GRADY CONSULTING, L.L.C.
Registered Professional Civil Engineers & Land Surveyors

STORMWATER MANAGEMENT DESIGN CALCULATIONS

715-737 Washington Street
Assessors Map F9 Lots 24 & 40

Pembroke, Massachusetts

Prepared for

Rose Realty Trust
David Spurling
55 Redwood Circle
Mashpee, MA 02649

January 24, 2020

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Summary

This analysis was prepared to demonstrate Compliance with the Massachusetts Stormwater Management Regulations and the Town of Pembroke Planning Board Rules and Regulations for Stormwater Management. The proposed project is for the construction of one 11,840 square foot structure for light industrial use.

The existing site is a commercial use building with office space and light industrial space for production of goods operating under Eastern Industrial Products. The site is located within the Town of Pembroke Residential-Commercial Zoning District. The proposed stormwater system consists of one infiltration basin to the northeast of the proposed building.

Pre-Development Stormwater flows are separated into 3 catchments areas and routed as follows:

Pre 1 – Flows to an existing depression on the southern portion of the property.
Pre 2 – Flows to an existing catch basin in Washington Street.
Pre 3 – Flows to an existing bordering vegetated wetland on the northern portion of the property.

Post-Development Stormwater flows are separated into 5 catchment areas. A proposed stormwater system consisting of one sediment forebay and an infiltration basin has been designed at an infiltration rate of 8.27 in/hr.

Post 1 – Flows to an existing depression on the southern portion of the property.
Post 2 – Flows to an existing catch basin in Washington Street.
Post 3 – Flows to catch basin #1 then to the infiltration basin.
Post 4 – Flows to catch basin #2 then to the infiltration basin.
Post 5 – Roof drains flow to the infiltration basin.
Post 6 – Flows to the infiltration basin.
Post 7 – Flows to an existing bordering vegetated wetland on the northern portion of the property

The design, as proposed, reduces peak runoff rates, improves and promotes infiltration, and improves stormwater quality and treatment prior to discharge.

This analysis is divided into the following sections:

Section I	Overall Site Analysis
Section II	Compliance with Massachusetts Storm water Management Regulations
Section III	Operation And Maintenance Plan

The calculations have been performed for the 2, 10, 25, and 100-year 24 hour storm event, using the HydroCAD 10.00 computer program. This computer program is based upon the Soils Conservation Service (SCS) TR-20 and TR-55 computer models and uses the SCS Curvilinear Unit rainfall distribution.

Peak Flow Summary

	100 Yr	25 Yr	10 Yr	2 Yr
Pre 1	0.11	0.04	0.01	0.00
Pre 2	2.88	1.79	1.16	0.39
Pre 3	1.63	0.55	0.19	0.01
	4.62	2.38	1.36	0.40
Post 1	0.11	0.04	0.01	0.00
Post 2	1.63	1.03	0.67	0.24
(To Basin) Post 3, 4, 5,6	0.61	0.00	0.00	0.00
Post 7	1.02	0.42	0.17	0.01
	3.37	1.49	0.85	0.25
Pre 1 vs	0.11	0.04	0.01	0.00
Post 1	0.11	0.04	0.01	0.00
Pre 2 vs	2.88	1.79	1.16	0.39
Post 2	1.63	1.03	0.67	0.24
Pre 3 vs	1.63	0.55	0.19	0.01
Post 7	1.02	0.42	0.17	0.01
(Routed) Post 3, 4, 5, 6	0.61	0.00	0.00	0.00
Total Post	1.63	0.42	0.17	0.01

Elevations	100 Yr	25 Yr	10 Yr	2 Yr	Top	bottom
Basin	80.88	80.25	79.64	78.72	82.00	77.00

Infiltration Basin – The infiltration basin is designed with a low elevation of 77.00' and a high elevation of 82.00' with a design recharge volume of 6,408.9 cubic feet. A 6" wide by 9" high weir is designed at an elevation of 80.25'. A six foot spillway is designed at an elevation of 81.00'. Overflow from this basin is routed to the existing bordering vegetated wetland area.

OVERFLOW SPILLWAY DESIGN - INFILTRATION BASIN

Job No.: 16-134
Location: Washington Street

- Design Spillway for Q_{100} into Basin

Q_{100} = 6.44 cfs

- Length of Spillway = 6 ft

- Set Spillway Elevation 0.1 Above 100 Year Level of Basin

100 Year Level =	80.88
Feet above 100 Year Level=	0.1
	80.98
Use Spillway Elevation =	81.00

- Set Top of Berm (0.50 min) feet Above 100 Year Spillway Surface

$Q = CLH^{3/2}$

Q = Discharge Over Broad Crested Weir
C = 2.7 Handbook of Hydraulics p. 5-40, King & Brater
L = Length of Weir
H = Head on Weir

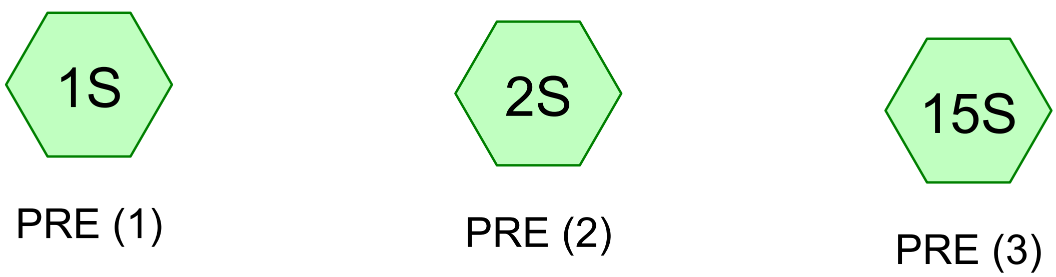
$H = (Q/CL)^{2/3}$

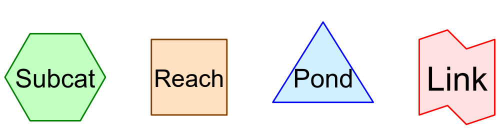
$H = 6.44 / (2.7*6)^{2/3}$ = 0.54

Top of Berm Elevation = 81 + 0.54 = 81.54 min

Use 82.00

Section I
Overall Site Analysis





Routing Diagram for 737WashingtonSt
Prepared by {enter your company name here}, Printed 1/24/2020
HydroCAD® 10.00-24 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.092	96	Gravel surface, HSG A (2S)
0.169	98	Paved roads w/curbs & sewers, HSG A (2S)
0.104	98	Roofs, HSG A (2S)
3.111	43	Woods/grass comb., Fair, HSG A (1S, 2S, 15S)
3.475	**49**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
3.475	HSG A	1S, 2S, 15S
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
3.475		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.092	0.000	0.000	0.000	0.000	0.092	Gravel surface	2S
0.169	0.000	0.000	0.000	0.000	0.169	Paved roads w/curbs & sewers	2S
0.104	0.000	0.000	0.000	0.000	0.104	Roofs	2S
3.111	0.000	0.000	0.000	0.000	3.111	Woods/grass comb., Fair	1S, 2S, 15S
3.475	**0.000**	**0.000**	**0.000**	**0.000**	**3.475**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 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: PRE (1) Runoff Area=6,647 sf 0.00% Impervious Runoff Depth=0.04"
Tc=10.0 min CN=43 Runoff=0.00 cfs 0.001 af

Subcatchment 2S: PRE (2) Runoff Area=47,114 sf 25.17% Impervious Runoff Depth=0.53"
Tc=10.0 min CN=61 Runoff=0.39 cfs 0.048 af

Subcatchment 15S: PRE (3) Runoff Area=97,629 sf 0.00% Impervious Runoff Depth=0.04"
Tc=10.0 min CN=43 Runoff=0.01 cfs 0.007 af

Total Runoff Area = 3.475 ac Runoff Volume = 0.056 af Average Runoff Depth = 0.19"
92.17% Pervious = 3.203 ac 7.83% Impervious = 0.272 ac

Summary for Subcatchment 1S: PRE (1)

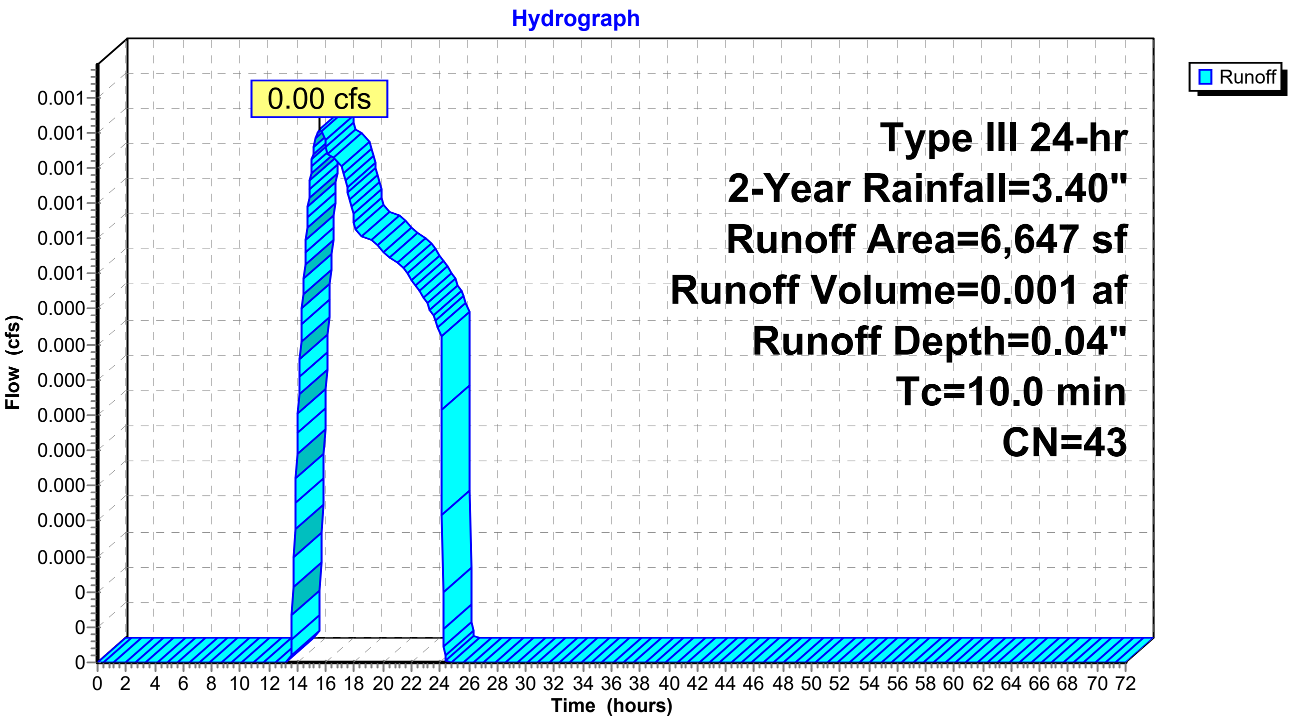
Runoff = 0.00 cfs @ 15.58 hrs, Volume= 0.001 af, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (sf)	CN	Description
6,647	43	Woods/grass comb., Fair, HSG A
6,647	43	100.00% Pervious Area

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

Subcatchment 1S: PRE (1)



Summary for Subcatchment 2S: PRE (2)

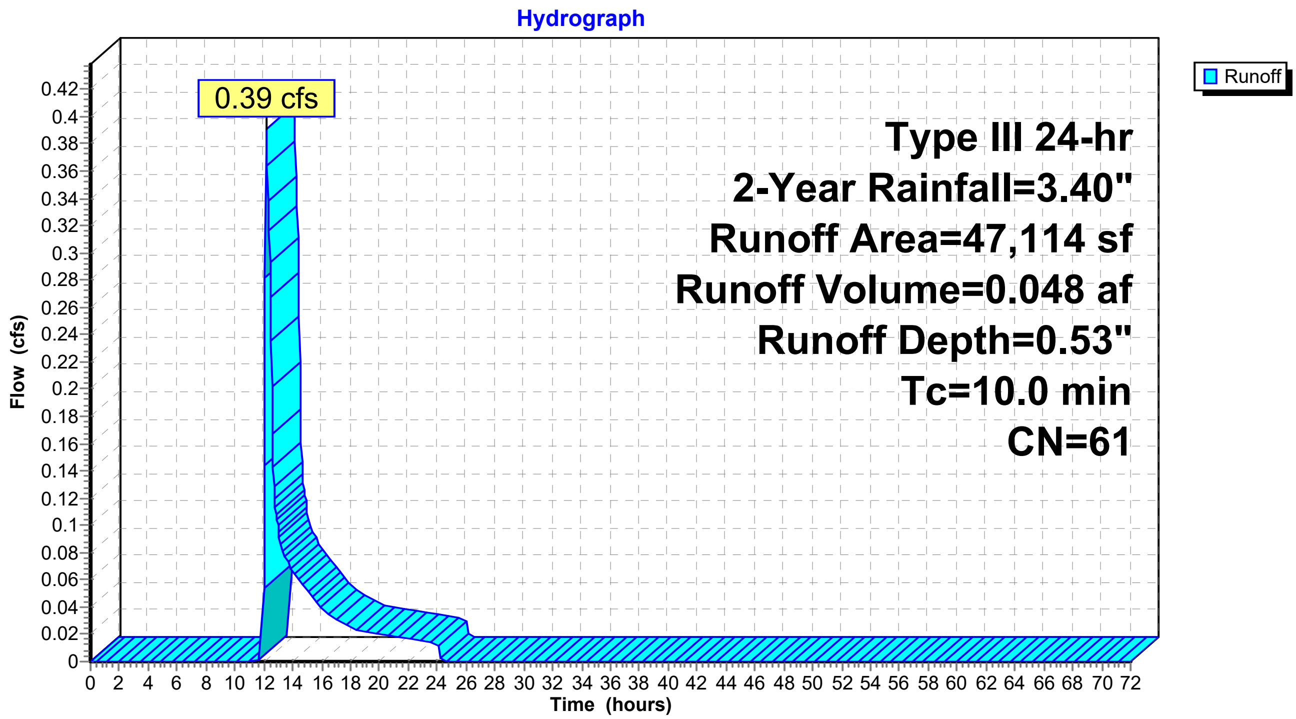
Runoff = 0.39 cfs @ 12.19 hrs, Volume= 0.048 af, Depth= 0.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (sf)	CN	Description
4,027	96	Gravel surface, HSG A
4,509	98	Roofs, HSG A
7,349	98	Paved roads w/curbs & sewers, HSG A
31,229	43	Woods/grass comb., Fair, HSG A
47,114	61	Weighted Average
35,256	49	74.83% Pervious Area
11,858	98	25.17% Impervious Area

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

Subcatchment 2S: PRE (2)



Summary for Subcatchment 15S: PRE (3)

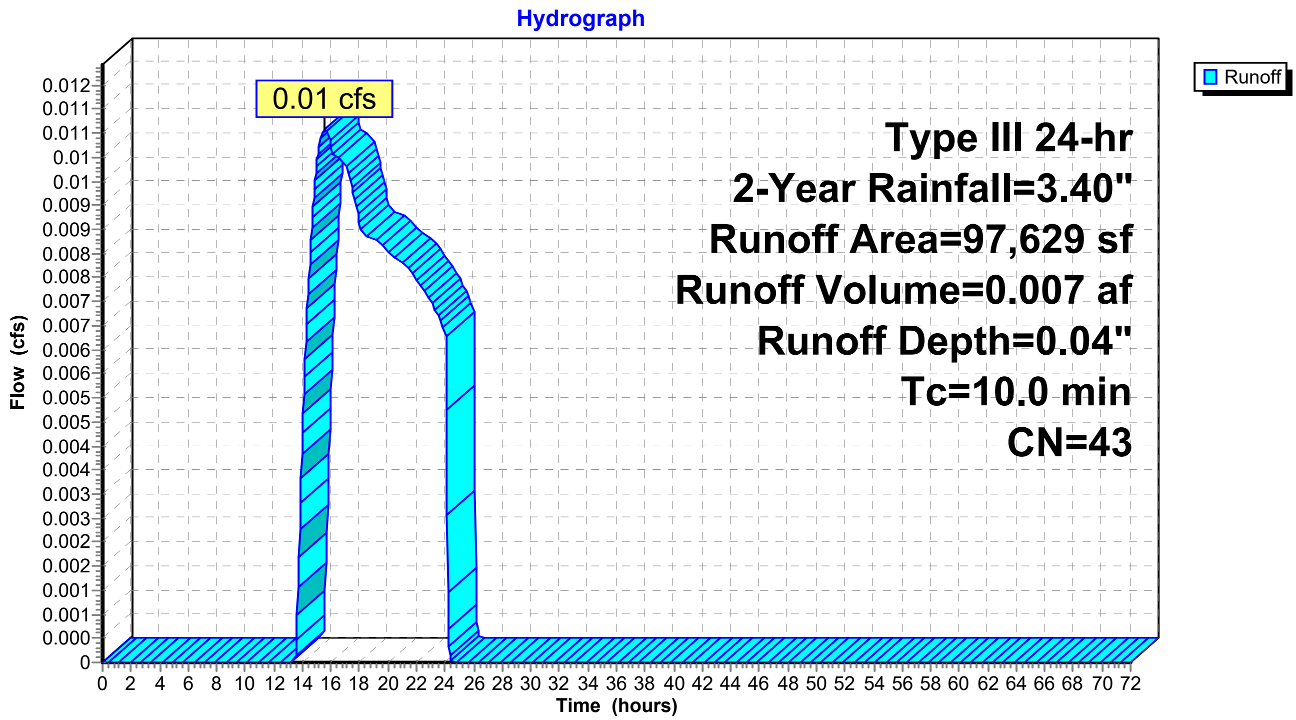
Runoff = 0.01 cfs @ 15.58 hrs, Volume= 0.007 af, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (sf)	CN	Description
97,629	43	Woods/grass comb., Fair, HSG A
97,629	43	100.00% Pervious Area

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

Subcatchment 15S: PRE (3)



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 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: PRE (1) Runoff Area=6,647 sf 0.00% Impervious Runoff Depth=0.27"
Tc=10.0 min CN=43 Runoff=0.01 cfs 0.003 af

Subcatchment 2S: PRE (2) Runoff Area=47,114 sf 25.17% Impervious Runoff Depth=1.19"
Tc=10.0 min CN=61 Runoff=1.16 cfs 0.107 af

Subcatchment 15S: PRE (3) Runoff Area=97,629 sf 0.00% Impervious Runoff Depth=0.27"
Tc=10.0 min CN=43 Runoff=0.19 cfs 0.051 af

Total Runoff Area = 3.475 ac Runoff Volume = 0.162 af Average Runoff Depth = 0.56"
92.17% Pervious = 3.203 ac 7.83% Impervious = 0.272 ac

Summary for Subcatchment 1S: PRE (1)

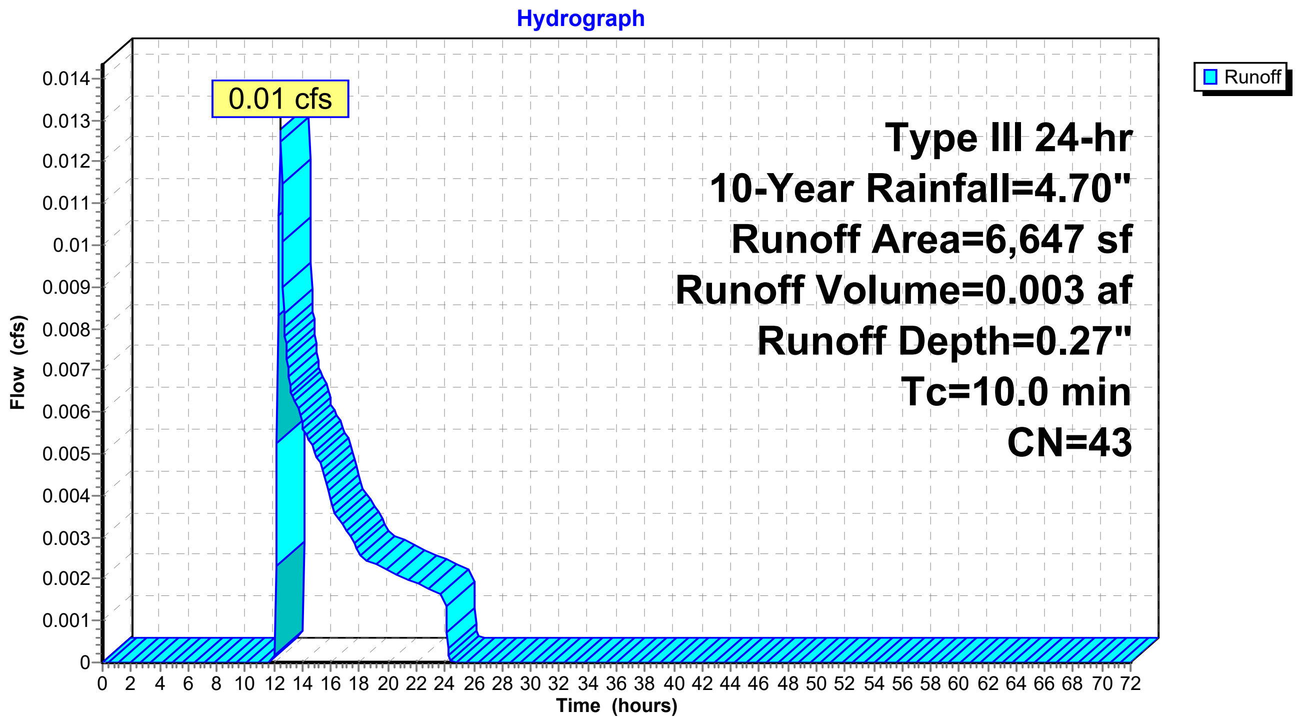
Runoff = 0.01 cfs @ 12.46 hrs, Volume= 0.003 af, Depth= 0.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
6,647	43	Woods/grass comb., Fair, HSG A
6,647	43	100.00% Pervious Area

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

Subcatchment 1S: PRE (1)



Summary for Subcatchment 2S: PRE (2)

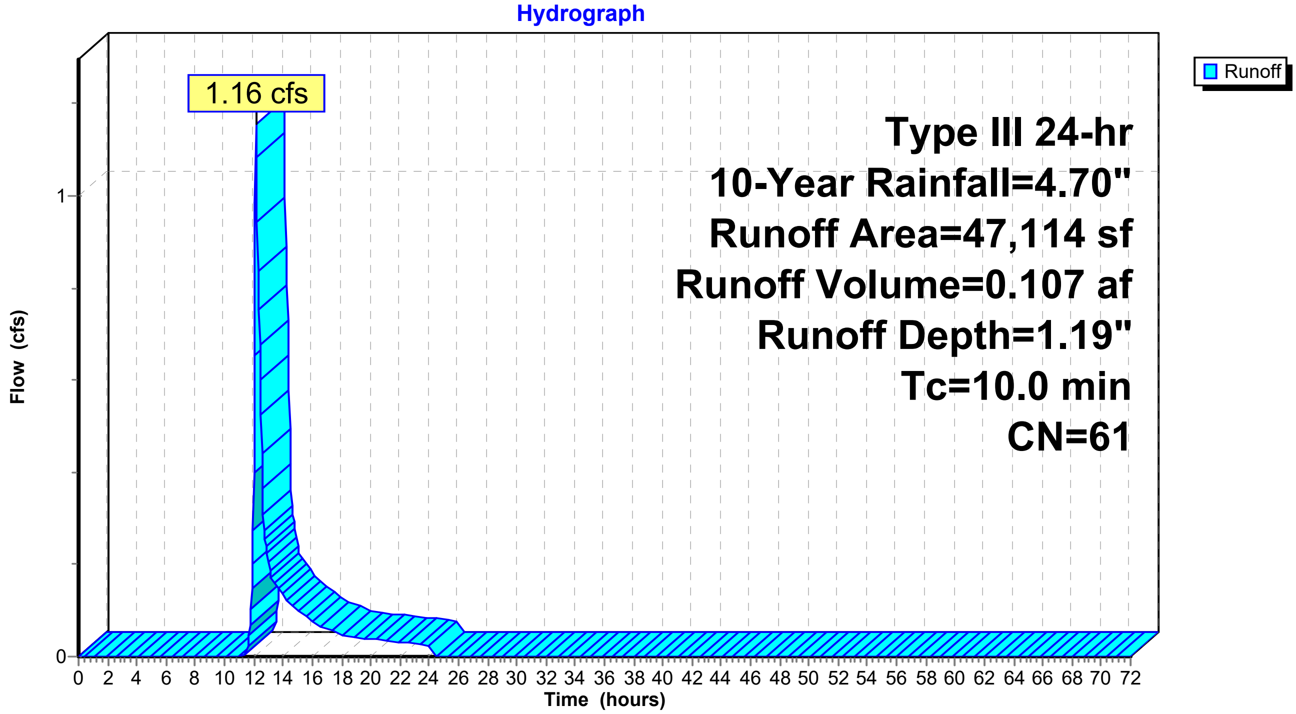
Runoff = 1.16 cfs @ 12.16 hrs, Volume= 0.107 af, Depth= 1.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
4,027	96	Gravel surface, HSG A
4,509	98	Roofs, HSG A
7,349	98	Paved roads w/curbs & sewers, HSG A
31,229	43	Woods/grass comb., Fair, HSG A
47,114	61	Weighted Average
35,256	49	74.83% Pervious Area
11,858	98	25.17% Impervious Area

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

Subcatchment 2S: PRE (2)



Summary for Subcatchment 15S: PRE (3)

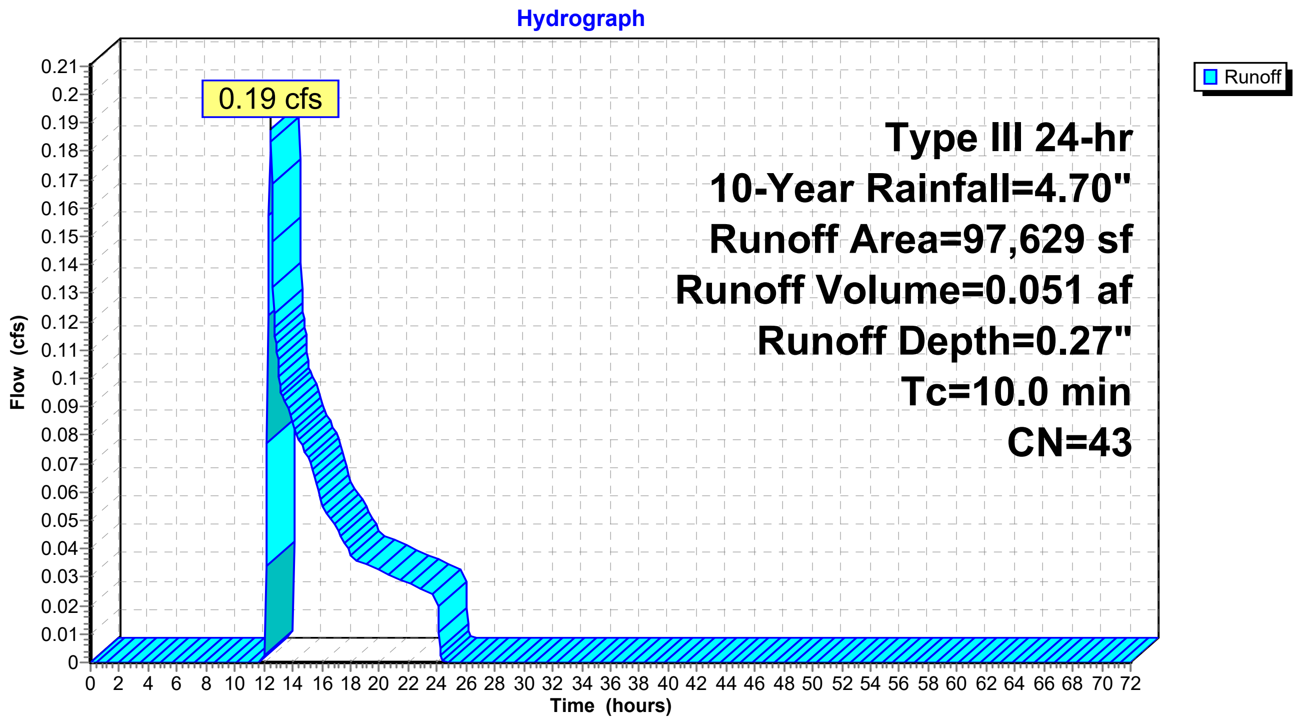
Runoff = 0.19 cfs @ 12.46 hrs, Volume= 0.051 af, Depth= 0.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
97,629	43	Woods/grass comb., Fair, HSG A
97,629	43	100.00% Pervious Area

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

Subcatchment 15S: PRE (3)



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 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: PRE (1) Runoff Area=6,647 sf 0.00% Impervious Runoff Depth=0.54"
Tc=10.0 min CN=43 Runoff=0.04 cfs 0.007 af

Subcatchment 2S: PRE (2) Runoff Area=47,114 sf 25.17% Impervious Runoff Depth=1.74"
Tc=10.0 min CN=61 Runoff=1.79 cfs 0.157 af

Subcatchment 15S: PRE (3) Runoff Area=97,629 sf 0.00% Impervious Runoff Depth=0.54"
Tc=10.0 min CN=43 Runoff=0.55 cfs 0.100 af

Total Runoff Area = 3.475 ac Runoff Volume = 0.264 af Average Runoff Depth = 0.91"
92.17% Pervious = 3.203 ac 7.83% Impervious = 0.272 ac

Summary for Subcatchment 1S: PRE (1)

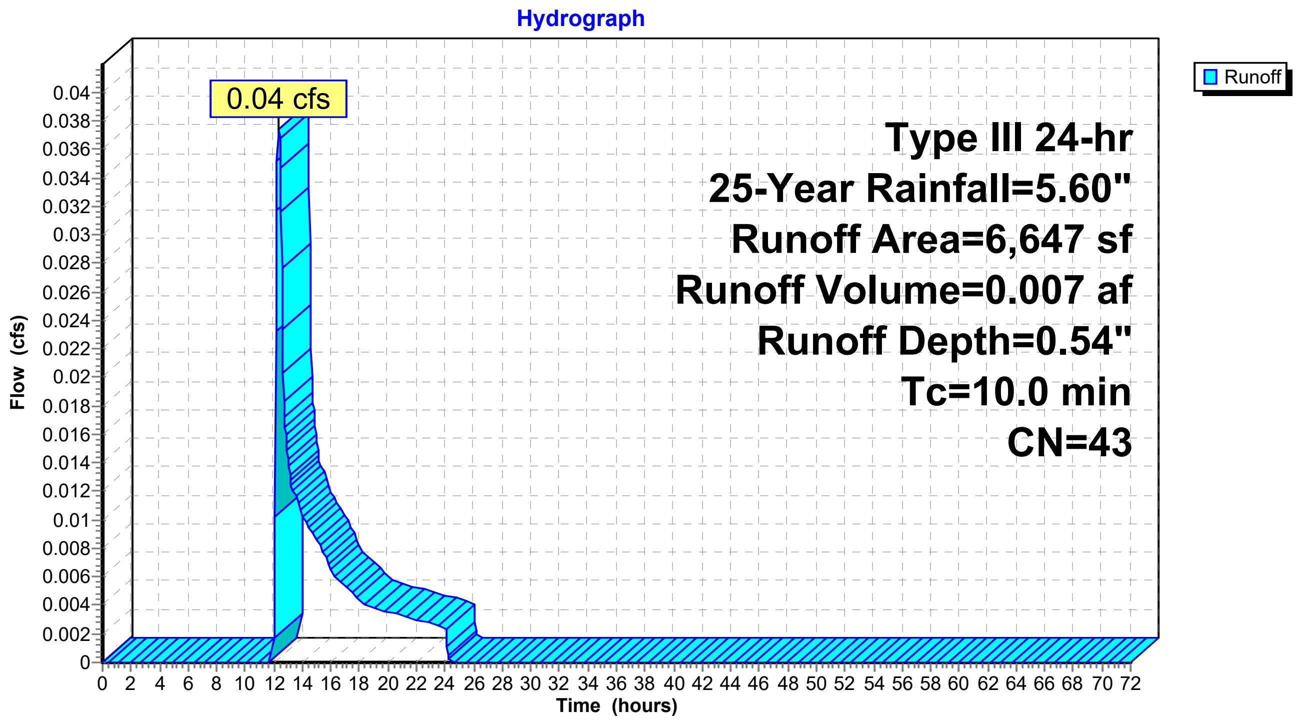
Runoff = 0.04 cfs @ 12.35 hrs, Volume= 0.007 af, Depth= 0.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
6,647	43	Woods/grass comb., Fair, HSG A
6,647	43	100.00% Pervious Area

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

Subcatchment 1S: PRE (1)



Summary for Subcatchment 2S: PRE (2)

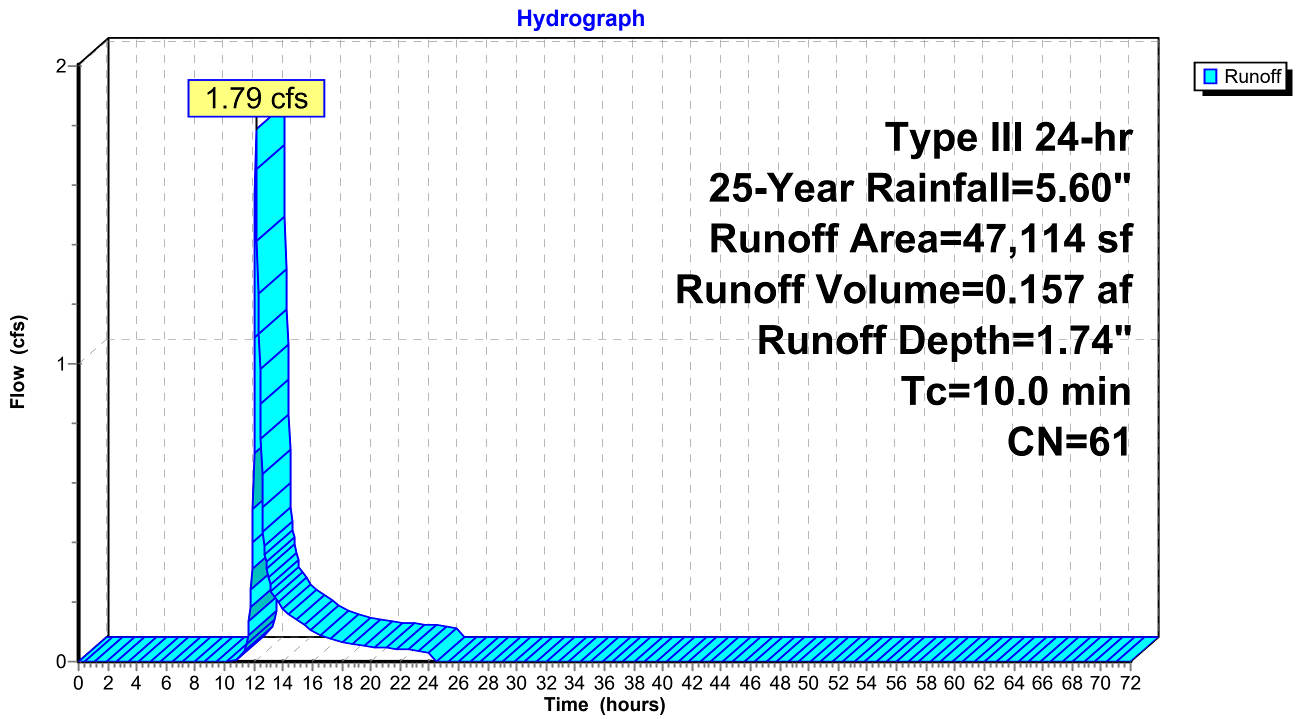
Runoff = 1.79 cfs @ 12.16 hrs, Volume= 0.157 af, Depth= 1.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
4,027	96	Gravel surface, HSG A
4,509	98	Roofs, HSG A
7,349	98	Paved roads w/curbs & sewers, HSG A
31,229	43	Woods/grass comb., Fair, HSG A
47,114	61	Weighted Average
35,256	49	74.83% Pervious Area
11,858	98	25.17% Impervious Area

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

Subcatchment 2S: PRE (2)



Summary for Subcatchment 15S: PRE (3)

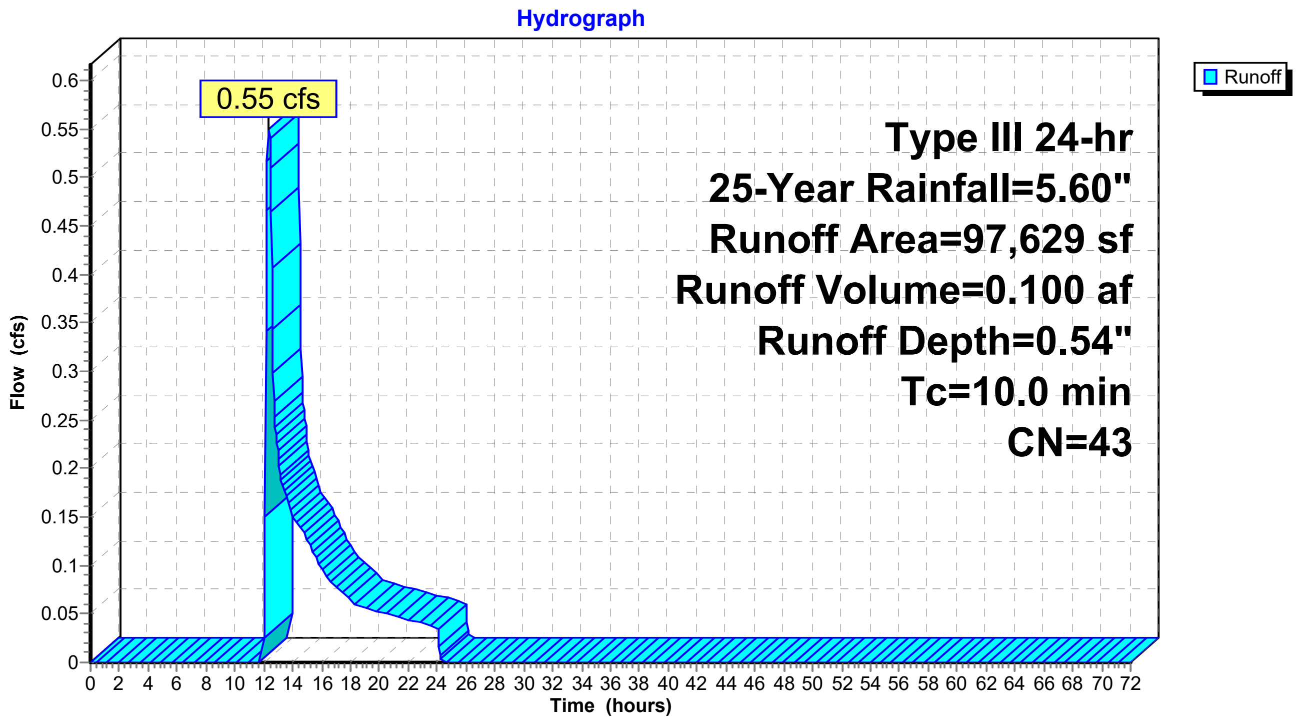
Runoff = 0.55 cfs @ 12.35 hrs, Volume= 0.100 af, Depth= 0.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
97,629	43	Woods/grass comb., Fair, HSG A
97,629	43	100.00% Pervious Area

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

Subcatchment 15S: PRE (3)



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 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: PRE (1) Runoff Area=6,647 sf 0.00% Impervious Runoff Depth=1.07"
Tc=10.0 min CN=43 Runoff=0.11 cfs 0.014 af

Subcatchment 2S: PRE (2) Runoff Area=47,114 sf 25.17% Impervious Runoff Depth=2.70"
Tc=10.0 min CN=61 Runoff=2.88 cfs 0.244 af

Subcatchment 15S: PRE (3) Runoff Area=97,629 sf 0.00% Impervious Runoff Depth=1.07"
Tc=10.0 min CN=43 Runoff=1.63 cfs 0.201 af

Total Runoff Area = 3.475 ac Runoff Volume = 0.458 af Average Runoff Depth = 1.58"
92.17% Pervious = 3.203 ac 7.83% Impervious = 0.272 ac

Summary for Subcatchment 1S: PRE (1)

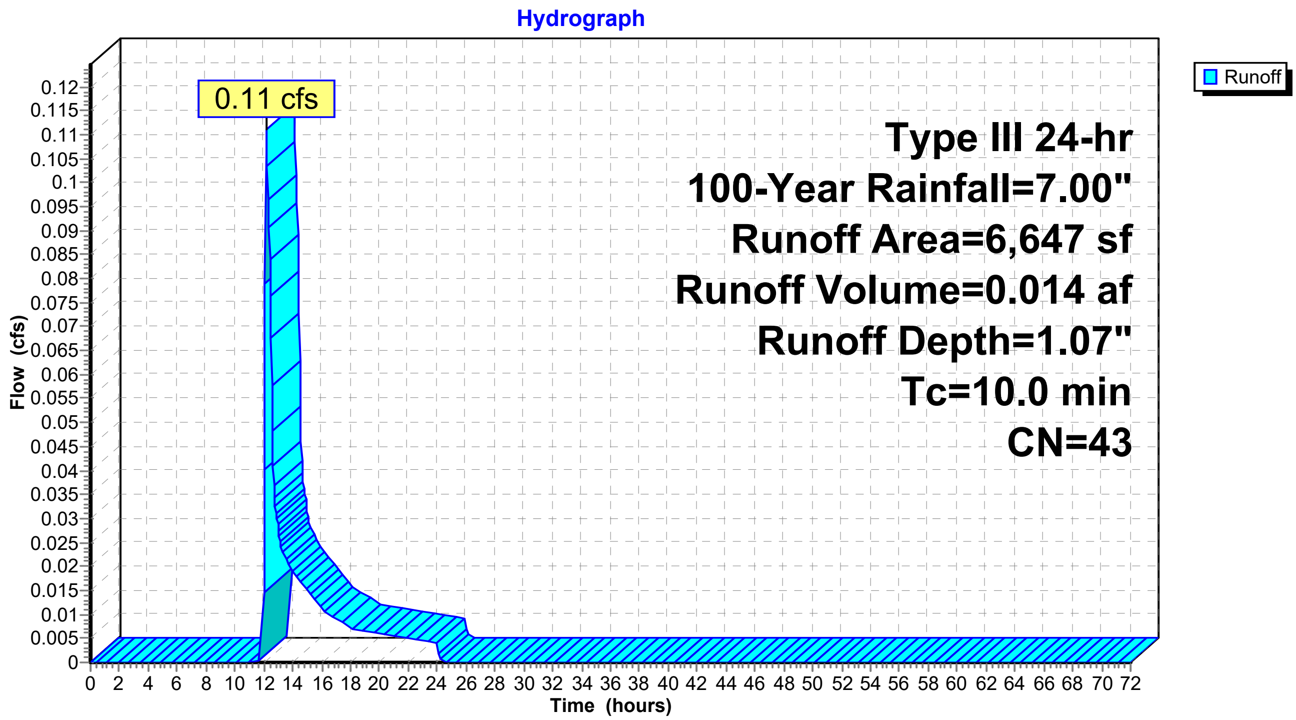
Runoff = 0.11 cfs @ 12.19 hrs, Volume= 0.014 af, Depth= 1.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (sf)	CN	Description
6,647	43	Woods/grass comb., Fair, HSG A
6,647	43	100.00% Pervious Area

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

Subcatchment 1S: PRE (1)



Summary for Subcatchment 2S: PRE (2)

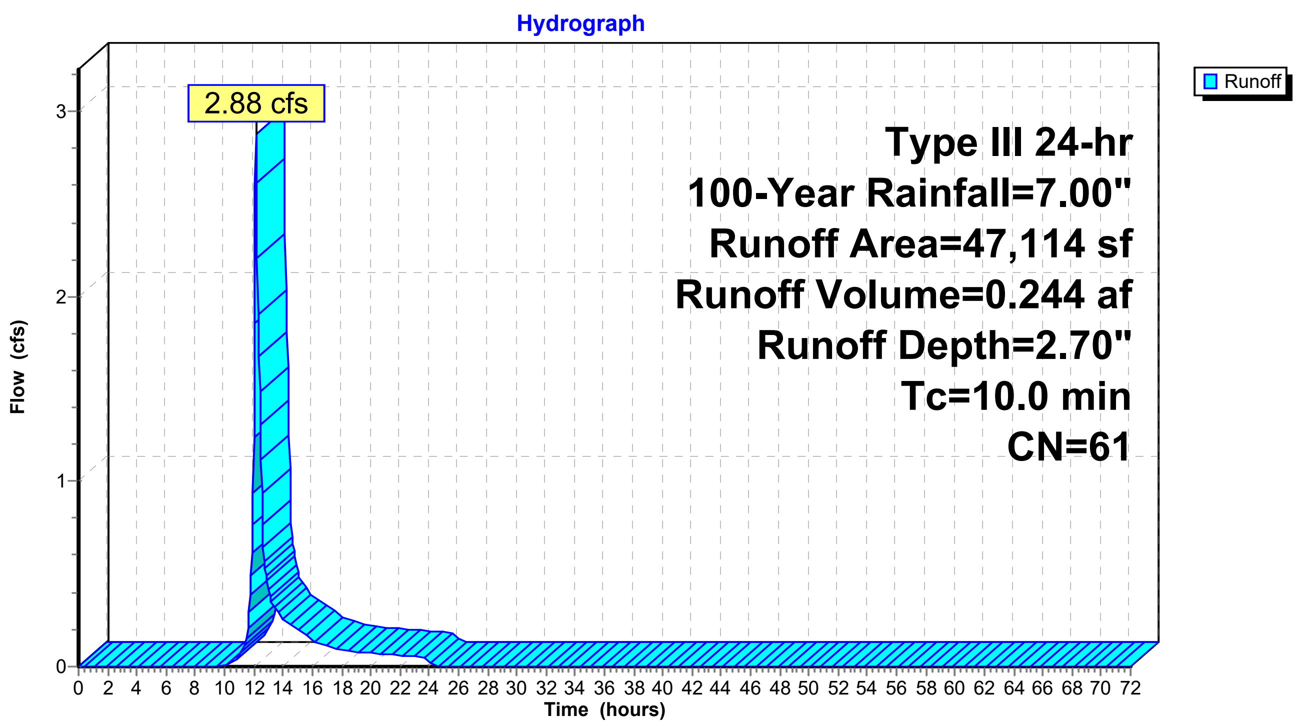
Runoff = 2.88 cfs @ 12.15 hrs, Volume= 0.244 af, Depth= 2.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (sf)	CN	Description
4,027	96	Gravel surface, HSG A
4,509	98	Roofs, HSG A
7,349	98	Paved roads w/curbs & sewers, HSG A
31,229	43	Woods/grass comb., Fair, HSG A
47,114	61	Weighted Average
35,256	49	74.83% Pervious Area
11,858	98	25.17% Impervious Area

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

Subcatchment 2S: PRE (2)



Summary for Subcatchment 15S: PRE (3)

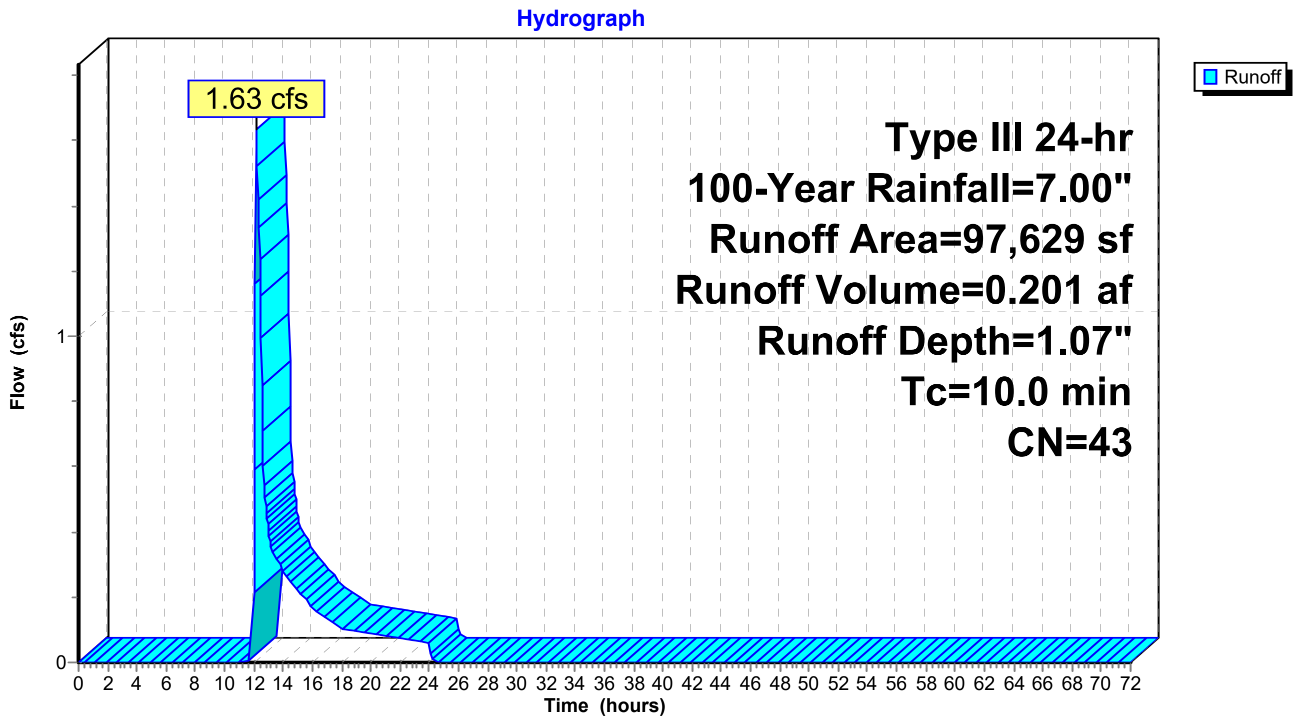
Runoff = 1.63 cfs @ 12.19 hrs, Volume= 0.201 af, Depth= 1.07"

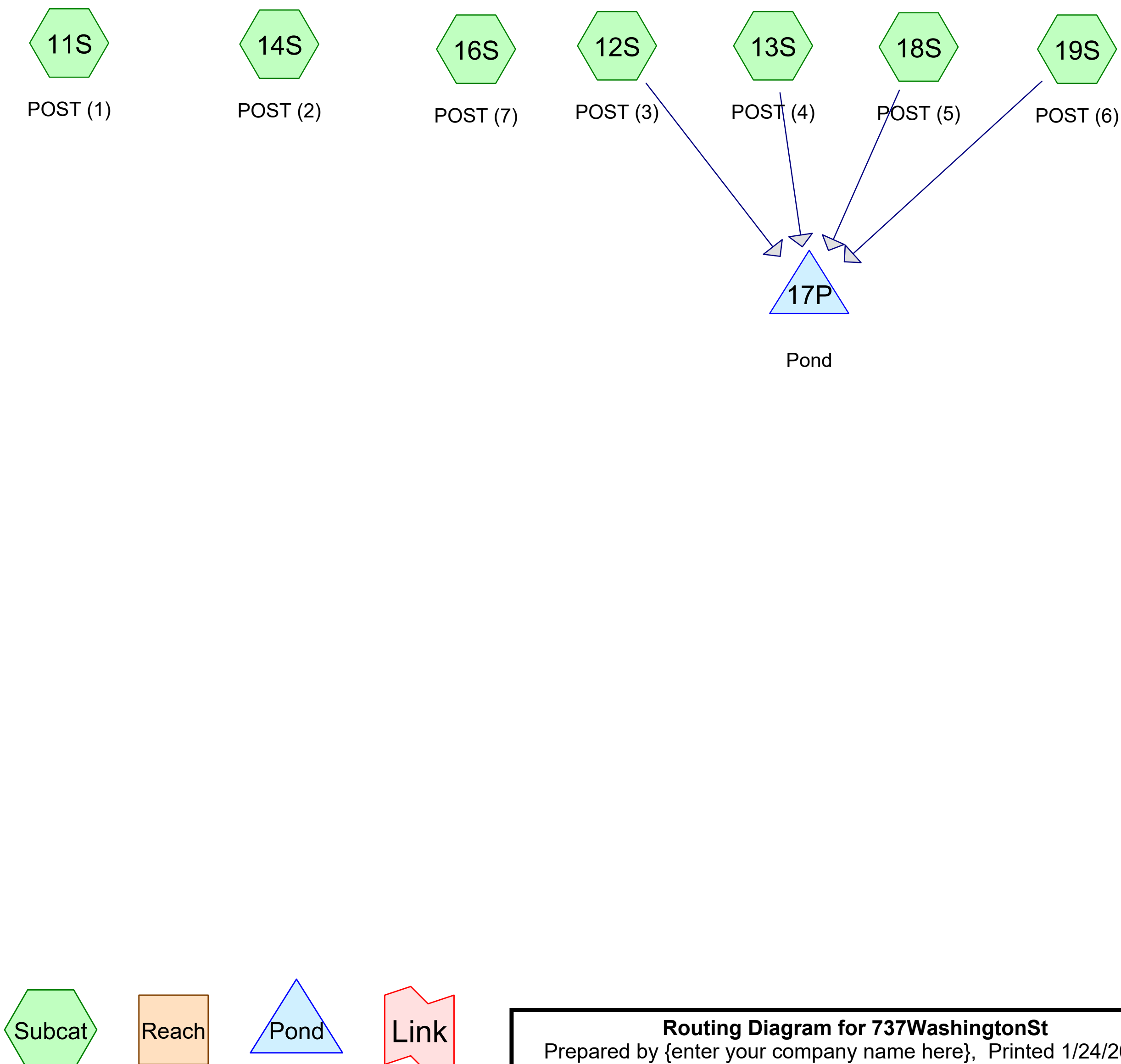
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (sf)	CN	Description
97,629	43	Woods/grass comb., Fair, HSG A
97,629	43	100.00% Pervious Area

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

Subcatchment 15S: PRE (3)





Routing Diagram for 737WashingtonSt
Prepared by {enter your company name here}, Printed 1/24/2020
HydroCAD® 10.00-24 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.076	49	50-75% Grass cover, Fair, HSG A (13S)
0.148	96	Gravel surface, HSG A (13S)
0.682	98	Paved parking, HSG A (12S, 13S, 14S, 16S)
0.379	98	Roofs, HSG A (14S, 18S)
1.993	43	Woods/grass comb., Fair, HSG A (11S, 12S, 14S, 16S, 19S)
3.279	**63**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
3.279	HSG A	11S, 12S, 13S, 14S, 16S, 18S, 19S
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
3.279		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.076	0.000	0.000	0.000	0.000	0.076	50-75% Grass cover, Fair	13S
0.148	0.000	0.000	0.000	0.000	0.148	Gravel surface	13S
0.682	0.000	0.000	0.000	0.000	0.682	Paved parking	12S, 13S, 14S, 16S
0.379	0.000	0.000	0.000	0.000	0.379	Roofs	14S, 18S
1.993	0.000	0.000	0.000	0.000	1.993	Woods/grass comb., Fair	11S, 12S, 14S, 16S, 19S
3.279	**0.000**	**0.000**	**0.000**	**0.000**	**3.279**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 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 11S: POST (1) Runoff Area=6,450 sf 0.00% Impervious Runoff Depth=0.04"
Tc=10.0 min CN=43 Runoff=0.00 cfs 0.000 af

Subcatchment 12S: POST (3) Runoff Area=14,288 sf 86.68% Impervious Runoff Depth=2.45"
Tc=10.0 min CN=91 Runoff=0.80 cfs 0.067 af

Subcatchment 13S: POST (4) Runoff Area=20,056 sf 51.23% Impervious Runoff Depth=2.26"
Tc=10.0 min CN=89 Runoff=1.05 cfs 0.087 af

Subcatchment 14S: POST (2) Runoff Area=26,373 sf 32.83% Impervious Runoff Depth=0.53"
Tc=10.0 min CN=61 Runoff=0.22 cfs 0.027 af

Subcatchment 16S: POST (7) Runoff Area=38,797 sf 7.44% Impervious Runoff Depth=0.11"
Tc=10.0 min CN=47 Runoff=0.01 cfs 0.008 af

Subcatchment 18S: POST (5) Runoff Area=12,000 sf 100.00% Impervious Runoff Depth=3.17"
Tc=10.0 min CN=98 Runoff=0.79 cfs 0.073 af

Subcatchment 19S: POST (6) Runoff Area=24,850 sf 0.00% Impervious Runoff Depth=0.04"
Tc=10.0 min CN=43 Runoff=0.00 cfs 0.002 af

Pond 17P: Pond Peak Elev=78.72' Storage=3,297 cf Inflow=2.63 cfs 0.228 af
Primary=0.43 cfs 0.228 af Secondary=0.00 cfs 0.000 af Outflow=0.43 cfs 0.228 af

Total Runoff Area = 3.279 ac Runoff Volume = 0.263 af Average Runoff Depth = 0.96"
67.65% Pervious = 2.218 ac 32.35% Impervious = 1.061 ac

Summary for Subcatchment 11S: POST (1)

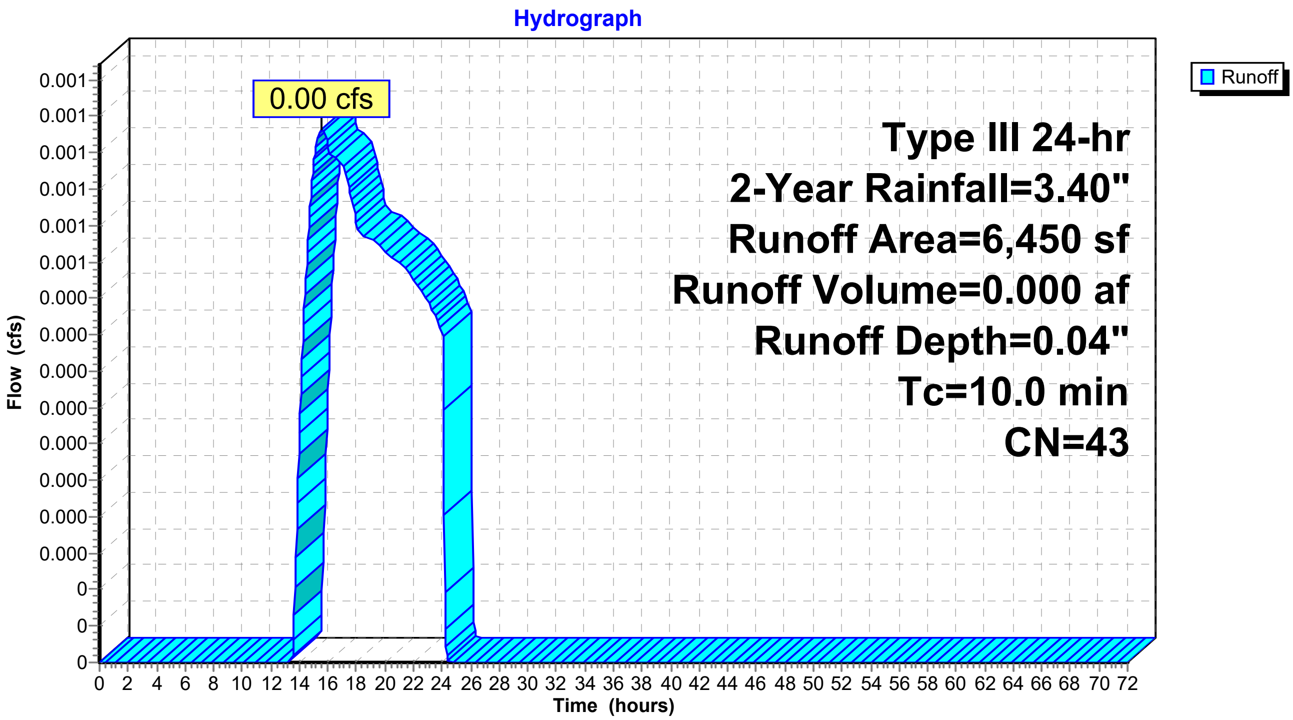
Runoff = 0.00 cfs @ 15.58 hrs, Volume= 0.000 af, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (sf)	CN	Description
6,450	43	Woods/grass comb., Fair, HSG A
6,450	43	100.00% Pervious Area

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

Subcatchment 11S: POST (1)



Summary for Subcatchment 12S: POST (3)

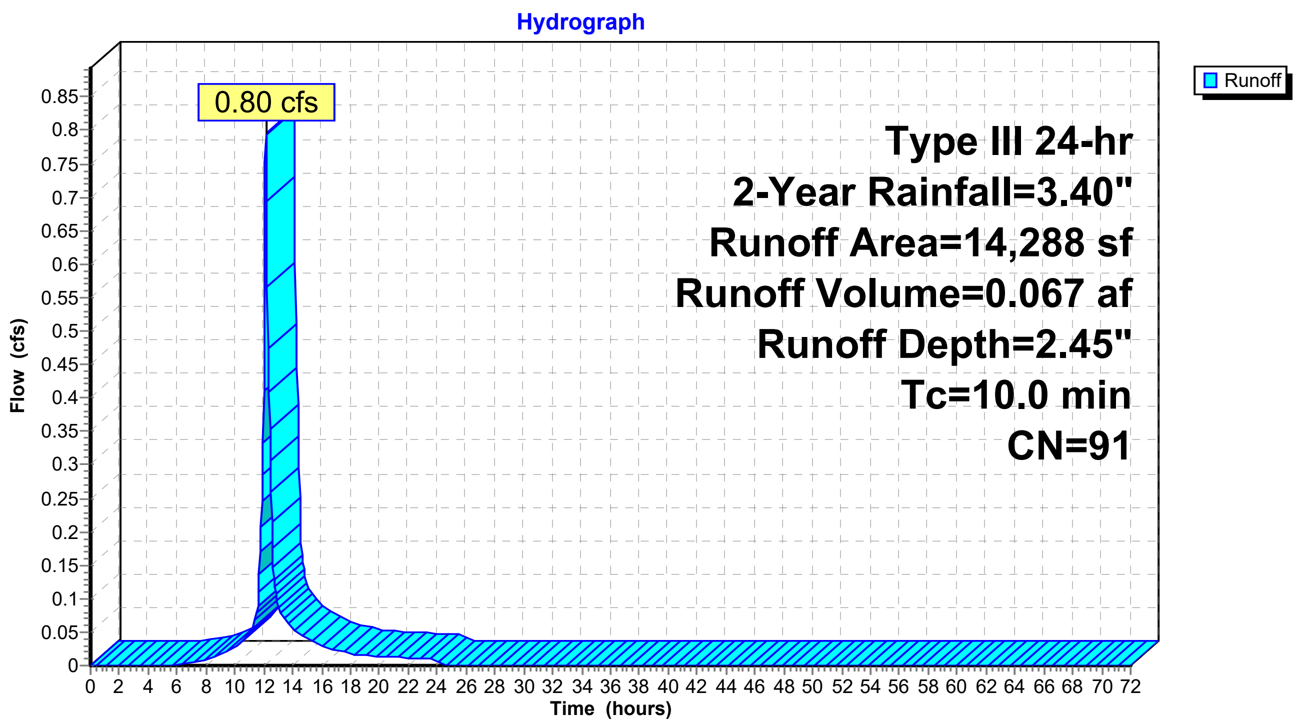
Runoff = 0.80 cfs @ 12.14 hrs, Volume= 0.067 af, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (sf)	CN	Description
12,385	98	Paved parking, HSG A
1,903	43	Woods/grass comb., Fair, HSG A
14,288	91	Weighted Average
1,903	43	13.32% Pervious Area
12,385	98	86.68% Impervious Area

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

Subcatchment 12S: POST (3)



Summary for Subcatchment 13S: POST (4)

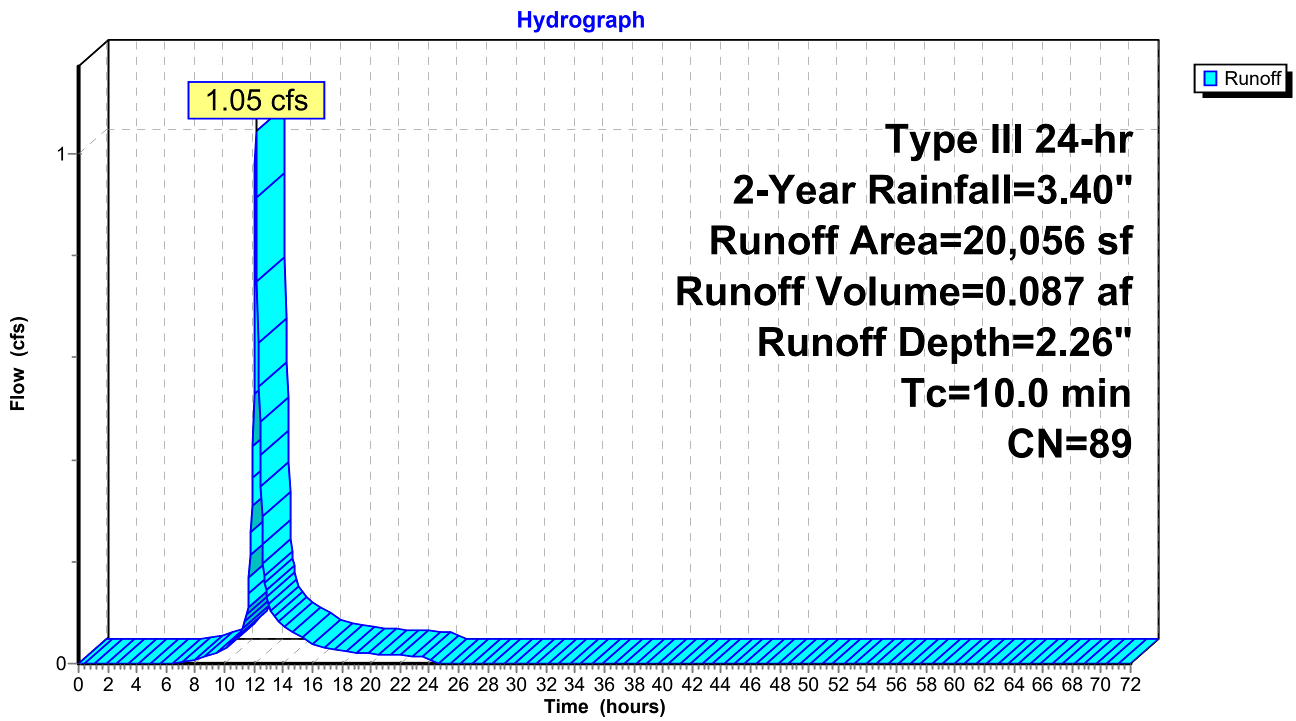
Runoff = 1.05 cfs @ 12.14 hrs, Volume= 0.087 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (sf)	CN	Description
6,466	96	Gravel surface, HSG A
10,275	98	Paved parking, HSG A
3,315	49	50-75% Grass cover, Fair, HSG A
20,056	89	Weighted Average
9,781	80	48.77% Pervious Area
10,275	98	51.23% Impervious Area

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

Subcatchment 13S: POST (4)



Summary for Subcatchment 14S: POST (2)

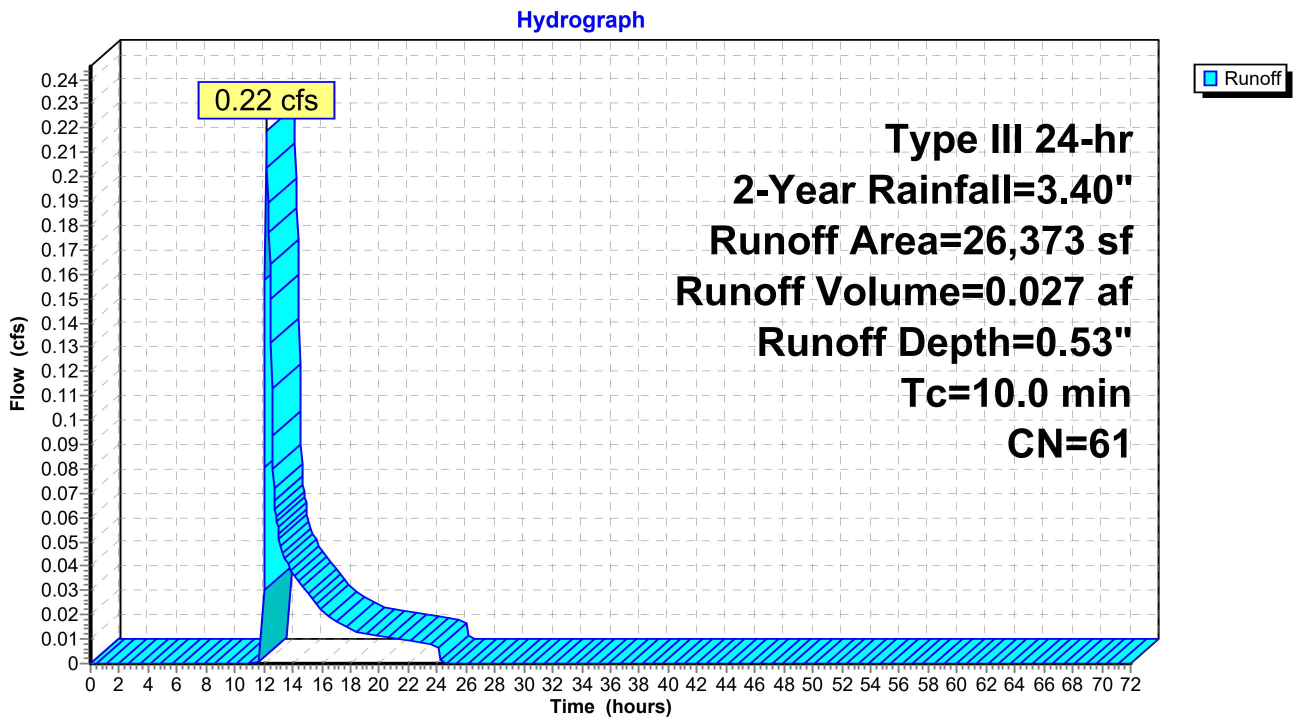
Runoff = 0.22 cfs @ 12.19 hrs, Volume= 0.027 af, Depth= 0.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (sf)	CN	Description
4,509	98	Roofs, HSG A
4,149	98	Paved parking, HSG A
17,715	43	Woods/grass comb., Fair, HSG A
26,373	61	Weighted Average
17,715	43	67.17% Pervious Area
8,658	98	32.83% Impervious Area

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

Subcatchment 14S: POST (2)



Summary for Subcatchment 16S: POST (7)

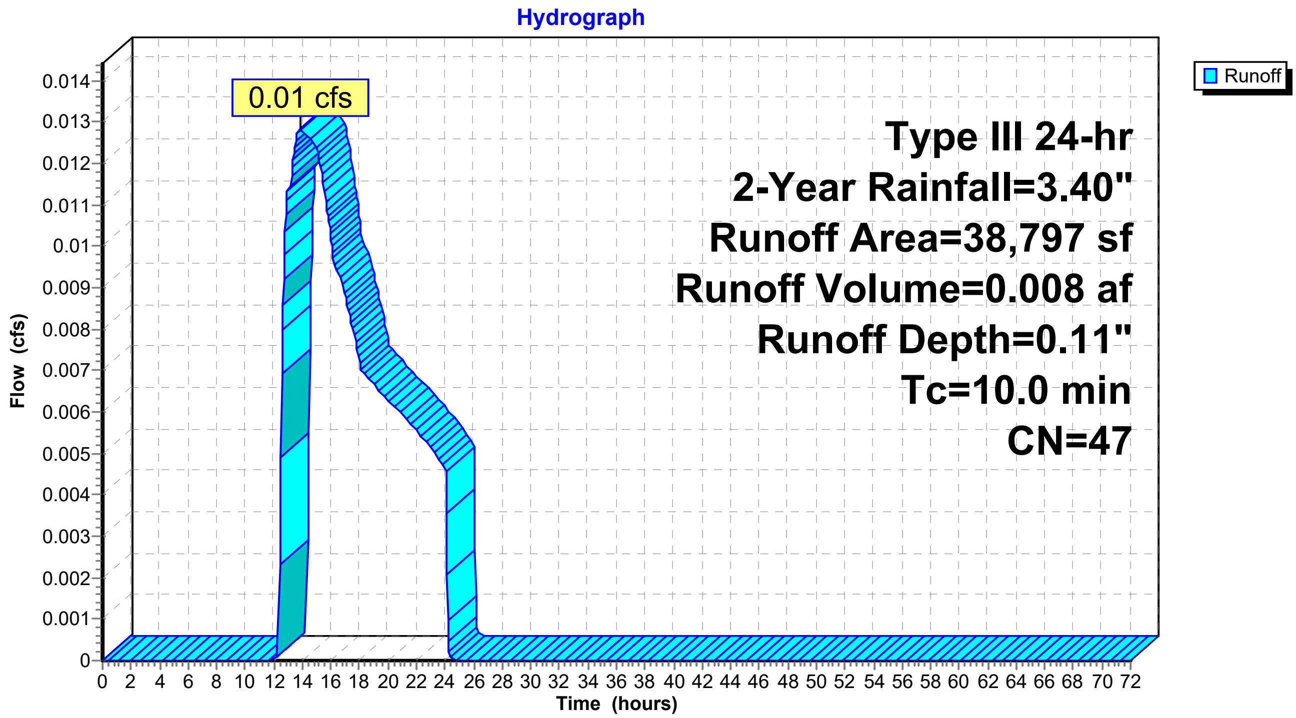
Runoff = 0.01 cfs @ 13.81 hrs, Volume= 0.008 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (sf)	CN	Description
35,911	43	Woods/grass comb., Fair, HSG A
2,886	98	Paved parking, HSG A
38,797	47	Weighted Average
35,911	43	92.56% Pervious Area
2,886	98	7.44% Impervious Area

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

Subcatchment 16S: POST (7)



Summary for Subcatchment 18S: POST (5)

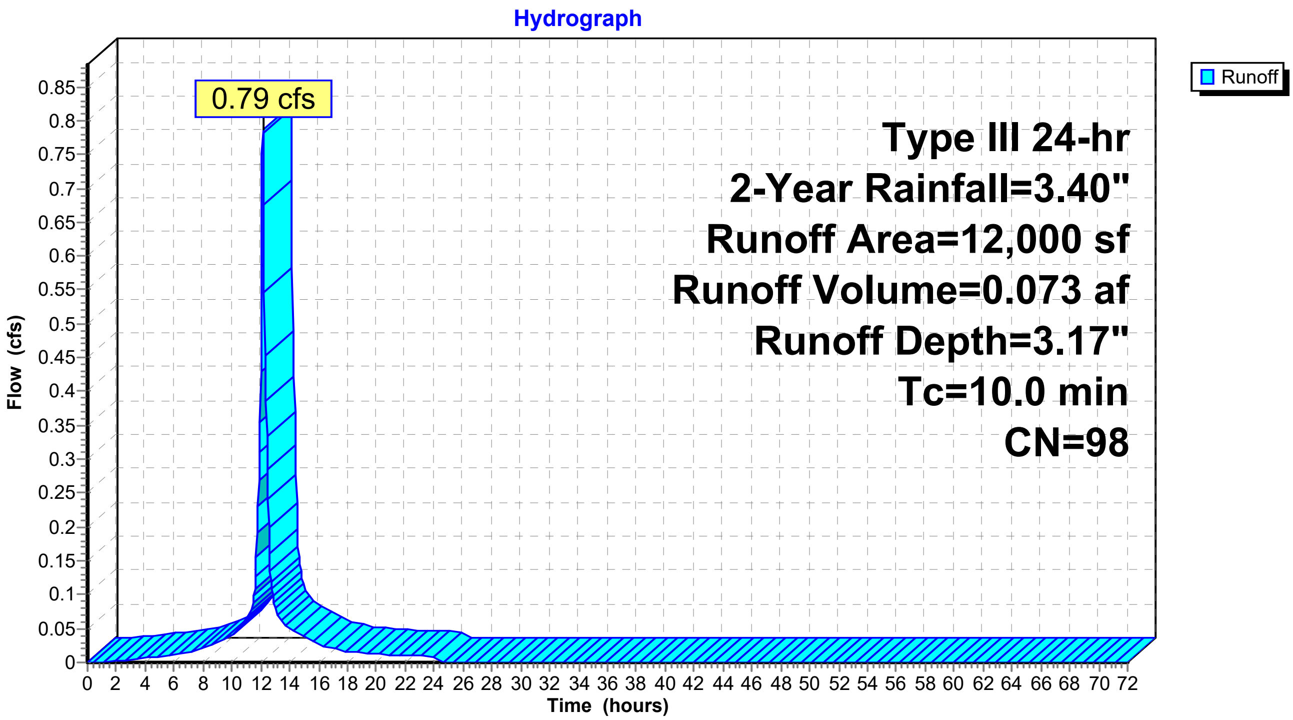
Runoff = 0.79 cfs @ 12.14 hrs, Volume= 0.073 af, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (sf)	CN	Description
12,000	98	Roofs, HSG A
12,000	98	100.00% Impervious Area

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

Subcatchment 18S: POST (5)



Summary for Subcatchment 19S: POST (6)

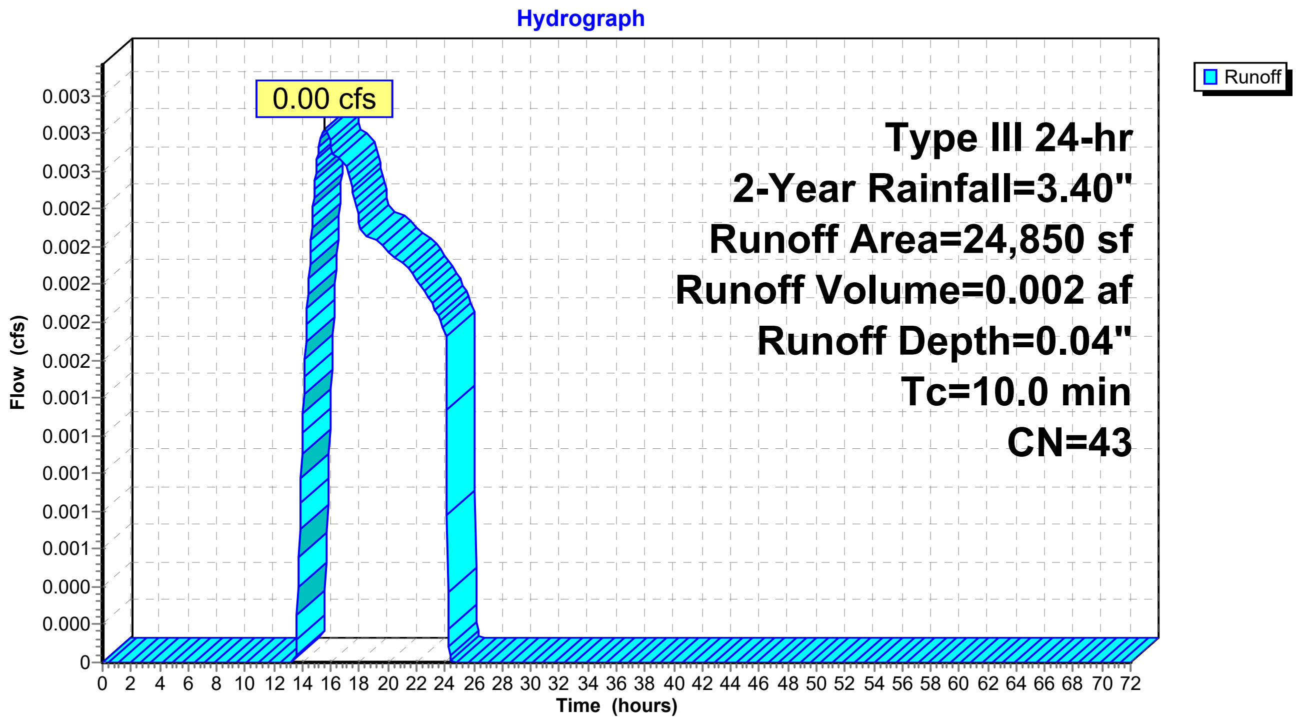
Runoff = 0.00 cfs @ 15.58 hrs, Volume= 0.002 af, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (sf)	CN	Description
24,850	43	Woods/grass comb., Fair, HSG A
24,850	43	100.00% Pervious Area

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

Subcatchment 19S: POST (6)



Summary for Pond 17P: Pond

Inflow Area = 1.634 ac, 48.68% Impervious, Inflow Depth = 1.68" for 2-Year event
Inflow = 2.63 cfs @ 12.14 hrs, Volume= 0.228 af
Outflow = 0.43 cfs @ 12.69 hrs, Volume= 0.228 af, Atten= 84%, Lag= 33.3 min
Primary = 0.43 cfs @ 12.69 hrs, Volume= 0.228 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 78.72' @ 12.69 hrs Surf.Area= 2,246 sf Storage= 3,297 cf

Plug-Flow detention time= 60.4 min calculated for 0.228 af (100% of inflow)
Center-of-Mass det. time= 60.4 min (855.9 - 795.5)

Volume	Invert	Avail.Storage	Storage Description
#1	77.00'	13,641 cf	**Custom Stage Data (Irregular)**Listed below

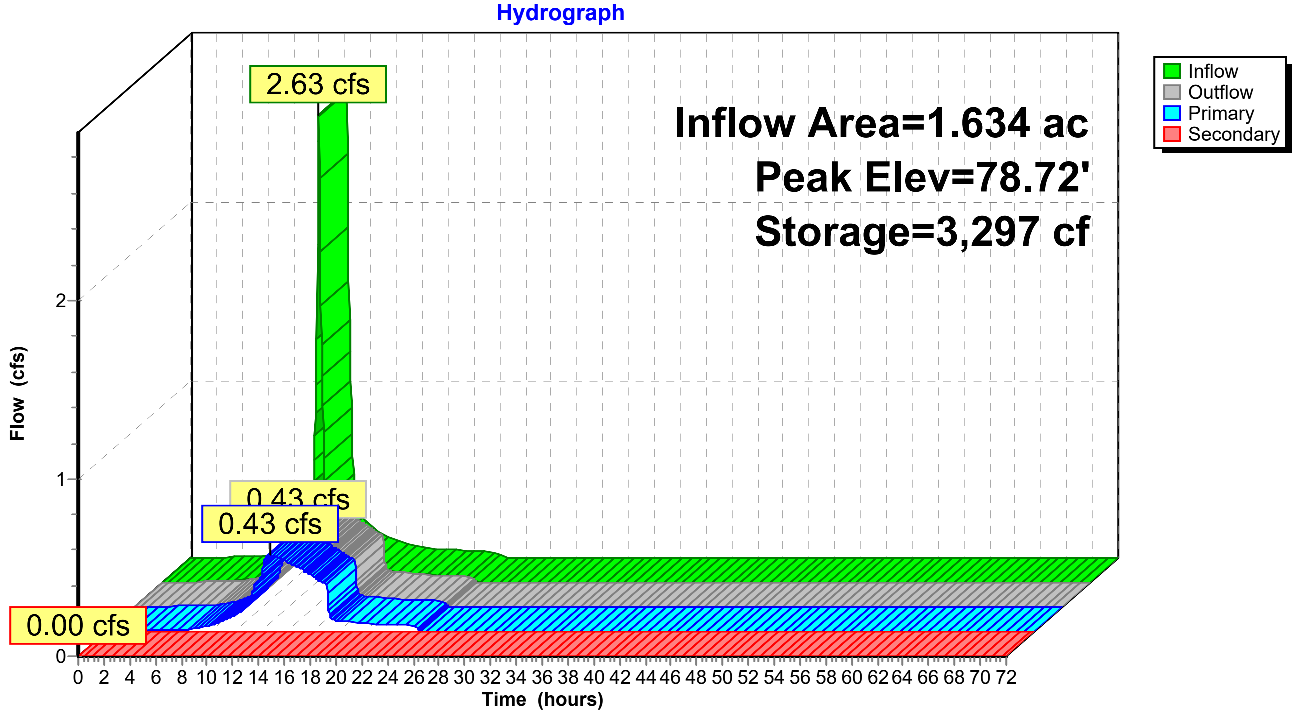
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
77.00	1,350	152.6	0	0	1,350
78.00	1,837	171.5	1,587	1,587	1,864
80.00	2,979	209.2	4,770	6,357	3,068
82.00	4,347	246.9	7,283	13,641	4,510

Device	Routing	Invert	Outlet Devices
#1	Primary	77.00'	**8.270 in/hr Exfiltration over Surface area**
#2	Secondary	80.25'	**0.5' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.43 cfs @ 12.69 hrs HW=78.72' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.43 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=77.00' (Free Discharge)
↑—**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 17P: Pond



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 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 11S: POST (1) Runoff Area=6,450 sf 0.00% Impervious Runoff Depth=0.27"
Tc=10.0 min CN=43 Runoff=0.01 cfs 0.003 af

Subcatchment 12S: POST (3) Runoff Area=14,288 sf 86.68% Impervious Runoff Depth=3.69"
Tc=10.0 min CN=91 Runoff=1.18 cfs 0.101 af

Subcatchment 13S: POST (4) Runoff Area=20,056 sf 51.23% Impervious Runoff Depth=3.49"
Tc=10.0 min CN=89 Runoff=1.58 cfs 0.134 af

Subcatchment 14S: POST (2) Runoff Area=26,373 sf 32.83% Impervious Runoff Depth=1.19"
Tc=10.0 min CN=61 Runoff=0.65 cfs 0.060 af

Subcatchment 16S: POST (7) Runoff Area=38,797 sf 7.44% Impervious Runoff Depth=0.44"
Tc=10.0 min CN=47 Runoff=0.17 cfs 0.032 af

Subcatchment 18S: POST (5) Runoff Area=12,000 sf 100.00% Impervious Runoff Depth=4.46"
Tc=10.0 min CN=98 Runoff=1.10 cfs 0.102 af

Subcatchment 19S: POST (6) Runoff Area=24,850 sf 0.00% Impervious Runoff Depth=0.27"
Tc=10.0 min CN=43 Runoff=0.05 cfs 0.013 af

Pond 17P: Pond Peak Elev=79.64' Storage=5,497 cf Inflow=3.86 cfs 0.350 af
Primary=0.53 cfs 0.350 af Secondary=0.00 cfs 0.000 af Outflow=0.53 cfs 0.350 af

Total Runoff Area = 3.279 ac Runoff Volume = 0.446 af Average Runoff Depth = 1.63"
67.65% Pervious = 2.218 ac 32.35% Impervious = 1.061 ac

Summary for Subcatchment 11S: POST (1)

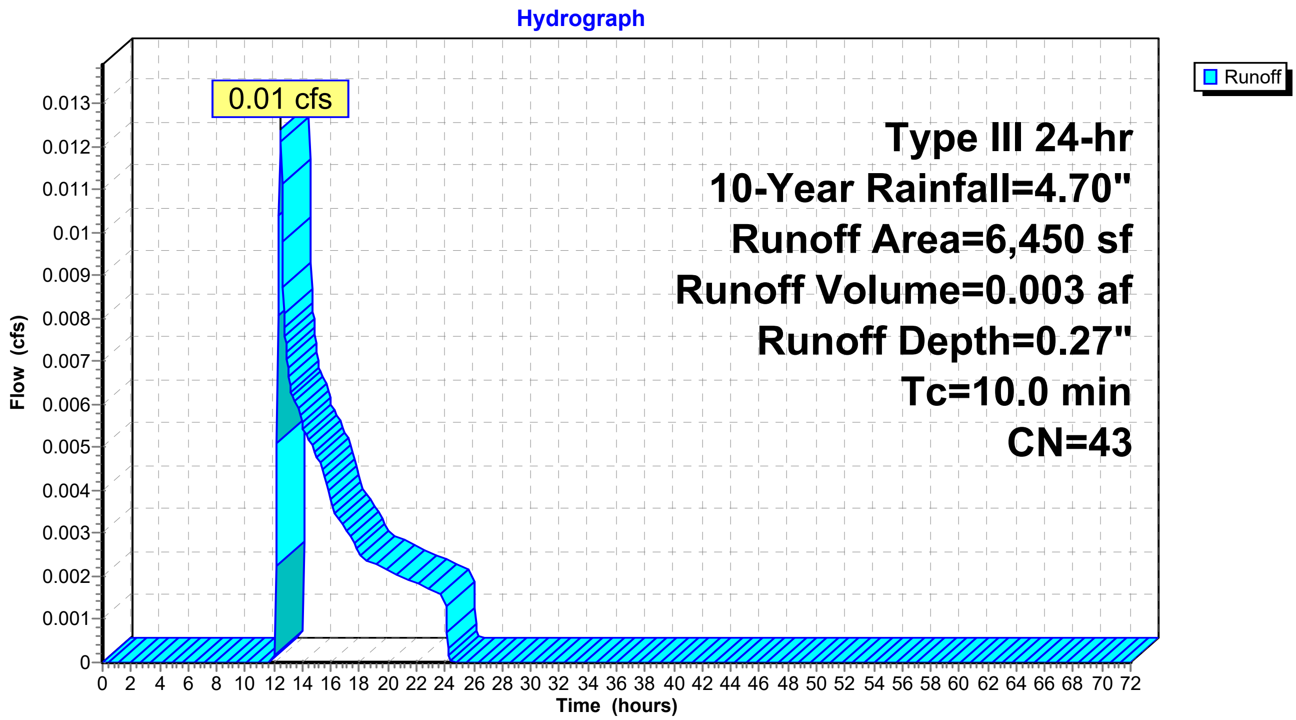
Runoff = 0.01 cfs @ 12.46 hrs, Volume= 0.003 af, Depth= 0.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
6,450	43	Woods/grass comb., Fair, HSG A
6,450	43	100.00% Pervious Area

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

Subcatchment 11S: POST (1)



Summary for Subcatchment 12S: POST (3)

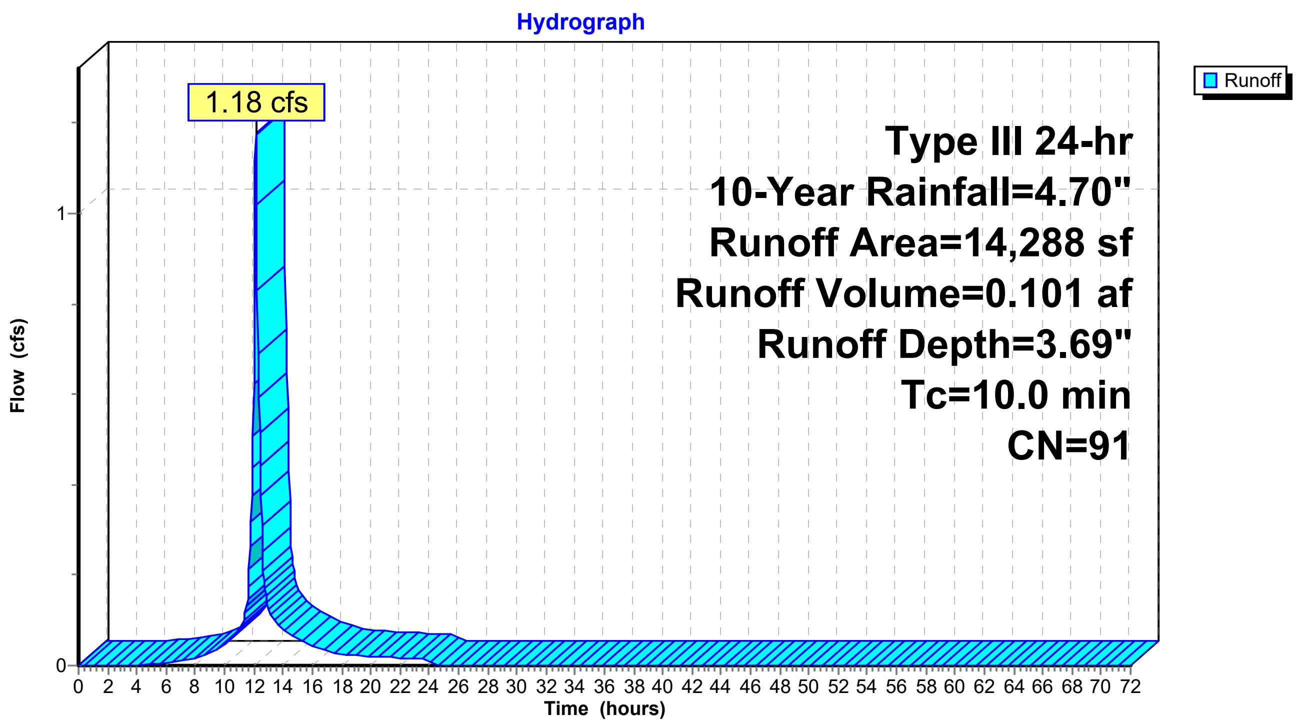
Runoff = 1.18 cfs @ 12.14 hrs, Volume= 0.101 af, Depth= 3.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
12,385	98	Paved parking, HSG A
1,903	43	Woods/grass comb., Fair, HSG A
14,288	91	Weighted Average
1,903	43	13.32% Pervious Area
12,385	98	86.68% Impervious Area

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

Subcatchment 12S: POST (3)



Summary for Subcatchment 13S: POST (4)

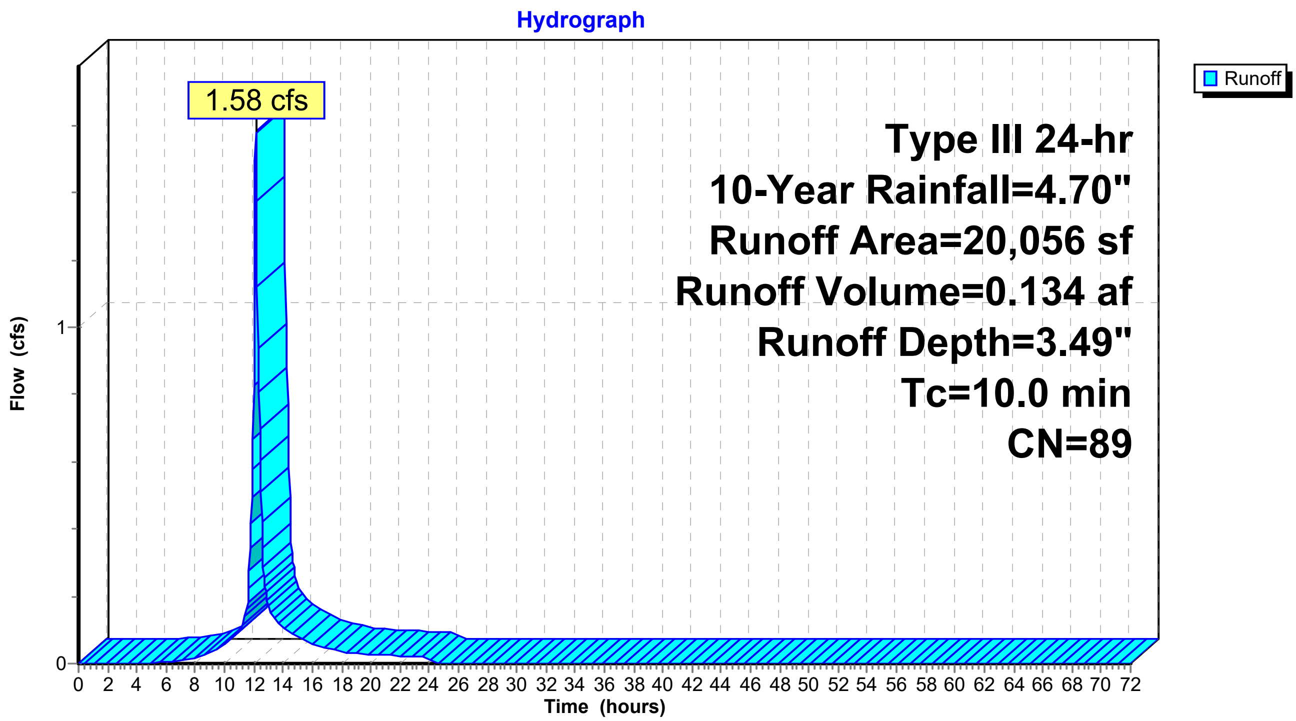
Runoff = 1.58 cfs @ 12.14 hrs, Volume= 0.134 af, Depth= 3.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
6,466	96	Gravel surface, HSG A
10,275	98	Paved parking, HSG A
3,315	49	50-75% Grass cover, Fair, HSG A
20,056	89	Weighted Average
9,781	80	48.77% Pervious Area
10,275	98	51.23% Impervious Area

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

Subcatchment 13S: POST (4)



Summary for Subcatchment 14S: POST (2)

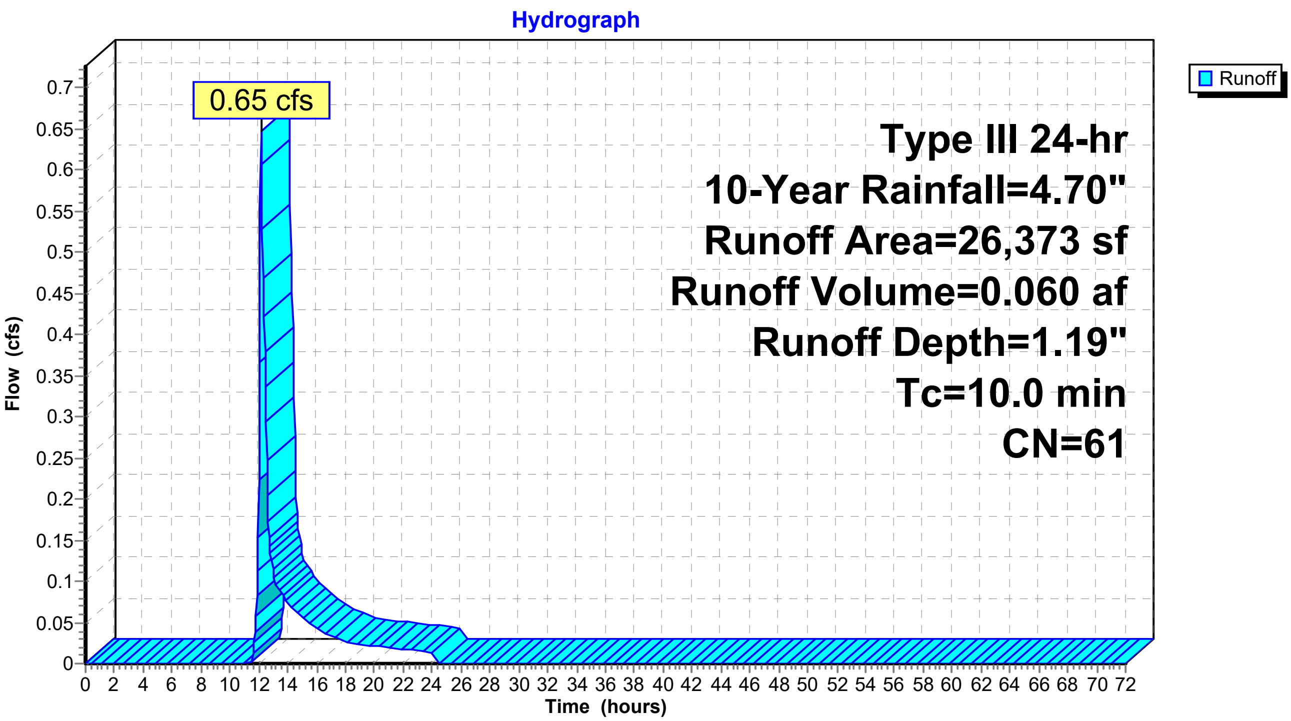
Runoff = 0.65 cfs @ 12.16 hrs, Volume= 0.060 af, Depth= 1.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
4,509	98	Roofs, HSG A
4,149	98	Paved parking, HSG A
17,715	43	Woods/grass comb., Fair, HSG A
26,373	61	Weighted Average
17,715	43	67.17% Pervious Area
8,658	98	32.83% Impervious Area

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

Subcatchment 14S: POST (2)



Summary for Subcatchment 16S: POST (7)

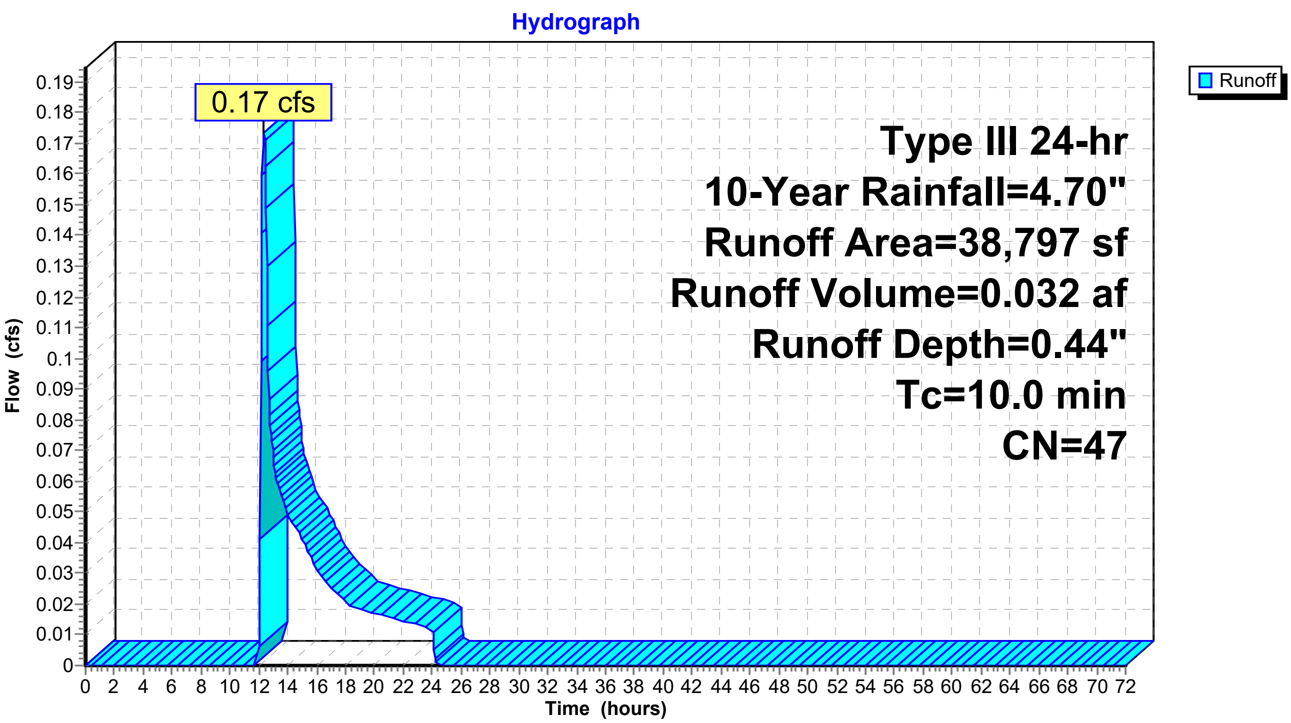
Runoff = 0.17 cfs @ 12.36 hrs, Volume= 0.032 af, Depth= 0.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
35,911	43	Woods/grass comb., Fair, HSG A
2,886	98	Paved parking, HSG A
38,797	47	Weighted Average
35,911	43	92.56% Pervious Area
2,886	98	7.44% Impervious Area

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

Subcatchment 16S: POST (7)



Summary for Subcatchment 18S: POST (5)

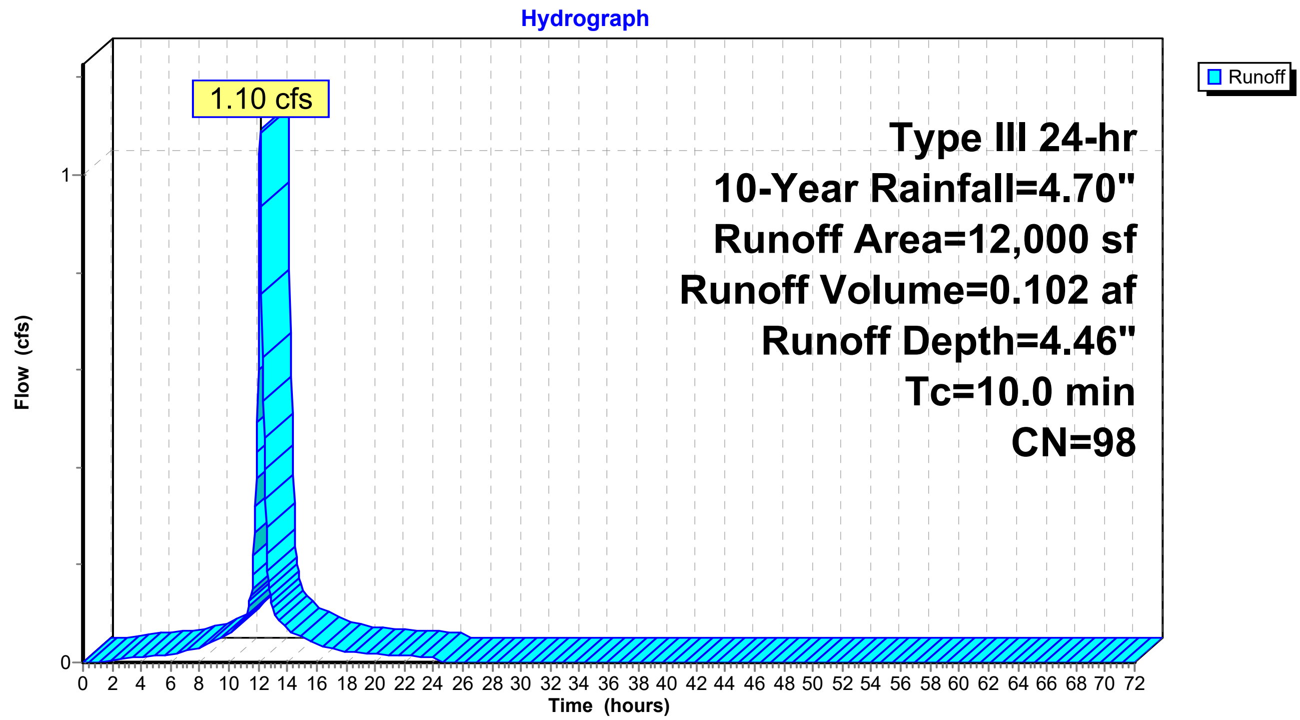
Runoff = 1.10 cfs @ 12.14 hrs, Volume= 0.102 af, Depth= 4.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
12,000	98	Roofs, HSG A
12,000	98	100.00% Impervious Area

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

Subcatchment 18S: POST (5)



Summary for Subcatchment 19S: POST (6)

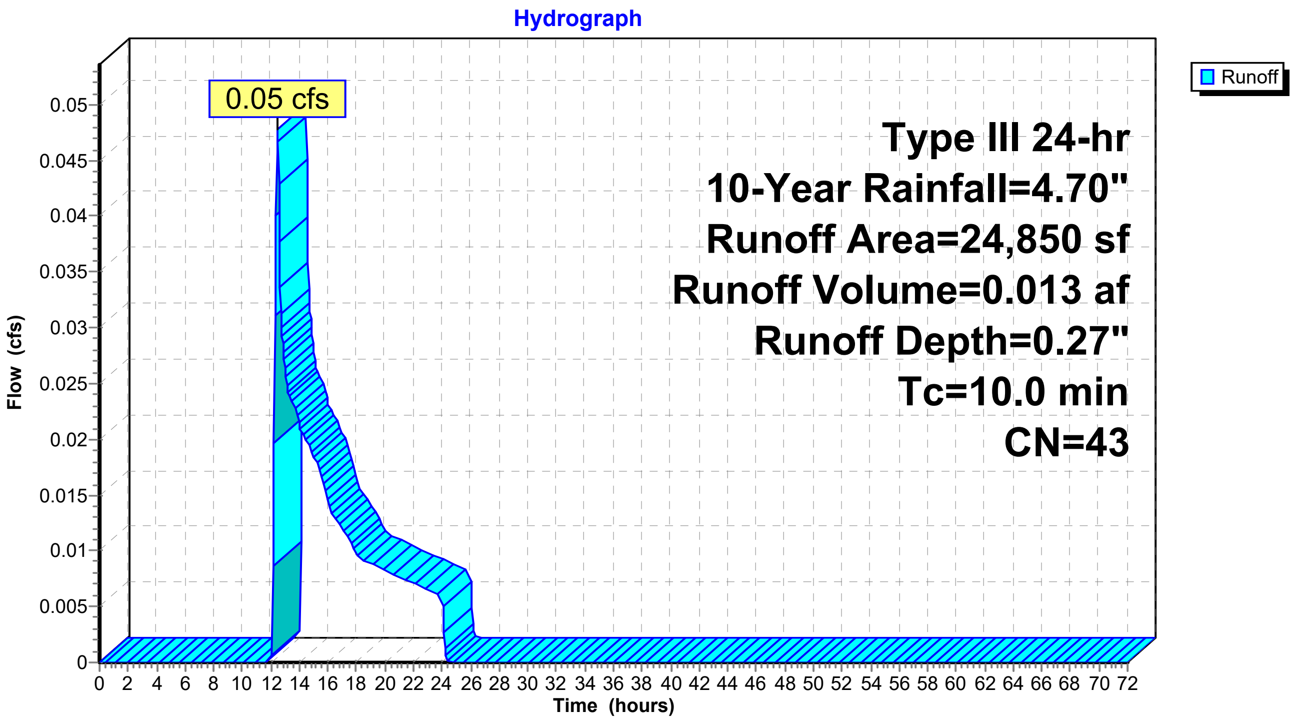
Runoff = 0.05 cfs @ 12.46 hrs, Volume= 0.013 af, Depth= 0.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
24,850	43	Woods/grass comb., Fair, HSG A
24,850	43	100.00% Pervious Area

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

Subcatchment 19S: POST (6)



Summary for Pond 17P: Pond

Inflow Area = 1.634 ac, 48.68% Impervious, Inflow Depth = 2.57" for 10-Year event
Inflow = 3.86 cfs @ 12.14 hrs, Volume= 0.350 af
Outflow = 0.53 cfs @ 12.82 hrs, Volume= 0.350 af, Atten= 86%, Lag= 41.2 min
Primary = 0.53 cfs @ 12.82 hrs, Volume= 0.350 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 79.64' @ 12.82 hrs Surf.Area= 2,773 sf Storage= 5,497 cf

Plug-Flow detention time= 91.7 min calculated for 0.350 af (100% of inflow)
Center-of-Mass det. time= 91.6 min (882.5 - 790.9)

Volume	Invert	Avail.Storage	Storage Description
#1	77.00'	13,641 cf	**Custom Stage Data (Irregular)**Listed below

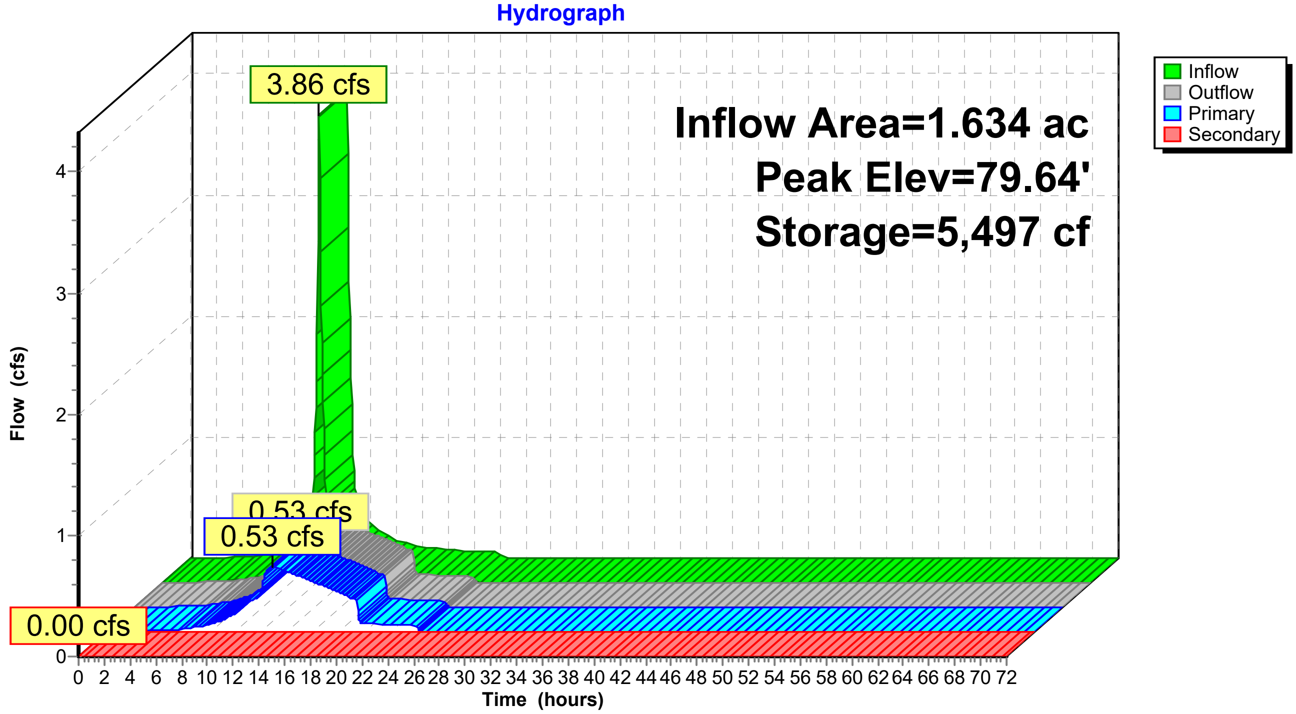
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
77.00	1,350	152.6	0	0	1,350
78.00	1,837	171.5	1,587	1,587	1,864
80.00	2,979	209.2	4,770	6,357	3,068
82.00	4,347	246.9	7,283	13,641	4,510

Device	Routing	Invert	Outlet Devices
#1	Primary	77.00'	**8.270 in/hr Exfiltration over Surface area**
#2	Secondary	80.25'	**0.5' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.53 cfs @ 12.82 hrs HW=79.64' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.53 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=77.00' (Free Discharge)
↑—**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 17P: Pond



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 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 11S: POST (1) Runoff Area=6,450 sf 0.00% Impervious Runoff Depth=0.54"
Tc=10.0 min CN=43 Runoff=0.04 cfs 0.007 af

Subcatchment 12S: POST (3) Runoff Area=14,288 sf 86.68% Impervious Runoff Depth=4.57"
Tc=10.0 min CN=91 Runoff=1.44 cfs 0.125 af

Subcatchment 13S: POST (4) Runoff Area=20,056 sf 51.23% Impervious Runoff Depth=4.35"
Tc=10.0 min CN=89 Runoff=1.96 cfs 0.167 af

Subcatchment 14S: POST (2) Runoff Area=26,373 sf 32.83% Impervious Runoff Depth=1.74"
Tc=10.0 min CN=61 Runoff=1.00 cfs 0.088 af

Subcatchment 16S: POST (7) Runoff Area=38,797 sf 7.44% Impervious Runoff Depth=0.77"
Tc=10.0 min CN=47 Runoff=0.42 cfs 0.057 af

Subcatchment 18S: POST (5) Runoff Area=12,000 sf 100.00% Impervious Runoff Depth=5.36"
Tc=10.0 min CN=98 Runoff=1.31 cfs 0.123 af

Subcatchment 19S: POST (6) Runoff Area=24,850 sf 0.00% Impervious Runoff Depth=0.54"
Tc=10.0 min CN=43 Runoff=0.14 cfs 0.026 af

Pond 17P: Pond Peak Elev=80.25' Storage=7,273 cf Inflow=4.78 cfs 0.440 af
Primary=0.60 cfs 0.440 af Secondary=0.00 cfs 0.000 af Outflow=0.60 cfs 0.440 af

Total Runoff Area = 3.279 ac Runoff Volume = 0.592 af Average Runoff Depth = 2.17"
67.65% Pervious = 2.218 ac 32.35% Impervious = 1.061 ac

Summary for Subcatchment 11S: POST (1)

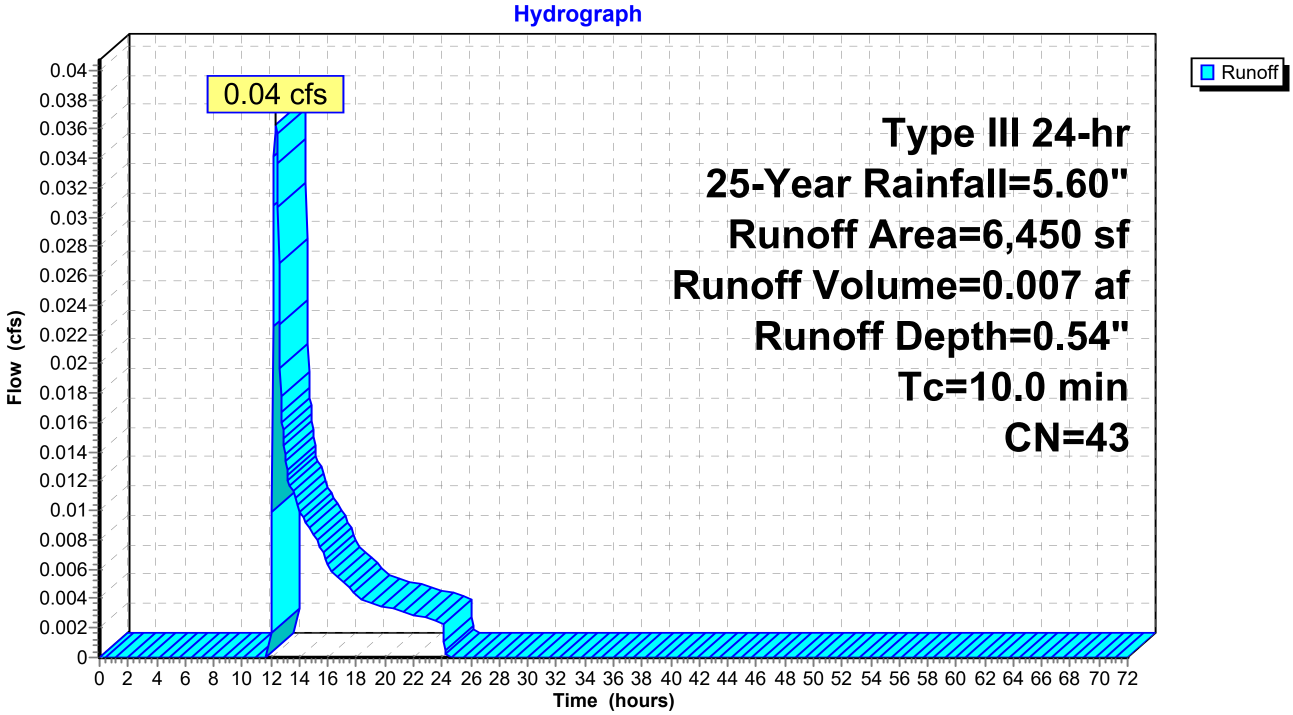
Runoff = 0.04 cfs @ 12.35 hrs, Volume= 0.007 af, Depth= 0.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
6,450	43	Woods/grass comb., Fair, HSG A
6,450	43	100.00% Pervious Area

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

Subcatchment 11S: POST (1)



Summary for Subcatchment 12S: POST (3)

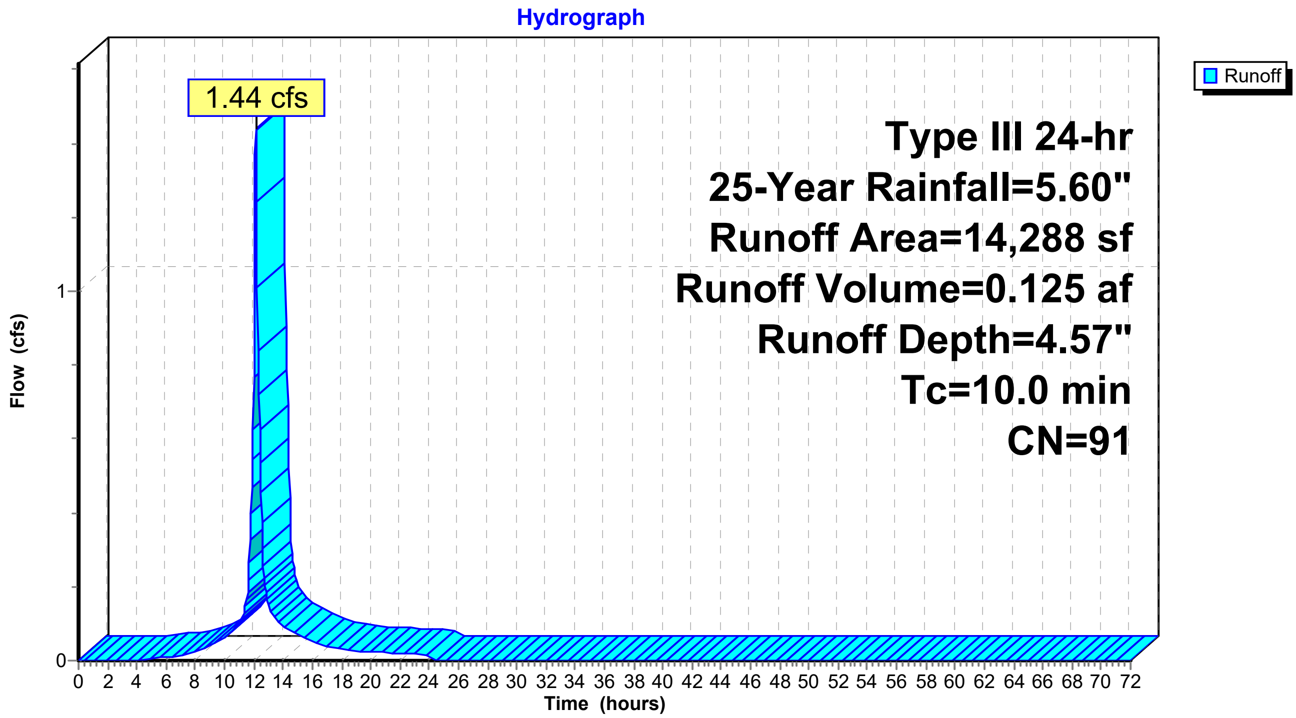
Runoff = 1.44 cfs @ 12.14 hrs, Volume= 0.125 af, Depth= 4.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
12,385	98	Paved parking, HSG A
1,903	43	Woods/grass comb., Fair, HSG A
14,288	91	Weighted Average
1,903	43	13.32% Pervious Area
12,385	98	86.68% Impervious Area

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

Subcatchment 12S: POST (3)



Summary for Subcatchment 13S: POST (4)

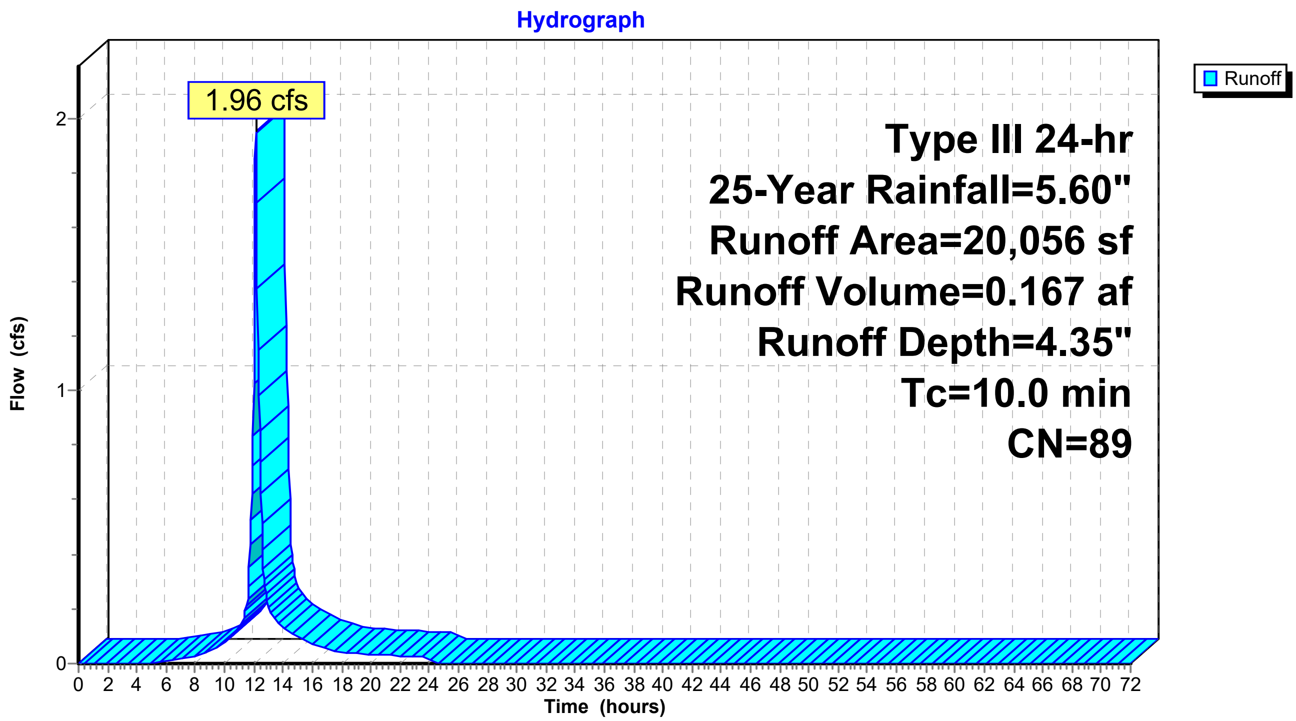
Runoff = 1.96 cfs @ 12.14 hrs, Volume= 0.167 af, Depth= 4.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
6,466	96	Gravel surface, HSG A
10,275	98	Paved parking, HSG A
3,315	49	50-75% Grass cover, Fair, HSG A
20,056	89	Weighted Average
9,781	80	48.77% Pervious Area
10,275	98	51.23% Impervious Area

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

Subcatchment 13S: POST (4)



Summary for Subcatchment 14S: POST (2)

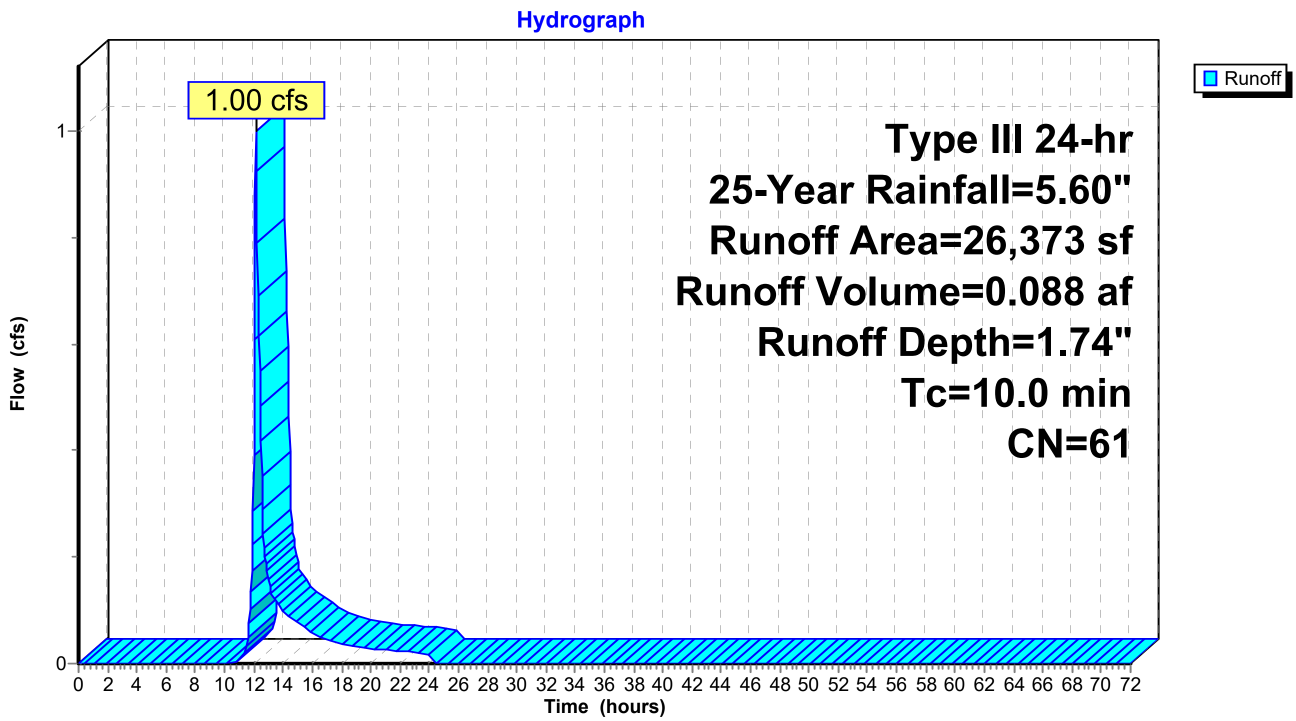
Runoff = 1.00 cfs @ 12.16 hrs, Volume= 0.088 af, Depth= 1.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
4,509	98	Roofs, HSG A
4,149	98	Paved parking, HSG A
17,715	43	Woods/grass comb., Fair, HSG A
26,373	61	Weighted Average
17,715	43	67.17% Pervious Area
8,658	98	32.83% Impervious Area

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

Subcatchment 14S: POST (2)



Summary for Subcatchment 16S: POST (7)

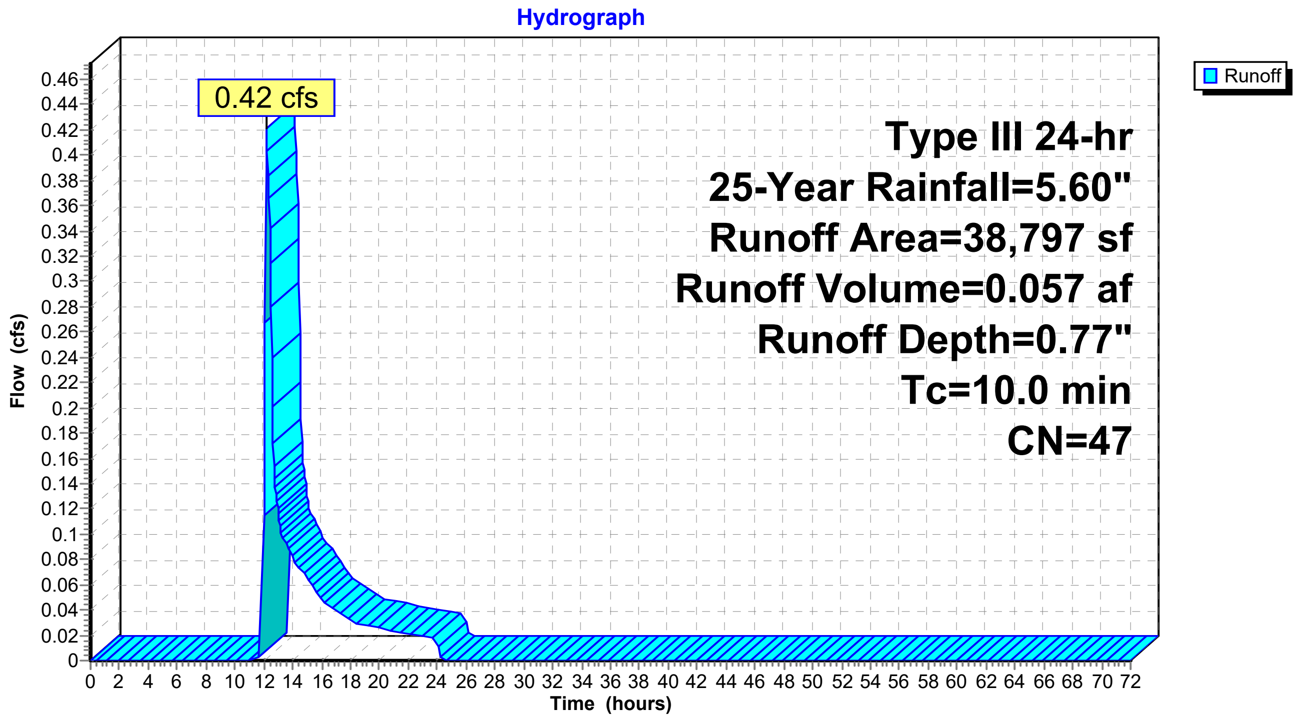
Runoff = 0.42 cfs @ 12.21 hrs, Volume= 0.057 af, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
35,911	43	Woods/grass comb., Fair, HSG A
2,886	98	Paved parking, HSG A
38,797	47	Weighted Average
35,911	43	92.56% Pervious Area
2,886	98	7.44% Impervious Area

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

Subcatchment 16S: POST (7)



Summary for Subcatchment 18S: POST (5)

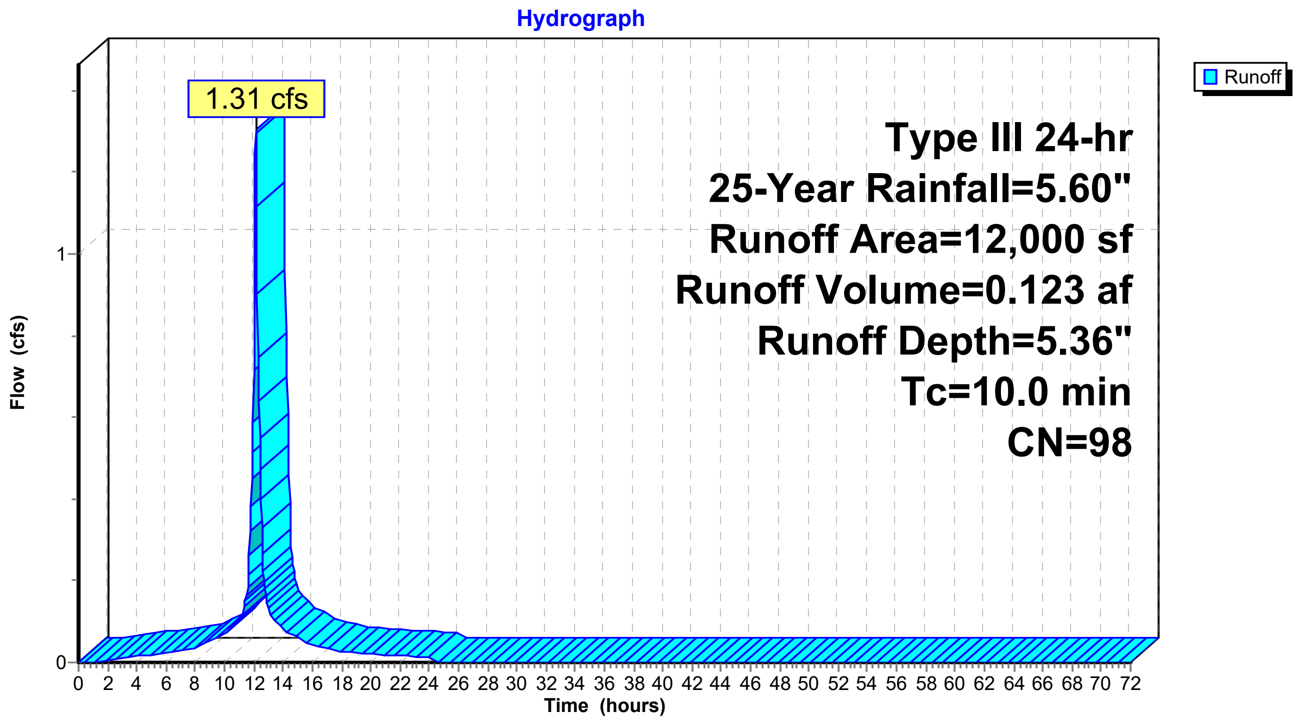
Runoff = 1.31 cfs @ 12.14 hrs, Volume= 0.123 af, Depth= 5.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
12,000	98	Roofs, HSG A
12,000	98	100.00% Impervious Area

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

Subcatchment 18S: POST (5)



Summary for Subcatchment 19S: POST (6)

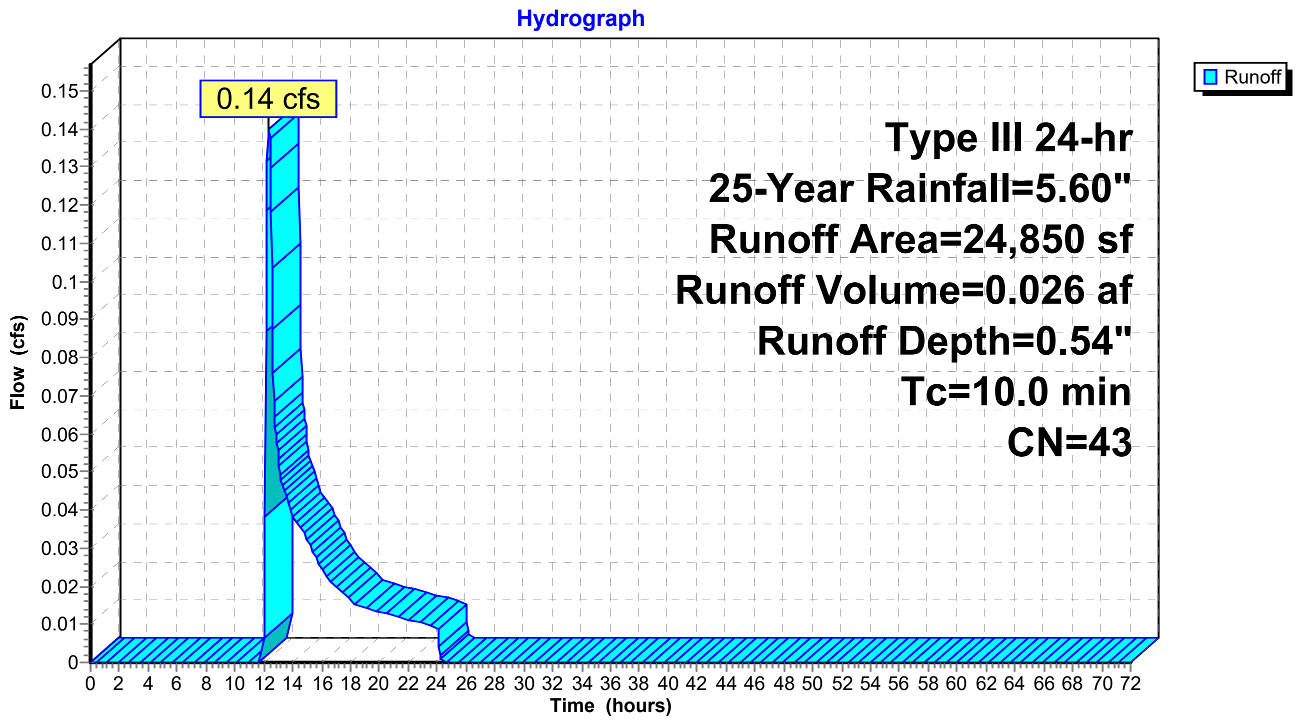
Runoff = 0.14 cfs @ 12.35 hrs, Volume= 0.026 af, Depth= 0.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (sf)	CN	Description
24,850	43	Woods/grass comb., Fair, HSG A
24,850	43	100.00% Pervious Area

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

Subcatchment 19S: POST (6)



Summary for Pond 17P: Pond

Inflow Area = 1.634 ac, 48.68% Impervious, Inflow Depth = 3.23" for 25-Year event
Inflow = 4.78 cfs @ 12.14 hrs, Volume= 0.440 af
Outflow = 0.60 cfs @ 12.92 hrs, Volume= 0.440 af, Atten= 87%, Lag= 46.9 min
Primary = 0.60 cfs @ 12.92 hrs, Volume= 0.440 af
Secondary = 0.00 cfs @ 12.92 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 80.25' @ 12.92 hrs Surf.Area= 3,151 sf Storage= 7,273 cf

Plug-Flow detention time= 112.7 min calculated for 0.440 af (100% of inflow)
Center-of-Mass det. time= 112.6 min (901.1 - 788.4)

Volume	Invert	Avail.Storage	Storage Description
#1	77.00'	13,641 cf	**Custom Stage Data (Irregular)**Listed below

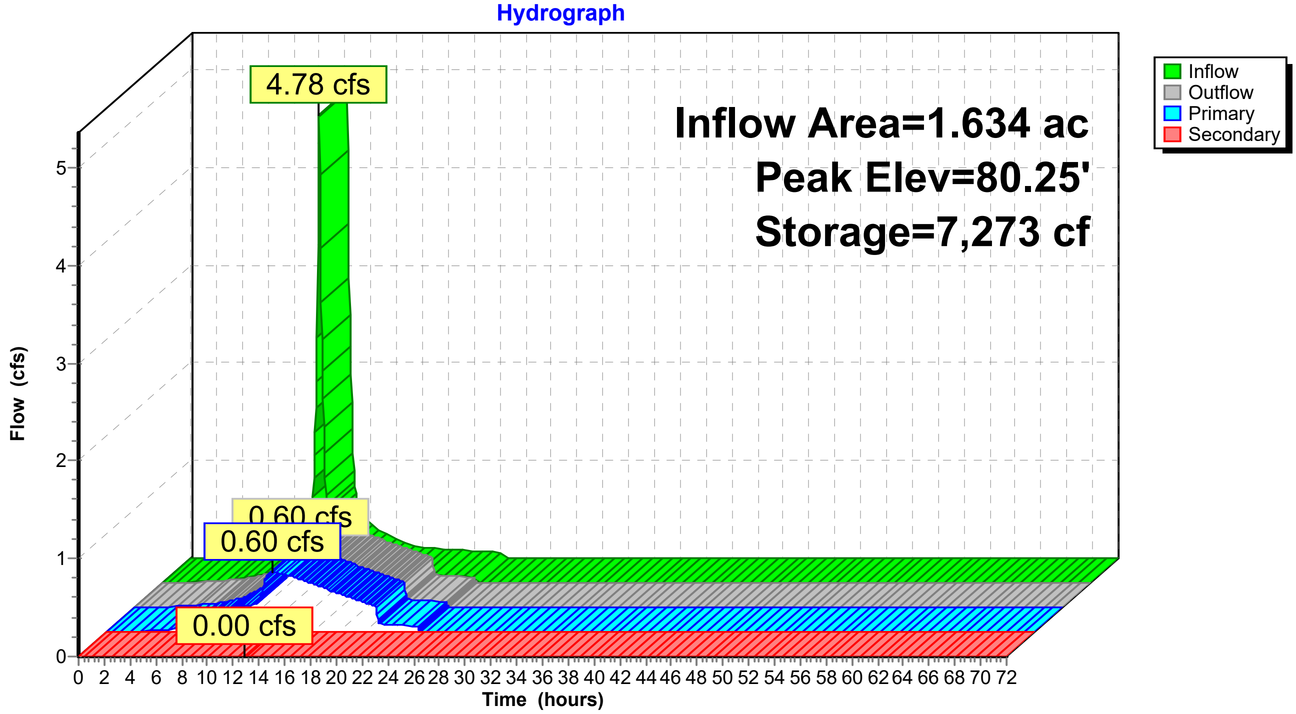
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
77.00	1,350	152.6	0	0	1,350
78.00	1,837	171.5	1,587	1,587	1,864
80.00	2,979	209.2	4,770	6,357	3,068
82.00	4,347	246.9	7,283	13,641	4,510

Device	Routing	Invert	Outlet Devices
#1	Primary	77.00'	**8.270 in/hr Exfiltration over Surface area**
#2	Secondary	80.25'	**0.5' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.60 cfs @ 12.92 hrs HW=80.25' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.60 cfs)

Secondary OutFlow Max=0.00 cfs @ 12.92 hrs HW=80.25' (Free Discharge)
└─**2=Sharp-Crested Rectangular Weir** (Weir Controls 0.00 cfs @ 0.11 fps)

Pond 17P: Pond



Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 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 11S: POST (1) Runoff Area=6,450 sf 0.00% Impervious Runoff Depth=1.07"
Tc=10.0 min CN=43 Runoff=0.11 cfs 0.013 af

Subcatchment 12S: POST (3) Runoff Area=14,288 sf 86.68% Impervious Runoff Depth=5.94"
Tc=10.0 min CN=91 Runoff=1.85 cfs 0.162 af

Subcatchment 13S: POST (4) Runoff Area=20,056 sf 51.23% Impervious Runoff Depth=5.71"
Tc=10.0 min CN=89 Runoff=2.53 cfs 0.219 af

Subcatchment 14S: POST (2) Runoff Area=26,373 sf 32.83% Impervious Runoff Depth=2.70"
Tc=10.0 min CN=61 Runoff=1.61 cfs 0.136 af

Subcatchment 16S: POST (7) Runoff Area=38,797 sf 7.44% Impervious Runoff Depth=1.41"
Tc=10.0 min CN=47 Runoff=1.02 cfs 0.104 af

Subcatchment 18S: POST (5) Runoff Area=12,000 sf 100.00% Impervious Runoff Depth=6.76"
Tc=10.0 min CN=98 Runoff=1.64 cfs 0.155 af

Subcatchment 19S: POST (6) Runoff Area=24,850 sf 0.00% Impervious Runoff Depth=1.07"
Tc=10.0 min CN=43 Runoff=0.42 cfs 0.051 af

Pond 17P: Pond Peak Elev=80.88' Storage=9,546 cf Inflow=6.40 cfs 0.588 af
Primary=0.68 cfs 0.533 af Secondary=0.61 cfs 0.054 af Outflow=1.29 cfs 0.588 af

Total Runoff Area = 3.279 ac Runoff Volume = 0.841 af Average Runoff Depth = 3.08"
67.65% Pervious = 2.218 ac 32.35% Impervious = 1.061 ac

Summary for Subcatchment 11S: POST (1)

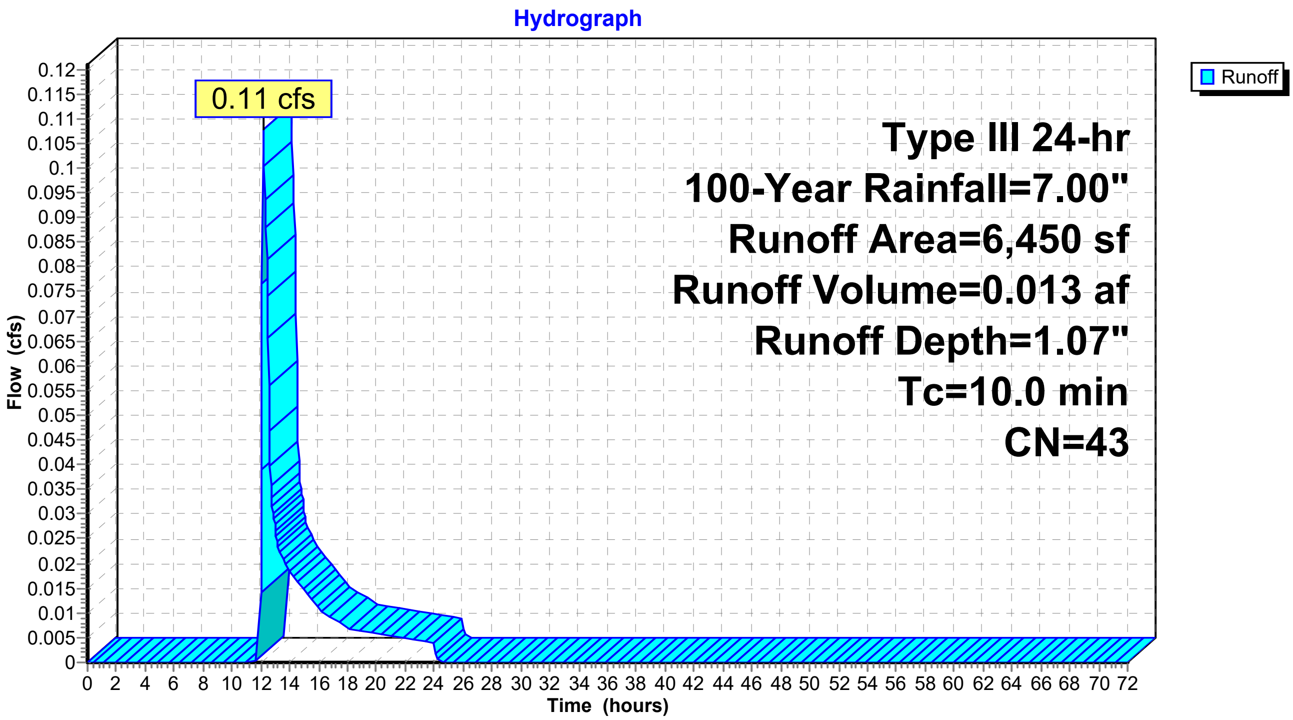
Runoff = 0.11 cfs @ 12.19 hrs, Volume= 0.013 af, Depth= 1.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (sf)	CN	Description
6,450	43	Woods/grass comb., Fair, HSG A
6,450	43	100.00% Pervious Area

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

Subcatchment 11S: POST (1)



Summary for Subcatchment 12S: POST (3)

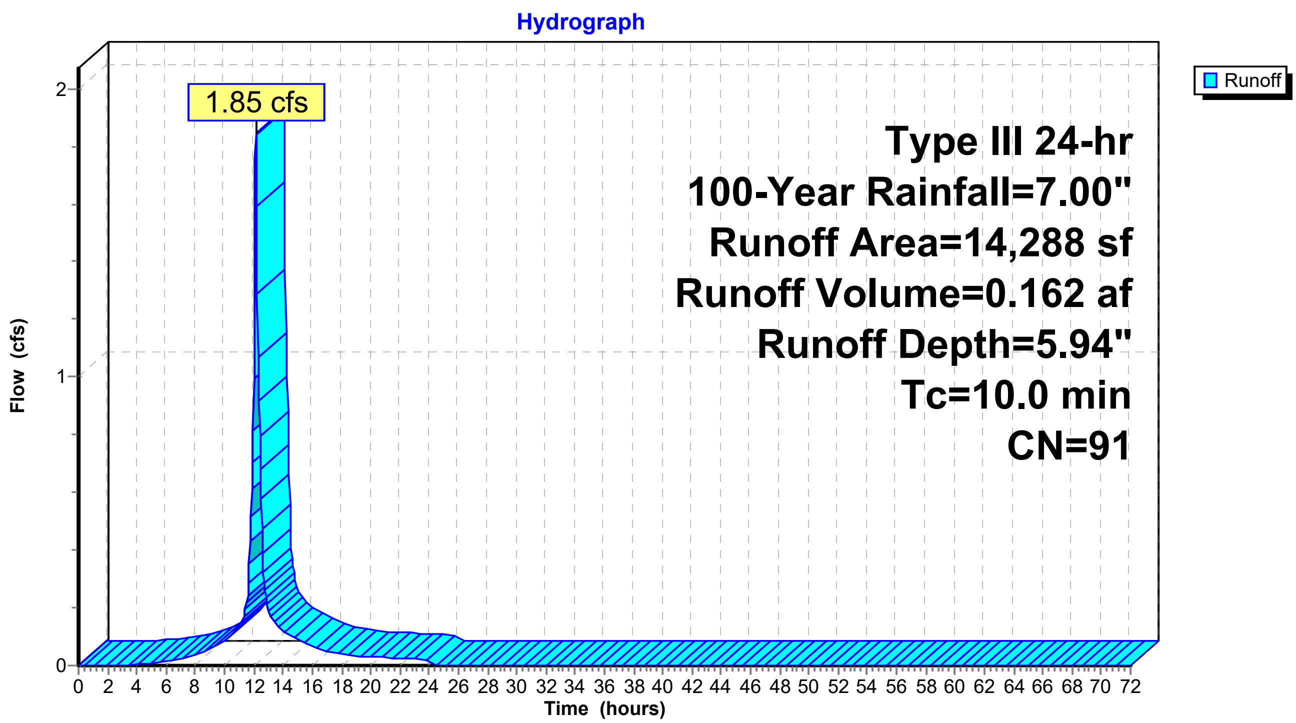
Runoff = 1.85 cfs @ 12.14 hrs, Volume= 0.162 af, Depth= 5.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (sf)	CN	Description
12,385	98	Paved parking, HSG A
1,903	43	Woods/grass comb., Fair, HSG A
14,288	91	Weighted Average
1,903	43	13.32% Pervious Area
12,385	98	86.68% Impervious Area

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

Subcatchment 12S: POST (3)



Summary for Subcatchment 13S: POST (4)

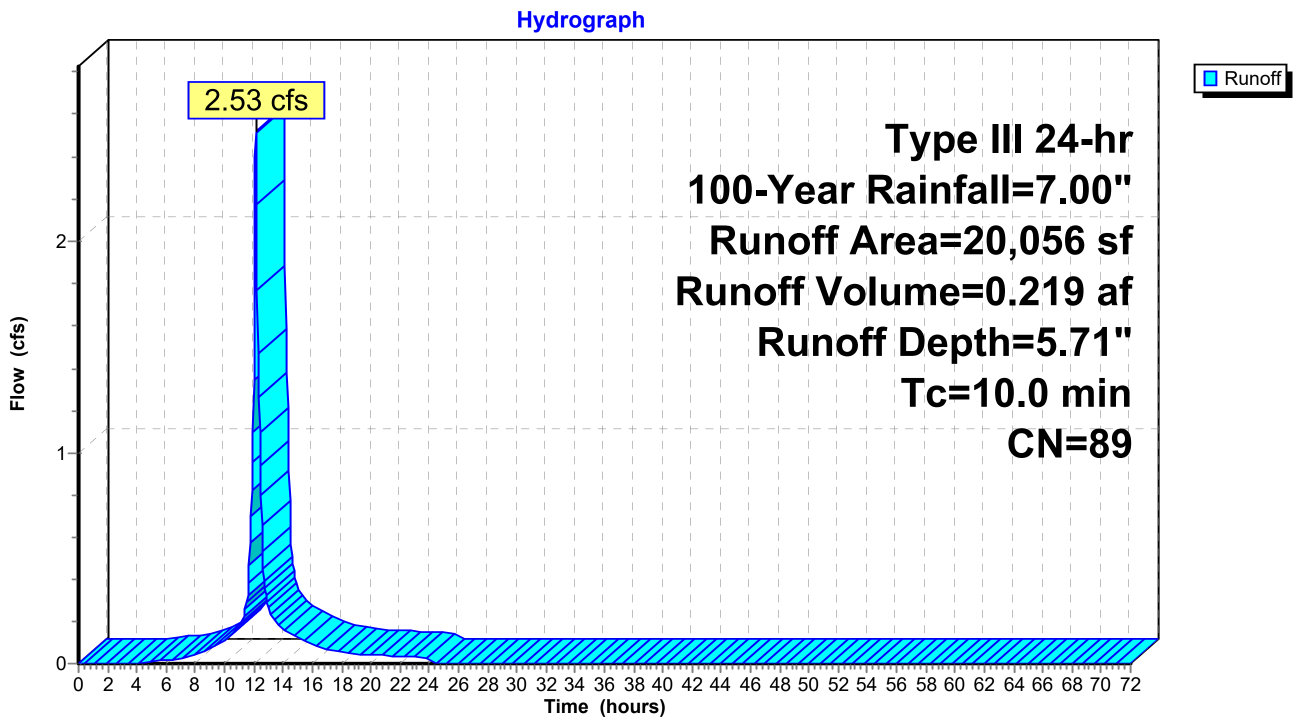
Runoff = 2.53 cfs @ 12.14 hrs, Volume= 0.219 af, Depth= 5.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (sf)	CN	Description
6,466	96	Gravel surface, HSG A
10,275	98	Paved parking, HSG A
3,315	49	50-75% Grass cover, Fair, HSG A
20,056	89	Weighted Average
9,781	80	48.77% Pervious Area
10,275	98	51.23% Impervious Area

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

Subcatchment 13S: POST (4)



Summary for Subcatchment 14S: POST (2)

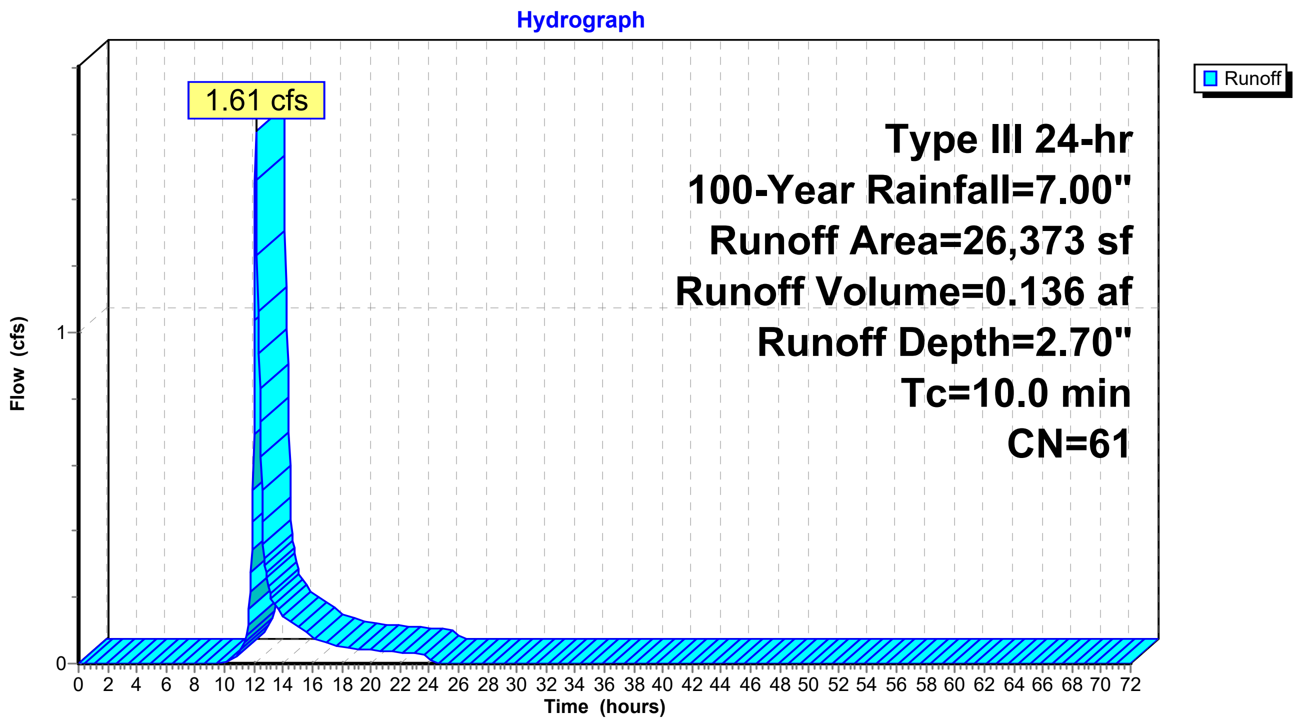
Runoff = 1.61 cfs @ 12.15 hrs, Volume= 0.136 af, Depth= 2.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (sf)	CN	Description
4,509	98	Roofs, HSG A
4,149	98	Paved parking, HSG A
17,715	43	Woods/grass comb., Fair, HSG A
26,373	61	Weighted Average
17,715	43	67.17% Pervious Area
8,658	98	32.83% Impervious Area

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

Subcatchment 14S: POST (2)



Summary for Subcatchment 16S: POST (7)

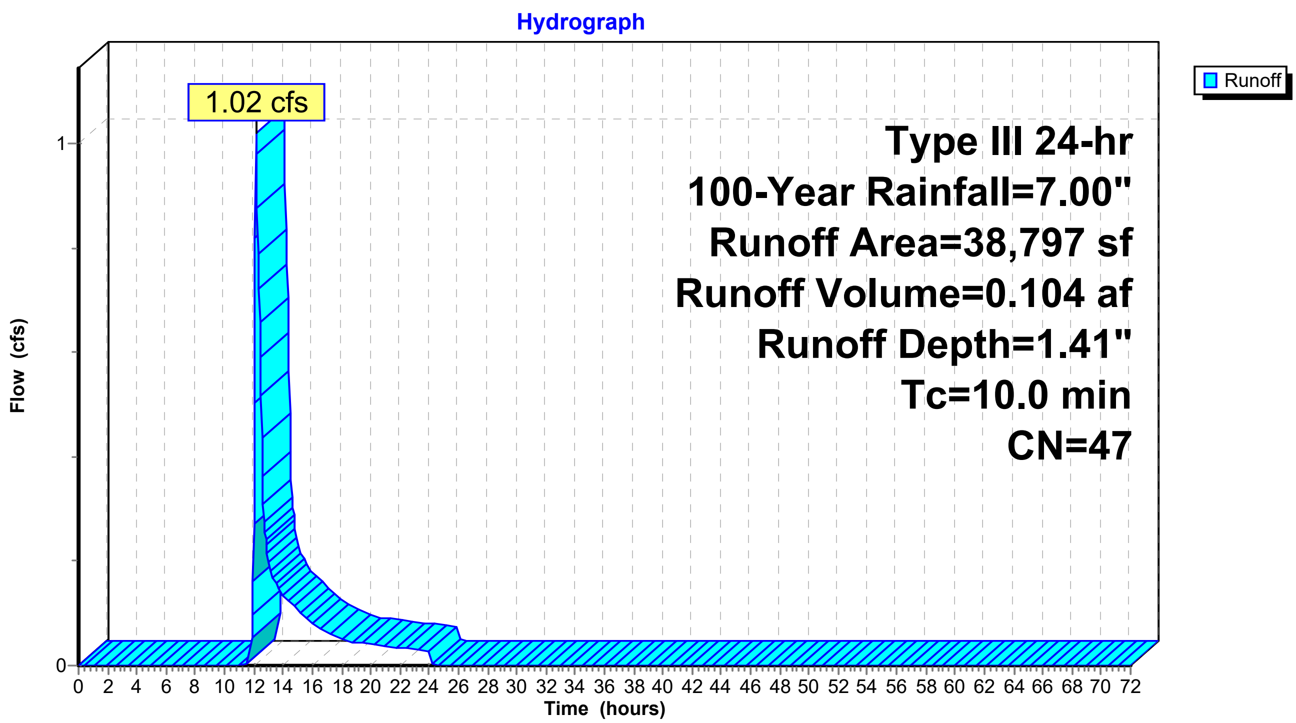
Runoff = 1.02 cfs @ 12.17 hrs, Volume= 0.104 af, Depth= 1.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (sf)	CN	Description
35,911	43	Woods/grass comb., Fair, HSG A
2,886	98	Paved parking, HSG A
38,797	47	Weighted Average
35,911	43	92.56% Pervious Area
2,886	98	7.44% Impervious Area

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

Subcatchment 16S: POST (7)



Summary for Subcatchment 18S: POST (5)

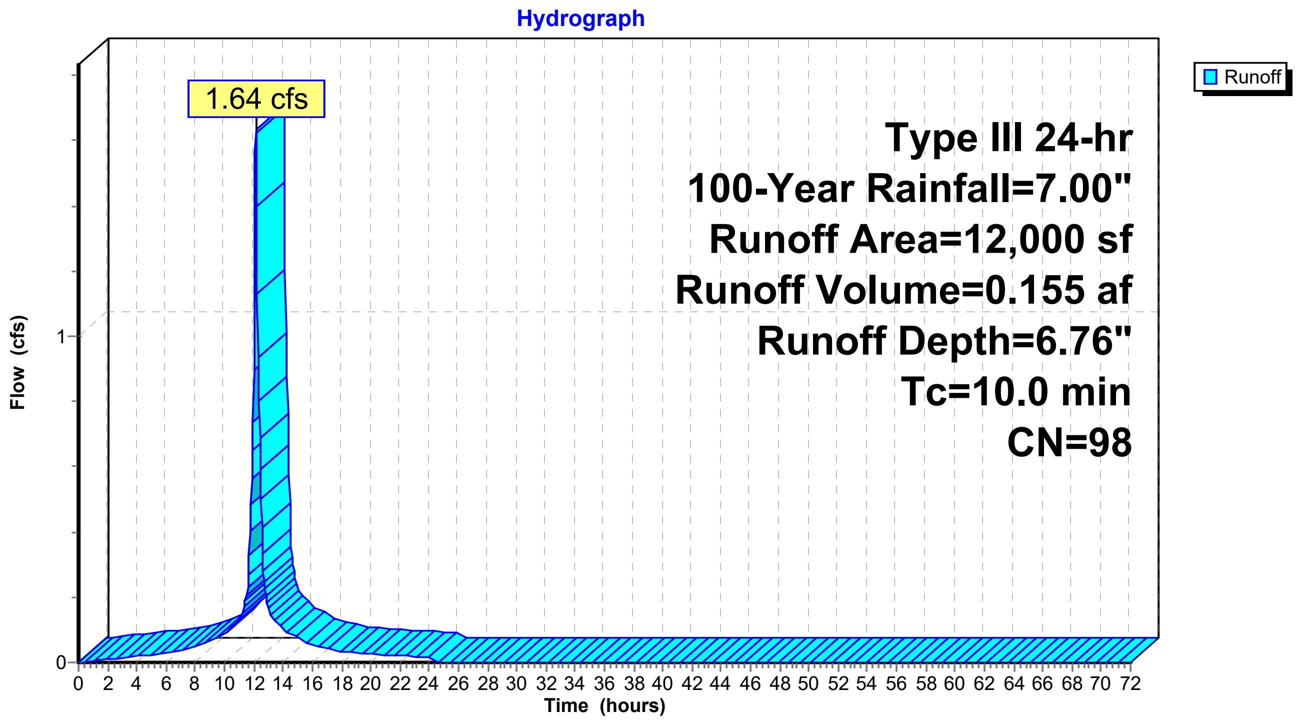
Runoff = 1.64 cfs @ 12.14 hrs, Volume= 0.155 af, Depth= 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (sf)	CN	Description
12,000	98	Roofs, HSG A
12,000	98	100.00% Impervious Area

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

Subcatchment 18S: POST (5)



Summary for Subcatchment 19S: POST (6)

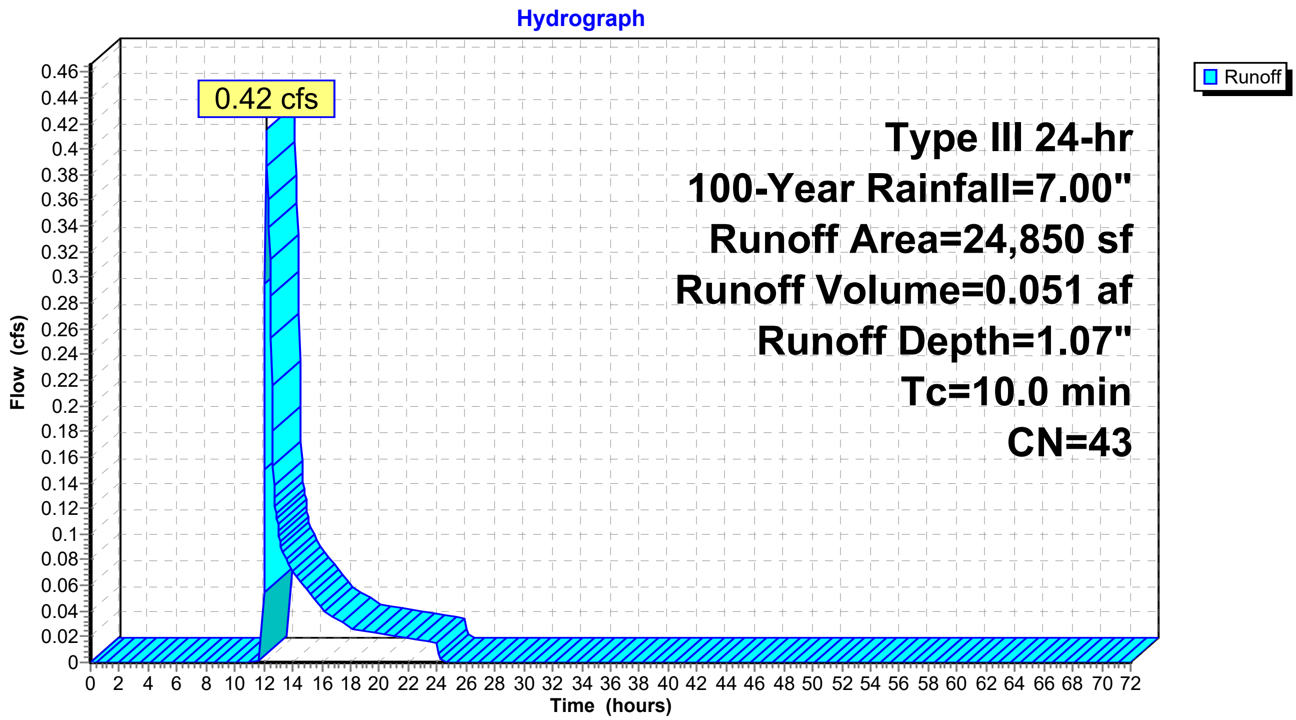
Runoff = 0.42 cfs @ 12.19 hrs, Volume= 0.051 af, Depth= 1.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (sf)	CN	Description
24,850	43	Woods/grass comb., Fair, HSG A
24,850	43	100.00% Pervious Area

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

Subcatchment 19S: POST (6)



Summary for Pond 17P: Pond

Inflow Area = 1.634 ac, 48.68% Impervious, Inflow Depth = 4.31" for 100-Year event
Inflow = 6.40 cfs @ 12.14 hrs, Volume= 0.588 af
Outflow = 1.29 cfs @ 12.63 hrs, Volume= 0.588 af, Atten= 80%, Lag= 29.5 min
Primary = 0.68 cfs @ 12.63 hrs, Volume= 0.533 af
Secondary = 0.61 cfs @ 12.63 hrs, Volume= 0.054 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 80.88' @ 12.63 hrs Surf.Area= 3,578 sf Storage= 9,546 cf

Plug-Flow detention time= 116.1 min calculated for 0.588 af (100% of inflow)
Center-of-Mass det. time= 116.0 min (901.3 - 785.3)

Volume	Invert	Avail.Storage	Storage Description
#1	77.00'	13,641 cf	**Custom Stage Data (Irregular)**Listed below

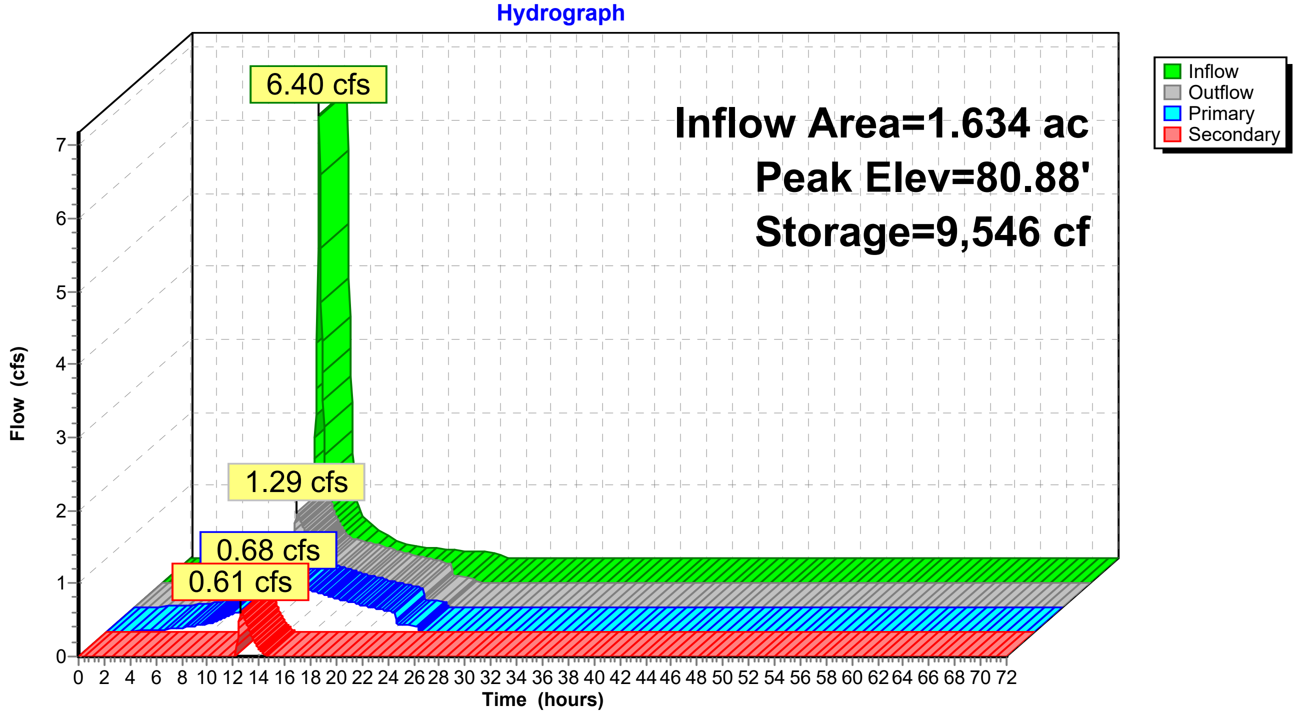
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
77.00	1,350	152.6	0	0	1,350
78.00	1,837	171.5	1,587	1,587	1,864
80.00	2,979	209.2	4,770	6,357	3,068
82.00	4,347	246.9	7,283	13,641	4,510

Device	Routing	Invert	Outlet Devices
#1	Primary	77.00'	**8.270 in/hr Exfiltration over Surface area**
#2	Secondary	80.25'	**0.5' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.68 cfs @ 12.63 hrs HW=80.87' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.68 cfs)

Secondary OutFlow Max=0.61 cfs @ 12.63 hrs HW=80.87' (Free Discharge)
↑—**2=Sharp-Crested Rectangular Weir** (Weir Controls 0.61 cfs @ 2.58 fps)

Pond 17P: Pond



Section II
Stormwater Compliance

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

Checklist for Stormwater Report

A. Introduction

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

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

The Stormwater Report must include:

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

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

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

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

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[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.

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

Signature and Date

Checklist

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

- [x] 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:

- [x] 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

- [x] 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 (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

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.

- ♦ **Standard 1: No New Untreated Discharges**

The proposed development proposes no new stormwater conveyances that discharge untreated stormwater off-site or cause down gradient erosion.

- ♦ **Standard 2: Peak Rate Attenuation**

The overall site analysis demonstrates that the stormwater management system has been designed so that the post-development peak discharge rates do not exceed the pre-development discharge rate for the 2-year, 10-year, 25-year & 100-year 24-hour storm events.

- ♦ **Standard 3: Recharge**

Required Recharge Volume

R_v = *F x Total Impervious Area*
The site is comprised of Group A Soils
F (Target Depth Factor) = 0.60"

Infiltration Basin: R_v = 0.60" x 1'/12" x 29,126 SF = 1,456.3 CF

Design Recharge Volume

Infiltration Basin = 6,408.9 CF (Volume below outlet)

Drawdown Within 72 Hours

$$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ Area)}$$

Where:
Rv = Storage Volume (required recharge volume)
K = Saturated Hydraulic Conductivity For "Static" and "Simple Dynamic" Methods, use Rawls Rate (see Table 2.3.3). For "Dynamic Field" Method, use 50% of the in-situ saturated hydraulic conductivity.
Bottom Area = Bottom Area of Recharge Structure

Infiltration Basin: $Time_{drawdown} = \frac{1,456.3CF}{(8.27")(1'/12")(1350SF)}$ = 1.56 hours < 72 hours

Mounding Analysis

"Mounding analysis is required when the vertical separation from the bottom of an exfiltration system to seasonal high groundwater is less than four (4) feet and the recharge system is proposed to attenuate the peak discharge from a 10-year or higher 24-hour storm (e.g., 10-year, 25-year, 50-year, or 100-year 24-hour storm). In such cases, the mounding analysis must demonstrate that the Required Recharge Volume (e.g., infiltration basin storage) is fully dewatered within 72 hours (so the next storm can be stored for exfiltration). The mounding analysis must also show that the groundwater mound that forms under the recharge system will not break out above the land or water surface of a wetland (e.g., it doesn't increase the water sheet elevation in a Bordering Vegetated Wetland, Salt Marsh, or Land Under Water within the 72-hour evaluation period)."

"The Hantush[1] or other equivalent method may be used to conduct the mounding analysis. The Hantush method predicts the maximum height of the groundwater mound beneath a rectangular or circular recharge area. It assumes unconfined groundwater flow, and that a linear relation exists between the water table elevation and water table decline rate. It results in a water table recession hydrograph depicting exponential decline. The Hantush method is available in proprietary software and free on-line calculators on theWeb in automated format. If the analysis indicates the mound will prevent the infiltration BMP from fully draining within the 72-hour period, an iterative process must be employed to determine an alternative design that drains within the 72-hour period."

A mounding calculation is not required since groundwater is greater than four feet below the bottom of the basin.

♦ Standard 4: Water Quality

<u>Water Quality Treatment Volume</u>

$V_{WQ} = D_{WQ} \times A_{IMP}$

D_{WQ} = *Water Quality Depth*: **one-inch** for land use with a higher potential pollutant load, within an area with an **infiltration rate greater than 2.4 inches per hour**, within a Zone II or Interim Wellhead Protection Area, or near or to another critical area; one-half-inch for all other areas.

A_{IMP} = *Impervious Area*

D_{WQ} = 1"

Infiltration Basin: V_{WQ} = 1"(1'/12") x 29,126 SF = 2,427.2 CF

Total Required = 2,427.2 CF
Total Proposed = 6,408.9 CF

[1] Hantush 1967 – See Reference for Standard 3.

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

Version 1, Automated: Mar. 4, 2008

TSS Removal Calculation Worksheet

Location: Infiltration Basin - Pretreatment

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Sediment Forebay	0.25	0.75	0.19	0.56
	0.00	0.56	0.00	0.56
	0.00	0.56	0.00	0.56
	0.00	0.56	0.00	0.56

Total TSS Removal = 44%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 737 Washington St., Pembroke
Prepared By: Grady Consulting LLC
Date: 12/6/2019

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

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

Mass. Dept. of Environmental Protection

Version 1, Automated: Mar. 4, 2008

TSS Removal Calculation Worksheet

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

Location: Infiltration Basin

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Sediment Forebay	**0.25**	**0.75**	**0.19**	**0.56**
Infiltration Basin	**0.80**	**0.56**	**0.45**	**0.11**
	0.00	**0.11**	**0.00**	**0.11**
	0.00	**0.11**	**0.00**	**0.11**

Total TSS Removal = 89%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **737 Washington St., Pembroke**
Prepared By: **Grady Consulting LLC**
Date: **12/6/2019**

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

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

Mass. Dept. of Environmental Protection

- **Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLS)**
  The site is not a land use with higher potential pollutant loads.

- **Standard 6: Critical Areas**
  The site is not located within an aquifer protection Zone II or Interim Wellhead Protection Area.

- **Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable**
  The project is not a redevelopment project.

- **Standard 8: Construction Period Pollution Prevention and Erosion and Sediment Control Plan**
  Erosion and sediment controls are detailed within the site plan.

- **Standard 9: Operation and Maintenance Plan**
  See O&M plan attached hereto.

- **Standard 10: Prohibition of Illicit Discharges**
  "All illicit discharges to the stormwater management system are prohibited."

  This statement is intended to meet Standard #10 of the Stormwater Management requirements

  Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater.

  Except for the potential for deliberate criminal act of discharge by an unauthorized entity for which the property owner has no control, there are to be no illicit discharges into the stormwater system.

____
Applicant\Owner

Section III

Operation & Maintenance

OPERATION AND MAINTENANCE PLAN

PROPOSED DRAINAGE SYSTEM – DURING CONSTRUCTION

737 Washington Street
Pembroke, Massachusetts

Owner:
Rose Realty Trust
55 Redwood Circle
Mashpee, MA 02649
Contact: David Spurling 781-826-9511 david@eiproducts.net

Party Responsible for Operation and Maintenance:
Rose Realty Trust
55 Redwood Circle
Mashpee, MA 02649
Contact: David Spurling 781-826-9511 david@eiproducts.net

Source of Funding:

Operation and Maintenance of this stormwater management system will be the responsibility of the property owner to include its successor and/or assigns, as the same may appear on record with the appropriate register of deeds.

During Construction:

During periods of active construction the stormwater management system shall be inspected on a weekly basis and within 24 hours of a storm event of greater than ½". Maintenance tasks shall be performed monthly or after significant rainfall events of 1" of rain or greater. During construction, silt-laden runoff shall be prevented from entering the drainage system and off-site properties. Temporary swales shall be constructed as needed during construction to direct runoff to sediment traps. Infiltration systems shall not be placed in service until after the installation of base course pavement and vegetative stabilization of the areas contributing to the systems.

During dewatering operations, all water pumped from the dewatering shall be directed to a "dirt bag" pumped sediment removal system (or approved equal) as manufactured by ACF Environmental. The unit shall be placed on a crushed stone blanket. Disposal of such "dirt bag" shall occur when the device is full and can no longer effectively filter sediment or allow water to pass at a reasonable flow rate. Disposal of this unit shall be the responsibility of the contractor and shall be as directed by the owner in accordance with applicable local, state, and federal guidelines and regulations.

Stabilized construction entrances shall be placed at the entrances and shall consist of 1½" to 2" stone and be constructed as shown on the approved plans.

All erosion and sedimentation control measures shall be in place prior to the commencement of any site work or earthwork operations, and shall be maintained during construction, and shall remain in place until all site work is complete and ground cover is established.

Heavy equipment shall not be used on basin bottoms.

All exposed soils not to be paved shall be stabilized as soon as practical. Seed mixes shall only be applied during appropriate periods as recommended by the seed supplier, typically May 1 to October 15. Any exposed soils that cannot be stabilized by vegetation during these dates shall be stabilized with hay bales, hay mulch, check dams, jute netting or other acceptable means.

Once each structure is in place, it should be maintained in accordance with the procedures described in the post-construction Operations and Maintenance Plan.

During dry periods where dust is created by construction activities the following control measures should be implemented.

- Sprinkling – The contractor may sprinkle the ground along haul roads and traffic areas until moist.
- Vegetative cover – Areas that are not expected to be disturbed regularly may be stabilized with vegetative cover.
- Mulch – Mulching can be used as a quick and effective means of dust control in recently disturbed areas.
- Spray on chemical soil treatments may be utilized. Application rates shall conform to manufacturers recommendations.

For additional information, refer to Performance, Standards and Guidelines for Stormwater Management in Massachusetts, published by the Department of Environmental Protection.

STORMWATER MANAGEMENT
BEST MANAGEMENT PRACTICES
INSPECTION SCHEDULE AND EVALUATION CHECKLIST – CONSTRUCTION PHASE

PROJECT LOCATION: 737 Washington Street, Pembroke
Latest Revision: 1/24/20

Stormwater Control Manager: _____ **Stamp**

Best Management Practice	Inspection Frequency (1)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/ Repair Needed yes/no List items	Date of Cleaning/Repair	Performed By	Water Level in Detention System
Silt socks & swales and silt traps	After every major storm event							
Dewatering Operations	Daily- during actual dewatering							
Temporary Construction Entrance	Daily or as needed.							

(1) Refer to the Massachusetts Stormwater Management, Volume Two: Stormwater Technical Handbook for recommendations regarding frequency for inspection and maintenance of specific BMPs.

Limited or no use of sodium chloride salts, fertilizers or pesticides recommended. Slow release fertilizer recommended.
Other notes:(Include deviations from: Con Com Order of Conditions, PB Approval, Construction Sequence and Approved Plan)

OPERATION AND MAINTENANCE PLAN
PROPOSED DRAINAGE SYSTEM – POST CONSTRUCTION
737 Washington Street
Pembroke, Massachusetts

Owner:
Rose Realty Trust
55 Redwood Circle
Mashpee, MA 02649
Contact: David Spurling 781-826-9511 david@eiproducts.net

Party Responsible for Operation and Maintenance:

After construction is complete the owner will be the party responsible for operation and maintenance of the drainage system. When the property is conveyed, the new owner will be the party responsible for operation and maintenance.

Source of Funding:

Operation and Maintenance of this stormwater management system will be the responsibility of the owner. The estimated annual budget for the operation and maintenance of the stormwater system is $500.

Schedule for Inspection and Maintenance:

Deep Sump Catch Basins
Deep sump catch basins shall become part of the roadway system and shall be inspected after every major storm event during construction and cleaned when sediment exceeds 18” depth. After construction when all slopes have been stabilized, basins shall be cleaned a minimum of twice per year. Disposal of the accumulated sediment shall be in accordance with applicable local, state, and federal guidelines and regulations.

Sediment Forebays (at grade)
At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational. When mowing grasses, keep the grass height lower than 6 inches, check for signs of riling and gullying and repair as needed. After removing sediment, replace any vegetation damaged during the clean-out by re-seeding or sodding. When re-seeding, incorporate practices such as hydro seeding with a tackifier, blanket or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

Any sediment removed from the infiltration systems should be disposed of in accordance with Town, State and Federal Regulations.

Infiltration Basin
The Infiltration BMP’s should be inspected on a quarterly basis: additional inspections should be scheduled during the first few months to make sure the vegetation is established adequately and also following major storm events. Additional inspections are required following any storm event that exceeds 2.5 inches in 24-hour period (the one-year frequency storm). Evidence of standing water for more than 48 hours following a storm would indicate possible failure of the infiltration surface. In that case, a qualified professional engineer should be retained to assess the

cause of failure and recommend corrective action, which should be immediately implemented to restore the function of the system. The basin should be inspected for slope integrity, soil moisture, vegetative health, soil stability, soil compaction, soil erosion, ponding and sedimentation. The basin should be mowed twice per year.

Regular maintenance tasks include mowing, watering, and weed and pest control. Only organic fertilizers, weed and pest control will be utilized.

Sediment and debris should be removed manually, at least twice per year, before the vegetation is impacted adversely. Periodic mowing (Twice per year) may be required to maintain the dense growth of vegetation. Care should be taken to protect basin from snow removal procedures and off street parking.

Lawn Fertilization

Lawn fertilizer shall be slow release and limited to 3 lbs per 1000 s.f. per year.

Stormwater Contamination Prevention

Exterior storage of hazardous materials including deicing chemicals, fertilizers, herbicides, pesticides, and other hazardous materials is prohibited. All hazardous materials are to be stored inside of the buildings no exterior storage of hazardous materials is allowed. Individual storage unit users shall be notified of the prohibition of illicit discharges to the stormwater management system.

Illicit Discharges

Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater. Illicit discharges are prohibited from the stormwater management system and the stormwater management system shall be inspected for illicit discharges annually.

The following is a list of discharges that are allowed under the EPA Construction General Permit (CGP) provided that appropriate stormwater controls are designed, installed, and maintained:
a. Stormwater discharges, including stormwater runoff, snowmelt runoff, and surface runoff and drainage, associated with construction activity under 40 CFR §122.26(b)(14) or § 122.26(b)(15)(i);
b. Stormwater discharges designated by EPA as needing a permit under 40 CFR § 122.26(a)(1)(v) or §122.26(b)(15)(ii);
c. Stormwater discharges from construction support activities *(e.g., concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, borrow areas)* provided:
i. The support activity is directly related to the construction site required to have permit coverage for stormwater discharges;
ii. The support activity is not a commercial operation, nor does it serve multiple unrelated construction projects;
iii. The support activity does not continue to operate beyond the completion of the construction activity at the project it supports; and
iv. Stormwater controls are implemented in accordance with Part 2 of the CGP and, if applicable, Part 3 of the CGP, for discharges from the support activity areas.

The following non-stormwater discharges from your construction activity, provided that, with the exception of water used to control dust and to irrigate areas to be vegetatively stabilized, these discharges are not routed to areas of exposed soil on your site and you comply with any applicable requirements for these discharges in Part 2 of the CGP:
i. Discharges from emergency fire-fighting activities;
ii. Fire hydrant flushings;
iii. Landscape irrigation;
iv. Water used to wash vehicles and equipment, provided that there is no discharge of soaps, solvents, or detergents used for such purposes;
v. Water used to control dust;
vi. Potable water including uncontaminated water line flushings;

vii. Routine external building washdown that does not use detergents;
viii. Pavement wash waters provided spills or leaks of toxic or hazardous materials have not occurred (unless all spill material has been removed) and where detergents are not used. You are prohibited from directing pavement wash waters directly into any surface water, storm drain inlet, or stormwater conveyance, unless the conveyance is connected to a sediment basin, sediment trap, or similarly effective control;
ix. Uncontaminated air conditioning or compressor condensate;
x. Uncontaminated, non-turbid discharges of ground water or spring water;
xi. Foundation or footing drains where flows are not contaminated with process materials such as solvents or contaminated ground water; and
xii. Construction dewatering water that has been treated by an appropriate control under Part 2.1.3.4 of the CGP; and
e. Discharges of stormwater listed above in Parts a, b, and c, or authorized nonstormwater discharges in Part d above, commingled with a discharge authorized by a different NPDES permit and/or a discharge that does not require NPDES permit authorization.

Snow Removal and De-icing

Snow removal will be the responsibility of the Owner. Snow will be plowed from Parking areas and driveways and shoveled or removed with a snow blower from walkways. Snow will be stored along roadways and walkways as shown on the Site Plan. If additional stockpiling area is needed, excess snow will be removed from the site with proper off-site disposal. Snow shall be stockpiled in areas where melting will be directed through the drainage systems and not directly to the wetlands. Stockpiling within any infiltration areas is prohibited.

Inspections

Yearly inspections of the stormwater management system shall be performed and an Inspection Schedule and Evaluation Checklist shall be maintained by the Owner and made available to regulatory officials if requested. Copies of the receipts for cleaning of the systems shall also be maintained.

The Owner shall be responsible to secure the services of a Licensed Engineer on an on-going basis. The inspector shall review the project with respect to the following:

- Proper installation and performance of the Stormwater Management System.
- Review of the controls to determine any damaged or ineffective controls.
- Corrective actions.

The Engineer shall prepare, stamp and submit, to the Owner, a report documenting the findings and should request the required maintenance or repair for the pollution prevention controls when the inspector finds that it is necessary for the control to be effective (see attached Inspection Schedule and Evaluation Checklist). The inspector shall notify the Owner to make the changes.

The owner and/or their employees responsible for the O&M of the stormwater management system shall be trained annually. Records of trained individuals shall be kept and submitted to the town with the check list. The records shall indicate the latest training date.

The attached inspection form shall be retained and kept available for a minimum of three years.

For additional information, refer to Performance, Standards and Guidelines for Stormwater Management in Massachusetts, published by the Department of Environmental Protection

Definition of Major Storm Event
For the purposes of this operation and maintenance plan a major storm event should be defined as a rainfall of such intensity or duration that causes observable movement of sediment on the

roadway or site. It is the intent of this plan to prevent this sediment from entering the drainage system. Prior to stabilization of the site this may occur more frequently with less intense storms. As the site is stabilized with ground cover the movement of sediment will only occur during more severe storms.

For additional information, refer to Performance Standards and Guidelines for Stormwater Management in Massachusetts, published by the Department of Environmental Protection.

STORMWATER MANAGEMENT
BEST MANAGEMENT PRACTICES

INSPECTION SCHEDULE AND EVALUATION CHECKLIST – POST CONSTRUCTION PHASE

PROJECT LOCATION: 737 Washington Street, Pembroke
Latest Revision 1/24/20

Best Management Practice	Inspection Frequency (1)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/ Repair Needed yes/no List items	Date of Cleaning/ Repair	Performed By	Water Level in Drainage System
Infiltration Basin	Twice per year							
Deep sump catch basins	Twice per year							

(1) Refer to the Massachusetts Stormwater Management, Volume Two: Stormwater Technical Handbook for recommendations regarding frequency for inspection and maintenance of specific BMPs.
(2) records shall be kept for a minimum of three years.

Limited or no use of sodium chloride salts, fertilizers or pesticides recommended. Slow release fertilizer recommended.
Other notes:(Include deviations from: Con Com Order of Conditions, PB Approval, Construction Sequence and Approved Plan)

Stormwater Control Manager: _____ **Stamp**

Infiltration Basins

Description: Infiltration basins are stormwater runoff impoundments that are constructed over permeable soils. Pretreatment is critical for effective performance of infiltration basins. Runoff from the design storm is stored until it exfiltrates through the soil of the basin floor.

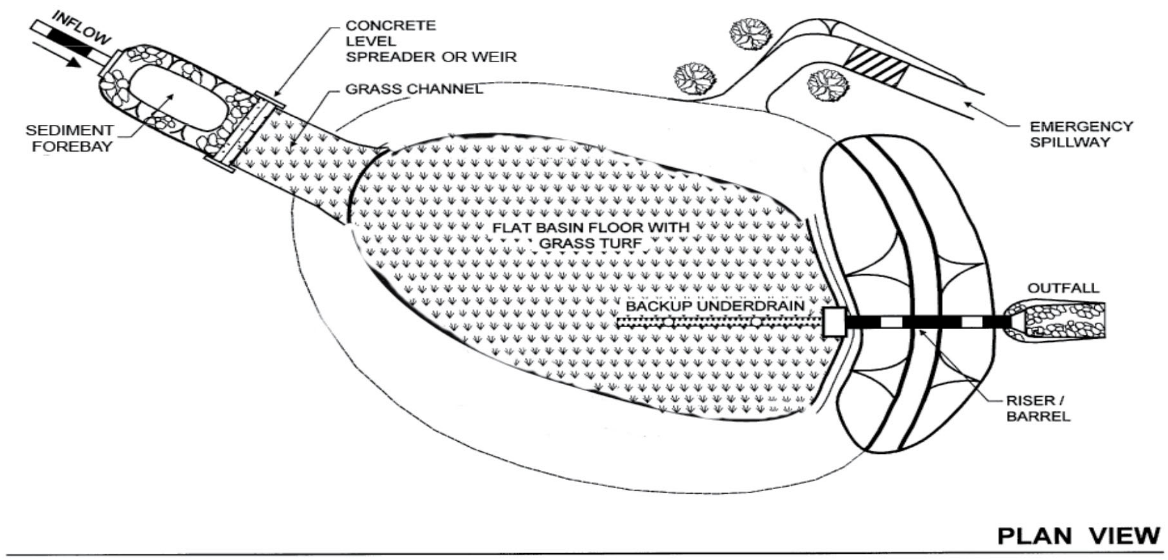
Ability to meet specific standards

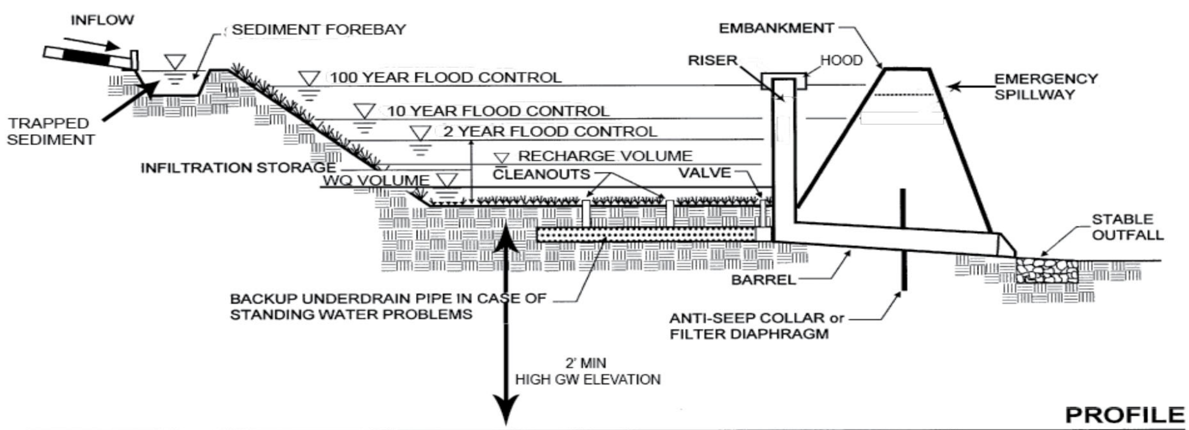
Standard	Description
2 - Peak Flow	Can be designed to provide peak flow attenuation.
3 - Recharge	Provides groundwater recharge.
4 - TSS Removal	80% TSS removal, with adequate pretreatment
5 - Higher Pollutant Loading	May be used if 44% of TSS is removed with a pretreatment BMP prior to infiltration. For some land uses with higher potential pollutant loads, use an oil grit separator, sand filter or equivalent for pretreatment prior to discharge to the infiltration basin. Infiltration must be done in compliance with 314 CMR 5.00
6 - Discharges near or to Critical Areas	Highly recommended, especially for discharges near cold-water fisheries. Requires 44% removal of TSS prior to discharge to infiltration basin
7 - Redevelopment	Typically not an option due to land area constraints

Advantages/Benefits:
- Provides groundwater recharge.
- Reduces local flooding.
- Preserves the natural water balance of the site.
- Can be used for larger sites than infiltration trenches or structures.

Disadvantages/Limitations:
- High failure rates due to improper siting, inadequate pretreatment, poor design and lack of maintenance.
- Restricted to fairly small drainage areas.
- Not appropriate for treating significant loads of sediment and other pollutants.
- Requires frequent maintenance.
- Can serve as a “regional” stormwater treatment facility

Pollutant Removal Efficiencies
- Total Suspended Solids (TSS) — 80% with pretreatment
- Total Nitrogen — 50% to 60%
- Total Phosphorus — 60% to 70%
- Metals (copper, lead, zinc, cadmium) — 85% to 90%
- Pathogens (coliform, e coli) — 90%





adapted from the Vermont Stormwater Manual

Maintenance

Activity	Frequency
Preventative maintenance	Twice a year
Inspect to ensure proper functioning	After every major storm during first 3 months of operation and twice a year thereafter and when there are discharges through the high outlet orifice.
Mow the buffer area, side slopes, and basin bottom if grassed floor; rake if stone bottom; remove trash and debris; remove grass clippings and accumulated organic matter	Twice a year
Inspect and clean pretreatment devices	Every other month recommended and at least twice a year and after every major storm event.

Special Features: High failure rate without adequate pretreatment and regular maintenance.

LID Alternative: Reduce impervious surfaces. Bioretention areas

Infiltration Basins

The following are variations of the infiltration basin design.

Full Exfiltration Basin Systems

These basin systems are sized to provide storage and exfiltration of the required recharge volume and treatment of the required water quality volume. They also attenuate peak discharges. Designs typically include an emergency overflow channel to discharge runoff volumes in excess of the design storm.

Partial or Off-line Exfiltration Basin Systems

Partial basin systems exfiltrate a portion of the runoff (usually the first flush or the first half inch), with the remaining runoff being directed to other BMPs. Flow splitters or weirs divert flows containing the first flush into the infiltration basin. This design is useful at sites where exfiltration cannot be achieved by downstream detention BMPs because of site condition limitations.

Applicability

The suitability of infiltration basins at a given site is restricted by several factors, including soils, slope, depth to water table, depth to bedrock, the presence of an impermeable layer, contributing watershed area, proximity to wells, surface waters, and foundations. Generally, infiltration basins are suitable at sites with gentle slopes, permeable soils, relatively deep bedrock and groundwater levels, and a contributing watershed area of approximately 2 to 15 acres. Table IB.1 presents the recommended site criteria for infiltration basins.

Pollution prevention and pretreatment are particularly important at sites where infiltration basins are located. A pollution prevention program that separates contaminated and uncontaminated runoff is essential. Uncontaminated runoff can be infiltrated directly, while contaminated runoff must be collected and pretreated using an appropriate combination of BMPs and then rerouted to the infiltration basin. This approach allows uncontaminated stormwater to be infiltrated during and immediately after the storm and permits the infiltration of contaminated stormwater after an appropriate detention time. The Pollution Prevention and Source Control Plan required by Stormwater Standard 4 must take these factors into account. For land uses with higher potential pollutant loads, provide a bypass to divert contaminated stormwater from the infiltration basin in storms larger than the design storm.

Table IB.1 - Site Criteria for Infiltration Basins
1. The contributing drainage area to any individual infiltration basin should be restricted to 15 acres or less.
2. The minimum depth to the seasonal high water table, bedrock, and/or impermeable layer should be 2 ft. from the bottom of the basin.
3. The minimum infiltration rate is 0.17 inches per hour. Infiltration basins must be sized in accordance with the procedures set forth in Volume 3.
4. One soil sample for every 5000 ft. of basin area is recommended, with a minimum of three samples for each infiltration basin. Samples should be taken at the actual location of the proposed infiltration basin so that any localized soil conditions are detected.
5. Infiltration basins should not be used at sites where soil have 30% or greater clay content, or 40% or greater silt clay content.
6. Infiltration basins should not be placed over fill materials.
7. The following setback requirements should apply to infiltration basin installations: • Distance from any slope greater than 15% - Minimum of 50 ft. • Distance from any soil absorption system- Minimum of 50 ft. • Distance from any private well - Minimum of 100 ft., additional setback distance may be required depending on hydrogeological conditions. • Distance from any public groundwater drinking supply wells - Zone I radius, additional setback distance may be required depending on hydrogeological conditions. • Distance from any surface drinking water supply - Zone A • Distance from any surface water of the commonwealth (other than surface water supplies and their tributaries) - Minimum of 50 ft. • Distance from any building foundations including slab foundations without basements - Minimum of 10 ft. downslope and 100 ft. upslope.

Prior to pretreatment, implement the pollution prevention and source control program specified in the Pollution Prevention and Source Control Plan to reduce the concentration of pollutants in the discharge. Program components include careful management of snow and deicing chemicals, fertilizers, herbicides, and pest control. The Plan must prohibit snow disposal in the basin and include measures to prevent runoff of stockpiled snow from entering the basin. Stockpiled snow contains concentrations of sand and deicing chemicals. At industrial sites, keep raw materials and wastes from being exposed to precipitation. Select pretreatment BMPs that remove coarse sediments, oil and grease, and floatable organic and inorganic materials, and soluble pollutants.

Effectiveness

Infiltration basins are highly effective treatment systems that remove many contaminants, including TSS. However, infiltration basins are not intended to remove coarse particulate pollutants. Use a pretreatment device to remove them before they enter the basin. The pollutant removal efficiency of the basin depends on how much runoff is exfiltrated by the basin.

Infiltration basins can be made to control peak discharges by incorporating additional stages in the design. To do this, design the riser outlet structure or weir with multiple orifices, with the lowest orifice set to achieve storage of the full recharge volume required by Standard 3. Design the upper orifices using the same procedures as extended detention basins. The basins can also be designed to achieve exfiltration of storms greater than the required recharge volume. However, in such cases, make sure the soils are permeable enough to allow the basin to exfiltrate the entire volume in a 72-hour period. This may necessitate increasing the size of the floor area of the basin. Generally, it is not economically feasible to provide storage for large infrequent storms, such as the 100-year 24-hour storm.

Planning Considerations

Carefully evaluate sites before planning infiltration basins, including investigating soils, depth to bedrock, and depth to water table. Suitable parent soils should have a minimum infiltration rate of 0.17 inches per hour. Infiltration basis must be sized in accordance with the procedures set forth in Volume 3. The slopes of the contributing drainage area for the infiltration basin must be less than 5%.

Design

Infiltration basins are highly effective treatment and disposal systems when designed properly. The first step before design is providing source control and implementing pollution prevention measures to minimize sediment and other contaminants in runoff discharged to the infiltration basin. Next, consider the appropriate pretreatment BMPs.

Design pretreatment BMPs to pretreat runoff before stormwater reaches the infiltration basin. For Critical Areas, land uses with potentially higher pollutant loads, and soils with rapid infiltration rates (greater than 2.4 inches/hour), pretreatment must remove at least 44% of the TSS. Proponents may comply with this requirement by proposing two pretreatment BMPs capable of removing 25% TSS. However, the issuing authorities (i.e., Conservation Commissions or MassDEP) may require additional pretreatment for other constituents beyond TSS for land uses with higher potential pollutant loads. If the land use has the potential to generate stormwater runoff with high concentrations of oil and grease, treatment by an oil grit separator or equivalent is required before discharge to the infiltration basin.

For discharges from areas other than Critical Areas, land uses with potentially higher pollutant loads, and soils with rapid infiltration rates, MassDEP also requires some TSS pretreatment. Common pretreatment for infiltration basins includes aggressive street sweeping, deep sump catch basins, oil/grit separators, vegetated filter strips, water quality swales, or sediment forebays. Fully stabilize all land surfaces contributing drainage to the infiltration practice after construction is complete to reduce the amount of sediment in runoff that flows to the pretreatment devices.

Always investigate site conditions. Infiltration basins must have a minimum separation from seasonal high groundwater of at least 2 feet. Greater separation is necessary for bedrock. If there is bedrock on the site, conduct an analysis to determine the appropriate vertical separation. The greater the distance from the bottom of the basin media to the seasonal high groundwater elevation, the less likely the basin will fail to drain in the 72-hour period following precipitation.

Determine soil infiltration rates using samples collected at the proposed location of the basin. Take one soil boring or dig one test pit for every 5,000 feet of basin area, with a minimum of three borings for each infiltration basin. Conduct the borings or test pits in the layer where infiltration is proposed. For example, if the A and B horizons are to be removed and the infiltration will be through the C horizon, conduct the borings or test pits through the C horizon. MassDEP requires that borings be at least 20 feet deep or extend to the depth of the limiting layer.

For each bore hole or test pit, evaluate the saturated hydraulic conductivity of the soil, depth to seasonal high groundwater, NRCS soil textural class, NRCS Hydrologic Soil Group, and the presence of fill materials in accordance with Volume 3. Never locate infiltration basins above fill. Never locate infiltration basins in Hydrologic Soil Group "D" soils. The minimum acceptable final soil infiltration rate is 0.17 inches per hour. Design the infiltration basin based on the soil evaluation set forth in Volume 3.

If the proposed basin is determined to be in Hydrologic Soil Group "C" soils, incorporate measures in the design to reduce the potential for clogging, such as providing more pretreatment or greater media depth to provide additional storage. Never use the results of a Title 5 percolation test to estimate a saturated hydraulic conductivity rate, because it tends to greatly overestimate the rate that water will infiltrate into the subsurface.

Estimate seasonal high groundwater based on soil mottles or through direct observation when borings are conducted in April or May, when groundwater levels are likely to be highest. If it is difficult to determine the seasonal high groundwater elevation from the borings or test pits, then use the Frimpter method developed by the USGS (Massachusetts/ Rhode Island District Office) to estimate seasonal high groundwater. After estimating the seasonal high groundwater using the Frimpter method, re-examine the bore holes or test pits to determine if there are any field indicators that corroborate the Frimpter method estimate.

Stabilize inlet channels to prevent incoming flow velocities from reaching erosive levels, which can scour the basin floor. Riprap is an excellent inlet stabilizer. Design the riprap so it terminates in a broad apron, thereby distributing runoff more evenly over the basin surface to promote better infiltration.

At a minimum, size the basin to hold the required recharge volume. Determine the required recharge volume using either the static or dynamic methods set forth in Volume 3. Remember that the required storage volume of an infiltration basin is the sum of the quantity of runoff entering the basin from the contributing area and the precipitation directly entering the basin. Include one foot of freeboard above the total of the required recharge volume and the direct precipitation volume to account for design uncertainty. When applying the dynamic method to size the basin, use only the bottom of the basin (i.e., do not include side wall exfiltration) for the effective infiltration area.

Design the infiltration basin to exfiltrate in no less than 72 hours. Consider only the basin floor as the effective infiltration area when determining whether the basin meets this requirement.

Design the basin floor to be as flat as possible to provide uniform ponding and exfiltration of the runoff. Design the basin floor to have as close to a 0% slope as possible. In no case shall the longitudinal slope exceed 1%. Enhanced deposition of sediment in low areas may clog the surface soils, resulting in reduced infiltration and wet areas. Design the side slopes of the basin to be no steeper than 3:1 (horizontal: vertical) to allow for proper vegetative stabilization, easier mowing, easier access, and better public safety.

For basins with a 1% longitudinal slope, it will be necessary to incorporate cells into the design, making sure that the depth of ponded water does not exceed 2 feet, because sloped basin floors cause water to move downhill, thereby decreasing the likelihood of infiltration. Make lateral slopes flat (i.e., 0% slope).

After the basin floor is shaped, place soil additives on the basin floor to amend the soil. The soil additives shall include compost, properly aged to kill any seed stock contained within the compost. Do not put biosolids in the compost. Mix native soils that were excavated from the A or B horizons to create the basin with the compost, and then scarify the native materials and compost into the parent material using a chisel plow or rotary device to a depth of 12 inches. Immediately after constructing the basin, stabilize its bottom and side slopes with a dense turf of water-tolerant grass. Use low-maintenance, rapidly germinating grasses, such as fescues. The selected grasses must be capable of surviving in both wet and dry conditions. Do not use sod, which can prevent roots from directly contacting the underlying soil. During the first two months, inspect the newly established vegetation several times to determine if any remedial actions (e.g., reseeding, irrigating) are necessary.

Never plant trees or shrubs within the basin or on the impounding embankments as they increase the chance of basin failure due to root decay or subsurface disturbance. The root penetration and thatch formation of the turf helps to maintain and may even enhance the original infiltration capacity. Soluble nutrients are taken up by the turf for growth, improving the pollutant removal capacity. Dense turf will impede soil erosion and scouring of the basin floor.

In place of turf, use a basin liner of 6 to 12 inches of fill material, such as coarse sand. Clean and replace this material as needed. Do not use loose stone, riprap, and other irregular materials requiring hand removal of debris and weeds.

Design embankments and spillways to conform to the regulatory guidelines of the state's Office of Dam Safety (302 CMR 10.00). Design infiltration basins to be below surrounding grade to avoid issues related to potential embankment failure. All infiltration basins must have an emergency spillway capable of bypassing runoff from large storms without damage to the impounding structure. Design the emergency spillway to divert the storm associated with brimful conditions without impinging upon the structural integrity of the basin. The brimful condition could be the required recharge volume or a design storm (such as the 2-year, 10-year, or 100-year storm if the basin is designed to provide peak rate attenuation in addition to exfiltration). The storm associated with the brimful conditions should not include the one foot of freeboard required to account for design uncertainty. Design the emergency spillway to shunt water toward a location where the water will not damage wetlands or buildings. A common error is to direct the spillway runoff toward an adjoining property not owned by an applicant. If the emergency spillway is designed to drain the emergency overflow toward an adjoining property, obtain a drainage easement and submit it to the Conservation Commission as part of the Wetlands NOI submission. Place vegetative buffers around the perimeter of the basin for erosion control and additional sediment and nutrient removal.

Monitoring wells: Install one monitoring well in the basin floor per every 5,000 square feet of basin floor. Make sure the monitoring well(s) extend 20 feet beneath the basin floor or to the limiting layer, whichever is higher.

Access: Include access in the basin design. The area at the top of the basin must provide unimpeded vehicular access around the entire basin perimeter. The access area shall be no less than 15 feet.

Inlet Structures: Place inlet structures at one longitudinal end of the basin, to maximize the flow path from the inlet to the overflow outlet. A common error is to design multiple inlet points around the entire basin perimeter.

Outlet structures: Infiltration basins must include an overflow outlet in addition to an emergency spillway. Whether using a single orifice or multiple orifices in the design, at a minimum, set the lowest orifice at or above the required recharge volume.

Drawdown device: Include a device to draw the basin down for maintenance purposes. If the basin includes multiple cells, include a drawdown device for each cell.

Fences: Do not place fences around basins located in Riverfront Areas, as required by 310 CMR 10.58(4)(d)1.d. to avoid impeding wildlife movement. In such cases, consider including a safety bench as part of the design.

Construction

Prior to construction, rope or fence off the area selected for the infiltration basin. Never allow construction equipment to drive across the area intended to serve as the infiltration basin.

Never use infiltration basins as temporary sediment traps for construction activities.

To limit smearing or compacting soils, never construct the basin in winter or when it is raining. Use light earth-moving equipment to excavate the infiltration basin because heavy equipment compacts the soils beneath the basin floor and side slopes and reduces infiltration capacity. Because some compaction of soils is inevitable during construction, add the required soil amendments and deeply till the basin floor with a rotary tiller or a disc harrow to a depth of 12 inches to restore infiltration rates after final grading.

Use proper erosion/sediment control during construction. Immediately following basin construction, stabilize the floor and side slopes of the basin with a dense turf of water-tolerant grass. Use low maintenance, rapidly germinating grasses, such as fescues. Do not sod the basin floor or side slopes. After the basin is completed, keep the basin roped or fenced off while construction proceeds on other parts of the site. Never direct construction period drainage to the infiltration basin. After construction is completed, do not direct runoff into the basin until the bottom and side slopes are fully stabilized.

Maintenance

Infiltration basins are prone to clogging and failure, so it is imperative to develop and implement aggressive maintenance plans and schedules. Installing the required pretreatment BMPs will significantly reduce maintenance requirements for the basin.

The Operation and Maintenance Plan required by Standard 9 must include inspections and preventive maintenance at least twice a year, and after every time drainage discharges through the high outlet orifice. The Plan must require inspecting the pretreatment BMPs in accordance with the minimal requirements specified for those practices and after every major storm event. A major storm event is defined as a storm that is equal to or greater than the 2-year, 24-hour storm (generally 2.9 to 3.6 inches in a 24-hour period, depending in geographic location in Massachusetts).

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

- Signs of differential settlement,
- Cracking,
- Erosion,
- Leakage in the embankments
- Tree growth on the embankments
- Condition of riprap,
- Sediment accumulation and
- The health of the turf.

At least twice a year, mow the buffer area, side slopes, and basin bottom. Remove grass clippings and accumulated organic matter to prevent an impervious organic mat from forming. Remove trash and debris at the same time. Use deep tilling to break up clogged surfaces, and revegetate immediately.

Remove sediment from the basin as necessary, but wait until the floor of the basin is thoroughly dry. Use light equipment to remove the top layer so as to not compact the underlying soil. Deeply till the remaining soil, and revegetate as soon as possible. Inspect and clean pretreatment devices associated with basins at least twice a year, and ideally every other month.

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United States Department of Agriculture

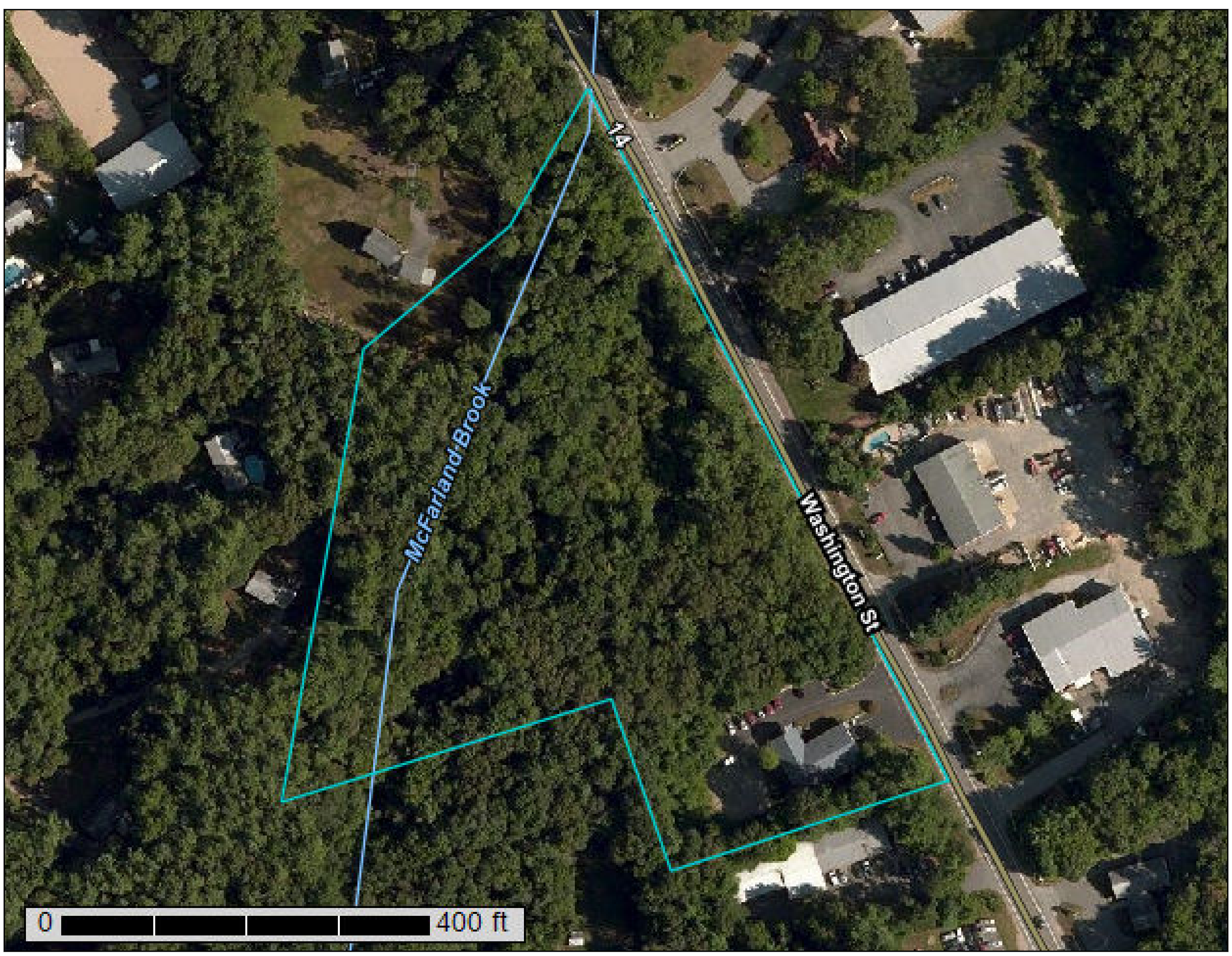
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Plymouth County, Massachusetts



December 4, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

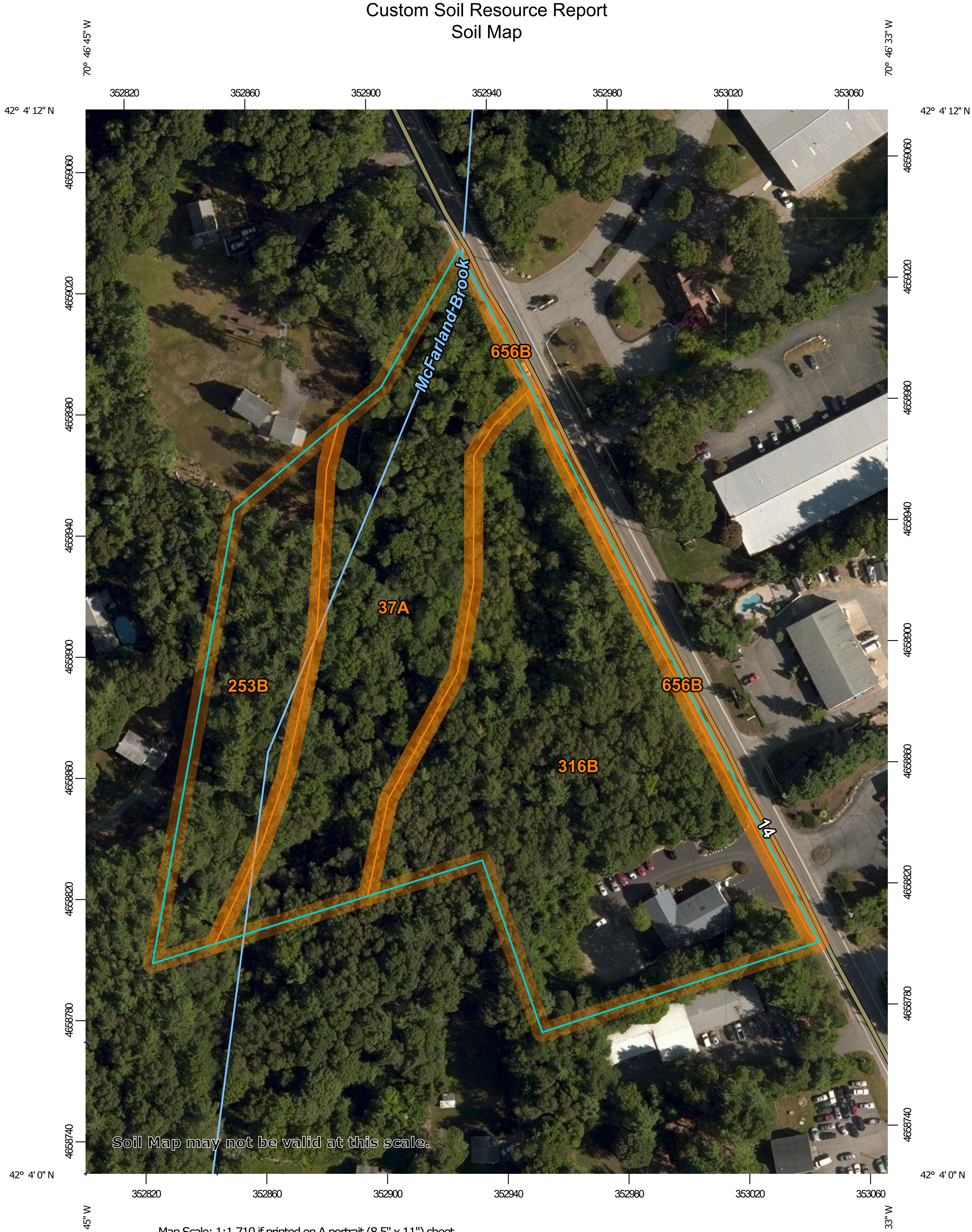
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:1,710 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

N

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 12, Sep 12, 2019

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

Date(s) aerial images were photographed: Aug 26, 2014—Sep 4, 2014

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
37A	Massasoit - Mashpee complex, 0 to 3 percent slopes	2.3	31.7%
253B	Hinckley loamy sand, 3 to 8 percent slopes	1.2	16.8%
316B	Scituate gravelly sandy loam, 3 to 8 percent slopes, very stony	3.6	50.2%
656B	Udorthents - Urban land complex, 0 to 8 percent slopes	0.1	1.3%
Totals for Area of Interest		**7.2**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Plymouth County, Massachusetts

37A—Massasoit - Mashpee complex, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: bd1q
Elevation: 0 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Massasoit and similar soils: 55 percent
Mashpee and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Massasoit

Setting

Landform: Terraces, depressions, drainageways
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy and gravelly glaciofluvial deposits

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
Oa - 1 to 3 inches: highly decomposed plant material
A - 3 to 5 inches: fine sand
Eg1 - 5 to 11 inches: fine sand
Eg2 - 11 to 13 inches: fine sand
Bhs - 13 to 17 inches: fine sand
Bsm - 17 to 23 inches: fine sand
Bs - 23 to 26 inches: fine sand
BC - 26 to 43 inches: fine sand
Cg - 43 to 80 inches: loamy very fine sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 7 to 20 inches to ortstein
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.01 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: Occasional
Available water storage in profile: Very low (about 1.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w

Hydrologic Soil Group: D
Hydric soil rating: Yes

Description of Mashpee

Setting

Landform: Depressions, drainageways, terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy and gravelly glaciofluvial deposits

Typical profile

Oe1 - 0 to 2 inches: moderately decomposed plant material
Oe2 - 2 to 4 inches: moderately decomposed plant material
Oa - 4 to 5 inches: highly decomposed plant material
AE - 5 to 7 inches: loamy fine sand
Eg - 7 to 11 inches: fine sand
Bh1 - 11 to 13 inches: fine sand
Bh2 - 13 to 17 inches: fine sand
Bs - 17 to 24 inches: loamy fine sand
C1 - 24 to 39 inches: fine sand
C2 - 39 to 65 inches: fine sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 5.95 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: Occasional
Available water storage in profile: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: A/D
Hydric soil rating: Yes

Minor Components

Deerfield

Percent of map unit: 5 percent
Landform: Outwash plains, terraces, deltas
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Rainberry

Percent of map unit: 3 percent
Landform: Depressions, kettles

Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: Yes

Squamscott

Percent of map unit: 2 percent
Landform: Lake terraces, lake plains
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

253B—Hinckley loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2svm8
Elevation: 0 to 1,430 feet
Mean annual precipitation: 36 to 53 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landform: Outwash terraces, outwash plains, moraines, kame terraces, outwash deltas, kames, eskers
Landform position (two-dimensional): Summit, backslope, footslope, shoulder
Landform position (three-dimensional): Nose slope, side slope, base slope, crest, riser, tread
Down-slope shape: Linear, convex, concave
Across-slope shape: Convex, linear, concave
Parent material: Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 8 inches: loamy sand
Bw1 - 8 to 11 inches: gravelly loamy sand
Bw2 - 11 to 16 inches: gravelly loamy sand
BC - 16 to 19 inches: very gravelly loamy sand

C - 19 to 65 inches: very gravelly sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: 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
Salinity, maximum in profile: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Windsor

Percent of map unit: 8 percent
Landform: Kames, eskers, outwash terraces, kame terraces, outwash plains, moraines, outwash deltas
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Nose slope, side slope, base slope, crest, riser, tread
Down-slope shape: Linear, convex, concave
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

Sudbury

Percent of map unit: 5 percent
Landform: Kame terraces, outwash plains, moraines, outwash deltas, outwash terraces
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope, base slope, head slope, tread
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Hydric soil rating: No

Agawam

Percent of map unit: 2 percent
Landform: Kame terraces, outwash plains, moraines, outwash deltas, kames, eskers, outwash terraces
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Nose slope, side slope, base slope, crest, tread, riser
Down-slope shape: Linear, convex, concave
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

316B—Scituate gravelly sandy loam, 3 to 8 percent slopes, very stony

Map Unit Setting

National map unit symbol: bczw
Elevation: 10 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

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

Description of Scituate, Very Stony

Setting

Landform: Drumlins, ridges
Landform position (two-dimensional): Footslope, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Coarse-loamy eolian deposits over sandy lodgment till

Typical profile

Ap - 0 to 11 inches: gravelly sandy loam
Bw1 - 11 to 15 inches: gravelly sandy loam
Bw2 - 15 to 20 inches: sandy loam
BC1 - 20 to 25 inches: gravelly sandy loam
BC2 - 25 to 35 inches: sandy loam
Cd1 - 35 to 46 inches: loamy coarse sand
Cd2 - 46 to 60 inches: loamy coarse sand

Properties and qualities

Slope: 3 to 8 percent
Percent of area covered with surface fragments: 1.5 percent
Depth to restrictive feature: 20 to 35 inches to densic material
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 15 to 20 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s

Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Birchwood, very stony
Percent of map unit: 5 percent
Landform: Ground moraines, till plains, drumlins
Landform position (two-dimensional): Summit, footslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Norwell, extremely stony
Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Woodbridge, very stony
Percent of map unit: 5 percent
Landform: Drumlins, till plains, hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Montauk, very stony
Percent of map unit: 5 percent
Landform: Till plains, drumlins, ground moraines
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

656B—Udorthents - Urban land complex, 0 to 8 percent slopes

Map Unit Setting
National map unit symbol: bd08
Elevation: 0 to 390 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents, loamy, and similar soils: 45 percent
Urban land: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents, Loamy

Setting

Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Coarse-loamy human transported material

Typical profile

^A - 0 to 5 inches: loam
^C1 - 5 to 21 inches: gravelly loam
^C2 - 21 to 80 inches: gravelly sandy loam

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to very high (0.01 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Udipsamments, wet substratum

Percent of map unit: 5 percent
Landform: Dikes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Hydric soil rating: No

Udorthents, wet substratum

Percent of map unit: 5 percent
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Udipsamments

Percent of map unit: 5 percent
Landform: Dikes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Hydric soil rating: No

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Commonwealth of Massachusetts

Pembroke, Massachusetts

Soil Suitability Assessment for On-site Sewage Disposal

Performed by: Kevin Grady Date: 8/9/14

GRADY CONSULTING, L.L.C.
71 Evergreen Street, Suite 1
Kingston, MA 02364
Phone: (781) 585-2300 Fax: (781) 585-2378

Witnessed by: Lisa Collety

Location Address or Lot #: 737 Washington Street

*Owner's Name *Address & *Telephone #: Rose Realty Trust, 55 Redwood Circle, Mashpee MA 02649, 781 826 9511

New Construction ___ Repair ___ Title V Inspection ___

Office Review

Published Soil Survey Available: No X Yes___
Year Published: _________ Publication Scale: _____________ Soil Map Unit: ___________
Drainage Class: _________ Soil Limitations: ______________________________________

Surficial Geology Report Available: No X Yes ___
Year Published: _________ Publication Scale: ______________
Geologic Material (Map Unit): ________________________________
Landform: ____

Flood Insurance Rate Map:

Above 500 year flood boundary:	**No** ____	**Yes** X
Within 500 year flood boundary	**No** X	**Yes** ____
Within 100 year flood boundary	**No** X	**Yes** ____

Wetland Area:
National Wetland Inventory Map (map unit): N/A
Wetlands Conservancy Program Map (map unit): ______________________________

Current Water Resource Conditions (USGS): **Month:** August
Range: **Above Normal** X **Normal** ______ **Below Normal** _____

Other References Reviewed: ______________________________

Depth of Naturally Occurring Pervious Material

Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes

If not, what is the depth of naturally occurring pervious material?

Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise, and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated on the attached soil evaluation form, are accurate and in accordance with CMR 15.100 through 15.107.

Signature: [signature] Date: 8/9/14

TITLE 5 ON-SITE REVIEW

Deep Hole # 1 **Date** 8/9/19 **Time** 10:00 **Weather** Sunny 80°
Location(identify on Site Plan)
Land Use Commercial **Slope(%)** 0-2 **Surface Stones** none
Vegetation Lawn/weeds **Landform**

Distances from: Open Water Body – ft. Possible Wet Area – ft. Drinking Water Well – ft.

Drainageway – ft. Propertyline 20 ft Other

DEEP OBSERVATION HOLE LOG

Depth From Surface (Inches)	Soil Horizon (USDA	Soil Texture (Munsell)	Soil Color	Soil Mottling	Other: Structures, Stones, Boulders, Consistency,%Gravel
0"-32"	Fill				
32"-36"	A	Loam	3/3		
36"-40	B	LoamySand	10YR5/6		Friable
40-132	C1	LoamySand	2.5Y6/4	none	Friable 5%gravel-few cobbles

Parent Material (geologic) Glacial Till **Depth to Bedrock**
Depth to Groundwater: **Standing Water in Hole:** 130" **Weeping from Pit Face**
Estimated Seasonal High Groundwater 10'-10"

DETERMINATION FOR SEASONAL HIGH WATER TABLE

Method Used:
X **Depth observed standing in observation hole:** 130 **inches** ___ **Depth to soil mottles:** ___ **inches**
___ **Depth to weeping from side of observation hole:** ___ **inches** ___ **Groundwater adjustment** ___ **ft**
Index Well # ___ **Reading Date** ___ **Index well level** ___ **Adj.factor** ___ **Adj.Groundwater level** ___

PERCOLATION TEST **Date** **Time**

Observation Hole #			**Time at 9"**	@10:00	
Depth of Perc	40-58		**Time at 6"**	10:24	
Start Presoak	9:23		**Time (9"-6")**	~~8min/in~~ 24	
End Presoak	9:39		**Rate Min/Inch**	8min/in	

Site Suitability Assessment: **Site Passed** X **Site Failed** ___ **Additional Testing Needed:**
Performed By Kevin Grady **Certification #**
Witnessed By Lisa Collins

Comments:

TITLE 5 ON-SITE REVIEW

Deep Hole # 2 **Date** 8/9/19 **Time** 10:15 **Weather** Sunny 80°
Location(identify on Site Plan) ____
Land Use Commercial **Slope(%)** 0-2 **Surface Stones** none
Vegetation Lawn/Woods **Landform** ____

Distances from: Open Water Body – ft. Possible Wet Area – ft. Drinking Water Well – ft.

Drainageway – ft. Propertyline 30 ft Other ____

DEEP OBSERVATION HOLE LOG

Depth From Surface (Inches)	Soil Horizon (USDA	Soil Texture (Munsell)	Soil Color	Soil Mottling	Other: Structures, Stones, Boulders, Consistency,%Gravel
0"-24"	Fill				
24-30	A	Loam	10YR3/3		
30-84	C1	Med Sand	2.5Y6/4		0% gravel loose
84-120	C2	Med Sand	2.5Y6/2	none	5% gravel loose

Parent Material (geologic) Glacial Till **Depth to Bedrock** ____
Depth to Groundwater: **Standing Water in Hole:** none **Weeping from Pit Face** none
Estimated Seasonal High Groundwater 10'-0" assumed no water encountered

DETERMINATION FOR SEASONAL HIGH WATER TABLE

Method Used:
___ **Depth observed standing in observation hole:** ____ **inches** ____ **Depth to soil mottles:** ____ **inches**
___ **Depth to weeping from side of observation hole:** ____ **inches** ____ **Groundwater adjustment** ____ **ft**
Index Well # ____ **Reading Date** ____ **Index well level** ____ **Adj.factor** ____ **Adj.Groundwater level** ____

PERCOLATION TEST **Date** ____ **Time** ____

Observation Hole #			**Time at 9"**	10:21	
Depth of Perc	30-48		**Time at 6"**	10:25	
Start Presoak	10:00		**Time (9"-6")**	4 min	
End Presoak	10:15		**Rate Min/Inch**	<2 min/in	

Site Suitability Assessment: **Site Passed** X **Site Failed** ____ **Additional Testing Needed:**

Performed By Kevin Grady **Certification #** ____

Witnessed By Lisa Cullity

Comments:

TITLE 5 ON-SITE REVIEW

Deep Hole # 3 **Date** 8/9/19 **Time** 10:00 **Weather** Sunny 80°
Location(identify on Site Plan)________
Land Use Commercial **Slope(%)** 0-2 **Surface Stones** stonewall
Vegetation Woods **Landform**________

Distances from: Open Water Body – ft. Possible Wet Area – ft. Drinking Water Well – ft.

Drainageway – ft. Propertyline 15 ft Other________

DEEP OBSERVATION HOLE LOG

Depth From Surface (Inches)	Soil Horizon (USDA	Soil Texture (Munsell)	Soil Color	Soil Mottling	Other: Structures, Stones, Boulders, Consistency,%Gravel
0-24	Fill	Fill ~~Loam~~			
24-30	A	A Loam	10YR3/3		
30-40	B	B Loamy Sand	10YR5/6		Friable
40-72	C	Loamy Sand	2.5Y4/4	none	few large Boulders @ Bottom well drained unable to Remove

Parent Material (geologic) Glacial Till **Depth to Bedrock**________
Depth to Groundwater: **Standing Water in Hole:** none **Weeping from Pit Face** none
Estimated Seasonal High Groundwater 6'-0" assumed no water

DETERMINATION FOR SEASONAL HIGH WATER TABLE

Method Used:
___ **Depth observed standing in observation hole:** ____**inches** ____**Depth to soil mottles:**____ **inches**
___ **Depth to weeping from side of observation hole:**____**inches** ____ **Groundwater adjustment**____**ft**
Index Well #____ **Reading Date**____ **Index well level**____ **Adj.factor**____ **Adj.Groundwater level**____

PERCOLATION TEST

Date________ **Time**________

Observation Hole #			**Time at 9"**		
Depth of Perc			**Time at 6"**		
Start Presoak			**Time (9"-6")**		
End Presoak			**Rate Min/Inch**		

Site Suitability Assessment: **Site Passed**____ **Site Failed**____ **Additional Testing Needed:**

Performed By________ **Certification #**________

Witnessed By________

Comments:

TITLE 5 ON-SITE REVIEW

Deep Hole # 4 **Date** 8/9/19 **Time** 11:00 **Weather** Sunny 80
Location(identify on Site Plan)________
Land Use commercial **Slope(%)** 0-2 **Surface Stones** stonewall
Vegetation woods **Landform**________

Distances from: Open Water Body – ft. Possible Wet Area – ft. Drinking Water Well – ft.

Drainageway – ft. Propertyline 30 ft Other________

DEEP OBSERVATION HOLE LOG

Depth From Surface (Inches)	Soil Horizon (USDA	Soil Texture (Munsell)	Soil Color	Soil Mottling	Other: Structures, Stones, Boulders, Consistency, %Gravel
0"-6"	A	Loam	10YR3/3		
6"-30"	B	Loamy Sand	10YR5/6		Friable
30"-120"	C	Loamy Sand	2.5Y6/4	none	5% gravel Friable

Parent Material (geologic) Glacial Till **Depth to Bedrock**________
Depth to Groundwater: **Standing Water in Hole:**____ **Weeping from Pit Face**____
Estimated Seasonal High Groundwater 10'-0" assumed no water

DETERMINATION FOR SEASONAL HIGH WATER TABLE

Method Used:
___ **Depth observed standing in observation hole:** ____**inches** ____**Depth to soil mottles:**____ **inches**
___ **Depth to weeping from side of observation hole:**____**inches** ____ **Groundwater adjustment**____**ft**
Index Well #____ **Reading Date**____ **Index well level**____ **Adj.factor**____ **Adj.Groundwater level**____

PERCOLATION TEST **Date**________ **Time**________

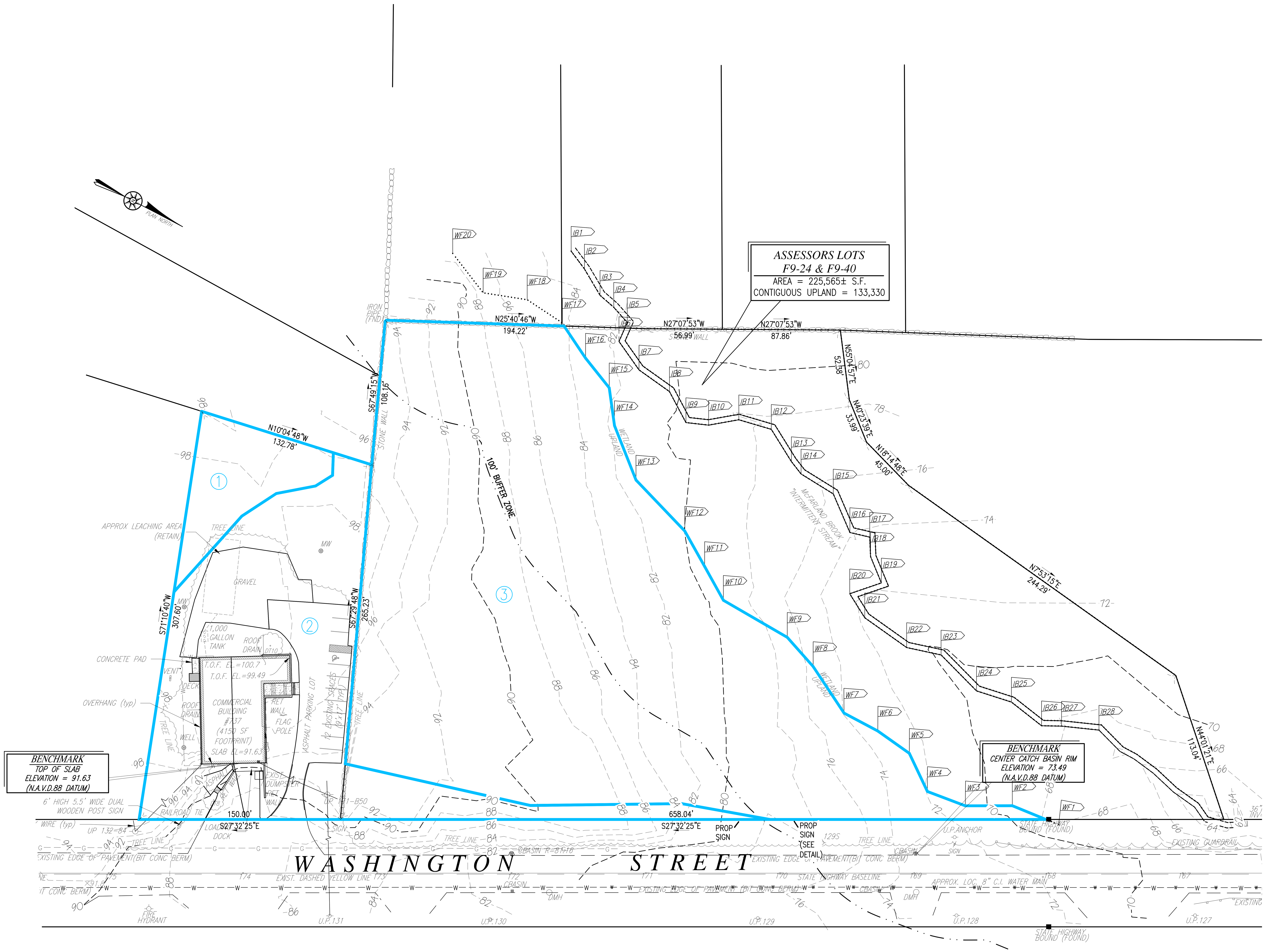
Observation Hole #			**Time at 9"**		
Depth of Perc			**Time at 6"**		
Start Presoak			**Time (9"-6")**		
End Presoak			**Rate Min/Inch**		

Site Suitability Assessment: **Site Passed**____ **Site Failed**____ **Additional Testing Needed:**

Performed By________ **Certification #**________

Witnessed By________

Comments:



Scale 1" = 20'

SITE PLAN

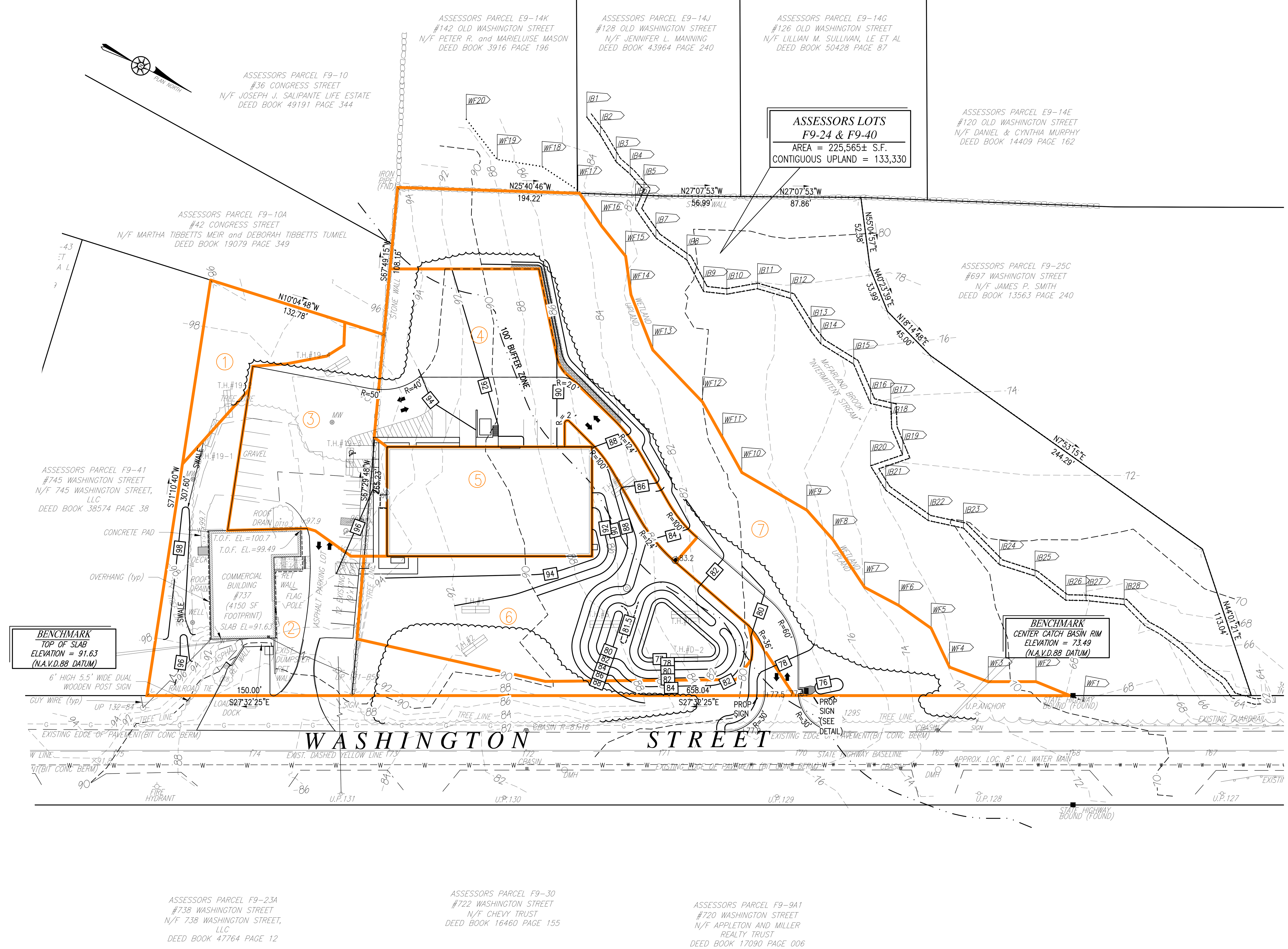
#715-737 WASHINGTON STREET
PEMBROKE, MASSACHUSETTS

PRE-DEVELOPMENT

PREPARED FOR:
ROSE REALTY TRUST
55 REDWOOD CIRCLE
MASHPEE, MA 02649

FEBRUARY 6, 2020
SCALE: 1"=40'
JOB No. 16-134

GRADY CONSULTING, L.L.C.
Civil Engineers and Land Surveyors
71 Evergreen Street, Suite 1, Kingston, MA 02364
Phone (781) 585-2300 Fax (781) 585-2378



Scale 1" = 20'

SITE PLAN

#715-737 WASHINGTON STREET
PEMBROKE, MASSACHUSETTS

POST-DEVELOPMENT

PREPARED FOR:
ROSE REALTY TRUST
55 REDWOOD CIRCLE
MASHPEE, MA 02649

FEBRUARY 6, 2020
SCALE: 1"=40'
JOB No. 16-134

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