Stormwater Report & Drainage Calculations

Site Redevelopment
34 & 38 Dane Street
Somerville, MA 02143

April 6, 2017

Prepared By: Scott P. Henderson, PE

P.O. Box 626
Lexington, MA 02420
hcscivil@gmail.com
774-993-9903

Table of Contents

Appendices

Design Calculations & Standards

Pre- and Post-Development drainage calculations were prepared utilizing the U.S. Soil Conservation Service Technical Release 20 – Urban Hydrology for Small Watersheds, the U.S. Soil Conservation Service National Engineering Hydrology Handbook, Natural Resources Conservation Service (NRCS) rainfall data, and accepted engineering design practice. These standards were applied in the use of HydroCAD stormwater modeling software to generate a representative model of existing hydrology and proposed stormwater management features. Details of this model can be found in the appendices of this report.

Where applicable, MA Department of Environmental Protection (DEP) Stormwater Handbook performance standards, along with accepted engineering practices, are utilized in preparing a stormwater management system design.

Locus Analysis & Project Summary

The project proponent and current property owner, Cassia and Paulo Dasilva, is proposing to renovate the existing single family home on the property to add a second unit to that building and also construct a new, 3-unit building to the north of the existing structure. The existing parcel is located on the East side of Dane Street and is, abuts residential properties to the east and south, and railway property to the north.

The NRCS Soil Survey classifies the native soils as a *Urban Land* (602), which lacks accurate soil information. The nearest native soil classification is *Merrimac-Urban Land Complex* (626B). This soil profile parent material is listed as "sandy and gravelly glaciofluvial deposits," which indicates that a relatively high infiltration rate can be expected for purposes of designing subsurface stormwater best management practices. In reality, due to the proximity to the railway corridor, the material on-site is likely a mixture of this parent material and urban fill that resulted from construction of the railroad. As such, a hydrologic soil classification of HSG-B was chosen to produce a stormwater model. Furthermore, the site access limitations and winter conditions prevented conducting on-site soil evaluation at the present time. As such, a conservative infiltration rate of 1.02 in/hr (based on published Rawls Rates) is used in modeling infiltration. The details of the NRCS classification can be found in the appendices of this report.

There are no wetland resource areas in the proximity of the proposed development and, as such, a filing with MA DEP or the Somerville Conservation Commission will not be required.

Pre-Development Condition

The project locus is currently improved with a single-family home, bituminous concrete driveway, landscaping and associated utilities. The total existing impervious footprint on the site is 2,936 square feet, which includes the existing house roof, accessory buildings, driveway, patios, and walkways. The entire lot surrounding the existing home is maintained as manicured lawn with the exception of several large trees and brush along the north and northwest site boundary.

The existing topography abruptly slopes downhill from the site frontage to the east and northeast with slopes ranging from 2 to 50 percent. The grade at the rear of the site is approximately 12 feet below the existing grade at the street. As such, runoff from the entire site flows to the abutting property to the east and ultimately to the railroad bed to the north.

Currently, there are no stormwater management practices employed on the property and all runoff flows overland uncontrolled off of the parcel. For the purposes of producing a hydrologic model, one design point was analyzed for the pre- and post-development condition.

Drainage calculations for the pre-development condition indicate peak rates of runoff and volumes for the aforementioned design storms as follows:

Pre-Development Analysis Results						
	2-Year Storm		10 Year Storm		100 Year Storm	
Design Point	Peak Flow [CFS]	Volume [CuFT]	Peak Flow [CFS]	Volume [CuFT]	Peak Flow [CFS]	Volume [CuFT]
A	0.20	662	0.44	1,404	1.09	3,475

Post-Development Condition

The applicant proposes the construction of a new 3-unit building and conversion of the existing building to 2 units, driveways, landscaping and associated utilities. The total proposed impervious footprint on the site will be 2,977 square feet, which is an increase of 41 square feet over the existing condition. In order to mitigate this increase in impervious area, the development includes a stormwater management system.

The proposed stormwater management system aims to capture runoff from the proposed roofs and route it into subsurface infiltration systems. The systems are sized to attenuate peak flows and volumes for all design storms. In total, two subsurface infiltration systems are proposed. For all systems, an infiltration rate of 1.02 inches per hour is used in hydrologic modeling. This is consistent with the MA DEP Stormwater Management Regulations, which requires the use of infiltration rates established empirically by Walter Rawls et al. In this case, the assumed Hydrologic Soil Rating of B is consistent with the use of this rate.

All of the proposed subsurface infiltration systems consist of ADS Stormtech SC310 plastic chambers set in a bed of double-washed, crushed stone. Roof runoff is piped directly into the system without pre-treatment as that runoff is free from suspended solids. Details of the drainage are shown on the site plans.

Drainage calculations for the post-development condition indicate peak rates of runoff and volumes for the aforementioned design storms as follows:

Post-Development Analysis Results						
	2-Year Storm		10 Year Storm		100 Year Storm	
Design Point	Peak Flow [CFS]	Volume [CuFT]	Peak Flow [CFS]	Volume [CuFT]	Peak Flow [CFS]	Volume [CuFT]
A	0.07	265	0.38	908	1.04	2,800

As indicated by the table above, the post-development condition for the analyzed design storms matches or reduces peak runoff rates and volumes from the project site.

Stormwater Best Management Practices

Subsurface Infiltration Systems – The two subsurface infiltration systems consist of ADS Stormtech SC310 plastic leaching chambers set in a bed of crushed stone. Each system consists of three units. In all cases, the systems have inspection ports set to grade where inlet pipes enter the system. Surcharge from these systems, which only occurs in high-volume rainfall events, will overflow at the lowest roof leaders at the rear of the buildings. This surcharge flows overland in the same manner in which runoff currently flows off-site.

Permeable Pavers – Permeable paver systems are proposed for all patios, walkways, and driveways to limit the increase in impervious area associated with the site redevelopment. None of these systems are designed as attenuation or infiltration BMPs, but are merely included to render the surfaces permeable. As such, these are not represented as BMPs in the stormwater model, but in reality, will provide additional infiltration capacity due to the stone reservoirs below each installation. Details of these paver systems are included on the site plans.

Closed Drainage – Each driveway proposed on site will have either a catch basin or trench drain to route water from the front of the site to the rear in order to prevent water issues. The discharges for these inlets will include rip-rap splash pads that will attenuate flow velocities and prevent erosion and scouring. These closed systems do not provide attenuation or infiltration and only serve to redirect runoff. All systems include sumps and hooded outlets to prevent migration of suspended solids and flotables.

Crushed Stone Infiltration Trench – There is a stone infiltration trench proposed at the rear of the site to intercept surface runoff that flows toward the abutter to the east. This is a measure to limit runoff to that property. This, coupled with other BMPs, should reduce the amount of runoff that flows to the neighboring property compared to the current condition.

Erosion Control

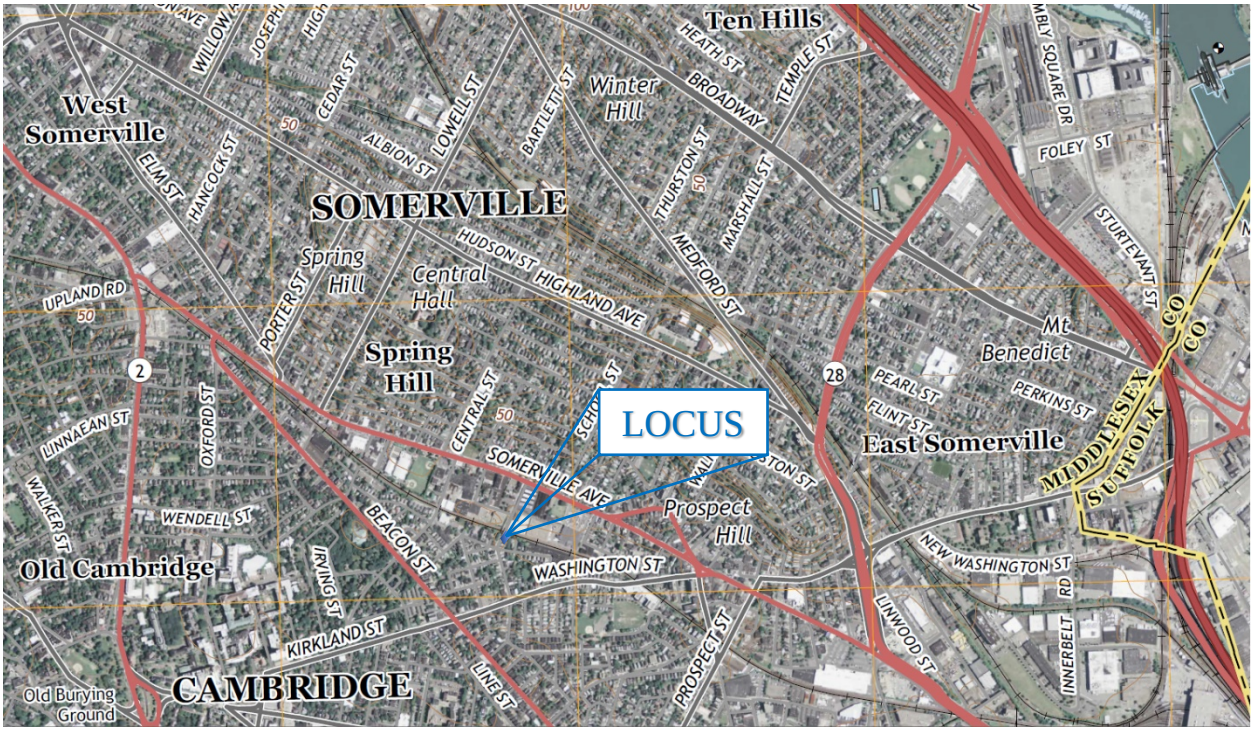
During construction, erosion control will be installed around the limit of work as indicated on the site plans and maintained until the entire site is stabilized with vegetation. The erosion control barrier will consist of a staked-in mulch sock barrier. Lastly, filter fabric will be installed permanently around the top and sides of all infiltration systems to prevent fine sediment from entering the leaching chambers and preventing exfiltration.

Appendix A

Locus Map

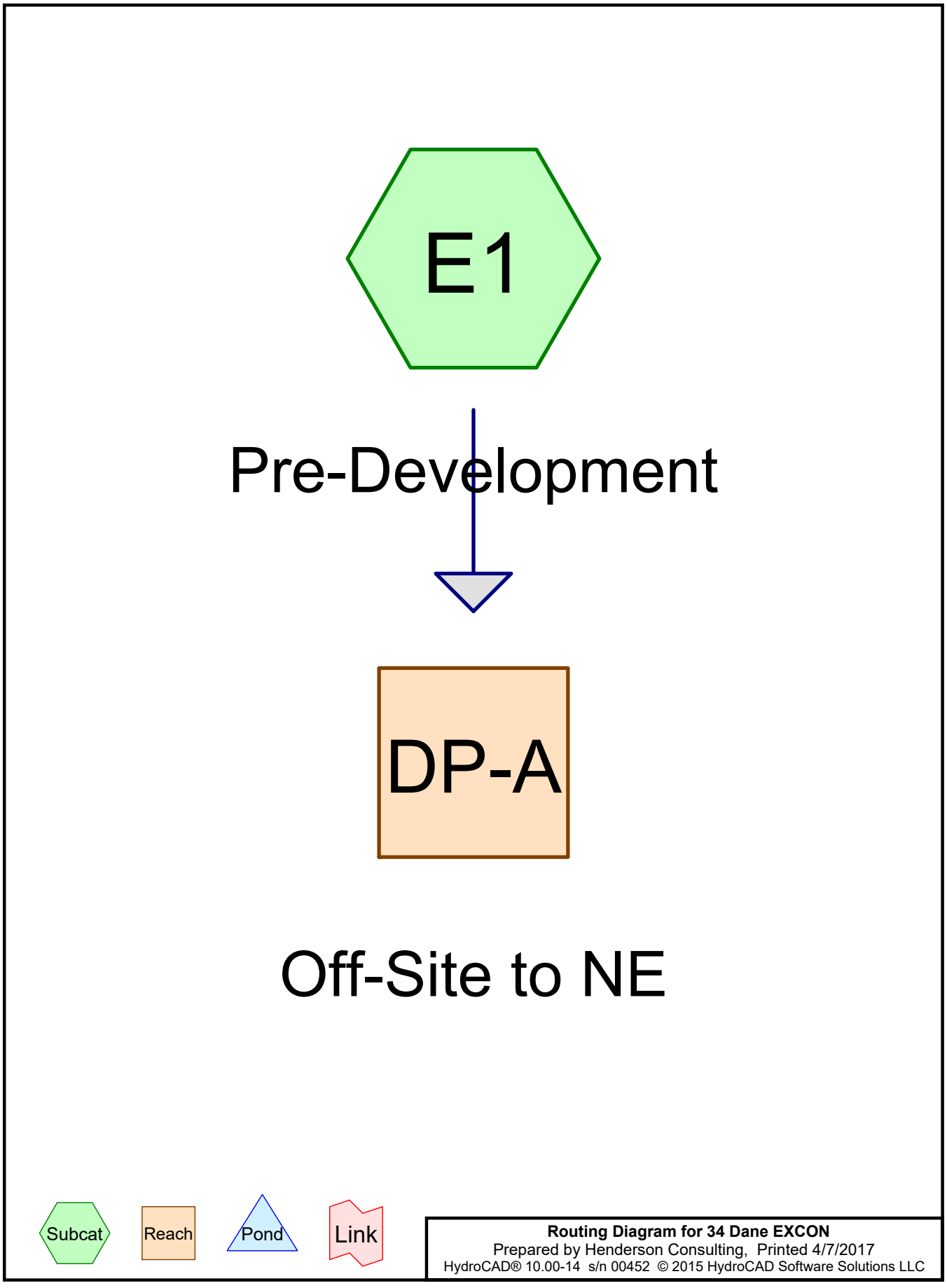
Locus Map

Site Redevelopment
34 & 38 Dane Street, Somerville, MA



Appendix B

Pre-Development Drainage Calculations



Routing Diagram for 34 Dane EXCON
Prepared by Henderson Consulting, Printed 4/7/2017

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
3,784	61	>75% Grass cover, Good, HSG B (E1)
2,056	98	Unconnected pavement, HSG B (E1)
880	98	Unconnected roofs, HSG B (E1)
720	58	Woods/grass comb., Good, HSG B (E1)
7,440	**75**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
7,440	HSG B	E1
0	HSG C	
0	HSG D	
0	Other	
7,440		**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	Su Nu
0	3,784	0	0	0	3,784	>75% Grass cover, Good	
0	2,056	0	0	0	2,056	Unconnected pavement	
0	880	0	0	0	880	Unconnected roofs	
0	720	0	0	0	720	Woods/grass comb., Good	
0	**7,440**	**0**	**0**	**0**	**7,440**	**TOTAL AREA**	

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

Subcatchment E1: Pre-Development Runoff Area=7,440 sf 39.46% Impervious Runoff Depth=1.07"
Tc=6.0 min CN=75 Runoff=0.20 cfs 662 cf

Reach DP-A: Off-Site to NE Inflow=0.20 cfs 662 cf
Outflow=0.20 cfs 662 cf

Total Runoff Area = 7,440 sf Runoff Volume = 662 cf Average Runoff Depth = 1.07"
60.54% Pervious = 4,504 sf 39.46% Impervious = 2,936 sf

Summary for Subcatchment E1: Pre-Development

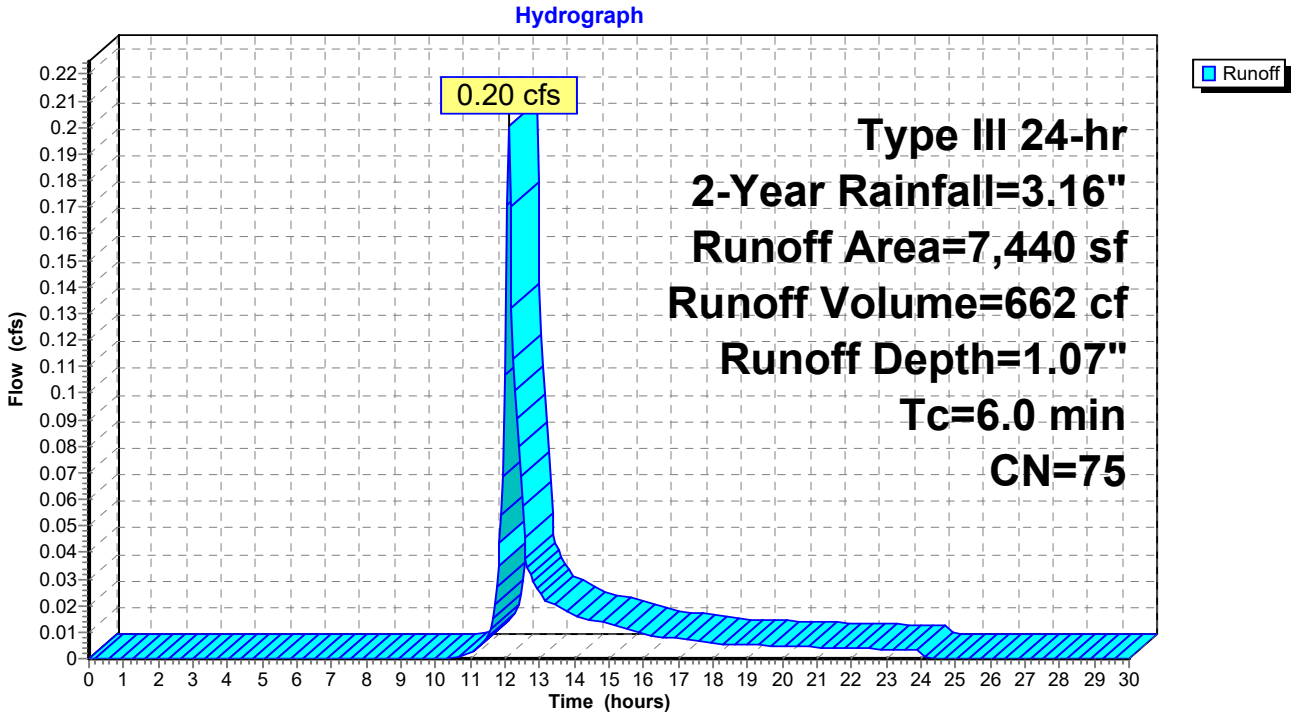
Runoff = 0.20 cfs @ 12.10 hrs, Volume= 662 cf, Depth= 1.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.16"

Area (sf)	CN	Description
880	98	Unconnected roofs, HSG B
2,056	98	Unconnected pavement, HSG B
3,784	61	>75% Grass cover, Good, HSG B
720	58	Woods/grass comb., Good, HSG B
7,440	75	Weighted Average
4,504		60.54% Pervious Area
2,936		39.46% Impervious Area
2,936		100.00% Unconnected

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

Subcatchment E1: Pre-Development

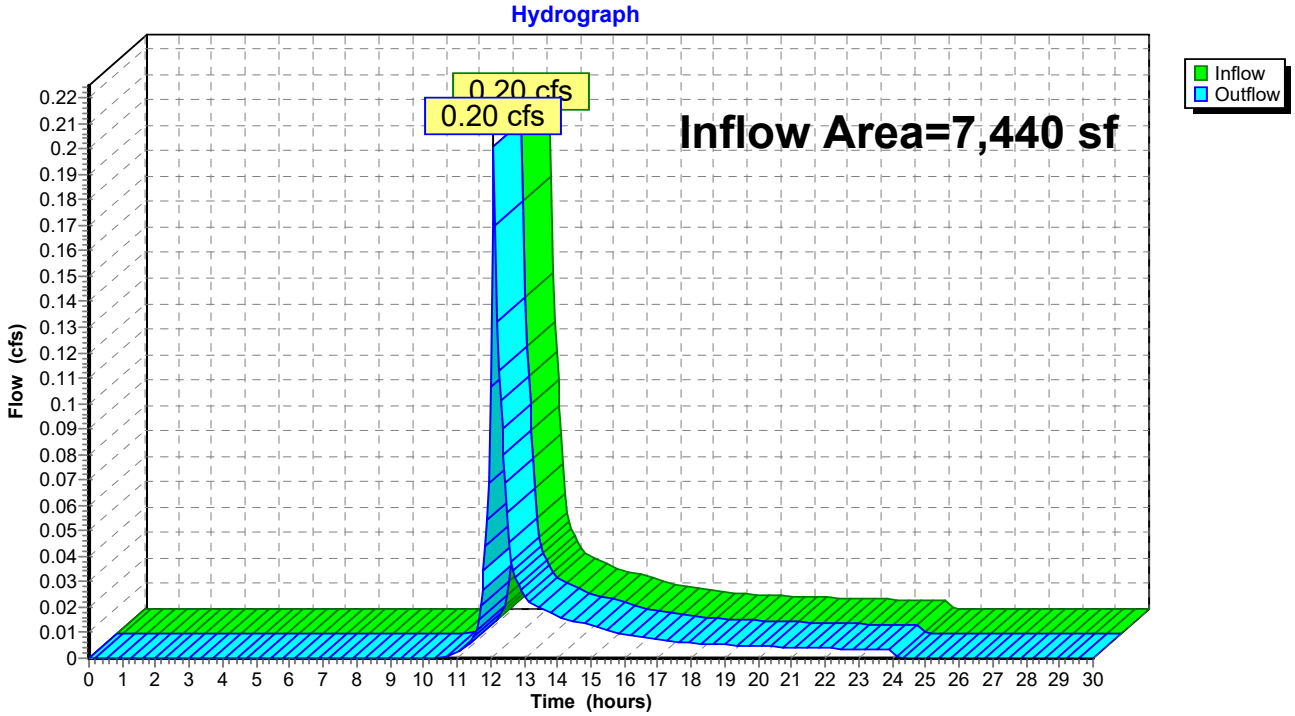


Summary for Reach DP-A: Off-Site to NE

Inflow Area = 7,440 sf, 39.46% Impervious, Inflow Depth = 1.07" for 2-Year event
Inflow = 0.20 cfs @ 12.10 hrs, Volume= 662 cf
Outflow = 0.20 cfs @ 12.10 hrs, Volume= 662 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP-A: Off-Site to NE



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

Subcatchment E1: Pre-Development Runoff Area=7,440 sf 39.46% Impervious Runoff Depth=2.26"
Tc=6.0 min CN=75 Runoff=0.44 cfs 1,404 cf

Reach DP-A: Off-Site to NE Inflow=0.44 cfs 1,404 cf
Outflow=0.44 cfs 1,404 cf

Total Runoff Area = 7,440 sf Runoff Volume = 1,404 cf Average Runoff Depth = 2.26"
60.54% Pervious = 4,504 sf 39.46% Impervious = 2,936 sf

Summary for Subcatchment E1: Pre-Development

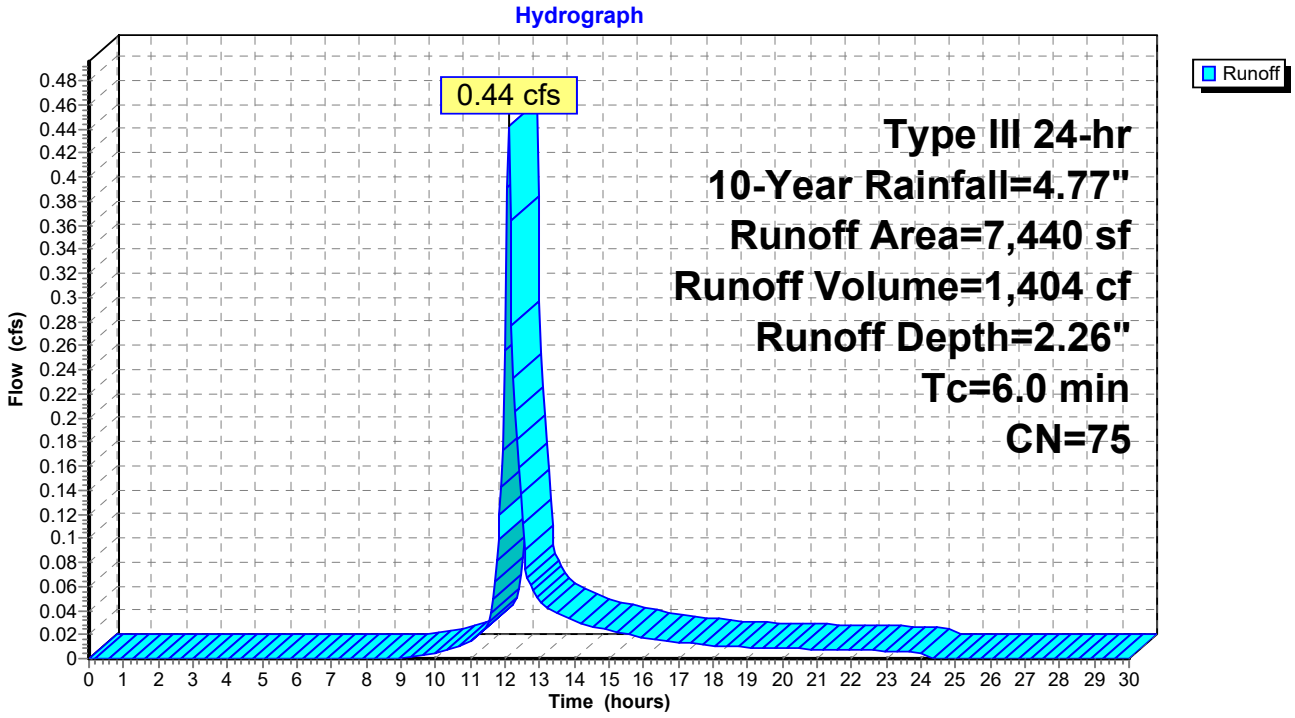
Runoff = 0.44 cfs @ 12.09 hrs, Volume= 1,404 cf, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.77"

Area (sf)	CN	Description
880	98	Unconnected roofs, HSG B
2,056	98	Unconnected pavement, HSG B
3,784	61	>75% Grass cover, Good, HSG B
720	58	Woods/grass comb., Good, HSG B
7,440	75	Weighted Average
4,504		60.54% Pervious Area
2,936		39.46% Impervious Area
2,936		100.00% Unconnected

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

Subcatchment E1: Pre-Development

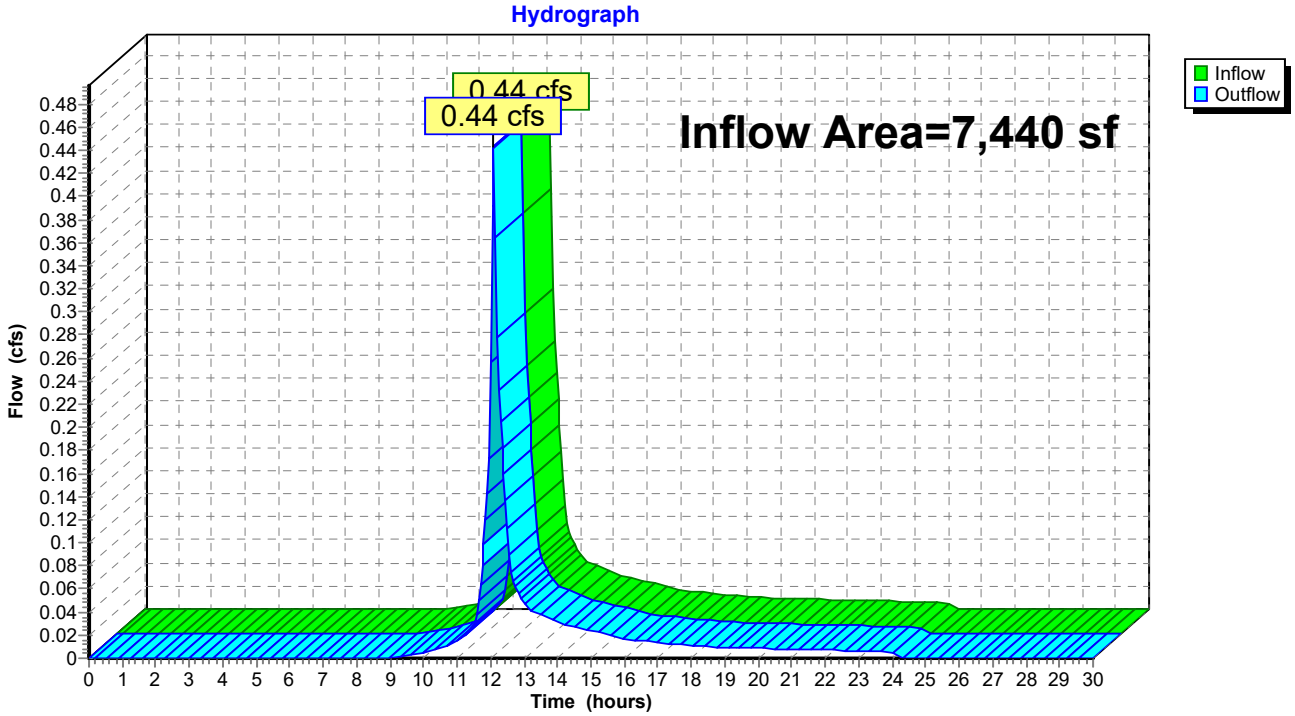


Summary for Reach DP-A: Off-Site to NE

Inflow Area = 7,440 sf, 39.46% Impervious, Inflow Depth = 2.26" for 10-Year event
Inflow = 0.44 cfs @ 12.09 hrs, Volume= 1,404 cf
Outflow = 0.44 cfs @ 12.09 hrs, Volume= 1,404 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP-A: Off-Site to NE



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

Subcatchment E1: Pre-Development Runoff Area=7,440 sf 39.46% Impervious Runoff Depth=5.60"
Tc=6.0 min CN=75 Runoff=1.09 cfs 3,475 cf

Reach DP-A: Off-Site to NE Inflow=1.09 cfs 3,475 cf
Outflow=1.09 cfs 3,475 cf

Total Runoff Area = 7,440 sf Runoff Volume = 3,475 cf Average Runoff Depth = 5.60"
60.54% Pervious = 4,504 sf 39.46% Impervious = 2,936 sf

Summary for Subcatchment E1: Pre-Development

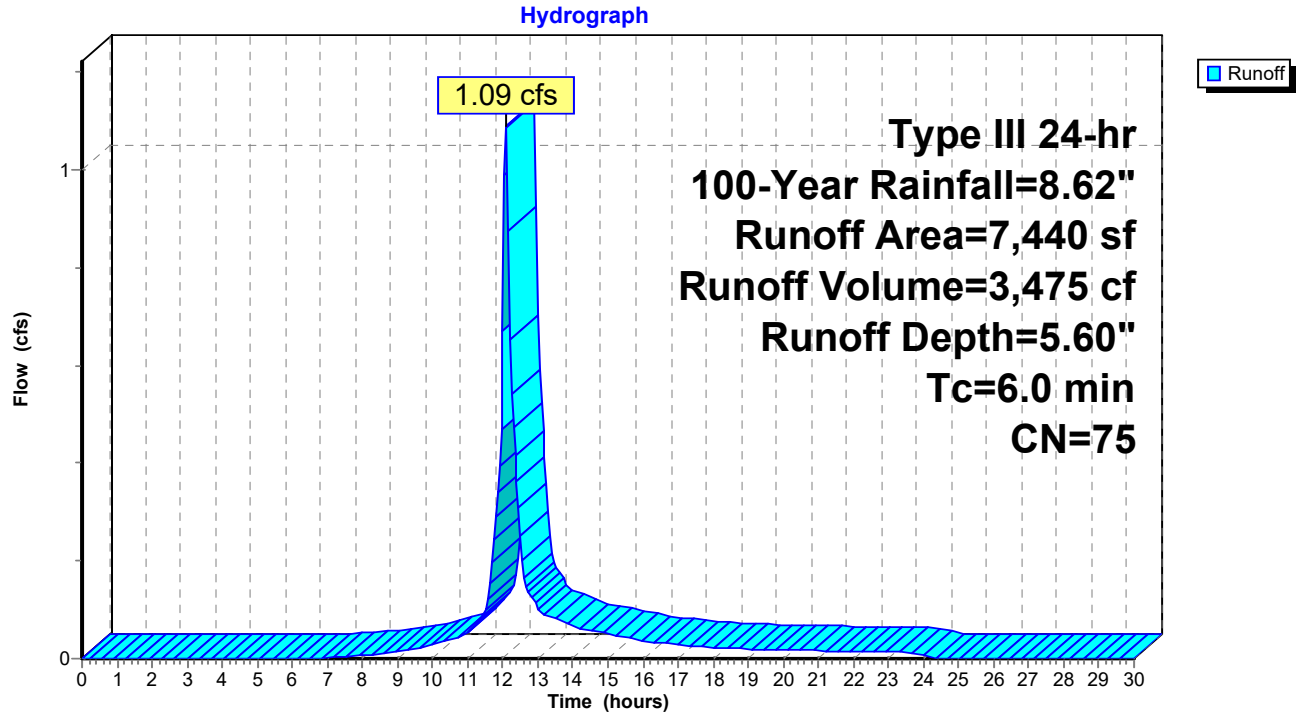
Runoff = 1.09 cfs @ 12.09 hrs, Volume= 3,475 cf, Depth= 5.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.62"

Area (sf)	CN	Description
880	98	Unconnected roofs, HSG B
2,056	98	Unconnected pavement, HSG B
3,784	61	>75% Grass cover, Good, HSG B
720	58	Woods/grass comb., Good, HSG B
7,440	75	Weighted Average
4,504		60.54% Pervious Area
2,936		39.46% Impervious Area
2,936		100.00% Unconnected

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

Subcatchment E1: Pre-Development

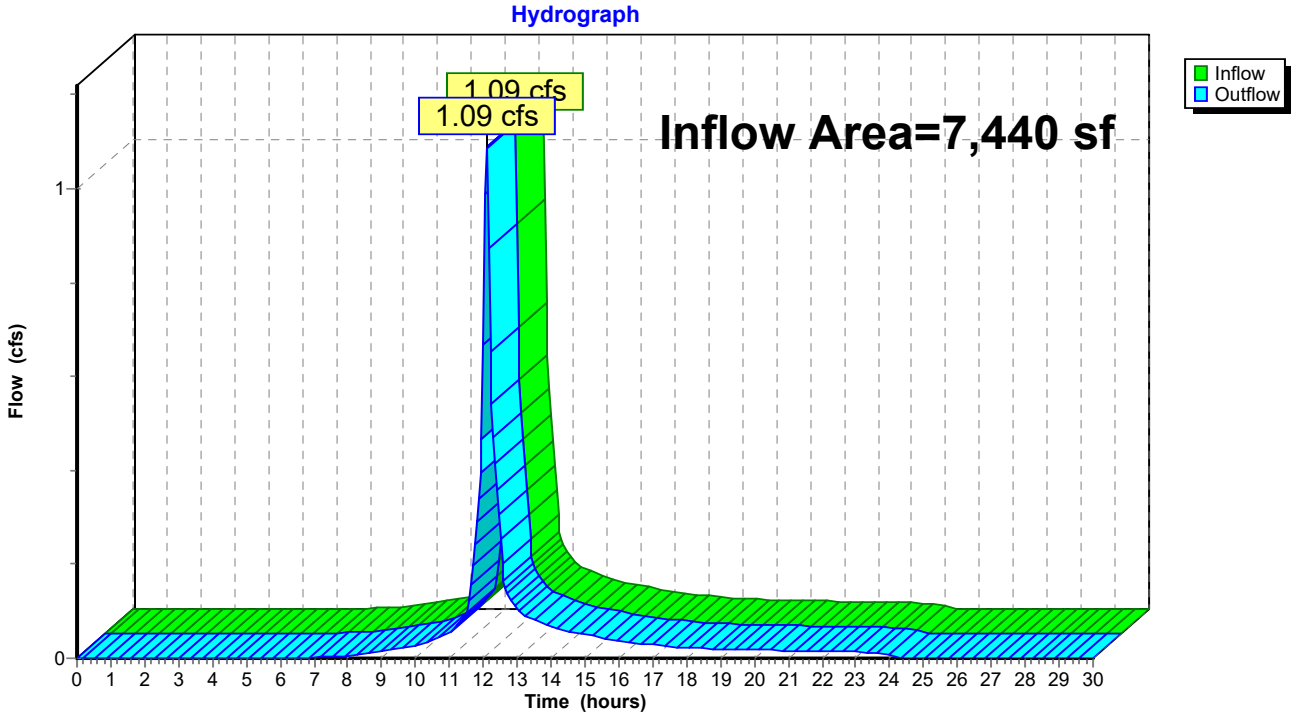


Summary for Reach DP-A: Off-Site to NE

Inflow Area = 7,440 sf, 39.46% Impervious, Inflow Depth = 5.60" for 100-Year event
Inflow = 1.09 cfs @ 12.09 hrs, Volume= 3,475 cf
Outflow = 1.09 cfs @ 12.09 hrs, Volume= 3,475 cf, Atten= 0%, Lag= 0.0 min

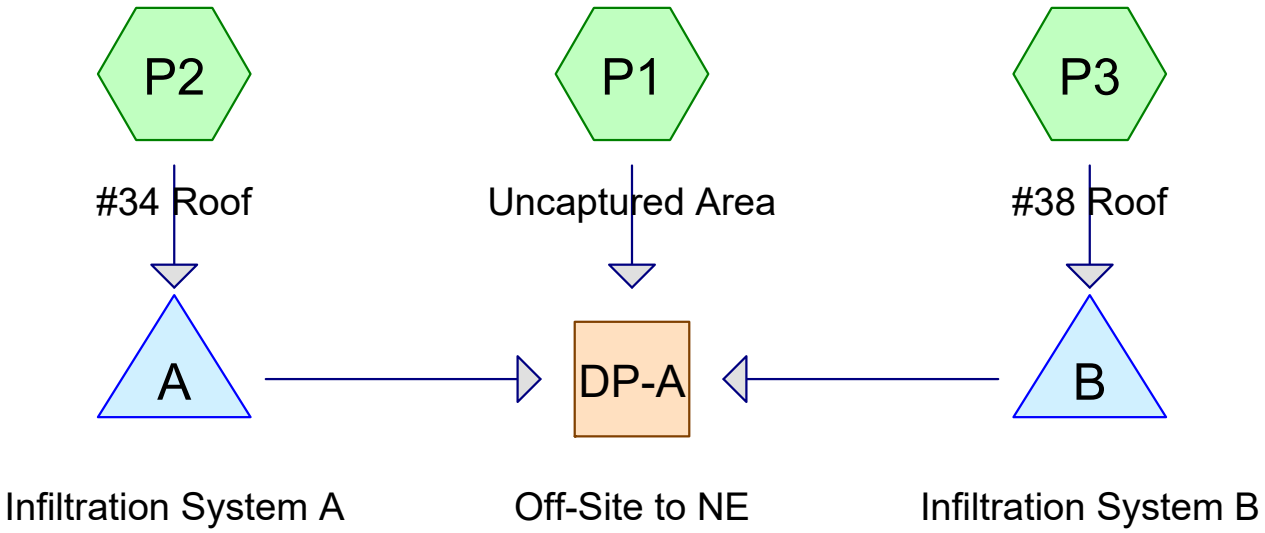
Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP-A: Off-Site to NE



Appendix C

Post-Development Drainage Calculations



Subcat Reach Pond Link

Routing Diagram for 34 Dane PROP
Prepared by Henderson Consulting, Printed 4/7/2017

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
2,687	61	>75% Grass cover, Good, HSG B (P1)
445	61	Permeable Paver Patio, HSG B (P1)
2,408	98	Roofs, HSG B (P2, P3)
1,400	98	Unconnected pavement, HSG B (P1)
500	58	Woods/grass comb., Good, HSG B (P1)
7,440	**80**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
7,440	HSG B	P1, P2, P3
0	HSG C	
0	HSG D	
0	Other	
7,440		**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	Su Nu
0	2,687	0	0	0	2,687	>75% Grass cover, Good	
0	445	0	0	0	445	Permeable Paver Patio	
0	2,408	0	0	0	2,408	Roofs	
0	1,400	0	0	0	1,400	Unconnected pavement	
0	500	0	0	0	500	Woods/grass comb., Good	
0	**7,440**	**0**	**0**	**0**	**7,440**	**TOTAL AREA**	

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

Subcatchment P1: Uncaptured Area Runoff Area=5,032 sf 27.82% Impervious Runoff Depth=0.62"
Tc=6.0 min UI Adjusted CN=66 Runoff=0.07 cfs 261 cf

Subcatchment P2: #34 Roof Runoff Area=1,208 sf 100.00% Impervious Runoff Depth=2.93"
Tc=6.0 min CN=98 Runoff=0.08 cfs 295 cf

Subcatchment P3: #38 Roof Runoff Area=1,200 sf 100.00% Impervious Runoff Depth=2.93"
Tc=6.0 min CN=98 Runoff=0.08 cfs 293 cf

Reach DP-A: Off-Site to NE Inflow=0.07 cfs 265 cf
Outflow=0.07 cfs 265 cf

Pond A: Infiltration System A Peak Elev=102.30' Storage=150 cf Inflow=0.08 cfs 295 cf
Discarded=0.00 cfs 266 cf Primary=0.00 cfs 3 cf Outflow=0.00 cfs 269 cf

Pond B: Infiltration System B Peak Elev=102.30' Storage=150 cf Inflow=0.08 cfs 293 cf
Discarded=0.00 cfs 266 cf Primary=0.00 cfs 1 cf Outflow=0.00 cfs 267 cf

Total Runoff Area = 7,440 sf Runoff Volume = 849 cf Average Runoff Depth = 1.37"
48.82% Pervious = 3,632 sf 51.18% Impervious = 3,808 sf

Summary for Subcatchment P1: Uncaptured Area

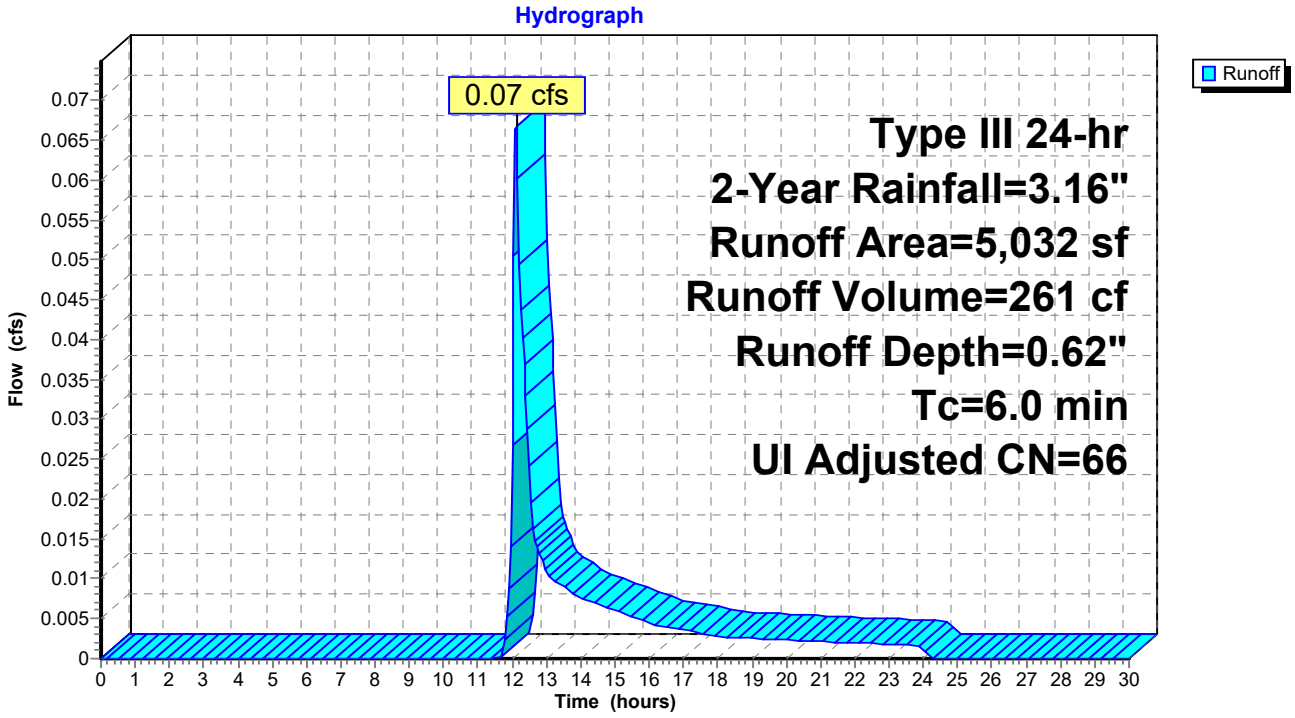
Runoff = 0.07 cfs @ 12.11 hrs, Volume= 261 cf, Depth= 0.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.16"

	Area (sf)	CN	Adj	Description
	1,400	98		Unconnected pavement, HSG B
	500	58		Woods/grass comb., Good, HSG B
	2,687	61		>75% Grass cover, Good, HSG B
*	445	61		Permeable Paver Patio, HSG B
	5,032	71	66	Weighted Average, UI Adjusted
	3,632			72.18% Pervious Area
	1,400			27.82% Impervious Area
	1,400			100.00% Unconnected

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

Subcatchment P1: Uncaptured Area



Summary for Subcatchment P2: #34 Roof

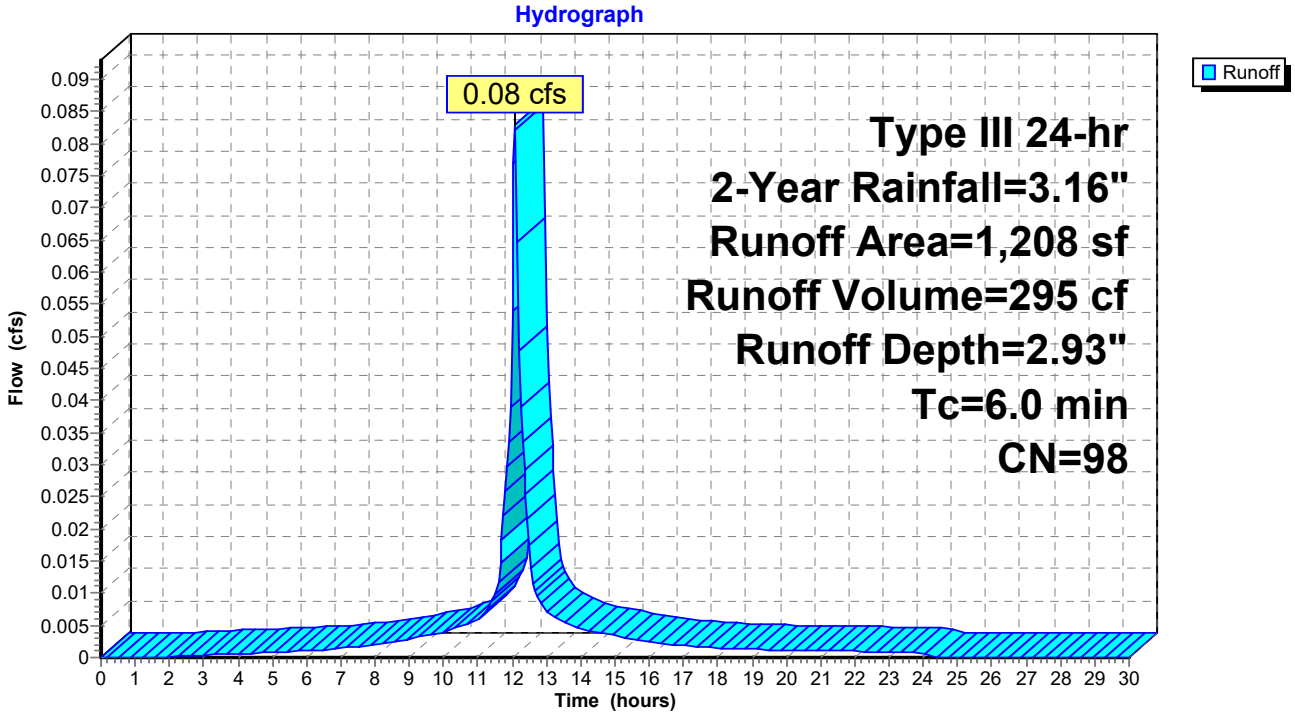
Runoff = 0.08 cfs @ 12.09 hrs, Volume= 295 cf, Depth= 2.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.16"

Area (sf)	CN	Description
1,208	98	Roofs, HSG B
1,208		100.00% Impervious Area

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

Subcatchment P2: #34 Roof



Summary for Subcatchment P3: #38 Roof

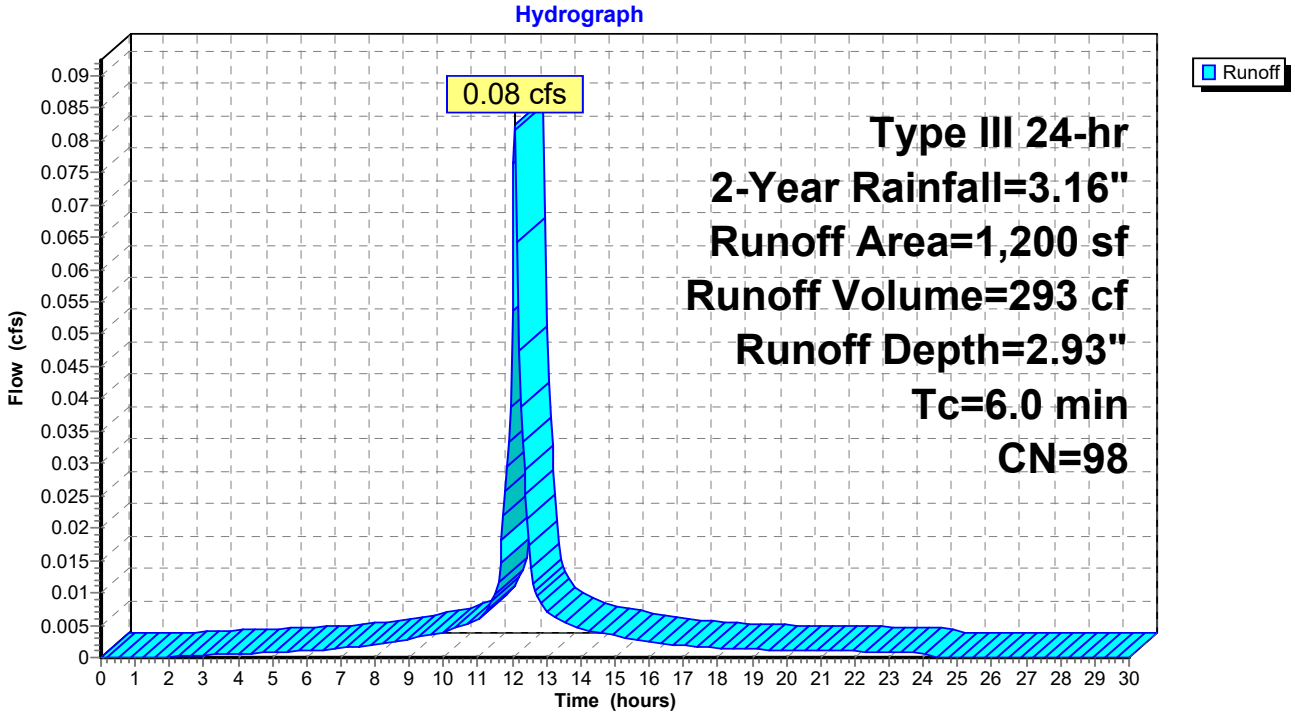
Runoff = 0.08 cfs @ 12.09 hrs, Volume= 293 cf, Depth= 2.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.16"

Area (sf)	CN	Description
1,200	98	Roofs, HSG B
1,200		100.00% Impervious Area

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

Subcatchment P3: #38 Roof

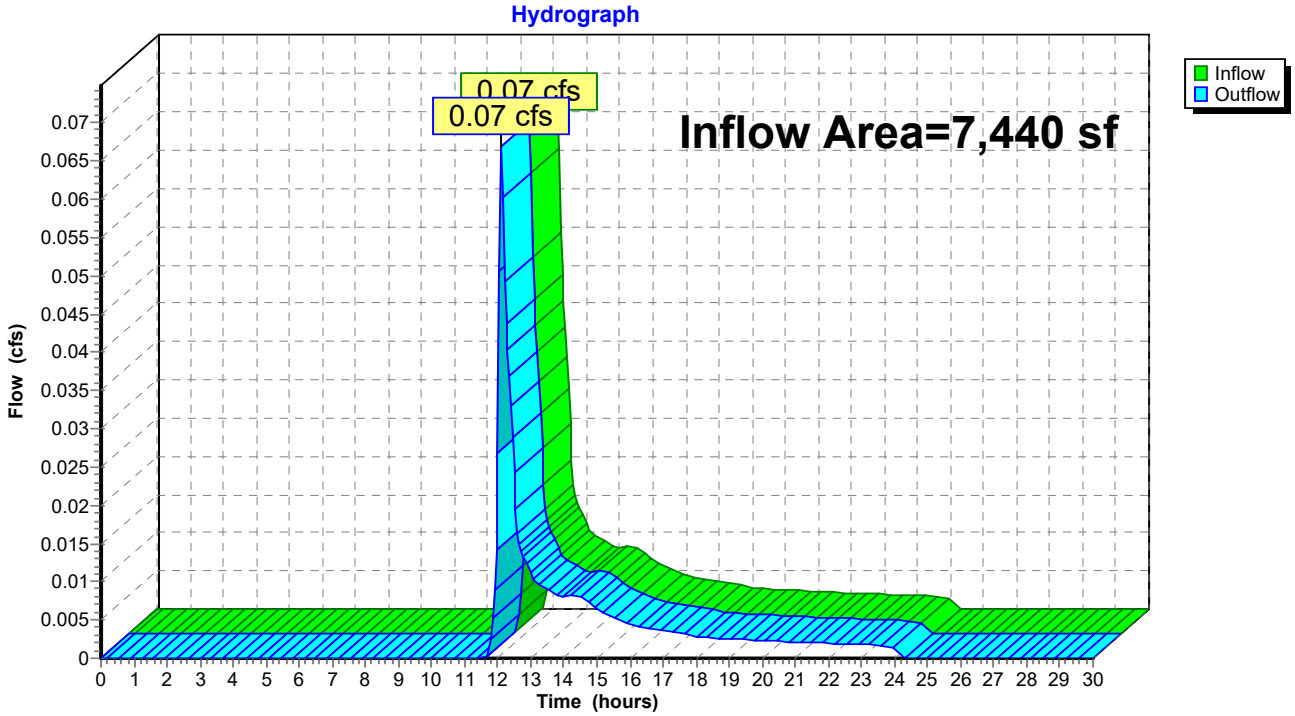


Summary for Reach DP-A: Off-Site to NE

Inflow Area = 7,440 sf, 51.18% Impervious, Inflow Depth = 0.43" for 2-Year event
Inflow = 0.07 cfs @ 12.11 hrs, Volume= 265 cf
Outflow = 0.07 cfs @ 12.11 hrs, Volume= 265 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP-A: Off-Site to NE



Summary for Pond A: Infiltration System A

Inflow Area = 1,208 sf,100.00% Impervious, Inflow Depth = 2.93" for 2-Year event
Inflow = 0.08 cfs @ 12.09 hrs, Volume= 295 cf
Outflow = 0.00 cfs @ 14.07 hrs, Volume= 269 cf, Atten= 95%, Lag= 119.0 min
Discarded = 0.00 cfs @ 14.05 hrs, Volume= 266 cf
Primary = 0.00 cfs @ 14.07 hrs, Volume= 3 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 102.30' @ 14.05 hrs Surf.Area= 132 sf Storage= 150 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 332.8 min (1,089.5 - 756.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	100.00'	104 cf	**12.50'W x 10.56'L x 2.33'H Field A** 308 cf Overall - 47 cf Embedded = 261 cf x 40.0% Voids
#2A	100.50'	47 cf	**ADS_StormTech SC-310** x 3 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 3 rows
		151 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	100.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	102.30'	**0.230 cfs Surcharge**

Discarded OutFlow Max=0.00 cfs @ 14.05 hrs HW=102.30' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 14.07 hrs HW=102.30' TW=0.00' (Dynamic Tailwater)
↑—**2=Surcharge** (Constant Controls 0.00 cfs)

Pond A: Infiltration System A - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 3 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

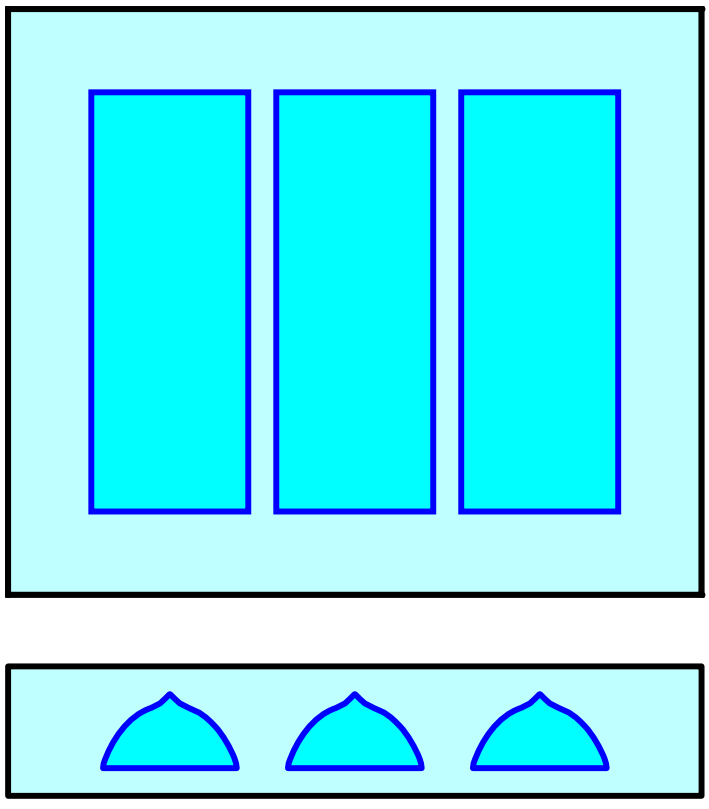
1 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 7.56' Row Length +18.0" End Stone x 2 = 10.56' Base Length
3 Rows x 34.0" Wide + 6.0" Spacing x 2 + 18.0" Side Stone x 2 = 12.50' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

3 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 3 Rows = 46.9 cf Chamber Storage

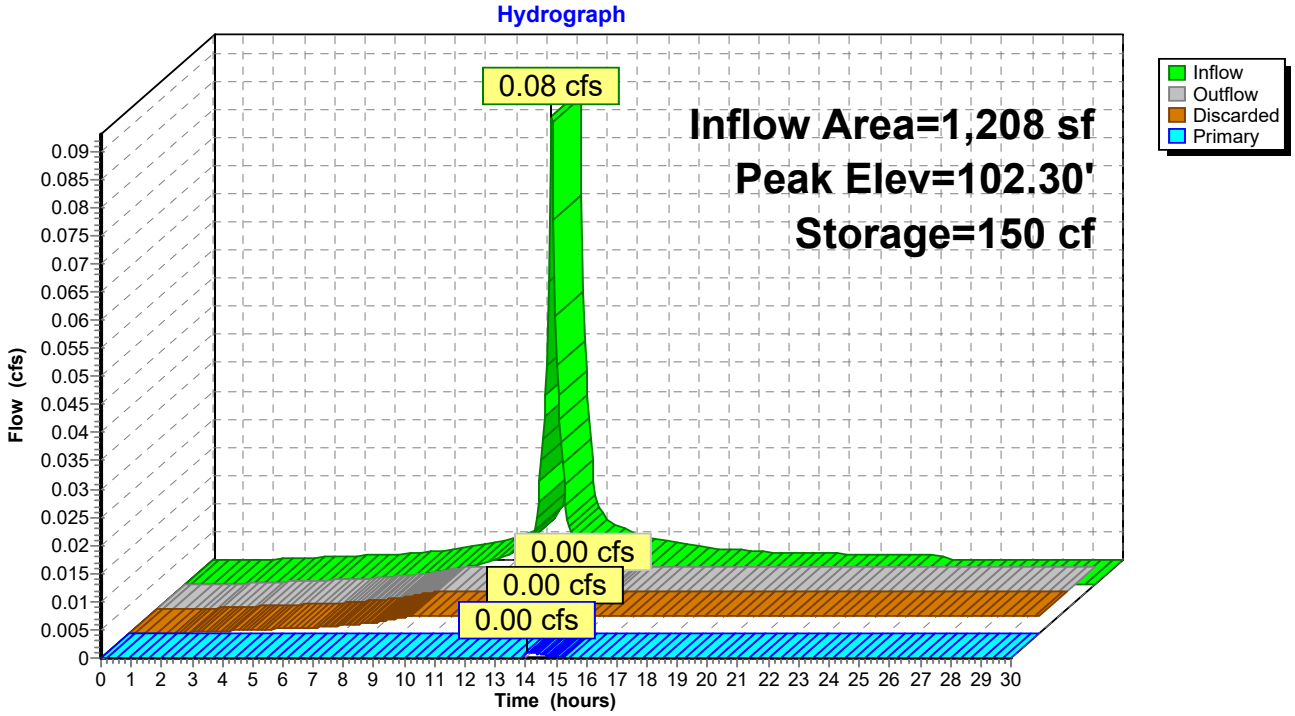
308.0 cf Field - 46.9 cf Chambers = 261.0 cf Stone x 40.0% Voids = 104.4 cf Stone Storage

Chamber Storage + Stone Storage = 151.3 cf = 0.003 af
Overall Storage Efficiency = 49.1%

3 Chambers
11.4 cy Field
9.7 cy Stone



Pond A: Infiltration System A



Summary for Pond B: Infiltration System B

Inflow Area = 1,200 sf,100.00% Impervious, Inflow Depth = 2.93" for 2-Year event
Inflow = 0.08 cfs @ 12.09 hrs, Volume= 293 cf
Outflow = 0.00 cfs @ 14.46 hrs, Volume= 267 cf, Atten= 95%, Lag= 142.3 min
Discarded = 0.00 cfs @ 14.45 hrs, Volume= 266 cf
Primary = 0.00 cfs @ 14.46 hrs, Volume= 1 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 102.30' @ 14.45 hrs Surf.Area= 132 sf Storage= 150 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 334.7 min (1,091.3 - 756.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	100.00'	104 cf	**12.50'W x 10.56'L x 2.33'H Field A** 308 cf Overall - 47 cf Embedded = 261 cf x 40.0% Voids
#2A	100.50'	47 cf	**ADS_StormTech SC-310** x 3 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 3 rows
		151 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	100.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	102.30'	**0.230 cfs Surcharge**

Discarded OutFlow Max=0.00 cfs @ 14.45 hrs HW=102.30' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 14.46 hrs HW=102.30' TW=0.00' (Dynamic Tailwater)
↑—**2=Surcharge** (Constant Controls 0.00 cfs)

Pond B: Infiltration System B - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 3 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

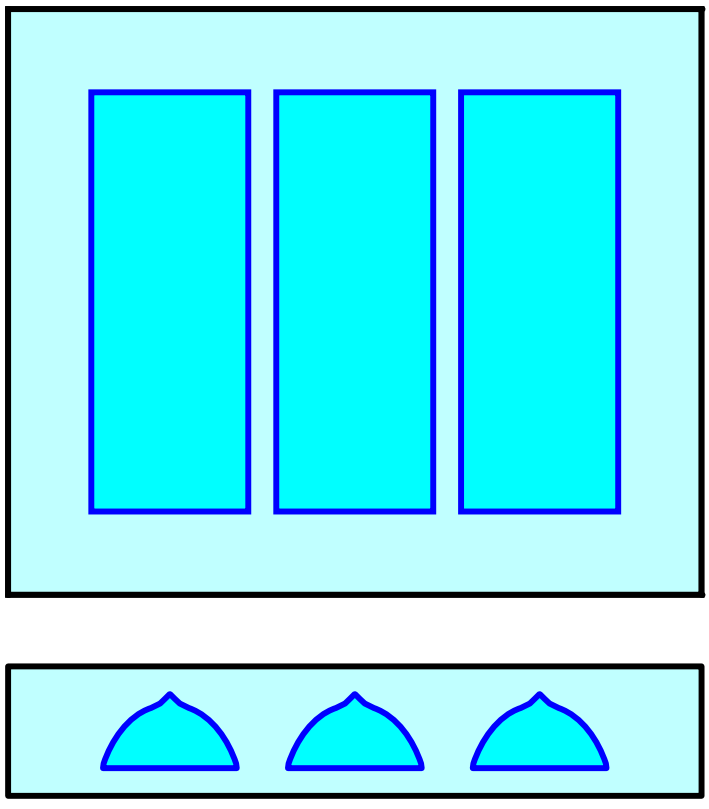
1 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 7.56' Row Length +18.0" End Stone x 2 = 10.56' Base Length
3 Rows x 34.0" Wide + 6.0" Spacing x 2 + 18.0" Side Stone x 2 = 12.50' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

3 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 3 Rows = 47.0 cf Chamber Storage

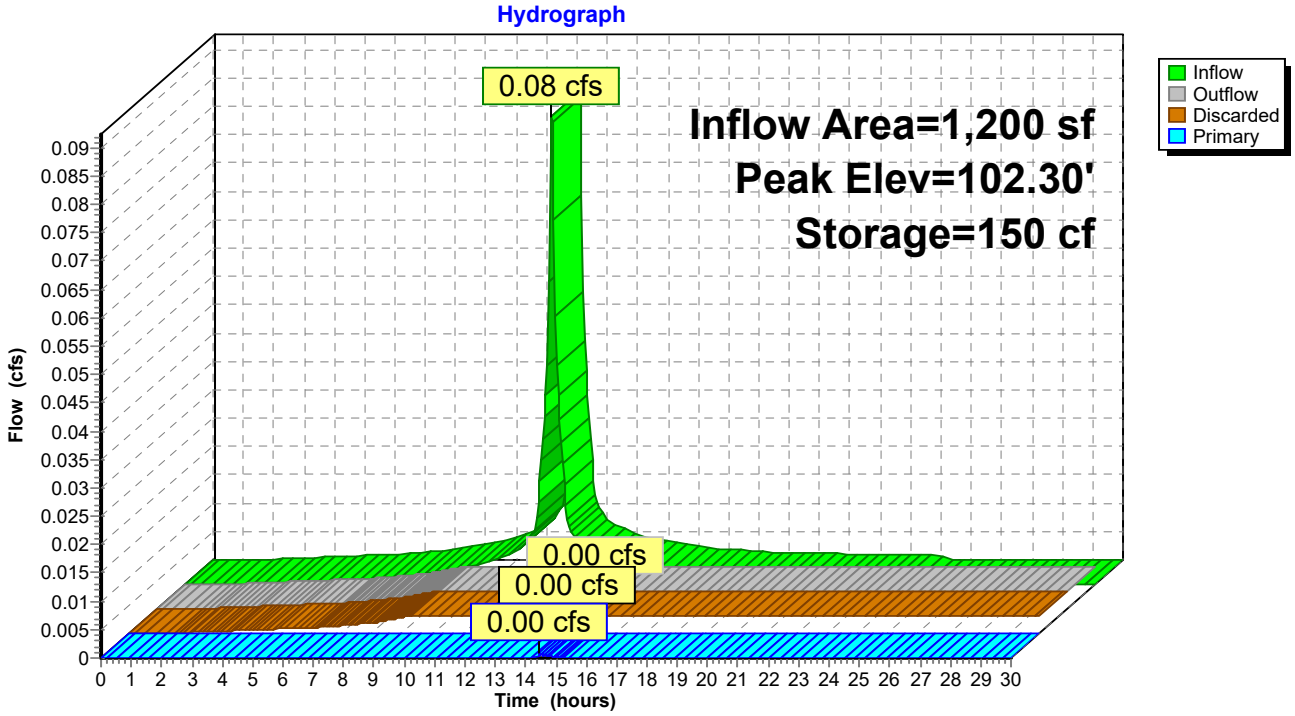
308.0 cf Field - 47.0 cf Chambers = 261.0 cf Stone x 40.0% Voids = 104.4 cf Stone Storage

Chamber Storage + Stone Storage = 151.4 cf = 0.003 af
Overall Storage Efficiency = 49.1%

3 Chambers
11.4 cy Field
9.7 cy Stone



Pond B: Infiltration System B



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

Subcatchment P1: Uncaptured Area Runoff Area=5,032 sf 27.82% Impervious Runoff Depth=1.57"
Tc=6.0 min UI Adjusted CN=66 Runoff=0.20 cfs 660 cf

Subcatchment P2: #34 Roof Runoff Area=1,208 sf 100.00% Impervious Runoff Depth=4.53"
Tc=6.0 min CN=98 Runoff=0.13 cfs 456 cf

Subcatchment P3: #38 Roof Runoff Area=1,200 sf 100.00% Impervious Runoff Depth=4.53"
Tc=6.0 min CN=98 Runoff=0.13 cfs 453 cf

Reach DP-A: Off-Site to NE Inflow=0.38 cfs 908 cf
Outflow=0.38 cfs 908 cf

Pond A: Infiltration System A Peak Elev=102.30' Storage=150 cf Inflow=0.13 cfs 456 cf
Discarded=0.00 cfs 286 cf Primary=0.11 cfs 125 cf Outflow=0.12 cfs 411 cf

Pond B: Infiltration System B Peak Elev=102.30' Storage=150 cf Inflow=0.13 cfs 453 cf
Discarded=0.00 cfs 286 cf Primary=0.10 cfs 123 cf Outflow=0.10 cfs 409 cf

Total Runoff Area = 7,440 sf Runoff Volume = 1,569 cf Average Runoff Depth = 2.53"
48.82% Pervious = 3,632 sf 51.18% Impervious = 3,808 sf

Summary for Subcatchment P1: Uncaptured Area

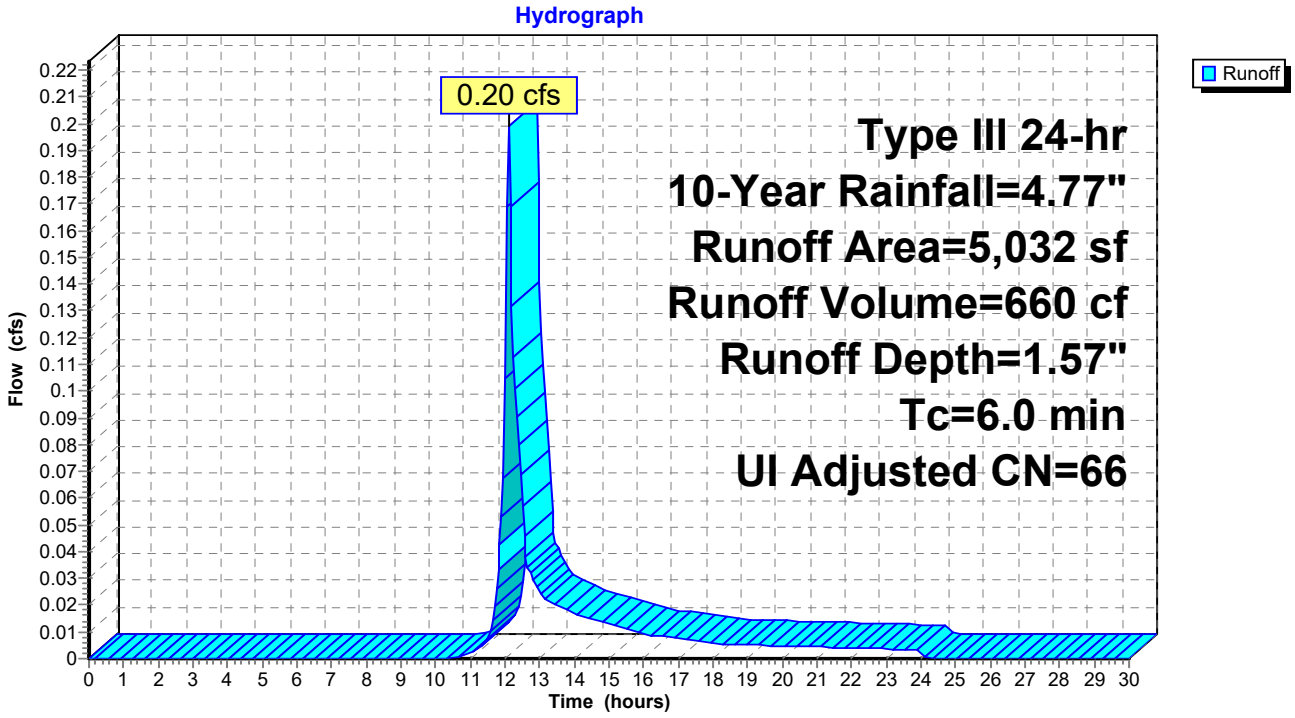
Runoff = 0.20 cfs @ 12.10 hrs, Volume= 660 cf, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.77"

	Area (sf)	CN	Adj	Description
	1,400	98		Unconnected pavement, HSG B
	500	58		Woods/grass comb., Good, HSG B
	2,687	61		>75% Grass cover, Good, HSG B
*	445	61		Permeable Paver Patio, HSG B
	5,032	71	66	Weighted Average, UI Adjusted
	3,632			72.18% Pervious Area
	1,400			27.82% Impervious Area
	1,400			100.00% Unconnected

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

Subcatchment P1: Uncaptured Area



Summary for Subcatchment P2: #34 Roof

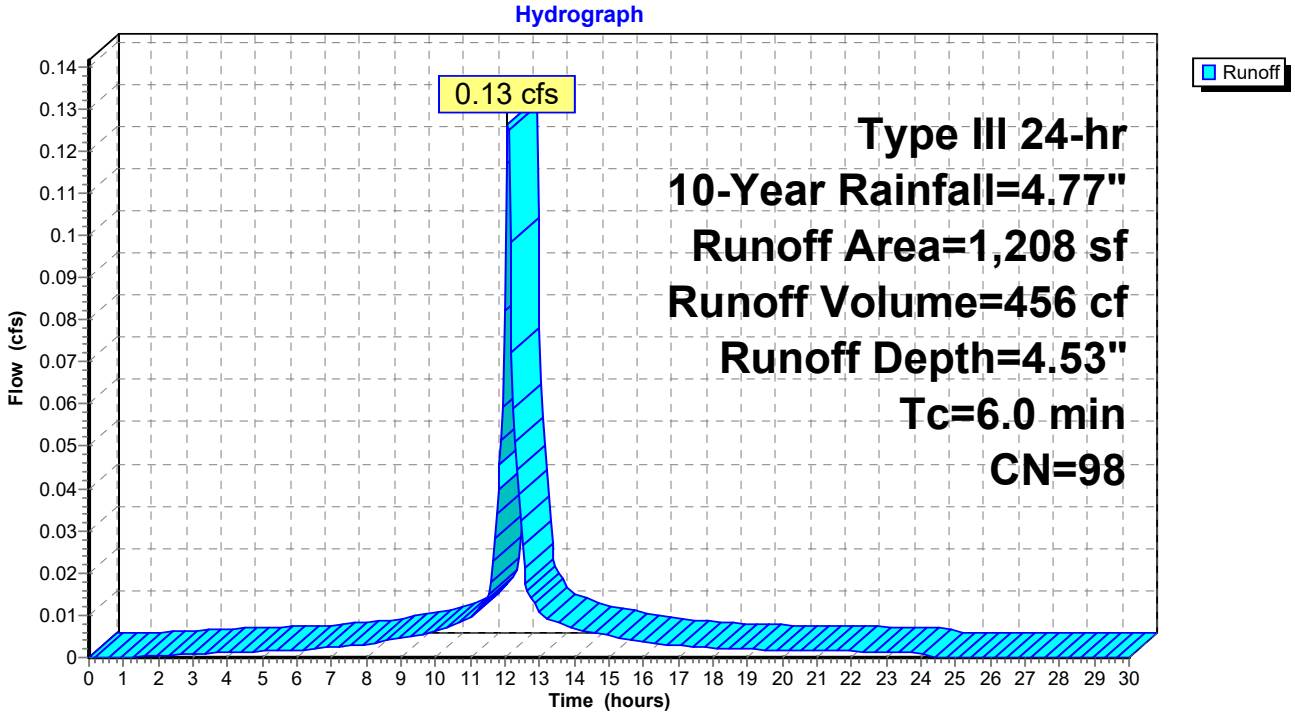
Runoff = 0.13 cfs @ 12.09 hrs, Volume= 456 cf, Depth= 4.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.77"

Area (sf)	CN	Description
1,208	98	Roofs, HSG B
1,208		100.00% Impervious Area

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

Subcatchment P2: #34 Roof



Summary for Subcatchment P3: #38 Roof

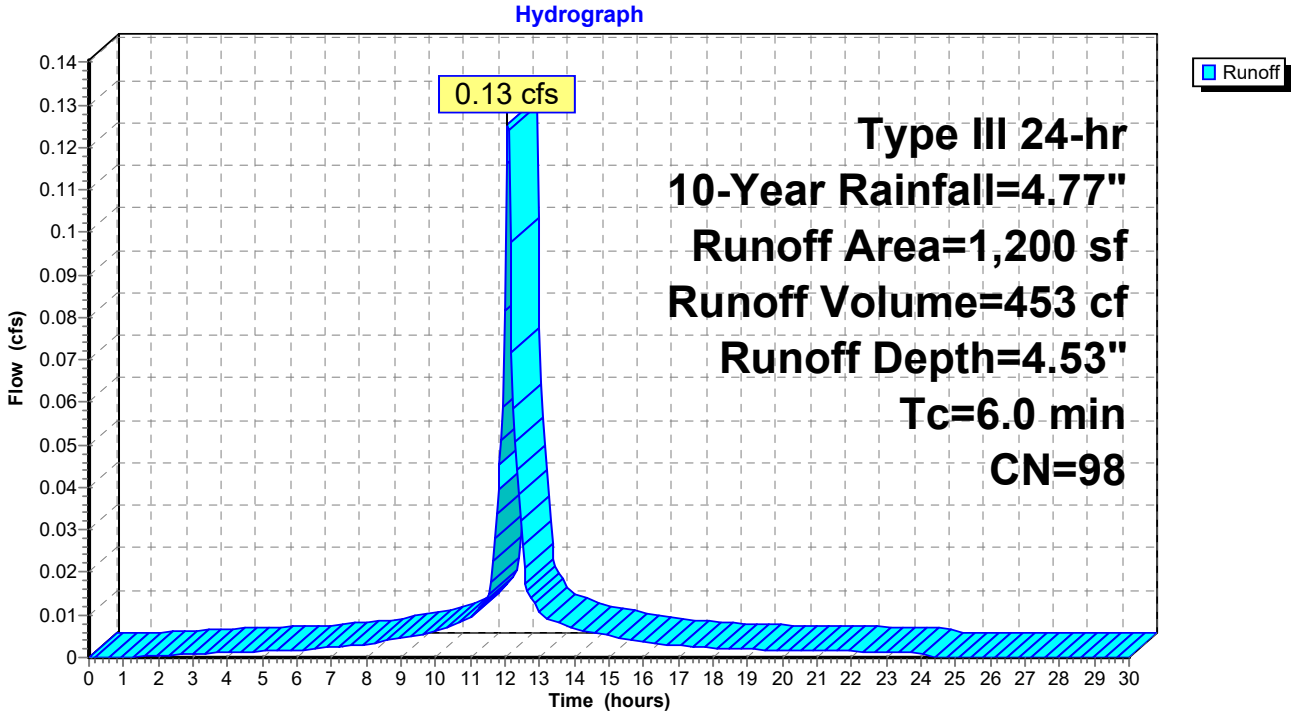
Runoff = 0.13 cfs @ 12.09 hrs, Volume= 453 cf, Depth= 4.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.77"

Area (sf)	CN	Description
1,200	98	Roofs, HSG B
1,200		100.00% Impervious Area

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

Subcatchment P3: #38 Roof

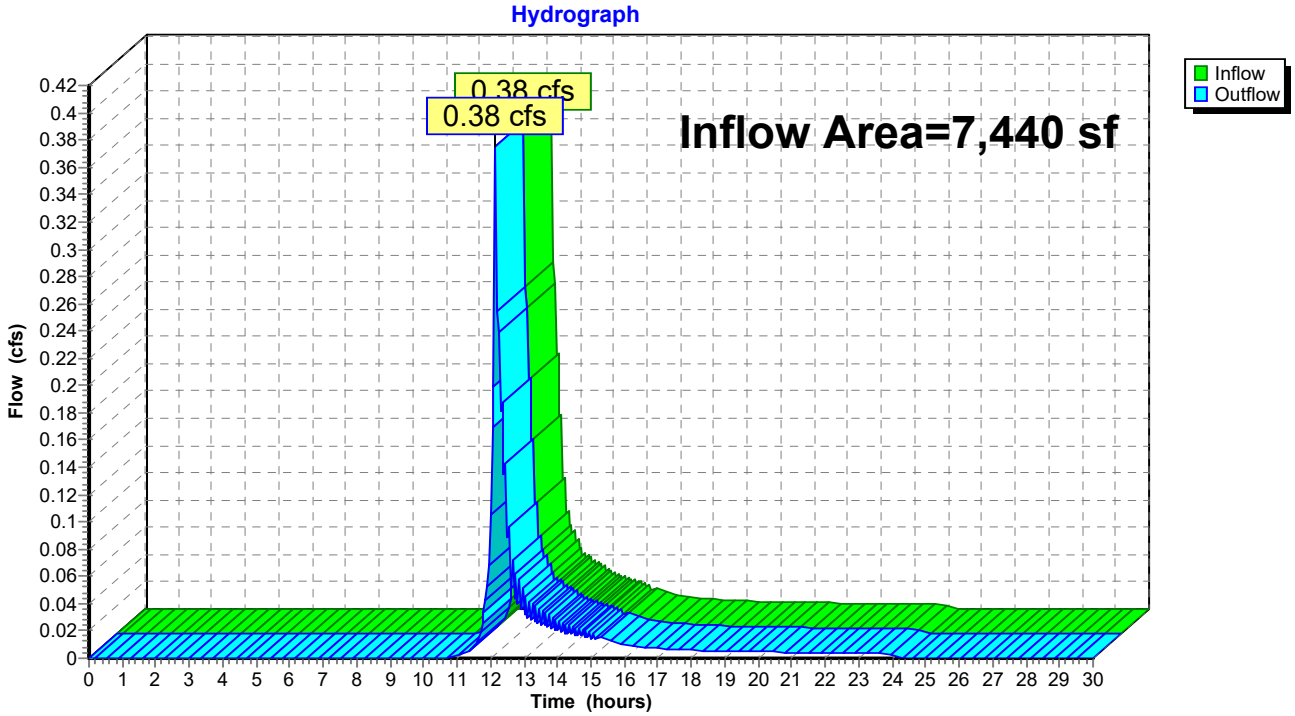


Summary for Reach DP-A: Off-Site to NE

Inflow Area = 7,440 sf, 51.18% Impervious, Inflow Depth = 1.46" for 10-Year event
Inflow = 0.38 cfs @ 12.15 hrs, Volume= 908 cf
Outflow = 0.38 cfs @ 12.15 hrs, Volume= 908 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP-A: Off-Site to NE



Summary for Pond A: Infiltration System A

Inflow Area = 1,208 sf,100.00% Impervious, Inflow Depth = 4.53" for 10-Year event
Inflow = 0.13 cfs @ 12.09 hrs, Volume= 456 cf
Outflow = 0.12 cfs @ 12.16 hrs, Volume= 411 cf, Atten= 8%, Lag= 4.3 min
Discarded = 0.00 cfs @ 12.15 hrs, Volume= 286 cf
Primary = 0.11 cfs @ 12.16 hrs, Volume= 125 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 102.30' @ 12.15 hrs Surf.Area= 132 sf Storage= 150 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 210.4 min (959.2 - 748.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	100.00'	104 cf	**12.50'W x 10.56'L x 2.33'H Field A** 308 cf Overall - 47 cf Embedded = 261 cf x 40.0% Voids
#2A	100.50'	47 cf	**ADS_StormTech SC-310** x 3 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 3 rows
		151 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	100.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	102.30'	**0.230 cfs Surcharge**

Discarded OutFlow Max=0.00 cfs @ 12.15 hrs HW=102.30' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=0.23 cfs @ 12.16 hrs HW=102.30' TW=0.00' (Dynamic Tailwater)
↑—**2=Surcharge** (Constant Controls 0.23 cfs)

Pond A: Infiltration System A - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 3 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

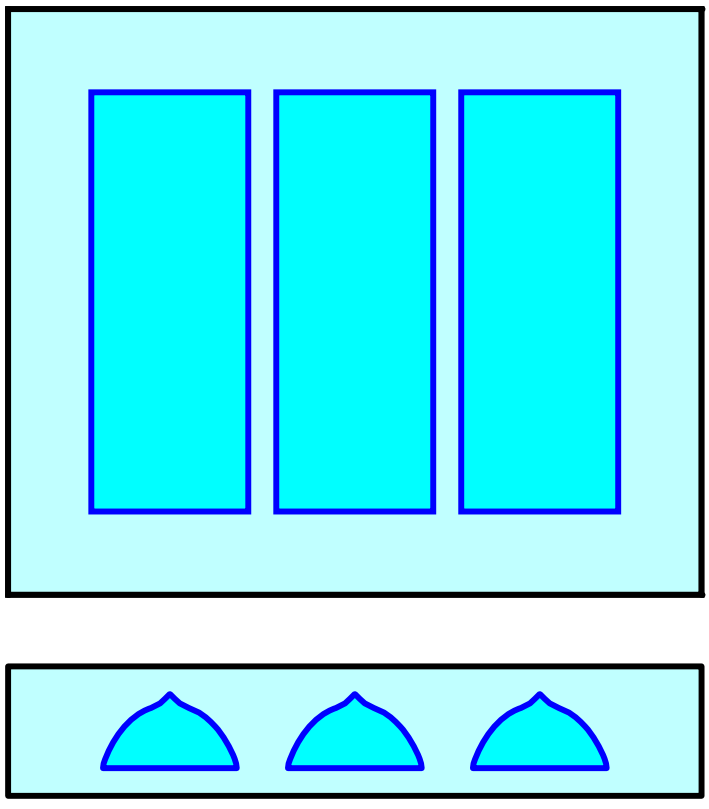
1 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 7.56' Row Length +18.0" End Stone x 2 = 10.56' Base Length
3 Rows x 34.0" Wide + 6.0" Spacing x 2 + 18.0" Side Stone x 2 = 12.50' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

3 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 3 Rows = 46.9 cf Chamber Storage

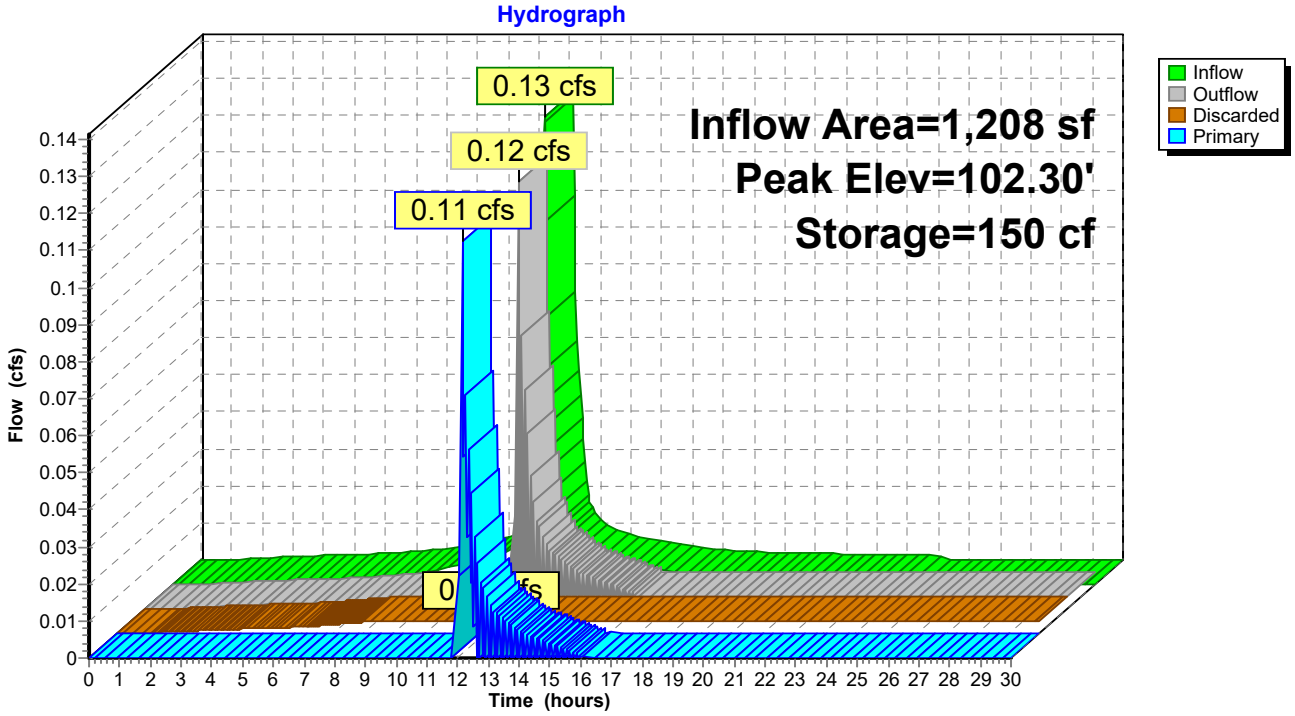
308.0 cf Field - 46.9 cf Chambers = 261.0 cf Stone x 40.0% Voids = 104.4 cf Stone Storage

Chamber Storage + Stone Storage = 151.3 cf = 0.003 af
Overall Storage Efficiency = 49.1%

3 Chambers
11.4 cy Field
9.7 cy Stone



Pond A: Infiltration System A



Summary for Pond B: Infiltration System B

Inflow Area = 1,200 sf,100.00% Impervious, Inflow Depth = 4.53" for 10-Year event
Inflow = 0.13 cfs @ 12.09 hrs, Volume= 453 cf
Outflow = 0.10 cfs @ 12.16 hrs, Volume= 409 cf, Atten= 18%, Lag= 4.7 min
Discarded = 0.00 cfs @ 12.15 hrs, Volume= 286 cf
Primary = 0.10 cfs @ 12.16 hrs, Volume= 123 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 102.30' @ 12.15 hrs Surf.Area= 132 sf Storage= 150 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 212.0 min (960.8 - 748.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	100.00'	104 cf	**12.50'W x 10.56'L x 2.33'H Field A** 308 cf Overall - 47 cf Embedded = 261 cf x 40.0% Voids
#2A	100.50'	47 cf	**ADS_StormTech SC-310** x 3 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 3 rows
		151 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	100.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	102.30'	**0.230 cfs Surcharge**

Discarded OutFlow Max=0.00 cfs @ 12.15 hrs HW=102.30' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 12.16 hrs HW=102.30' TW=0.00' (Dynamic Tailwater)
↑—**2=Surcharge** (Constant Controls 0.00 cfs)

Pond B: Infiltration System B - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 3 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

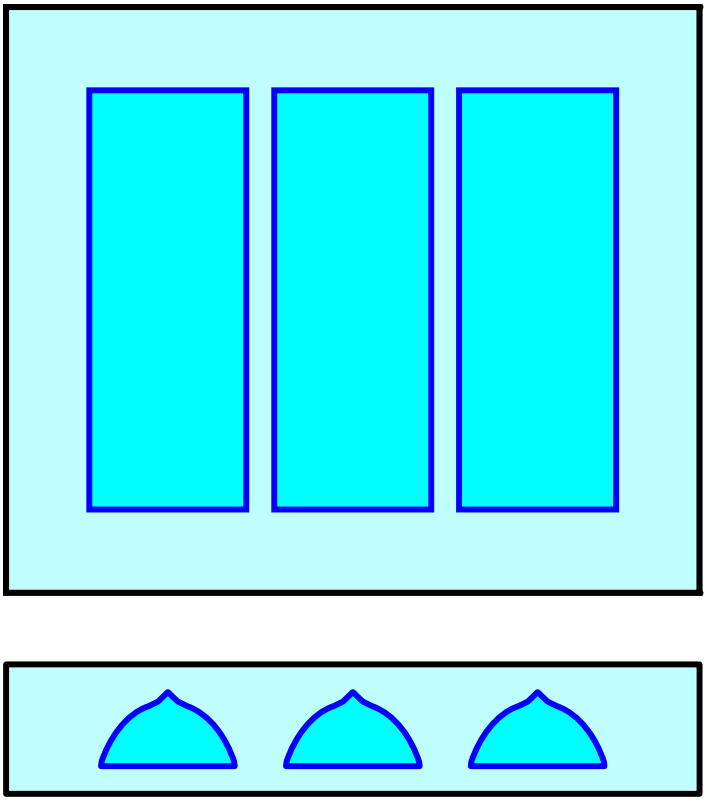
1 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 7.56' Row Length +18.0" End Stone x 2 = 10.56' Base Length
3 Rows x 34.0" Wide + 6.0" Spacing x 2 + 18.0" Side Stone x 2 = 12.50' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

3 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 3 Rows = 47.0 cf Chamber Storage

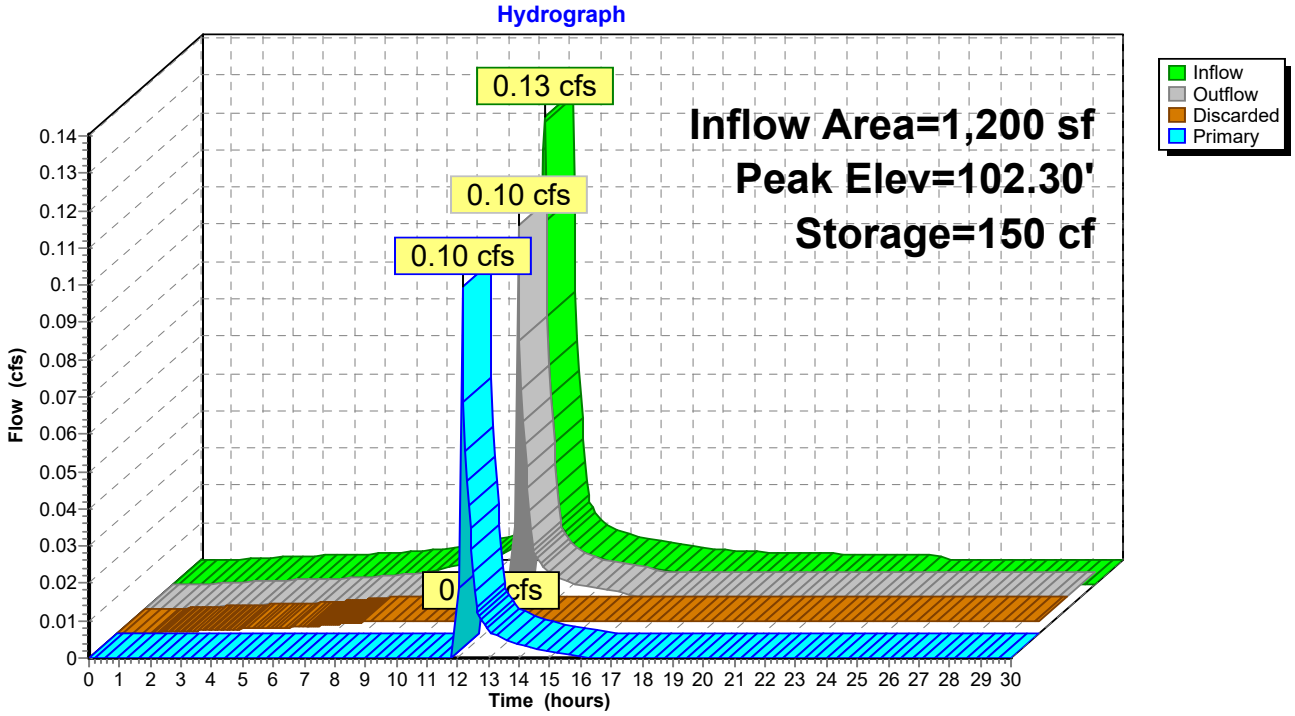
308.0 cf Field - 47.0 cf Chambers = 261.0 cf Stone x 40.0% Voids = 104.4 cf Stone Storage

Chamber Storage + Stone Storage = 151.4 cf = 0.003 af
Overall Storage Efficiency = 49.1%

3 Chambers
11.4 cy Field
9.7 cy Stone



Pond B: Infiltration System B



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

Subcatchment P1: Uncaptured Area Runoff Area=5,032 sf 27.82% Impervious Runoff Depth=4.52"
Tc=6.0 min UI Adjusted CN=66 Runoff=0.60 cfs 1,896 cf

Subcatchment P2: #34 Roof Runoff Area=1,208 sf 100.00% Impervious Runoff Depth=8.38"
Tc=6.0 min CN=98 Runoff=0.23 cfs 844 cf

Subcatchment P3: #38 Roof Runoff Area=1,200 sf 100.00% Impervious Runoff Depth=8.38"
Tc=6.0 min CN=98 Runoff=0.23 cfs 838 cf

Reach DP-A: Off-Site to NE Inflow=1.04 cfs 2,800 cf
Outflow=1.04 cfs 2,800 cf

Pond A: Infiltration System A Peak Elev=102.30' Storage=150 cf Inflow=0.23 cfs 844 cf
Discarded=0.00 cfs 315 cf Primary=0.23 cfs 455 cf Outflow=0.23 cfs 770 cf

Pond B: Infiltration System B Peak Elev=102.30' Storage=150 cf Inflow=0.23 cfs 838 cf
Discarded=0.00 cfs 315 cf Primary=0.23 cfs 450 cf Outflow=0.23 cfs 765 cf

Total Runoff Area = 7,440 sf Runoff Volume = 3,577 cf Average Runoff Depth = 5.77"
48.82% Pervious = 3,632 sf 51.18% Impervious = 3,808 sf

Summary for Subcatchment P1: Uncaptured Area

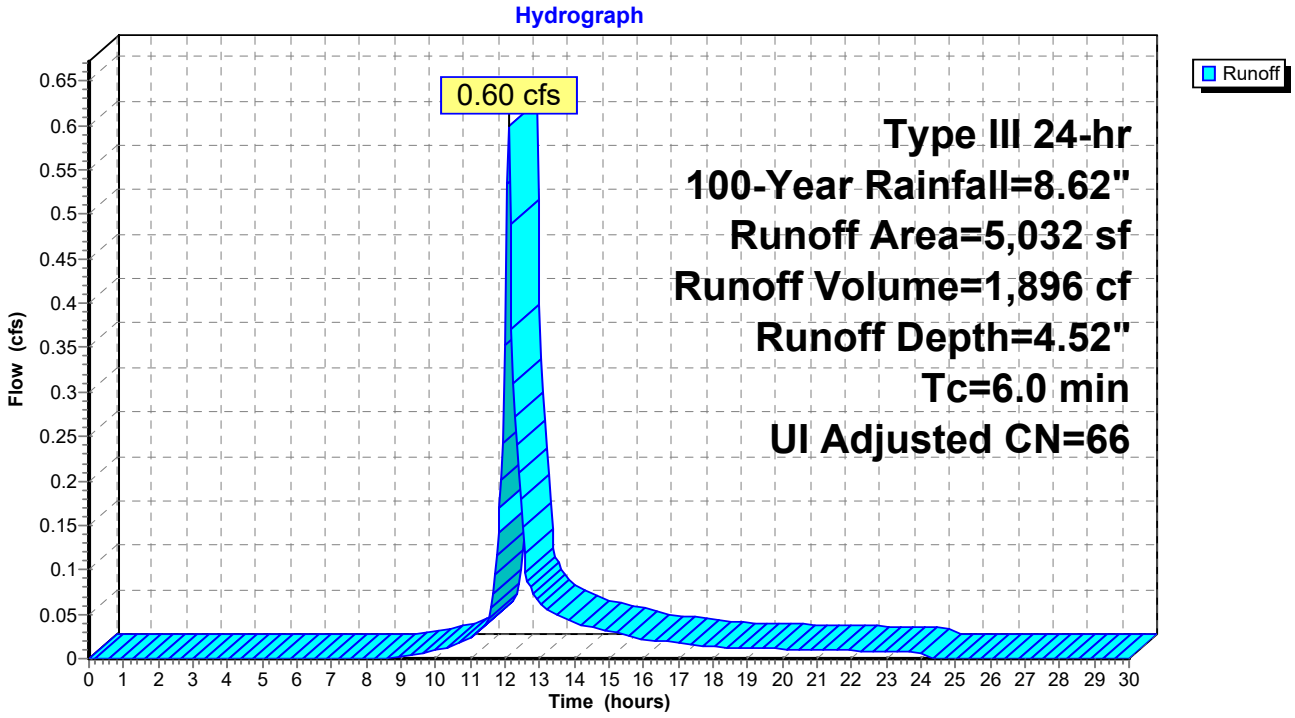
Runoff = 0.60 cfs @ 12.09 hrs, Volume= 1,896 cf, Depth= 4.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.62"

	Area (sf)	CN	Adj	Description
	1,400	98		Unconnected pavement, HSG B
	500	58		Woods/grass comb., Good, HSG B
	2,687	61		>75% Grass cover, Good, HSG B
*	445	61		Permeable Paver Patio, HSG B
	5,032	71	66	Weighted Average, UI Adjusted
	3,632			72.18% Pervious Area
	1,400			27.82% Impervious Area
	1,400			100.00% Unconnected

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

Subcatchment P1: Uncaptured Area



Summary for Subcatchment P2: #34 Roof

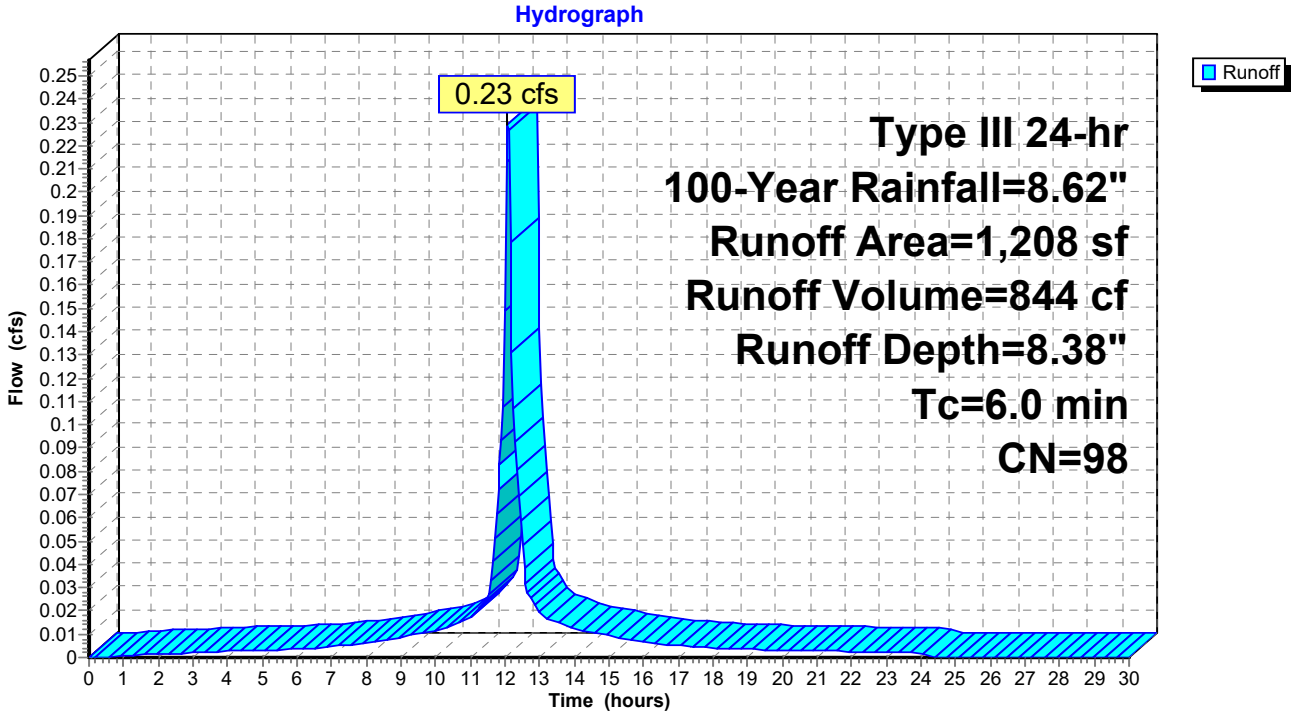
Runoff = 0.23 cfs @ 12.09 hrs, Volume= 844 cf, Depth= 8.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.62"

Area (sf)	CN	Description
1,208	98	Roofs, HSG B
1,208		100.00% Impervious Area

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

Subcatchment P2: #34 Roof



Summary for Subcatchment P3: #38 Roof

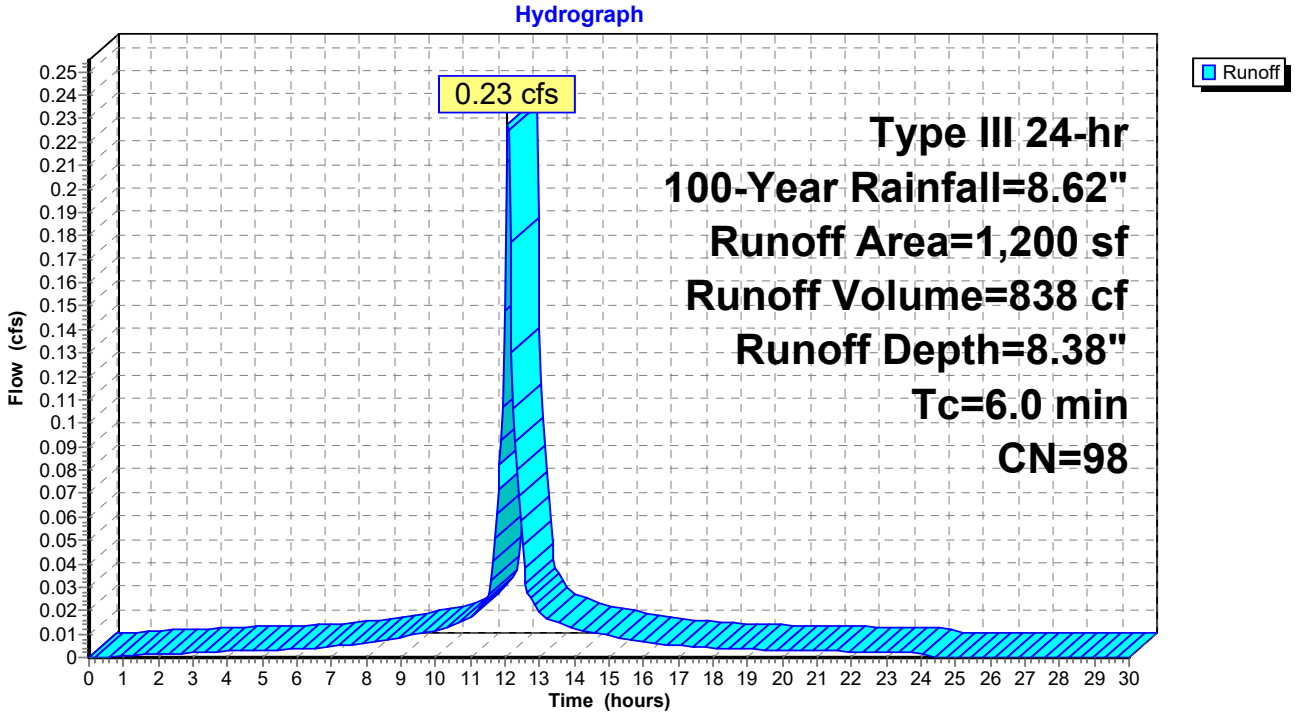
Runoff = 0.23 cfs @ 12.09 hrs, Volume= 838 cf, Depth= 8.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.62"

Area (sf)	CN	Description
1,200	98	Roofs, HSG B
1,200		100.00% Impervious Area

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

Subcatchment P3: #38 Roof

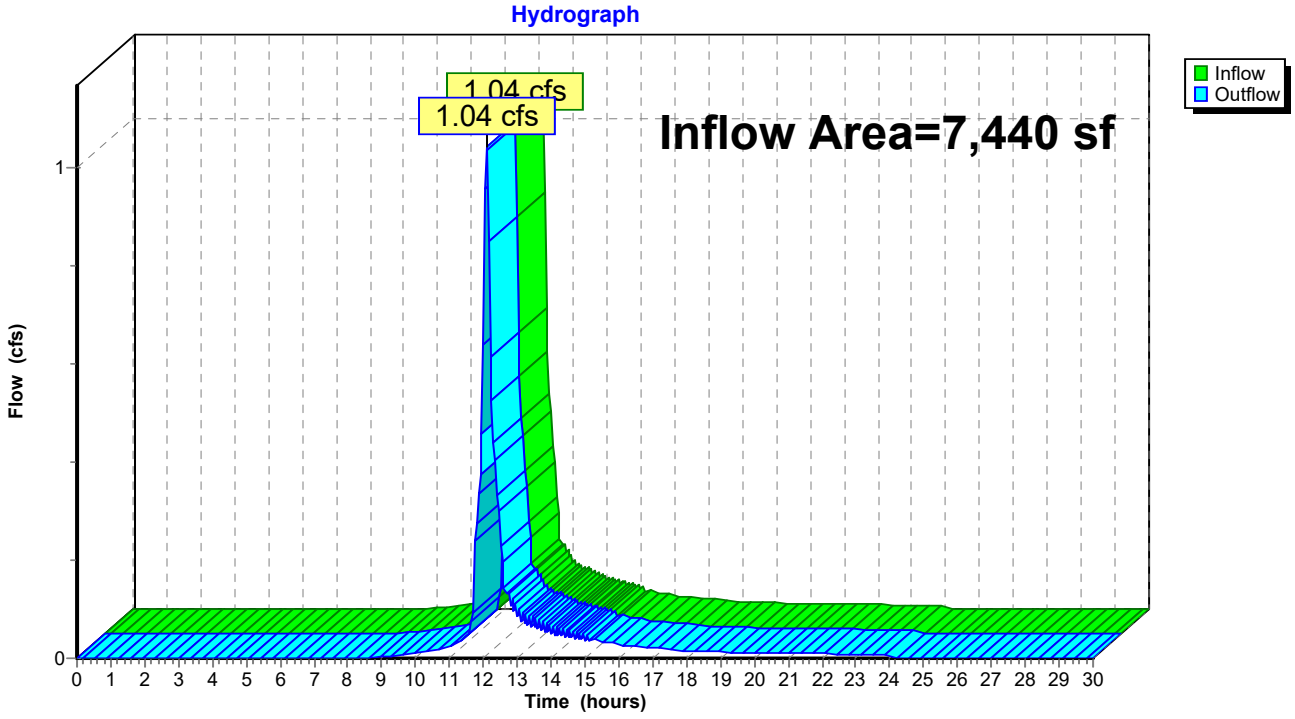


Summary for Reach DP-A: Off-Site to NE

Inflow Area = 7,440 sf, 51.18% Impervious, Inflow Depth = 4.52" for 100-Year event
Inflow = 1.04 cfs @ 12.09 hrs, Volume= 2,800 cf
Outflow = 1.04 cfs @ 12.09 hrs, Volume= 2,800 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach DP-A: Off-Site to NE



Summary for Pond A: Infiltration System A

Inflow Area = 1,208 sf,100.00% Impervious, Inflow Depth = 8.38" for 100-Year event
Inflow = 0.23 cfs @ 12.09 hrs, Volume= 844 cf
Outflow = 0.23 cfs @ 12.07 hrs, Volume= 770 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 12.06 hrs, Volume= 315 cf
Primary = 0.23 cfs @ 12.07 hrs, Volume= 455 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 102.30' @ 12.06 hrs Surf.Area= 132 sf Storage= 150 cf

Plug-Flow detention time= 154.4 min calculated for 770 cf (91% of inflow)
Center-of-Mass det. time= 108.7 min (849.1 - 740.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	100.00'	104 cf	**12.50'W x 10.56'L x 2.33'H Field A** 308 cf Overall - 47 cf Embedded = 261 cf x 40.0% Voids
#2A	100.50'	47 cf	**ADS_StormTech SC-310** x 3 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 3 rows
		151 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	100.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	102.30'	**0.230 cfs Surcharge**

Discarded OutFlow Max=0.00 cfs @ 12.06 hrs HW=102.30' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=0.23 cfs @ 12.07 hrs HW=102.30' TW=0.00' (Dynamic Tailwater)
↑—**2=Surcharge** (Constant Controls 0.23 cfs)

Pond A: Infiltration System A - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 3 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

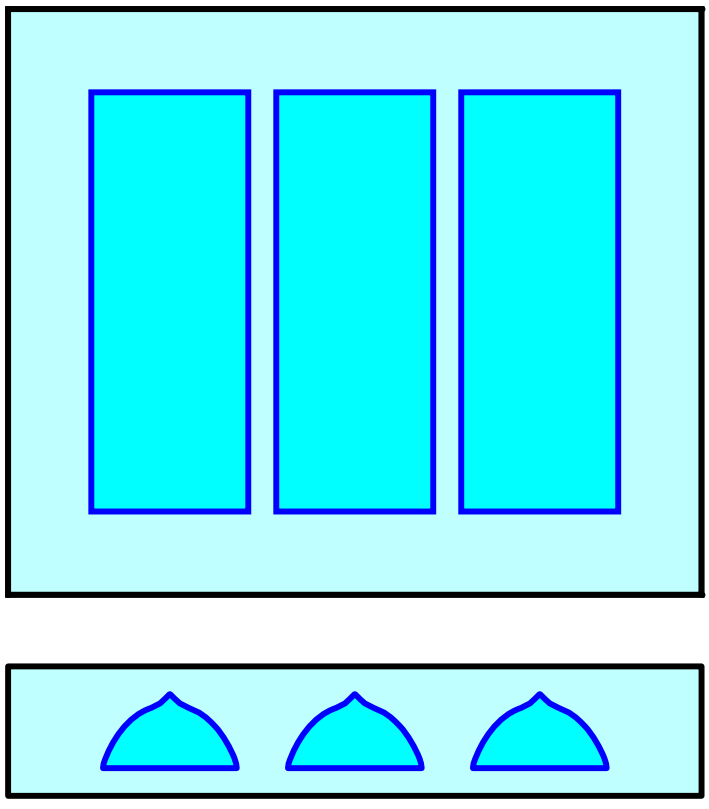
1 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 7.56' Row Length +18.0" End Stone x 2 = 10.56' Base Length
3 Rows x 34.0" Wide + 6.0" Spacing x 2 + 18.0" Side Stone x 2 = 12.50' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

3 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 3 Rows = 46.9 cf Chamber Storage

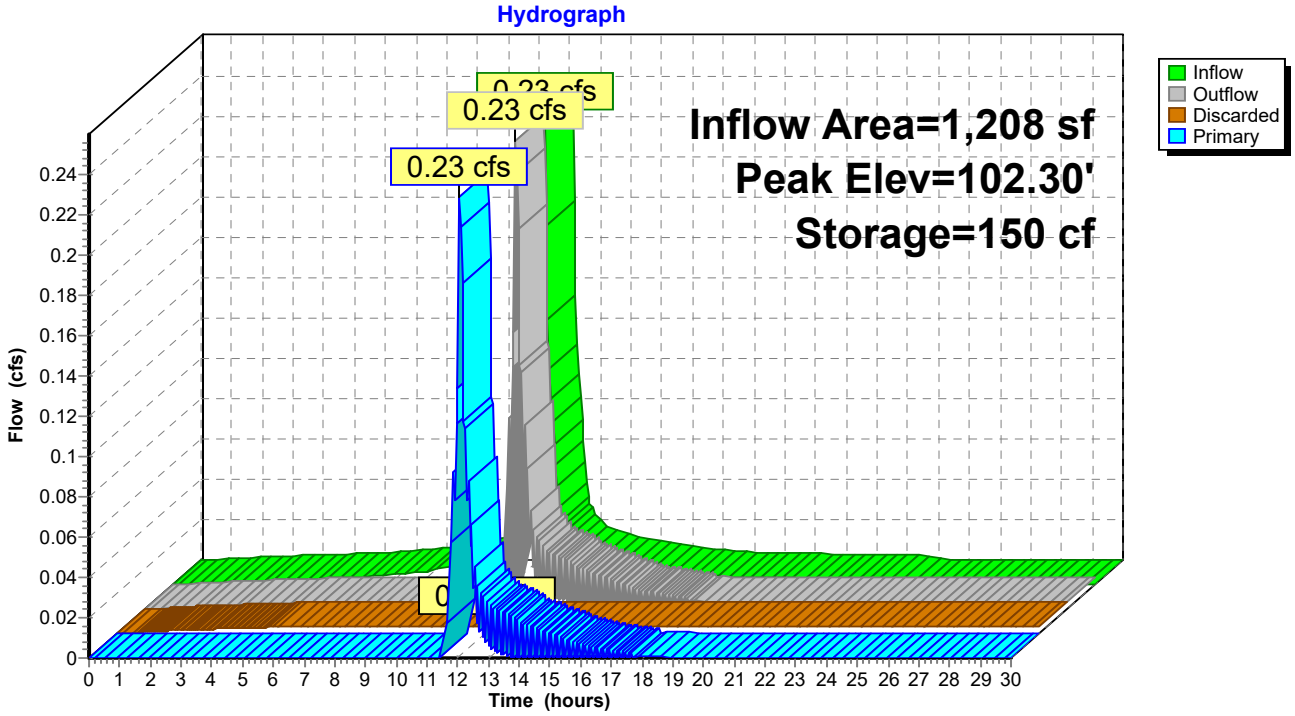
308.0 cf Field - 46.9 cf Chambers = 261.0 cf Stone x 40.0% Voids = 104.4 cf Stone Storage

Chamber Storage + Stone Storage = 151.3 cf = 0.003 af
Overall Storage Efficiency = 49.1%

3 Chambers
11.4 cy Field
9.7 cy Stone



Pond A: Infiltration System A



Summary for Pond B: Infiltration System B

Inflow Area = 1,200 sf,100.00% Impervious, Inflow Depth = 8.38" for 100-Year event
Inflow = 0.23 cfs @ 12.09 hrs, Volume= 838 cf
Outflow = 0.23 cfs @ 12.09 hrs, Volume= 765 cf, Atten= 0%, Lag= 0.2 min
Discarded = 0.00 cfs @ 12.10 hrs, Volume= 315 cf
Primary = 0.23 cfs @ 12.09 hrs, Volume= 450 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 102.30' @ 12.10 hrs Surf.Area= 132 sf Storage= 150 cf

Plug-Flow detention time= 155.3 min calculated for 765 cf (91% of inflow)
Center-of-Mass det. time= 109.5 min (849.8 - 740.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	100.00'	104 cf	**12.50'W x 10.56'L x 2.33'H Field A** 308 cf Overall - 47 cf Embedded = 261 cf x 40.0% Voids
#2A	100.50'	47 cf	**ADS_StormTech SC-310** x 3 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 2.07 sf x 3 rows
		151 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	100.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	102.30'	**0.230 cfs Surcharge**

Discarded OutFlow Max=0.00 cfs @ 12.10 hrs HW=102.30' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=0.23 cfs @ 12.09 hrs HW=102.30' TW=0.00' (Dynamic Tailwater)
↑—**2=Surcharge** (Constant Controls 0.23 cfs)

Pond B: Infiltration System B - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-310 (ADS StormTech® SC-310)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap
Row Length Adjustment= +0.44' x 2.07 sf x 3 rows

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

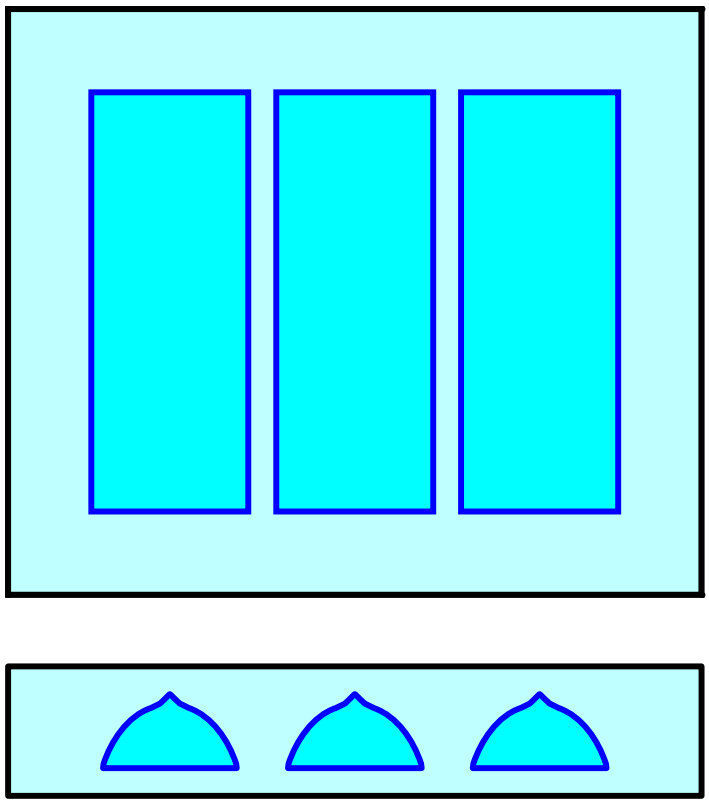
1 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 7.56' Row Length +18.0" End Stone x 2 = 10.56' Base Length
3 Rows x 34.0" Wide + 6.0" Spacing x 2 + 18.0" Side Stone x 2 = 12.50' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

3 Chambers x 14.7 cf +0.44' Row Adjustment x 2.07 sf x 3 Rows = 47.0 cf Chamber Storage

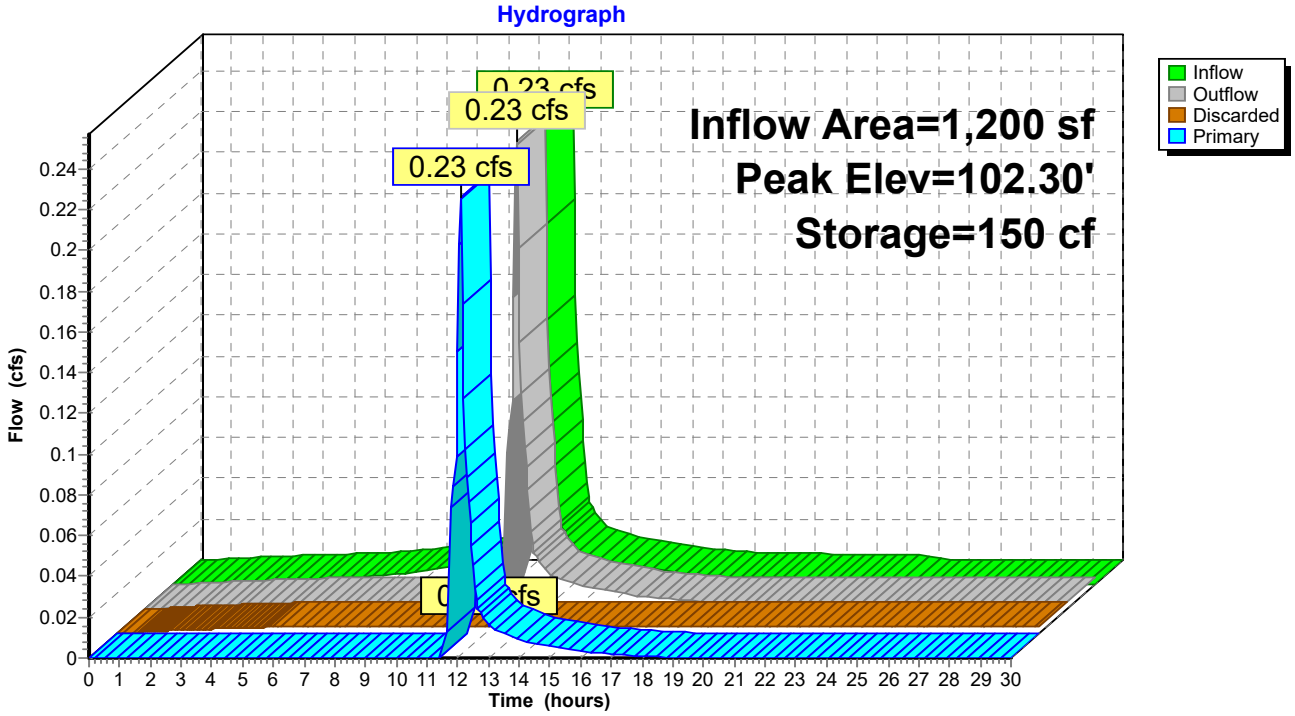
308.0 cf Field - 47.0 cf Chambers = 261.0 cf Stone x 40.0% Voids = 104.4 cf Stone Storage

Chamber Storage + Stone Storage = 151.4 cf = 0.003 af
Overall Storage Efficiency = 49.1%

3 Chambers
11.4 cy Field
9.7 cy Stone



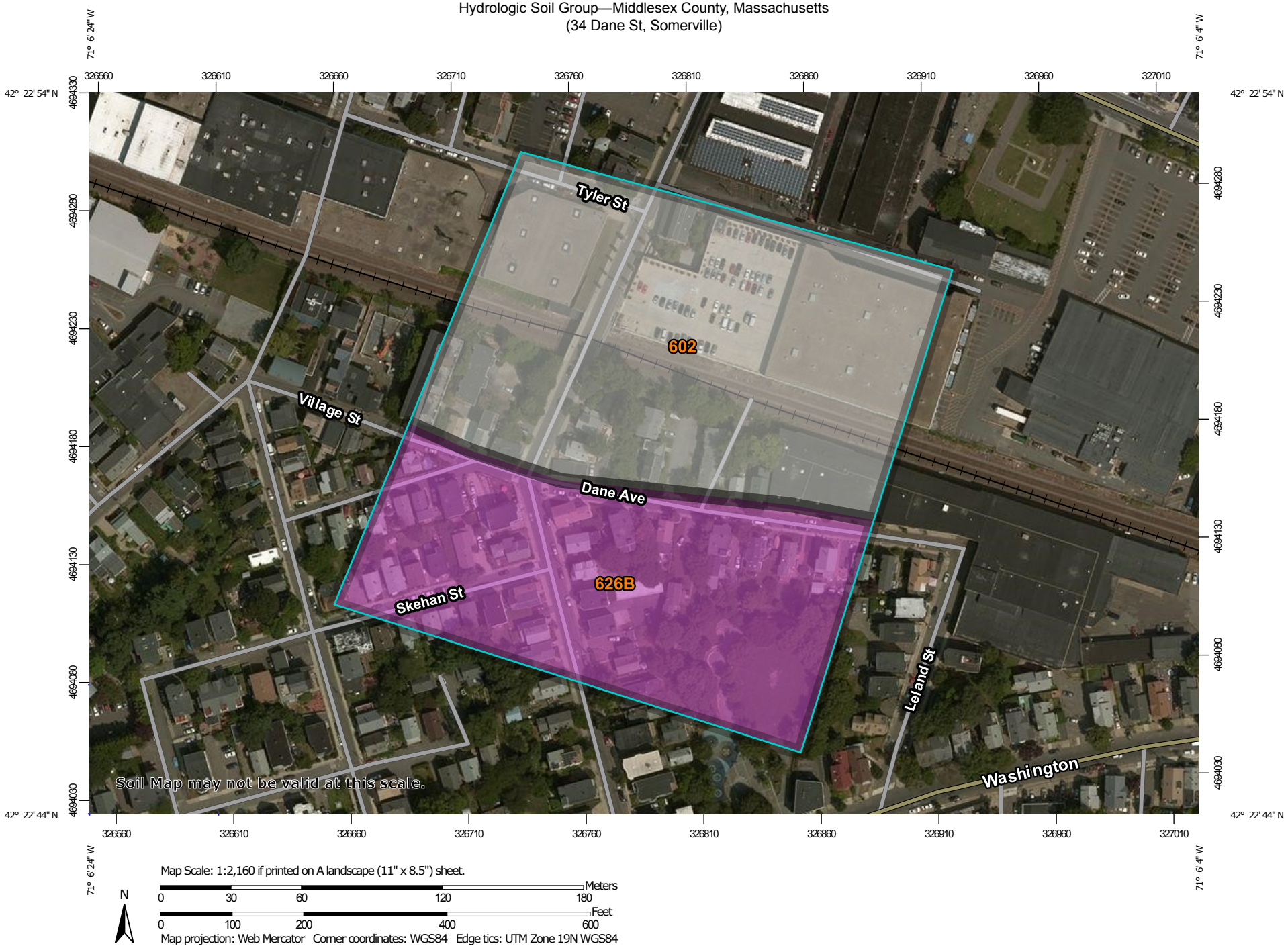
Pond B: Infiltration System B



Appendix D

Supporting Calculations & Forms

Hydrologic Soil Group—Middlesex County, Massachusetts
(34 Dane St, Somerville)



Map Scale: 1:2,160 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 30 60 120 180

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 Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 16, Sep 14, 2016

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

Date(s) aerial images were photographed: Aug 10, 2014—Aug 11, 2014

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Middlesex County, Massachusetts (MA017)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
602	Urban land		5.9	57.0%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	A	4.5	43.0%
Totals for Area of Interest			**10.4**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix E

Construction Period Operation & Maintenance Plan

Construction Period Stormwater Operation & Maintenance Plan

Site Redevelopment
34 & 38 Dane Street, Somerville, MA

April 6, 2017

Prepared By: Scott P. Henderson, PE

HENDERSON
Consulting Services

P.O. Box 626
Lexington, MA 02420
hcscivil@gmail.com
774-993-9903

Erosion and Sedimentation will be controlled at the site by utilizing Structural Practices, Stabilization Practices, and Dust Control. These practices correspond with plans entitled "Plan of Land, 34 & 38 Dane Street, Somerville, Massachusetts," dated April 6, 2017 as revised and approved, prepared by Henderson Consulting Services, hereinafter referred to as the Site Plans.

Responsible Party

Contractor (TBD)

Erosion & Sedimentation Control Practices

1) **Silt Sock Erosion Control Barrier** – A Filter Mitt erosion control barrier will be installed along downward slopes at the limit of work in locations where runoff leaves the project site. This control will be installed prior to major soil disturbance on the site. The barrier should be installed as shown on the Site Plans.

Filter Mitt Inspection/Maintenance *

a) Erosion control should be inspected immediately after each rainfall event of 1-inch or greater, and at least daily during prolonged rainfall. Inspect the depth of sediment, fabric tears, if the silt sock is securely attached to the ground, and to see that the stakes are firmly in the ground. Repair or replace as necessary.

b) Remove sediment deposits promptly after storm events to provide adequate storage volume for the next rain and to reduce pressure on the sock. Sediment will be removed from behind the sock when it becomes about 3 inches deep at the fence. Take care to avoid undermining sock during cleanout.

c) Remove all materials after the contributing drainage area has been properly stabilized. Sediment deposits remaining after the fabric has been removed should be graded to conform with the existing topography and vegetated.

2) **Stabilized Construction Entrance** – A stabilized construction entrance shall be placed at the location of the proposed driveway. The stabilized entrance shall be installed immediately following the removal of the existing bituminous concrete driveway. The entrance will keep mud and sediment from being tracked onto Dane Street by vehicles leaving the site. This stabilized entrance shall be 15 feet long and as wide as the proposed drive.

Construction Entrance Design/Construction Requirements *

a) Stone for a stabilized construction entrance shall consist of 1 to 3-inch stone placed on a stable foundation.

b) Pad dimensions: The minimum length of the gravel pad should be 15 feet. The pad should extend the full width of the proposed driveway, or wide enough so that the largest construction vehicle will fit in the entrance with room to spare; whichever is greater. If a

large amount of traffic is expected at the entrance, then the stabilized construction entrance should be wide enough to fit two vehicles across with room to spare.

c) A geotextile filter fabric shall be placed between the stone fill and the earth surface below the pad to reduce the migration of soil particles from the underlying soil into the stone and vice versa. The filter fabric should be Amoco woven polypropylene 1198 or equivalent.

Construction Entrance Inspection/Maintenance *

a) The entrance should be maintained in a condition that will prevent tracking or flowing of sediment onto Dane Street. This may require periodic topdressing with additional stone.

b) The construction entrance and sediment disposal area shall be inspected weekly and after heavy rains or heavy use.

c) Mud and sediment tracked or washed onto public road shall be immediately removed by sweeping.

d) If washing facilities are used, the sediment traps should be cleaned out as often as necessary to assure that adequate trapping efficiency and storage volume is available.

e) The pad shall be reshaped as needed for drainage and runoff control.

f) All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary practices are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

3) **Temporary Seeding** – Temporary seeding will allow a short-term vegetative cover on disturbed site areas that may be in danger of erosion. Temporary seeding will be done at stock piles and disturbed portions of the site where construction activity will temporarily cease for at least 21 days. The temporary seedings will stabilize cleared and unvegetated areas that will not be brought into final grade for several weeks or months.

Temporary Seeding Planting Procedures *

a) Planting should preferably be done between April 1st and June 30th, and September 1st through September 31st. If planting is done in the months of July and August, irrigation may be required. If planting is done between October 1st and March 31st, mulching should be applied immediately after planting. If seeding is done during the summer months, irrigation of some sort will probably be necessary.

b) Before seeding, install structural practice controls. Utilize Amoco supergro or equivalent.

c) The seedbed should be firm with a fairly fine surface. Perform all cultural operations across or at right angles to the slope. A minimum of 2 to 4-inches of tilled topsoil is

required. The topsoil must have a sandy loam to silt loam texture with 15% to 20% organic content.

d) Apply uniformly 2 tons of ground limestone per acre (100 lbs. Per 1,000 sq.ft.) or according to soil test. Apply uniformly 10-10-10 analysis fertilizer at the rate of 400 lbs. per acre (14 lbs. per 1,000 sq.ft.) or as indicated by soil test. Forty percent of the nitrogen should be in organic form. Work in lime and fertilizer to a depth of 4-inches using any suitable equipment.

e) Select the appropriate seed species for temporary cover from the following table.

Species	Seeding Rate (lbs/1,000 sq.ft.)	Seeding Rate (lbs/acre)	Recommended Seeding Dates	Seed Cover required
Annual Ryegrass	1	40	April 1st to June 1st August 15th to Sept. 15th	¼ inch
Foxtail Millet	0.7	30	May 1st to June 30th	½ to ¾ inch
Oats	2	80	April 1st to July 1st August 15th to Sept. 15th	1 to 1-½ inch
Winter Rye	3	120	August 15th to Oct. 15th	1 to 1-½ inch

Apply the seed uniformly by hydroseeding, broadcasting, or by hand.

f) Use an effective mulch, such as clean grain straw; tacked and/or tied with netting to protect seedbed and encourage plant growth.

Temporary Seeding Inspection/Maintenance *

a) Inspect within 6 weeks of planting to see if stands are adequate. Check for damage within 24 hours of the end to a heavy rainfall, defined as a 2-year storm event (i.e., 3.2 inches of rainfall within a twenty-four hour period). Stands should be uniform and dense. Fertilize, reseed, and mulch damaged and sparse areas immediately. Tack or tie down mulch as necessary.

b) Seeds should be supplied with adequate moisture. Furnish water as needed, especially in abnormally hot or dry weather. Water application rates should be controlled to prevent runoff.

4) **Dust Control** - Dust control will be utilized throughout the entire construction process of the site. For example, keeping disturbed surfaces moist during windy periods will be an effective control measure. The use of dust control will prevent the movement of soil to

offsite areas. However, care must be taken to not create runoff from excessive use of water to control dust. The following are methods of Dust Control that may be used on-site:

- Vegetative Cover – The most practical method for disturbed areas not subject to traffic.
- Sprinkling – The site may be sprinkled until the surface is wet. Sprinkling will be effective for dust control on haul roads and other traffic routes.
- Stone – Stone will be used to stabilize construction entrances; will also be effective for dust control.

5) **Material Stockpiling** – Material stockpiles shall be located as far from abutting lots and the street as possible.

Appendix F

Post-Construction Operation & Maintenance Plan

Post-Construction Stormwater Operation & Maintenance Plan

Site Redevelopment
34 & 38 Dane Street, Somerville, MA

April 6, 2017

Prepared By: Scott P. Henderson, PE

HENDERSON
Consulting Services

P.O. Box 626
Lexington, MA 02420
hcscivil@gmail.com
774-993-9903

Best Management Practices (BMPs) pursuant to the MA DEP Stormwater Management Regulations and accepted design practice have been implemented and utilized for the project. The following information provided is to be used as a guideline for monitoring and maintaining the performance of the drainage facilities constructed as part of the site development. The structural Best Management Practices (BMPs) shall be inspected during rainfall conditions during the first year of operation to verify functionality.

Responsible Party

34 & 38 Dane Street Homeowners

City of Somerville Contact Information

Somerville Engineering Department
1 Franey Road
Somerville, MA 02145
(617) 625-6600 x5410

Maintenance:

1. **Infiltration Systems** – Subsurface infiltration systems shall be inspected at least twice per year (April and October recommended) to verify that sediment is not being discharged into the system and that the system is functioning properly. If sediment depth within the system exceeds three inches, an experienced contractor or designer shall be contacted to consult on methods to clean and remediate the system. Furthermore, at least once per year, the system shall be inspected immediately following a heavy rainfall (3 inches or more in a 24-hour period) to ensure that the system drains within 72 hours of the end of said storm. If, after 72 hours, the system is still retaining water, the homeowner shall contact a licensed professional civil engineer to determine a method for remediating the system failure. Typically, flushing and vacuuming of the system will remediate failure.
2. **Catch Basins & Trench Drain** – The catch basins on-site are designed with deep sumps to capture sediment and hooded outlets to prevent migration of hydrocarbons and floatables into the drainage systems. These catch basins should be cleaned twice annually in the spring and fall. A licensed contractor should be hired to clean the catch basins with a high-efficiency vacuum truck.

Landscape Maintenance:

This management measure seeks to control the storm water impacts of landscaping and lawn care practices through education and outreach on methods that reduce nutrient loadings and the amount of storm water runoff generated from lawns. Nutrient loads generated by fertilizer use on suburban lawns can be significant, and recent research has shown that lawns produce more surface runoff than previously thought.

Using proper landscaping techniques can effectively increase the value of a property while benefiting the environment. These practices can benefit the environment by reducing water use; decreasing energy use (because less water pumping and treatment is required); minimizing runoff of storm and irrigation water that transports soils, fertilizers, and pesticides; and creating additional habitat for plants and wildlife. The following lawn and landscaping management practices will be encouraged:

- Mow lawns at the highest recommended height.
- Minimize lawn size and maintain existing native vegetation.
- Collect rainwater for landscaping/gardening needs (rain barrels and cisterns to capture roof runoff).
- Raise public awareness for promoting the water efficient maintenance practices by informing users of water efficient irrigation techniques and other innovative approaches to water conservation.
- Abide by water restrictions and other conservation measures implemented by the City of Somerville
- Water only when necessary.
- Use automatic irrigation systems to reduce water use.
- Stabilize eroded soils immediately with seeding and/or appropriate plant materials.

Permeable Paver Patio Maintenance:

This management measure involves maintaining the functionality of the permeable paver system to ensure it functions to infiltrate stormwater runoff. The proposed system consists of Techo-Bloc Pavers (or equal) installed on a series of aggregate layers designed to treat and infiltrate stormwater water.

There are preventative and active maintenance measures that should be taken to ensure that the paver system remains permeable.

- Driveway applications are subject to increased pollution and should be cleaned annually with a high-efficiency vacuum truck.
- In order to prevent clogging of the pea stone in the gaps between pavers, use of sand, salt, and other de-icing materials is prohibited.
- Care should be taken to not spread dirt and debris onto the pavers during regular landscape maintenance. The patio should be swept or cleared with a leaf blower after landscape maintenance is complete.
- Inspect the pavers after rainfall for any standing water. If standing water remains for more than 30 minutes after rainfall stops, immediate maintenance is required.

- If standing water is present, at least one of the following measures should be taken to repair the paver system:
    - Utilize a vacuum sweeper to remove the pea stone from between the pavers. Replace pea stone in kind with clean material.
    - Utilize a power washer to flush out the gaps between pavers. Replace pea stone as needed.
- If neither of the aforementioned methods repairs the system, contact the design engineer to inspect and recommend a method to remediate the system.