DRAINAGE REPORT

135, 139 & 149R Howard Street
(Map 10 / Lots 75, 76, & 77)
Reading, Massachusetts

CIVIL DESIGN
Consultants, Inc.
Survey - Design - Permitting - Construction Administration
30 River Street
Methuen, MA 01844-3032
Tel: (978) 416-0920
Fax: (978) 416-7865

APPLICANT:

Infrastructure Holdings, LLC
122 Boston Road
Billerica, MA 01862

SUBMITTED TO:

Town of Reading
Town Hall
16 Lowell Street
Reading, MA 01867

ISSUED:

December 21, 2018

CDCI FILE #: 18-10120

DRAINAGE REPORT

TAB 1

DRAINAGE REPORT

135, 139 & 149R Howard Street
Reading, Massachusetts

PROJECT DESCRIPTION

The applicant proposes to develop 135, 139 & 149R Howard Street in Reading, MA into a six (6) lot single family residential subdivision. The parcels total 4.1-AC± of land and contains two (2) existing single family residences. The project consists of construction of a new 346-FT roadway along with associated infrastructure including driveways, landscaping, drainage facilities, and utilities. Project plans entitled *Definitive Subdivision Plans for 135, 139 & 149R Howard Street*, dated December 5, 2018, have been prepared by this office and provided for your review. These plans illustrate the proposal in detail including zoning, easements, construction details, roadway profile and provisions for utilities. Drainage will be collected and routed through a series of best management practices sized to address the MADEP Stormwater Management Standards as well as the local stormwater regulations.

SITE DESCRIPTION

The total lot area of the project site is approximately 4.1-AC and provides 247-FT of frontage on Howard Street. On-site resource areas consist of bordering vegetated wetland, a 100-FT Wetland Buffer, the local 25-FT Zone of Natural Vegetation, and the 35-FT No Foundation Zone. Elevations range from a high of approximately 167-FT adjacent to the existing dwellings, #139 & # 139, to a low of approximately 156-FT at the wetlands in the northern portion of the site. The wetlands drain through a culvert to the north. The wetland resource areas have been delineated by Norse Environmental in August of 2018

According to the Natural Resource Conservation Service Soil Survey for Middlesex County, Massachusetts soils beyond the limit of the wetlands consist of Haven-Urban Land Complex (Hydrologic Soils Group (HSG) A) and Paxton-Urban Land Complex (HSG-C). Test pits were conducted by Norse Environmental Services, Inc. in October of 2018 to determine soil texture and estimated seasonal high groundwater elevations. Test pit logs are provided under Tab 5 of this report. Finally, according to the Flood Insurance Rate Map for Essex County, Massachusetts Panel 313 of 656 (25017C0313E), no part of this site is located within the 100-year base flood elevation.

SURFACE DRAINAGE

Pre-Development Condition

The pre-development condition consists of three (3) watershed areas contributing to a three (3) design points. Design Point #1 (DP-1) receives runoff from drainage area EWA-1 and consists of overland flow to the wetlands located in the northern portion of the site. Design Point #2 (DP-2) receives runoff from EWA-2 and consists of overland flow offsite to the northeast. Design Point #3 (DP-3) receives runoff from EWA-3 and consists of overland flow offsite towards Howard Street to the southeast. Contributing areas to the Design Points are detailed in the following Table 1.

TABLE 1: EXISTING WATERSHED DESIGN POINT DETAILS

DESIGN POINT	AREA NAME	AREA (Acres)	Tc (min.)	CN
DP-1	EWA-1	2.80	20.7	43
DP-2	EWA-2	1.34	20.9	33
DP-3	EWA-3	0.22	9.9	49

Post-Development Condition

The proposed project includes six (6) single family residences. Other components include construction of a new 346-FT roadway along with associated infrastructure. Associated infrastructure includes landscaping, drainage facilities and utilities. Drainage will be collected and routed through a series of best management practices sized to address the MADEP Stormwater Management Standards as well as the local stormwater regulations. Impervious area will include the roadway, driveways and roof tops and totals approximately 0.71-AC.

The proposed construction results in two (2) individual sub-watersheds discharging to DP-1. DP-1 receives flow from a proposed infiltration basin (PWA-1A) as well as overland flow from PWA-1B. PWA-2 discharges to DP-2 and is smaller in area than EWA-2 dues to directing flows to the proposed infiltration basin. PWA-3 discharges to DP-3 and is also smaller in area than EWA-3 due to the proposed grading on the site. The design points are summarized in Table 2 below.

TABLE 2: PROPOSED WATERSHED DESIGN POINT DETAILS

DESIGN POINT	AREA NAME	AREA (Acres)	Tc (min.)	CN
DP-1	PWA-1A	3.13	15.6	58
	PWA-1B	0.64	14.0	37
DP-2	PWA-2	0.52	9.6	37
DP-3	PWA-3	0.08	6.0	38

Peak Discharge Comparison

As illustrated in the following tables, the impact of the proposed improvements has been mitigated through the use of best management practices including swales, a sediment forebay, and an infiltration basin for up to and including the 100-year, 24-hour storm event.

Design Point #1

	2-YR	10-YR	25-YR	100-YR
	(3.1-IN)	(4.5-IN)	(5.3-IN)	(6.5-IN)
	CFS	CFS	CFS	CFS
Pre-Development	0.0	0.1	0.4	1.2
Post-Development	0.0	0.0	0.3	1.2

Design Point #2

	2-YR	10-YR	25-YR	100-YR
	(3.1-IN)	(4.5-IN)	(5.3-IN)	(6.5-IN)
	CFS	CFS	CFS	CFS
Pre-Development	0.0	0.0	0.0	0.1
Post-Development	0.0	0.0	0.0	0.1

Design Point #3

	2-YR	10-YR	25-YR	100-YR
	(3.1-IN)	(4.5-IN)	(5.3-IN)	(6.5-IN)
	CFS	CFS	CFS	CFS
Pre-Development	0.0	0.1	0.1	0.2
Post-Development	0.0	0.0	0.0	0.0

METHODOLOGY

Drainage calculations were performed using the computer program HydroCAD by HydroCAD Software Solutions, LLC based upon Technical Release 20 (TR-20), developed by the NRCS, formerly the Soils Conservation Service. Drainage calculations were prepared for the 2-YR, 10-YR, 25-YR, and 100-YR Type III 24-hour storm events. Rainfall data corresponds with National Weather Service Technical Paper 40 (TP-40) used in Technical Release 55 (TR-55). Curve numbers were generated using the information provided in TR-55 and the SCS Soils Survey. The storm drain system is designed to convey the 25-Year storm event to the infiltration ponds using the Rational Method. Culvert Design was performed using Hydraflow Express Extension by Autodesk. Pipe Design Calculations are located under Tab 5.

TAB 2

CIVIL DESIGN
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LAND SURVEYING
30 River Street
Methuen, MA 01844
Tel: (978) 416-0920
Fax: (978) 416-7865

PROJECT:
SINGLE FAMILY RESIDENTIAL DEVELOPMENT
135, 139 & 149 HOWARD STREET
READING, MA 01867

PREPARED FOR:
INFRASTRUCTURE HOLDINGS, LLC
122 BOSTON ROAD
BILLERICA, MA 01862

FIGURE 1: ORTHO

PREPARED BY: WJH
SCALE: 1"=400'
CDCI FILE #: 18-10120
DATE: DECEMBER 4, 2018

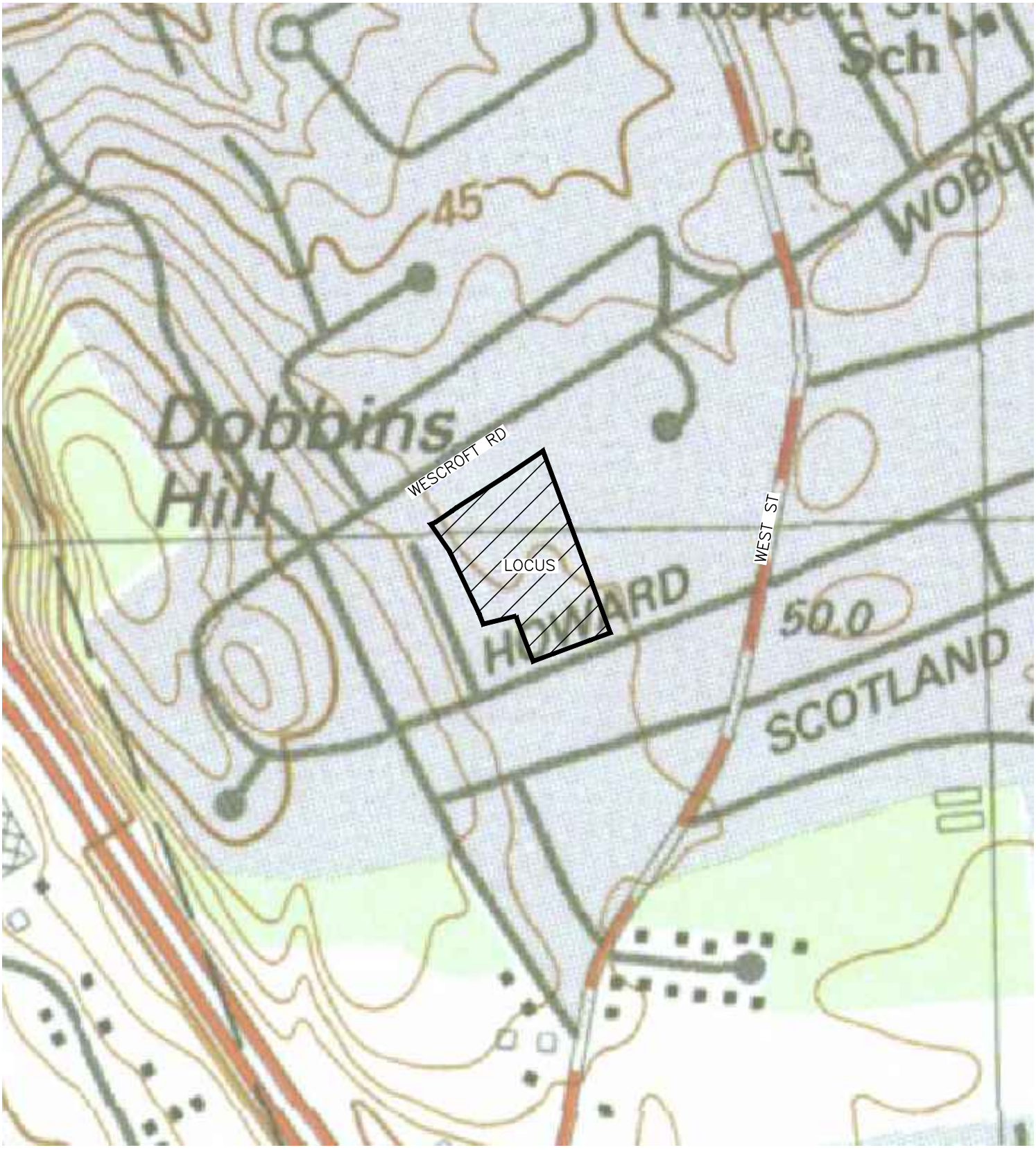

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FIGURE 2: USGS

PREPARED BY: WJH
SCALE: 1"=400'
CDCI FILE #: 18-10120
DATE: DECEMBER 4, 2018

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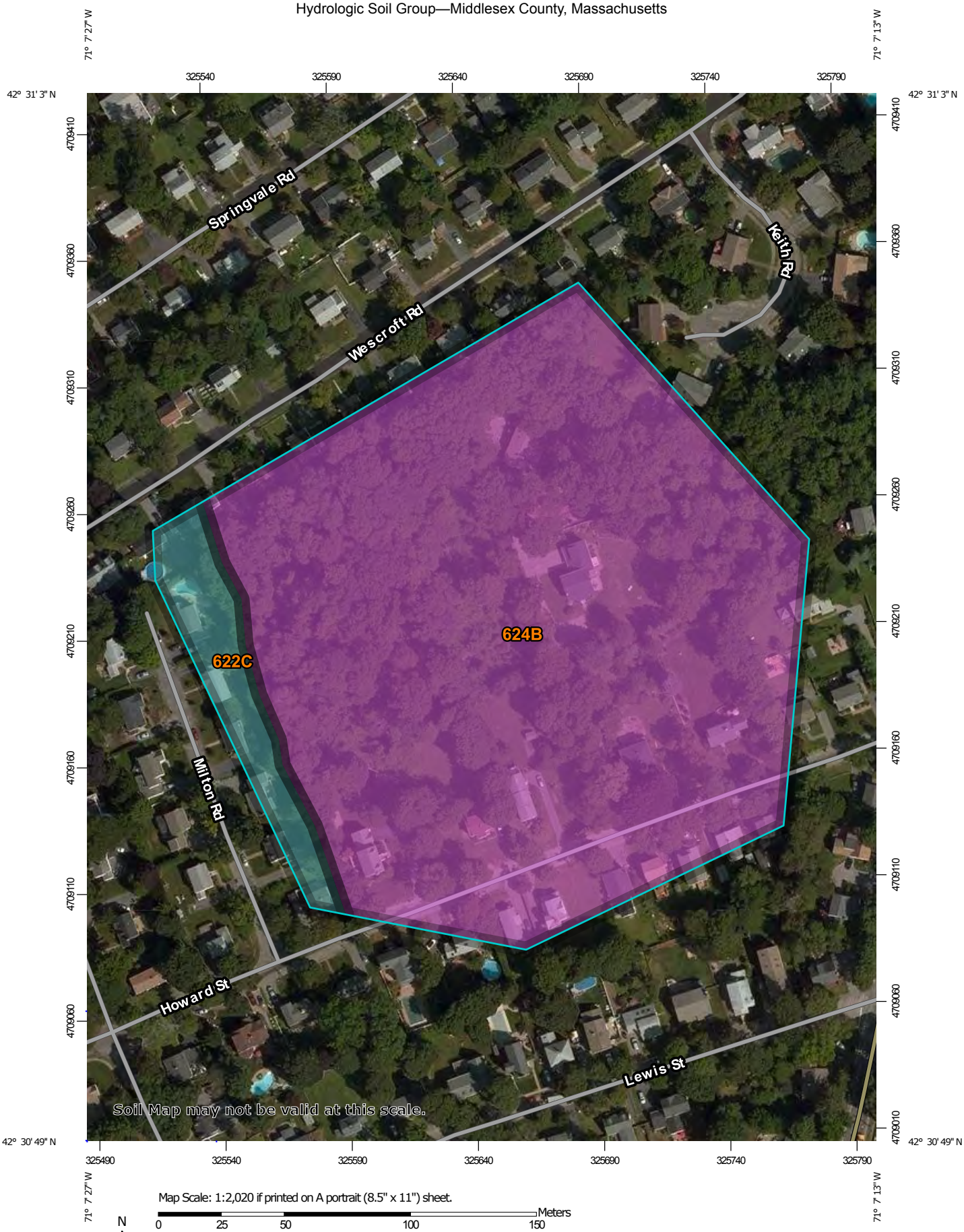
FIGURE 3: FIRM

PREPARED BY: WJH
SCALE: 1"=400'
CDCI FILE #: 18-10120
DATE: DECEMBER 4, 2018


71° 7'27" W
71° 7'13" W
42° 31' 3" N
42° 30' 49" N
325540
325590
325640
325690
325740
325790
325490
4709410
4709360
4709310
4709260
4709210
4709160
4709110
4709060
4709010
Springvale Rd
Wescroft Rd
Keith Rd
Milton Rd
Howard St
Lewis St
624B
622C
Soil Map may not be valid at this scale.
Map Scale: 1:2,020 if printed on A portrait (8.5" x 11") sheet.
Meters
0 25 50 100 150
Feet
0 50 100 200 300
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Lines

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Points

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 18, Sep 7, 2018

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

Date(s) aerial images were photographed: Aug 10, 2014—Aug 25, 2014

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.

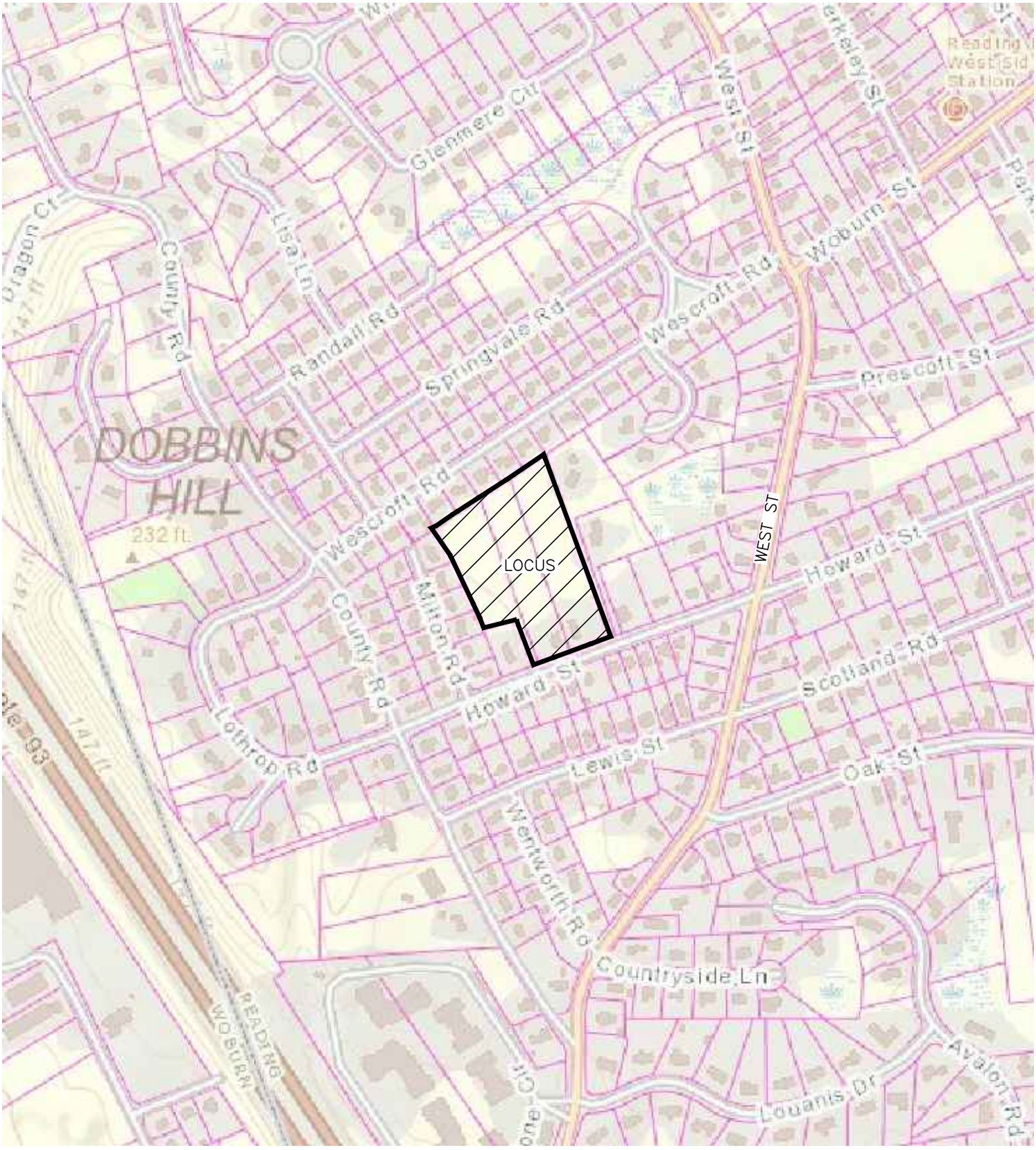


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FIGURE 5: NHESP

PREPARED BY: WJH
SCALE: 1"=400'
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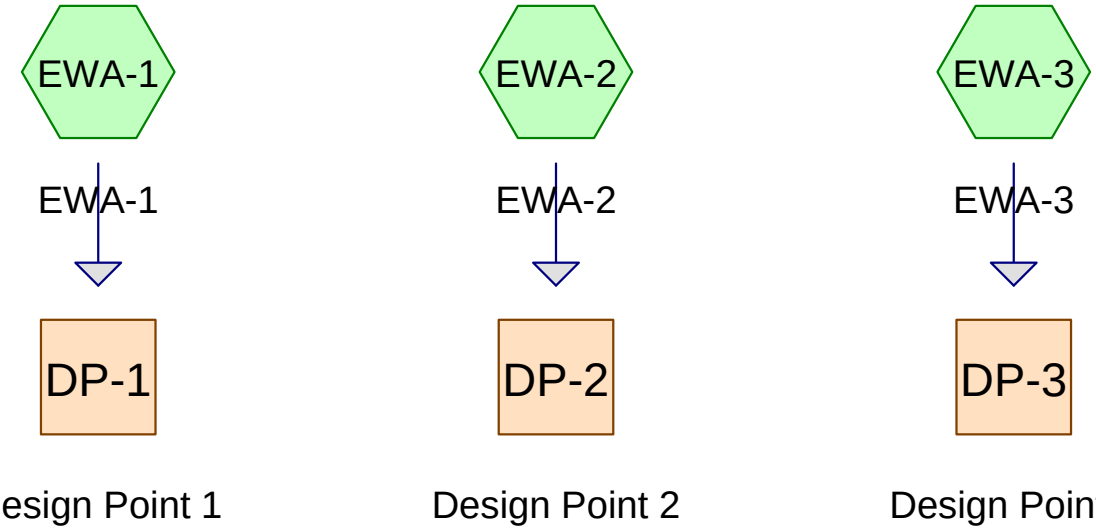
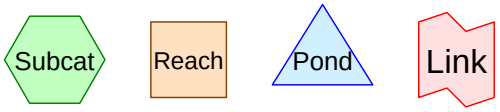
TAB 3





Drainage Diagram for Pre-Development-112118
Prepared by Civil Design Consultants, Inc., Printed 12/4/2018

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.650	30	Woods, Good, HSG A (EWA-1, EWA-2, EWA-3)
1.050	39	>75% Grass cover, Good, HSG A (EWA-1, EWA-2, EWA-3)
0.130	70	Woods, Good, HSG C (EWA-1)
0.230	74	>75% Grass cover, Good, HSG C (EWA-1)
0.300	98	Paved parking, HSG A (EWA-1, EWA-2, EWA-3)
4.360	40	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
4.000	HSG A	EWA-1, EWA-2, EWA-3
0.000	HSG B	
0.360	HSG C	EWA-1
0.000	HSG D	
0.000	Other	
4.360		**TOTAL AREA**

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWA-1: EWA-1 Runoff Area=2.800 ac 7.86% Impervious Runoff Depth>0.01"
Flow Length=204' Tc=20.7 min CN=43 Runoff=0.0 cfs 0.002 af

Subcatchment EWA-2: EWA-2 Runoff Area=1.340 ac 2.99% Impervious Runoff Depth=0.00"
Flow Length=224' Tc=20.9 min CN=33 Runoff=0.0 cfs 0.000 af

Subcatchment EWA-3: EWA-3 Runoff Area=0.220 ac 18.18% Impervious Runoff Depth>0.07"
Flow Length=50' Slope=0.0350 '/' Tc=9.9 min CN=49 Runoff=0.0 cfs 0.001 af

Reach DP-1: Design Point 1 Inflow=0.0 cfs 0.002 af
Outflow=0.0 cfs 0.002 af

Reach DP-2: Design Point 2 Inflow=0.0 cfs 0.000 af
Outflow=0.0 cfs 0.000 af

Reach DP-3: Design Point 3 Inflow=0.0 cfs 0.001 af
Outflow=0.0 cfs 0.001 af

Total Runoff Area = 4.360 ac Runoff Volume = 0.003 af Average Runoff Depth = 0.01"
93.12% Pervious = 4.060 ac 6.88% Impervious = 0.300 ac

Summary for Subcatchment EWA-1: EWA-1

[73] Warning: Peak may fall outside time span

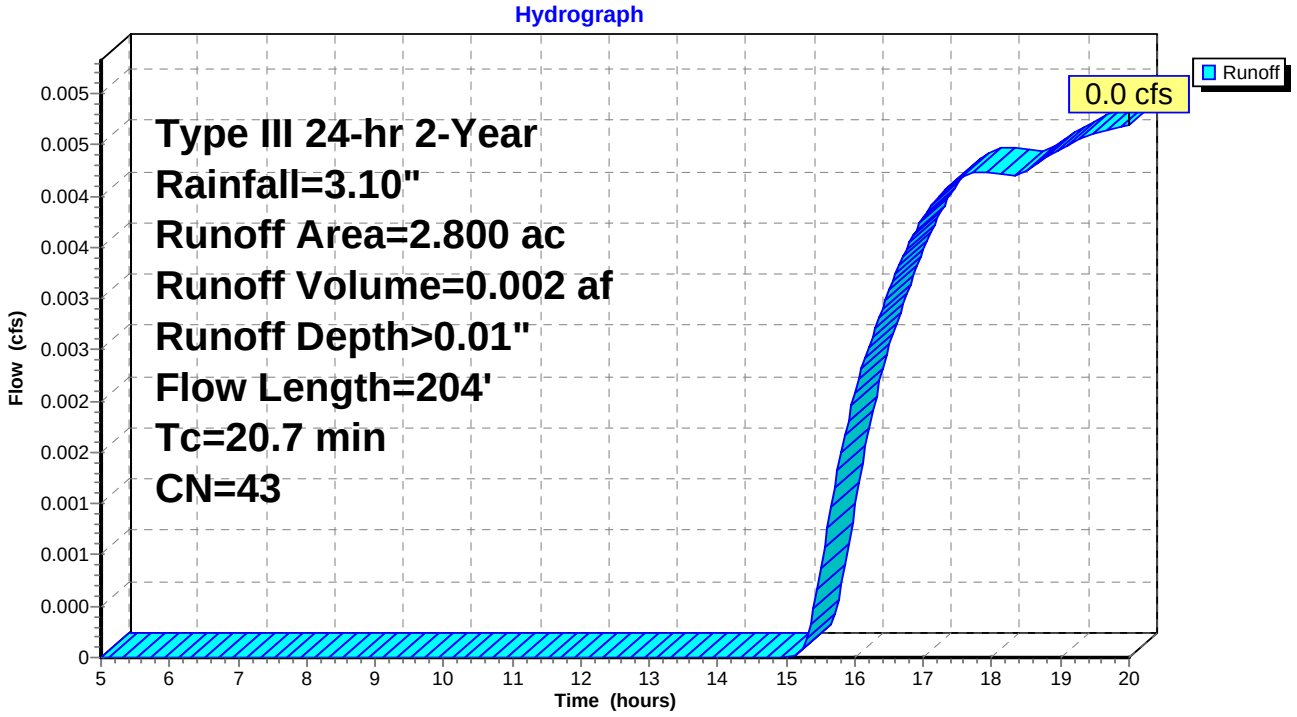
Runoff = 0.0 cfs @ 20.00 hrs, Volume= 0.002 af, Depth> 0.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (ac)	CN	Description
1.540	30	Woods, Good, HSG A
0.130	70	Woods, Good, HSG C
0.680	39	>75% Grass cover, Good, HSG A
0.220	98	Paved parking, HSG A
0.230	74	>75% Grass cover, Good, HSG C
2.800	43	Weighted Average
2.580		92.14% Pervious Area
0.220		7.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.2	154	0.0150	0.61		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.7	204	Total			

Subcatchment EWA-1: EWA-1



Summary for Subcatchment EWA-2: EWA-2

[45] Hint: Runoff=Zero

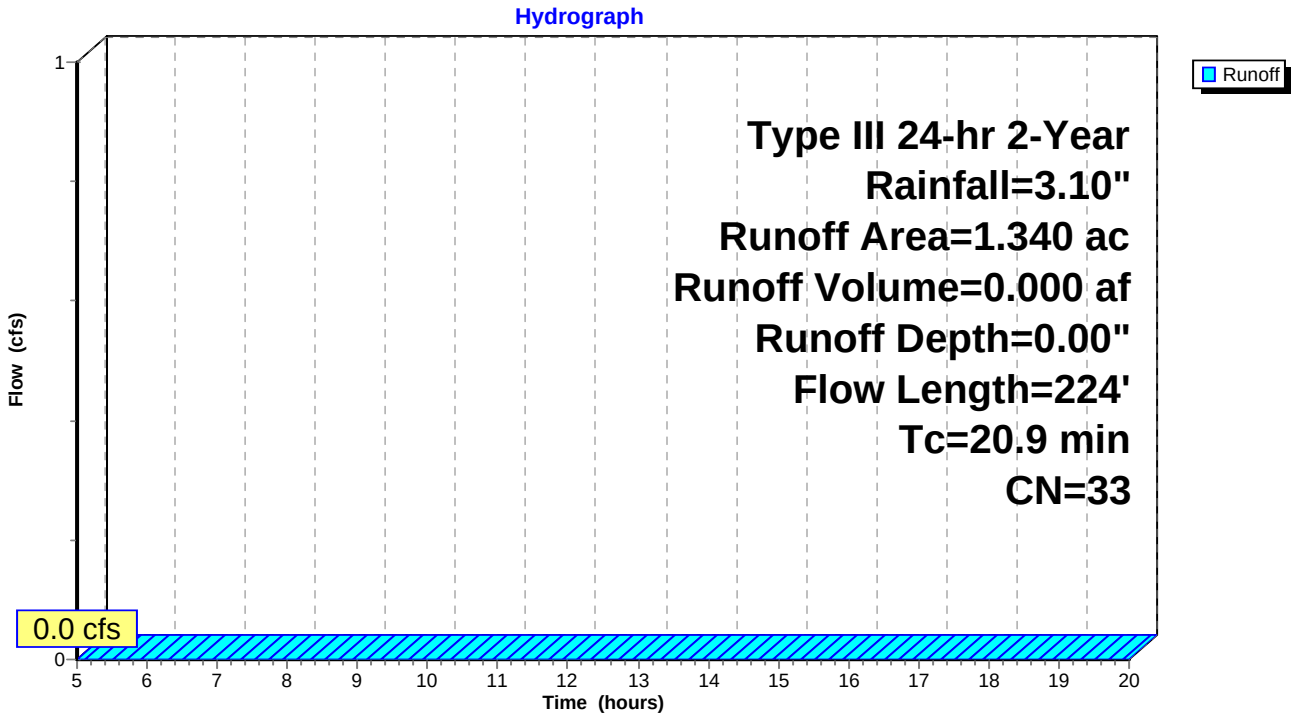
Runoff = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (ac)	CN	Description
0.040	98	Paved parking, HSG A
1.090	30	Woods, Good, HSG A
0.210	39	>75% Grass cover, Good, HSG A
1.340	33	Weighted Average
1.300		97.01% Pervious Area
0.040		2.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.4	174	0.0170	0.65		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.9	224	Total			

Subcatchment EWA-2: EWA-2



Summary for Subcatchment EWA-3: EWA-3

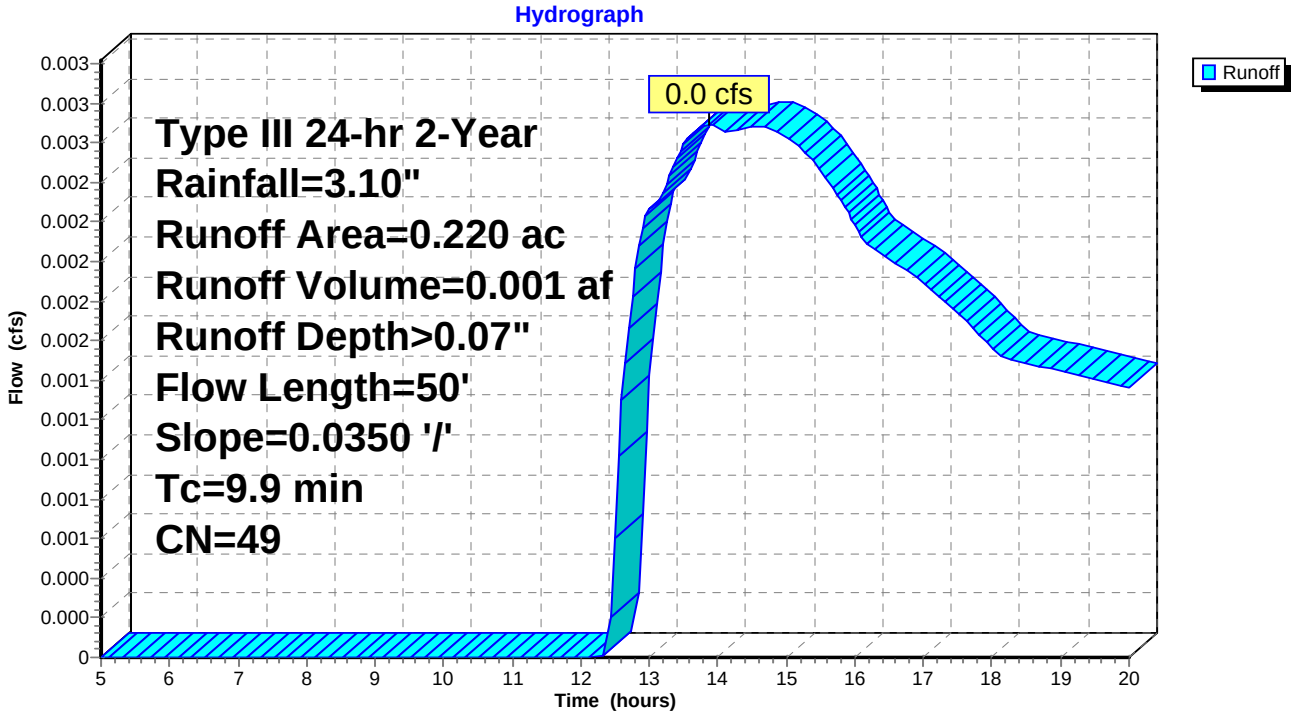
Runoff = 0.0 cfs @ 13.86 hrs, Volume= 0.001 af, Depth> 0.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (ac)	CN	Description
0.040	98	Paved parking, HSG A
0.160	39	>75% Grass cover, Good, HSG A
0.020	30	Woods, Good, HSG A
0.220	49	Weighted Average
0.180		81.82% Pervious Area
0.040		18.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	19	0.0350	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
6.8	31	0.0350	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
9.9	50	Total			

Subcatchment EWA-3: EWA-3



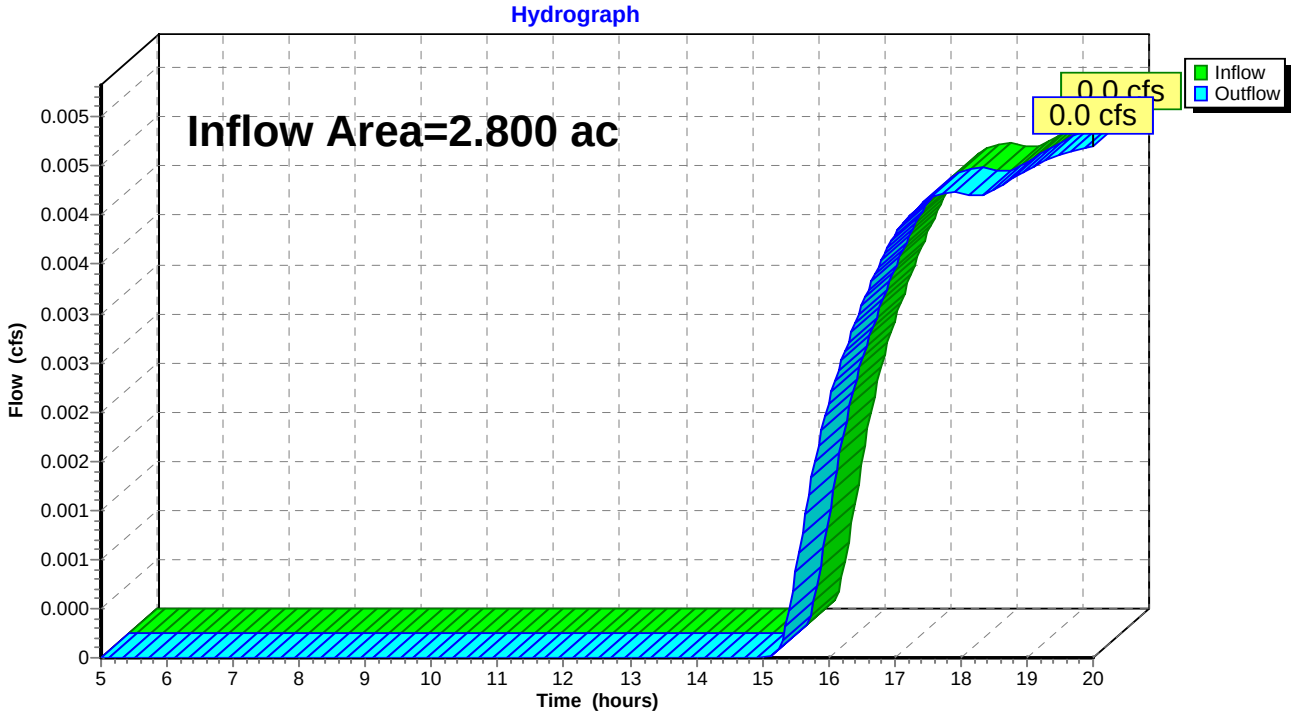
Summary for Reach DP-1: Design Point 1

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

Inflow Area = 2.800 ac, 7.86% Impervious, Inflow Depth > 0.01" for 2-Year event
Inflow = 0.0 cfs @ 20.00 hrs, Volume= 0.002 af
Outflow = 0.0 cfs @ 20.00 hrs, Volume= 0.002 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-1: Design Point 1



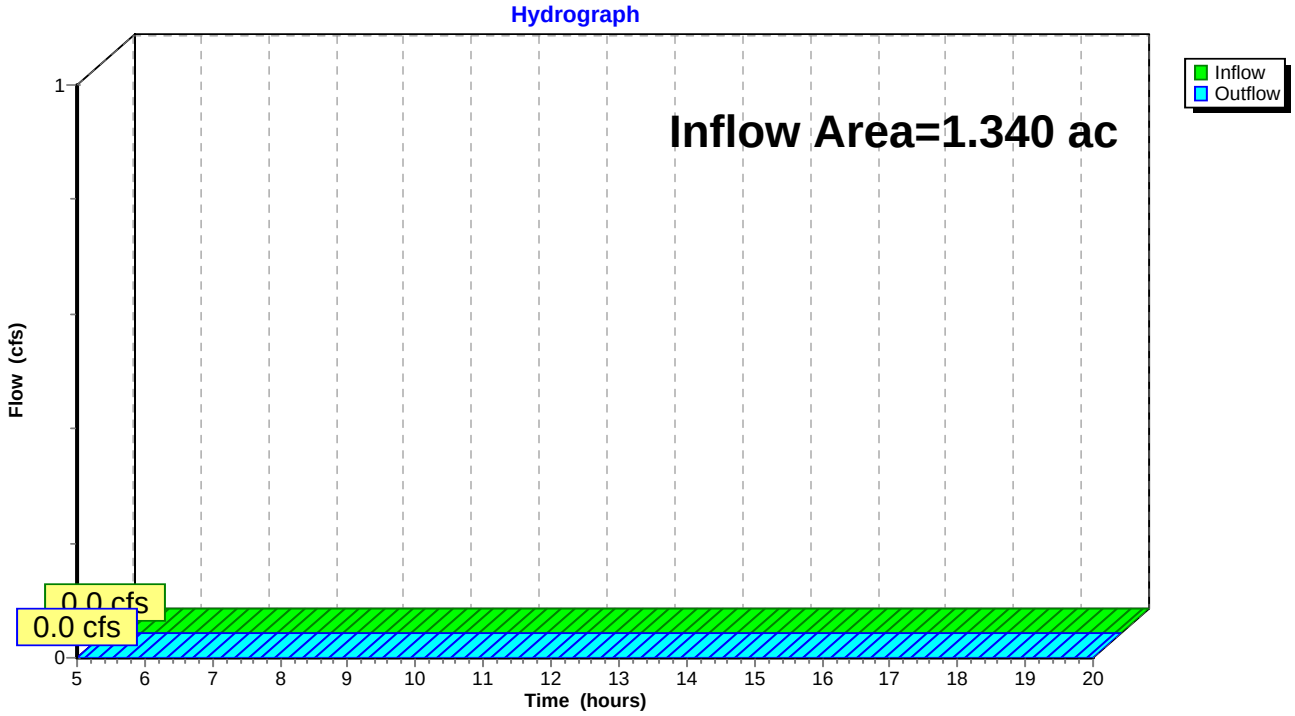
Summary for Reach DP-2: Design Point 2

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

Inflow Area = 1.340 ac, 2.99% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-2: Design Point 2



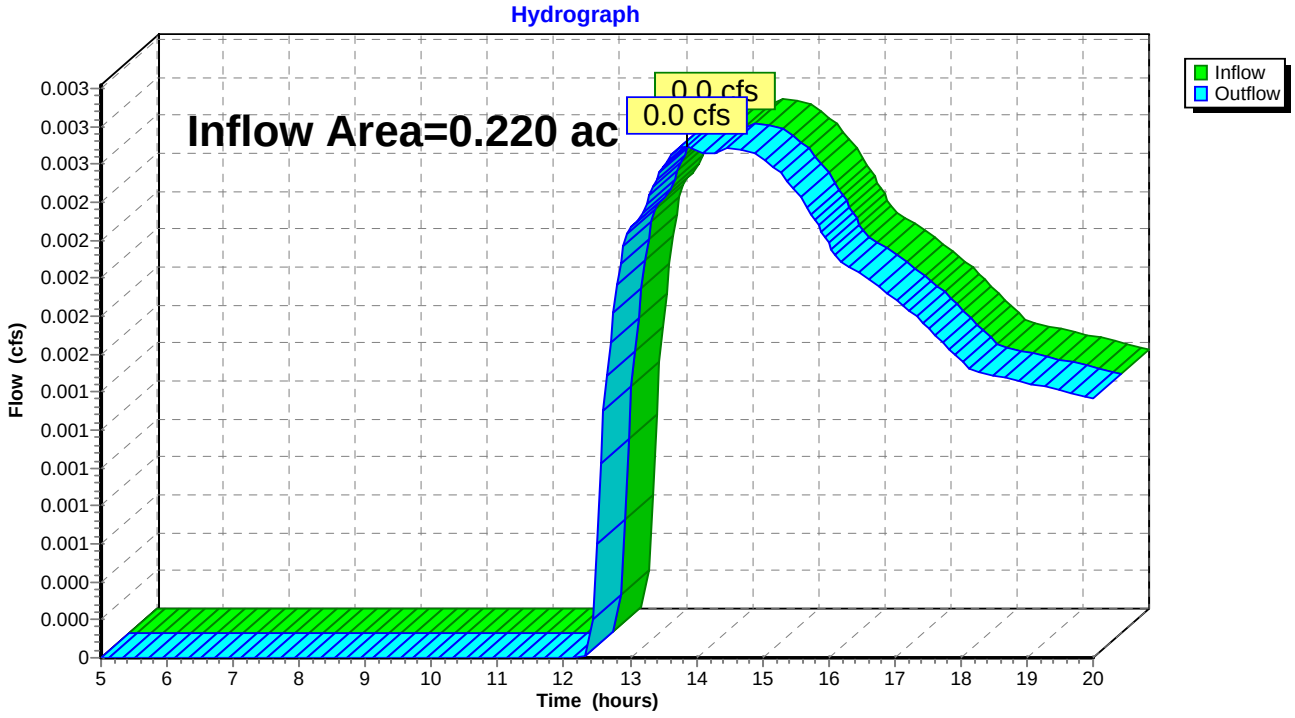
Summary for Reach DP-3: Design Point 3

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

Inflow Area = 0.220 ac, 18.18% Impervious, Inflow Depth > 0.07" for 2-Year event
Inflow = 0.0 cfs @ 13.86 hrs, Volume= 0.001 af
Outflow = 0.0 cfs @ 13.86 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-3: Design Point 3



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWA-1: EWA-1 Runoff Area=2.800 ac 7.86% Impervious Runoff Depth>0.18"
Flow Length=204' Tc=20.7 min CN=43 Runoff=0.1 cfs 0.042 af

Subcatchment EWA-2: EWA-2 Runoff Area=1.340 ac 2.99% Impervious Runoff Depth>0.00"
Flow Length=224' Tc=20.9 min CN=33 Runoff=0.0 cfs 0.000 af

Subcatchment EWA-3: EWA-3 Runoff Area=0.220 ac 18.18% Impervious Runoff Depth>0.39"
Flow Length=50' Slope=0.0350 '/' Tc=9.9 min CN=49 Runoff=0.0 cfs 0.007 af

Reach DP-1: Design Point 1 Inflow=0.1 cfs 0.042 af
Outflow=0.1 cfs 0.042 af

Reach DP-2: Design Point 2 Inflow=0.0 cfs 0.000 af
Outflow=0.0 cfs 0.000 af

Reach DP-3: Design Point 3 Inflow=0.0 cfs 0.007 af
Outflow=0.0 cfs 0.007 af

Total Runoff Area = 4.360 ac Runoff Volume = 0.049 af Average Runoff Depth = 0.14"
93.12% Pervious = 4.060 ac 6.88% Impervious = 0.300 ac

Summary for Subcatchment EWA-1: EWA-1

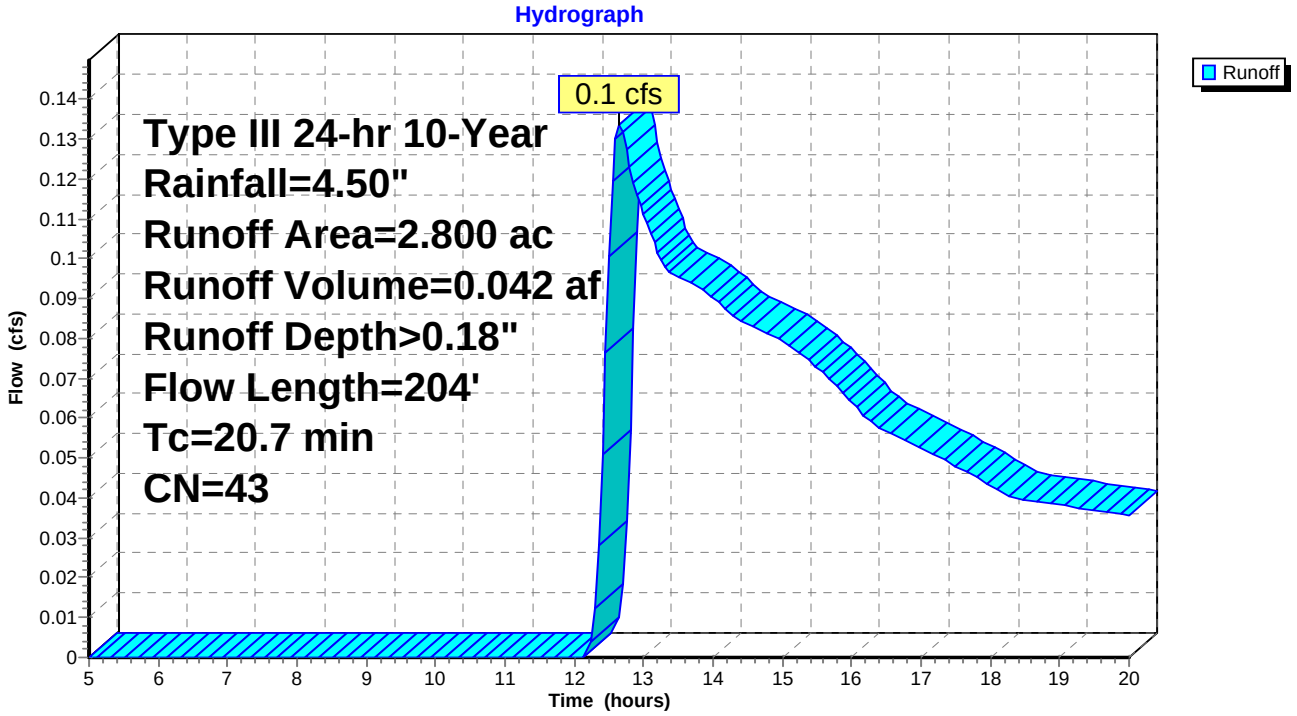
Runoff = 0.1 cfs @ 12.66 hrs, Volume= 0.042 af, Depth> 0.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (ac)	CN	Description
1.540	30	Woods, Good, HSG A
0.130	70	Woods, Good, HSG C
0.680	39	>75% Grass cover, Good, HSG A
0.220	98	Paved parking, HSG A
0.230	74	>75% Grass cover, Good, HSG C
2.800	43	Weighted Average
2.580		92.14% Pervious Area
0.220		7.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.2	154	0.0150	0.61		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.7	204	Total			

Subcatchment EWA-1: EWA-1



Summary for Subcatchment EWA-2: EWA-2

[73] Warning: Peak may fall outside time span

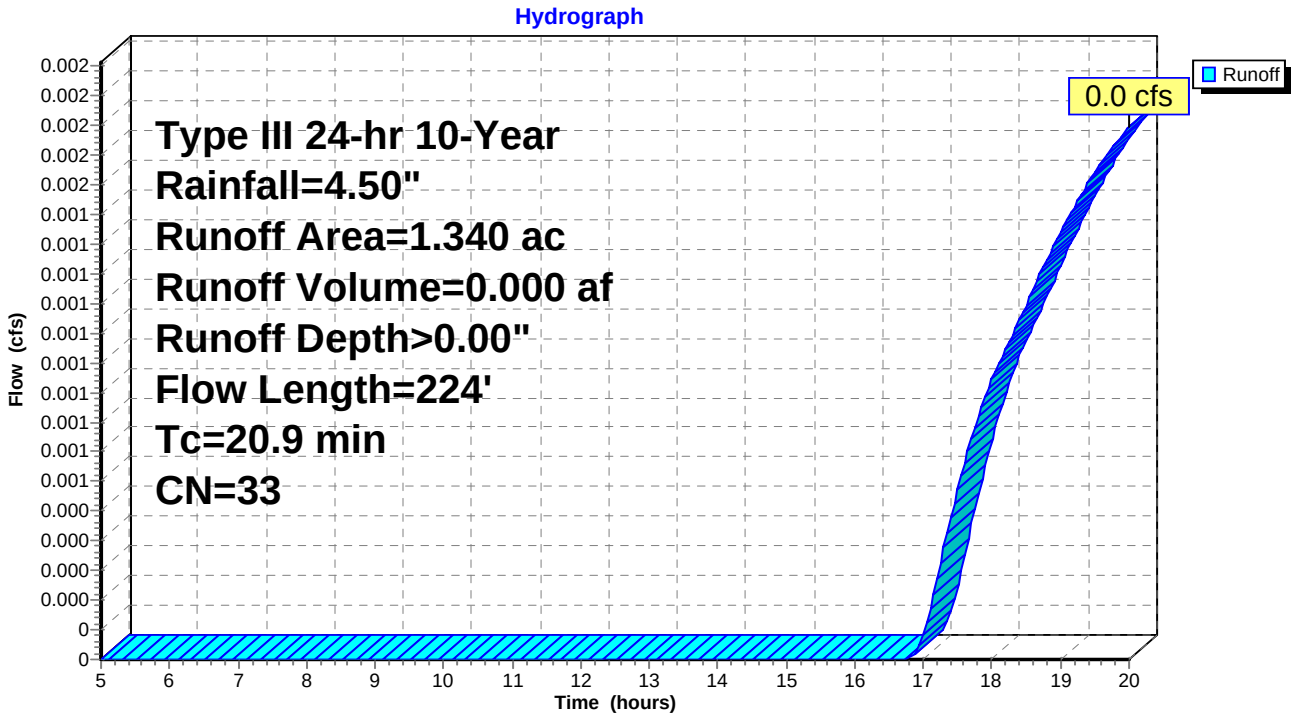
Runoff = 0.0 cfs @ 20.00 hrs, Volume= 0.000 af, Depth> 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (ac)	CN	Description
0.040	98	Paved parking, HSG A
1.090	30	Woods, Good, HSG A
0.210	39	>75% Grass cover, Good, HSG A
1.340	33	Weighted Average
1.300		97.01% Pervious Area
0.040		2.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.4	174	0.0170	0.65		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.9	224	Total			

Subcatchment EWA-2: EWA-2



Summary for Subcatchment EWA-3: EWA-3

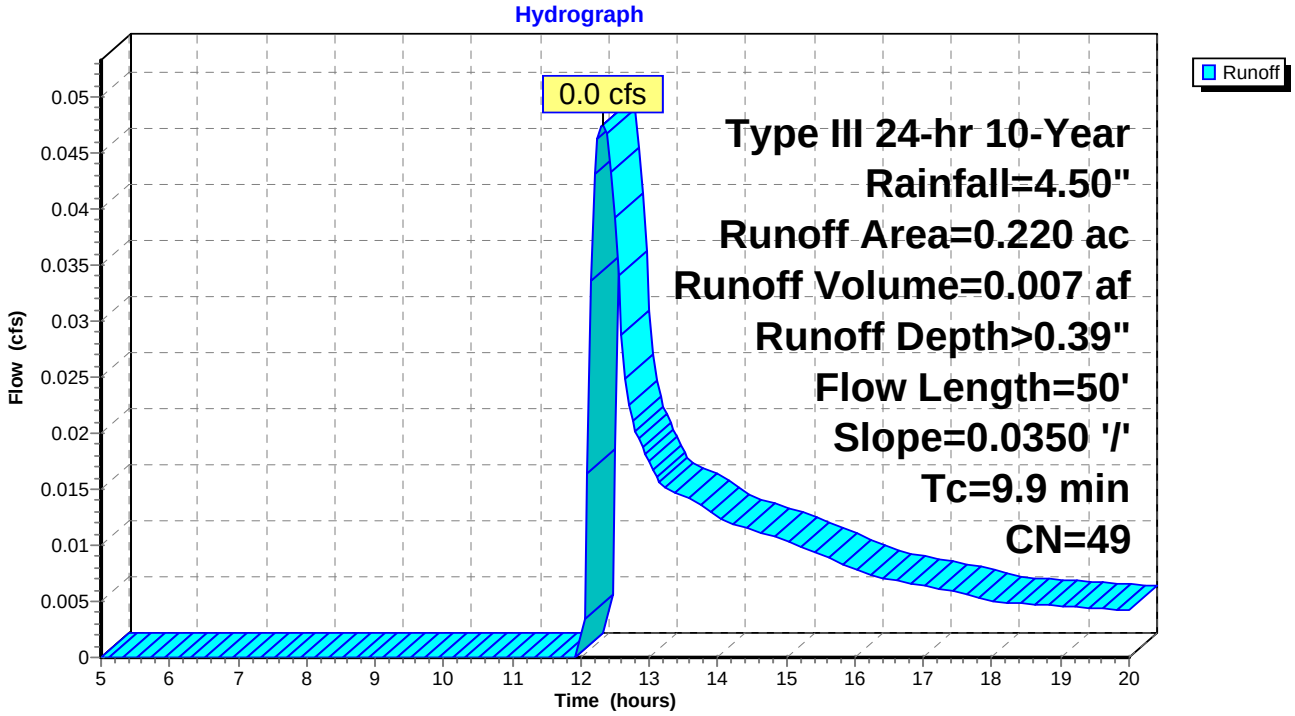
Runoff = 0.0 cfs @ 12.33 hrs, Volume= 0.007 af, Depth> 0.39"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (ac)	CN	Description
0.040	98	Paved parking, HSG A
0.160	39	>75% Grass cover, Good, HSG A
0.020	30	Woods, Good, HSG A
0.220	49	Weighted Average
0.180		81.82% Pervious Area
0.040		18.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	19	0.0350	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
6.8	31	0.0350	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
9.9	50	Total			

Subcatchment EWA-3: EWA-3



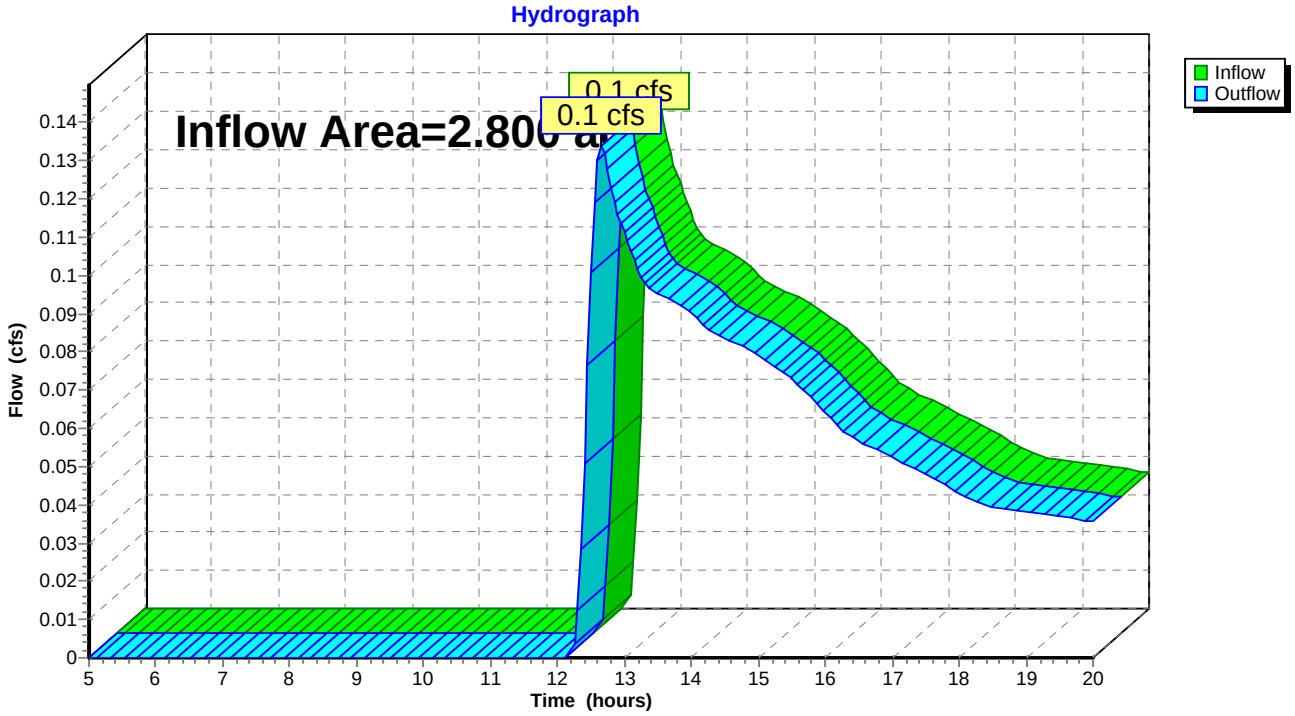
Summary for Reach DP-1: Design Point 1

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

Inflow Area = 2.800 ac, 7.86% Impervious, Inflow Depth > 0.18" for 10-Year event
Inflow = 0.1 cfs @ 12.66 hrs, Volume= 0.042 af
Outflow = 0.1 cfs @ 12.66 hrs, Volume= 0.042 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-1: Design Point 1



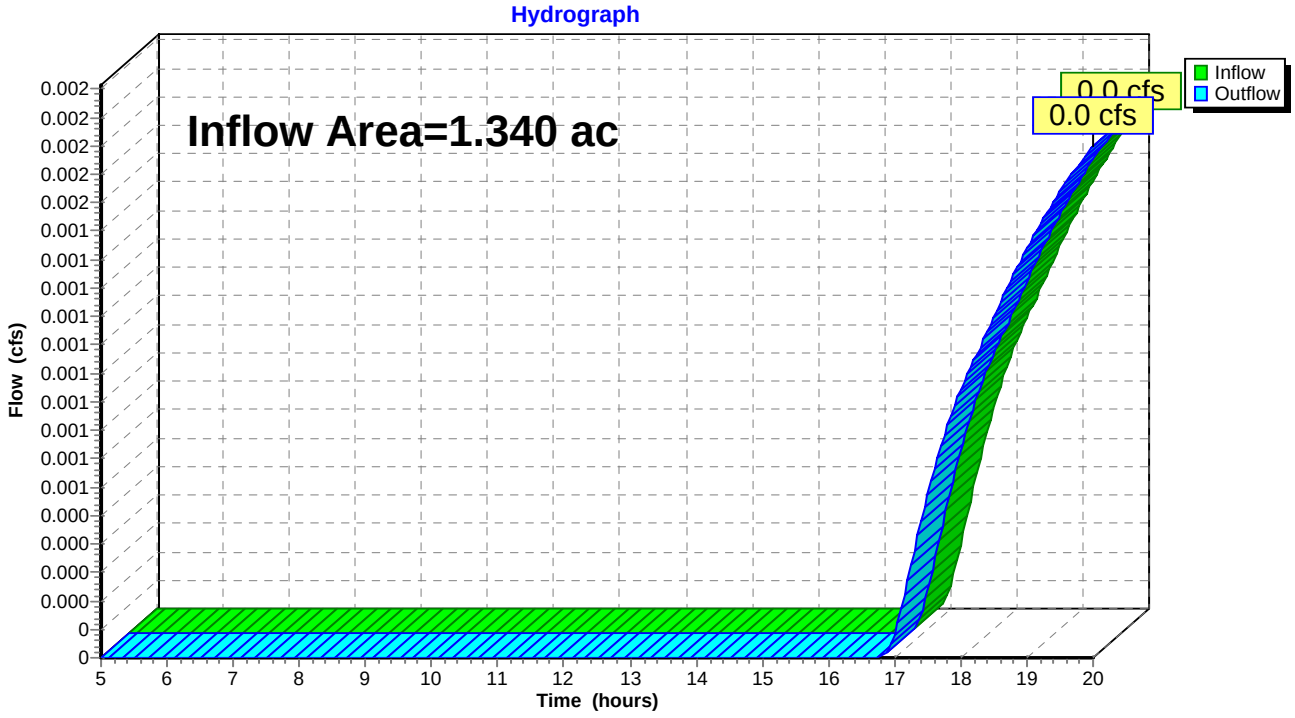
Summary for Reach DP-2: Design Point 2

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

Inflow Area = 1.340 ac, 2.99% Impervious, Inflow Depth > 0.00" for 10-Year event
Inflow = 0.0 cfs @ 20.00 hrs, Volume= 0.000 af
Outflow = 0.0 cfs @ 20.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-2: Design Point 2



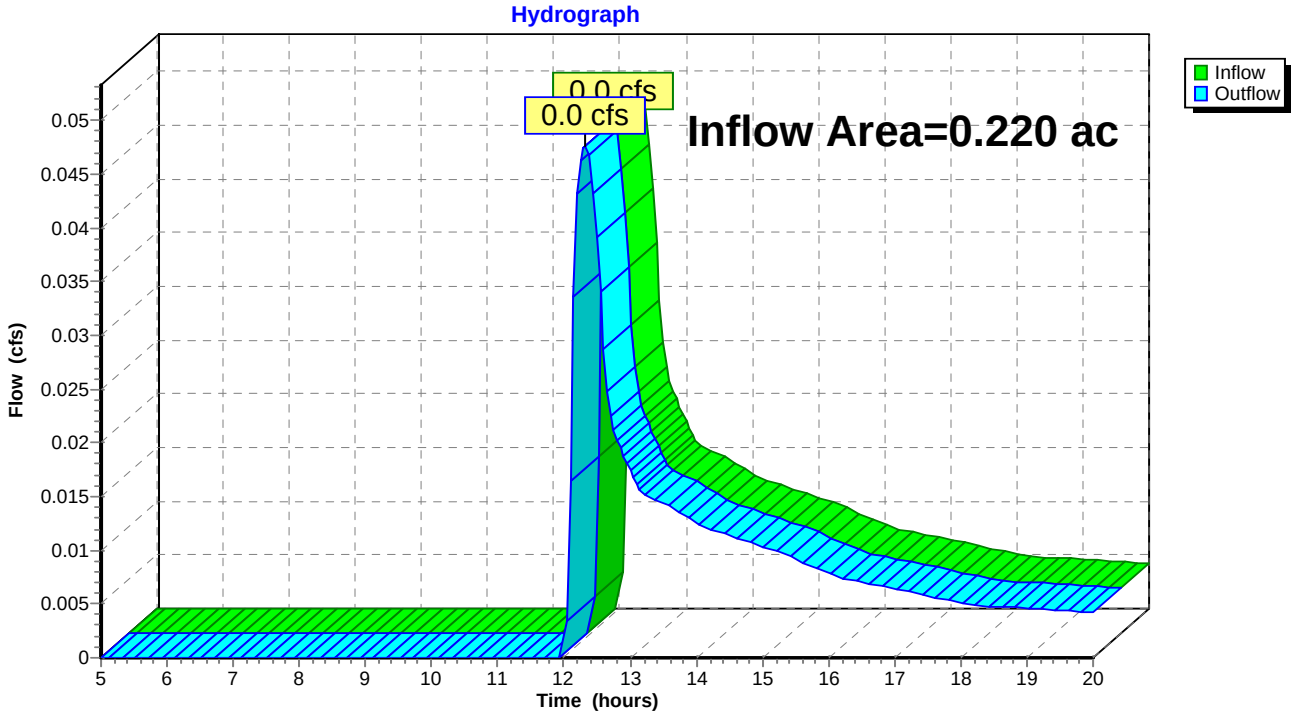
Summary for Reach DP-3: Design Point 3

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

Inflow Area = 0.220 ac, 18.18% Impervious, Inflow Depth > 0.39" for 10-Year event
Inflow = 0.0 cfs @ 12.33 hrs, Volume= 0.007 af
Outflow = 0.0 cfs @ 12.33 hrs, Volume= 0.007 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-3: Design Point 3



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWA-1: EWA-1 Runoff Area=2.800 ac 7.86% Impervious Runoff Depth>0.37"
Flow Length=204' Tc=20.7 min CN=43 Runoff=0.4 cfs 0.086 af

Subcatchment EWA-2: EWA-2 Runoff Area=1.340 ac 2.99% Impervious Runoff Depth>0.05"
Flow Length=224' Tc=20.9 min CN=33 Runoff=0.0 cfs 0.005 af

Subcatchment EWA-3: EWA-3 Runoff Area=0.220 ac 18.18% Impervious Runoff Depth>0.66"
Flow Length=50' Slope=0.0350 '/' Tc=9.9 min CN=49 Runoff=0.1 cfs 0.012 af

Reach DP-1: Design Point 1 Inflow=0.4 cfs 0.086 af
Outflow=0.4 cfs 0.086 af

Reach DP-2: Design Point 2 Inflow=0.0 cfs 0.005 af
Outflow=0.0 cfs 0.005 af

Reach DP-3: Design Point 3 Inflow=0.1 cfs 0.012 af
Outflow=0.1 cfs 0.012 af

Total Runoff Area = 4.360 ac Runoff Volume = 0.103 af Average Runoff Depth = 0.28"
93.12% Pervious = 4.060 ac 6.88% Impervious = 0.300 ac

Summary for Subcatchment EWA-1: EWA-1

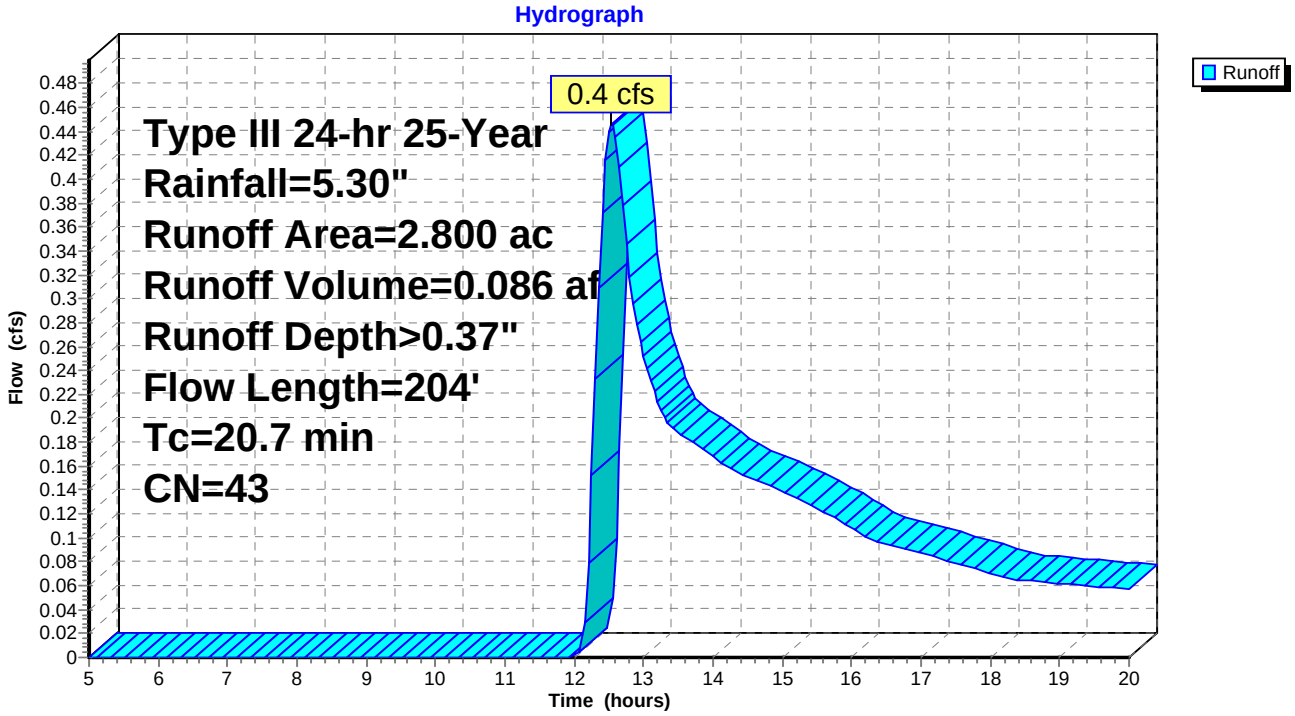
Runoff = 0.4 cfs @ 12.54 hrs, Volume= 0.086 af, Depth> 0.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

Area (ac)	CN	Description
1.540	30	Woods, Good, HSG A
0.130	70	Woods, Good, HSG C
0.680	39	>75% Grass cover, Good, HSG A
0.220	98	Paved parking, HSG A
0.230	74	>75% Grass cover, Good, HSG C
2.800	43	Weighted Average
2.580		92.14% Pervious Area
0.220		7.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.2	154	0.0150	0.61		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.7	204	Total			

Subcatchment EWA-1: EWA-1



Summary for Subcatchment EWA-2: EWA-2

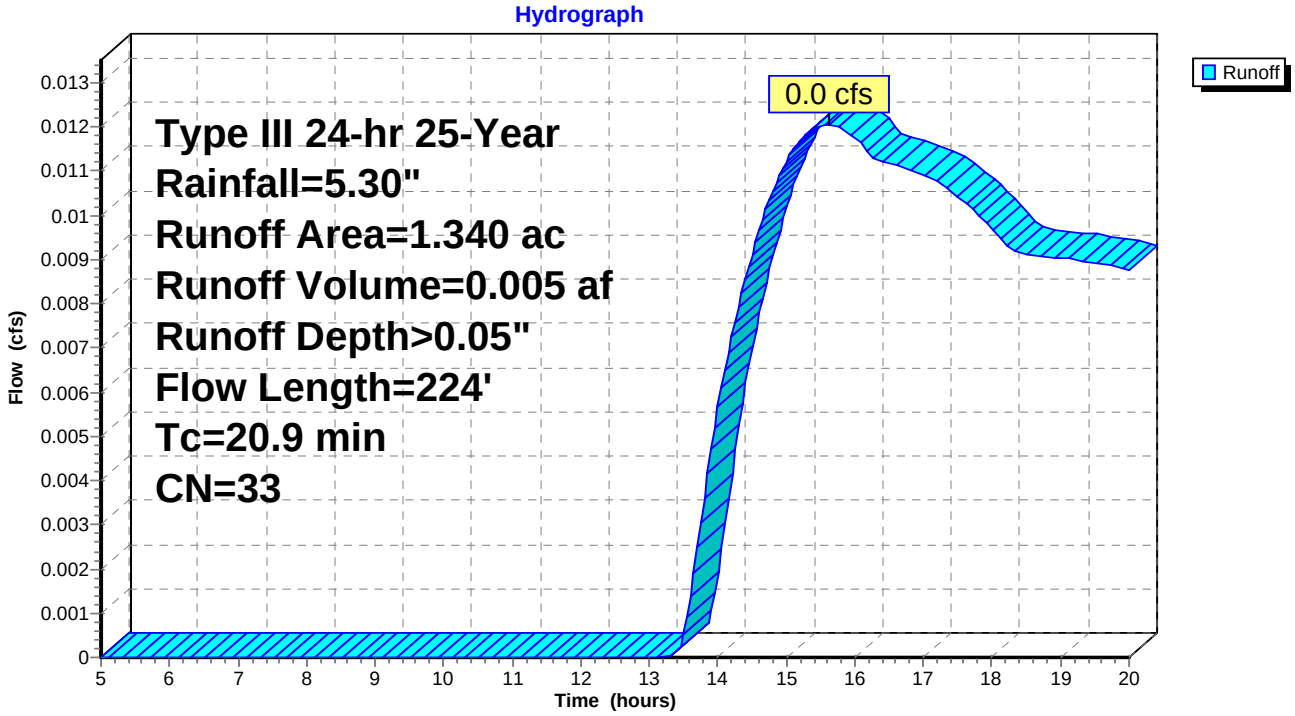
Runoff = 0.0 cfs @ 15.61 hrs, Volume= 0.005 af, Depth> 0.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

Area (ac)	CN	Description
0.040	98	Paved parking, HSG A
1.090	30	Woods, Good, HSG A
0.210	39	>75% Grass cover, Good, HSG A
1.340	33	Weighted Average
1.300		97.01% Pervious Area
0.040		2.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.4	174	0.0170	0.65		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.9	224	Total			

Subcatchment EWA-2: EWA-2



Summary for Subcatchment EWA-3: EWA-3

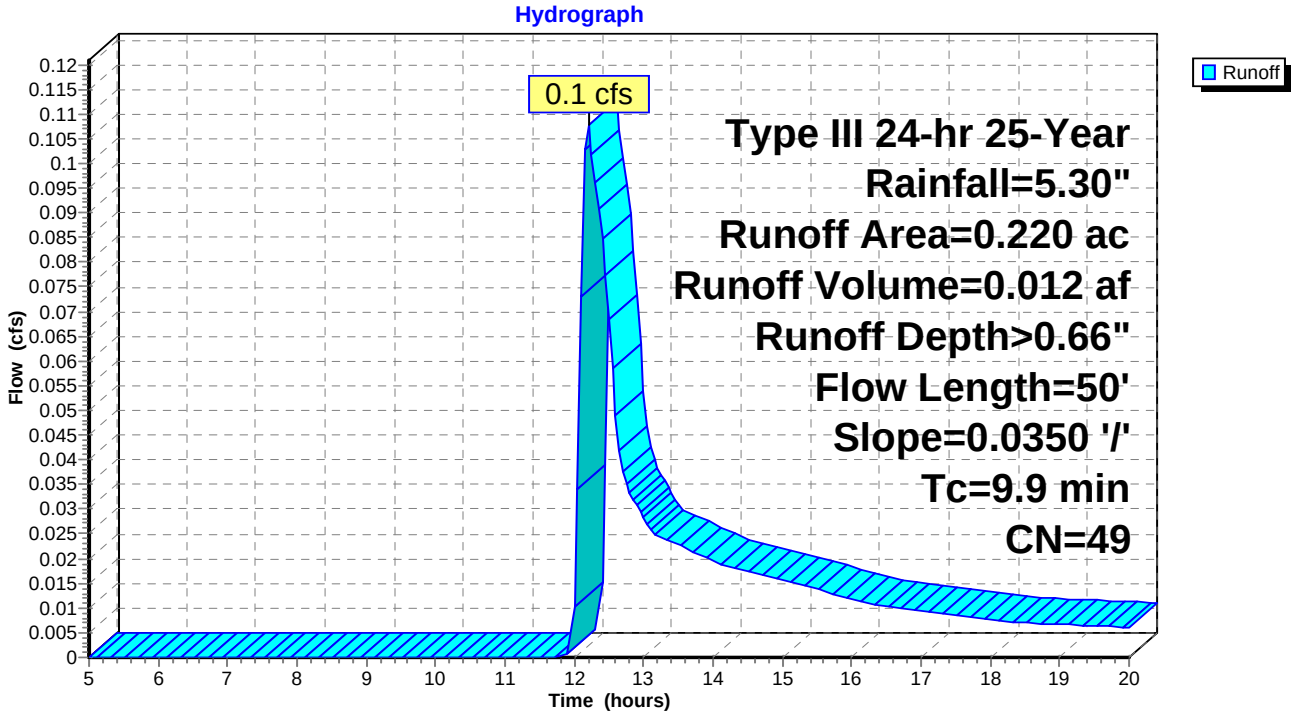
Runoff = 0.1 cfs @ 12.20 hrs, Volume= 0.012 af, Depth> 0.66"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

Area (ac)	CN	Description
0.040	98	Paved parking, HSG A
0.160	39	>75% Grass cover, Good, HSG A
0.020	30	Woods, Good, HSG A
0.220	49	Weighted Average
0.180		81.82% Pervious Area
0.040		18.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	19	0.0350	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
6.8	31	0.0350	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
9.9	50	Total			

Subcatchment EWA-3: EWA-3



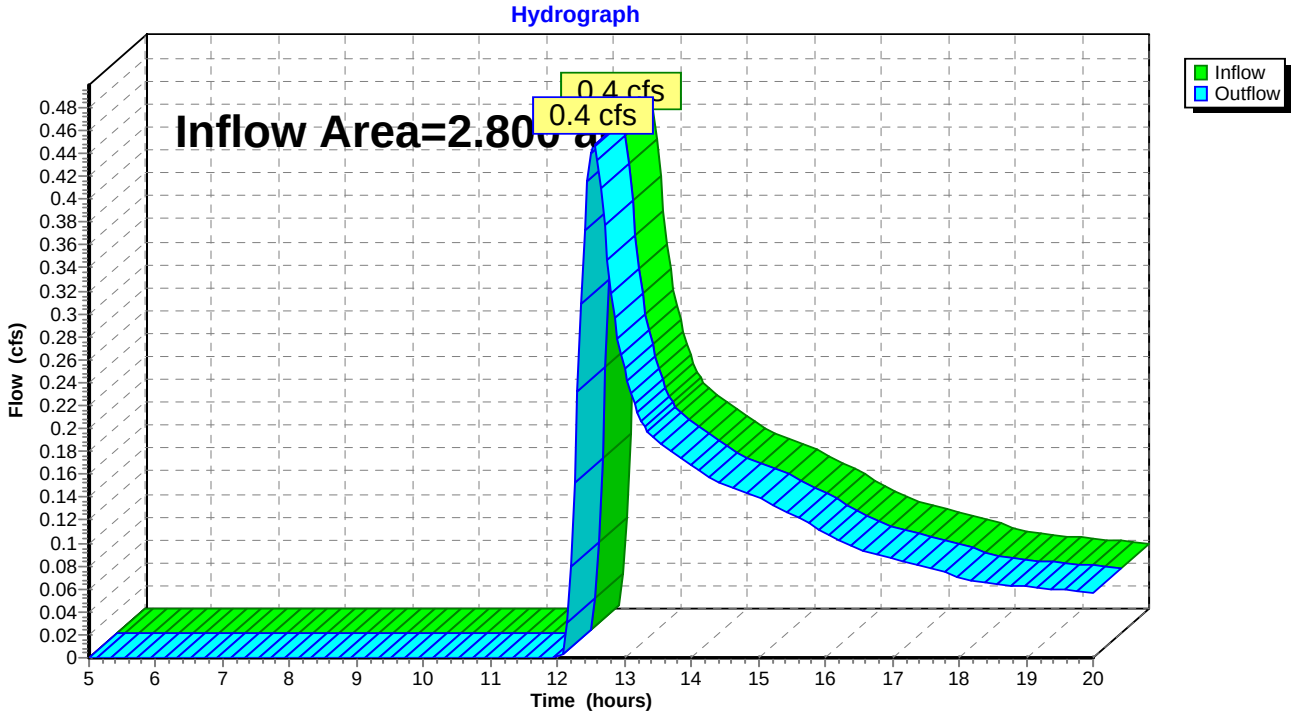
Summary for Reach DP-1: Design Point 1

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

Inflow Area = 2.800 ac, 7.86% Impervious, Inflow Depth > 0.37" for 25-Year event
Inflow = 0.4 cfs @ 12.54 hrs, Volume= 0.086 af
Outflow = 0.4 cfs @ 12.54 hrs, Volume= 0.086 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-1: Design Point 1



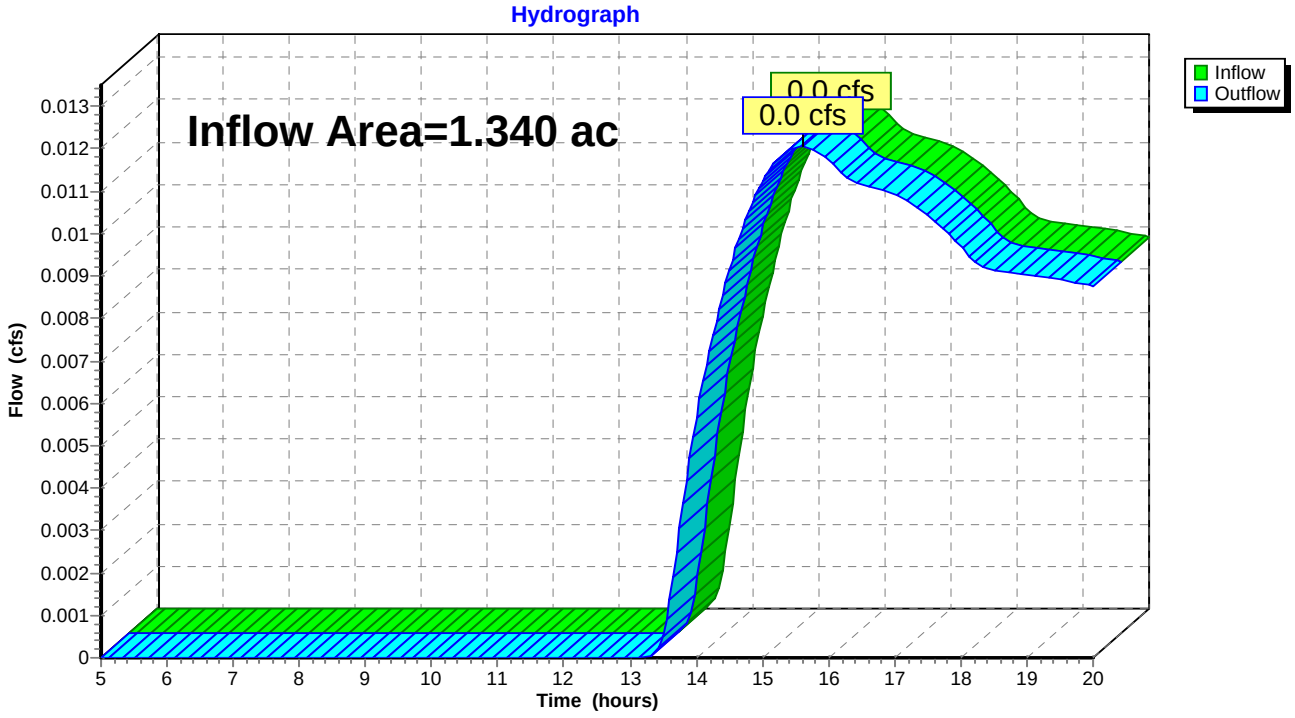
Summary for Reach DP-2: Design Point 2

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

Inflow Area = 1.340 ac, 2.99% Impervious, Inflow Depth > 0.05" for 25-Year event
Inflow = 0.0 cfs @ 15.61 hrs, Volume= 0.005 af
Outflow = 0.0 cfs @ 15.61 hrs, Volume= 0.005 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-2: Design Point 2



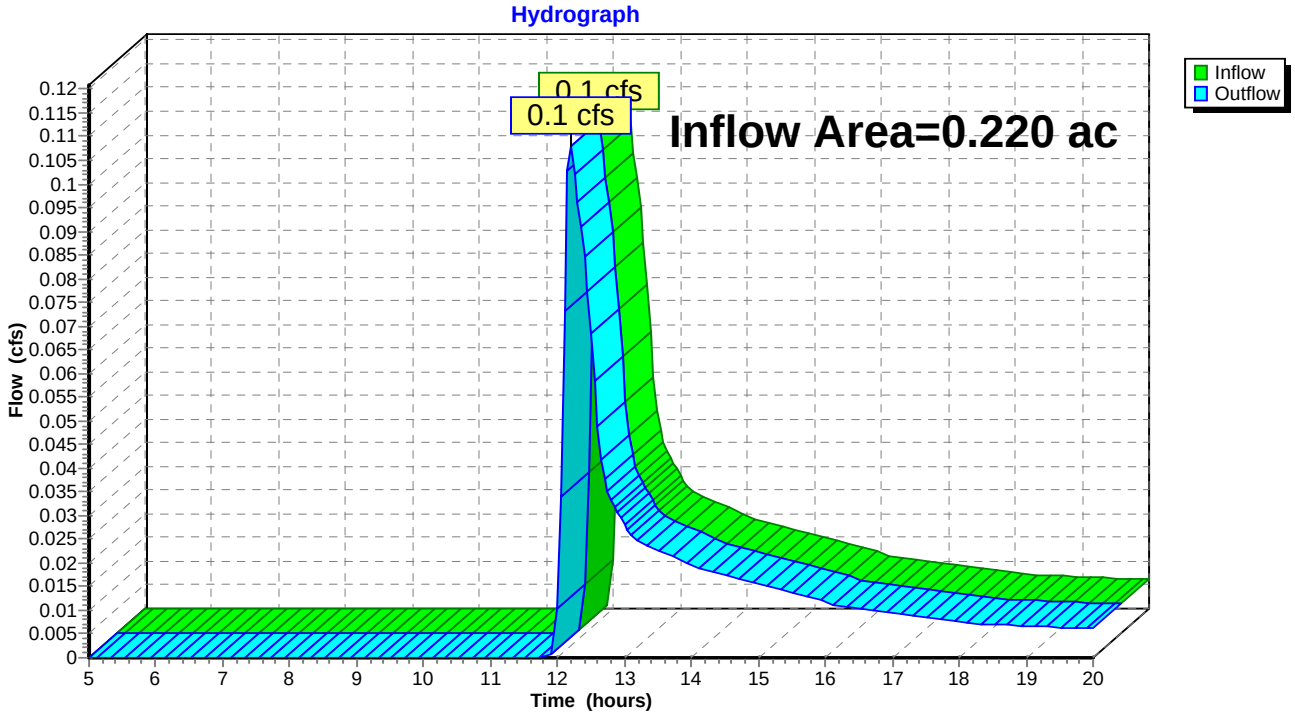
Summary for Reach DP-3: Design Point 3

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

Inflow Area = 0.220 ac, 18.18% Impervious, Inflow Depth > 0.66" for 25-Year event
Inflow = 0.1 cfs @ 12.20 hrs, Volume= 0.012 af
Outflow = 0.1 cfs @ 12.20 hrs, Volume= 0.012 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-3: Design Point 3



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWA-1: EWA-1 Runoff Area=2.800 ac 7.86% Impervious Runoff Depth>0.75"
Flow Length=204' Tc=20.7 min CN=43 Runoff=1.2 cfs 0.174 af

Subcatchment EWA-2: EWA-2 Runoff Area=1.340 ac 2.99% Impervious Runoff Depth>0.20"
Flow Length=224' Tc=20.9 min CN=33 Runoff=0.1 cfs 0.023 af

Subcatchment EWA-3: EWA-3 Runoff Area=0.220 ac 18.18% Impervious Runoff Depth>1.17"
Flow Length=50' Slope=0.0350 '/' Tc=9.9 min CN=49 Runoff=0.2 cfs 0.021 af

Reach DP-1: Design Point 1 Inflow=1.2 cfs 0.174 af
Outflow=1.2 cfs 0.174 af

Reach DP-2: Design Point 2 Inflow=0.1 cfs 0.023 af
Outflow=0.1 cfs 0.023 af

Reach DP-3: Design Point 3 Inflow=0.2 cfs 0.021 af
Outflow=0.2 cfs 0.021 af

Total Runoff Area = 4.360 ac Runoff Volume = 0.219 af Average Runoff Depth = 0.60"
93.12% Pervious = 4.060 ac 6.88% Impervious = 0.300 ac

Summary for Subcatchment EWA-1: EWA-1

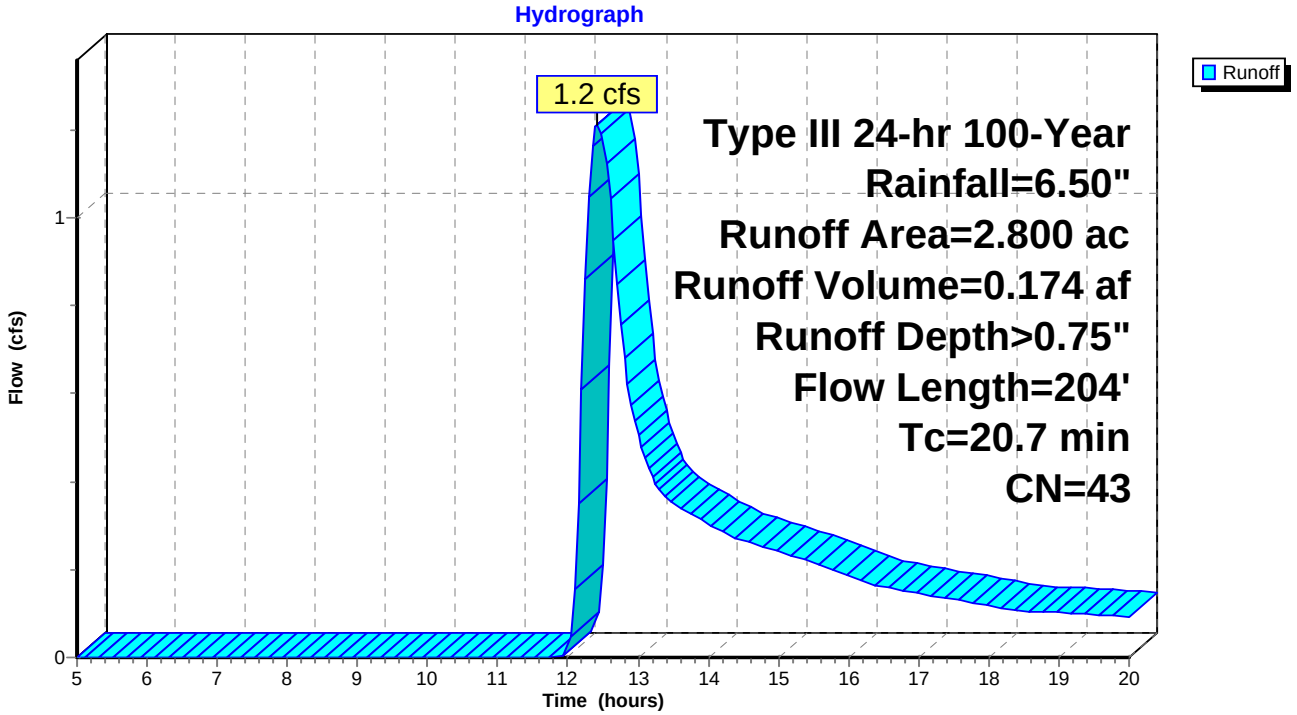
Runoff = 1.2 cfs @ 12.42 hrs, Volume= 0.174 af, Depth> 0.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (ac)	CN	Description
1.540	30	Woods, Good, HSG A
0.130	70	Woods, Good, HSG C
0.680	39	>75% Grass cover, Good, HSG A
0.220	98	Paved parking, HSG A
0.230	74	>75% Grass cover, Good, HSG C
2.800	43	Weighted Average
2.580		92.14% Pervious Area
0.220		7.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.2	154	0.0150	0.61		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.7	204	Total			

Subcatchment EWA-1: EWA-1



Summary for Subcatchment EWA-2: EWA-2

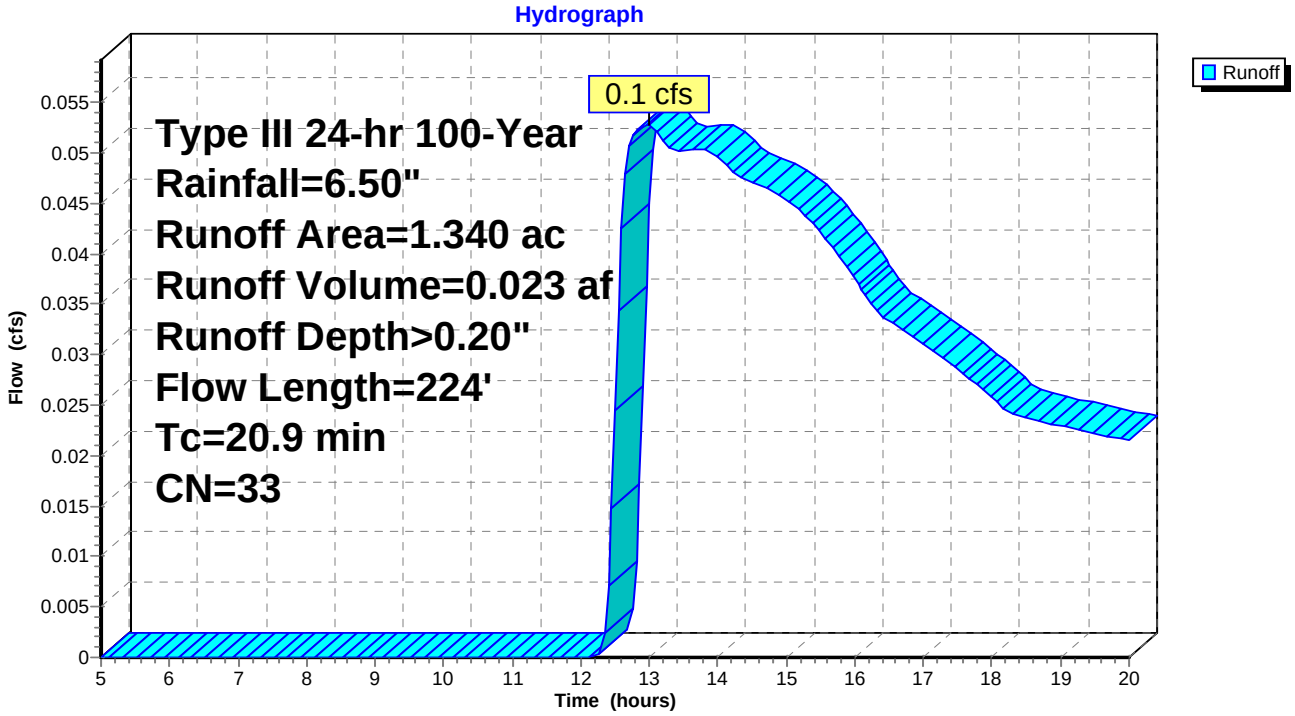
Runoff = 0.1 cfs @ 12.99 hrs, Volume= 0.023 af, Depth> 0.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (ac)	CN	Description
0.040	98	Paved parking, HSG A
1.090	30	Woods, Good, HSG A
0.210	39	>75% Grass cover, Good, HSG A
1.340	33	Weighted Average
1.300		97.01% Pervious Area
0.040		2.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.4	174	0.0170	0.65		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.9	224	Total			

Subcatchment EWA-2: EWA-2



Summary for Subcatchment EWA-3: EWA-3

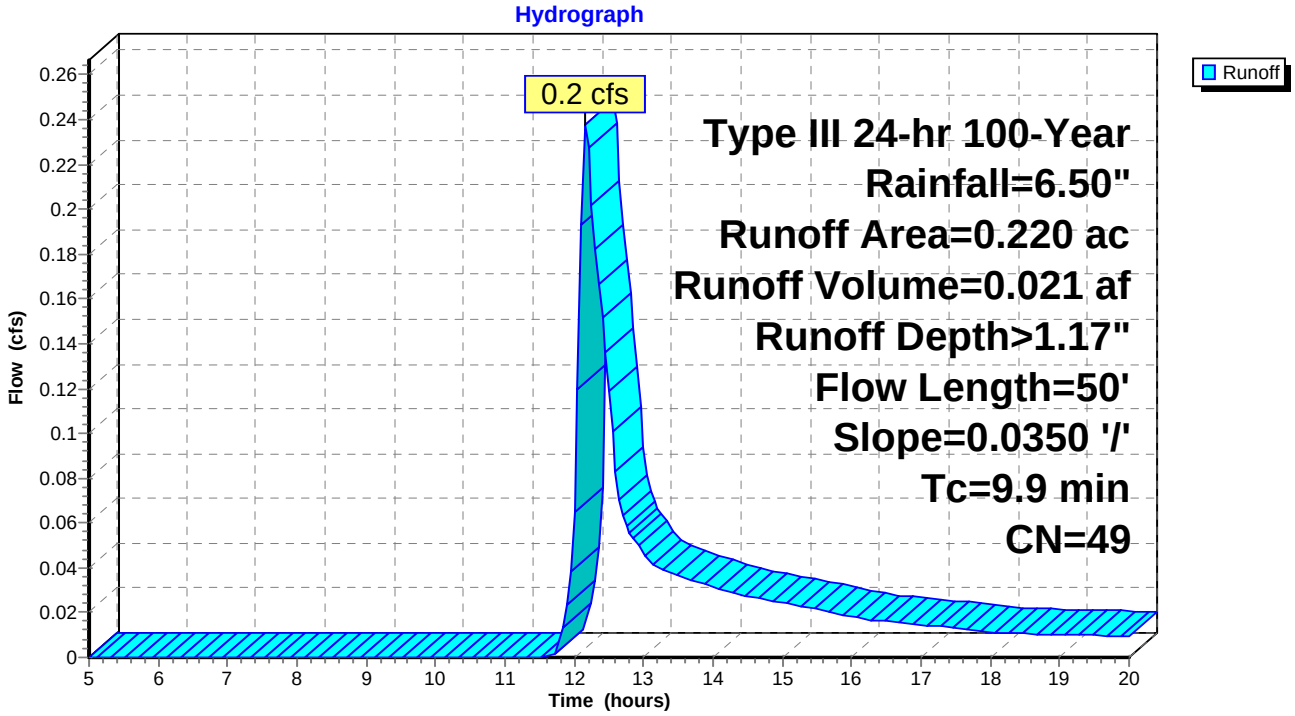
Runoff = 0.2 cfs @ 12.17 hrs, Volume= 0.021 af, Depth> 1.17"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (ac)	CN	Description
0.040	98	Paved parking, HSG A
0.160	39	>75% Grass cover, Good, HSG A
0.020	30	Woods, Good, HSG A
0.220	49	Weighted Average
0.180		81.82% Pervious Area
0.040		18.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	19	0.0350	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
6.8	31	0.0350	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
9.9	50	Total			

Subcatchment EWA-3: EWA-3



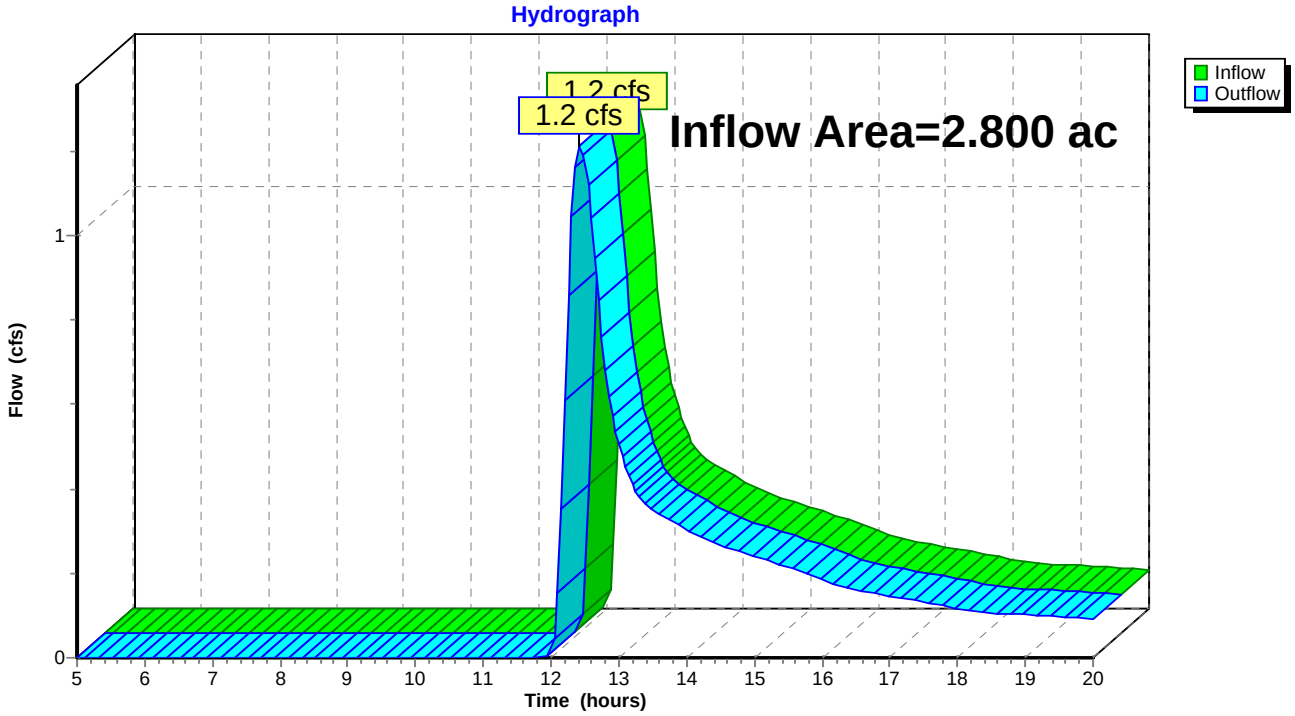
Summary for Reach DP-1: Design Point 1

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

Inflow Area = 2.800 ac, 7.86% Impervious, Inflow Depth > 0.75" for 100-Year event
Inflow = 1.2 cfs @ 12.42 hrs, Volume= 0.174 af
Outflow = 1.2 cfs @ 12.42 hrs, Volume= 0.174 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-1: Design Point 1



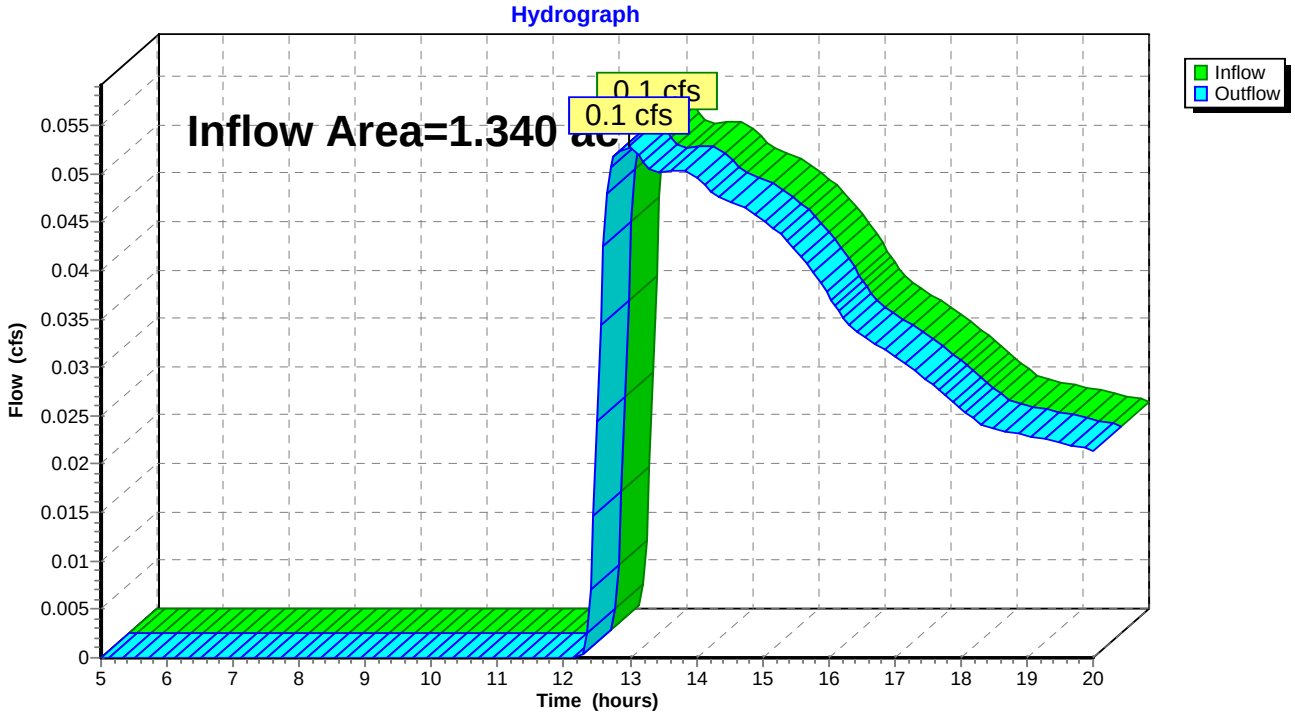
Summary for Reach DP-2: Design Point 2

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

Inflow Area = 1.340 ac, 2.99% Impervious, Inflow Depth > 0.20" for 100-Year event
Inflow = 0.1 cfs @ 12.99 hrs, Volume= 0.023 af
Outflow = 0.1 cfs @ 12.99 hrs, Volume= 0.023 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-2: Design Point 2



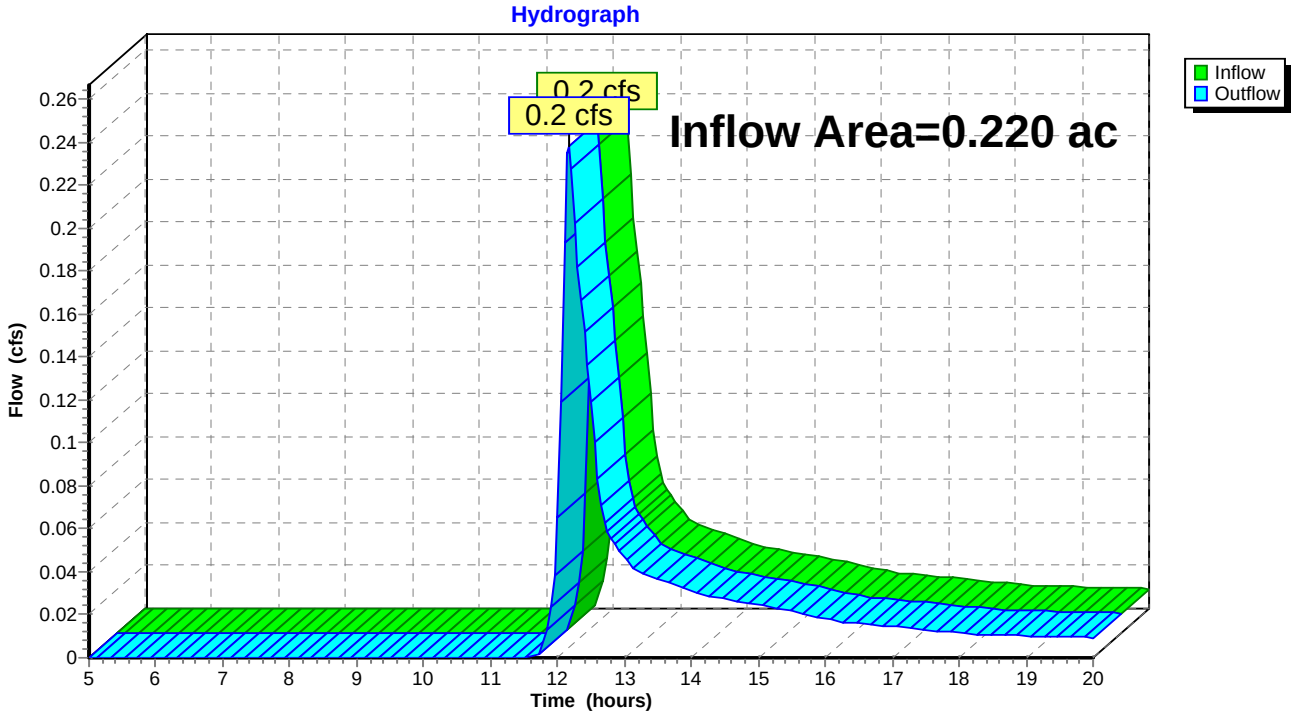
Summary for Reach DP-3: Design Point 3

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

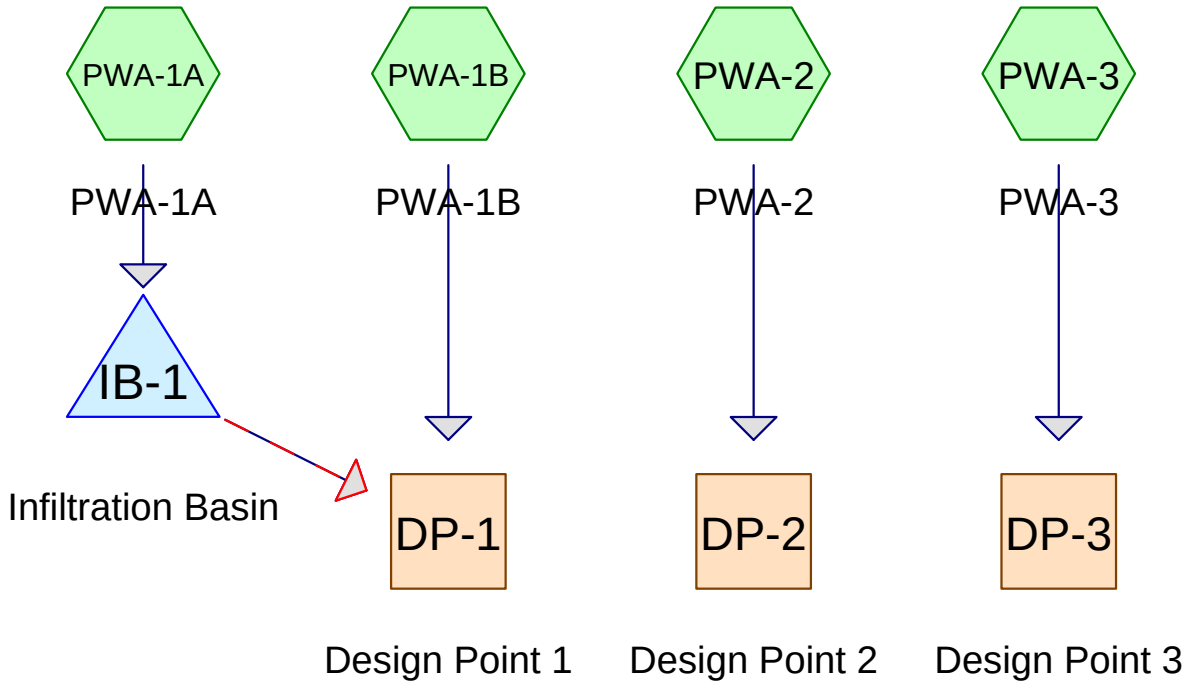
Inflow Area = 0.220 ac, 18.18% Impervious, Inflow Depth > 1.17" for 100-Year event
Inflow = 0.2 cfs @ 12.17 hrs, Volume= 0.021 af
Outflow = 0.2 cfs @ 12.17 hrs, Volume= 0.021 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-3: Design Point 3



TAB 4



Subcat Reach Pond Link

Drainage Diagram for Post-Development-112118

Prepared by Civil Design Consultants, Inc., Printed 12/4/2018

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.810	30	Woods, Good, HSG A (PWA-1A, PWA-1B, PWA-2, PWA-3)
2.370	39	>75% Grass cover, Good, HSG A (PWA-1A, PWA-1B, PWA-2, PWA-3)
0.070	70	Woods, Good, HSG C (PWA-1B)
0.230	74	>75% Grass cover, Good, HSG C (PWA-1A)
0.180	98	Offsite Impervious (PWA-1A)
0.460	98	Paved parking, HSG A (PWA-1A)
0.250	98	Roofs, HSG A (PWA-1A, PWA-1B)
4.370	52	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
3.890	HSG A	PWA-1A, PWA-1B, PWA-2, PWA-3
0.000	HSG B	
0.300	HSG C	PWA-1A, PWA-1B
0.000	HSG D	
0.180	Other	PWA-1A
4.370		**TOTAL AREA**

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Fill (inches)
1	PWA-1A	0.00	0.00	47.0	0.0050	0.013	12.0	0.0	0.0
2	IB-1	158.40	158.20	20.0	0.0100	0.013	8.0	0.0	0.0

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PWA-1A: PWA-1A Runoff Area=3.130 ac 28.12% Impervious Runoff Depth>0.26"
Flow Length=387' Tc=15.6 min CN=58 Runoff=0.4 cfs 0.068 af

Subcatchment PWA-1B: PWA-1B Runoff Area=0.640 ac 1.56% Impervious Runoff Depth=0.00"
Flow Length=140' Tc=14.0 min CN=37 Runoff=0.0 cfs 0.000 af

Subcatchment PWA-2: PWA-2 Runoff Area=0.520 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=104' Slope=0.0200 '/' Tc=9.6 min CN=37 Runoff=0.0 cfs 0.000 af

Subcatchment PWA-3: PWA-3 Runoff Area=0.080 ac 0.00% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=38 Runoff=0.0 cfs 0.000 af

Reach DP-1: Design Point 1 Inflow=0.0 cfs 0.000 af
Outflow=0.0 cfs 0.000 af

Reach DP-2: Design Point 2 Inflow=0.0 cfs 0.000 af
Outflow=0.0 cfs 0.000 af

Reach DP-3: Design Point 3 Inflow=0.0 cfs 0.000 af
Outflow=0.0 cfs 0.000 af

Pond IB-1: Infiltration Basin Peak Elev=158.24' Storage=541 cf Inflow=0.4 cfs 0.068 af
Discarded=0.2 cfs 0.068 af Primary=0.0 cfs 0.000 af Secondary=0.0 cfs 0.000 af Outflow=0.2 cfs 0.068 af

Total Runoff Area = 4.370 ac Runoff Volume = 0.068 af Average Runoff Depth = 0.19"
79.63% Pervious = 3.480 ac 20.37% Impervious = 0.890 ac

Summary for Subcatchment PWA-1A: PWA-1A

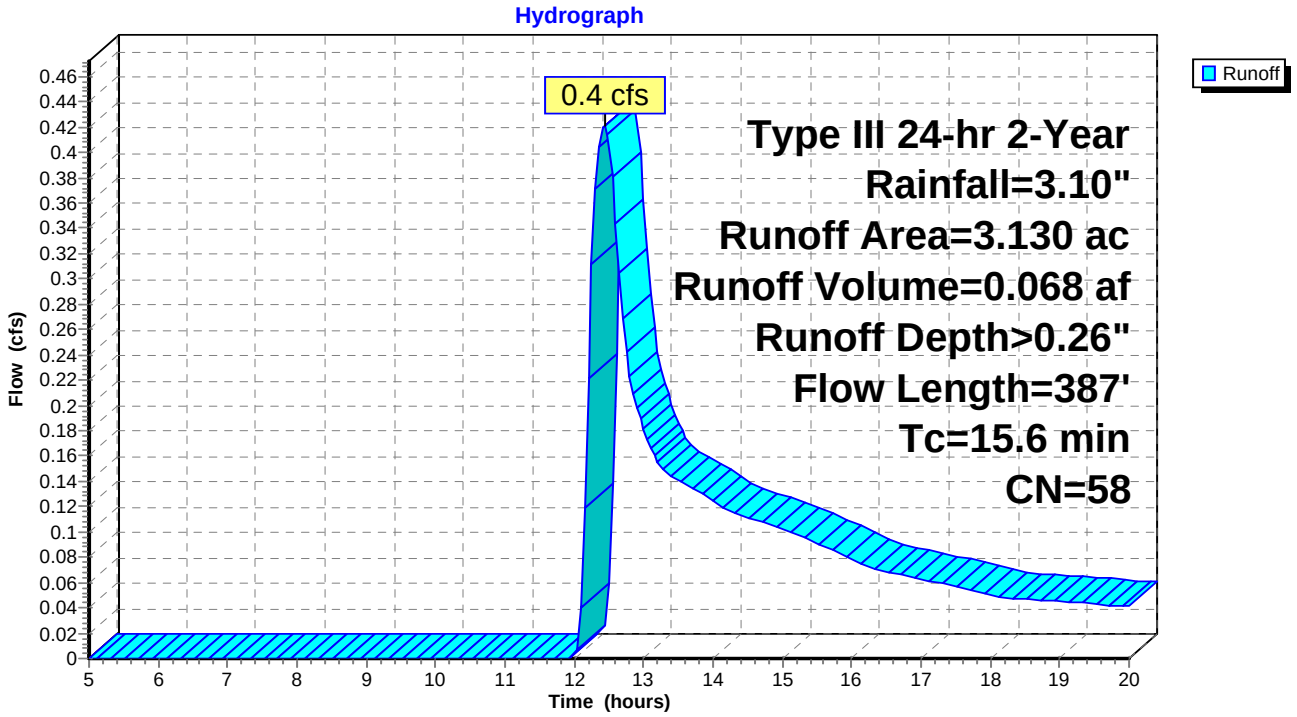
Runoff = 0.4 cfs @ 12.43 hrs, Volume= 0.068 af, Depth> 0.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

	Area (ac)	CN	Description
	0.460	98	Paved parking, HSG A
	0.240	98	Roofs, HSG A
	1.810	39	>75% Grass cover, Good, HSG A
	0.210	30	Woods, Good, HSG A
*	0.180	98	Offsite Impervious
	0.230	74	>75% Grass cover, Good, HSG C
	3.130	58	Weighted Average
	2.250		71.88% Pervious Area
	0.880		28.12% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.0	168	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.7	122	0.0350	2.81		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.2	47	0.0050	3.21	2.5	**Pipe Channel, Driveway Culvert** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
15.6	387	Total			

Subcatchment PWA-1A: PWA-1A



Summary for Subcatchment PWA-1B: PWA-1B

[45] Hint: Runoff=Zero

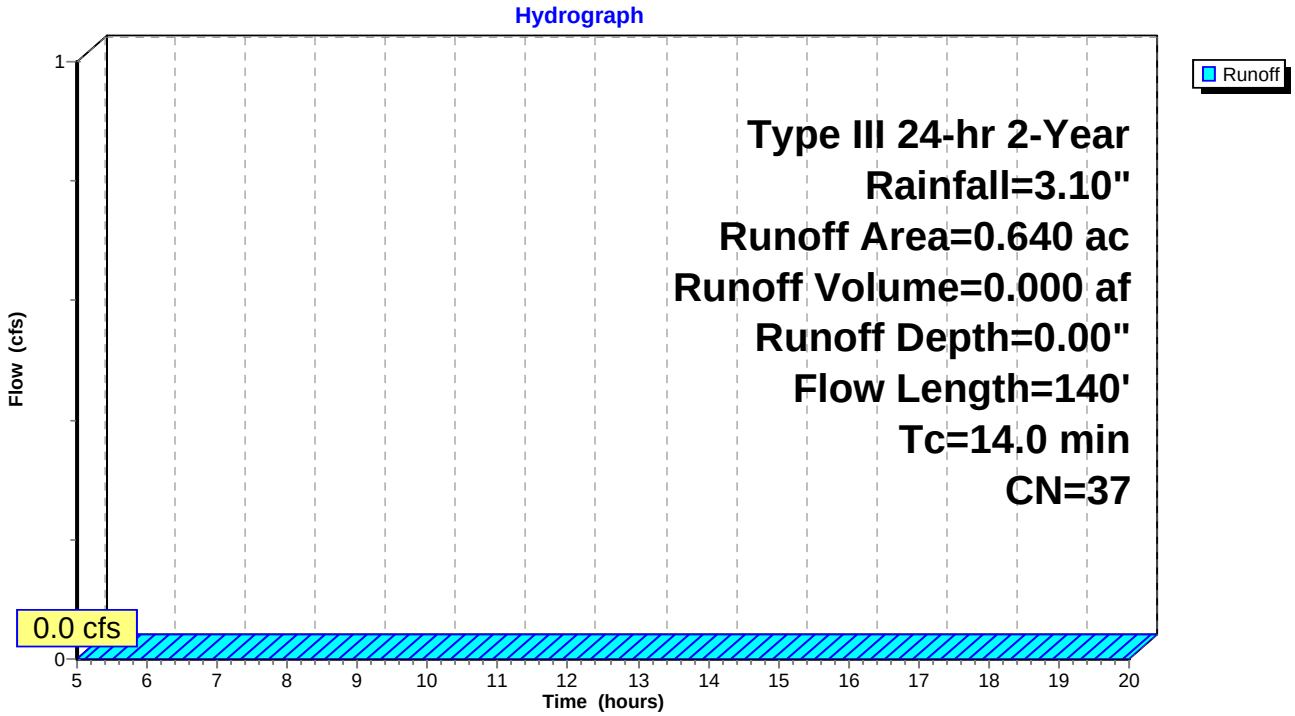
Runoff = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (ac)	CN	Description
0.070	70	Woods, Good, HSG C
0.010	98	Roofs, HSG A
0.100	39	>75% Grass cover, Good, HSG A
0.460	30	Woods, Good, HSG A
0.640	37	Weighted Average
0.630		98.44% Pervious Area
0.010		1.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.5	90	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.0	140	Total			

Subcatchment PWA-1B: PWA-1B



Summary for Subcatchment PWA-2: PWA-2

[45] Hint: Runoff=Zero

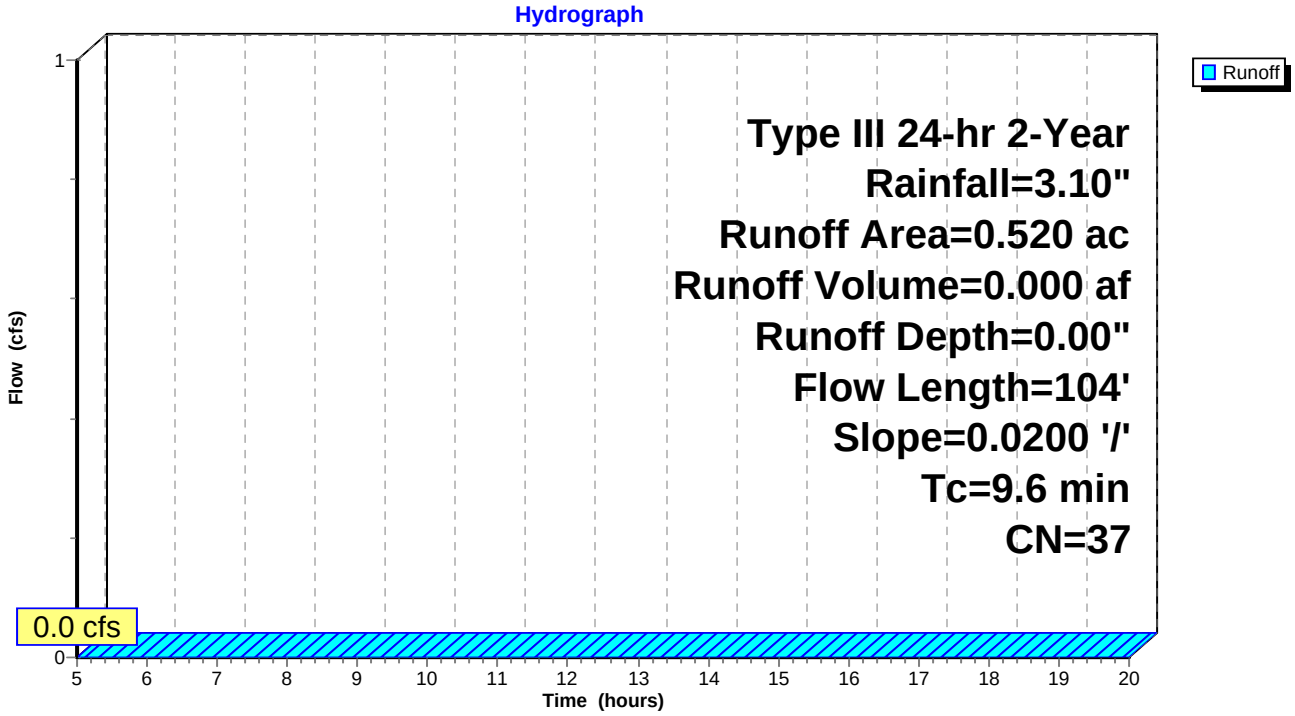
Runoff = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (ac)	CN	Description
0.130	30	Woods, Good, HSG A
0.390	39	>75% Grass cover, Good, HSG A
0.520	37	Weighted Average
0.520		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
1.3	54	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.6	104	Total			

Subcatchment PWA-2: PWA-2



Summary for Subcatchment PWA-3: PWA-3

[45] Hint: Runoff=Zero

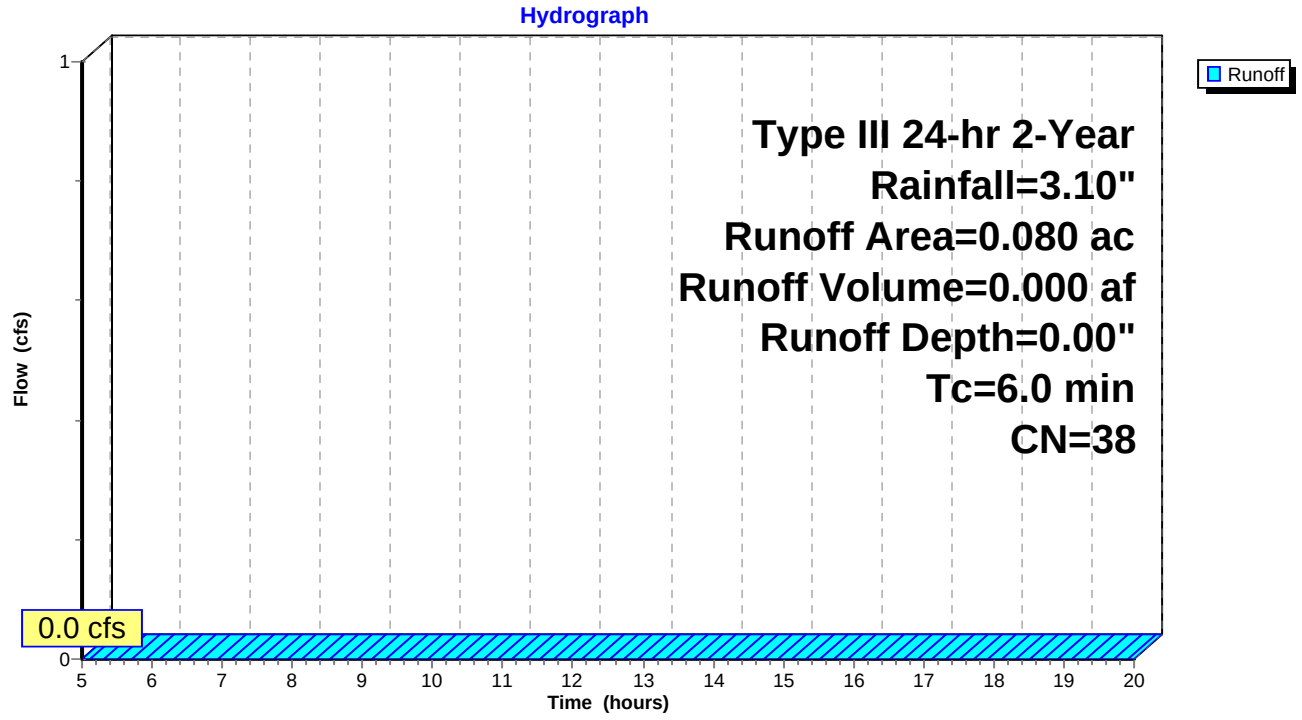
Runoff = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (ac)	CN	Description
0.070	39	>75% Grass cover, Good, HSG A
0.010	30	Woods, Good, HSG A
0.080	38	Weighted Average
0.080		100.00% Pervious Area

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

Subcatchment PWA-3: PWA-3



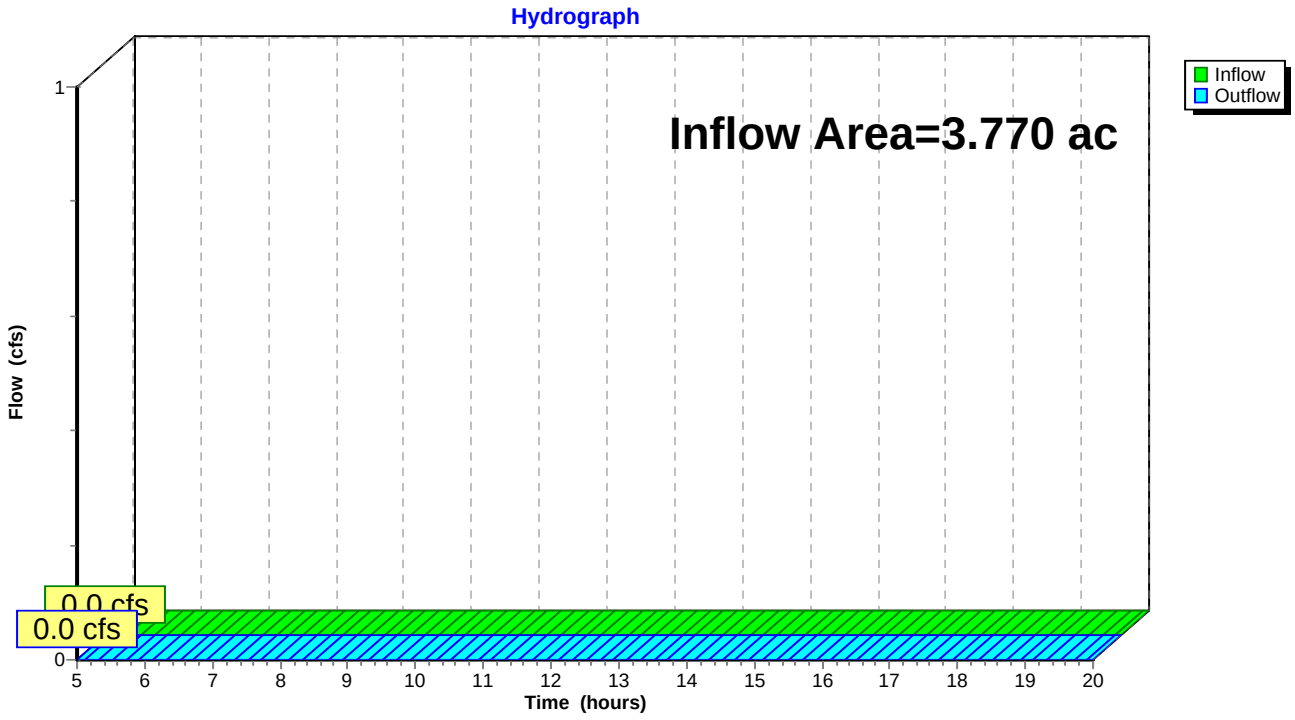
Summary for Reach DP-1: Design Point 1

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

Inflow Area = 3.770 ac, 23.61% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-1: Design Point 1



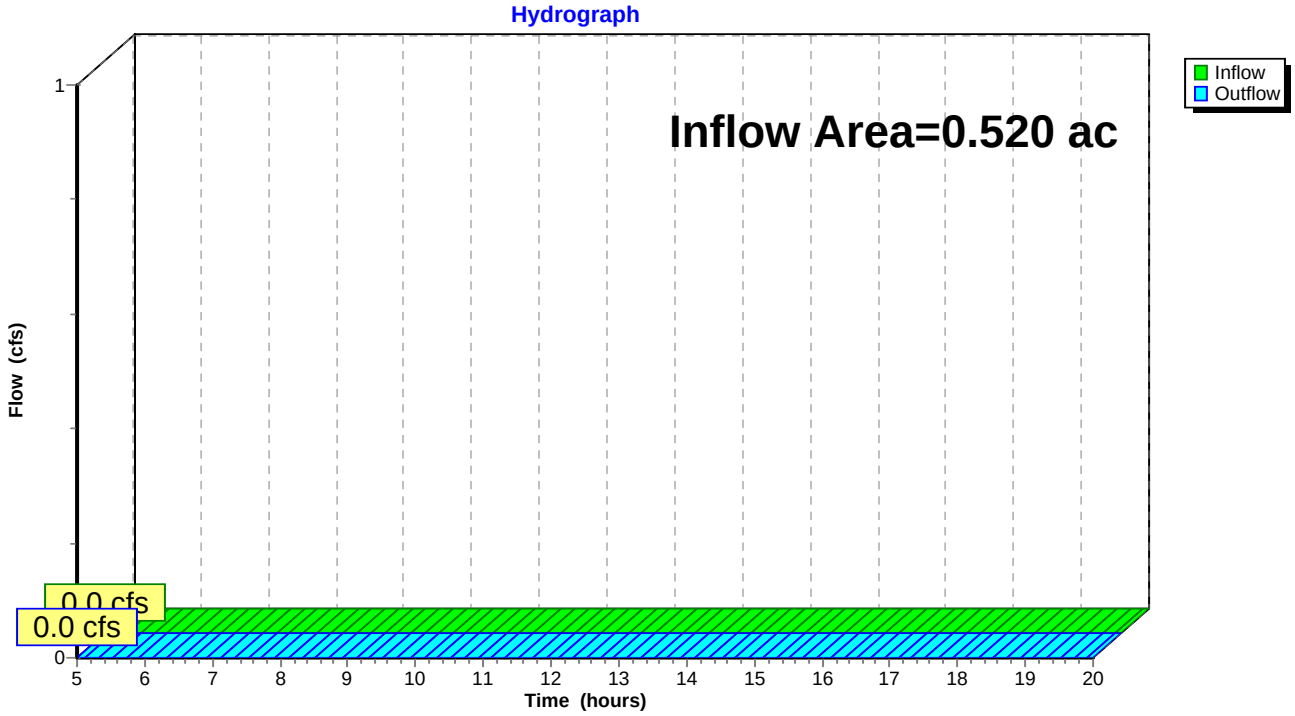
Summary for Reach DP-2: Design Point 2

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

Inflow Area = 0.520 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-2: Design Point 2



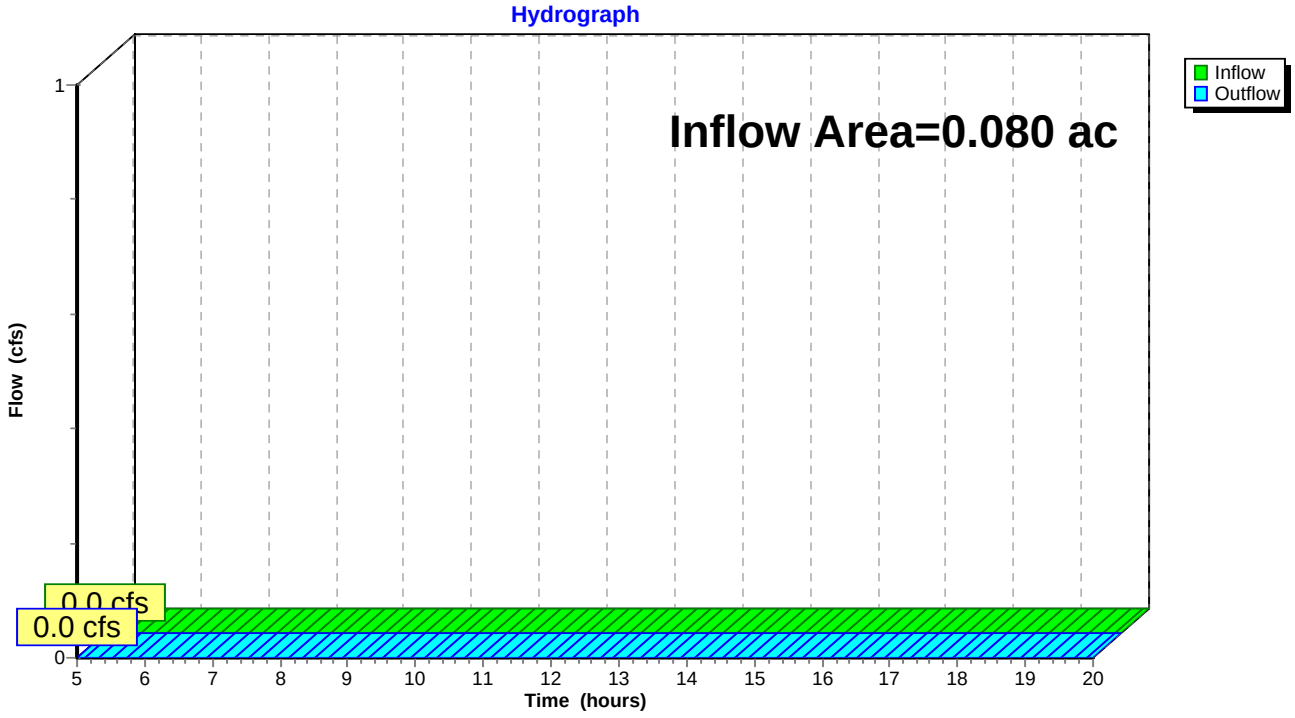
Summary for Reach DP-3: Design Point 3

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

Inflow Area = 0.080 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af
Outflow = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-3: Design Point 3



Summary for Pond IB-1: Infiltration Basin

Inflow Area = 3.130 ac, 28.12% Impervious, Inflow Depth > 0.26" for 2-Year event
Inflow = 0.4 cfs @ 12.43 hrs, Volume= 0.068 af
Outflow = 0.2 cfs @ 13.23 hrs, Volume= 0.068 af, Atten= 64%, Lag= 47.8 min
Discarded = 0.2 cfs @ 13.23 hrs, Volume= 0.068 af
Primary = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af
Secondary = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 158.24' @ 13.23 hrs Surf.Area= 2,736 sf Storage= 541 cf

Plug-Flow detention time= 36.8 min calculated for 0.067 af (99% of inflow)
Center-of-Mass det. time= 34.7 min (915.3 - 880.6)

Volume	Invert	Avail.Storage	Storage Description
#1	158.00'	16,264 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
158.00	1,777	0	0	1,777
159.00	7,090	4,139	4,139	7,095
160.00	8,427	7,749	11,888	8,468
160.50	9,083	4,376	16,264	9,144

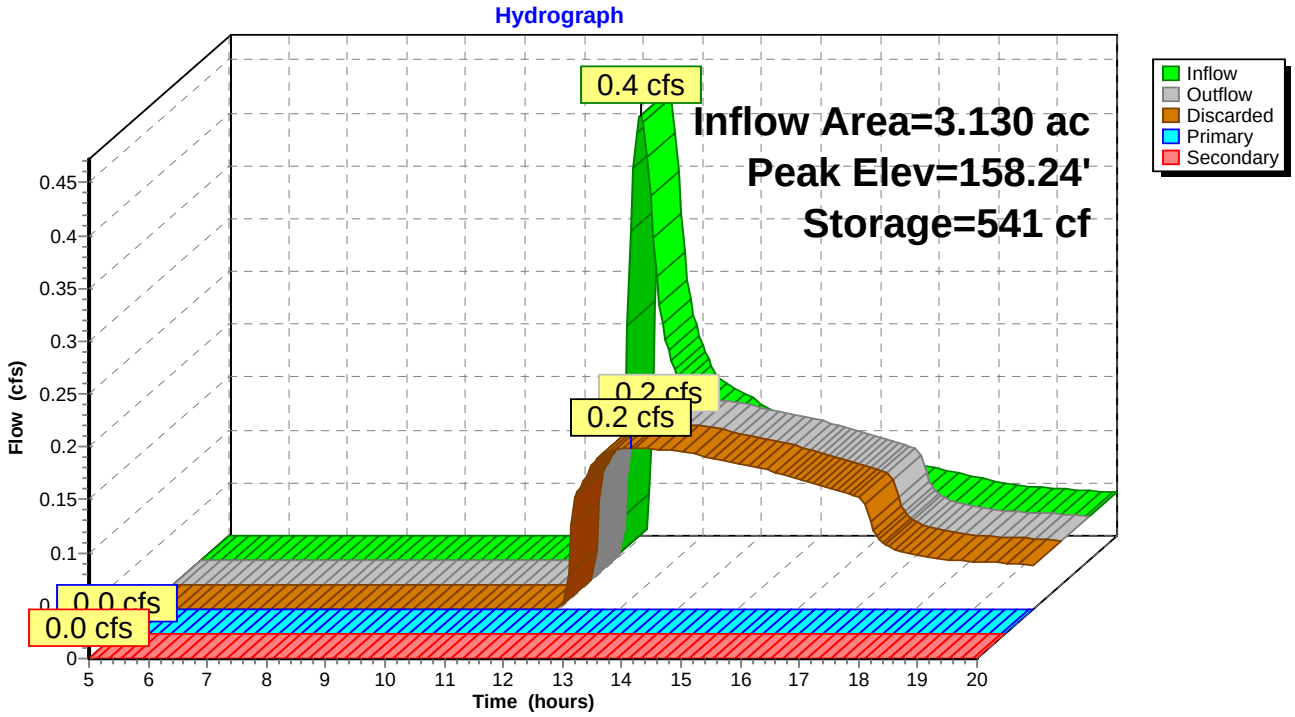
Device	Routing	Invert	Outlet Devices
#1	Discarded	158.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	158.40'	**8.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 158.40' / 158.20' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#3	Secondary	159.50'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#4	Device 2	159.50'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	158.65'	**60.0 deg Sharp-Crested Vee/Trap Weir** C= 2.53

Discarded OutFlow Max=0.2 cfs @ 13.23 hrs HW=158.24' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.2 cfs)

Primary OutFlow Max=0.0 cfs @ 5.00 hrs HW=158.00' (Free Discharge)
└**2=Culvert** (Controls 0.0 cfs)
  └**4=Orifice/Grate** (Controls 0.0 cfs)
  └**5=Sharp-Crested Vee/Trap Weir** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 5.00 hrs HW=158.00' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond IB-1: Infiltration Basin



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PWA-1A: PWA-1A Runoff Area=3.130 ac 28.12% Impervious Runoff Depth>0.80"
Flow Length=387' Tc=15.6 min CN=58 Runoff=2.0 cfs 0.209 af

Subcatchment PWA-1B: PWA-1B Runoff Area=0.640 ac 1.56% Impervious Runoff Depth>0.04"
Flow Length=140' Tc=14.0 min CN=37 Runoff=0.0 cfs 0.002 af

Subcatchment PWA-2: PWA-2 Runoff Area=0.520 ac 0.00% Impervious Runoff Depth>0.04"
Flow Length=104' Slope=0.0200 '/' Tc=9.6 min CN=37 Runoff=0.0 cfs 0.002 af

Subcatchment PWA-3: PWA-3 Runoff Area=0.080 ac 0.00% Impervious Runoff Depth>0.06"
Tc=6.0 min CN=38 Runoff=0.0 cfs 0.000 af

Reach DP-1: Design Point 1 Inflow=0.0 cfs 0.008 af
Outflow=0.0 cfs 0.008 af

Reach DP-2: Design Point 2 Inflow=0.0 cfs 0.002 af
Outflow=0.0 cfs 0.002 af

Reach DP-3: Design Point 3 Inflow=0.0 cfs 0.000 af
Outflow=0.0 cfs 0.000 af

Pond IB-1: Infiltration Basin Peak Elev=158.87' Storage=3,278 cf Inflow=2.0 cfs 0.209 af
Discarded=0.3 cfs 0.184 af Primary=0.0 cfs 0.006 af Secondary=0.0 cfs 0.000 af Outflow=0.4 cfs 0.190 af

Total Runoff Area = 4.370 ac Runoff Volume = 0.214 af Average Runoff Depth = 0.59"
79.63% Pervious = 3.480 ac 20.37% Impervious = 0.890 ac

Summary for Subcatchment PWA-1A: PWA-1A

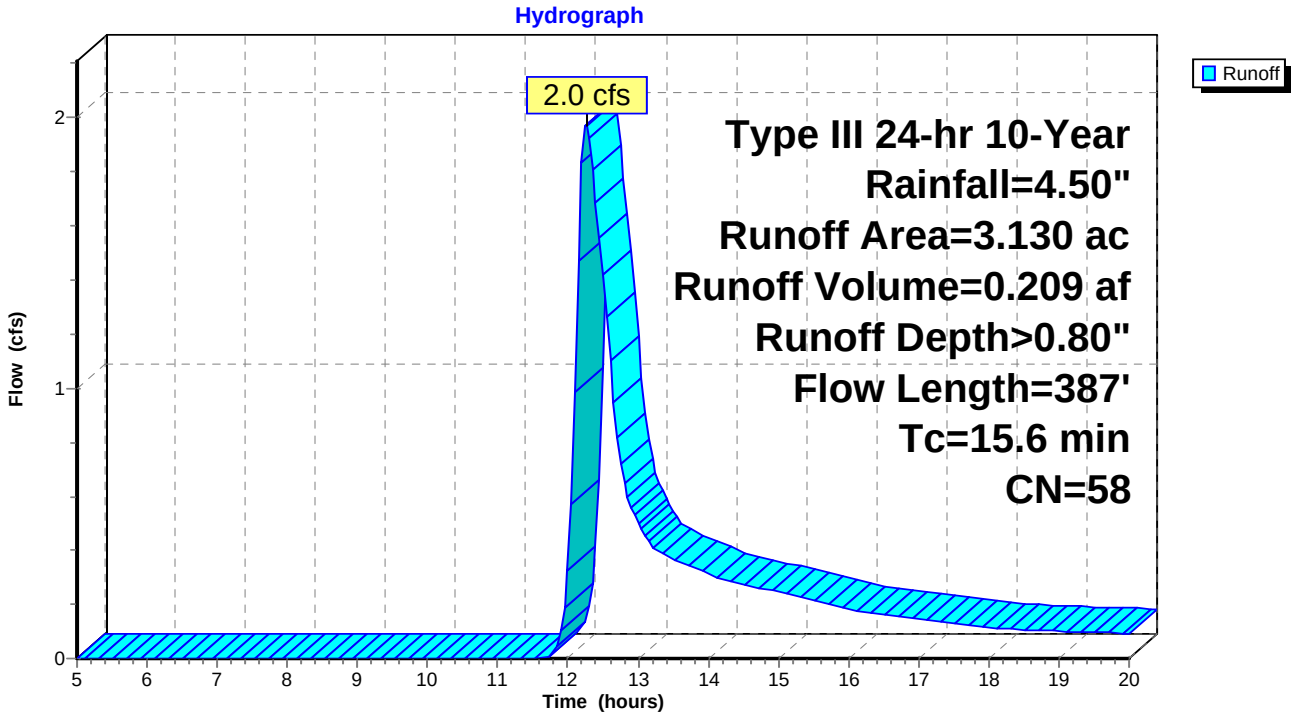
Runoff = 2.0 cfs @ 12.26 hrs, Volume= 0.209 af, Depth> 0.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

	Area (ac)	CN	Description
	0.460	98	Paved parking, HSG A
	0.240	98	Roofs, HSG A
	1.810	39	>75% Grass cover, Good, HSG A
	0.210	30	Woods, Good, HSG A
*	0.180	98	Offsite Impervious
	0.230	74	>75% Grass cover, Good, HSG C
	3.130	58	Weighted Average
	2.250		71.88% Pervious Area
	0.880		28.12% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.0	168	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.7	122	0.0350	2.81		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.2	47	0.0050	3.21	2.5	**Pipe Channel, Driveway Culvert** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
15.6	387	Total			

Subcatchment PWA-1A: PWA-1A



Summary for Subcatchment PWA-1B: PWA-1B

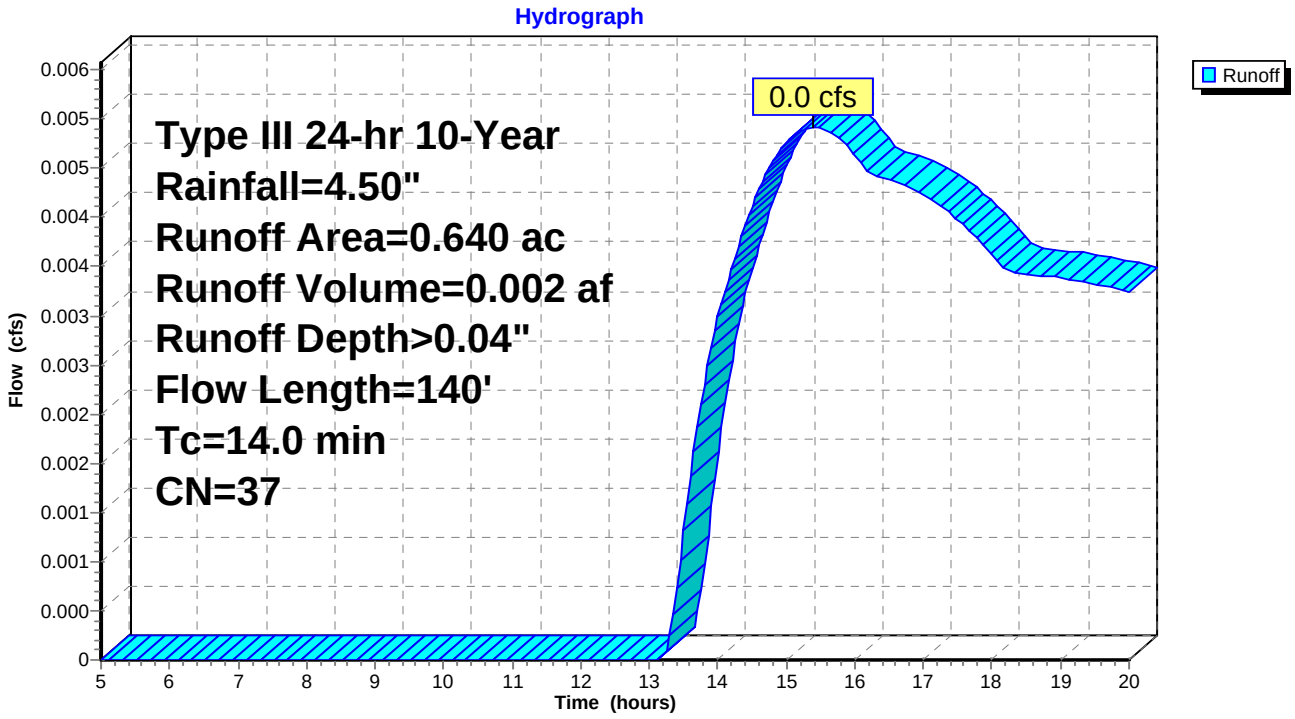
Runoff = 0.0 cfs @ 15.40 hrs, Volume= 0.002 af, Depth> 0.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (ac)	CN	Description
0.070	70	Woods, Good, HSG C
0.010	98	Roofs, HSG A
0.100	39	>75% Grass cover, Good, HSG A
0.460	30	Woods, Good, HSG A
0.640	37	Weighted Average
0.630		98.44% Pervious Area
0.010		1.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.5	90	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.0	140	Total			

Subcatchment PWA-1B: PWA-1B



Summary for Subcatchment PWA-2: PWA-2

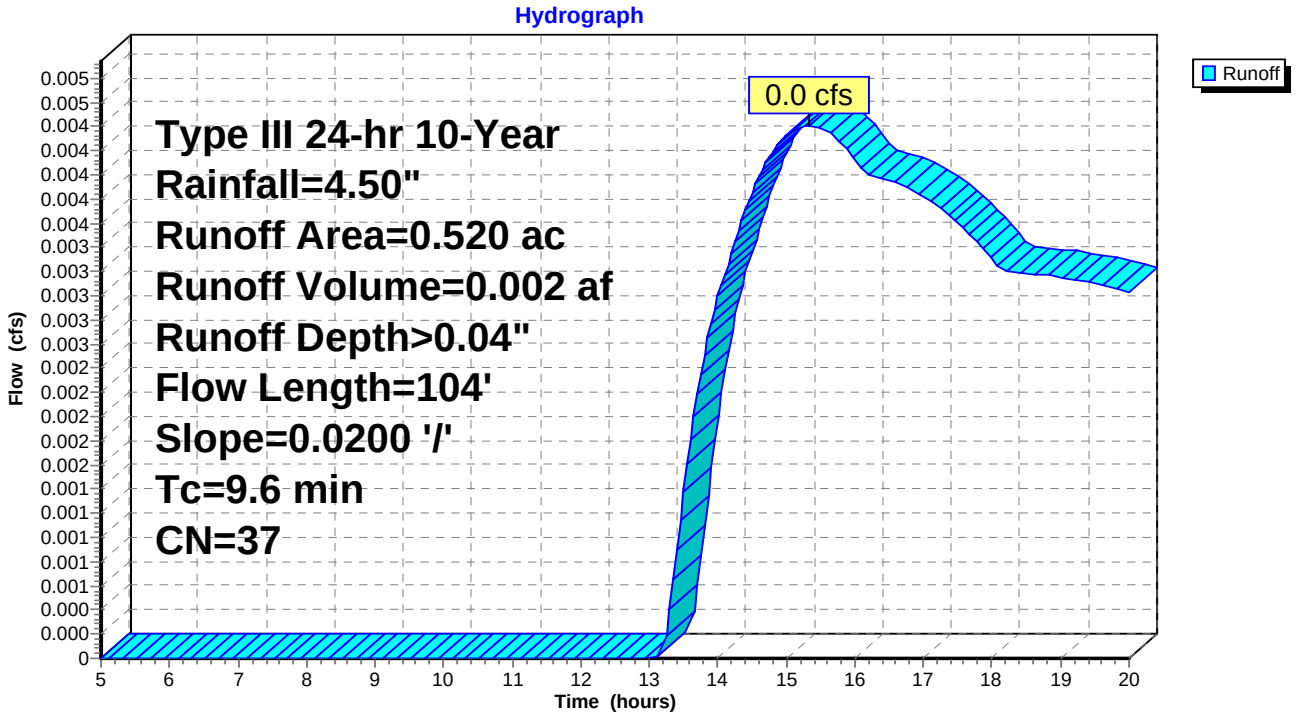
Runoff = 0.0 cfs @ 15.34 hrs, Volume= 0.002 af, Depth> 0.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (ac)	CN	Description
0.130	30	Woods, Good, HSG A
0.390	39	>75% Grass cover, Good, HSG A
0.520	37	Weighted Average
0.520		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
1.3	54	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.6	104	Total			

Subcatchment PWA-2: PWA-2



Summary for Subcatchment PWA-3: PWA-3

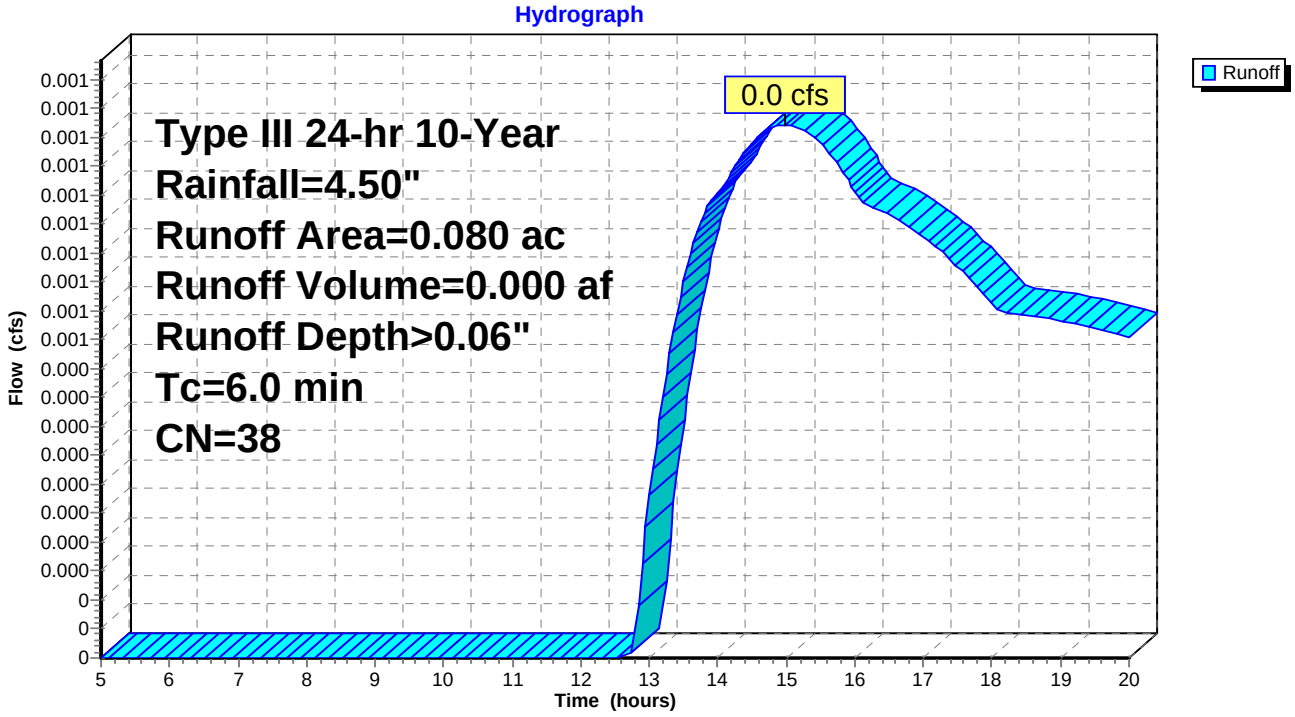
Runoff = 0.0 cfs @ 14.98 hrs, Volume= 0.000 af, Depth> 0.06"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (ac)	CN	Description
0.070	39	>75% Grass cover, Good, HSG A
0.010	30	Woods, Good, HSG A
0.080	38	Weighted Average
0.080		100.00% Pervious Area

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

Subcatchment PWA-3: PWA-3



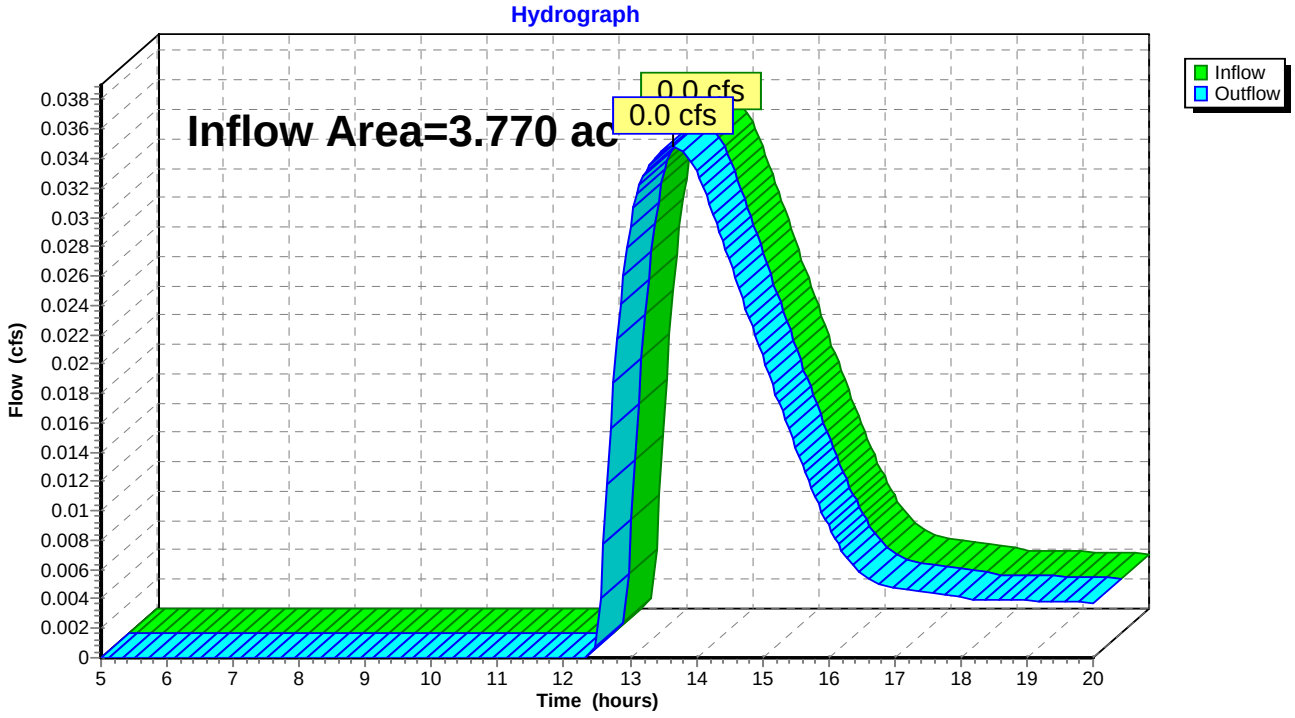
Summary for Reach DP-1: Design Point 1

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

Inflow Area = 3.770 ac, 23.61% Impervious, Inflow Depth > 0.03" for 10-Year event
Inflow = 0.0 cfs @ 13.63 hrs, Volume= 0.008 af
Outflow = 0.0 cfs @ 13.63 hrs, Volume= 0.008 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-1: Design Point 1



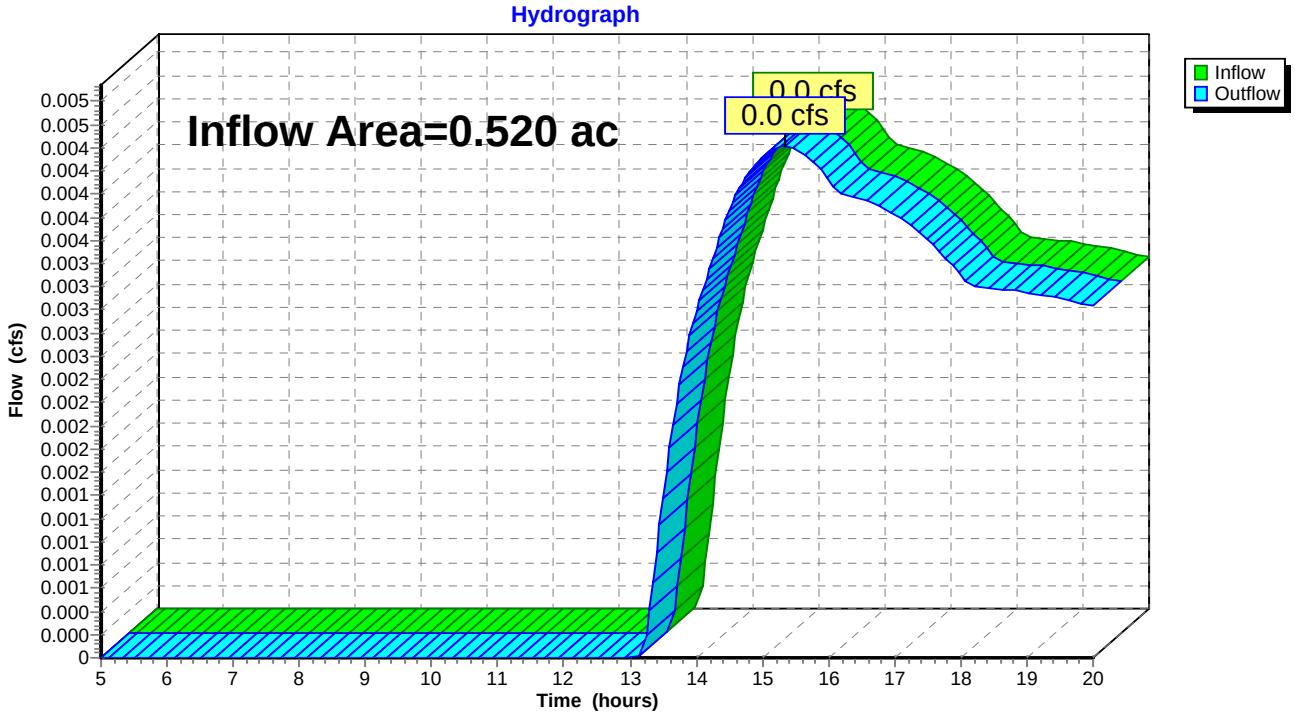
Summary for Reach DP-2: Design Point 2

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

Inflow Area = 0.520 ac, 0.00% Impervious, Inflow Depth > 0.04" for 10-Year event
Inflow = 0.0 cfs @ 15.34 hrs, Volume= 0.002 af
Outflow = 0.0 cfs @ 15.34 hrs, Volume= 0.002 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-2: Design Point 2



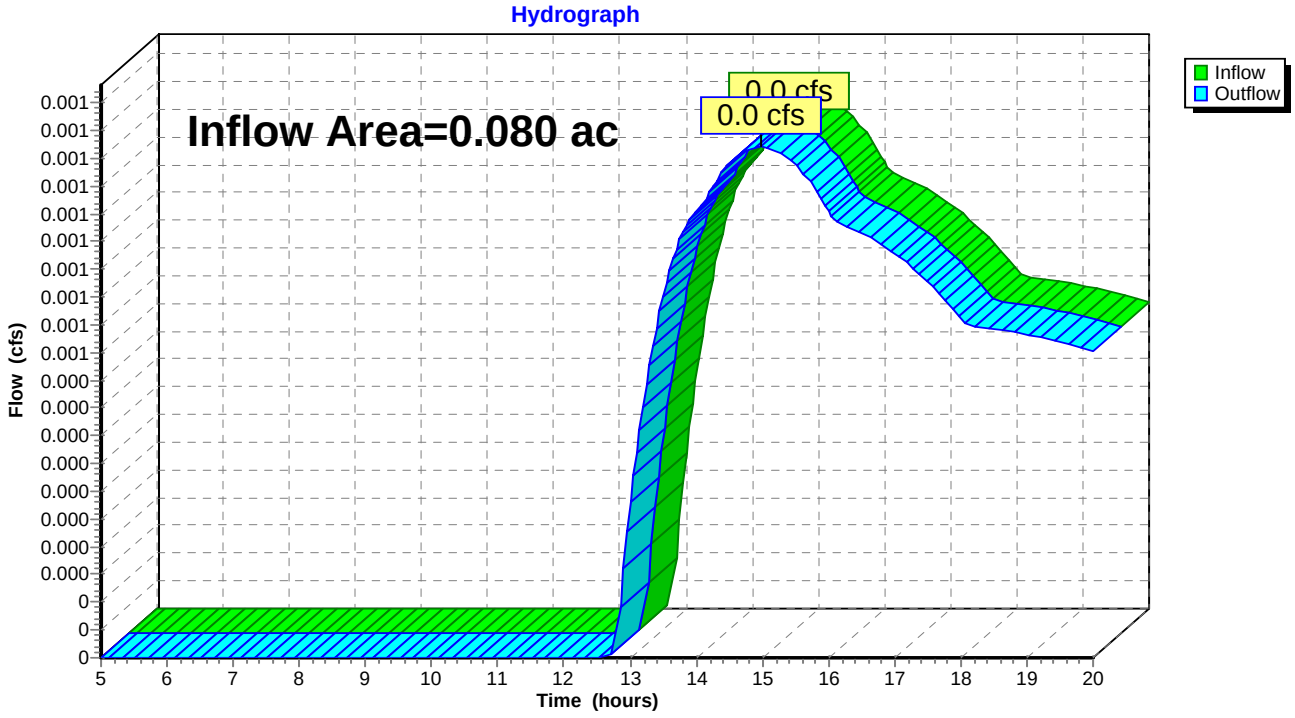
Summary for Reach DP-3: Design Point 3

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

Inflow Area = 0.080 ac, 0.00% Impervious, Inflow Depth > 0.06" for 10-Year event
Inflow = 0.0 cfs @ 14.98 hrs, Volume= 0.000 af
Outflow = 0.0 cfs @ 14.98 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-3: Design Point 3



Summary for Pond IB-1: Infiltration Basin

Inflow Area = 3.130 ac, 28.12% Impervious, Inflow Depth > 0.80" for 10-Year event
Inflow = 2.0 cfs @ 12.26 hrs, Volume= 0.209 af
Outflow = 0.4 cfs @ 13.40 hrs, Volume= 0.190 af, Atten= 81%, Lag= 68.2 min
Discarded = 0.3 cfs @ 13.40 hrs, Volume= 0.184 af
Primary = 0.0 cfs @ 13.40 hrs, Volume= 0.006 af
Secondary = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 158.87' @ 13.40 hrs Surf.Area= 6,202 sf Storage= 3,278 cf

Plug-Flow detention time= 121.1 min calculated for 0.189 af (90% of inflow)
Center-of-Mass det. time= 92.0 min (938.6 - 846.6)

Volume	Invert	Avail.Storage	Storage Description
#1	158.00'	16,264 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
158.00	1,777	0	0	1,777
159.00	7,090	4,139	4,139	7,095
160.00	8,427	7,749	11,888	8,468
160.50	9,083	4,376	16,264	9,144

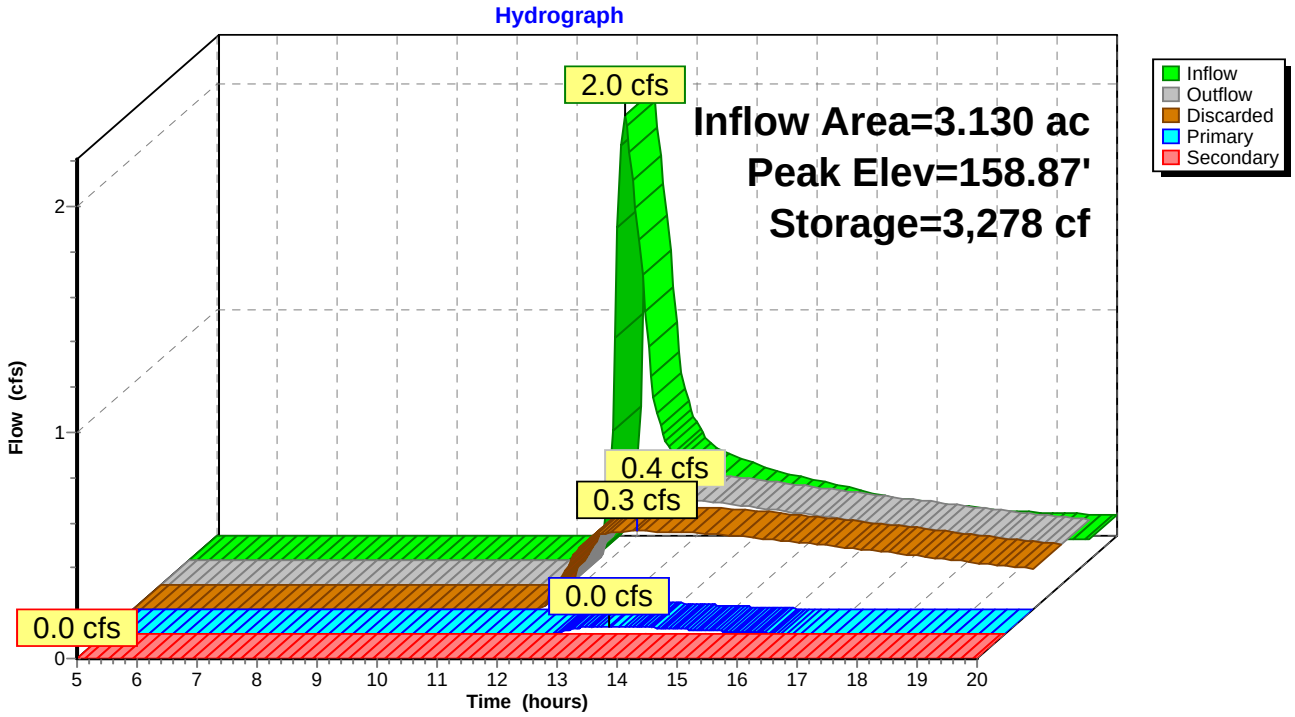
Device	Routing	Invert	Outlet Devices
#1	Discarded	158.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	158.40'	**8.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 158.40' / 158.20' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#3	Secondary	159.50'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#4	Device 2	159.50'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	158.65'	**60.0 deg Sharp-Crested Vee/Trap Weir** C= 2.53

Discarded OutFlow Max=0.3 cfs @ 13.40 hrs HW=158.87' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.3 cfs)

Primary OutFlow Max=0.0 cfs @ 13.40 hrs HW=158.87' (Free Discharge)
└**2=Culvert** (Passes 0.0 cfs of 0.5 cfs potential flow)
  └**4=Orifice/Grate** (Controls 0.0 cfs)
  └**5=Sharp-Crested Vee/Trap Weir** (Weir Controls 0.0 cfs @ 1.19 fps)

Secondary OutFlow Max=0.0 cfs @ 5.00 hrs HW=158.00' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond IB-1: Infiltration Basin



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PWA-1A: PWA-1A Runoff Area=3.130 ac 28.12% Impervious Runoff Depth>1.20"
Flow Length=387' Tc=15.6 min CN=58 Runoff=3.2 cfs 0.313 af

Subcatchment PWA-1B: PWA-1B Runoff Area=0.640 ac 1.56% Impervious Runoff Depth>0.15"
Flow Length=140' Tc=14.0 min CN=37 Runoff=0.0 cfs 0.008 af

Subcatchment PWA-2: PWA-2 Runoff Area=0.520 ac 0.00% Impervious Runoff Depth>0.15"
Flow Length=104' Slope=0.0200 '/' Tc=9.6 min CN=37 Runoff=0.0 cfs 0.006 af

Subcatchment PWA-3: PWA-3 Runoff Area=0.080 ac 0.00% Impervious Runoff Depth>0.18"
Tc=6.0 min CN=38 Runoff=0.0 cfs 0.001 af

Reach DP-1: Design Point 1 Inflow=0.3 cfs 0.058 af
Outflow=0.3 cfs 0.058 af

Reach DP-2: Design Point 2 Inflow=0.0 cfs 0.006 af
Outflow=0.0 cfs 0.006 af

Reach DP-3: Design Point 3 Inflow=0.0 cfs 0.001 af
Outflow=0.0 cfs 0.001 af

Pond IB-1: Infiltration Basin Peak Elev=159.14' Storage=5,162 cf Inflow=3.2 cfs 0.313 af
Discarded=0.4 cfs 0.227 af Primary=0.2 cfs 0.051 af Secondary=0.0 cfs 0.000 af Outflow=0.7 cfs 0.278 af

Total Runoff Area = 4.370 ac Runoff Volume = 0.328 af Average Runoff Depth = 0.90"
79.63% Pervious = 3.480 ac 20.37% Impervious = 0.890 ac

Summary for Subcatchment PWA-1A: PWA-1A

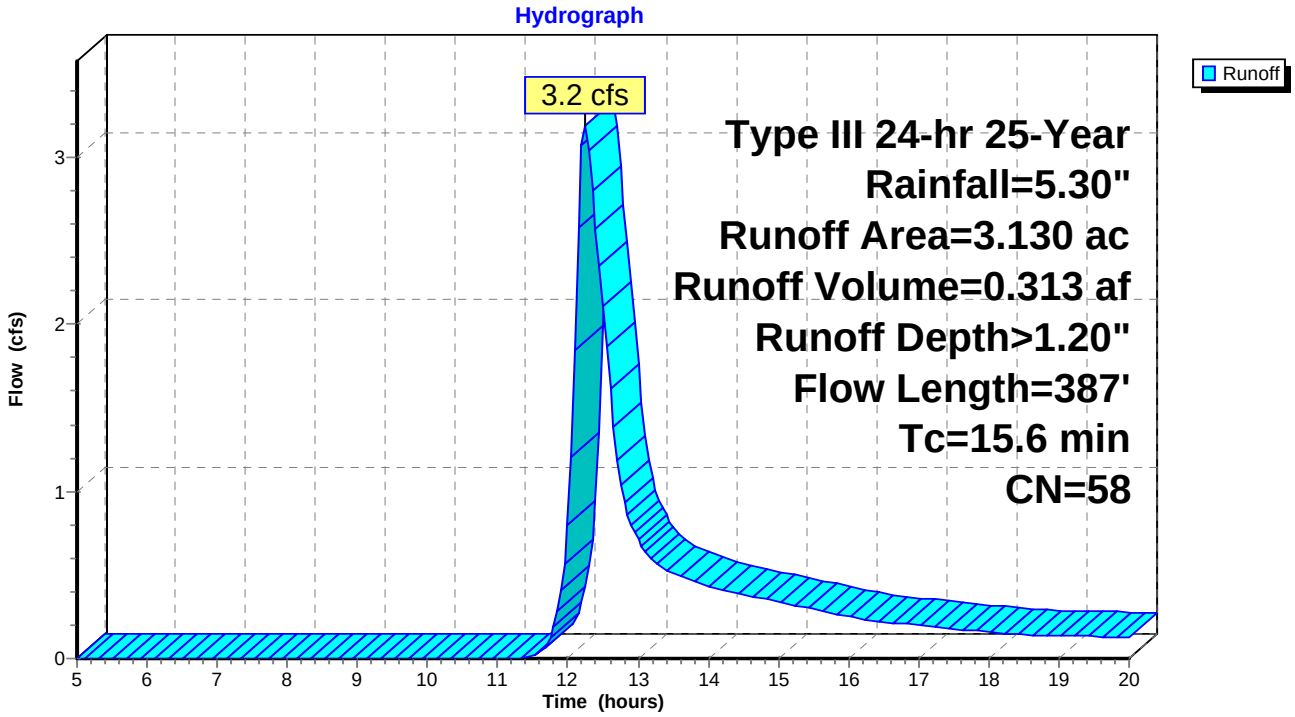
Runoff = 3.2 cfs @ 12.25 hrs, Volume= 0.313 af, Depth> 1.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

	Area (ac)	CN	Description
	0.460	98	Paved parking, HSG A
	0.240	98	Roofs, HSG A
	1.810	39	>75% Grass cover, Good, HSG A
	0.210	30	Woods, Good, HSG A
*	0.180	98	Offsite Impervious
	0.230	74	>75% Grass cover, Good, HSG C
	3.130	58	Weighted Average
	2.250		71.88% Pervious Area
	0.880		28.12% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.0	168	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.7	122	0.0350	2.81		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.2	47	0.0050	3.21	2.5	**Pipe Channel, Driveway Culvert** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
15.6	387	Total			

Subcatchment PWA-1A: PWA-1A



Summary for Subcatchment PWA-1B: PWA-1B

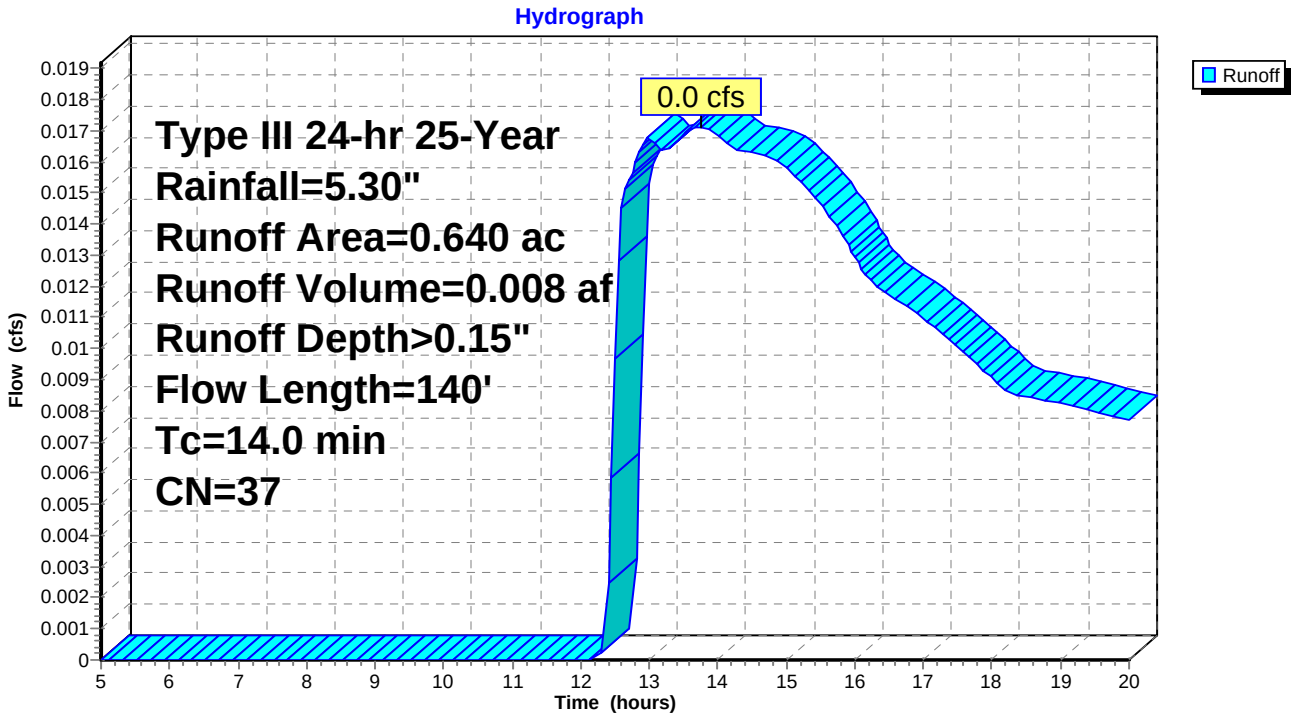
Runoff = 0.0 cfs @ 13.74 hrs, Volume= 0.008 af, Depth> 0.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

Area (ac)	CN	Description
0.070	70	Woods, Good, HSG C
0.010	98	Roofs, HSG A
0.100	39	>75% Grass cover, Good, HSG A
0.460	30	Woods, Good, HSG A
0.640	37	Weighted Average
0.630		98.44% Pervious Area
0.010		1.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.5	90	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.0	140	Total			

Subcatchment PWA-1B: PWA-1B



Summary for Subcatchment PWA-2: PWA-2

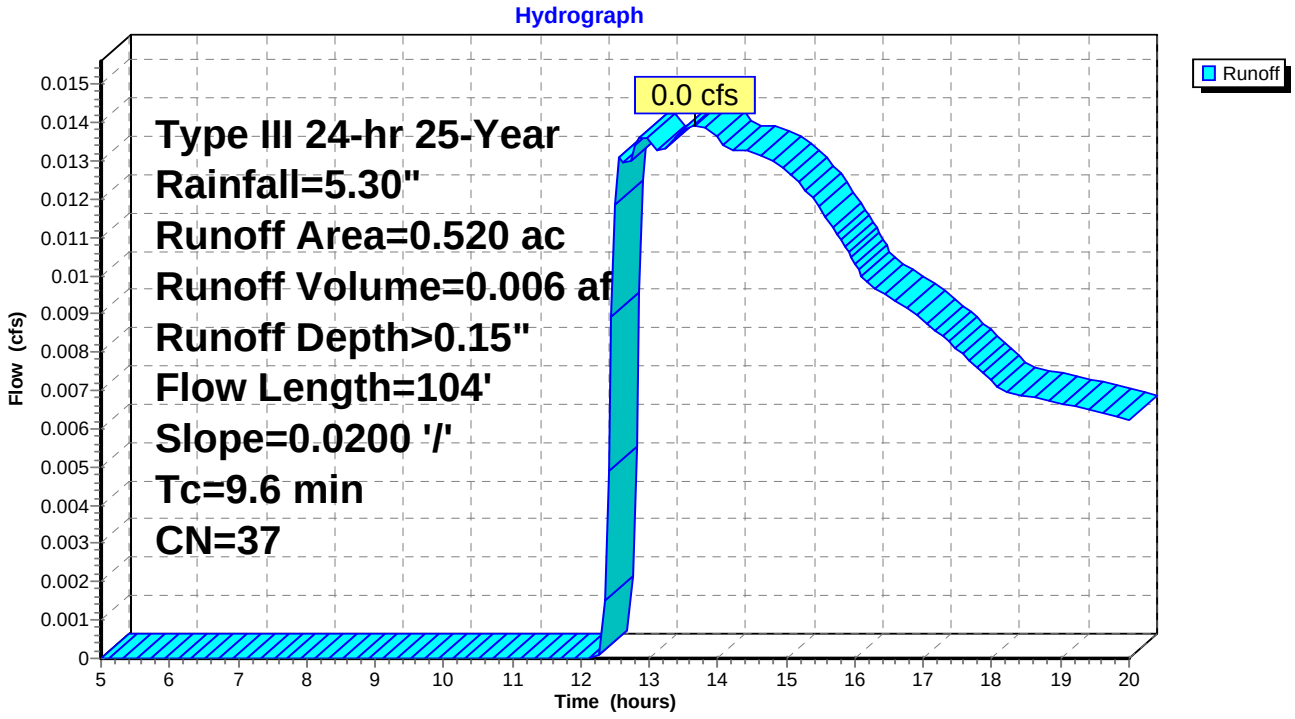
Runoff = 0.0 cfs @ 13.67 hrs, Volume= 0.006 af, Depth> 0.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

Area (ac)	CN	Description
0.130	30	Woods, Good, HSG A
0.390	39	>75% Grass cover, Good, HSG A
0.520	37	Weighted Average
0.520		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
1.3	54	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.6	104	Total			

Subcatchment PWA-2: PWA-2



Summary for Subcatchment PWA-3: PWA-3

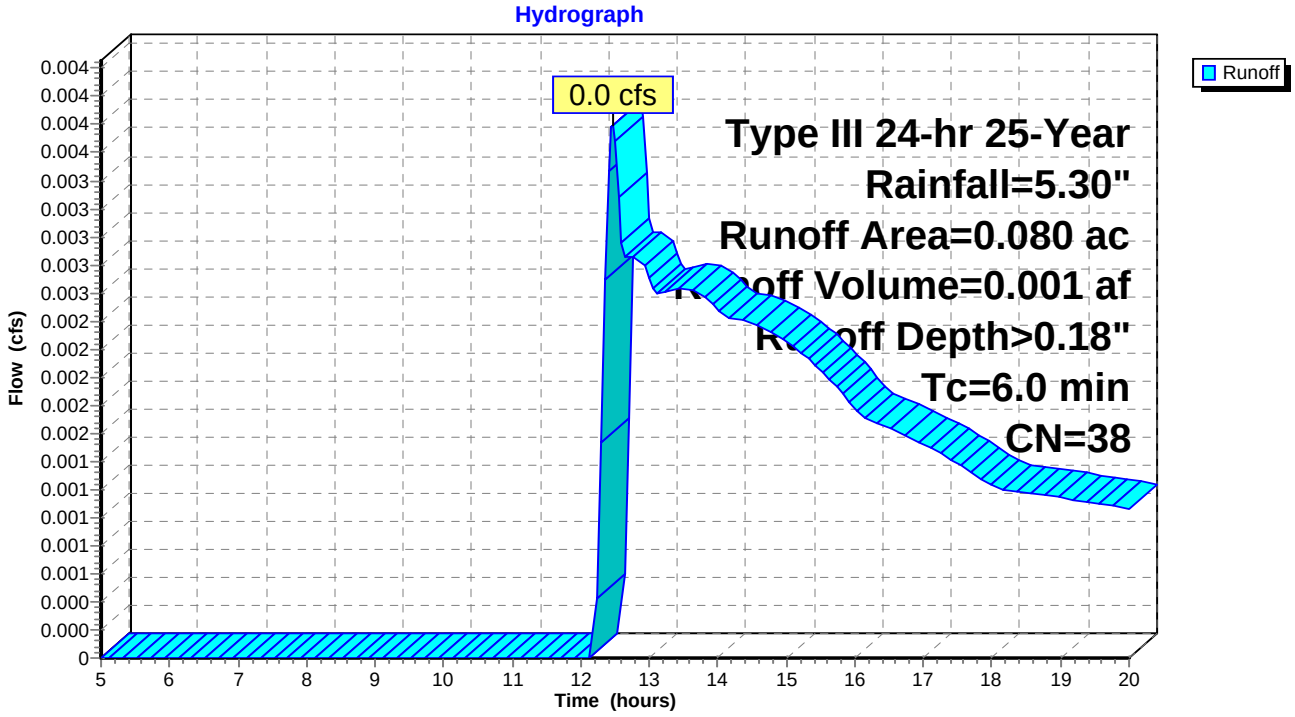
Runoff = 0.0 cfs @ 12.46 hrs, Volume= 0.001 af, Depth> 0.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

Area (ac)	CN	Description
0.070	39	>75% Grass cover, Good, HSG A
0.010	30	Woods, Good, HSG A
0.080	38	Weighted Average
0.080		100.00% Pervious Area

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

Subcatchment PWA-3: PWA-3



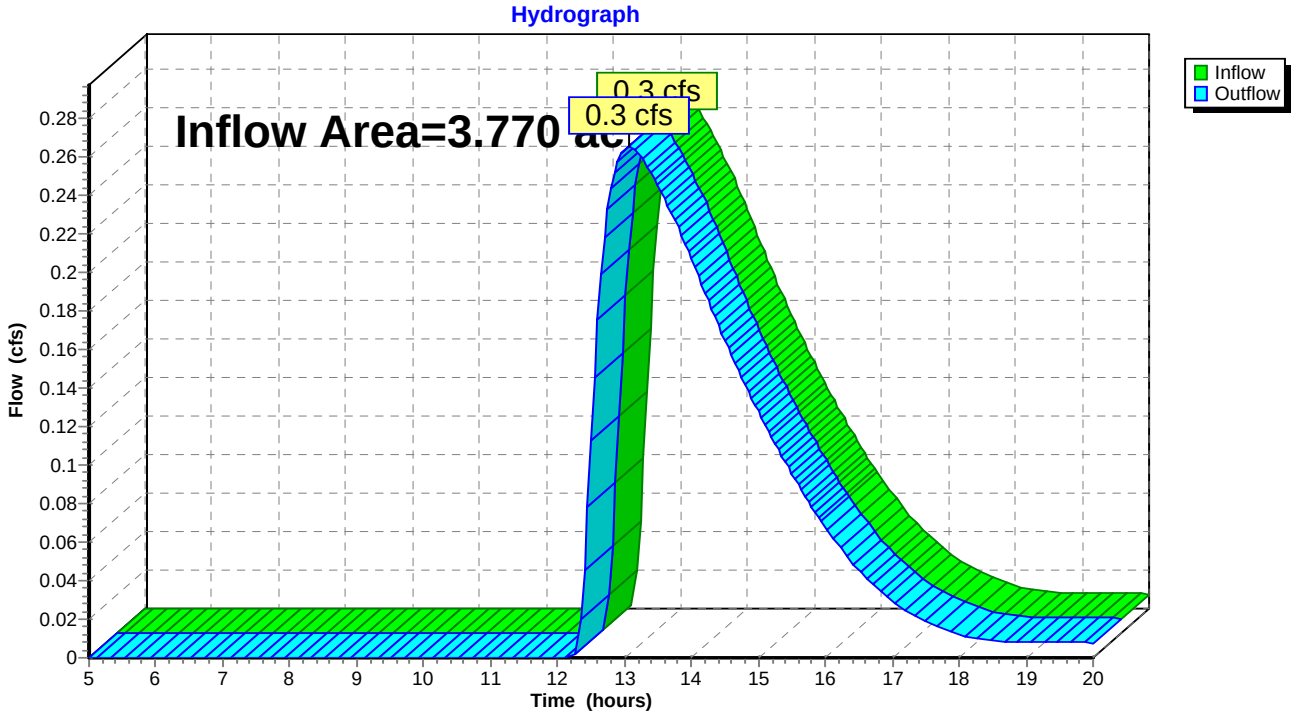
Summary for Reach DP-1: Design Point 1

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

Inflow Area = 3.770 ac, 23.61% Impervious, Inflow Depth > 0.19" for 25-Year event
Inflow = 0.3 cfs @ 13.07 hrs, Volume= 0.058 af
Outflow = 0.3 cfs @ 13.07 hrs, Volume= 0.058 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-1: Design Point 1



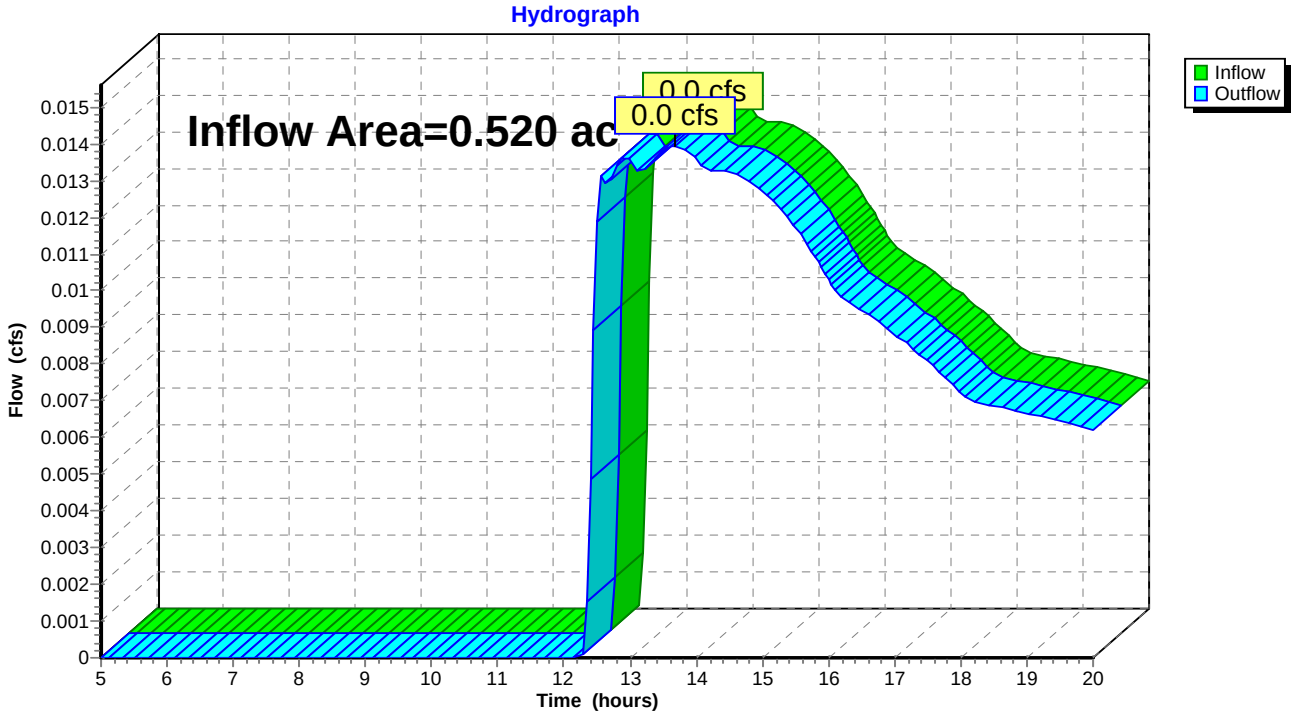
Summary for Reach DP-2: Design Point 2

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

Inflow Area = 0.520 ac, 0.00% Impervious, Inflow Depth > 0.15" for 25-Year event
Inflow = 0.0 cfs @ 13.67 hrs, Volume= 0.006 af
Outflow = 0.0 cfs @ 13.67 hrs, Volume= 0.006 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-2: Design Point 2



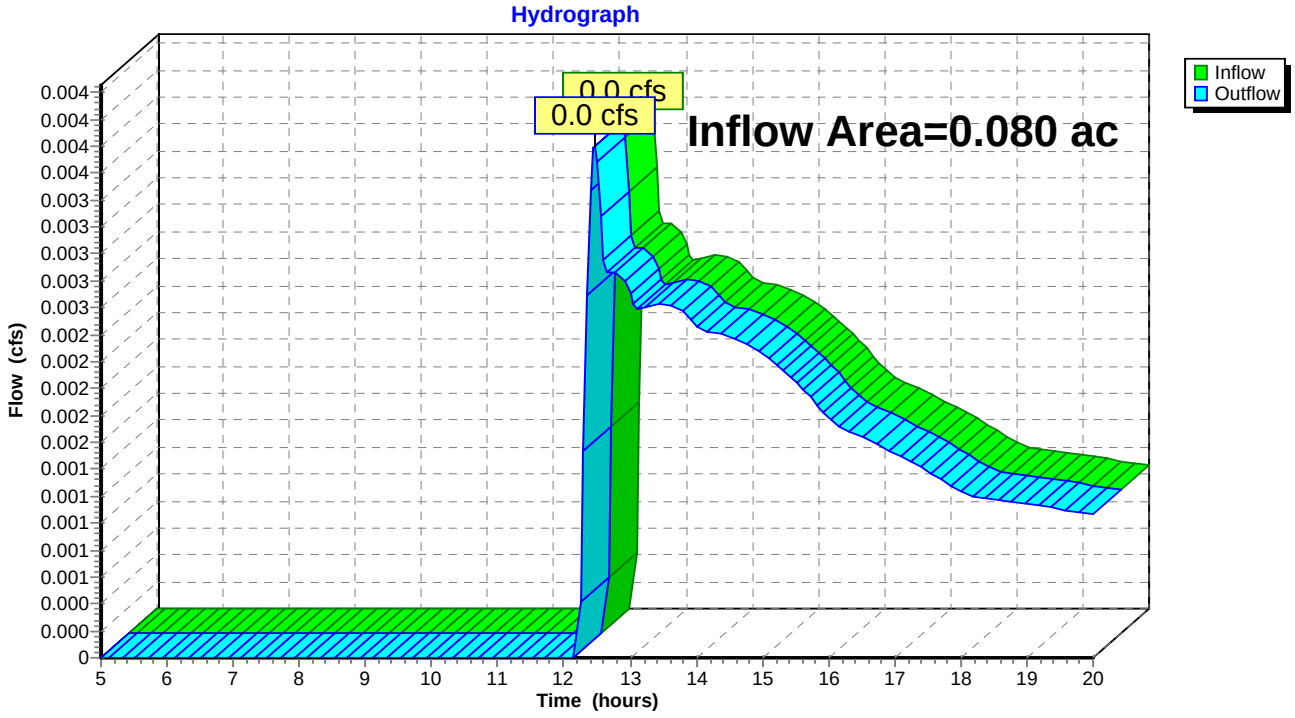
Summary for Reach DP-3: Design Point 3

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

Inflow Area = 0.080 ac, 0.00% Impervious, Inflow Depth > 0.18" for 25-Year event
Inflow = 0.0 cfs @ 12.46 hrs, Volume= 0.001 af
Outflow = 0.0 cfs @ 12.46 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-3: Design Point 3



Summary for Pond IB-1: Infiltration Basin

Inflow Area = 3.130 ac, 28.12% Impervious, Inflow Depth > 1.20" for 25-Year event
Inflow = 3.2 cfs @ 12.25 hrs, Volume= 0.313 af
Outflow = 0.7 cfs @ 13.08 hrs, Volume= 0.278 af, Atten= 79%, Lag= 50.1 min
Discarded = 0.4 cfs @ 13.08 hrs, Volume= 0.227 af
Primary = 0.2 cfs @ 13.08 hrs, Volume= 0.051 af
Secondary = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 159.14' @ 13.08 hrs Surf.Area= 7,273 sf Storage= 5,162 cf

Plug-Flow detention time= 121.7 min calculated for 0.277 af (88% of inflow)
Center-of-Mass det. time= 87.1 min (923.8 - 836.6)

Volume	Invert	Avail.Storage	Storage Description
#1	158.00'	16,264 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
158.00	1,777	0	0	1,777
159.00	7,090	4,139	4,139	7,095
160.00	8,427	7,749	11,888	8,468
160.50	9,083	4,376	16,264	9,144

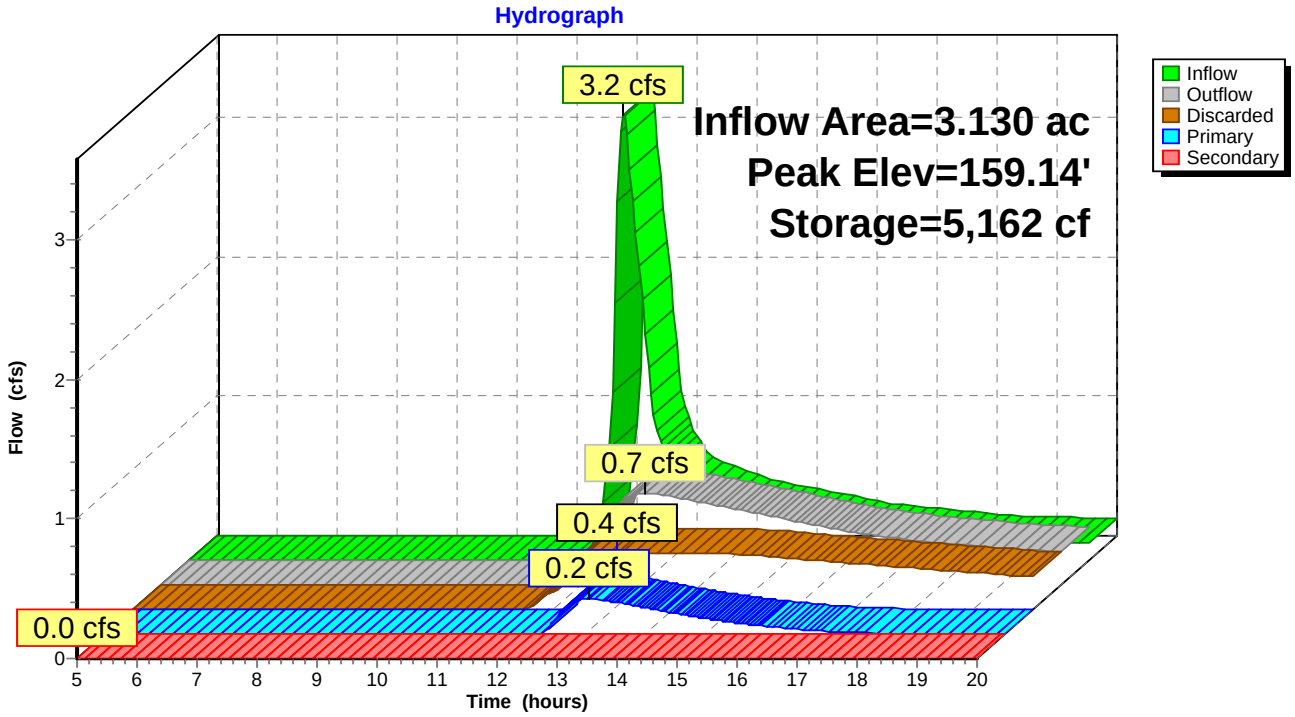
Device	Routing	Invert	Outlet Devices
#1	Discarded	158.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	158.40'	**8.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 158.40' / 158.20' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#3	Secondary	159.50'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#4	Device 2	159.50'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	158.65'	**60.0 deg Sharp-Crested Vee/Trap Weir** C= 2.53

Discarded OutFlow Max=0.4 cfs @ 13.08 hrs HW=159.14' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.4 cfs)

Primary OutFlow Max=0.2 cfs @ 13.08 hrs HW=159.14' (Free Discharge)
└**2=Culvert** (Passes 0.2 cfs of 1.0 cfs potential flow)
  └**4=Orifice/Grate** (Controls 0.0 cfs)
  └**5=Sharp-Crested Vee/Trap Weir** (Weir Controls 0.2 cfs @ 1.78 fps)

Secondary OutFlow Max=0.0 cfs @ 5.00 hrs HW=158.00' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond IB-1: Infiltration Basin



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PWA-1A: PWA-1A Runoff Area=3.130 ac 28.12% Impervious Runoff Depth>1.88"
Flow Length=387' Tc=15.6 min CN=58 Runoff=5.3 cfs 0.491 af

Subcatchment PWA-1B: PWA-1B Runoff Area=0.640 ac 1.56% Impervious Runoff Depth>0.40"
Flow Length=140' Tc=14.0 min CN=37 Runoff=0.1 cfs 0.021 af

Subcatchment PWA-2: PWA-2 Runoff Area=0.520 ac 0.00% Impervious Runoff Depth>0.40"
Flow Length=104' Slope=0.0200 '/' Tc=9.6 min CN=37 Runoff=0.1 cfs 0.017 af

Subcatchment PWA-3: PWA-3 Runoff Area=0.080 ac 0.00% Impervious Runoff Depth>0.45"
Tc=6.0 min CN=38 Runoff=0.0 cfs 0.003 af

Reach DP-1: Design Point 1 Inflow=1.2 cfs 0.201 af
Outflow=1.2 cfs 0.201 af

Reach DP-2: Design Point 2 Inflow=0.1 cfs 0.017 af
Outflow=0.1 cfs 0.017 af

Reach DP-3: Design Point 3 Inflow=0.0 cfs 0.003 af
Outflow=0.0 cfs 0.003 af

Pond IB-1: Infiltration Basin Peak Elev=159.51' Storage=7,953 cf Inflow=5.3 cfs 0.491 af
Discarded=0.4 cfs 0.258 af Primary=1.1 cfs 0.179 af Secondary=0.1 cfs 0.001 af Outflow=1.6 cfs 0.438 af

Total Runoff Area = 4.370 ac Runoff Volume = 0.533 af Average Runoff Depth = 1.46"
79.63% Pervious = 3.480 ac 20.37% Impervious = 0.890 ac

Summary for Subcatchment PWA-1A: PWA-1A

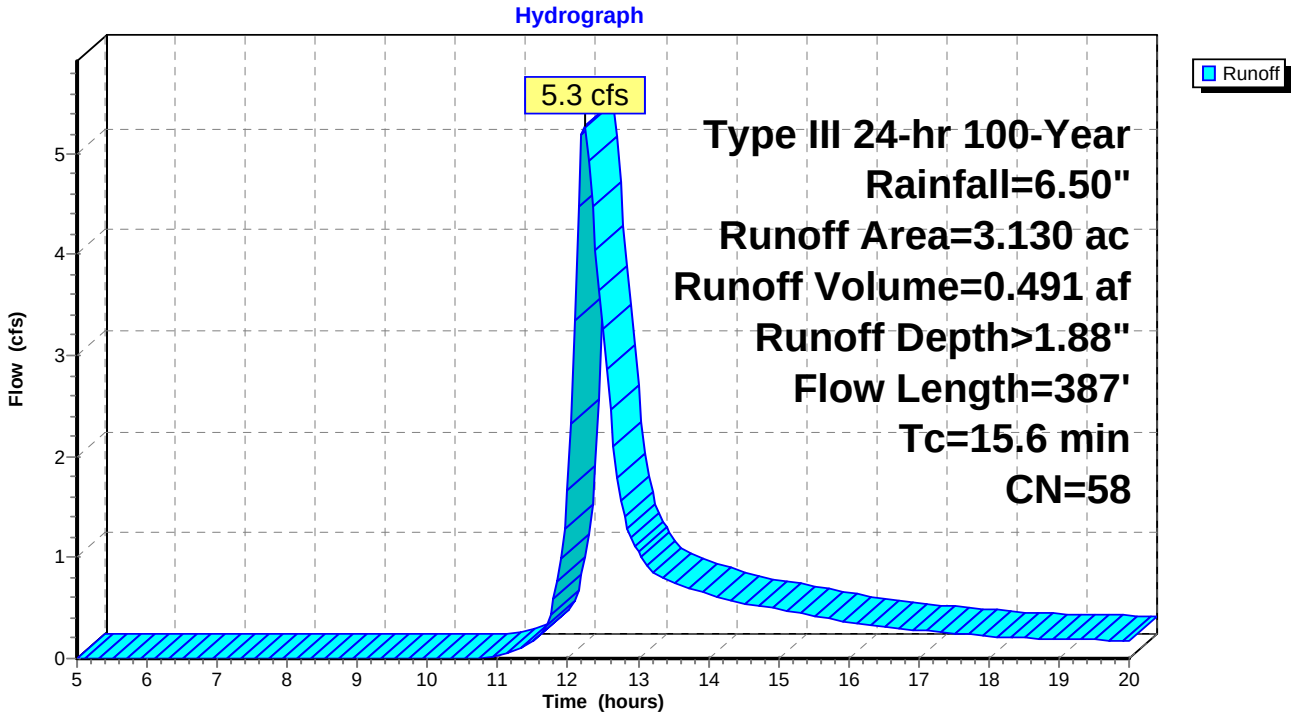
Runoff = 5.3 cfs @ 12.24 hrs, Volume= 0.491 af, Depth> 1.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

	Area (ac)	CN	Description
	0.460	98	Paved parking, HSG A
	0.240	98	Roofs, HSG A
	1.810	39	>75% Grass cover, Good, HSG A
	0.210	30	Woods, Good, HSG A
*	0.180	98	Offsite Impervious
	0.230	74	>75% Grass cover, Good, HSG C
	3.130	58	Weighted Average
	2.250		71.88% Pervious Area
	0.880		28.12% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.0	168	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.7	122	0.0350	2.81		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.2	47	0.0050	3.21	2.5	**Pipe Channel, Driveway Culvert** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
15.6	387	Total			

Subcatchment PWA-1A: PWA-1A



Summary for Subcatchment PWA-1B: PWA-1B

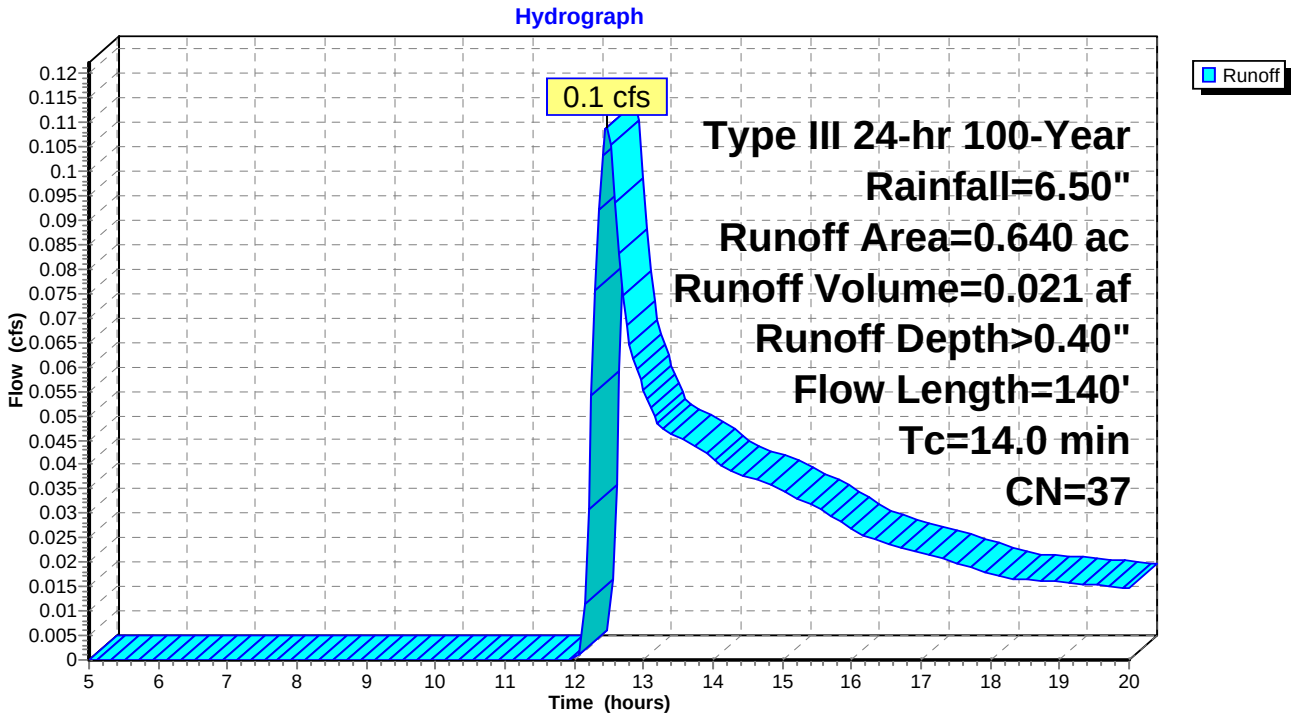
Runoff = 0.1 cfs @ 12.47 hrs, Volume= 0.021 af, Depth> 0.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (ac)	CN	Description
0.070	70	Woods, Good, HSG C
0.010	98	Roofs, HSG A
0.100	39	>75% Grass cover, Good, HSG A
0.460	30	Woods, Good, HSG A
0.640	37	Weighted Average
0.630		98.44% Pervious Area
0.010		1.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.5	90	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.0	140	Total			

Subcatchment PWA-1B: PWA-1B



Summary for Subcatchment PWA-2: PWA-2

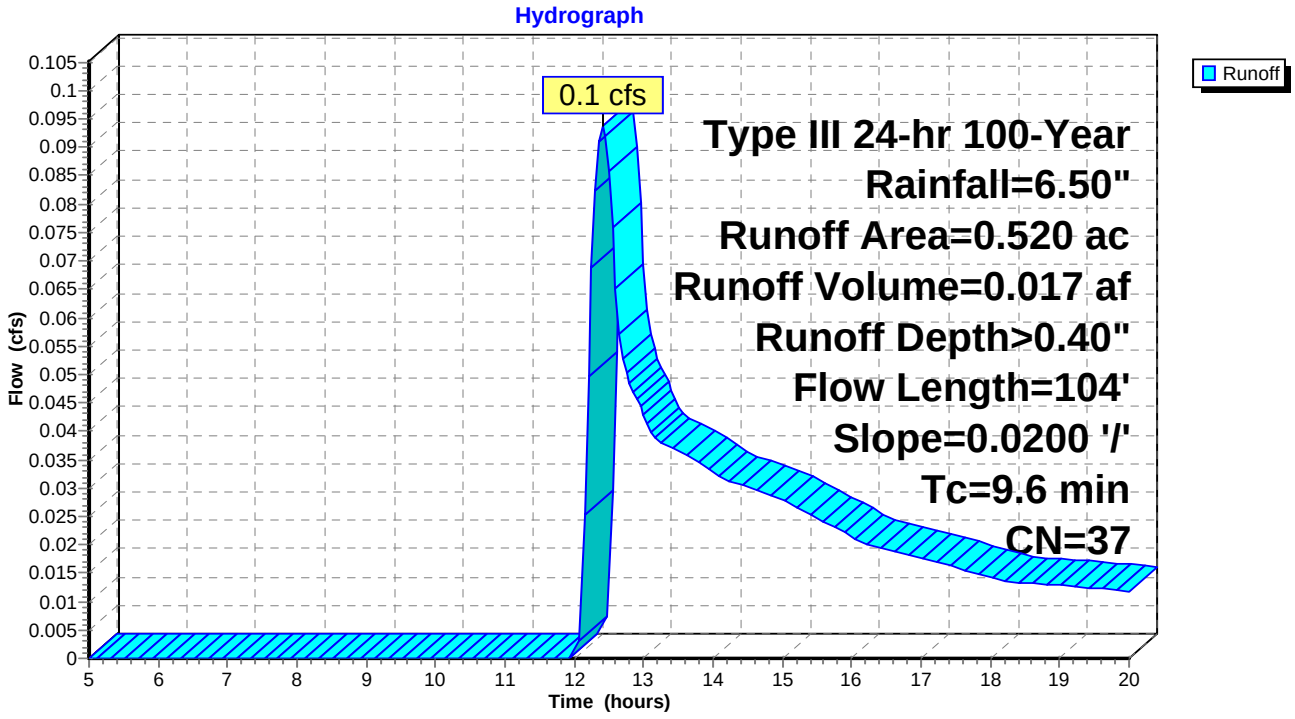
Runoff = 0.1 cfs @ 12.41 hrs, Volume= 0.017 af, Depth> 0.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (ac)	CN	Description
0.130	30	Woods, Good, HSG A
0.390	39	>75% Grass cover, Good, HSG A
0.520	37	Weighted Average
0.520		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.10"
1.3	54	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.6	104	Total			

Subcatchment PWA-2: PWA-2



Summary for Subcatchment PWA-3: PWA-3

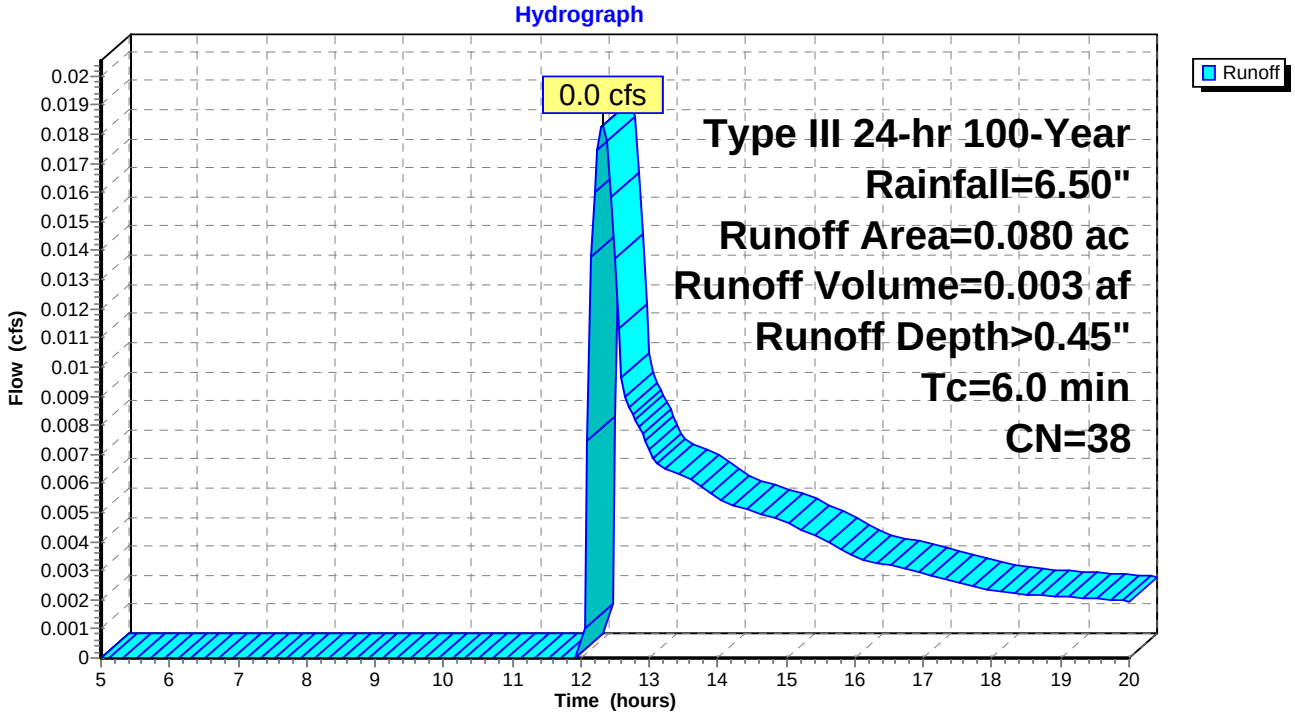
Runoff = 0.0 cfs @ 12.32 hrs, Volume= 0.003 af, Depth> 0.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (ac)	CN	Description
0.070	39	>75% Grass cover, Good, HSG A
0.010	30	Woods, Good, HSG A
0.080	38	Weighted Average
0.080		100.00% Pervious Area

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

Subcatchment PWA-3: PWA-3



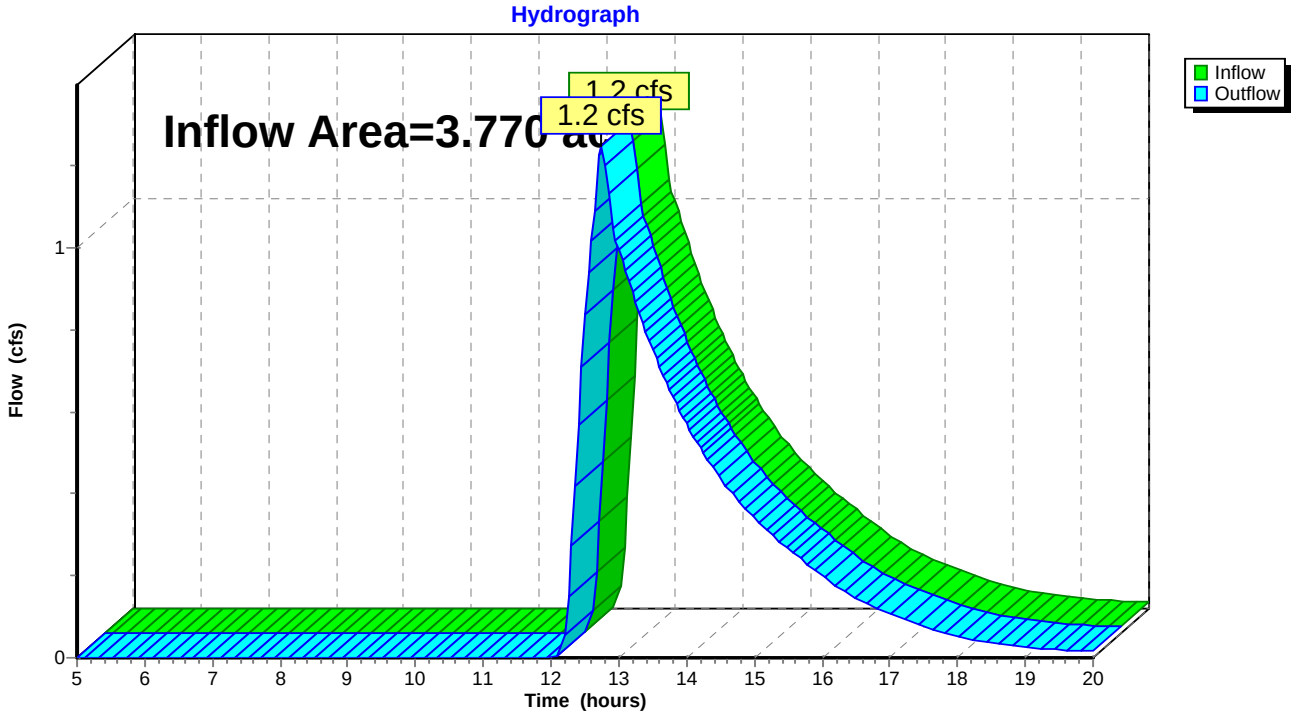
Summary for Reach DP-1: Design Point 1

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

Inflow Area = 3.770 ac, 23.61% Impervious, Inflow Depth > 0.64" for 100-Year event
Inflow = 1.2 cfs @ 12.74 hrs, Volume= 0.201 af
Outflow = 1.2 cfs @ 12.74 hrs, Volume= 0.201 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-1: Design Point 1



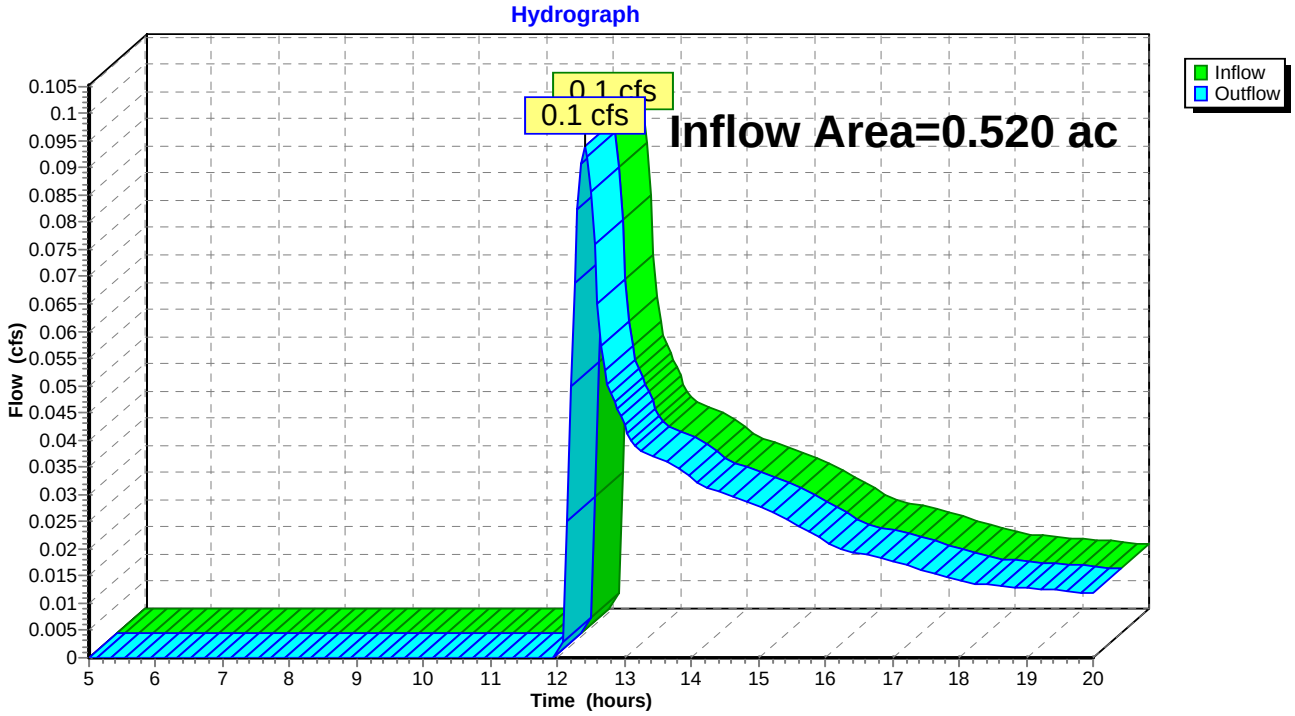
Summary for Reach DP-2: Design Point 2

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

Inflow Area = 0.520 ac, 0.00% Impervious, Inflow Depth > 0.40" for 100-Year event
Inflow = 0.1 cfs @ 12.41 hrs, Volume= 0.017 af
Outflow = 0.1 cfs @ 12.41 hrs, Volume= 0.017 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-2: Design Point 2



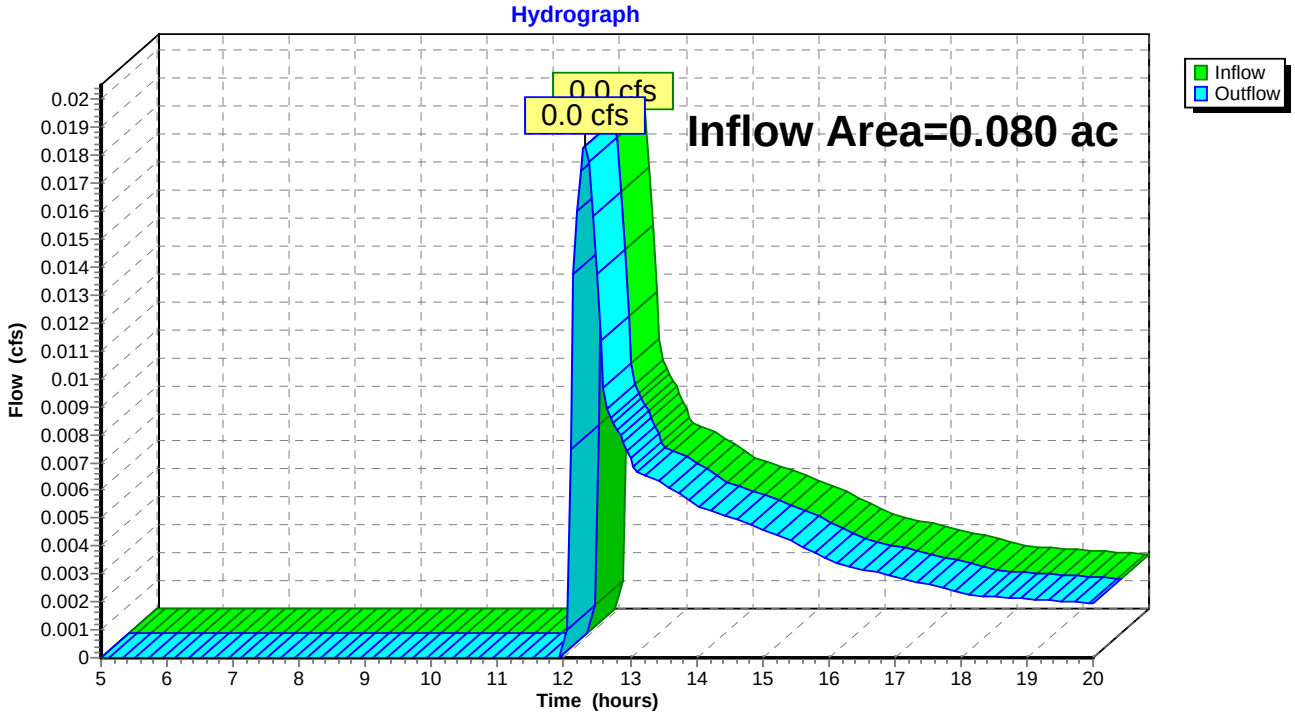
Summary for Reach DP-3: Design Point 3

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

Inflow Area = 0.080 ac, 0.00% Impervious, Inflow Depth > 0.45" for 100-Year event
Inflow = 0.0 cfs @ 12.32 hrs, Volume= 0.003 af
Outflow = 0.0 cfs @ 12.32 hrs, Volume= 0.003 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach DP-3: Design Point 3



Summary for Pond IB-1: Infiltration Basin

Inflow Area = 3.130 ac, 28.12% Impervious, Inflow Depth > 1.88" for 100-Year event
Inflow = 5.3 cfs @ 12.24 hrs, Volume= 0.491 af
Outflow = 1.6 cfs @ 12.74 hrs, Volume= 0.438 af, Atten= 69%, Lag= 30.6 min
Discarded = 0.4 cfs @ 12.74 hrs, Volume= 0.258 af
Primary = 1.1 cfs @ 12.74 hrs, Volume= 0.179 af
Secondary = 0.1 cfs @ 12.74 hrs, Volume= 0.001 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 159.51' @ 12.74 hrs Surf.Area= 7,762 sf Storage= 7,953 cf

Plug-Flow detention time= 106.2 min calculated for 0.437 af (89% of inflow)
Center-of-Mass det. time= 72.8 min (899.1 - 826.3)

Volume	Invert	Avail.Storage	Storage Description
#1	158.00'	16,264 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
158.00	1,777	0	0	1,777
159.00	7,090	4,139	4,139	7,095
160.00	8,427	7,749	11,888	8,468
160.50	9,083	4,376	16,264	9,144

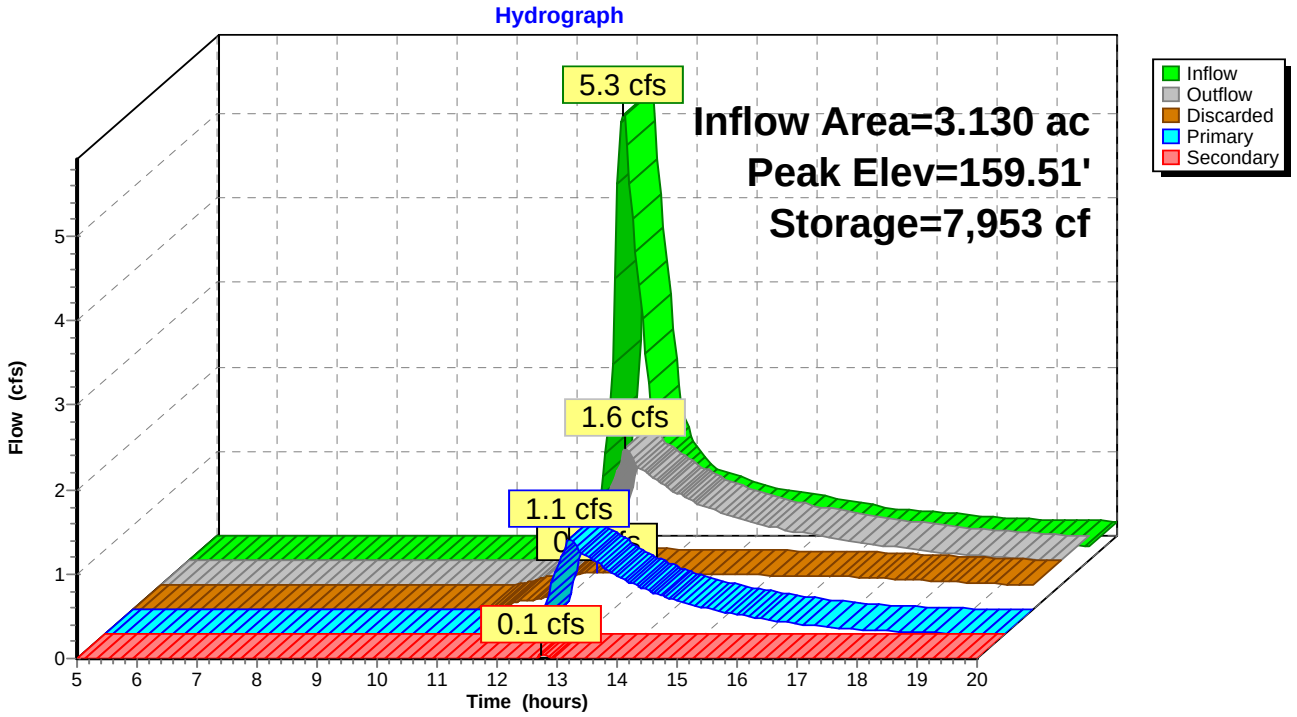
Device	Routing	Invert	Outlet Devices
#1	Discarded	158.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	158.40'	**8.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 158.40' / 158.20' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#3	Secondary	159.50'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#4	Device 2	159.50'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	158.65'	**60.0 deg Sharp-Crested Vee/Trap Weir** C= 2.53

Discarded OutFlow Max=0.4 cfs @ 12.74 hrs HW=159.51' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.4 cfs)

Primary OutFlow Max=1.1 cfs @ 12.74 hrs HW=159.51' (Free Discharge)
└**2=Culvert** (Passes 1.1 cfs of 1.4 cfs potential flow)
  └**4=Orifice/Grate** (Weir Controls 0.1 cfs @ 0.38 fps)
  └**5=Sharp-Crested Vee/Trap Weir** (Weir Controls 1.0 cfs @ 2.35 fps)

Secondary OutFlow Max=0.0 cfs @ 12.74 hrs HW=159.51' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Weir Controls 0.0 cfs @ 0.27 fps)

Pond IB-1: Infiltration Basin



TAB 5

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

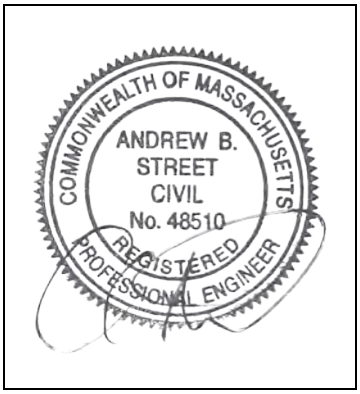
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



12/31/2018

Signature and Date

Checklist

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

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

☒ No disturbance to any Wetland Resource Areas

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

☐ Reduced Impervious Area (Redevelopment Only)

☒ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

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

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

☐ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☒ Other (describe): Infiltration Basins

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☐ An Illicit Discharge Compliance Statement is attached;

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

Project: 135, 139 & 149R Howard Street
Location: Reading, MA
Client: Infrastructure Holdings, LLC

Project Number: 18-10120
Prepared By: William Hall, P.E.
Date: December 21, 2018

STORMWATER MANAGEMENT STANDARDS CALCULATIONS

Standard 1: Velocity & Rip-Rap Apron Sizing and Gradation Calculations

Outlet:	Q_{10}: (CFS)	Velocity (FPS)	Req'd	D_o: (FT)	L_A: (FT)	W_1: (FT)	W_2: (FT)	T_W: (FT)	d_{50}: (FT)
FES-2	2.8	3.9	Yes	1	12.0	3.0	15.0	0.5	0.16
FES-4	3.8	5.0	Yes	1	13.8	3.0	16.8	0.5	0.23

Conclusion: Discharge from outlet FES-4 for up to and including the 10-Year storm event is 5.0 FPS, requiring velocity protection. The Stormwater Management System conforms to Standard 1.

Standard 2: Peak Discharge Summary

Design Point 1	2-Year (3.1-IN)	10-Year (4.5-IN)	25-Year (5.3-IN)	100-Year (6.5-IN)
Pre-Development Conditions:	0.0	0.1	0.5	1.2
Post Development Conditions:	0.0	0.0	0.3	1.2
Design Point 2				
Pre-Development Conditions:	0.0	0.0	0.0	0.1
Post Development Conditions:	0.0	0.0	0.0	0.1
Design Point 3				
Pre-Development Conditions:	0.0	0.1	0.1	0.2
Post Development Conditions:	0.0	0.0	0.0	0.0

Conclusion: The Stormwater Management System conforms to Standard 2.

Standard 3: Recharge Calculations (Static Method)

Infiltration Pond 1

Hydrologic Soils Group:	A	B	C	D		
Total Proposed Impervious Area:	0.70	0.00	0.00	0.00	0.70	
Target Factor:	0.60	0.35	0.25	0.10		
Required Recharge Volume:	1,525	0	0	0	1,525	CF

Capture Area Adjustment

Total Site Impervious:	0.71	Ac.
Impervious Draining to Basin:	0.70	Ac.
Adjusted Recharge Volume:	1,546	CF

Volume Below Lowest Outlet:	2,066	CF
Elevation of Lowest Invert:	158.65	

Determine Drawdown Time

Saturated Hydraulic Conductivity (Rawls Rate):	2.41	IN/HR
Bottom Area of Infiltration Basin:	1,777	SF
Drawdown Time:	5.8	HRS

Conclusion: The volume provided below the lowest invert in the infiltration basin exceed the minimum recharge volume required. In addition, the basin drains within 48-HRS to comply local regulations and 72-HRS to comply with DEP regulations. The Stormwater Management System conforms to Standard 3.

Standard 4: Water Quality Volume Calculations

Infiltration Pond 1

Water Quality Depth:	0.5	IN
Total Proposed Impervious Area:	0.71	Acres
Required Water Quality Volume:	1,289	CF
Provided Water Quality Volume:	2,066	CF

TSS Removal Rate Calculations

Treatment Provided at Discharge From Infiltration Pond 1

	TSS Removal Rate	Starting TSS Load	Amount Removed	Remaining Load
Street Sweeping:	5%	1.00	0.05	0.95
Sediment Forebay & Infiltration Basin:	80%	0.95	0.76	0.19
TSS Removed at Discharge from Pond:				81.0%

Conclusion: The volume provided below the lowest invert in the infiltration basins exceeds the Water Quality Volume and the Weighted Average TSS Removal Rate exceeds 80%. The Stormwater Management System conforms to Standard 4.

Standard 5: Land Uses With Higher Potential Pollutant Loads

Conclusion: The proposed use is not considered a Land Use with Higher Potential Pollutant Loads. This Standard is NOT Applicable.

Standard 6: Critical Areas

Conclusion: The proposal is not located within a Critical Area. This Standard is NOT Applicable.

Standard 7: Redevelopment

Conclusion: The development does not meet the criteria for Redevelopment. This Standard is NOT Applicable.

Standard 8: Construction Period Controls

Conclusion: The project is covered by a NPDES Construction General Permit. The SWPPP will be submitted prior to construction to address construction period pollution prevention measures and to reduce the potential for erosion and sedimentation. The Stormwater Management System Conforms to Standard 8.

Standard 9: Operations and Maintenance Plan

Conclusion: An Operations and Maintenance Plan has been prepared and provided with this summary. The Stormwater Management System Conforms to Standard 9.

Standard 10: Illicit Discharges to Drainage System

Conclusion: All off-site discharges are comprised entirely of stormwater. The Stormwater Management System Conforms to Standard 10.

Project: 135, 139 & 149R Howard Street
Location: Reading, MA
Client: Infrastructure Holdings, LLC

Project Number: 18-10120
Prepared By: William Hall, P.E.
Date: December 21, 2018

FOREBAY SIZING CALCULATIONS

Infiltration Pond 1

Watershed Charactoristics

Impervious Area (Ai):	0.70	Acres
Required (0.1-IN x Ai):	254	CF
Sediment Forebay Volume:	432	CF
	OK	

Stage / Storage Tables

Sediment Forebay:	Elevation	Surface Area (SF)	Incremental Storage (CF)	Total Storage (CF)
	158.6	355	0	0
	159.0	479	167	167
	159.5	582	265	432

Project: 135, 139 & 149R Howard Street
Location: Reading, MA 01867
Client: Infrastructure Holdings LLC

Project Number: 18-10120
Prepared By: William Hall, P.E.
Date: December 3, 2018

Groundwater Mounding Analysis - Prop. Infiltration Basin

K = Saturated hydrailic conductivity = 4.82 ft/day (2.41 in/hr)

Sy = Specific Yield of Sand = 0.25

Hi = Initial Saturated Thickness = 5.7 (ESHW to Confining Layer)

Bottom area = bottom area of recharge structure = 1,777-SF

Recharge Rate = RRV/RA = 1,525 cf / 1,777 sf/day = 0.86

Time = Drawdown Time = 5.8 hr = 0.24-day

Hantush Method Data output from www.aqtesolv.com equatons are as follows:

$$h_m^2 - h_i^2 = Z_m(t) = (2w/K)vtS*(0.5A/(4vt)^{1/2},0.5B/(4vt)^{1/2}) \ldots\ldots (1)$$

$$\nu = K\bar{b}/\varepsilon \ldots\ldots (2)$$

$$\bar{b} = 0.5[h_i(0) + h(t)] \ldots\ldots (3)$$

$$h_m^2 - h_i^2 = Z_m(t) - Z_m(t-t_0) \ldots\ldots (4)$$

Proposed Infiltration Basin

Hydraulic Conductivity (K) =	4.82	[L/T]
Specific Yield (ε) =	.25	[dimensionless]
Initial Saturated Thickness (h_i) =	5.7	[L]
Length of Recharge Area (A) =	55	[L]
Width of Recharge Area (B) =	32.3	[L]
Recharge Rate (w) =	0.86	[L/T]
Time (t) =	.24	[T] (t > t_0)

Results of Groundwater Mounding Calculation

Solution by Successive Approximation

Iteration	$\bar{b}$	h_m*	% Change
1	5.7	6.4688916841836	13.4893277926947
2	6.0844458420918	6.51636275746867	0.73383626751915
3	6.108181378734336	6.51927372218559	4.46716185894758E-02
4	6.1096368610928	6.51945214955872	2.73692102428225E-03
5	6.109726074779366	6.51946308596853	1.67750442181536E-04
6	6.109731542984276	6.51946375629656	1.02819514680164E-05

K [L/T]	ε	h_i [L]	A [L]	B [L]	w [L/T]	t [T]	h_m [L]
4.82	.25	5.7	55	32.3	0.86	.24	6.51946375629656

maximum water-table rise (h_m - h_i) at time t = .24 is 0.819463756296563

Therefore, a mound of 0.82- ft will not encroach the storage capacity of the infiltration system

Project:	135, 139 & 149R Howard Street	Project Number:	18-10120
Location:	Reading, MA	Prepared By:	William Hall, PE
Client:	Infrastructure Holdings, LLC	Date:	December 21, 2018

GUTTER CAPACITY CALCULATIONS

Cross Slope of Roadway:	**0.03**	FT/FT
Width of Flow From Face of Curb:	**12.0**	FT
Depth of Flow in Gutter Line:	0.36	FT
Slope (Direction of Flow):	**0.010**	FT/FT
Mannings "N":	**0.016**	
Gutter Capacity (Q):	7.6	CFS
Peak Discharge (Q):	3.2	CFS

7.6 > 3.2 OK

Culvert Report - Lot 3 Driveway

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Dec 4 2018

Circular Culvert

Invert Elev Dn (ft)	=	160.50
Pipe Length (ft)	=	33.00
Slope (%)	=	0.52
Invert Elev Up (ft)	=	160.67
Rise (in)	=	12.0
Shape	=	Circular
Span (in)	=	12.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Circular Culvert
Culvert Entrance	=	Smooth tapered inlet throat
Coeff. K,M,c,Y,k	=	0.534, 0.555, 0.0196, 0.9, 0.2

Embankment

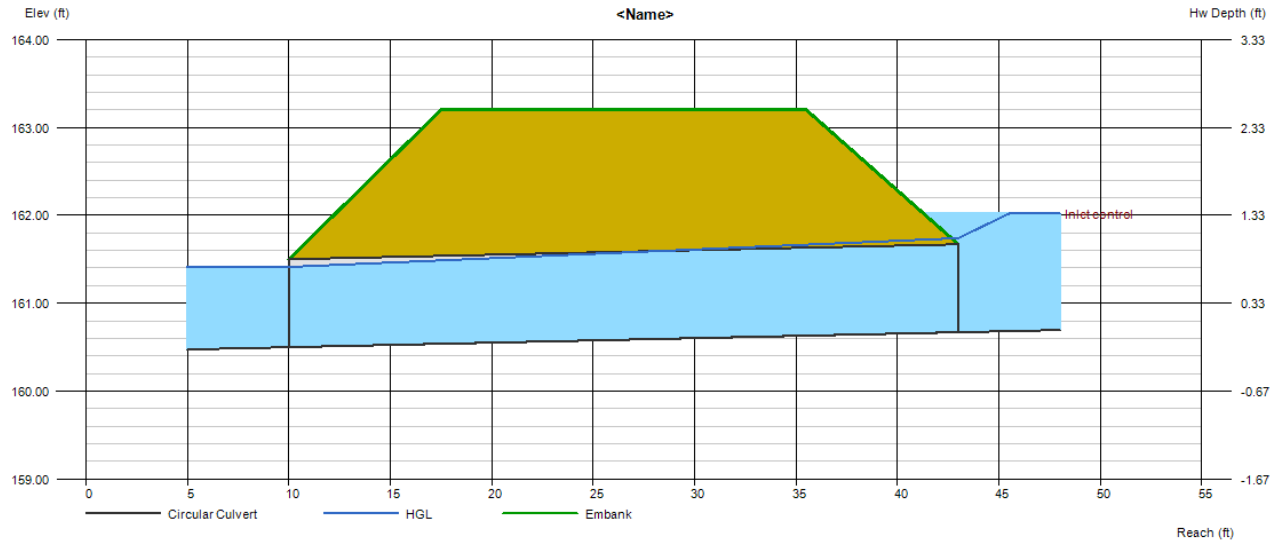
Top Elevation (ft)	=	163.20
Top Width (ft)	=	18.00
Crest Width (ft)	=	20.00

Calculations

Qmin (cfs)	=	3.77
Qmax (cfs)	=	3.77
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	3.77
Qpipe (cfs)	=	3.77
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.01
Veloc Up (ft/s)	=	4.80
HGL Dn (ft)	=	161.41
HGL Up (ft)	=	161.74
Hw Elev (ft)	=	162.02
Hw/D (ft)	=	1.35
Flow Regime	=	Inlet Control



Culvert Report - Lot 2 Driveway

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Dec 4 2018

Circular Culvert

Invert Elev Dn (ft)	=	160.91
Pipe Length (ft)	=	35.00
Slope (%)	=	0.51
Invert Elev Up (ft)	=	161.09
Rise (in)	=	12.0
Shape	=	Circular
Span (in)	=	12.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Circular Culvert
Culvert Entrance	=	Smooth tapered inlet throat
Coeff. K,M,c,Y,k	=	0.534, 0.555, 0.0196, 0.9, 0.2

Embankment

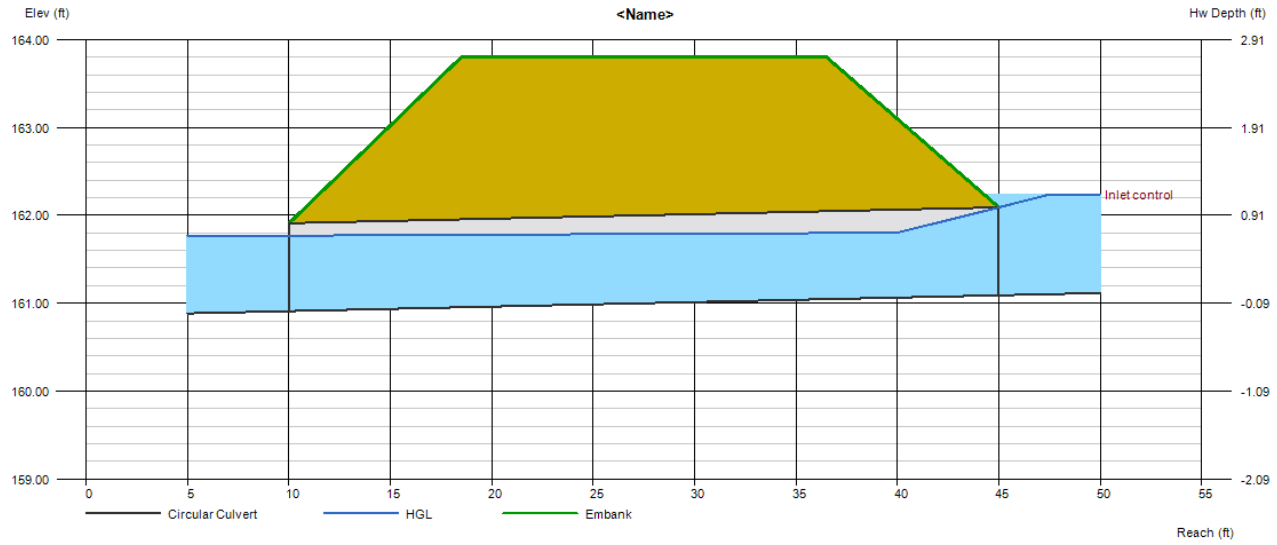
Top Elevation (ft)	=	163.80
Top Width (ft)	=	18.00
Crest Width (ft)	=	20.00

Calculations

Qmin (cfs)	=	2.81
Qmax (cfs)	=	2.81
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	2.81
Qpipe (cfs)	=	2.81
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.91
Veloc Up (ft/s)	=	4.66
HGL Dn (ft)	=	161.77
HGL Up (ft)	=	161.81
Hw Elev (ft)	=	162.24
Hw/D (ft)	=	1.15
Flow Regime	=	Inlet Control



Soil Suitability Assessment for Stormwater Management

City/Town: Reading, MA
Site: 135, 139 & 149 Howard Street
Soil Evaluator/Soil Scientist: Steven Eriksen

A. Facility Information

1. Facility Information

Kevin Greenwood
Owner Name

135, 139 & 141 Howard Street — Map/Lot: Map 10 Lots 75, 76 & 77
Street Address

Reading — MA — 01867
City/Town — State — Zip Code

B. Site Information

1. (Check one) New Construction ☒ Upgrade ☐ Repair ☐

2. Published Soil Survey available? Yes ☒ No ☐ If yes: Web Soil Survey (Year Published) 1"=1120 (Publication Scale) 624B (Soil Map Unit)

Haven-Urban Land complex (Soil Name) Few to None (Soil limitations)

3. Surficial Geological Report available? Yes ☐ No ☒ If yes: ____ (Year Published) ____ (Publication Scale) ____ (Map Unit)

____ (Geologic Material) ____ (Landform)

4. Flood Rate Insurance Map:

Above the 500-year flood boundary? Yes ☒ No ☐ Within the 100-year flood boundary? Yes ☐ No ☒

Within the 500-year flood boundary? Yes ☐ No ☒ Within a Velocity Zone? Yes ☐ No ☒

5. Wetland Area: National Wetland Inventory Map ____ (Map Unit) ____ (Name)

Wetlands Conservancy Program Map ____ (Map Unit) ____ (Name)

6. Current Water Resource Conditions (USGS) Oct/2018 (Month/Year) Range: Above Normal ☒ Normal ☐ Below Normal ☐

7. Other references reviewed: ____

Soil Suitability Assessment for Stormwater Management

City/Town: Reading, MA
Site: 135, 139 & 149 Howard Street
Soil Evaluator/Soil Scientist: Steven Eriksen

C. On-Site Review

Deep Observation Hole Number: TP-1 – TP 7 | 10/17/18 (Date) | 8:30 a.m. (Time) | partly cloudy- 60F (Weather)

1. Location

   Ground Elevation at Surface of Hole _____

   Location (Identify on Plan) _____

2. Land Use: Existing single-family dwellings, lawn & woodland (e.g. woodland, agricultural field, vacant lot, etc.) | None (Surface Stones) | 0-3% (Slope (%))

   Lawn & woods (Vegetation) | Outwash (Landform) | Toeslope (Position on landscape (attach sheet))

3. Distances from: Open Water Body >100 ft. feet | Drainage Way >50 ft. feet | Possible Wet Area >50 ft feet

   Property Line _____ feet | Drinking Water Well _____ feet | Other _____

4. Parent Material: Outwash | Unsuitable Materials Present: Yes ☐ No ☒

   If Yes: Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock ☐

5. Groundwater Observed: Yes ☒ No ☐ - See attached test tit information

   If Yes: Depth Weeping from Pit _____ | Depth Standing Water in Hole _____

   Estimated Depth to High Groundwater: _____ inches | _____ elevation

Soil Suitability Assessment for Stormwater Management

City/Town: Reading, MA
Site: 135, 139 & 149 Howard Street
Soil Evaluator/Soil Scientist: Steven Eriksen

Deep Observation Hole Number: TP-1

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-12"	Ap	10 YR 2/2				FSL			Granular	Friable	
12-24"	Bw	10 YR 4/4				FSL			Weak Blocky	Friable	
24-48"	C1	2.5Y 4/3	40"	7.5 YR 5/6	15%	LS&G		10%	Massive	Firm	

Additional Notes: ESHWT 40" .

Soil Suitability Assessment for Stormwater Management

City/Town: Reading, MA
Site: 135, 139 & 149 Howard Street
Soil Evaluator/Soil Scientist: Steven Eriksen

Deep Observation Hole Number: TP-2

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-9"	Ap	10YR 2/2				FSL			Granular	Friable	
9-18"	Bw	10 YR 5/6				FSL			Weak Blocky	Friable	
18-42"	C1	7.5 YR 3/3	30"	7.5YR 5/6	10%	Silt Loam Lenses			Massive	Friable	
42-96"	C2	2.5 Y 3/3		7.5 YR 4/4	15%	LS&G		10%	Massive	Firm	

Additional Notes: ESHWT 30"

Soil Suitability Assessment for Stormwater Management

City/Town: Reading, MA
Site: 135, 139 & 149 Howard Street
Soil Evaluator/Soil Scientist: Steven Eriksen

Deep Observation Hole Number: TP-3

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-12"	Ap	10YR 2/2				FSL			Granular	Friable	
12-20"	Bw	10YR 4/4				FSL			Weak Blocky	Friable	
20-50"	C1	2.5Y 4/3	34"	7.5YR 5/6	15%	LS&G		10%	Massive	Firm	

Additional Notes: ESHWT 34"

Soil Suitability Assessment for Stormwater Management

City/Town: Reading, MA
Site: 135, 139 & 149 Howard Street
Soil Evaluator/Soil Scientist: Steven Eriksen

Deep Observation Hole Number: TP-4

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-12"	Ap	10YR 2/2				FSL			Granular	Friable	
12-26"	Bw	10YR 4/4				FSL			Weak Blocky	Friable	
26-72"	C1	2.5 Y 4/3	34"	7.5YR 5/4	10%	LS&G			Massive	Firm	

Additional Notes: ESHWT 34"

Soil Suitability Assessment for Stormwater Management

City/Town: Reading, MA
Site: 135, 139 & 149 Howard Street
Soil Evaluator/Soil Scientist: Steven Eriksen

Deep Observation Hole Number: TP-5

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-12"	Ap	10YR 2/2				FSL			Granular	Friable	
12-24"	Bw	10YR 4/4				FSL			Weak Blocky	Friable	
24-66"	C1	2.5Y 4/3	28"	7.5YR 5/6	10%	LS&G			Massive	Firm	

Additional Notes: ESHWT 28"

Soil Suitability Assessment for Stormwater Management

City/Town: Reading, MA
Site: 135, 139 & 149 Howard Street
Soil Evaluator/Soil Scientist: Steven Eriksen

Deep Observation Hole Number: TP-6

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-10"	Ap	10YR 2/2				FSL			Granular	Friable	
10-24"	Bw	10YR 4/4				FSL			Weak Blocky	Friable	
24-60"	C1	2.5Y 4/3	28"	7.5 YR 5/6	10%	LS&G			Massive	Firm	

Additional Notes: ESHWT 28"

Soil Suitability Assessment for Stormwater Management

City/Town: Reading, MA
Site: 135, 139 & 149 Howard Street
Soil Evaluator/Soil Scientist: Steven Eriksen

Deep Observation Hole Number: TP-7

Depth (In.)	Soil Horizon / Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-9"	Ap	10YR 2/2				FSL			Granular	Friable	
9-20"	Bw	10YR 4/4				FSL			Weak Blocky	Friable	
20-46"	C1	7.5YR 3/3	30"	7.5YR 4/6	15%	Silt loam lenses			Massive	Friable	
46-96"	C2	2.5 Y 3/3		7.5 YR 4/4	20%	LS&G		10%	Massive	Firm	

Additional Notes: ESHWT 30" / Weeping 72"

Soil Suitability Assessment for Stormwater Management

City/Town: Reading, MA
Site: 135, 139 & 149 Howard Street
Soil Evaluator/Soil Scientist: Steven Eriksen

E. Test Pit Locations – See Plan

Soil Suitability Assessment for Stormwater Management

City/Town: Reading, MA
Site: 135, 139 & 149 Howard Street
Soil Evaluator/Soil Scientist: Steven Eriksen

D. Certification

I certify that I have passed the soil evaluator examination* approved by the Department of Environmental Protection and that the above analysis was performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017.

Signature of Soil Evaluator	Date
Steve Eriksen Typed or Printed Name of Soil Evaluator	SE685 Soil Evaluator Number
Christopher Cole	Reading Engineering Division

OPERATIONS AND MAINTENANCE PLAN

December 4, 2018

This Operations and Maintenance (O&M) Plan has been prepared in accordance with the Stormwater Management Policy issued by the Department of Environmental Protection (DEP) for *'Definitive Subdivision Plans for 135, 139 & 149R Howard Street,'* a residential development located at 135, 139 & 149R Howard Street in Reading, MA.

Project Summary

The applicant proposes to develop 135, 139 & 149R Howard Street in Reading, MA into a six (6) lot single family residential subdivision. The parcels total 4.1-AC± of land and contains two (2) existing single family residences. The project consists of construction of a new 346-FT roadway along with associated infrastructure including driveways, landscaping, drainage facilities, and utilities. Project plans entitled *Definitive Subdivision Plans for 135, 139 & 149R Howard Street*, dated December 5, 2018, have been prepared by this office and provided for your review. These plans illustrate the proposal in detail including zoning, easements, construction details, roadway profile and provisions for utilities.

Property Owner / Applicant / Responsible Party:

Infrastructure Holdings, LLC
Kevin Greenwood
122 Boston Road
Billerica, MA 01862

Construction Period Pollution Prevention Plan:

A Stormwater Pollution Prevention Plan (SWPPP) will be prepared prior to construction to address the project's NPDES obligations with the EPA. The SWPPP will address the requirements of the Construction Period Pollution Prevention Plan.

Long Term Operations and Maintenance Plan:

See attached Long Term Operations and Maintenance Plan.

System Map:

See Sheet C-5 entitled Grading, Drainage & Landscaping Plan with an issue date of _____, 2018 for the location of all stormwater management facilities.

LONG TERM OPERATIONS AND MAINTENANCE PROGRAM

December 4, 2018

This Long Term Operations and Maintenance Program Plan has been prepared in accordance with the Stormwater Management Policy issued by the Department of Environmental Protection (DEP) for the proposed *Definitive Subdivision Plan for 135, 139 & 149R Howard Street*, a residential development located at 135, 139 & 149R Howard Street in Reading, MA. Upon a period beginning twelve months after the completion of the roadway, all structural BMP's shall be inspected twice annually, once in April and once in November. The inspection shall be performed as indicated below:

Street Sweeping

Street sweeping can be an effective method to reduce pollutant loading in runoff generated from pavement. Street sweeping shall be performed in accordance with the Town of Reading's maintenance program.

Snow Storage / Removal

Snow plowed from the proposed roadway will be placed or disposed of in accordance with the policy developed by DEP. Any snow that accumulates in front of the swale at the end of the cul-de-sac shall be removed to ensure that the drainage systems functions properly. Under no circumstances shall snow plowed or removed from the road be stockpiled within wetland resource areas. If conditions arise where snow storage areas are at capacity the Operator is required to remove and dispose of snow off site in conformance with all local, state and federal regulations.

Drainage Outfalls

The outlets of the storm water management system will be inspected biannually. Any evidence of erosion or other damage will be reported to the appropriate town representative and repaired as soon as possible. Any sediment should be removed from the outlet structures.

Sediment Forebay

Sediments and associated pollutants are removed only when sediment forebays are actually cleaned out, so regular maintenance is essential. Frequently removing accumulated sediments will make it less likely that sediments will be re-suspended. At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational, otherwise the practice will discharge excess amounts of suspended sediments. When mowing grasses, keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Check for signs of rilling and gullying and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by either reseeding or resodding. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs in the forebay while the seeds germinate and develop roots.

Infiltration Basin

Infiltration basins are prone to clogging and failure, so it is imperative to develop and implement aggressive maintenance plans and schedules. Installing the required pretreatment BMPs will significantly reduce maintenance requirements for the basin. Inspections and preventive maintenance must be performed at least twice a year.

Once the basin is in use, inspect it after every major storm for the first few months to ensure it is stabilized and functioning properly and if necessary take corrective action. Note how long water remains standing in the basin after a storm; standing water within the basin 48 to 72 hours after a storm indicates that the infiltration capacity may have been overestimated. If the ponding is due to clogging, immediately address the reasons for the clogging (such as upland sediment erosion, excessive compaction of soils, or low spots).

Thereafter, inspect the infiltration basin at least twice per year. Important items to check during the inspection include:

- Signs of differential settlement,
- Cracking,
- Erosion,

• Leakage in the embankments,
• Tree growth on the embankments,
• Condition of riprap,
• Operation of the drawdown device,
• Sediment accumulation and
• The health of the turf.

At least twice a year, mow the buffer area, side slopes, and basin bottom. Remove grass clippings and accumulated organic matter to prevent an impervious organic mat from forming. Remove trash and debris at the same time. Use deep tilling to break up clogged surfaces, and revegetate immediately. Remove sediment from the basin as necessary, but wait until the floor of the basin is thoroughly dry. Use light equipment to remove the top layer so as to not compact the underlying soil. Deeply till the remaining soil, and revegetate as soon as possible. Inspect and clean pretreatment devices associated with basins at least twice a year, and ideally every other month.

Estimated Operations and Maintenance Budget

It is anticipated that the stormwater management system will require an annual budget of $2,500 to maintain.