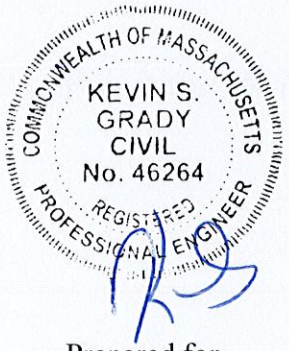
GRADY CONSULTING, L.L.C.
Registered Professional Civil Engineers & Land Surveyors

STORMWATER MANAGEMENT DESIGN CALCULATIONS

405 VFW Dr.

Assessors Map 20-50-0
Rockland, Massachusetts



Prepared for
405 VFW Drive, LLC
405 VFW Dr.
Rockland, MA 02370

October 5, 2023

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SUMMARY

This analysis was prepared to demonstrate Compliance with the State Stormwater Regulations. The proposed project is for the construction of a storage garage with associated stormwater mitigation and controls.

The area of the proposed work is currently developed with a contractor's yard with gravel and paved surfaces, adjacent to a wetland to the east and south, and developed lots to the north and west. Stormwater currently flows overland from the site towards the southwest wetlands.

The attenuation of storm water flows has been achieved by routing the proposed roof runoff into a pipe and stone subsurface infiltration trench Once full, runoff will travel overland into the existing wetlands. No water quality treatment is provided because the proposed impervious area consists of roof.

DP-1 – Runoff from gravel areas, roof areas, and paved areas which flow towards the southwest corner of the lot towards the wetlands.

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 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.

SUMMARY OF STORMWATER FLOWS

PRE-DEVELOPMENT RUNOFF

	2 YR	10 YR	25 YR	100 YR
DP-1	9.82	14.70	18.46	25.99

POST-DEVELOPMENT RUNOFF

	2 YR	10 YR	25 YR	100 YR
DP-1	9.63	14.6	18.44	25.97

REDUCTION IN RUNOFF

	2 YR	10 YR	25 YR	100 YR
DP-1	0.19	0.10	0.02	0.02

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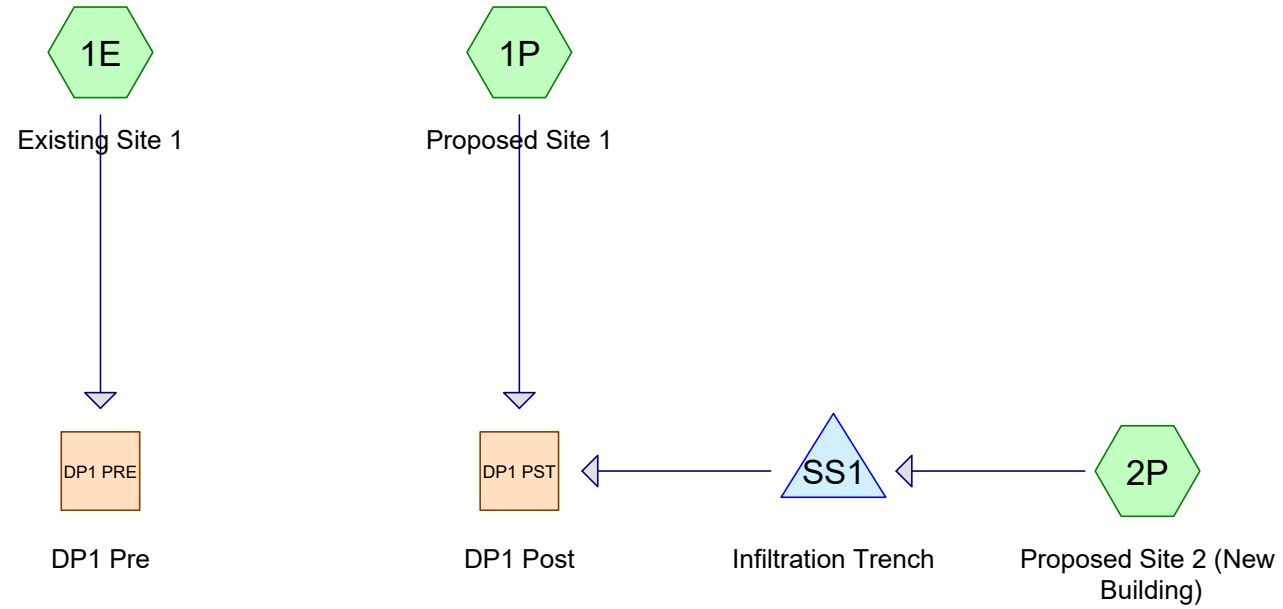
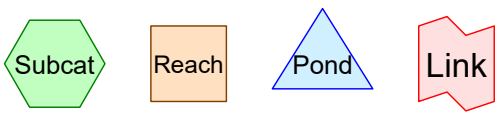
Section I
Overall Site Analysis





Routing Diagram for 405 VFW Dr Rockland
Prepared by Grady Consulting LLC

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
157,300	96	Gravel surface, HSG B (1E, 1P)
63,230	98	Paved parking, HSG B (1E, 1P)
25,298	98	Unconnected roofs, HSG B (1E, 1P, 2P)
40,598	98	Water Surface, HSG B (1E, 1P)
286,426	**97**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
286,426	HSG B	1E, 1P, 2P
0	HSG C	
0	HSG D	
0	Other	
286,426		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Subcatchm Numbers
0	157,300	0	0	0	157,300	Gravel surface	
0	63,230	0	0	0	63,230	Paved parking	
0	25,298	0	0	0	25,298	Unconnected roofs	
0	40,598	0	0	0	40,598	Water Surface	
0	**286,426**	**0**	**0**	**0**	**286,426**	**TOTAL AREA**	

Time span=5.00-20.00 hrs, dt=0.10 hrs, 151 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1E: Existing Site 1 Runoff Area=143,213 sf 44.33% Impervious Runoff Depth>2.83"
Flow Length=516' Tc=5.0 min CN=97 Runoff=9.82 cfs 33,736 cf

Subcatchment 1P: Proposed Site 1 Runoff Area=140,213 sf 44.67% Impervious Runoff Depth>2.83"
Flow Length=516' Tc=5.0 min CN=97 Runoff=9.62 cfs 33,029 cf

Subcatchment 2P: Proposed Site 2 (New Runoff Area=3,000 sf 100.00% Impervious Runoff Depth>2.91"
Flow Length=516' Tc=5.0 min CN=98 Runoff=0.21 cfs 728 cf

Reach DP1 PRE: DP1 Pre Inflow=9.82 cfs 33,736 cf
Outflow=9.82 cfs 33,736 cf

Reach DP1 PST: DP1 Post Inflow=9.63 cfs 33,202 cf
Outflow=9.63 cfs 33,202 cf

Pond SS1: Infiltration Trench Peak Elev=134.72' Storage=187 cf Inflow=0.21 cfs 728 cf
Discarded=0.01 cfs 479 cf Primary=0.27 cfs 173 cf Outflow=0.28 cfs 652 cf

Total Runoff Area = 286,426 sf Runoff Volume = 67,493 cf Average Runoff Depth = 2.83"
54.92% Pervious = 157,300 sf 45.08% Impervious = 129,126 sf

Summary for Subcatchment 1E: Existing Site 1

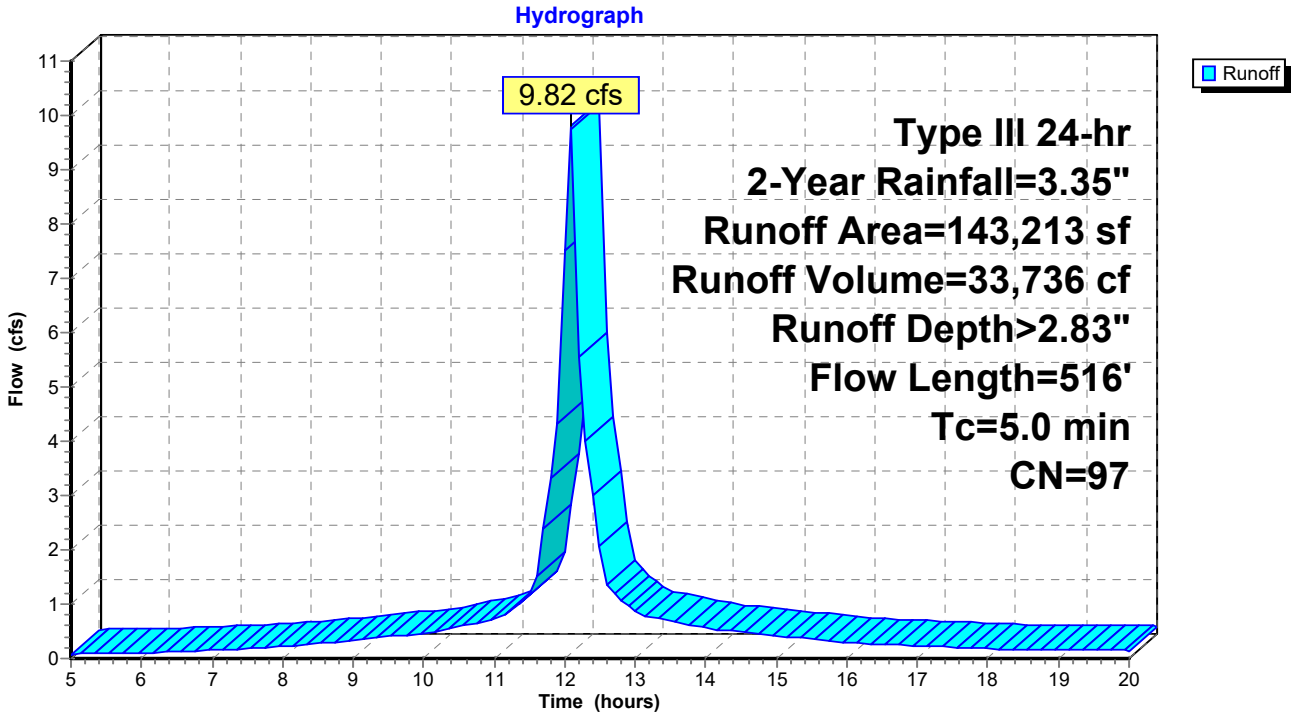
Runoff = 9.82 cfs @ 12.08 hrs, Volume= 33,736 cf, Depth> 2.83"
Routed to Reach DP1 PRE : DP1 Pre

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 2-Year Rainfall=3.35"

Area (sf)	CN	Description
32,040	98	Paved parking, HSG B
79,725	96	Gravel surface, HSG B
11,149	98	Unconnected roofs, HSG B
20,299	98	Water Surface, HSG B
143,213	97	Weighted Average
79,725		55.67% Pervious Area
63,488		44.33% Impervious Area
11,149		17.56% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1E: Existing Site 1



Summary for Subcatchment 1P: Proposed Site 1

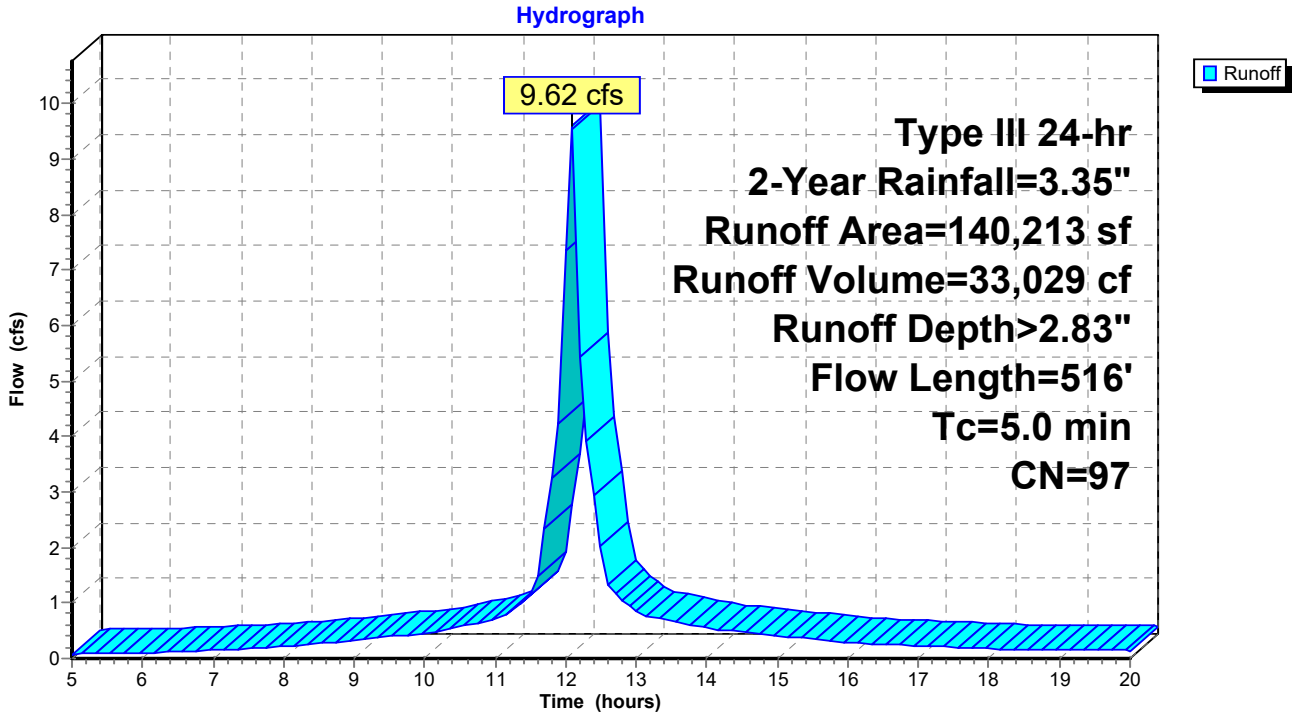
Runoff = 9.62 cfs @ 12.08 hrs, Volume= 33,029 cf, Depth> 2.83"
Routed to Reach DP1 PST : DP1 Post

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 2-Year Rainfall=3.35"

Area (sf)	CN	Description
31,190	98	Paved parking, HSG B
77,575	96	Gravel surface, HSG B
11,149	98	Unconnected roofs, HSG B
20,299	98	Water Surface, HSG B
140,213	97	Weighted Average
77,575		55.33% Pervious Area
62,638		44.67% Impervious Area
11,149		17.80% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1P: Proposed Site 1



Summary for Subcatchment 2P: Proposed Site 2 (New Building)

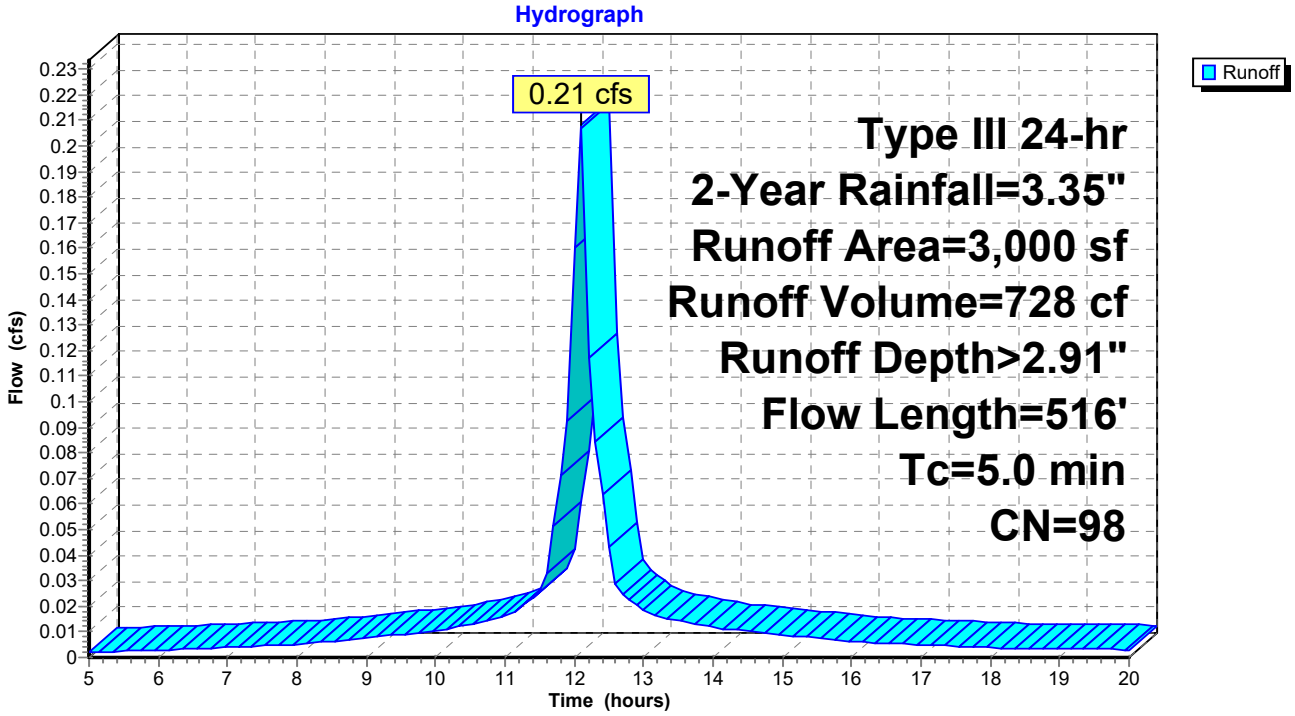
Runoff = 0.21 cfs @ 12.08 hrs, Volume= 728 cf, Depth> 2.91"
Routed to Pond SS1 : Infiltration Trench

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 2-Year Rainfall=3.35"

Area (sf)	CN	Description
3,000	98	Unconnected roofs, HSG B
3,000		100.00% Impervious Area
3,000		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 2P: Proposed Site 2 (New Building)

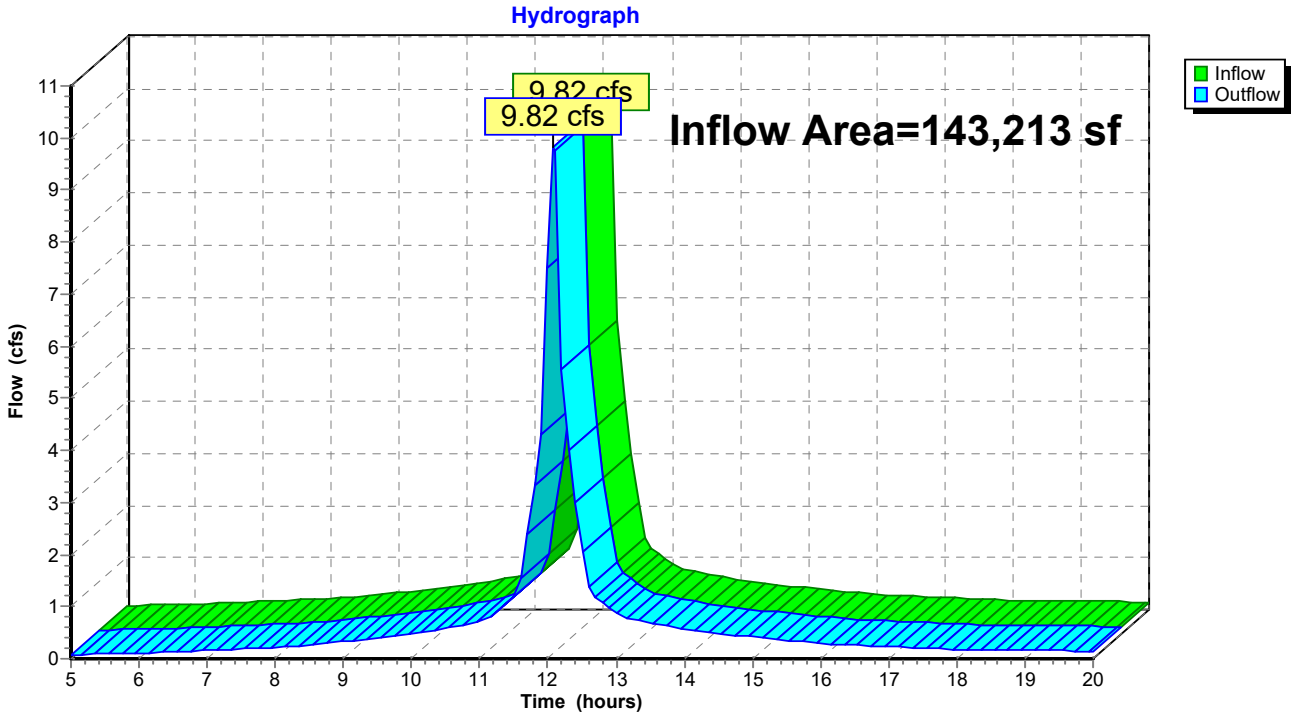


Summary for Reach DP1 PRE: DP1 Pre

Inflow Area = 143,213 sf, 44.33% Impervious, Inflow Depth > 2.83" for 2-Year event
Inflow = 9.82 cfs @ 12.08 hrs, Volume= 33,736 cf
Outflow = 9.82 cfs @ 12.08 hrs, Volume= 33,736 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Reach DP1 PRE: DP1 Pre

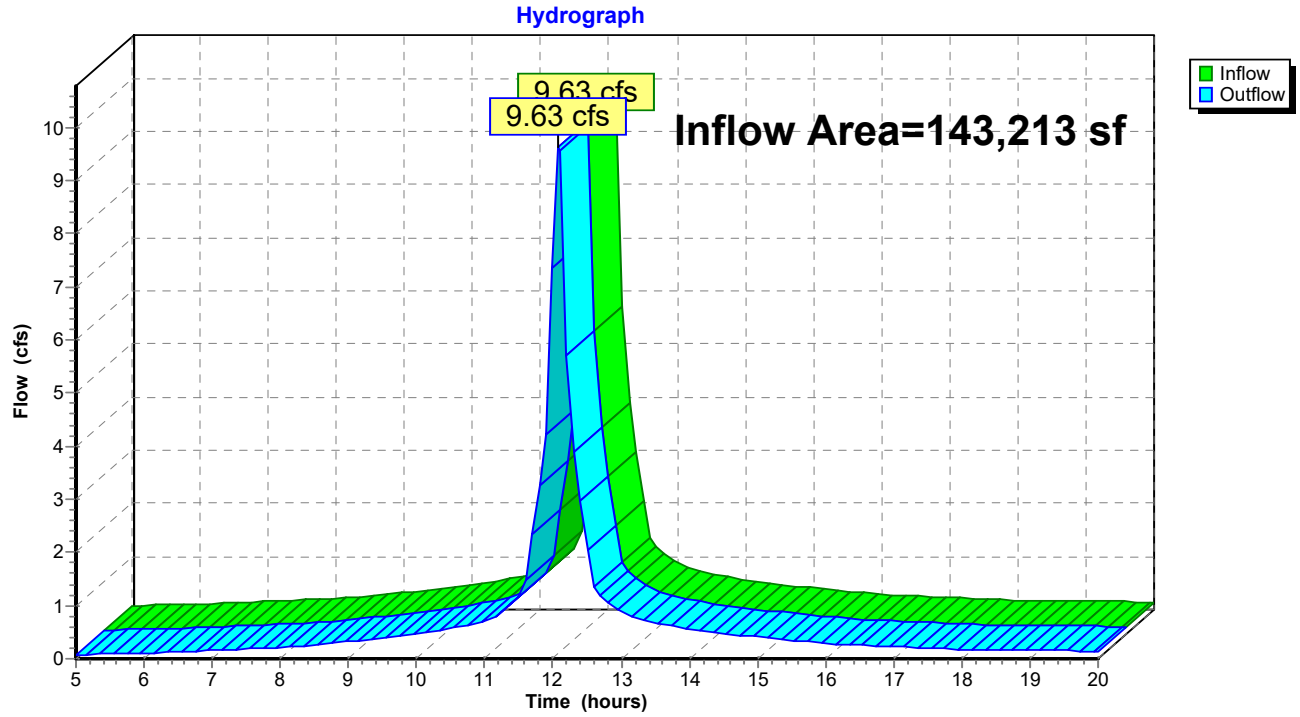


Summary for Reach DP1 PST: DP1 Post

Inflow Area = 143,213 sf, 45.83% Impervious, Inflow Depth > 2.78" for 2-Year event
Inflow = 9.63 cfs @ 12.09 hrs, Volume= 33,202 cf
Outflow = 9.63 cfs @ 12.09 hrs, Volume= 33,202 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Reach DP1 PST: DP1 Post



Summary for Pond SS1: Infiltration Trench

Inflow Area = 3,000 sf,100.00% Impervious, Inflow Depth > 2.91" for 2-Year event
Inflow = 0.21 cfs @ 12.08 hrs, Volume= 728 cf
Outflow = 0.28 cfs @ 12.20 hrs, Volume= 652 cf, Atten= 0%, Lag= 6.8 min
Discarded = 0.01 cfs @ 19.48 hrs, Volume= 479 cf
Primary = 0.27 cfs @ 12.20 hrs, Volume= 173 cf
Routed to Reach DP1 PST : DP1 Post

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Peak Elev= 134.72' @ 12.16 hrs Surf.Area= 450 sf Storage= 187 cf

Plug-Flow detention time= 100.8 min calculated for 647 cf (89% of inflow)
Center-of-Mass det. time= 66.3 min (803.8 - 737.4)

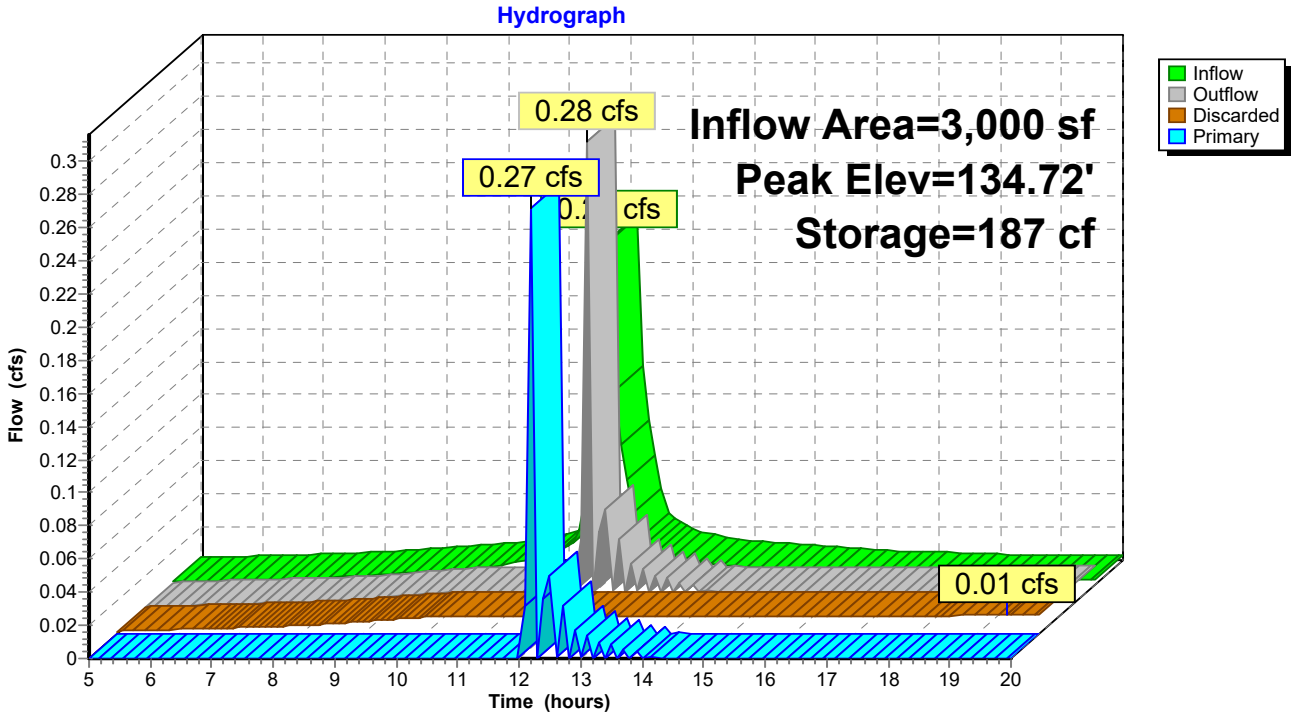
Volume	Invert	Avail.Storage	Storage Description
#1	132.00'	180 cf	**15.00'W x 30.00'L x 1.00'H Prismatoid** 450 cf Overall x 40.0% Voids
#2	132.33'	7 cf	**4.0" Round Pipe Storage** x 3 L= 28.0'
		187 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	132.00'	**1.020 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	135.00'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600 Limited to weir flow at low heads
#3	Primary	134.25'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 19.48 hrs HW=132.50' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.26 cfs @ 12.20 hrs HW=134.57' TW=0.00' (Dynamic Tailwater)
├**2=Orifice/Grate** (Controls 0.00 cfs)
└**3=Orifice/Grate** (Orifice Controls 0.26 cfs @ 1.94 fps)

Pond SS1: Infiltration Trench



Stage-Discharge for Pond SS1: Infiltration Trench

Elevation (feet)	Discharge (cfs)	Discarded (cfs)	Primary (cfs)
132.00	0.00	0.00	0.00
132.05	0.01	0.01	0.00
132.10	0.01	0.01	0.00
132.15	0.01	0.01	0.00
132.20	0.01	0.01	0.00
132.25	0.01	0.01	0.00
132.30	0.01	0.01	0.00
132.35	0.01	0.01	0.00
132.40	0.01	0.01	0.00
132.45	0.01	0.01	0.00
132.50	0.01	**0.01**	0.00
132.55	0.01	0.01	0.00
132.60	0.01	0.01	0.00
132.65	0.01	0.01	0.00
132.70	0.01	0.01	0.00
132.75	0.01	0.01	0.00
132.80	0.01	0.01	0.00
132.85	0.01	0.01	0.00
132.90	0.01	0.01	0.00
132.95	0.01	0.01	0.00
133.00	0.01	0.01	0.00
133.05	0.01	0.01	0.00
133.10	0.01	0.01	0.00
133.15	0.01	0.01	0.00
133.20	0.01	0.01	0.00
133.25	0.01	0.01	0.00
133.30	0.01	0.01	0.00
133.35	0.01	0.01	0.00
133.40	0.01	0.01	0.00
133.45	0.01	0.01	0.00
133.50	0.01	0.01	0.00
133.55	0.01	0.01	0.00
133.60	0.01	0.01	0.00
133.65	0.01	0.01	0.00
133.70	0.01	0.01	0.00
133.75	0.01	0.01	0.00
133.80	0.01	0.01	0.00
133.85	0.01	0.01	0.00
133.90	0.01	0.01	0.00
133.95	0.01	0.01	0.00
134.00	0.01	0.01	0.00
134.05	0.01	0.01	0.00
134.10	0.01	0.01	0.00
134.15	0.01	0.01	0.00
134.20	0.01	0.01	0.00
134.25	0.01	0.01	0.00
134.30	0.02	0.01	0.01
134.35	0.04	0.01	0.03
134.40	0.08	0.01	0.07
134.45	0.12	0.01	0.11
134.50	0.18	0.01	0.17
134.55	0.24	0.01	0.23
134.60	0.31	0.01	0.30
134.65	0.37	0.01	0.36
134.70	0.44	0.01	0.43
134.75	0.48	0.01	0.47
134.80	0.53	0.01	0.52
134.85	0.57	0.01	0.56
134.90	0.61	0.01	0.60
134.95	0.64	0.01	0.63
135.00	0.68	0.01	0.67
135.05	0.74	0.01	0.72
135.10	0.83	0.01	0.82
135.15	0.97	0.01	0.96
135.20	1.14	0.01	1.13
135.25	1.33	0.01	1.32
135.30	1.54	0.01	1.53
135.35	1.77	0.01	1.76
135.40	2.00	0.01	1.98
135.45	2.21	0.01	2.20
135.50	**2.37**	0.01	**2.36**

Stage-Area-Storage for Pond SS1: Infiltration Trench

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
132.00	450	0
132.05	450	9
132.10	450	18
132.15	450	27
132.20	450	36
132.25	450	45
132.30	450	54
132.35	463	63
132.40	473	73
132.45	477	83
132.50	**478**	94
132.55	477	104
132.60	472	114
132.65	461	124
132.70	450	133
132.75	450	142
132.80	450	151
132.85	450	160
132.90	450	169
132.95	450	178
133.00	450	**187**
133.05	450	187
133.10	450	187
133.15	450	187
133.20	450	187
133.25	450	187
133.30	450	187
133.35	450	187
133.40	450	187
133.45	450	187
133.50	450	187
133.55	450	187
133.60	450	187
133.65	450	187
133.70	450	187
133.75	450	187
133.80	450	187
133.85	450	187
133.90	450	187
133.95	450	187
134.00	450	187
134.05	450	187
134.10	450	187
134.15	450	187
134.20	450	187
134.25	450	187
134.30	450	187
134.35	450	187
134.40	450	187
134.45	450	187
134.50	450	187
134.55	450	187
134.60	450	187
134.65	450	187
134.70	450	187
134.75	450	187
134.80	450	187
134.85	450	187
134.90	450	187
134.95	450	187
135.00	450	187
135.05	450	187
135.10	450	187
135.15	450	187
135.20	450	187
135.25	450	187
135.30	450	187
135.35	450	187
135.40	450	187
135.45	450	187
135.50	450	187

Time span=5.00-20.00 hrs, dt=0.10 hrs, 151 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1E: Existing Site 1 Runoff Area=143,213 sf 44.33% Impervious Runoff Depth>4.30"
Flow Length=516' Tc=5.0 min CN=97 Runoff=14.70 cfs 51,300 cf

Subcatchment 1P: Proposed Site 1 Runoff Area=140,213 sf 44.67% Impervious Runoff Depth>4.30"
Flow Length=516' Tc=5.0 min CN=97 Runoff=14.39 cfs 50,226 cf

Subcatchment 2P: Proposed Site 2 (New Runoff Area=3,000 sf 100.00% Impervious Runoff Depth>4.38"
Flow Length=516' Tc=5.0 min CN=98 Runoff=0.31 cfs 1,094 cf

Reach DP1 PRE: DP1 Pre Inflow=14.70 cfs 51,300 cf
Outflow=14.70 cfs 51,300 cf

Reach DP1 PST: DP1 Post Inflow=14.60 cfs 50,680 cf
Outflow=14.60 cfs 50,680 cf

Pond SS1: Infiltration Trench Peak Elev=134.62' Storage=187 cf Inflow=0.31 cfs 1,094 cf
Discarded=0.01 cfs 518 cf Primary=0.34 cfs 455 cf Outflow=0.35 cfs 973 cf

Total Runoff Area = 286,426 sf Runoff Volume = 102,620 cf Average Runoff Depth = 4.30"
54.92% Pervious = 157,300 sf 45.08% Impervious = 129,126 sf

Summary for Subcatchment 1E: Existing Site 1

Runoff = 14.70 cfs @ 12.08 hrs, Volume= 51,300 cf, Depth> 4.30"
Routed to Reach DP1 PRE : DP1 Pre

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 10-Year Rainfall=4.95"

Area (sf)	CN	Description
32,040	98	Paved parking, HSG B
79,725	96	Gravel surface, HSG B
11,149	98	Unconnected roofs, HSG B
20,299	98	Water Surface, HSG B
143,213	97	Weighted Average
79,725		55.67% Pervious Area
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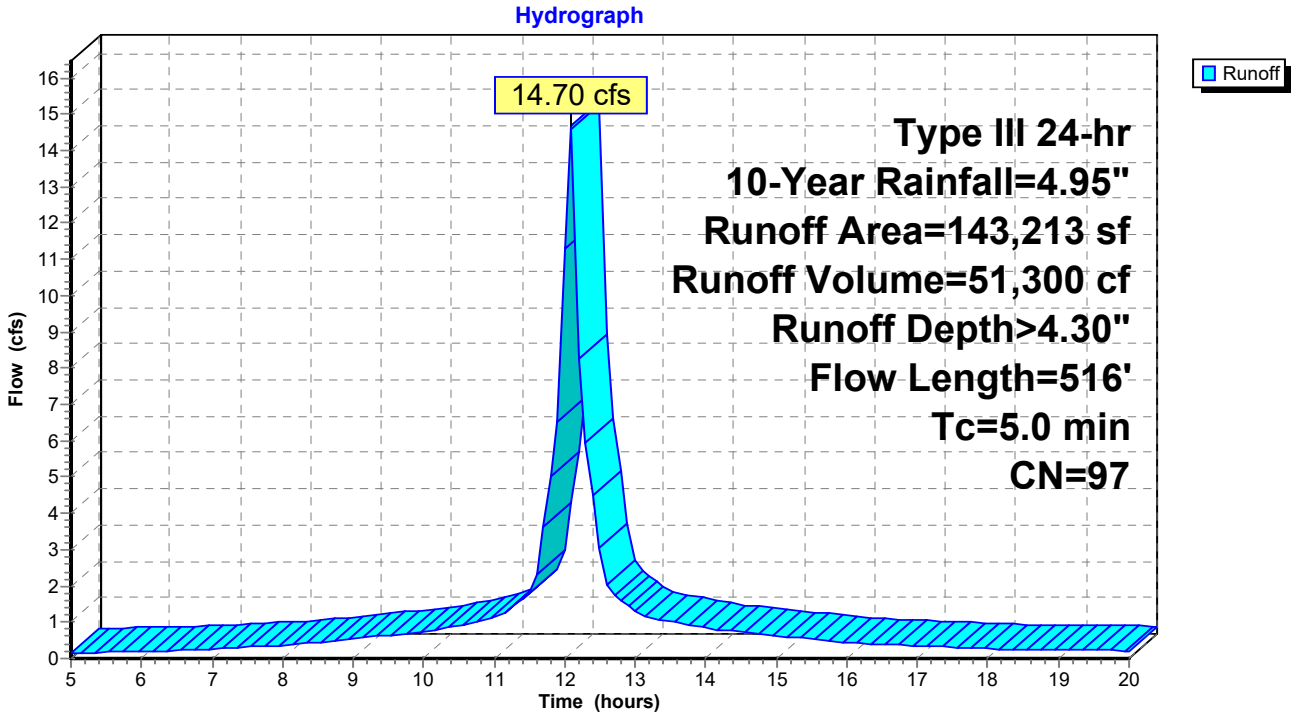
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1E: Existing Site 1



Summary for Subcatchment 1P: Proposed Site 1

Runoff = 14.39 cfs @ 12.08 hrs, Volume= 50,226 cf, Depth> 4.30"
Routed to Reach DP1 PST : DP1 Post

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 10-Year Rainfall=4.95"

Area (sf)	CN	Description
31,190	98	Paved parking, HSG B
77,575	96	Gravel surface, HSG B
11,149	98	Unconnected roofs, HSG B
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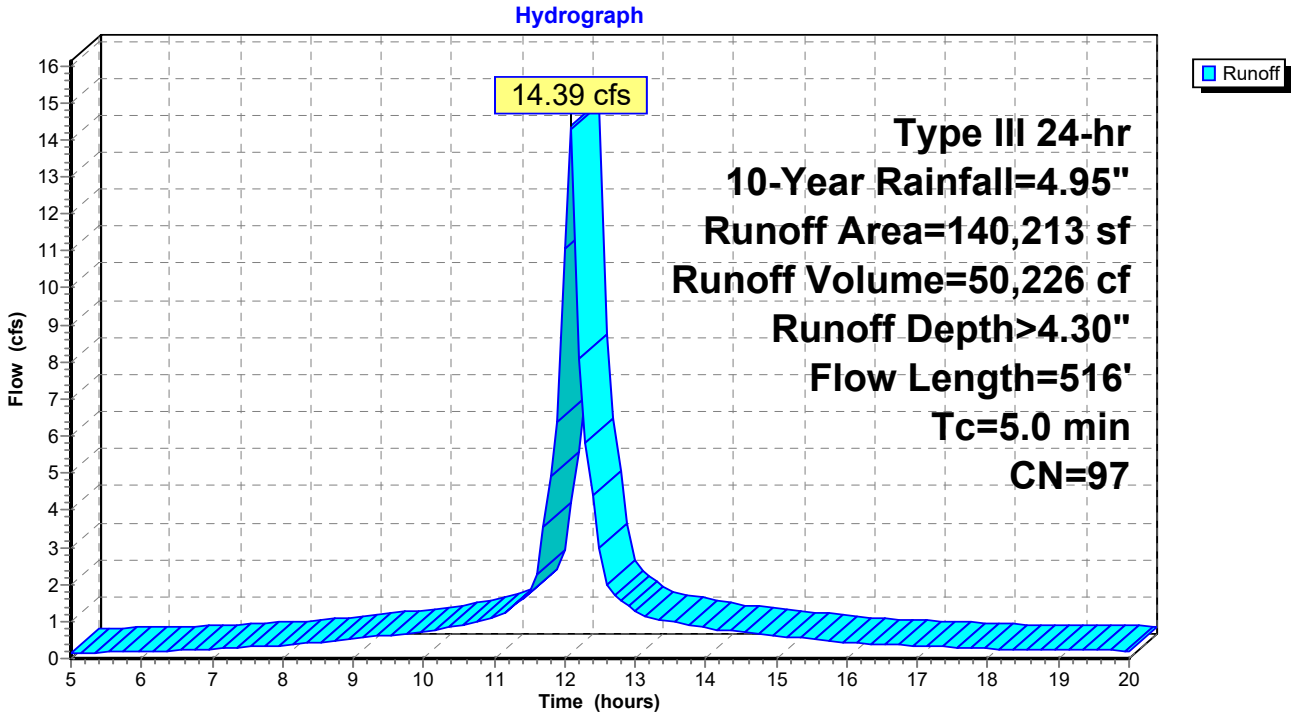
140,213	97	Weighted Average
77,575		55.33% Pervious Area
62,638		44.67% Impervious Area
11,149		17.80% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1P: Proposed Site 1



Summary for Subcatchment 2P: Proposed Site 2 (New Building)

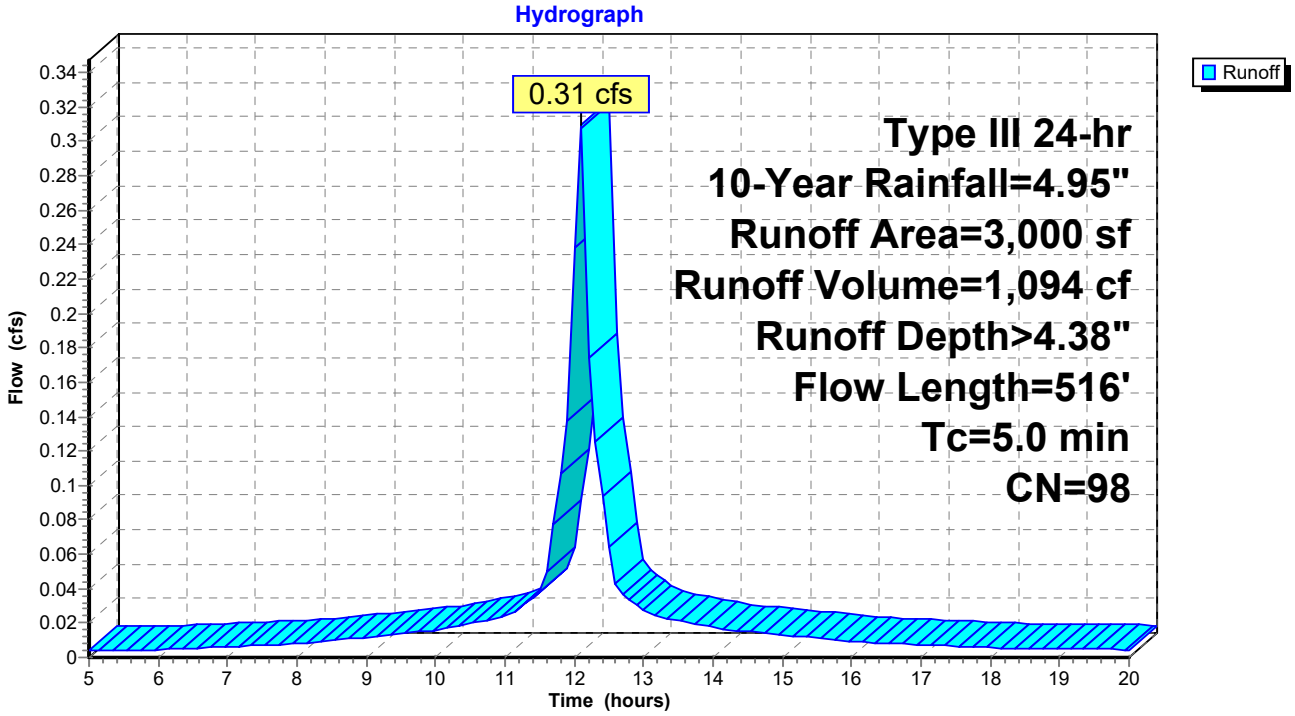
Runoff = 0.31 cfs @ 12.08 hrs, Volume= 1,094 cf, Depth> 4.38"
Routed to Pond SS1 : Infiltration Trench

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 10-Year Rainfall=4.95"

Area (sf)	CN	Description
3,000	98	Unconnected roofs, HSG B
3,000		100.00% Impervious Area
3,000		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 2P: Proposed Site 2 (New Building)

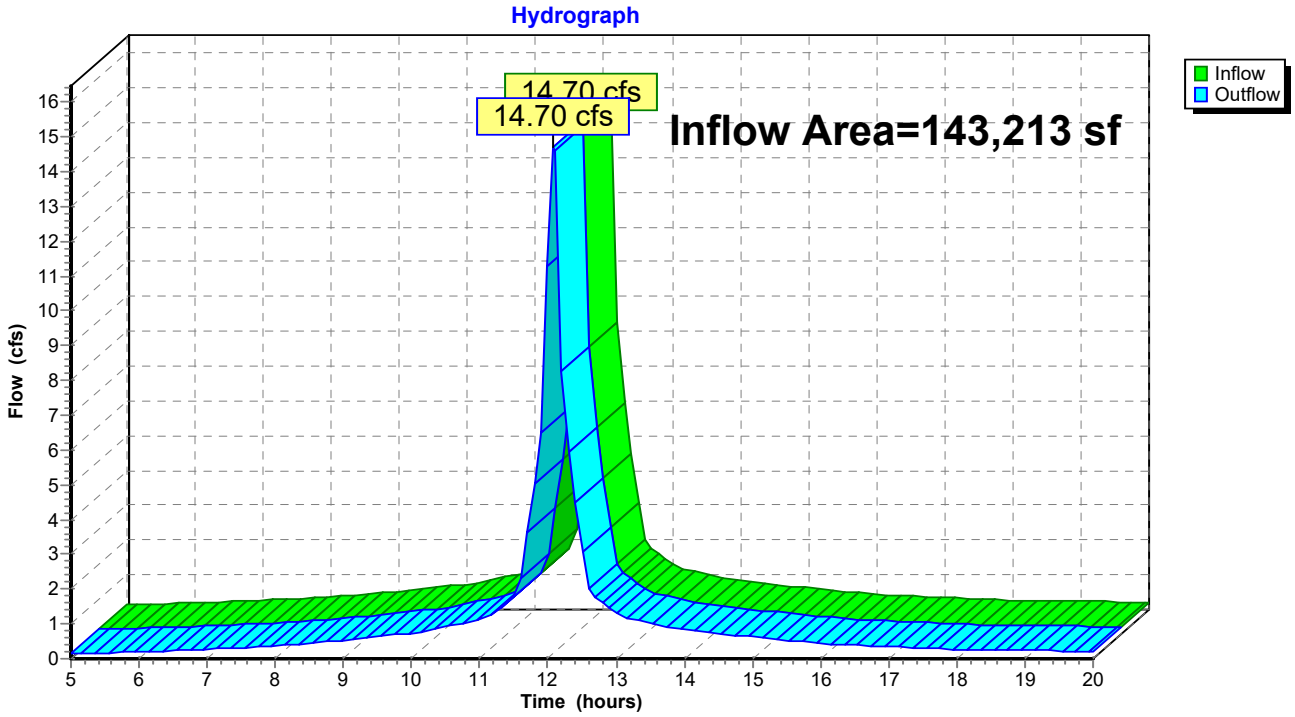


Summary for Reach DP1 PRE: DP1 Pre

Inflow Area = 143,213 sf, 44.33% Impervious, Inflow Depth > 4.30" for 10-Year event
Inflow = 14.70 cfs @ 12.08 hrs, Volume= 51,300 cf
Outflow = 14.70 cfs @ 12.08 hrs, Volume= 51,300 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Reach DP1 PRE: DP1 Pre

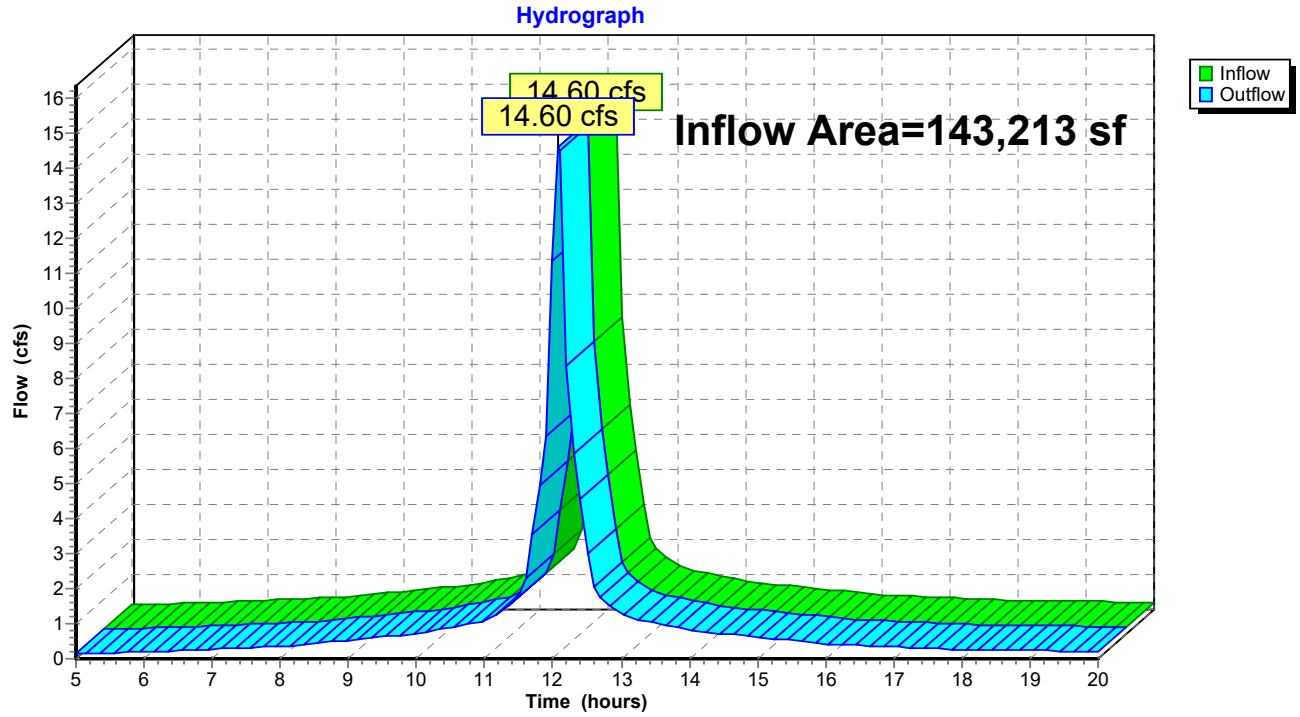


Summary for Reach DP1 PST: DP1 Post

Inflow Area = 143,213 sf, 45.83% Impervious, Inflow Depth > 4.25" for 10-Year event
Inflow = 14.60 cfs @ 12.08 hrs, Volume= 50,680 cf
Outflow = 14.60 cfs @ 12.08 hrs, Volume= 50,680 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Reach DP1 PST: DP1 Post



Summary for Pond SS1: Infiltration Trench

Inflow Area = 3,000 sf,100.00% Impervious, Inflow Depth > 4.38" for 10-Year event
Inflow = 0.31 cfs @ 12.08 hrs, Volume= 1,094 cf
Outflow = 0.35 cfs @ 12.02 hrs, Volume= 973 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.01 cfs @ 11.57 hrs, Volume= 518 cf
Primary = 0.34 cfs @ 12.02 hrs, Volume= 455 cf
Routed to Reach DP1 PST : DP1 Post

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Peak Elev= 134.62' @ 12.00 hrs Surf.Area= 450 sf Storage= 187 cf

Plug-Flow detention time= 73.5 min calculated for 973 cf (89% of inflow)
Center-of-Mass det. time= 36.2 min (770.6 - 734.5)

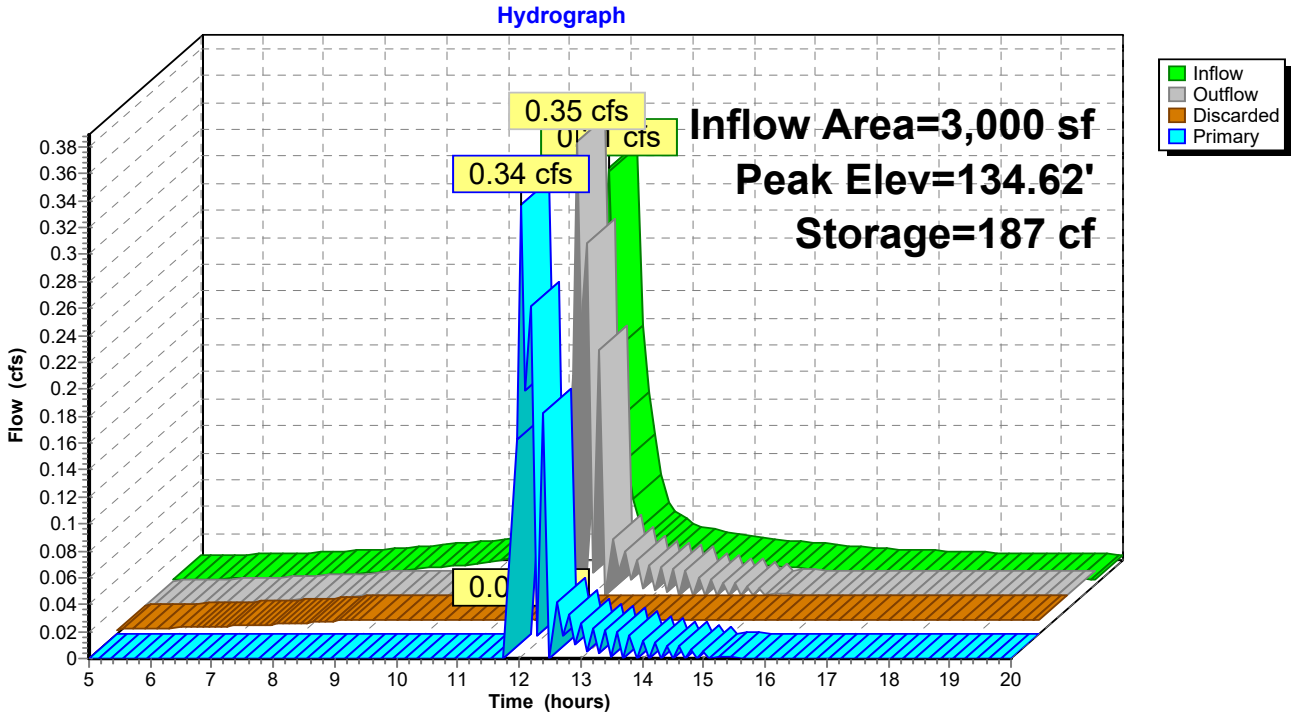
Volume	Invert	Avail.Storage	Storage Description
#1	132.00'	180 cf	**15.00'W x 30.00'L x 1.00'H Prismatoid** 450 cf Overall x 40.0% Voids
#2	132.33'	7 cf	**4.0" Round Pipe Storage** x 3 L= 28.0'
		187 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	132.00'	**1.020 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	135.00'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600 Limited to weir flow at low heads
#3	Primary	134.25'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 11.57 hrs HW=132.48' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.30 cfs @ 12.02 hrs HW=134.60' TW=0.00' (Dynamic Tailwater)
├**2=Orifice/Grate** (Controls 0.00 cfs)
└**3=Orifice/Grate** (Orifice Controls 0.30 cfs @ 2.02 fps)

Pond SS1: Infiltration Trench



Stage-Discharge for Pond SS1: Infiltration Trench

Elevation (feet)	Discharge (cfs)	Discarded (cfs)	Primary (cfs)
132.00	0.00	0.00	0.00
132.05	0.01	0.01	0.00
132.10	0.01	0.01	0.00
132.15	0.01	0.01	0.00
132.20	0.01	0.01	0.00
132.25	0.01	0.01	0.00
132.30	0.01	0.01	0.00
132.35	0.01	0.01	0.00
132.40	0.01	0.01	0.00
132.45	0.01	0.01	0.00
132.50	0.01	**0.01**	0.00
132.55	0.01	0.01	0.00
132.60	0.01	0.01	0.00
132.65	0.01	0.01	0.00
132.70	0.01	0.01	0.00
132.75	0.01	0.01	0.00
132.80	0.01	0.01	0.00
132.85	0.01	0.01	0.00
132.90	0.01	0.01	0.00
132.95	0.01	0.01	0.00
133.00	0.01	0.01	0.00
133.05	0.01	0.01	0.00
133.10	0.01	0.01	0.00
133.15	0.01	0.01	0.00
133.20	0.01	0.01	0.00
133.25	0.01	0.01	0.00
133.30	0.01	0.01	0.00
133.35	0.01	0.01	0.00
133.40	0.01	0.01	0.00
133.45	0.01	0.01	0.00
133.50	0.01	0.01	0.00
133.55	0.01	0.01	0.00
133.60	0.01	0.01	0.00
133.65	0.01	0.01	0.00
133.70	0.01	0.01	0.00
133.75	0.01	0.01	0.00
133.80	0.01	0.01	0.00
133.85	0.01	0.01	0.00
133.90	0.01	0.01	0.00
133.95	0.01	0.01	0.00
134.00	0.01	0.01	0.00
134.05	0.01	0.01	0.00
134.10	0.01	0.01	0.00
134.15	0.01	0.01	0.00
134.20	0.01	0.01	0.00
134.25	0.01	0.01	0.00
134.30	0.02	0.01	0.01
134.35	0.04	0.01	0.03
134.40	0.08	0.01	0.07
134.45	0.12	0.01	0.11
134.50	0.18	0.01	0.17
134.55	0.24	0.01	0.23
134.60	0.31	0.01	0.30
134.65	0.37	0.01	0.36
134.70	0.44	0.01	0.43
134.75	0.48	0.01	0.47
134.80	0.53	0.01	0.52
134.85	0.57	0.01	0.56
134.90	0.61	0.01	0.60
134.95	0.64	0.01	0.63
135.00	0.68	0.01	0.67
135.05	0.74	0.01	0.72
135.10	0.83	0.01	0.82
135.15	0.97	0.01	0.96
135.20	1.14	0.01	1.13
135.25	1.33	0.01	1.32
135.30	1.54	0.01	1.53
135.35	1.77	0.01	1.76
135.40	2.00	0.01	1.98
135.45	2.21	0.01	2.20
135.50	**2.37**	0.01	**2.36**

Stage-Area-Storage for Pond SS1: Infiltration Trench

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
132.00	450	0
132.05	450	9
132.10	450	18
132.15	450	27
132.20	450	36
132.25	450	45
132.30	450	54
132.35	463	63
132.40	473	73
132.45	477	83
132.50	**478**	94
132.55	477	104
132.60	472	114
132.65	461	124
132.70	450	133
132.75	450	142
132.80	450	151
132.85	450	160
132.90	450	169
132.95	450	178
133.00	450	**187**
133.05	450	187
133.10	450	187
133.15	450	187
133.20	450	187
133.25	450	187
133.30	450	187
133.35	450	187
133.40	450	187
133.45	450	187
133.50	450	187
133.55	450	187
133.60	450	187
133.65	450	187
133.70	450	187
133.75	450	187
133.80	450	187
133.85	450	187
133.90	450	187
133.95	450	187
134.00	450	187
134.05	450	187
134.10	450	187
134.15	450	187
134.20	450	187
134.25	450	187
134.30	450	187
134.35	450	187
134.40	450	187
134.45	450	187
134.50	450	187
134.55	450	187
134.60	450	187
134.65	450	187
134.70	450	187
134.75	450	187
134.80	450	187
134.85	450	187
134.90	450	187
134.95	450	187
135.00	450	187
135.05	450	187
135.10	450	187
135.15	450	187
135.20	450	187
135.25	450	187
135.30	450	187
135.35	450	187
135.40	450	187
135.45	450	187
135.50	450	187

Time span=5.00-20.00 hrs, dt=0.10 hrs, 151 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1E: Existing Site 1 Runoff Area=143,213 sf 44.33% Impervious Runoff Depth>5.43"
Flow Length=516' Tc=5.0 min CN=97 Runoff=18.46 cfs 64,856 cf

Subcatchment 1P: Proposed Site 1 Runoff Area=140,213 sf 44.67% Impervious Runoff Depth>5.43"
Flow Length=516' Tc=5.0 min CN=97 Runoff=18.08 cfs 63,497 cf

Subcatchment 2P: Proposed Site 2 (New Runoff Area=3,000 sf 100.00% Impervious Runoff Depth>5.51"
Flow Length=516' Tc=5.0 min CN=98 Runoff=0.39 cfs 1,376 cf

Reach DP1 PRE: DP1 Pre Inflow=18.46 cfs 64,856 cf
Outflow=18.46 cfs 64,856 cf

Reach DP1 PST: DP1 Post Inflow=18.44 cfs 64,189 cf
Outflow=18.44 cfs 64,189 cf

Pond SS1: Infiltration Trench Peak Elev=134.65' Storage=187 cf Inflow=0.39 cfs 1,376 cf
Discarded=0.01 cfs 541 cf Primary=0.36 cfs 692 cf Outflow=0.37 cfs 1,232 cf

Total Runoff Area = 286,426 sf Runoff Volume = 129,729 cf Average Runoff Depth = 5.44"
54.92% Pervious = 157,300 sf 45.08% Impervious = 129,126 sf

Summary for Subcatchment 1E: Existing Site 1

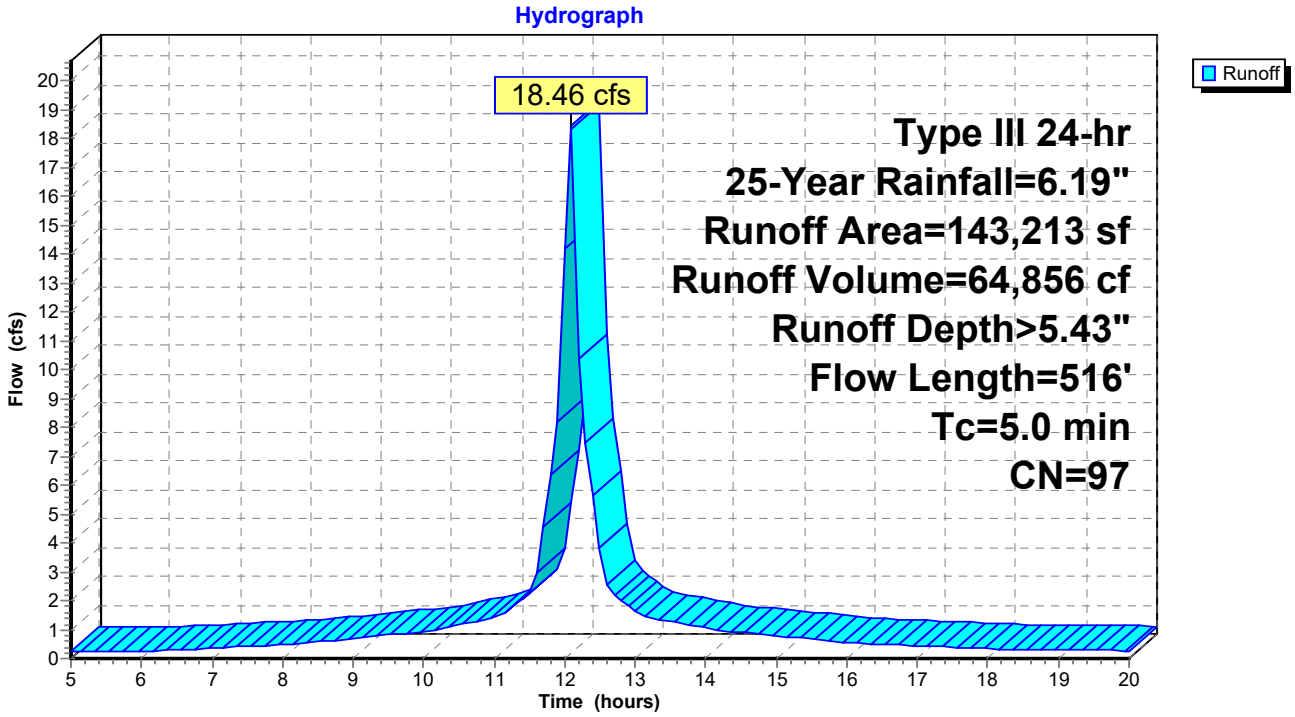
Runoff = 18.46 cfs @ 12.08 hrs, Volume= 64,856 cf, Depth> 5.43"
Routed to Reach DP1 PRE : DP1 Pre

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 25-Year Rainfall=6.19"

Area (sf)	CN	Description
32,040	98	Paved parking, HSG B
79,725	96	Gravel surface, HSG B
11,149	98	Unconnected roofs, HSG B
20,299	98	Water Surface, HSG B
143,213	97	Weighted Average
79,725		55.67% Pervious Area
63,488		44.33% Impervious Area
11,149		17.56% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1E: Existing Site 1



Summary for Subcatchment 1P: Proposed Site 1

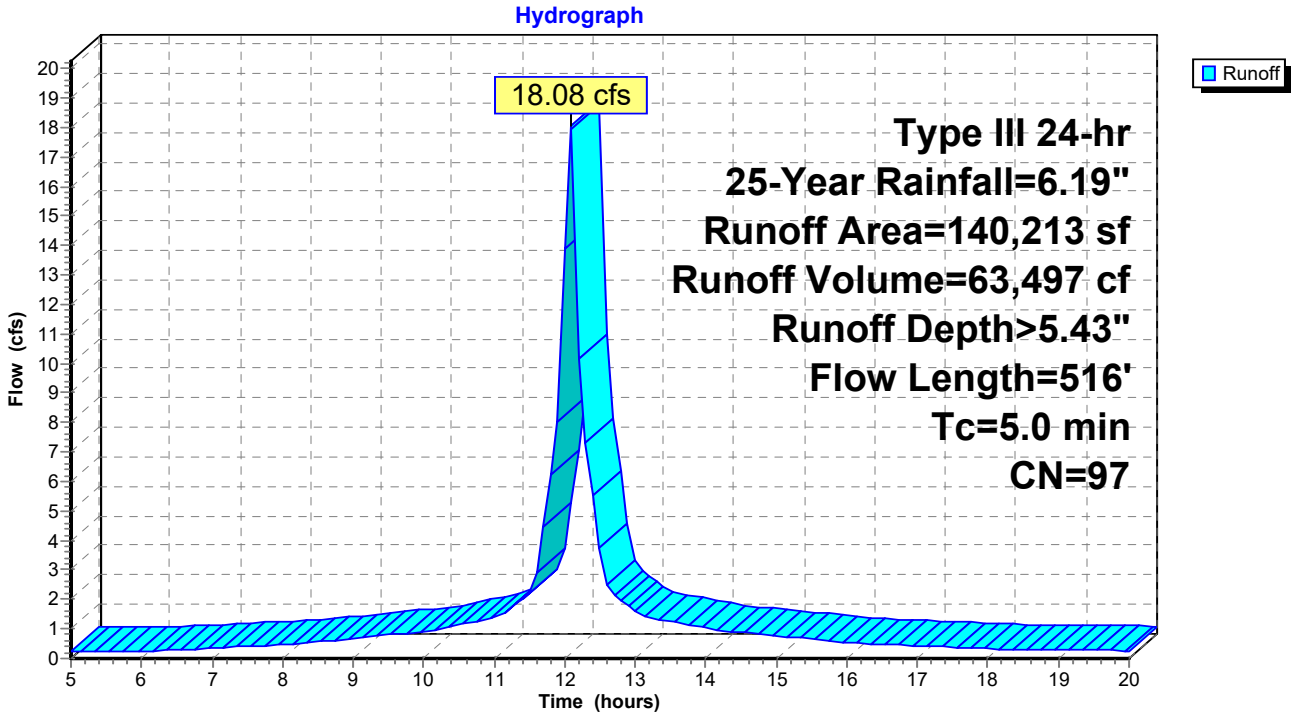
Runoff = 18.08 cfs @ 12.08 hrs, Volume= 63,497 cf, Depth> 5.43"
Routed to Reach DP1 PST : DP1 Post

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 25-Year Rainfall=6.19"

Area (sf)	CN	Description
31,190	98	Paved parking, HSG B
77,575	96	Gravel surface, HSG B
11,149	98	Unconnected roofs, HSG B
20,299	98	Water Surface, HSG B
140,213	97	Weighted Average
77,575		55.33% Pervious Area
62,638		44.67% Impervious Area
11,149		17.80% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1P: Proposed Site 1



Summary for Subcatchment 2P: Proposed Site 2 (New Building)

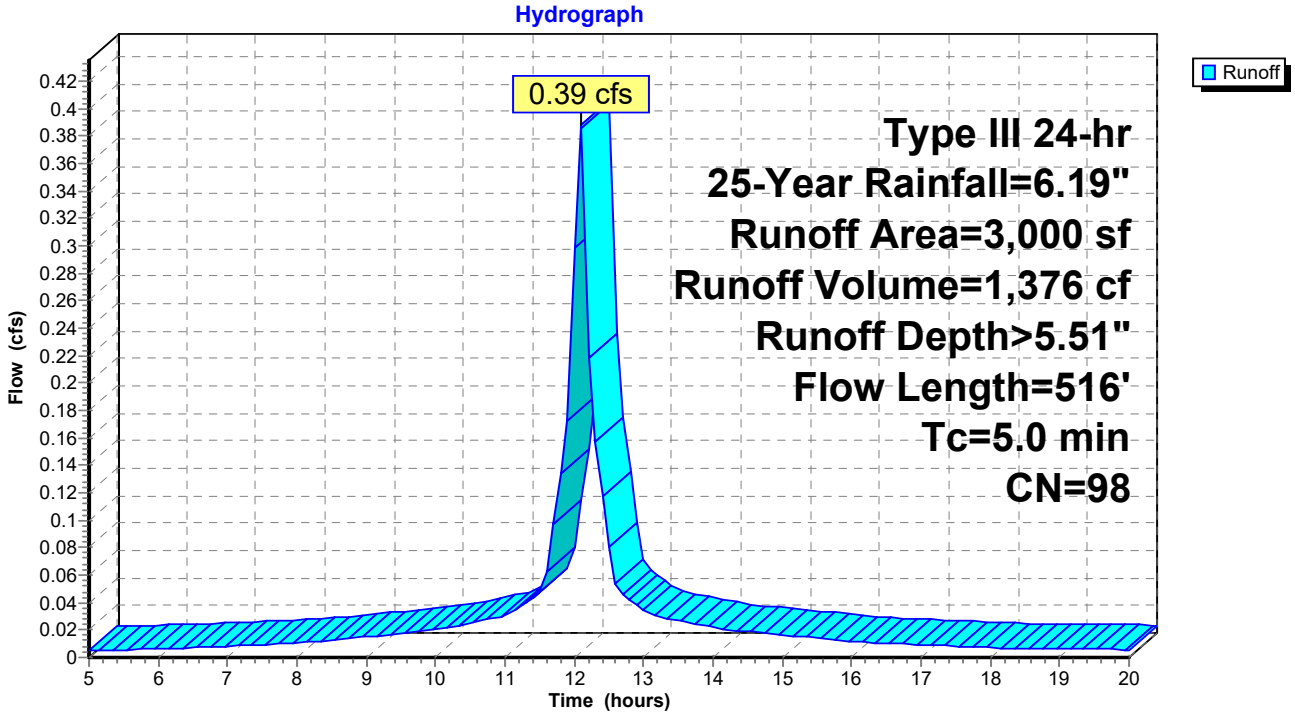
Runoff = 0.39 cfs @ 12.08 hrs, Volume= 1,376 cf, Depth> 5.51"
Routed to Pond SS1 : Infiltration Trench

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 25-Year Rainfall=6.19"

Area (sf)	CN	Description
3,000	98	Unconnected roofs, HSG B
3,000		100.00% Impervious Area
3,000		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 2P: Proposed Site 2 (New Building)

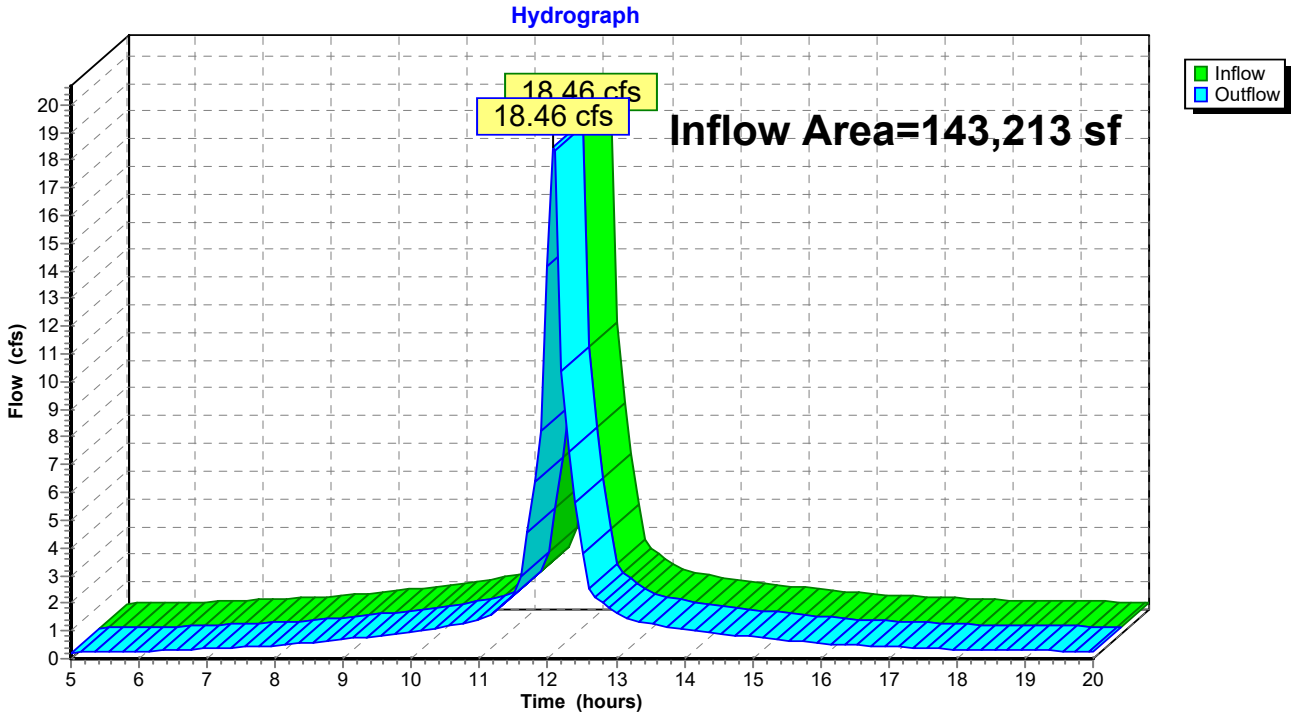


Summary for Reach DP1 PRE: DP1 Pre

Inflow Area = 143,213 sf, 44.33% Impervious, Inflow Depth > 5.43" for 25-Year event
Inflow = 18.46 cfs @ 12.08 hrs, Volume= 64,856 cf
Outflow = 18.46 cfs @ 12.08 hrs, Volume= 64,856 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Reach DP1 PRE: DP1 Pre

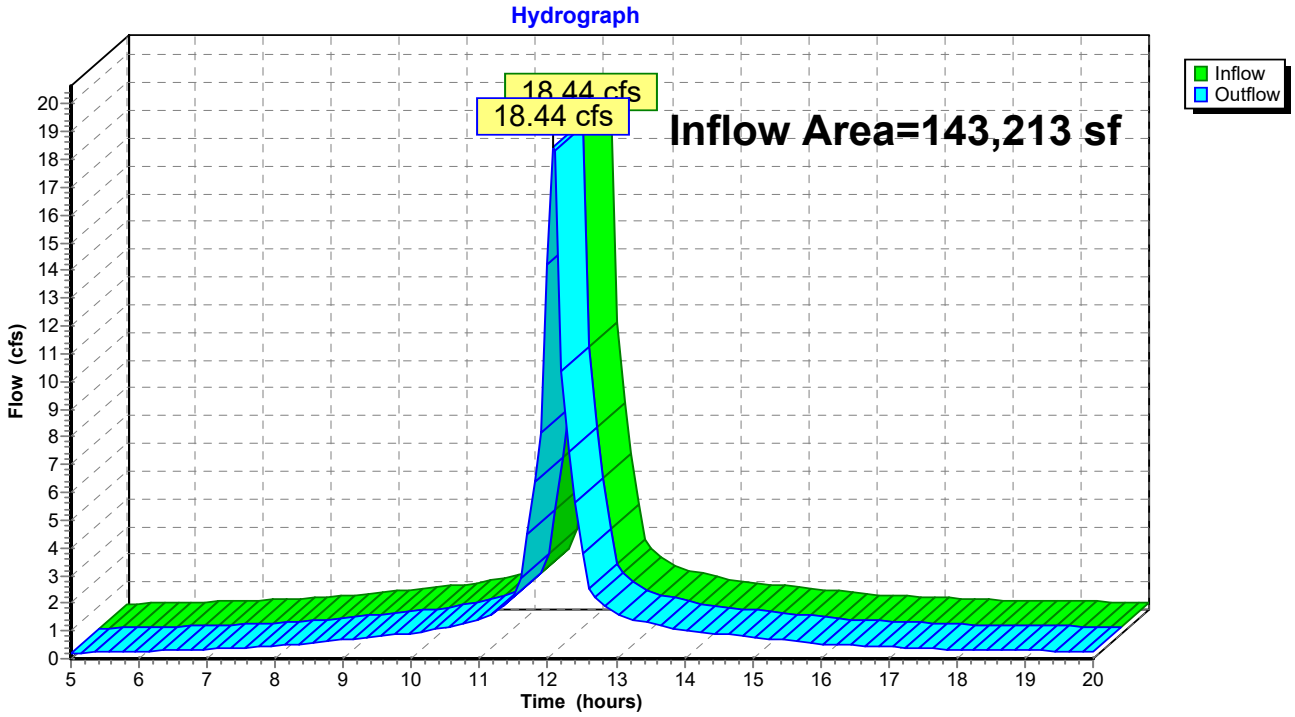


Summary for Reach DP1 PST: DP1 Post

Inflow Area = 143,213 sf, 45.83% Impervious, Inflow Depth > 5.38" for 25-Year event
Inflow = 18.44 cfs @ 12.08 hrs, Volume= 64,189 cf
Outflow = 18.44 cfs @ 12.08 hrs, Volume= 64,189 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Reach DP1 PST: DP1 Post



Summary for Pond SS1: Infiltration Trench

Inflow Area = 3,000 sf,100.00% Impervious, Inflow Depth > 5.51" for 25-Year event
Inflow = 0.39 cfs @ 12.08 hrs, Volume= 1,376 cf
Outflow = 0.37 cfs @ 12.08 hrs, Volume= 1,232 cf, Atten= 4%, Lag= 0.0 min
Discarded = 0.01 cfs @ 11.10 hrs, Volume= 541 cf
Primary = 0.36 cfs @ 12.08 hrs, Volume= 692 cf
Routed to Reach DP1 PST : DP1 Post

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Peak Elev= 134.65' @ 12.08 hrs Surf.Area= 450 sf Storage= 187 cf

Plug-Flow detention time= 60.9 min calculated for 1,224 cf (89% of inflow)
Center-of-Mass det. time= 26.5 min (759.8 - 733.3)

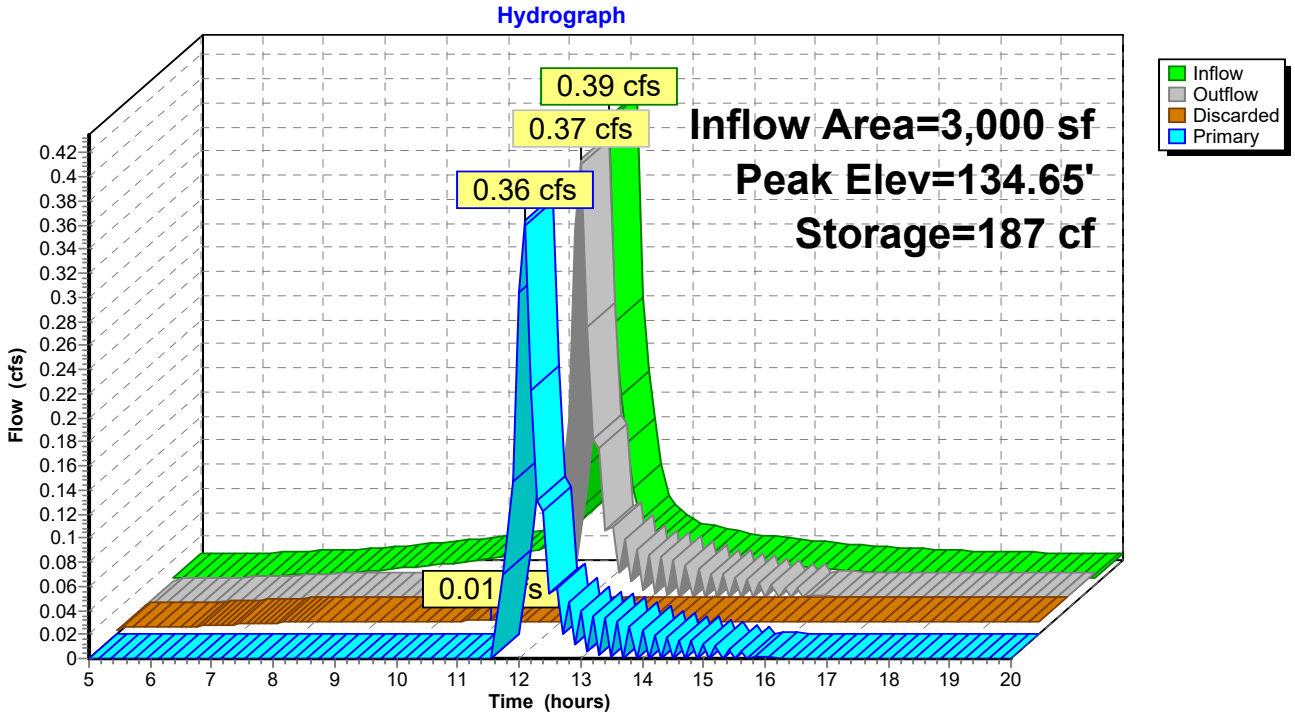
Volume	Invert	Avail.Storage	Storage Description
#1	132.00'	180 cf	**15.00'W x 30.00'L x 1.00'H Prismatoid** 450 cf Overall x 40.0% Voids
#2	132.33'	7 cf	**4.0" Round Pipe Storage** x 3 L= 28.0'
		187 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	132.00'	**1.020 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	135.00'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600 Limited to weir flow at low heads
#3	Primary	134.25'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 11.10 hrs HW=132.49' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.35 cfs @ 12.08 hrs HW=134.64' TW=0.00' (Dynamic Tailwater)
├**2=Orifice/Grate** (Controls 0.00 cfs)
└**3=Orifice/Grate** (Orifice Controls 0.35 cfs @ 2.12 fps)

Pond SS1: Infiltration Trench



Stage-Discharge for Pond SS1: Infiltration Trench

Elevation (feet)	Discharge (cfs)	Discarded (cfs)	Primary (cfs)
132.00	0.00	0.00	0.00
132.05	0.01	0.01	0.00
132.10	0.01	0.01	0.00
132.15	0.01	0.01	0.00
132.20	0.01	0.01	0.00
132.25	0.01	0.01	0.00
132.30	0.01	0.01	0.00
132.35	0.01	0.01	0.00
132.40	0.01	0.01	0.00
132.45	0.01	0.01	0.00
132.50	0.01	**0.01**	0.00
132.55	0.01	0.01	0.00
132.60	0.01	0.01	0.00
132.65	0.01	0.01	0.00
132.70	0.01	0.01	0.00
132.75	0.01	0.01	0.00
132.80	0.01	0.01	0.00
132.85	0.01	0.01	0.00
132.90	0.01	0.01	0.00
132.95	0.01	0.01	0.00
133.00	0.01	0.01	0.00
133.05	0.01	0.01	0.00
133.10	0.01	0.01	0.00
133.15	0.01	0.01	0.00
133.20	0.01	0.01	0.00
133.25	0.01	0.01	0.00
133.30	0.01	0.01	0.00
133.35	0.01	0.01	0.00
133.40	0.01	0.01	0.00
133.45	0.01	0.01	0.00
133.50	0.01	0.01	0.00
133.55	0.01	0.01	0.00
133.60	0.01	0.01	0.00
133.65	0.01	0.01	0.00
133.70	0.01	0.01	0.00
133.75	0.01	0.01	0.00
133.80	0.01	0.01	0.00
133.85	0.01	0.01	0.00
133.90	0.01	0.01	0.00
133.95	0.01	0.01	0.00
134.00	0.01	0.01	0.00
134.05	0.01	0.01	0.00
134.10	0.01	0.01	0.00
134.15	0.01	0.01	0.00
134.20	0.01	0.01	0.00
134.25	0.01	0.01	0.00
134.30	0.02	0.01	0.01
134.35	0.04	0.01	0.03
134.40	0.08	0.01	0.07
134.45	0.12	0.01	0.11
134.50	0.18	0.01	0.17
134.55	0.24	0.01	0.23
134.60	0.31	0.01	0.30
134.65	0.37	0.01	0.36
134.70	0.44	0.01	0.43
134.75	0.48	0.01	0.47
134.80	0.53	0.01	0.52
134.85	0.57	0.01	0.56
134.90	0.61	0.01	0.60
134.95	0.64	0.01	0.63
135.00	0.68	0.01	0.67
135.05	0.74	0.01	0.72
135.10	0.83	0.01	0.82
135.15	0.97	0.01	0.96
135.20	1.14	0.01	1.13
135.25	1.33	0.01	1.32
135.30	1.54	0.01	1.53
135.35	1.77	0.01	1.76
135.40	2.00	0.01	1.98
135.45	2.21	0.01	2.20
135.50	**2.37**	0.01	**2.36**

Stage-Area-Storage for Pond SS1: Infiltration Trench

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
132.00	450	0
132.05	450	9
132.10	450	18
132.15	450	27
132.20	450	36
132.25	450	45
132.30	450	54
132.35	463	63
132.40	473	73
132.45	477	83
132.50	**478**	94
132.55	477	104
132.60	472	114
132.65	461	124
132.70	450	133
132.75	450	142
132.80	450	151
132.85	450	160
132.90	450	169
132.95	450	178
133.00	450	**187**
133.05	450	187
133.10	450	187
133.15	450	187
133.20	450	187
133.25	450	187
133.30	450	187
133.35	450	187
133.40	450	187
133.45	450	187
133.50	450	187
133.55	450	187
133.60	450	187
133.65	450	187
133.70	450	187
133.75	450	187
133.80	450	187
133.85	450	187
133.90	450	187
133.95	450	187
134.00	450	187
134.05	450	187
134.10	450	187
134.15	450	187
134.20	450	187
134.25	450	187
134.30	450	187
134.35	450	187
134.40	450	187
134.45	450	187
134.50	450	187
134.55	450	187
134.60	450	187
134.65	450	187
134.70	450	187
134.75	450	187
134.80	450	187
134.85	450	187
134.90	450	187
134.95	450	187
135.00	450	187
135.05	450	187
135.10	450	187
135.15	450	187
135.20	450	187
135.25	450	187
135.30	450	187
135.35	450	187
135.40	450	187
135.45	450	187
135.50	450	187

Time span=5.00-20.00 hrs, dt=0.10 hrs, 151 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1E: Existing Site 1 Runoff Area=143,213 sf 44.33% Impervious Runoff Depth>7.71"
Flow Length=516' Tc=5.0 min CN=97 Runoff=25.99 cfs 91,967 cf

Subcatchment 1P: Proposed Site 1 Runoff Area=140,213 sf 44.67% Impervious Runoff Depth>7.71"
Flow Length=516' Tc=5.0 min CN=97 Runoff=25.45 cfs 90,041 cf

Subcatchment 2P: Proposed Site 2 (New Runoff Area=3,000 sf 100.00% Impervious Runoff Depth>7.77"
Flow Length=516' Tc=5.0 min CN=98 Runoff=0.55 cfs 1,942 cf

Reach DP1 PRE: DP1 Pre Inflow=25.99 cfs 91,967 cf
Outflow=25.99 cfs 91,967 cf

Reach DP1 PST: DP1 Post Inflow=25.97 cfs 91,242 cf
Outflow=25.97 cfs 91,242 cf

Pond SS1: Infiltration Trench Peak Elev=134.80' Storage=187 cf Inflow=0.55 cfs 1,942 cf
Discarded=0.01 cfs 567 cf Primary=0.52 cfs 1,201 cf Outflow=0.53 cfs 1,768 cf

Total Runoff Area = 286,426 sf Runoff Volume = 183,950 cf Average Runoff Depth = 7.71"
54.92% Pervious = 157,300 sf 45.08% Impervious = 129,126 sf

Summary for Subcatchment 1E: Existing Site 1

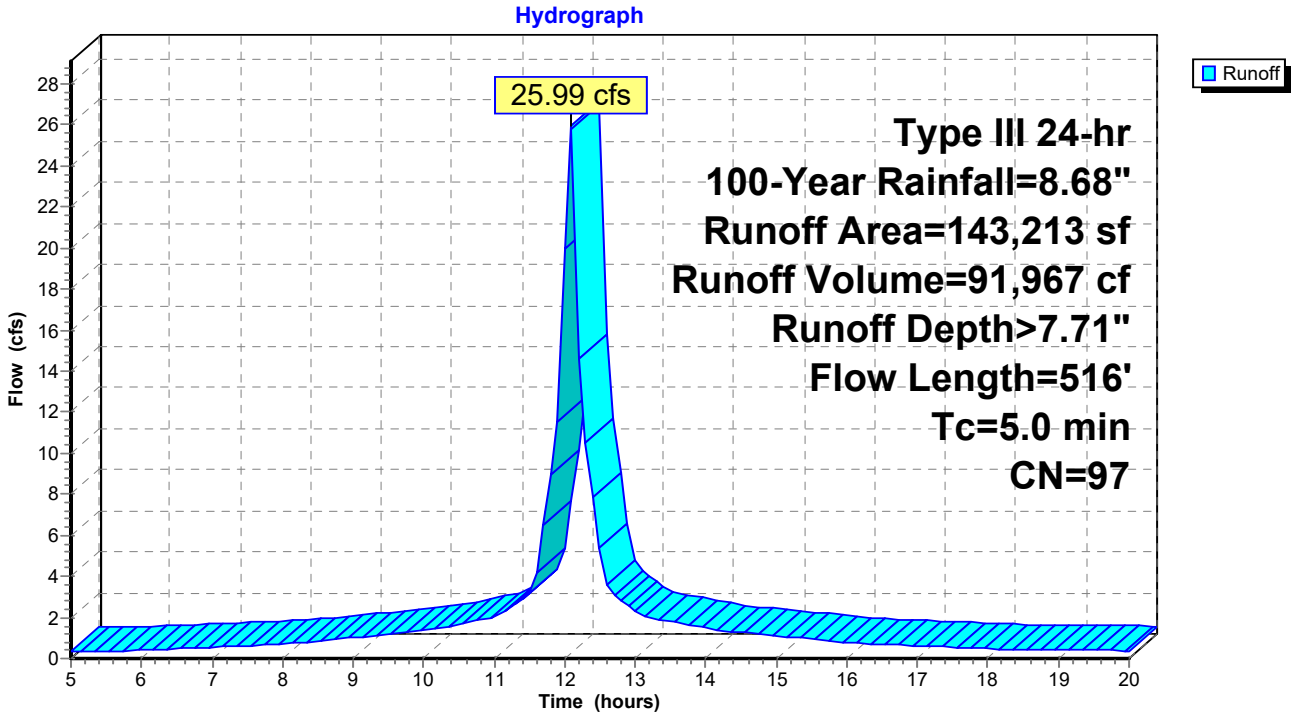
Runoff = 25.99 cfs @ 12.08 hrs, Volume= 91,967 cf, Depth> 7.71"
Routed to Reach DP1 PRE : DP1 Pre

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 100-Year Rainfall=8.68"

Area (sf)	CN	Description
32,040	98	Paved parking, HSG B
79,725	96	Gravel surface, HSG B
11,149	98	Unconnected roofs, HSG B
20,299	98	Water Surface, HSG B
143,213	97	Weighted Average
79,725		55.67% Pervious Area
63,488		44.33% Impervious Area
11,149		17.56% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1E: Existing Site 1



Summary for Subcatchment 1P: Proposed Site 1

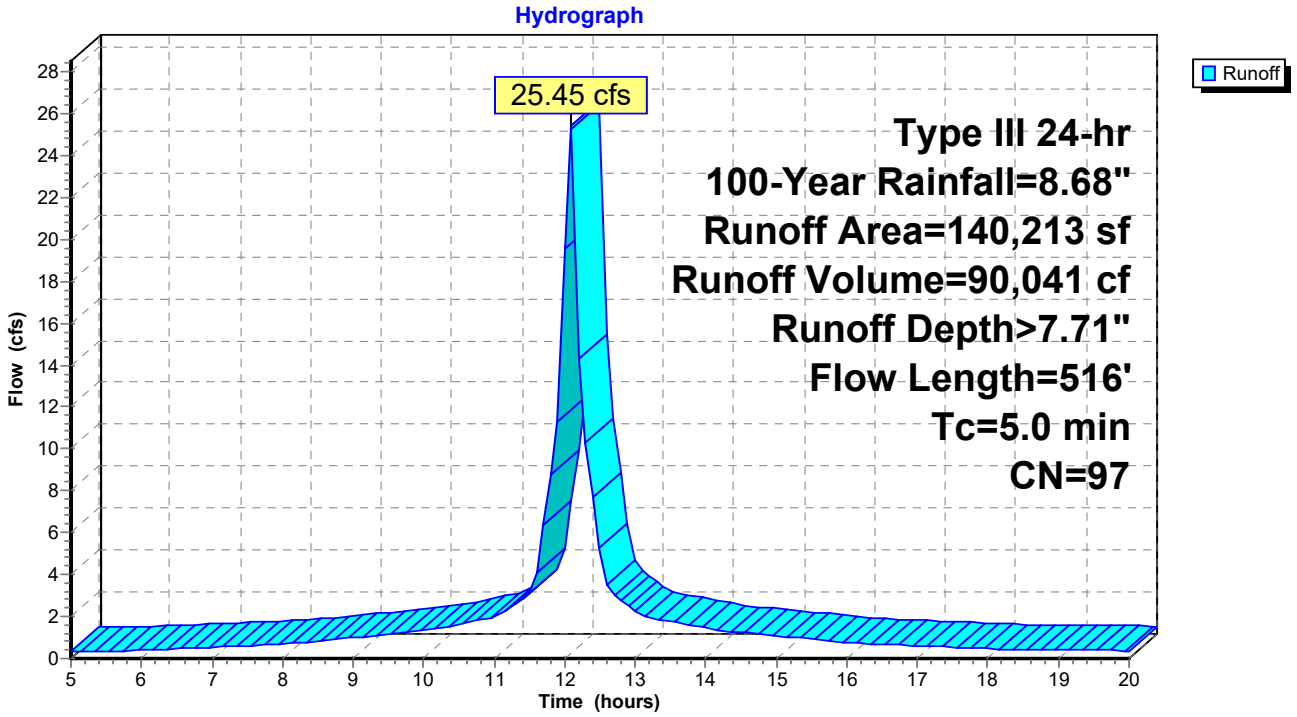
Runoff = 25.45 cfs @ 12.08 hrs, Volume= 90,041 cf, Depth> 7.71"
Routed to Reach DP1 PST : DP1 Post

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 100-Year Rainfall=8.68"

Area (sf)	CN	Description
31,190	98	Paved parking, HSG B
77,575	96	Gravel surface, HSG B
11,149	98	Unconnected roofs, HSG B
20,299	98	Water Surface, HSG B
140,213	97	Weighted Average
77,575		55.33% Pervious Area
62,638		44.67% Impervious Area
11,149		17.80% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1P: Proposed Site 1



Summary for Subcatchment 2P: Proposed Site 2 (New Building)

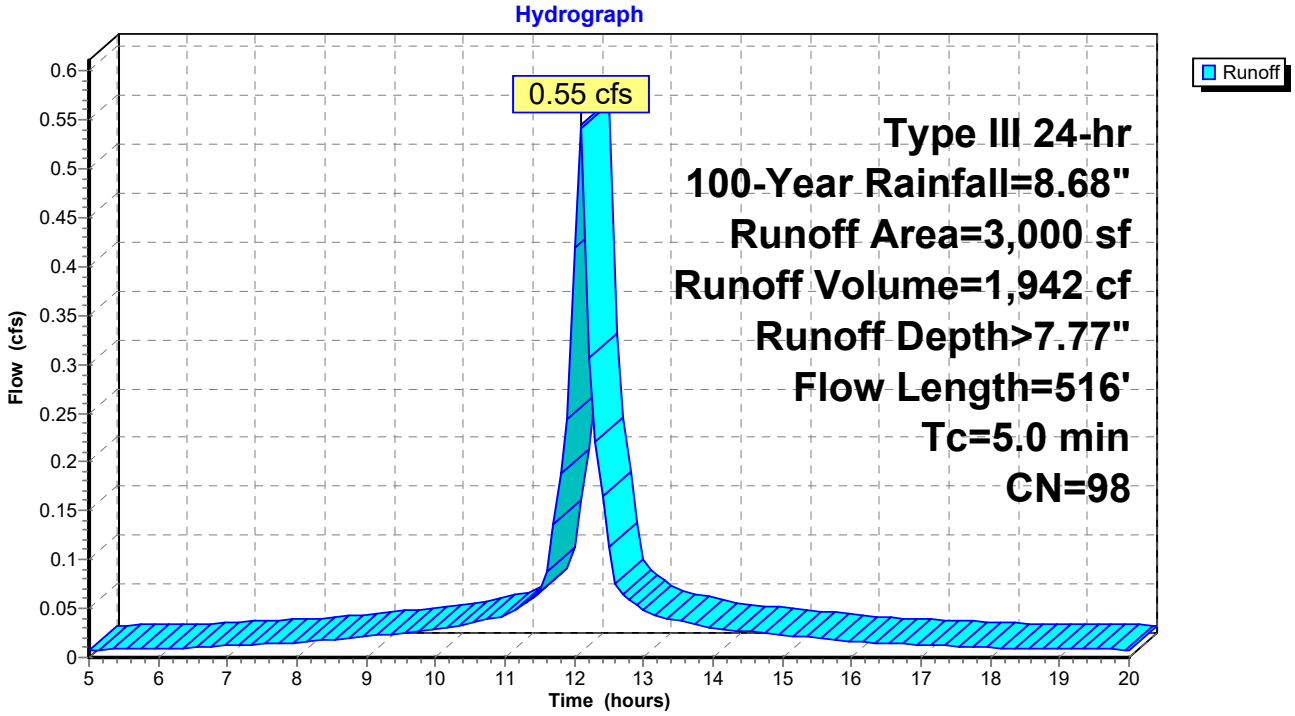
Runoff = 0.55 cfs @ 12.08 hrs, Volume= 1,942 cf, Depth> 7.77"
Routed to Pond SS1 : Infiltration Trench

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Type III 24-hr 100-Year Rainfall=8.68"

Area (sf)	CN	Description
3,000	98	Unconnected roofs, HSG B
3,000		100.00% Impervious Area
3,000		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.23		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.35"
0.4	98	0.0400	4.06		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.5	132	0.0800	4.55		**Shallow Concentrated Flow, Gravel** Unpaved Kv= 16.1 fps
1.2	236	0.0500	3.35		**Shallow Concentrated Flow, Wetland** Grassed Waterway Kv= 15.0 fps
2.8	516	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 2P: Proposed Site 2 (New Building)

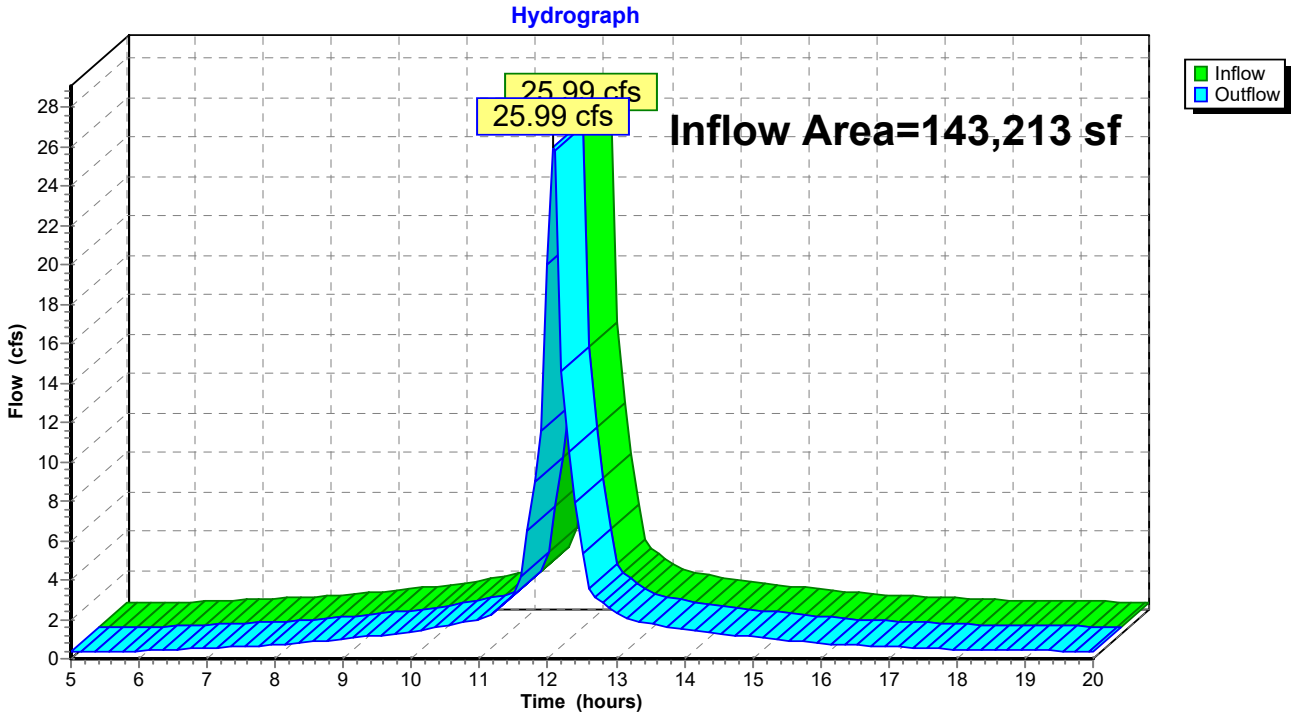


Summary for Reach DP1 PRE: DP1 Pre

Inflow Area = 143,213 sf, 44.33% Impervious, Inflow Depth > 7.71" for 100-Year event
Inflow = 25.99 cfs @ 12.08 hrs, Volume= 91,967 cf
Outflow = 25.99 cfs @ 12.08 hrs, Volume= 91,967 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Reach DP1 PRE: DP1 Pre

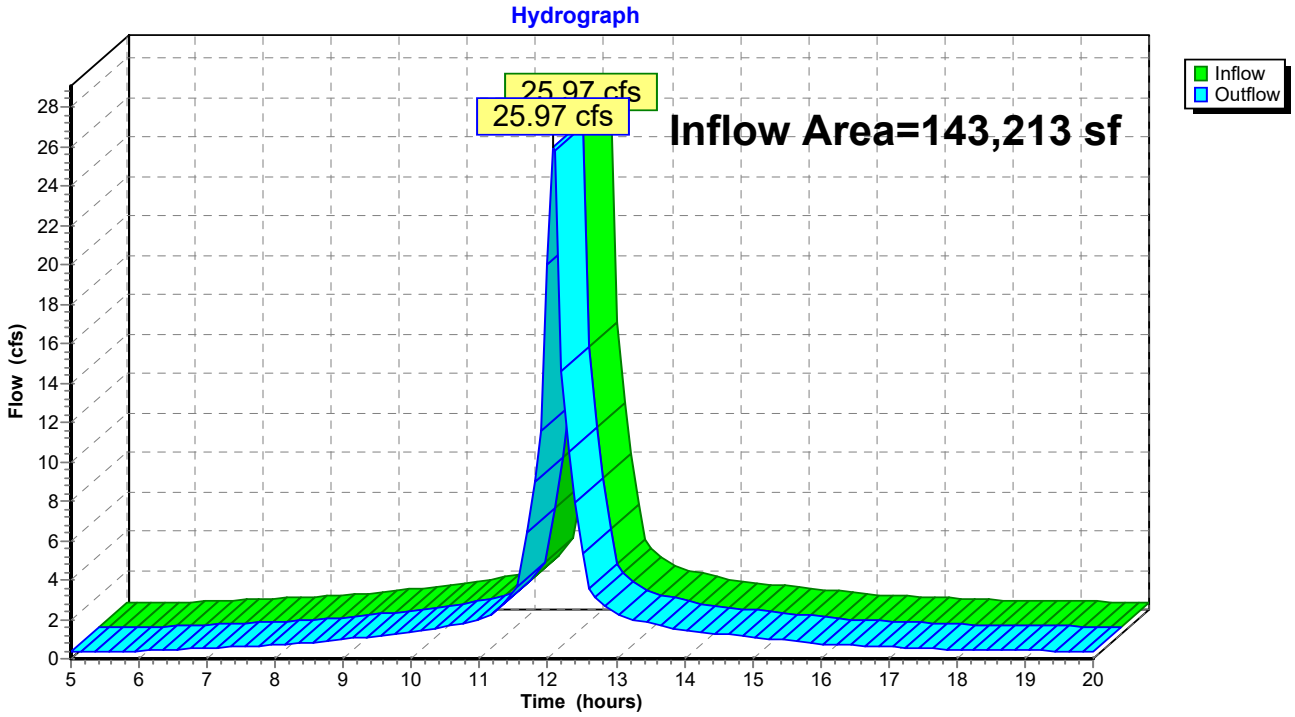


Summary for Reach DP1 PST: DP1 Post

Inflow Area = 143,213 sf, 45.83% Impervious, Inflow Depth > 7.65" for 100-Year event
Inflow = 25.97 cfs @ 12.08 hrs, Volume= 91,242 cf
Outflow = 25.97 cfs @ 12.08 hrs, Volume= 91,242 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs

Reach DP1 PST: DP1 Post



Summary for Pond SS1: Infiltration Trench

Inflow Area = 3,000 sf,100.00% Impervious, Inflow Depth > 7.77" for 100-Year event
Inflow = 0.55 cfs @ 12.08 hrs, Volume= 1,942 cf
Outflow = 0.53 cfs @ 12.08 hrs, Volume= 1,768 cf, Atten= 3%, Lag= 0.0 min
Discarded = 0.01 cfs @ 10.04 hrs, Volume= 567 cf
Primary = 0.52 cfs @ 12.08 hrs, Volume= 1,201 cf
Routed to Reach DP1 PST : DP1 Post

Routing by Dyn-Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.10 hrs
Peak Elev= 134.80' @ 12.08 hrs Surf.Area= 450 sf Storage= 187 cf

Plug-Flow detention time= 50.7 min calculated for 1,768 cf (91% of inflow)
Center-of-Mass det. time= 18.6 min (750.7 - 732.1)

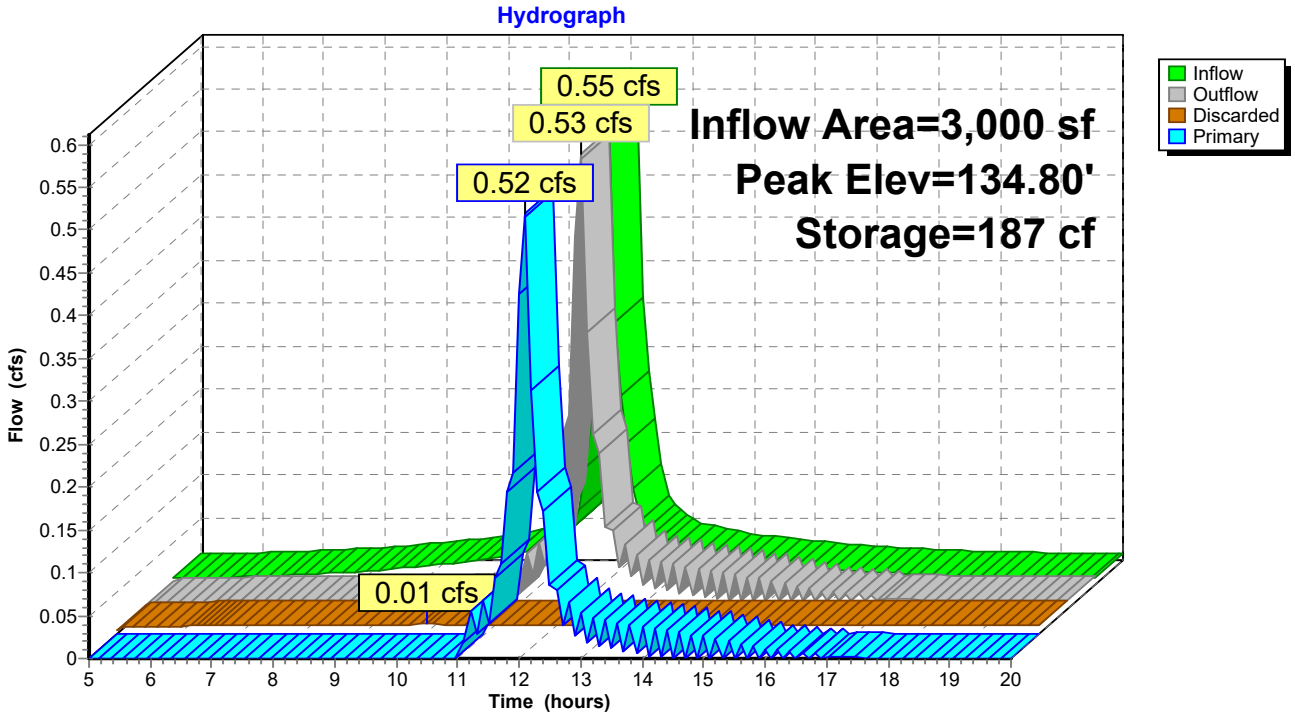
Volume	Invert	Avail.Storage	Storage Description
#1	132.00'	180 cf	**15.00'W x 30.00'L x 1.00'H Prismatoid** 450 cf Overall x 40.0% Voids
#2	132.33'	7 cf	**4.0" Round Pipe Storage** x 3 L= 28.0'
		187 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	132.00'	**1.020 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	135.00'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600 Limited to weir flow at low heads
#3	Primary	134.25'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 10.04 hrs HW=132.50' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.50 cfs @ 12.08 hrs HW=134.78' TW=0.00' (Dynamic Tailwater)
├**2=Orifice/Grate** (Controls 0.00 cfs)
└**3=Orifice/Grate** (Orifice Controls 0.50 cfs @ 2.54 fps)

Pond SS1: Infiltration Trench



Stage-Discharge for Pond SS1: Infiltration Trench

Elevation (feet)	Discharge (cfs)	Discarded (cfs)	Primary (cfs)
132.00	0.00	0.00	0.00
132.05	0.01	0.01	0.00
132.10	0.01	0.01	0.00
132.15	0.01	0.01	0.00
132.20	0.01	0.01	0.00
132.25	0.01	0.01	0.00
132.30	0.01	0.01	0.00
132.35	0.01	0.01	0.00
132.40	0.01	0.01	0.00
132.45	0.01	0.01	0.00
132.50	0.01	**0.01**	0.00
132.55	0.01	0.01	0.00
132.60	0.01	0.01	0.00
132.65	0.01	0.01	0.00
132.70	0.01	0.01	0.00
132.75	0.01	0.01	0.00
132.80	0.01	0.01	0.00
132.85	0.01	0.01	0.00
132.90	0.01	0.01	0.00
132.95	0.01	0.01	0.00
133.00	0.01	0.01	0.00
133.05	0.01	0.01	0.00
133.10	0.01	0.01	0.00
133.15	0.01	0.01	0.00
133.20	0.01	0.01	0.00
133.25	0.01	0.01	0.00
133.30	0.01	0.01	0.00
133.35	0.01	0.01	0.00
133.40	0.01	0.01	0.00
133.45	0.01	0.01	0.00
133.50	0.01	0.01	0.00
133.55	0.01	0.01	0.00
133.60	0.01	0.01	0.00
133.65	0.01	0.01	0.00
133.70	0.01	0.01	0.00
133.75	0.01	0.01	0.00
133.80	0.01	0.01	0.00
133.85	0.01	0.01	0.00
133.90	0.01	0.01	0.00
133.95	0.01	0.01	0.00
134.00	0.01	0.01	0.00
134.05	0.01	0.01	0.00
134.10	0.01	0.01	0.00
134.15	0.01	0.01	0.00
134.20	0.01	0.01	0.00
134.25	0.01	0.01	0.00
134.30	0.02	0.01	0.01
134.35	0.04	0.01	0.03
134.40	0.08	0.01	0.07
134.45	0.12	0.01	0.11
134.50	0.18	0.01	0.17
134.55	0.24	0.01	0.23
134.60	0.31	0.01	0.30
134.65	0.37	0.01	0.36
134.70	0.44	0.01	0.43
134.75	0.48	0.01	0.47
134.80	0.53	0.01	0.52
134.85	0.57	0.01	0.56
134.90	0.61	0.01	0.60
134.95	0.64	0.01	0.63
135.00	0.68	0.01	0.67
135.05	0.74	0.01	0.72
135.10	0.83	0.01	0.82
135.15	0.97	0.01	0.96
135.20	1.14	0.01	1.13
135.25	1.33	0.01	1.32
135.30	1.54	0.01	1.53
135.35	1.77	0.01	1.76
135.40	2.00	0.01	1.98
135.45	2.21	0.01	2.20
135.50	**2.37**	0.01	**2.36**

Stage-Area-Storage for Pond SS1: Infiltration Trench

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
132.00	450	0
132.05	450	9
132.10	450	18
132.15	450	27
132.20	450	36
132.25	450	45
132.30	450	54
132.35	463	63
132.40	473	73
132.45	477	83
132.50	**478**	94
132.55	477	104
132.60	472	114
132.65	461	124
132.70	450	133
132.75	450	142
132.80	450	151
132.85	450	160
132.90	450	169
132.95	450	178
133.00	450	**187**
133.05	450	187
133.10	450	187
133.15	450	187
133.20	450	187
133.25	450	187
133.30	450	187
133.35	450	187
133.40	450	187
133.45	450	187
133.50	450	187
133.55	450	187
133.60	450	187
133.65	450	187
133.70	450	187
133.75	450	187
133.80	450	187
133.85	450	187
133.90	450	187
133.95	450	187
134.00	450	187
134.05	450	187
134.10	450	187
134.15	450	187
134.20	450	187
134.25	450	187
134.30	450	187
134.35	450	187
134.40	450	187
134.45	450	187
134.50	450	187
134.55	450	187
134.60	450	187
134.65	450	187
134.70	450	187
134.75	450	187
134.80	450	187
134.85	450	187
134.90	450	187
134.95	450	187
135.00	450	187
135.05	450	187
135.10	450	187
135.15	450	187
135.20	450	187
135.25	450	187
135.30	450	187
135.35	450	187
135.40	450	187
135.45	450	187
135.50	450	187

Section II
Stormwater Management

♦ STANDARD #1 No New Stormwater Conveyances

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

♦ STANDARD #2 Post Development Peak Discharge

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 yr, 10 yr, 25yr & 100 yr 24 hr storm events.

♦ STANDARD #3 RECHARGE TO GROUNDWATER

Roof area on pervious surface= 2,150 SF

Required Recharge Volume – (2,150 SF * 0.35") * 1'/12" = 63 CF

Proposed infiltration (Stone and Pipe Subsurface System) = 187 CF

Total proposed infiltration = 187 CF

♦ STANDARD #4 WATER QUALITY

Total proposed non-roof impervious areas=0 SF

Required Water Quality Volume - 0 SF * 0.5" * 1' / 12" = 0 CF

Proposed infiltration (Stone and Pipe Subsurface System) = 187 CF

Proposed water quality volume = 187 CF

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

Existing Infiltration Basin

Storage Volume = 187 CF stored below outlet

$$\text{Time} = \frac{187\ CF}{(1.02")(1'/12")(450\ SF)} = 4.9 \text{ hours} < 72 \text{ hours}$$

- **STANDARD #5 Land Uses With Higher Potential Pollutant Loads**
  This site will not produce a higher potential pollutant load.

- **STANDARD #6 Critical Areas**
  The site is not located within a Zone I or Zone II Area.

- **STANDARD #7 Redevelopment**
  The project is not a redevelopment.

- **STANDARD #8 Erosion & Sediment Control Plan**
  Erosion and sediment controls are detailed within the plan.

- **STANDARD #9 Operation & Maintenance Plan**
  See O&M plan attached hereto.

- **STANDARD #10 Illicit Discharge Statement**
  "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

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

Version 1, Automated: Mar. 4, 2008

Location: 405 VFW Dr

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Infiltration Trench *	**0.80**	**1.00**	**0.80**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**

Total TSS Removal = **80%**

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

Project: 23-299
Prepared By: GAP
Date: 10/5/2023

*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

*no pretreatment provided, all runoff is roof runoff

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

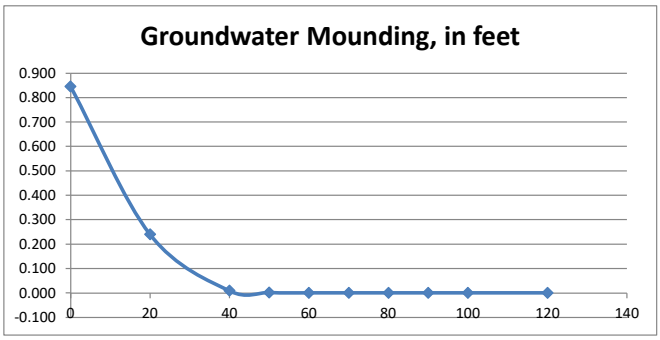
Input Values

2.0400	***R***	**Recharge (infiltration) rate (feet/day)**
0.260	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
6.56	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
15.000	**x**	**1/2 length of basin (x direction, in feet)**
7.500	**y**	**1/2 width of basin (y direction, in feet)**
0.204	**t**	**duration of infiltration period (days)**
20.000	**hi(0)**	**initial thickness of saturated zone (feet)**

20.845	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.845	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.845	0
0.240	20
0.009	40
0.002	50
0.001	60
0.001	70
0.001	80
0.001	90
0.001	100
0.001	120

Re-Calculate Now



Disclaimer

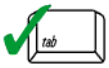
This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

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.

[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.

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

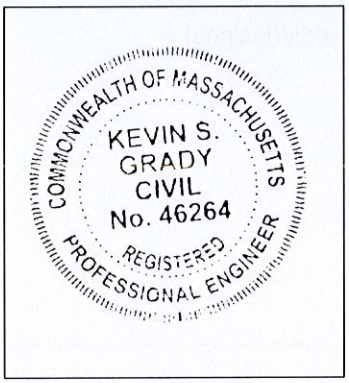
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



KG 10/5/23

Signature and Date

Checklist

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

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

☒ No disturbance to any Wetland Resource Areas

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

☐ Reduced Impervious Area (Redevelopment Only)

☐ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

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

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

☐ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☐ Other (describe): _____

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☐ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☒ An Illicit Discharge Compliance Statement is attached;

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

OPERATION AND MAINTENANCE PLAN

PROPOSED SITE WORK – DURING CONSTRUCTION

Map 20-50-0
405 VFW Dr.
Rockland, MA

Owner:

405 VFW Drive, LLC
405 VFW Dr.
Rockland, MA

Party Responsible for Operation and Maintenance:

405 VFW Drive, LLC
405 VFW Dr.
Rockland, MA

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:

Construction activities shall follow the Construction Sequence shown on the approved plans. 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 and subsurface storage 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. Water from construction dewatering activities should not be directed into any of the existing or proposed stormwater management facilities system unless it is fully treated prior to discharge. 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.

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.

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: 405 VFW Drive
Rockland, MA

Latest Revision: October 5, 2023

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							

(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
Map 20-50-0
405 VFW Dr.
Rockland, MA

Owner:

405 VFW Drive, LLC
405 VFW Dr.
Rockland, MA

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 $1,000.

Schedule for Inspection and Maintenance:

Infiltration Trench

Because infiltration trenches are prone to failure due to clogging, it is imperative that they be aggressively maintained on a regular schedule. Using pretreatment BMPs will significantly reduce the maintenance requirements for the trench itself. Removing accumulated sediment from a deep sump catch basin or a vegetated filter strip is considerably less difficult and less costly than rehabilitating a trench. Eventually, the infiltration trench will have to be rehabilitated, but regular maintenance will prolong its operational life and delay the day when rehabilitation is needed. With appropriate design and aggressive maintenance, rehabilitation can be delayed for a decade or more. Perform preventive maintenance at least twice a year.

Inspect and clean pretreatment BMPs every six months and after every major storm event (2 year return frequency). Check inlet and outlet pipes to determine if they are clogged. Remove accumulated sediment, trash, debris, leaves and grass clippings from mowing. Remove tree seedlings, before they become firmly established.

Inspect the infiltration trench after the first several rainfall events, after all major storms, and on regularly scheduled dates every six months. If the top of the trench is grassed, it must be mowed on a seasonal basis. Grass height must be maintained to be no more than four inches. Routinely remove grass clippings leaves and accumulated sediment from the surface of the trench.

Inspect the trench 24 hours or several days after a rain event, to look for ponded water. If there is ponded water at the surface of the trench, it is likely that the trench surface is clogged. To address surface clogging, remove and replace the topsoil or first layer of stone aggregate and the filter fabric. If water is ponded inside the trench, it may indicate that the bottom of the trench has

failed. To rehabilitate a failed trench, all accumulated sediment must be stripped from the bottom, the bottom of the trench must be scarified and tilled to induce infiltration, and all of the stone aggregate and filter fabric or media must be removed and replaced.

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 materials are to be stored inside of the buildings no exterior storage of materials is allowed. No fueling of equipment is allowed on the premises and is prohibited.

Individual storage unit users shall be notified of the prohibition of illicit discharges to the stormwater management system.

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 rain garden and 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.

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.

This Standard prohibits illicit discharges to stormwater management systems. The stormwater management system is the system for conveying, treating, and infiltrating stormwater on-site, including stormwater best management practices and any pipes intended to transport stormwater to the groundwater, a surface water, or municipal separate storm sewer system. Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater. Notwithstanding the foregoing, an illicit discharge does not include discharges from the following activities or facilities: firefighting, water line flushing, landscape irrigation, uncontaminated groundwater, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, dechlorinated water from swimming pools, water used for street washing and water used to clean residential buildings without detergents.

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 405 VFW Dr.
Latest Revision October 5, 2023

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 Trench	Twice a 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 Trenches

Description: Infiltration trenches are shallow excavations filled with stone. They can be designed to capture sheet flow or piped inflow. The stone provides underground storage for stormwater runoff. The stored runoff gradually exfiltrates through the bottom and/or sides of the trench into the subsoil and eventually into the water table.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Full exfiltration trench systems may be designed for peak rate attenuation
3 - Recharge	Provides groundwater recharge.
4 - TSS Removal	80% TSS removal credit when combined with one or more pretreatment BMPs.
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 load an oil grit separator or equivalent must be used prior to discharge to the infiltration structure. Infiltration must be done in compliance with 314 CMR 5.00.
6 - Discharges near or to Critical Areas	Highly recommended with pretreatment to remove at least 44% TSS removal prior to discharge.
7 - Redevelopment	Suitable with pretreatment.

Advantages/Benefits:

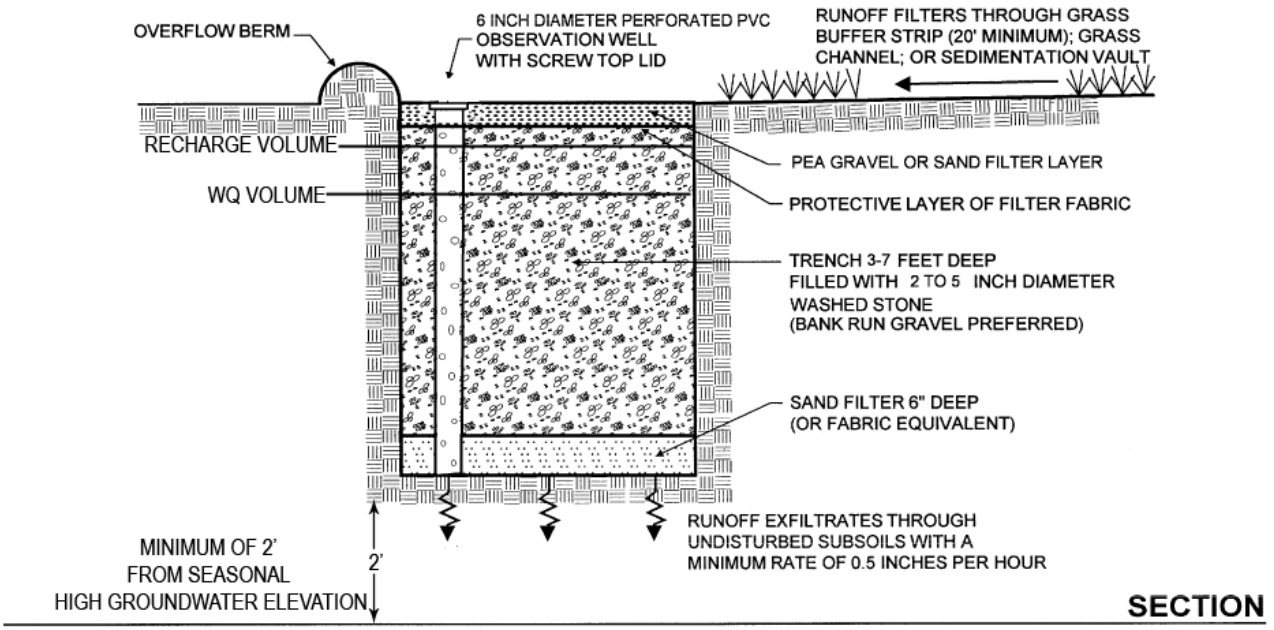
- Provides groundwater recharge.
- Reduces downstream flooding and protects stream bank integrity for small storms.
- Preserves the natural water balance of the site.
- Provides a high degree of runoff pollution control when properly designed and maintained.
- Reduces the size and cost of downstream stormwater control facilities and/or storm drain systems by infiltrating stormwater in upland areas.
- Suitable where space is limited.

Disadvantages/Limitations:

- High failure rates due to improper siting, inadequate pollution prevention and pretreatment, poor design, construction and maintenance.
- Use restricted to small drainage areas.
- Depending on runoff quality, potential risk of groundwater contamination.
- Requires frequent maintenance.
- Susceptible to clogging with sediment.

Pollutant Removal Efficiencies

• Total Suspended Solids (TSS)	80% with pretreatment
• Total Nitrogen	40% to 70%
• Total Phosphorus	40% to 70%
• Metals (copper, lead, zinc, cadmium)	85% to 90%
• Pathogens (coliform, e coli)	Up to 90%



Example of Infiltration Trench

adapted from the University of New Hampshire

Maintenance

Activity	Frequency
Inspect units and remove debris	Every 6 months and after every major storm
Remove sediment from pretreatment BMPs	Every 6 months and after every major storm

Special Features:

High failure rate without adequate pretreatment and regular maintenance

LID Alternative:

Reduce impervious areas
Bioretention areas

Infiltration Trenches

Infiltration trenches can be designed for complete exfiltration or partial exfiltration, where a portion of the runoff volume is directed to the trench and the remainder is conveyed to other BMPs.

Full Exfiltration Trench Systems

Infiltration trenches must be sized to provide storage and exfiltration of the required water quality volume. Full exfiltration systems also provide control of peak discharges and water quality treatment for all storm events equal to or less than the design storm selected. In selecting the design storm, the minimum peak rate attenuation storm event must include the 2- and 10-year 24-hour storm events and may include the 100-year 24-hour storm event, if the runoff from that storm will increase flooding up- or downstream of the site. An emergency overflow channel is required to discharge runoff volumes in excess of the design storm. Economic and physical constraints can restrict the use of full exfiltration systems. Generally, it is not practical to provide storage for large infrequent storms, such as the 100-year storm.

Partial or Water Quality Exfiltration Trench Systems

These systems exfiltrate a portion of the runoff, while the remainder is conveyed to other BMPs. At a minimum, they must be sized to exfiltrate the recharge volume required by Stormwater Management Standard 3. There are two methods of partial infiltration. The first relies on off-line treatment where a portion of the runoff, or the "first-flush," is routed from the main channel to the trench by means of a weir or other diversion structure. The second method is on-line, and uses a perforated pipe at the top of the trench. This underdrain must be placed near the top of the trench. Refer to the design section below. After the trench fills to capacity, excess runoff is discharged through the perforated pipe and directed to other BMPs.

Applicability

Infiltration trenches always require a pretreatment BMP. For sheet flow, pretreatment BMP structures that may be used include vegetated filter strips and pea stone gravel diaphragms. For piped flow, a sediment forebay should be used.

Infiltration trenches are feasible at sites with gentle slopes, permeable soils, and where seasonal high groundwater levels are at least two feet below the bottom of the trench. MassDEP recommends providing greater depths from the bottom of the trench to seasonal high groundwater elevation to reduce the potential for failure. Depth to bedrock will need to be evaluated to determine if use of an infiltration trench is feasible.

Contributing drainage areas must be relatively small and not exceed 5 acres. Infiltration trenches are suitable for parking lots, rooftop areas, local roads, highways, and small residential developments.

Infiltration trenches are adaptable to many sites because of their thin profile. Table IT.1 lists the recommended site criteria. Infiltration trenches can be used in upland areas of larger sites to reduce the overall amount of runoff and improve water quality while reducing the size and costs of downgradient BMPs.

Infiltration trenches are effective at mimicking the natural, pre-development hydrological regime at a site. Full exfiltration systems that have been carefully designed may be capable of controlling peak discharges from the 2-year and 10-year 24-hour storm.

Planning Considerations

MassDEP highly recommends using infiltration trenches near Critical Areas. They may be used to treat stormwater discharges from areas of higher potential pollutant loads, provided 44% of TSS is removed prior to infiltration. For some land uses with higher potential pollutant load, an oil grit separator or equivalent device may be required prior to discharge to the infiltration trench. When an oil/grit separator is used, pipe the runoff to the infiltration trench. Discharges from land uses with higher potential pollutant loads require compliance with 314 CMR 5.00.

Before planning infiltration trenches, carefully evaluate the subsurface of the site including soils, depth to bedrock, and depth to the water table. Make sure soils have a minimum percolation rate of 0.17 inches per hour.

Make the slopes of the contributing drainage area less than 5%. Infiltration trenches have extremely high failure rates, usually due to clogging, so pretreatment is essential. Infiltration trenches are not intended to remove coarse particulate pollutants, and generally are difficult to rehabilitate once clogged. Typical pretreatment BMPs for infiltration trenches

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

October 4, 2023

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.

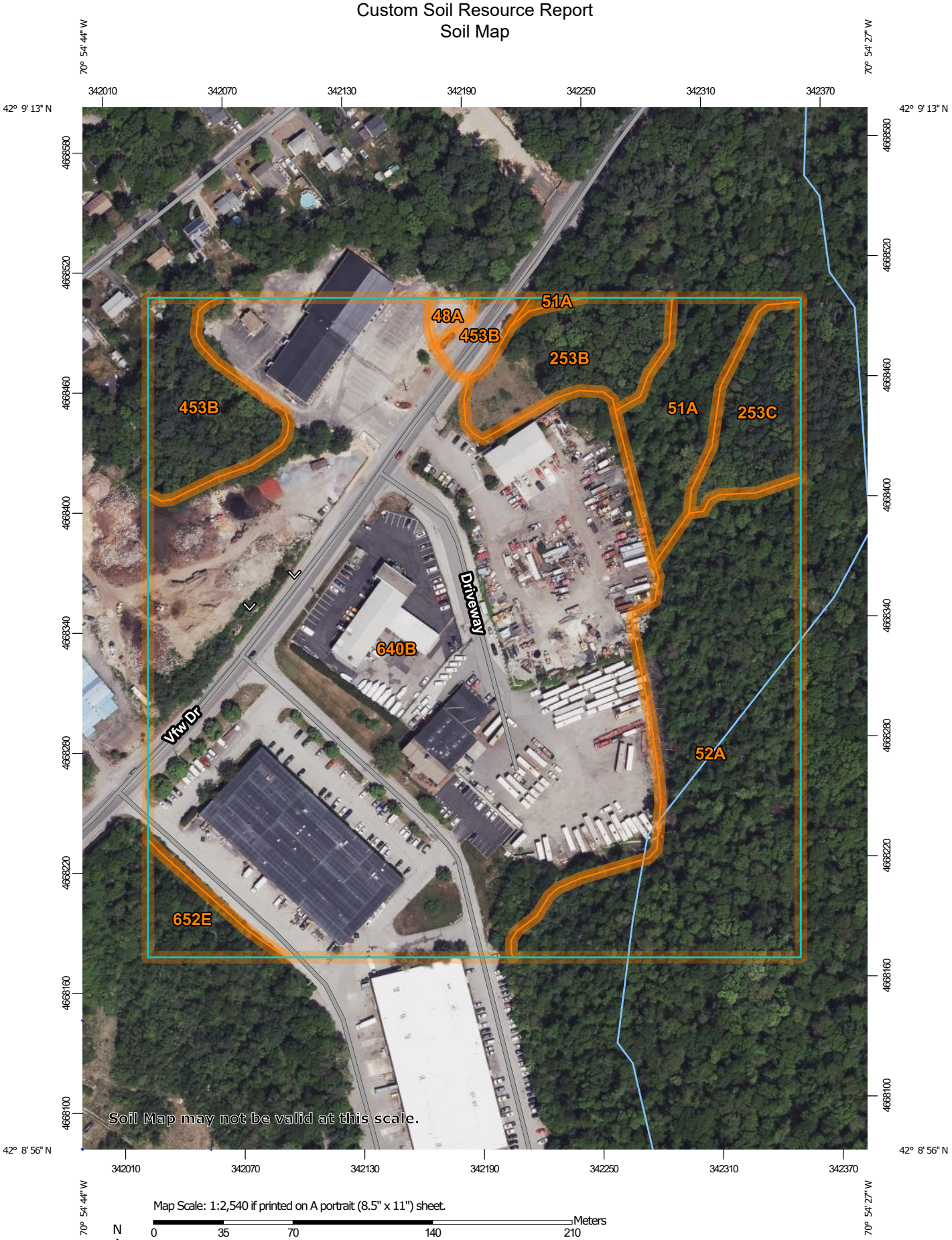
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree 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.



Map Scale: 1:2,540 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 35 70 140 210

Feet
0 100 200 400 600

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 16, Sep 10, 2023

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

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
48A	Brockton sandy loam, 0 to 3 percent slopes, extremely stony	0.1	0.3%
51A	Swansea muck, 0 to 1 percent slopes	1.2	4.4%
52A	Freetown muck, 0 to 1 percent slopes	4.8	18.1%
253B	Hinckley loamy sand, 3 to 8 percent slopes	1.1	4.2%
253C	Hinckley loamy sand, 8 to 15 percent slopes	0.9	3.4%
453B	Gloucester - Canton complex, 3 to 8 percent slopes, extremely bouldery	1.3	5.0%
640B	Urban land, till substratum, 0 to 8 percent slopes	16.8	62.8%
652E	Udorthents, refuse substratum, 8 to 35 percent slopes	0.5	1.8%
Totals for Area of Interest		**26.8**	**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

48A—Brockton sandy loam, 0 to 3 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: bqt8
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

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

Description of Brockton, Extremely Stony

Setting

Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy lodgment till

Typical profile

Oe - 0 to 5 inches: moderately decomposed plant material
A - 5 to 14 inches: sandy loam
Cg - 14 to 20 inches: gravelly loamy sand
Cdg - 20 to 65 inches: gravelly loamy sand

Properties and qualities

Slope: 0 to 3 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 14 to 28 inches to densic material
Drainage class: Very poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.01 to 1.42 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C/D
Ecological site: F149BY008MA - Very Wet Outwash
Hydric soil rating: Yes

Minor Components

Swansea

Percent of map unit: 4 percent
Landform: Marshes, swamps, bogs, kettles, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Ridgebury, extremely stony

Percent of map unit: 4 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Mattapoisett, extremely stony

Percent of map unit: 4 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Whitman, extremely stony

Percent of map unit: 4 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Norwell, extremely stony

Percent of map unit: 4 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

51A—Swansea muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2trl2
Elevation: 0 to 1,140 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Swansea

Setting

Landform: Bogs, swamps
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material over loose sandy and gravelly glaciofluvial deposits

Typical profile

Oa1 - 0 to 24 inches: muck
Oa2 - 24 to 34 inches: muck
Cg - 34 to 79 inches: coarse sand

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 16.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8w
Hydrologic Soil Group: B/D
Ecological site: F144AY043MA - Acidic Organic Wetlands
Hydric soil rating: Yes

Minor Components

Freetown

Percent of map unit: 10 percent
Landform: Bogs, swamps
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Scarboro

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Whitman

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

52A—Freetown muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2t2q9
Elevation: 0 to 1,110 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Freetown

Setting

Landform: Depressions, depressions, swamps, kettles, marshes, bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave

Across-slope shape: Concave
Parent material: Highly decomposed organic material

Typical profile

Oe - 0 to 2 inches: mucky peat
Oa - 2 to 79 inches: muck

Properties and qualities

Slope: 0 to 1 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 19.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: F144AY043MA - Acidic Organic Wetlands
Hydric soil rating: Yes

Minor Components

Whitman

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Scarboro

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Swansea

Percent of map unit: 5 percent
Landform: Bogs, swamps, marshes, depressions, depressions, kettles
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
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 deltas, outwash terraces, kames, kame terraces, moraines, eskers, outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Nose slope, side slope, base slope, crest, riser, tread
Down-slope shape: Concave, convex, linear
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
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
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Windsor

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

Sudbury

Percent of map unit: 5 percent
Landform: Outwash deltas, outwash terraces, moraines, outwash plains, kame terraces
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Head slope, side slope, base slope, tread
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: No

Agawam

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

253C—Hinckley loamy sand, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2svm9
Elevation: 0 to 1,480 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

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 deltas, outwash terraces, moraines, eskers, kames, outwash plains, kame terraces
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Head slope, nose slope, side slope, crest, riser
Down-slope shape: Concave, convex, linear
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: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
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
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Sudbury

Percent of map unit: 5 percent
Landform: Outwash deltas, moraines, outwash plains, kame terraces, outwash terraces
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear

Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent
Landform: Kames, outwash plains, outwash terraces, moraines, eskers
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Head slope, nose slope, side slope, crest, riser
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Windsor

Percent of map unit: 5 percent
Landform: Moraines, eskers, kames, outwash deltas, outwash terraces, outwash plains, kame terraces
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Head slope, nose slope, side slope, crest, riser
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

453B—Gloucester - Canton complex, 3 to 8 percent slopes, extremely bouldery

Map Unit Setting

National map unit symbol: bd1b
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

Gloucester, extremely bouldery, and similar soils: 50 percent
Canton, extremely bouldery, and similar soils: 45 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gloucester, Extremely Bouldery

Setting

Landform: Ground moraines, hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy and gravelly supraglacial meltout till

Typical profile

A - 0 to 3 inches: gravelly fine sandy loam
Bw1 - 3 to 11 inches: very gravelly fine sandy loam
Bw2 - 11 to 15 inches: very gravelly sandy loam
C1 - 15 to 24 inches: very gravelly loamy sand
C2 - 24 to 87 inches: very gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F144AY032NH - Dry Till Uplands
Hydric soil rating: No

Description of Canton, Extremely Bouldery

Setting

Landform: Ridges, hills, till plains
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Coarse-loamy eolian deposits over sandy and gravelly supraglacial meltout till

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oe - 1 to 2 inches: moderately decomposed plant material
A - 2 to 3 inches: very fine sandy loam
E - 3 to 4 inches: very fine sandy loam
Bw1 - 4 to 5 inches: very fine sandy loam
Bw2 - 5 to 15 inches: very fine sandy loam
Bw3 - 15 to 24 inches: fine sandy loam
BC - 24 to 28 inches: gravelly loamy sand
2C1 - 28 to 49 inches: gravelly coarse sand
2C2 - 49 to 73 inches: gravelly loamy coarse sand

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 20 to 36 inches to strongly contrasting textural stratification
Drainage class: Well drained

Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Hinckley, bouldery

Percent of map unit: 3 percent
Landform: Outwash deltas, terraces, kames, eskers
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Hollis

Percent of map unit: 2 percent
Landform: Ridges, hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

640B—Urban land, till substratum, 0 to 8 percent slopes

Map Unit Composition

Urban land, till substratum: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

652E—Udorthents, refuse substratum, 8 to 35 percent slopes

Map Unit Setting

National map unit symbol: 2pr8l
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, refuse substratum, and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents, Refuse Substratum

Setting

Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Excavated and filled loamy land over made land, refuse

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: 8 to 35 percent
Depth to restrictive feature: 20 to 39 inches to manufactured layer
Drainage class: Well drained
Runoff class: High
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 supply, 0 to 60 inches: Low (about 3.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: F149BY100NY - Urban Site Complex
Hydric soil rating: No

Minor Components

Udorthents, loamy

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

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