

STORMWATER REPORT

for the

PEMBROKE 5 MA

85 WASHINGTON STREET

PEMBROKE, MASSACHUSETTS

MAY 2021

(REV 1, OCTOBER 15, 2021)

PREPARED FOR:

NEXIUS

PREPARED BY:



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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 8²
- Operation and Maintenance Plan required by Standard 9

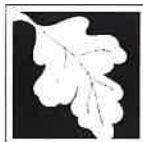
In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans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

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

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

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

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



Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

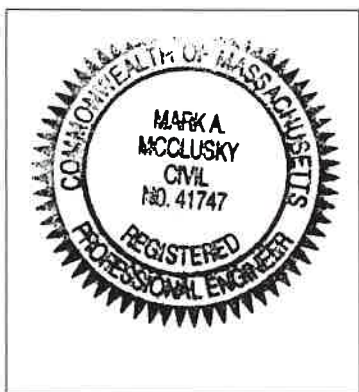
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



Mark A. McClusky 10/14/21
Signature and Date

Checklist

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

- ☒ New development
- ☐ Redevelopment
- ☐ Mix of New Development and Redevelopment



Checklist for Stormwater Report

Checklist (continued)

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

- ☒ No disturbance to any Wetland Resource Areas
 - ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
 - ☐ Reduced Impervious Area (Redevelopment Only)
 - ☒ Minimizing disturbance to existing trees and shrubs
 - ☐ LID Site Design Credit Requested:
 - ☐ Credit 1
 - ☐ Credit 2
 - ☐ Credit 3
 - ☒ Use of "country drainage" versus curb and gutter conveyance and pipe
 - ☐ Bioretention Cells (includes Rain Gardens)
 - ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
 - ☐ Treebox Filter
 - ☐ Water Quality Swale
 - ☐ Grass Channel
 - ☐ Green Roof
 - ☒ Other (describe): 50'x50' pervious crushed stone compound to provide temp storage and infiltration of runoff
-

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 Field¹
- ☒ 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.

A. INTRODUCTION

On behalf of NEXIUS and Verizon Wireless, McMahon Associates (McMahon) prepared the following revised stormwater report in general accordance with the Massachusetts Wetlands Protection Act, M.G.L. Chapter 131, Section 40 and the Pembroke Stormwater Management By-Law Article XXXV to evaluate the potential construction and post-development impacts created by the installation of a proposed wireless communication facility in Pembroke, Massachusetts.

The revisions included within this updated stormwater report are in response to the overall project submission peer review completed by Merrill Engineers & Land Surveyors (July 12, 2021), and especially the items related to stormwater including in-field soil identification via soil excavations (test pits), soil percolation or infiltration tests, incorporation of the existing parking area storm sewer catch basin with associated piping to the Existing Conditions and Proposed Conditions HydroCAD modeling, and updating of previously submitted Existing Conditions and Proposed Conditions Watershed Plans.

The overall purpose of the project is to construct a wireless communications facility and antenna tower for Verizon Wireless for the benefit its users to reduce communication gaps and dropped calls. The project is generally bounded by Washington Street to the east, commercial properties to the north and south and forest to the west. The overall site is approximately 1.9 acres. The project proposes approximately 10,500 square feet (sf) (0.24 acre) of disturbance which includes selective tree removal, installation of a gravel access drive, gravel parking area, crushed stone compound with concrete slab, chain link fence, 120 foot (ft) tall monopole antenna tower and associated utilities. Please see Figure 1 for the overall project location.

The objective of this report is to determine the existing condition and post construction condition runoff or peak flows and design appropriate stormwater mitigation measures to ensure that post construction peak flows match or are less than existing condition runoff peak flows.

FIGURE 1 – SITE LOCATION MAP



B. EXISTING CONDITIONS

In general, the site includes a wooded area to the west and retail developments to the north, east and south. A 7,890 sf building with associated 26 stall parking & area, paved driveway and sidewalks are located on the northeastern half of the lot, closest to Washington Street. The existing developed area within the lot is landscaped and the parking lot contains one (1) storm sewer catch basin.

Based on the updated Existing Conditions survey plan, it appears that essentially all roof runoff and pavement runoff are routed to the existing storm sewer catch basin, and then discharged through a 12-inch diameter reinforced concrete pipe (RCP). The existing site contains a total of 20,100 sf of impervious (pavement, sidewalk, roof) area within the 82,914 sf lot and all runoff is eventually discharged off site to the southwest via overland flow (no point discharges).

Project Area

The eventual project area of concern is currently an undeveloped, partially wooded area of land located to the rear or southwest of the existing parking lot. Based on review of Natural Resources Conservation Service (NRCS) soil survey, the lot or parcel contains Scituate gravelly sandy loam (316B), Birchwood Sand (321C), and Urban Land (640B). Urban land typically consists of soil altered by man-made activities such as cutting and filling and no attempt to identify the parent soil is made.

After further review of the NRCS data, the percentage of parcel coverage for the respective soils listed above are approximately 73%, 6%, and 21%, respectively. Please note that the proposed wireless communication facility and gravel driveway will be completely within the Scituate Gravelly sandy loam soil (316B) with C/D rated soil, which has a reported estimated infiltration rate of 0.2 in/hr. Please see Appendix C for the NRCS soil survey data.

Wetland Resource Areas

Based on review of the wetland resource areas on Oliver, MassGIS's Online Mapping Tool, the project area is not located within the vicinity of any wetland resource areas or wetland resource area boundaries or buffers.

Existing Drainage System

As previously described, the existing storm system within the previously developed portion of the parcel consists of one storm sewer catch basin with a 12-inch diameter RCP discharge or outlet pipe. This catch basin collects stormwater runoff from the paved parking area, driveway, adjacent sidewalks, and is assumed to include all roof runoff.

As can be seen in the previously submitted site plans, the proposed wireless communication facility will be located in an undeveloped portion of the lot and will not connect to or affect the current on-site storm sewer system.

Soil Classification

According to the soil survey in Plymouth County, Massachusetts prepared by the NRCS, soils at this site consist of mostly Scituate gravelly sandy loam (316B) with Urban land (640B) closest to Washington Street and a small amount of Birchwood sand (321C) at the western corner.

Scituate soils generally consist of gravelly sandy loam, this site is classified with 3 to 8 percent slopes and are very stony. Based on the NRCS, definitions, the dual HSG rating for a particular soil is dependent on the terrain and is either naturally graded to drain runoff or collects runoff.

Based on the positive slope or free-draining nature of the existing terrain or topography, the first letter of the hydrologic soil group rating was used for each soil unit within the hydrologic calculations. Since Urban Land is typically not rated, and the areal extent of Birchwood Sand is relatively small, a conservative HSG rating of "C" was applied to each soil unit. Please refer to the Appendix for the Hydrologic Soil Group Map.

Flood Zone Classification

According to the most recent Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) on Community-Panel Number 25023C0206J, effective date 8/15/2012, the project area, is not within the 100-year floodplain. Refer to Figure 2 – FEMA Flood Map.

Natural Heritage and Endangered Species Program

The Massachusetts Wetlands Protection Act requires that no project may be permitted that will have any adverse effect on specified habitat site of rare vertebrate or invertebrate species, as identified by procedures set forth in 310 CMR 10.59.

Based upon review of the Massachusetts Natural Heritage and Endangered Species Program (NHESP) within Oliver, MassGIS's Online Mapping Tool, the project area is not located within Estimated or Priority Habitat and there are no Certified Vernal Pools in, or nearby the inspected area. Refer to Figure 3 – Natural Heritage & Endangered Species (NHESP) Map.

Area of Critical Environmental Concern (ACEC)

There are no areas of environmental concern or outstanding resource waters within the proposed project area. Refer to Figure 4 – Outstanding Water Resources & Figure 5 – Areas of Critical Environmental Concern (ACEC) Map.

FIGURE 2 – FEMA FLOOD MAP
National Flood Hazard Layer FIRMette

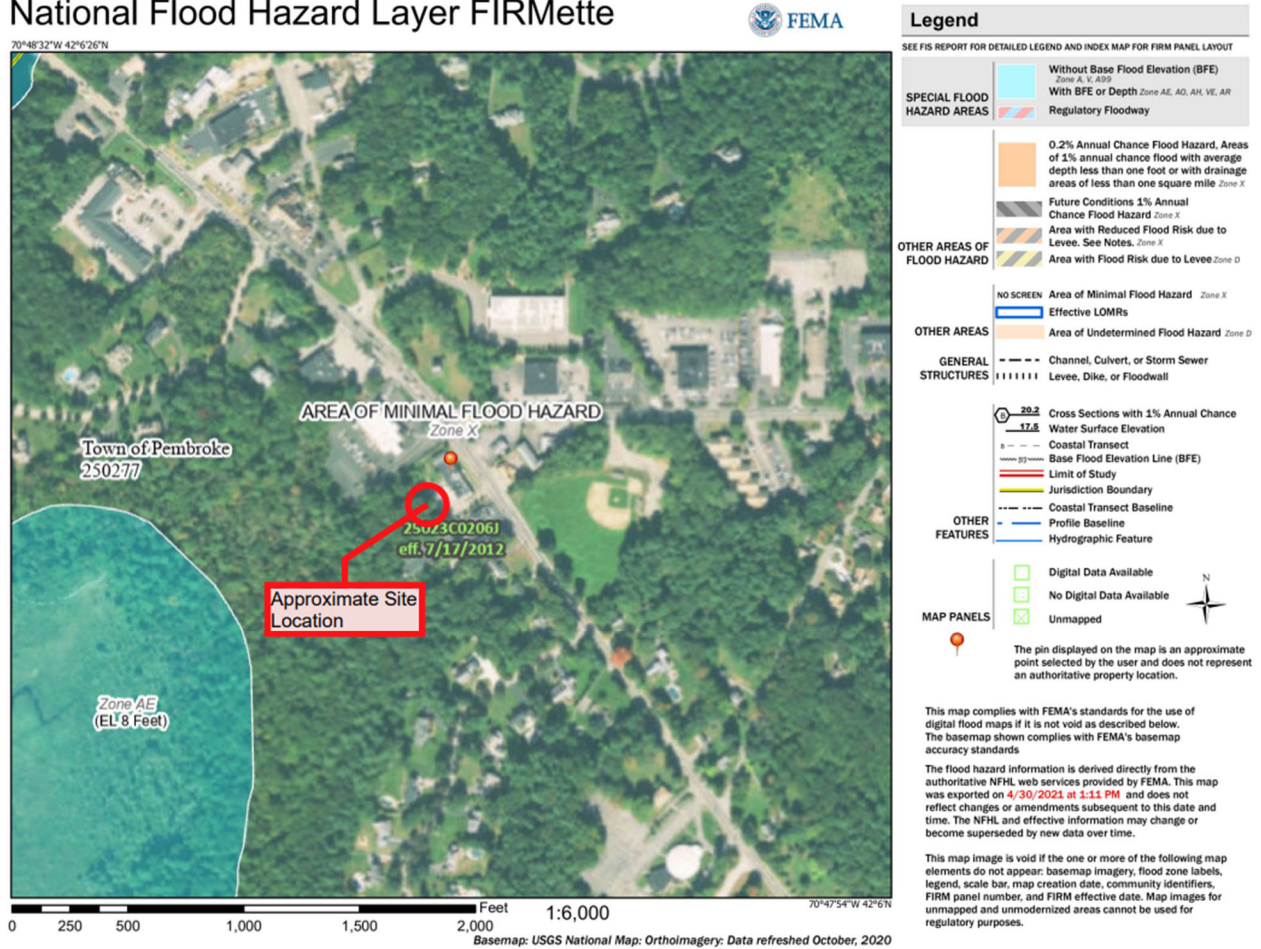


FIGURE 3 – NATURAL HERITAGE & ENDANGERED SPECIES (NHESP)
MAP

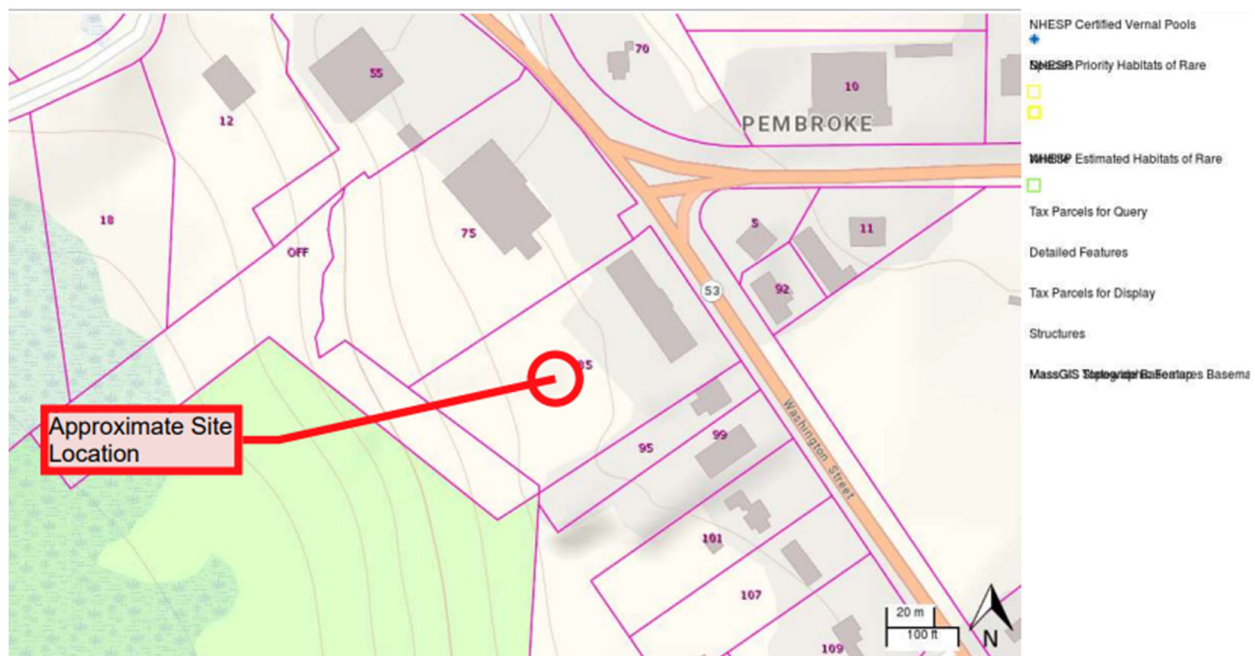
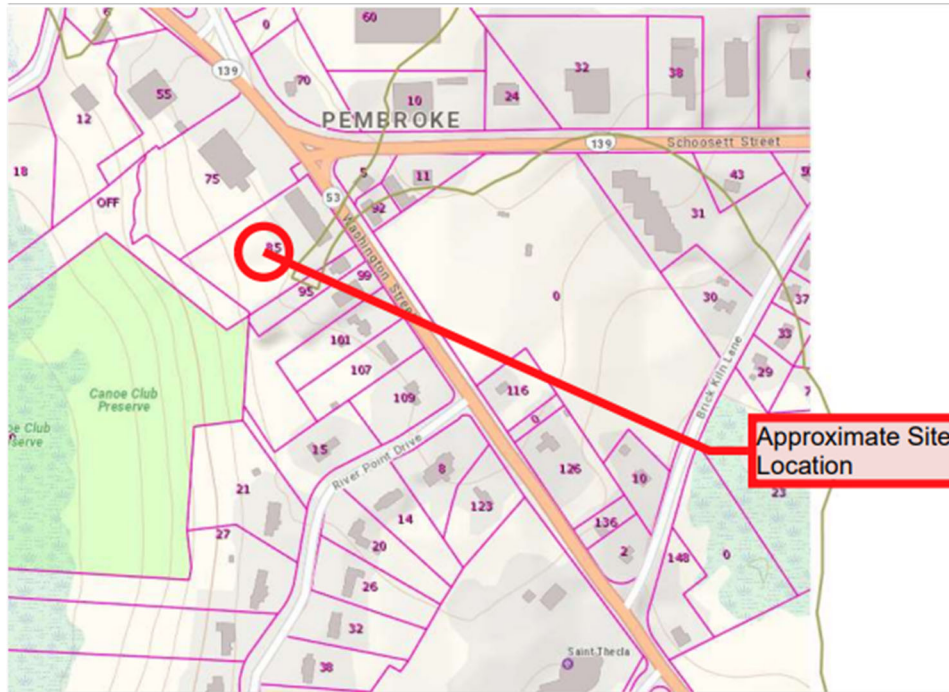
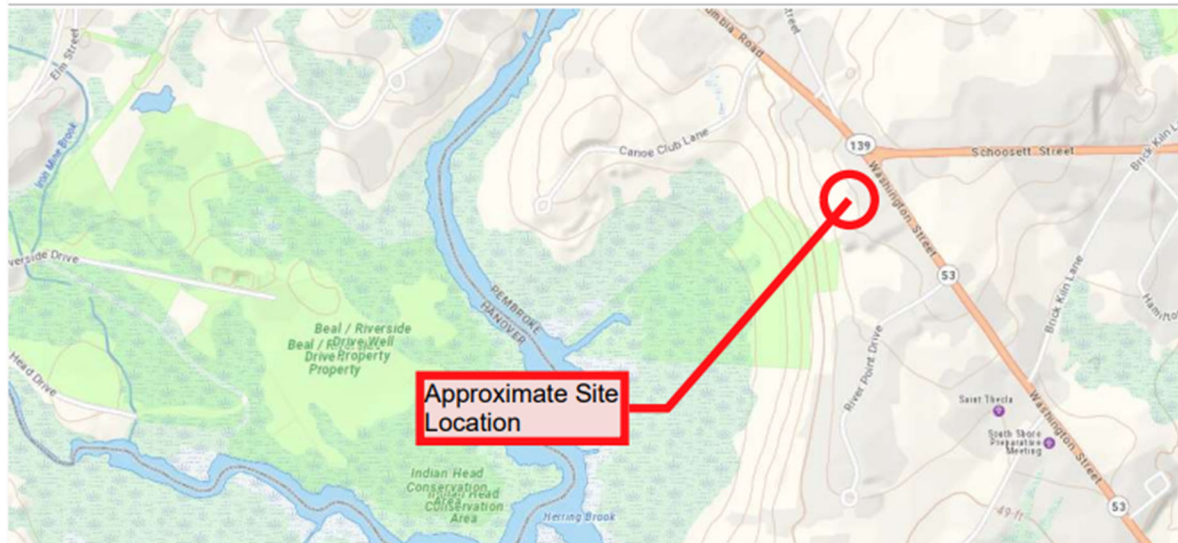


FIGURE 4 – OUTSTANDING WATER RESOURCES



- Outstanding Resource Waters Outlines
 - ACEC
 - Cape Cod National Seashore
 - Protected Shoreline
 - Public Water Supply Watershed
 - Retired Public Water Supply
 - Scenic/Protected River
 - Wildlife Refuge
- Tax Parcels for Query
- Detailed Features
- Tax Parcels for Display
- Structures
- MassGIS Topography Base

FIGURE 5 –AREAS OF CRITICAL ENVIRONMENTAL CONCERN
(ACEC) MAP



Existing Conditions Drainage Analysis

The following is a description and analysis of the existing conditions as they relate to stormwater runoff from the site or parcel.

Methodology

Hydrologic analyses were performed using site-specific precipitation frequency data based on former Soil Conservation Service (SCS), Technical Release 20 (TR-20) to compare the existing and proposed conditions stormwater runoff. The 1, 2, 10, 25, 50 and 100-year statistically based rain events were modeled for a Type III 24-hour storm utilizing HydroCAD version 10.0.

The following Massachusetts rainfall amounts were utilized for each design storm event. The rainfall distributions are based on conservative data provided by the Northeast Regional Climate Center (NRCC). The NRCC rainfall totals are more conservative than older or previous SCS 24-hour rainfall total per statistical year event.

- 1-Year Storm Event = 2.78 inches/24 hours
- 2-Year Storm Event = 3.35 inches/24 hours
- 10-Year Storm Event = 4.95 inches/24 hours
- 25-Year Storm Event = 6.19 inches/24 hours
- 50-Year Storm Event = 7.33 inches/24 hours
- 100-Year Storm Event = 8.68 inches/24 hours

The hydrologic and hydraulic models or HydroCAD reports (pre and post construction) are included in Appendix A of this report.

Existing Conditions Watershed Summary

Based on the topography, existing conditions stormwater runoff from the site (area 1S) appears to flow to the southwest corner of the lot (2L). Stormwater runoff from the parking lot, adjacent sidewalks, and roof are routed to the storm sewer catch basin, and then discharges at the 12-inch RCP outlet point, located approximately 20 feet southeast of the rearmost edge of parking.

Runoff from the RCP outlet then travels via overland and also flows to the southwest corner (design point 2L). It appears stormwater runoff ultimately discharges to the North River via overland flow. The Existing Conditions watershed map is provided in Appendix B and the existing conditions peak flows for each modeled rain event are listed in Table 1 below.

C. PROJECT DESCRIPTION

The proposed project of concern consists of a 50'x50' crushed stone compound with four lease areas for potential wireless providers. Verizon Wireless will locate at this site. Approximately 1,560 sf of gravel access drive, 1,680 sf of very porous crushed stone surface to a depth of 12-inches and approximately 820sf of impervious surface (communication equipment or pad) will be installed. The 820 sf of impervious area conservatively represents all four (4) proposed lease areas being occupied with three (3), 12'x20' communications shelters totaling 720 sf, and one Verizon pad with 100 sf of impervious pad or communication cabinets.

Proposed Drainage Analysis

The following is an analysis of proposed conditions as they relate to stormwater runoff from the parcel with the proposed improvements.

Methodology

The same methodology and rainfall distributions for the existing conditions were used for the proposed conditions modeling. Please note that the in-situ infiltration rate is 1.4 in/hr, and the rate used in HydroCAD model is 0.7 in/hr. No mottles or evidence of a high groundwater table were observed.

Proposed Conditions Analysis

For the proposed conditions or post construction condition scenario, existing drainage patterns will be maintained. The Proposed Conditions watershed map is provided in Appendix B and the proposed conditions peak flows for each modeled rain event are listed in Table 1 below.

Proposed Conditions Watershed Summary

As can be seen in the site plan and the proposed grading, the small communications facility development will maintain current drainage patterns. Although land alterations will occur for the construction of the communication facility, the crushed stone compound will act as a means of storage volume for runoff generated from the gravel driveway and communication pad or equipment.

As can be seen in Table 1, peak discharge rates decrease for the 1, 2, 10, 25, 50, and 100-year statistical rain events when existing conditions are compared to proposed conditions at the designated design point, 2L. As stated above, based on the undeveloped nature of the proposed project location and moderately draining soils on site limits areas to provide stormwater quality so as not to disturb a greater area. Although the proposed crushed stone compound area was not formally intended to be a groundwater recharge measure, the pervious crushed stone compound will in fact perform as a detention with infiltration system.

Table 1: Summary of Peak Discharge (cfs)

	Storm Year					
	1	2	10	25	50	100
Design Point 2L						
Existing	1.82	2.47	4.49	6.19	7.81	9.76
Proposed	1.79	2.41	4.34	5.96	7.51	9.37
Change	-0.03	-0.06	-0.15	-0.23	-0.30	- .39

In conclusion, from review of Table 1 above and comparison of the Existing Conditions and Proposed Conditions HydroCAD reports in Appendix A, it can be seen that the post construction peak flows will be attenuated or reduced for the 1, 2, 10, 25, 50, and 100-year statistical rain events for the proposed communications facility. The facility will include a 50'x50' pervious crushed stone compound with gravel access drive, gravel parking area, communications pads with communication cabinets or shelters, and an antenna tower.

D. MITIGATION METHODS

Soil Erosion and Sedimentation Controls

Soil erosion and sedimentation control concerns have been considered in the design and construction planning process for this project. Control measures for soil erosion and sedimentation will be installed before construction activities begin and will be maintained throughout construction. Straw wattles and silt fence have been proposed at the limits of disturbance perimeter and a silt sack is proposed within catch basin in parking area. A stabilized construction entrance is proposed to limit potential sediment from tracking off the project site. Once established, these measures will be monitored weekly until construction is complete. The location of perimeter erosion controls will serve as the strict limits of disturbance for the project. Areas beyond these limits as shown on the plans will be left undisturbed and in their completely natural condition. In the event of a significant rainstorm (i.e. greater than 1") the sedimentation control measures will be inspected and repaired or replaced as necessary.

Operation and Maintenance Plan

Under lease agreement with Verizon Wireless, after project approval and construction the operation and maintenance of the crushed stone compound will be the responsibility of Verizon Wireless. Refer to Appendix D for the stormwater operation and maintenance actions.

Construction Sequence

The anticipated sequence of construction proceeds as follows:

1. Complete a "DIGSAFE" prior to any onsite activity.
2. Install erosion and sediment control (E&S) measures as indicated on the Soil Erosion & Sedimentation Control Plan and Notes sheet ES-1 and Soil Erosion & Sedimentation Control Details & Notes sheet ES-2. E&S measures include catch basin inlet protection, stabilized construction entrance, silt fence and straw waddles. Additional E&S measures shall be added, as necessary, to protect adjacent downgradient areas.
3. Tree clearing and grubbing in area of proposed construction.

4. Excavate top soils from proposed gravel drive limits and within compound and for utility trench.
5. Install underground utility conduit.
6. Excavate for and construct antennal tower foundation, grade compound.
7. Place subgrade for gravel compound area, gravel drive and parking.
8. Install gravel and concrete pads
9. Install antenna tower, communication equipment and fence.
10. Plant, seed, and stabilize disturbed soil surfaces.
11. Clean catch basins of any collected sediment or debris, dispose of properly.
12. Remove sedimentation controls once all disturbed areas have been finally stabilized and healthy vegetation has been established.

E. STORMWATER MANAGEMENT STANDARDS

The project has been designed to meet the Stormwater Management Standards outlined in 310 CMR 10.05(6)(k) to the maximum extent possible. This project qualifies as a limited project under 310 CMR 10.53(3)(d). Due to the low infiltrating soil, classified as type C/D the project aimed to meet the following Stormwater Management Standards to the maximum extent practicable. The projects conformance with these standards is described below.

Standard 1: No New Untreated Discharges

The project meets this standard. This standard has two parts where all new stormwater discharges must be treated and stormwater discharges must not cause erosion. The proposed crushed stone compound performs as a detention with infiltration area to attenuate runoff flows prior to discharging downgradient and the designated design point. Due to the nature of the project, located within woodlands with no daily vehicle trips and crushed stone proposed base, the runoff is assumed to be clean and would therefore meet the standard of no new untreated outlets as part of this project. Existing low points will remain and the flows within the project site will remain the same.

Standard 2: Peak Rate Attenuation

This standard has been met for all modeled design storms including the 1, 2, 10, 25, 50, and 100-year rain events. As can be seen in Table 1, the peak discharge during each of the storm years analyzed decreases under post-development scenario. The crushed stone compound provides peak rate flow attenuation for the compound area by discarding or infiltrating runoff. That is, the small increase in impervious areas of concrete pads and electrical equipment and the runoff generate from these new impervious surfaces is offset by the 12-inch thick layer of crushed stone compound with infiltration and storage capacity within the voids between the stone.

Standard 3: Recharge

This project has met and exceeds this standard. As stated previously, the project soils are poorly draining type C/D. According to the Stormwater Standards, new impervious surface area and the NRCS soil type, the required recharge volume is 595 cf. However, based on the infield infiltration rate and reduction of the measured field rate per the stormwater standards for design and ensuing modeling results, the compound will recharge between 609 cf for the 1 year rain event and up to 2352 cf for the 100 year rain event.

Standard 4: Water Quality

This standard has been met to the maximum extent practicable. The communications facility will be an unmanned site and therefore no daily vehicular traffic is expected, nor are any impervious vehicle surfaces (pavement) proposed. Therefore, no formal stormwater management structures such as hooded catch basins, piping, are required or even appropriate for the proposed project to remove TSS.

The following is a list of communication and utility related appurtenances in which Verizon Wireless will monitor during their routine quarterly inspections.

- DC batteries are required as part of electrical backup but are typically

fully encased in plastic battery containers (similar to sealed car batteries)
and within locked communications cabinets;

- Each carrier may install a diesel or propane powered emergency electrical generator. In each case, the carrier shall comply with Federal, State, and local fuel storage container and containment requirements;
- There are no provisions for potable water faucets, mains, or service connections and therefore vehicle washing will not be possible;
- Fertilizers, herbicides, pesticides will not be utilized or stored at this site;
- No oils are stored within the communications pads or shelters or within the compound;
- No pets will exist at the facilities, therefore no pet waste;
- No on-site sanitary sewage or septic systems are proposed for this project;
- Snow clearing will be limited to the existing access road and gravel parking or travel ways. Snow on shelters and within the compound is normally or typically left in place (not cleared);
- No road salt or de-icers will be used or necessary for the operation of this facility;
- Street sweeping is not proposed or viable for this proposed project;
- The commercial carrier technicians and staff are trained of need for immediate response and containment in the event of an unforeseeable event or spill and will contact the individual carrier's emergency response department, as well as contacting local Fire Departments and Landlord;

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

This standard is not applicable as there are no land uses within the project area that have higher potential pollutant loads.

Standard 6: Critical Areas

This standard is not applicable as there are no critical areas within the project area.

Standard 7: Redevelopment Projects

The proposed project is not considered a redevelopment project. However, the project qualifies as a limited project under 310 CMR 10.53(3)(d). As proposed, the project meets MA DEP Stormwater Management Standards 1, 2, 3, 8, 9, and 10. Standards 4 and 5 are not applicable to the project.

Standard 8: Erosion and Sediment Control

This standard has been met. Soil and erosion control shall be provided during construction by means of silt fence, straw waddles, stabilized construction entrance and silt sacks as described earlier in the report. The chosen contractor will be responsible to adhere to the Soil Erosion & Sedimentation Control Plan and Notes sheet ES-1 and Soil Erosion & Sedimentation Control Details & Notes sheet ES-2. Verizon Wireless shall use their long-term pollution prevention procedures once the project is constructed.

Standard 9: Operation and Maintenance Plan

This standard has been met. The operation and maintenance plan for the post-construction BMP's on this project has been included. Please refer to the attached appendix for the Operation and Maintenance Plan and Long-Term Pollution Prevention Plan.

Standard 10: Illicit Discharges

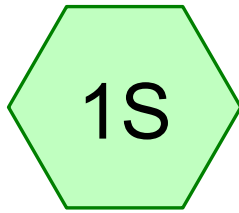
There are no known or suspected illicit discharges to the Washington Street stormwater management (existing or proposed) system at the site, based on review of existing survey.

F. CONCLUSION

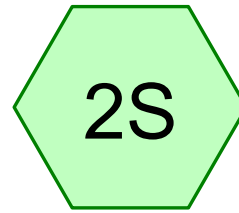
This report summarizes the potential project impacts and the stormwater runoff peak flow results for the existing and proposed conditions as a result of the communication facility installation improvements project. As can be seen in Table 1, peak discharge rates decrease for the 1, 2, 10, 25, 50, and 100-year statistical rain events when existing conditions are compared to proposed conditions at the designated design point, 2L.

Erosion and sediment control measures will be implemented to minimize impacts from construction. Furthermore, the project has been designed to meet the applicable MA DEP Stormwater Management Standards.

APPENDIX A – HYDROCAD REPORTS, EXISTING & PROPOSED



CATCHMENT A



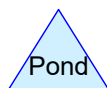
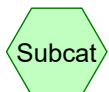
CATCHMENT B

CB
3P

CB1

2L

Project Total



Routing Diagram for VZW Pembroke 5 MA - HydroCAD - Existing 10.04.21

Prepared by {enter your company name here}, Printed 10/13/2021
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VZW Pembroke 5 MA - HydroCAD - Existing 10.04.21

Prepared by {enter your company name here}

Printed 10/13/2021

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Page 2

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-Year	NRCC 24-hr	C	Default	24.00	1	2.78	2
2	2-Year	NRCC 24-hr	C	Default	24.00	1	3.35	2
3	10-Year	NRCC 24-hr	C	Default	24.00	1	4.95	2
4	25-Year	NRCC 24-hr	C	Default	24.00	1	6.19	2
5	50-Year	NRCC 24-hr	C	Default	24.00	1	7.33	2
6	100-Year	NRCC 24-hr	C	Default	24.00	1	8.68	2

VZW Pembroke 5 MA - HydroCAD - Existing 10.04.21

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.320	74	>75% Grass cover, Good, HSG C (1S)
0.181	98	Building Roof, HSG C (2S)
0.069	87	Mulch/Dirt roads, HSG C (1S)
0.279	98	Parking, Drive, F&R Sidewalks, HSG C (2S)
1.054	70	Woods, Good, HSG C (1S)
1.903	78	TOTAL AREA

VZW Pembroke 5 MA - HydroCAD - Existing 10.04.21 NRCC 24-hr C 1-Year Rainfall=2.78"

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Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A

Runoff Area=62,853 sf 0.00% Impervious Runoff Depth=0.68"
Flow Length=359' Tc=14.5 min CN=72 Runoff=0.81 cfs 0.082 af

Subcatchment2S: CATCHMENT B

Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=2.55"
Flow Length=110' Slope=0.0070 '/' Tc=6.0 min CN=98 Runoff=1.30 cfs 0.098 af

Pond 3P: CB1

Peak Elev=82.31' Inflow=1.30 cfs 0.098 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/' Outflow=1.30 cfs 0.098 af

Link 2L: Project Total

Inflow=1.82 cfs 0.180 af
Primary=1.82 cfs 0.180 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.180 af Average Runoff Depth = 1.13"
75.81% Pervious = 1.443 ac 24.19% Impervious = 0.461 ac

Summary for Subcatchment 1S: CATCHMENT A

Runoff = 0.81 cfs @ 12.24 hrs, Volume= 0.082 af, Depth= 0.68"

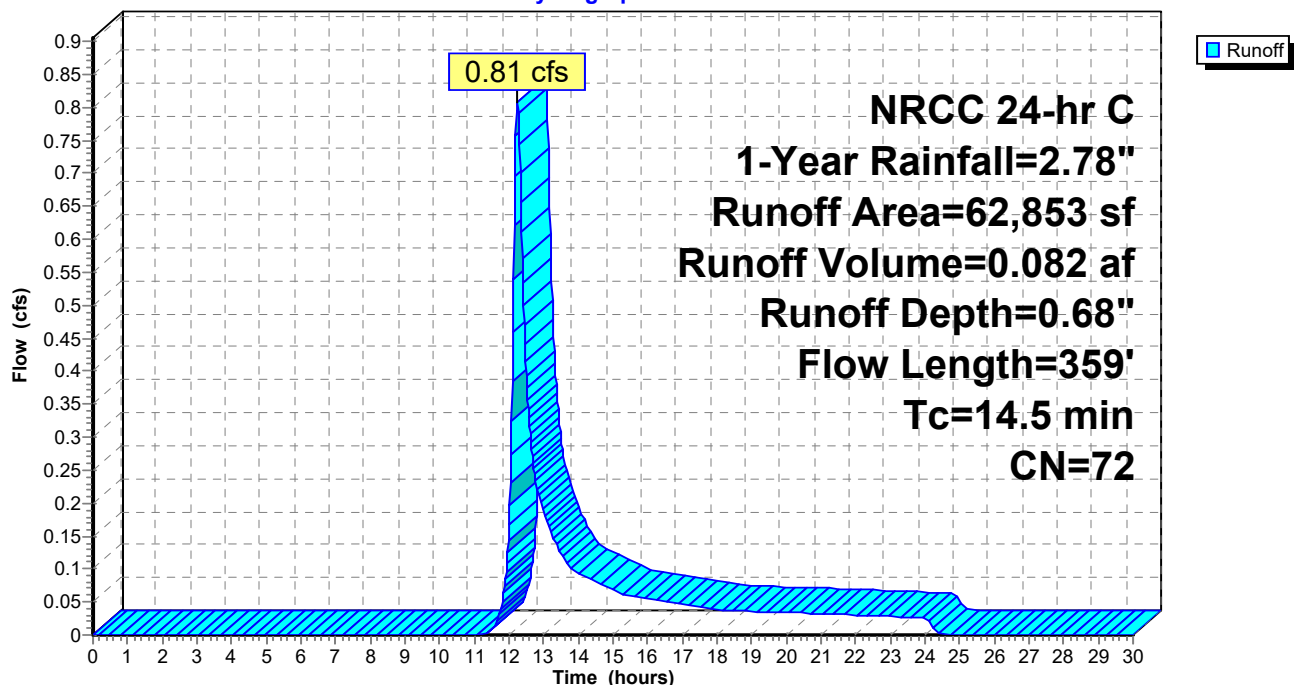
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 1-Year Rainfall=2.78"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
45,892	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
62,853	72	Weighted Average
62,853		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A

Hydrograph



Summary for Subcatchment 2S: CATCHMENT B

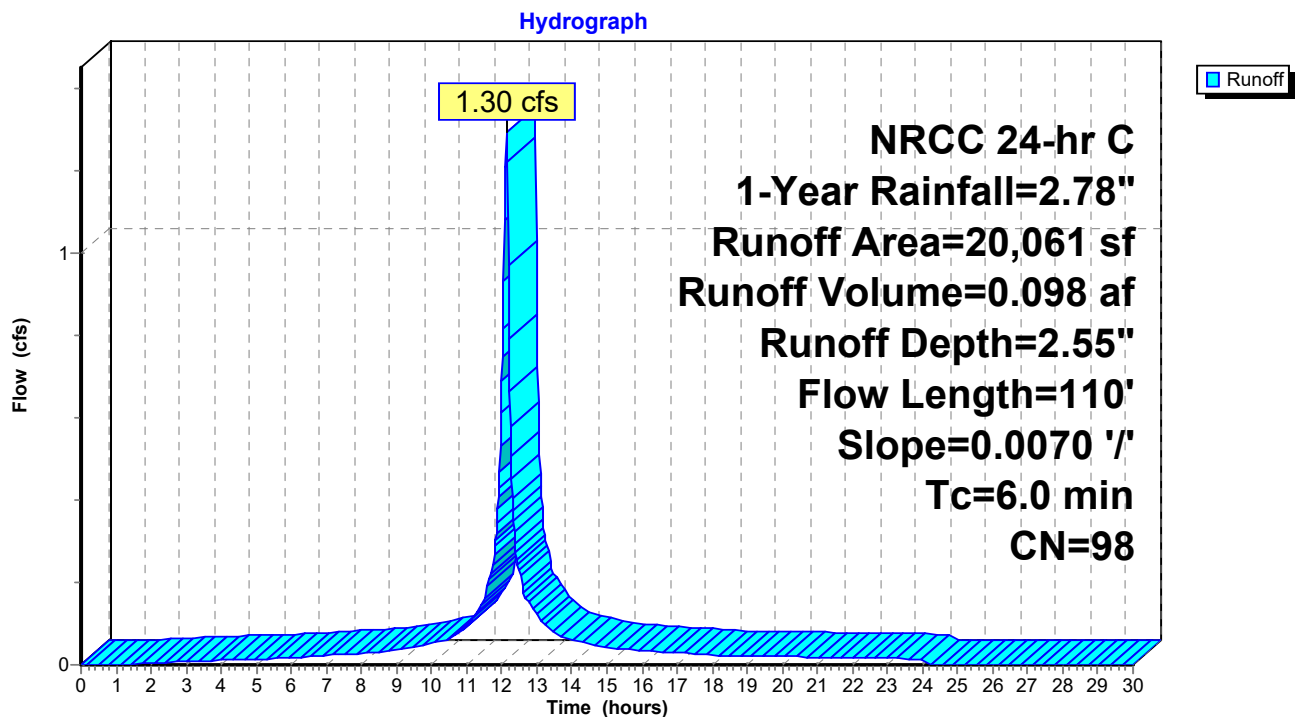
Runoff = 1.30 cfs @ 12.13 hrs, Volume= 0.098 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 1-Year Rainfall=2.78"

	Area (sf)	CN	Description
*	12,171	98	Parking, Drive, F&R Sidewalks, HSG C
*	7,890	98	Building Roof, HSG C
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: CATCHMENT B



Summary for Pond 3P: CB1

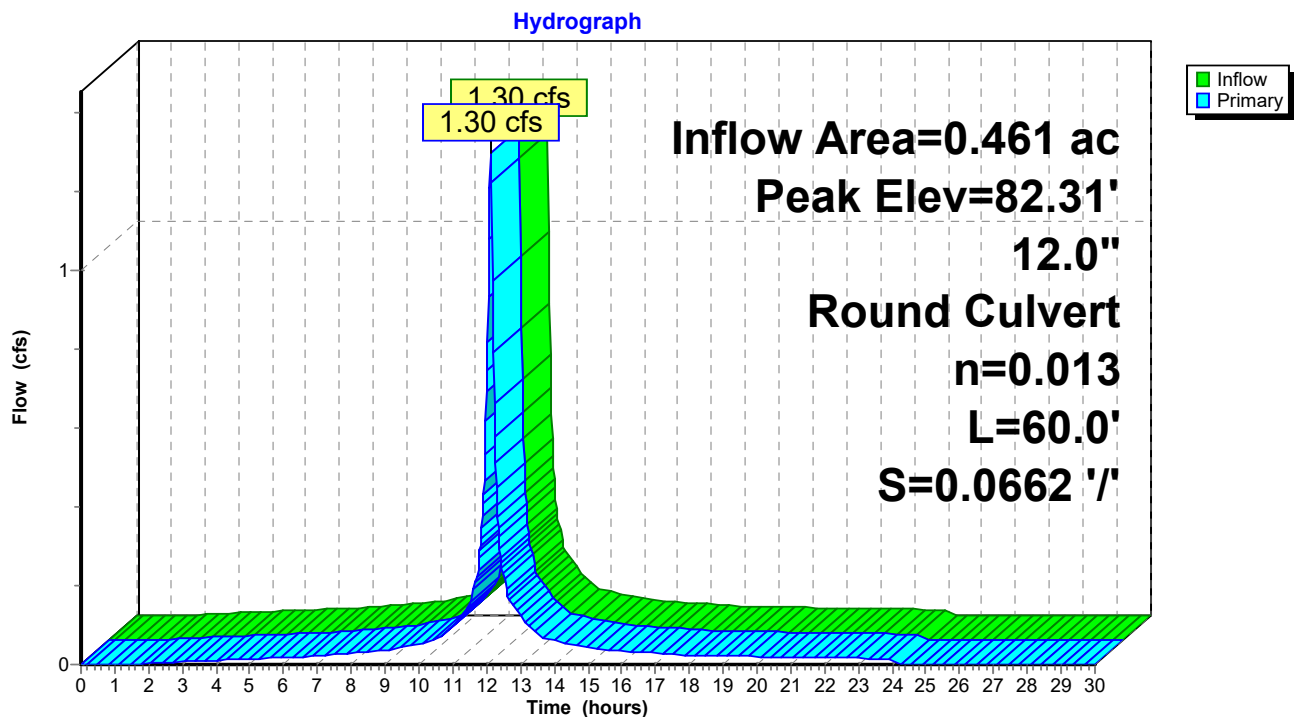
Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 2.55" for 1-Year event
 Inflow = 1.30 cfs @ 12.13 hrs, Volume= 0.098 af
 Outflow = 1.30 cfs @ 12.13 hrs, Volume= 0.098 af, Atten= 0%, Lag= 0.0 min
 Primary = 1.30 cfs @ 12.13 hrs, Volume= 0.098 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 82.31' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=1.29 cfs @ 12.13 hrs HW=82.31' TW=0.00' (Dynamic Tailwater)
 ↑1=Culvert (Inlet Controls 1.29 cfs @ 2.63 fps)

Pond 3P: CB1

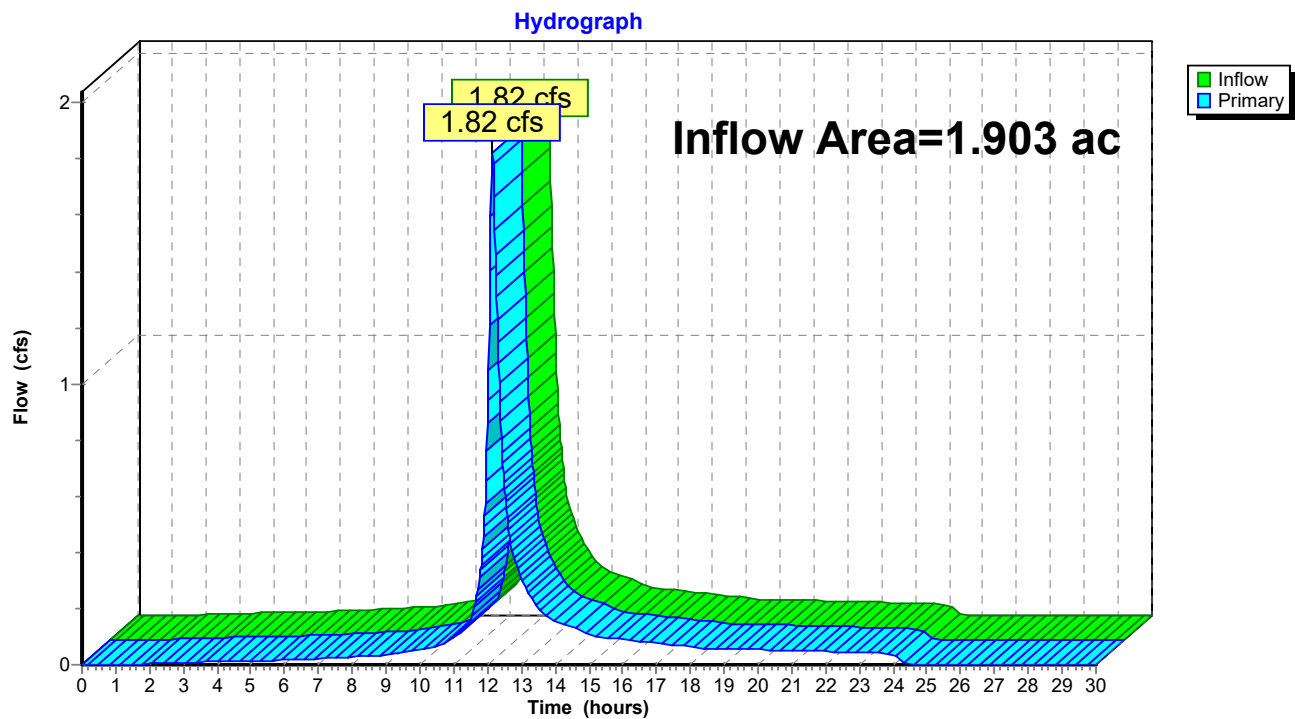


Summary for Link 2L: Project Total

Inflow Area = 1.903 ac, 24.19% Impervious, Inflow Depth = 1.13" for 1-Year event
Inflow = 1.82 cfs @ 12.14 hrs, Volume= 0.180 af
Primary = 1.82 cfs @ 12.14 hrs, Volume= 0.180 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total



VZW Pembroke 5 MA - HydroCAD - Existing 10.04.21 NRCC 24-hr C 2-Year Rainfall=3.35"

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Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A

Runoff Area=62,853 sf 0.00% Impervious Runoff Depth=1.02"
Flow Length=359' Tc=14.5 min CN=72 Runoff=1.29 cfs 0.123 af

Subcatchment2S: CATCHMENT B

Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=3.12"
Flow Length=110' Slope=0.0070 '/' Tc=6.0 min CN=98 Runoff=1.57 cfs 0.120 af

Pond 3P: CB1

Peak Elev=82.38' Inflow=1.57 cfs 0.120 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/' Outflow=1.57 cfs 0.120 af

Link 2L: Project Total

Inflow=2.47 cfs 0.243 af
Primary=2.47 cfs 0.243 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.243 af Average Runoff Depth = 1.53"
75.81% Pervious = 1.443 ac 24.19% Impervious = 0.461 ac

Summary for Subcatchment 1S: CATCHMENT A

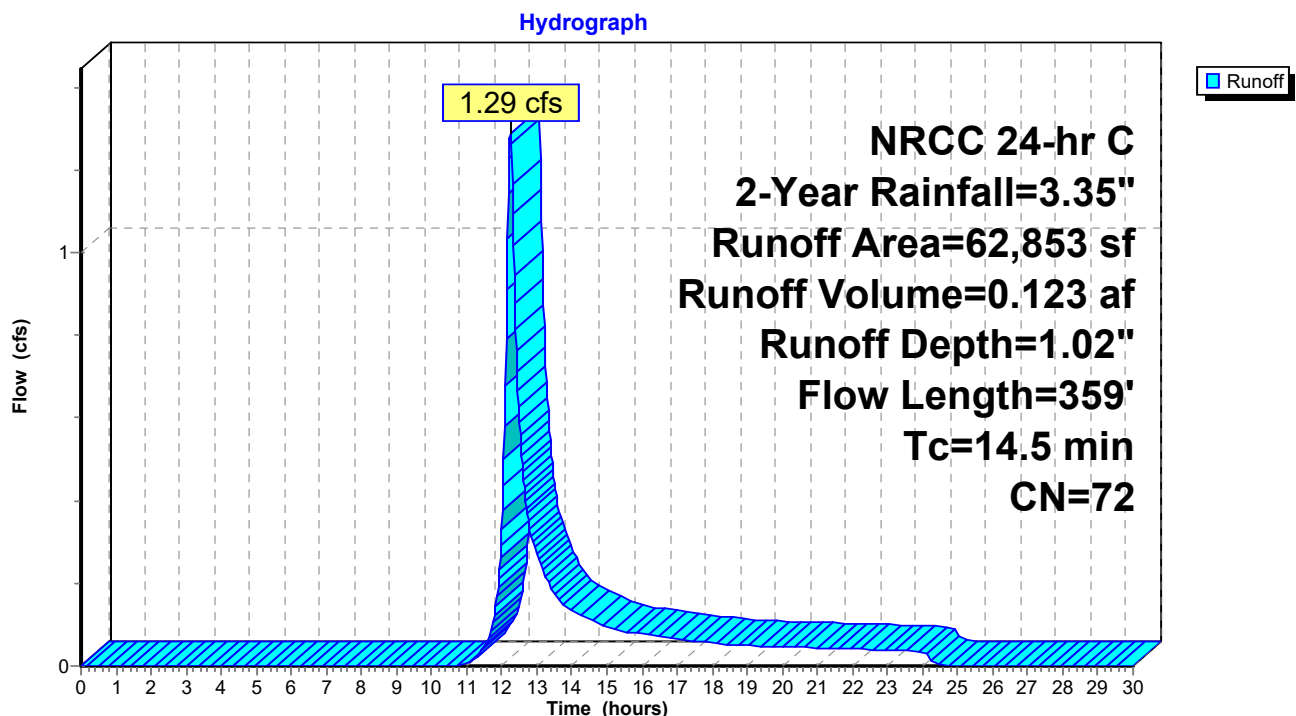
Runoff = 1.29 cfs @ 12.24 hrs, Volume= 0.123 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 2-Year Rainfall=3.35"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
45,892	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
62,853	72	Weighted Average
62,853		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A



Summary for Subcatchment 2S: CATCHMENT B

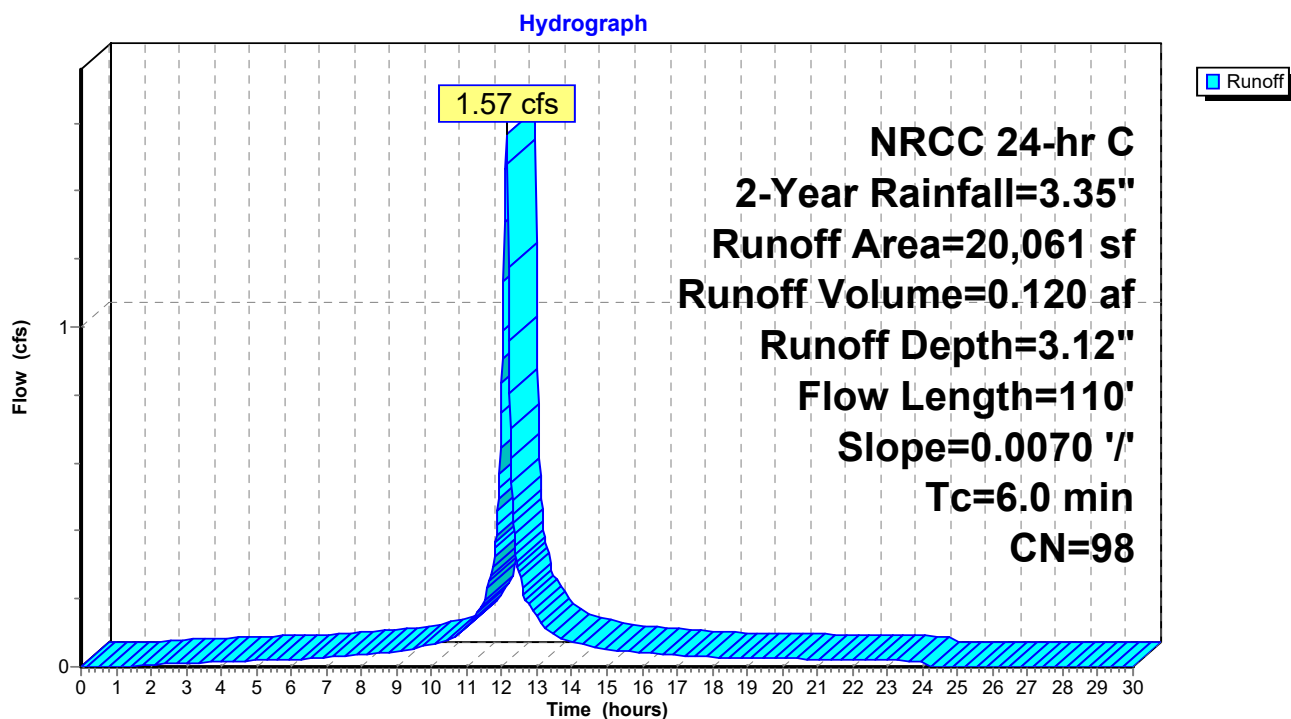
Runoff = 1.57 cfs @ 12.13 hrs, Volume= 0.120 af, Depth= 3.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 2-Year Rainfall=3.35"

	Area (sf)	CN	Description
*	12,171	98	Parking, Drive, F&R Sidewalks, HSG C
*	7,890	98	Building Roof, HSG C
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: CATCHMENT B



Summary for Pond 3P: CB1

Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 3.12" for 2-Year event
 Inflow = 1.57 cfs @ 12.13 hrs, Volume= 0.120 af
 Outflow = 1.57 cfs @ 12.13 hrs, Volume= 0.120 af, Atten= 0%, Lag= 0.0 min
 Primary = 1.57 cfs @ 12.13 hrs, Volume= 0.120 af

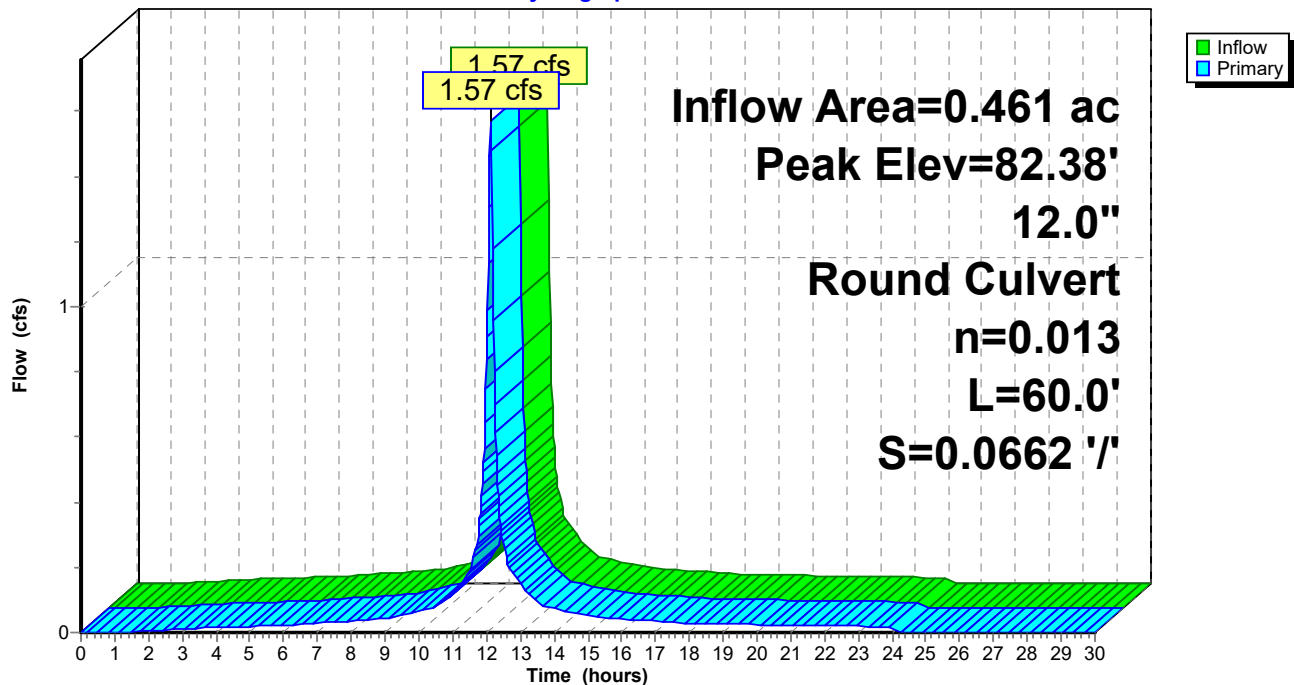
Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 82.38' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=1.56 cfs @ 12.13 hrs HW=82.38' TW=0.00' (Dynamic Tailwater)
 ↑ **1=Culvert** (Inlet Controls 1.56 cfs @ 2.79 fps)

Pond 3P: CB1

Hydrograph

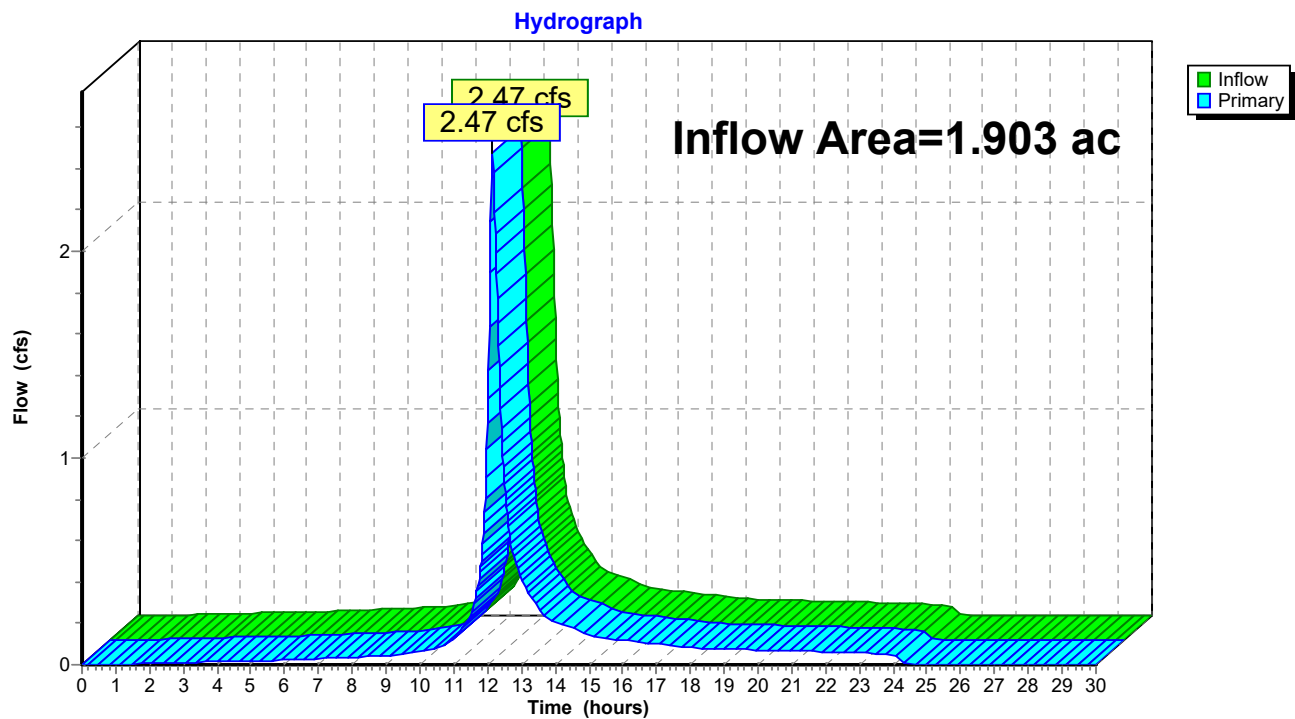


Summary for Link 2L: Project Total

Inflow Area = 1.903 ac, 24.19% Impervious, Inflow Depth = 1.53" for 2-Year event
Inflow = 2.47 cfs @ 12.15 hrs, Volume= 0.243 af
Primary = 2.47 cfs @ 12.15 hrs, Volume= 0.243 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total



VZW Pembroke 5 MA - HydroCAD - Existing 10.04.2NRCC 24-hr C 10-Year Rainfall=4.95"

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Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A

Runoff Area=62,853 sf 0.00% Impervious Runoff Depth=2.16"
Flow Length=359' Tc=14.5 min CN=72 Runoff=2.86 cfs 0.260 af

Subcatchment2S: CATCHMENT B

Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=4.71"
Flow Length=110' Slope=0.0070 '/' Tc=6.0 min CN=98 Runoff=2.33 cfs 0.181 af

Pond 3P: CB1

Peak Elev=82.59' Inflow=2.33 cfs 0.181 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/' Outflow=2.33 cfs 0.181 af

Link 2L: Project Total

Inflow=4.49 cfs 0.441 af
Primary=4.49 cfs 0.441 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.441 af Average Runoff Depth = 2.78"
75.81% Pervious = 1.443 ac 24.19% Impervious = 0.461 ac

Summary for Subcatchment 1S: CATCHMENT A

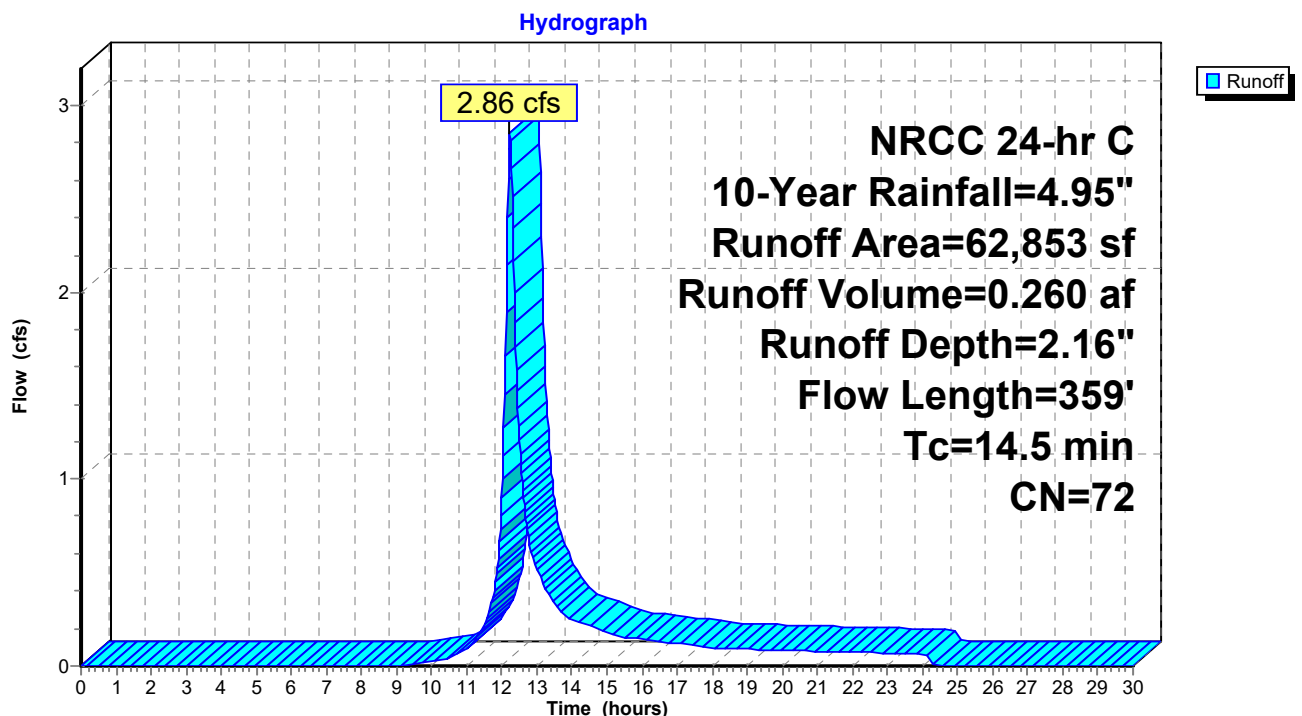
Runoff = 2.86 cfs @ 12.23 hrs, Volume= 0.260 af, Depth= 2.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 10-Year Rainfall=4.95"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
45,892	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
62,853	72	Weighted Average
62,853		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A



Summary for Subcatchment 2S: CATCHMENT B

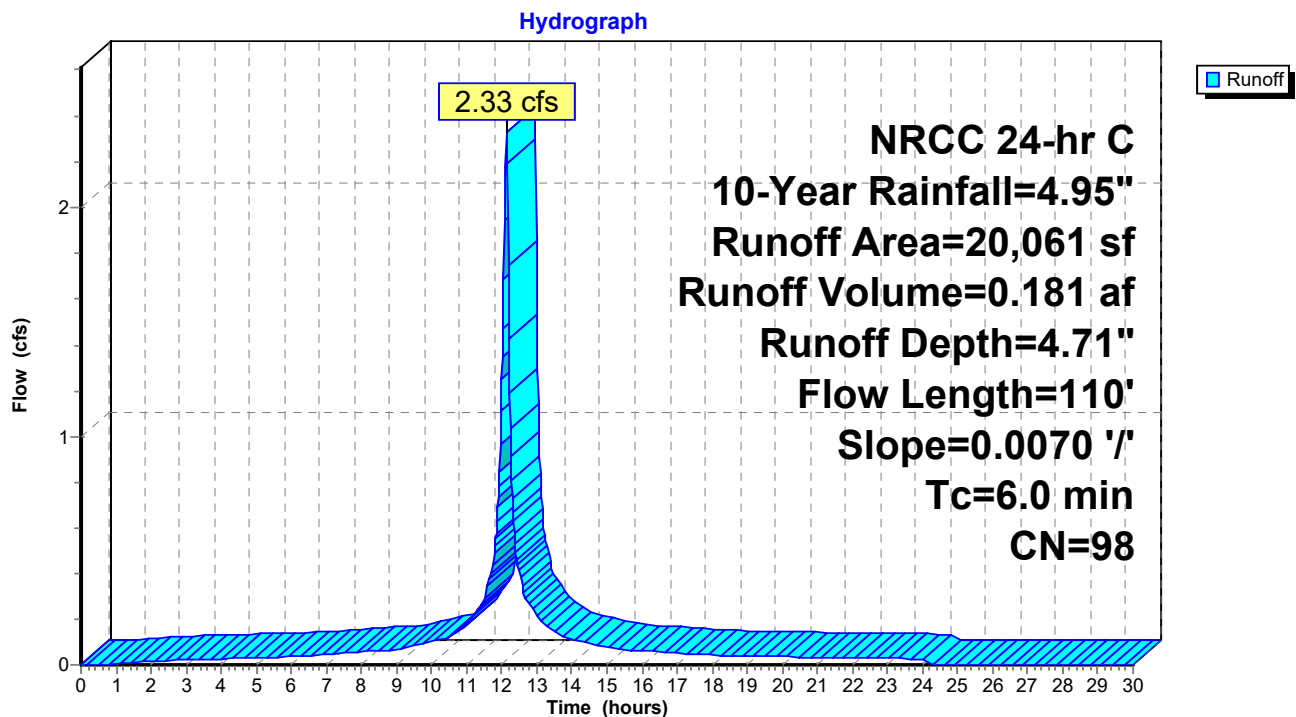
Runoff = 2.33 cfs @ 12.13 hrs, Volume= 0.181 af, Depth= 4.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 10-Year Rainfall=4.95"

	Area (sf)	CN	Description
*	12,171	98	Parking, Drive, F&R Sidewalks, HSG C
*	7,890	98	Building Roof, HSG C
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: CATCHMENT B



Summary for Pond 3P: CB1

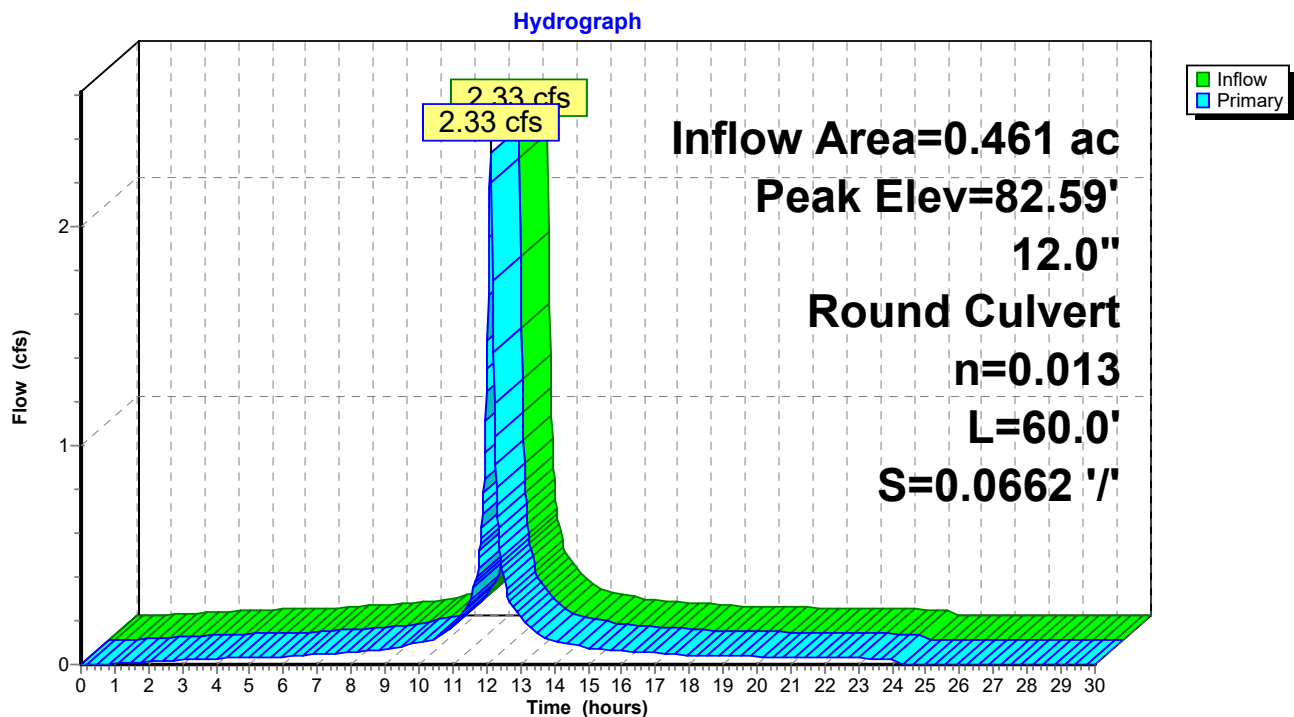
Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 4.71" for 10-Year event
 Inflow = 2.33 cfs @ 12.13 hrs, Volume= 0.181 af
 Outflow = 2.33 cfs @ 12.13 hrs, Volume= 0.181 af, Atten= 0%, Lag= 0.0 min
 Primary = 2.33 cfs @ 12.13 hrs, Volume= 0.181 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 82.59' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=2.31 cfs @ 12.13 hrs HW=82.58' TW=0.00' (Dynamic Tailwater)
 ↑ **1=Culvert** (Inlet Controls 2.31 cfs @ 3.18 fps)

Pond 3P: CB1

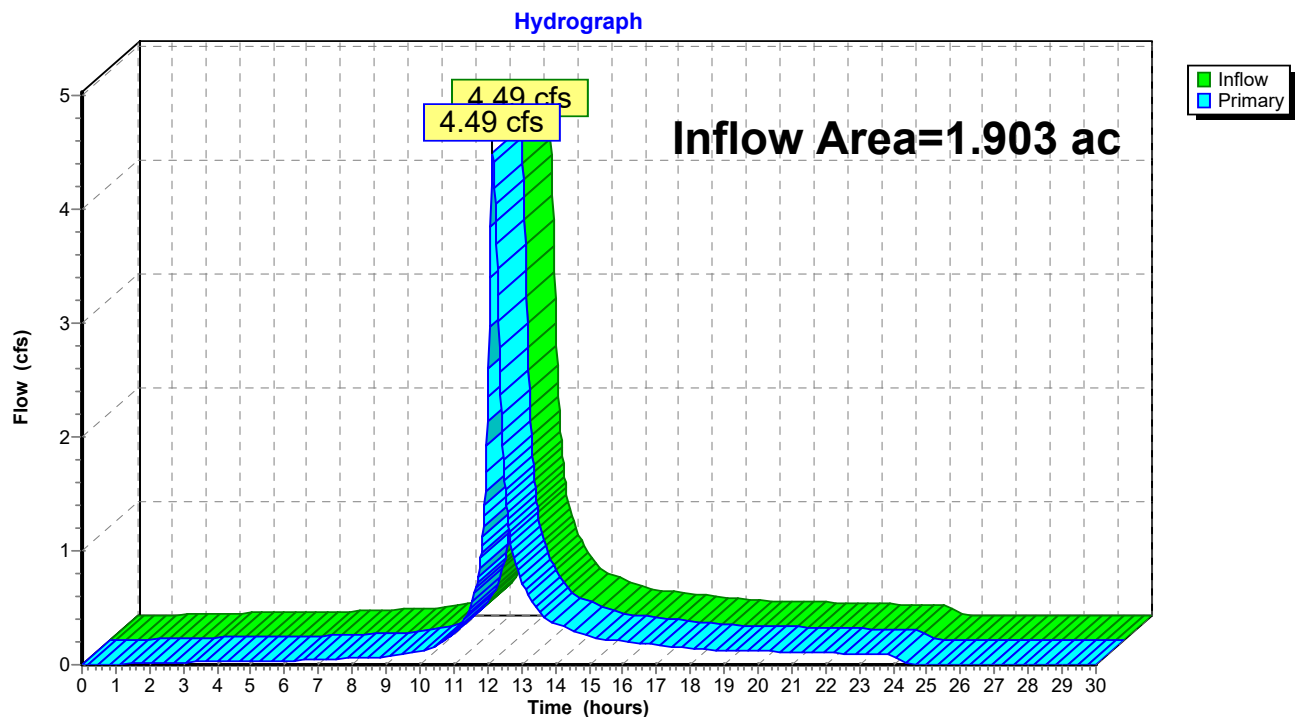


Summary for Link 2L: Project Total

Inflow Area = 1.903 ac, 24.19% Impervious, Inflow Depth = 2.78" for 10-Year event
Inflow = 4.49 cfs @ 12.15 hrs, Volume= 0.441 af
Primary = 4.49 cfs @ 12.15 hrs, Volume= 0.441 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total



VZW Pembroke 5 MA - HydroCAD - Existing 10.04.2NRCC 24-hr C 25-Year Rainfall=6.19"

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Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A

Runoff Area=62,853 sf 0.00% Impervious Runoff Depth=3.15"
Flow Length=359' Tc=14.5 min CN=72 Runoff=4.20 cfs 0.379 af

Subcatchment2S: CATCHMENT B

Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=5.95"
Flow Length=110' Slope=0.0070 '/' Tc=6.0 min CN=98 Runoff=2.92 cfs 0.228 af

Pond 3P: CB1

Peak Elev=82.81' Inflow=2.92 cfs 0.228 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/' Outflow=2.92 cfs 0.228 af

Link 2L: Project Total

Inflow=6.19 cfs 0.607 af
Primary=6.19 cfs 0.607 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.607 af Average Runoff Depth = 3.83"
75.81% Pervious = 1.443 ac 24.19% Impervious = 0.461 ac

Summary for Subcatchment 1S: CATCHMENT A

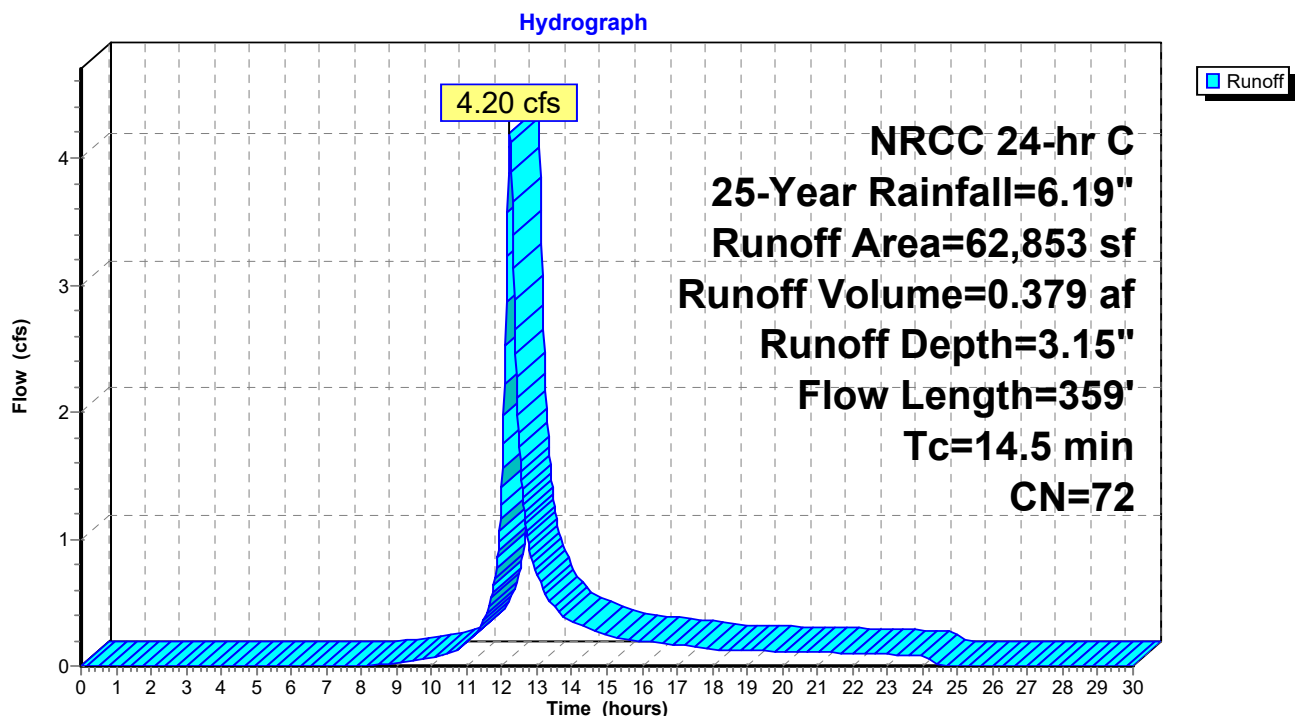
Runoff = 4.20 cfs @ 12.23 hrs, Volume= 0.379 af, Depth= 3.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 25-Year Rainfall=6.19"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
45,892	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
62,853	72	Weighted Average
62,853		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A



Summary for Subcatchment 2S: CATCHMENT B

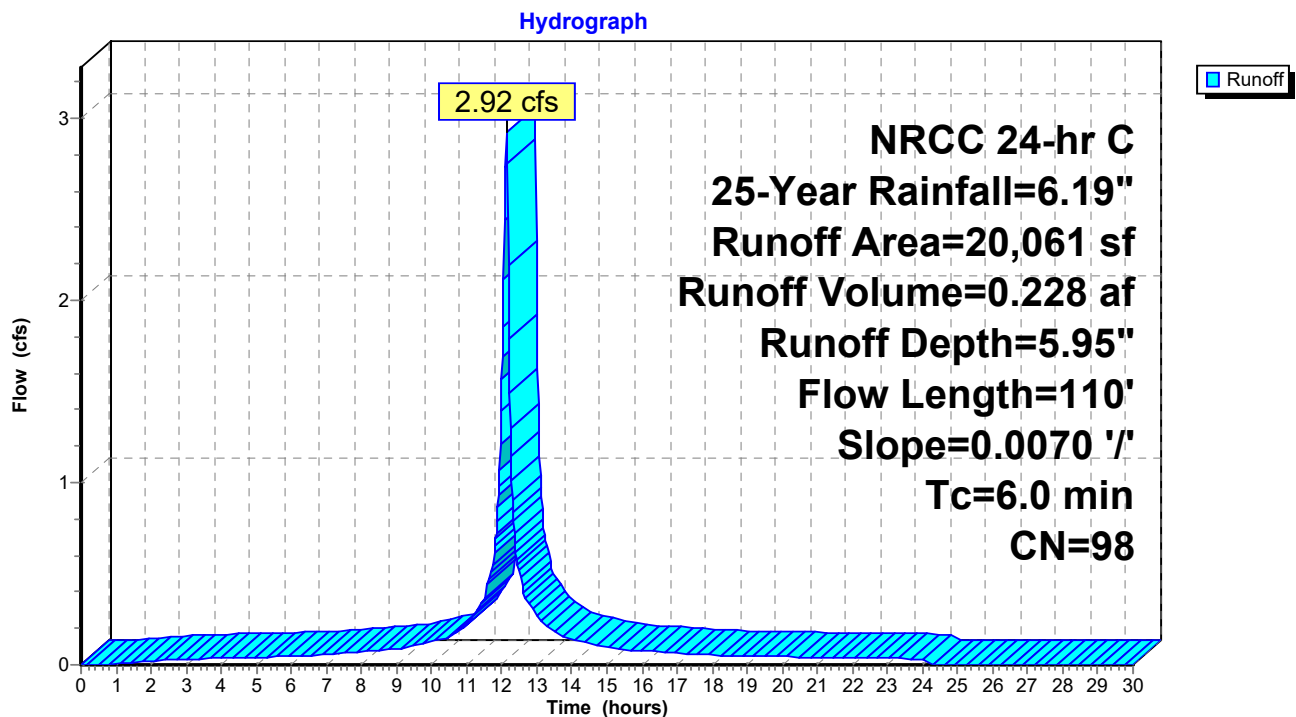
Runoff = 2.92 cfs @ 12.13 hrs, Volume= 0.228 af, Depth= 5.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 25-Year Rainfall=6.19"

	Area (sf)	CN	Description
*	12,171	98	Parking, Drive, F&R Sidewalks, HSG C
*	7,890	98	Building Roof, HSG C
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: CATCHMENT B



Summary for Pond 3P: CB1

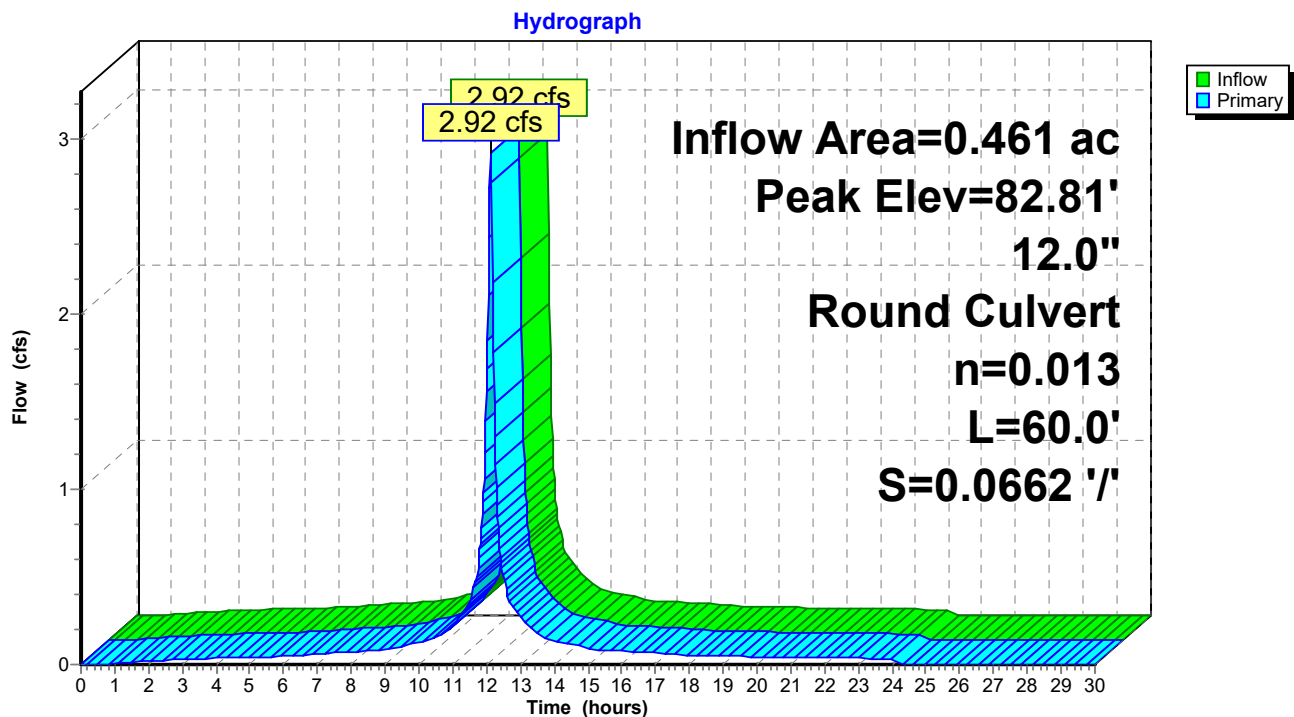
Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 5.95" for 25-Year event
 Inflow = 2.92 cfs @ 12.13 hrs, Volume= 0.228 af
 Outflow = 2.92 cfs @ 12.13 hrs, Volume= 0.228 af, Atten= 0%, Lag= 0.0 min
 Primary = 2.92 cfs @ 12.13 hrs, Volume= 0.228 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 82.81' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=2.90 cfs @ 12.13 hrs HW=82.80' TW=0.00' (Dynamic Tailwater)
 ↑ **1=Culvert** (Inlet Controls 2.90 cfs @ 3.69 fps)

Pond 3P: CB1

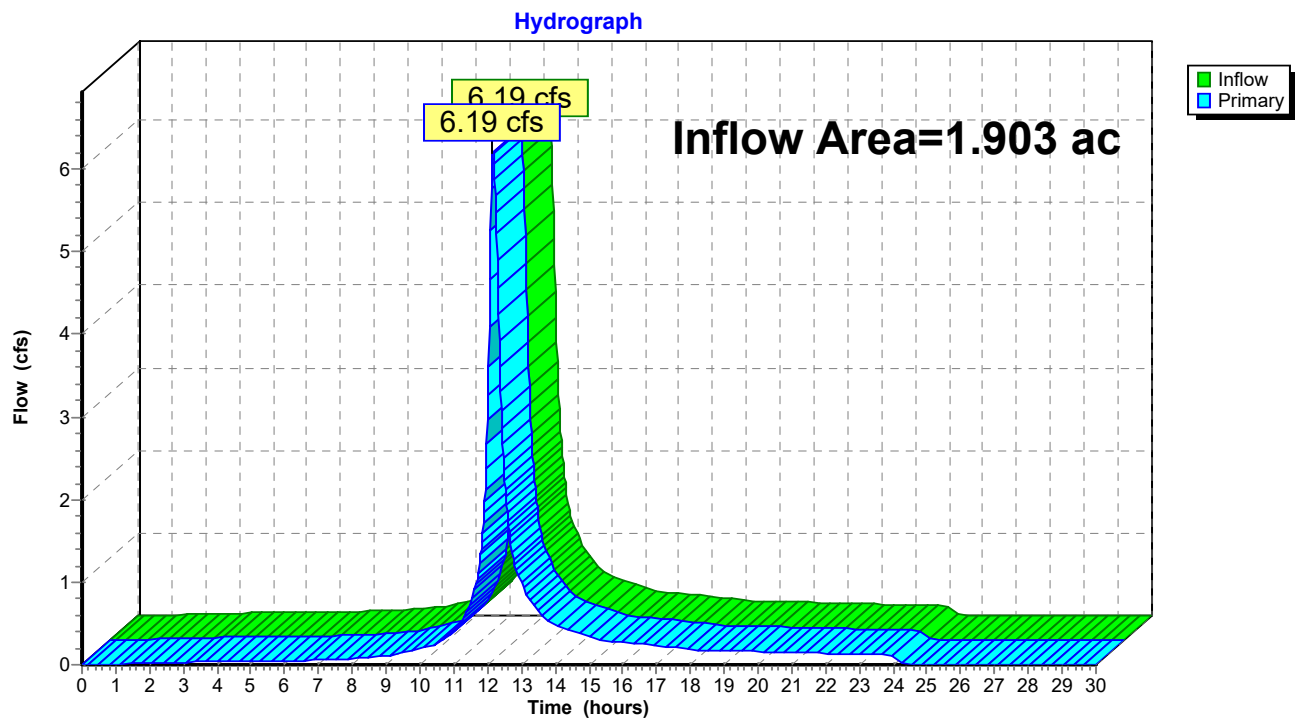


Summary for Link 2L: Project Total

Inflow Area = 1.903 ac, 24.19% Impervious, Inflow Depth = 3.83" for 25-Year event
Inflow = 6.19 cfs @ 12.16 hrs, Volume= 0.607 af
Primary = 6.19 cfs @ 12.16 hrs, Volume= 0.607 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total



VZW Pembroke 5 MA - HydroCAD - Existing 10.04.2NRCC 24-hr C 50-Year Rainfall=7.33"

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Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A

Runoff Area=62,853 sf 0.00% Impervious Runoff Depth=4.11"
Flow Length=359' Tc=14.5 min CN=72 Runoff=5.48 cfs 0.494 af

Subcatchment2S: CATCHMENT B

Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=7.09"
Flow Length=110' Slope=0.0070 '/' Tc=6.0 min CN=98 Runoff=3.47 cfs 0.272 af

Pond 3P: CB1

Peak Elev=83.05' Inflow=3.47 cfs 0.272 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/' Outflow=3.47 cfs 0.272 af

Link 2L: Project Total

Inflow=7.81 cfs 0.767 af
Primary=7.81 cfs 0.767 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.767 af Average Runoff Depth = 4.83"
75.81% Pervious = 1.443 ac 24.19% Impervious = 0.461 ac

Summary for Subcatchment 1S: CATCHMENT A

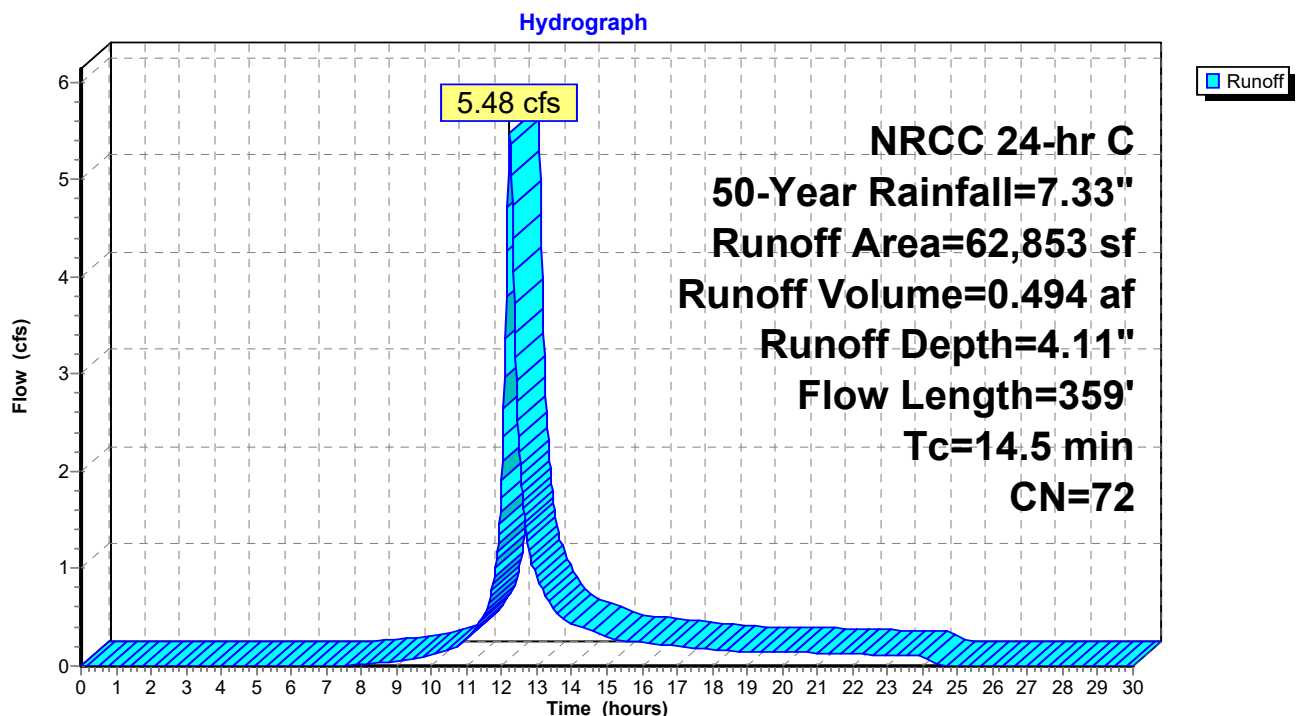
Runoff = 5.48 cfs @ 12.23 hrs, Volume= 0.494 af, Depth= 4.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 50-Year Rainfall=7.33"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
45,892	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
62,853	72	Weighted Average
62,853		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A



Summary for Subcatchment 2S: CATCHMENT B

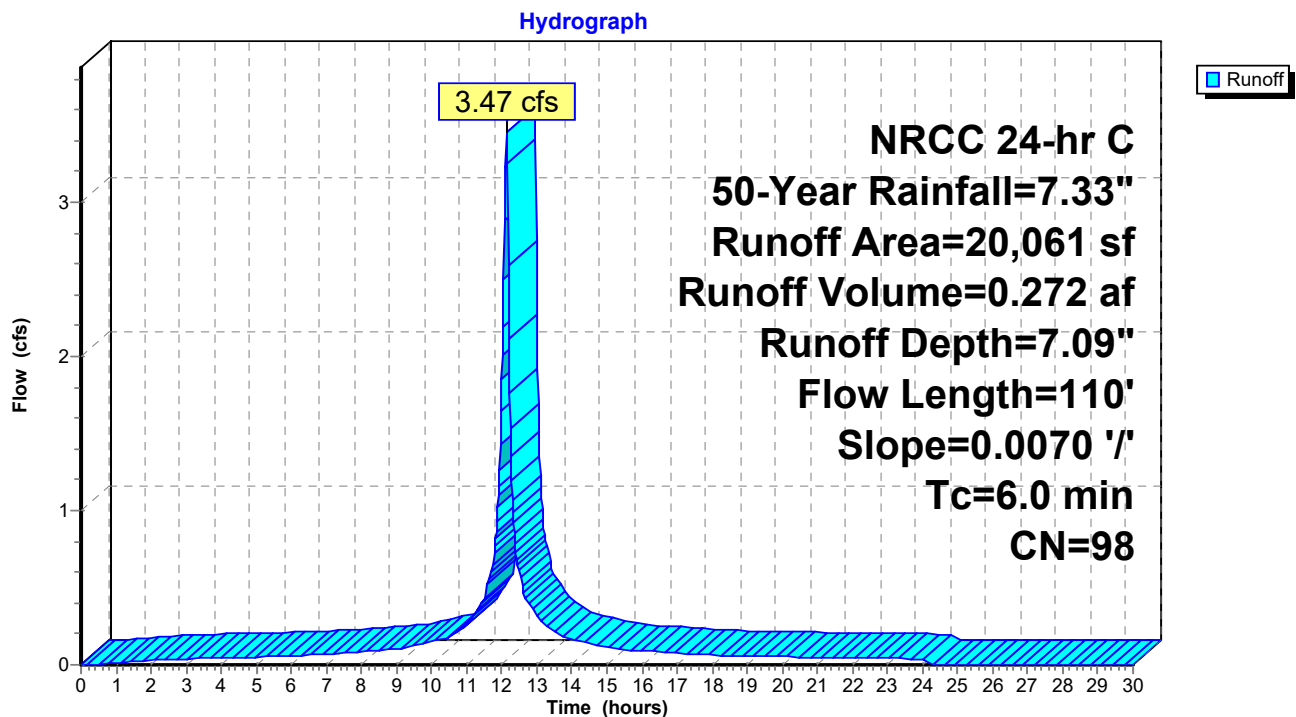
Runoff = 3.47 cfs @ 12.13 hrs, Volume= 0.272 af, Depth= 7.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 50-Year Rainfall=7.33"

	Area (sf)	CN	Description
*	12,171	98	Parking, Drive, F&R Sidewalks, HSG C
*	7,890	98	Building Roof, HSG C
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: CATCHMENT B



Summary for Pond 3P: CB1

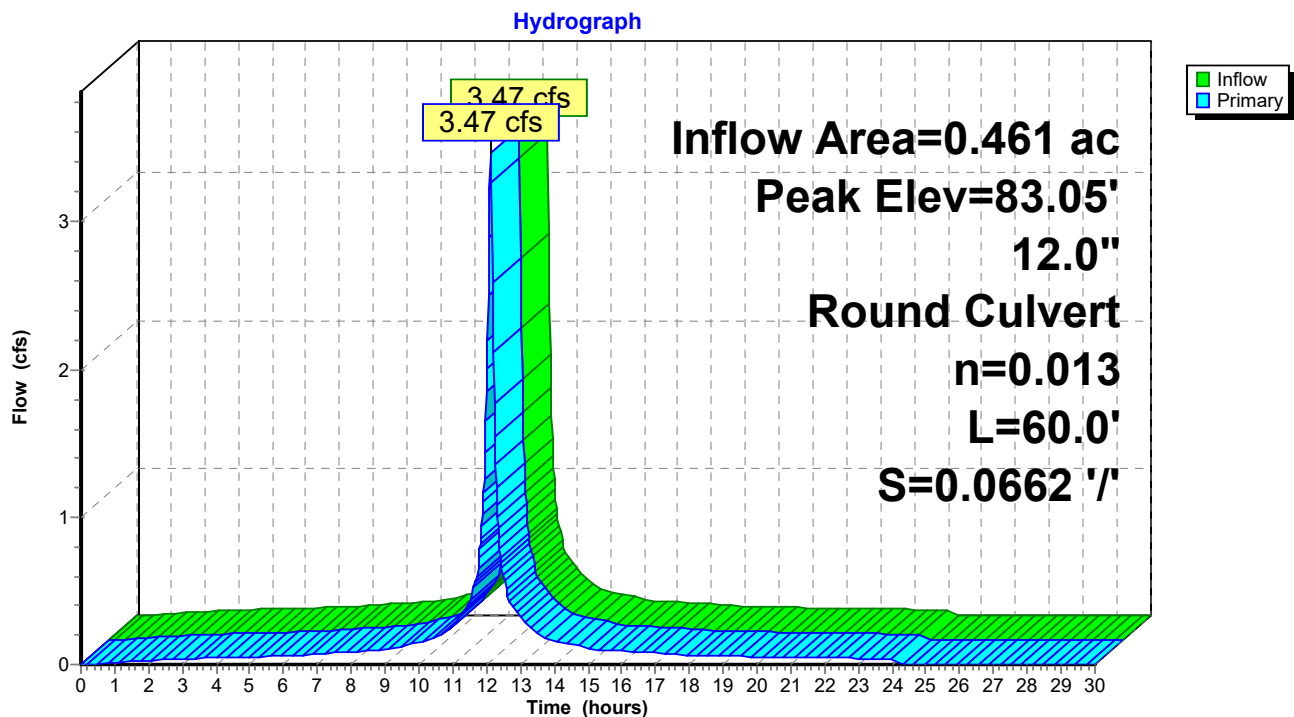
Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 7.09" for 50-Year event
 Inflow = 3.47 cfs @ 12.13 hrs, Volume= 0.272 af
 Outflow = 3.47 cfs @ 12.13 hrs, Volume= 0.272 af, Atten= 0%, Lag= 0.0 min
 Primary = 3.47 cfs @ 12.13 hrs, Volume= 0.272 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 83.05' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=3.44 cfs @ 12.13 hrs HW=83.04' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Culvert** (Inlet Controls 3.44 cfs @ 4.38 fps)

Pond 3P: CB1

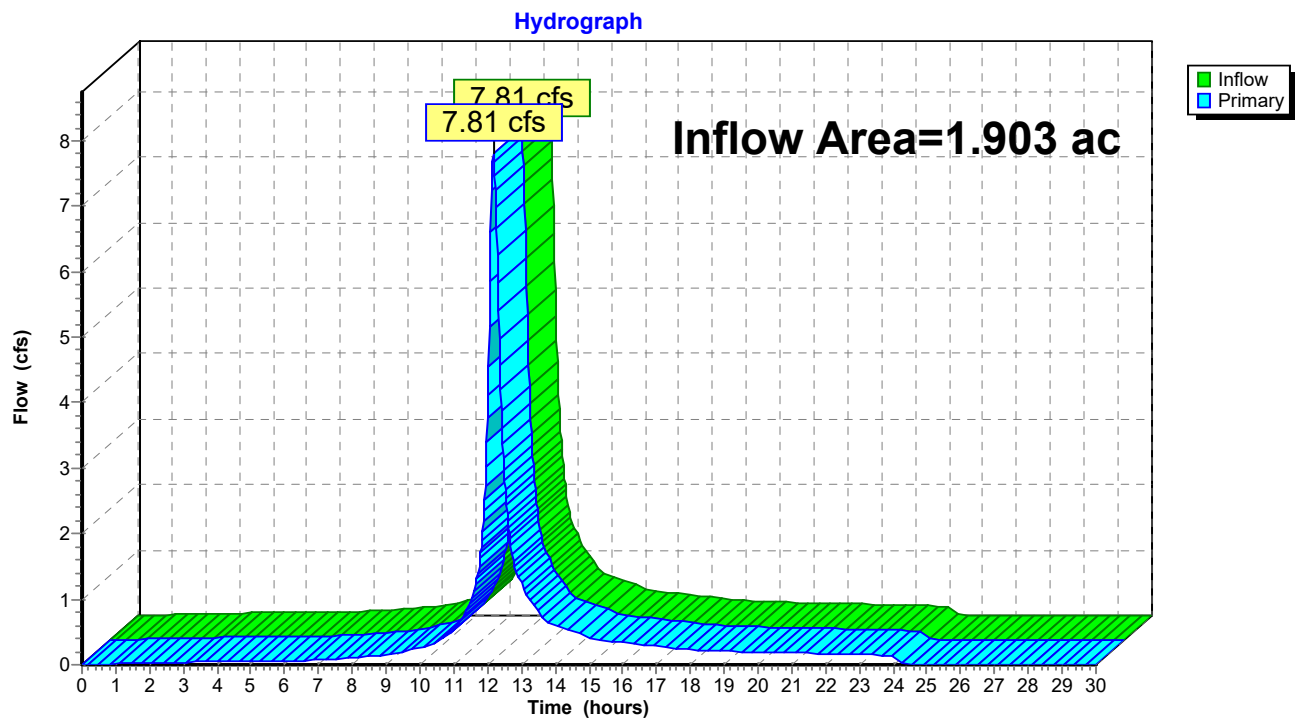


Summary for Link 2L: Project Total

Inflow Area = 1.903 ac, 24.19% Impervious, Inflow Depth = 4.83" for 50-Year event
Inflow = 7.81 cfs @ 12.16 hrs, Volume= 0.767 af
Primary = 7.81 cfs @ 12.16 hrs, Volume= 0.767 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total



VZW Pembroke 5 MA - HydroCAD - Existing 10.04.NRCC 24-hr C 100-Year Rainfall=8.68"

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Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A

Runoff Area=62,853 sf 0.00% Impervious Runoff Depth=5.30"
Flow Length=359' Tc=14.5 min CN=72 Runoff=7.04 cfs 0.637 af

Subcatchment2S: CATCHMENT B

Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=8.44"
Flow Length=110' Slope=0.0070 '/' Tc=6.0 min CN=98 Runoff=4.11 cfs 0.324 af

Pond 3P: CB1

Peak Elev=83.39' Inflow=4.11 cfs 0.324 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/' Outflow=4.11 cfs 0.324 af

Link 2L: Project Total

Inflow=9.76 cfs 0.961 af
Primary=9.76 cfs 0.961 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.961 af Average Runoff Depth = 6.06"
75.81% Pervious = 1.443 ac 24.19% Impervious = 0.461 ac

Summary for Subcatchment 1S: CATCHMENT A

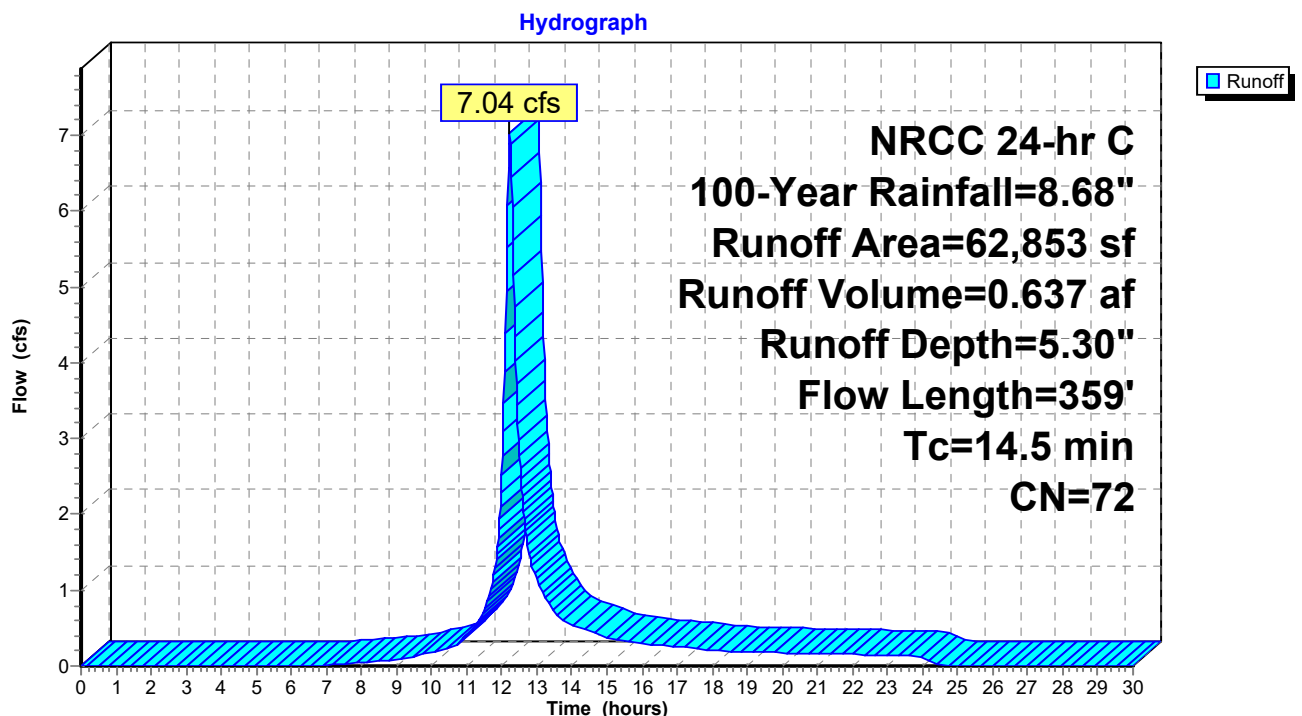
Runoff = 7.04 cfs @ 12.23 hrs, Volume= 0.637 af, Depth= 5.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
45,892	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
62,853	72	Weighted Average
62,853		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A



Summary for Subcatchment 2S: CATCHMENT B

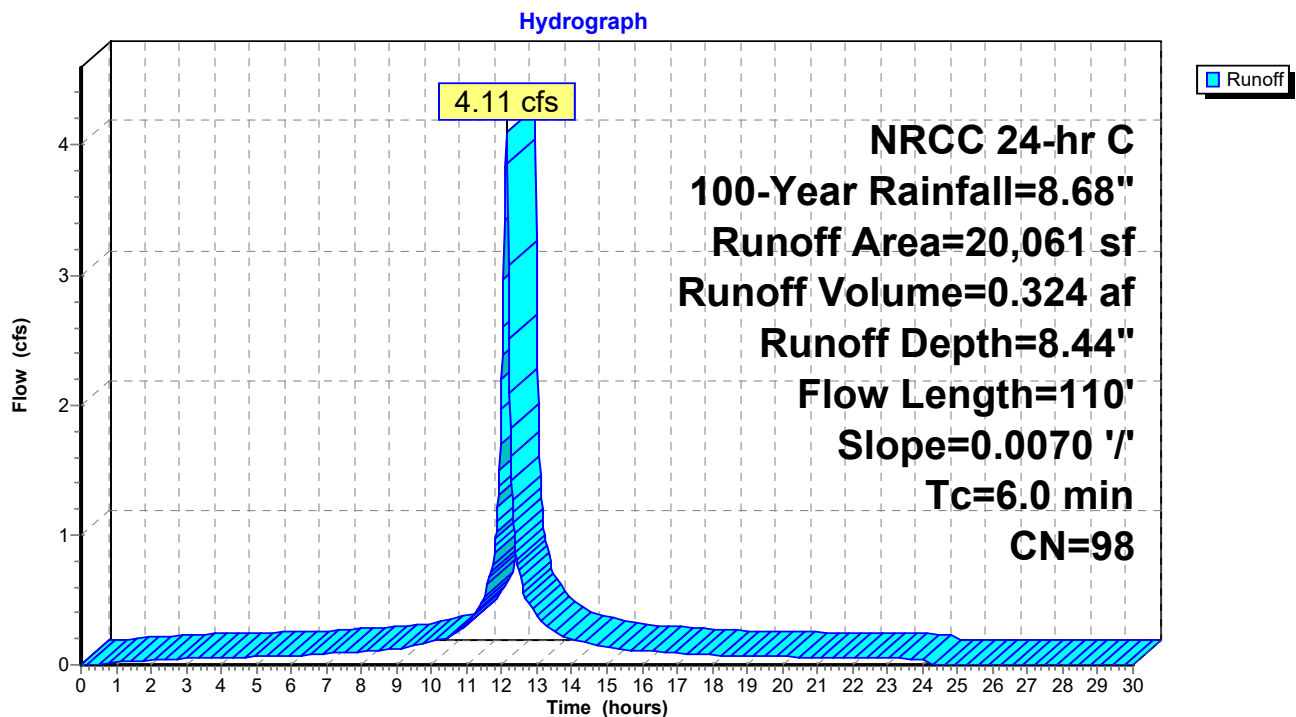
Runoff = 4.11 cfs @ 12.13 hrs, Volume= 0.324 af, Depth= 8.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

	Area (sf)	CN	Description
*	12,171	98	Parking, Drive, F&R Sidewalks, HSG C
*	7,890	98	Building Roof, HSG C
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: CATCHMENT B



Summary for Pond 3P: CB1

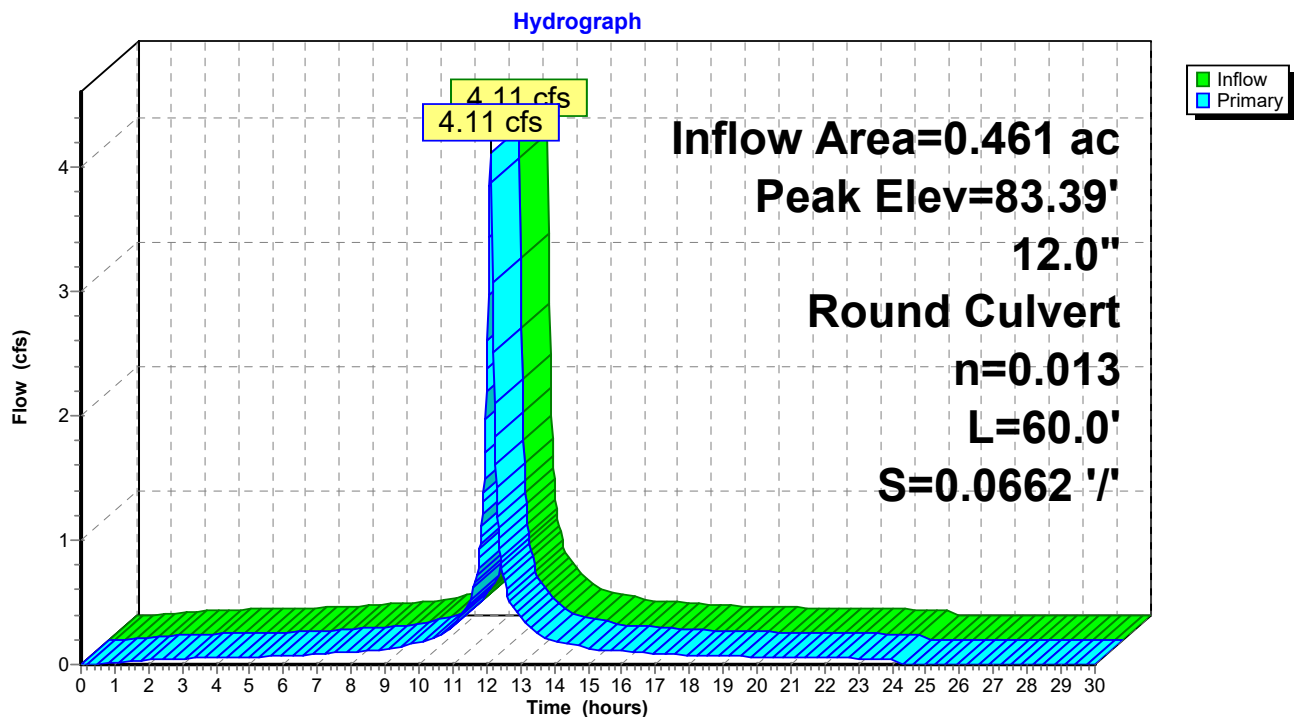
Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 8.44" for 100-Year event
 Inflow = 4.11 cfs @ 12.13 hrs, Volume= 0.324 af
 Outflow = 4.11 cfs @ 12.13 hrs, Volume= 0.324 af, Atten= 0%, Lag= 0.0 min
 Primary = 4.11 cfs @ 12.13 hrs, Volume= 0.324 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 83.39' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=4.07 cfs @ 12.13 hrs HW=83.39' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Culvert** (Inlet Controls 4.07 cfs @ 5.19 fps)

Pond 3P: CB1

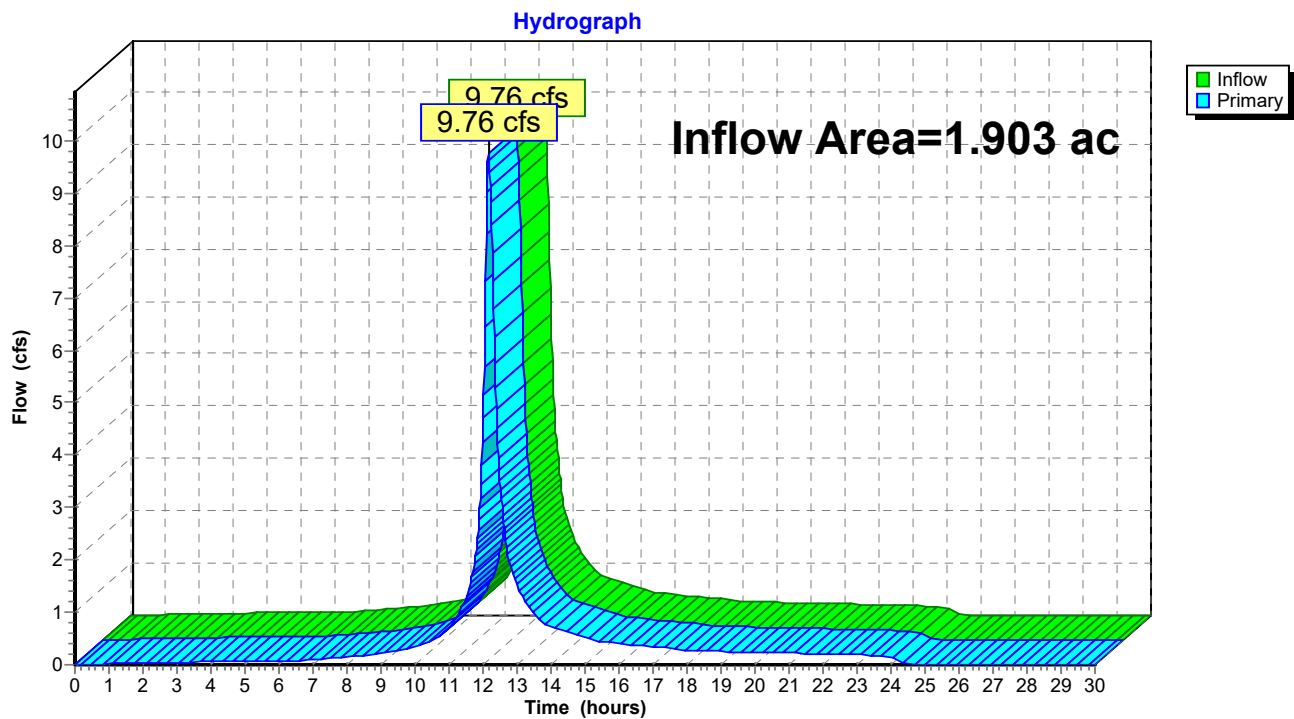


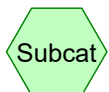
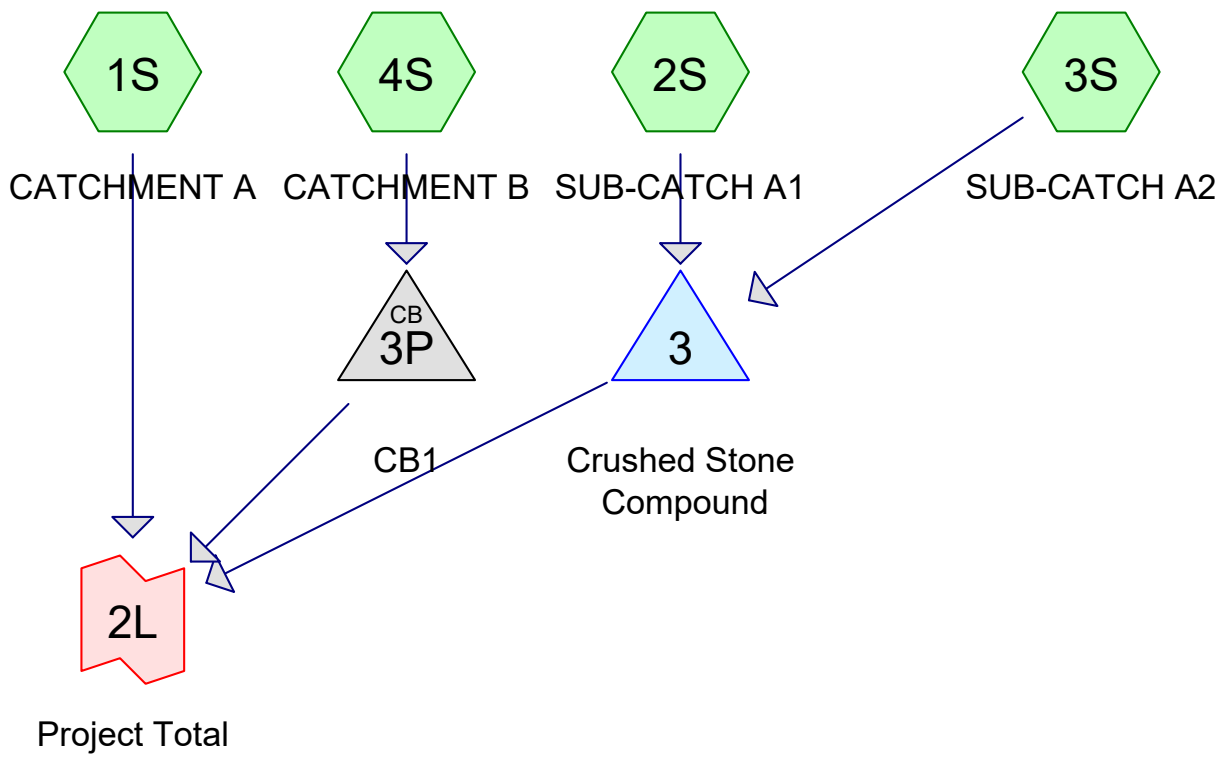
Summary for Link 2L: Project Total

Inflow Area = 1.903 ac, 24.19% Impervious, Inflow Depth = 6.06" for 100-Year event
Inflow = 9.76 cfs @ 12.16 hrs, Volume= 0.961 af
Primary = 9.76 cfs @ 12.16 hrs, Volume= 0.961 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total

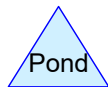




Subcat



Reach



Pond



Link

Routing Diagram for VZW Pembroke 5 MA - HydroCAD - Proposed 10.04.2

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VZW Pembroke 5 MA - HydroCAD - Proposed 10.04.21

Prepared by {enter your company name here}

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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-Year	NRCC 24-hr	C	Default	24.00	1	2.78	2
2	2-Year	NRCC 24-hr	C	Default	24.00	1	3.35	2
3	10-Year	NRCC 24-hr	C	Default	24.00	1	4.95	2
4	25-Year	NRCC 24-hr	C	Default	24.00	1	6.19	2
5	50-Year	NRCC 24-hr	C	Default	24.00	1	7.33	2
6	100-Year	NRCC 24-hr	C	Default	24.00	1	8.68	2

VZW Pembroke 5 MA - HydroCAD - Proposed 10.04.21

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.017	99	3 Future Carrier Pads (12'x20' ea) (2S)
0.320	74	>75% Grass cover, Good, HSG C (1S)
0.181	98	Building Roof (4S)
0.039	89	Crushed Stone Compound (exposed) (2S)
0.069	87	Mulch/Dirt roads, HSG C (1S)
0.279	98	Parking, Driveway, F&R Sidewalks (4S)
0.036	85	Proposed Gravel Drive, HSG C (3S)
0.002	99	VZW Comm Equip & Pads (2S)
0.960	70	Woods, Good, HSG C (1S)
1.903	79	TOTAL AREA

VZW Pembroke 5 MA - HydroCAD - Proposed 10.04.2 NRCC 24-hr C 1-Year Rainfall=2.78"

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Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A Runoff Area=58,793 sf 0.00% Impervious Runoff Depth=0.68"
Flow Length=359' Tc=14.5 min CN=72 Runoff=0.76 cfs 0.077 af

Subcatchment2S: SUB-CATCH A1 Runoff Area=2,500 sf 32.80% Impervious Runoff Depth=1.95"
Flow Length=70' Slope=0.0050 '/ Tc=6.0 min CN=92 Runoff=0.14 cfs 0.009 af

Subcatchment3S: SUB-CATCH A2 Runoff Area=1,560 sf 0.00% Impervious Runoff Depth=1.41"
Flow Length=90' Slope=0.0070 '/ Tc=6.0 min CN=85 Runoff=0.06 cfs 0.004 af

Subcatchment4S: CATCHMENT B Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=2.55"
Flow Length=110' Slope=0.0070 '/ Tc=6.0 min CN=98 Runoff=1.30 cfs 0.098 af

Pond 3: Crushed Stone Compound Peak Elev=72.62' Storage=0.003 af Inflow=0.20 cfs 0.014 af
Discarded=0.04 cfs 0.014 af Primary=0.00 cfs 0.000 af Outflow=0.04 cfs 0.014 af

Pond 3P: CB1 Peak Elev=82.31' Inflow=1.30 cfs 0.098 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/ Outflow=1.30 cfs 0.098 af

Link 2L: Project Total Inflow=1.79 cfs 0.174 af
Primary=1.79 cfs 0.174 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.188 af Average Runoff Depth = 1.18"
74.82% Pervious = 1.424 ac 25.18% Impervious = 0.479 ac

Summary for Subcatchment 1S: CATCHMENT A

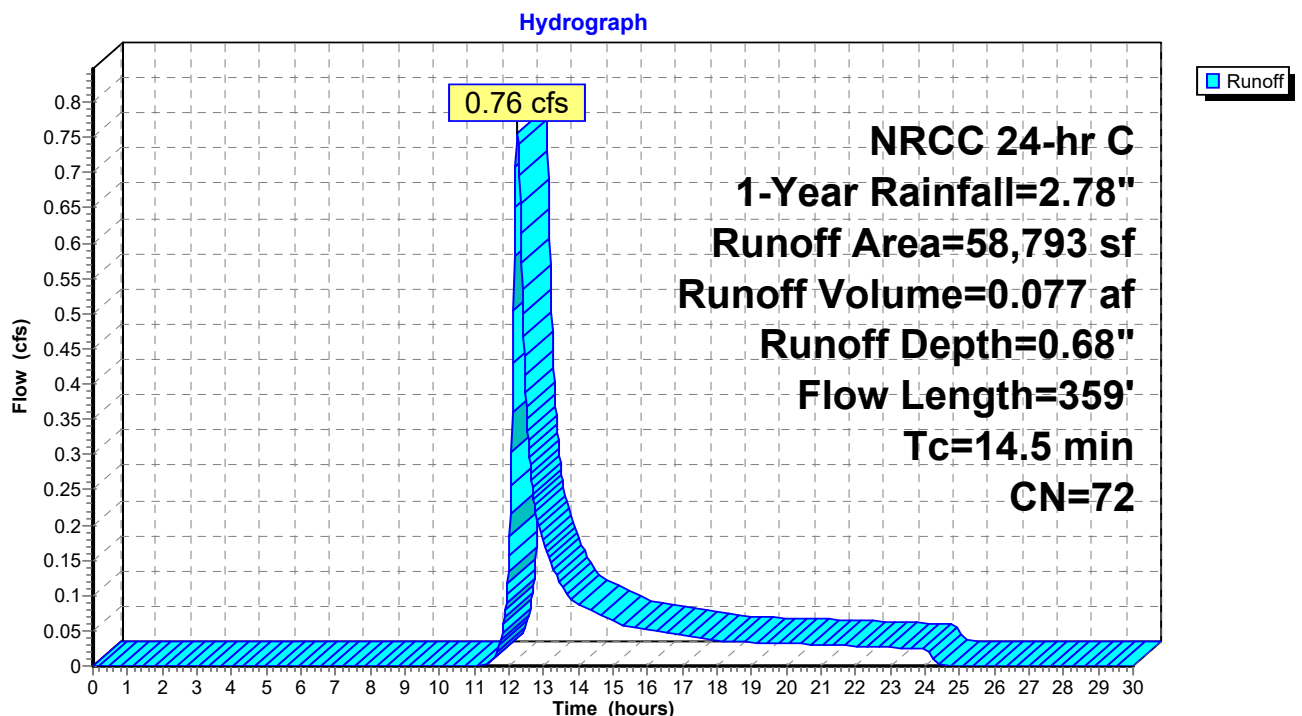
Runoff = 0.76 cfs @ 12.24 hrs, Volume= 0.077 af, Depth= 0.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 1-Year Rainfall=2.78"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
41,832	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
58,793	72	Weighted Average
58,793		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A



Summary for Subcatchment 2S: SUB-CATCH A1

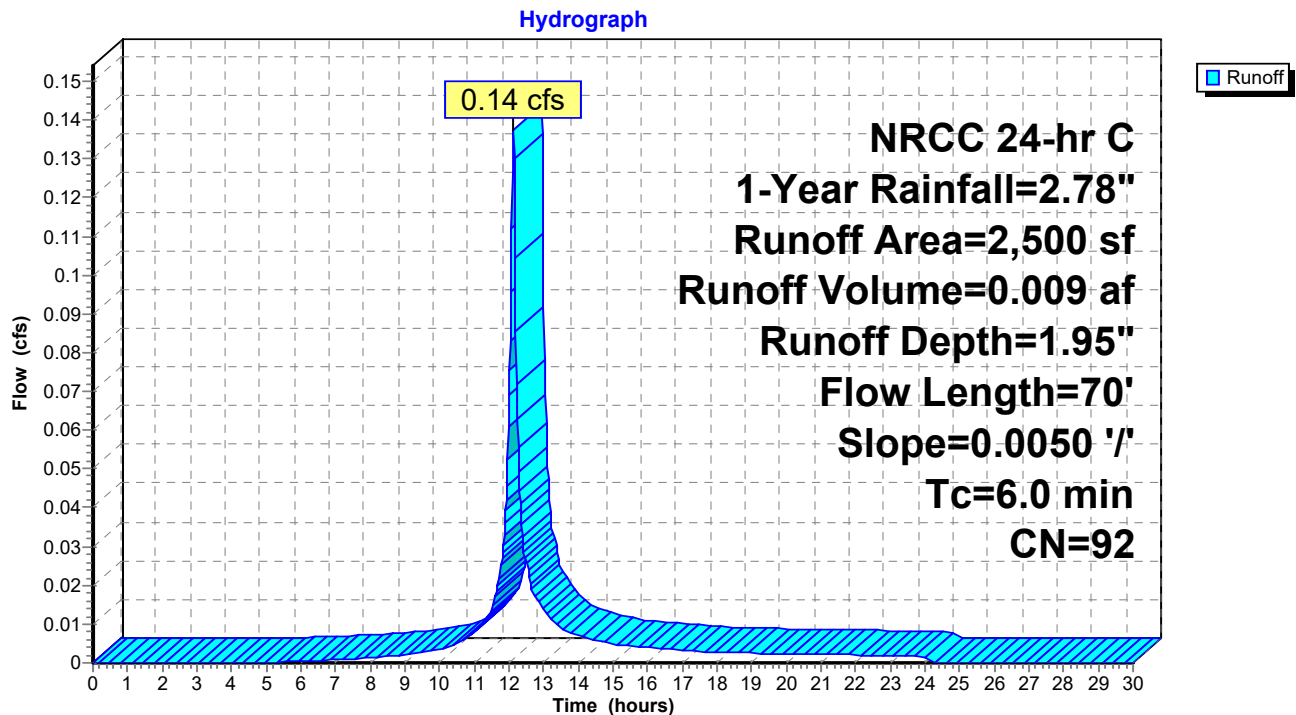
Runoff = 0.14 cfs @ 12.13 hrs, Volume= 0.009 af, Depth= 1.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 1-Year Rainfall=2.78"

Area (sf)	CN	Description
* 1,680	89	Crushed Stone Compound (exposed)
* 100	99	VZW Comm Equip & Pads
* 720	99	3 Future Carrier Pads (12'x20' ea)
2,500	92	Weighted Average
1,680		67.20% Pervious Area
820		32.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	70	0.0050	0.34		Lag/CN Method,
3.5	70	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: SUB-CATCH A1



Summary for Subcatchment 3S: SUB-CATCH A2

Runoff = 0.06 cfs @ 12.13 hrs, Volume= 0.004 af, Depth= 1.41"

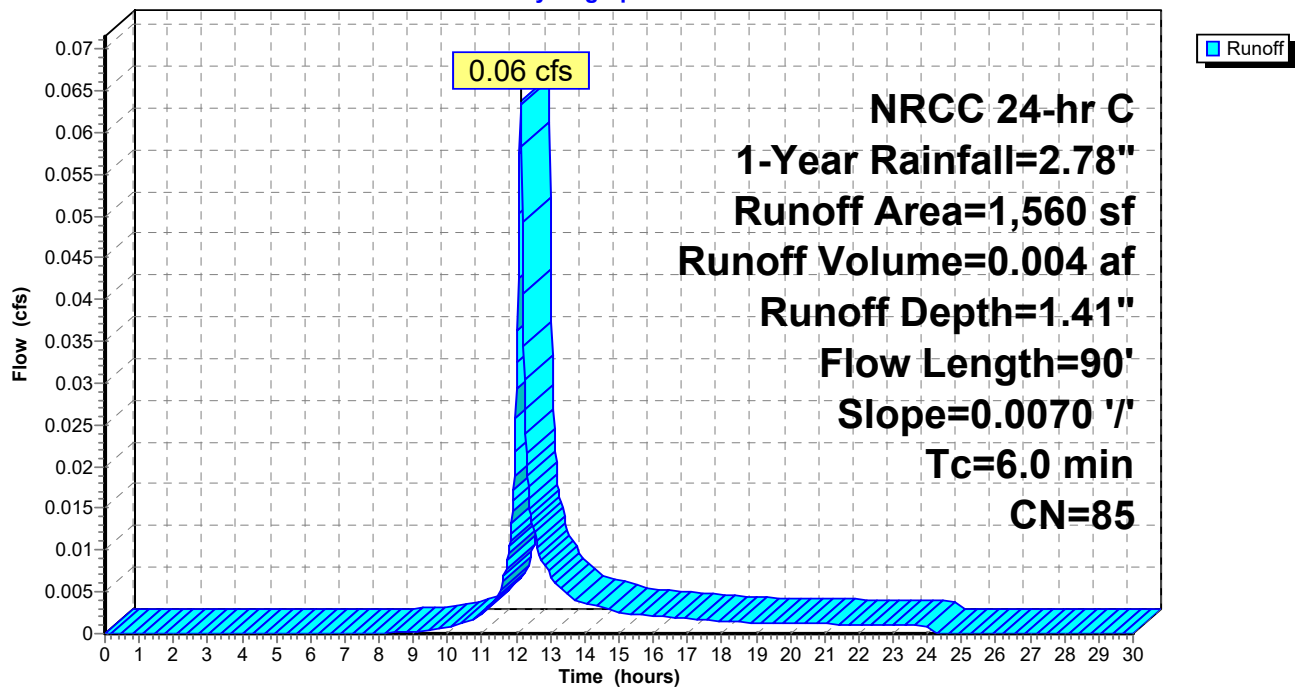
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 1-Year Rainfall=2.78"

Area (sf)	CN	Description
* 1,560	85	Proposed Gravel Drive, HSG C
1,560		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	90	0.0070	0.32		Lag/CN Method,
4.7	90	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 3S: SUB-CATCH A2

Hydrograph



Summary for Subcatchment 4S: CATCHMENT B

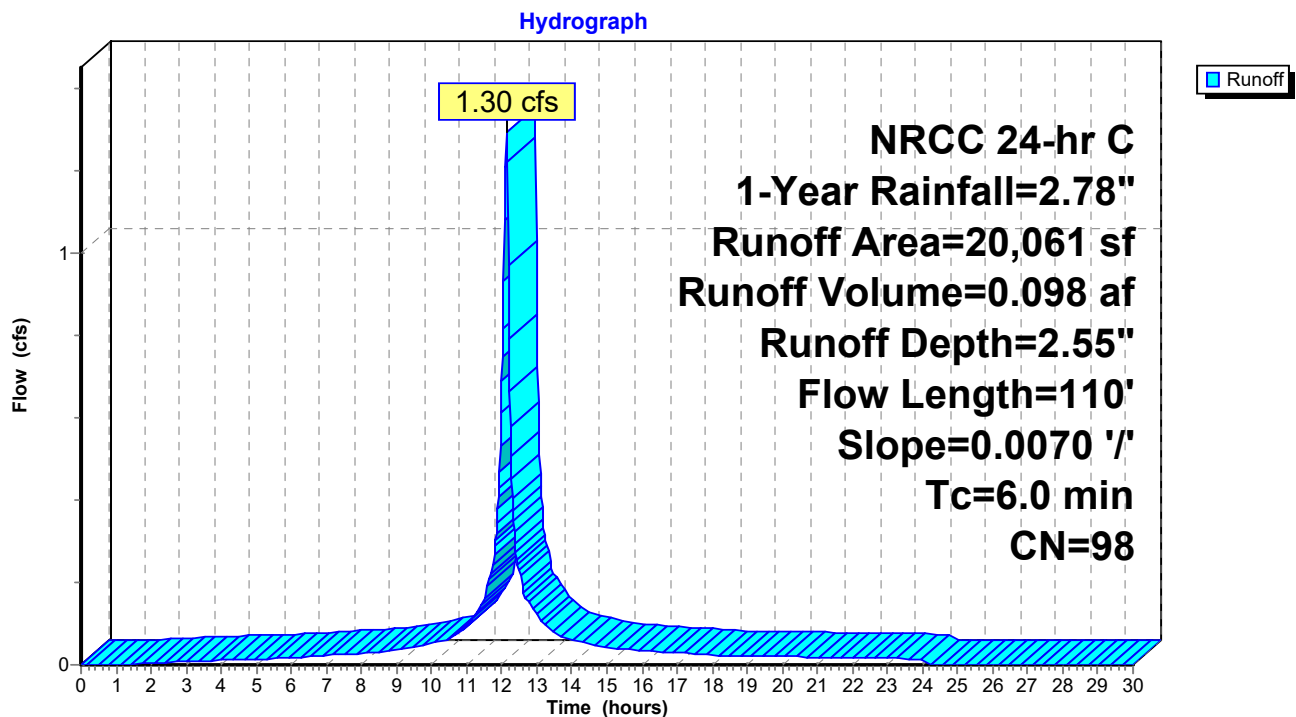
Runoff = 1.30 cfs @ 12.13 hrs, Volume= 0.098 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 1-Year Rainfall=2.78"

	Area (sf)	CN	Description
*	12,171	98	Parking, Driveway, F&R Sidewalks
*	7,890	98	Building Roof
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 4S: CATCHMENT B



Summary for Pond 3: Crushed Stone Compound

Inflow Area = 0.093 ac, 20.20% Impervious, Inflow Depth = 1.74" for 1-Year event
 Inflow = 0.20 cfs @ 12.13 hrs, Volume= 0.014 af
 Outflow = 0.04 cfs @ 12.00 hrs, Volume= 0.014 af, Atten= 80%, Lag= 0.0 min
 Discarded = 0.04 cfs @ 12.00 hrs, Volume= 0.014 af
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 72.62' @ 12.45 hrs Surf.Area= 0.057 ac Storage= 0.003 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
 Center-of-Mass det. time= 15.6 min (835.7 - 820.1)

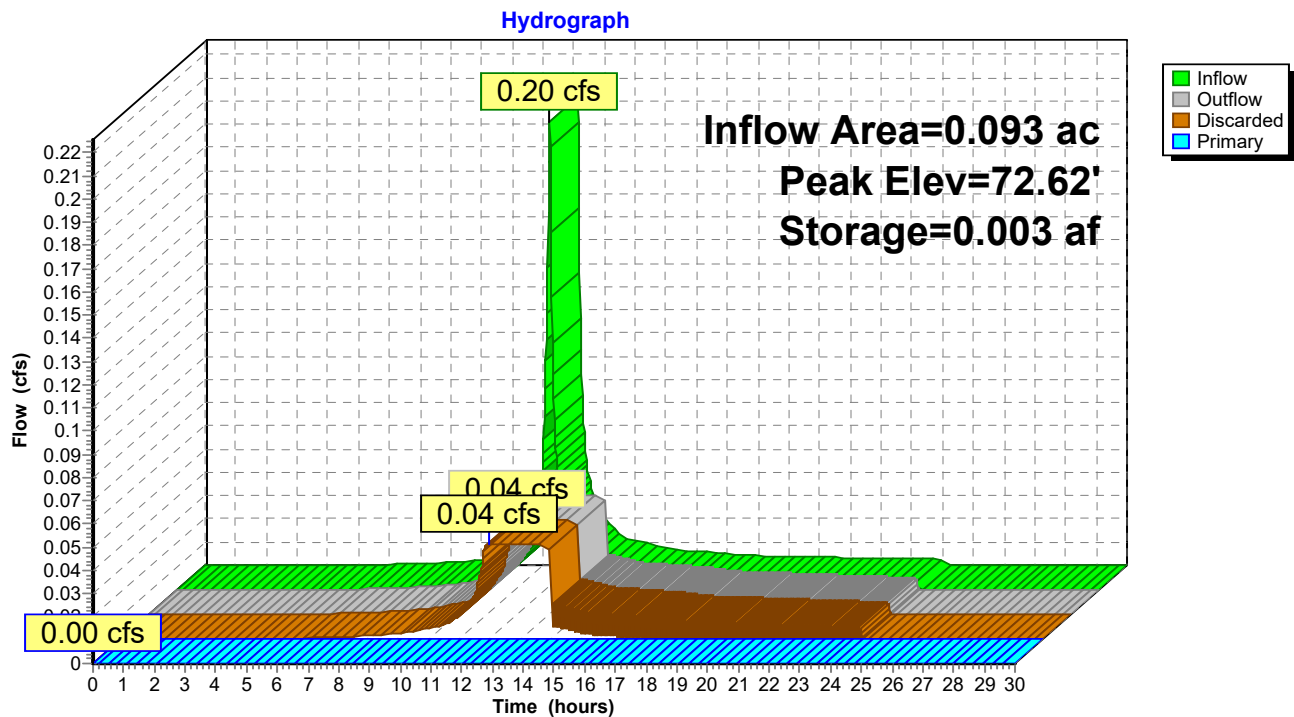
Volume	Invert	Avail.Storage	Storage Description
#1	72.50'	0.023 af	50.00'W x 50.00'L x 1.00'H Prismatic 0.057 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	73.45'	50.0' long x 1.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#2	Discarded	72.50'	0.700 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.04 cfs @ 12.00 hrs HW=72.51' (Free Discharge)
 ↑ **2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=72.50' TW=0.00' (Dynamic Tailwater)
 ↑ **1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3: Crushed Stone Compound



Summary for Pond 3P: CB1

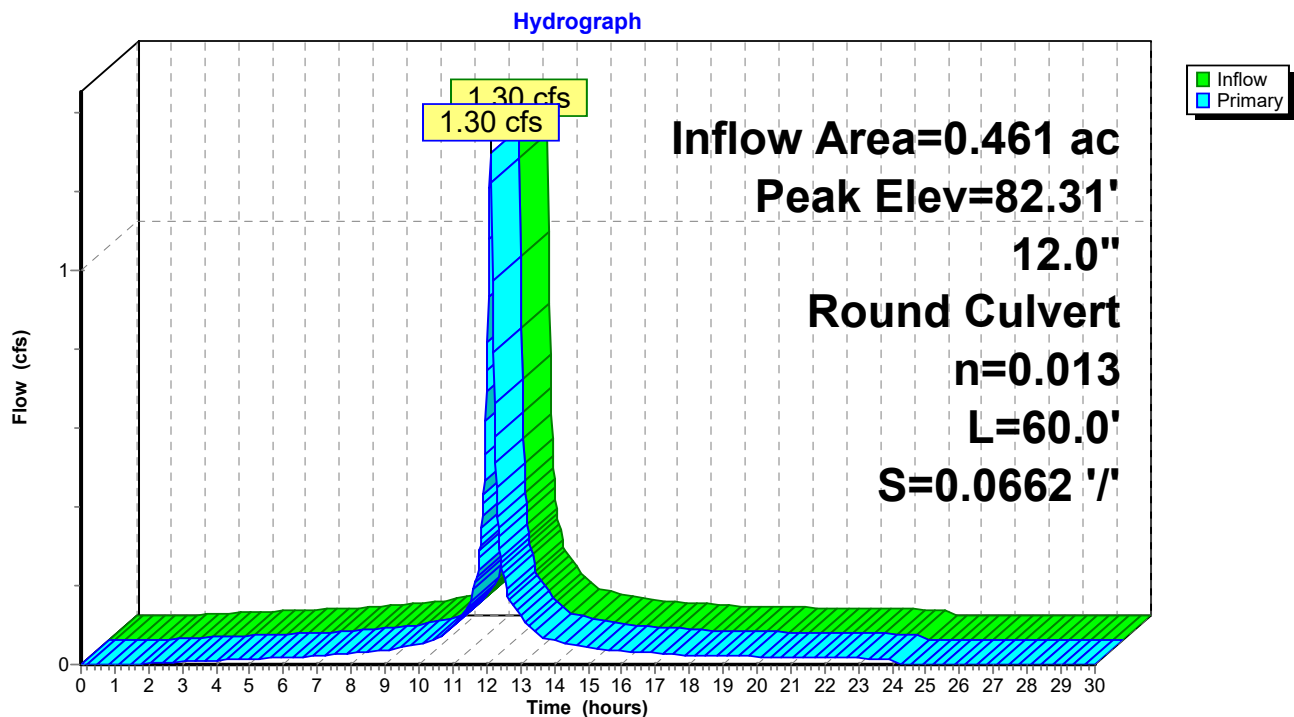
Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 2.55" for 1-Year event
 Inflow = 1.30 cfs @ 12.13 hrs, Volume= 0.098 af
 Outflow = 1.30 cfs @ 12.13 hrs, Volume= 0.098 af, Atten= 0%, Lag= 0.0 min
 Primary = 1.30 cfs @ 12.13 hrs, Volume= 0.098 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 82.31' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=1.29 cfs @ 12.13 hrs HW=82.31' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Culvert** (Inlet Controls 1.29 cfs @ 2.63 fps)

Pond 3P: CB1

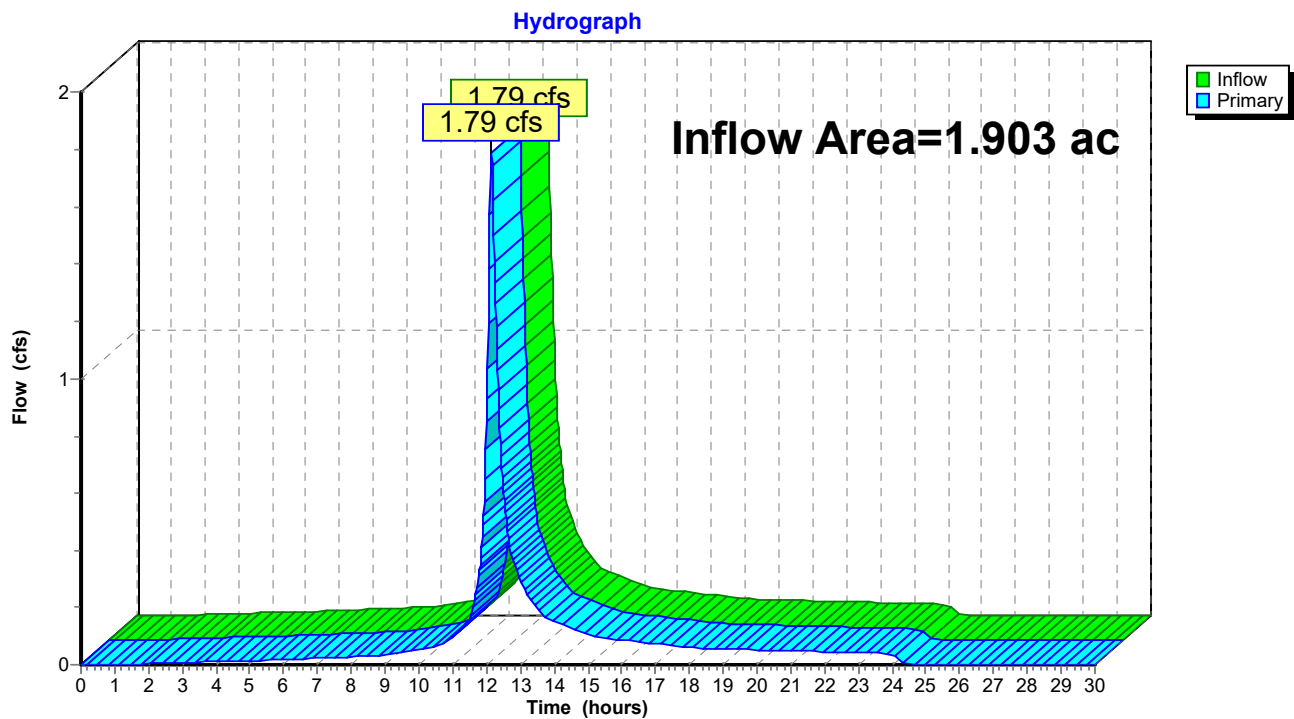


Summary for Link 2L: Project Total

Inflow Area = 1.903 ac, 25.18% Impervious, Inflow Depth = 1.10" for 1-Year event
Inflow = 1.79 cfs @ 12.14 hrs, Volume= 0.174 af
Primary = 1.79 cfs @ 12.14 hrs, Volume= 0.174 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total



VZW Pembroke 5 MA - HydroCAD - Proposed 10.04.2 NRCC 24-hr C 2-Year Rainfall=3.35"

Prepared by {enter your company name here}

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Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A Runoff Area=58,793 sf 0.00% Impervious Runoff Depth=1.02"
Flow Length=359' Tc=14.5 min CN=72 Runoff=1.21 cfs 0.115 af

Subcatchment2S: SUB-CATCH A1 Runoff Area=2,500 sf 32.80% Impervious Runoff Depth=2.49"
Flow Length=70' Slope=0.0050 '/ Tc=6.0 min CN=92 Runoff=0.17 cfs 0.012 af

Subcatchment3S: SUB-CATCH A2 Runoff Area=1,560 sf 0.00% Impervious Runoff Depth=1.89"
Flow Length=90' Slope=0.0070 '/ Tc=6.0 min CN=85 Runoff=0.09 cfs 0.006 af

Subcatchment4S: CATCHMENT B Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=3.12"
Flow Length=110' Slope=0.0070 '/ Tc=6.0 min CN=98 Runoff=1.57 cfs 0.120 af

Pond 3: Crushed Stone Compound Peak Elev=72.69' Storage=0.004 af Inflow=0.26 cfs 0.018 af
Discarded=0.04 cfs 0.018 af Primary=0.00 cfs 0.000 af Outflow=0.04 cfs 0.018 af

Pond 3P: CB1 Peak Elev=82.38' Inflow=1.57 cfs 0.120 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/ Outflow=1.57 cfs 0.120 af

Link 2L: Project Total Inflow=2.41 cfs 0.235 af
Primary=2.41 cfs 0.235 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.252 af Average Runoff Depth = 1.59"
74.82% Pervious = 1.424 ac 25.18% Impervious = 0.479 ac

Summary for Subcatchment 1S: CATCHMENT A

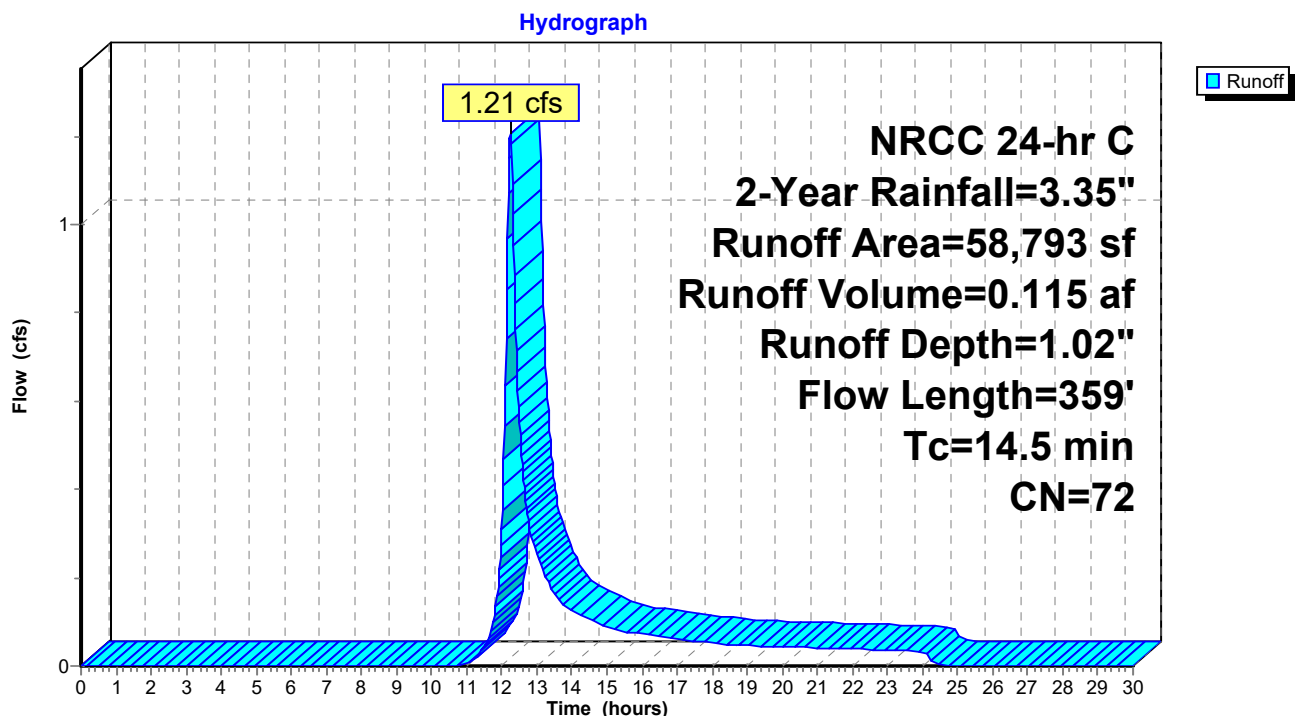
Runoff = 1.21 cfs @ 12.24 hrs, Volume= 0.115 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 2-Year Rainfall=3.35"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
41,832	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
58,793	72	Weighted Average
58,793		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A



Summary for Subcatchment 2S: SUB-CATCH A1

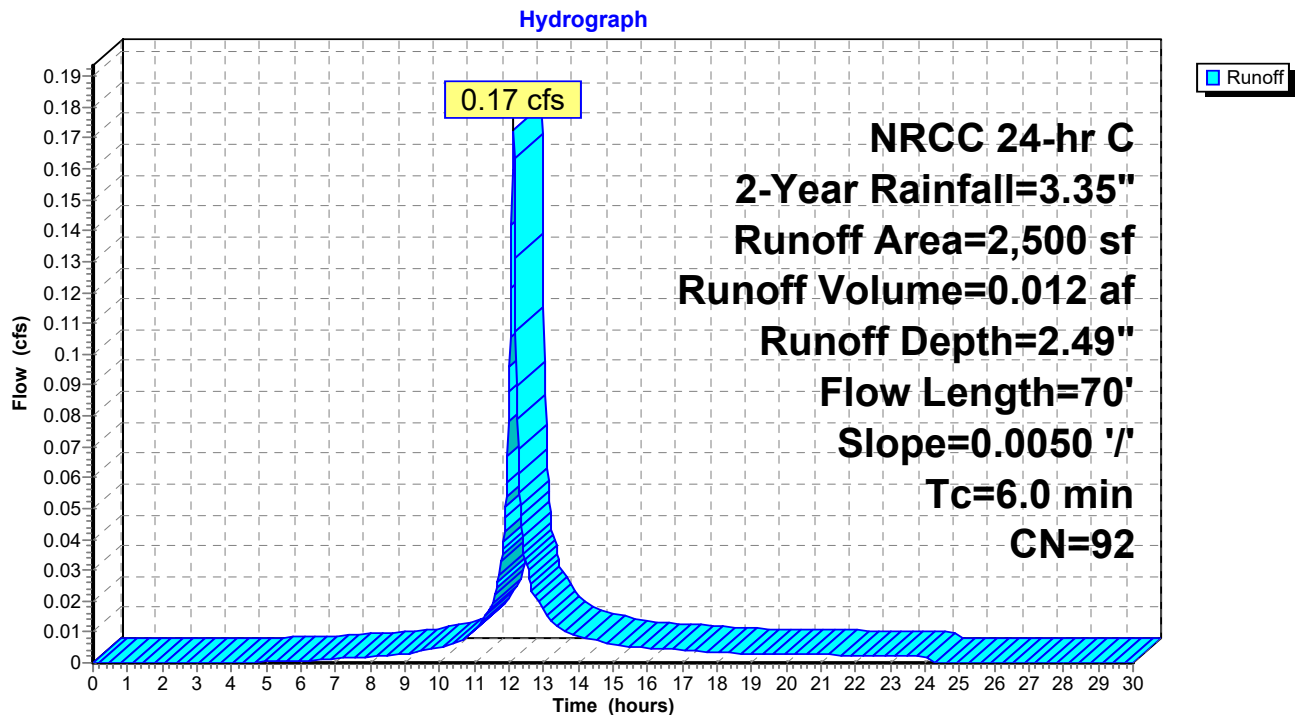
Runoff = 0.17 cfs @ 12.13 hrs, Volume= 0.012 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 2-Year Rainfall=3.35"

Area (sf)	CN	Description
* 1,680	89	Crushed Stone Compound (exposed)
* 100	99	VZW Comm Equip & Pads
* 720	99	3 Future Carrier Pads (12'x20' ea)
2,500	92	Weighted Average
1,680		67.20% Pervious Area
820		32.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	70	0.0050	0.34		Lag/CN Method,
3.5	70	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: SUB-CATCH A1



Summary for Subcatchment 3S: SUB-CATCH A2

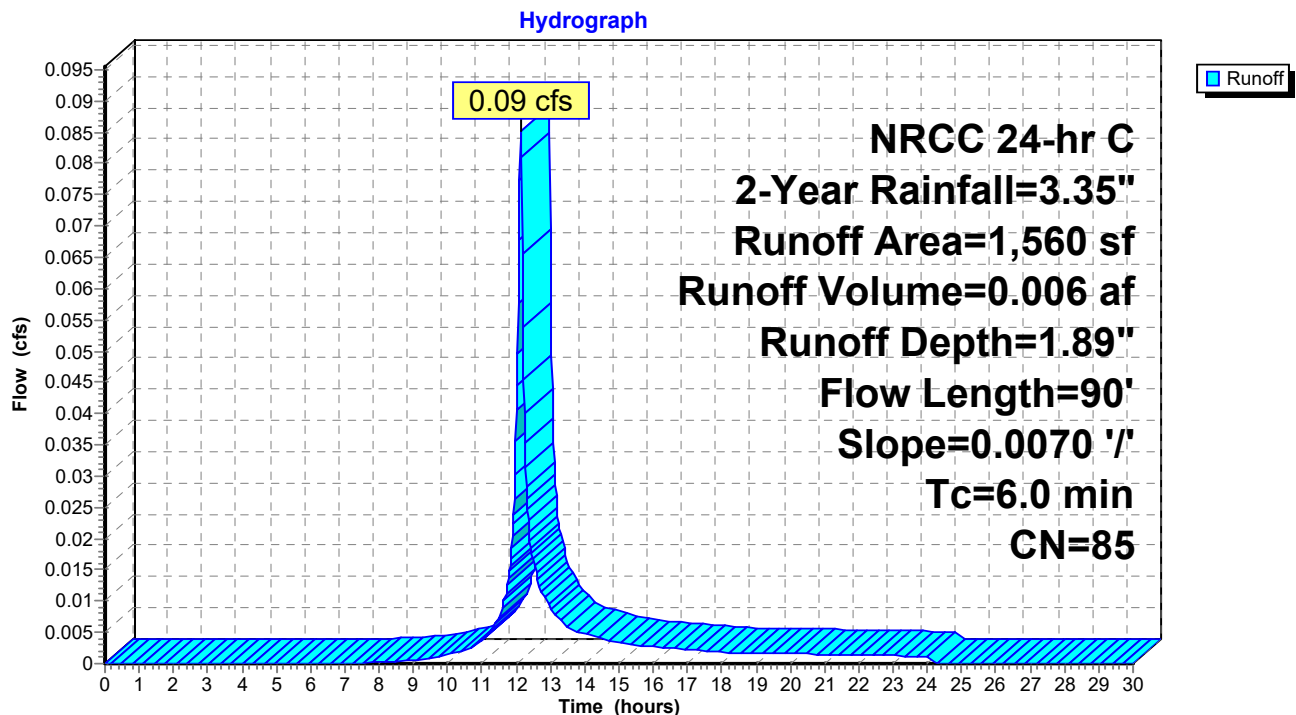
Runoff = 0.09 cfs @ 12.13 hrs, Volume= 0.006 af, Depth= 1.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 2-Year Rainfall=3.35"

Area (sf)	CN	Description
* 1,560	85	Proposed Gravel Drive, HSG C
1,560		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	90	0.0070	0.32		Lag/CN Method,
4.7	90	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 3S: SUB-CATCH A2



Summary for Subcatchment 4S: CATCHMENT B

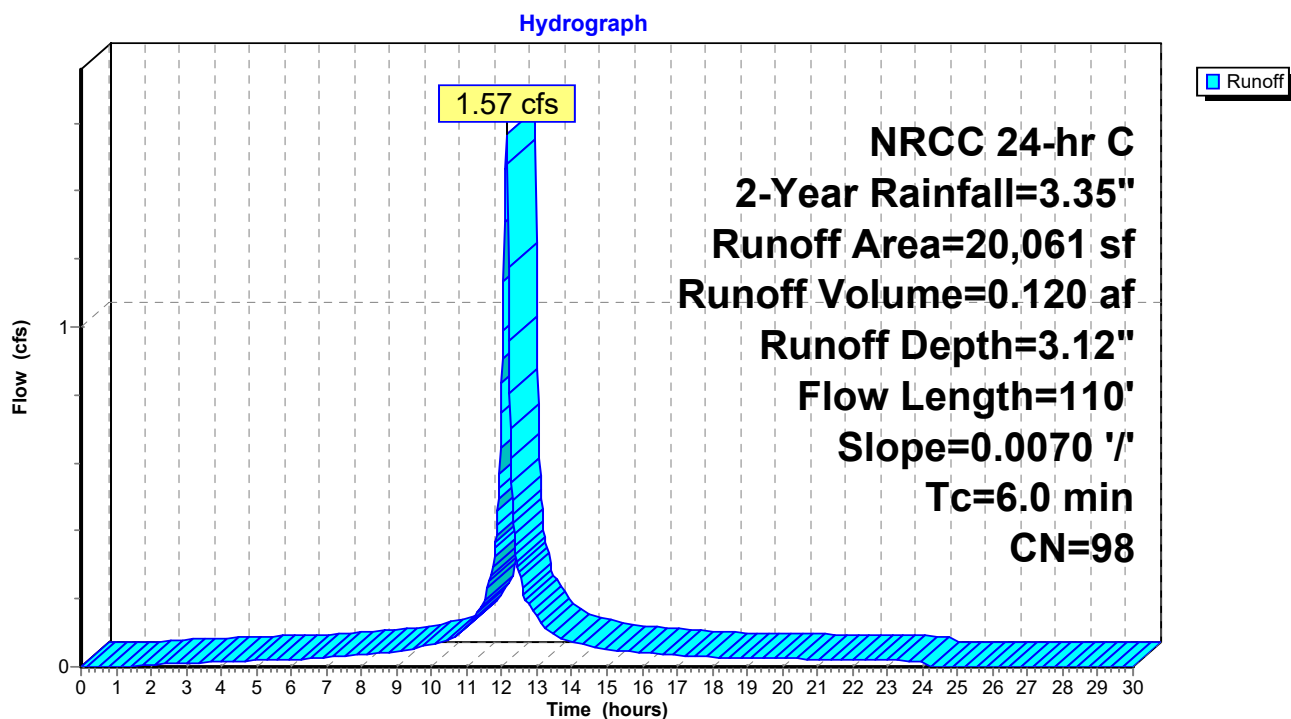
Runoff = 1.57 cfs @ 12.13 hrs, Volume= 0.120 af, Depth= 3.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 2-Year Rainfall=3.35"

	Area (sf)	CN	Description
*	12,171	98	Parking, Driveway, F&R Sidewalks
*	7,890	98	Building Roof
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 4S: CATCHMENT B



Summary for Pond 3: Crushed Stone Compound

Inflow Area = 0.093 ac, 20.20% Impervious, Inflow Depth = 2.26" for 2-Year event
 Inflow = 0.26 cfs @ 12.13 hrs, Volume= 0.018 af
 Outflow = 0.04 cfs @ 11.92 hrs, Volume= 0.018 af, Atten= 84%, Lag= 0.0 min
 Discarded = 0.04 cfs @ 11.92 hrs, Volume= 0.018 af
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 72.69' @ 12.59 hrs Surf.Area= 0.057 ac Storage= 0.004 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
 Center-of-Mass det. time= 26.7 min (839.0 - 812.3)

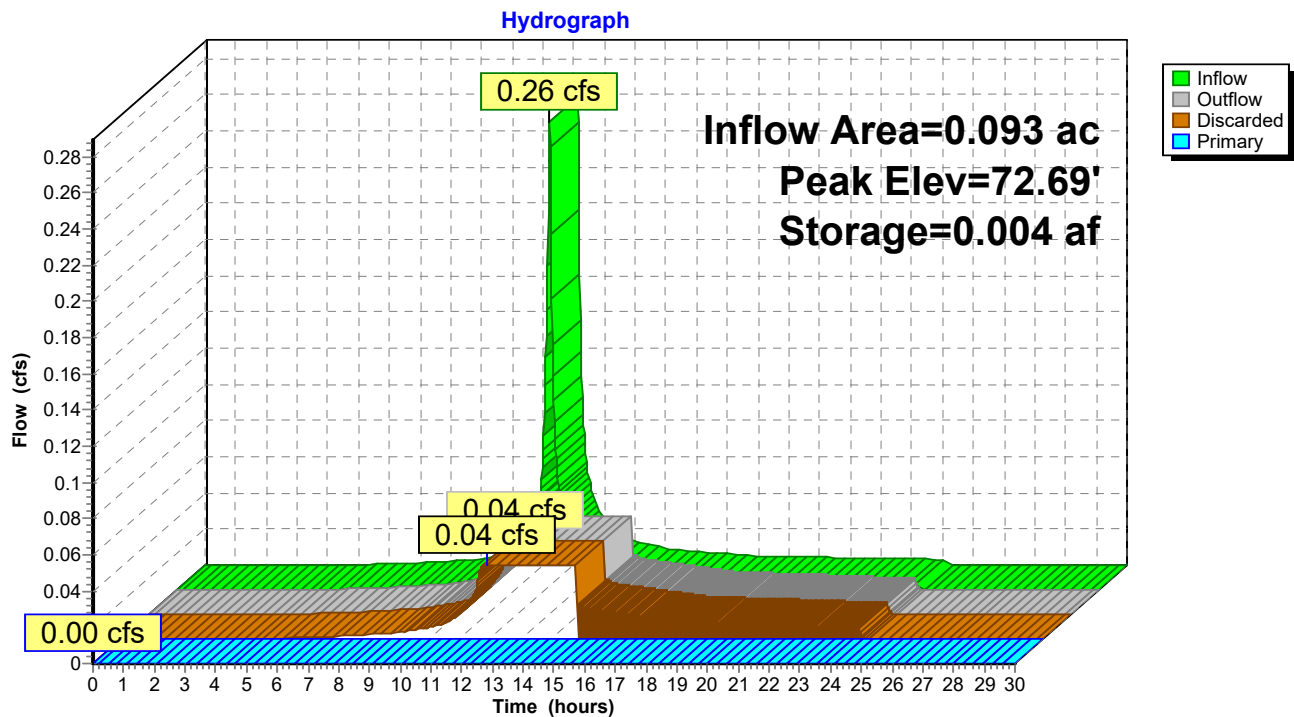
Volume	Invert	Avail.Storage	Storage Description
#1	72.50'	0.023 af	50.00'W x 50.00'L x 1.00'H Prismatic 0.057 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	73.45'	50.0' long x 1.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#2	Discarded	72.50'	0.700 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.04 cfs @ 11.92 hrs HW=72.51' (Free Discharge)
 ↑**2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=72.50' TW=0.00' (Dynamic Tailwater)
 ↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3: Crushed Stone Compound



Summary for Pond 3P: CB1

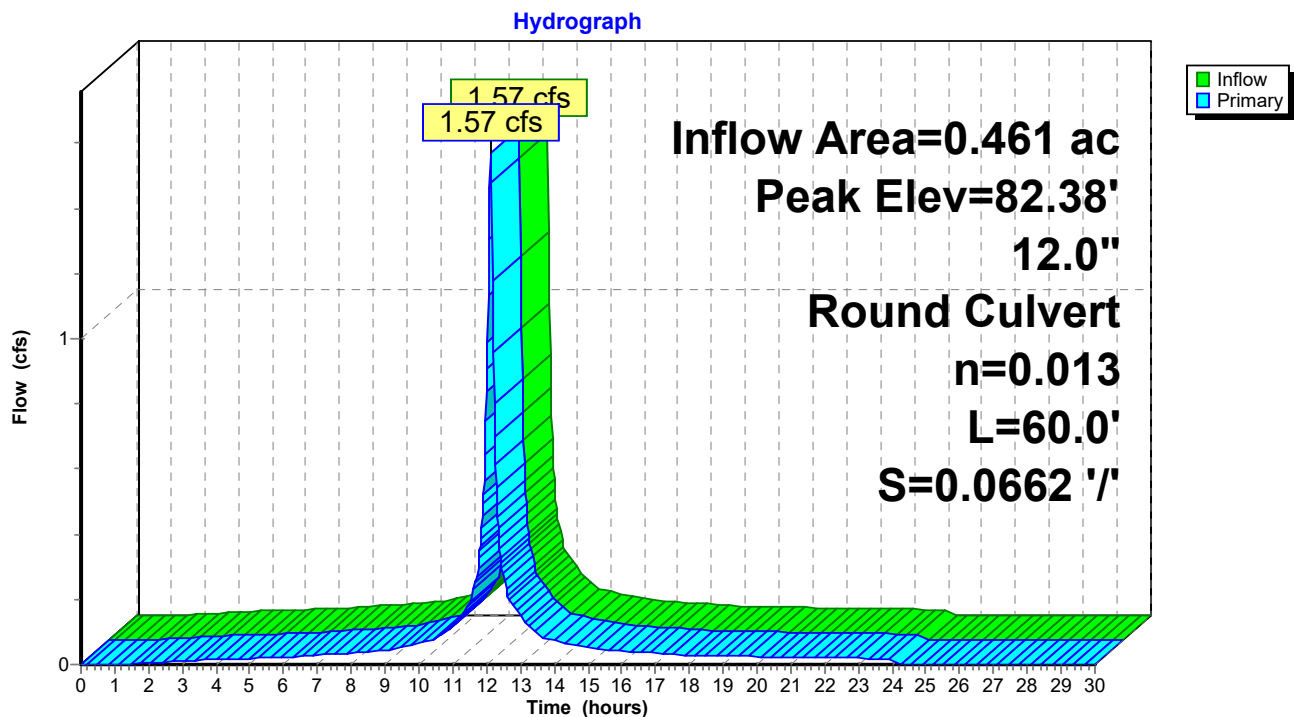
Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 3.12" for 2-Year event
 Inflow = 1.57 cfs @ 12.13 hrs, Volume= 0.120 af
 Outflow = 1.57 cfs @ 12.13 hrs, Volume= 0.120 af, Atten= 0%, Lag= 0.0 min
 Primary = 1.57 cfs @ 12.13 hrs, Volume= 0.120 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 82.38' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=1.56 cfs @ 12.13 hrs HW=82.38' TW=0.00' (Dynamic Tailwater)
 ↑ **1=Culvert** (Inlet Controls 1.56 cfs @ 2.79 fps)

Pond 3P: CB1

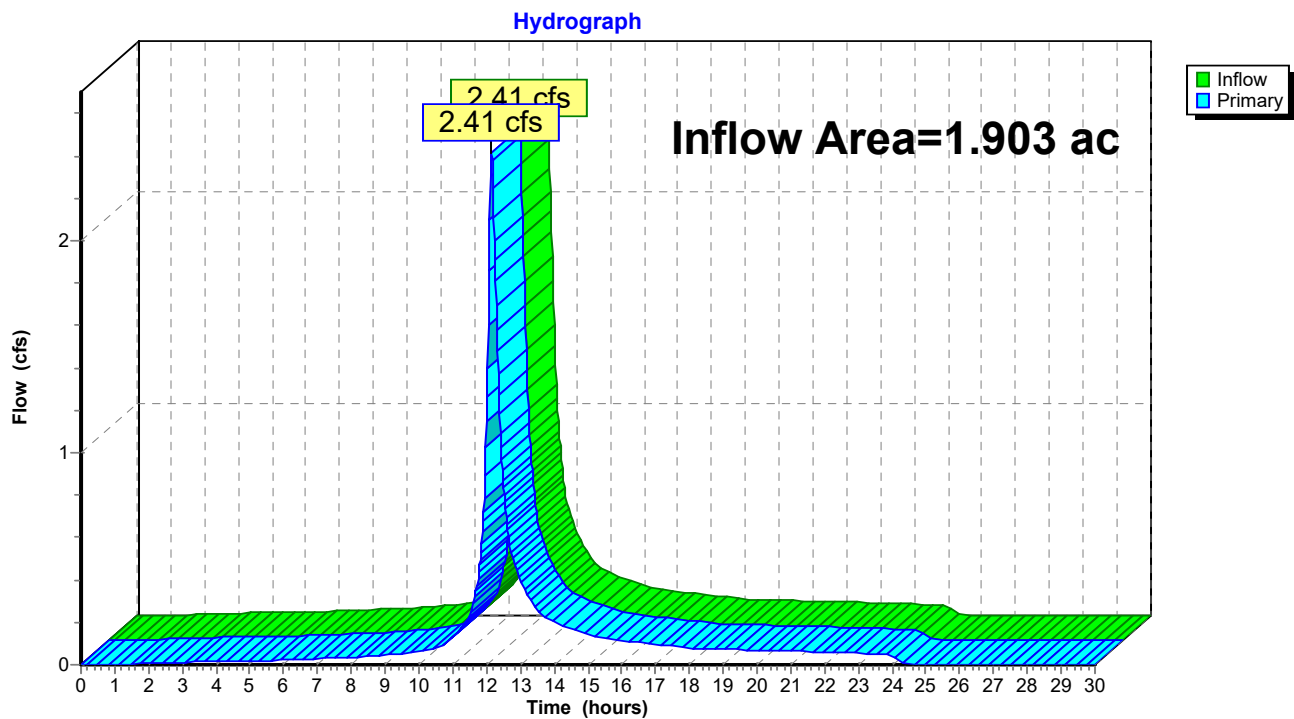


Summary for Link 2L: Project Total

Inflow Area = 1.903 ac, 25.18% Impervious, Inflow Depth = 1.48" for 2-Year event
Inflow = 2.41 cfs @ 12.15 hrs, Volume= 0.235 af
Primary = 2.41 cfs @ 12.15 hrs, Volume= 0.235 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total



VZW Pembroke 5 MA - HydroCAD - Proposed 10.04 NRCC 24-hr C 10-Year Rainfall=4.95"

Prepared by {enter your company name here}

Printed 10/14/2021

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Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A Runoff Area=58,793 sf 0.00% Impervious Runoff Depth=2.16"
Flow Length=359' Tc=14.5 min CN=72 Runoff=2.67 cfs 0.243 af

Subcatchment2S: SUB-CATCH A1 Runoff Area=2,500 sf 32.80% Impervious Runoff Depth=4.04"
Flow Length=70' Slope=0.0050 '/ Tc=6.0 min CN=92 Runoff=0.27 cfs 0.019 af

Subcatchment3S: SUB-CATCH A2 Runoff Area=1,560 sf 0.00% Impervious Runoff Depth=3.32"
Flow Length=90' Slope=0.0070 '/ Tc=6.0 min CN=85 Runoff=0.15 cfs 0.010 af

Subcatchment4S: CATCHMENT B Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=4.71"
Flow Length=110' Slope=0.0070 '/ Tc=6.0 min CN=98 Runoff=2.33 cfs 0.181 af

Pond 3: Crushed Stone Compound Peak Elev=72.91' Storage=0.009 af Inflow=0.42 cfs 0.029 af
Discarded=0.04 cfs 0.029 af Primary=0.00 cfs 0.000 af Outflow=0.04 cfs 0.029 af

Pond 3P: CB1 Peak Elev=82.59' Inflow=2.33 cfs 0.181 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/ Outflow=2.33 cfs 0.181 af

Link 2L: Project Total Inflow=4.34 cfs 0.424 af
Primary=4.34 cfs 0.424 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.453 af Average Runoff Depth = 2.86"
74.82% Pervious = 1.424 ac 25.18% Impervious = 0.479 ac

Summary for Subcatchment 1S: CATCHMENT A

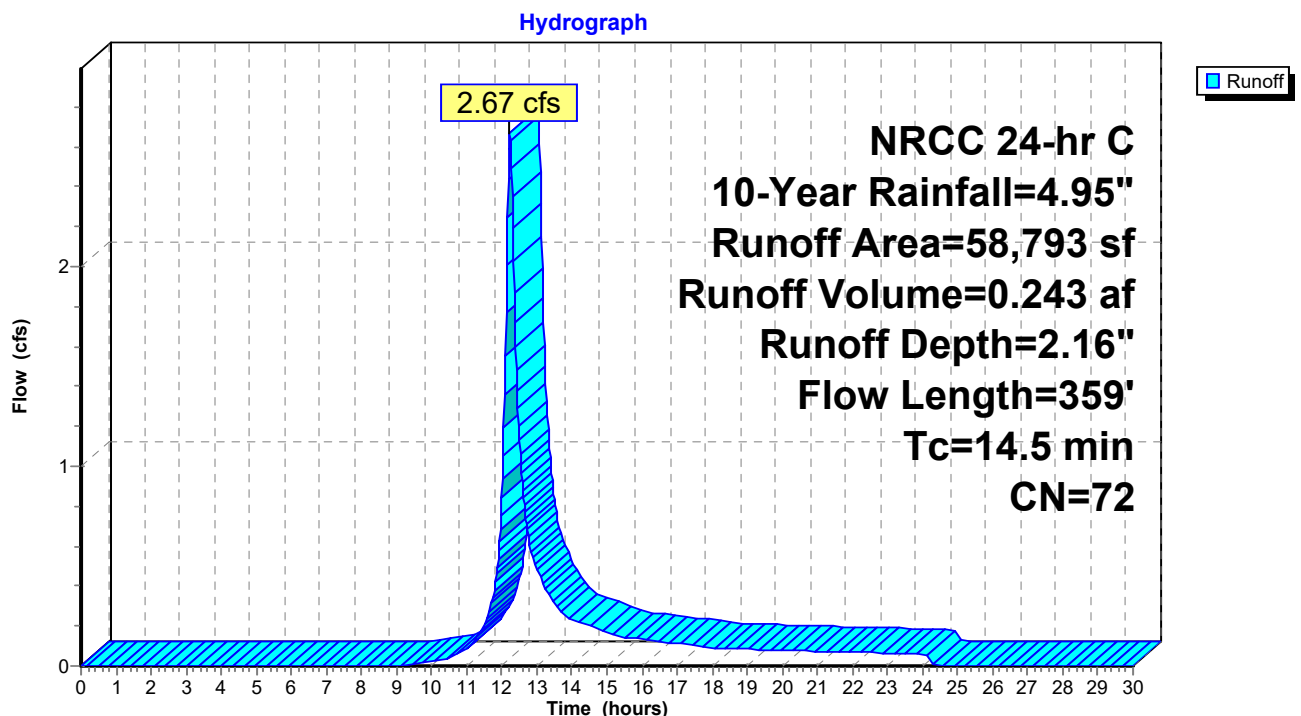
Runoff = 2.67 cfs @ 12.23 hrs, Volume= 0.243 af, Depth= 2.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 10-Year Rainfall=4.95"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
41,832	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
58,793	72	Weighted Average
58,793		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A



Summary for Subcatchment 2S: SUB-CATCH A1

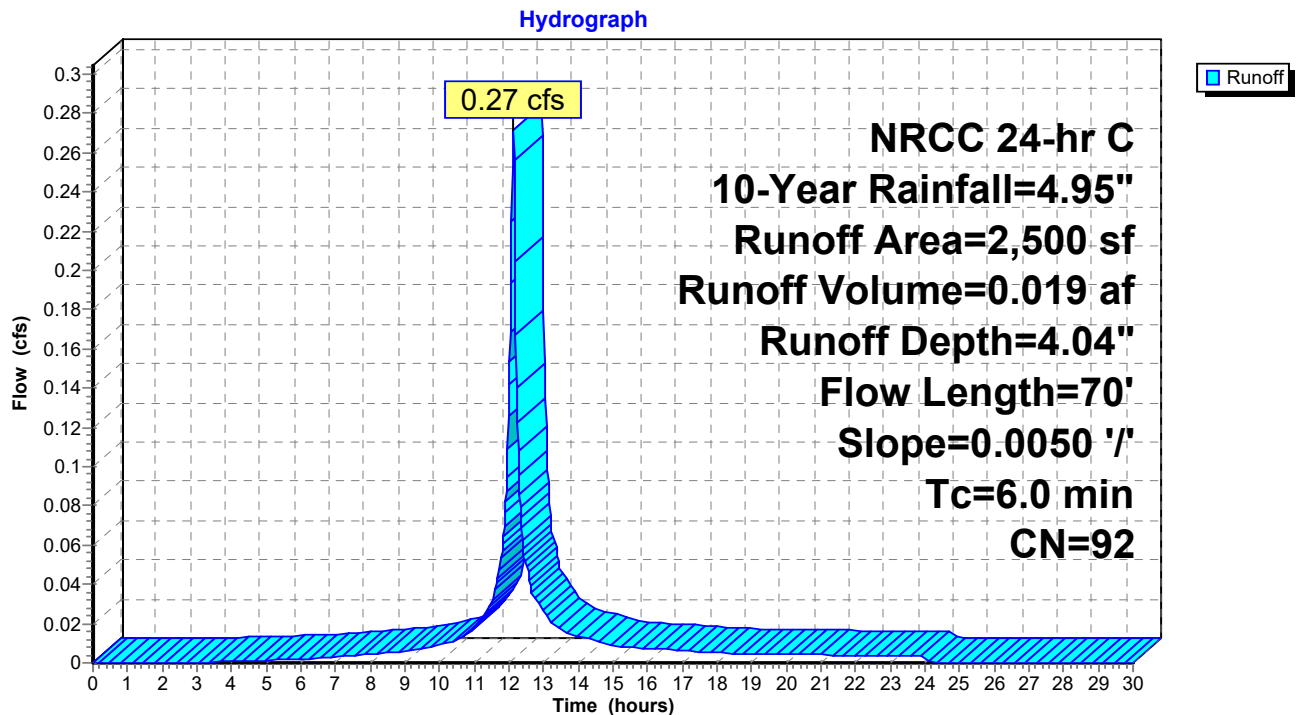
Runoff = 0.27 cfs @ 12.13 hrs, Volume= 0.019 af, Depth= 4.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 10-Year Rainfall=4.95"

Area (sf)	CN	Description
* 1,680	89	Crushed Stone Compound (exposed)
* 100	99	VZW Comm Equip & Pads
* 720	99	3 Future Carrier Pads (12'x20' ea)
2,500	92	Weighted Average
1,680		67.20% Pervious Area
820		32.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	70	0.0050	0.34		Lag/CN Method,
3.5	70	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: SUB-CATCH A1



Summary for Subcatchment 3S: SUB-CATCH A2

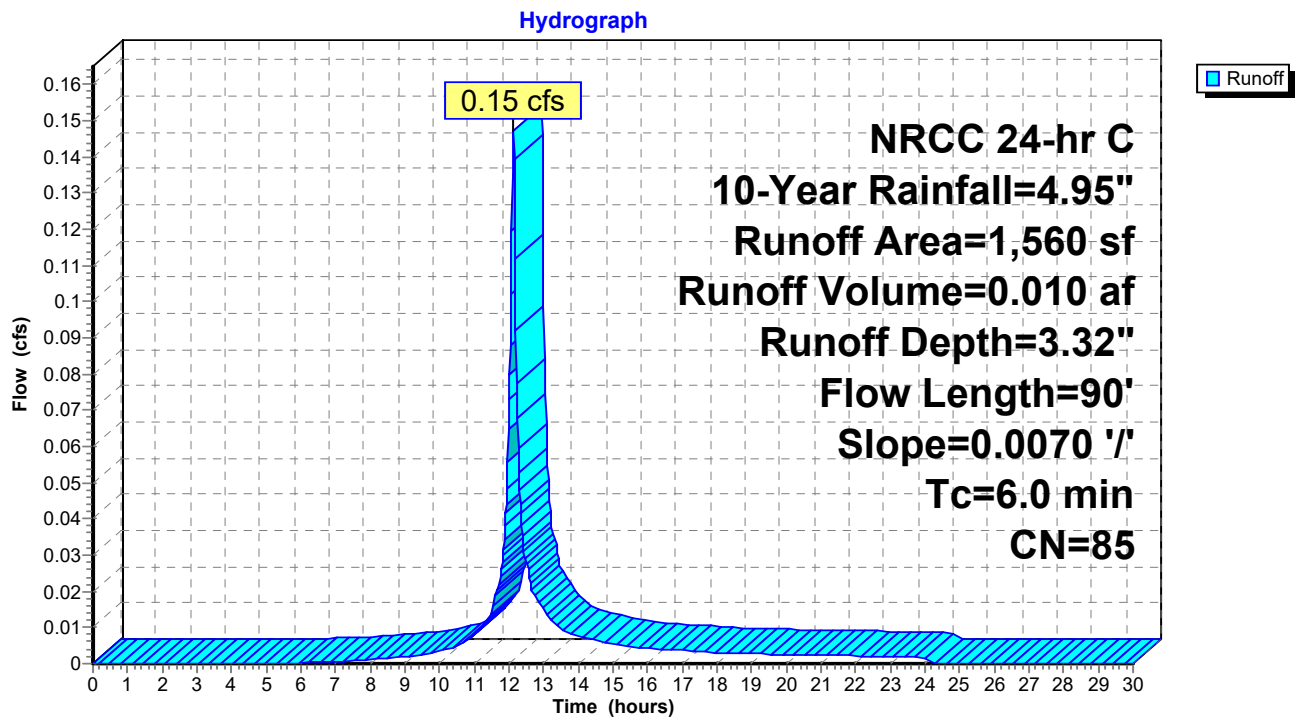
Runoff = 0.15 cfs @ 12.13 hrs, Volume= 0.010 af, Depth= 3.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 10-Year Rainfall=4.95"

Area (sf)	CN	Description
* 1,560	85	Proposed Gravel Drive, HSG C
1,560		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	90	0.0070	0.32		Lag/CN Method,
4.7	90	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 3S: SUB-CATCH A2



Summary for Subcatchment 4S: CATCHMENT B

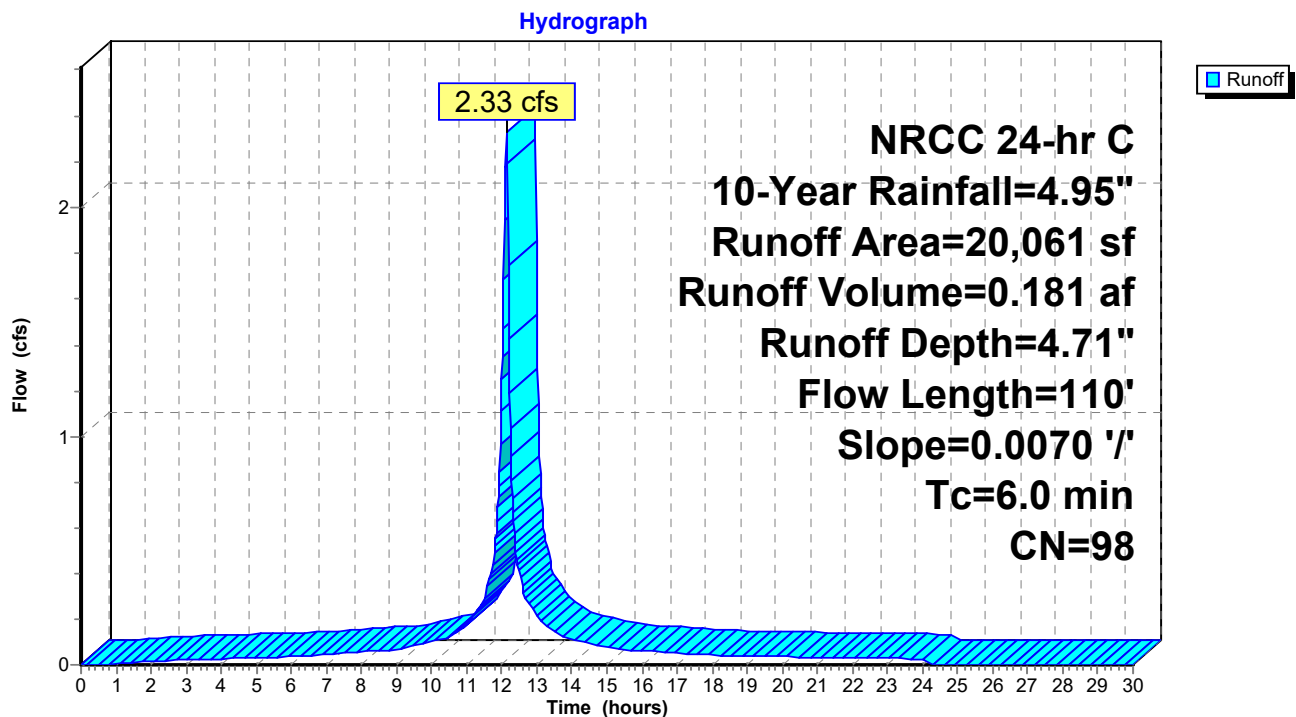
Runoff = 2.33 cfs @ 12.13 hrs, Volume= 0.181 af, Depth= 4.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 10-Year Rainfall=4.95"

	Area (sf)	CN	Description
*	12,171	98	Parking, Driveway, F&R Sidewalks
*	7,890	98	Building Roof
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 4S: CATCHMENT B



Summary for Pond 3: Crushed Stone Compound

Inflow Area = 0.093 ac, 20.20% Impervious, Inflow Depth = 3.76" for 10-Year event
 Inflow = 0.42 cfs @ 12.13 hrs, Volume= 0.029 af
 Outflow = 0.04 cfs @ 11.70 hrs, Volume= 0.029 af, Atten= 90%, Lag= 0.0 min
 Discarded = 0.04 cfs @ 11.70 hrs, Volume= 0.029 af
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 72.91' @ 13.01 hrs Surf.Area= 0.057 ac Storage= 0.009 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
 Center-of-Mass det. time= 69.5 min (866.7 - 797.2)

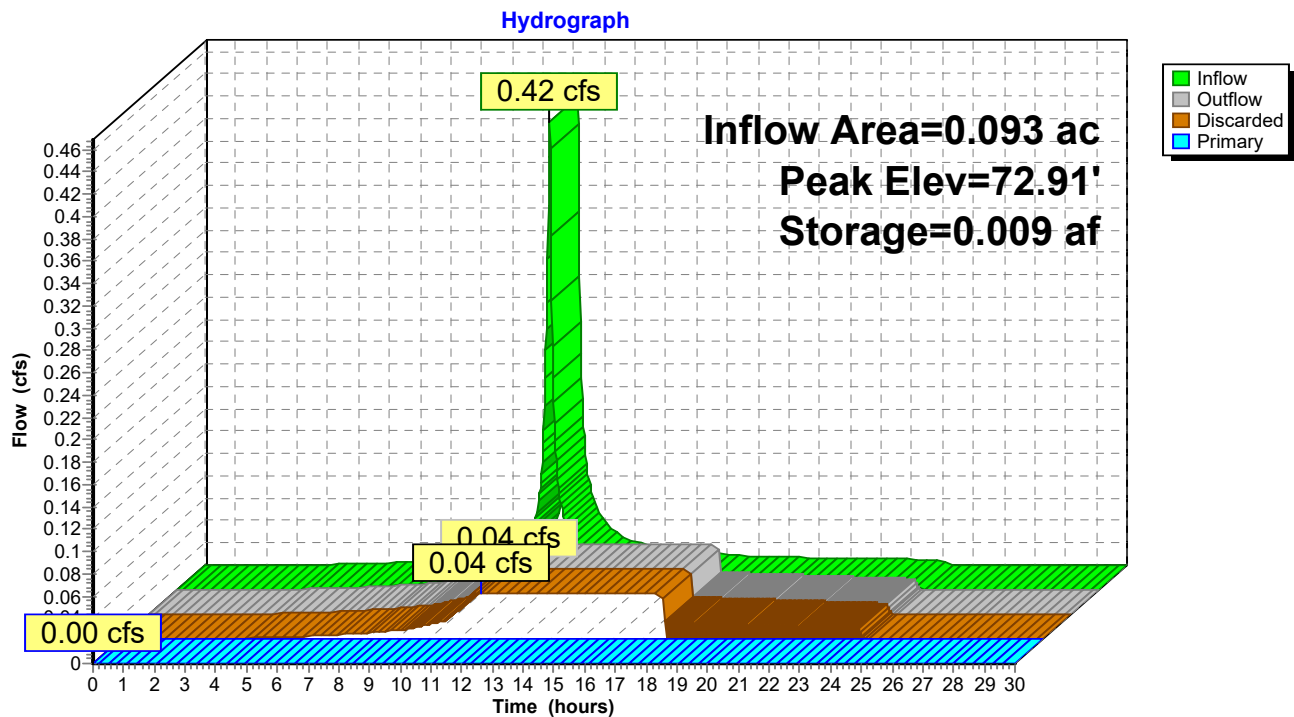
Volume	Invert	Avail.Storage	Storage Description
#1	72.50'	0.023 af	50.00'W x 50.00'L x 1.00'H Prismatic 0.057 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	73.45'	50.0' long x 1.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#2	Discarded	72.50'	0.700 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.04 cfs @ 11.70 hrs HW=72.51' (Free Discharge)
 ↑ **2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=72.50' TW=0.00' (Dynamic Tailwater)
 ↑ **1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3: Crushed Stone Compound



Summary for Pond 3P: CB1

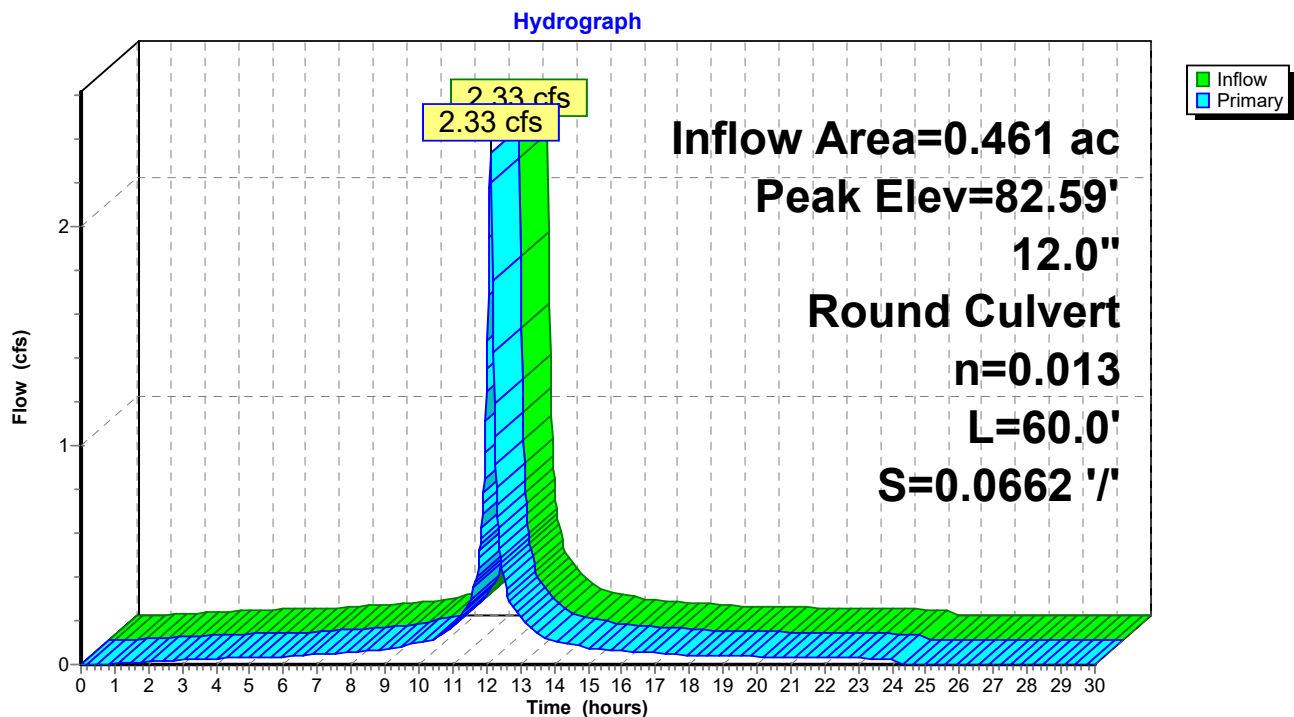
Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 4.71" for 10-Year event
 Inflow = 2.33 cfs @ 12.13 hrs, Volume= 0.181 af
 Outflow = 2.33 cfs @ 12.13 hrs, Volume= 0.181 af, Atten= 0%, Lag= 0.0 min
 Primary = 2.33 cfs @ 12.13 hrs, Volume= 0.181 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 82.59' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=2.31 cfs @ 12.13 hrs HW=82.58' TW=0.00' (Dynamic Tailwater)
 ↑ **1=Culvert** (Inlet Controls 2.31 cfs @ 3.18 fps)

Pond 3P: CB1

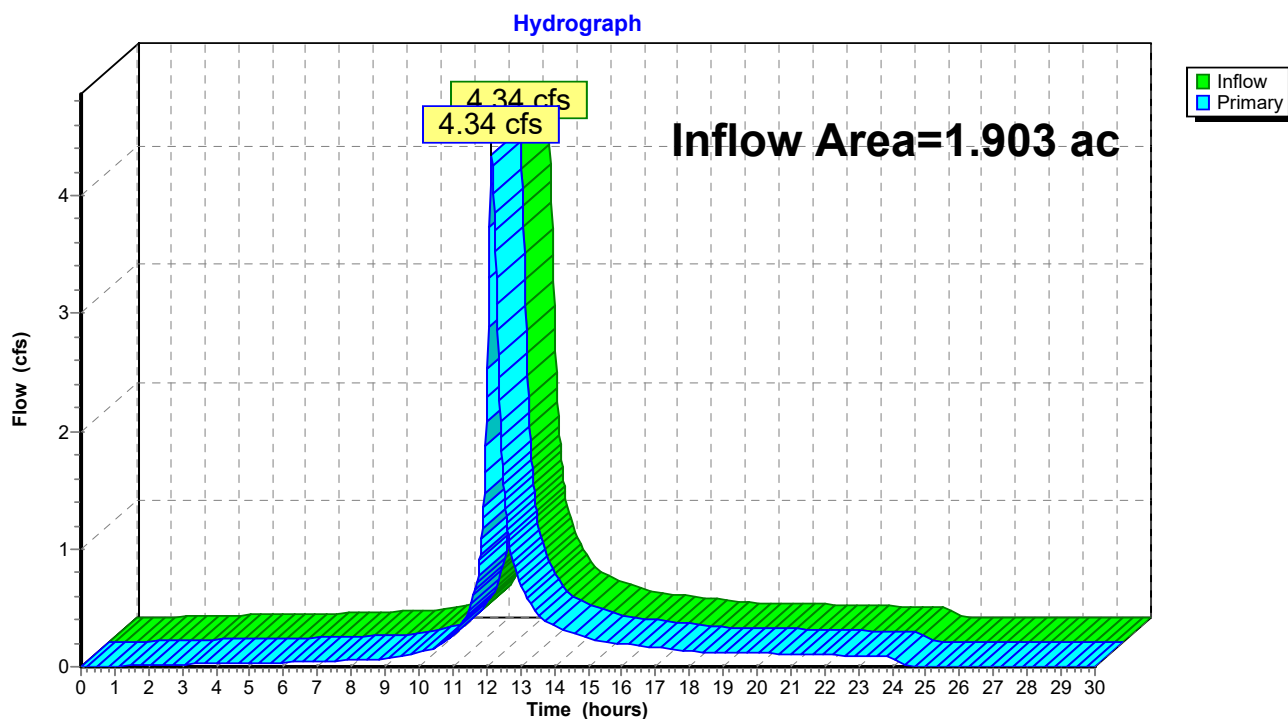


Summary for Link 2L: Project Total

Inflow Area = 1.903 ac, 25.18% Impervious, Inflow Depth = 2.67" for 10-Year event
Inflow = 4.34 cfs @ 12.15 hrs, Volume= 0.424 af
Primary = 4.34 cfs @ 12.15 hrs, Volume= 0.424 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total



VZW Pembroke 5 MA - HydroCAD - Proposed 10.04 NRCC 24-hr C 25-Year Rainfall=6.19"

Prepared by {enter your company name here}

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Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A Runoff Area=58,793 sf 0.00% Impervious Runoff Depth=3.15"
Flow Length=359' Tc=14.5 min CN=72 Runoff=3.93 cfs 0.354 af

Subcatchment2S: SUB-CATCH A1 Runoff Area=2,500 sf 32.80% Impervious Runoff Depth=5.26"
Flow Length=70' Slope=0.0050 '/ Tc=6.0 min CN=92 Runoff=0.35 cfs 0.025 af

Subcatchment3S: SUB-CATCH A2 Runoff Area=1,560 sf 0.00% Impervious Runoff Depth=4.48"
Flow Length=90' Slope=0.0070 '/ Tc=6.0 min CN=85 Runoff=0.20 cfs 0.013 af

Subcatchment4S: CATCHMENT B Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=5.95"
Flow Length=110' Slope=0.0070 '/ Tc=6.0 min CN=98 Runoff=2.92 cfs 0.228 af

Pond 3: Crushed Stone Compound Peak Elev=73.12' Storage=0.014 af Inflow=0.54 cfs 0.039 af
Discarded=0.04 cfs 0.039 af Primary=0.00 cfs 0.000 af Outflow=0.04 cfs 0.039 af

Pond 3P: CB1 Peak Elev=82.81' Inflow=2.92 cfs 0.228 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/ Outflow=2.92 cfs 0.228 af

Link 2L: Project Total Inflow=5.96 cfs 0.583 af
Primary=5.96 cfs 0.583 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.621 af Average Runoff Depth = 3.92"
74.82% Pervious = 1.424 ac 25.18% Impervious = 0.479 ac

Summary for Subcatchment 1S: CATCHMENT A

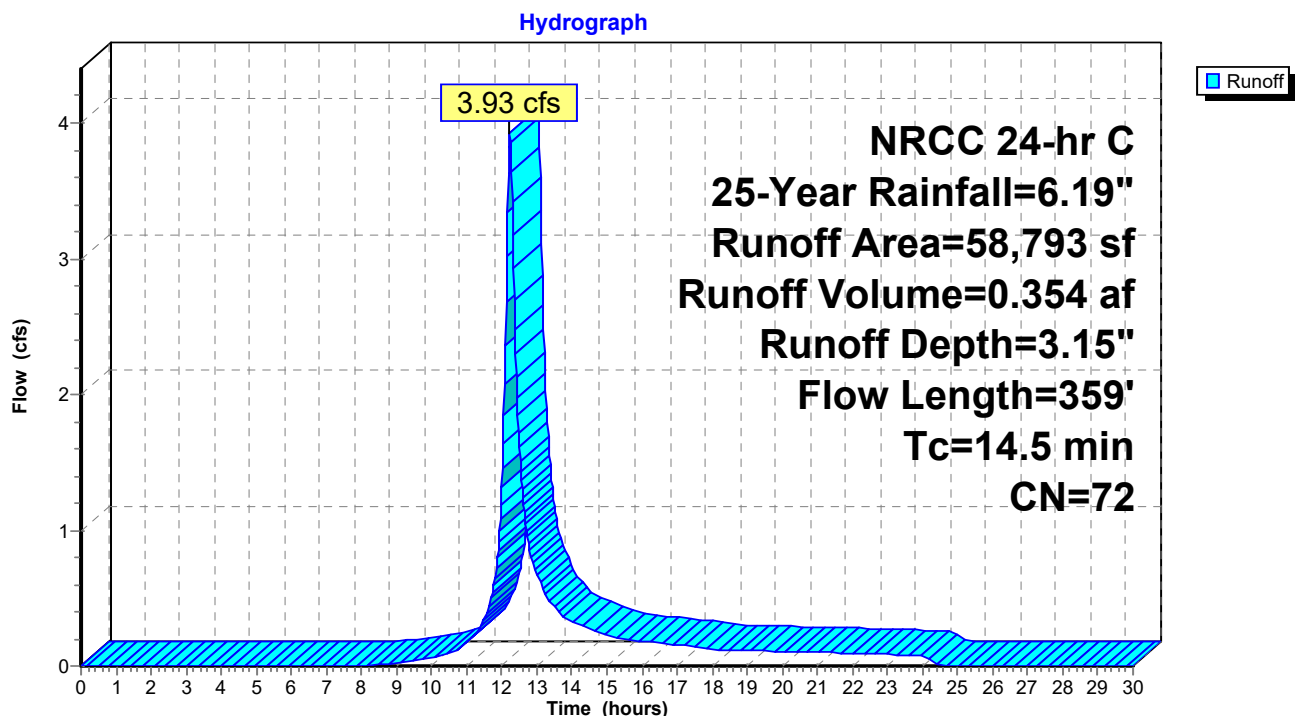
Runoff = 3.93 cfs @ 12.23 hrs, Volume= 0.354 af, Depth= 3.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 25-Year Rainfall=6.19"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
41,832	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
58,793	72	Weighted Average
58,793		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A



Summary for Subcatchment 2S: SUB-CATCH A1

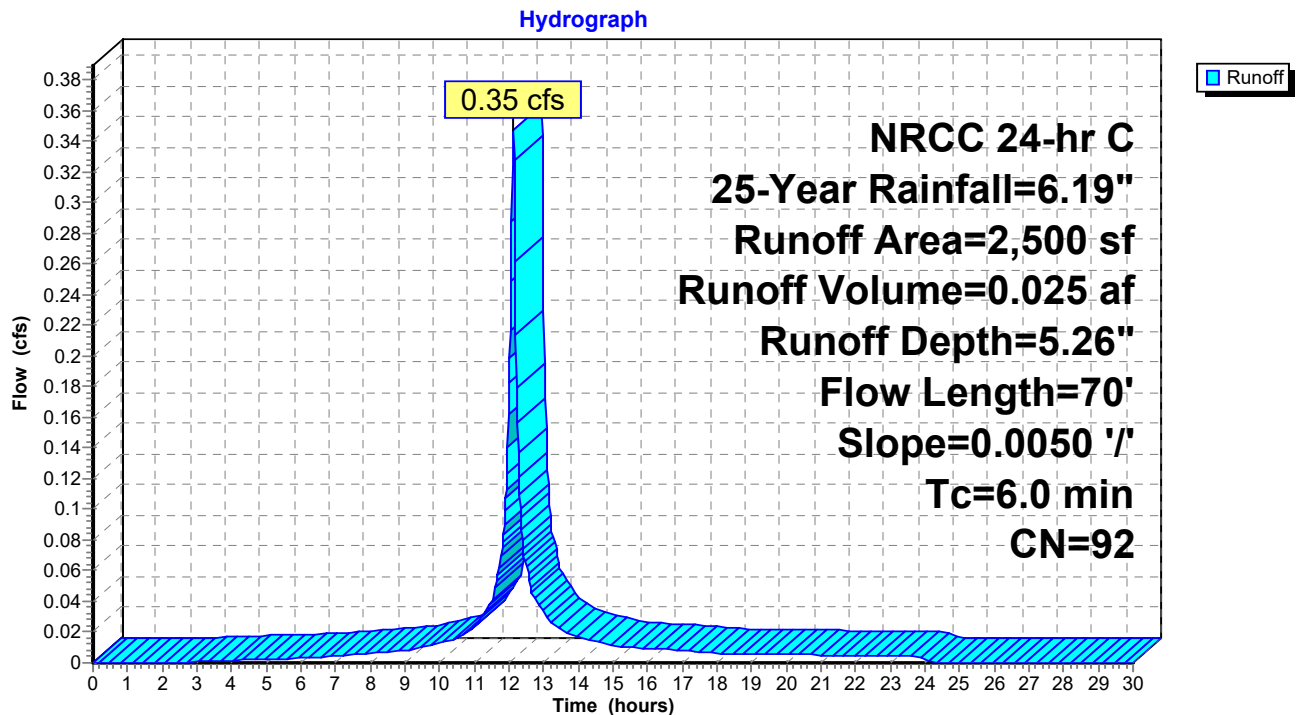
Runoff = 0.35 cfs @ 12.13 hrs, Volume= 0.025 af, Depth= 5.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 25-Year Rainfall=6.19"

Area (sf)	CN	Description
* 1,680	89	Crushed Stone Compound (exposed)
* 100	99	VZW Comm Equip & Pads
* 720	99	3 Future Carrier Pads (12'x20' ea)
2,500	92	Weighted Average
1,680		67.20% Pervious Area
820		32.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	70	0.0050	0.34		Lag/CN Method,
3.5	70	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: SUB-CATCH A1



Summary for Subcatchment 3S: SUB-CATCH A2

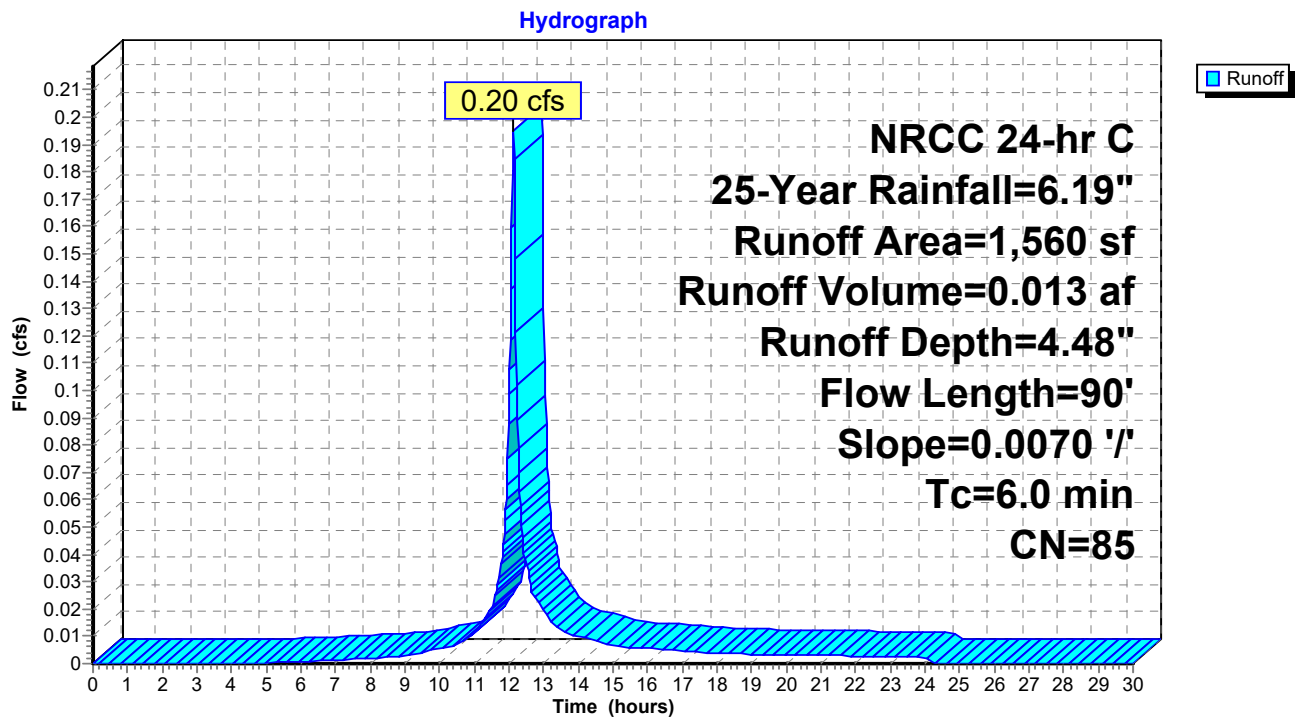
Runoff = 0.20 cfs @ 12.13 hrs, Volume= 0.013 af, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 25-Year Rainfall=6.19"

Area (sf)	CN	Description
* 1,560	85	Proposed Gravel Drive, HSG C
1,560		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	90	0.0070	0.32		Lag/CN Method,
4.7	90	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 3S: SUB-CATCH A2



Summary for Subcatchment 4S: CATCHMENT B

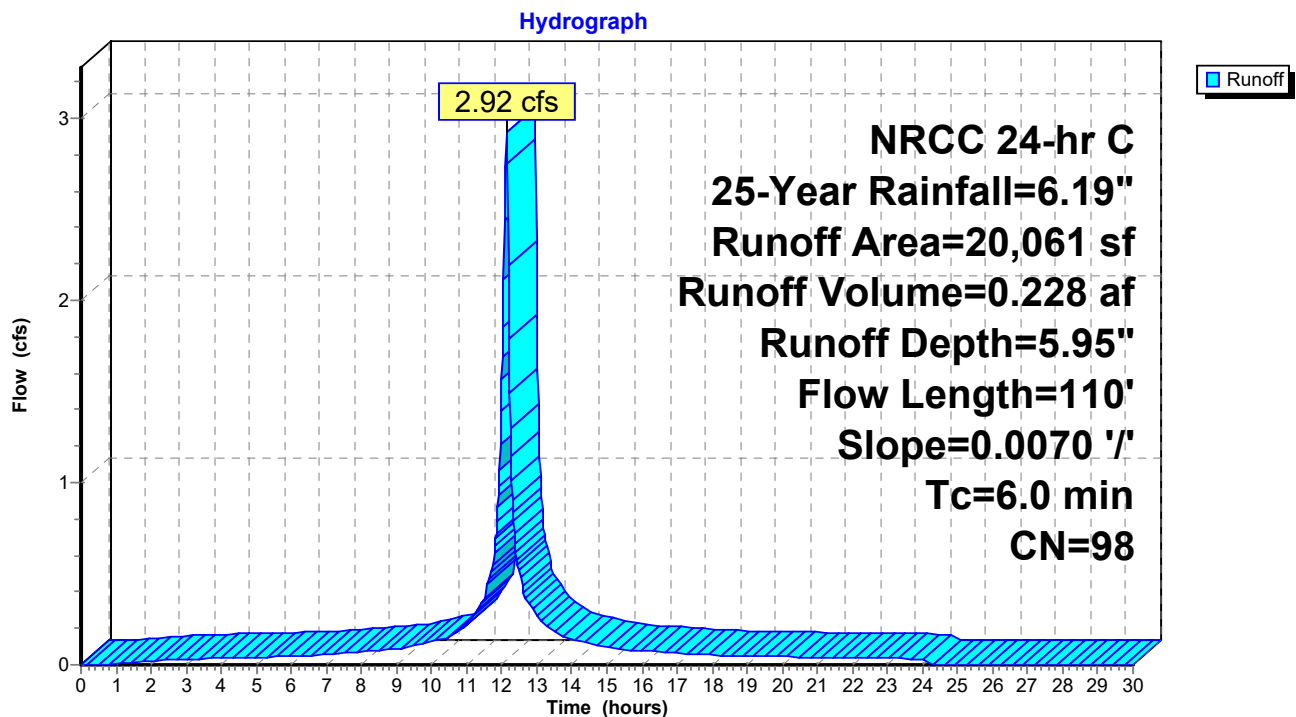
Runoff = 2.92 cfs @ 12.13 hrs, Volume= 0.228 af, Depth= 5.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 25-Year Rainfall=6.19"

	Area (sf)	CN	Description
*	12,171	98	Parking, Driveway, F&R Sidewalks
*	7,890	98	Building Roof
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 4S: CATCHMENT B



Summary for Pond 3: Crushed Stone Compound

Inflow Area = 0.093 ac, 20.20% Impervious, Inflow Depth = 4.96" for 25-Year event
 Inflow = 0.54 cfs @ 12.13 hrs, Volume= 0.039 af
 Outflow = 0.04 cfs @ 11.46 hrs, Volume= 0.039 af, Atten= 93%, Lag= 0.0 min
 Discarded = 0.04 cfs @ 11.46 hrs, Volume= 0.039 af
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 73.12' @ 13.29 hrs Surf.Area= 0.057 ac Storage= 0.014 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
 Center-of-Mass det. time= 113.1 min (902.4 - 789.2)

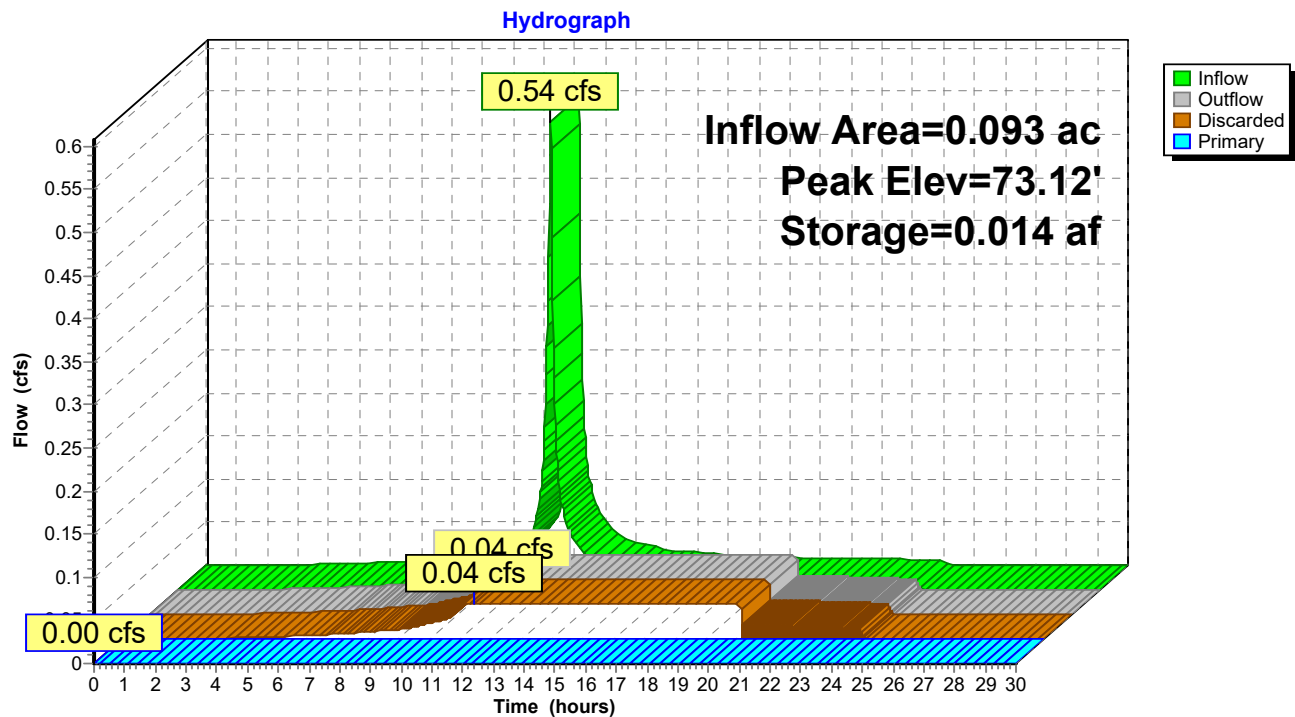
Volume	Invert	Avail.Storage	Storage Description
#1	72.50'	0.023 af	50.00'W x 50.00'L x 1.00'H Prismatic 0.057 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	73.45'	50.0' long x 1.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#2	Discarded	72.50'	0.700 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.04 cfs @ 11.46 hrs HW=72.51' (Free Discharge)
 ↑**2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=72.50' TW=0.00' (Dynamic Tailwater)
 ↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3: Crushed Stone Compound



Summary for Pond 3P: CB1

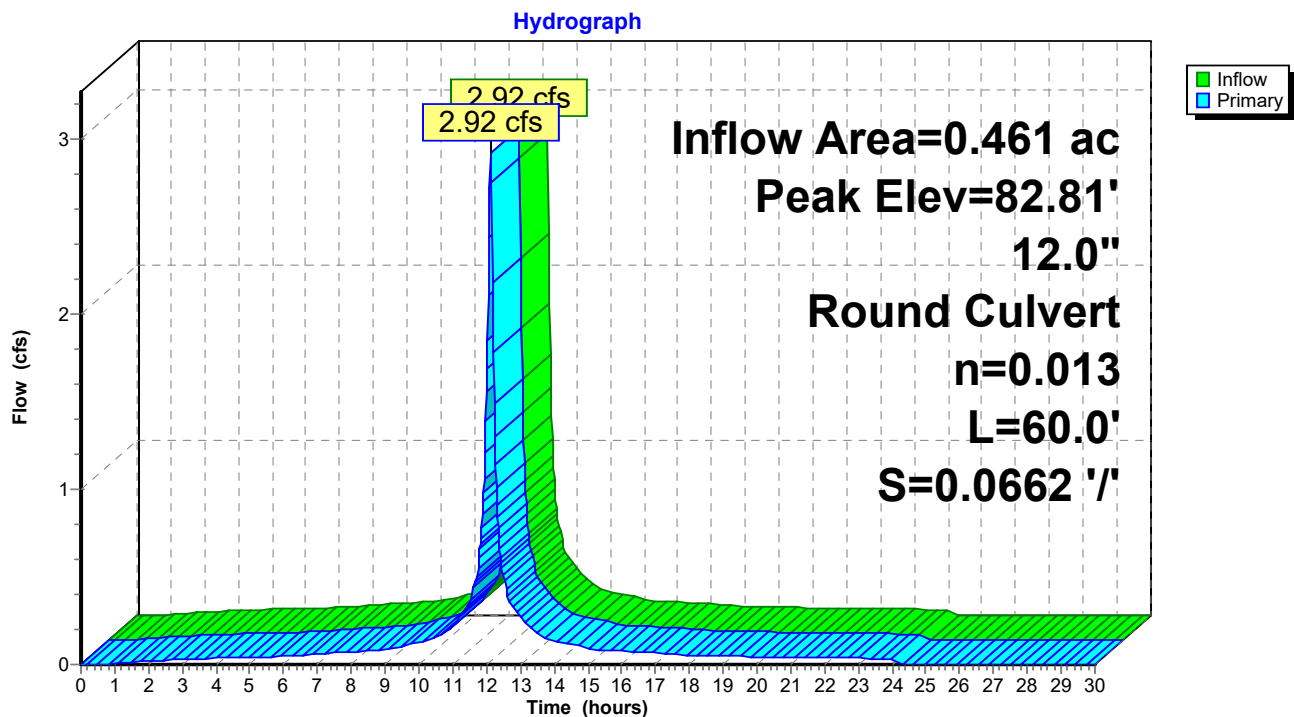
Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 5.95" for 25-Year event
 Inflow = 2.92 cfs @ 12.13 hrs, Volume= 0.228 af
 Outflow = 2.92 cfs @ 12.13 hrs, Volume= 0.228 af, Atten= 0%, Lag= 0.0 min
 Primary = 2.92 cfs @ 12.13 hrs, Volume= 0.228 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 82.81' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=2.90 cfs @ 12.13 hrs HW=82.80' TW=0.00' (Dynamic Tailwater)
 ↑ **1=Culvert** (Inlet Controls 2.90 cfs @ 3.69 fps)

Pond 3P: CB1

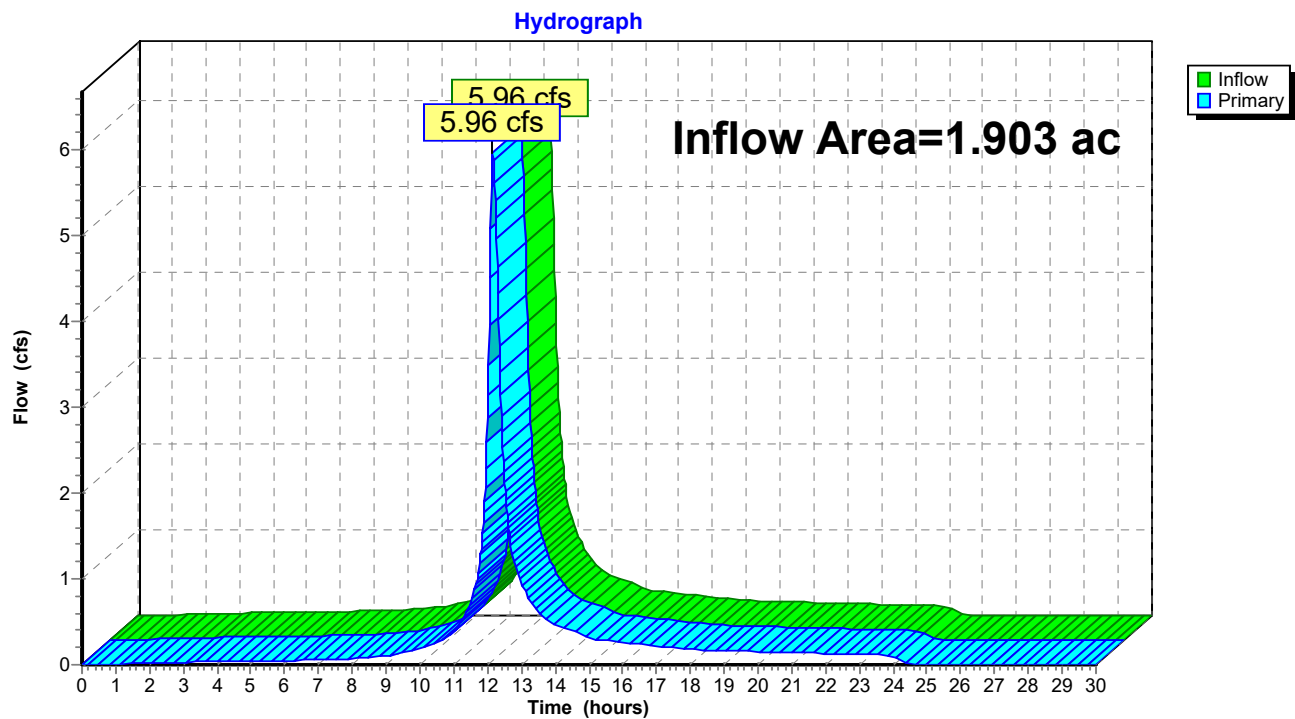


Summary for Link 2L: Project Total

Inflow Area = 1.903 ac, 25.18% Impervious, Inflow Depth = 3.67" for 25-Year event
Inflow = 5.96 cfs @ 12.16 hrs, Volume= 0.583 af
Primary = 5.96 cfs @ 12.16 hrs, Volume= 0.583 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total



VZW Pembroke 5 MA - HydroCAD - Proposed 10.04 NRCC 24-hr C 50-Year Rainfall=7.33"

Prepared by {enter your company name here}

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Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A

Runoff Area=58,793 sf 0.00% Impervious Runoff Depth=4.11"
Flow Length=359' Tc=14.5 min CN=72 Runoff=5.13 cfs 0.462 af

Subcatchment2S: SUB-CATCH A1

Runoff Area=2,500 sf 32.80% Impervious Runoff Depth=6.38"
Flow Length=70' Slope=0.0050 '/ Tc=6.0 min CN=92 Runoff=0.42 cfs 0.031 af

Subcatchment3S: SUB-CATCH A2

Runoff Area=1,560 sf 0.00% Impervious Runoff Depth=5.57"
Flow Length=90' Slope=0.0070 '/ Tc=6.0 min CN=85 Runoff=0.24 cfs 0.017 af

Subcatchment4S: CATCHMENT B

Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=7.09"
Flow Length=110' Slope=0.0070 '/ Tc=6.0 min CN=98 Runoff=3.47 cfs 0.272 af

Pond 3: Crushed Stone Compound

Peak Elev=73.32' Storage=0.019 af Inflow=0.66 cfs 0.047 af
Discarded=0.04 cfs 0.047 af Primary=0.00 cfs 0.000 af Outflow=0.04 cfs 0.047 af

Pond 3P: CB1

Peak Elev=83.05' Inflow=3.47 cfs 0.272 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/ Outflow=3.47 cfs 0.272 af

Link 2L: Project Total

Inflow=7.51 cfs 0.735 af
Primary=7.51 cfs 0.735 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.782 af Average Runoff Depth = 4.93"
74.82% Pervious = 1.424 ac 25.18% Impervious = 0.479 ac

Summary for Subcatchment 1S: CATCHMENT A

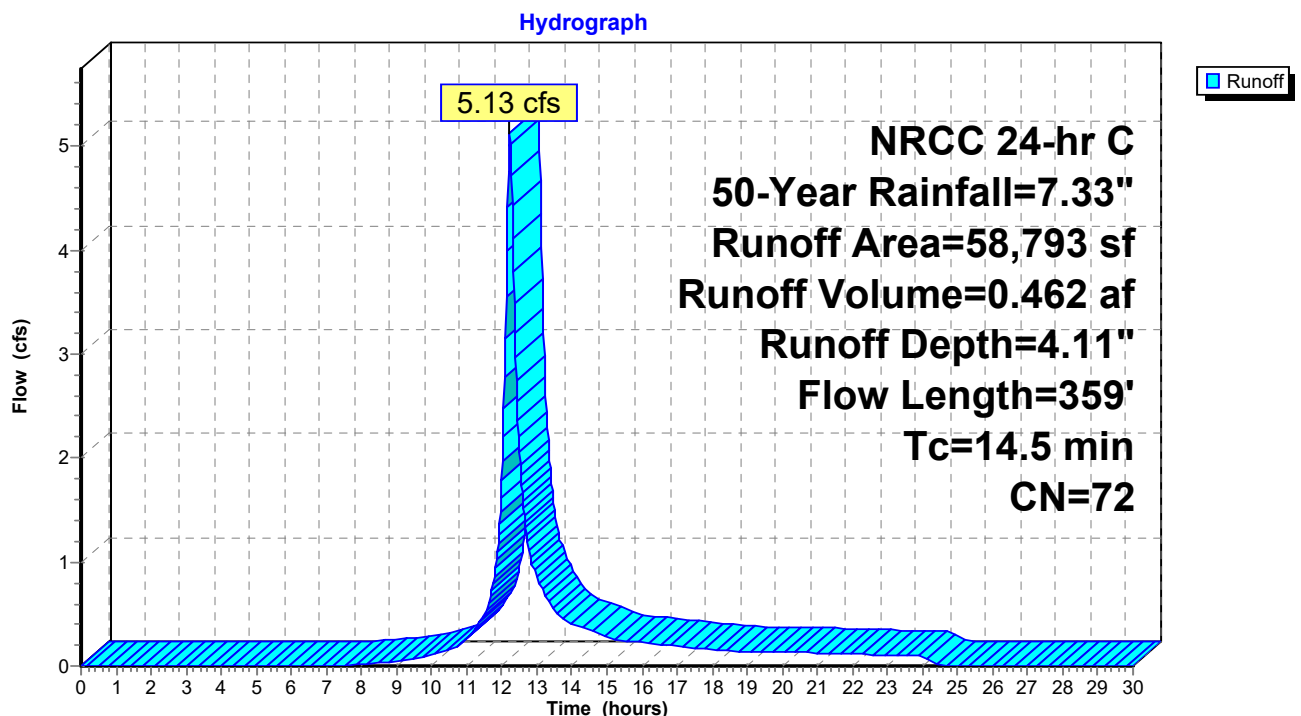
Runoff = 5.13 cfs @ 12.23 hrs, Volume= 0.462 af, Depth= 4.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 50-Year Rainfall=7.33"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
41,832	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
58,793	72	Weighted Average
58,793		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A



Summary for Subcatchment 2S: SUB-CATCH A1

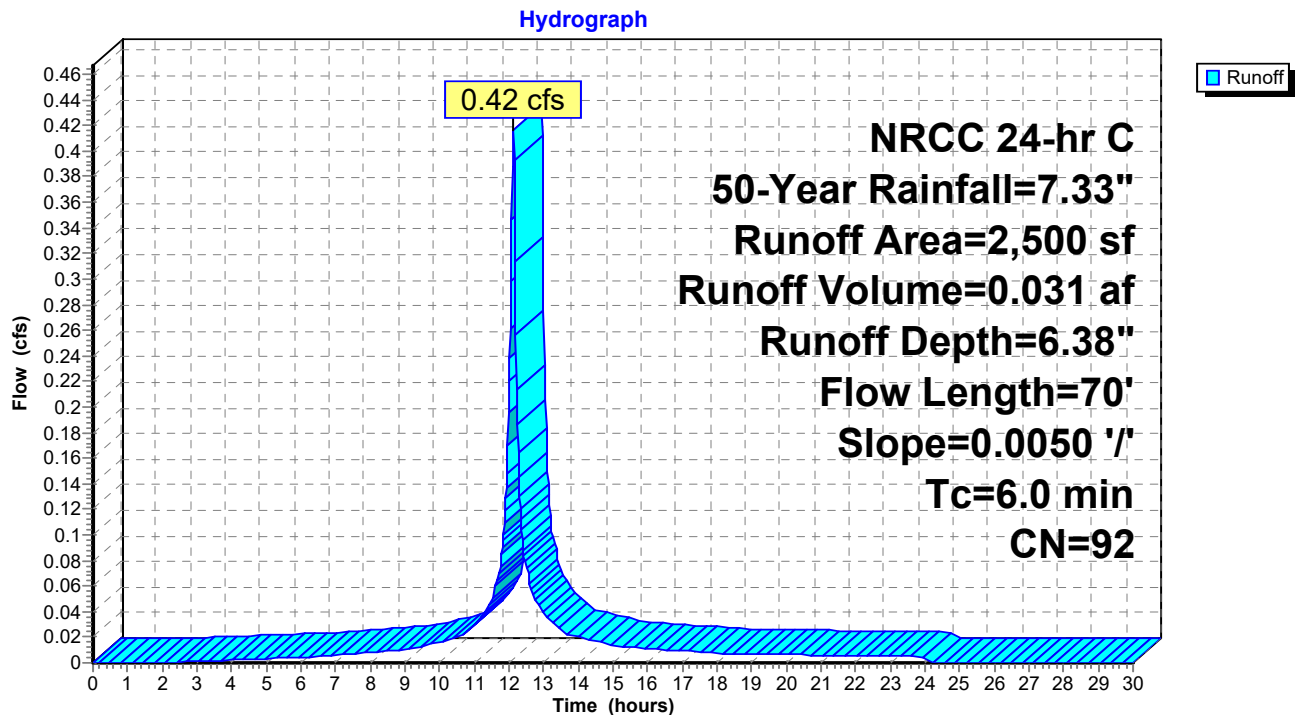
Runoff = 0.42 cfs @ 12.13 hrs, Volume= 0.031 af, Depth= 6.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 50-Year Rainfall=7.33"

Area (sf)	CN	Description
* 1,680	89	Crushed Stone Compound (exposed)
* 100	99	VZW Comm Equip & Pads
* 720	99	3 Future Carrier Pads (12'x20' ea)
2,500	92	Weighted Average
1,680		67.20% Pervious Area
820		32.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	70	0.0050	0.34		Lag/CN Method,
3.5	70	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: SUB-CATCH A1



Summary for Subcatchment 3S: SUB-CATCH A2

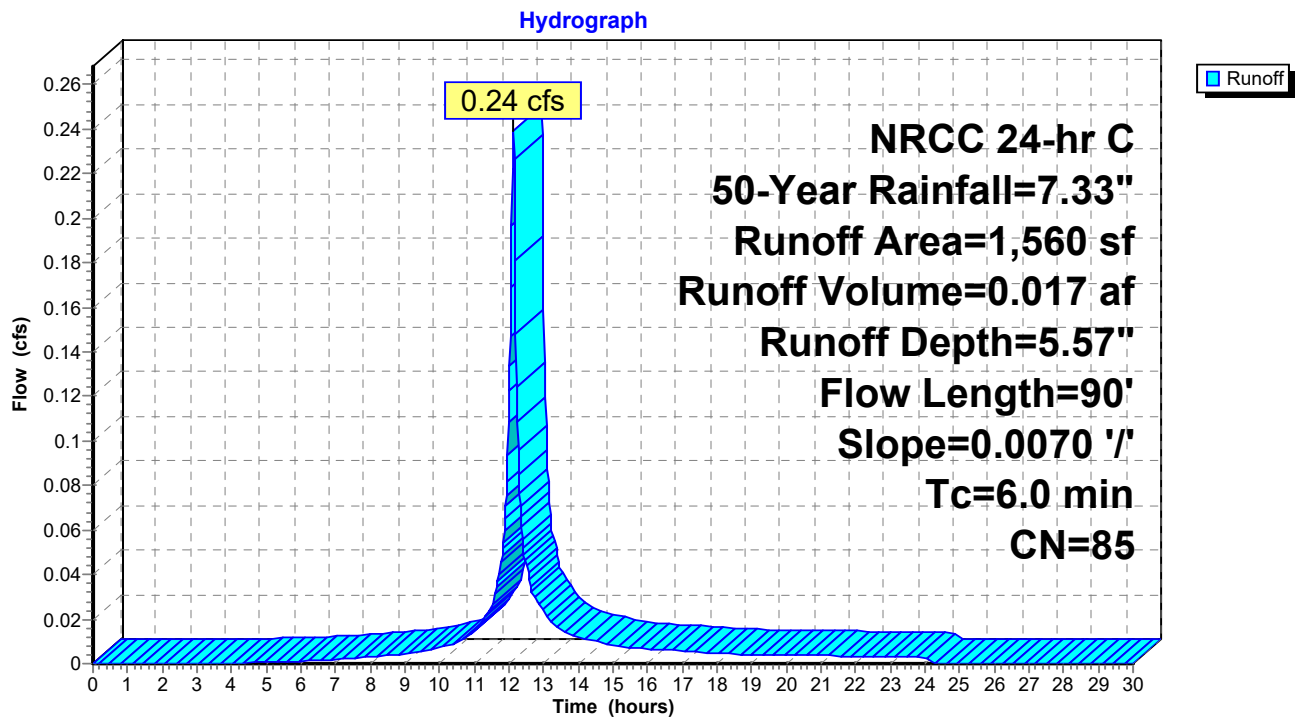
Runoff = 0.24 cfs @ 12.13 hrs, Volume= 0.017 af, Depth= 5.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 50-Year Rainfall=7.33"

Area (sf)	CN	Description
* 1,560	85	Proposed Gravel Drive, HSG C
1,560		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	90	0.0070	0.32		Lag/CN Method,
4.7	90	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 3S: SUB-CATCH A2



Summary for Subcatchment 4S: CATCHMENT B

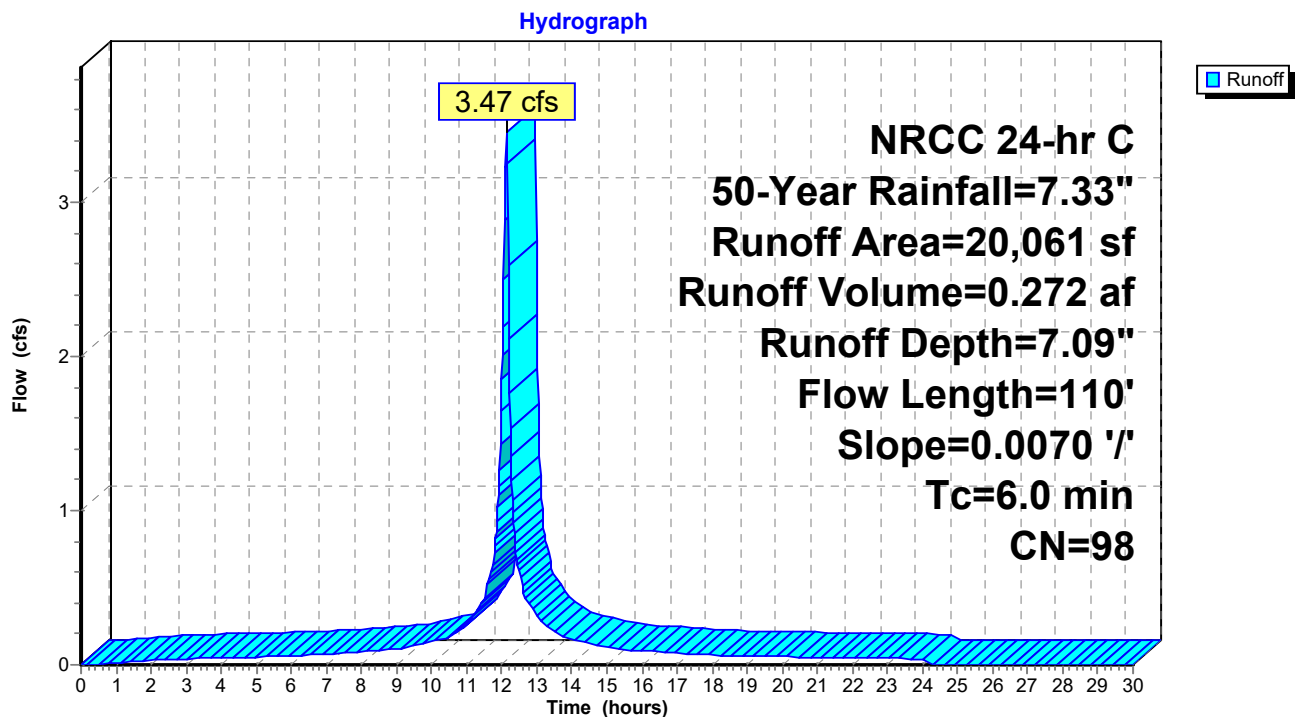
Runoff = 3.47 cfs @ 12.13 hrs, Volume= 0.272 af, Depth= 7.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 NRCC 24-hr C 50-Year Rainfall=7.33"

	Area (sf)	CN	Description
*	12,171	98	Parking, Driveway, F&R Sidewalks
*	7,890	98	Building Roof
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 4S: CATCHMENT B



Summary for Pond 3: Crushed Stone Compound

Inflow Area = 0.093 ac, 20.20% Impervious, Inflow Depth = 6.07" for 50-Year event
 Inflow = 0.66 cfs @ 12.13 hrs, Volume= 0.047 af
 Outflow = 0.04 cfs @ 11.26 hrs, Volume= 0.047 af, Atten= 94%, Lag= 0.0 min
 Discarded = 0.04 cfs @ 11.26 hrs, Volume= 0.047 af
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 73.32' @ 13.51 hrs Surf.Area= 0.057 ac Storage= 0.019 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
 Center-of-Mass det. time= 159.7 min (943.3 - 783.6)

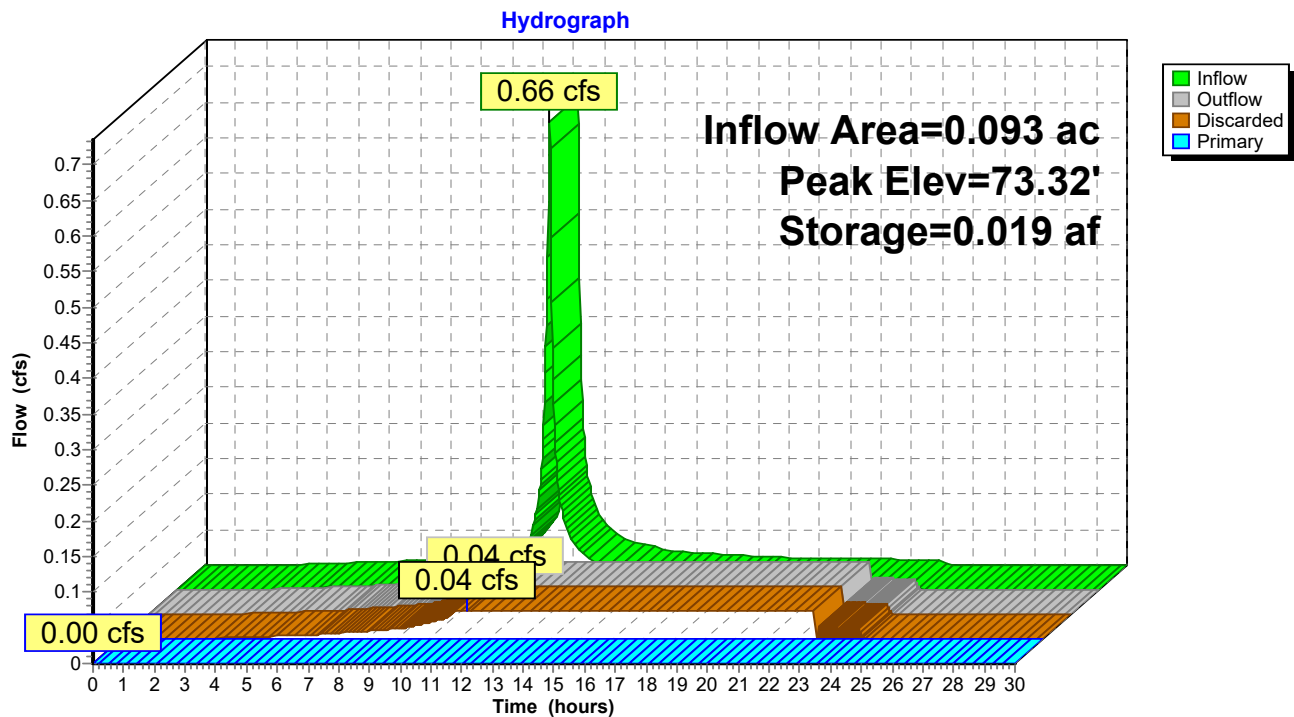
Volume	Invert	Avail.Storage	Storage Description
#1	72.50'	0.023 af	50.00'W x 50.00'L x 1.00'H Prismatic 0.057 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	73.45'	50.0' long x 1.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#2	Discarded	72.50'	0.700 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.04 cfs @ 11.26 hrs HW=72.51' (Free Discharge)
 ↑ **2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=72.50' TW=0.00' (Dynamic Tailwater)
 ↑ **1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3: Crushed Stone Compound



Summary for Pond 3P: CB1

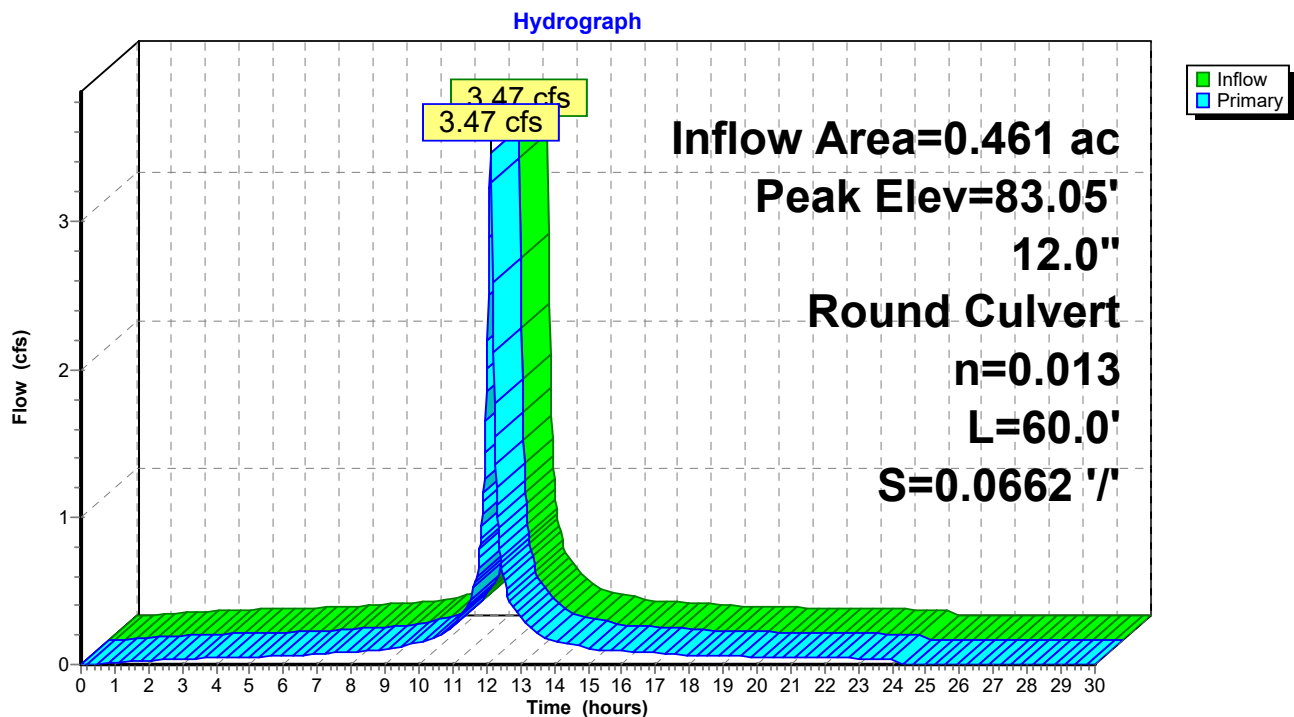
Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 7.09" for 50-Year event
 Inflow = 3.47 cfs @ 12.13 hrs, Volume= 0.272 af
 Outflow = 3.47 cfs @ 12.13 hrs, Volume= 0.272 af, Atten= 0%, Lag= 0.0 min
 Primary = 3.47 cfs @ 12.13 hrs, Volume= 0.272 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 83.05' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/ Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=3.44 cfs @ 12.13 hrs HW=83.04' TW=0.00' (Dynamic Tailwater)
 ↑1=Culvert (Inlet Controls 3.44 cfs @ 4.38 fps)

Pond 3P: CB1

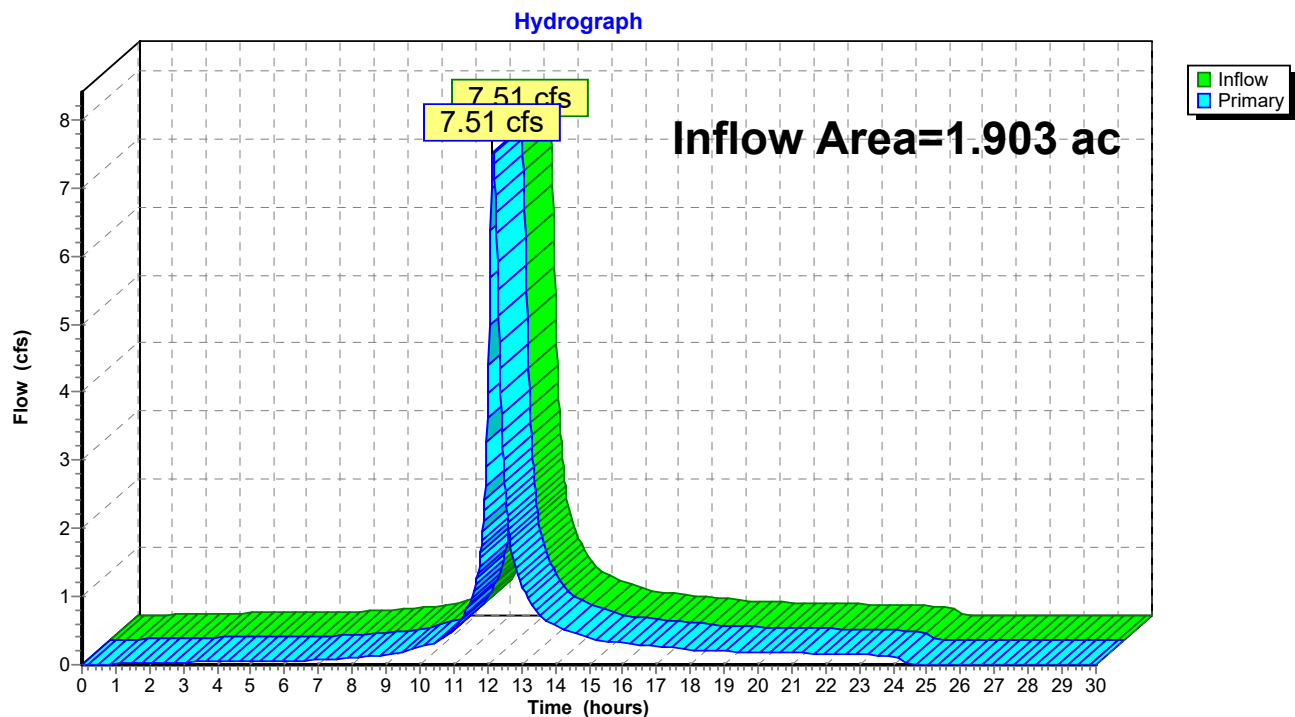


Summary for Link 2L: Project Total

Inflow Area = 1.903 ac, 25.18% Impervious, Inflow Depth = 4.63" for 50-Year event
Inflow = 7.51 cfs @ 12.16 hrs, Volume= 0.735 af
Primary = 7.51 cfs @ 12.16 hrs, Volume= 0.735 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total



VZW Pembroke 5 MA - HydroCAD - Proposed 10.0 NRCC 24-hr C 100-Year Rainfall=8.68"

Prepared by {enter your company name here}

Printed 10/14/2021

HydroCAD® 10.10-5a s/n 10822 © 2020 HydroCAD Software Solutions LLC

Page 49

Time span=0.00-30.00 hrs, dt=0.02 hrs, 1501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: CATCHMENT A Runoff Area=58,793 sf 0.00% Impervious Runoff Depth=5.30"
Flow Length=359' Tc=14.5 min CN=72 Runoff=6.58 cfs 0.596 af

Subcatchment2S: SUB-CATCH A1 Runoff Area=2,500 sf 32.80% Impervious Runoff Depth=7.72"
Flow Length=70' Slope=0.0050 '/ Tc=6.0 min CN=92 Runoff=0.50 cfs 0.037 af

Subcatchment3S: SUB-CATCH A2 Runoff Area=1,560 sf 0.00% Impervious Runoff Depth=6.87"
Flow Length=90' Slope=0.0070 '/ Tc=6.0 min CN=85 Runoff=0.29 cfs 0.021 af

Subcatchment4S: CATCHMENT B Runoff Area=20,061 sf 100.00% Impervious Runoff Depth=8.44"
Flow Length=110' Slope=0.0070 '/ Tc=6.0 min CN=98 Runoff=4.11 cfs 0.324 af

Pond 3: Crushed Stone Compound Peak Elev=73.46' Storage=0.022 af Inflow=0.79 cfs 0.057 af
Discarded=0.04 cfs 0.054 af Primary=0.08 cfs 0.003 af Outflow=0.12 cfs 0.057 af

Pond 3P: CB1 Peak Elev=83.39' Inflow=4.11 cfs 0.324 af
12.0" Round Culvert n=0.013 L=60.0' S=0.0662 '/ Outflow=4.11 cfs 0.324 af

Link 2L: Project Total Inflow=9.37 cfs 0.923 af
Primary=9.37 cfs 0.923 af

Total Runoff Area = 1.903 ac Runoff Volume = 0.977 af Average Runoff Depth = 6.16"
74.82% Pervious = 1.424 ac 25.18% Impervious = 0.479 ac

Summary for Subcatchment 1S: CATCHMENT A

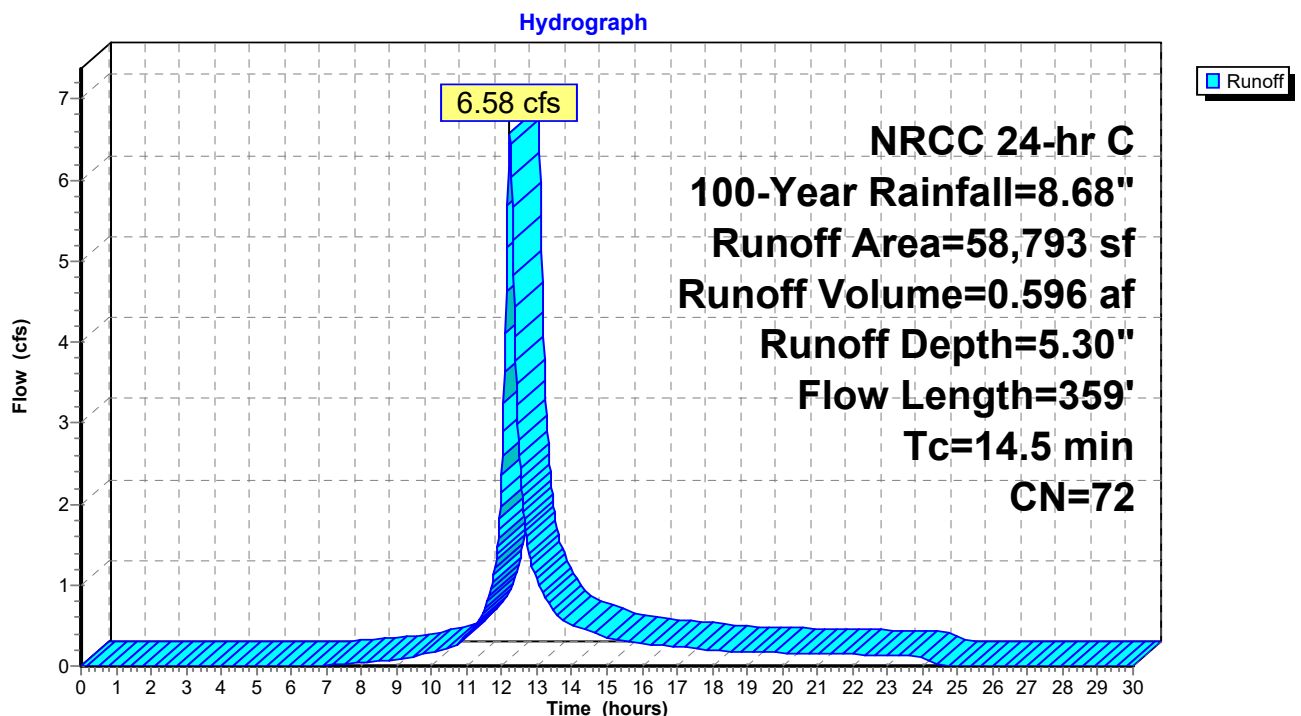
Runoff = 6.58 cfs @ 12.23 hrs, Volume= 0.596 af, Depth= 5.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

Area (sf)	CN	Description
13,955	74	>75% Grass cover, Good, HSG C
41,832	70	Woods, Good, HSG C
* 3,006	87	Mulch/Dirt roads, HSG C
58,793	72	Weighted Average
58,793		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	15	0.1110	0.22		Sheet Flow, Sheet Flow Grass: Short n= 0.150 P2= 3.00"
9.8	85	0.1110	0.14		Sheet Flow, Sheet Flow Woods: Light underbrush n= 0.400 P2= 3.00"
2.0	147	0.0630	1.25		Shallow Concentrated Flow, Shallow Concentrated Flow Woodland Kv= 5.0 fps
1.6	112	0.0520	1.14		Shallow Concentrated Flow, Shallow Concentrated Woodland Kv= 5.0 fps
14.5	359	Total			

Subcatchment 1S: CATCHMENT A



Summary for Subcatchment 2S: SUB-CATCH A1

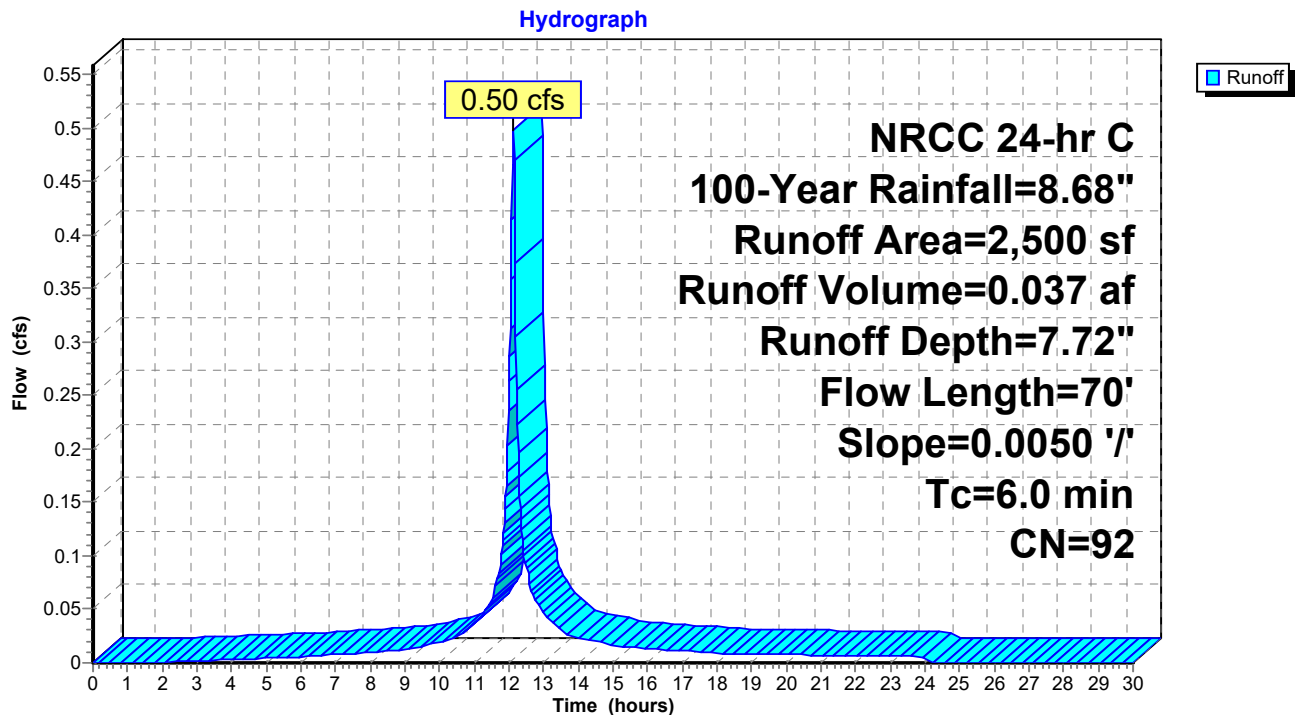
Runoff = 0.50 cfs @ 12.13 hrs, Volume= 0.037 af, Depth= 7.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

Area (sf)	CN	Description
* 1,680	89	Crushed Stone Compound (exposed)
* 100	99	VZW Comm Equip & Pads
* 720	99	3 Future Carrier Pads (12'x20' ea)
2,500	92	Weighted Average
1,680		67.20% Pervious Area
820		32.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	70	0.0050	0.34		Lag/CN Method,
3.5	70	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 2S: SUB-CATCH A1



Summary for Subcatchment 3S: SUB-CATCH A2

Runoff = 0.29 cfs @ 12.13 hrs, Volume= 0.021 af, Depth= 6.87"

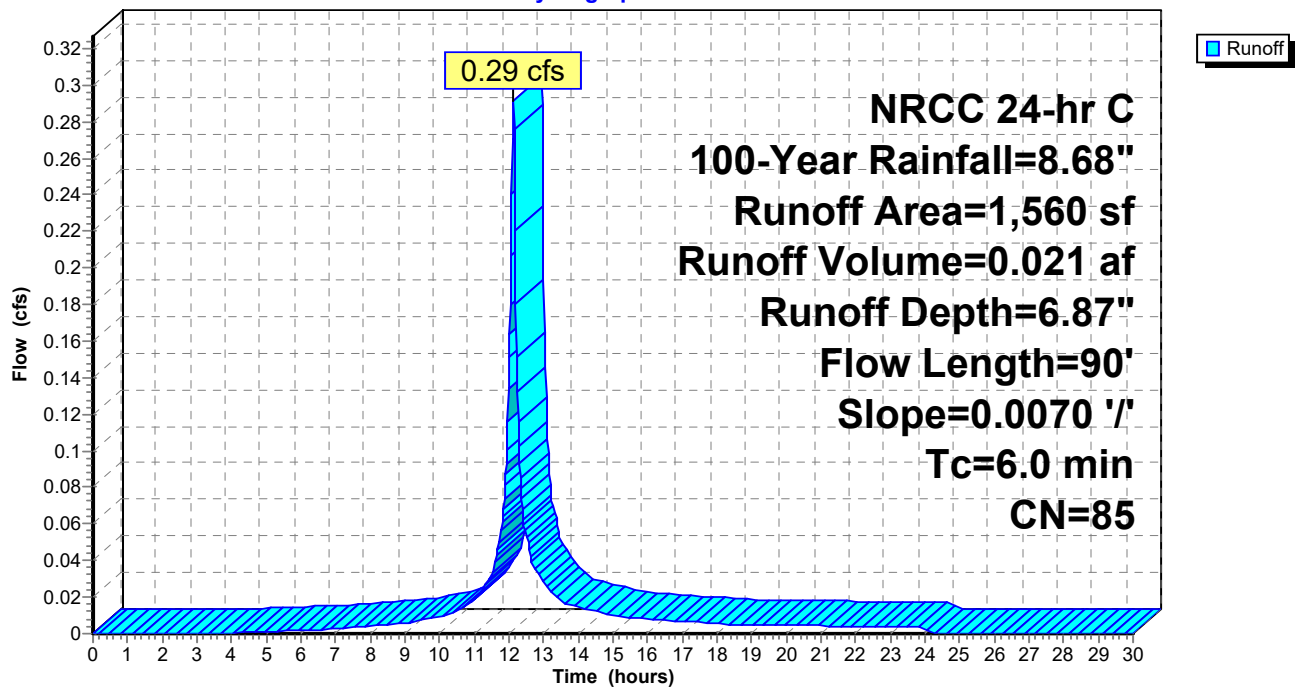
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

Area (sf)	CN	Description
* 1,560	85	Proposed Gravel Drive, HSG C
1,560		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	90	0.0070	0.32		Lag/CN Method,
4.7	90	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 3S: SUB-CATCH A2

Hydrograph



Summary for Subcatchment 4S: CATCHMENT B

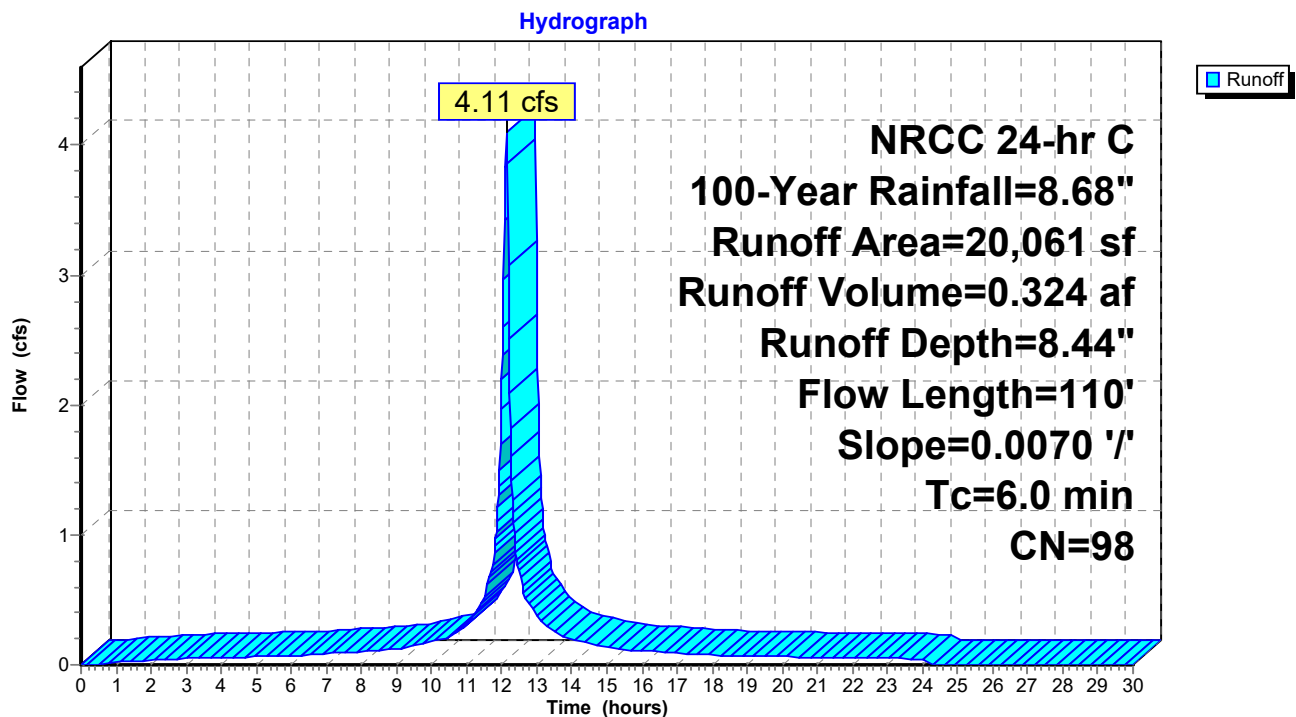
Runoff = 4.11 cfs @ 12.13 hrs, Volume= 0.324 af, Depth= 8.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

	Area (sf)	CN	Description
*	12,171	98	Parking, Driveway, F&R Sidewalks
*	7,890	98	Building Roof
	20,061	98	Weighted Average
	20,061		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	110	0.0070	0.60		Lag/CN Method,
3.1	110	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 4S: CATCHMENT B



Summary for Pond 3: Crushed Stone Compound

Inflow Area = 0.093 ac, 20.20% Impervious, Inflow Depth = 7.39" for 100-Year event
 Inflow = 0.79 cfs @ 12.13 hrs, Volume= 0.057 af
 Outflow = 0.12 cfs @ 12.59 hrs, Volume= 0.057 af, Atten= 85%, Lag= 27.9 min
 Discarded = 0.04 cfs @ 11.04 hrs, Volume= 0.054 af
 Primary = 0.08 cfs @ 12.59 hrs, Volume= 0.003 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 73.46' @ 12.59 hrs Surf.Area= 0.057 ac Storage= 0.022 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
 Center-of-Mass det. time= 183.1 min (961.3 - 778.2)

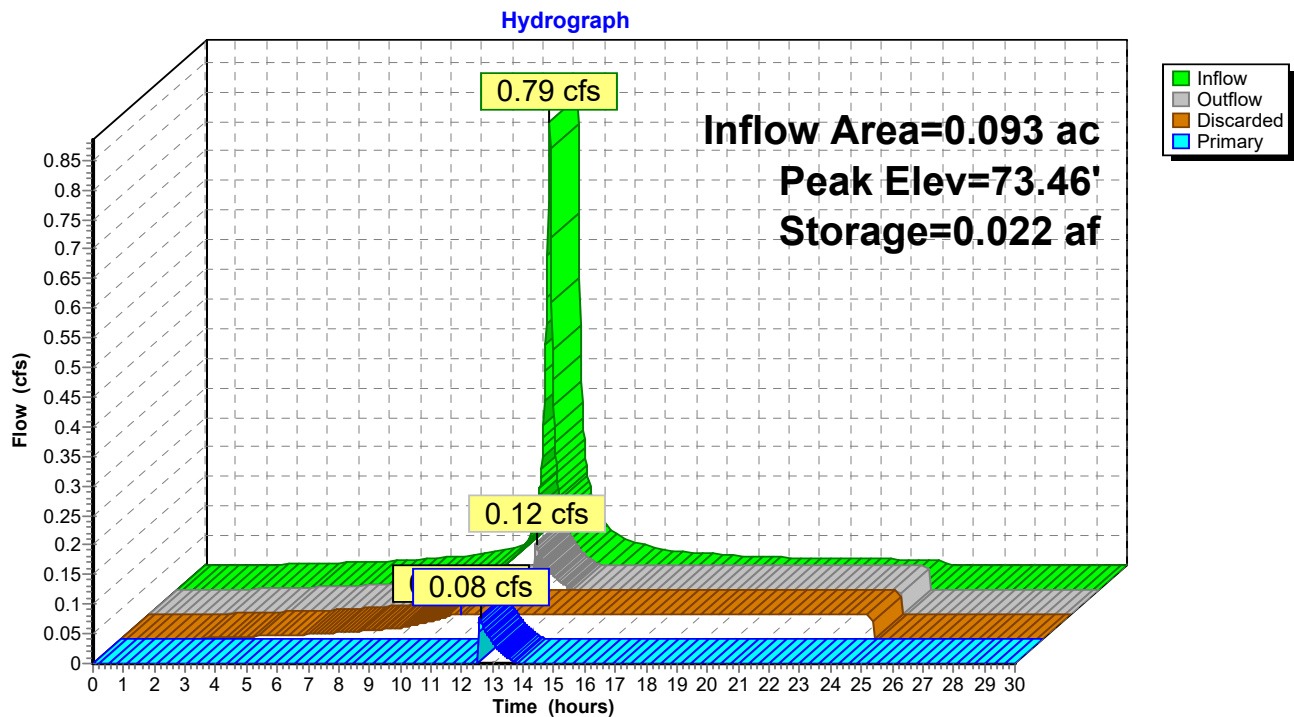
Volume	Invert	Avail.Storage	Storage Description
#1	72.50'	0.023 af	50.00'W x 50.00'L x 1.00'H Prismatic 0.057 af Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	73.45'	50.0' long x 1.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#2	Discarded	72.50'	0.700 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.04 cfs @ 11.04 hrs HW=72.51' (Free Discharge)
 ↑**2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.08 cfs @ 12.59 hrs HW=73.46' TW=0.00' (Dynamic Tailwater)
 ↑**1=Broad-Crested Rectangular Weir** (Weir Controls 0.08 cfs @ 0.22 fps)

Pond 3: Crushed Stone Compound



Summary for Pond 3P: CB1

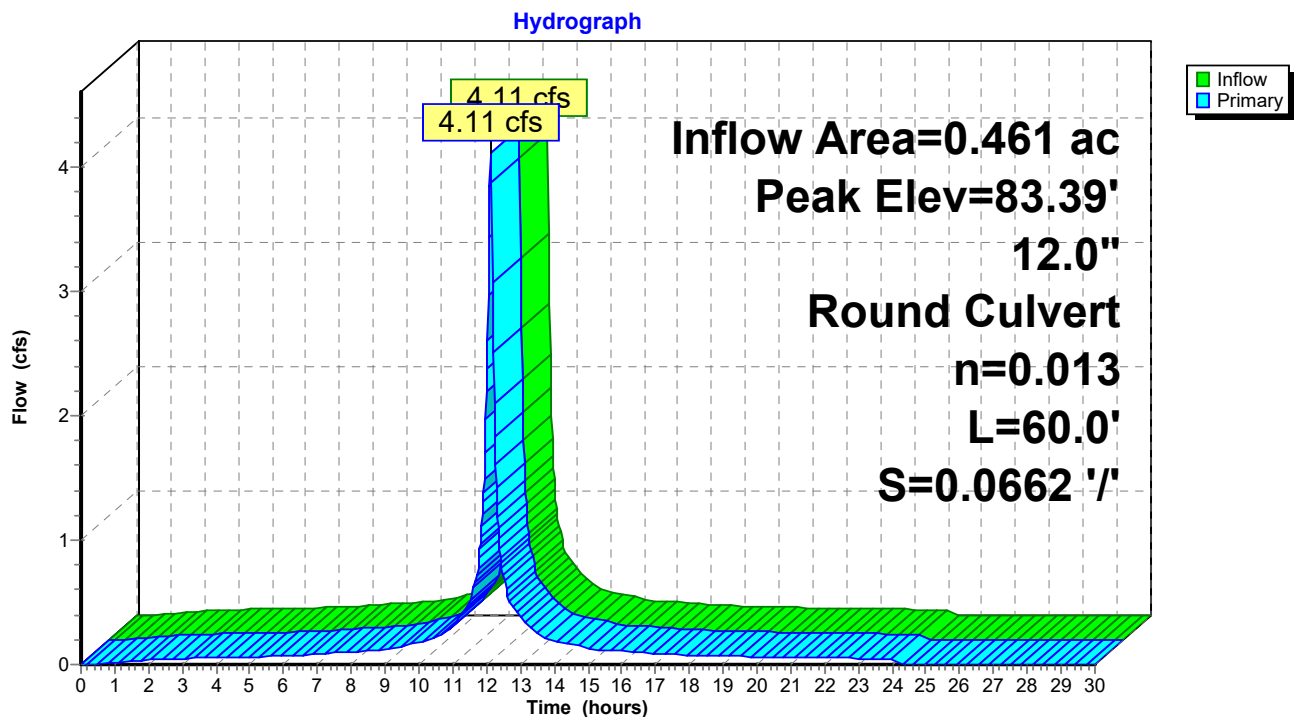
Inflow Area = 0.461 ac, 100.00% Impervious, Inflow Depth = 8.44" for 100-Year event
 Inflow = 4.11 cfs @ 12.13 hrs, Volume= 0.324 af
 Outflow = 4.11 cfs @ 12.13 hrs, Volume= 0.324 af, Atten= 0%, Lag= 0.0 min
 Primary = 4.11 cfs @ 12.13 hrs, Volume= 0.324 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs
 Peak Elev= 83.39' @ 12.13 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	81.71'	12.0" Round Culvert L= 60.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 81.71' / 77.74' S= 0.0662 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf

Primary OutFlow Max=4.07 cfs @ 12.13 hrs HW=83.39' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Culvert** (Inlet Controls 4.07 cfs @ 5.19 fps)

Pond 3P: CB1

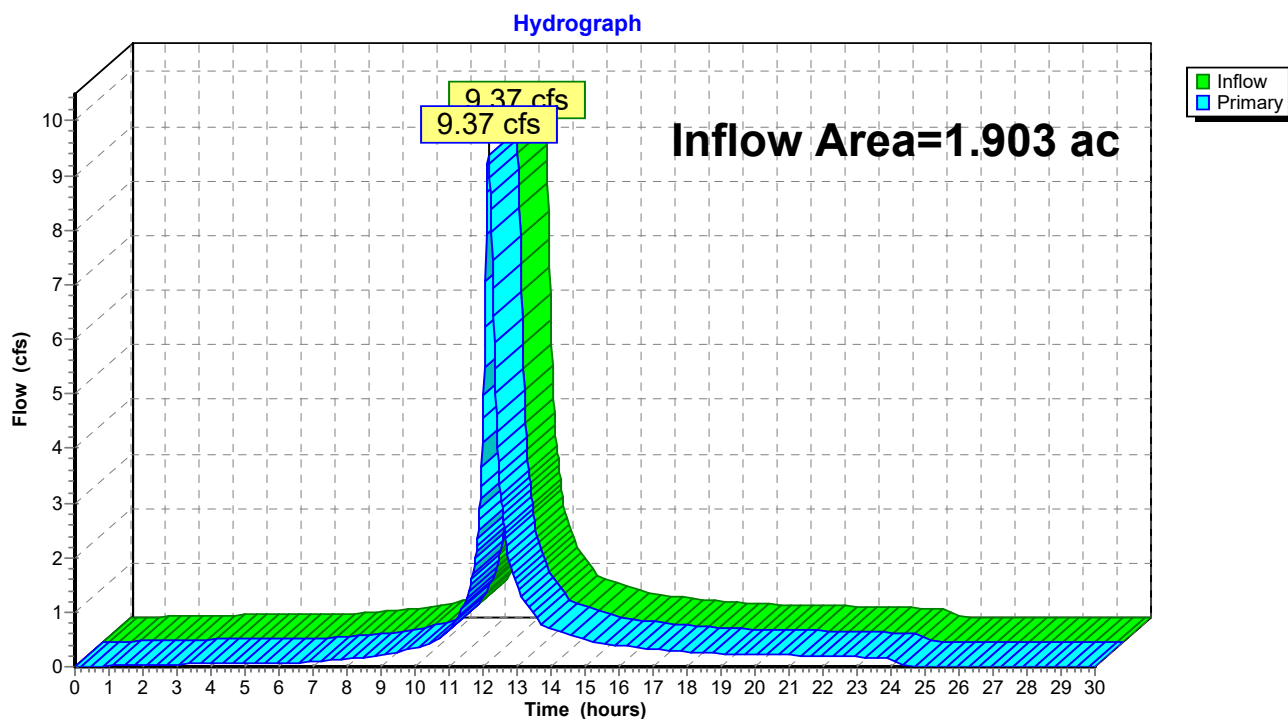


Summary for Link 2L: Project Total

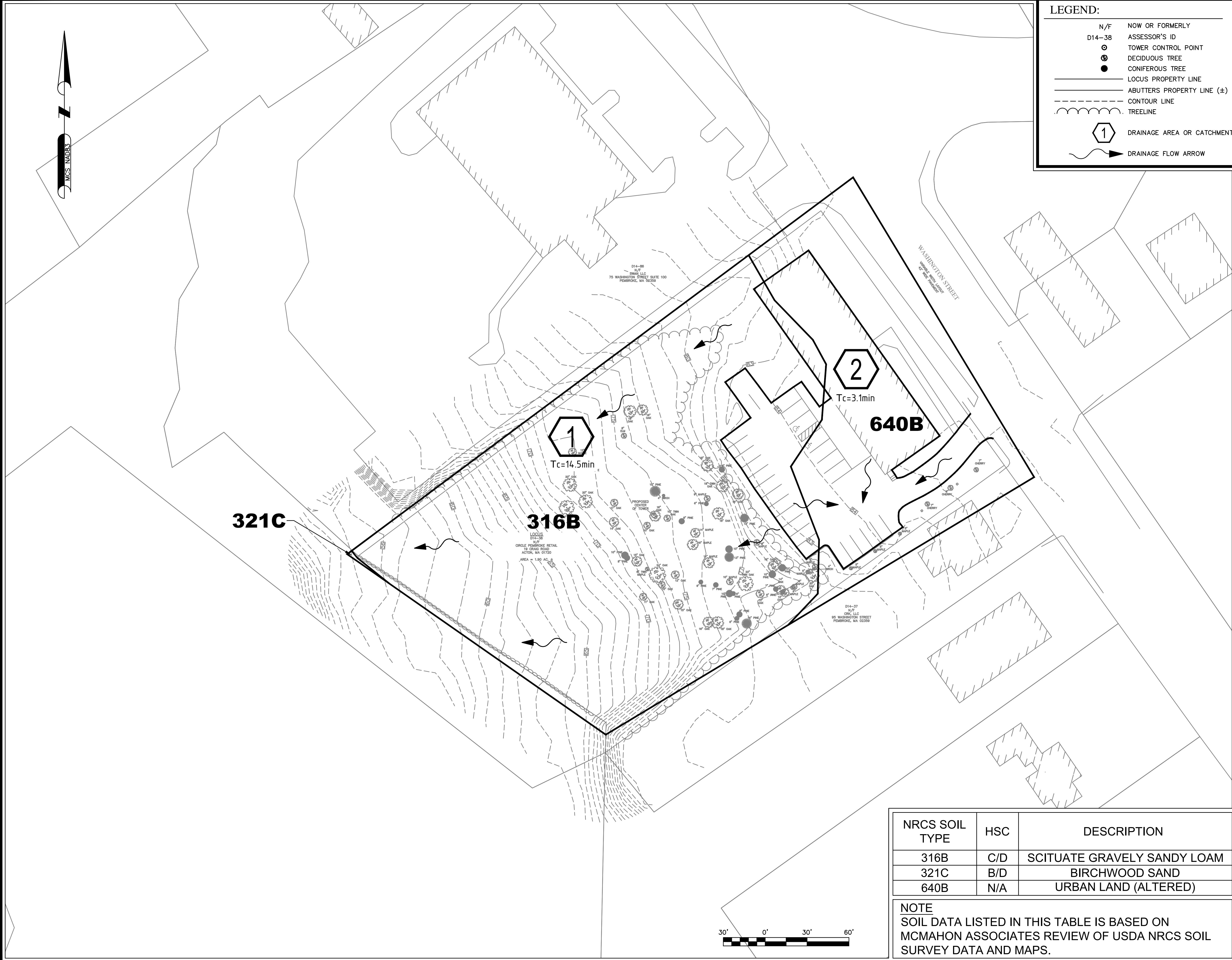
Inflow Area = 1.903 ac, 25.18% Impervious, Inflow Depth = 5.82" for 100-Year event
Inflow = 9.37 cfs @ 12.16 hrs, Volume= 0.923 af
Primary = 9.37 cfs @ 12.16 hrs, Volume= 0.923 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.02 hrs

Link 2L: Project Total



APPENDIX B – DRAINAGE AREA MAPS



LEGEND:

N/F	NOW OR FORMERLY
D14-38	ASSESSOR'S ID
○	TOWER CONTROL POINT
⊗	DECIDUOUS TREE
●	CONIFEROUS TREE
—	LOCUS PROPERTY LINE
---	ABUTTERS PROPERTY LINE (±)
- - -	CONTOUR LINE
~~~~~	TREELINE
1	DRAINAGE AREA OR CATCHMENT
→	DRAINAGE FLOW ARROW

PREPARED BY:

**nexus**  
TRANSFORM YOUR BUSINESS...THROUGH WIRELESS

A&E OFFICE:  
300 APOLLO DRIVE, SUITE 7  
CHELMSFORD, MA 01824  
1 (978) 923-7965

APPLICANT:

**verizon**

CELLCO PARTNERSHIP d/b/a  
VERIZON WIRELESS  
118 FLANDERS ROAD, 3RD FLOOR  
WESTBOROUGH, MA 01581

I HEREBY CERTIFY TO THE BEST OF MY PROFESSIONAL KNOWLEDGE, INFORMATION AND BELIEF THAT:

THIS SURVEY HAS BEEN PERFORMED IN THE FIELD UNDER MY SUPERVISION, AND TO MY KNOWLEDGE, BELIEF AND INFORMATION, THIS SURVEY HAS BEEN PERFORMED IN ACCORDANCE WITH CURRENTLY ACCEPTED ACCURACY STANDARDS;

DANIEL F. STASZ PLS #47160

SUBMITTALS			
REV	DATE	DESCRIPTION	BY
0	05/03/2021	DRAINAGE REPORT	MM
1	10/14/2021	DRAINAGE REPORT	MM

SITE INFO:

SITE NAME:  
**PEMBROKE_5_MA**

LOCATION CODE:

SITE ADDRESS:  
85 WASHINGTON STREET  
PEMBROKE, MA 02359

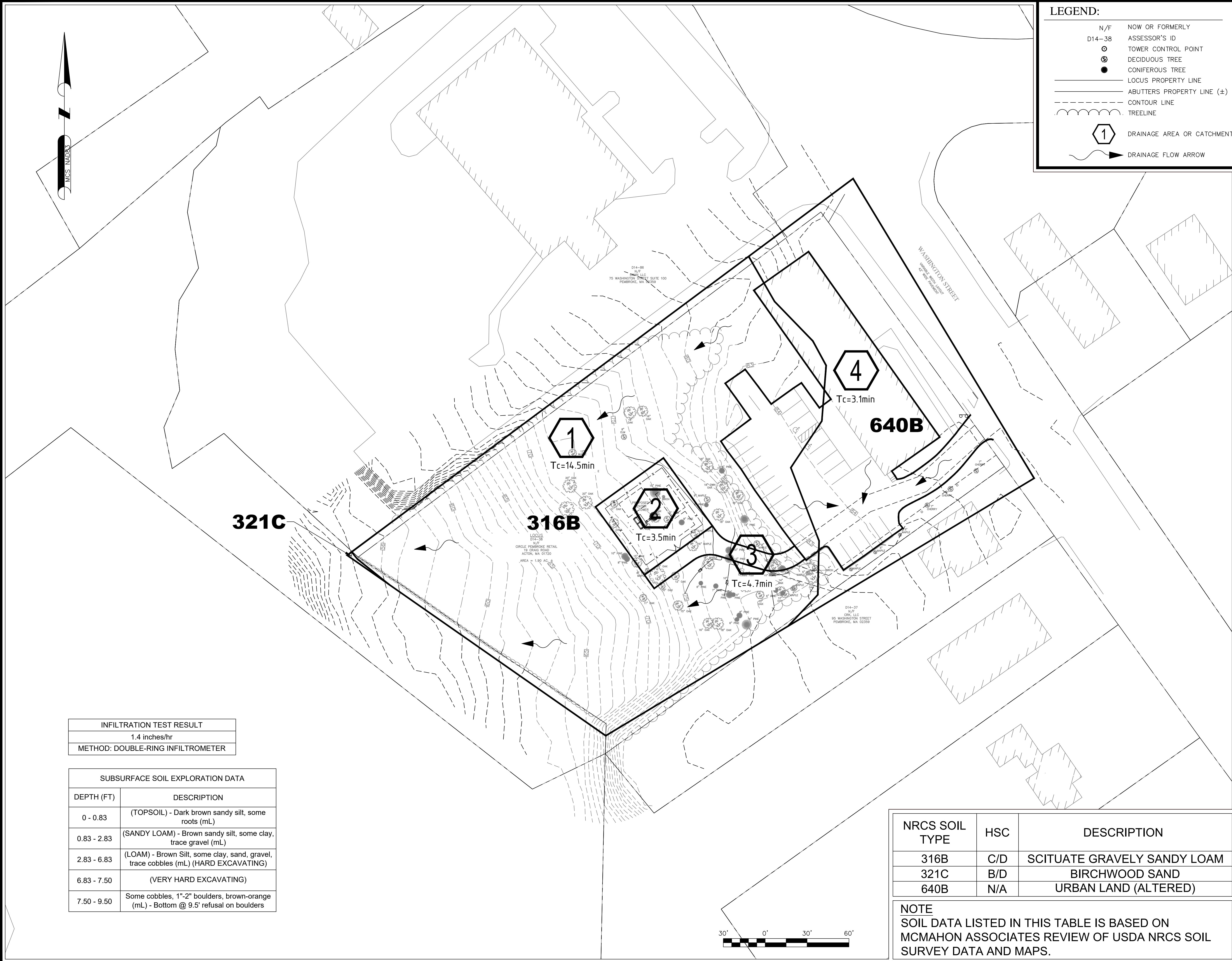
SHEET TITLE:  
**EXISTING DRAINAGE**

NEXIUS PROJ. NO: 20161495803	SHEET NUMBER:
CHECKED BY: BCF	<b>D-1</b>
CHECKED BY DATE: 2/2/2021	

NRCS SOIL TYPE	HSC	DESCRIPTION
316B	C/D	SCITUATE GRAVELY SANDY LOAM
321C	B/D	BIRCHWOOD SAND
640B	N/A	URBAN LAND (ALTERED)

**NOTE**  
SOIL DATA LISTED IN THIS TABLE IS BASED ON MCMAHON ASSOCIATES REVIEW OF USDA NRCS SOIL SURVEY DATA AND MAPS.





**LEGEND:**

N/F	NOW OR FORMERLY
D14-38	ASSESSOR'S ID
○	TOWER CONTROL POINT
⊗	DECIDUOUS TREE
●	CONIFEROUS TREE
—	LOCUS PROPERTY LINE
- - -	ABUTTERS PROPERTY LINE (±)
- - -	CONTOUR LINE
~~~~~	TREELINE
①	DRAINAGE AREA OR CATCHMENT
→	DRAINAGE FLOW ARROW

PREPARED BY:

nexus
TRANSFORM YOUR BUSINESS...THROUGH WIRELESS

A&E OFFICE:
300 APOLLO DRIVE, SUITE 7
CHELMSFORD, MA 01824
1 (978) 923-7965

APPLICANT:

verizon

CELLCO PARTNERSHIP d/b/a
VERIZON WIRELESS
118 FLANDERS ROAD, 3RD FLOOR
WESTBOROUGH, MA 01581

I HEREBY CERTIFY TO THE BEST OF MY PROFESSIONAL KNOWLEDGE, INFORMATION AND BELIEF THAT:

THIS SURVEY HAS BEEN PERFORMED IN THE FIELD UNDER MY SUPERVISION, AND TO MY KNOWLEDGE, BELIEF AND INFORMATION, THIS SURVEY HAS BEEN PERFORMED IN ACCORDANCE WITH CURRENTLY ACCEPTED ACCURACY STANDARDS;

DANIEL F. STASZ PLS #47160

SUBMITTALS			
REV	DATE	DESCRIPTION	BY
0	05/03/2021	DRAINAGE REPORT	MM
1	10/14/2021	DRAINAGE REPORT	MM

SITE INFO:

SITE NAME:
PEMBROKE_5_MA

LOCATION CODE:

SITE ADDRESS:
85 WASHINGTON STREET
PEMBROKE, MA 02359

SHEET TITLE:

PROPOSED DRAINAGE

NEXIUS PROJ. NO: 20161495803	SHEET NUMBER:
CHECKED BY: BCF	D-2
CHECKED BY DATE: 2/2/2021	

INFILTRATION TEST RESULT	
1.4 inches/hr	
METHOD: DOUBLE-RING INFILTRMETER	

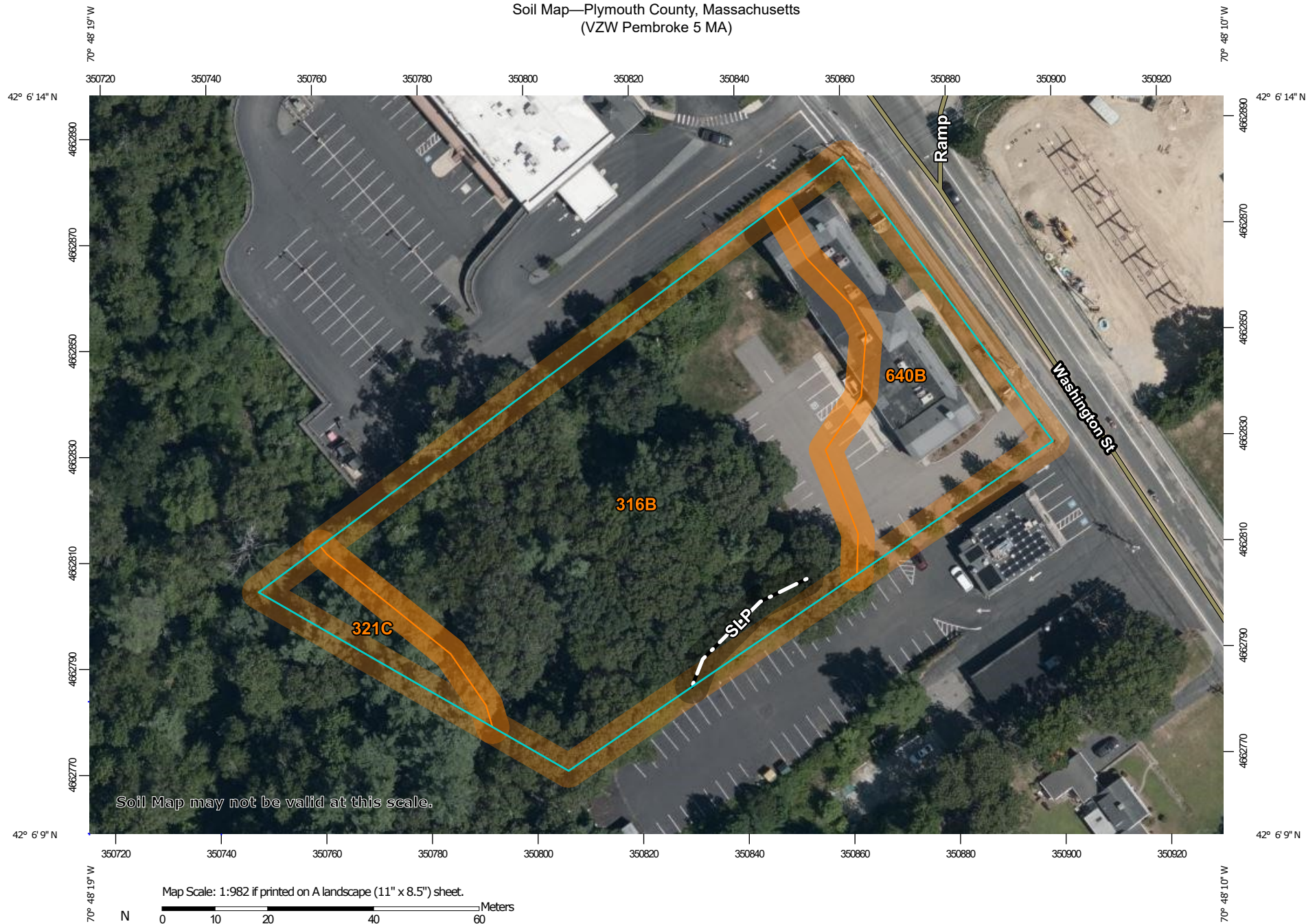
SUBSURFACE SOIL EXPLORATION DATA	
DEPTH (FT)	DESCRIPTION
0 - 0.83	(TOPSOIL) - Dark brown sandy silt, some roots (mL)
0.83 - 2.83	(SANDY LOAM) - Brown sandy silt, some clay, trace gravel (mL)
2.83 - 6.83	(LOAM) - Brown Silt, some clay, sand, gravel, trace cobbles (mL) (HARD EXCAVATING)
6.83 - 7.50	(VERY HARD EXCAVATING)
7.50 - 9.50	Some cobbles, 1"-2" boulders, brown-orange (mL) - Bottom @ 9.5' refusal on boulders

NRCS SOIL TYPE	HSC	DESCRIPTION
316B	C/D	SCITUATE GRAVELY SANDY LOAM
321C	B/D	BIRCHWOOD SAND
640B	N/A	URBAN LAND (ALTERED)

NOTE
SOIL DATA LISTED IN THIS TABLE IS BASED ON MCMAHON ASSOCIATES REVIEW OF USDA NRCS SOIL SURVEY DATA AND MAPS.

APPENDIX C – NRCS DATA

Soil Map—Plymouth County, Massachusetts
(VZW Pembroke 5 MA)



Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

10/13/2021
Page 1 of 3


MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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 14, Sep 2, 2021

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

Date(s) aerial images were photographed: Jul 31, 2019—Sep 1, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
316B	Scituate gravelly sandy loam, 3 to 8 percent slopes, very stony	1.5	73.3%
321C	Birchwood sand, 8 to 15 percent slopes, very stony	0.1	5.4%
640B	Urban land, till substratum, 0 to 8 percent slopes	0.4	21.3%
Totals for Area of Interest		2.0	100.0%

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
316B	Scituate gravelly sandy loam, 3 to 8 percent slopes, very stony	C/D	1.5	73.3%
321C	Birchwood sand, 8 to 15 percent slopes, very stony	B/D	0.1	5.4%
640B	Urban land, till substratum, 0 to 8 percent slopes		0.4	21.3%
Totals for Area of Interest			2.0	100.0%

Depth to Water Table

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
316B	Scituate gravelly sandy loam, 3 to 8 percent slopes, very stony	38	1.5	73.3%
321C	Birchwood sand, 8 to 15 percent slopes, very stony	48	0.1	5.4%
640B	Urban land, till substratum, 0 to 8 percent slopes	>200	0.4	21.3%
Totals for Area of Interest			2.0	100.0%

Description

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Interpret Nulls as Zero: No

Beginning Month: January

Ending Month: December

Depth to Any Soil Restrictive Layer

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
316B	Scituate gravelly sandy loam, 3 to 8 percent slopes, very stony	90	1.5	73.3%
321C	Birchwood sand, 8 to 15 percent slopes, very stony	102	0.1	5.4%
640B	Urban land, till substratum, 0 to 8 percent slopes	>200	0.4	21.3%
Totals for Area of Interest			2.0	100.0%

Description

A "restrictive layer" is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers.

This theme presents the depth to any type of restrictive layer that is described for each map unit. If more than one type of restrictive layer is described for an individual soil type, the depth to the shallowest one is presented. If no restrictive layer is described in a map unit, it is represented by the "greater than 200" depth class.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Interpret Nulls as Zero: No

APPENDIX D – OPERATION AND MAINTENANCE PLAN & LONG-TERM POLLUTION PREVENTION PLAN

**Verizon Wireless
Pembroke 5 MA
Stormwater Management System
Operation and Maintenance Plan (O&M)
and
Long Term Pollution Prevention Plan (LTPPP)**

Oct 2021

This Stormwater Management System Operation and Maintenance Plan provides for the inspection and maintenance of structural Best Management Practices (BMPs) and for measures to prevent pollution associated with the construction of cellular communication antenna tower in the Town of Pembroke, MA.

This document has been prepared in accordance with the requirements of the Stormwater Regulations included in the Massachusetts Wetlands Protection Act Regulations (310 CMR 10).

Responsible Party

Verizon Wireless is the lease owner of the facility area and will be responsible for the maintenance of the roadway facilities and associated stormwater management features, in accordance with Town standards.

Questions or concerns regarding maintenance activities may be addressed to Lease/Maintenance Owner:

Verizon Wireless
118 Flanders Road
Westborough, MA 01581

Maintenance Measures

The stormwater management system covered by this Operation and Maintenance Plan consists of the following components:

- Communications Compound

The communications compound shall be inspected and cleaned at a minimum of once per year before May 1st of each year. The site shall be inspected for general refuse including cups, drink containers, food wrappers, telecom project related debris such as coaxial cable, electronics communications equipment, adhesive and cementing compound containers, wire spools, etc. and be properly removed of and disposed of at an approved facility or waste transfer station. As the proposed compound surface shall be porous crushed stone to provide rain water infiltration

and groundwater recharge, the facility and surface shall be kept clean and free of any liquids or liquid-filled containers that may contaminate the rainwater or runoff for infiltration.

If inspection indicates the need for major repairs of structural surfaces, the inspector should contact Verizon Wireless to initiate procedures to effect repairs in accordance with Town standard construction practices.

Practices for Long Term Pollution Prevention

In general, long term pollution prevention and related maintenance activities will be conducted consistent with Town of Pembroke's Bylaws.

For the facilities covered by this Operation and Maintenance Plan, long term pollution prevention includes the following measures:

Routine Inspection and Maintenance of Stormwater BMPs

Verizon will conduct inspection and maintenance of the stormwater management practices in accordance with the guidelines discussed above.

Spill Prevention and Response

Verizon Wireless will implement response procedures for releases of significant materials such as fuels, oils, or chemical materials onto the ground or other areas that could reasonably be expected to discharge to surface or groundwater.

- Reportable quantities will immediately be reported to the applicable Federal, State, and local agencies as required by law. The Town should also be notified. Reportable quantities of chemical, fuels, or oils are established under the Clean Water Act and enforced through MassDEP. The MassDEP Emergency Response Program shall be immediately notified in accordance with required procedures for the report of a release (telephone 888-304-1133).
- Applicable containment and cleanup procedures will be performed immediately. Impacted material collected during the response must be removed promptly and disposed of in accordance with Federal, State, and local requirements. A licensed emergency response contractor may be required to assist in cleanup of releases depending on the amount of the release and the ability of the responsible party to perform the required response.
- Reportable quantities of chemical, fuels, or oils are established under the Clean Water Act and enforced through DEP.

Maintenance of Landscaped Areas

Routine mowing should be conducted during spring and summer months as needed given the tower is unmanned.

Snow and Ice Management

Snow and Ice Management shall be conducted as needed given the tower is unmanned.

Prohibition of Illicit Discharges

The MassDEP Stormwater Management Standards prohibit illicit discharges to the storm water management system. Illicit discharges are discharges that do not entirely consist of stormwater, except for certain specified non-stormwater discharges.

Examples of discharges from the following sources are not considered illicit discharges:

Firefighting activities*	Riparian habitats/wetlands
Foundation drain lines	Potable water sources
Line flushing	Dechlorinated swimming pool water
Footing drains	Street sweeping
Irrigation systems	Wash water from buildings (without detergents)
Residential car washing	Condensation from air conditioning units
Uncontaminated groundwater	Run-on from private driveways caused by precipitation
Rising groundwater	Lawn watering

*Water from firefighting activities is allowed under this permit and need only be addressed where they are identified as significant sources of pollutants to waters of the United States.

There are no known or proposed illicit connections associated with this project. If a potential illicit discharge to the facilities covered by this plan is detected (e.g., dry weather flows at any pipe outlet, evidence of contamination of surface water discharge by non-stormwater sources), Verizon Wireless shall be notified for assistance in determining the nature and source of the discharge, and for resolution through the Town's IDDE program.

Owners Signature

APPENDIX E – WATER QUALITY VOLUME/GROUNDWATER RECHARGE CALCS

GROUNDWATER RECHARGE

Additional / Proposed Impervious Surfaces = gravel driveway, 3 shelters (12'x20'), VZW Pad and cabinets

Additional / Proposed Impervious Area = 1560 sf + 720 sf + 100 sf = **2380 sf**

Applicable HSG = C soils (316B Scituate gravelly sandy loam)

Applicable HSG Volume to recharge = Impervious Area x 0.25 in

Required Recharge Volume = 2380 sf x 0.25 inches = **595 sf**

APPENDIX F - PROPOSED PROJECT PLANS (UNDER SEPARATE
COVER)

APPENDIX G – FIELD & OFFICE TEST RESULTS

COSTA CONSULTING ENGINEERS

**104 MOODY ST
LUDLOW, MA 01056**

**TEL: 413-583-4377
FAX: 413-583-4486**

WWW.COSTACONSULTINGENGINEERS.COM

9/28/21

McMahon Associates
94 North Elm St; Suite 308
Westfield, MA 01085

Attention: Mr. Mark McClusky, P.E.
Project Manager

Re: Nexius VZW
Infiltration Testing
Pembroke, MA
CCE File No. 695

Mr. McClusky:

In accordance with Proposal/Agreement P20-288 (formerly p20-886) executed on 9/3/21 with McMahon Associates, Costa Consulting Engineers (CCE) submits the results of a test pit investigation and infiltration test program performed at 85 Washington St. in Pembroke, MA. The site location is shown on Figure 1.

Scope of Work

In accordance with the Agreement, CCE performed the following:

1. Engaged an excavation contractor to excavate one test pit and an infiltration test area.
2. Obtained two soil samples and prepared test pit logs. Observations were made to estimate the seasonal high groundwater table by redox features.
3. Performed one double ring infiltration test in accordance with ASTM D3385 at 1.5 feet below the ground surface.
4. Performed hydrometer and sieves test on two samples to classify the soil samples in accordance with USDA classification system.
5. Prepared a letter report summarizing the results of the Work.

Project Information

CCE understands the proposed project will consist of a cell tower enclosed within 50 foot by 50 foot compound. The results of CCE's work will be for stormwater management design for within the compound area.

Test Pit Excavation

One test pit, TP1, was excavated on 9/20/21 by SiteCon Excavators of Pembroke, MA by using a Volvo ECR58 excavator. The test pit location is shown on Drawing 1. The test pit condition was inspected and logged by CCE and the test pit log is included in the Appendix. The test pit depth 9.5ft where it encountered bucket refusal on two boulders. Photos of the test pit and the associated spoil pile are included in the Appendix. The test pit was open for about 7 hours to allow for a groundwater observation. At the end of the observation period, the test pit was backfilled with spoils and leveled at the ground surface.

Lab Testing

CCE performed laboratory testing to classify the soil and verify visual classifications performed in the field. Table 1 summarizes the laboratory test results. Additional laboratory test data is included in the Appendix. Soil descriptions are provided in accordance with the Unified Soil Classification System (USCS) and the United States Department of Agriculture system (USDA).

Table 1: Laboratory Test Results

Test Method	Test Pit	Sample No.	Depth (ft)	Soil Classification	
				USCS	USDA
USDA soil texture (sieve & hydrometer)	TP1	S1	2	Brown sandy SILT, some clay, trace gravel (ML)	SANDY LOAM
USDA soil texture (sieve & hydrometer)	TP1	S2	4.3	brown SILT, some clay, sand, gravel, trace cobbles (ML)	LOAM

Infiltration Testing

One double ring infiltration test (ASTM D3385), I1, was performed on 9/20/21 by excavating one pit to 1.5 feet deep. The infiltration test location is shown on Drawing 1. An infiltration pit log and a photo are included in the Appendix. At the end of the test, the pit was backfilled with spoils and leveled at the ground surface.

Results

The test pit revealed 10 inches of dark brown sandy SILT with some roots, underlain by 2 feet of brown sandy SILT with some clay and a trace of gravel (SANDY LOAM), followed by brown SILT with some clay, sand, gravel and a trace of cobbles with occasional 2 foot diameter boulders (LOAM) to 9.5 feet deep. Excavation effort increased with depth and bucket refusal occurred at 9.5 feet deep. The soil's color turned to brownish-orange from 8 to 9.5 feet deep. No evidence of oxidation or redox features was observed in the test pit. The test pit was left open for about 7 hours and during that time, no evidence of groundwater was observed in the excavation.

CCE#695
Nexius VZW
85 Washington St; Pembroke, MA

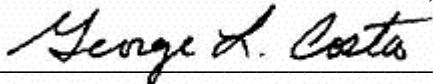
9/28/21
Infiltration Testing

Infiltration test II was performed at 1.5 feet below the ground surface on the same soil that was observed at the same depth in test pit TP1. This soil consists of brown sandy SILT with some clay and a trace of gravel. The Unified Soil Classification is ML. The USDA classification is SANDY LOAM. Steady state infiltration conditions occurred at about 1.5 hours after the start of the test. The test continued under steady state conditions for about an additional hour. The lowest measured steady state infiltration rate is 1.4 inches per hour.

If you have any questions, please contact CCE.

Very truly yours,

COSTA CONSULTING ENGINEERS, INC.

By: 
George L. Costa, P.E., President

GLC:glc
Attachments: Appendix

CCE# 695
Nexius VZW
85 Washington St; Pembroke, MA

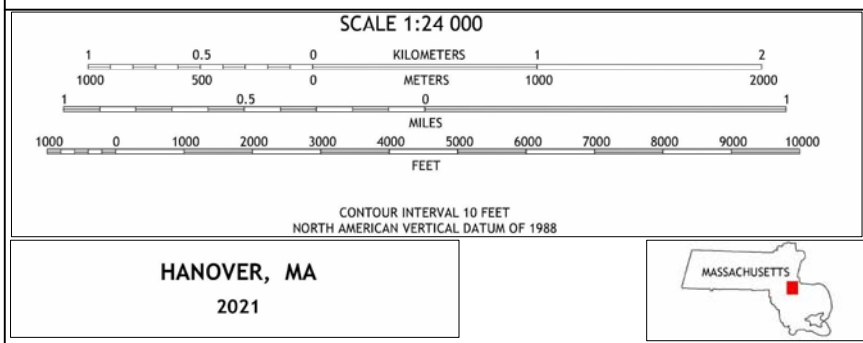
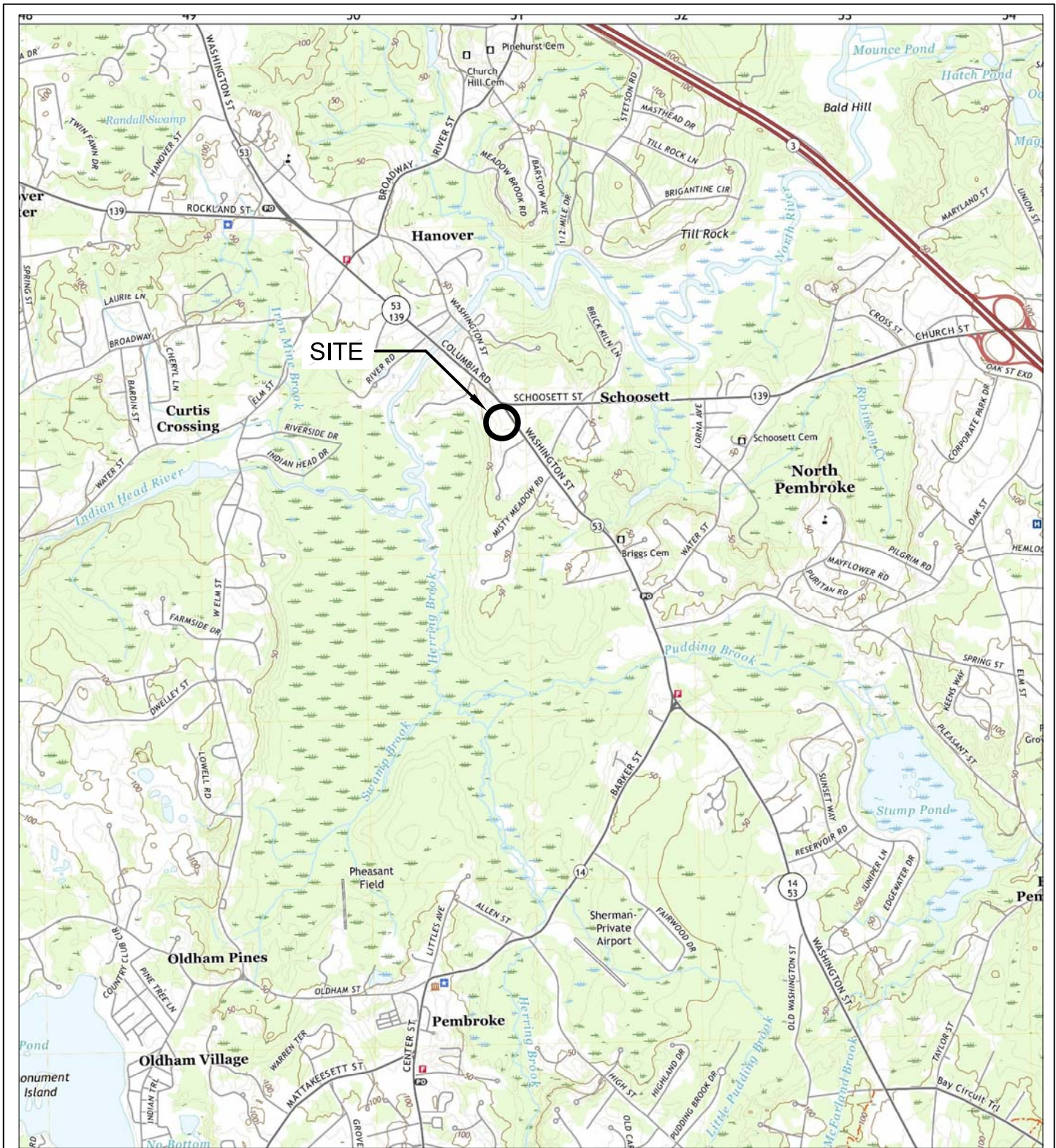
9/28/21
Infiltration Testing

Appendix

CCE# 695
Nexius VZW
85 Washington St; Pembroke, MA

9/28/21
Infiltration Testing

Exhibits

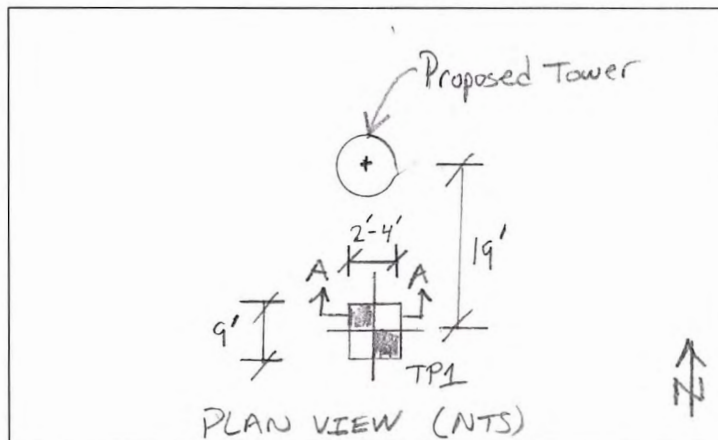


NEXIUS VZW			
85 Washington St.			
PEMBROKE			MA
COSTA CONSULTING ENGINEERS, INC.			
104 MOODY ST.		LUDLOW, MA 01056	
SCALE AS SHOWN	MADE BY: GLC CH'KD BY: GLC	DATE 9/28/21 DATE 9/28/21	FILE 695
SITE LOCATION			FIG NO. 1

CCE# 695
Nexius VZW
85 Washington St; Pembroke, MA

9/28/21
Infiltration Testing

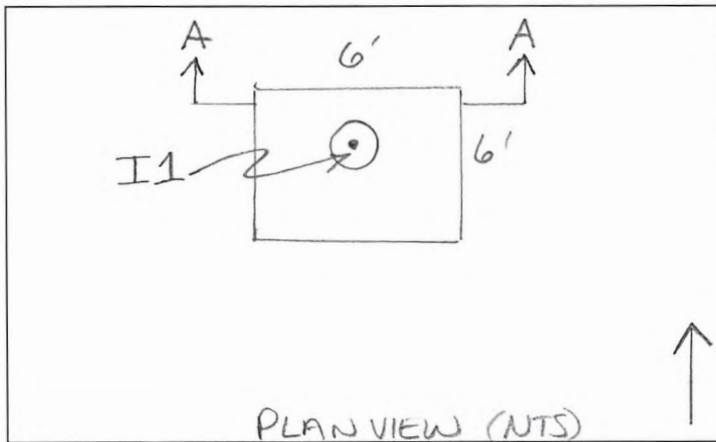
Pit Logs

TEST PIT LOGDate 9/20/21Project Nexus V2WTest Pit No. TP1Location 85 Washington St; Pembroke, MARes. Engr. G. COSTANOTES

- Volvo ECR58 Excavator
- Operator: Dave Elliot (SiteCon Excavators)
- weather: sunny 65°F
- 07:20 - 08:15: EXCAVATE PIT
- 14:45 - 15:00: BACKFILL PIT
- No groundwater

Ground Surface Elevation 75

Sample Depth	Description	Depth ft
A	leaves on surface A	1
	dark brown sandy SILT, some roots (ML) (TOP SOIL)	0.83
(S1)	(SANDY LOAM) brown sandy SILT, some clay, trace gravel (ML)	2
		2.83
		3
	(LOAM) brown SILT, some clay, sand, gravel, trace cobbles (ML)	4
(S2)	• Hard excavating	5
		6
	• very hard excavating	6.83
		7
	• some cobbles, 1'-2' boulders	7.5
	• brown-orange (ML)	8
	boulders	9
		9.5
	Bottom @ 9.5' refusal on boulders	10

TEST PIT LOGDate 9/20/21Project Nexus VZWTest Pit No. I1Location 85 Washington St; Pembroke MARes. Engr. G. COSTANOTES

- Volvo ECR58 Excavator
- Operator: Dave Elliot (Site Con Excavators)
- Weather: Sunny 65°F
- 10:00 - 15:00
- No groundwater

Ground Surface Elevation 75.5

Sample Depth	Description	Depth Ft
	A	
	Leaves at surface	0
	dark brown sandy SILT, some roots (ML) (TOPSOIL)	0.83
	• brown sandy SILT, some clay, trace gravel (ML)	1
	• (SANDY LOAM)	1.5
	I1 test location	2
	Bottom @ 2'	

CCE# 695
Nexius VZW
85 Washington St; Pembroke, MA

9/28/21
Infiltration Testing

Photos



Photo 1: TP1



Photo 2: TP1 spoils



Photo 3: I1

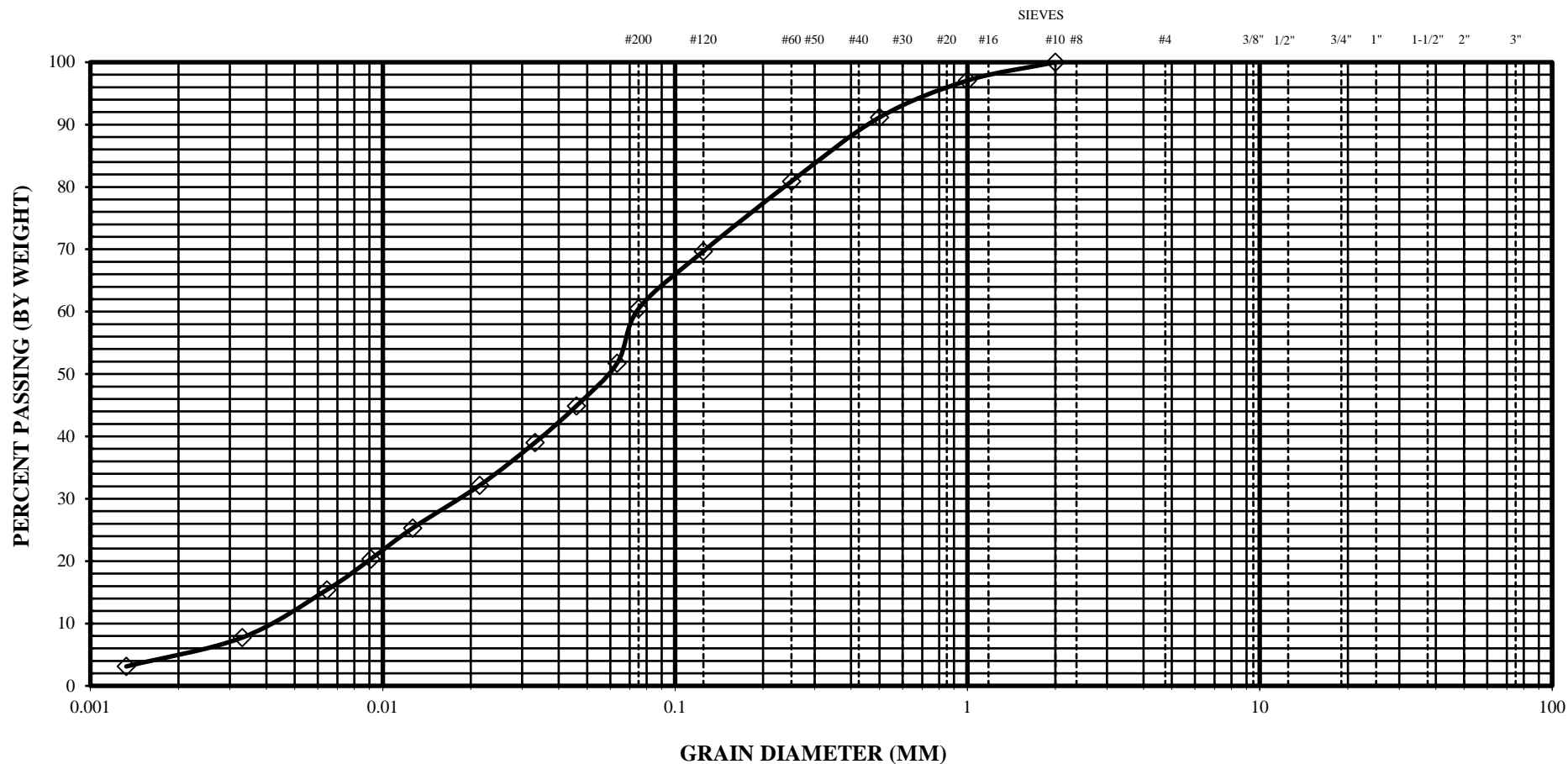
CCE# 695
Nexius VZW
85 Washington St; Pembroke, MA

9/28/21
Infiltration Testing

Laboratory Test Data

HYDROMETER ANALYSIS

SIEVE ANALYSIS



UNIFIED SOILS
CLASSIFICATION



CLAY OR SILT

SAND

FINE

MEDIUM

COARSE

GRAVEL

FINE

COARSE

COBBLES

COBBLE 3 - 12 "
BOULDER > 12"

NOTES:

1. Sampled by: .
2. Source: .
3. USCS Desc.: brown sandy SILT, some clay, trace gravel
4. Gravel: 8.9%

BORING / TEST PIT	SAMPLE	DEPTH, (in)	ELEV, (ft)
TP1	S1	24	73

Nexus VZW		
Pembroke MA		
COSTA CONSULTING ENGINEERS, INC.		
104 MOODY ST; LUDLOW, MA 01056		
MADE BY: GLC	DATE: 9/28/21	FILE NO.
CH'KD BY: GLC	DATE: 9/28/21	695
ASTM 422		FIGURE NO.
GRAIN SIZE DISTRIBUTION		1

Boring / Test Pit	TP1
Sample No.	S1
Depth, (in)	24.0
Elevation, (ft)	73
Stratum	.
USCS	.
USDA	SANDY LOAM

U.S Standard Sieve Size	Sieve Size (mm)	Percent Passing (by weight)*
#10	2.00	100.0
#18	1.00	97.1
#35	0.50	91.1
#60	0.250	80.9
#120	0.125	69.7
#200	0.075	60.5
	0.063	51.7
	0.046	44.9
	0.033	39.0
	0.021	32.2
	0.013	25.3
	0.009	20.4
	0.006	15.4
	0.003	7.8
	0.001	3.1

Notes:

1. Sampled by:	.
2. Source:	.
3. USCS Desc.:	brown sandy SILT, some clay, trace gravel
4. Gravel:	8.9%

Nexius VZW		
Pembroke		MA
COSTA CONSULTING ENGINEERS, INC.		
104 MOODY ST; LUDLOW, MA 01056		
MADE BY: GLC	DATE: 9/28/21	FILE NO.
CHKD BY: GLC	DATE: 9/28/21	695
ASTM 422		FIGURE NO.
GRAIN SIZE DISTRIBUTION		2

ASTM 422 Particle Size Analysis Results / Textural Analysis Results

Boring / Test Pit	TP1
Sample ID.	S1
Date	9/28/21

USDA Size Fractions

Main Fractions	Size (mm)	Percent
Sand	2.0 to > 0.05	53.5
Silt	0.05 to > 0.002	41.8
Clay	<=0.002	4.7
Total	<=2.0	100.0

Sand Fractions	Size (mm)	Percent
Very Coarse	2.0 to >1.0	2.9
Coarse	1.0 to > 0.5	5.9
Medium	0.5 to > 0.25	10.3
Fine	0.25 to > 0.10	15.8
Very Fine	0.10 to > 0.05	18.6
Total		53.5

Silt Fractions	Size (mm)	Percent
Coarse	0.05 to >0.02	15.5
Medium	0.02 to > 0.005	19.1
Fine	0.005 to > 0.002	7.2
Total		41.8

Percent of Whole Sample

Size (mm)	Sieve #	% Passing
2.00	10	100.0
1.00	18	97.1
0.50	35	91.1
0.250	60	80.9
0.125	120	69.7
0.075	200	60.5

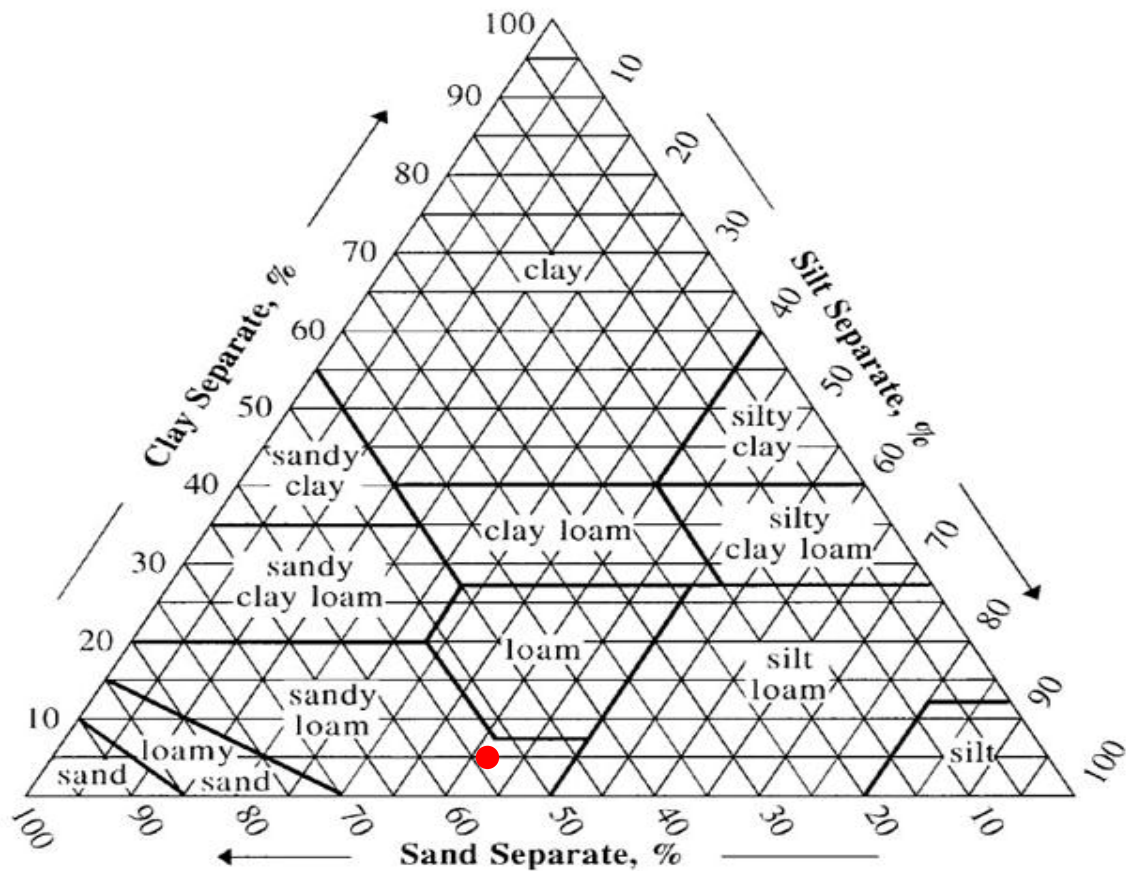
USDA Textural Type = SANDY LOAM

Gravel Content = 8.9%

1. Sampled by: _____
2. Source: _____
3. USCS Desc.: brown sandy SILT, some clay, trace gravel

Nexius VZW		
Pembroke		MA
COSTA CONSULTING ENGINEERS, INC.		
104 MOODY ST; LUDLOW, MA 01056		
MADE BY: GLC	DATE: 9/28/21	FILE NO.
CH'KD BY: GLC	DATE: 9/28/21	695
USDA TEXTURAL ANALYSIS		FIGURE NO.
		3

Soil Texture Triangle



Symbol	Sample I.D.	Textural Type
●	S1	SANDY LOAM

Gravel	>2.0 mm
Sand	2.0 - 0.05 mm
Silt	0.05 - 0.002 mm
Clay	<0.002 mm

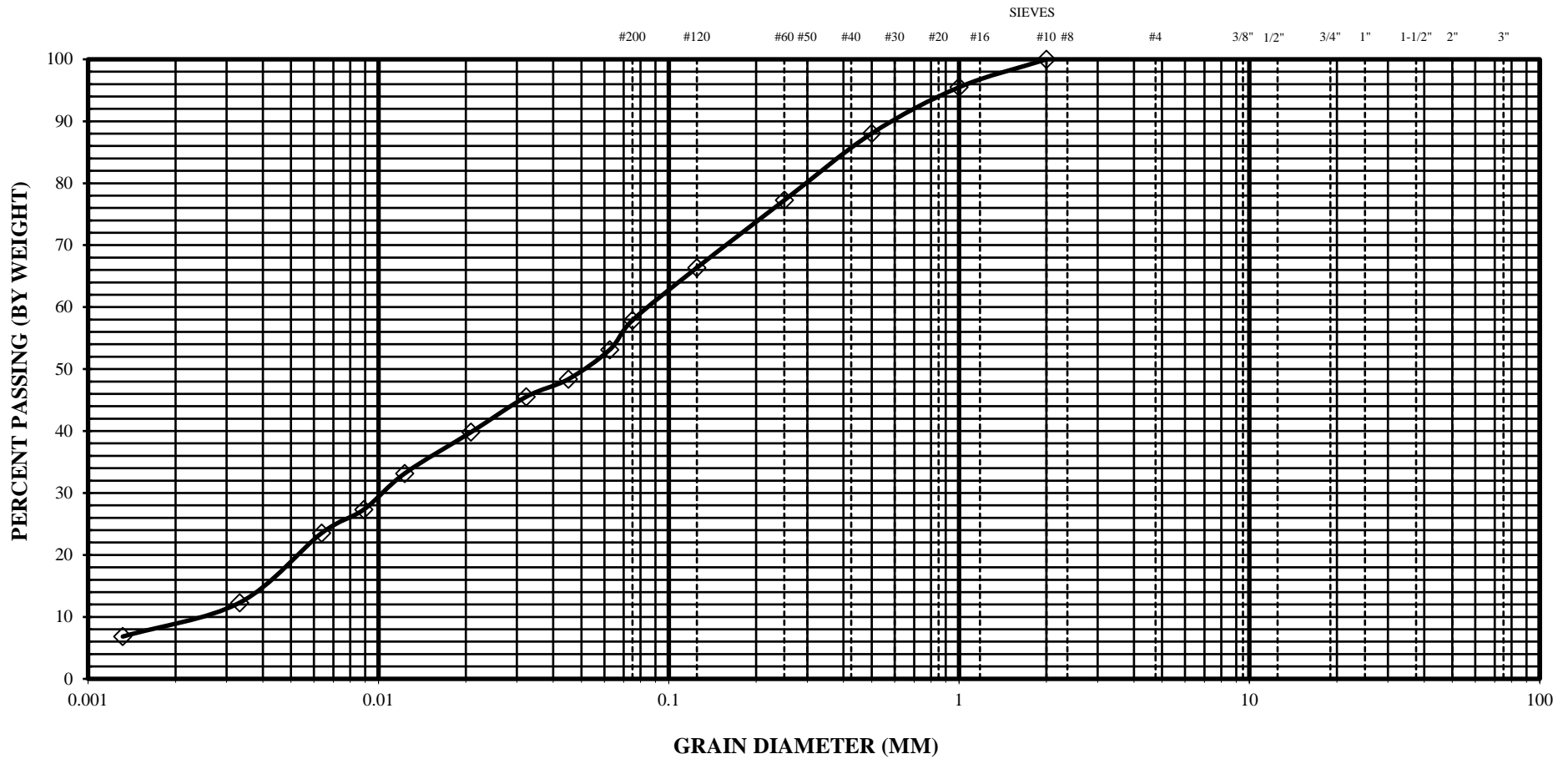
Notes:

1. Sampled by: _____
2. Source: _____
3. USCS Desc.: brown sandy SILT, some clay, trace gravel
4. Gravel: 8.9%

Nexus VZW		
Pembroke		MA
COSTA CONSULTING ENGINEERS, INC.		
104 MOODY ST; LUDLOW, MA 01056		
MADE BY: GLC	DATE: 9/28/21	FILE NO.
CH'KD BY: GLC	DATE: 9/28/21	695
SOIL TEXTURAL TRIANGLE		FIGURE NO.
		4

HYDROMETER ANALYSIS

SIEVE ANALYSIS



NOTES:

1. Sampled by: .
2. Source: .
3. USCS Desc.: brown SILT, some clay, sand, gravel
4. Gravel: 18.8%

BORING / TEST PIT	SAMPLE	DEPTH, (in)	ELEV, (ft)
TP1	S2	51.6	70.7

Nexus VZW		
Pembroke		MA
COSTA CONSULTING ENGINEERS, INC.		
104 MOODY ST; LUDLOW, MA 01056		
MADE BY: GLC	DATE: 9/28/21	FILE NO.
CH'KD BY: GLC	DATE: 9/28/21	695
ASTM 422		FIGURE NO.
GRAIN SIZE DISTRIBUTION		1

Boring / Test Pit	TP1
Sample No.	S2
Depth, (in)	51.6
Elevation, (ft)	70.7
Stratum	.
USCS	.
USDA	LOAM

U.S Standard Sieve Size	Sieve Size (mm)	Percent Passing (by weight)*
#10	2.00	100.0
#18	1.00	95.5
#35	0.50	88.0
#60	0.250	77.2
#120	0.125	66.4
#200	0.075	57.9
	0.063	53.1
	0.045	48.4
	0.032	45.5
	0.021	39.8
	0.012	33.2
	0.009	27.3
	0.006	23.5
	0.003	12.3
	0.001	6.8

Notes:

1. Sampled by:	.
2. Source:	.
3. USCS Desc.:	brown SILT, some clay, sand, gravel
4. Gravel:	18.8%

Nexius VZW		
Pembroke	MA	
COSTA CONSULTING ENGINEERS, INC.		
104 MOODY ST; LUDLOW, MA 01056		
MADE BY: GLC	DATE: 9/28/21	FILE NO.
CH'KD BY: GLC	DATE: 9/28/21	695
ASTM 422		FIGURE NO. 2
GRAIN SIZE DISTRIBUTION		

ASTM 422 Particle Size Analysis Results / Textural Analysis Results

Boring / Test Pit	TP1
Sample ID.	S2
Date	9/28/21

USDA Size Fractions

Main Fractions	Size (mm)	Percent
Sand	2.0 to > 0.05	50.3
Silt	0.05 to > 0.002	41.0
Clay	<=0.002	8.7
Total	<=2.0	100.0

Sand Fractions	Size (mm)	Percent
Very Coarse	2.0 to >1.0	4.5
Coarse	1.0 to > 0.5	7.5
Medium	0.5 to > 0.25	10.8
Fine	0.25 to > 0.10	15.1
Very Fine	0.10 to > 0.05	12.4
Total		50.3

Silt Fractions	Size (mm)	Percent
Coarse	0.05 to >0.02	10.5
Medium	0.02 to > 0.005	20.7
Fine	0.005 to > 0.002	9.8
Total		41.0

Percent of Whole Sample

Size (mm)	Sieve #	% Passing
2.00	10	100.0
1.00	18	95.5
0.50	35	88.0
0.250	60	77.2
0.125	120	66.4
0.075	200	57.9

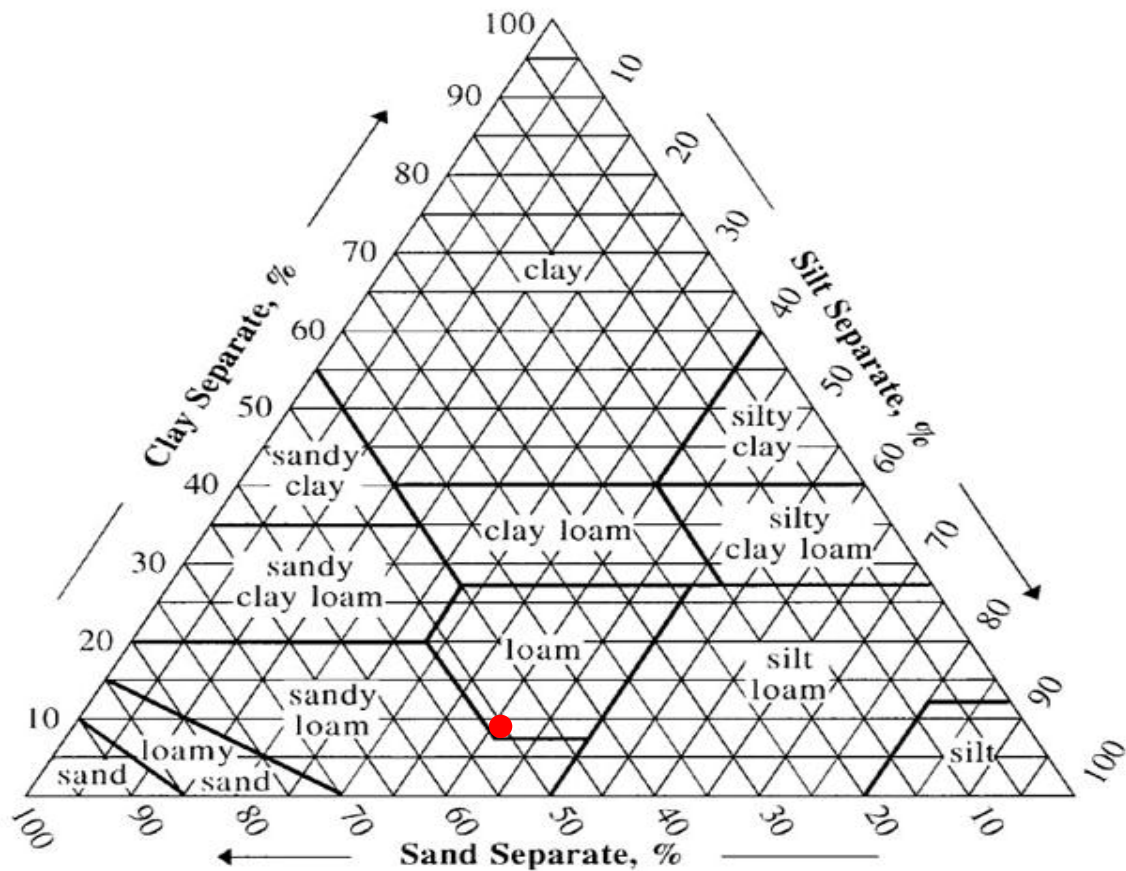
USDA Textural Type = LOAM

Gravel Content = 18.8%

1. Sampled by: _____
2. Source: _____
3. USCS Desc.: brown SILT, some clay, sand, gravel

Nexius VZW		
Pembroke		MA
COSTA CONSULTING ENGINEERS, INC.		
104 MOODY ST; LUDLOW, MA 01056		
MADE BY: GLC	DATE: 9/28/21	FILE NO.
CH'KD BY: GLC	DATE: 9/28/21	695
USDA TEXTURAL ANALYSIS		FIGURE NO.
		3

Soil Texture Triangle



Symbol	Sample I.D.	Textural Type
●	S2	LOAM

Gravel	>2.0 mm
Sand	2.0 - 0.05 mm
Silt	0.05 - 0.002 mm
Clay	<0.002 mm

Notes:

1. Sampled by: _____
2. Source: _____
3. USCS Desc.: brown SILT, some clay, sand, gravel
4. Gravel: 18.8%

Nexus VZW		
Pembroke		MA
COSTA CONSULTING ENGINEERS, INC.		
104 MOODY ST; LUDLOW, MA 01056		
MADE BY: GLC	DATE: 9/28/21	FILE NO.
CH'KD BY: GLC	DATE: 9/28/21	695
SOIL TEXTURAL TRIANGLE		FIGURE NO.
		4

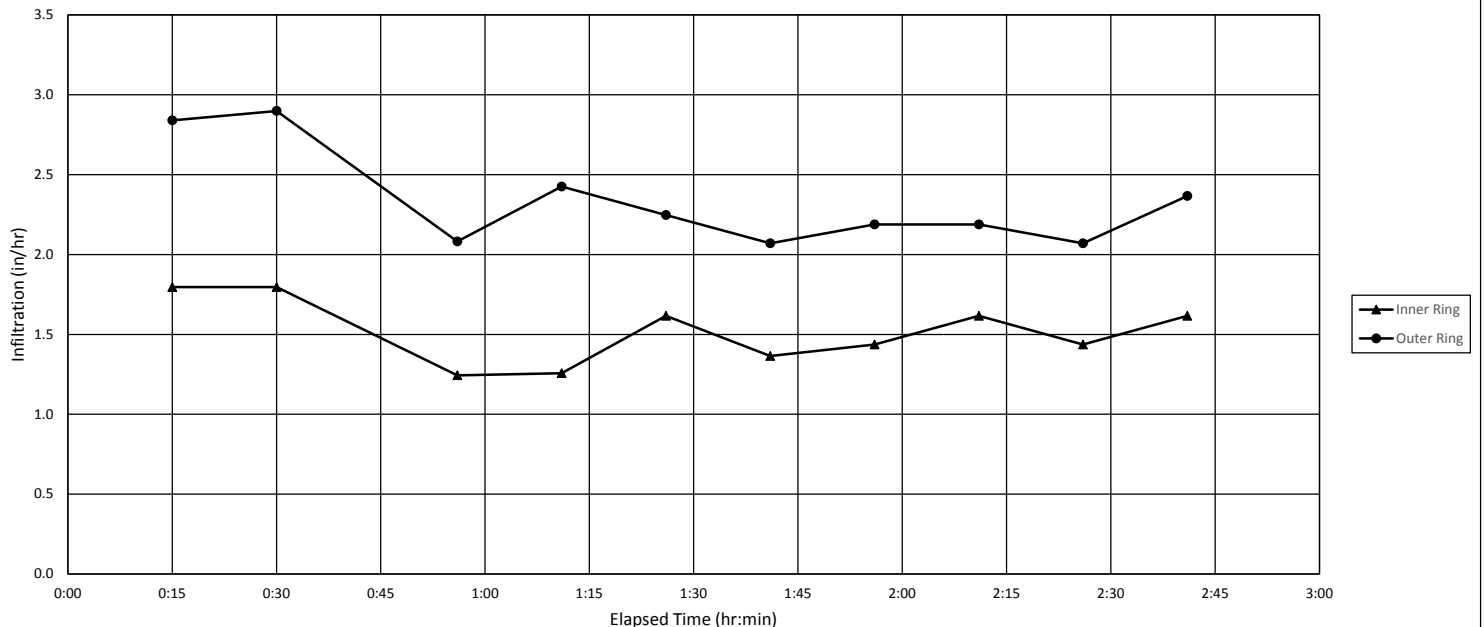
CCE# 695
Nexius VZW
85 Washington St; Pembroke, MA

9/28/21
Infiltration Testing

Infiltration Test Data

ASTM D3385 "Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer"

Project Name:		Nexius VZW				Constants	Area (in) ²	Liquid Depth (in)	Liquid Container Number	Marriotte Tube Volume		Costa Consulting Engineers		
Address:		85 Washington St; Pembroke, MA										P.O. Box 51493		
Test No.:		TP1-I1				Inner Ring	111.35	3	1			Springfield, MA 01152		
Liquid Used:		tap H2O	pH:			Annular Space	338.13	3	2			CCE# 695		
Tested By:		George Costa				Liquid level by: (X) Flow Valve () Float Valve () Mariotte					Report 1			
GWT Depth (ft)		>10	Test Depth (ft) 1.5 (El. 74)			Outer Ring Depth (in)		5	target depth is 6"					
Trial	Start / End	Date MM/DD/YY	Time HR:MIN	Elapsed Time Chg/(Total) (min)	Flow Readings				Liquid Temp (F)	Inner Infiltration (in/h)	Outer Infiltration (in/h)	Ground Temp (F)	Air Temp (F)	Remarks (weather, etc.)
					Inner Ring Mariotte Reading (in)	Inner Flow (in) ³	Outer Ring Mariotte Reading (in)	Outer Flow (in) ³						
	Initial Fill	9/20/21	10:50						72			65	68	sunny
1	Start Test	9/20/21	11:23	0:15	1265.00	50	1265.00	240	72	1.8	2.8	65	68	sunny
	End Test	9/20/21	11:38	0:15	1215.00		1025.00		72				68	sunny
2	Start Test	9/20/21	11:38	0:15	1215.00	50	1025.00	245	72	1.8	2.9	65	68	sunny
	End Test	9/20/21	11:53	0:30	1165.00		780.00		72				68	sunny
3	Start Test	9/20/21	11:53	0:26	1165.00	60	780.00	305	72	1.2	2.1	65	68	sunny
	End Test	9/20/21	12:19	0:56	1105.00		475.00		72				68	sunny
4	Start Test	9/20/21	12:19	0:15	1105.00	35	475.00	205	72	1.3	2.4	65	68	sunny
	End Test	9/20/21	12:34	1:11	1070.00		270.00		72				68	sunny
5	Start Test	9/20/21	12:34	0:15	1070.00	45	270.00	190	72	1.6	2.2	65	68	sunny
	End Test	9/20/21	12:49	1:26	1025.00		80.00		72				68	sunny
6	Start Test	9/20/21	12:52	0:15	1278.00	38	1265.00	175	72	1.4	2.1	65	68	sunny
	End Test	9/20/21	13:07	1:41	1240.00		1090.00		72				68	sunny
7	Start Test	9/20/21	13:07	0:15	1240.00	40	1090.00	185	72	1.4	2.2	65	68	sunny
	End Test	9/20/21	13:22	1:56	1200.00		905.00		72				68	sunny
8	Start Test	9/20/21	13:22	0:15	1200.00	45	905.00	185	72	1.6	2.2	65	68	sunny
	End Test	9/20/21	13:37	2:11	1155.00		720.00		72				68	sunny
9	Start Test	9/20/21	13:37	0:15	1155.00	40	720.00	175	72	1.4	2.1	65	68	sunny
	End Test	9/20/21	13:52	2:26	1115.00		545.00		72				68	sunny
10	Start Test	9/20/21	13:52	0:15	1115.00	45	545.00	200	72	1.6	2.4	65	68	sunny
	End Test	9/20/21	14:07	2:41	1070.00		345.00		72				68	sunny



CCE# 695
Nexius VZW
85 Washington St; Pembroke, MA

9/28/21
Infiltration Testing

Last Page