA regulations for confined space entry if entering manhole

iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches) proceed to Step 2. If not proceed to Step 3.

StormTech Isolator Row (not to scale)



Step 2) Clean out Isolator Row using the JetVac process

A) A fixed culvert cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable

B) Apply multiple passes of JetVac until backflush water is clean

C) Vacuum manhole sump as required

Step 3) Replace all caps, lids and covers, record observations and actions

Step 4) Inspect & clean catch basins and manholes upstream of the StormTech system

Sample Maintenance Log

Date	Stadia Rod Readings		Sediment Depth (1) - (2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/01	6.3 ft.	none		New installation. Fixed point is CI frame at grade	djm
9/24/01		6.2	0.1 ft.	Some grit felt	sm
6/20/03		5.8	0.5 ft.	Mucky feel, debris visible in manhole and in Isolator row, maintenance due	rv
7/7/03	6.3 ft.		0	System jetted and vacuumed	djm

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70 Inwood Road, Suite 3 | Rocky Hill | Connecticut | 06067

860.529.8188 | 888.892.2694 | fax 866.328.8401 | www.stormtech.com