

# Drainage Report and Stormwater Management Plan

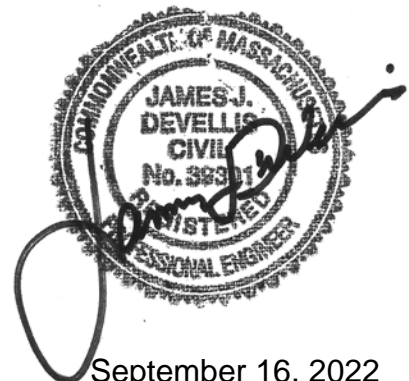
Emerson Homes  
Comprehensive Permit  
10 High Street  
Topsfield, Massachusetts

Applicant

The Caleb Group/Emerson Homes

Civil Engineer, Landscape Architect & Site Planner

DeVellis Zrein Inc.  
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# 1. Executive Summary

The Applicant is proposing a new residential building through the Comprehensive Permit Application process to be located at 10 High Street (the Site) in Topsfield, Massachusetts.

This project consists of one elderly housing residential apartment building serviced by a new access driveway from High Street with 48 parking spaces. Proposed utilities (water, gas, electric/cable/fire and drainage, on-site septic) are proposed within the proposed development.

The Site currently consists of grass, ball fields, a tennis court and wooded areas.

A Notice of Intent will be submitted to address working within the wetland jurisdictional areas. As there are on-site wetland resources areas on the eastern and western perimeters of the Site. The Site is outside of any FEMA-FIRM 100-year flood zones and within Zone X (Minimal Flood Hazard).

This report addresses the drainage characteristics of the proposed residential project with respect to current and future stormwater runoff. It qualifies and quantifies the drainage mitigation with respect to stormwater runoff volumes, runoff rates, and stormwater quality as well as the addressing sediment and runoff controls during and after the construction process.

DeVellis Zrein Inc. (DZI) has analyzed the pre-development and post-development conditions of the project site and developed a stormwater management plan to mitigate the impacts resulting from this proposed project. The report addresses the stormwater maintenance protocol required to help ensure that the drainage system is maintained properly and achieve longevity and effectiveness. The proposed construction will increase the impervious surface area on-site and the stormwater management system has been designed to mitigate any increase in stormwater runoff to ensure that the post-development peak runoff rate from the site will be less than to the existing peak runoff rates. DEP Regulations require an applicant to match the rate in which stormwater leaves the Site. The future stormwater runoff from the development area will be reduced with drainage improvements such as a closed piping system with catch basin structures, a surface rain garden and a surface stormwater detention basin.

The future maintenance and upkeep of the site will be the responsibility of the Applicant and the project. The stormwater design addresses ease of maintenance concerns while meeting all of the state stormwater requirements and standards. Massachusetts Performance Standards and Regulations for Stormwater Management "Best Management Practices" have all been exceeded.

The following narrative provides a description of both the existing and proposed site conditions, and the methodology for design and implementation of stormwater management systems for the project.

## 2. Existing Conditions

The project site is approximately 12.5+/- acres, located along the northern edge of High Street.

There are Massachusetts Department of Environmental Protection (DEP) regulated resources on site jurisdictional buffer limits. The site is serviced by Municipal water. The proposed building will require an on-site septic system as no municipal sewer service is available.

The site will be accessed from High Street which is a public way.

The site is currently undeveloped with the exception of playing fields and a tennis court and can be generally described as having a combination of woods and open grass.

The topography is sloping from higher areas (elevation 67 feet) along the northwestern area and towards the east (elevation 64) and west (elevation 66) site where the wetland resource areas exist. A small area abutting High Street drains back to High Street (elevation 68 down to elevation 66). In general, the site is considered relatively flat.

## Description of Contributing Area

The following is a brief description of the drainage area:

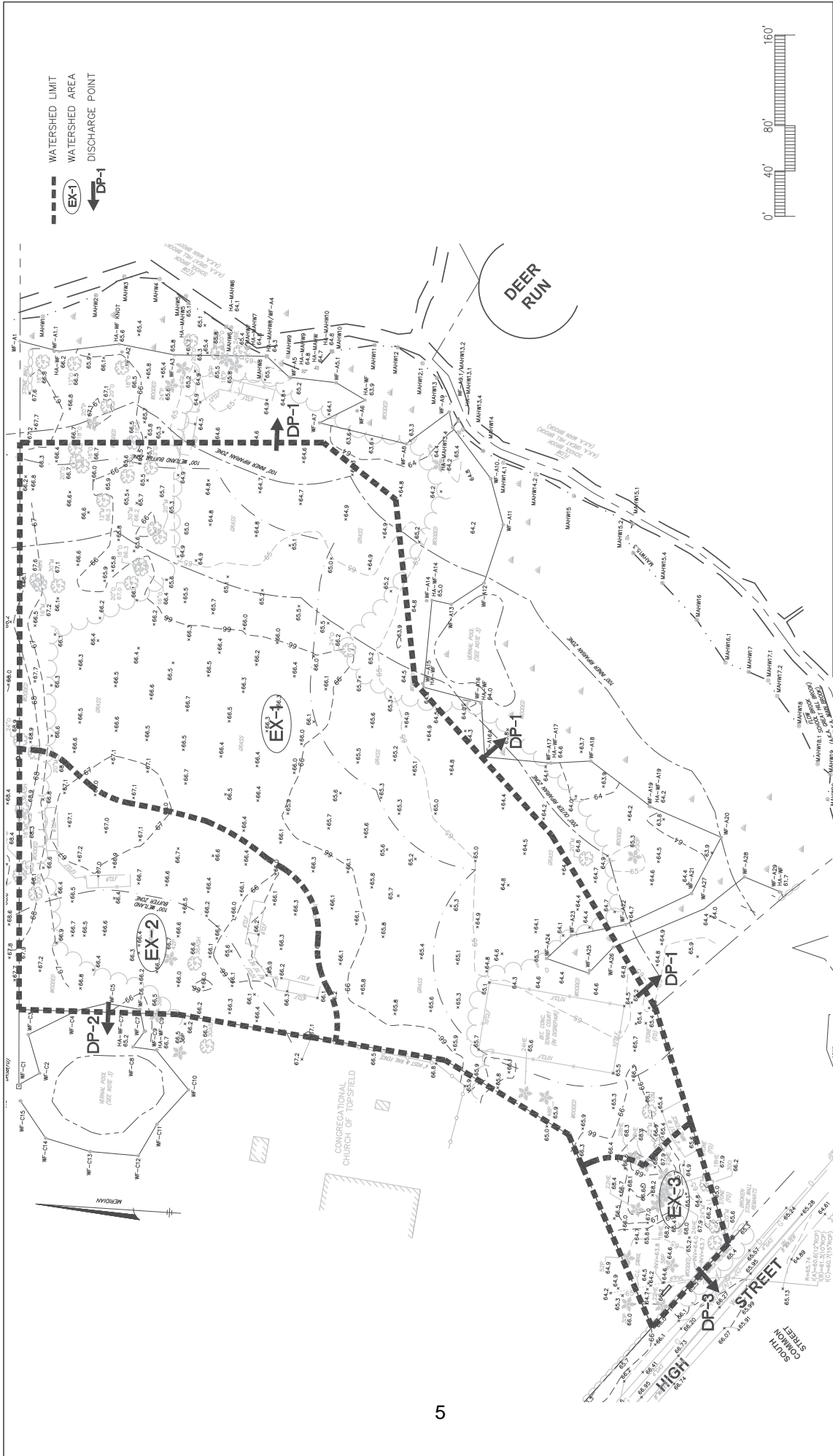
The analysis has been prepared to identify each existing drainage area and the design has been performed to reduce pre- and post- runoff conditions to each area.

The existing development area and the area of effective drainage study is approximately 5.6 acres (Figure EX) and is categorized with three distinct watersheds; EX-1, EX-2 and EX-3 which are tributary to both wetland areas and the small area at High Street.

DZI has performed test pits throughout the site to determine subsurface conditions and current and historic high groundwater levels on the Site.

For the purpose of this hydrologic analysis, the following assumptions were made:

- Whenever possible, the property line and/or an arbitrary line, outside the limit of proposed work are delineated as the watershed boundary.
- The total watershed area for the existing conditions is used as the comparison base for the watershed area in the proposed conditions.



WATERSHED LIMIT  
 WATERSHED AREA  
 DISCHARGE POINT

EX-1  
 DP-1

0' 40' 80' 160'

Site Planning, Civil Engineering, Landscape Architecture  
 DeVellis Zrein Inc.  
 10 High Street  
 Topsfield, MA

Job #: \_\_\_\_\_  
 Drawn by: IAZ  
 Checked by: \_\_\_\_\_  
 Date: 08.03.22  
 Scale: 1" = 80'

**DZI**  
 DeVellis Zrein Inc.

Title: EXISTING WATERSHED MAP

# Soil Conditions

The soils are defined by the Soil Conservation Services (SCS) Soil Survey of Essex County, Massachusetts. The site development area is comprised of soil Type B. See copy of the SCS Soils Survey at the end of this memo. The following table lists the soil designation, soil name and the soil group.

**Table 1 - SCS Soil Types**

<b>Map Designation</b>	<b>Soil Name</b>	<b>Soil Group</b>
260A	Sudbury Fine Sandy Loam 0 to 3% slopes	B

## Existing Drainage Area Summary

The following table summarizes the existing drainage area, including the pertinent information used for the hydrologic analysis:

### **Existing Conditions Drainage Area - Characteristics**

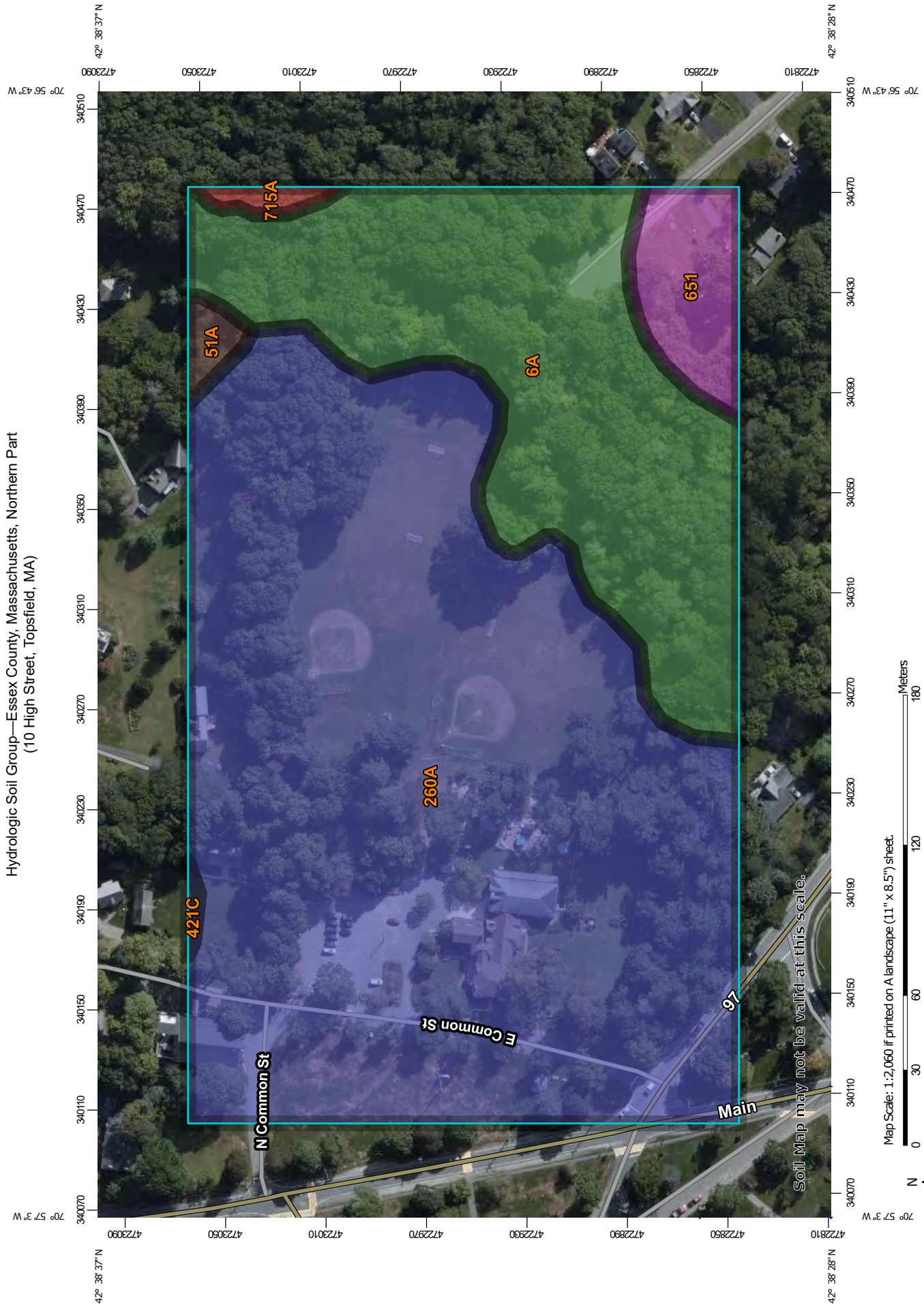
<b>Drainage Area</b>	<b>Area (acres)</b>	<b>Curve Number</b>	<b>Tc (min.)</b>
EX-1	4.2	68	16.5
EX-2	1.1	68	6.0
EX-3	0.3	60	6.0

## Peak Discharge Runoff Rates

The existing peak flow rates, tributary to the drainage point, were calculated for the 2, 10, 25 and 100-year storm events in accordance with guidelines given in DEP's Stormwater Management Policy. Results are presented in the following section of this report. Refer to Existing Watershed Plan for a delineation of the watershed areas and their respective points of concentration.



Hydrologic Soil Group—Essex County, Massachusetts, Northern Part  
(10 High Street, Topsfield, MA)



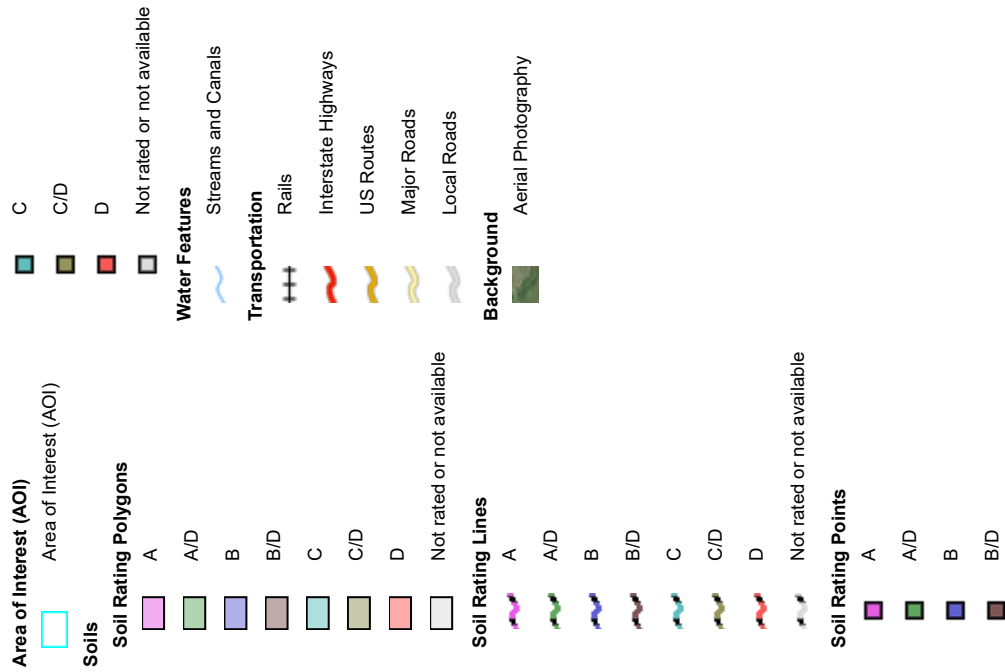
Map Scale: 1:2,060 if printed on A landscape (11" x 8.5") sheet.



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



## MAP LEGEND



## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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: Essex County, Massachusetts, Northern Part  
 Survey Area Data: Version 17, 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: Sep 13, 2019—Oct 5, 2019

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



## Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	A/D	5.4	26.5%
51A	Swansea muck, 0 to 1 percent slopes	B/D	0.2	0.8%
260A	Sudbury fine sandy loam, 0 to 3 percent slopes	B	13.9	68.1%
421C	Canton fine sandy loam, 8 to 15 percent slopes, very stony	B	0.0	0.1%
651	Udorthents, smoothed	A	0.8	3.9%
715A	Ridgebury and Leicester fine sandy loams, 0 to 3 percent slopes, extremely stony	D	0.1	0.6%
<b>Totals for Area of Interest</b>			<b>20.4</b>	<b>100.0%</b>

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* None Specified

*Tie-break Rule:* Higher

### 3. Proposed Conditions

This proposed project consists of one residential apartment building serviced by a new access driveway from High Street with 48 parking spaces. Proposed utilities (water, gas, electric/cable/fire and drainage, on-site septic) are proposed within the proposed development.

When impervious surfaces such as pavement and roof top are proposed, there will be an increase in stormwater runoff if mitigation is not provided. A stormwater management system is required to maintain the characteristics of the existing watersheds to the extent practicable.

Meeting current conditions are the requirement. Runoff rates at the discharge point are required to be maintained to existing conditions by temporarily holding runoff and slowly releasing it off site to meet existing peak flow rates.

The stormwater objectives of this project are summarized as follows:

1. Decrease the rate of runoff by providing stormwater retention
2. Exceed proper engineering standards of Topsfield's DPW and the DEP

#### **Drainage Area PR-1A**

Drainage Area PR-1A encompasses the proposed building, the majority of the access drive, the parking area and the above round stormwater detention basin with perimeter landscaping.

All areas within PR-1A will eventually enter into the stormwater detention area to reduce the rates of runoff by collection and detention.

#### **Drainage Area PR-1B**

Drainage Area PR-1B encompasses areas outside of the building and parking and generally described as lawn area, landscaping or woods. This area will sheet flows towards the direction of the wetland area (DP-1) un-detained.

#### **Drainage Area PR-2**

Drainage Area PR-2B encompasses areas outside of the building and parking and generally described as lawn area, landscaping or woods. This area will sheet flows towards the direction of the wetland area (DP-2) un-detained.

#### **Drainage Area PR-3**

Drainage Area PR-3 encompasses part of the access drive area closest to High Street, perimeter landscape areas and the rain garden along the site access drive near High Street. Runoff from the paved area is collected by a catch basin and is carried to the rain garden. Outflow from the rain garden is connected to an existing drain line that originates from the site and carries stormwater from the abutting land to the west (DP-3).

### Proposed Drainage Area Summary

The following summarizes the proposed drainage areas, including the pertinent information used for the hydrologic analysis:

#### **Proposed Conditions Drainage Area Characteristics Summary:**

<b>Drainage Area</b>	<b>Area (Acres)</b>	<b>Curve Number</b>	<b>T<sub>c</sub> (min.)</b>
PR-1A	1.99	93	6.0
PR-1B	2.20	61	6.0
PR-2	1.02	65	6.0
PR-3	0.38	70	6.0

### Peak Discharge Runoff Rates

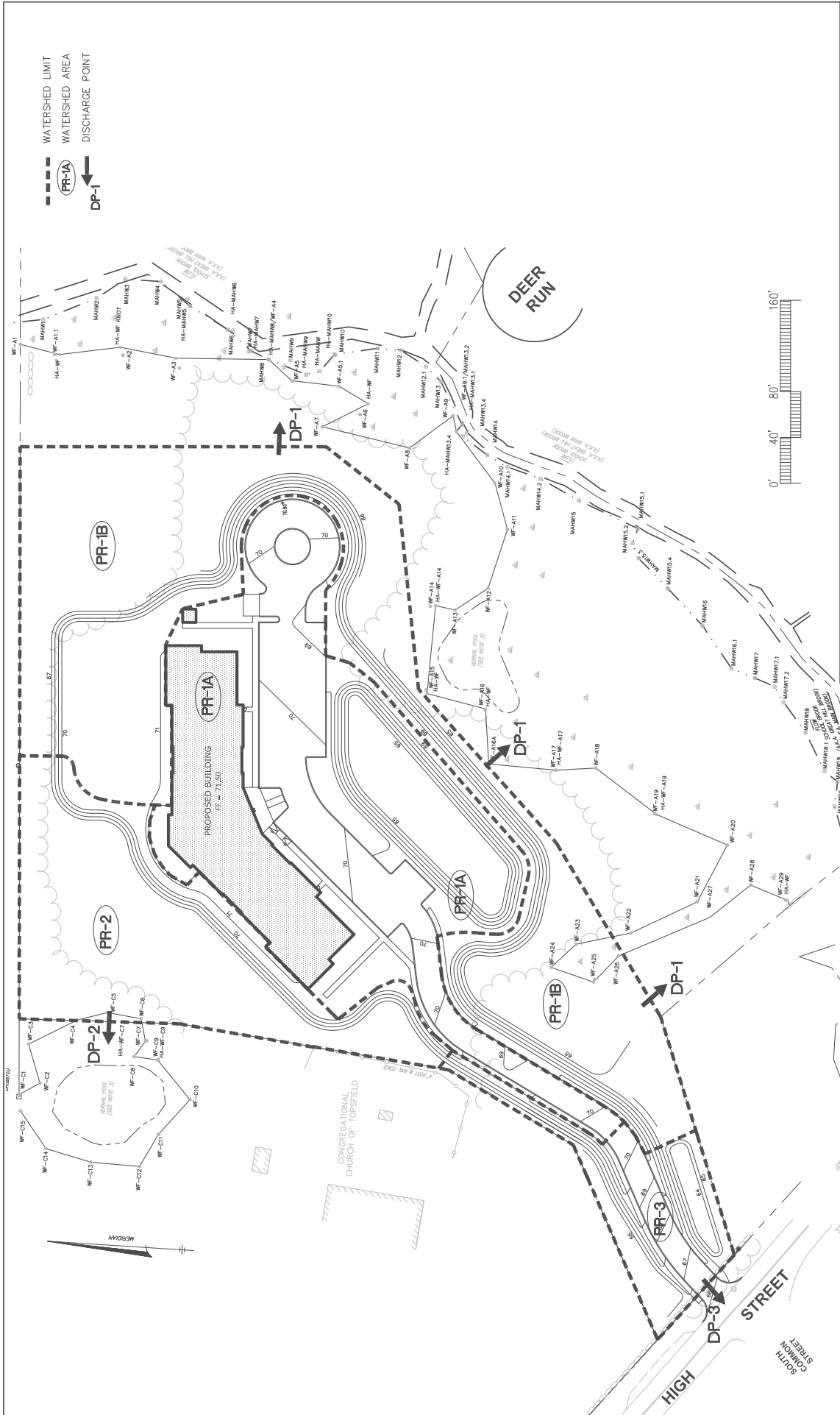
The proposed peak flow rates, tributary to the drainage point, were calculated for the 2, 10, 25 and 100-year storm events in accordance with guidelines given in DEP's Stormwater Management Policy. Results are presented in the following table. Refer to Proposed Watershed Plan for a delineation of the watershed areas and their respective points of concentration.

### Summary of Results

As previously stated, the resultant post-development peak discharge rates for the discharge points are less than the pre-development peak discharge rates. The following table provides a summary of the pre and post development data. The following table demonstrates peak flows at the design points for each of the design storms has been met.

#### **Peak Rates of Runoff Leaving the Site:**

<b>Location</b>	<b>2-Year Storm</b>		<b>10-Year Storm</b>		<b>25-Year Storm</b>		<b>100-Year Storm</b>	
	<b>Exist (cfs)</b>	<b>Prop (cfs)</b>	<b>Exist (cfs)</b>	<b>Prop (cfs)</b>	<b>Exist (cfs)</b>	<b>Prop (cfs)</b>	<b>Exist (cfs)</b>	<b>Prop (cfs)</b>
<b>DP-1</b>	2.39	0.69	5.45	2.78	8.11	4.67	11.52	7.26
<b>DP-2</b>	0.81	0.64	1.97	1.79	2.91	2.75	4.13	4.00
<b>DP-3</b>	0.07	0.00	0.30	0.07	0.50	0.33	0.76	0.53



Sketch No. **PR**  
 Project Name: 10 High Street  
 Topsfield, MA

Site Planning, Civil Engineering, Landscape Architecture  
**DZI**  
 DeVellis Zrein Inc.  
 208 North Street  
 Boston, MA 02111  
 Phone: 617.452.1111  
 Email: info@dzicons.com

Job #: \_\_\_\_\_  
 Drawn by: **IAZ** Checked by: \_\_\_\_\_  
 Date: 08.03.22  
 Scale: 1" = 80'

Title: **PROPOSED WATERSHED MAP**

## 4. Methodology and Design Criteria Hydrologic Model

The drainage analysis was performed using the Soil Conservation Service (SCS) TR-20 method and the drainage software HydroCAD 7.10, as developed by Applied Microcomputer Systems. Data used in the design is as follows:

### Design Storms

Rainfall data for the 2, 10, 25 and 100- year frequency rainfall events (for a 24-hour precipitation) was taken from the Rainfall Frequency Atlas of the United States (TP-40). The following table outlines the rainfall used for the TR-20 method.

### **Rainfall Data**

<b>Storm Event</b>	<b>Rainfall</b>
2-Year	3.20 inches
10-Year	4.60 inches
25-Year	5.6 inches
100-Year	6.8 inches

### Time of Concentration

The 'time of concentration' ( $T_c$ ) for each watershed was determined by finding the time necessary for runoff to travel from the hydraulically most distant point in the watershed to the point of concentration. The travel path was drawn based on the topography and the time was calculated using the TR-55 Method and HydroCAD. A minimum  $T_c$  of 6.0 minutes was used.

### Curve Numbers

Based on the cover type and hydrologic soil group, a weighted curve number (CN) was determined for each of the watersheds utilizing the SCS TR-55 method.

## 5. Department of Environmental Protection Stormwater Management Standards

***Standard 1:*** No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

The project does not propose any new untreated outfalls or discharge of untreated water into wetlands or waters of the Commonwealth. All proposed impervious surfaces will be collected and treated with catch basins and detained on-site with a detention / recharge system.

***Standard 2:*** Stormwater management systems shall be designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for discharges to land subject to coastal storm flowage as defined in 310 CMR 10.04.

The project will reduce the post-development stormwater peak discharge rate to pre-development conditions via infiltration pipes and a detention system.

***Standard 3:*** Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

The intent of this standard is to ensure that the infiltration volume of precipitation into the ground under post-development conditions is at least as much as the infiltration volume under pre-development conditions. Standard 3 requires the restoration of recharge, using infiltration measures and careful site design.

The project will provide groundwater recharge. The infiltration provided within the detention / recharge system recharges stormwater back into the ground per the required amounts.

The NRCS classifies soils into one hydrologic groups B, indicative of the minimum infiltration obtained for a soil after prolonged wetting. Group A soils have the lowest runoff potential and the highest infiltration rates, while Group D soils have the highest runoff potential and the lowest infiltration rates. The required recharge volume, the stormwater volume that must be infiltrated, was determined using existing site conditions and the infiltration rates set forth below.



Hydrologic Group Volume to Recharge (Total Impervious Area)	
Hydrologic Group	Volume to Recharge Total Impervious Area
A	0.60 inches of runoff
<b>B</b>	<b>0.35 inches of runoff</b>
C	0.25 inches of runoff
D	0.10 inches of runoff

The soils are defined by the Soil Conservation Services (SCS) Soil Survey of Essex County, Massachusetts. The site area is comprised of one soil types.

**Standard 4: Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).**

This standard is met by this project:

- a) Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;
- b) Structural stormwater best management practices are sized to capture the required water quality volume as determined in accordance with the Massachusetts Stormwater Handbook; and
- c) Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

The stormwater runoff from the proposed parking and access drive will exceed the 80% TSS removal as the project is equipped with catch basins and a detention basin.

A long-term Operation and Maintenance Plan associated with this project has been designed and is included within this report.

**Standard 5: Regards land uses with higher potential pollutant loads:**

This is Not Applicable.

**Standard 6: Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply and stormwater discharges near or to any other critical area require the use of the specific source control and pollution prevention measures and the specific structural stormwater best**

**management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook.**

This is Not Applicable.

***Standard 7:*** Regards redevelopment projects:

This is Not Applicable.

***Standard 8:*** A plan to control construction-related impacts, including erosion, sedimentation, and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.

The Sediment and Erosion Control Plan contains provisions for the construction related items such as silt controls, sequencing and Operation and Maintenance provisions for construction and post construction activities. A NPDES/SWPPP will be required and when a contractor is awarded the project, this plan will be submitted with all of the appropriate information on it.

***Standard 9:*** A Long -Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed.

The Long-Term Operation and Maintenance Plan has been prepared within this report and referenced on the plans that include the routine and non-routine maintenance tasks to be undertaken after construction is complete and a schedule for implementing those tasks.

***Standard 10:*** All illicit discharges to the stormwater management system are prohibited.

Standard 10 prohibits illicit discharges to stormwater management systems. By acceptance of this document, the Applicant acknowledges that the stormwater management system is the system for conveying, treating, and infiltrating stormwater on-site, including stormwater best management practices and any pipes intended to transport stormwater to the groundwater, a surface water, or municipal separate storm sewer system. Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater. This document shall serve as the Illicit Discharge Compliance Statement verifying that no illicit discharges exist on the site and within the pollution prevention plan measures to prevent illicit discharges to the stormwater management system, including wastewater discharges and discharges of stormwater contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances, oil, or grease.



# 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.<sup>1</sup> This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8<sup>2</sup>
- 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.

<sup>1</sup> 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.

<sup>2</sup> 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

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## 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.

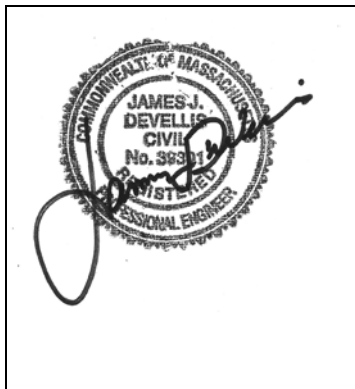
A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

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### 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



*James J. Devellis*

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### 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

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## 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): Rain Garden / Detention Basin

### 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

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## Checklist (continued)

### Standard 2: Peak Rate Attenuation

- Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.
- Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.
- Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

### Standard 3: Recharge

- Soil Analysis provided.
- Required Recharge Volume calculation provided.
- Required Recharge volume reduced through use of the LID site Design Credits.
- Sizing the infiltration, BMPs is based on the following method: Check the method used.
  - Static
  - Simple Dynamic
  - Dynamic Field<sup>1</sup>
- Runoff from all impervious areas at the site discharging to the infiltration BMP.
- Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
  - Site is comprised solely of C and D soils and/or bedrock at the land surface
  - M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
  - Solid Waste Landfill pursuant to 310 CMR 19.000
  - Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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<sup>1</sup> 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.



# Checklist for Stormwater Report

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## 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

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## 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

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## 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.

## **6. Stormwater Operation and Maintenance Plan**

### *Introduction*

DeVellis Zrein Inc. has prepared this report as a guide to establish maintenance protocol for the on-site drainage improvements serving the Proposed Falcon Farms Subdivision. The goal of the Storm Water Operation and Maintenance Plan is not only to protect off-site wetlands and water resources abutting the site, but also to protect those resources in the region that may be affected by the activities at the site.

The proposed site drainage improvements include:

- Catch Basin Inlets
- Drain pipe network
- Rain Garden System
- Detention Basin System
- Landscaping

The proposed water quality treatment measures will result in improved removal of the total suspended solids (TSS) load in runoff from the site for the proposed parking improvements as well as throughout the existing parking areas.

An effective drainage maintenance program will ensure that the removal of TSS from the stormwater runoff continues for the life of the facility. The Operation and Maintenance Plan will be implemented by the Applicant and will not be the responsibility of the Town of Topsfield

### *Source Control*

The first tier of non-structural controls includes a comprehensive source control program of regular maintenance of the stormwater management components.

### *Pavement Sweeping Program*

The removal of contaminants directly from paved surfaces before contact with storm water is a valuable method for reducing pollutant loading in stormwater.

It is proposed that the parking and drive areas will be cleaned on a bi-annual basis with two sweepings per year. Sweeping at the beginning of spring is recommended and at the end of fall. Because of the small size of the project, the sweeping can be accomplished with a traditional street sweeper or through routine landscape maintenance with hands sweeping and blowers.

## *Catch Basins*

The new catch basins along the road will be equipped with deep sumps to collect sands and solids and a hood to hold floatable materials and oil/gas contaminants from leaving the catch basin. The catch basins are recommended to be cleaned during the same schedule as the sweeping.

## *Detention Basin System*

The actual removal of sediments and associated pollutants and trash occurs only when inlets are cleaned out; therefore, regular maintenance is required. At a minimum, the water quality basin should be cleaned two times per year and inspected annually. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations.

## *Rain Garden*

The raingarden at the site entrance will collect stormwater from the southern portion of the drive. The selected plantings will clean the water and provide habitat and food for the wildlife. In the summer months, the raingardens also allow the stormwater to cool and infiltrate into the root systems. This area provides surface stormwater mitigation which can easily be maintained and cared for and is located in a highly visible area that will be cared for.

## *Landscaping*

The proposed project provides extensive landscaping along the perimeter and throughout.

A landscape plan has been provided to include hardy indigenous plants that are appropriate to survive in a parking environment in New England winters.

In the spring, the owner shall verify that the plants planted and included on the Planting Plan remain in good health in perpetuity. If there is damage, the plants are to be replaced in the same manner.

## *During Construction*

- Prior to construction, install tree protection and erosion and sediment control measures as shown on the plan and details.
- The site contractor shall inspect all sediment and erosion control structures after each rainfall event and at the end of the working day.
- All measures shall be maintained in good working order. If repair is necessary, it shall be initiated within 24 hours of inspection.
- Silt shall be removed from the silt fence if 3-inches or greater and as needed.
- Sediment shall be contained within the construction site and away from drainage structures.

- Damaged or deteriorated erosion control measures will be repaired immediately after identification
- The silt fence shall be kept in close contact with the ground and reset as necessary.
- The contractor's site superintendent will be responsible for inspection, maintenance and repair activities.
- All disturbed areas will be treated with 4" of topsoil and seed.
- Remove siltation controls upon completion of permanent vegetation over disturbed areas.

### *Post Construction*

The following site performance requirements are to be established at the property:

- Parking and drive areas will be cleaned with sweeper on a bi-annual basis with two (2) sweepings per year. Sweeping at the beginning of each season is recommended.
- Inspect the perimeter landscaping annually, in the spring, for erosion of side slopes, embankments, and accumulated sediment. Necessary sediment removal, earth repair and/or reseeding shall be performed immediately upon identification.
- Routinely pick up and remove litter from the parking areas, islands and perimeter landscape area, in addition to pavement sweeping.
- Inspect and clean drainage inlets and sediment forebays yearly. Clean and/or repair as needed.
- Inspect and clean outlet flared end sections and associated rip-rap yearly. Clean and/or repair as needed.

### *Stormwater Management System Owner*

This site is owned by the Applicant (or successor/owner) who will be responsible for the Operation and Maintenance.

## *Estimated Operations Budget*

It is not anticipated that the stormwater maintenance required would be considered extraordinary. A yearly estimated operations budget for consideration to carry out the Operations and Maintenance Plan requirements is as follows:

- **\$1000:** Inspect the perimeter landscaping annually, in the spring, for erosion of side slopes, embankments, and accumulated sediment. Necessary sediment removal, earth repair and/or reseeding shall be performed immediately upon identification.
- **\$2000:** Clean all catch basin structures bi-annually (twice per year) to remove accumulated sand, sediment, and floatable products. Dispose and transport accumulated sediment off-site in accordance with applicable local, state and federal guidelines and regulations.
- **\$500:** Remove accumulated leaves and debris from catch basins and inlet/outlet openings.
- **\$500:** Routinely pick up and remove litter from the Site.
- **\$500:** Replant/replenish the detention basin and rain garden systems with specific plantings. Trim and prune as needed.



## Appendix A – Hydrologic Calculations and Drain Pipe Calculations

- Hydrologic Model - Existing Conditions
  - Stormwater Runoff Area Calculations
  - Existing Conditions Calculations
  - 2-Year Storm
  - 10-Year Storm
  - 25-Year Storm
  - 100-Year Storm
- Hydrologic Model - Proposed Conditions
  - Stormwater Runoff Area Calculations
  - Proposed Conditions Calculations
  - 2-Year Storm
  - 10-Year Storm
  - 25-Year Storm
  - 100-Year Storm

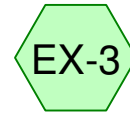
## Hydrologic Model - Existing Conditions



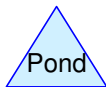
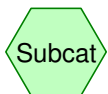
EX-1



EX-2



EX-3



**Routing Diagram for Existing Conditions**

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Page 2

**Area Listing (all nodes)**

Area (acres)	CN	Description (subcatchment-numbers)
3.906	69	50-75% Grass cover, Fair, HSG B (EX-1, EX-2)
0.020	98	Impervious, HSG B (EX-2)
0.165	98	Paved Tennis Court, HSG B (EX-1)
1.498	60	Woods, Fair, HSG B (EX-1, EX-2, EX-3)
<b>5.589</b>	<b>68</b>	<b>TOTAL AREA</b>

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Page 3

**Soil Listing (all nodes)**

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
5.589	HSG B	EX-1, EX-2, EX-3
0.000	HSG C	
0.000	HSG D	
0.000	Other	
<b>5.589</b>		<b>TOTAL AREA</b>

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**Ground Covers (all nodes)**

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	3.906	0.000	0.000	0.000	3.906	50-75% Grass cover, Fair	EX-1, EX-2
0.000	0.020	0.000	0.000	0.000	0.020	Impervious	EX-2
0.000	0.165	0.000	0.000	0.000	0.165	Paved Tennis Court	EX-1
0.000	1.498	0.000	0.000	0.000	1.498	Woods, Fair	EX-1, EX-2, EX-3
<b>0.000</b>	<b>5.589</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>5.589</b>	<b>TOTAL AREA</b>	

**Existing Conditions**

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Type III 24-hr 2-year Rainfall=3.20"

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Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment EX-1: EX-1**

Runoff Area=183,039 sf 3.93% Impervious Runoff Depth=0.73"  
Flow Length=330' Tc=16.5 min CN=68 Runoff=2.23 cfs 0.257 af

**Subcatchment EX-2: EX-2**

Runoff Area=48,302 sf 1.78% Impervious Runoff Depth=0.73"  
Tc=6.0 min CN=68 Runoff=0.81 cfs 0.068 af

**Subcatchment EX-3: EX-3**

Runoff Area=12,123 sf 0.00% Impervious Runoff Depth=0.41"  
Tc=6.0 min CN=60 Runoff=0.07 cfs 0.009 af

**Total Runoff Area = 5.589 ac Runoff Volume = 0.334 af Average Runoff Depth = 0.72"**  
**96.69% Pervious = 5.404 ac 3.31% Impervious = 0.185 ac**



**Existing Conditions**

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 Type III 24-hr 2-year Rainfall=3.20"

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**Summary for Subcatchment EX-1: EX-1**

Runoff = 2.23 cfs @ 12.27 hrs, Volume= 0.257 af, Depth= 0.73"

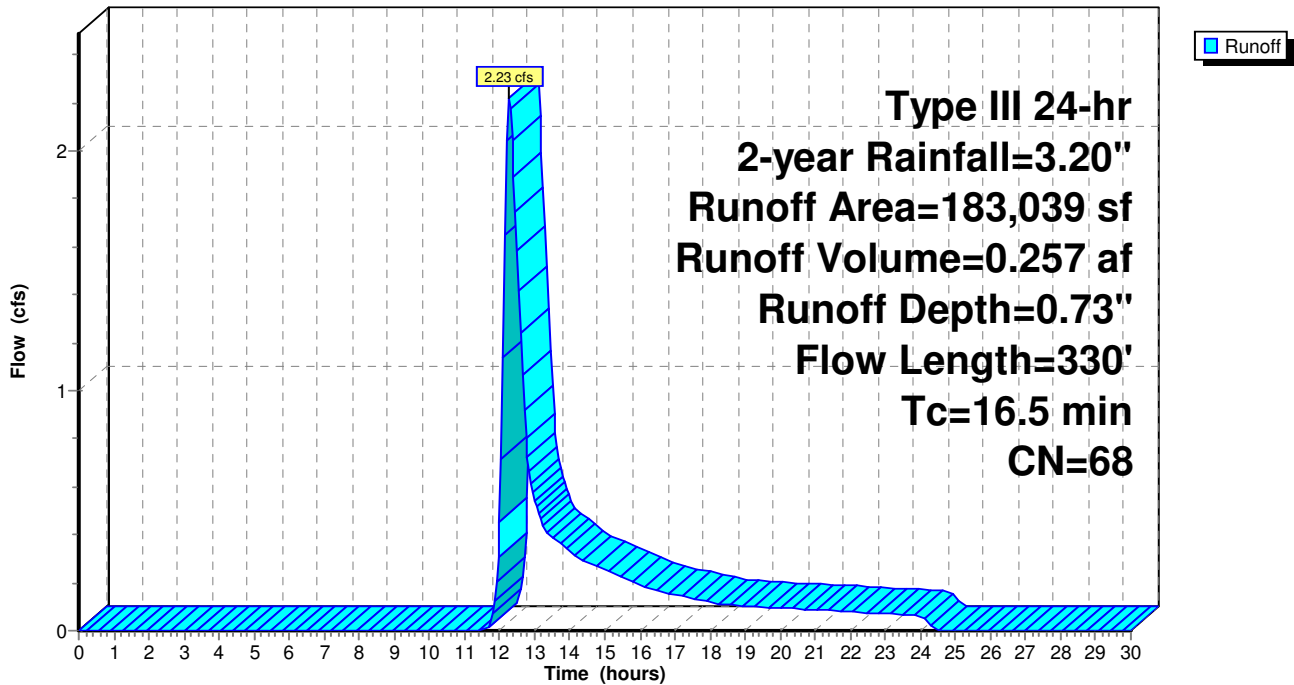
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
* 7,192	98	Paved Tennis Court, HSG B
44,957	60	Woods, Fair, HSG B
130,890	69	50-75% Grass cover, Fair, HSG B
183,039	68	Weighted Average
175,847		96.07% Pervious Area
7,192		3.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		<b>Sheet Flow, T1</b>
					Grass: Short n= 0.150 P2= 3.20"
6.7	280	0.0100	0.70		<b>Shallow Concentrated Flow, T2</b>
					Short Grass Pasture Kv= 7.0 fps
16.5	330	Total			

**Subcatchment EX-1: EX-1**

Hydrograph



**Existing Conditions**

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 Type III 24-hr 2-year Rainfall=3.20"

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**Summary for Subcatchment EX-2: EX-2**

Runoff = 0.81 cfs @ 12.11 hrs, Volume= 0.068 af, Depth= 0.73"

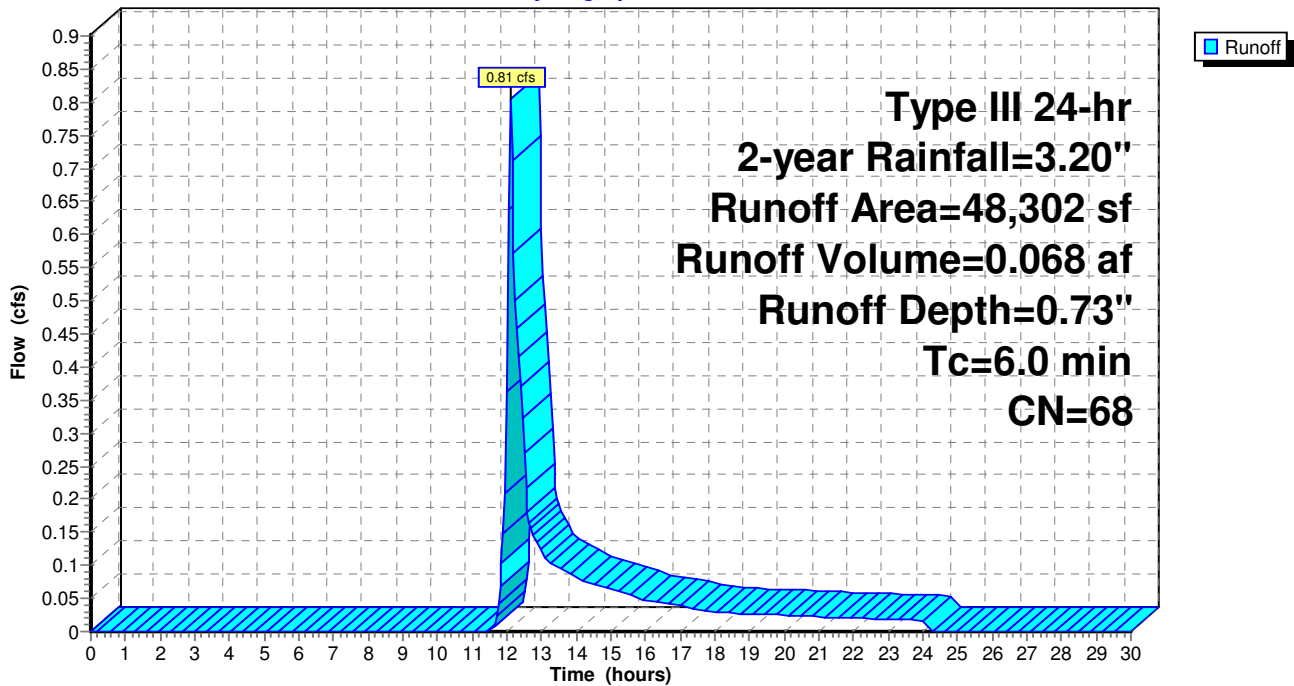
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
8,171	60	Woods, Fair, HSG B
39,271	69	50-75% Grass cover, Fair, HSG B
* 860	98	Impervious, HSG B
48,302	68	Weighted Average
47,442		98.22% Pervious Area
860		1.78% Impervious Area

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

**Subcatchment EX-2: EX-2**

Hydrograph



**Existing Conditions**

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 Type III 24-hr 2-year Rainfall=3.20"

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**Summary for Subcatchment EX-3: EX-3**

Runoff = 0.07 cfs @ 12.14 hrs, Volume= 0.009 af, Depth= 0.41"

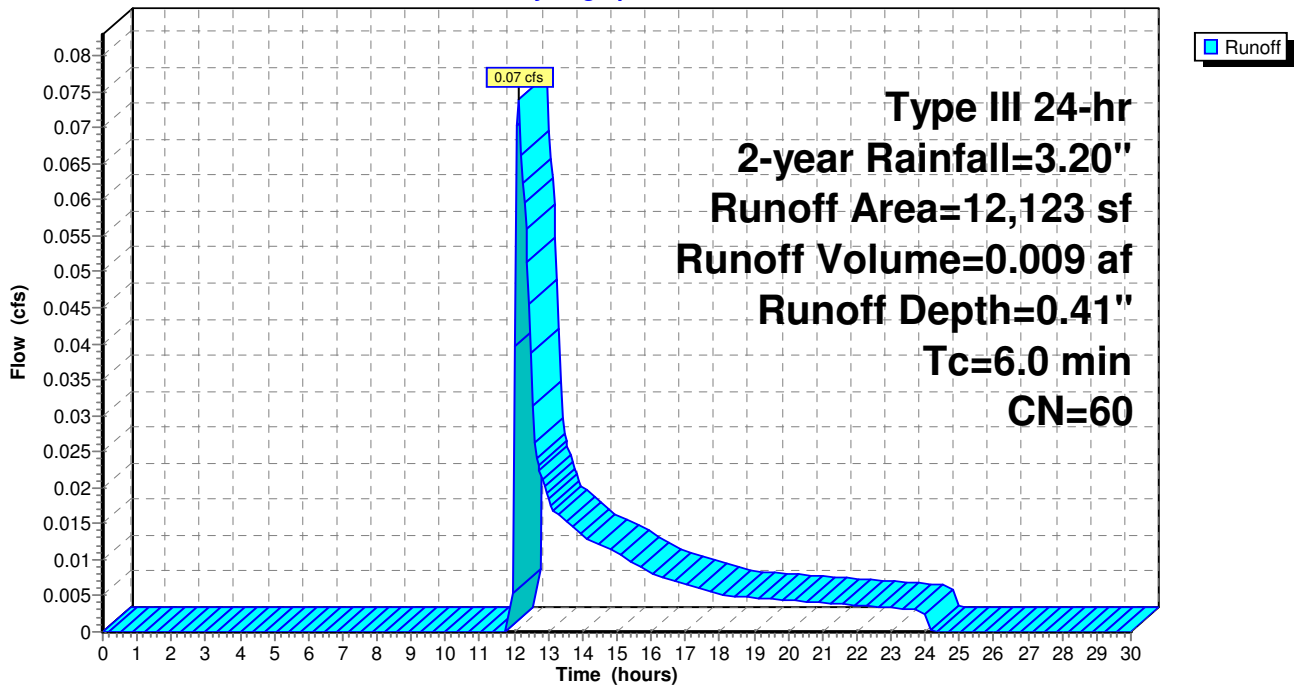
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
12,123	60	Woods, Fair, HSG B
12,123		100.00% Pervious Area

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

**Subcatchment EX-3: EX-3**

Hydrograph



## Existing Conditions

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Type III 24-hr 10-year Rainfall=4.60"

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Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

### Subcatchment EX-1: EX-1

Runoff Area=183,039 sf 3.93% Impervious Runoff Depth=1.60"  
Flow Length=330' Tc=16.5 min CN=68 Runoff=5.45 cfs 0.560 af

### Subcatchment EX-2: EX-2

Runoff Area=48,302 sf 1.78% Impervious Runoff Depth=1.60"  
Tc=6.0 min CN=68 Runoff=1.97 cfs 0.148 af

### Subcatchment EX-3: EX-3

Runoff Area=12,123 sf 0.00% Impervious Runoff Depth=1.07"  
Tc=6.0 min CN=60 Runoff=0.30 cfs 0.025 af

**Total Runoff Area = 5.589 ac Runoff Volume = 0.733 af Average Runoff Depth = 1.57"**  
**96.69% Pervious = 5.404 ac 3.31% Impervious = 0.185 ac**

**Existing Conditions**

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 Type III 24-hr 10-year Rainfall=4.60"

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**Summary for Subcatchment EX-1: EX-1**

Runoff = 5.45 cfs @ 12.25 hrs, Volume= 0.560 af, Depth= 1.60"

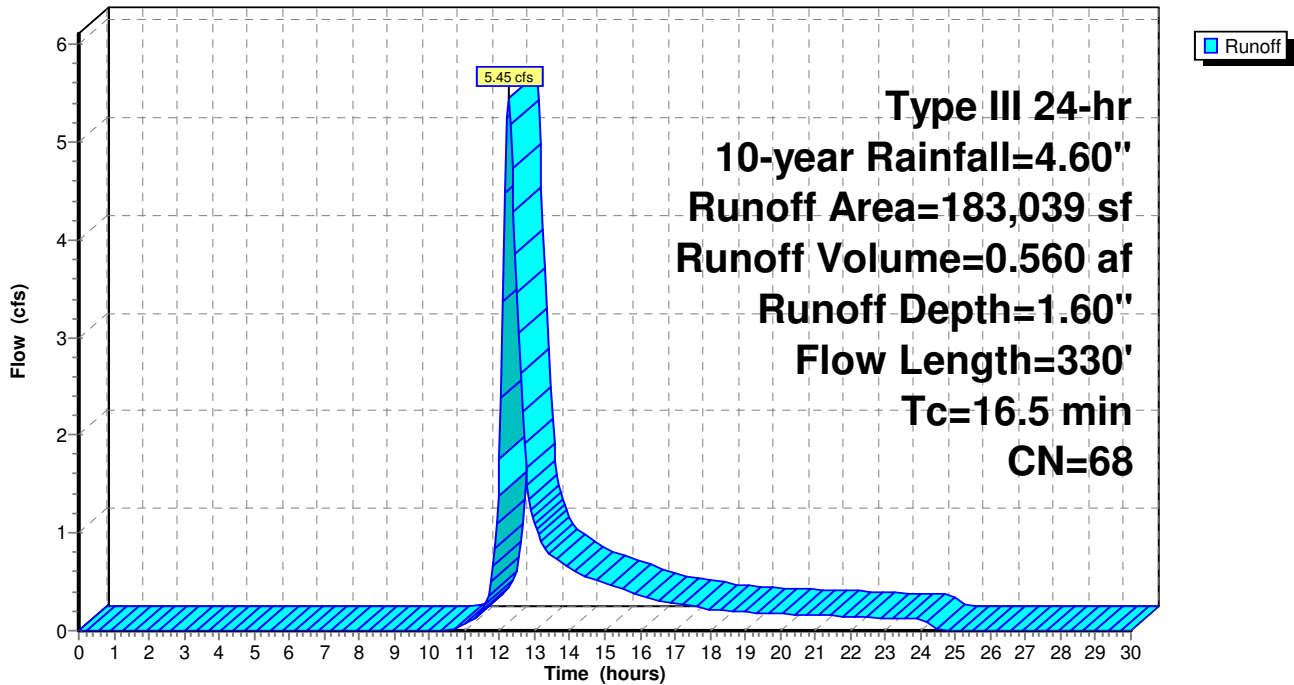
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10-year Rainfall=4.60"

Area (sf)	CN	Description
* 7,192	98	Paved Tennis Court, HSG B
44,957	60	Woods, Fair, HSG B
130,890	69	50-75% Grass cover, Fair, HSG B
183,039	68	Weighted Average
175,847		96.07% Pervious Area
7,192		3.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		<b>Sheet Flow, T1</b>
					Grass: Short n= 0.150 P2= 3.20"
6.7	280	0.0100	0.70		<b>Shallow Concentrated Flow, T2</b>
					Short Grass Pasture Kv= 7.0 fps
16.5	330	Total			

**Subcatchment EX-1: EX-1**

Hydrograph



**Existing Conditions**

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10 High Street, Topsfield  
 Type III 24-hr 10-year Rainfall=4.60"

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**Summary for Subcatchment EX-2: EX-2**

Runoff = 1.97 cfs @ 12.10 hrs, Volume= 0.148 af, Depth= 1.60"

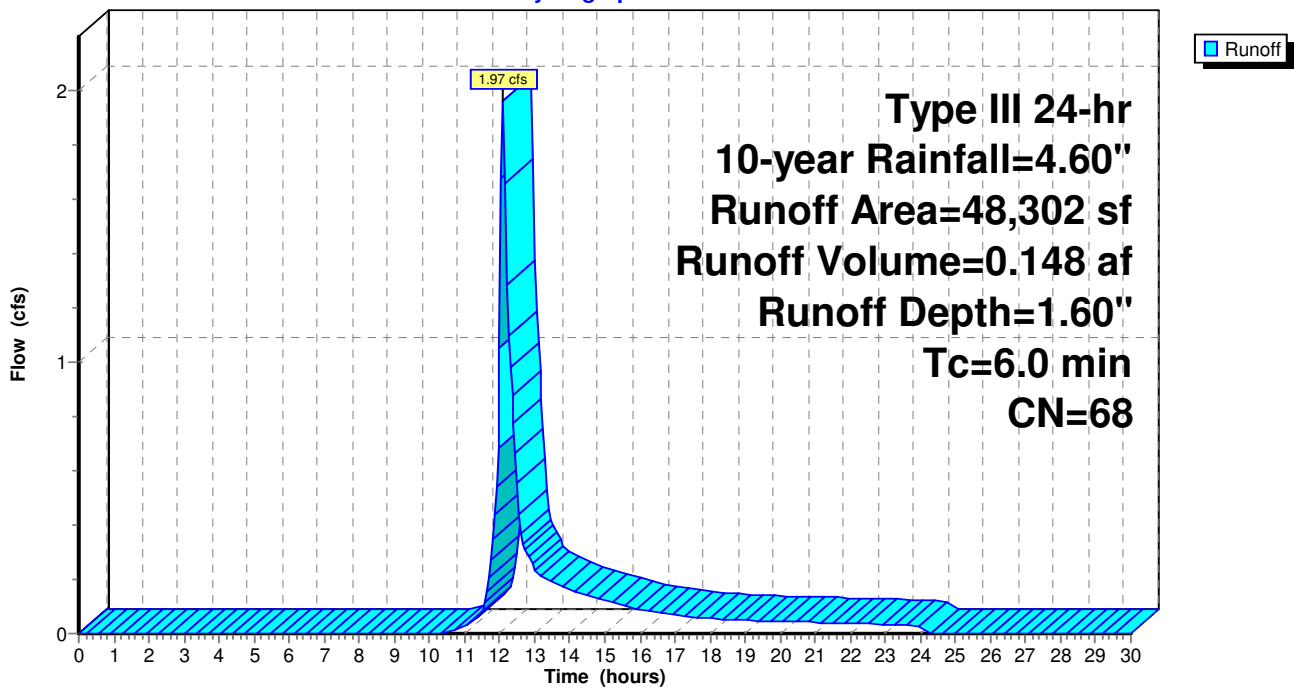
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10-year Rainfall=4.60"

Area (sf)	CN	Description
8,171	60	Woods, Fair, HSG B
39,271	69	50-75% Grass cover, Fair, HSG B
* 860	98	Impervious, HSG B
48,302	68	Weighted Average
47,442		98.22% Pervious Area
860		1.78% Impervious Area

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

**Subcatchment EX-2: EX-2**

Hydrograph



**Existing Conditions**

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 Type III 24-hr 10-year Rainfall=4.60"

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**Summary for Subcatchment EX-3: EX-3**

Runoff = 0.30 cfs @ 12.11 hrs, Volume= 0.025 af, Depth= 1.07"

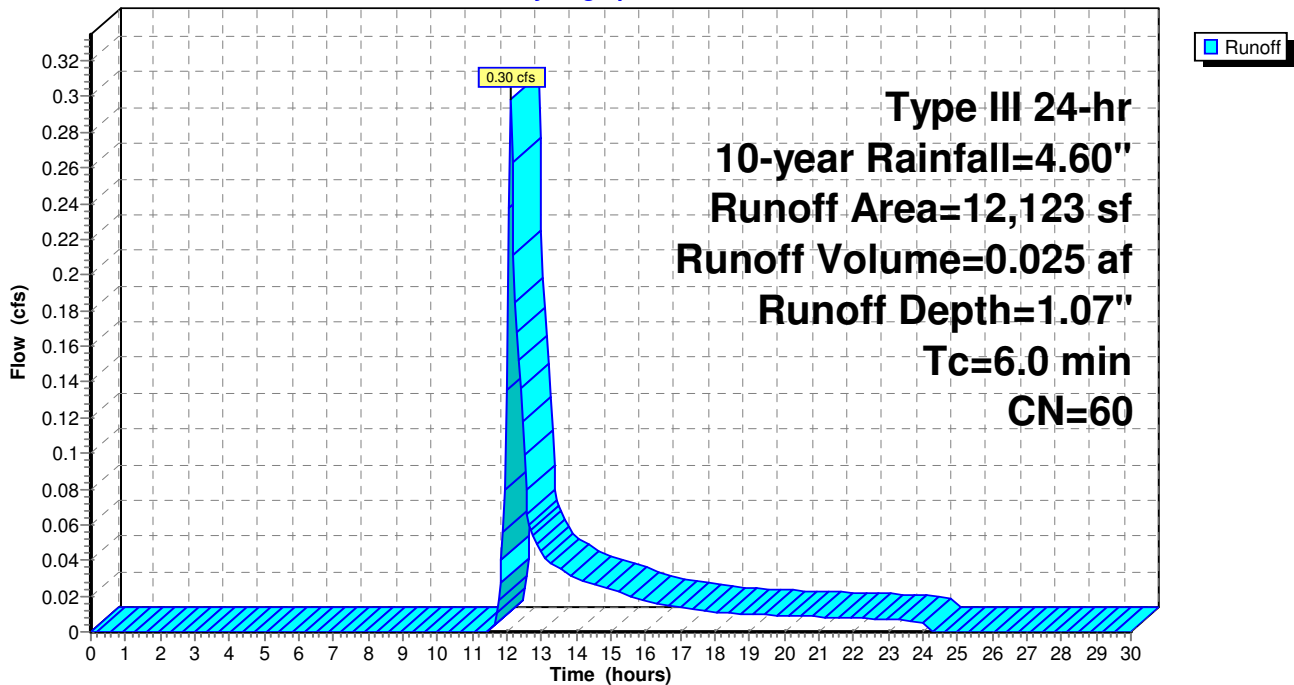
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10-year Rainfall=4.60"

Area (sf)	CN	Description
12,123	60	Woods, Fair, HSG B
12,123		100.00% Pervious Area

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

**Subcatchment EX-3: EX-3**

Hydrograph



**Existing Conditions**

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Type III 24-hr 25-Year Rainfall=5.60"

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Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment EX-1: EX-1** Runoff Area=183,039 sf 3.93% Impervious Runoff Depth=2.32"  
Flow Length=330' Tc=16.5 min CN=68 Runoff=8.11 cfs 0.812 af

**Subcatchment EX-2: EX-2** Runoff Area=48,302 sf 1.78% Impervious Runoff Depth=2.32"  
Tc=6.0 min CN=68 Runoff=2.91 cfs 0.214 af

**Subcatchment EX-3: EX-3** Runoff Area=12,123 sf 0.00% Impervious Runoff Depth=1.67"  
Tc=6.0 min CN=60 Runoff=0.50 cfs 0.039 af

**Total Runoff Area = 5.589 ac Runoff Volume = 1.064 af Average Runoff Depth = 2.29"**  
**96.69% Pervious = 5.404 ac 3.31% Impervious = 0.185 ac**



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Type III 24-hr 25-Year Rainfall=5.60"

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**Summary for Subcatchment EX-1: EX-1**

Runoff = 8.11 cfs @ 12.24 hrs, Volume= 0.812 af, Depth= 2.32"

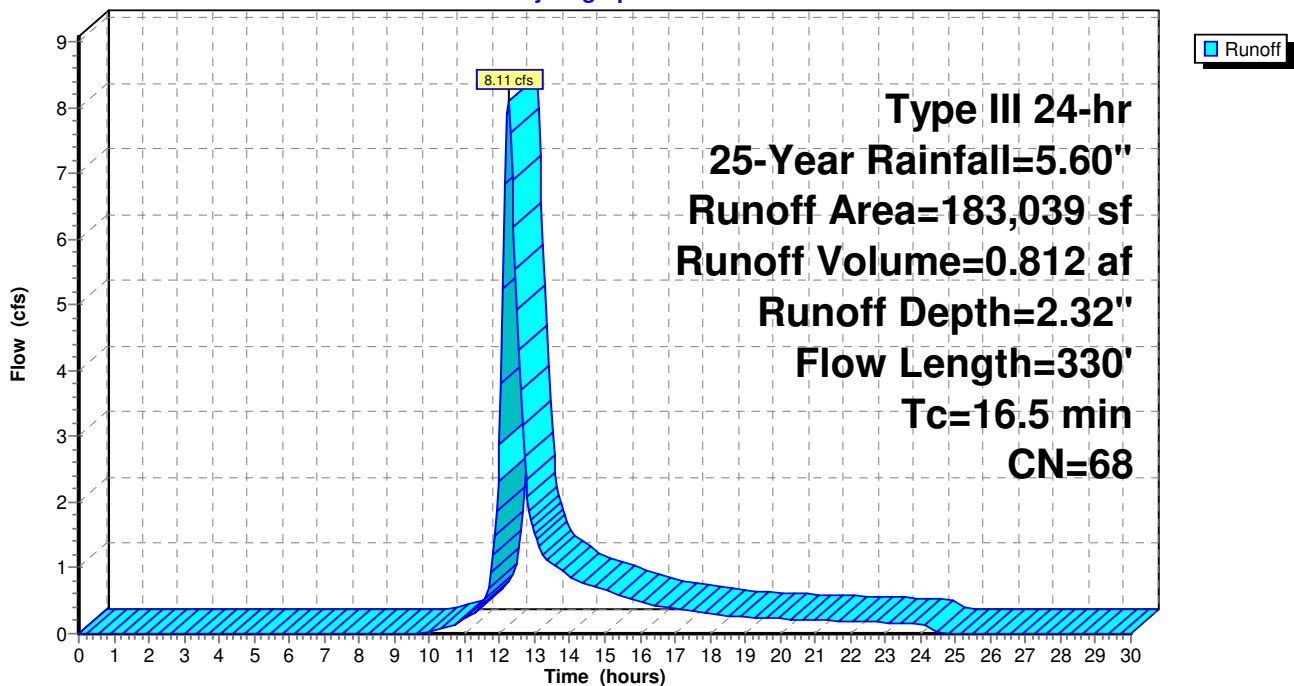
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
* 7,192	98	Paved Tennis Court, HSG B
44,957	60	Woods, Fair, HSG B
130,890	69	50-75% Grass cover, Fair, HSG B
183,039	68	Weighted Average
175,847		96.07% Pervious Area
7,192		3.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		<b>Sheet Flow, T1</b>
					Grass: Short n= 0.150 P2= 3.20"
6.7	280	0.0100	0.70		<b>Shallow Concentrated Flow, T2</b>
					Short Grass Pasture Kv= 7.0 fps
16.5	330	Total			

**Subcatchment EX-1: EX-1**

Hydrograph



**Existing Conditions**

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 Type III 24-hr 25-Year Rainfall=5.60"  
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**Summary for Subcatchment EX-2: EX-2**

Runoff = 2.91 cfs @ 12.10 hrs, Volume= 0.214 af, Depth= 2.32"

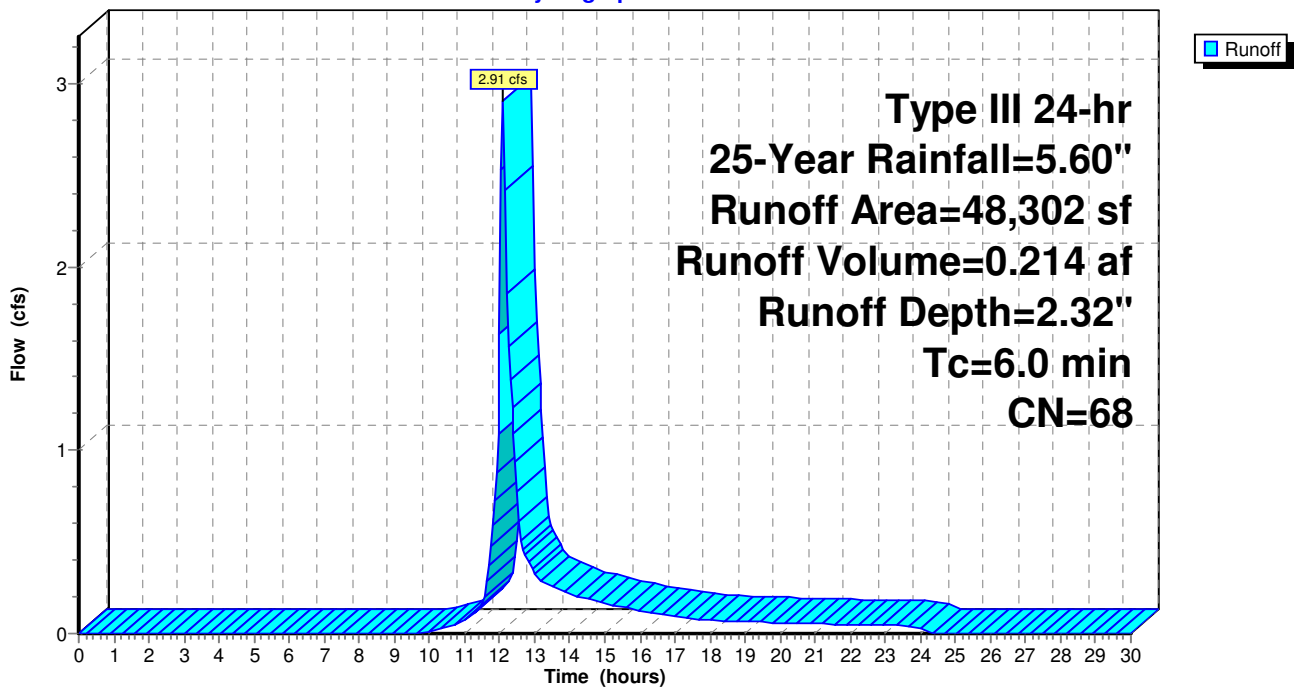
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
8,171	60	Woods, Fair, HSG B
39,271	69	50-75% Grass cover, Fair, HSG B
* 860	98	Impervious, HSG B
48,302	68	Weighted Average
47,442		98.22% Pervious Area
860		1.78% Impervious Area

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

**Subcatchment EX-2: EX-2**

Hydrograph



**Existing Conditions**

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 Type III 24-hr 25-Year Rainfall=5.60"

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**Summary for Subcatchment EX-3: EX-3**

Runoff = 0.50 cfs @ 12.10 hrs, Volume= 0.039 af, Depth= 1.67"

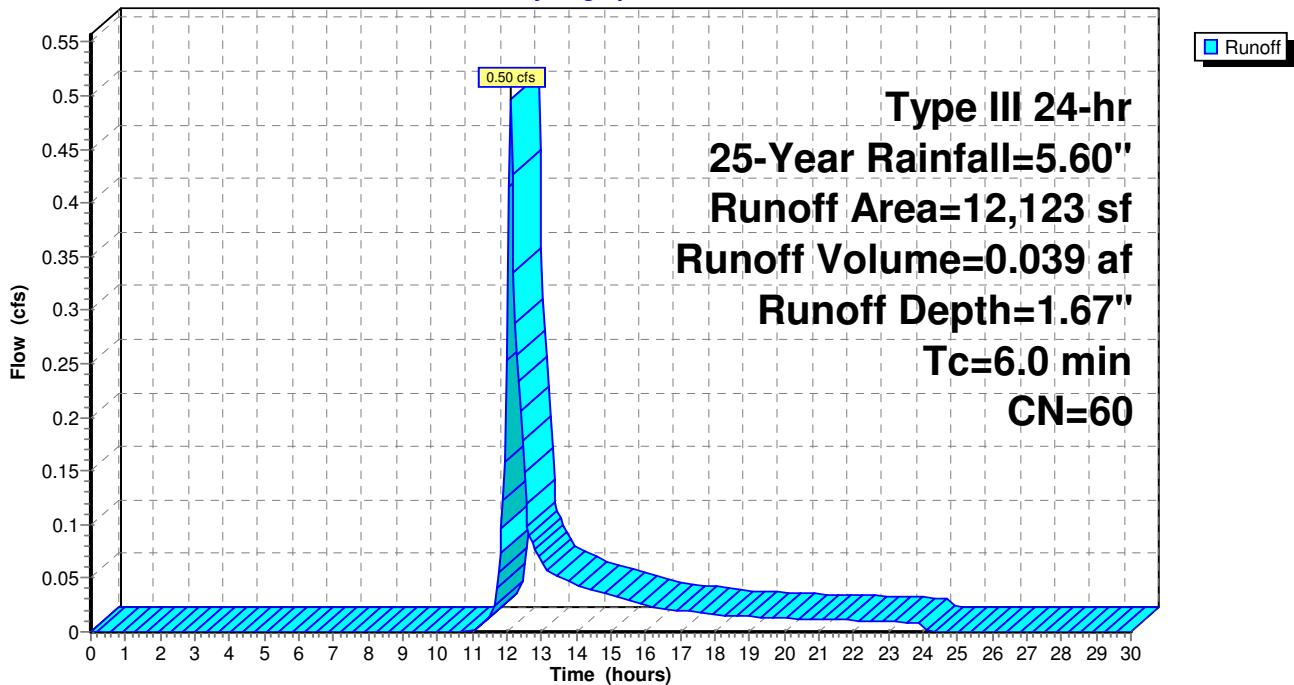
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
12,123	60	Woods, Fair, HSG B
12,123		100.00% Pervious Area

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

**Subcatchment EX-3: EX-3**

Hydrograph



**Existing Conditions**

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Type III 24-hr 100-year Rainfall=6.80"

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Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment EX-1: EX-1** Runoff Area=183,039 sf 3.93% Impervious Runoff Depth=3.25"  
Flow Length=330' Tc=16.5 min CN=68 Runoff=11.52 cfs 1.138 af

**Subcatchment EX-2: EX-2** Runoff Area=48,302 sf 1.78% Impervious Runoff Depth=3.25"  
Tc=6.0 min CN=68 Runoff=4.13 cfs 0.300 af

**Subcatchment EX-3: EX-3** Runoff Area=12,123 sf 0.00% Impervious Runoff Depth=2.46"  
Tc=6.0 min CN=60 Runoff=0.76 cfs 0.057 af

**Total Runoff Area = 5.589 ac Runoff Volume = 1.495 af Average Runoff Depth = 3.21"**  
**96.69% Pervious = 5.404 ac 3.31% Impervious = 0.185 ac**

**Existing Conditions**

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**Summary for Subcatchment EX-1: EX-1**

Runoff = 11.52 cfs @ 12.23 hrs, Volume= 1.138 af, Depth= 3.25"

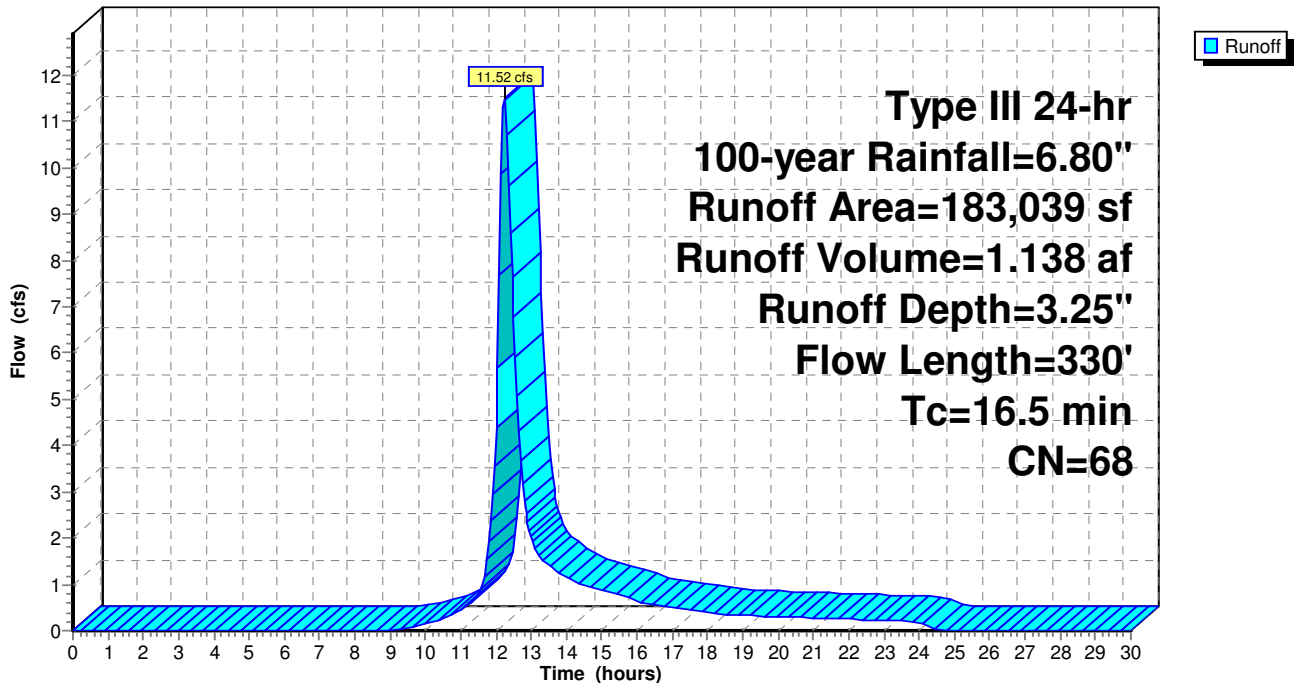
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 100-year Rainfall=6.80"

Area (sf)	CN	Description
* 7,192	98	Paved Tennis Court, HSG B
44,957	60	Woods, Fair, HSG B
130,890	69	50-75% Grass cover, Fair, HSG B
183,039	68	Weighted Average
175,847		96.07% Pervious Area
7,192		3.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		<b>Sheet Flow, T1</b>
					Grass: Short n= 0.150 P2= 3.20"
6.7	280	0.0100	0.70		<b>Shallow Concentrated Flow, T2</b>
					Short Grass Pasture Kv= 7.0 fps
16.5	330	Total			

**Subcatchment EX-1: EX-1**

Hydrograph



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 Type III 24-hr 100-year Rainfall=6.80"  
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**Summary for Subcatchment EX-2: EX-2**

Runoff = 4.13 cfs @ 12.09 hrs, Volume= 0.300 af, Depth= 3.25"

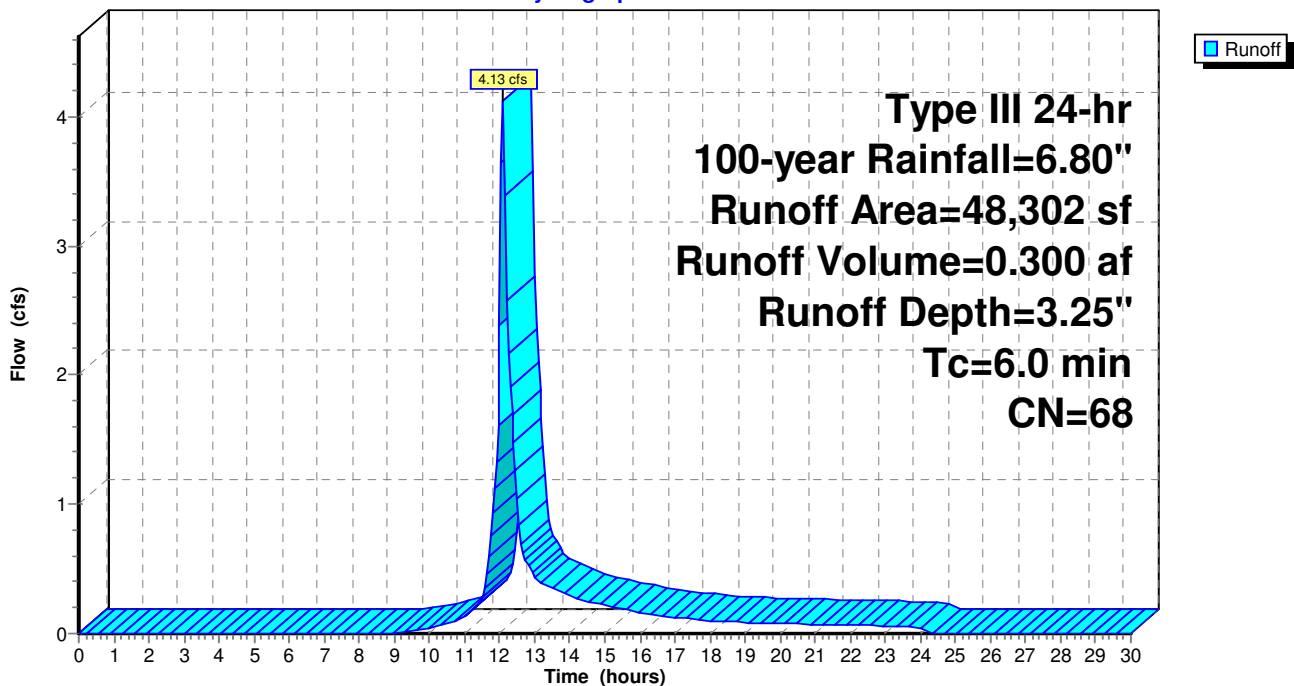
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 100-year Rainfall=6.80"

Area (sf)	CN	Description
8,171	60	Woods, Fair, HSG B
39,271	69	50-75% Grass cover, Fair, HSG B
* 860	98	Impervious, HSG B
48,302	68	Weighted Average
47,442		98.22% Pervious Area
860		1.78% Impervious Area

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

**Subcatchment EX-2: EX-2**

Hydrograph



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**Summary for Subcatchment EX-3: EX-3**

Runoff = 0.76 cfs @ 12.10 hrs, Volume= 0.057 af, Depth= 2.46"

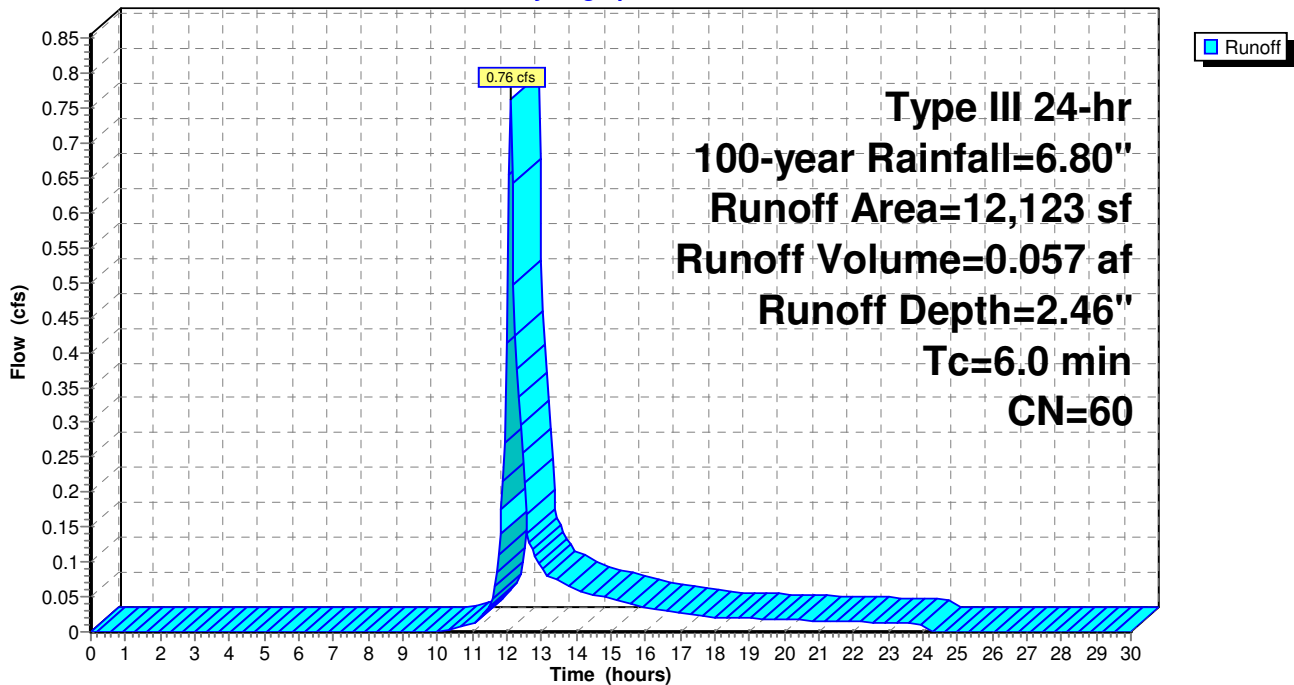
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 100-year Rainfall=6.80"

Area (sf)	CN	Description
12,123	60	Woods, Fair, HSG B
12,123		100.00% Pervious Area

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

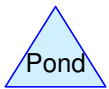
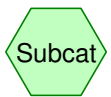
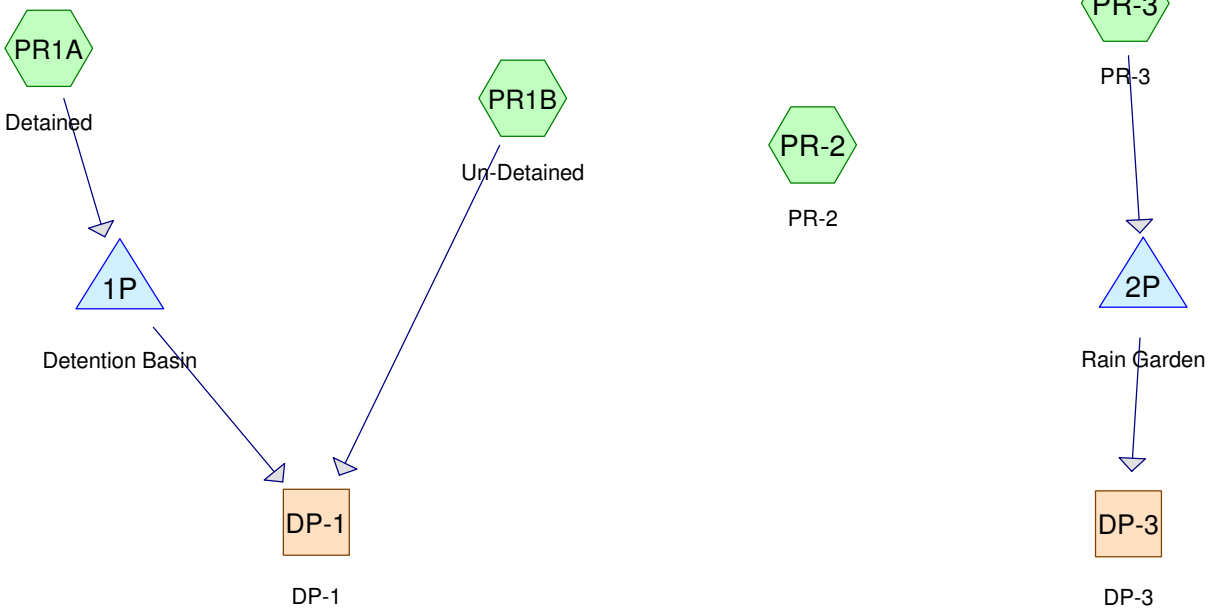
**Subcatchment EX-3: EX-3**

Hydrograph



## Hydrologic Model - Proposed Conditions





**Routing Diagram for Proposed Conditions**  
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**Proposed Conditions**

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**Area Listing (all nodes)**

Area (acres)	CN	Description (subcatchment-numbers)
0.518	69	50-75% Grass cover, Fair, HSG B (PR-2)
2.429	61	>75% Grass cover, Good, HSG B (PR-2, PR-3, PR1A, PR1B)
0.369	98	Detention Basin (PR1A)
1.343	98	Paved parking and roof, HSG B (PR1A)
0.098	98	Paved parking, HSG B (PR-3)
0.832	60	Woods, Fair, HSG B (PR-2, PR-3, PR1B)
<b>5.589</b>	<b>74</b>	<b>TOTAL AREA</b>

**Proposed Conditions**

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**Soil Listing (all nodes)**

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
5.220	HSG B	PR-2, PR-3, PR1A, PR1B
0.000	HSG C	
0.000	HSG D	
0.369	Other	PR1A
<b>5.589</b>		<b>TOTAL AREA</b>

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**Ground Covers (all nodes)**

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.518	0.000	0.000	0.000	0.518	50-75% Grass cover, Fair	PR-2
0.000	2.429	0.000	0.000	0.000	2.429	>75% Grass cover, Good	PR-2, PR-3, PR1A, PR1B
0.000	0.000	0.000	0.000	0.369	0.369	Detention Basin	PR1A
0.000	0.098	0.000	0.000	0.000	0.098	Paved parking	PR-3
0.000	1.343	0.000	0.000	0.000	1.343	Paved parking and roof	PR1A
0.000	0.832	0.000	0.000	0.000	0.832	Woods, Fair	PR-2, PR-3, PR1B
<b>0.000</b>	<b>5.220</b>	<b>0.000</b>	<b>0.000</b>	<b>0.369</b>	<b>5.589</b>	<b>TOTAL AREA</b>	

**Proposed Conditions**

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10 High Street, Topsfield  
Type III 24-hr 2-year Rainfall=3.20"

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Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment PR-2: PR-2** Runoff Area=44,310 sf 0.00% Impervious Runoff Depth=0.60"  
Tc=0.0 min CN=65 Runoff=0.64 cfs 0.051 af

**Subcatchment PR-3: PR-3** Runoff Area=16,655 sf 25.64% Impervious Runoff Depth=0.83"  
Tc=6.0 min CN=70 Runoff=0.33 cfs 0.026 af

**Subcatchment PR1A: Detained** Runoff Area=86,719 sf 85.97% Impervious Runoff Depth=2.45"  
Tc=6.0 min CN=93 Runoff=5.40 cfs 0.406 af

**Subcatchment PR1B: Un-Detained** Runoff Area=95,780 sf 0.00% Impervious Runoff Depth=0.44"  
Tc=6.0 min CN=61 Runoff=0.69 cfs 0.081 af

**Reach DP-1: DP-1** Inflow=0.69 cfs 0.138 af  
Outflow=0.69 cfs 0.138 af

**Reach DP-3: DP-3** Inflow=0.00 cfs 0.000 af  
Outflow=0.00 cfs 0.000 af

**Pond 1P: Detention Basin** Peak Elev=85.79' Storage=8,131 cf Inflow=5.40 cfs 0.406 af  
Discarded=0.26 cfs 0.350 af Primary=0.22 cfs 0.056 af Outflow=0.49 cfs 0.406 af

**Pond 2P: Rain Garden** Peak Elev=64.25' Storage=375 cf Inflow=0.33 cfs 0.026 af  
Discarded=0.04 cfs 0.026 af Primary=0.00 cfs 0.000 af Outflow=0.04 cfs 0.026 af

**Total Runoff Area = 5.589 ac Runoff Volume = 0.564 af Average Runoff Depth = 1.21"**  
**67.63% Pervious = 3.780 ac 32.37% Impervious = 1.809 ac**

**Proposed Conditions**

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 Type III 24-hr 2-year Rainfall=3.20"

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**Summary for Subcatchment PR-2: PR-2**

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

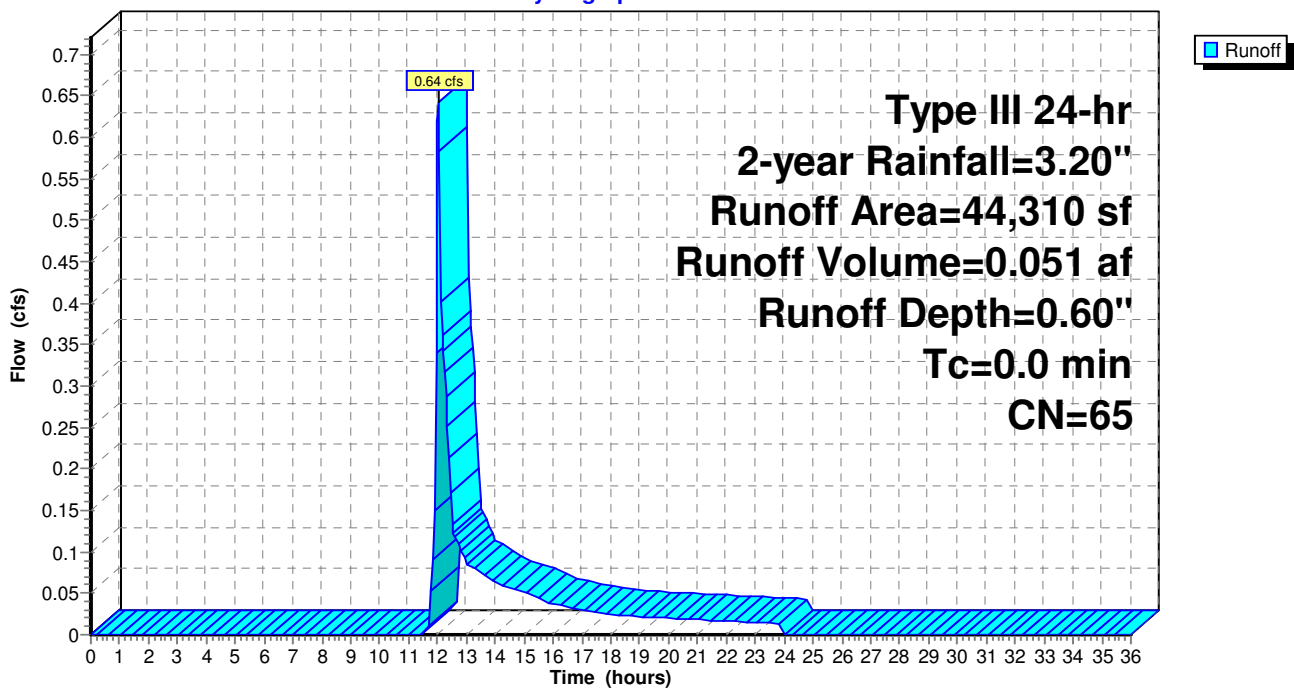
Runoff = 0.64 cfs @ 12.02 hrs, Volume= 0.051 af, Depth= 0.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
11,793	61	>75% Grass cover, Good, HSG B
9,948	60	Woods, Fair, HSG B
22,569	69	50-75% Grass cover, Fair, HSG B
44,310	65	Weighted Average
44,310		100.00% Pervious Area

**Subcatchment PR-2: PR-2**

Hydrograph



**Proposed Conditions**

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**Summary for Subcatchment PR-3: PR-3**

Runoff = 0.33 cfs @ 12.10 hrs, Volume= 0.026 af, Depth= 0.83"

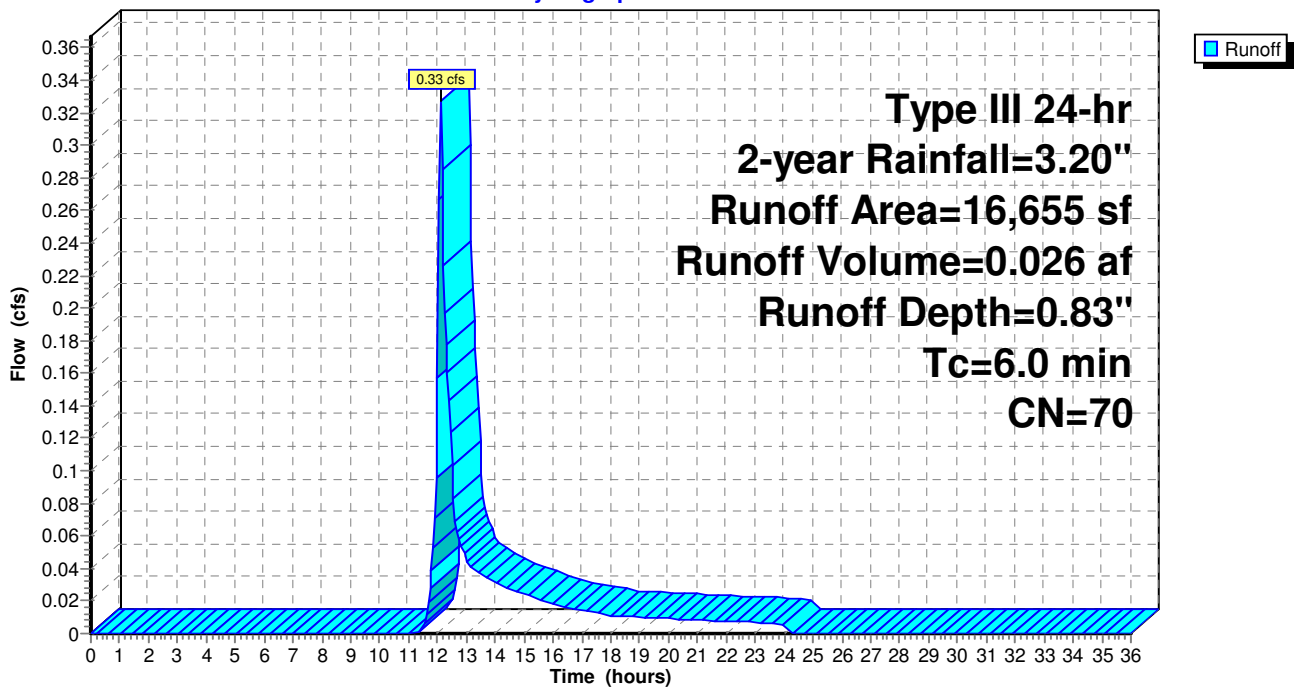
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
4,270	98	Paved parking, HSG B
9,642	61	>75% Grass cover, Good, HSG B
2,743	60	Woods, Fair, HSG B
16,655	70	Weighted Average
12,385		74.36% Pervious Area
4,270		25.64% Impervious Area

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

**Subcatchment PR-3: PR-3**

Hydrograph



**Proposed Conditions**

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 Type III 24-hr 2-year Rainfall=3.20"

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**Summary for Subcatchment PR1A: Detained**

Runoff = 5.40 cfs @ 12.09 hrs, Volume= 0.406 af, Depth= 2.45"

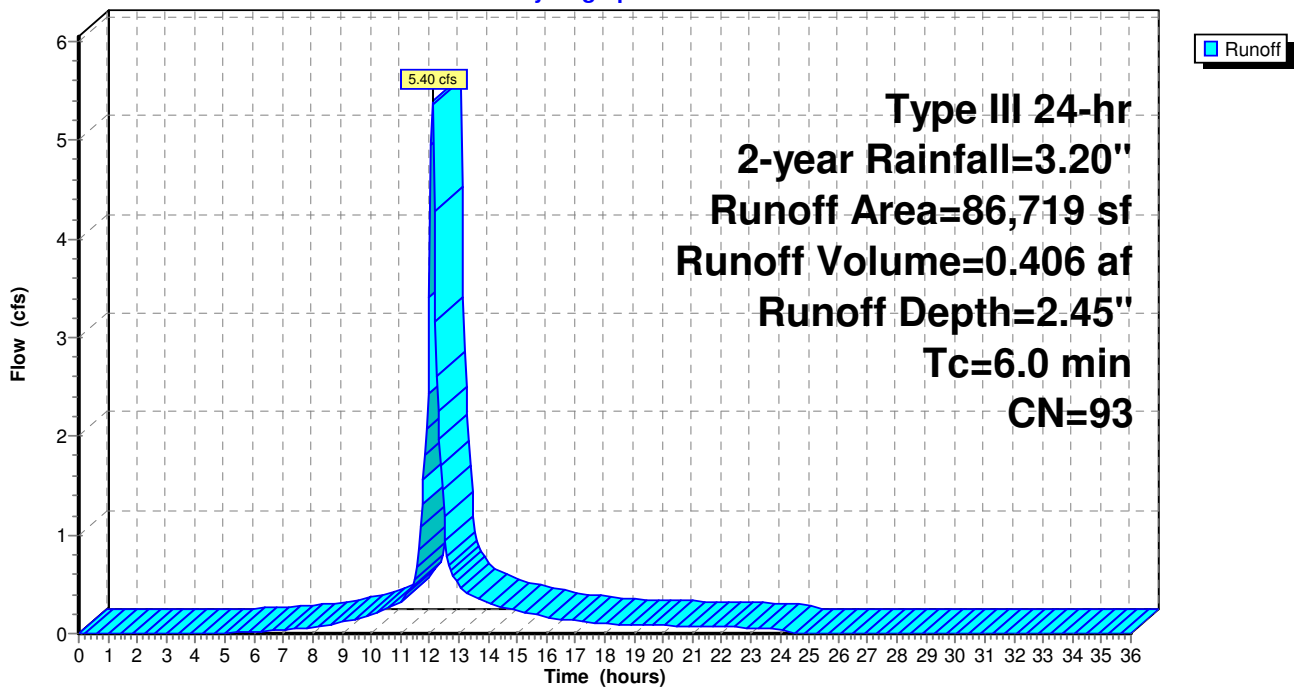
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2-year Rainfall=3.20"

	Area (sf)	CN	Description
*	58,487	98	Paved parking and roof, HSG B
	12,170	61	>75% Grass cover, Good, HSG B
*	16,062	98	Detention Basin
	86,719	93	Weighted Average
	12,170		14.03% Pervious Area
	74,549		85.97% Impervious Area

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

**Subcatchment PR1A: Detained**

Hydrograph





**Proposed Conditions**

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 Type III 24-hr 2-year Rainfall=3.20"

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**Summary for Subcatchment PR1B: Un-Detained**

Runoff = 0.69 cfs @ 12.13 hrs, Volume= 0.081 af, Depth= 0.44"

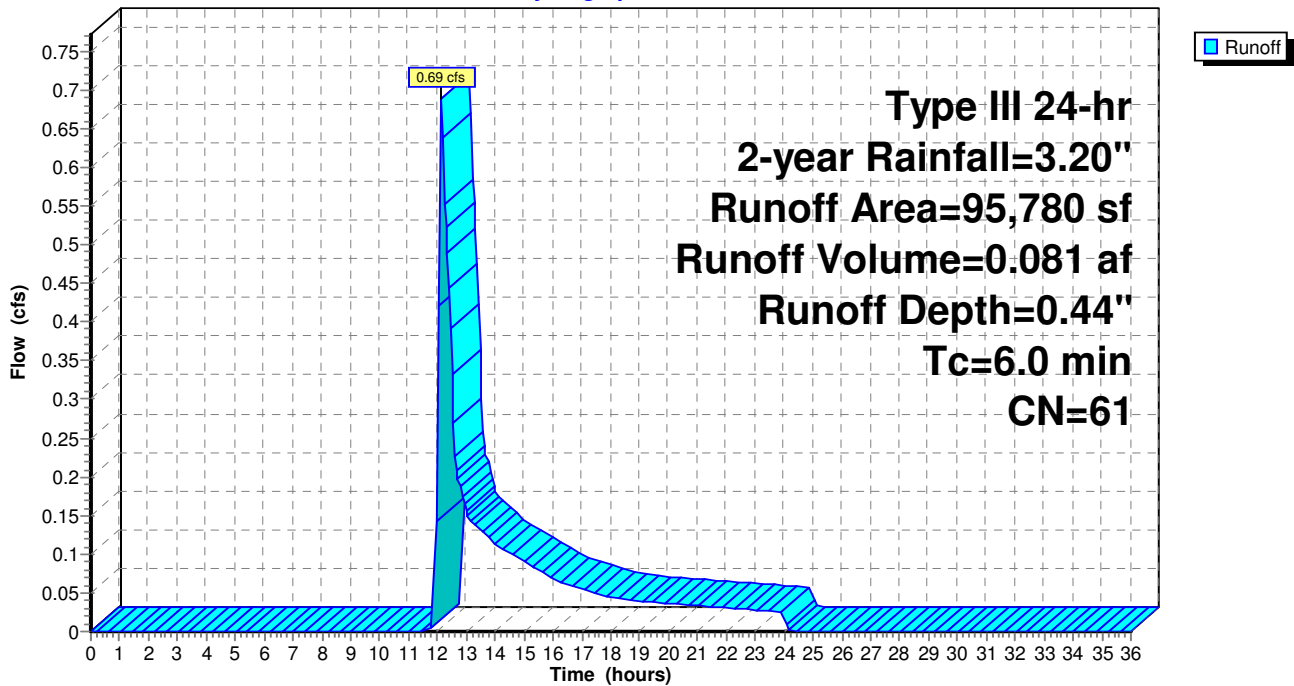
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
23,560	60	Woods, Fair, HSG B
72,220	61	>75% Grass cover, Good, HSG B
95,780	61	Weighted Average
95,780		100.00% Pervious Area

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

**Subcatchment PR1B: Un-Detained**

Hydrograph



# Proposed Conditions

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## Summary for Reach DP-1: DP-1

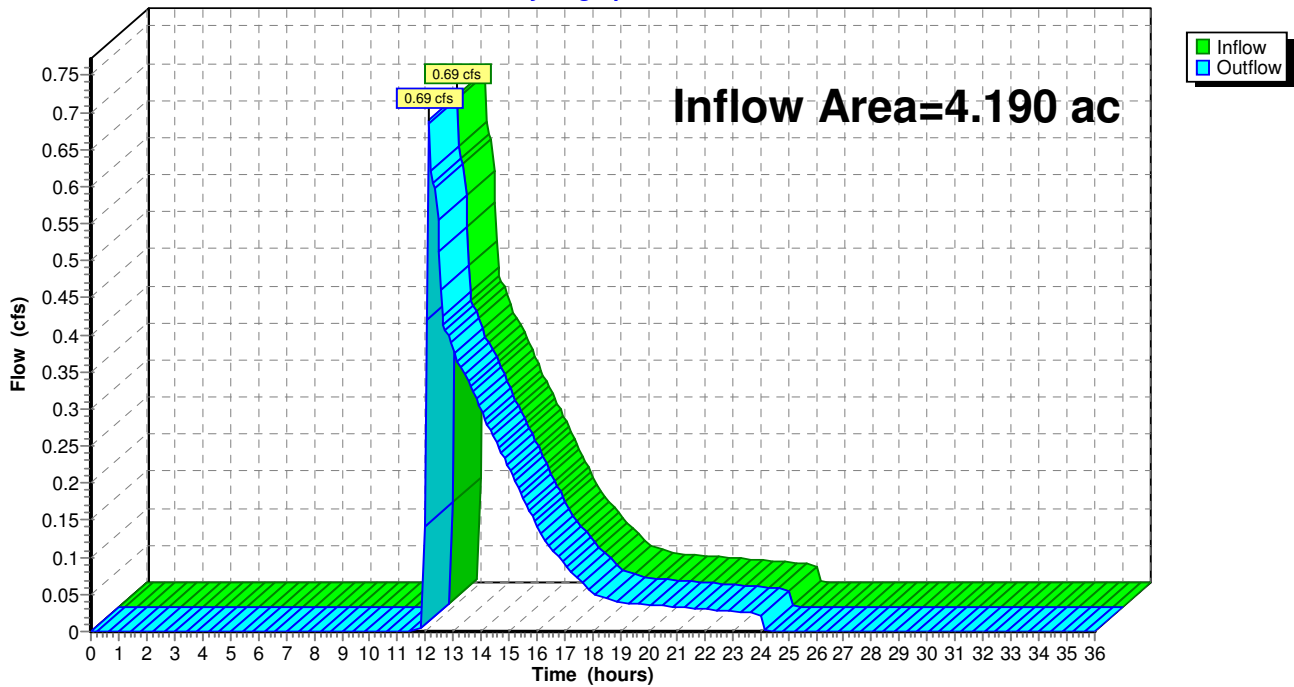
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.190 ac, 40.85% Impervious, Inflow Depth = 0.39" for 2-year event  
Inflow = 0.69 cfs @ 12.13 hrs, Volume= 0.138 af  
Outflow = 0.69 cfs @ 12.13 hrs, Volume= 0.138 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

### Reach DP-1: DP-1

Hydrograph



**Proposed Conditions**

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Type III 24-hr 2-year Rainfall=3.20"

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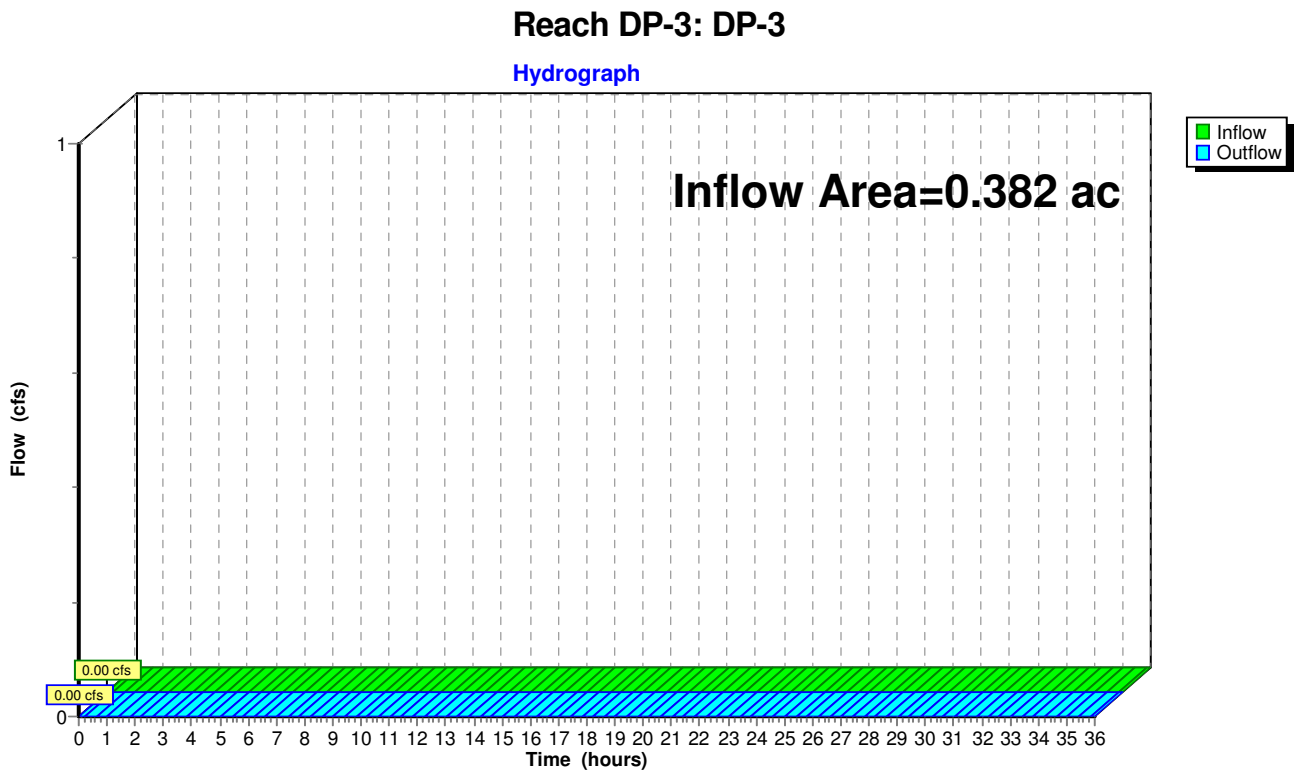
Page 11

**Summary for Reach DP-3: DP-3**

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

Inflow Area = 0.382 ac, 25.64% Impervious, Inflow Depth = 0.00" for 2-year event  
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af  
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs



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**Summary for Pond 1P: Detention Basin**

Inflow Area = 1.991 ac, 85.97% Impervious, Inflow Depth = 2.45" for 2-year event  
 Inflow = 5.40 cfs @ 12.09 hrs, Volume= 0.406 af  
 Outflow = 0.49 cfs @ 13.01 hrs, Volume= 0.406 af, Atten= 91%, Lag= 55.2 min  
 Discarded = 0.26 cfs @ 13.01 hrs, Volume= 0.350 af  
 Primary = 0.22 cfs @ 13.01 hrs, Volume= 0.056 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Peak Elev= 85.79' @ 13.01 hrs Surf.Area= 10,847 sf Storage= 8,131 cf

Plug-Flow detention time= 232.1 min calculated for 0.406 af (100% of inflow)  
 Center-of-Mass det. time= 231.8 min ( 1,024.5 - 792.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	85.00'	51,122 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
85.00	9,640	0	0
86.00	11,161	10,401	10,401
87.00	12,738	11,950	22,350
88.00	14,372	13,555	35,905
89.00	16,062	15,217	51,122

Device	Routing	Invert	Outlet Devices
#1	Discarded	85.00'	<b>1.020 in/hr Exfiltration over Surface area</b> Conductivity to Groundwater Elevation = 62.00'
#2	Primary	85.50'	<b>6.0" Vert. Orifice/Grate</b> C= 0.600
#3	Primary	86.00'	<b>6.0" Vert. Orifice/Grate</b> C= 0.600

**Discarded OutFlow** Max=0.26 cfs @ 13.01 hrs HW=85.79' (Free Discharge)  
 ↑1=Exfiltration ( Controls 0.26 cfs)

**Primary OutFlow** Max=0.22 cfs @ 13.01 hrs HW=85.79' (Free Discharge)  
 ↑2=Orifice/Grate (Orifice Controls 0.22 cfs @ 1.85 fps)  
 ↑3=Orifice/Grate ( Controls 0.00 cfs)

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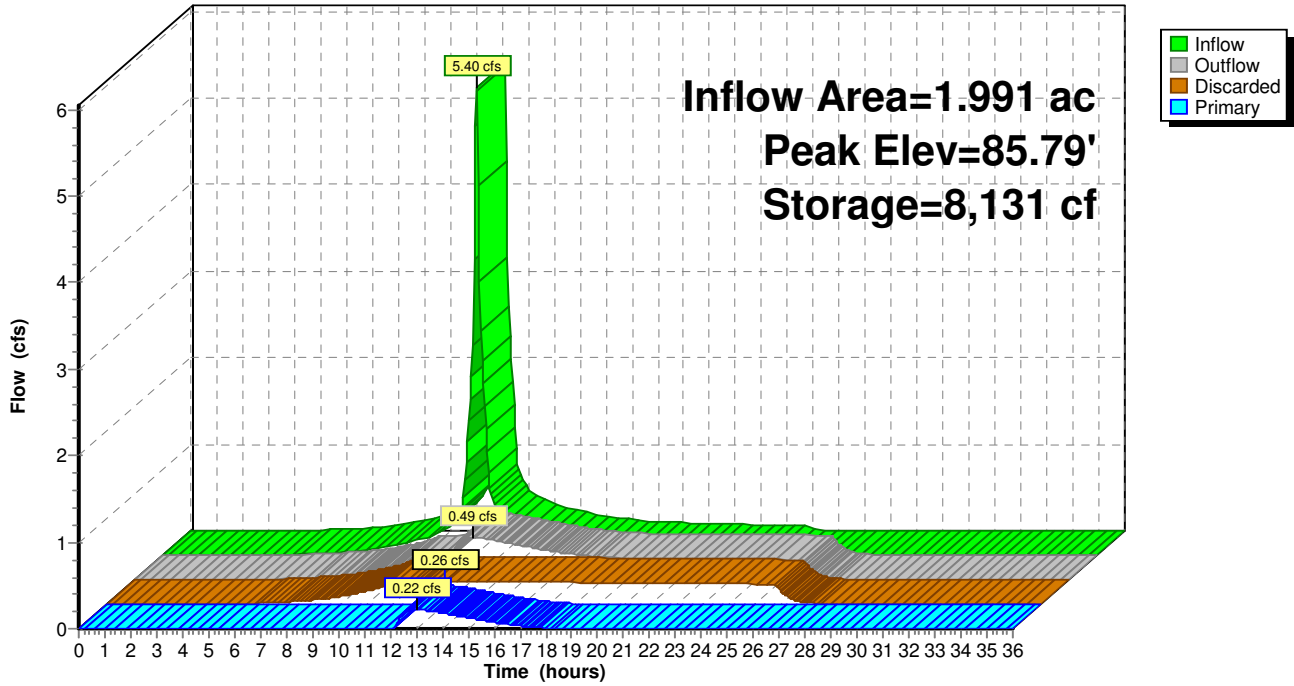
10 High Street, Topsfield  
Type III 24-hr 2-year Rainfall=3.20"

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**Pond 1P: Detention Basin**

Hydrograph



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*Type III 24-hr 2-year Rainfall=3.20"*

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**Summary for Pond 2P: Rain Garden**

Inflow Area = 0.382 ac, 25.64% Impervious, Inflow Depth = 0.83" for 2-year event  
 Inflow = 0.33 cfs @ 12.10 hrs, Volume= 0.026 af  
 Outflow = 0.04 cfs @ 13.08 hrs, Volume= 0.026 af, Atten= 87%, Lag= 58.5 min  
 Discarded = 0.04 cfs @ 13.08 hrs, Volume= 0.026 af  
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Peak Elev= 64.25' @ 13.08 hrs Surf.Area= 1,615 sf Storage= 375 cf

Plug-Flow detention time= 85.8 min calculated for 0.026 af (100% of inflow)  
 Center-of-Mass det. time= 85.7 min ( 961.5 - 875.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	64.00'	1,847 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
64.00	1,384	0	0
65.00	2,309	1,847	1,847

Device	Routing	Invert	Outlet Devices
#1	Discarded	64.00'	<b>1.020 in/hr Exfiltration over Surface area</b> Conductivity to Groundwater Elevation = 62.00'
#2	Primary	64.50'	<b>6.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Discarded OutFlow** Max=0.04 cfs @ 13.08 hrs HW=64.25' (Free Discharge)

↑1=Exfiltration ( Controls 0.04 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=64.00' (Free Discharge)

↑2=Orifice/Grate ( Controls 0.00 cfs)

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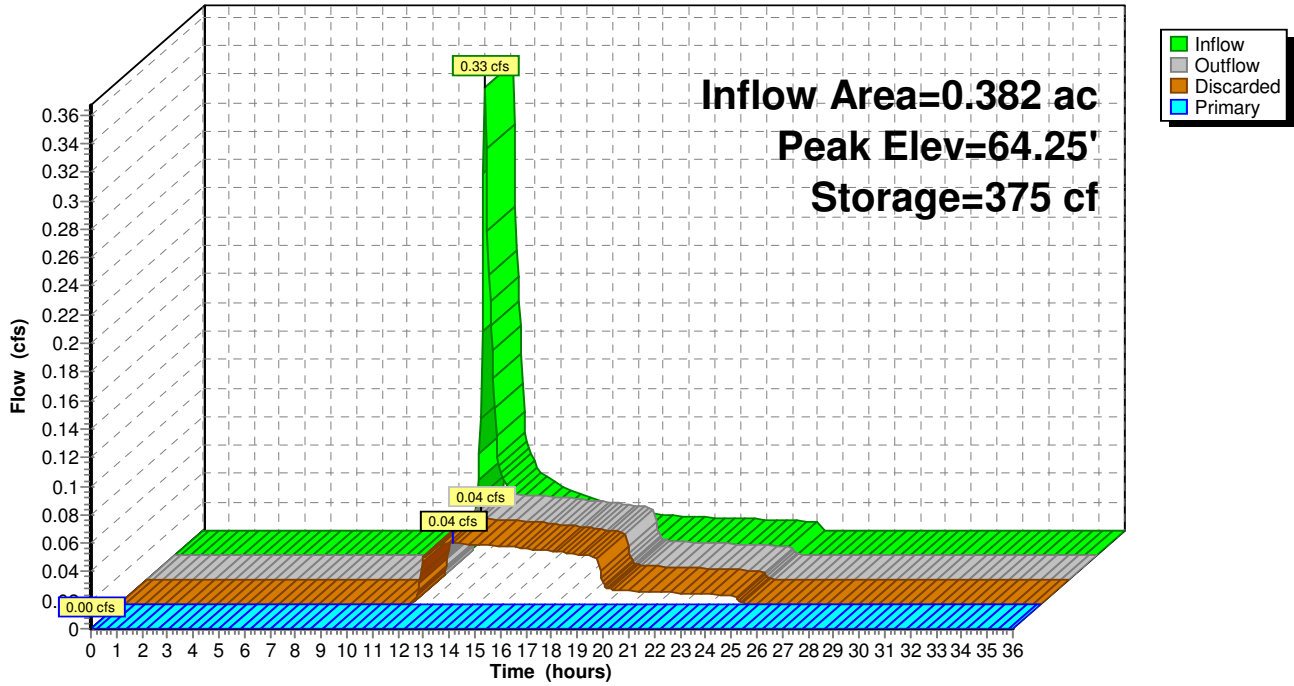
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Type III 24-hr 2-year Rainfall=3.20"

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**Pond 2P: Rain Garden**

Hydrograph



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Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment PR-2: PR-2** Runoff Area=44,310 sf 0.00% Impervious Runoff Depth=1.39"  
Tc=0.0 min CN=65 Runoff=1.79 cfs 0.118 af

**Subcatchment PR-3: PR-3** Runoff Area=16,655 sf 25.64% Impervious Runoff Depth=1.74"  
Tc=6.0 min CN=70 Runoff=0.75 cfs 0.056 af

**Subcatchment PR1A: Detained** Runoff Area=86,719 sf 85.97% Impervious Runoff Depth=3.81"  
Tc=6.0 min CN=93 Runoff=8.20 cfs 0.631 af

**Subcatchment PR1B: Un-Detained** Runoff Area=95,780 sf 0.00% Impervious Runoff Depth=1.14"  
Tc=6.0 min CN=61 Runoff=2.54 cfs 0.208 af

**Reach DP-1: DP-1** Inflow=2.78 cfs 0.416 af  
Outflow=2.78 cfs 0.416 af

**Reach DP-3: DP-3** Inflow=0.07 cfs 0.006 af  
Outflow=0.07 cfs 0.006 af

**Pond 1P: Detention Basin** Peak Elev=86.20' Storage=12,613 cf Inflow=8.20 cfs 0.631 af  
Discarded=0.28 cfs 0.423 af Primary=0.74 cfs 0.208 af Outflow=1.02 cfs 0.631 af

**Pond 2P: Rain Garden** Peak Elev=64.56' Storage=916 cf Inflow=0.75 cfs 0.056 af  
Discarded=0.06 cfs 0.049 af Primary=0.07 cfs 0.006 af Outflow=0.13 cfs 0.056 af

**Total Runoff Area = 5.589 ac Runoff Volume = 1.013 af Average Runoff Depth = 2.18"**  
**67.63% Pervious = 3.780 ac 32.37% Impervious = 1.809 ac**



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**Summary for Subcatchment PR-2: PR-2**

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

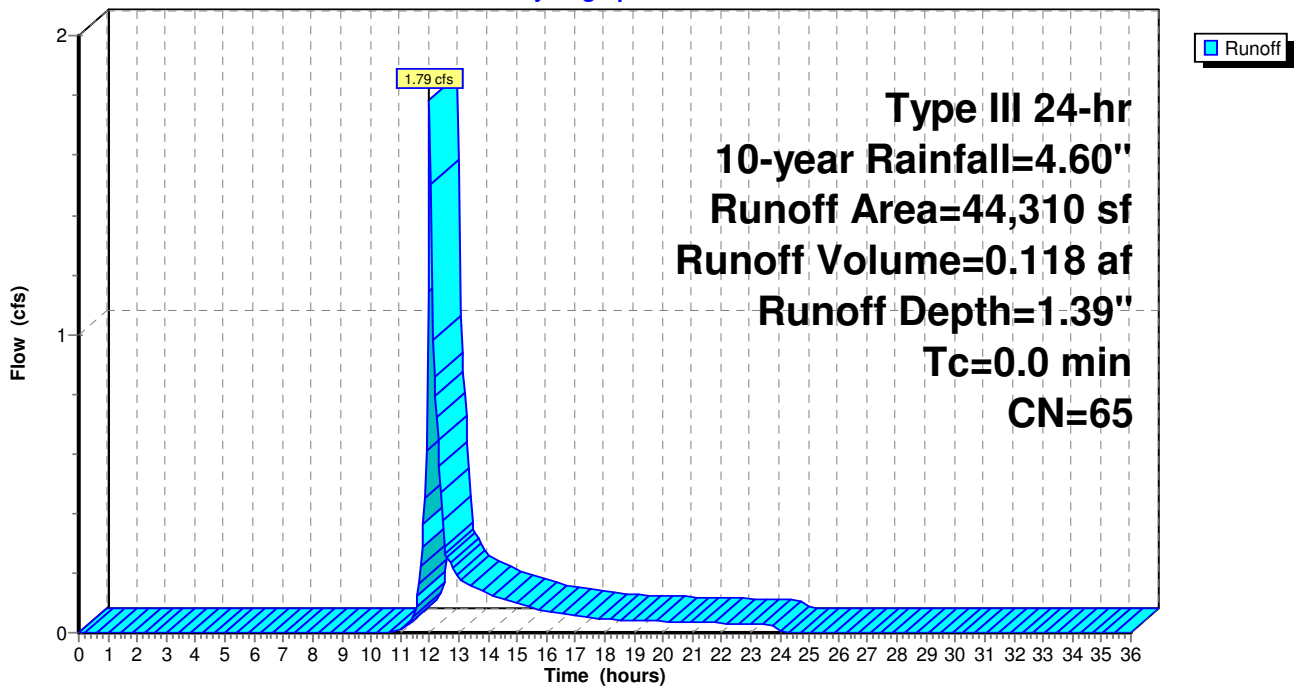
Runoff = 1.79 cfs @ 12.01 hrs, Volume= 0.118 af, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10-year Rainfall=4.60"

Area (sf)	CN	Description
11,793	61	>75% Grass cover, Good, HSG B
9,948	60	Woods, Fair, HSG B
22,569	69	50-75% Grass cover, Fair, HSG B
44,310	65	Weighted Average
44,310		100.00% Pervious Area

**Subcatchment PR-2: PR-2**

Hydrograph



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**Summary for Subcatchment PR-3: PR-3**

Runoff = 0.75 cfs @ 12.10 hrs, Volume= 0.056 af, Depth= 1.74"

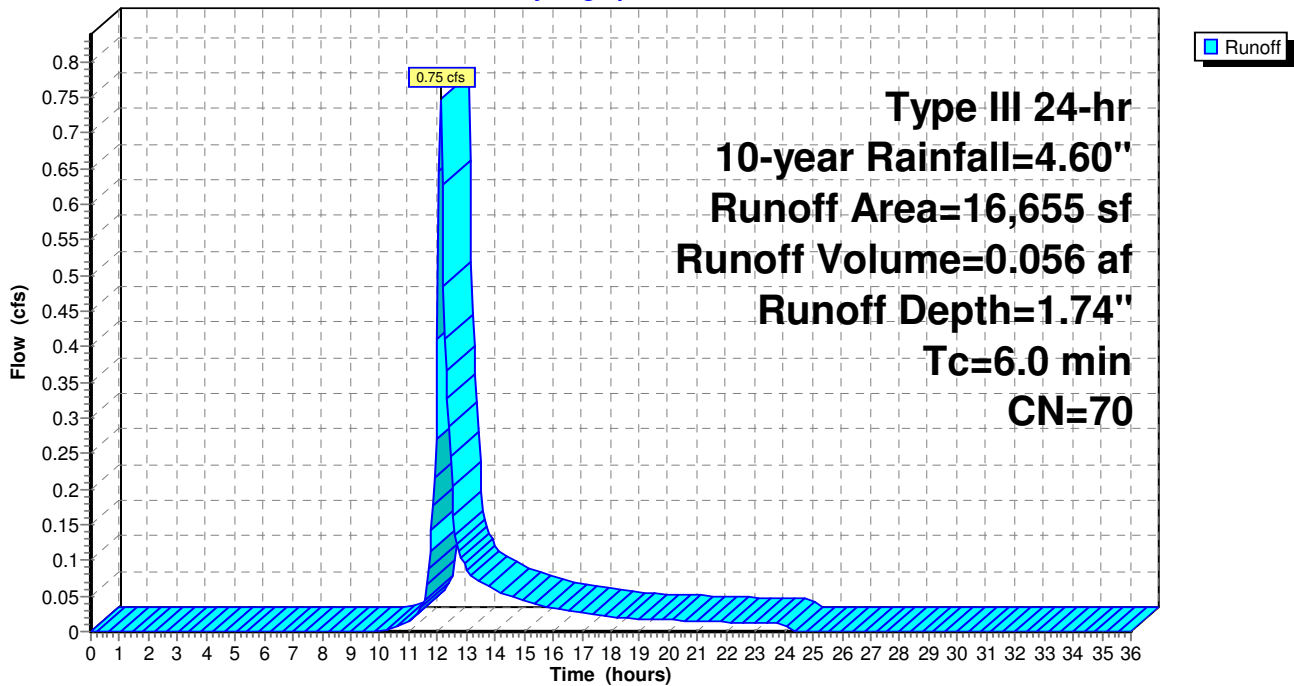
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10-year Rainfall=4.60"

Area (sf)	CN	Description
4,270	98	Paved parking, HSG B
9,642	61	>75% Grass cover, Good, HSG B
2,743	60	Woods, Fair, HSG B
16,655	70	Weighted Average
12,385		74.36% Pervious Area
4,270		25.64% Impervious Area

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

**Subcatchment PR-3: PR-3**

Hydrograph



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**Summary for Subcatchment PR1A: Detained**

Runoff = 8.20 cfs @ 12.09 hrs, Volume= 0.631 af, Depth= 3.81"

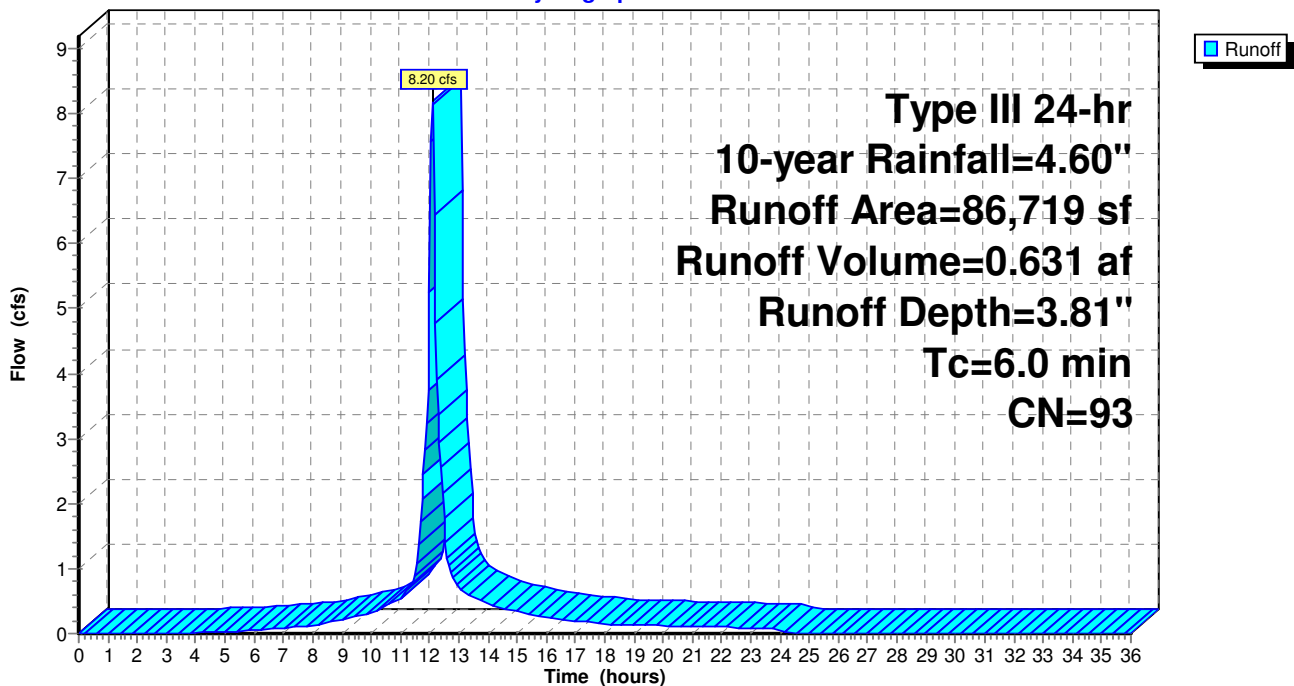
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10-year Rainfall=4.60"

	Area (sf)	CN	Description
*	58,487	98	Paved parking and roof, HSG B
	12,170	61	>75% Grass cover, Good, HSG B
*	16,062	98	Detention Basin
	86,719	93	Weighted Average
	12,170		14.03% Pervious Area
	74,549		85.97% Impervious Area

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

**Subcatchment PR1A: Detained**

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**Summary for Subcatchment PR1B: Un-Detained**

Runoff = 2.54 cfs @ 12.11 hrs, Volume= 0.208 af, Depth= 1.14"

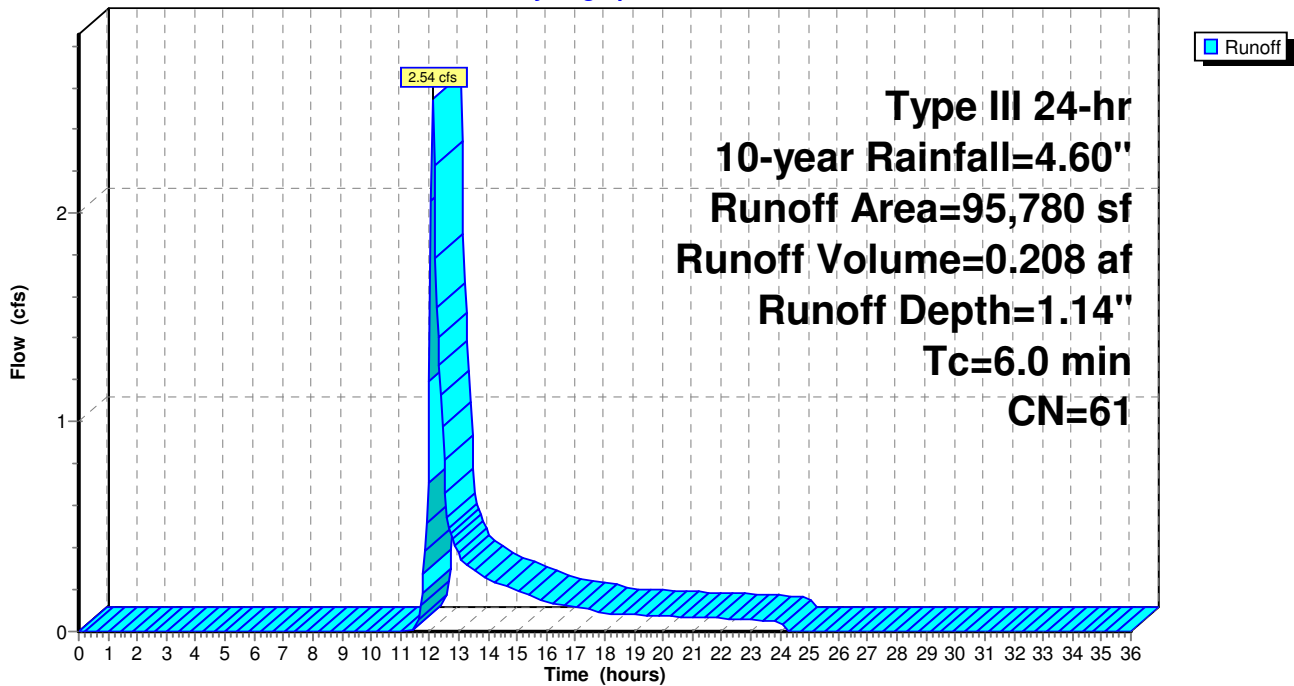
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10-year Rainfall=4.60"

Area (sf)	CN	Description
23,560	60	Woods, Fair, HSG B
72,220	61	>75% Grass cover, Good, HSG B
95,780	61	Weighted Average
95,780		100.00% Pervious Area

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

**Subcatchment PR1B: Un-Detained**

Hydrograph



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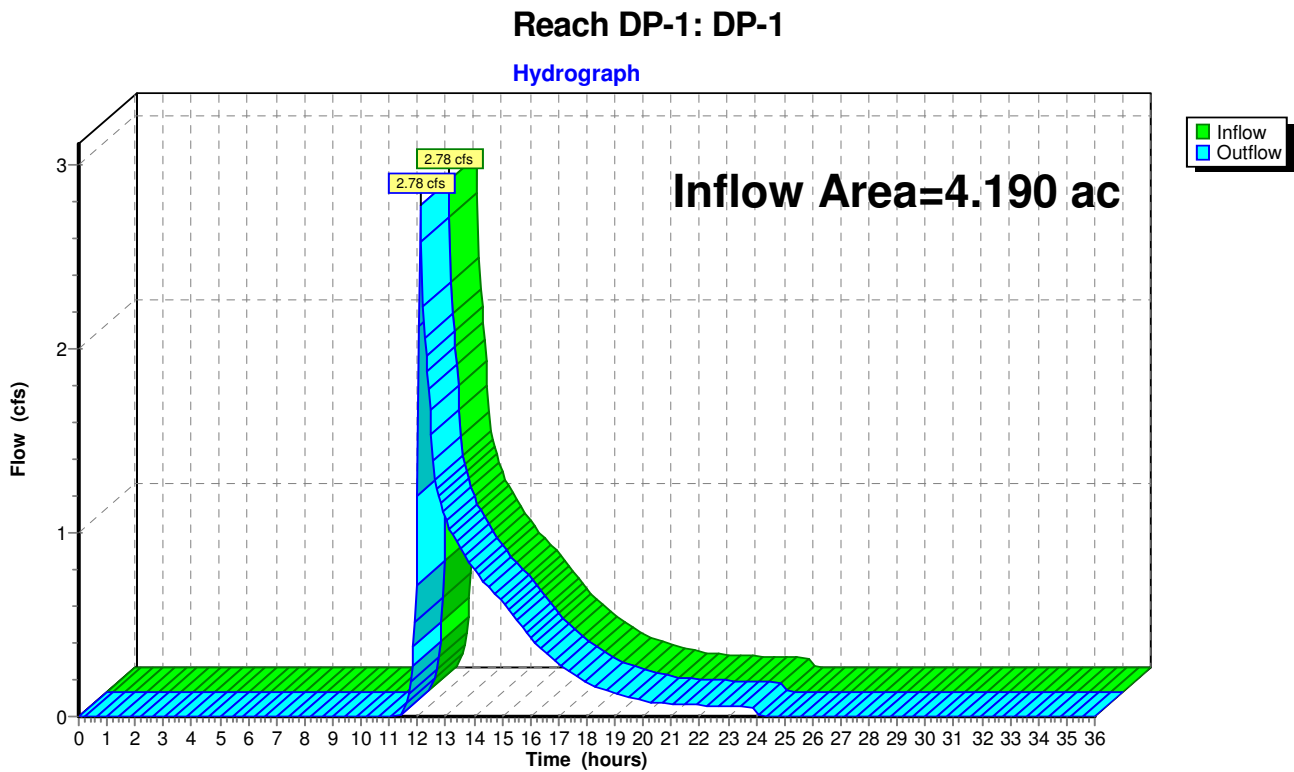
Page 21

## Summary for Reach DP-1: DP-1

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

Inflow Area = 4.190 ac, 40.85% Impervious, Inflow Depth = 1.19" for 10-year event  
Inflow = 2.78 cfs @ 12.11 hrs, Volume= 0.416 af  
Outflow = 2.78 cfs @ 12.11 hrs, Volume= 0.416 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs



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## Summary for Reach DP-3: DP-3

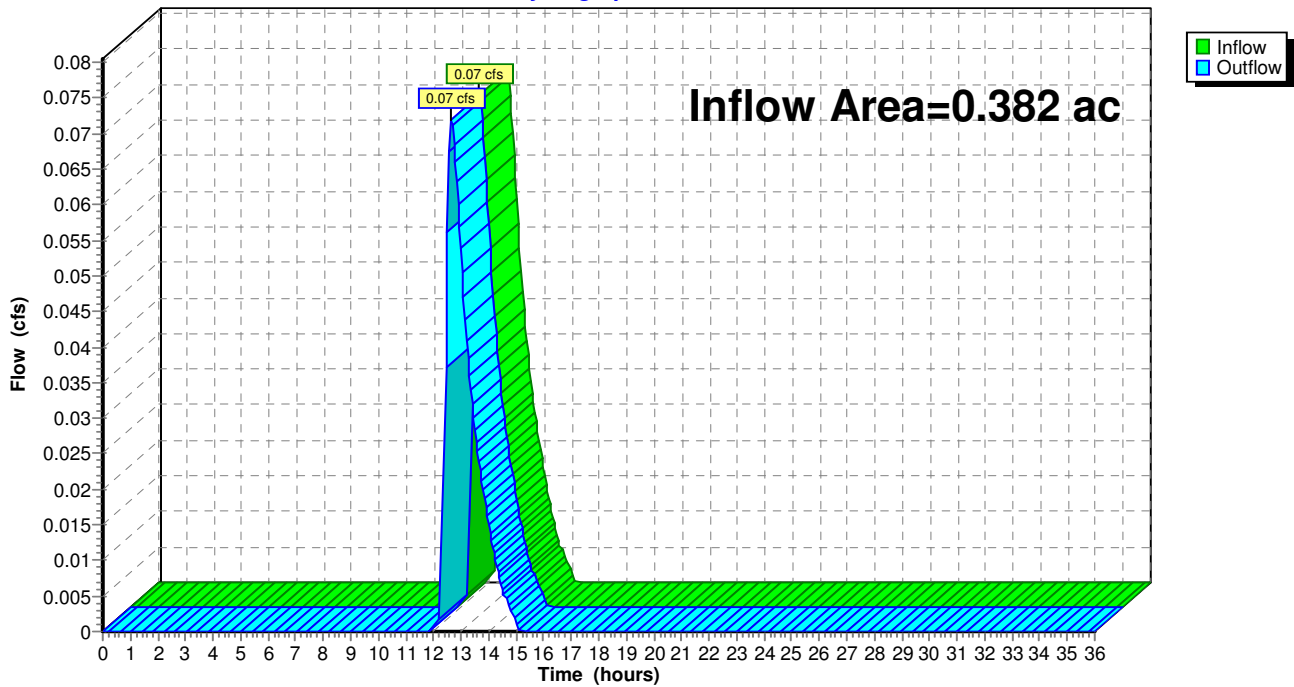
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.382 ac, 25.64% Impervious, Inflow Depth = 0.19" for 10-year event  
Inflow = 0.07 cfs @ 12.63 hrs, Volume= 0.006 af  
Outflow = 0.07 cfs @ 12.63 hrs, Volume= 0.006 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

### Reach DP-3: DP-3

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**Summary for Pond 1P: Detention Basin**

Inflow Area = 1.991 ac, 85.97% Impervious, Inflow Depth = 3.81" for 10-year event  
 Inflow = 8.20 cfs @ 12.09 hrs, Volume= 0.631 af  
 Outflow = 1.02 cfs @ 12.67 hrs, Volume= 0.631 af, Atten= 88%, Lag= 34.8 min  
 Discarded = 0.28 cfs @ 12.67 hrs, Volume= 0.423 af  
 Primary = 0.74 cfs @ 12.67 hrs, Volume= 0.208 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Peak Elev= 86.20' @ 12.67 hrs Surf.Area= 11,469 sf Storage= 12,613 cf

Plug-Flow detention time= 219.7 min calculated for 0.630 af (100% of inflow)  
 Center-of-Mass det. time= 219.8 min ( 1,000.7 - 780.8 )

Volume	Invert	Avail.Storage	Storage Description
#1	85.00'	51,122 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
85.00	9,640	0	0
86.00	11,161	10,401	10,401
87.00	12,738	11,950	22,350
88.00	14,372	13,555	35,905
89.00	16,062	15,217	51,122

Device	Routing	Invert	Outlet Devices
#1	Discarded	85.00'	<b>1.020 in/hr Exfiltration over Surface area</b> Conductivity to Groundwater Elevation = 62.00'
#2	Primary	85.50'	<b>6.0" Vert. Orifice/Grate</b> C= 0.600
#3	Primary	86.00'	<b>6.0" Vert. Orifice/Grate</b> C= 0.600

**Discarded OutFlow** Max=0.28 cfs @ 12.67 hrs HW=86.20' (Free Discharge)

↑1=Exfiltration ( Controls 0.28 cfs)

**Primary OutFlow** Max=0.74 cfs @ 12.67 hrs HW=86.20' (Free Discharge)

↑2=Orifice/Grate (Orifice Controls 0.63 cfs @ 3.21 fps)

↑3=Orifice/Grate (Orifice Controls 0.11 cfs @ 1.50 fps)

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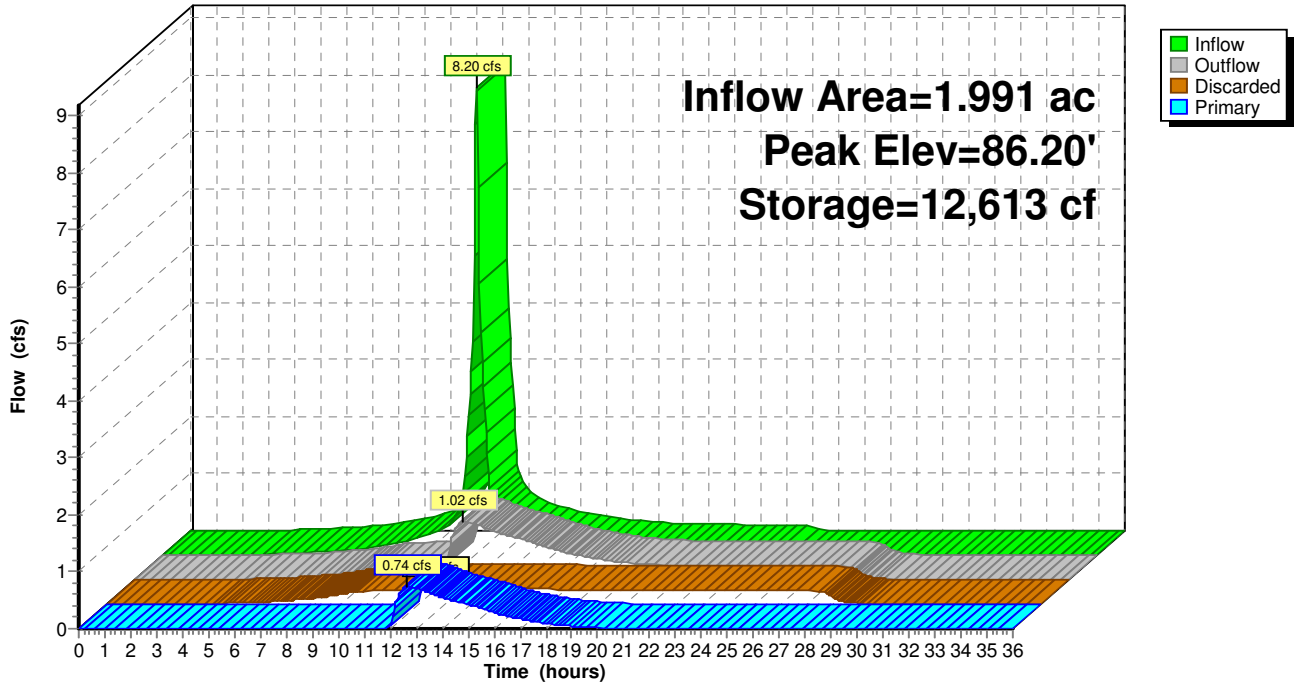
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**Pond 1P: Detention Basin**

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**Summary for Pond 2P: Rain Garden**

Inflow Area = 0.382 ac, 25.64% Impervious, Inflow Depth = 1.74" for 10-year event  
 Inflow = 0.75 cfs @ 12.10 hrs, Volume= 0.056 af  
 Outflow = 0.13 cfs @ 12.63 hrs, Volume= 0.056 af, Atten= 83%, Lag= 32.1 min  
 Discarded = 0.06 cfs @ 12.63 hrs, Volume= 0.049 af  
 Primary = 0.07 cfs @ 12.63 hrs, Volume= 0.006 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Peak Elev= 64.56' @ 12.63 hrs Surf.Area= 1,900 sf Storage= 916 cf

Plug-Flow detention time= 160.8 min calculated for 0.056 af (100% of inflow)  
 Center-of-Mass det. time= 160.6 min ( 1,012.8 - 852.3 )

Volume	Invert	Avail.Storage	Storage Description
#1	64.00'	1,847 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
64.00	1,384	0	0
65.00	2,309	1,847	1,847

Device	Routing	Invert	Outlet Devices
#1	Discarded	64.00'	<b>1.020 in/hr Exfiltration over Surface area</b> Conductivity to Groundwater Elevation = 62.00'
#2	Primary	64.50'	<b>6.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Discarded OutFlow** Max=0.06 cfs @ 12.63 hrs HW=64.56' (Free Discharge)

↑1=Exfiltration ( Controls 0.06 cfs)

**Primary OutFlow** Max=0.07 cfs @ 12.63 hrs HW=64.56' (Free Discharge)

↑2=Orifice/Grate (Weir Controls 0.07 cfs @ 0.79 fps)

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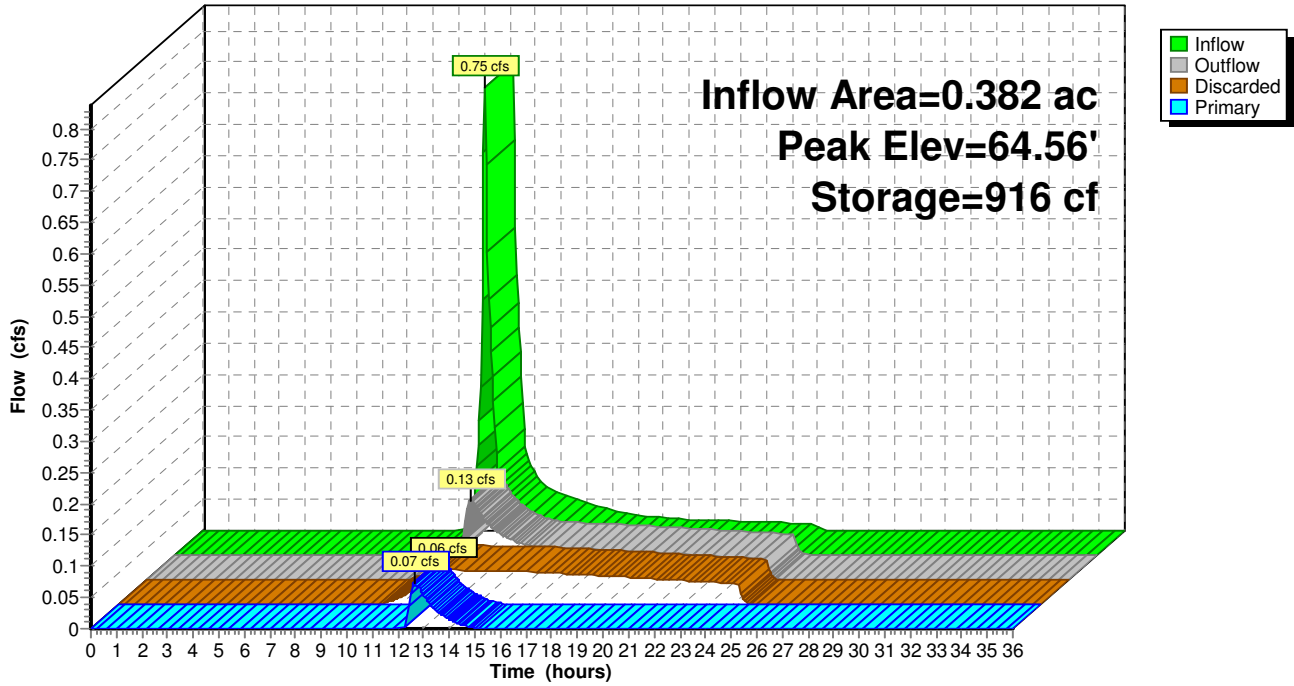
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Type III 24-hr 10-year Rainfall=4.60"

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**Pond 2P: Rain Garden**

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Type III 24-hr 25-Year Rainfall=5.60"

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Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment PR-2: PR-2** Runoff Area=44,310 sf 0.00% Impervious Runoff Depth=2.06"  
Tc=0.0 min CN=65 Runoff=2.75 cfs 0.175 af

**Subcatchment PR-3: PR-3** Runoff Area=16,655 sf 25.64% Impervious Runoff Depth=2.49"  
Tc=6.0 min CN=70 Runoff=1.09 cfs 0.079 af

**Subcatchment PR1A: Detained** Runoff Area=86,719 sf 85.97% Impervious Runoff Depth=4.79"  
Tc=6.0 min CN=93 Runoff=10.18 cfs 0.794 af

**Subcatchment PR1B: Un-Detained** Runoff Area=95,780 sf 0.00% Impervious Runoff Depth=1.74"  
Tc=6.0 min CN=61 Runoff=4.16 cfs 0.319 af

**Reach DP-1: DP-1** Inflow=4.67 cfs 0.653 af  
Outflow=4.67 cfs 0.653 af

**Reach DP-3: DP-3** Inflow=0.33 cfs 0.023 af  
Outflow=0.33 cfs 0.023 af

**Pond 1P: Detention Basin** Peak Elev=86.47' Storage=15,842 cf Inflow=10.18 cfs 0.794 af  
Discarded=0.30 cfs 0.461 af Primary=1.25 cfs 0.333 af Outflow=1.55 cfs 0.794 af

**Pond 2P: Rain Garden** Peak Elev=64.66' Storage=1,113 cf Inflow=1.09 cfs 0.079 af  
Discarded=0.06 cfs 0.057 af Primary=0.33 cfs 0.023 af Outflow=0.39 cfs 0.079 af

**Total Runoff Area = 5.589 ac Runoff Volume = 1.368 af Average Runoff Depth = 2.94"**  
**67.63% Pervious = 3.780 ac 32.37% Impervious = 1.809 ac**

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### Summary for Subcatchment PR-2: PR-2

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

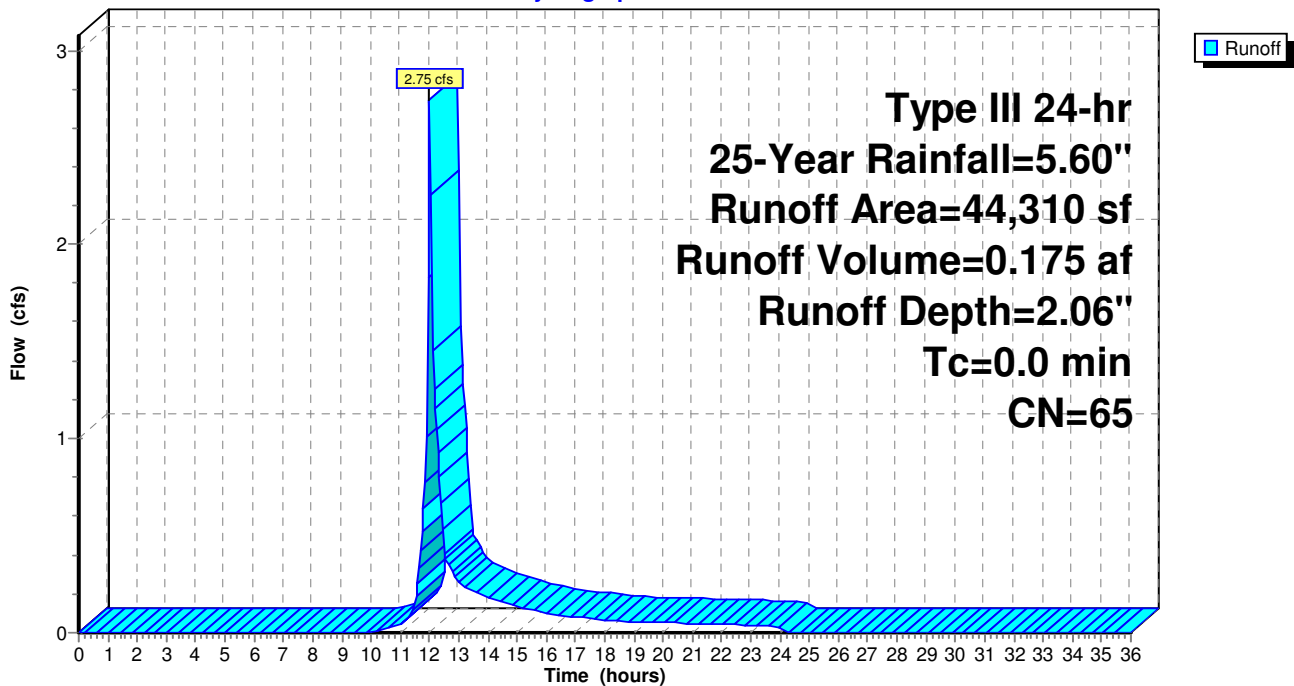
Runoff = 2.75 cfs @ 12.01 hrs, Volume= 0.175 af, Depth= 2.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
11,793	61	>75% Grass cover, Good, HSG B
9,948	60	Woods, Fair, HSG B
22,569	69	50-75% Grass cover, Fair, HSG B
44,310	65	Weighted Average
44,310		100.00% Pervious Area

### Subcatchment PR-2: PR-2

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 Type III 24-hr 25-Year Rainfall=5.60"

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**Summary for Subcatchment PR-3: PR-3**

Runoff = 1.09 cfs @ 12.10 hrs, Volume= 0.079 af, Depth= 2.49"

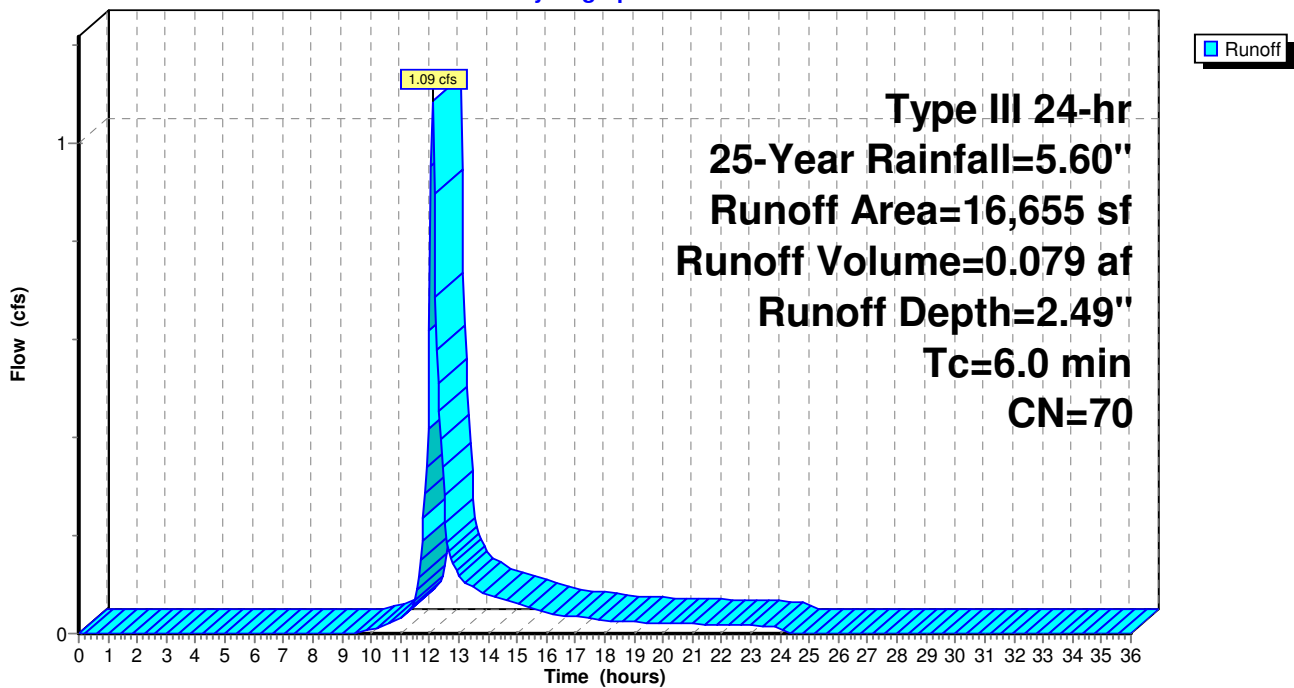
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
4,270	98	Paved parking, HSG B
9,642	61	>75% Grass cover, Good, HSG B
2,743	60	Woods, Fair, HSG B
16,655	70	Weighted Average
12,385		74.36% Pervious Area
4,270		25.64% Impervious Area

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

**Subcatchment PR-3: PR-3**

Hydrograph



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**Summary for Subcatchment PR1A: Detained**

Runoff = 10.18 cfs @ 12.09 hrs, Volume= 0.794 af, Depth= 4.79"

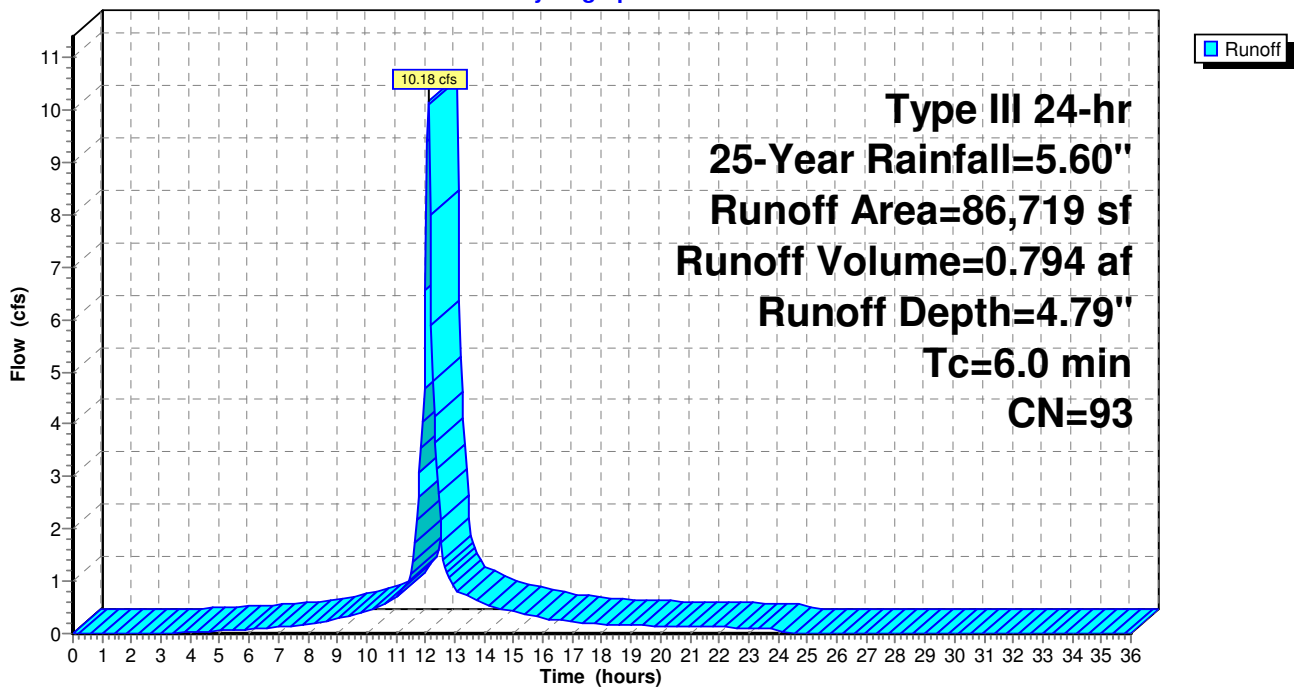
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25-Year Rainfall=5.60"

	Area (sf)	CN	Description
*	58,487	98	Paved parking and roof, HSG B
	12,170	61	>75% Grass cover, Good, HSG B
*	16,062	98	Detention Basin
	86,719	93	Weighted Average
	12,170		14.03% Pervious Area
	74,549		85.97% Impervious Area

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

**Subcatchment PR1A: Detained**

Hydrograph



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**Summary for Subcatchment PR1B: Un-Detained**

Runoff = 4.16 cfs @ 12.10 hrs, Volume= 0.319 af, Depth= 1.74"

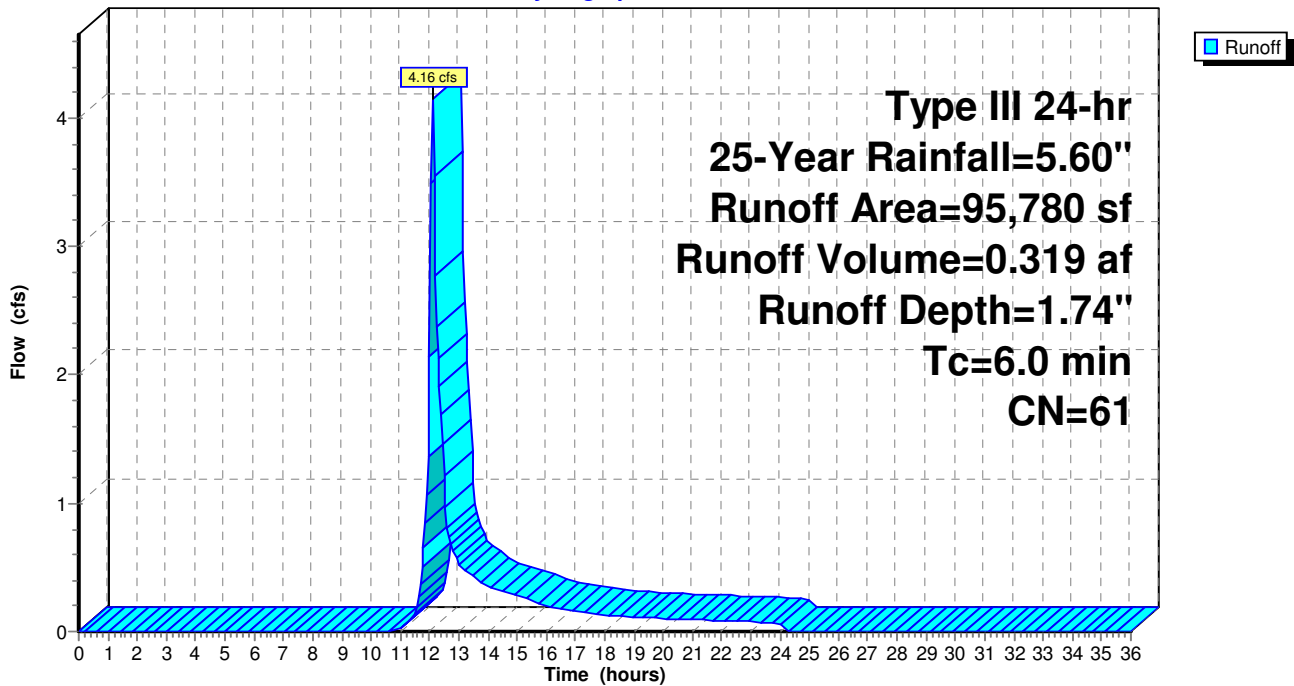
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
23,560	60	Woods, Fair, HSG B
72,220	61	>75% Grass cover, Good, HSG B
95,780	61	Weighted Average
95,780		100.00% Pervious Area

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

**Subcatchment PR1B: Un-Detained**

Hydrograph



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## Summary for Reach DP-1: DP-1

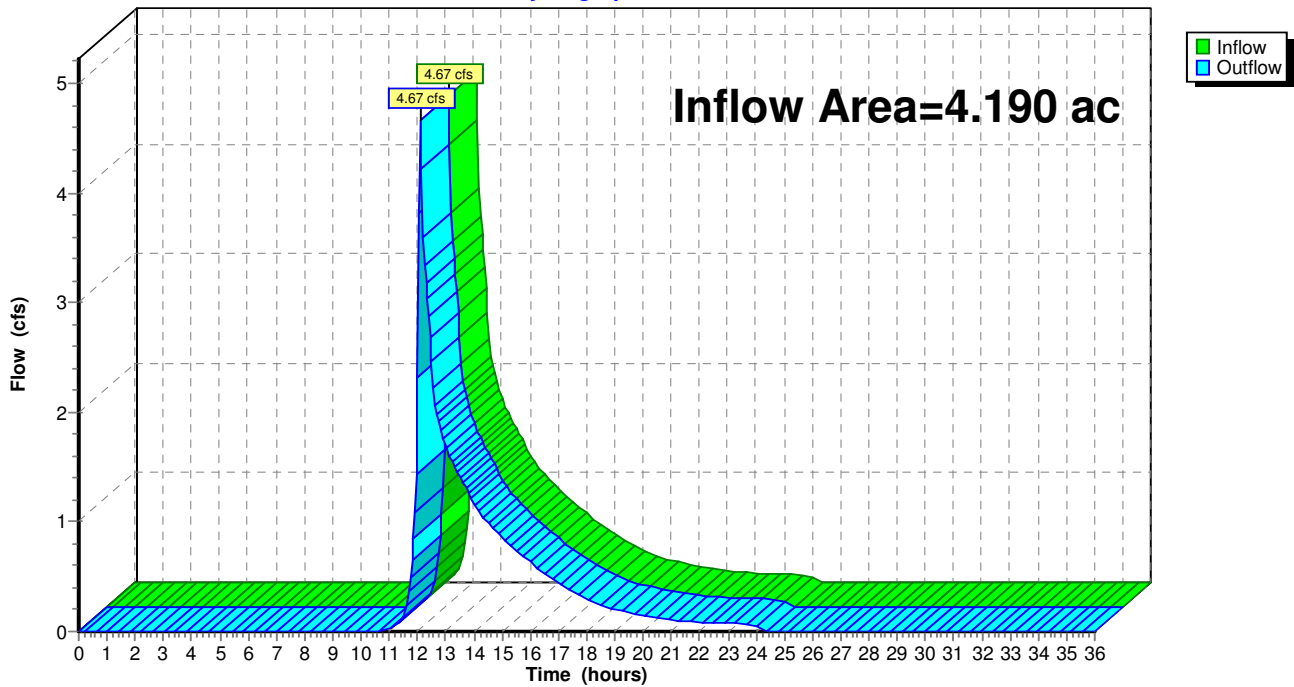
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.190 ac, 40.85% Impervious, Inflow Depth = 1.87" for 25-Year event  
Inflow = 4.67 cfs @ 12.11 hrs, Volume= 0.653 af  
Outflow = 4.67 cfs @ 12.11 hrs, Volume= 0.653 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

### Reach DP-1: DP-1

Hydrograph





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## Summary for Reach DP-3: DP-3

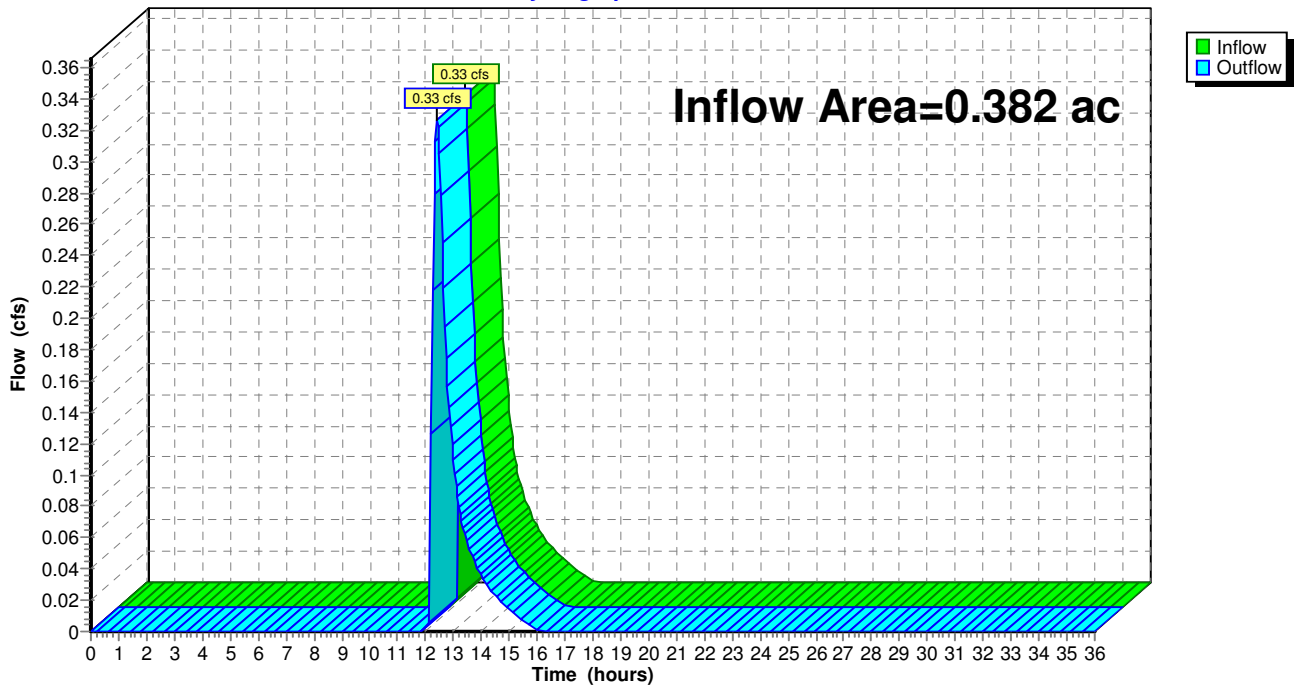
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.382 ac, 25.64% Impervious, Inflow Depth = 0.71" for 25-Year event  
Inflow = 0.33 cfs @ 12.41 hrs, Volume= 0.023 af  
Outflow = 0.33 cfs @ 12.41 hrs, Volume= 0.023 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

### Reach DP-3: DP-3

Hydrograph



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**Summary for Pond 1P: Detention Basin**

Inflow Area = 1.991 ac, 85.97% Impervious, Inflow Depth = 4.79" for 25-Year event  
 Inflow = 10.18 cfs @ 12.09 hrs, Volume= 0.794 af  
 Outflow = 1.55 cfs @ 12.58 hrs, Volume= 0.794 af, Atten= 85%, Lag= 29.6 min  
 Discarded = 0.30 cfs @ 12.58 hrs, Volume= 0.461 af  
 Primary = 1.25 cfs @ 12.58 hrs, Volume= 0.333 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Peak Elev= 86.47' @ 12.58 hrs Surf.Area= 11,905 sf Storage= 15,842 cf

Plug-Flow detention time= 208.9 min calculated for 0.793 af (100% of inflow)  
 Center-of-Mass det. time= 209.2 min ( 984.1 - 775.0 )

Volume	Invert	Avail.Storage	Storage Description
#1	85.00'	51,122 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
85.00	9,640	0	0
86.00	11,161	10,401	10,401
87.00	12,738	11,950	22,350
88.00	14,372	13,555	35,905
89.00	16,062	15,217	51,122

Device	Routing	Invert	Outlet Devices
#1	Discarded	85.00'	<b>1.020 in/hr Exfiltration over Surface area</b> Conductivity to Groundwater Elevation = 62.00'
#2	Primary	85.50'	<b>6.0" Vert. Orifice/Grate</b> C= 0.600
#3	Primary	86.00'	<b>6.0" Vert. Orifice/Grate</b> C= 0.600

**Discarded OutFlow** Max=0.30 cfs @ 12.58 hrs HW=86.47' (Free Discharge)

↑1=Exfiltration ( Controls 0.30 cfs)

**Primary OutFlow** Max=1.25 cfs @ 12.58 hrs HW=86.47' (Free Discharge)

↑2=Orifice/Grate (Orifice Controls 0.80 cfs @ 4.09 fps)

↑3=Orifice/Grate (Orifice Controls 0.45 cfs @ 2.34 fps)

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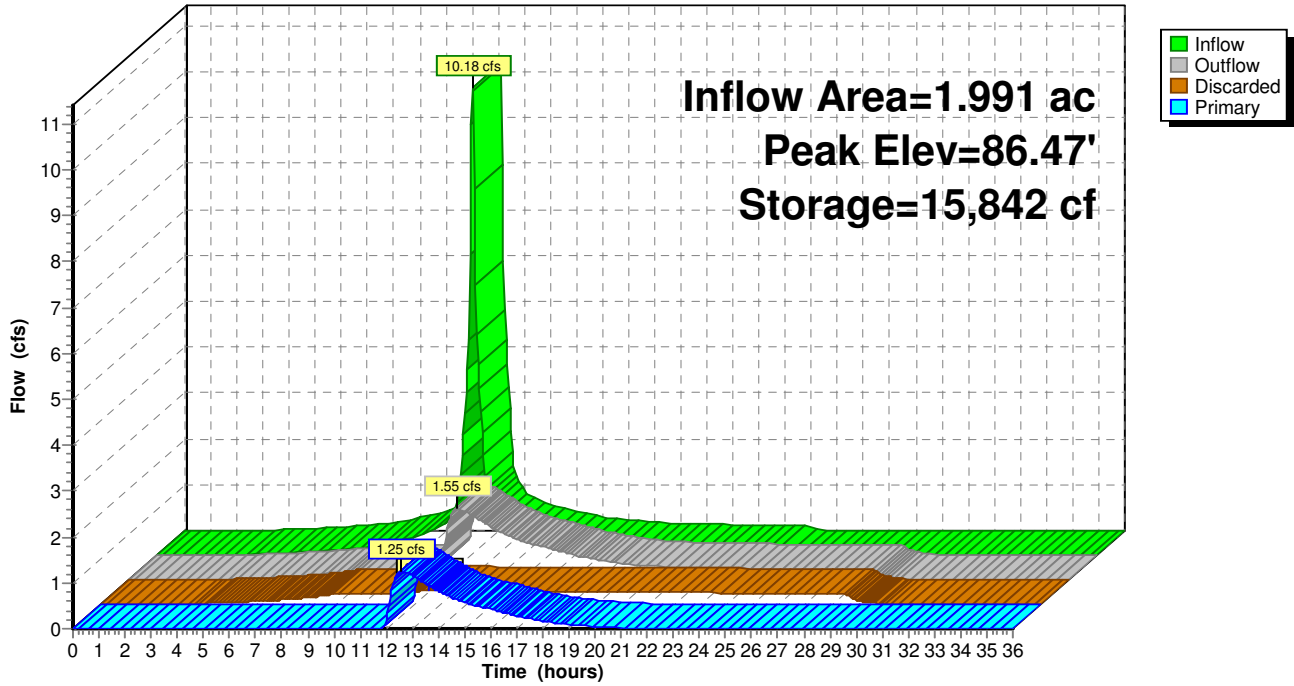
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Type III 24-hr 25-Year Rainfall=5.60"

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**Pond 1P: Detention Basin**

Hydrograph



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Type III 24-hr 25-Year Rainfall=5.60"

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### Summary for Pond 2P: Rain Garden

Inflow Area = 0.382 ac, 25.64% Impervious, Inflow Depth = 2.49" for 25-Year event  
Inflow = 1.09 cfs @ 12.10 hrs, Volume= 0.079 af  
Outflow = 0.39 cfs @ 12.41 hrs, Volume= 0.079 af, Atten= 64%, Lag= 19.0 min  
Discarded = 0.06 cfs @ 12.41 hrs, Volume= 0.057 af  
Primary = 0.33 cfs @ 12.41 hrs, Volume= 0.023 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
Peak Elev= 64.66' @ 12.41 hrs Surf.Area= 1,994 sf Storage= 1,113 cf

Plug-Flow detention time= 136.3 min calculated for 0.079 af (100% of inflow)  
Center-of-Mass det. time= 136.2 min ( 977.9 - 841.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	64.00'	1,847 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
64.00	1,384	0	0
65.00	2,309	1,847	1,847

Device	Routing	Invert	Outlet Devices
#1	Discarded	64.00'	<b>1.020 in/hr Exfiltration over Surface area</b> Conductivity to Groundwater Elevation = 62.00'
#2	Primary	64.50'	<b>6.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Discarded OutFlow** Max=0.06 cfs @ 12.41 hrs HW=64.66' (Free Discharge)

↑1=Exfiltration ( Controls 0.06 cfs)

**Primary OutFlow** Max=0.32 cfs @ 12.41 hrs HW=64.66' (Free Discharge)

↑2=Orifice/Grate (Weir Controls 0.32 cfs @ 1.30 fps)

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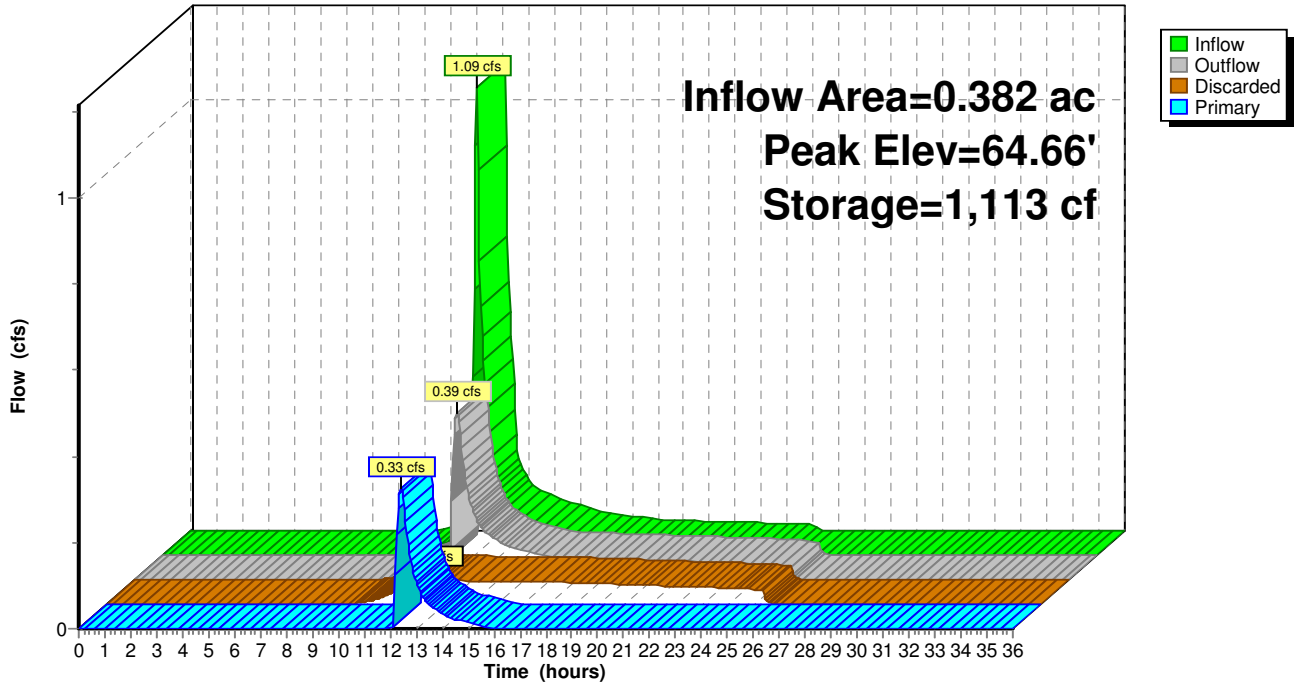
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Type III 24-hr 25-Year Rainfall=5.60"

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**Pond 2P: Rain Garden**

Hydrograph



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Type III 24-hr 100-year Rainfall=6.80"

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Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

<b>Subcatchment PR-2: PR-2</b>	Runoff Area=44,310 sf 0.00% Impervious Runoff Depth=2.95" Tc=0.0 min CN=65 Runoff=4.00 cfs 0.250 af
<b>Subcatchment PR-3: PR-3</b>	Runoff Area=16,655 sf 25.64% Impervious Runoff Depth=3.45" Tc=6.0 min CN=70 Runoff=1.52 cfs 0.110 af
<b>Subcatchment PR1A: Detained</b>	Runoff Area=86,719 sf 85.97% Impervious Runoff Depth=5.97" Tc=6.0 min CN=93 Runoff=12.54 cfs 0.991 af
<b>Subcatchment PR1B: Un-Detained</b>	Runoff Area=95,780 sf 0.00% Impervious Runoff Depth=2.56" Tc=6.0 min CN=61 Runoff=6.30 cfs 0.469 af
<b>Reach DP-1: DP-1</b>	Inflow=7.26 cfs 0.961 af Outflow=7.26 cfs 0.961 af
<b>Reach DP-3: DP-3</b>	Inflow=0.53 cfs 0.046 af Outflow=0.53 cfs 0.046 af
<b>Pond 1P: Detention Basin</b>	Peak Elev=86.81' Storage=19,905 cf Inflow=12.54 cfs 0.991 af Discarded=0.31 cfs 0.499 af Primary=1.68 cfs 0.492 af Outflow=1.99 cfs 0.991 af
<b>Pond 2P: Rain Garden</b>	Peak Elev=64.81' Storage=1,423 cf Inflow=1.52 cfs 0.110 af Discarded=0.07 cfs 0.064 af Primary=0.53 cfs 0.046 af Outflow=0.59 cfs 0.110 af

**Total Runoff Area = 5.589 ac Runoff Volume = 1.820 af Average Runoff Depth = 3.91"**  
**67.63% Pervious = 3.780 ac 32.37% Impervious = 1.809 ac**

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## Summary for Subcatchment PR-2: PR-2

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

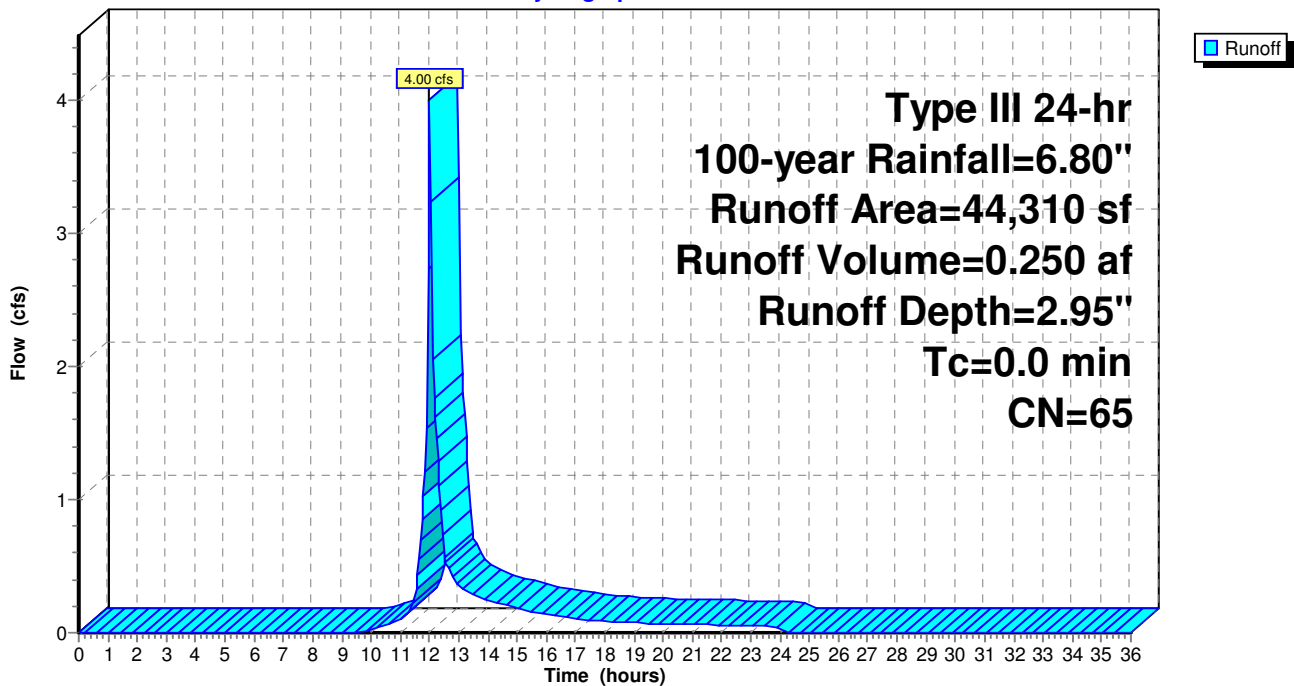
Runoff = 4.00 cfs @ 12.01 hrs, Volume= 0.250 af, Depth= 2.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100-year Rainfall=6.80"

Area (sf)	CN	Description
11,793	61	>75% Grass cover, Good, HSG B
9,948	60	Woods, Fair, HSG B
22,569	69	50-75% Grass cover, Fair, HSG B
44,310	65	Weighted Average
44,310		100.00% Pervious Area

### Subcatchment PR-2: PR-2

Hydrograph



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**Summary for Subcatchment PR-3: PR-3**

Runoff = 1.52 cfs @ 12.09 hrs, Volume= 0.110 af, Depth= 3.45"

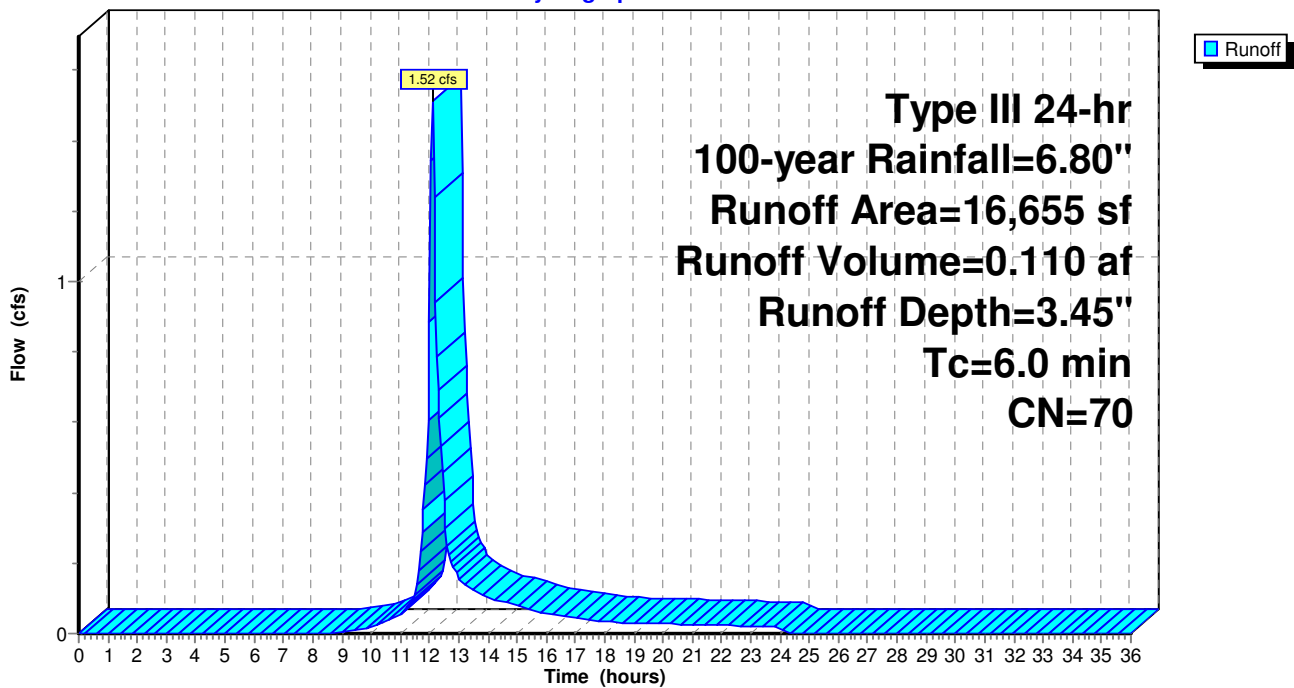
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 100-year Rainfall=6.80"

Area (sf)	CN	Description
4,270	98	Paved parking, HSG B
9,642	61	>75% Grass cover, Good, HSG B
2,743	60	Woods, Fair, HSG B
16,655	70	Weighted Average
12,385		74.36% Pervious Area
4,270		25.64% Impervious Area

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

**Subcatchment PR-3: PR-3**

Hydrograph





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**Summary for Subcatchment PR1A: Detained**

Runoff = 12.54 cfs @ 12.09 hrs, Volume= 0.991 af, Depth= 5.97"

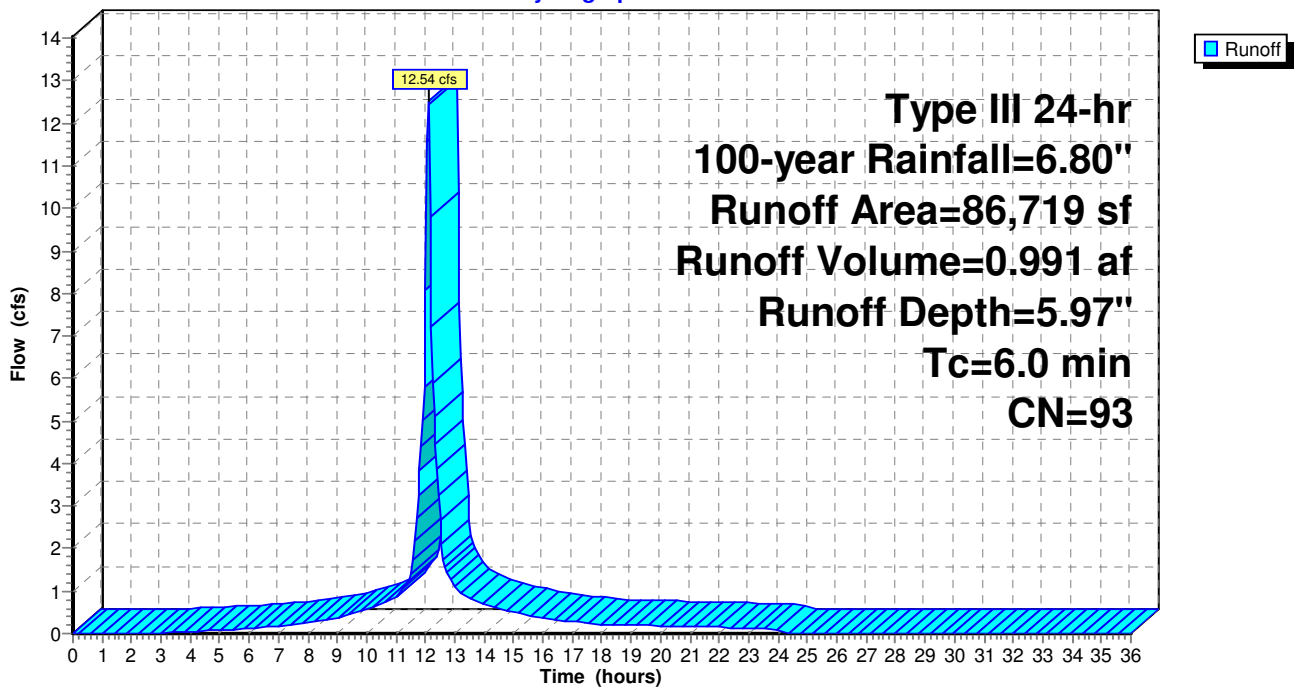
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 100-year Rainfall=6.80"

	Area (sf)	CN	Description
*	58,487	98	Paved parking and roof, HSG B
	12,170	61	>75% Grass cover, Good, HSG B
*	16,062	98	Detention Basin
	86,719	93	Weighted Average
	12,170		14.03% Pervious Area
	74,549		85.97% Impervious Area

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

**Subcatchment PR1A: Detained**

Hydrograph



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**Summary for Subcatchment PR1B: Un-Detained**

Runoff = 6.30 cfs @ 12.10 hrs, Volume= 0.469 af, Depth= 2.56"

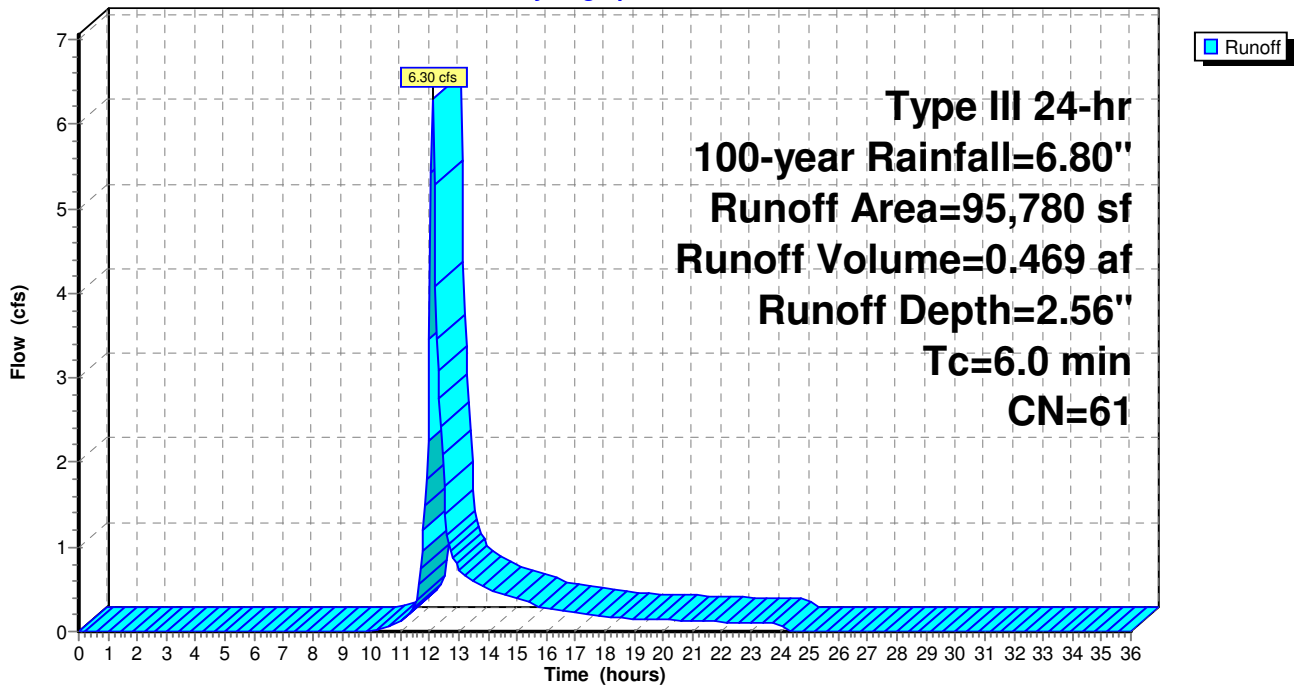
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 100-year Rainfall=6.80"

Area (sf)	CN	Description
23,560	60	Woods, Fair, HSG B
72,220	61	>75% Grass cover, Good, HSG B
95,780	61	Weighted Average
95,780		100.00% Pervious Area

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

**Subcatchment PR1B: Un-Detained**

Hydrograph



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## Summary for Reach DP-1: DP-1

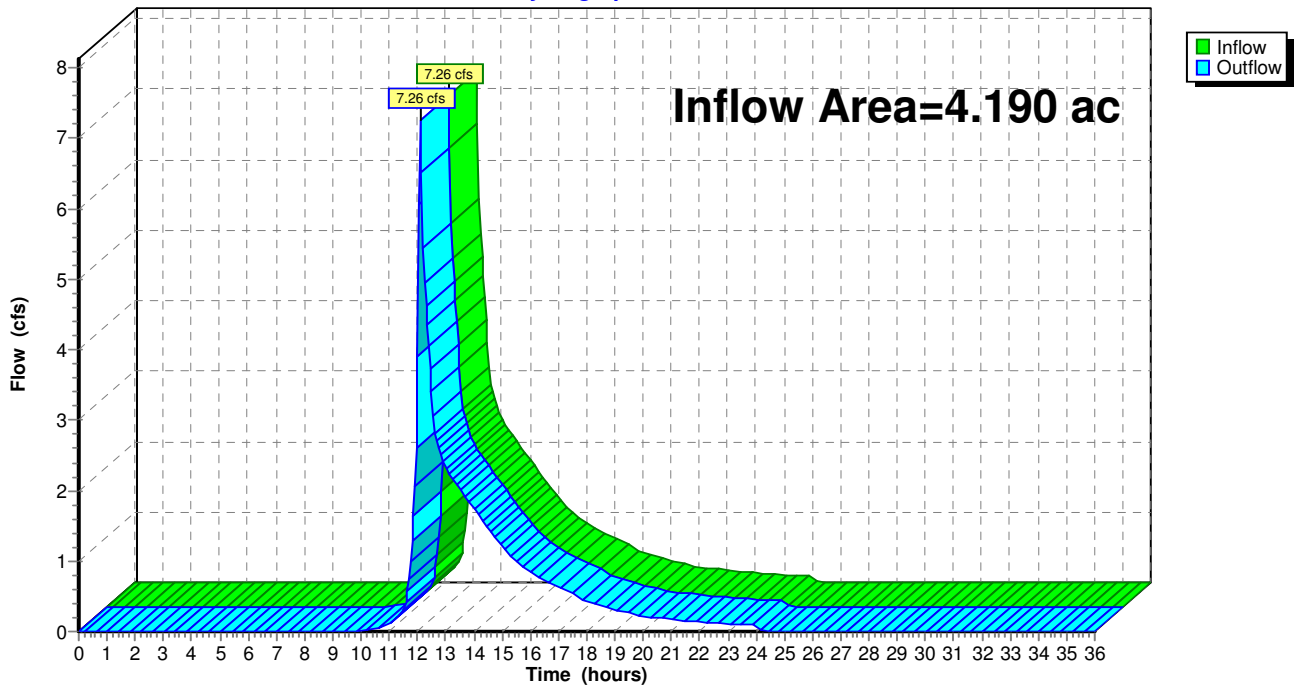
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.190 ac, 40.85% Impervious, Inflow Depth = 2.75" for 100-year event  
Inflow = 7.26 cfs @ 12.11 hrs, Volume= 0.961 af  
Outflow = 7.26 cfs @ 12.11 hrs, Volume= 0.961 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

### Reach DP-1: DP-1

Hydrograph



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**Summary for Reach DP-3: DP-3**

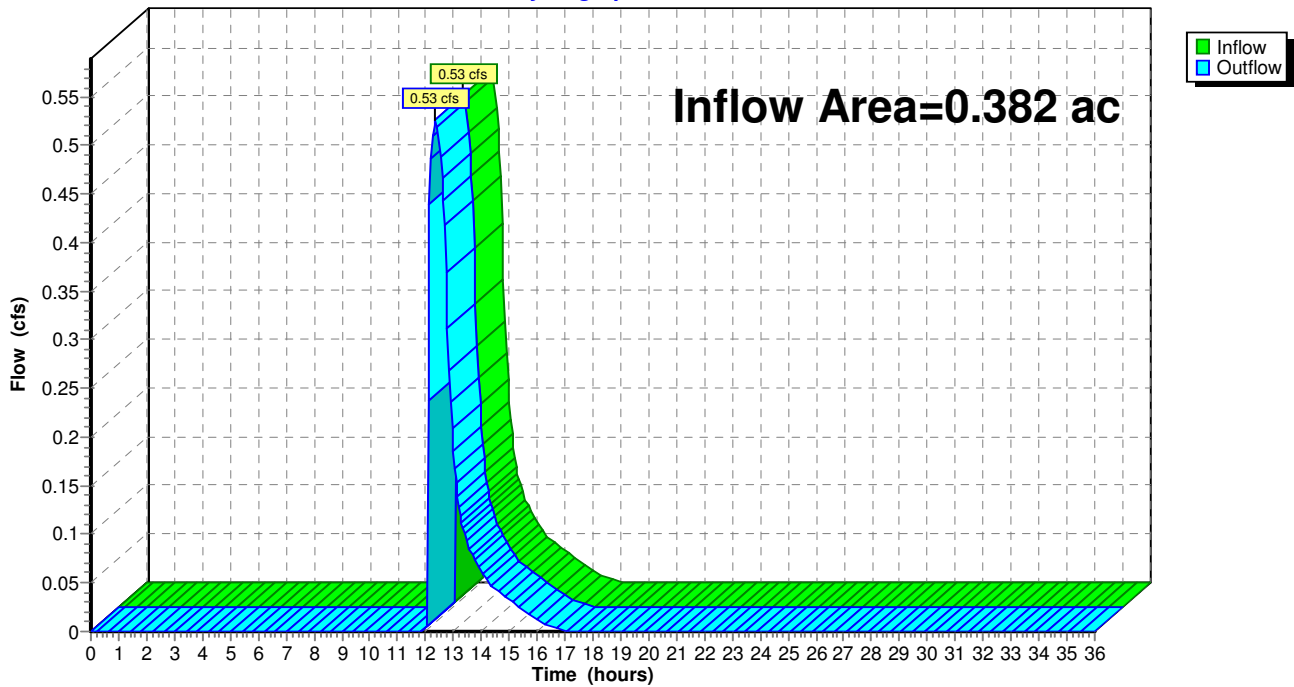
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.382 ac, 25.64% Impervious, Inflow Depth = 1.43" for 100-year event  
Inflow = 0.53 cfs @ 12.36 hrs, Volume= 0.046 af  
Outflow = 0.53 cfs @ 12.36 hrs, Volume= 0.046 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

**Reach DP-3: DP-3**

Hydrograph



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**Summary for Pond 1P: Detention Basin**

Inflow Area = 1.991 ac, 85.97% Impervious, Inflow Depth = 5.97" for 100-year event  
 Inflow = 12.54 cfs @ 12.09 hrs, Volume= 0.991 af  
 Outflow = 1.99 cfs @ 12.57 hrs, Volume= 0.991 af, Atten= 84%, Lag= 28.9 min  
 Discarded = 0.31 cfs @ 12.57 hrs, Volume= 0.499 af  
 Primary = 1.68 cfs @ 12.57 hrs, Volume= 0.492 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Peak Elev= 86.81' @ 12.57 hrs Surf.Area= 12,432 sf Storage= 19,905 cf

Plug-Flow detention time= 200.7 min calculated for 0.991 af (100% of inflow)  
 Center-of-Mass det. time= 200.5 min ( 970.1 - 769.6 )

Volume	Invert	Avail.Storage	Storage Description
#1	85.00'	51,122 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
85.00	9,640	0	0
86.00	11,161	10,401	10,401
87.00	12,738	11,950	22,350
88.00	14,372	13,555	35,905
89.00	16,062	15,217	51,122

Device	Routing	Invert	Outlet Devices
#1	Discarded	85.00'	<b>1.020 in/hr Exfiltration over Surface area</b> Conductivity to Groundwater Elevation = 62.00'
#2	Primary	85.50'	<b>6.0" Vert. Orifice/Grate</b> C= 0.600
#3	Primary	86.00'	<b>6.0" Vert. Orifice/Grate</b> C= 0.600

**Discarded OutFlow** Max=0.31 cfs @ 12.57 hrs HW=86.80' (Free Discharge)

↑1=Exfiltration ( Controls 0.31 cfs)

**Primary OutFlow** Max=1.68 cfs @ 12.57 hrs HW=86.80' (Free Discharge)

↑2=Orifice/Grate (Orifice Controls 0.97 cfs @ 4.95 fps)

↑3=Orifice/Grate (Orifice Controls 0.70 cfs @ 3.59 fps)

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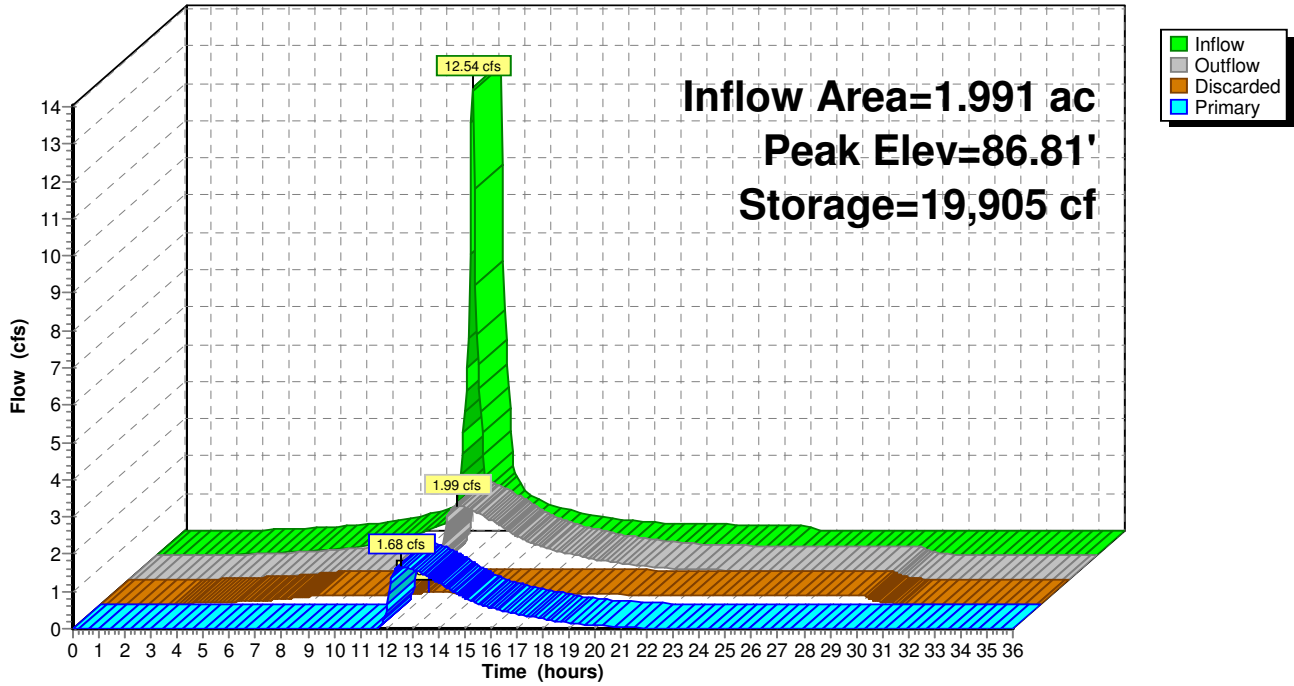
10 High Street, Topsfield  
Type III 24-hr 100-year Rainfall=6.80"

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**Pond 1P: Detention Basin**

Hydrograph



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**Summary for Pond 2P: Rain Garden**

Inflow Area = 0.382 ac, 25.64% Impervious, Inflow Depth = 3.45" for 100-year event  
 Inflow = 1.52 cfs @ 12.09 hrs, Volume= 0.110 af  
 Outflow = 0.59 cfs @ 12.36 hrs, Volume= 0.110 af, Atten= 61%, Lag= 16.2 min  
 Discarded = 0.07 cfs @ 12.36 hrs, Volume= 0.064 af  
 Primary = 0.53 cfs @ 12.36 hrs, Volume= 0.046 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs  
 Peak Elev= 64.81' @ 12.36 hrs Surf.Area= 2,133 sf Storage= 1,423 cf

Plug-Flow detention time= 117.1 min calculated for 0.110 af (100% of inflow)  
 Center-of-Mass det. time= 117.0 min ( 949.2 - 832.2 )

Volume	Invert	Avail.Storage	Storage Description
#1	64.00'	1,847 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
64.00	1,384	0	0
65.00	2,309	1,847	1,847

Device	Routing	Invert	Outlet Devices
#1	Discarded	64.00'	<b>1.020 in/hr Exfiltration over Surface area</b> Conductivity to Groundwater Elevation = 62.00'
#2	Primary	64.50'	<b>6.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Discarded OutFlow** Max=0.07 cfs @ 12.36 hrs HW=64.81' (Free Discharge)

↑1=Exfiltration ( Controls 0.07 cfs)

**Primary OutFlow** Max=0.53 cfs @ 12.36 hrs HW=64.81' (Free Discharge)

↑2=Orifice/Grate (Orifice Controls 0.53 cfs @ 2.68 fps)

**Proposed Conditions**

Prepared by {enter your company name here}

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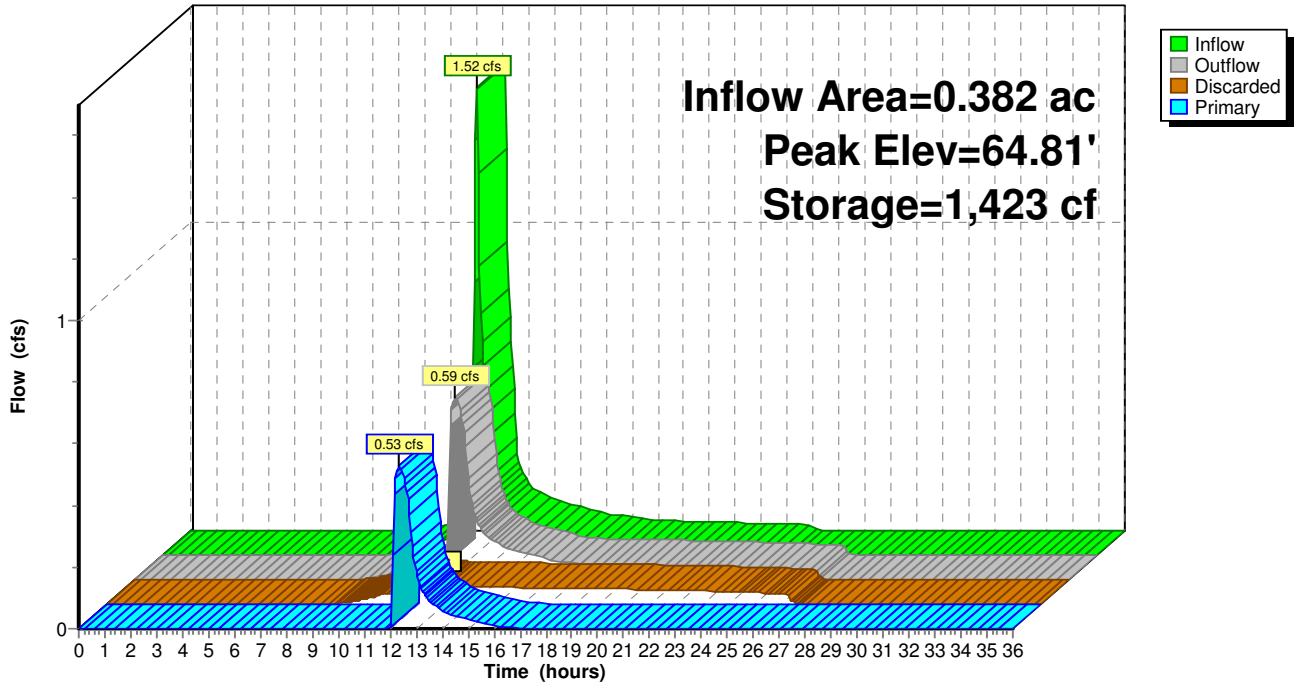
10 High Street, Topsfield  
Type III 24-hr 100-year Rainfall=6.80"

Printed 8/9/2022

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**Pond 2P: Rain Garden**

Hydrograph





## Appendix B –

### TSS Calculations

The proposed design exceeds the Department of Environmental Protection requirements for Best Management Practices and water quality.

**INSTRUCTIONS:**

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Emerson Homes Topsfield

BMP <sup>1</sup>	C TSS Removal Rate <sup>1</sup>	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Street Sweeping - 1%	0.01	1.00	0.01	0.99
Deep Sump and Hooded Catch Basin	0.25	0.99	0.25	0.74
Sediment Forebay	0.25	0.74	0.19	0.56
Infiltration Basin	0.80	0.56	0.45	0.11
	0.00	0.11	0.00	0.11

**Total TSS Removal = 89%**  
 Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: Emerson Homes Topsfield  
 Prepared By: DeVellis Zrein, Inc.  
 Date: 16-Sep-22

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

**TSS Removal Calculation Worksheet**

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed  
 1. From MassDEP Stormwater Handbook Vol. 1

## Water Volume Calculations

- Infiltration Volume Calculations
- Drawdown Calculations

## DeVellis Zrein Inc.

Land Planning / Civil Engineering  
PO Box 307  
Foxboro MA 02035

## Computations

Project	Emerson Homes Topsfield	Project #	21-2G1S-463
Location	Topsfield	Sheet	1 of 1
Calculated by	JJD	Date	9/16/2022
Checked by	TOG	Date	9/16/2022
Title	Recharge Volume		

**Methodology** DEP Stormwater Management Standards

### Design

**Criteria 1:** Based on the NRCS Hydrologic Soil Group "B"

### Recharge

**Volume:** Proposed Impervious Area within PR-1A = 62,770 SF

Required Recharge Volume =  $62,770 \text{ sf} \times 0.35 \text{ inches}/12 \text{ (in/ft)}$

Required Recharge Volume = 1,831 C.F.

Provided Recharge Volume within the basin exfiltrated into the ground during the 2-year storm event =  $0.350 \text{ ac feet} = 15,250 \text{ C.F.}$

$15,250 \text{ C.F.} > 1,831 \text{ C.F.}$  therefore exceeds requirement

## DeVellis Zrein Inc.

Land Planning / Civil Engineering  
PO Box 307  
Foxboro MA 02035

## Computations

Project	<u>10 High Street</u>	Project #	<u>21-2G1S-463</u>
Location	<u>Topsfield</u>	Sheet	<u>1 of 1</u>
Calculated by	<u>IAZ</u>	Date	<u>9/9/2022</u>
Checked by	<u></u>	Date	<u></u>
Title	<u>Draw Down Calculations</u>		

**Methodology** DEP Stormwater Management Standards

### Design

**Criteria:** Stormwater Infiltration system Draw down in less than 72 hours

### Draw

**Down** Time =  $R_v / (k)(\text{Bottom Area})$

Where:

$R_v$  = Storage Volume

$k$  = Hydraulic Conductivity

$$R_v = 1,831 \text{ CF}$$

$$k = 1.02 \text{ in/hr}$$

$$\text{Bottom Area} = 9,640 \text{ SF}$$

$$\text{Time} = 1831 / (1.02)(1/12)(9640)$$

$$\text{Time} = 2.2 \text{ hours}$$

## Appendix C –

### Site Plans

FULL SIZE PLANS PROVIDED WITHIN THE APPLICATION SUBMISSION  
UNDER SEPARATE COVER

END OF DRAINAGE REPORT