

DRAINAGE ANALYSIS REPORT

**#3 Forest Park Drive
Bourne, MA
Map 39, Parcel 77.7**

PREPARED FOR

**C & L Shearer Holdings, LLC.
P.O. Box 538
West Falmouth, MA 02574**

PREPARED BY

**Bracken Engineering, Inc.
49 Herring Pond Road
Buzzards Bay, MA 02532**



**Zachary L. Basinski, P.E.
September 5, 2023**

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Introduction:

The purpose of this report is to analyze the hydrologic impacts associated with the development of a proposed 9,600 sf warehouse building and associated parking lot and loading areas. The stormwater system is designed to meet the Town of Bourne Zoning Regulations and the Massachusetts Stormwater Management Act.

Existing Conditions:

The locus is shown as parcel 77.7 on sheet 39.0 of the Town of Bourne Assessors Maps. The total area of the site is 40,000± s.f., or approximately 0.92 acres and the total anticipated area of disturbance is 35,695± SF.

The site is abutted by a developed industrial lot to the south located off Portside Drive, a commercial lot under construction to the west located off of Forest Park Drive, Forest Park Drive to the north and a developed commercial lot to the east.

The site is a vacant lot. Soil on the site consists of a Merrimac fine sandy loam. These soils have high infiltration and a very low runoff rate. The topography consists of higher elevations along the east and west property lines with a lower valley in the middle of the site, sloping to the rear of the lot. Two existing fill piles lie near the front of the lot. The site then rises with a gradual slope up towards the westerly property line. Existing runoff on the site predominately drains towards the low point in the middle of the lot where it infiltrates naturally or flows off site to the rear of the lot where it infiltrates on undisturbed soils. A small portion of the front of the lot runs off to Forest Park Drive where it either infiltrates along the shoulder or enters the drainage system of Forest Park Drive.

Proposed Conditions:

The proposed project consists of constructing a 9,600 s.f. warehouse building with associated parking area and loading zone areas. All proposed parking, loading areas and entrance driveways will be paved. New stormwater runoff associated with the proposed building and proposed loading dock area will be directed towards three (3) proposed stormwater management areas. The stormwater management areas are located along the north, east, and southern property lines. Runoff from the parking area and driveway shall be routed towards the a sediment forebay and rain garden before being infiltrated in subsurface basins. Runoff from the proposed roof shall be piped directly to two rain gardens for treatment prior to subsurface infiltration.

The stormwater management areas have been sized to treat the required water quality volume and completely mitigate the required recharge volume onsite. See the enclosed calculations for further details.

Stormwater Recharge:

Infiltration BMP's have been designed using the "static" method to infiltrate the Required Recharge Volume for each subcatchment area. Merrimac fine sandy loam soils have a hydrologic soil classification of "A" and accordingly a 0.60-inch Target Depth Factor. Soil conditions will be confirmed to verify the substratum to be sand with an 8.27 inch/hour Rawls Rate. The drawdown analysis for the Required Recharge Volume has been provided. See attached calculations for each BMP. Since the infiltration BMP's have been sized to attenuate the 100-year storm event and the separation distance to seasonal high groundwater is greater than four feet, groundwater mounding calculations have not been provided.

Method of Calculation:

The stormwater management areas were analyzed utilizing standard engineering practices and the Soil Conservation Service (SCS) Technical Release 20 (TR20). The systems were sized using the rainfall data for a two (2), ten (10), twenty-five (25), and one hundred (100) year, twenty-four (24) hour duration storm frequencies. Based on the U.S. Department of Agriculture's Technical Release Paper 40 (TP40) rainfall maps, the precipitation is 3.5", 4.8", 5.7", and 7.1" respectively.

To assist in the analysis, the computer software program "HydroCAD" was used to develop hydrographs and infiltration area inflow/outflow calculations.

The drainage area boundaries were developed from on-site survey topography, the anticipated development footprint and proposed site grades.

The proposed subsurface infiltration system has been designed to treat and recharge runoff up to a 7.1" (100-yr) storm event.

Critical Areas:

The site is located within a Zone II wellhead protection zone and a Bourne Water Resource Protection District.

Erosion and Sediment Controls:

Erosion control measures including silt socks, tracking pads, silt sacks and construction notes are shown on site development plans.

Operations and Maintenance Plan:

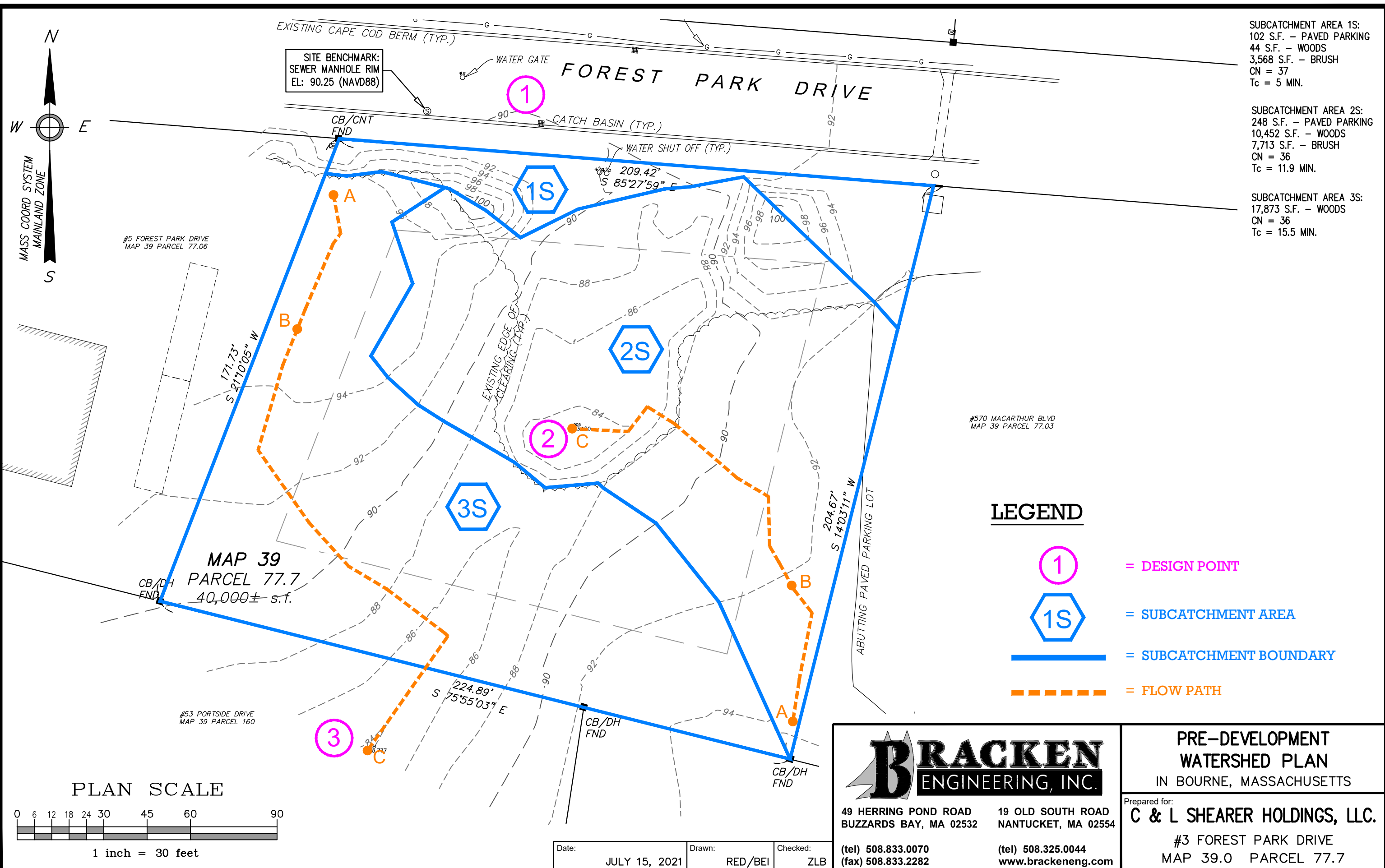
An operation and maintenance plan is included, see appendix.

Conclusion:

The drainage system has been designed in accordance with the Town of Bourne Zoning By-law utilizing the Massachusetts Stormwater Management Standards. A stormwater management system incorporating low impact development techniques has been designed to treat, mitigate and recharge the increase in stormwater runoff onsite. The following chart identifies the pre- and post-development stormwater characteristics at the identified design points.

TABLE 1:

STORM EVENT (Year)	2		10		25		100	
Design Point	PRE (cfs)	POST (cfs)	PRE (cfs)	POST (cfs)	PRE (cfs)	POST (cfs)	PRE (cfs)	POST (cfs)
1	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.01
2	0.00	--	0.00	--	0.02	--	0.10	--
2P	--	0.43	--	0.85	--	1.17	--	1.65
3	0.00	0.00	0.00	0.00	0.02	0.01	0.09	0.04
4P	--	0.29	--	0.49	--	0.63	--	0.84
5P	--	0.43	--	0.72	--	0.93	--	1.26



SUBCATCHMENT AREA 1S:
 102 S.F. - PAVED PARKING
 44 S.F. - WOODS
 3,568 S.F. - BRUSH
 CN = 37
 Tc = 5 MIN.

SUBCATCHMENT AREA 2S:
 248 S.F. - PAVED PARKING
 10,452 S.F. - WOODS
 7,713 S.F. - BRUSH
 CN = 36
 Tc = 11.9 MIN.

SUBCATCHMENT AREA 3S:
 17,873 S.F. - WOODS
 CN = 36
 Tc = 15.5 MIN.

LEGEND



= DESIGN POINT



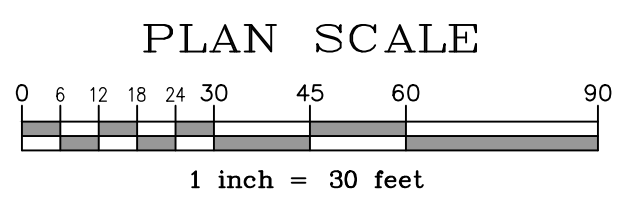
= SUBCATCHMENT AREA



= SUBCATCHMENT BOUNDARY



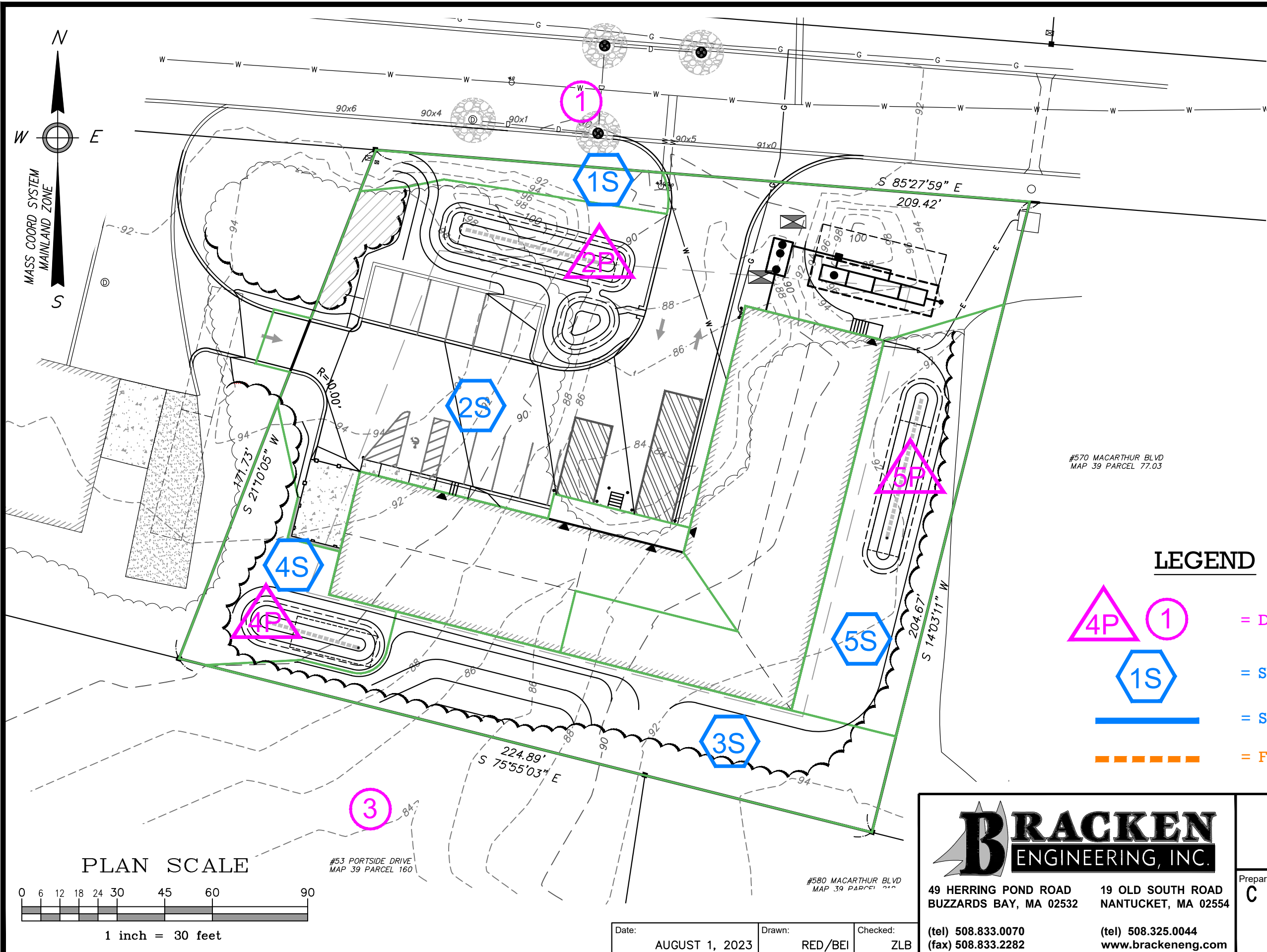
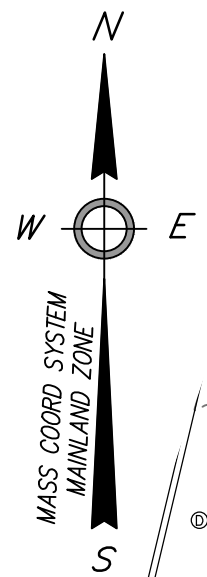
= FLOW PATH



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PRE-DEVELOPMENT WATERSHED PLAN
 IN BOURNE, MASSACHUSETTS
 Prepared for: **C & L SHEARER HOLDINGS, LLC.**
 #3 FOREST PARK DRIVE
 MAP 39.0 PARCEL 77.7

Date:	Drawn:	Checked:
JULY 15, 2021	RED/BEI	ZLB



- SUBCATCHMENT AREA 1S:
971 S.F. - GRASS
CN = 39
Tc = 5 MIN.
- SUBCATCHMENT AREA 2S:
7,995 S.F. - PAVED PARKING
512 S.F. - WOODS
6435 S.F. - GRASS
980 S.F. - RAIN GARDEN
1,009 S.F. - FUTURE PARKING
CN = 70
Tc = 5 MIN.
- SUBCATCHMENT AREA 3S:
2,081 S.F. - WOODS
3,326 S.F. - GRASS
CN = 38
Tc = 5 MIN.
- SUBCATCHMENT AREA 4S:
952 S.F. - WOODS
1,005 S.F. - GRASS
523 S.F. - RAIN GARDEN
4,177 S.F. - ROOF
CN = 80
Tc = 5 MIN.
- SUBCATCHMENT AREA 5S:
822 S.F. - WOODS
2,461 S.F. - GRASS
5,775 S.F. - ROOF
783 S.F. - RAIN GARDEN
CN = 79
Tc = 5 MIN.

#570 MACARTHUR BLVD
MAP 39 PARCEL 77.03

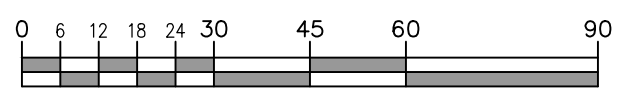
#53 PORTSIDE DRIVE
MAP 39 PARCEL 160

#580 MACARTHUR BLVD
MAP 39 PARCEL 77.03

LEGEND

- = DESIGN POINT
- = SUBCATCHMENT AREA
- = SUBCATCHMENT BOUNDARY
- = FLOW PATH

PLAN SCALE



1 inch = 30 feet

Date: AUGUST 1, 2023	Drawn: RED/BEI	Checked: ZLB
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BRACKEN
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49 HERRING POND ROAD
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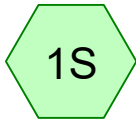
19 OLD SOUTH ROAD
NANTUCKET, MA 02554

(tel) 508.325.0044
www.brackeneng.com

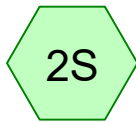
**POST-DEVELOPMENT
WATERSHED PLAN**
IN BOURNE, MASSACHUSETTS

Prepared for:
C & L SHEARER HOLDINGS, LLC.

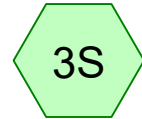
#3 FOREST PARK DRIVE
MAP 39.0 PARCEL 77.7



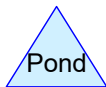
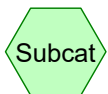
Subcatchment Area 1



Subcatchment Area 2



Subcatchment Area 3



3 Forest Park Drive - Pre-Development

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Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	A - 2 YR	Type III 24-hr		Default	24.00	1	3.50	2
2	B - 10 YR	Type III 24-hr		Default	24.00	1	4.80	2
3	C - 25 YR	Type III 24-hr		Default	24.00	1	5.70	2
4	D - 100YR	Type III 24-hr		Default	24.00	1	7.10	2

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Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
11,281	35	Brush, Fair, HSG A (1S, 2S)
350	98	Paved parking, HSG A (1S, 2S)
28,369	36	Woods, Fair, HSG A (1S, 2S, 3S)
40,000	36	TOTAL AREA

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Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
40,000	HSG A	1S, 2S, 3S
0	HSG B	
0	HSG C	
0	HSG D	
0	Other	
40,000		TOTAL AREA

3 Forest Park Drive - Pre-Development

Type III 24-hr A - 2 YR Rainfall=3.50"

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Summary for Subcatchment 1S: Subcatchment Area 1

[49] Hint: $T_c < 2dt$ may require smaller dt

[45] Hint: Runoff=Zero

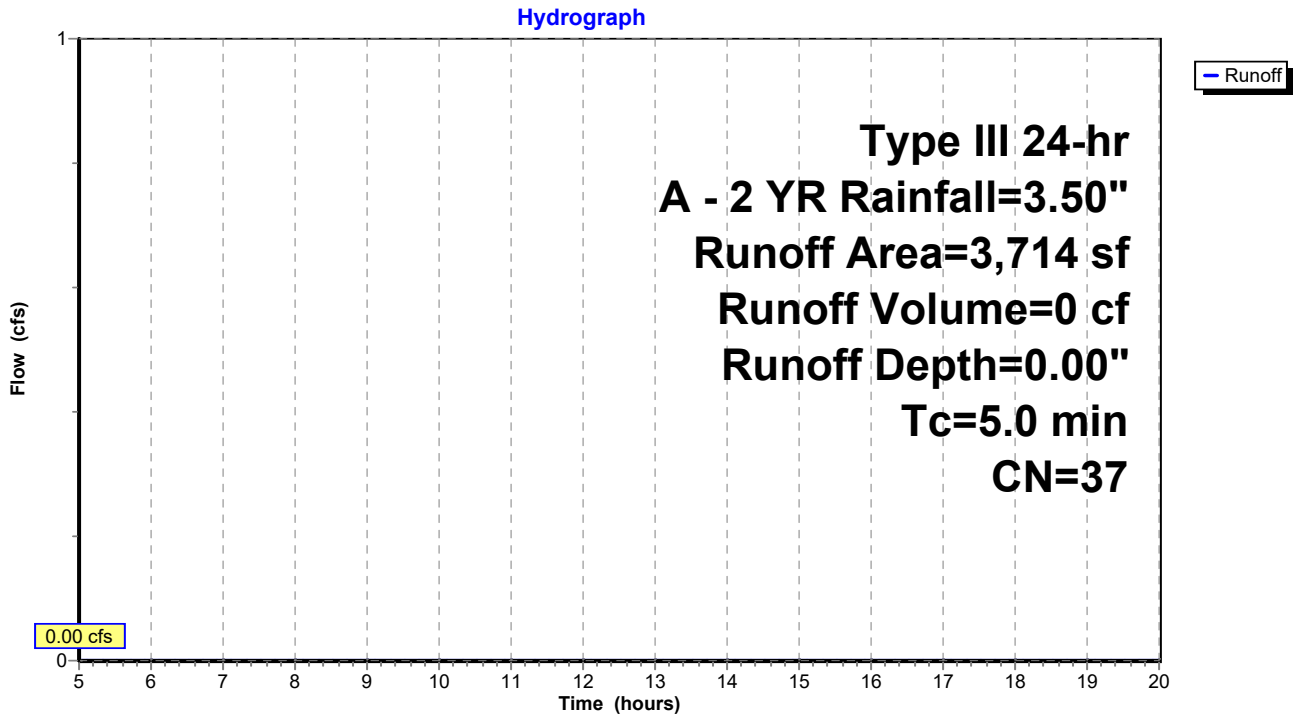
Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, $dt=0.05$ hrs
Type III 24-hr A - 2 YR Rainfall=3.50"

Area (sf)	CN	Description
102	98	Paved parking, HSG A
44	36	Woods, Fair, HSG A
3,568	35	Brush, Fair, HSG A
3,714	37	Weighted Average
3,612		97.25% Pervious Area
102		2.75% Impervious Area

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

Subcatchment 1S: Subcatchment Area 1



3 Forest Park Drive - Pre-Development

Type III 24-hr A - 2 YR Rainfall=3.50"

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Summary for Subcatchment 2S: Subcatchment Area 2

[45] Hint: Runoff=Zero

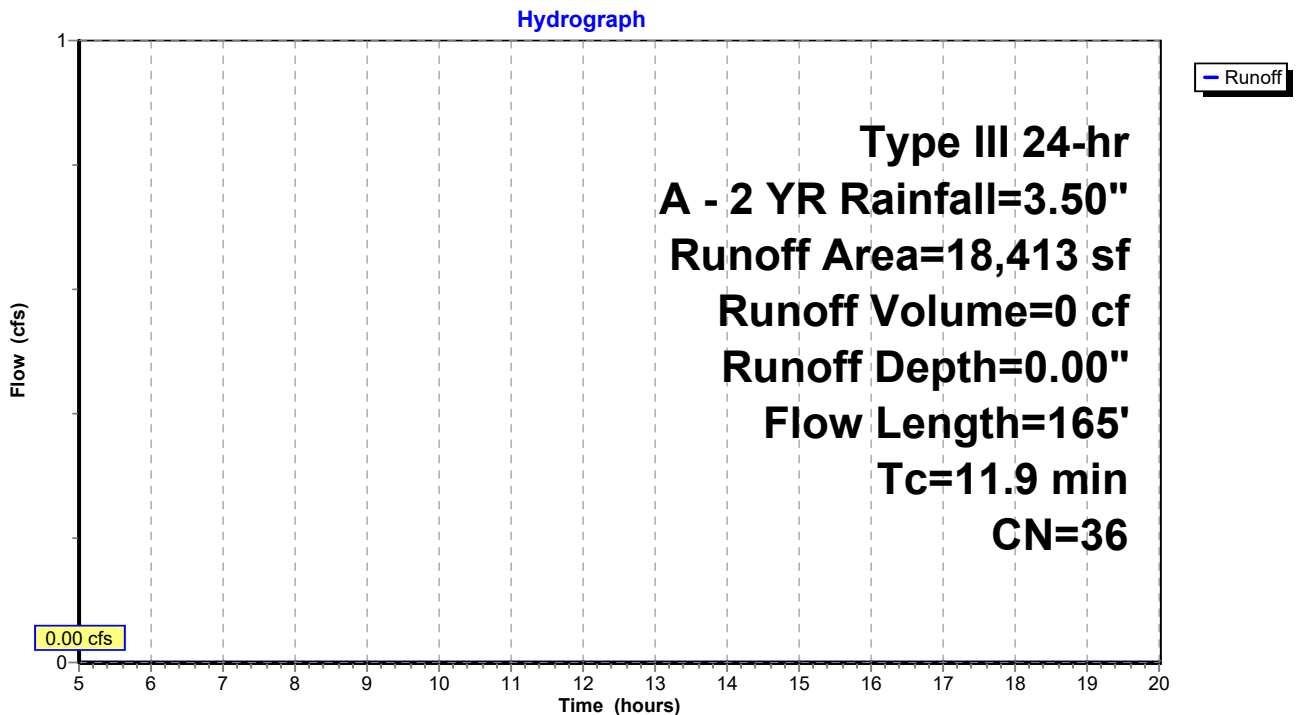
Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr A - 2 YR Rainfall=3.50"

Area (sf)	CN	Description
248	98	Paved parking, HSG A
10,452	36	Woods, Fair, HSG A
7,713	35	Brush, Fair, HSG A
18,413	36	Weighted Average
18,165		98.65% Pervious Area
248		1.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0268	0.08		Sheet Flow, A-B Woods: Light underbrush n= 0.400 P2= 3.40"
1.3	115	0.0814	1.43		Shallow Concentrated Flow, B-C Woodland Kv= 5.0 fps
11.9	165	Total			

Subcatchment 2S: Subcatchment Area 2



3 Forest Park Drive - Pre-Development

Type III 24-hr A - 2 YR Rainfall=3.50"

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Summary for Subcatchment 3S: Subcatchment Area 3

[45] Hint: Runoff=Zero

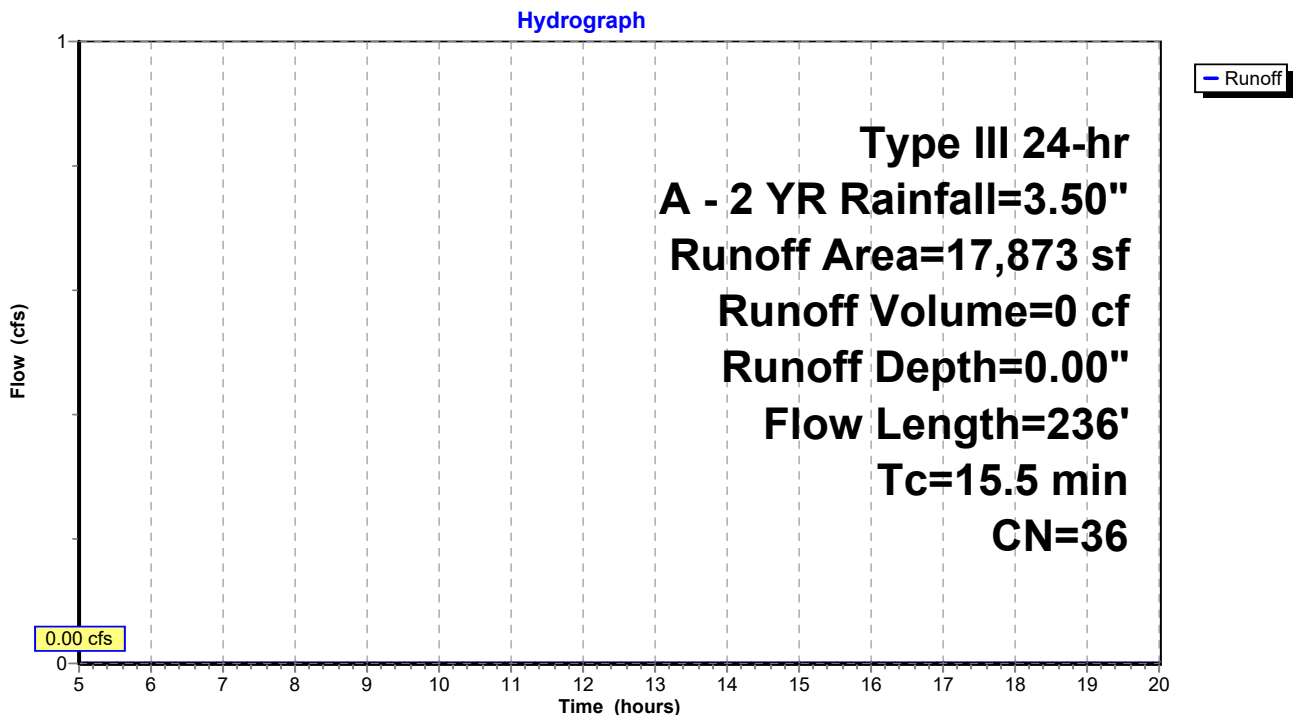
Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr A - 2 YR Rainfall=3.50"

Area (sf)	CN	Description
17,873	36	Woods, Fair, HSG A
17,873		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	50	0.0166	0.06		Sheet Flow, A-B Woods: Light underbrush n= 0.400 P2= 3.40"
2.6	186	0.0577	1.20		Shallow Concentrated Flow, B-C Woodland Kv= 5.0 fps
15.5	236	Total			

Subcatchment 3S: Subcatchment Area 3



3 Forest Park Drive - Pre-Development

Type III 24-hr B - 10 YR Rainfall=4.80"

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Summary for Subcatchment 1S: Subcatchment Area 1

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 0.00 cfs @ 14.83 hrs, Volume= 24 cf, Depth > 0.08"

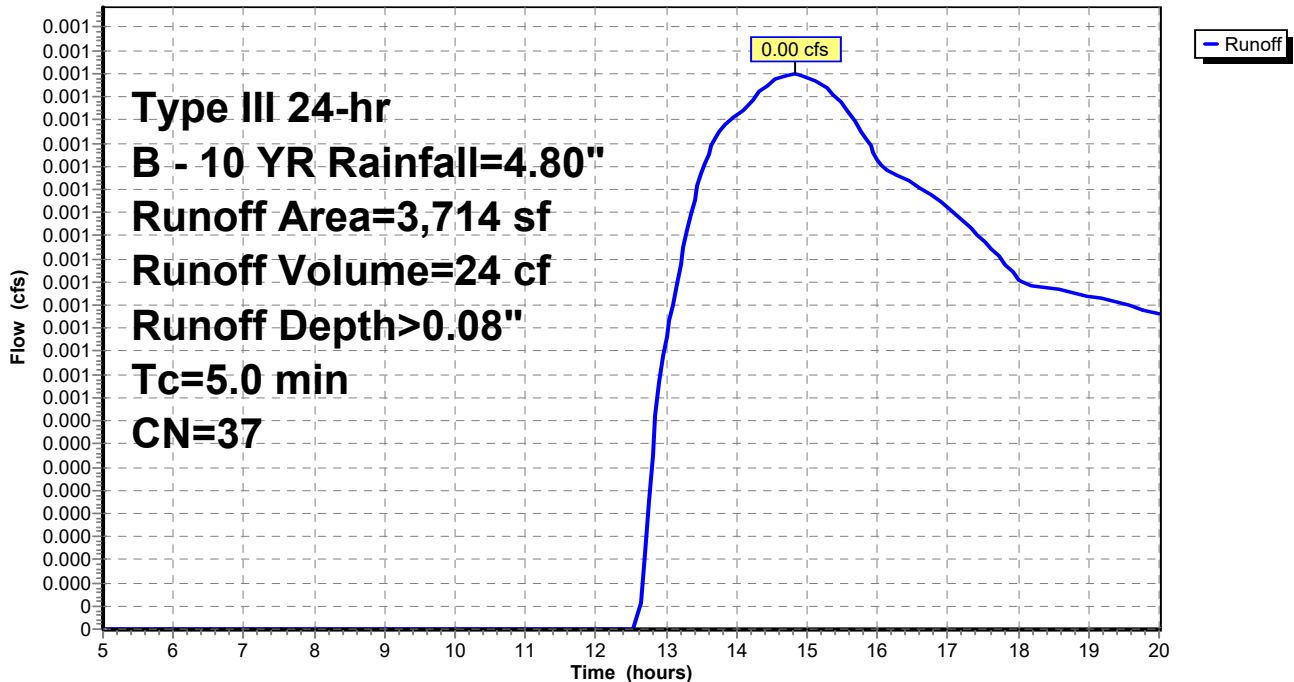
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, $dt=0.05$ hrs
Type III 24-hr B - 10 YR Rainfall=4.80"

Area (sf)	CN	Description
102	98	Paved parking, HSG A
44	36	Woods, Fair, HSG A
3,568	35	Brush, Fair, HSG A
3,714	37	Weighted Average
3,612		97.25% Pervious Area
102		2.75% Impervious Area

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

Subcatchment 1S: Subcatchment Area 1

Hydrograph



3 Forest Park Drive - Pre-Development

Type III 24-hr B - 10 YR Rainfall=4.80"

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Summary for Subcatchment 2S: Subcatchment Area 2

Runoff = 0.00 cfs @ 15.21 hrs, Volume= 86 cf, Depth> 0.06"

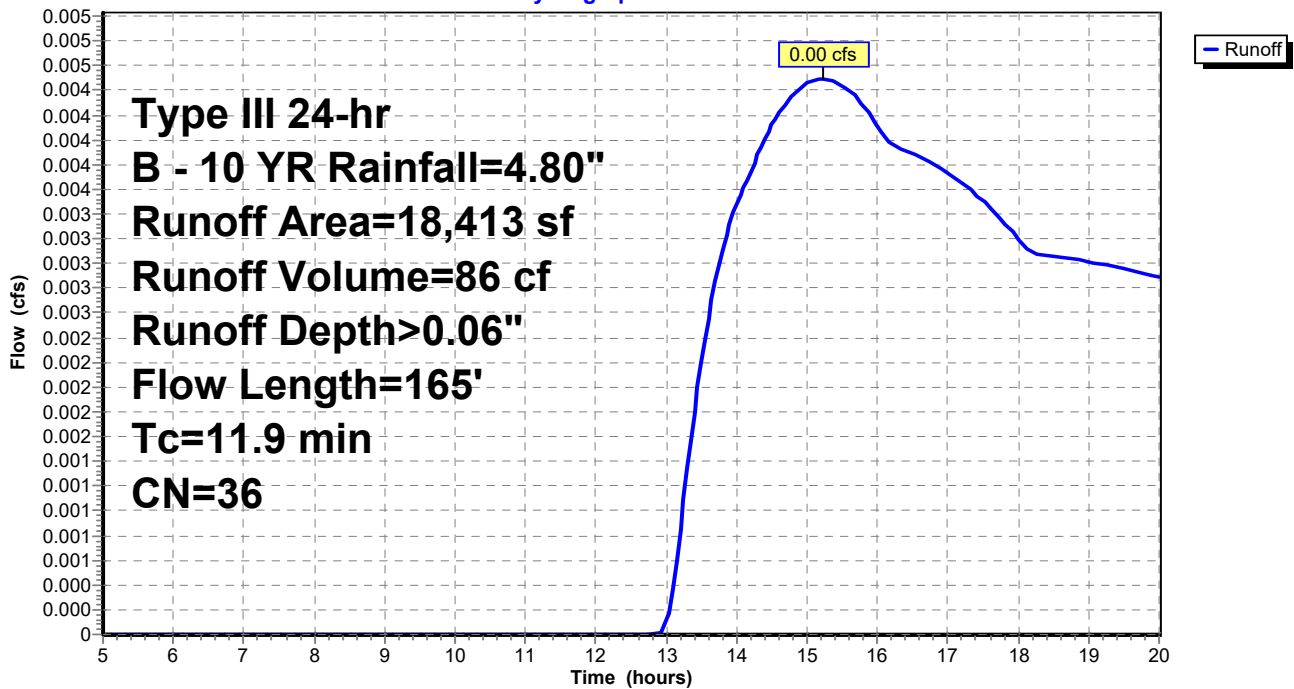
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr B - 10 YR Rainfall=4.80"

Area (sf)	CN	Description
248	98	Paved parking, HSG A
10,452	36	Woods, Fair, HSG A
7,713	35	Brush, Fair, HSG A
18,413	36	Weighted Average
18,165		98.65% Pervious Area
248		1.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0268	0.08		Sheet Flow, A-B Woods: Light underbrush n= 0.400 P2= 3.40"
1.3	115	0.0814	1.43		Shallow Concentrated Flow, B-C Woodland Kv= 5.0 fps
11.9	165	Total			

Subcatchment 2S: Subcatchment Area 2

Hydrograph



3 Forest Park Drive - Pre-Development

Type III 24-hr B - 10 YR Rainfall=4.80"

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Summary for Subcatchment 3S: Subcatchment Area 3

Runoff = 0.00 cfs @ 15.28 hrs, Volume= 83 cf, Depth> 0.06"

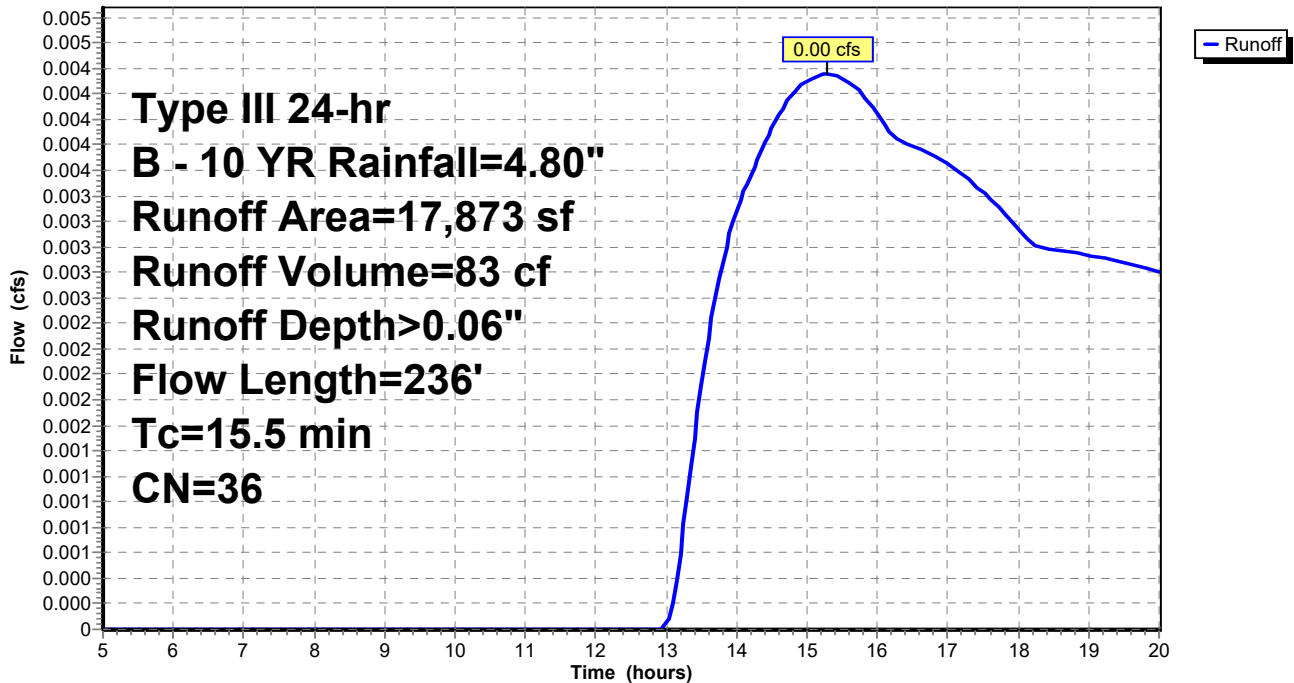
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr B - 10 YR Rainfall=4.80"

Area (sf)	CN	Description
17,873	36	Woods, Fair, HSG A
17,873		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	50	0.0166	0.06		Sheet Flow, A-B Woods: Light underbrush n= 0.400 P2= 3.40"
2.6	186	0.0577	1.20		Shallow Concentrated Flow, B-C Woodland Kv= 5.0 fps
15.5	236	Total			

Subcatchment 3S: Subcatchment Area 3

Hydrograph



3 Forest Park Drive - Pre-Development

Type III 24-hr C - 25 YR Rainfall=5.70"

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Summary for Subcatchment 1S: Subcatchment Area 1

[49] Hint: $T_c < 2dt$ may require smaller dt

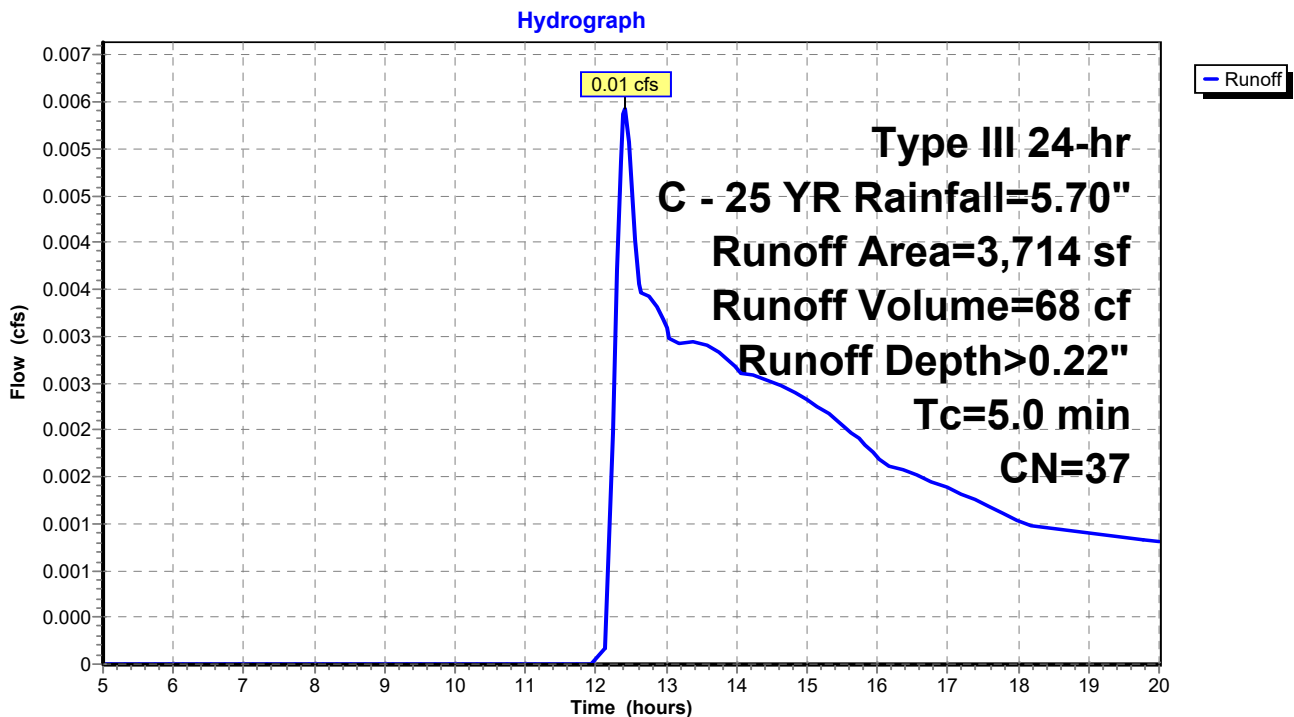
Runoff = 0.01 cfs @ 12.42 hrs, Volume= 68 cf, Depth > 0.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr C - 25 YR Rainfall=5.70"

Area (sf)	CN	Description
102	98	Paved parking, HSG A
44	36	Woods, Fair, HSG A
3,568	35	Brush, Fair, HSG A
3,714	37	Weighted Average
3,612		97.25% Pervious Area
102		2.75% Impervious Area

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

Subcatchment 1S: Subcatchment Area 1



3 Forest Park Drive - Pre-Development

Type III 24-hr C - 25 YR Rainfall=5.70"

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Summary for Subcatchment 2S: Subcatchment Area 2

Runoff = 0.02 cfs @ 12.57 hrs, Volume= 278 cf, Depth> 0.18"

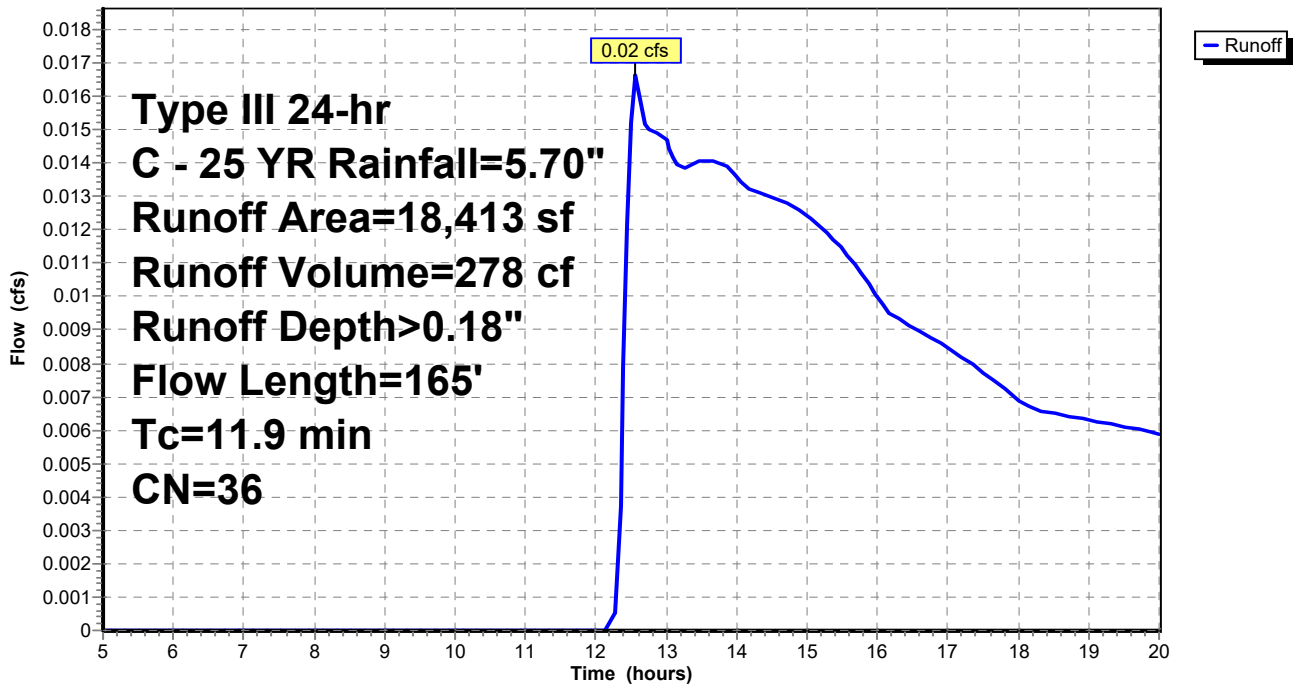
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr C - 25 YR Rainfall=5.70"

Area (sf)	CN	Description
248	98	Paved parking, HSG A
10,452	36	Woods, Fair, HSG A
7,713	35	Brush, Fair, HSG A
18,413	36	Weighted Average
18,165		98.65% Pervious Area
248		1.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0268	0.08		Sheet Flow, A-B Woods: Light underbrush n= 0.400 P2= 3.40"
1.3	115	0.0814	1.43		Shallow Concentrated Flow, B-C Woodland Kv= 5.0 fps
11.9	165	Total			

Subcatchment 2S: Subcatchment Area 2

Hydrograph



3 Forest Park Drive - Pre-Development

Type III 24-hr C - 25 YR Rainfall=5.70"

Prepared by Microsoft

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Summary for Subcatchment 3S: Subcatchment Area 3

Runoff = 0.02 cfs @ 12.65 hrs, Volume= 269 cf, Depth> 0.18"

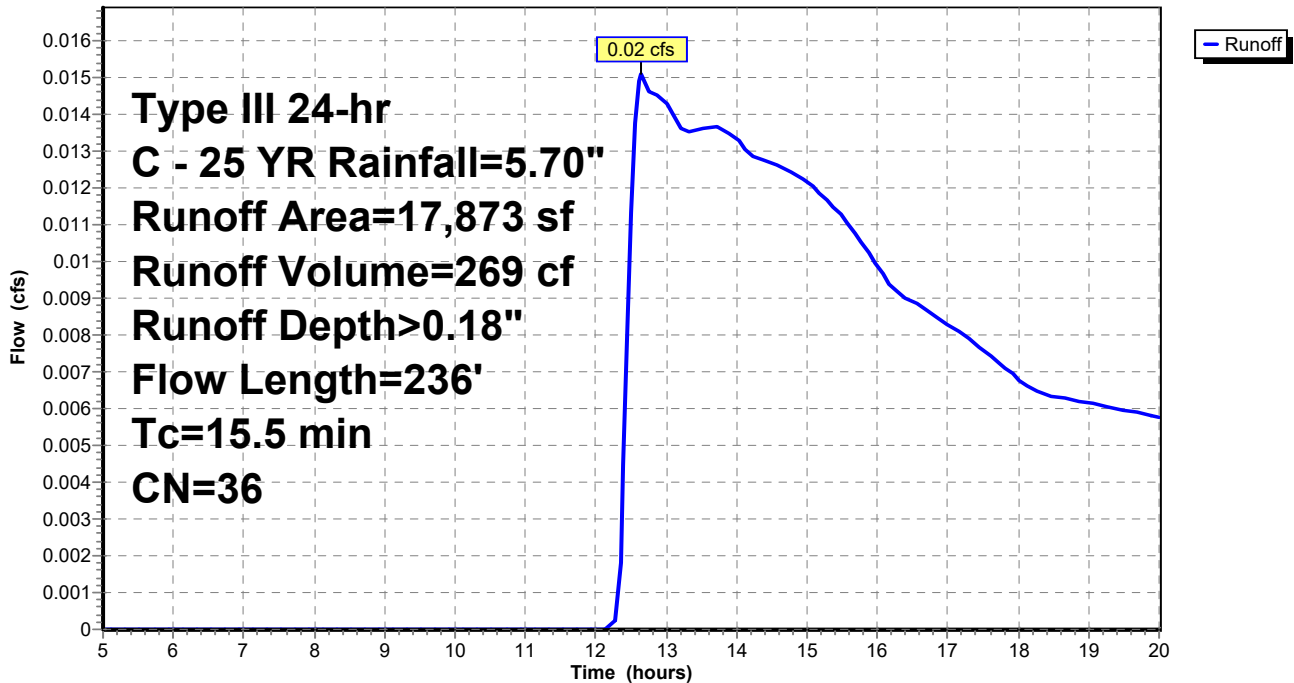
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr C - 25 YR Rainfall=5.70"

Area (sf)	CN	Description
17,873	36	Woods, Fair, HSG A
17,873		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	50	0.0166	0.06		Sheet Flow, A-B Woods: Light underbrush n= 0.400 P2= 3.40"
2.6	186	0.0577	1.20		Shallow Concentrated Flow, B-C Woodland Kv= 5.0 fps
15.5	236	Total			

Subcatchment 3S: Subcatchment Area 3

Hydrograph



3 Forest Park Drive - Pre-Development

Type III 24-hr D - 100YR Rainfall=7.10"

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Summary for Subcatchment 1S: Subcatchment Area 1

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 0.03 cfs @ 12.28 hrs, Volume= 174 cf, Depth > 0.56"

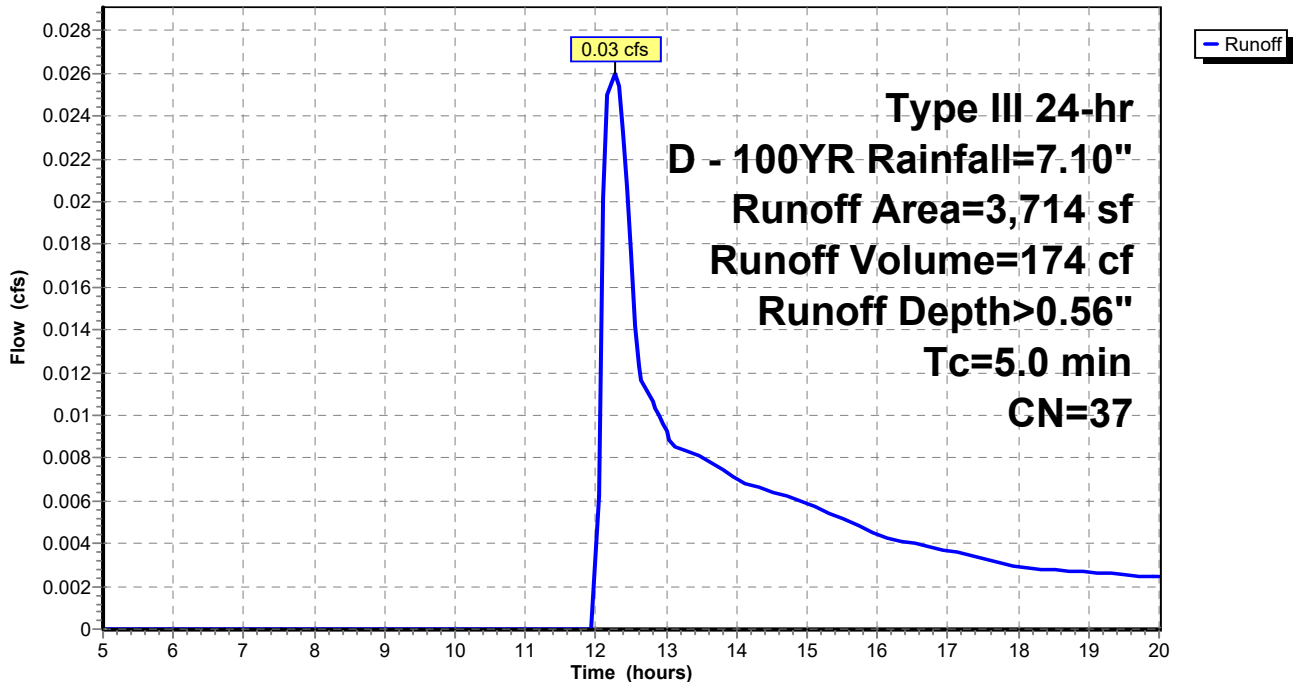
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, $dt=0.05$ hrs
Type III 24-hr D - 100YR Rainfall=7.10"

Area (sf)	CN	Description
102	98	Paved parking, HSG A
44	36	Woods, Fair, HSG A
3,568	35	Brush, Fair, HSG A
3,714	37	Weighted Average
3,612		97.25% Pervious Area
102		2.75% Impervious Area

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

Subcatchment 1S: Subcatchment Area 1

Hydrograph



3 Forest Park Drive - Pre-Development

Type III 24-hr D - 100YR Rainfall=7.10"

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Summary for Subcatchment 2S: Subcatchment Area 2

Runoff = 0.10 cfs @ 12.41 hrs, Volume= 760 cf, Depth> 0.50"

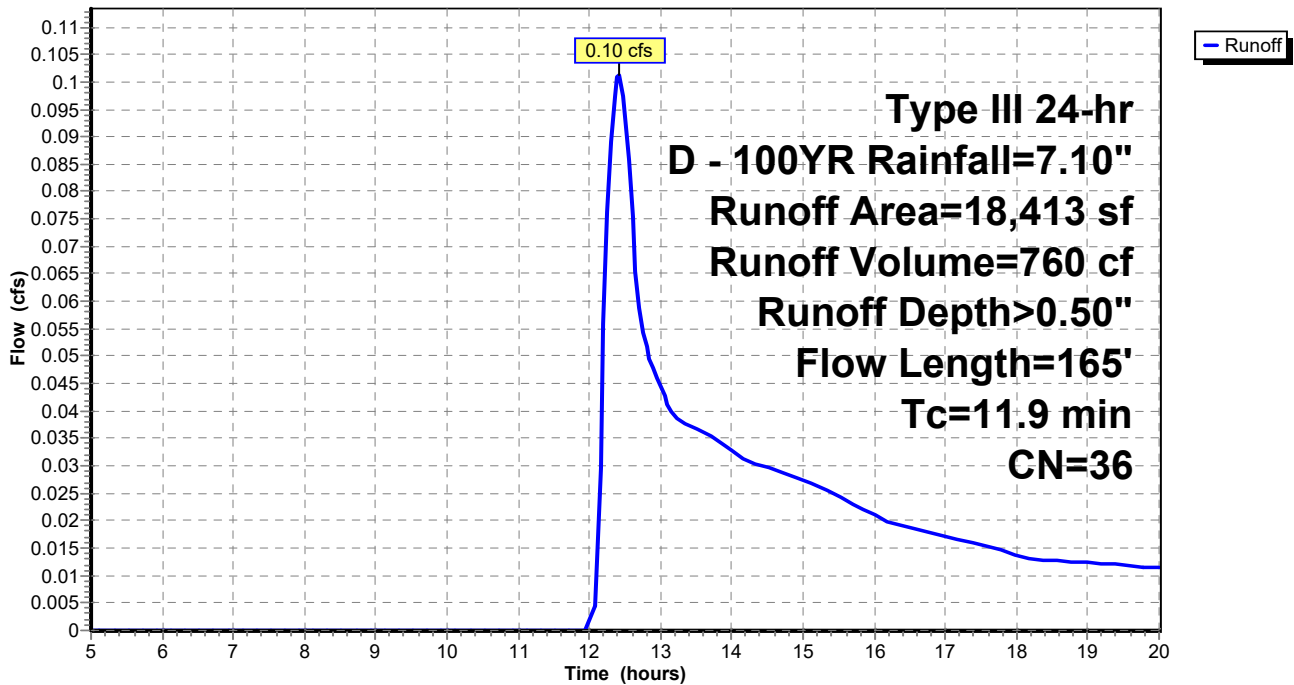
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr D - 100YR Rainfall=7.10"

Area (sf)	CN	Description
248	98	Paved parking, HSG A
10,452	36	Woods, Fair, HSG A
7,713	35	Brush, Fair, HSG A
18,413	36	Weighted Average
18,165		98.65% Pervious Area
248		1.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	50	0.0268	0.08		Sheet Flow, A-B Woods: Light underbrush n= 0.400 P2= 3.40"
1.3	115	0.0814	1.43		Shallow Concentrated Flow, B-C Woodland Kv= 5.0 fps
11.9	165	Total			

Subcatchment 2S: Subcatchment Area 2

Hydrograph



3 Forest Park Drive - Pre-Development

Type III 24-hr D - 100YR Rainfall=7.10"

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Summary for Subcatchment 3S: Subcatchment Area 3

Runoff = 0.09 cfs @ 12.47 hrs, Volume= 735 cf, Depth> 0.49"

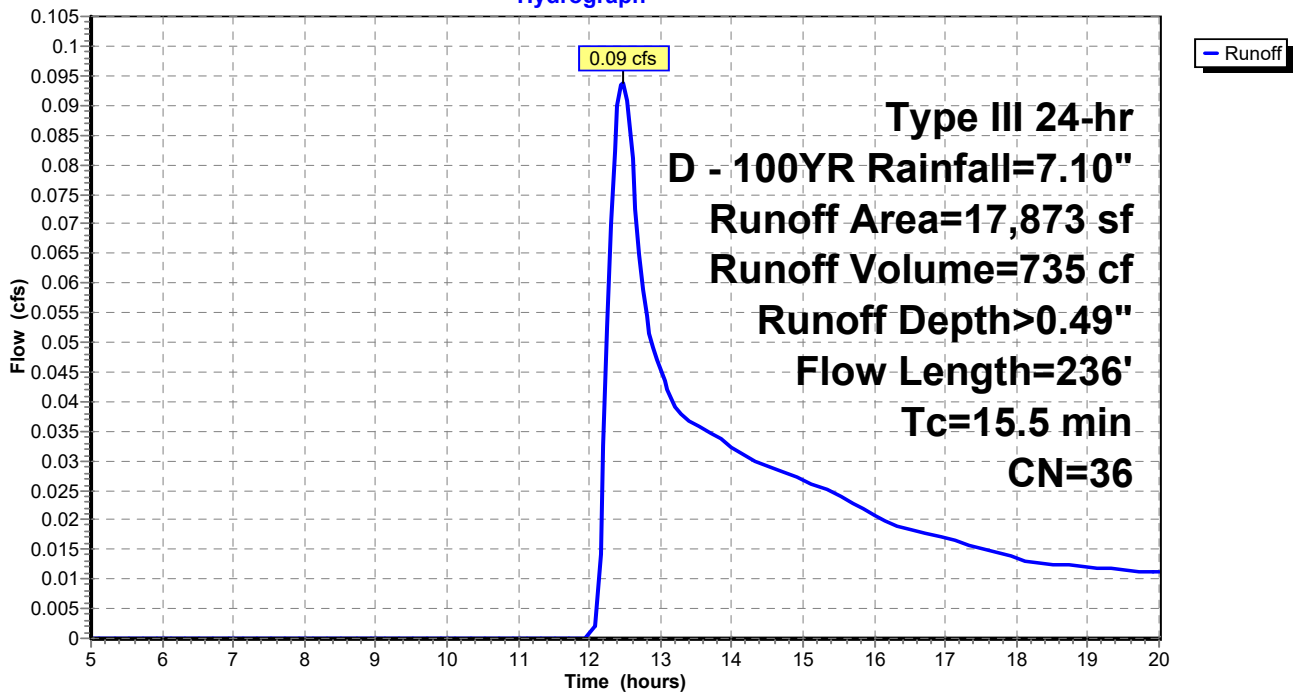
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr D - 100YR Rainfall=7.10"

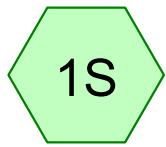
Area (sf)	CN	Description
17,873	36	Woods, Fair, HSG A
17,873		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	50	0.0166	0.06		Sheet Flow, A-B Woods: Light underbrush n= 0.400 P2= 3.40"
2.6	186	0.0577	1.20		Shallow Concentrated Flow, B-C Woodland Kv= 5.0 fps
15.5	236	Total			

Subcatchment 3S: Subcatchment Area 3

Hydrograph

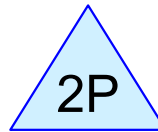




Subcatchment Area 1



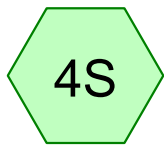
Subcatchment Area 2



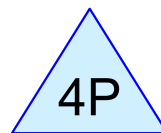
Rain Garden #1



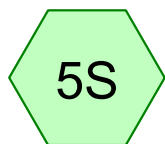
Subcatchment Area 4



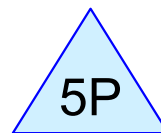
Subcatchment Area 3



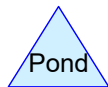
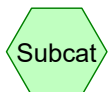
Rain Garden #2



Subcatchment Area 5



Rain Garden #3



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Project Notes

Rainfall events imported from "5 Forest Park Drive - Pre-Development.hcp"

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Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
14,198	39	>75% Grass cover, Good, HSG A (1S, 2S, 3S, 4S, 5S)
1,009	98	Future Parking (2S)
8,344	98	Paved parking, HSG A (2S, 5S)
980	30	Rain Garden (2S)
1,306	98	Rain Garden (4S, 5S)
9,952	98	Roofs, HSG A (4S, 5S)
42	98	Stoop (2S)
4,367	36	Woods, Fair, HSG A (2S, 3S, 4S, 5S)
40,198	69	TOTAL AREA

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Soil Listing (selected nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
36,861	HSG A	1S, 2S, 3S, 4S, 5S
0	HSG B	
0	HSG C	
0	HSG D	
3,337	Other	2S, 4S, 5S
40,198		TOTAL AREA

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Ground Covers (selected nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Sub Num
14,198	0	0	0	0	14,198	>75% Grass cover, Good	
0	0	0	0	1,009	1,009	Future Parking	
8,344	0	0	0	0	8,344	Paved parking	
0	0	0	0	2,286	2,286	Rain Garden	
9,952	0	0	0	0	9,952	Roofs	
0	0	0	0	42	42	Stoop	
4,367	0	0	0	0	4,367	Woods, Fair	
36,861	0	0	0	3,337	40,198	TOTAL AREA	

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Type III 24-hr A - 2 YR Rainfall=3.50"

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

Subcatchment 1S: Subcatchment Area 1	Runoff Area=971 sf 0.00% Impervious Runoff Depth>0.00" Tc=5.0 min CN=39 Runoff=0.00 cfs 0 cf
Subcatchment 2S: Subcatchment Area 2	Runoff Area=16,973 sf 53.30% Impervious Runoff Depth>0.92" Tc=5.0 min CN=70 Runoff=0.43 cfs 1,294 cf
Subcatchment 3S: Subcatchment Area 4	Runoff Area=5,407 sf 0.00% Impervious Runoff Depth>0.00" Tc=5.0 min CN=38 Runoff=0.00 cfs 0 cf
Subcatchment 4S: Subcatchment Area 3	Runoff Area=6,657 sf 70.60% Impervious Runoff Depth>1.52" Tc=5.0 min CN=80 Runoff=0.29 cfs 841 cf
Subcatchment 5S: Subcatchment Area 5	Runoff Area=10,190 sf 67.78% Impervious Runoff Depth>1.45" Tc=5.0 min CN=79 Runoff=0.43 cfs 1,230 cf
Pond 2P: Rain Garden #1	Peak Elev=78.72' Storage=553 cf Inflow=0.43 cfs 1,294 cf Outflow=0.05 cfs 1,106 cf
Pond 4P: Rain Garden #2	Peak Elev=80.33' Storage=526 cf Inflow=0.29 cfs 841 cf Outflow=0.02 cfs 411 cf
Pond 5P: Rain Garden #3	Peak Elev=81.36' Storage=619 cf Inflow=0.43 cfs 1,230 cf Outflow=0.05 cfs 966 cf

Total Runoff Area = 40,198 sf Runoff Volume = 3,365 cf Average Runoff Depth = 1.00"
48.62% Pervious = 19,545 sf 51.38% Impervious = 20,653 sf

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Type III 24-hr A - 2 YR Rainfall=3.50"

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Summary for Subcatchment 1S: Subcatchment Area 1

[49] Hint: $T_c < 2dt$ may require smaller dt

[73] Warning: Peak may fall outside time span

Runoff = 0.00 cfs @ 20.00 hrs, Volume= 0 cf, Depth> 0.00"

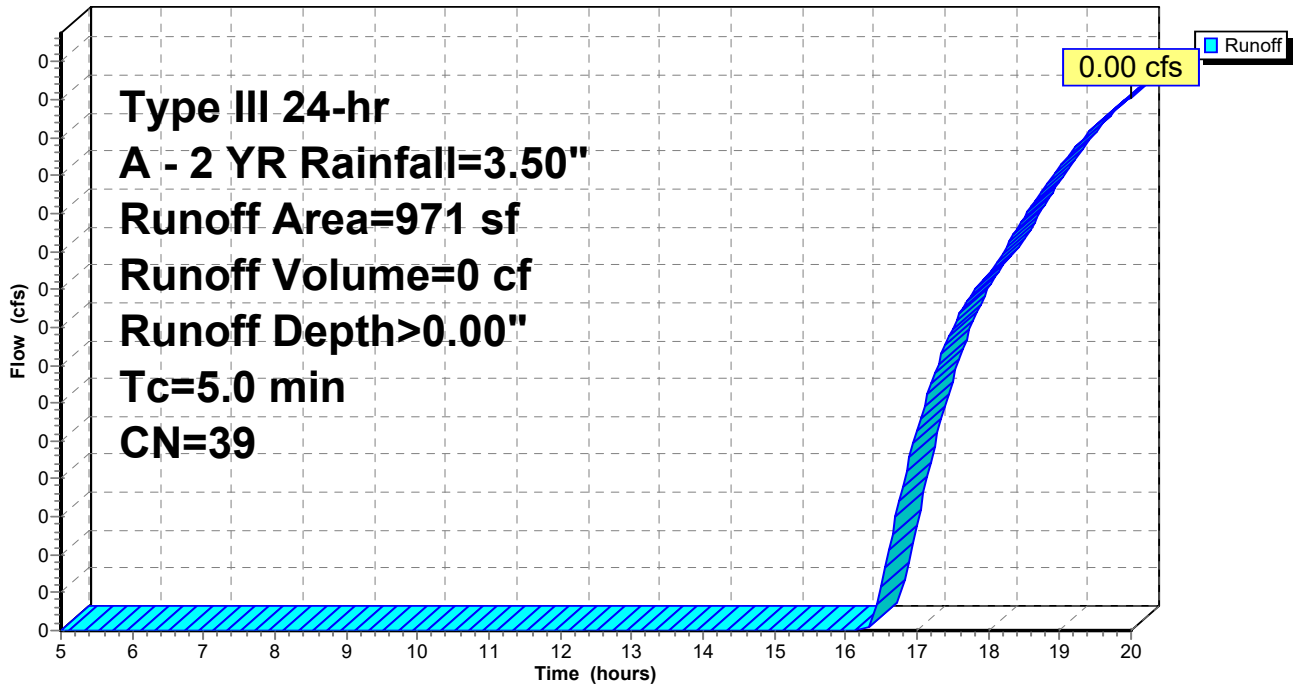
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr A - 2 YR Rainfall=3.50"

Area (sf)	CN	Description
971	39	>75% Grass cover, Good, HSG A
971		100.00% Pervious Area

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

Subcatchment 1S: Subcatchment Area 1

Hydrograph



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Type III 24-hr A - 2 YR Rainfall=3.50"

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Summary for Subcatchment 2S: Subcatchment Area 2

[49] Hint: $T_c < 2dt$ may require smaller dt

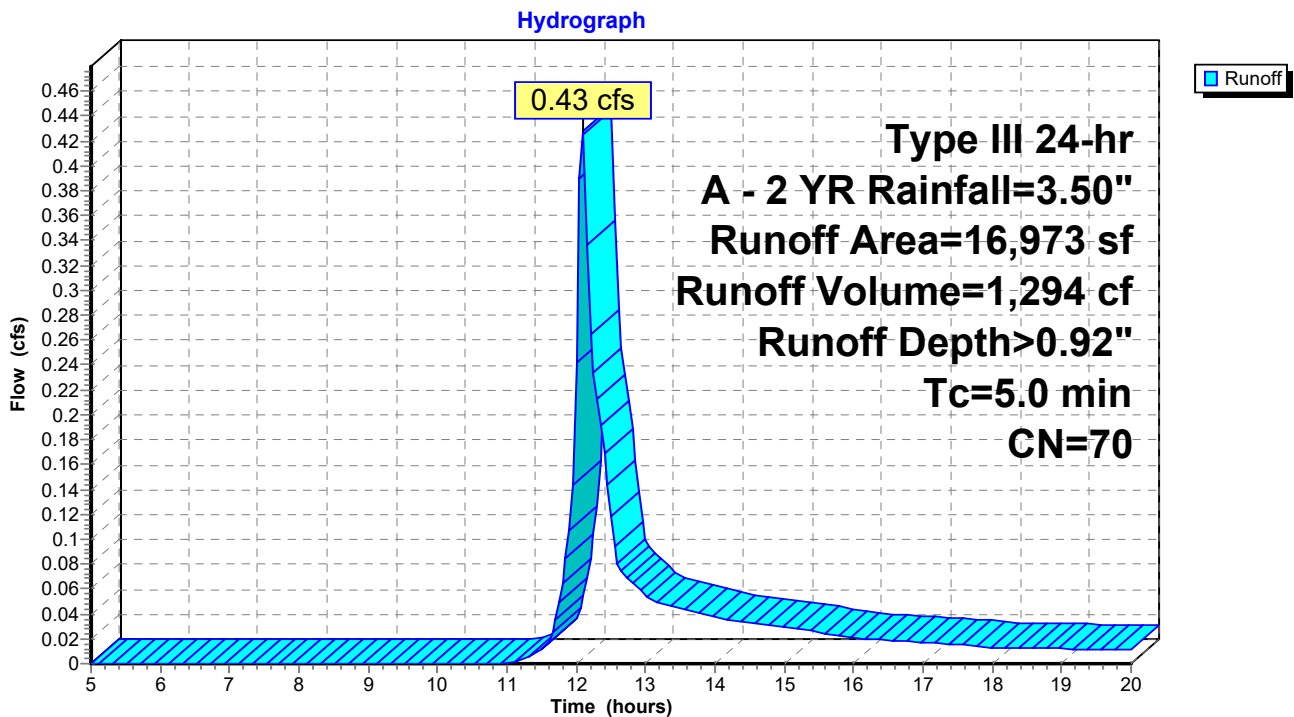
Runoff = 0.43 cfs @ 12.09 hrs, Volume= 1,294 cf, Depth > 0.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr A - 2 YR Rainfall=3.50"

Area (sf)	CN	Description
7,995	98	Paved parking, HSG A
512	36	Woods, Fair, HSG A
6,435	39	>75% Grass cover, Good, HSG A
* 980	30	Rain Garden
* 1,009	98	Future Parking
* 42	98	Stoop
16,973	70	Weighted Average
7,927		46.70% Pervious Area
9,046		53.30% Impervious Area

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

Subcatchment 2S: Subcatchment Area 2



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Type III 24-hr A - 2 YR Rainfall=3.50"

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Summary for Subcatchment 3S: Subcatchment Area 4

[49] Hint: $T_c < 2dt$ may require smaller dt

[73] Warning: Peak may fall outside time span

Runoff = 0.00 cfs @ 20.00 hrs, Volume= 0 cf, Depth> 0.00"

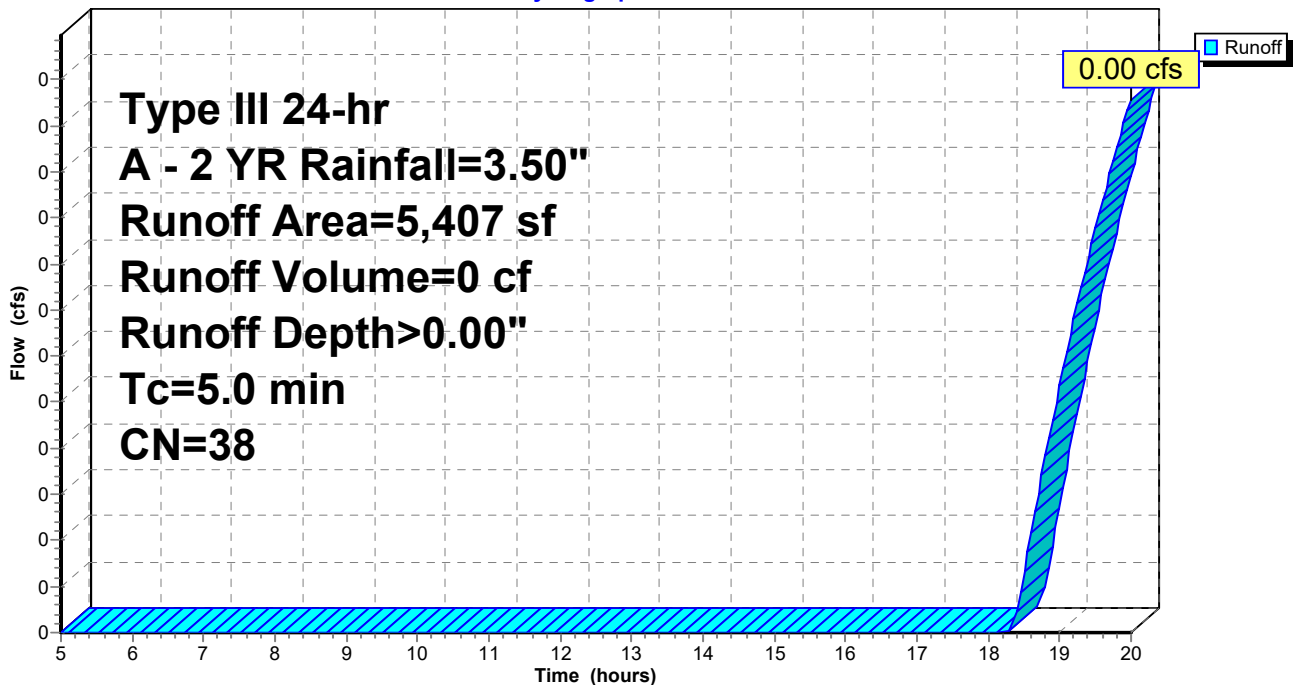
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, $dt= 0.05$ hrs
Type III 24-hr A - 2 YR Rainfall=3.50"

Area (sf)	CN	Description
2,081	36	Woods, Fair, HSG A
3,326	39	>75% Grass cover, Good, HSG A
5,407	38	Weighted Average
5,407		100.00% Pervious Area

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

Subcatchment 3S: Subcatchment Area 4

Hydrograph



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Type III 24-hr A - 2 YR Rainfall=3.50"

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Summary for Subcatchment 4S: Subcatchment Area 3

[49] Hint: $T_c < 2dt$ may require smaller dt

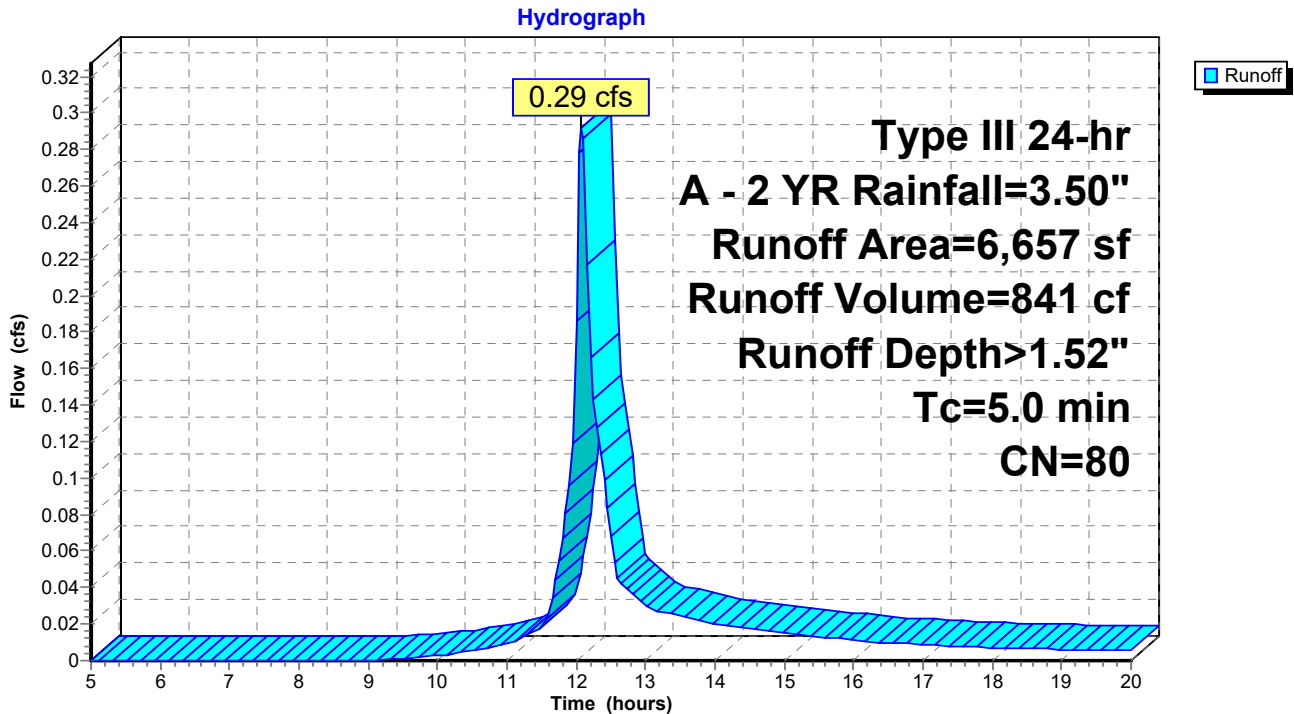
Runoff = 0.29 cfs @ 12.08 hrs, Volume= 841 cf, Depth > 1.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr A - 2 YR Rainfall=3.50"

Area (sf)	CN	Description
952	36	Woods, Fair, HSG A
1,005	39	>75% Grass cover, Good, HSG A
* 523	98	Rain Garden
4,177	98	Roofs, HSG A
6,657	80	Weighted Average
1,957		29.40% Pervious Area
4,700		70.60% Impervious Area

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

Subcatchment 4S: Subcatchment Area 3



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Type III 24-hr A - 2 YR Rainfall=3.50"

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Summary for Subcatchment 5S: Subcatchment Area 5

[49] Hint: $T_c < 2dt$ may require smaller dt

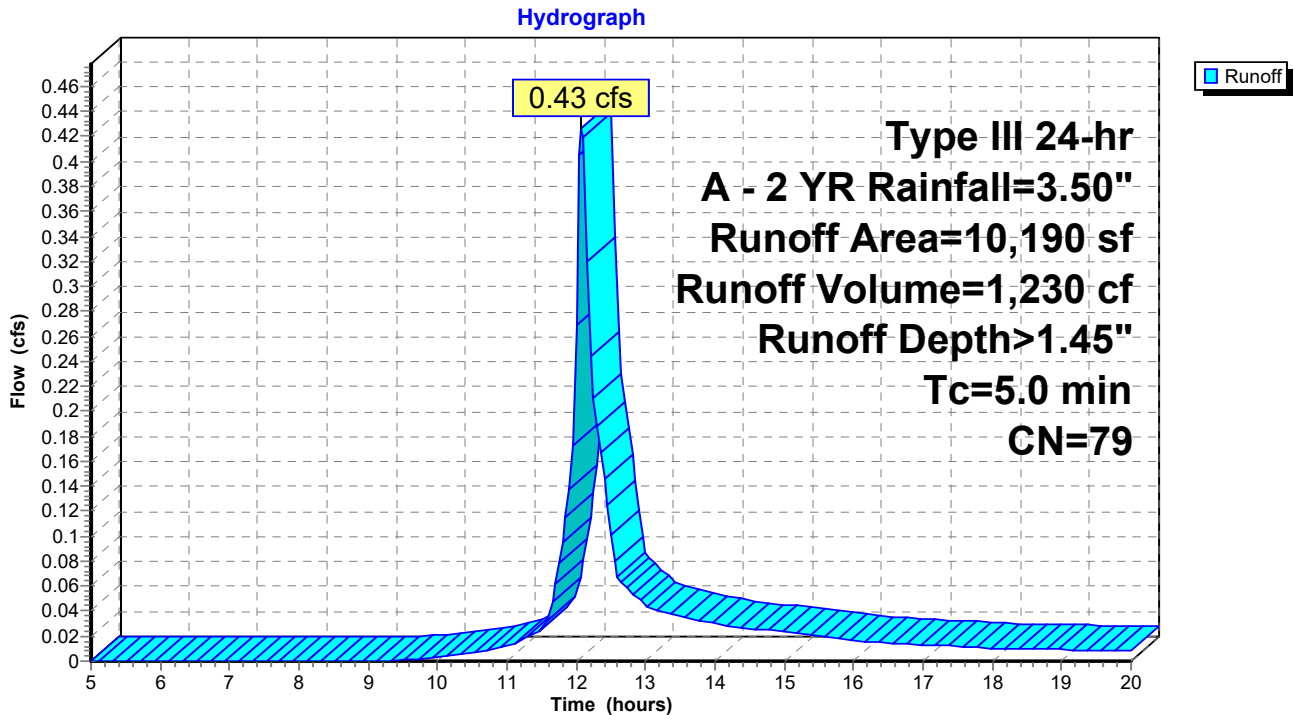
Runoff = 0.43 cfs @ 12.08 hrs, Volume= 1,230 cf, Depth > 1.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, $dt=0.05$ hrs
Type III 24-hr A - 2 YR Rainfall=3.50"

Area (sf)	CN	Description
822	36	Woods, Fair, HSG A
2,461	39	>75% Grass cover, Good, HSG A
5,775	98	Roofs, HSG A
349	98	Paved parking, HSG A
* 783	98	Rain Garden
10,190	79	Weighted Average
3,283		32.22% Pervious Area
6,907		67.78% Impervious Area

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

Subcatchment 5S: Subcatchment Area 5



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Type III 24-hr A - 2 YR Rainfall=3.50"

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Summary for Pond 2P: Rain Garden #1

Inflow Area = 16,973 sf, 53.30% Impervious, Inflow Depth > 0.92" for A - 2 YR event
 Inflow = 0.43 cfs @ 12.09 hrs, Volume= 1,294 cf
 Outflow = 0.05 cfs @ 13.08 hrs, Volume= 1,106 cf, Atten= 88%, Lag= 59.2 min
 Discarded = 0.05 cfs @ 13.08 hrs, Volume= 1,106 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 78.72' @ 13.08 hrs Surf.Area= 500 sf Storage= 553 cf

Plug-Flow detention time= 149.9 min calculated for 1,106 cf (85% of inflow)
 Center-of-Mass det. time= 106.6 min (929.5 - 822.9)

Volume	Invert	Avail.Storage	Storage Description
#1	84.49'	923 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious 10.00'W x 50.00'L x 7.00'H Prismaoid 3,500 cf Overall - 1,195 cf Embedded = 2,305 cf x 40.0% Voids
#2	76.50'	922 cf	
#3	77.50'	1,018 cf	
		2,863 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
84.49	197	104.8	0.0	0	0	197
85.50	197	104.8	40.0	80	80	303
85.99	197	104.8	40.0	39	118	354
86.00	197	104.8	30.0	1	119	355
87.74	197	104.8	30.0	103	222	538
87.75	197	104.8	30.0	1	222	539
87.99	197	104.8	30.0	14	236	564
88.00	197	104.8	100.0	2	238	565
89.00	553	127.1	100.0	360	598	992
89.50	751	136.5	100.0	325	923	1,200

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.50'	8.270 in/hr Exfiltration over Wetted area from 76.50' - 82.83' Excluded Wetted area = 500 sf

Discarded OutFlow Max=0.05 cfs @ 13.08 hrs HW=78.72' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.05 cfs)

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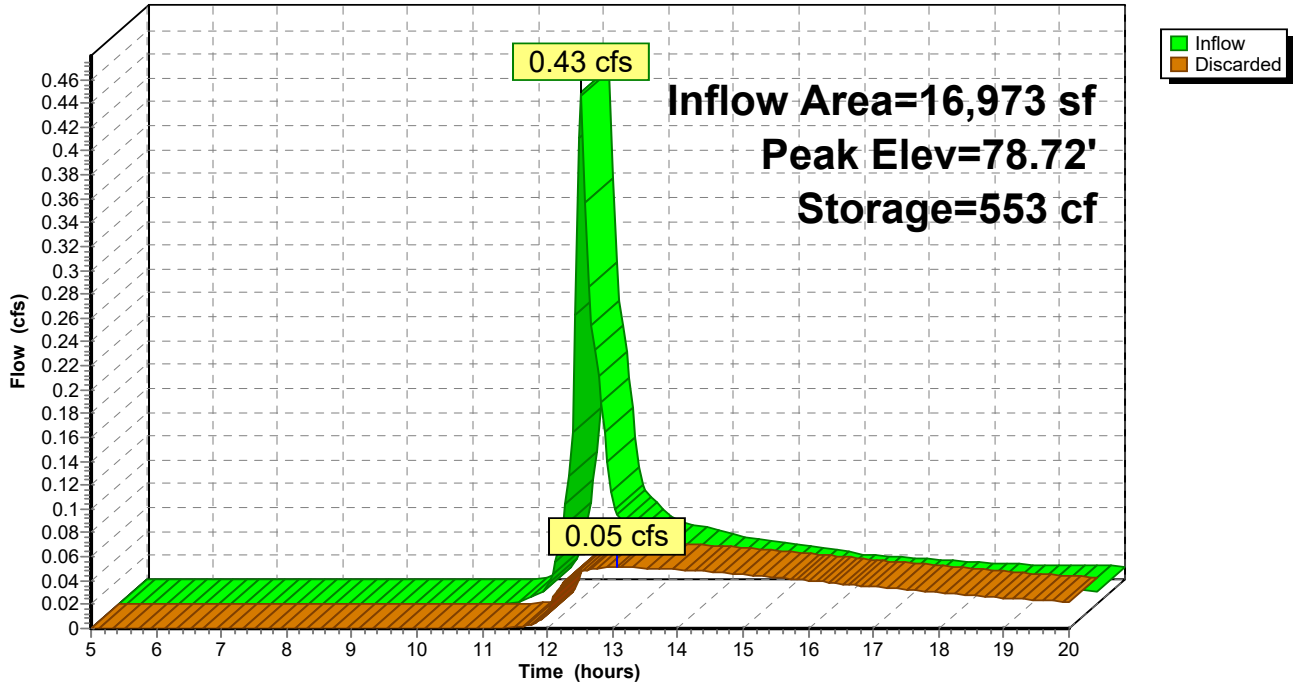
Type III 24-hr A - 2 YR Rainfall=3.50"

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Pond 2P: Rain Garden #1

Hydrograph



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Type III 24-hr A - 2 YR Rainfall=3.50"

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Summary for Pond 4P: Rain Garden #2

Inflow Area = 6,657 sf, 70.60% Impervious, Inflow Depth > 1.52" for A - 2 YR event
 Inflow = 0.29 cfs @ 12.08 hrs, Volume= 841 cf
 Outflow = 0.02 cfs @ 14.32 hrs, Volume= 411 cf, Atten= 94%, Lag= 134.3 min
 Discarded = 0.02 cfs @ 14.32 hrs, Volume= 411 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 80.33' @ 14.32 hrs Surf.Area= 260 sf Storage= 526 cf

Plug-Flow detention time= 236.7 min calculated for 411 cf (49% of inflow)
 Center-of-Mass det. time= 152.0 min (951.4 - 799.4)

Volume	Invert	Avail.Storage	Storage Description
#1	85.99'	863 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious
#2	76.50'	489 cf	10.00'W x 26.00'L x 7.00'H Prismaoid
			1,820 cf Overall - 597 cf Embedded = 1,223 cf x 40.0% Voids
#3	77.50'	509 cf	6.00'D x 6.00'H Vertical Cone/Cylinder x 3 Inside #2
			597 cf Overall - 3.0" Wall Thickness = 509 cf
		1,861 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
85.99	133	72.6	0.0	0	0	133
86.00	133	72.3	40.0	1	1	137
86.99	133	72.6	40.0	53	53	208
87.00	133	72.6	30.0	0	54	209
87.74	133	72.6	30.0	30	83	263
87.75	133	72.6	30.0	0	84	264
87.99	133	72.6	30.0	10	93	281
88.00	133	72.6	100.0	1	94	282
89.00	379	91.4	100.0	246	340	540
90.00	681	110.3	100.0	523	863	860

Device	Routing	Invert	Outlet Devices
#1	Discarded	79.00'	8.270 in/hr Exfiltration over Wetted area from 79.00' - 87.00' Excluded Wetted area = 440 sf

Discarded OutFlow Max=0.02 cfs @ 14.32 hrs HW=80.33' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.02 cfs)

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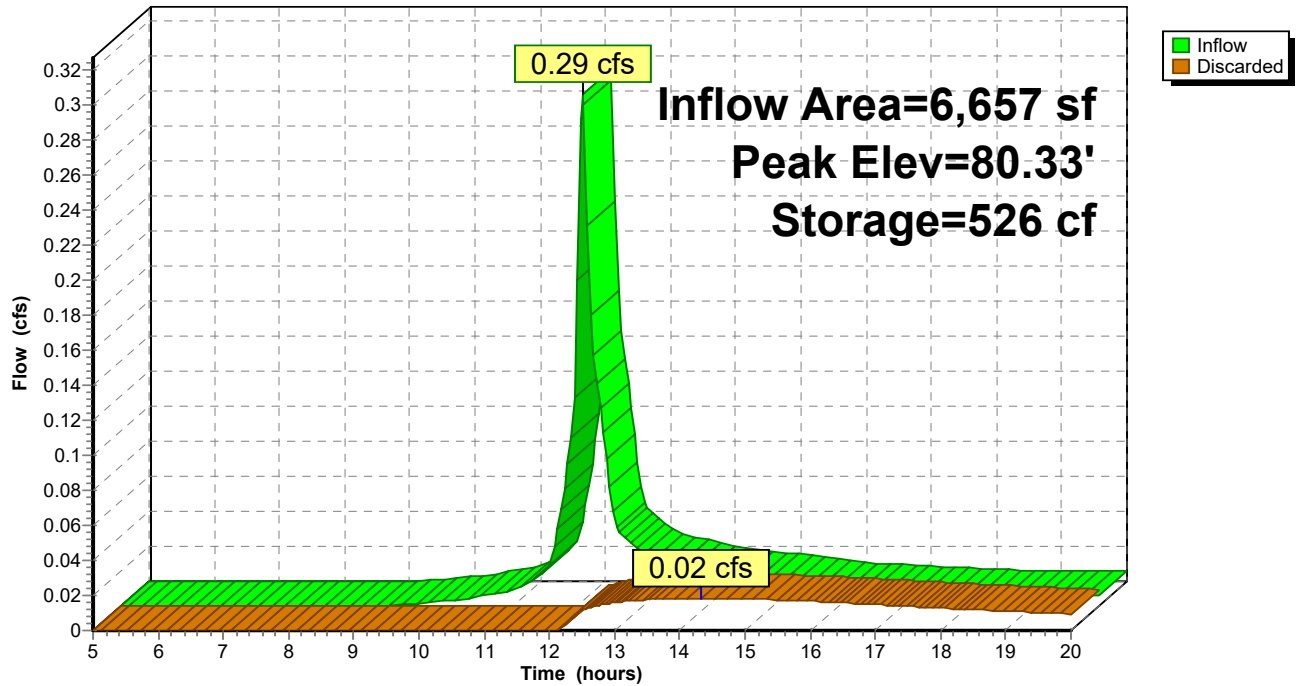
Type III 24-hr A - 2 YR Rainfall=3.50"

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Pond 4P: Rain Garden #2

Hydrograph



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Type III 24-hr A - 2 YR Rainfall=3.50"

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Summary for Pond 5P: Rain Garden #3

Inflow Area = 10,190 sf, 67.78% Impervious, Inflow Depth > 1.45" for A - 2 YR event
 Inflow = 0.43 cfs @ 12.08 hrs, Volume= 1,230 cf
 Outflow = 0.05 cfs @ 12.97 hrs, Volume= 966 cf, Atten= 89%, Lag= 53.1 min
 Discarded = 0.05 cfs @ 12.97 hrs, Volume= 966 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 81.36' @ 12.97 hrs Surf.Area= 420 sf Storage= 619 cf

Plug-Flow detention time= 177.8 min calculated for 963 cf (78% of inflow)
 Center-of-Mass det. time= 122.1 min (923.9 - 801.8)

Volume	Invert	Avail.Storage	Storage Description
#1	86.49'	978 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious 10.00'W x 42.00'L x 7.00'H Prismaoid 2,940 cf Overall - 995 cf Embedded = 1,945 cf x 40.0% Voids 6.00'D x 6.00'H Vertical Cone/Cylinder x 5 Inside #2 995 cf Overall - 3.0" Wall Thickness = 848 cf
#2	78.50'	778 cf	
#3	79.50'	848 cf	
		2,604 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
86.49	213	112.6	0.0	0	0	213
86.50	213	112.6	40.0	1	1	214
87.99	213	112.6	40.0	127	128	382
88.00	213	112.6	30.0	1	128	383
89.74	213	112.6	30.0	111	240	579
89.75	213	112.6	30.0	1	240	580
89.99	213	112.6	30.0	15	256	607
90.00	213	112.6	100.0	2	258	608
91.00	579	131.4	100.0	381	639	993
91.50	783	140.8	100.0	339	978	1,208

Device	Routing	Invert	Outlet Devices
#1	Discarded	79.00'	8.270 in/hr Exfiltration over Wetted area from 79.00' - 87.00' Excluded Wetted area = 472 sf

Discarded OutFlow Max=0.05 cfs @ 12.97 hrs HW=81.36' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.05 cfs)

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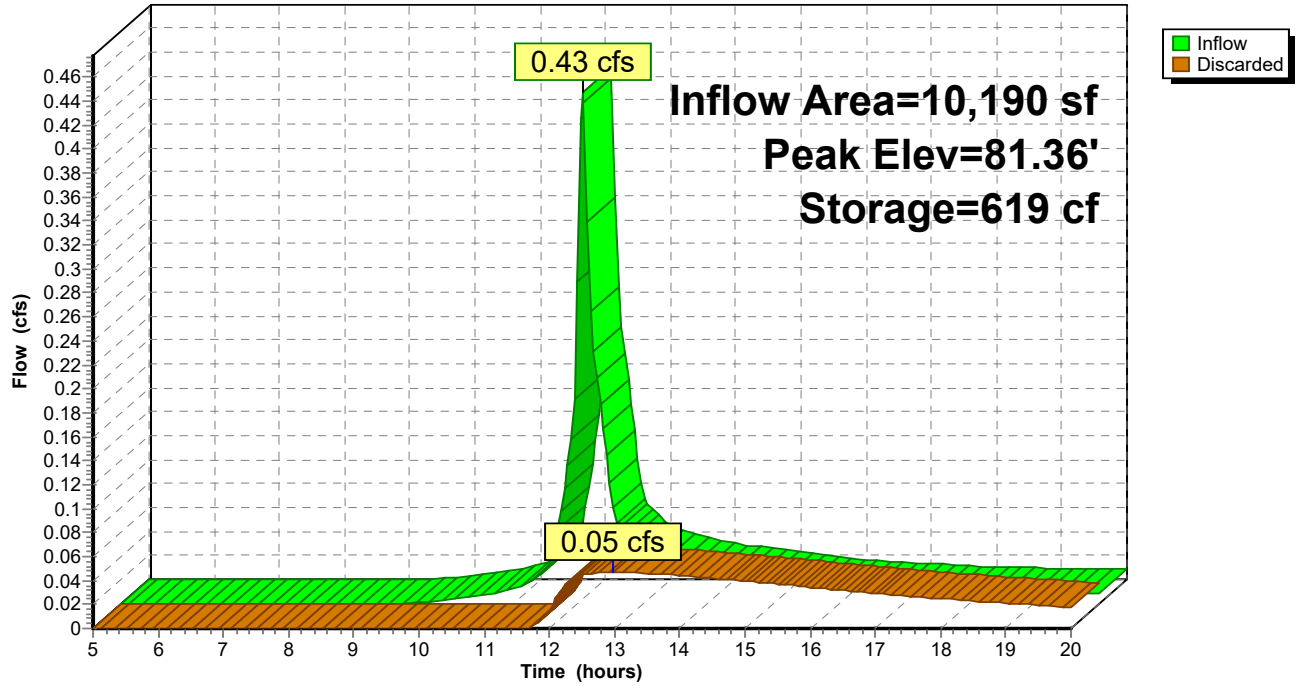
Type III 24-hr A - 2 YR Rainfall=3.50"

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Pond 5P: Rain Garden #3

Hydrograph



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Type III 24-hr B - 10 YR Rainfall=4.80"

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

Subcatchment 1S: Subcatchment Area 1	Runoff Area=971 sf 0.00% Impervious Runoff Depth>0.12" Tc=5.0 min CN=39 Runoff=0.00 cfs 10 cf
Subcatchment 2S: Subcatchment Area 2	Runoff Area=16,973 sf 53.30% Impervious Runoff Depth>1.74" Tc=5.0 min CN=70 Runoff=0.85 cfs 2,458 cf
Subcatchment 3S: Subcatchment Area 4	Runoff Area=5,407 sf 0.00% Impervious Runoff Depth>0.10" Tc=5.0 min CN=38 Runoff=0.00 cfs 45 cf
Subcatchment 4S: Subcatchment Area 3	Runoff Area=6,657 sf 70.60% Impervious Runoff Depth>2.54" Tc=5.0 min CN=80 Runoff=0.49 cfs 1,408 cf
Subcatchment 5S: Subcatchment Area 5	Runoff Area=10,190 sf 67.78% Impervious Runoff Depth>2.45" Tc=5.0 min CN=79 Runoff=0.72 cfs 2,083 cf
Pond 2P: Rain Garden #1	Peak Elev=80.75' Storage=1,141 cf Inflow=0.85 cfs 2,458 cf Outflow=0.10 cfs 2,065 cf
Pond 4P: Rain Garden #2	Peak Elev=82.25' Storage=812 cf Inflow=0.49 cfs 1,408 cf Outflow=0.04 cfs 904 cf
Pond 5P: Rain Garden #3	Peak Elev=83.22' Storage=1,071 cf Inflow=0.72 cfs 2,083 cf Outflow=0.08 cfs 1,686 cf

Total Runoff Area = 40,198 sf Runoff Volume = 6,004 cf Average Runoff Depth = 1.79"
48.62% Pervious = 19,545 sf 51.38% Impervious = 20,653 sf

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Type III 24-hr B - 10 YR Rainfall=4.80"

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Summary for Subcatchment 2S: Subcatchment Area 2

[49] Hint: $T_c < 2dt$ may require smaller dt

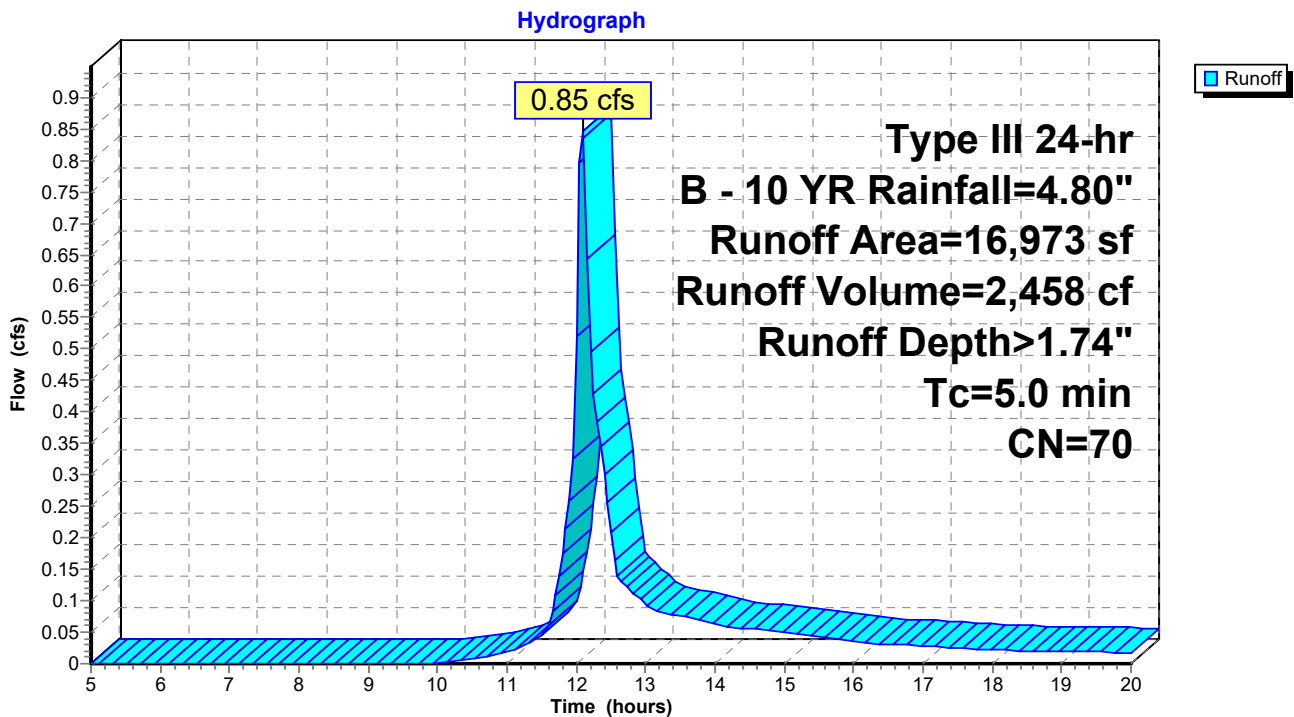
Runoff = 0.85 cfs @ 12.08 hrs, Volume= 2,458 cf, Depth > 1.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr B - 10 YR Rainfall=4.80"

Area (sf)	CN	Description
7,995	98	Paved parking, HSG A
512	36	Woods, Fair, HSG A
6,435	39	>75% Grass cover, Good, HSG A
* 980	30	Rain Garden
* 1,009	98	Future Parking
* 42	98	Stoop
16,973	70	Weighted Average
7,927		46.70% Pervious Area
9,046		53.30% Impervious Area

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

Subcatchment 2S: Subcatchment Area 2



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Type III 24-hr B - 10 YR Rainfall=4.80"

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Summary for Subcatchment 4S: Subcatchment Area 3

[49] Hint: $T_c < 2dt$ may require smaller dt

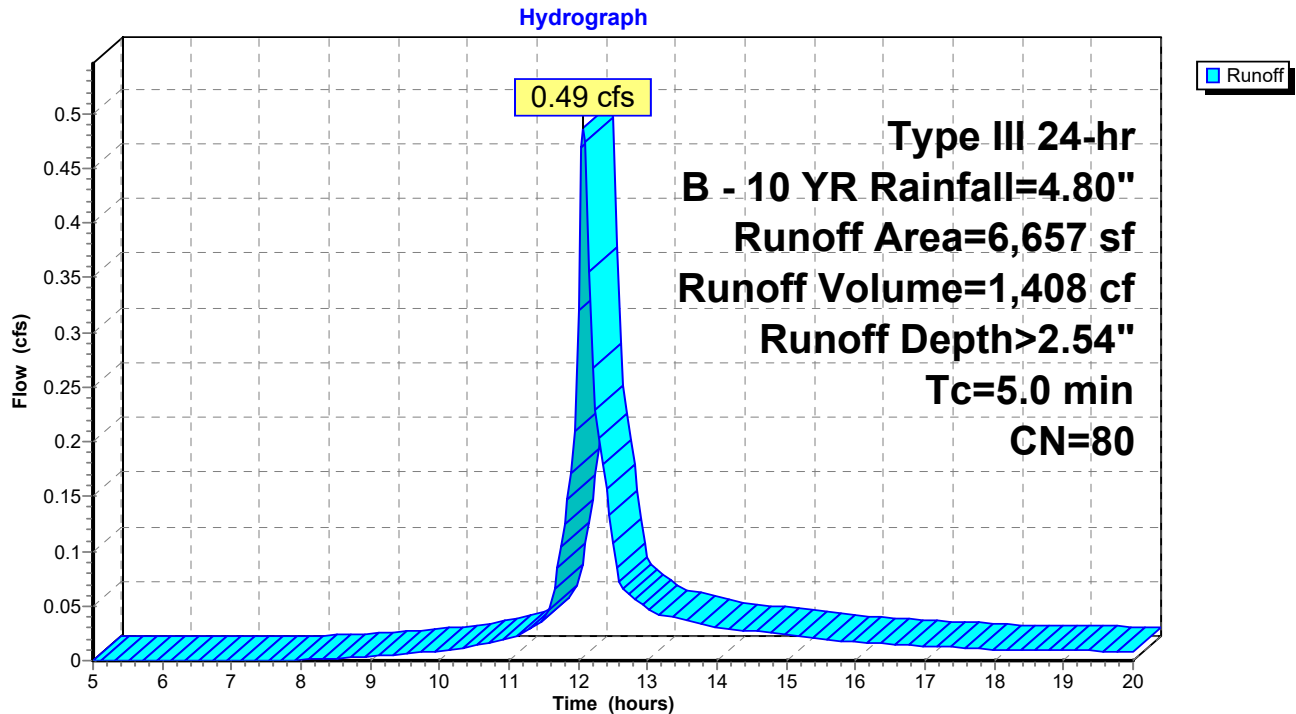
Runoff = 0.49 cfs @ 12.08 hrs, Volume= 1,408 cf, Depth > 2.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr B - 10 YR Rainfall=4.80"

Area (sf)	CN	Description
952	36	Woods, Fair, HSG A
1,005	39	>75% Grass cover, Good, HSG A
* 523	98	Rain Garden
4,177	98	Roofs, HSG A
6,657	80	Weighted Average
1,957		29.40% Pervious Area
4,700		70.60% Impervious Area

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

Subcatchment 4S: Subcatchment Area 3



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Type III 24-hr B - 10 YR Rainfall=4.80"

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Summary for Subcatchment 5S: Subcatchment Area 5

[49] Hint: $T_c < 2dt$ may require smaller dt

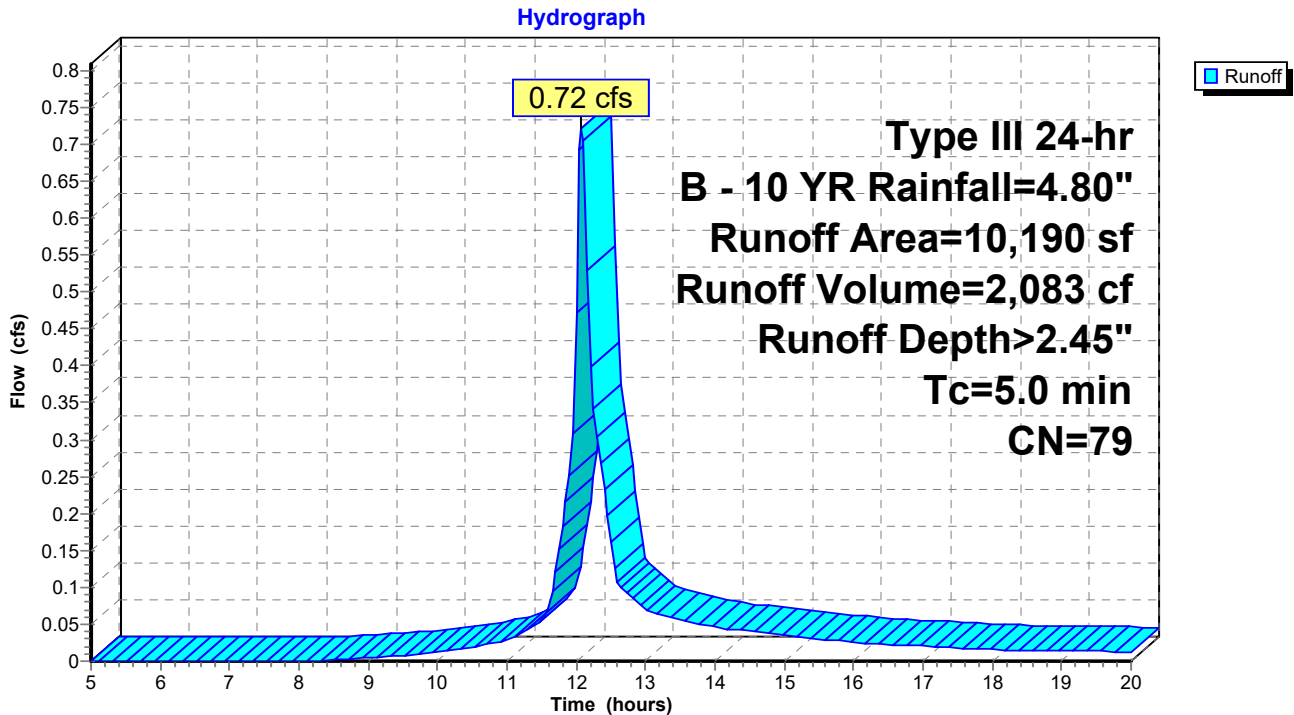
Runoff = 0.72 cfs @ 12.08 hrs, Volume= 2,083 cf, Depth> 2.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr B - 10 YR Rainfall=4.80"

Area (sf)	CN	Description
822	36	Woods, Fair, HSG A
2,461	39	>75% Grass cover, Good, HSG A
5,775	98	Roofs, HSG A
349	98	Paved parking, HSG A
* 783	98	Rain Garden
10,190	79	Weighted Average
3,283		32.22% Pervious Area
6,907		67.78% Impervious Area

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

Subcatchment 5S: Subcatchment Area 5



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Type III 24-hr B - 10 YR Rainfall=4.80"

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Summary for Pond 2P: Rain Garden #1

Inflow Area = 16,973 sf, 53.30% Impervious, Inflow Depth > 1.74" for B - 10 YR event
 Inflow = 0.85 cfs @ 12.08 hrs, Volume= 2,458 cf
 Outflow = 0.10 cfs @ 12.97 hrs, Volume= 2,065 cf, Atten= 88%, Lag= 53.2 min
 Discarded = 0.10 cfs @ 12.97 hrs, Volume= 2,065 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 80.75' @ 12.97 hrs Surf.Area= 500 sf Storage= 1,141 cf

Plug-Flow detention time= 159.6 min calculated for 2,065 cf (84% of inflow)
 Center-of-Mass det. time= 113.3 min (921.7 - 808.4)

Volume	Invert	Avail.Storage	Storage Description
#1	84.49'	923 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious 10.00'W x 50.00'L x 7.00'H Prismaoid 3,500 cf Overall - 1,195 cf Embedded = 2,305 cf x 40.0% Voids
#2	76.50'	922 cf	
#3	77.50'	1,018 cf	
		2,863 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
84.49	197	104.8	0.0	0	0	197
85.50	197	104.8	40.0	80	80	303
85.99	197	104.8	40.0	39	118	354
86.00	197	104.8	30.0	1	119	355
87.74	197	104.8	30.0	103	222	538
87.75	197	104.8	30.0	1	222	539
87.99	197	104.8	30.0	14	236	564
88.00	197	104.8	100.0	2	238	565
89.00	553	127.1	100.0	360	598	992
89.50	751	136.5	100.0	325	923	1,200

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.50'	8.270 in/hr Exfiltration over Wetted area from 76.50' - 82.83' Excluded Wetted area = 500 sf

Discarded OutFlow Max=0.10 cfs @ 12.97 hrs HW=80.75' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.10 cfs)

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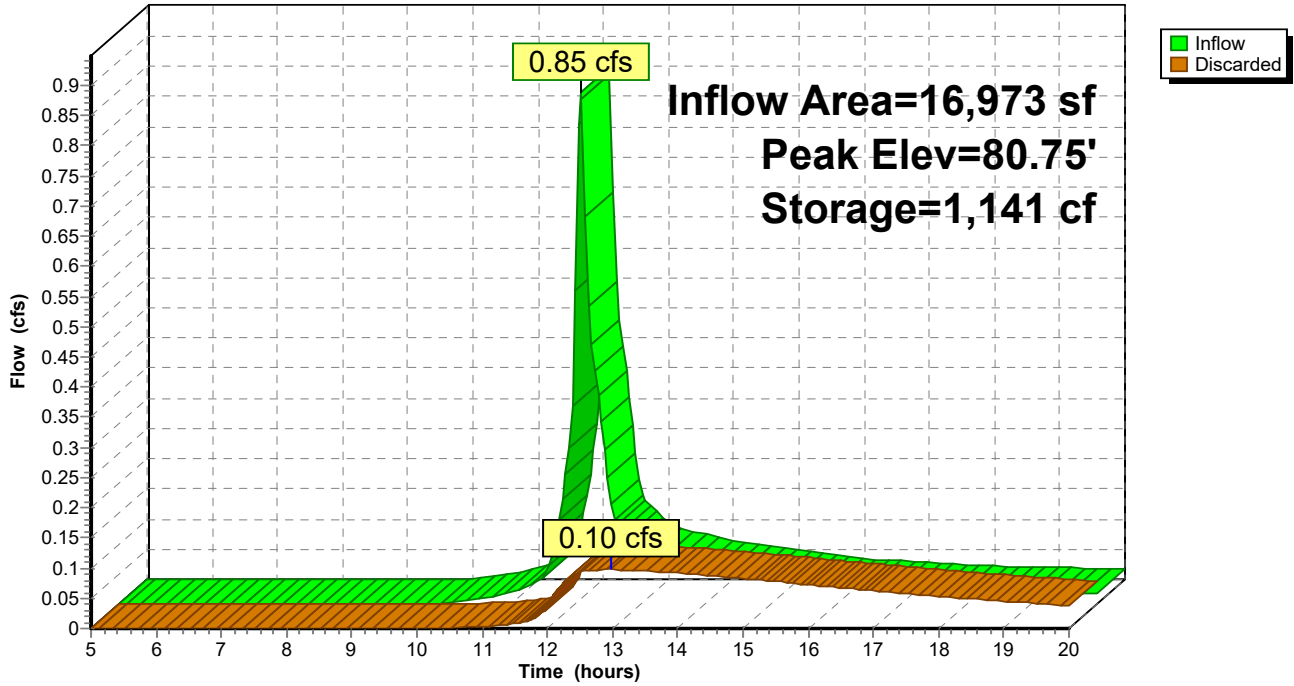
Type III 24-hr B - 10 YR Rainfall=4.80"

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Pond 2P: Rain Garden #1

Hydrograph



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Type III 24-hr B - 10 YR Rainfall=4.80"

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Summary for Pond 4P: Rain Garden #2

Inflow Area = 6,657 sf, 70.60% Impervious, Inflow Depth > 2.54" for B - 10 YR event
 Inflow = 0.49 cfs @ 12.08 hrs, Volume= 1,408 cf
 Outflow = 0.04 cfs @ 13.06 hrs, Volume= 904 cf, Atten= 91%, Lag= 58.8 min
 Discarded = 0.04 cfs @ 13.06 hrs, Volume= 904 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 82.25' @ 13.06 hrs Surf.Area= 260 sf Storage= 812 cf

Plug-Flow detention time= 211.0 min calculated for 904 cf (64% of inflow)
 Center-of-Mass det. time= 138.5 min (926.2 - 787.7)

Volume	Invert	Avail.Storage	Storage Description
#1	85.99'	863 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious
#2	76.50'	489 cf	10.00'W x 26.00'L x 7.00'H Prismaoid 1,820 cf Overall - 597 cf Embedded = 1,223 cf x 40.0% Voids
#3	77.50'	509 cf	6.00'D x 6.00'H Vertical Cone/Cylinder x 3 Inside #2 597 cf Overall - 3.0" Wall Thickness = 509 cf
		1,861 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
85.99	133	72.6	0.0	0	0	133
86.00	133	72.3	40.0	1	1	137
86.99	133	72.6	40.0	53	53	208
87.00	133	72.6	30.0	0	54	209
87.74	133	72.6	30.0	30	83	263
87.75	133	72.6	30.0	0	84	264
87.99	133	72.6	30.0	10	93	281
88.00	133	72.6	100.0	1	94	282
89.00	379	91.4	100.0	246	340	540
90.00	681	110.3	100.0	523	863	860

Device	Routing	Invert	Outlet Devices
#1	Discarded	79.00'	8.270 in/hr Exfiltration over Wetted area from 79.00' - 87.00' Excluded Wetted area = 440 sf

Discarded OutFlow Max=0.04 cfs @ 13.06 hrs HW=82.25' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.04 cfs)

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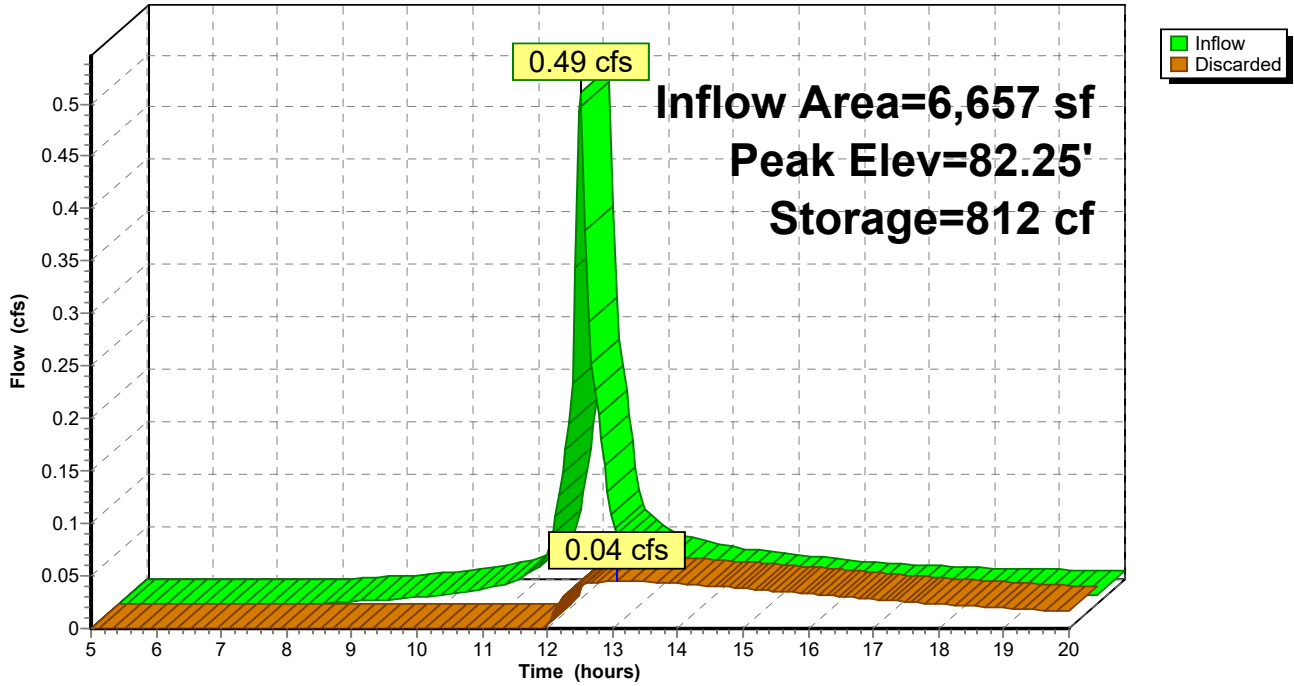
Type III 24-hr B - 10 YR Rainfall=4.80"

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Pond 4P: Rain Garden #2

Hydrograph



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Type III 24-hr B - 10 YR Rainfall=4.80"

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Summary for Pond 5P: Rain Garden #3

Inflow Area = 10,190 sf, 67.78% Impervious, Inflow Depth > 2.45" for B - 10 YR event
 Inflow = 0.72 cfs @ 12.08 hrs, Volume= 2,083 cf
 Outflow = 0.08 cfs @ 12.83 hrs, Volume= 1,686 cf, Atten= 88%, Lag= 45.3 min
 Discarded = 0.08 cfs @ 12.83 hrs, Volume= 1,686 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 83.22' @ 12.83 hrs Surf.Area= 420 sf Storage= 1,071 cf

Plug-Flow detention time= 176.4 min calculated for 1,686 cf (81% of inflow)
 Center-of-Mass det. time= 124.9 min (914.8 - 789.9)

Volume	Invert	Avail.Storage	Storage Description
#1	86.49'	978 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious 10.00'W x 42.00'L x 7.00'H Prismaoid 2,940 cf Overall - 995 cf Embedded = 1,945 cf x 40.0% Voids 6.00'D x 6.00'H Vertical Cone/Cylinder x 5 Inside #2 995 cf Overall - 3.0" Wall Thickness = 848 cf
#2	78.50'	778 cf	
#3	79.50'	848 cf	
		2,604 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
86.49	213	112.6	0.0	0	0	213
86.50	213	112.6	40.0	1	1	214
87.99	213	112.6	40.0	127	128	382
88.00	213	112.6	30.0	1	128	383
89.74	213	112.6	30.0	111	240	579
89.75	213	112.6	30.0	1	240	580
89.99	213	112.6	30.0	15	256	607
90.00	213	112.6	100.0	2	258	608
91.00	579	131.4	100.0	381	639	993
91.50	783	140.8	100.0	339	978	1,208

Device	Routing	Invert	Outlet Devices
#1	Discarded	79.00'	8.270 in/hr Exfiltration over Wetted area from 79.00' - 87.00' Excluded Wetted area = 472 sf

Discarded OutFlow Max=0.08 cfs @ 12.83 hrs HW=83.22' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.08 cfs)

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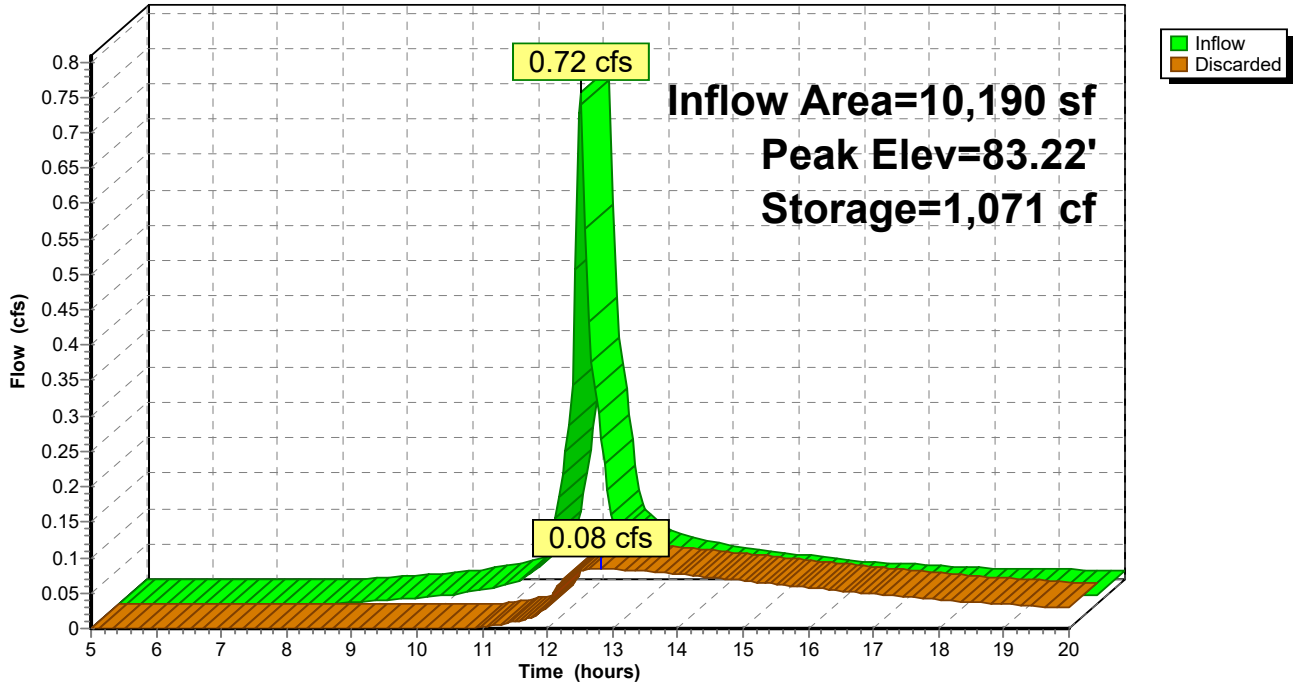
Type III 24-hr B - 10 YR Rainfall=4.80"

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Pond 5P: Rain Garden #3

Hydrograph



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Type III 24-hr C - 25 YR Rainfall=5.70"

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

Subcatchment 1S: Subcatchment Area 1	Runoff Area=971 sf 0.00% Impervious Runoff Depth>0.30" Tc=5.0 min CN=39 Runoff=0.00 cfs 24 cf
Subcatchment 2S: Subcatchment Area 2	Runoff Area=16,973 sf 53.30% Impervious Runoff Depth>2.38" Tc=5.0 min CN=70 Runoff=1.17 cfs 3,362 cf
Subcatchment 3S: Subcatchment Area 4	Runoff Area=5,407 sf 0.00% Impervious Runoff Depth>0.26" Tc=5.0 min CN=38 Runoff=0.01 cfs 117 cf
Subcatchment 4S: Subcatchment Area 3	Runoff Area=6,657 sf 70.60% Impervious Runoff Depth>3.29" Tc=5.0 min CN=80 Runoff=0.63 cfs 1,825 cf
Subcatchment 5S: Subcatchment Area 5	Runoff Area=10,190 sf 67.78% Impervious Runoff Depth>3.19" Tc=5.0 min CN=79 Runoff=0.93 cfs 2,712 cf
Pond 2P: Rain Garden #1	Peak Elev=82.34' Storage=1,605 cf Inflow=1.17 cfs 3,362 cf Outflow=0.13 cfs 2,816 cf
Pond 4P: Rain Garden #2	Peak Elev=86.88' Storage=1,045 cf Inflow=0.63 cfs 1,825 cf Outflow=0.06 cfs 1,267 cf
Pond 5P: Rain Garden #3	Peak Elev=84.58' Storage=1,403 cf Inflow=0.93 cfs 2,712 cf Outflow=0.11 cfs 2,221 cf

Total Runoff Area = 40,198 sf Runoff Volume = 8,039 cf Average Runoff Depth = 2.40"
48.62% Pervious = 19,545 sf 51.38% Impervious = 20,653 sf

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Type III 24-hr C - 25 YR Rainfall=5.70"

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Summary for Subcatchment 1S: Subcatchment Area 1

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 0.00 cfs @ 12.36 hrs, Volume= 24 cf, Depth> 0.30"

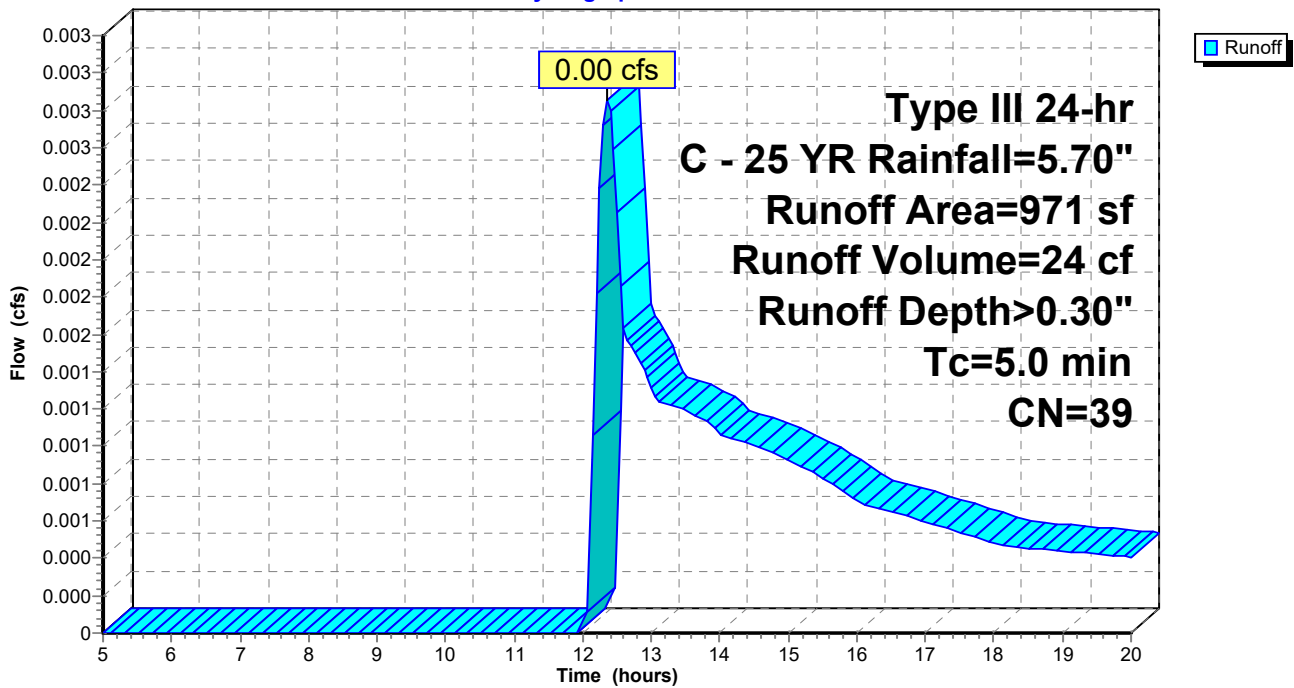
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr C - 25 YR Rainfall=5.70"

Area (sf)	CN	Description
971	39	>75% Grass cover, Good, HSG A
971		100.00% Pervious Area

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

Subcatchment 1S: Subcatchment Area 1

Hydrograph



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Type III 24-hr C - 25 YR Rainfall=5.70"

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Summary for Subcatchment 2S: Subcatchment Area 2

[49] Hint: $T_c < 2dt$ may require smaller dt

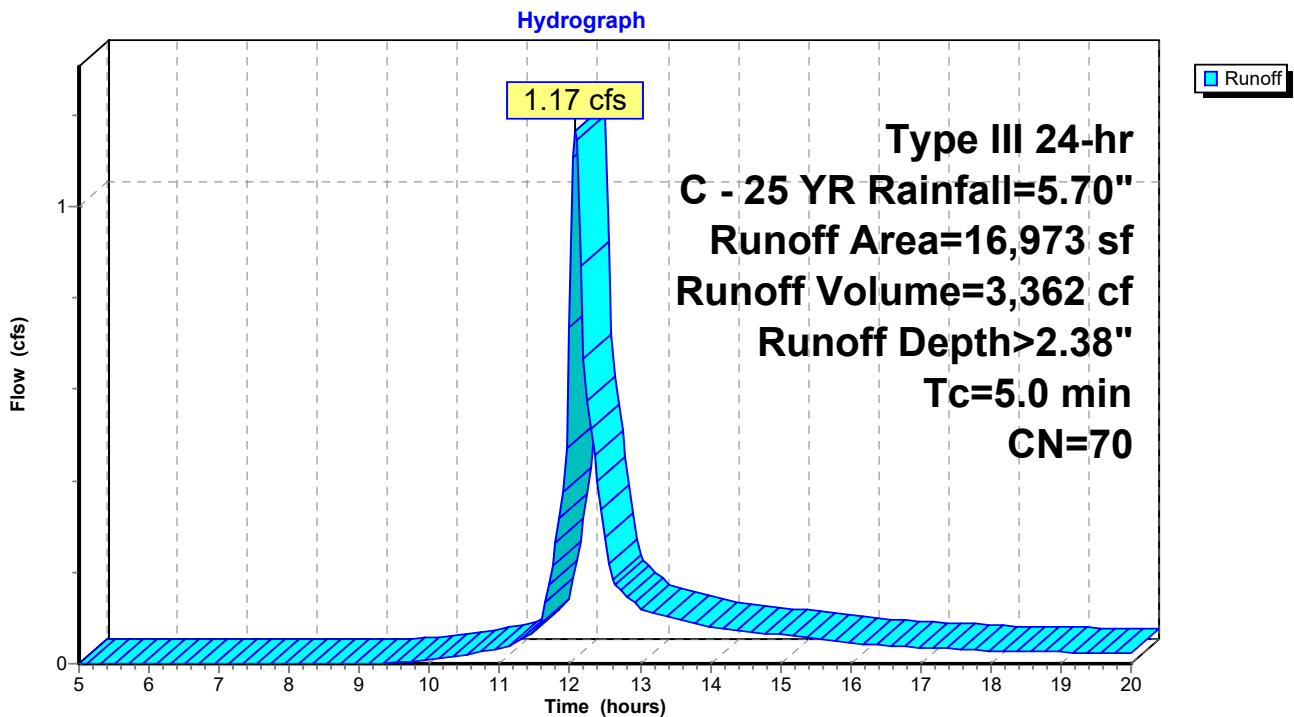
Runoff = 1.17 cfs @ 12.08 hrs, Volume= 3,362 cf, Depth > 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr C - 25 YR Rainfall=5.70"

Area (sf)	CN	Description
7,995	98	Paved parking, HSG A
512	36	Woods, Fair, HSG A
6,435	39	>75% Grass cover, Good, HSG A
* 980	30	Rain Garden
* 1,009	98	Future Parking
* 42	98	Stoop
16,973	70	Weighted Average
7,927		46.70% Pervious Area
9,046		53.30% Impervious Area

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

Subcatchment 2S: Subcatchment Area 2



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Type III 24-hr C - 25 YR Rainfall=5.70"

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Summary for Subcatchment 3S: Subcatchment Area 4

[49] Hint: $T_c < 2dt$ may require smaller dt

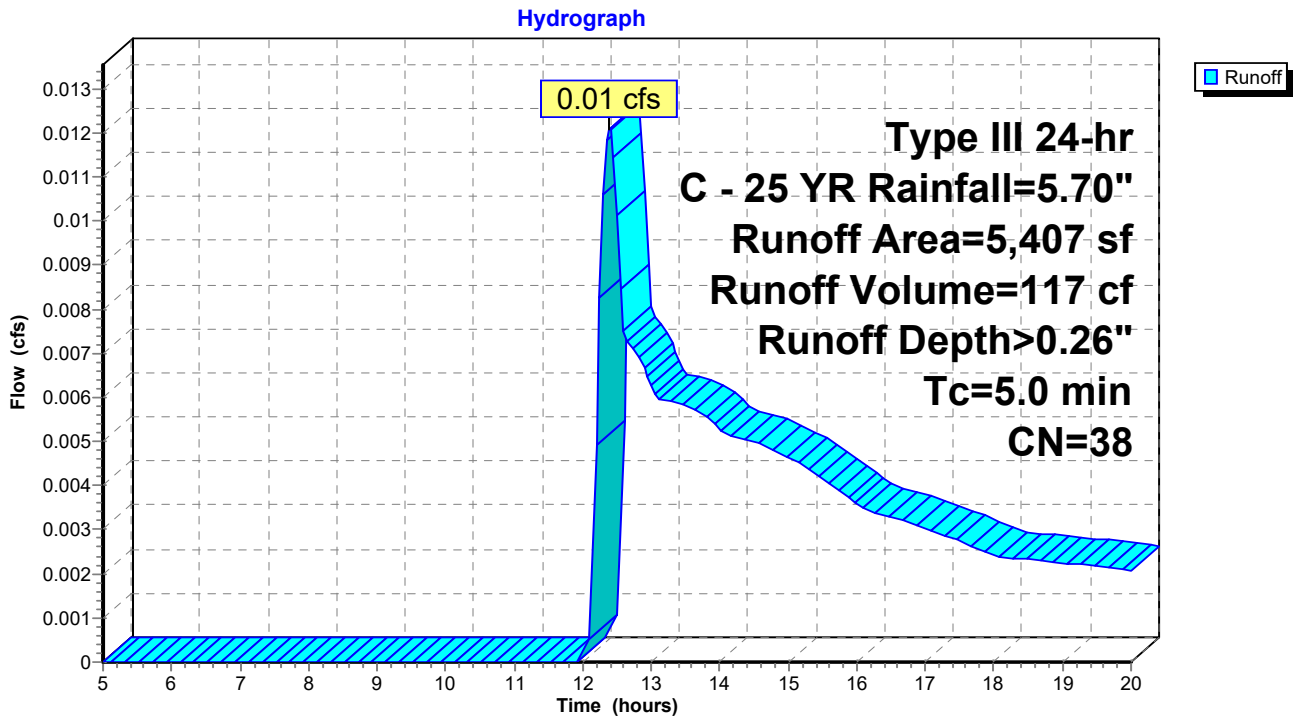
Runoff = 0.01 cfs @ 12.39 hrs, Volume= 117 cf, Depth > 0.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, $dt=0.05$ hrs
Type III 24-hr C - 25 YR Rainfall=5.70"

Area (sf)	CN	Description
2,081	36	Woods, Fair, HSG A
3,326	39	>75% Grass cover, Good, HSG A
5,407	38	Weighted Average
5,407		100.00% Pervious Area

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

Subcatchment 3S: Subcatchment Area 4



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Type III 24-hr C - 25 YR Rainfall=5.70"

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Summary for Subcatchment 4S: Subcatchment Area 3

[49] Hint: $T_c < 2dt$ may require smaller dt

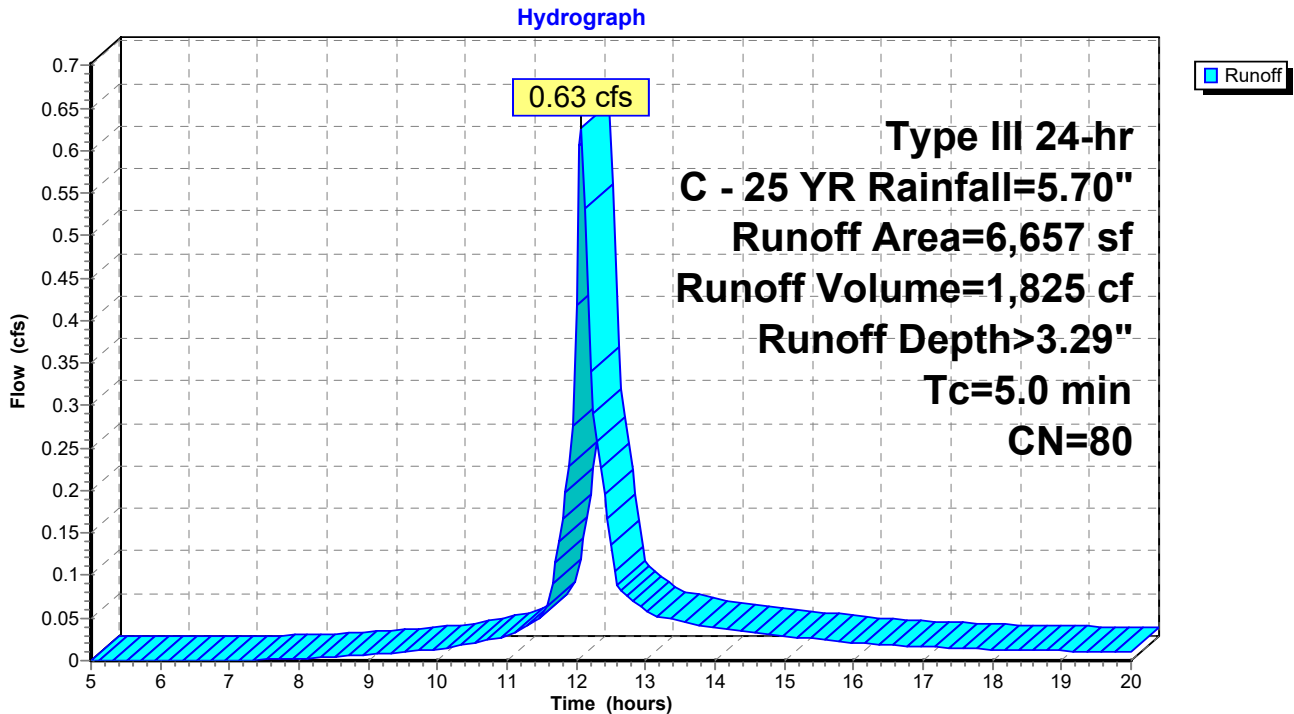
Runoff = 0.63 cfs @ 12.08 hrs, Volume= 1,825 cf, Depth> 3.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr C - 25 YR Rainfall=5.70"

Area (sf)	CN	Description
952	36	Woods, Fair, HSG A
1,005	39	>75% Grass cover, Good, HSG A
* 523	98	Rain Garden
4,177	98	Roofs, HSG A
6,657	80	Weighted Average
1,957		29.40% Pervious Area
4,700		70.60% Impervious Area

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

Subcatchment 4S: Subcatchment Area 3



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Type III 24-hr C - 25 YR Rainfall=5.70"

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Summary for Subcatchment 5S: Subcatchment Area 5

[49] Hint: $T_c < 2dt$ may require smaller dt

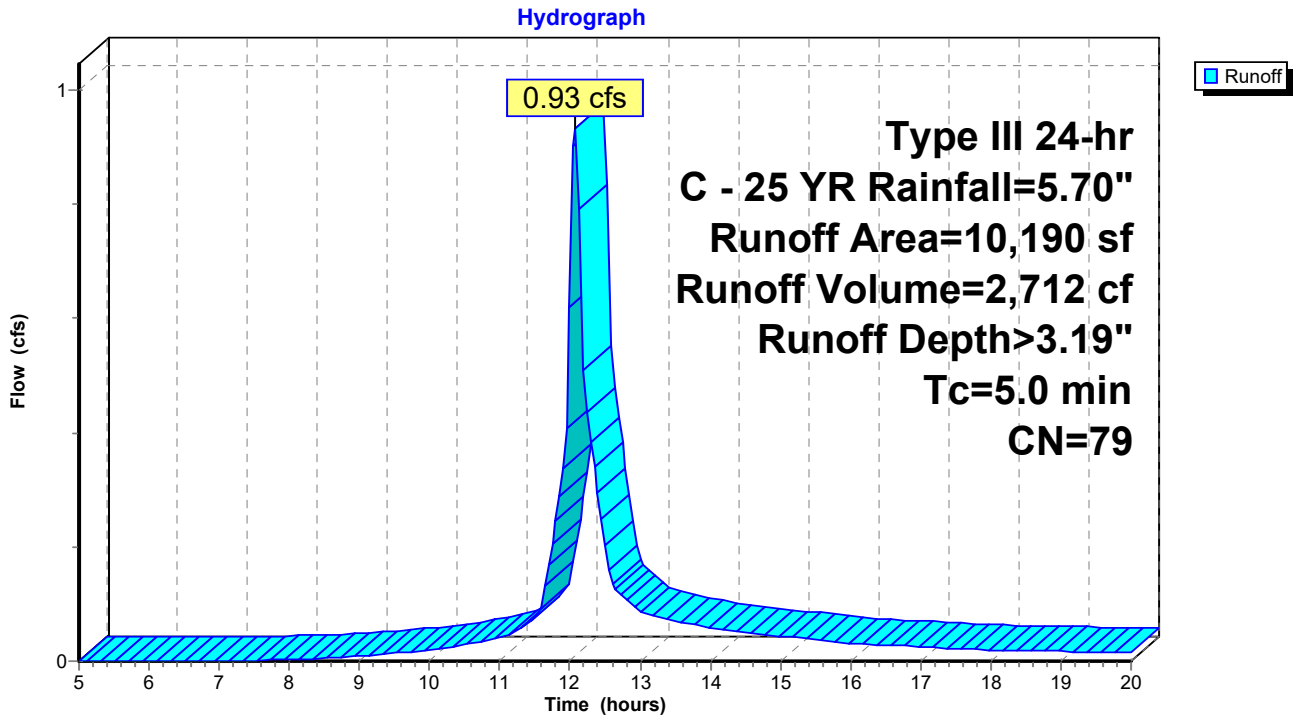
Runoff = 0.93 cfs @ 12.08 hrs, Volume= 2,712 cf, Depth > 3.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr C - 25 YR Rainfall=5.70"

Area (sf)	CN	Description
822	36	Woods, Fair, HSG A
2,461	39	>75% Grass cover, Good, HSG A
5,775	98	Roofs, HSG A
349	98	Paved parking, HSG A
* 783	98	Rain Garden
10,190	79	Weighted Average
3,283		32.22% Pervious Area
6,907		67.78% Impervious Area

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

Subcatchment 5S: Subcatchment Area 5



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Type III 24-hr C - 25 YR Rainfall=5.70"

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Summary for Pond 2P: Rain Garden #1

Inflow Area = 16,973 sf, 53.30% Impervious, Inflow Depth > 2.38" for C - 25 YR event
 Inflow = 1.17 cfs @ 12.08 hrs, Volume= 3,362 cf
 Outflow = 0.13 cfs @ 12.92 hrs, Volume= 2,816 cf, Atten= 88%, Lag= 50.3 min
 Discarded = 0.13 cfs @ 12.92 hrs, Volume= 2,816 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 82.34' @ 12.92 hrs Surf.Area= 500 sf Storage= 1,605 cf

Plug-Flow detention time= 162.4 min calculated for 2,816 cf (84% of inflow)
 Center-of-Mass det. time= 115.8 min (917.2 - 801.4)

Volume	Invert	Avail.Storage	Storage Description
#1	84.49'	923 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious 10.00'W x 50.00'L x 7.00'H Prismaoid 3,500 cf Overall - 1,195 cf Embedded = 2,305 cf x 40.0% Voids 6.00'D x 6.00'H Vertical Cone/Cylinder x 6 Inside #2 1,195 cf Overall - 3.0" Wall Thickness = 1,018 cf
#2	76.50'	922 cf	
#3	77.50'	1,018 cf	
		2,863 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
84.49	197	104.8	0.0	0	0	197
85.50	197	104.8	40.0	80	80	303
85.99	197	104.8	40.0	39	118	354
86.00	197	104.8	30.0	1	119	355
87.74	197	104.8	30.0	103	222	538
87.75	197	104.8	30.0	1	222	539
87.99	197	104.8	30.0	14	236	564
88.00	197	104.8	100.0	2	238	565
89.00	553	127.1	100.0	360	598	992
89.50	751	136.5	100.0	325	923	1,200

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.50'	8.270 in/hr Exfiltration over Wetted area from 76.50' - 82.83' Excluded Wetted area = 500 sf

Discarded OutFlow Max=0.13 cfs @ 12.92 hrs HW=82.34' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.13 cfs)

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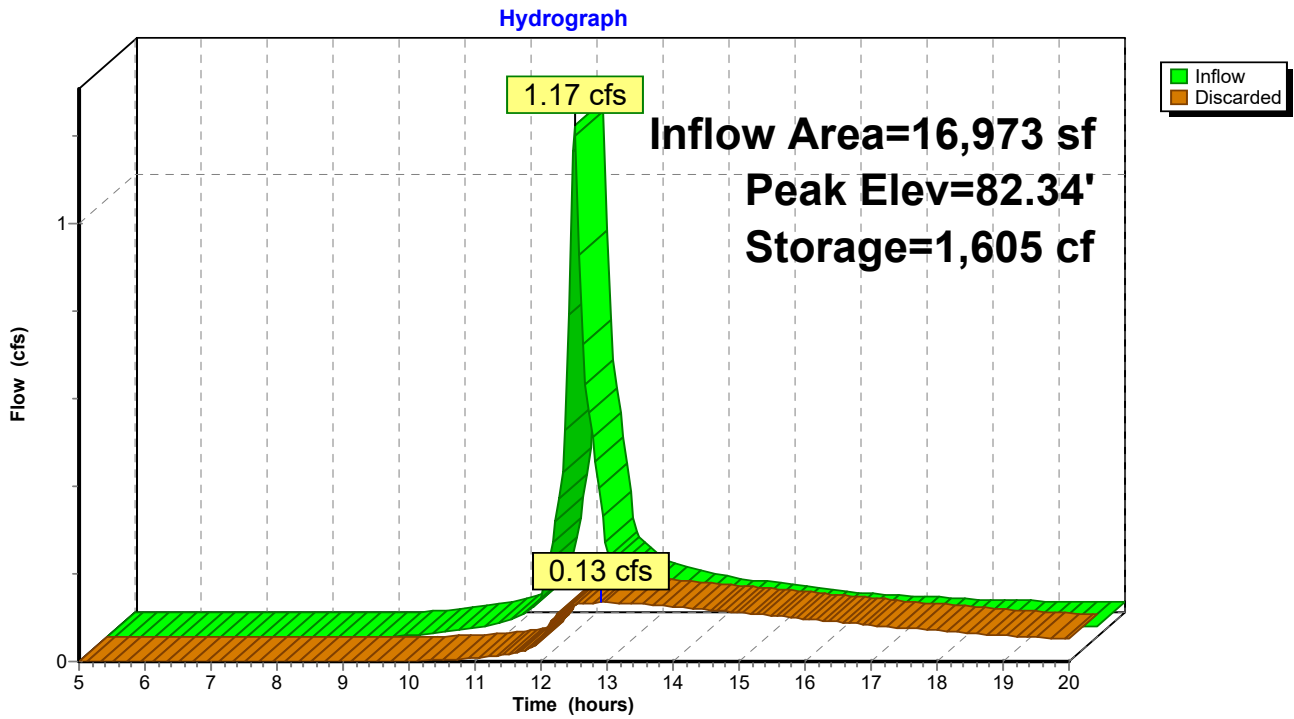
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Type III 24-hr C - 25 YR Rainfall=5.70"

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Pond 2P: Rain Garden #1



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Type III 24-hr C - 25 YR Rainfall=5.70"

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Summary for Pond 4P: Rain Garden #2

Inflow Area = 6,657 sf, 70.60% Impervious, Inflow Depth > 3.29" for C - 25 YR event
 Inflow = 0.63 cfs @ 12.08 hrs, Volume= 1,825 cf
 Outflow = 0.06 cfs @ 12.50 hrs, Volume= 1,267 cf, Atten= 90%, Lag= 25.5 min
 Discarded = 0.06 cfs @ 12.50 hrs, Volume= 1,267 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 86.88' @ 12.96 hrs Surf.Area= 260 sf Storage= 1,045 cf

Plug-Flow detention time= 204.9 min calculated for 1,263 cf (69% of inflow)
 Center-of-Mass det. time= 138.6 min (920.3 - 781.6)

Volume	Invert	Avail.Storage	Storage Description
#1	85.99'	863 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious
#2	76.50'	489 cf	10.00'W x 26.00'L x 7.00'H Prismaoid 1,820 cf Overall - 597 cf Embedded = 1,223 cf x 40.0% Voids
#3	77.50'	509 cf	6.00'D x 6.00'H Vertical Cone/Cylinder x 3 Inside #2 597 cf Overall - 3.0" Wall Thickness = 509 cf
		1,861 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
85.99	133	72.6	0.0	0	0	133
86.00	133	72.3	40.0	1	1	137
86.99	133	72.6	40.0	53	53	208
87.00	133	72.6	30.0	0	54	209
87.74	133	72.6	30.0	30	83	263
87.75	133	72.6	30.0	0	84	264
87.99	133	72.6	30.0	10	93	281
88.00	133	72.6	100.0	1	94	282
89.00	379	91.4	100.0	246	340	540
90.00	681	110.3	100.0	523	863	860

Device	Routing	Invert	Outlet Devices
#1	Discarded	79.00'	8.270 in/hr Exfiltration over Wetted area from 79.00' - 87.00' Excluded Wetted area = 440 sf

Discarded OutFlow Max=0.06 cfs @ 12.50 hrs HW=86.27' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.06 cfs)

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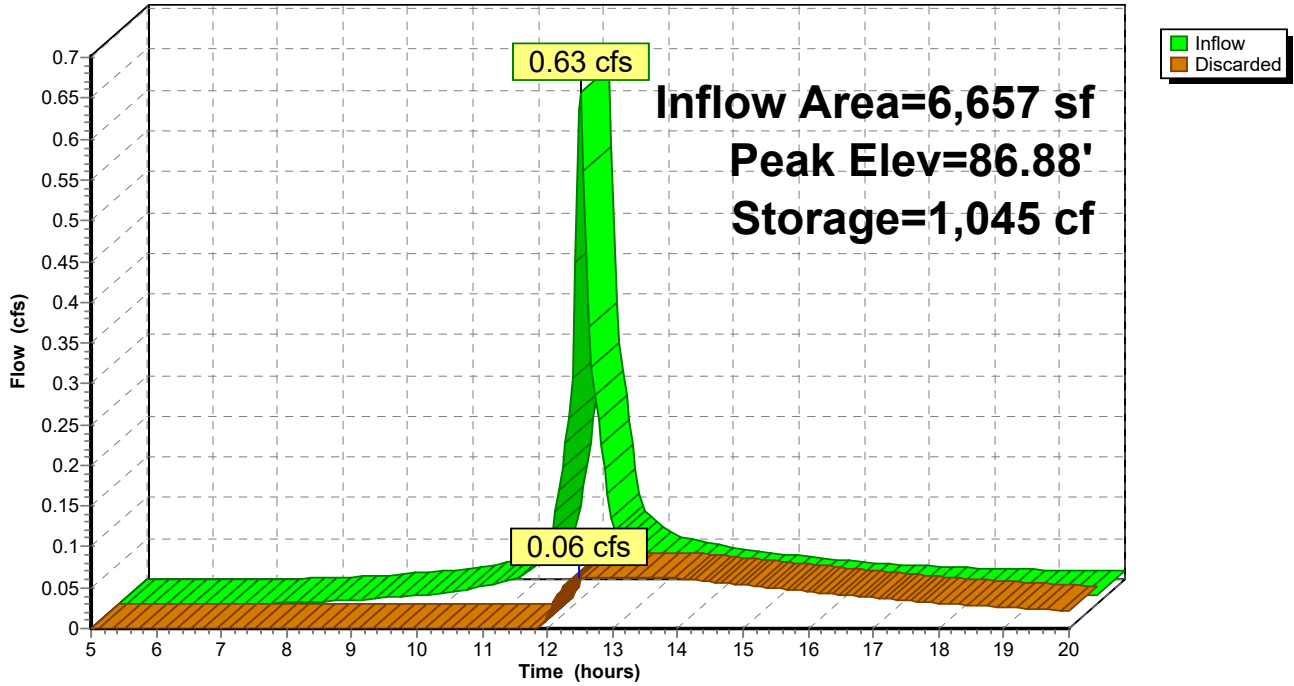
Type III 24-hr C - 25 YR Rainfall=5.70"

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Pond 4P: Rain Garden #2

Hydrograph



3 Forest Park Drive - Post-Development

Type III 24-hr C - 25 YR Rainfall=5.70"

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Summary for Pond 5P: Rain Garden #3

Inflow Area = 10,190 sf, 67.78% Impervious, Inflow Depth > 3.19" for C - 25 YR event
 Inflow = 0.93 cfs @ 12.08 hrs, Volume= 2,712 cf
 Outflow = 0.11 cfs @ 12.77 hrs, Volume= 2,221 cf, Atten= 88%, Lag= 41.9 min
 Discarded = 0.11 cfs @ 12.77 hrs, Volume= 2,221 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 84.58' @ 12.77 hrs Surf.Area= 420 sf Storage= 1,403 cf

Plug-Flow detention time= 175.1 min calculated for 2,214 cf (82% of inflow)
 Center-of-Mass det. time= 125.9 min (909.7 - 783.8)

Volume	Invert	Avail.Storage	Storage Description
#1	86.49'	978 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious 10.00'W x 42.00'L x 7.00'H Prismaoid 2,940 cf Overall - 995 cf Embedded = 1,945 cf x 40.0% Voids 6.00'D x 6.00'H Vertical Cone/Cylinder x 5 Inside #2 995 cf Overall - 3.0" Wall Thickness = 848 cf
#2	78.50'	778 cf	
#3	79.50'	848 cf	
		2,604 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
86.49	213	112.6	0.0	0	0	213
86.50	213	112.6	40.0	1	1	214
87.99	213	112.6	40.0	127	128	382
88.00	213	112.6	30.0	1	128	383
89.74	213	112.6	30.0	111	240	579
89.75	213	112.6	30.0	1	240	580
89.99	213	112.6	30.0	15	256	607
90.00	213	112.6	100.0	2	258	608
91.00	579	131.4	100.0	381	639	993
91.50	783	140.8	100.0	339	978	1,208

Device	Routing	Invert	Outlet Devices
#1	Discarded	79.00'	8.270 in/hr Exfiltration over Wetted area from 79.00' - 87.00' Excluded Wetted area = 472 sf

Discarded OutFlow Max=0.11 cfs @ 12.77 hrs HW=84.58' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.11 cfs)

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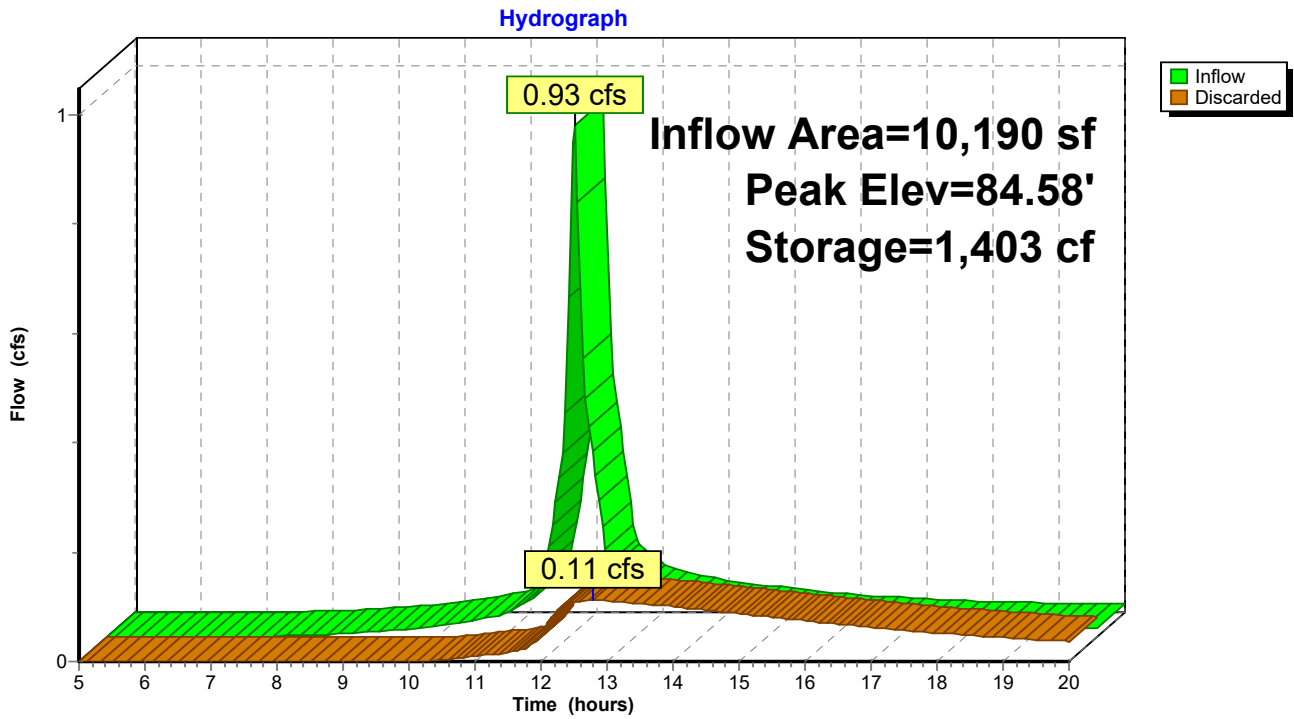
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Type III 24-hr C - 25 YR Rainfall=5.70"

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Pond 5P: Rain Garden #3



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Type III 24-hr D - 100YR Rainfall=7.00"

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

Subcatchment 1S: Subcatchment Area 1	Runoff Area=971 sf 0.00% Impervious Runoff Depth>0.66" Tc=5.0 min CN=39 Runoff=0.01 cfs 54 cf
Subcatchment 2S: Subcatchment Area 2	Runoff Area=16,973 sf 53.30% Impervious Runoff Depth>3.37" Tc=5.0 min CN=70 Runoff=1.65 cfs 4,761 cf
Subcatchment 3S: Subcatchment Area 4	Runoff Area=5,407 sf 0.00% Impervious Runoff Depth>0.60" Tc=5.0 min CN=38 Runoff=0.04 cfs 269 cf
Subcatchment 4S: Subcatchment Area 3	Runoff Area=6,657 sf 70.60% Impervious Runoff Depth>4.41" Tc=5.0 min CN=80 Runoff=0.84 cfs 2,448 cf
Subcatchment 5S: Subcatchment Area 5	Runoff Area=10,190 sf 67.78% Impervious Runoff Depth>4.31" Tc=5.0 min CN=79 Runoff=1.26 cfs 3,656 cf
Pond 2P: Rain Garden #1	Peak Elev=88.80' Storage=2,437 cf Inflow=1.65 cfs 4,761 cf Outflow=0.15 cfs 3,878 cf
Pond 4P: Rain Garden #2	Peak Elev=89.33' Storage=1,476 cf Inflow=0.84 cfs 2,448 cf Outflow=0.06 cfs 1,708 cf
Pond 5P: Rain Garden #3	Peak Elev=90.20' Storage=1,932 cf Inflow=1.26 cfs 3,656 cf Outflow=0.13 cfs 3,008 cf

Total Runoff Area = 40,198 sf Runoff Volume = 11,187 cf Average Runoff Depth = 3.34"
48.62% Pervious = 19,545 sf 51.38% Impervious = 20,653 sf

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Type III 24-hr D - 100YR Rainfall=7.00"

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Summary for Subcatchment 1S: Subcatchment Area 1

[49] Hint: $T_c < 2dt$ may require smaller dt

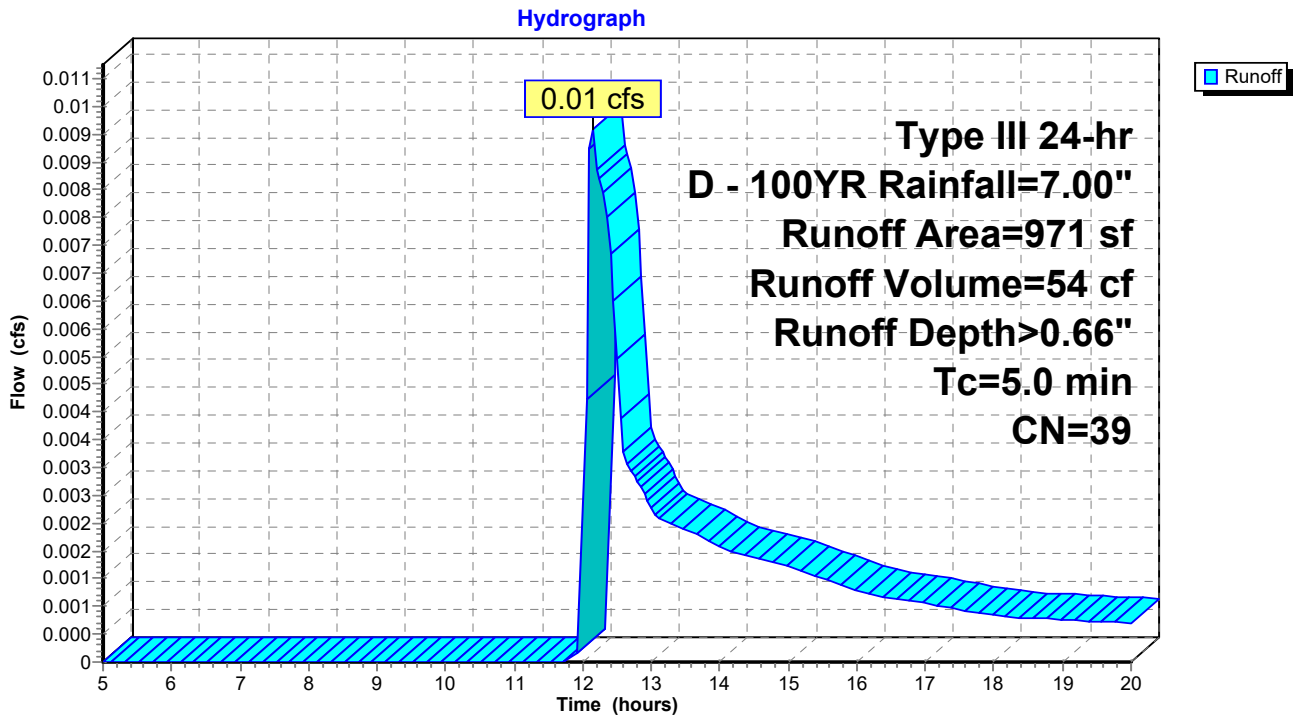
Runoff = 0.01 cfs @ 12.14 hrs, Volume= 54 cf, Depth > 0.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr D - 100YR Rainfall=7.00"

Area (sf)	CN	Description
971	39	>75% Grass cover, Good, HSG A
971		100.00% Pervious Area

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

Subcatchment 1S: Subcatchment Area 1



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Summary for Subcatchment 2S: Subcatchment Area 2

[49] Hint: $T_c < 2dt$ may require smaller dt

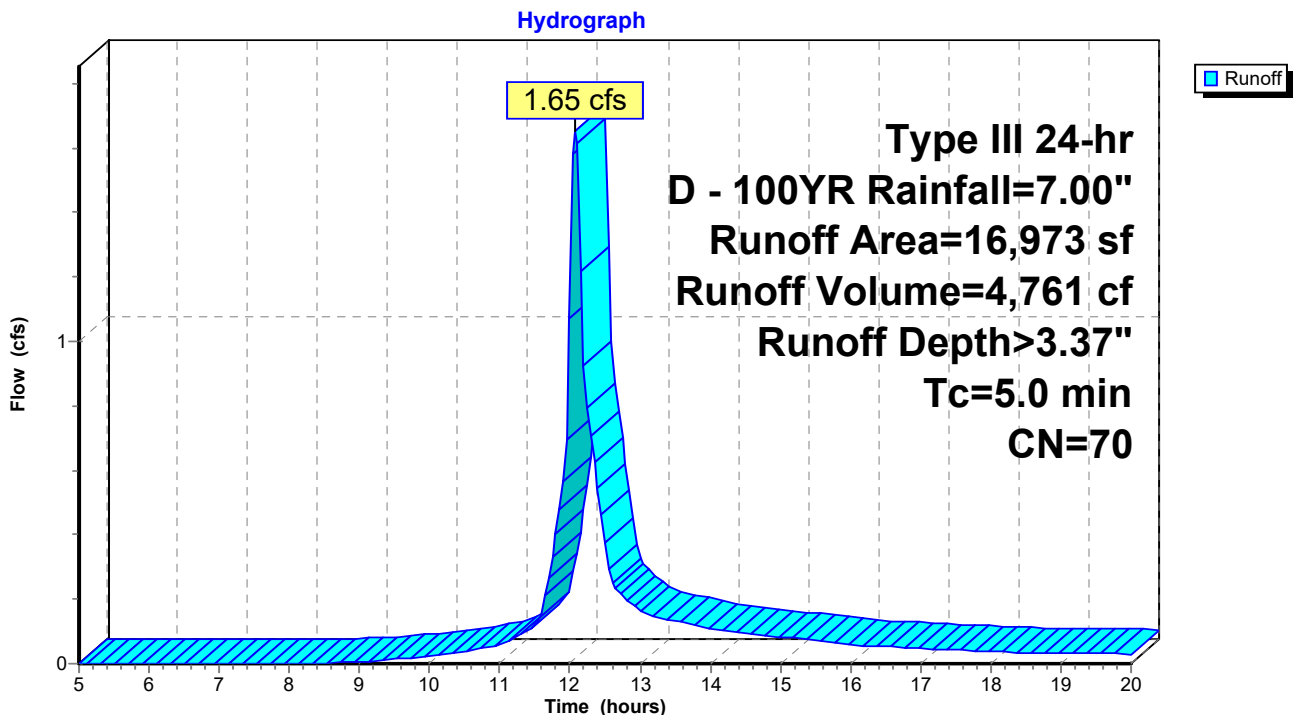
Runoff = 1.65 cfs @ 12.08 hrs, Volume= 4,761 cf, Depth > 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr D - 100YR Rainfall=7.00"

Area (sf)	CN	Description
7,995	98	Paved parking, HSG A
512	36	Woods, Fair, HSG A
6,435	39	>75% Grass cover, Good, HSG A
* 980	30	Rain Garden
* 1,009	98	Future Parking
* 42	98	Stoop
16,973	70	Weighted Average
7,927		46.70% Pervious Area
9,046		53.30% Impervious Area

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

Subcatchment 2S: Subcatchment Area 2



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Type III 24-hr D - 100YR Rainfall=7.00"

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Summary for Subcatchment 3S: Subcatchment Area 4

[49] Hint: $T_c < 2dt$ may require smaller dt

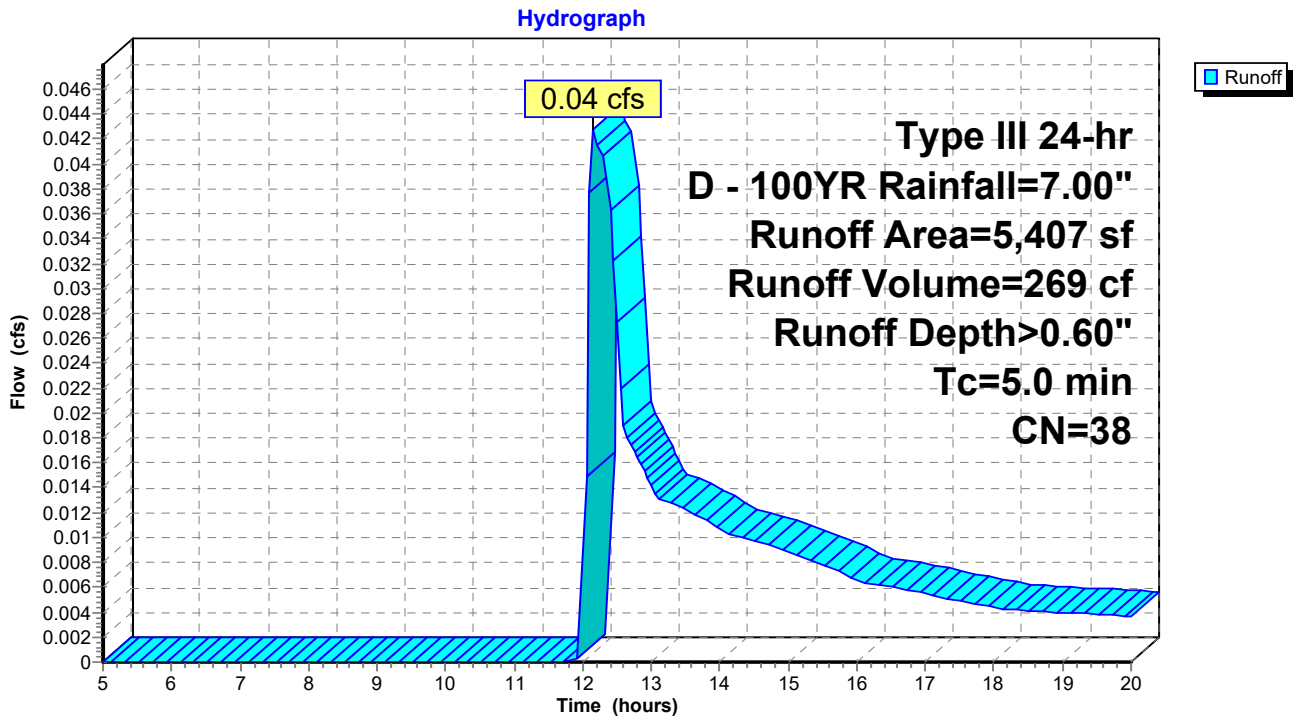
Runoff = 0.04 cfs @ 12.15 hrs, Volume= 269 cf, Depth > 0.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr D - 100YR Rainfall=7.00"

Area (sf)	CN	Description
2,081	36	Woods, Fair, HSG A
3,326	39	>75% Grass cover, Good, HSG A
5,407	38	Weighted Average
5,407		100.00% Pervious Area

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

Subcatchment 3S: Subcatchment Area 4



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Summary for Subcatchment 4S: Subcatchment Area 3

[49] Hint: $T_c < 2dt$ may require smaller dt

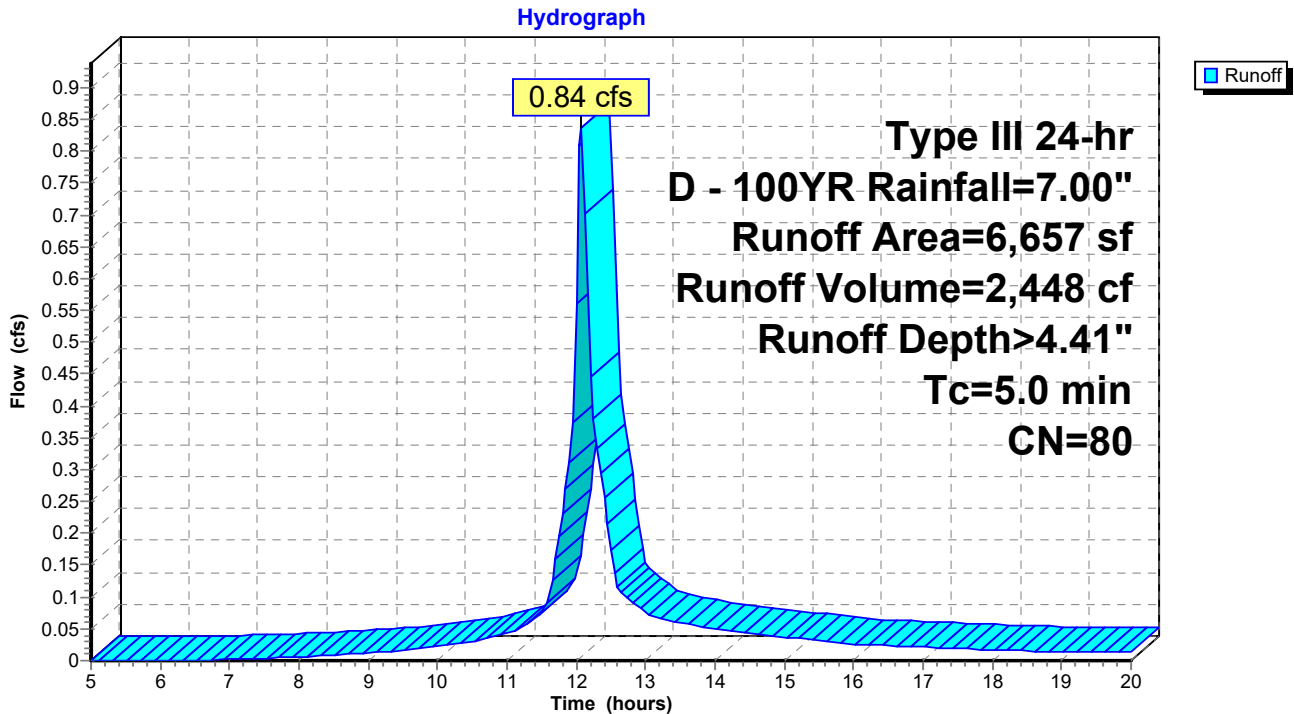
Runoff = 0.84 cfs @ 12.07 hrs, Volume= 2,448 cf, Depth > 4.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr D - 100YR Rainfall=7.00"

Area (sf)	CN	Description
952	36	Woods, Fair, HSG A
1,005	39	>75% Grass cover, Good, HSG A
* 523	98	Rain Garden
4,177	98	Roofs, HSG A
6,657	80	Weighted Average
1,957		29.40% Pervious Area
4,700		70.60% Impervious Area

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

Subcatchment 4S: Subcatchment Area 3



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Type III 24-hr D - 100YR Rainfall=7.00"

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Summary for Subcatchment 5S: Subcatchment Area 5

[49] Hint: $T_c < 2dt$ may require smaller dt

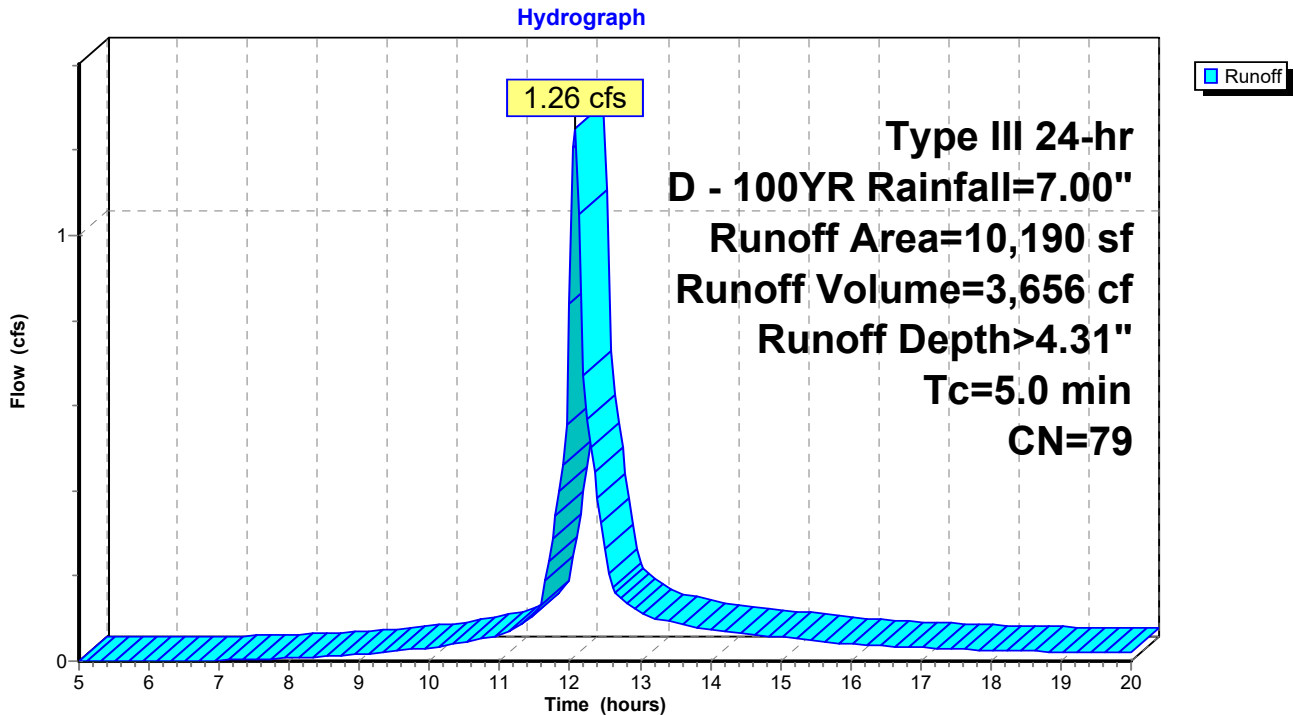
Runoff = 1.26 cfs @ 12.07 hrs, Volume= 3,656 cf, Depth > 4.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr D - 100YR Rainfall=7.00"

Area (sf)	CN	Description
822	36	Woods, Fair, HSG A
2,461	39	>75% Grass cover, Good, HSG A
5,775	98	Roofs, HSG A
349	98	Paved parking, HSG A
* 783	98	Rain Garden
10,190	79	Weighted Average
3,283		32.22% Pervious Area
6,907		67.78% Impervious Area

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

Subcatchment 5S: Subcatchment Area 5



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Type III 24-hr D - 100YR Rainfall=7.00"

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Summary for Pond 2P: Rain Garden #1

Inflow Area = 16,973 sf, 53.30% Impervious, Inflow Depth > 3.37" for D - 100YR event
 Inflow = 1.65 cfs @ 12.08 hrs, Volume= 4,761 cf
 Outflow = 0.15 cfs @ 12.20 hrs, Volume= 3,878 cf, Atten= 91%, Lag= 7.3 min
 Discarded = 0.15 cfs @ 12.20 hrs, Volume= 3,878 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 88.80' @ 13.22 hrs Surf.Area= 500 sf Storage= 2,437 cf

Plug-Flow detention time= 186.8 min calculated for 3,878 cf (81% of inflow)
 Center-of-Mass det. time= 135.9 min (929.4 - 793.5)

Volume	Invert	Avail.Storage	Storage Description
#1	84.49'	923 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious 10.00'W x 50.00'L x 7.00'H Prismaoid 3,500 cf Overall - 1,195 cf Embedded = 2,305 cf x 40.0% Voids
#2	76.50'	922 cf	
#3	77.50'	1,018 cf	
		2,863 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
84.49	197	104.8	0.0	0	0	197
85.50	197	104.8	40.0	80	80	303
85.99	197	104.8	40.0	39	118	354
86.00	197	104.8	30.0	1	119	355
87.74	197	104.8	30.0	103	222	538
87.75	197	104.8	30.0	1	222	539
87.99	197	104.8	30.0	14	236	564
88.00	197	104.8	100.0	2	238	565
89.00	553	127.1	100.0	360	598	992
89.50	751	136.5	100.0	325	923	1,200

Device	Routing	Invert	Outlet Devices
#1	Discarded	76.50'	8.270 in/hr Exfiltration over Wetted area from 76.50' - 82.83' Excluded Wetted area = 500 sf

Discarded OutFlow Max=0.15 cfs @ 12.20 hrs HW=82.91' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.15 cfs)

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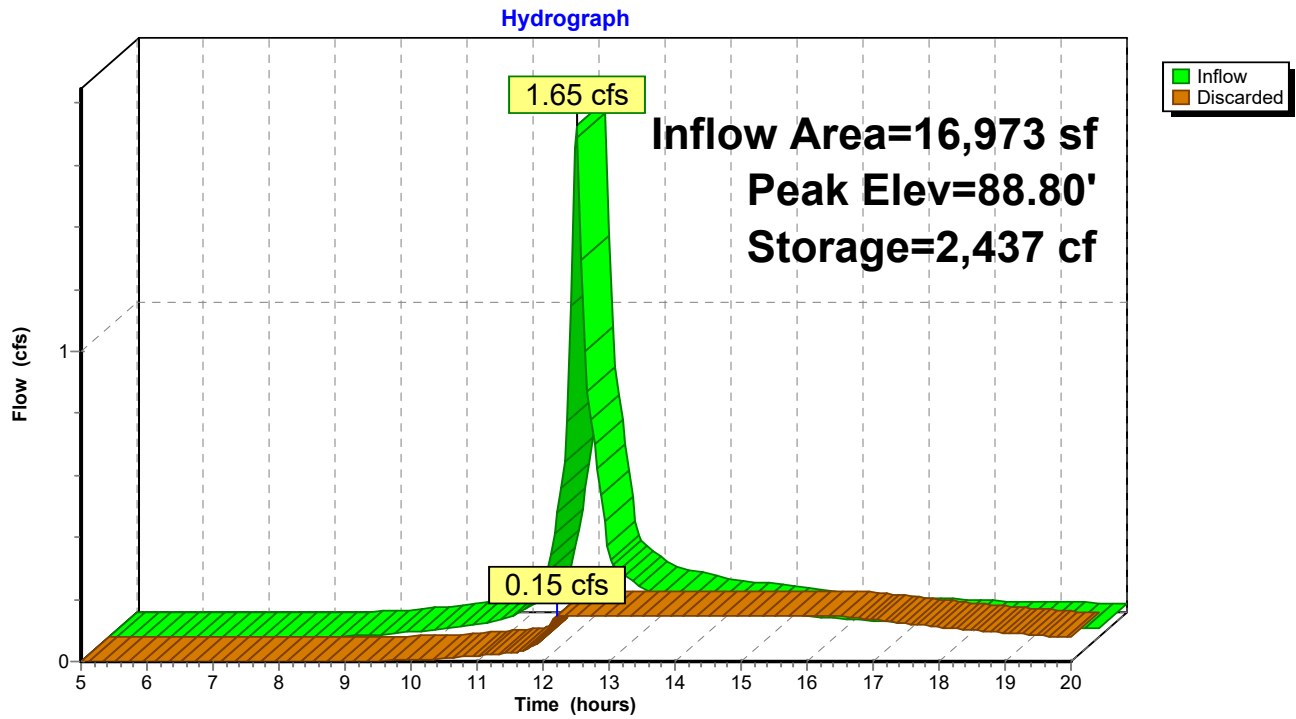
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Type III 24-hr D - 100YR Rainfall=7.00"

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Pond 2P: Rain Garden #1



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Type III 24-hr D - 100YR Rainfall=7.00"

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Summary for Pond 4P: Rain Garden #2

Inflow Area = 6,657 sf, 70.60% Impervious, Inflow Depth > 4.41" for D - 100YR event
 Inflow = 0.84 cfs @ 12.07 hrs, Volume= 2,448 cf
 Outflow = 0.06 cfs @ 12.15 hrs, Volume= 1,708 cf, Atten= 93%, Lag= 4.5 min
 Discarded = 0.06 cfs @ 12.15 hrs, Volume= 1,708 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 89.33' @ 13.42 hrs Surf.Area= 260 sf Storage= 1,476 cf

Plug-Flow detention time= 238.9 min calculated for 1,708 cf (70% of inflow)
 Center-of-Mass det. time= 172.7 min (947.4 - 774.7)

Volume	Invert	Avail.Storage	Storage Description
#1	85.99'	863 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious
#2	76.50'	489 cf	10.00'W x 26.00'L x 7.00'H Prismaoid 1,820 cf Overall - 597 cf Embedded = 1,223 cf x 40.0% Voids
#3	77.50'	509 cf	6.00'D x 6.00'H Vertical Cone/Cylinder x 3 Inside #2 597 cf Overall - 3.0" Wall Thickness = 509 cf
		1,861 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
85.99	133	72.6	0.0	0	0	133
86.00	133	72.3	40.0	1	1	137
86.99	133	72.6	40.0	53	53	208
87.00	133	72.6	30.0	0	54	209
87.74	133	72.6	30.0	30	83	263
87.75	133	72.6	30.0	0	84	264
87.99	133	72.6	30.0	10	93	281
88.00	133	72.6	100.0	1	94	282
89.00	379	91.4	100.0	246	340	540
90.00	681	110.3	100.0	523	863	860

Device	Routing	Invert	Outlet Devices
#1	Discarded	79.00'	8.270 in/hr Exfiltration over Wetted area from 79.00' - 87.00' Excluded Wetted area = 440 sf

Discarded OutFlow Max=0.06 cfs @ 12.15 hrs HW=87.15' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.06 cfs)

3 Forest Park Drive - Post-Development

Prepared by {enter your company name here}

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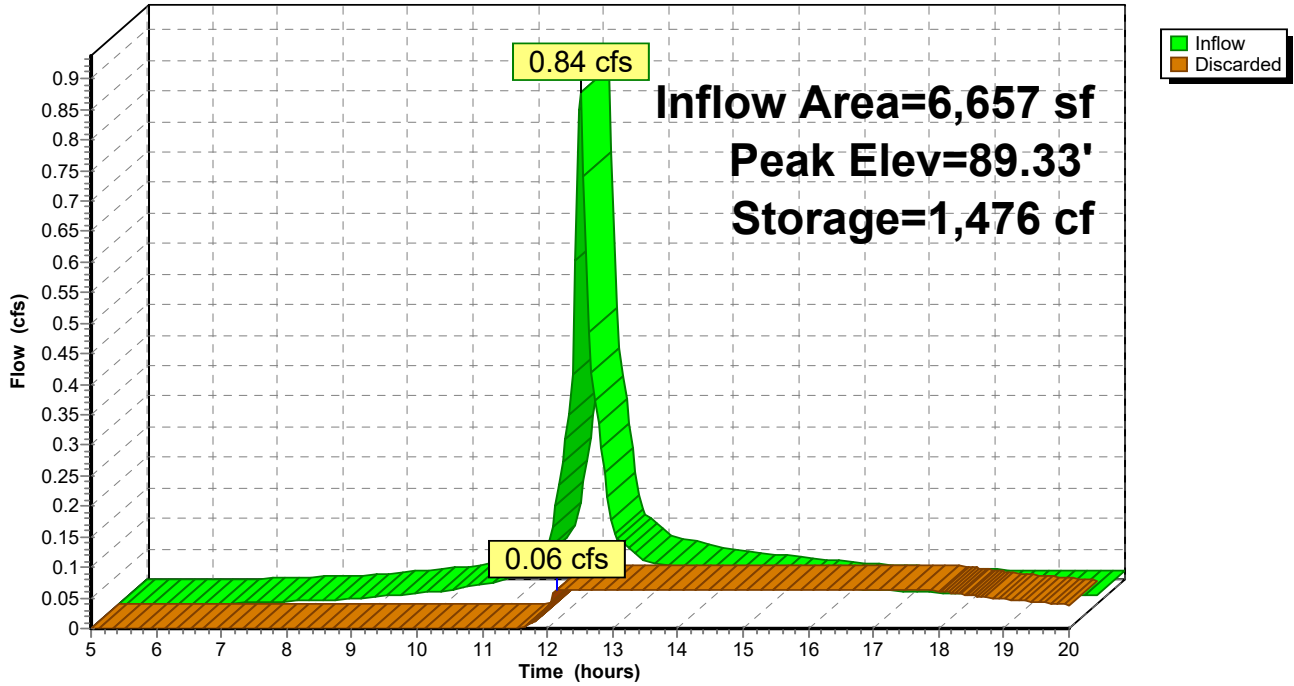
Type III 24-hr D - 100YR Rainfall=7.00"

Printed 8/7/2023

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Pond 4P: Rain Garden #2

Hydrograph



3 Forest Park Drive - Post-Development

Type III 24-hr D - 100YR Rainfall=7.00"

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Summary for Pond 5P: Rain Garden #3

Inflow Area = 10,190 sf, 67.78% Impervious, Inflow Depth > 4.31" for D - 100YR event
 Inflow = 1.26 cfs @ 12.07 hrs, Volume= 3,656 cf
 Outflow = 0.13 cfs @ 12.30 hrs, Volume= 3,008 cf, Atten= 90%, Lag= 13.5 min
 Discarded = 0.13 cfs @ 12.30 hrs, Volume= 3,008 cf

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Peak Elev= 90.20' @ 12.89 hrs Surf.Area= 420 sf Storage= 1,932 cf

Plug-Flow detention time= 182.0 min calculated for 2,998 cf (82% of inflow)
 Center-of-Mass det. time= 133.4 min (910.2 - 776.7)

Volume	Invert	Avail.Storage	Storage Description
#1	86.49'	978 cf	Custom Stage Data (Irregular) Listed below (Recalc) -Impervious 10.00'W x 42.00'L x 7.00'H Prismaoid 2,940 cf Overall - 995 cf Embedded = 1,945 cf x 40.0% Voids
#2	78.50'	778 cf	
#3	79.50'	848 cf	
		2,604 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
86.49	213	112.6	0.0	0	0	213
86.50	213	112.6	40.0	1	1	214
87.99	213	112.6	40.0	127	128	382
88.00	213	112.6	30.0	1	128	383
89.74	213	112.6	30.0	111	240	579
89.75	213	112.6	30.0	1	240	580
89.99	213	112.6	30.0	15	256	607
90.00	213	112.6	100.0	2	258	608
91.00	579	131.4	100.0	381	639	993
91.50	783	140.8	100.0	339	978	1,208

Device	Routing	Invert	Outlet Devices
#1	Discarded	79.00'	8.270 in/hr Exfiltration over Wetted area from 79.00' - 87.00' Excluded Wetted area = 472 sf

Discarded OutFlow Max=0.13 cfs @ 12.30 hrs HW=87.35' (Free Discharge)
 ↑1=Exfiltration (Exfiltration Controls 0.13 cfs)

3 Forest Park Drive - Post-Development

Prepared by {enter your company name here}

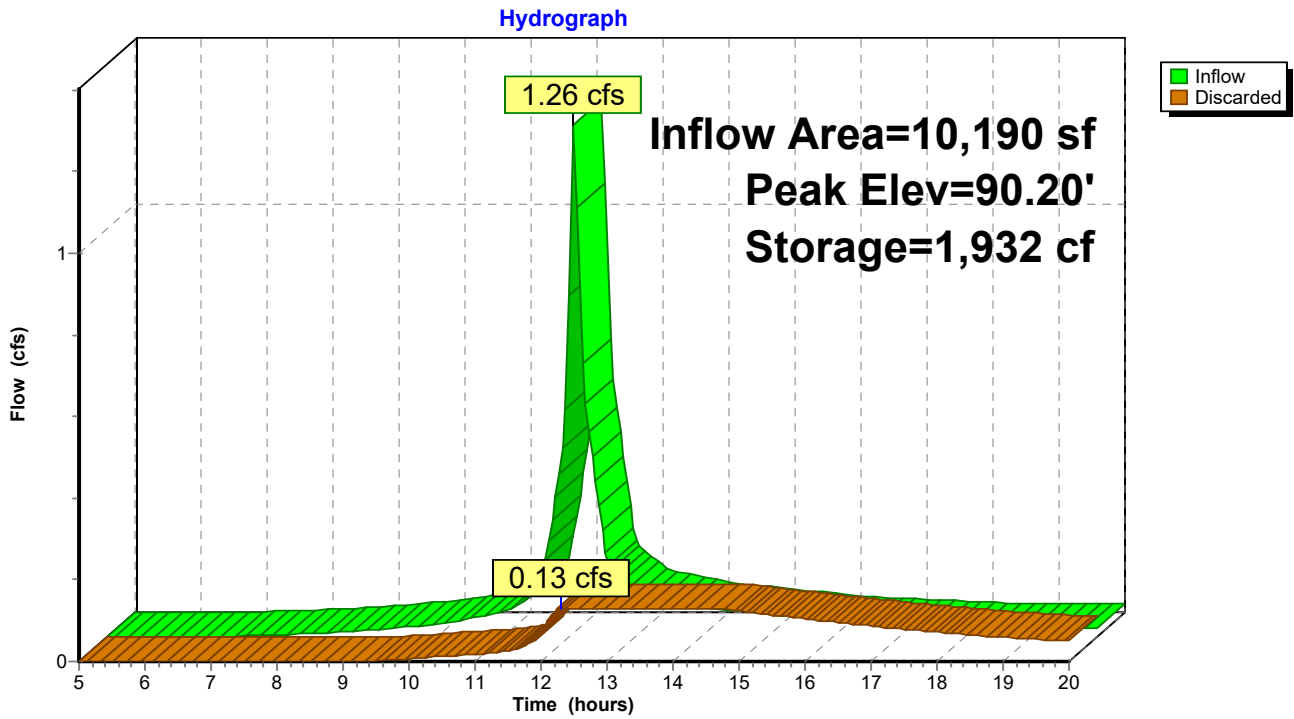
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Type III 24-hr D - 100YR Rainfall=7.00"

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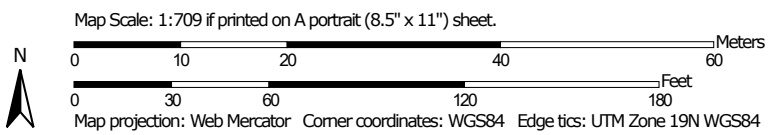
Pond 5P: Rain Garden #3



Soil Map—Barnstable County, Massachusetts
(3 Forest Park Drive)




Soil Map may not be valid at this scale.




MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Barnstable County, Massachusetts

Survey Area Data: Version 17, Jun 9, 2020

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

Date(s) aerial images were photographed: Jul 10, 2018—Nov 17, 2018

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	0.8	53.7%
254C	Merrimac fine sandy loam, 8 to 15 percent slopes	0.3	18.0%
265B	Enfield silt loam, 3 to 8 percent slopes	0.4	28.3%
Totals for Area of Interest		1.5	100.0%

Barnstable County, Massachusetts

254B—Merrimac fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2tyqs

Elevation: 0 to 1,290 feet

Mean annual precipitation: 36 to 71 inches

Mean annual air temperature: 39 to 55 degrees F

Frost-free period: 140 to 240 days

Farmland classification: All areas are prime farmland

Map Unit Composition

Merrimac and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Merrimac

Setting

Landform: Outwash terraces, eskers, moraines, outwash plains, kames

Landform position (two-dimensional): Backslope, footslope, summit, shoulder

Landform position (three-dimensional): Side slope, crest, tread, riser

Down-slope shape: Convex

Across-slope shape: Convex

Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam

Bw1 - 10 to 22 inches: fine sandy loam

Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand

2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Somewhat excessively drained

Runoff class: Very low

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to very high (1.42 to 99.90 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 2 percent

Maximum salinity: Nonsaline (0.0 to 1.4 mmhos/cm)

Sodium adsorption ratio, maximum: 1.0

Available water capacity: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2s

Hydrologic Soil Group: A

Ecological site: F145XY008MA - Dry Outwash

Hydric soil rating: No

Minor Components

Sudbury

Percent of map unit: 5 percent

Landform: Terraces, deltas, outwash plains

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Tread, dip

Down-slope shape: Concave

Across-slope shape: Linear

Hydric soil rating: No

Hinckley

Percent of map unit: 5 percent

Landform: Kames, eskers, deltas, outwash plains

Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Head slope, crest, side
slope, nose slope, rise

Down-slope shape: Convex

Across-slope shape: Convex, linear

Hydric soil rating: No

Windsor

Percent of map unit: 3 percent

Landform: Outwash plains, outwash terraces, deltas, dunes

Landform position (two-dimensional): Shoulder

Landform position (three-dimensional): Tread, riser

Down-slope shape: Linear, convex

Across-slope shape: Linear, convex

Hydric soil rating: No

Agawam

Percent of map unit: 2 percent

Landform: Stream terraces, outwash plains, kames, outwash
terraces, eskers, moraines

Landform position (three-dimensional): Rise

Down-slope shape: Convex

Across-slope shape: Convex

Hydric soil rating: No

Data Source Information

Soil Survey Area: Barnstable County, Massachusetts

Survey Area Data: Version 17, Jun 9, 2020

Barnstable County, Massachusetts

254C—Merrimac fine sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2tyqt

Elevation: 0 to 1,030 feet

Mean annual precipitation: 36 to 71 inches

Mean annual air temperature: 39 to 55 degrees F

Frost-free period: 140 to 240 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Merrimac and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Merrimac

Setting

Landform: Kames, outwash terraces, eskers, moraines, outwash plains

Landform position (two-dimensional): Backslope, footslope, shoulder, summit

Landform position (three-dimensional): Crest, side slope, tread, riser

Down-slope shape: Convex

Across-slope shape: Convex

Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam

Bw1 - 10 to 22 inches: fine sandy loam

Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand

2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 8 to 15 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Somewhat excessively drained

Runoff class: Very low

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to very high (1.42 to 99.90 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 2 percent

Maximum salinity: Nonsaline (0.0 to 1.4 mmhos/cm)

Sodium adsorption ratio, maximum: 1.0

Available water capacity: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2s

Hydrologic Soil Group: A

Ecological site: F145XY008MA - Dry Outwash

Hydric soil rating: No

Minor Components

Hinckley

Percent of map unit: 5 percent

Landform: Eskers, deltas, outwash plains, kames

Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Head slope, crest, side slope, nose slope, rise

Down-slope shape: Convex

Across-slope shape: Convex, linear

Hydric soil rating: No

Sudbury

Percent of map unit: 5 percent

Landform: Deltas, outwash plains, terraces

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Tread, dip

Down-slope shape: Concave

Across-slope shape: Linear

Hydric soil rating: No

Windsor

Percent of map unit: 5 percent

Landform: Outwash terraces, deltas, dunes, outwash plains

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Tread, riser

Down-slope shape: Linear, convex

Across-slope shape: Linear, convex

Hydric soil rating: No

Data Source Information

Soil Survey Area: Barnstable County, Massachusetts

Survey Area Data: Version 17, Jun 9, 2020

Barnstable County, Massachusetts

265B—Enfield silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 98qt
Elevation: 0 to 1,000 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Enfield

Setting

Landform: Outwash plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Riser
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Silty, friable loamy eolian deposits over loose sandy glaciofluvial deposits; silty, friable loamy eolian deposits over loose sandy glaciofluvial deposits

Typical profile

H1 - 0 to 12 inches: silt loam
H2 - 12 to 31 inches: silt loam
H3 - 31 to 60 inches: gravelly coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 16 to 40 inches to strongly contrasting textural stratification
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B

Hydric soil rating: No

Minor Components

Merrimac

Percent of map unit: 10 percent

Hydric soil rating: No

Carver

Percent of map unit: 5 percent

Hydric soil rating: No

Hinckley

Percent of map unit: 5 percent

Hydric soil rating: No

Data Source Information

Soil Survey Area: Barnstable County, Massachusetts
Survey Area Data: Version 17, Jun 9, 2020

Required Stormwater Recharge Volume

The NRCS classifies the on-site soils as being in hydrologic group A, indicative of a low runoff potential and high infiltration rates.

Therefore:

Required Recharge Volume = (0.6 inches) * (1 ft/12 inches) * A_{imp} , where A_{imp} is the impervious area onsite.

Required Recharge Volume = (0.6 inch) * (1 ft/12 inches) * 17,590 s.f. = **879.5 c.f.**

The total available storage capacity of the subsurface infiltration system is **2,163 c.f.**

Analyzing a 2-year storm event on site, the following recharge volume is provided by the proposed subsurface infiltration system: **1,086 c.f.**

Therefore:

Total Provided Recharge Volume = 1,086 c.f. > 879.5 c.f. Required

Drawdown Calculations for Stormwater Management Systems

Exfiltration Rate: 8.27 in/hr = 0.689 ft/hr Merrimac Fine Sandy Loam

Subsurface Sys. 2P:	100-YR Recharge Volume:	2,437.00 c.f.			
	Bottom Area:	500 s.f.			
	Bottom Exfiltration rate =	500 s.f.	x	0.689 ft/hr	= 344.5 c.f./hour
	Drawdown Time =	2,437.00 c.f.	/	344.5 c.f./hr	= 7.074 hours
7.1 hours < 72 hours, therefore, system complies with drawdown time.					

Subsurface Sys. 4P:	100-YR Recharge Volume:	1,476.00 c.f.			
	Bottom Area:	260 s.f.			
	Bottom Exfiltration rate =	260 s.f.	x	0.689 ft/hr	= 179.1 c.f./hour
	Drawdown Time =	1,476.00 c.f.	/	179.1 c.f./hr	= 8.239 hours
8.2 hours < 72 hours, therefore, system complies with drawdown time.					

Subsurface Sys. 5P:	100-YR Recharge Volume:	1,932.00 c.f.			
	Bottom Area:	420 s.f.			
	Bottom Exfiltration rate =	420 s.f.	x	0.689 ft/hr	= 289.4 c.f./hour
	Drawdown Time =	1,932.00 c.f.	/	289.4 c.f./hr	= 6.676 hours
6.7 hours < 72 hours, therefore, system complies with drawdown time.					



Project: 3 Forest Park Drive – Bourne, MA Rain Garden #1
 Prepared By: ZLB
 Date: 08/08/2023

TSS Removal Calculation Worksheet

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load	Amount Removed (BxC)	Remaining Load (C-D)
Street Sweeping	10%	1.00	0.10	0.90
Sediment Forebay	25%	0.90	0.22	0.68
Rain Garden	90%	0.68	0.61	0.07
Total TSS Removal =			93%	

Note: Greater than 44% TSS removed prior to infiltration

Appendix H

Required Water Quality

This site falls within or discharges to a critical area. Therefore, 1" water quality volume is to be used.

Rain Garden #1

Required WQV = (1.0 inch) * (1 ft/12 inches) * A_{imp} , where A_{imp} is the impervious area onsite.

WQV = (1.0 inch) * (1 ft/12 inches) * 9,004 s.f. = **751 c.f.**

Water Quality Volume below overflow grate elevation 89.40 = **811 c.f.**

Water Quality Volume Provided = 811 c.f. > 751 c.f. Required

Rain Garden #2

Required WQV = (1.0 inch) * (1 ft/12 inches) * A_{imp} , where A_{imp} is the impervious area onsite.

WQV = (1.0 inch) * (1 ft/12 inches) * 4,177 s.f. = **348 c.f.**

Water Quality Volume below overflow grate elevation 89.20 = **488 c.f.**

Water Quality Volume Provided = 488c.f. > 348 c.f. Required

Rain Garden #3

Required WQV = (1.0 inch) * (1 ft/12 inches) * A_{imp} , where A_{imp} is the impervious area onsite.

WQV = (1.0 inch) * (1 ft/12 inches) * 5,775 s.f. = **482 c.f.**

Water Quality Volume below overflow grate elevation 91.00 = **639 c.f.**

Water Quality Volume Provided = 639 c.f. > 482 c.f. Required

Required Sediment Forebay Sizing

Rain Garden Forebay #1

Required Sediment Forebay Volume = (0.1 inch) * (1 ft/12 inches) * A_{imp} = **75.0 c.f.**

Sediment Control Volume below check dam elevation 89.50 = **190 c.f.**

Sediment Control Volume Provided = 190 c.f. > 75.0 c.f. Required

CONSTRUCTION PERIOD POLLUTION PREVENTION & EROSION AND SEDIMENTATION CONTROL PLAN

The reconstruction of the proposed development is to be done sequentially according to elevation and siting needs.

Siltation control is to be established as needed to protect the abutting property and roadway from eroding soil and siltation during construction. Silts sacks are to be installed in all existing abutting catch basins.

No washing and/or cleaning of vehicles and/or equipment is to take place on site. In order to prevent mud and debris from being transported offsite. If debris is transported onto abutting properties it is to be removed immediately to maintain public safety. Any mud or siltation that has been tracked offsite is to be cleaned up before crews leave for the day.

Care should be taken to avoid excessive compaction of the area being used for onsite recharge. Filter fabric and/or silt sacks are to be placed under the grate of all catch basins. All basins and drains are to be checked monthly or before and after large rain storms, 0.5 inches or greater. This barrier is to be replaced when silt has built up or any damage has been found during inspection. The silt sacks are to be emptied and washed when they are 1/3 full. Site will then be brought to proposed subgrade for the patio and lawn areas. Once subgrade is obtained and all abutting landscape areas have been stabilized, the final patio areas shall be installed.

Care should be taken throughout the construction process to protect the infiltration areas from siltation and heavy vehicle traffic. It is recommended to stake or flag these areas as a visual reminder to onsite contractors.

A construction dumpster shall be kept onsite where it is out of the way of construction. All trash, scraps, offcuts, and the like are to be deposited in the dumpster as soon as possible. The dumpster is to be covered at the end of the work day to prevent wind-borne debris from littering the neighboring properties. All contractors are responsible for cleaning up their waste and scraps. If it is necessary to store materials onsite, they must be kept neat and orderly.

OPERATIONS AND MAINTENANCE PLAN

Facility Location: 3 Forest Park Drive, Bourne, MA
Assessors Map 39, Parcel 77.7

Proposed Facility Owner: C & L Shearer Holdings, LLC
P.O. Box 538
West Falmouth, MA 02574

Facility Description:

The drainage system Best Management Practice (BMP) is designed for a commercial development consisting of one building, and associated loading areas. Drainage system components consist of the following:

- Three (3) subsurface drywell systems
- Three (3) rain gardens with subsurface infiltration
- One (1) sediment forebay

Maintenance During Site Preparation:

1. Tree clearing and removal of topsoil shall be kept at a minimum in conformance with the Design Plan.
2. Stockpile areas for top and subsoil shall be located in an area away from the low points to avoid entering the drainage system. The perimeter of stockpile areas is to be staked with silt fence and/or haybales, if required.
3. All erosion control measures shall be inspected and repaired or replaced following every rainfall event.
4. Shoulders and side slopes shall be protected with mulch, hay, sod or approved equal until all slopes are permanently stabilized.

Maintenance During Building Construction:

1. The driveway entrance shall be designated prior to work. The entrance shall be prepared by removing top and subsoil and placing crushed stone in accordance with Plan Details. This entrance shall be the sole entrance during construction of the buildings, driveway, and site preparation. This apron shall be pitched away from the roadway to prevent runoff from the apron entering the roadway.
2. Areas that drain to the main driveway, such as lawn and landscaped areas shall be permanently stabilized prior to final pavement.
3. The owner of the facilities (Shearer Holdings, LLC), or its agent, shall inspect all of the erosion control measures on a weekly basis and repair/replace as required. The owner/agent shall also inspect all erosion control measures after each significant rainstorm.
4. The rain gardens and drywells shall be protected with crushed stone and rip-rap until stabilized with vegetation.

Routine Maintenance:

The routine maintenance program shall begin only after the following:

- Construction and slope stabilization are complete;
- All disturbed areas are adequately vegetated and stabilized;
- All leaching systems have been pumped and completely cleaned;
- The system has been completely inspected by the design engineer and the Planning Board's engineer and found to be functioning as designed in that no clogging of the leaching system has occurred during construction.

Routine maintenance shall consist of the following:

1. The leaching systems shall be inspected annually.
2. The rain gardens are to be cleared of debris and sediment on a bi-annual basis, including the stone diaphragm.
3. Forebay is to be inspected annually. Excessive sediment buildup is to be removed as required.

EMERGENCY SPILL CLEANUP PLAN

Facility Location: 3 Forest Park Drive, Bourne, MA
Assessors Map 39, Parcel 77.7

- 1) The owner of the facility shall have a designated person with overall responsibility for spill response cleanup.
- 2) Key personnel shall be trained in the use of this plan and spill containment and cleanup methods. All employees should have basic knowledge of spill control procedures.
- 3) A summary of this plan shall be posted in a prominent location in the building. The Summary shall identify the spill cleanup coordinators, location of cleanup kit, and phone numbers of regulatory agencies and individuals to be contacted in the event of a spill.
- 4) In the event of a spill, the following shall be notified:

a. Bourne Fire Department	508-759-4412
b. Department of Environmental Protection	508-946-2700
c. Bourne Water District	508-563-2294
d. Bourne Board of Health	508-759-0600 Ext 1513
- 5) The cleanup of spills shall begin immediately.
- 6) An emergency spill containment and cleanup kit shall be stored and maintained on site. The kit shall be stored in a manner that allows rapid access and use by employees. A Spill Safety Supply-Oilup Sorbent® 31 Gallon Spill Response Kit or equal and Two Spillmagnet™ 24" x 24" drain covers shall be stored with the emergency spill response and containment kit. Kits and refills are available from Lab Safety Supply (800-356-0783).
- 7) The emergency spill cleanup plan shall be updated regularly.

OWNER CERTIFICATION

Facility Location: 3 Forest Park Drive, Bourne, MA
Assessors Map 39, Parcel 77.7

I, Shearer Holding, LLC, hereby acknowledge that I have read and understand the Operation and Maintenance Plan and Emergency Spill Cleanup Plan, which shall be adhered to during and after construction. A copy of the Emergency Spill Cleanup Plan shall be given to each tenant with the Hazardous Waste Acknowledgement Form.

C & L Shearer Holding, LLC

Date



Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.¹ This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8²
- Operation and Maintenance Plan required by Standard 9

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

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

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

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

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



Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



9/5/2023

Signature and Date

Checklist

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

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



Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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



Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

Standard 3: Recharge

- Soil Analysis provided.
- Required Recharge Volume calculation provided.
- Required Recharge volume reduced through use of the LID site Design Credits.
- Sizing the infiltration, BMPs is based on the following method: Check the method used.
 - Static
 - Simple Dynamic
 - Dynamic Field¹
- Runoff from all impervious areas at the site discharging to the infiltration BMP.
- Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
 - Site is comprised solely of C and D soils and/or bedrock at the land surface
 - M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
 - Solid Waste Landfill pursuant to 310 CMR 19.000
 - Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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



Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

- The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
- Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

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

- Good housekeeping practices;
 - Provisions for storing materials and waste products inside or under cover;
 - Vehicle washing controls;
 - Requirements for routine inspections and maintenance of stormwater BMPs;
 - Spill prevention and response plans;
 - Provisions for maintenance of lawns, gardens, and other landscaped areas;
 - Requirements for storage and use of fertilizers, herbicides, and pesticides;
 - Pet waste management provisions;
 - Provisions for operation and management of septic systems;
 - Provisions for solid waste management;
 - Snow disposal and plowing plans relative to Wetland Resource Areas;
 - Winter Road Salt and/or Sand Use and Storage restrictions;
 - Street sweeping schedules;
 - Provisions for prevention of illicit discharges to the stormwater management system;
 - Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
 - Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
 - List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
- A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.
 - Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:
 - is within the Zone II or Interim Wellhead Protection Area
 - is near or to other critical areas
 - is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
 - involves runoff from land uses with higher potential pollutant loads.
 - The Required Water Quality Volume is reduced through use of the LID site Design Credits.
 - Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.



Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

- The BMP is sized (and calculations provided) based on:
 - The ½" or 1" Water Quality Volume or
 - The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
- The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
- A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

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

- The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.
- The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted **prior to** the discharge of stormwater to the post-construction stormwater BMPs.
- The NPDES Multi-Sector General Permit does **not** cover the land use.
- LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
- All exposure has been eliminated.
- All exposure has **not** been eliminated and all BMPs selected are on MassDEP LUHPPL list.
- The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

- The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
- Critical areas and BMPs are identified in the Stormwater Report.



Checklist for Stormwater Report

Checklist (continued)

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

- The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
 - Limited Project
 - Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
 - Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
 - Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
 - Bike Path and/or Foot Path
 - Redevelopment Project
 - Redevelopment portion of mix of new and redevelopment.
- Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
- The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

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

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

- Narrative;
 - Construction Period Operation and Maintenance Plan;
 - Names of Persons or Entity Responsible for Plan Compliance;
 - Construction Period Pollution Prevention Measures;
 - Erosion and Sedimentation Control Plan Drawings;
 - Detail drawings and specifications for erosion control BMPs, including sizing calculations;
 - Vegetation Planning;
 - Site Development Plan;
 - Construction Sequencing Plan;
 - Sequencing of Erosion and Sedimentation Controls;
 - Operation and Maintenance of Erosion and Sedimentation Controls;
 - Inspection Schedule;
 - Maintenance Schedule;
 - Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



Checklist for Stormwater Report

Checklist (continued)

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

- The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has **not** been included in the Stormwater Report but will be submitted **before** land disturbance begins.
- The project is **not** covered by a NPDES Construction General Permit.
- The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
- The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

- The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
 - Name of the stormwater management system owners;
 - Party responsible for operation and maintenance;
 - Schedule for implementation of routine and non-routine maintenance tasks;
 - Plan showing the location of all stormwater BMPs maintenance access areas;
 - Description and delineation of public safety features;
 - Estimated operation and maintenance budget; and
 - Operation and Maintenance Log Form.
- The responsible party is **not** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
 - A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
 - A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

- The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
- An Illicit Discharge Compliance Statement is attached;
- NO Illicit Discharge Compliance Statement is attached but will be submitted **prior to** the discharge of any stormwater to post-construction BMPs.