STORMWATER REPORT
377 LANGLEY ROAD
NEWTON, MASSACHUSETTS

December 7, 2016

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INTRODUCTION

VTP Associates has performed a stormwater management analysis to evaluate the post-development impacts created by the proposed residential at #377 Langley Road in Newton, Massachusetts. The project will include a new building with three units, a surface driveways, landscaped areas, and an associated stormwater management system.

VTP Associates analyzed the hydrology for the drainage areas impacted by the proposed work utilizing the Soil Conservation Service's (SCS) Runoff Curve Number (CN) methodology. VTP Associates used the HydroCAD computer modeling system in conjunction with the SCS's methods to determine the peak rate of runoff for the 2, 10, and 100-year storm events.

VTP Associates proposes the use of best management practices (BMPs) as defined by the Massachusetts Department of Environmental Protection (MA DEP) for stormwater management onsite to protect downstream receiving waters from adverse water quality impacts due to stormwater runoff. Mitigating the rate and quality of stormwater runoff from the project site will also help to lessen the environmental impact of the proposed development.

METHODOLOGY

Hydrology and Hydraulics

VTP Associates analyzed the survey base plan and conducted a site visit to determine the existing drainage flow patterns onsite. The existing conditions survey, in conjunction with aerial photography, and site visits were used to determine existing surface coverage areas for the site. VTP Associates determined that a majority of the pre-developed surface cover for the study area is pervious cover. Initial soil research was determined using the Natural Resources Conservation Service (NRCS) soil survey maps for Middlesex County, Massachusetts via Web Soil Survey 1.1. According to the soil survey, the soil on the site consists of the following:

631C:	Charlton – Urban land – Hollis complex, rocky
602:	Urban Land
654:	Udorthents, Loamy

VTP Associates used a Hydrologic soil group 'C' for its drainage calculations. The test pit information has been included within this report. As per the Mass DEP Stormwater Hydrology Handbook for Conservation Commissions, VTP used a design infiltration rate of 0.27 in/hr for 'C' soils.

For each subcatchment area, VTP Associates determined drainage flow path lengths, surface cover type and slopes for sheet and shallow concentrated flow. The information was used to calculate the time of concentration (Tc) for each subcatchment areas. Where applicable, a minimum Tc of 5 minutes was used; the minimum value for highly developed, small catchment areas. SCS Runoff Curve Numbers were selected by using the cover type and hydrologic soil group of each area. The peak runoff rates for the 2, 10 and 100-year storm events were then determined by inputting the weighted CN, Tc, drainage areas, and drainage system information into the HydroCAD storm water modeling system computer program. The storm events were based on the 24-hour duration storm with a SCS Type III storm distribution curve.

Storm Event

VTP Associates used Massachusetts rainfall data maps from Technical Paper 40, Rainfall Frequency Atlas of the United States and the City of Newton's Requirements for On-Site Drainage to estimate the rainfall depth for the 2, 10 and 100-year storms. The rainfall depths for the 24-hour storm events used are as follows:

Storm Event	24-Hour Rainfall Depth (inches)
2-year	3.1
10-year	4.5
100-year	7.0

HYDROLOGICAL ANALYSIS

Pre-Development Conditions

The existing site consists of a one- story brick house, a driveway, walkways and landscaped areas. Approximately 4,896 square feet (20.7%) of the site is impervious cover. The site is bound by residential building to the south and north, Bowen Upper Field to the west, and Langley Road to the east.

VTP Associates compiled the existing drainage areas from an existing conditions survey prepared by VTP Associates. Additionally, VTP Associates conducted site visits to evaluate the existing onsite drainage patterns and watershed divides from the existing conditions survey. At present, stormwater runoffs from the existing study area drain to the west abutter (Bowen Upper Field) (E1). The pre-development drainage areas are shown on "Figure 1: Pre-Development Drainage Areas."

Post Development Conditions

The proposed project includes a two and half story building with three units, a surface driveways, patio areas, walkways, landscaped areas and associated drainage improvements. As a result, the proposed site will have approximately 11,089 s.f. of impervious cover (47.1%). The same overall area was analyzed for the proposed conditions as the pre-development conditions and is shown on "Figure 2: Post-Development Drainage Areas." Similar to pre-development conditions, the stormwater runoff flows in the same direction. The same design point was used as in the pre-development conditions.

The new building will have approximately 4,699 square feet of impervious, or roof, and the driveways will be approximately 5,497square feet. The roof runoff area (PR1) will be collected by roof leaders and discharge into the onsite infiltration system #1 (INF-1). The driveway runoff (PD) will be collected by two catch basin and discharge into onsite infiltration system #1 (INF-1). The roof runoff area (PR2) will be collected by roof leaders and discharge into the onsite infiltration system #2 (INF-2). Infiltration system #1 has an overflow to the City Drain and infiltration system #2 has an overflow to the rear of the lot (west abutter). The intent of the proposed stormwater management systems are to infiltrate stormwater runoff of the proposed building and driveway. The infiltration system was designed to control the 100-year storm with the addition of overflow to the infiltration systems and help mitigate proposed peak rates of runoff to less than existing conditions. The drainage areas can be seen on "Figure 2: Post-Development Drainage Areas."

VTP Associates analyzed the pre- and post-development site conditions to determine the peak rates of runoff at the design points. By incorporating the stormwater management features discussed above, the peak rates of runoff in the post-development condition is to be better than pre-development levels. Pre-development peak runoff rates vs. post-development peak runoff rates for the 2, 10, and 100-year storm events are presented in Table 1 below.

Table 1, Pre-development vs. Post-Development Peak Rate of Runoff

Design Point #1 – West Abutter (Bowen Upper Field)

STORM EVENT (DESIGN POINT)	*PRE-DEVELOPMENT PEAK RATE OF RUNOFF (CFS)*	*POST-DEVELOPMENT PEAK RATE OF RUNOFF (CFS)*	*PRE-DEVELOPMENT VOLUME OF RUNOFF (AF)*	*POST-DEVELOPMENT VOLUME OF RUNOFF (AF)*
2-YEAR	0.81	0.27+0.17* = 0.44	0.057	0.020+0.013* = 0.033
10-YEAR	1.56	0.57+0.24*= 0.81	0.107	0.005+0.018* = 0.023
100-YEAR	2.99	1.16+0.38* = 1.54	0.206	0.008+0.030* = 0.038

***Overflow from Infiltration System #2.**

CONCLUSION

The post-development peak rate of runoff is expected to be less than or equal to pre-development levels for the 2, 10, and 100-year storm events. Although there is increased impervious coverage on the site as a result of the proposed redevelopment, the addition of the underground infiltration systems controls the post-development runoff to pre-development levels or better.

ENCLOSURES

Test Pits
NRCS Soil Map
Pre-Development Drainage Areas (Figure 1)
Post-Development Drainage Areas (Figure 2)
Pre & Post Development HydroCAD Calculations

TESTPIT LOG

TESTPIT #1 (#373 Langley Rd)
0–10" TOPSOIL
10–35" SUBSOIL
35–94" SILTY LOAM
WITH GRAVEL
(GLACIAL TILL)

NO WATER
NO REFUSAL
PERC RATE > 20MPI

TESTPIT #2 (#377 Langley Rd)
0–8" TOPSOIL
8–24" SILTY LOAM

NO WATER
REFUSAL @ 24"
PERC RATE > 20MPI

TESTPIT #1 (#377 Langley Rd)
0–8" TOPSOIL
8–36" SUBSOIL
36–80" SILTY LOAM WITH
GRAVEL & COBBLES

NO WATER
REFUSAL @ 80"
PERC RATE > 20MPI

Custom Soil Resource Report
Soil Map

Map Scale: 1:467 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 5 10 20 30

Feet
0 20 40 80 120

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 1:25,000.

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: http://websoilsurvey.nrcs.usda.gov
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

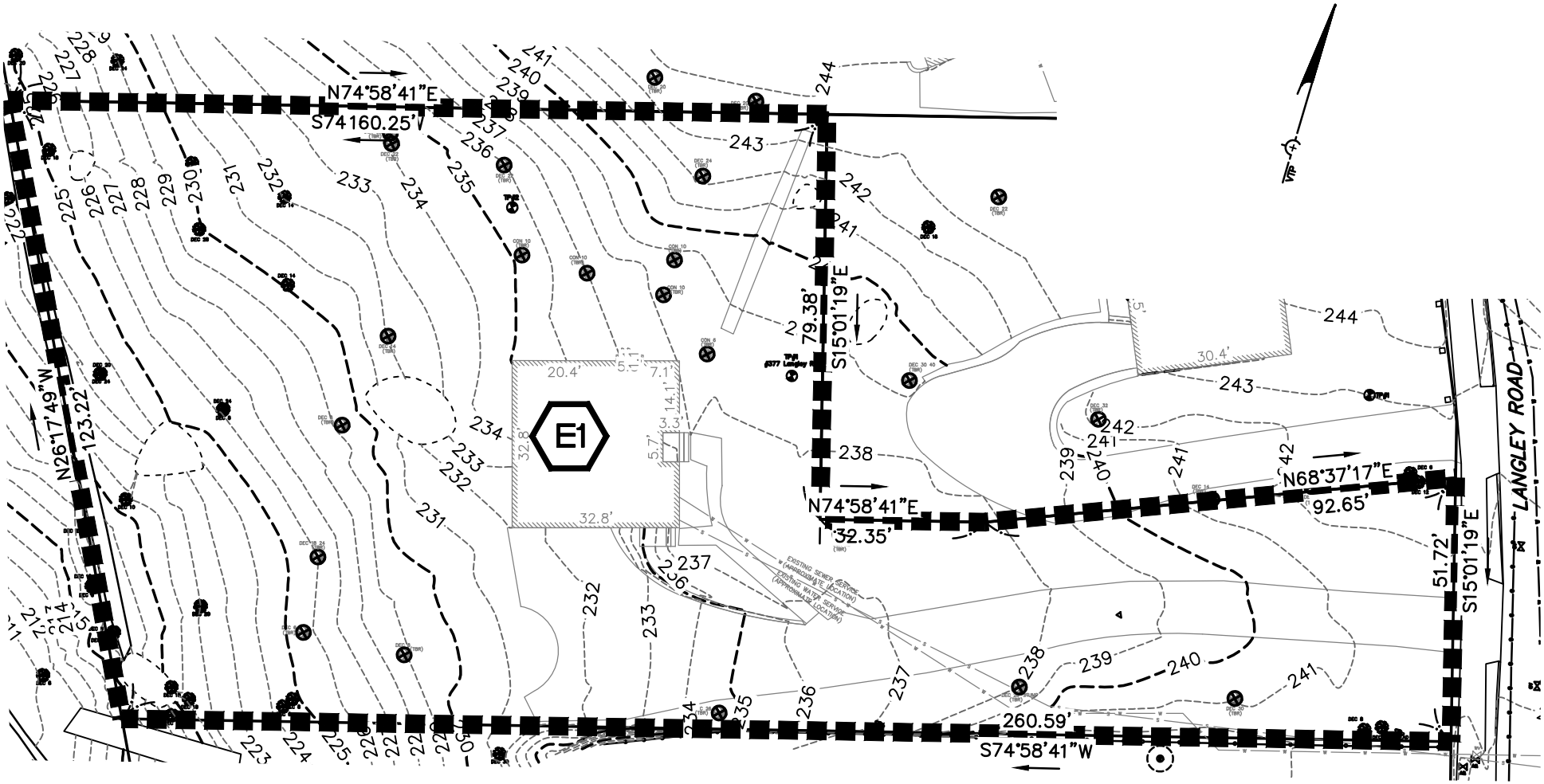
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

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

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

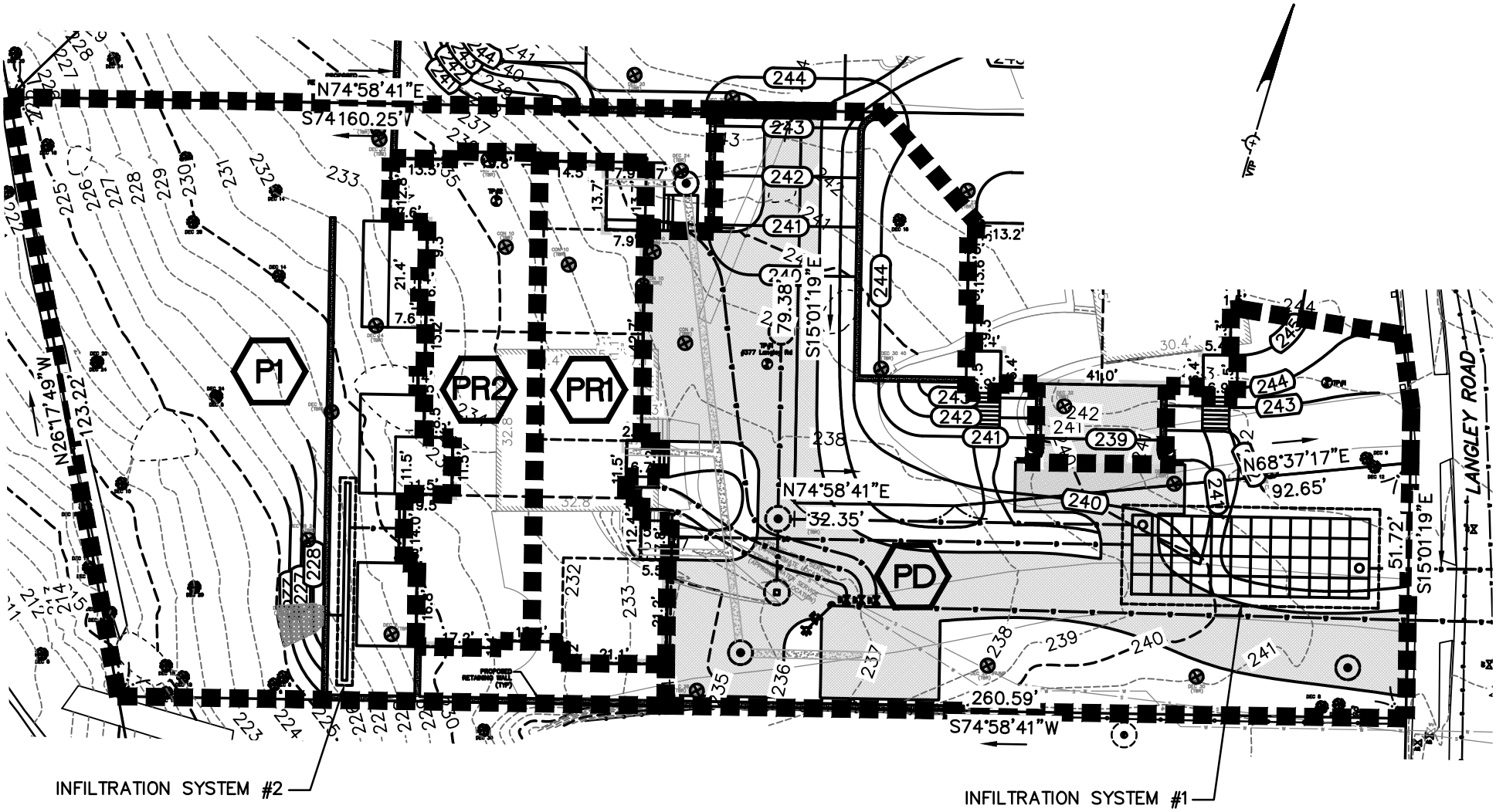
Map Unit Legend

Middlesex County, Massachusetts (MA017)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
602	Urban land	0.1	18.3%
631C	Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky	0.3	71.7%
654	Udorthents, loamy	0.0	10.0%
Totals for Area of Interest		**0.5**	**100.0%**



SCALE: 1in.=30ft.
DATE: OCTOBER 7, 2016

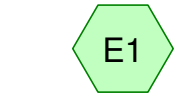
FIGURE 1:
PRE-DEVELOPMENT DRAINAGE AREAS
#377 LANGLEY ROAD NEWTON, MA



SCALE: 1in.=30ft.
DATE: OCTOBER 7, 2016

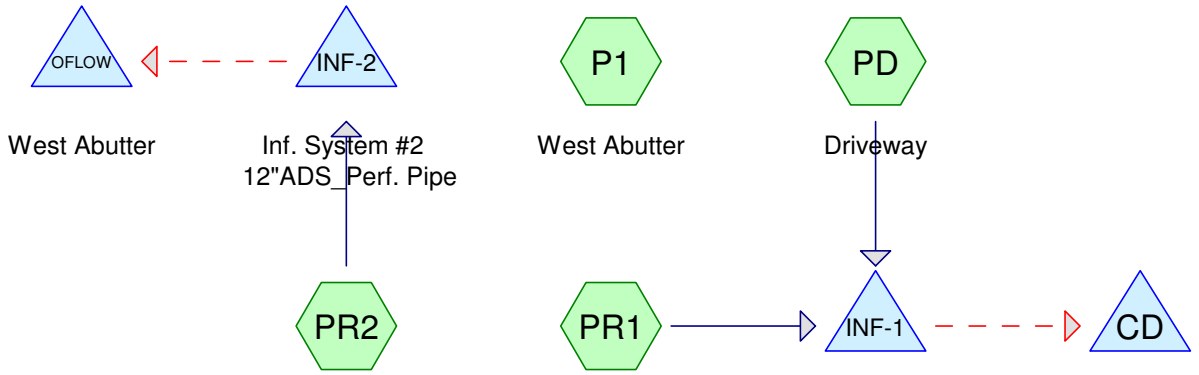
FIGURE 2:
POST-DEVELOPMENT DRAINAGE AREAS
#377 LANGLEY ROAD NEWTON, MA

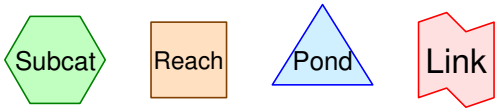
PRE-DEVELOPMENT CONDITIONS



West Abutter (Bowen Upper Field)

POST-DEVELOPMENT CONDITIONS





Routing Diagram for 216168_377 Langley Rd Newton, MA
Prepared by VTP associates, inc., Printed 12/7/2016

Summary for Subcatchment E1: West Abutter (Bowen Upper Field)

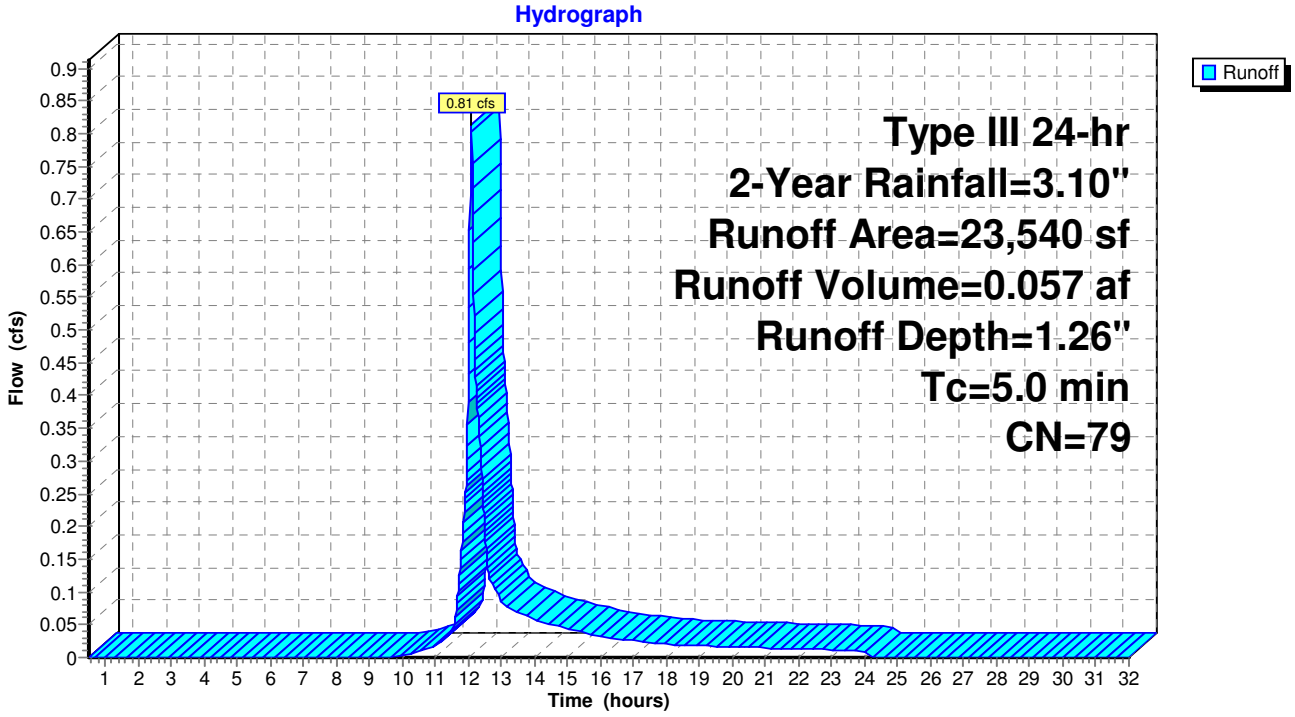
Runoff = 0.81 cfs @ 12.08 hrs, Volume= 0.057 af, Depth= 1.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

	Area (sf)	CN	Description
*	1,081	98	Roof House
*	2,900	98	Driveway
*	331	98	Walks/Steps/Landing
*	199	98	Ret. Wall
*	385	98	Ledge
	18,644	74	>75% Grass cover, Good, HSG C
	23,540	79	Weighted Average
	18,644		79.20% Pervious Area
	4,896		20.80% Impervious Area

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

Subcatchment E1: West Abutter (Bowen Upper Field)



Summary for Subcatchment P1: West Abutter

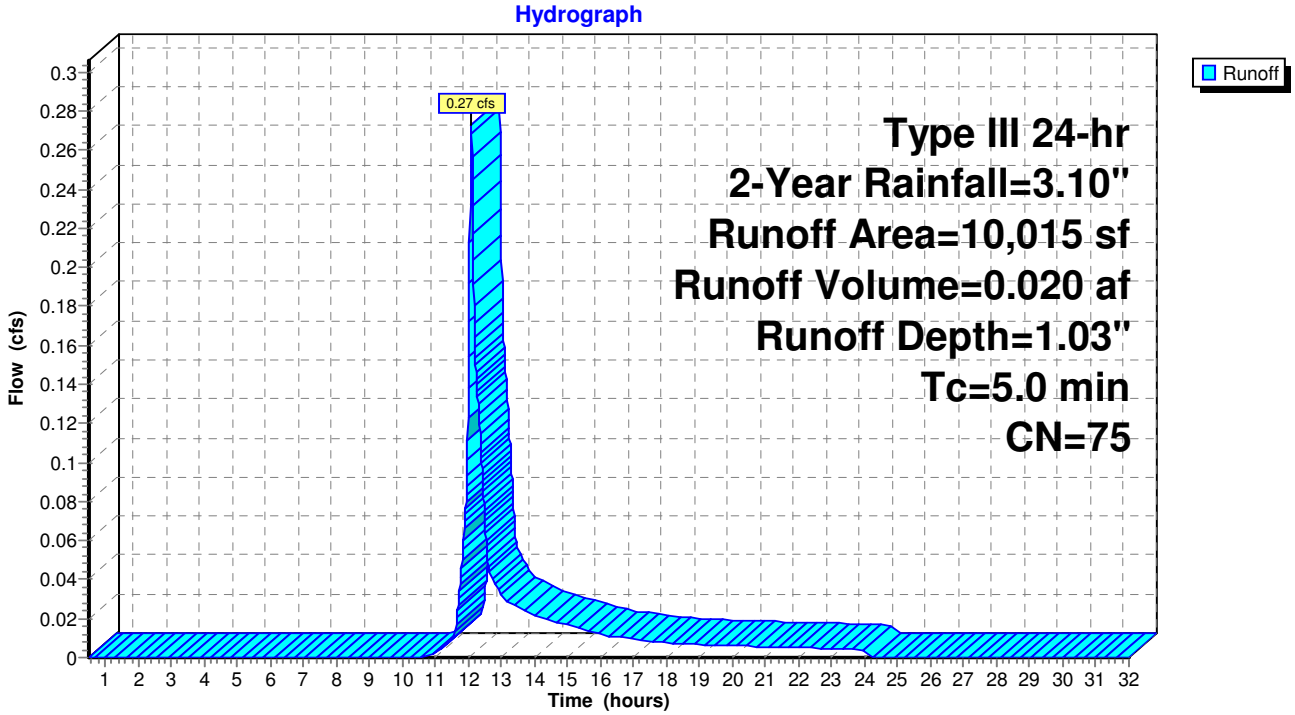
Runoff = 0.27 cfs @ 12.08 hrs, Volume= 0.020 af, Depth= 1.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

	Area (sf)	CN	Description
*	58	98	Patio
*	243	98	Ret. Walls
*	200	98	Ledge
	9,514	74	>75% Grass cover, Good, HSG C
	10,015	75	Weighted Average
	9,514		95.00% Pervious Area
	501		5.00% Impervious Area

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

Subcatchment P1: West Abutter



Summary for Subcatchment PD: Driveway

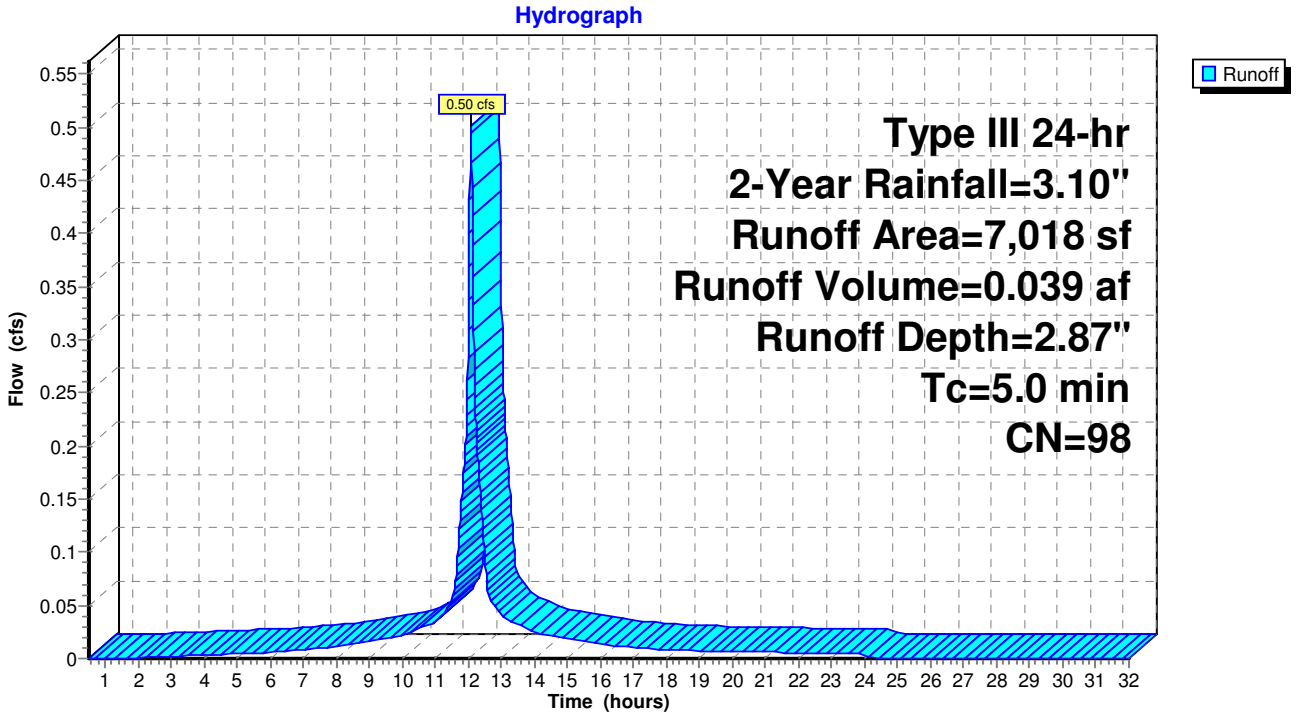
Runoff = 0.50 cfs @ 12.07 hrs, Volume= 0.039 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

	Area (sf)	CN	Description
*	5,497	98	Prop. Driveway
*	138	98	Ret. Walls
*	1,383	98	Walks
	7,018	98	Weighted Average
	7,018		100.00% Impervious Area

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

Subcatchment PD: Driveway



Summary for Subcatchment PR1: Prop. Roof-1

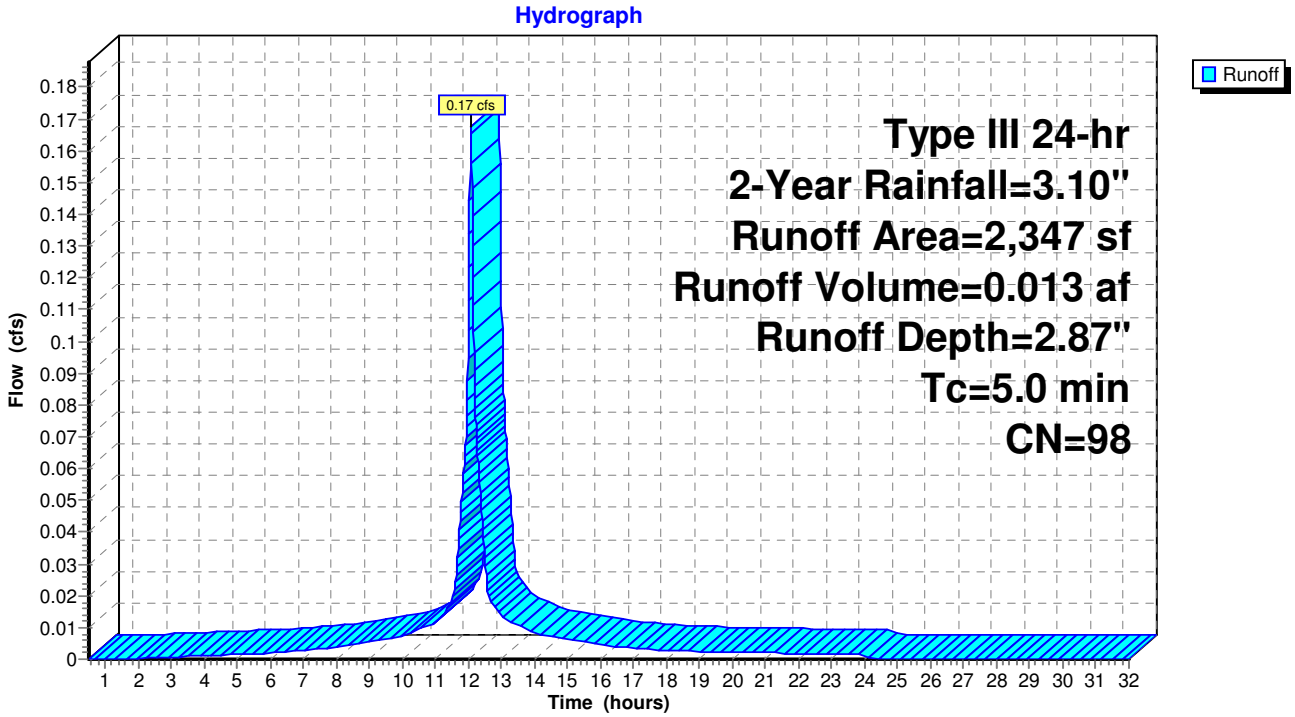
Runoff = 0.17 cfs @ 12.07 hrs, Volume= 0.013 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

	Area (sf)	CN	Description
*	2,347	98	Prop. Roof
	2,347		100.00% Impervious Area

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

Subcatchment PR1: Prop. Roof-1



Summary for Subcatchment PR2: Prop. Roof-2

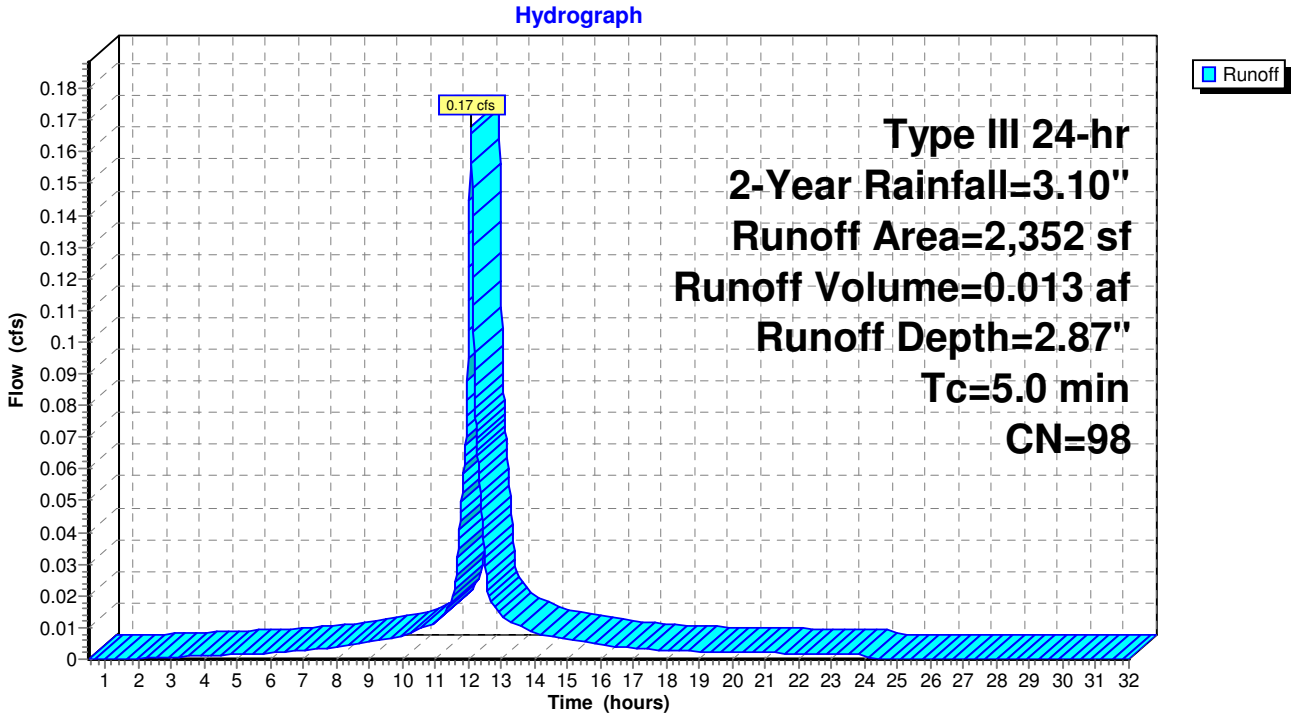
Runoff = 0.17 cfs @ 12.07 hrs, Volume= 0.013 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

	Area (sf)	CN	Description
*	2,352	98	Prop. Roof
	2,352		100.00% Impervious Area

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

Subcatchment PR2: Prop. Roof-2

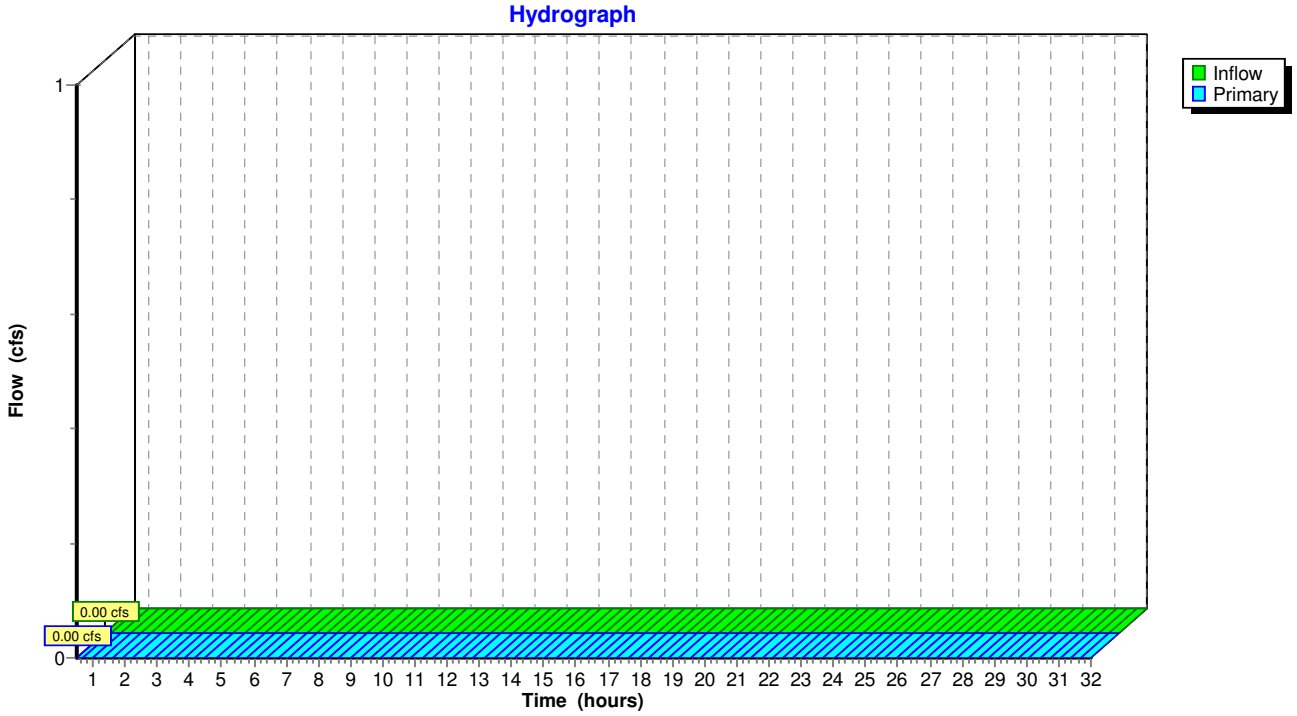


Summary for Pond CD: City Drain

Inflow	=	0.00 cfs @	0.50 hrs,	Volume=	0.000 af
Primary	=	0.00 cfs @	0.50 hrs,	Volume=	0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs

Pond CD: City Drain



Summary for Pond INF-1: Inf. System #1 Low Profile Galleys

Inflow Area = 0.215 ac,100.00% Impervious, Inflow Depth = 2.87" for 2-Year event
Inflow = 0.67 cfs @ 12.07 hrs, Volume= 0.051 af
Outflow = 0.01 cfs @ 5.89 hrs, Volume= 0.015 af, Atten= 99%, Lag= 0.0 min
Discarded = 0.01 cfs @ 5.89 hrs, Volume= 0.015 af
Secondary = 0.00 cfs @ 0.50 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Peak Elev= 236.29' @ 23.00 hrs Surf.Area= 0.024 ac Storage= 0.041 af

Plug-Flow detention time= 503.8 min calculated for 0.015 af (29% of inflow)
Center-of-Mass det. time= 318.3 min (1,074.5 - 756.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	233.35'	0.017 af	**20.00'W x 52.00'L x 4.00'H Field A** 0.096 af Overall - 0.048 af Embedded = 0.048 af x 35.0% Voids
#2A	234.35'	0.034 af	**Galley 4x4x3** x 48 Inside #1 Inside= 42.0"W x 30.0"H => 8.91 sf x 3.50'L = 31.2 cf Outside= 48.0"W x 36.0"H => 10.81 sf x 4.00'L = 43.2 cf 4 Rows of 12 Chambers
		0.051 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	233.35'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Secondary	236.35'	**8.0" Round 8" CPP (Overflow)** L= 54.4' Ke= 0.200 Inlet / Outlet Invert= 236.35' / 235.00' S= 0.0248 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.01 cfs @ 5.89 hrs HW=233.39' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.50 hrs HW=233.35' (Free Discharge)
↑**2=8" CPP (Overflow)** (Controls 0.00 cfs)

Pond INF-1: Inf. System #1 Low Profile Galleys - Chamber Wizard Field A

Chamber Model = Galley 4x4x3 (Concrete Galley, Shea LE-EGLPH, LE-CGLPH or equivalent)
Inside= 42.0"W x 30.0"H => 8.91 sf x 3.50'L = 31.2 cf
Outside= 48.0"W x 36.0"H => 10.81 sf x 4.00'L = 43.2 cf

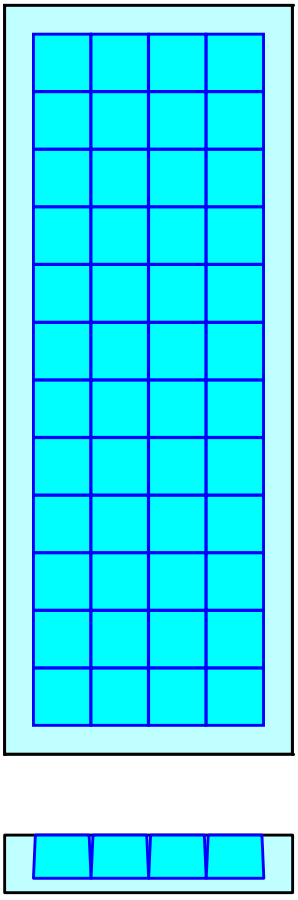
12 Chambers/Row x 4.00' Long = 48.00' Row Length +24.0" End Stone x 2 = 52.00' Base Length
4 Rows x 48.0" Wide + 24.0" Side Stone x 2 = 20.00' Base Width
12.0" Base + 36.0" Chamber Height = 4.00' Field Height

48 Chambers x 31.2 cf = 1,497.2 cf Chamber Storage
48 Chambers x 43.2 cf = 2,075.3 cf Displacement

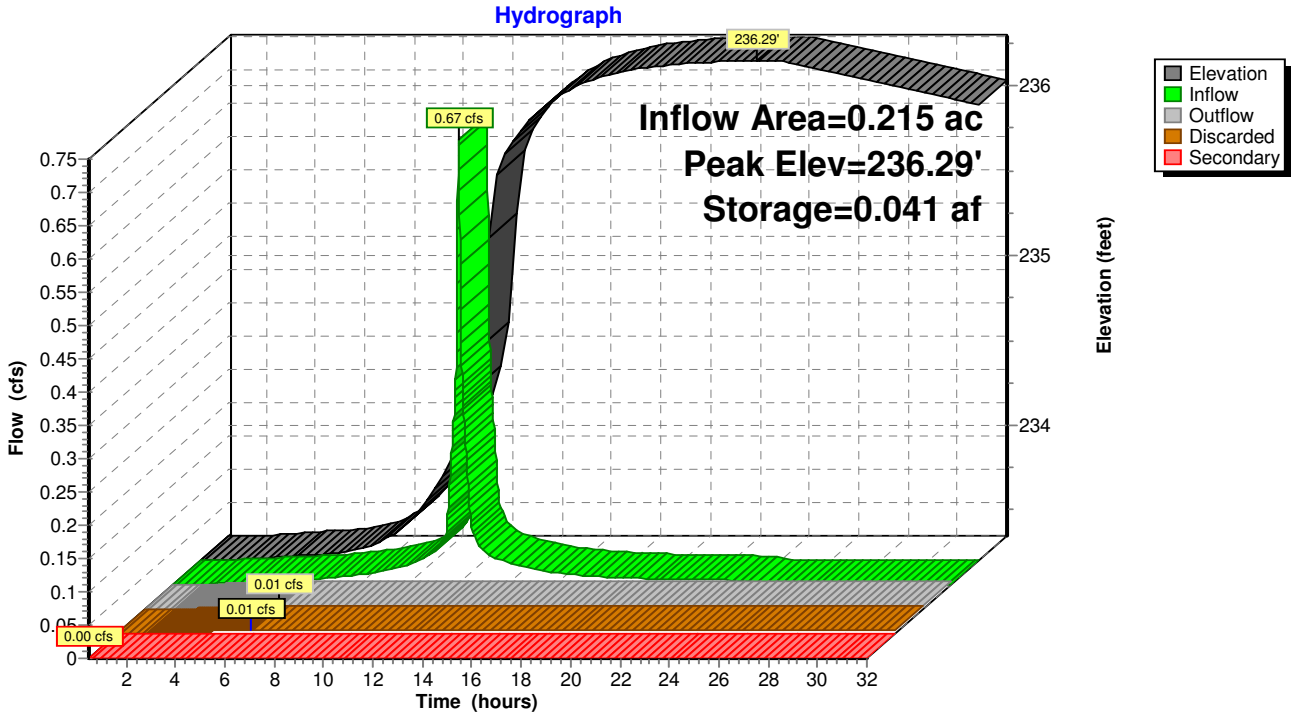
4,160.0 cf Field - 2,075.3 cf Chambers = 2,084.7 cf Stone x 35.0% Voids = 729.6 cf Stone Storage

Chamber Storage + Stone Storage = 2,226.8 cf = 0.051 af
Overall Storage Efficiency = 53.5%
Overall System Size = 52.00' x 20.00' x 4.00'

48 Chambers
154.1 cy Field
77.2 cy Stone



Pond INF-1: Inf. System #1 Low Profile Galleys



Summary for Pond INF-2: Inf. System #2 12"ADS_Perf. Pipe

Inflow Area = 0.054 ac,100.00% Impervious, Inflow Depth = 2.87" for 2-Year event
Inflow = 0.17 cfs @ 12.07 hrs, Volume= 0.013 af
Outflow = 0.17 cfs @ 12.08 hrs, Volume= 0.011 af, Atten= 1%, Lag= 0.6 min
Discarded = 0.00 cfs @ 3.76 hrs, Volume= 0.002 af
Secondary = 0.17 cfs @ 12.08 hrs, Volume= 0.009 af

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Peak Elev= 230.72' @ 12.08 hrs Surf.Area= 0.003 ac Storage= 0.003 af

Plug-Flow detention time= 158.6 min calculated for 0.011 af (84% of inflow)
Center-of-Mass det. time= 92.5 min (848.6 - 756.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	228.50'	0.003 af	**3.21'W x 42.00'L x 2.71'H Field A** 0.008 af Overall - 0.001 af Embedded = 0.007 af x 35.0% Voids
#2A	229.50'	0.001 af	**ADS N-12 12** x 2 Inside #1 Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf
		0.003 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	228.50'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Secondary	230.50'	**6.0" Round 6" CPP (Overflow)** L= 4.0' Ke= 0.200 Inlet / Outlet Invert= 230.50' / 230.10' S= 0.1000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

Discarded OutFlow Max=0.00 cfs @ 3.76 hrs HW=228.53' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Secondary OutFlow Max=0.17 cfs @ 12.08 hrs HW=230.72' (Free Discharge)
↑—**2=6" CPP (Overflow)** (Inlet Controls 0.17 cfs @ 2.00 fps)

Pond INF-2: Inf. System #2 12"ADS_Perf. Pipe - Chamber Wizard Field A

Chamber Model = ADS N-12 12 (ADS N-12® Pipe)
Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf
Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf

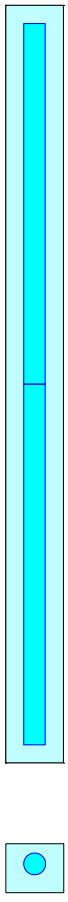
2 Chambers/Row x 20.00' Long = 40.00' Row Length +12.0" End Stone x 2 = 42.00' Base Length
1 Rows x 14.5" Wide + 12.0" Side Stone x 2 = 3.21' Base Width
12.0" Base + 14.5" Chamber Height + 6.0" Cover = 2.71' Field Height

2 Chambers x 16.2 cf = 32.4 cf Chamber Storage
2 Chambers x 20.9 cf = 41.9 cf Displacement

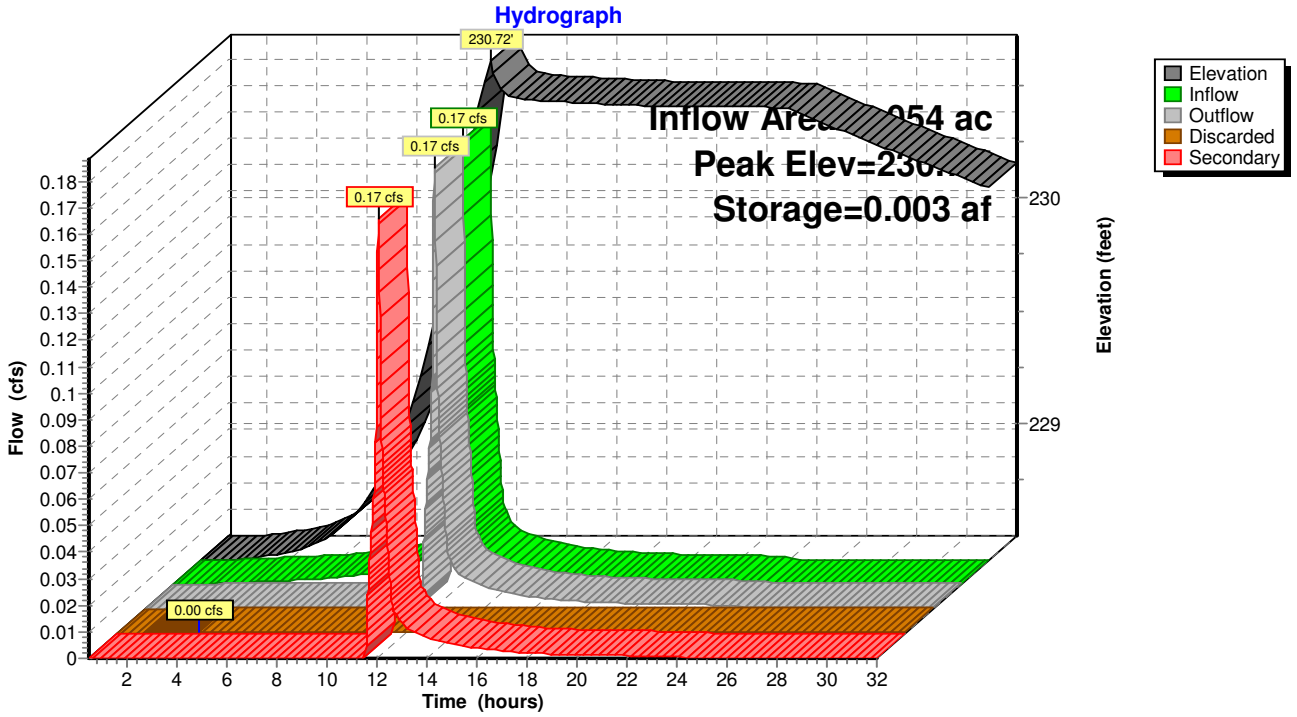
365.1 cf Field - 41.9 cf Chambers = 323.2 cf Stone x 35.0% Voids = 113.1 cf Stone Storage

Chamber Storage + Stone Storage = 145.5 cf = 0.003 af
Overall Storage Efficiency = 39.9%
Overall System Size = 42.00' x 3.21' x 2.71'

2 Chambers
13.5 cy Field
12.0 cy Stone



Pond INF-2: Inf. System #2 12"ADS_Perf. Pipe

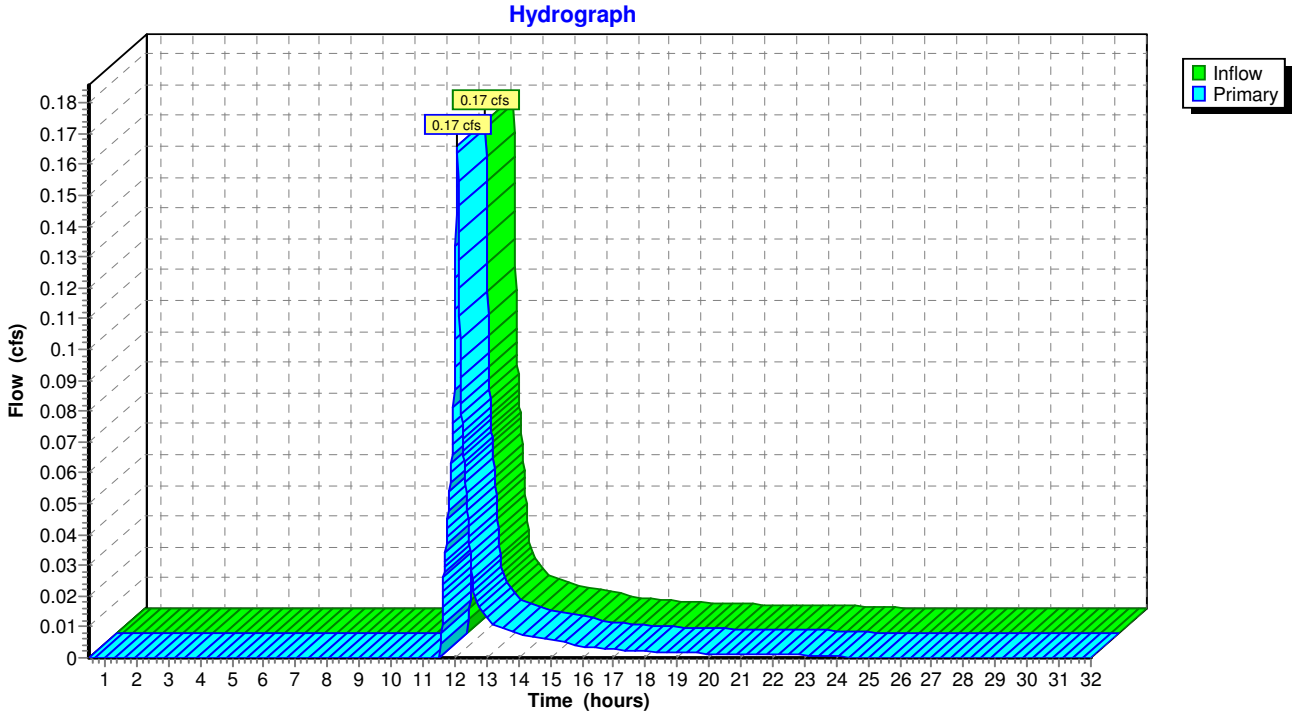


Summary for Pond OFLOW: West Abutter

Inflow = 0.17 cfs @ 12.08 hrs, Volume= 0.009 af
Primary = 0.17 cfs @ 12.08 hrs, Volume= 0.009 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs

Pond OFLOW: West Abutter



Summary for Subcatchment E1: West Abutter (Bowen Upper Field)

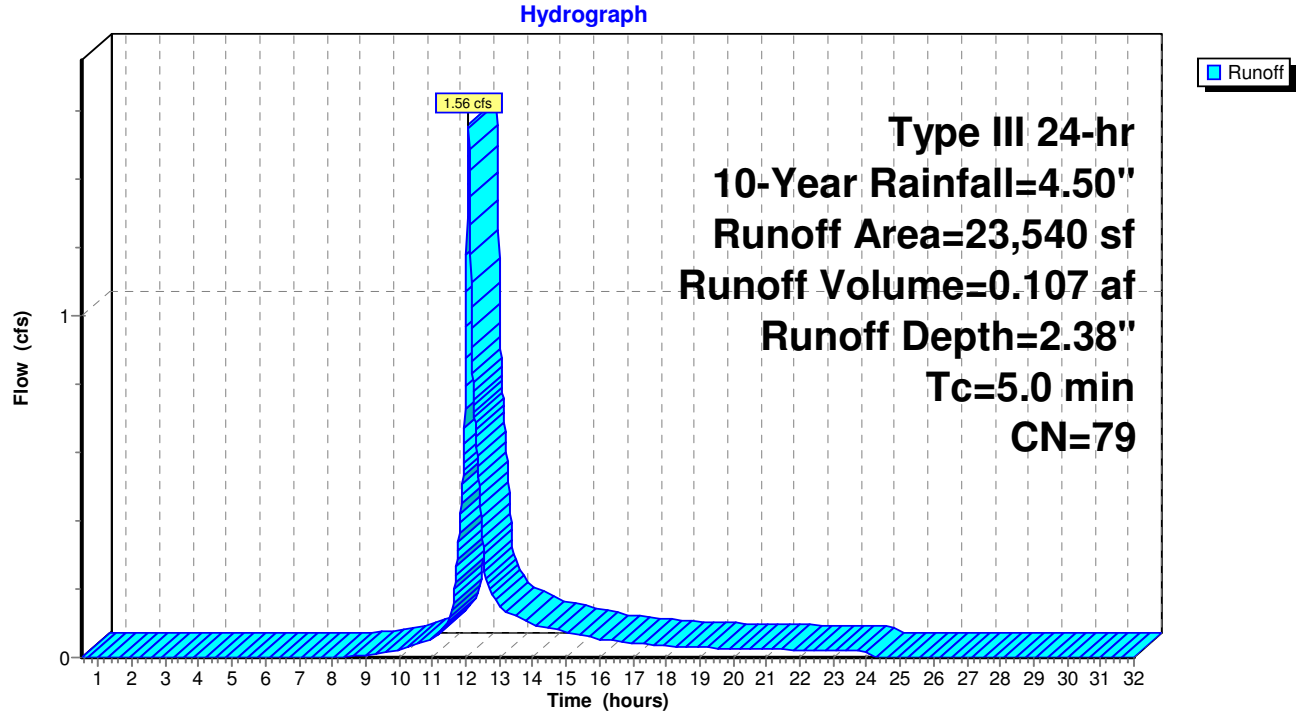
Runoff = 1.56 cfs @ 12.08 hrs, Volume= 0.107 af, Depth= 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	1,081	98	Roof House
*	2,900	98	Driveway
*	331	98	Walks/Steps/Landing
*	199	98	Ret. Wall
*	385	98	Ledge
	18,644	74	>75% Grass cover, Good, HSG C
	23,540	79	Weighted Average
	18,644		79.20% Pervious Area
	4,896		20.80% Impervious Area

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

Subcatchment E1: West Abutter (Bowen Upper Field)



Summary for Subcatchment P1: West Abutter

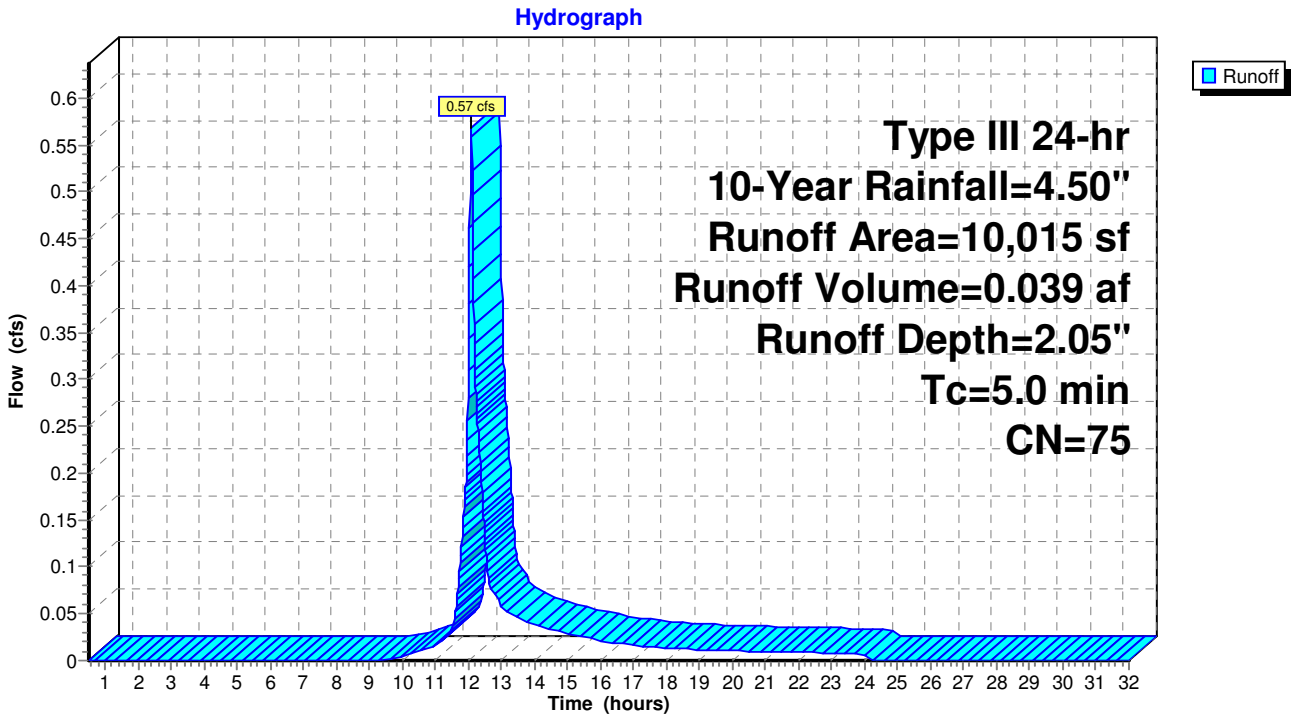
Runoff = 0.57 cfs @ 12.08 hrs, Volume= 0.039 af, Depth= 2.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	58	98	Patio
*	243	98	Ret. Walls
*	200	98	Ledge
	9,514	74	>75% Grass cover, Good, HSG C
	10,015	75	Weighted Average
	9,514		95.00% Pervious Area
	501		5.00% Impervious Area

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

Subcatchment P1: West Abutter



Summary for Subcatchment PD: Driveway

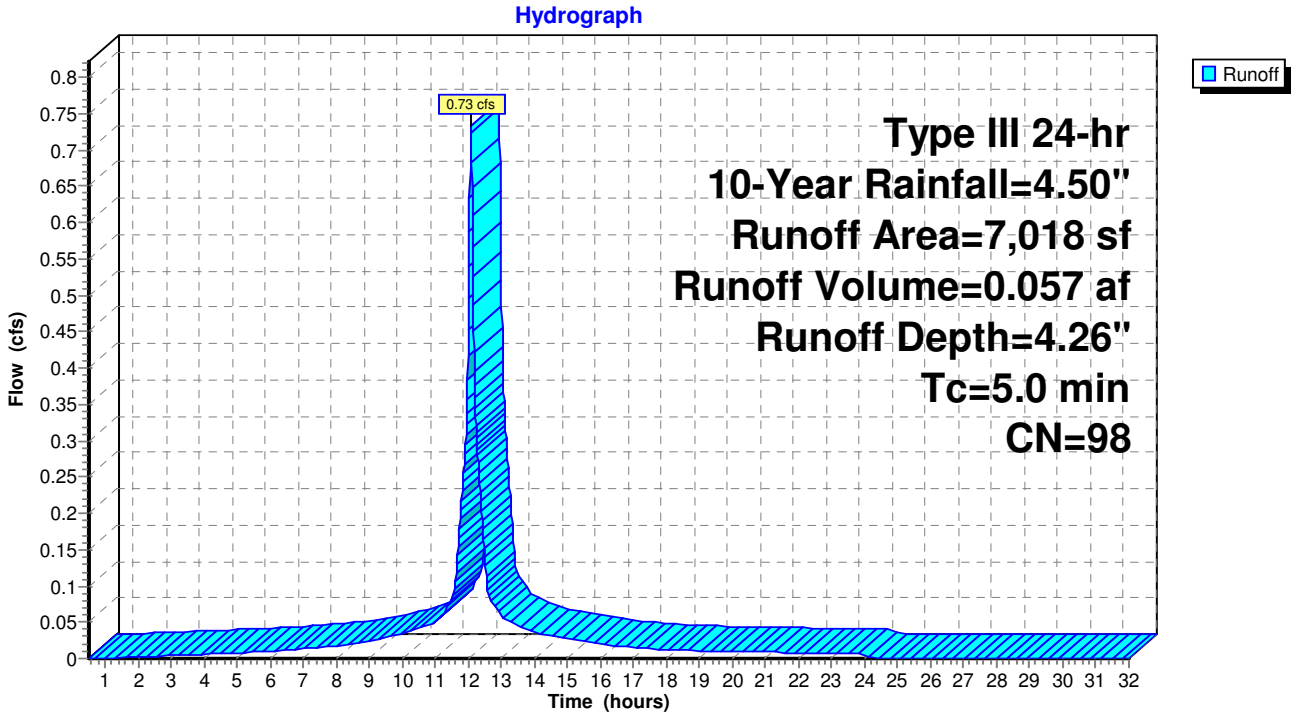
Runoff = 0.73 cfs @ 12.07 hrs, Volume= 0.057 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	5,497	98	Prop. Driveway
*	138	98	Ret. Walls
*	1,383	98	Walks
	7,018	98	Weighted Average
	7,018		100.00% Impervious Area

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

Subcatchment PD: Driveway



Summary for Subcatchment PR1: Prop. Roof-1

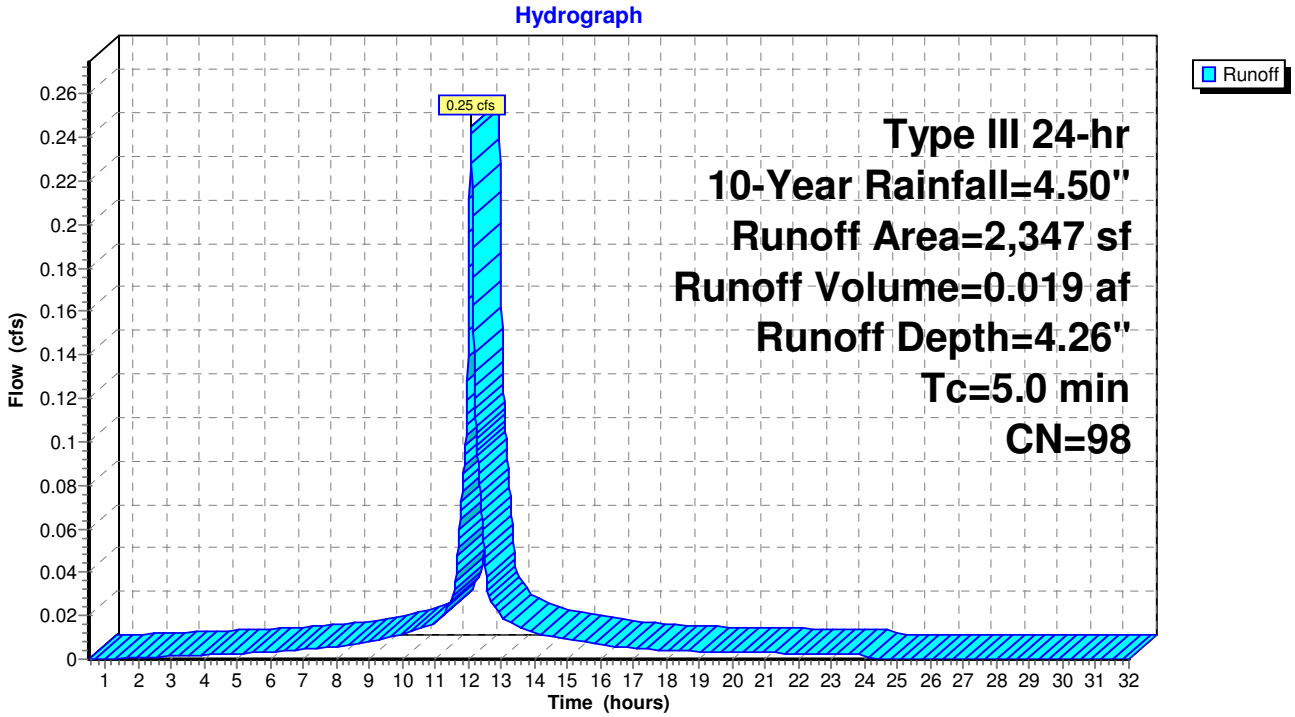
Runoff = 0.25 cfs @ 12.07 hrs, Volume= 0.019 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	2,347	98	Prop. Roof
	2,347		100.00% Impervious Area

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

Subcatchment PR1: Prop. Roof-1



Summary for Subcatchment PR2: Prop. Roof-2

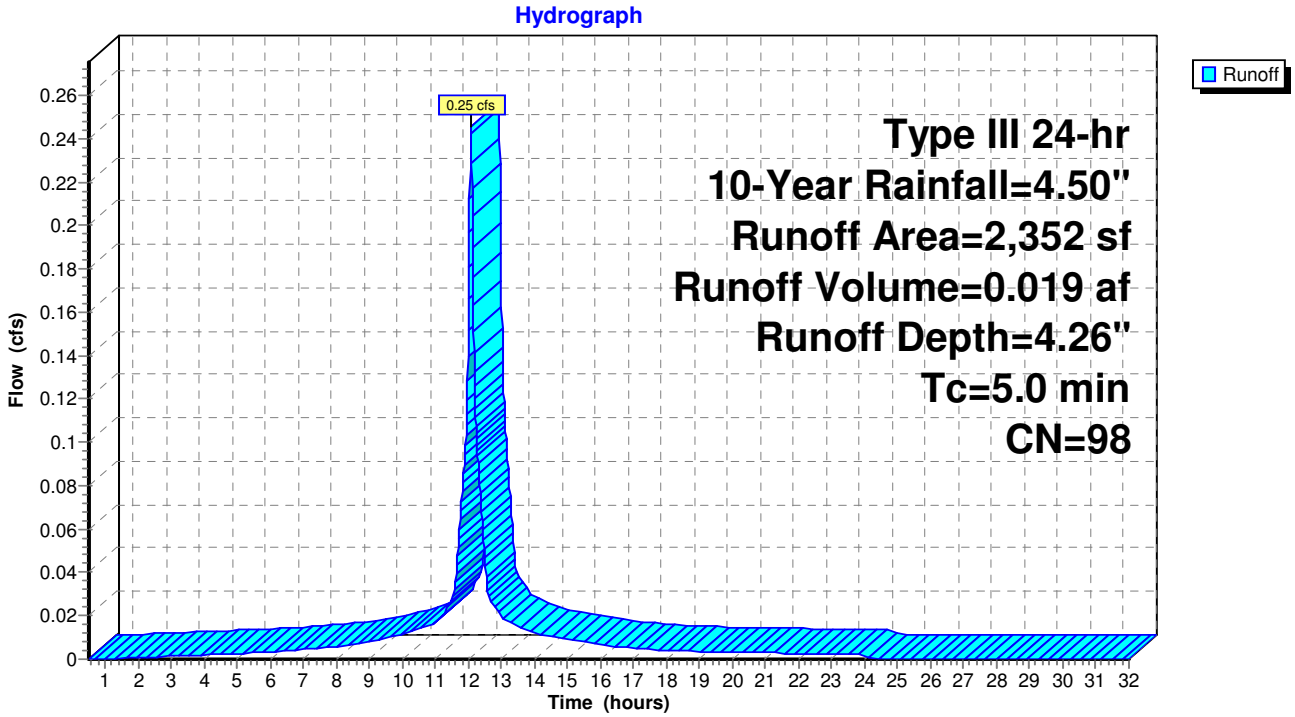
Runoff = 0.25 cfs @ 12.07 hrs, Volume= 0.019 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	2,352	98	Prop. Roof
	2,352		100.00% Impervious Area

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

Subcatchment PR2: Prop. Roof-2

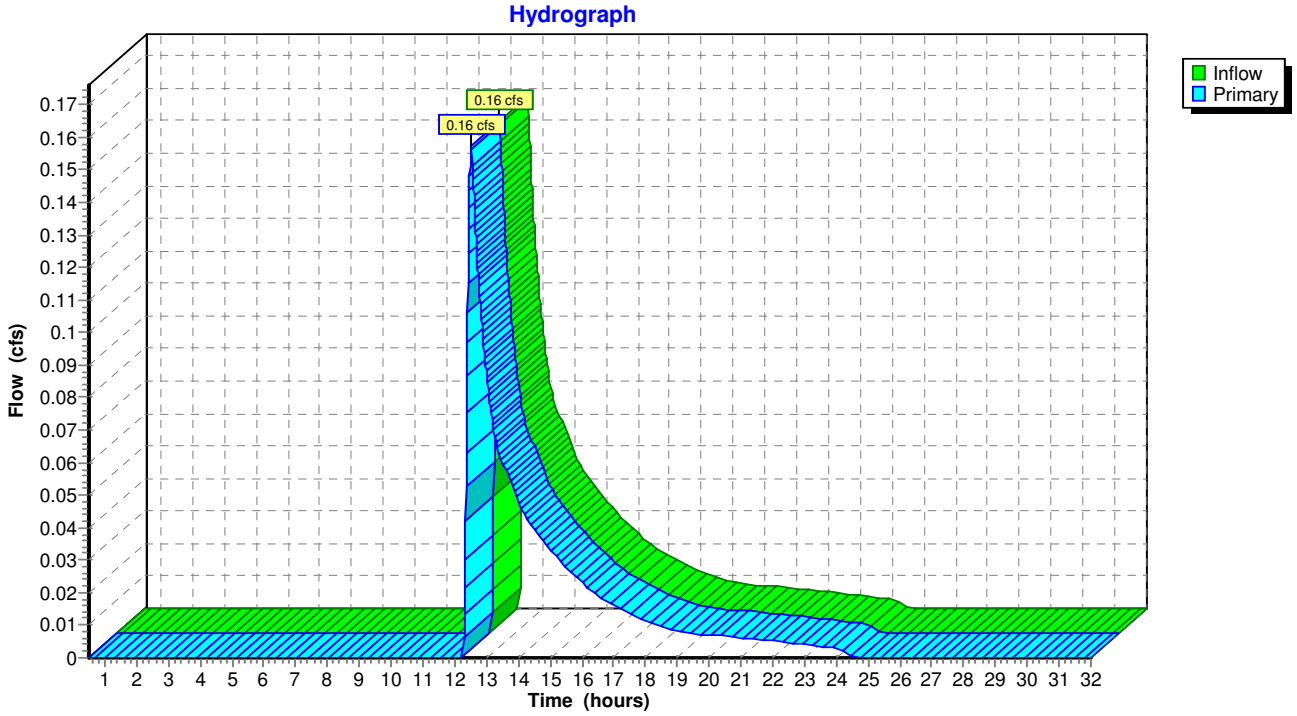


Summary for Pond CD: City Drain

Inflow	=	0.16 cfs @	12.52 hrs, Volume=	0.023 af
Primary	=	0.16 cfs @	12.52 hrs, Volume=	0.023 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs

Pond CD: City Drain



Summary for Pond INF-1: Inf. System #1 Low Profile Galleys

Inflow Area = 0.215 ac,100.00% Impervious, Inflow Depth = 4.26" for 10-Year event
Inflow = 0.98 cfs @ 12.07 hrs, Volume= 0.076 af
Outflow = 0.16 cfs @ 12.52 hrs, Volume= 0.039 af, Atten= 83%, Lag= 27.1 min
Discarded = 0.01 cfs @ 3.88 hrs, Volume= 0.016 af
Secondary = 0.16 cfs @ 12.52 hrs, Volume= 0.023 af

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Peak Elev= 236.54' @ 12.52 hrs Surf.Area= 0.024 ac Storage= 0.045 af

Plug-Flow detention time= 331.6 min calculated for 0.039 af (51% of inflow)
Center-of-Mass det. time= 205.4 min (954.3 - 748.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	233.35'	0.017 af	**20.00'W x 52.00'L x 4.00'H Field A** 0.096 af Overall - 0.048 af Embedded = 0.048 af x 35.0% Voids
#2A	234.35'	0.034 af	**Galley 4x4x3** x 48 Inside #1 Inside= 42.0"W x 30.0"H => 8.91 sf x 3.50'L = 31.2 cf Outside= 48.0"W x 36.0"H => 10.81 sf x 4.00'L = 43.2 cf 4 Rows of 12 Chambers
		0.051 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	233.35'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Secondary	236.35'	**8.0" Round 8" CPP (Overflow)** L= 54.4' Ke= 0.200 Inlet / Outlet Invert= 236.35' / 235.00' S= 0.0248 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.01 cfs @ 3.88 hrs HW=233.39' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=0.16 cfs @ 12.52 hrs HW=236.54' (Free Discharge)
↑—**2=8" CPP (Overflow)** (Inlet Controls 0.16 cfs @ 1.87 fps)

Pond INF-1: Inf. System #1 Low Profile Galleys - Chamber Wizard Field A

Chamber Model = Galley 4x4x3 (Concrete Galley, Shea LE-EGLPH, LE-CGLPH or equivalent)
Inside= 42.0"W x 30.0"H => 8.91 sf x 3.50'L = 31.2 cf
Outside= 48.0"W x 36.0"H => 10.81 sf x 4.00'L = 43.2 cf

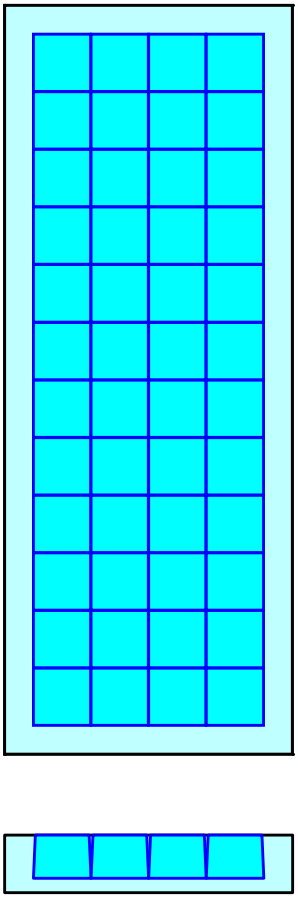
12 Chambers/Row x 4.00' Long = 48.00' Row Length +24.0" End Stone x 2 = 52.00' Base Length
4 Rows x 48.0" Wide + 24.0" Side Stone x 2 = 20.00' Base Width
12.0" Base + 36.0" Chamber Height = 4.00' Field Height

48 Chambers x 31.2 cf = 1,497.2 cf Chamber Storage
48 Chambers x 43.2 cf = 2,075.3 cf Displacement

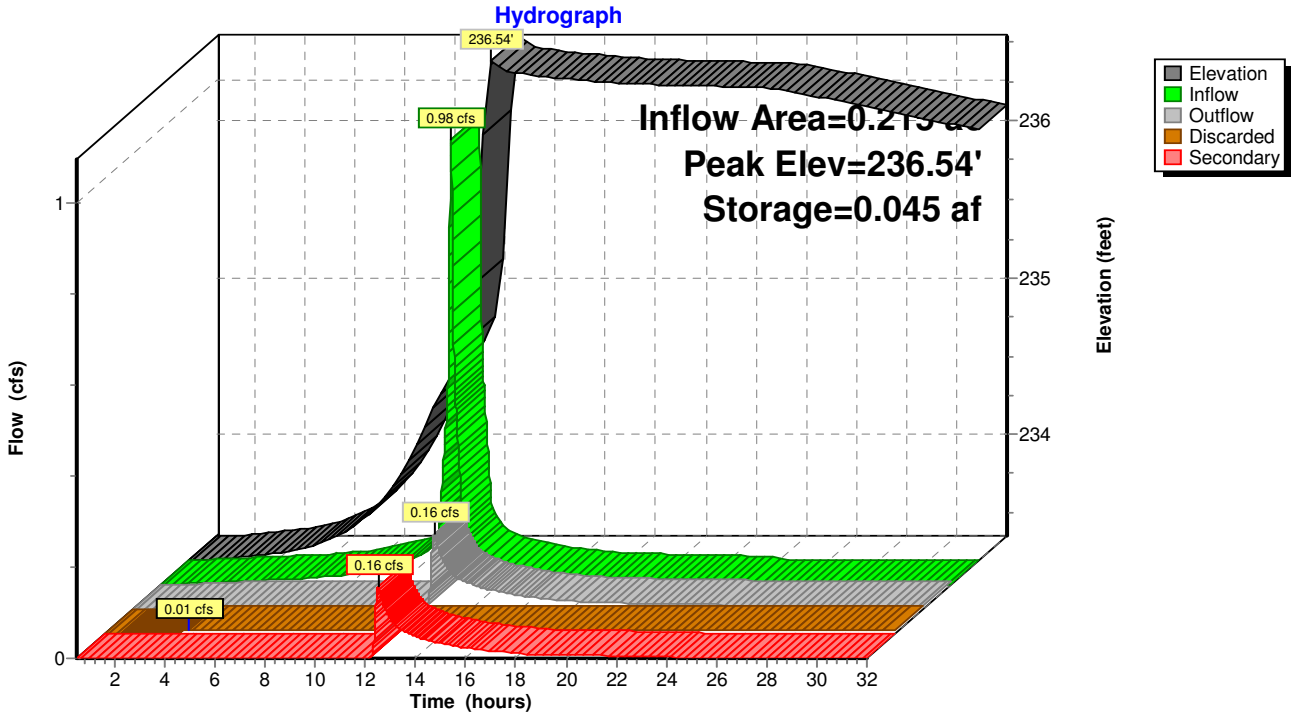
4,160.0 cf Field - 2,075.3 cf Chambers = 2,084.7 cf Stone x 35.0% Voids = 729.6 cf Stone Storage

Chamber Storage + Stone Storage = 2,226.8 cf = 0.051 af
Overall Storage Efficiency = 53.5%
Overall System Size = 52.00' x 20.00' x 4.00'

48 Chambers
154.1 cy Field
77.2 cy Stone



Pond INF-1: Inf. System #1 Low Profile Galleys



Summary for Pond INF-2: Inf. System #2 12"ADS_Perf. Pipe

Inflow Area = 0.054 ac,100.00% Impervious, Inflow Depth = 4.26" for 10-Year event
Inflow = 0.25 cfs @ 12.07 hrs, Volume= 0.019 af
Outflow = 0.24 cfs @ 12.08 hrs, Volume= 0.017 af, Atten= 1%, Lag= 0.5 min
Discarded = 0.00 cfs @ 2.47 hrs, Volume= 0.002 af
Secondary = 0.24 cfs @ 12.08 hrs, Volume= 0.015 af

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Peak Elev= 230.77' @ 12.08 hrs Surf.Area= 0.003 ac Storage= 0.003 af

Plug-Flow detention time= 124.3 min calculated for 0.017 af (89% of inflow)
Center-of-Mass det. time= 72.3 min (821.2 - 748.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	228.50'	0.003 af	**3.21'W x 42.00'L x 2.71'H Field A** 0.008 af Overall - 0.001 af Embedded = 0.007 af x 35.0% Voids
#2A	229.50'	0.001 af	**ADS N-12 12** x 2 Inside #1 Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf
		0.003 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	228.50'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Secondary	230.50'	**6.0" Round 6" CPP (Overflow)** L= 4.0' Ke= 0.200 Inlet / Outlet Invert= 230.50' / 230.10' S= 0.1000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

Discarded OutFlow Max=0.00 cfs @ 2.47 hrs HW=228.53' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Secondary OutFlow Max=0.24 cfs @ 12.08 hrs HW=230.77' (Free Discharge)
↑—**2=6" CPP (Overflow)** (Inlet Controls 0.24 cfs @ 2.22 fps)

Pond INF-2: Inf. System #2 12"ADS_Perf. Pipe - Chamber Wizard Field A

Chamber Model = ADS N-12 12 (ADS N-12® Pipe)
Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf
Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf

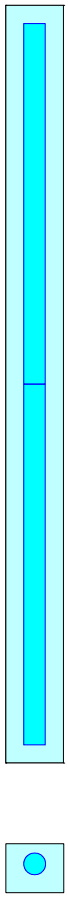
2 Chambers/Row x 20.00' Long = 40.00' Row Length +12.0" End Stone x 2 = 42.00' Base Length
1 Rows x 14.5" Wide + 12.0" Side Stone x 2 = 3.21' Base Width
12.0" Base + 14.5" Chamber Height + 6.0" Cover = 2.71' Field Height

2 Chambers x 16.2 cf = 32.4 cf Chamber Storage
2 Chambers x 20.9 cf = 41.9 cf Displacement

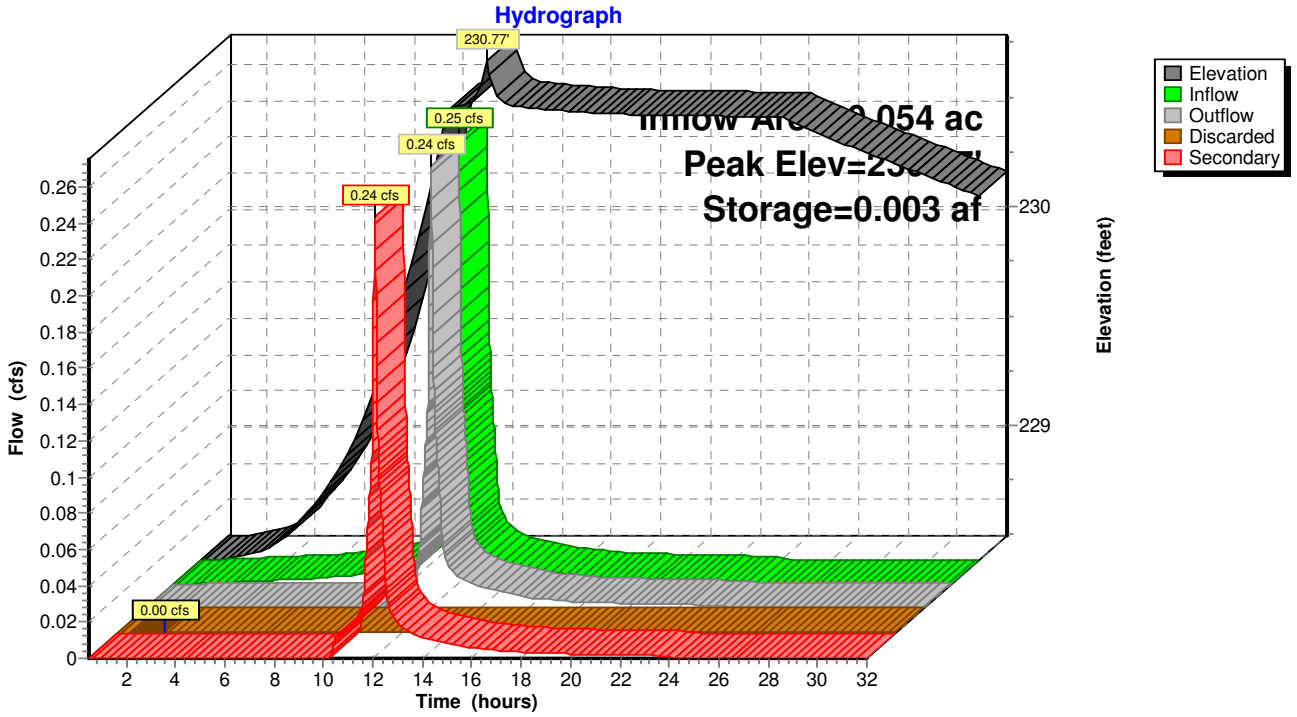
365.1 cf Field - 41.9 cf Chambers = 323.2 cf Stone x 35.0% Voids = 113.1 cf Stone Storage

Chamber Storage + Stone Storage = 145.5 cf = 0.003 af
Overall Storage Efficiency = 39.9%
Overall System Size = 42.00' x 3.21' x 2.71'

2 Chambers
13.5 cy Field
12.0 cy Stone



Pond INF-2: Inf. System #2 12"ADS_Perf. Pipe

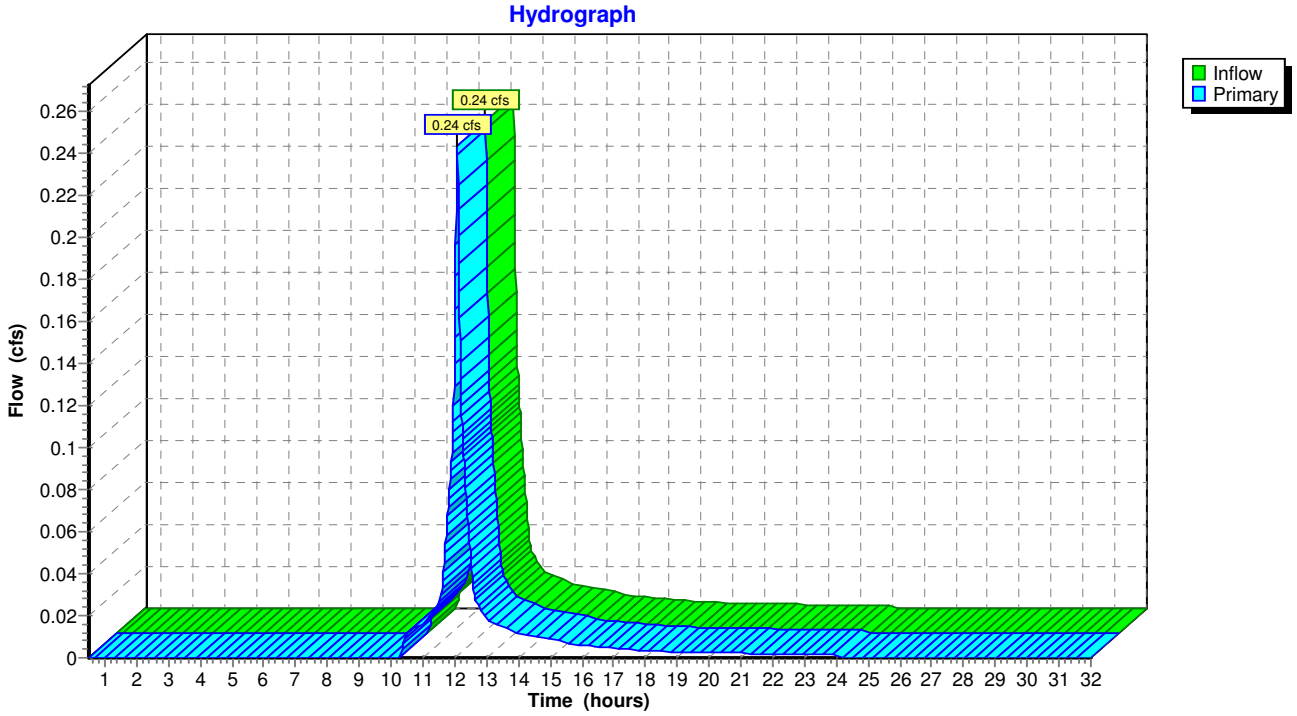


Summary for Pond OFLOW: West Abutter

Inflow = 0.24 cfs @ 12.08 hrs, Volume= 0.015 af
Primary = 0.24 cfs @ 12.08 hrs, Volume= 0.015 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs

Pond OFLOW: West Abutter



Summary for Subcatchment E1: West Abutter (Bowen Upper Field)

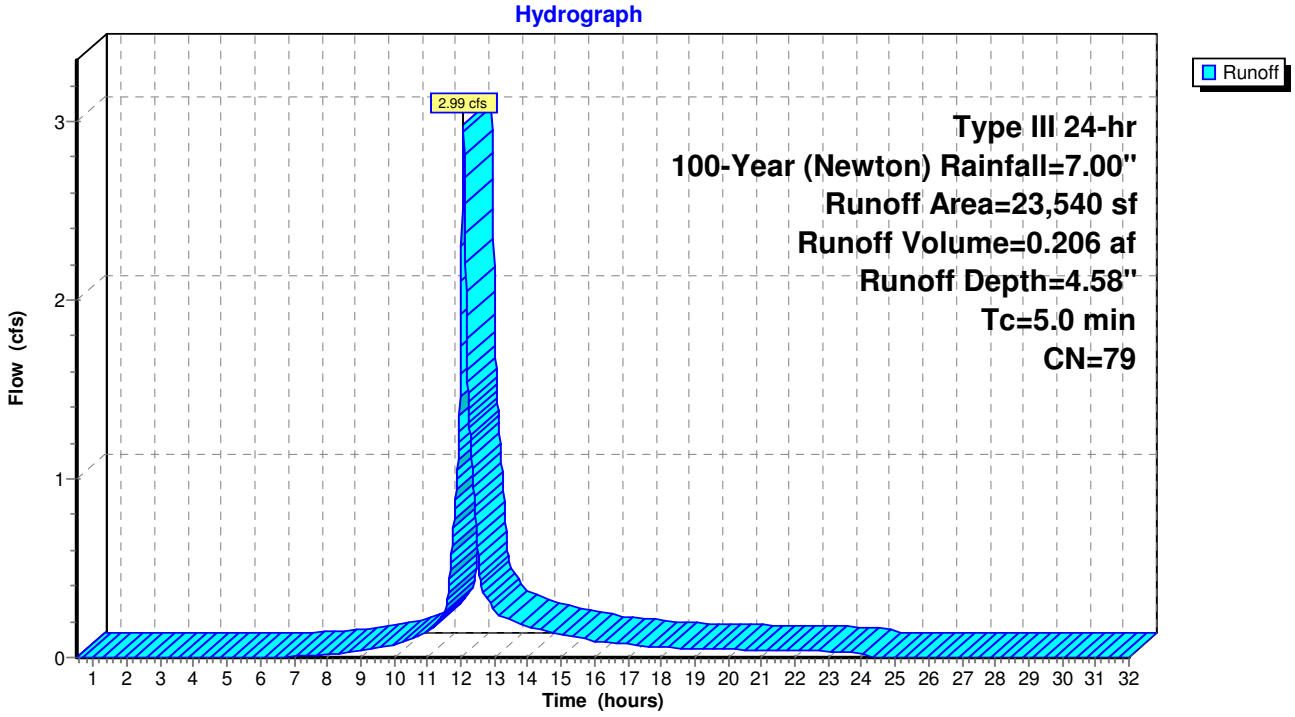
Runoff = 2.99 cfs @ 12.07 hrs, Volume= 0.206 af, Depth= 4.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year (Newton) Rainfall=7.00"

	Area (sf)	CN	Description
*	1,081	98	Roof House
*	2,900	98	Driveway
*	331	98	Walks/Steps/Landing
*	199	98	Ret. Wall
*	385	98	Ledge
	18,644	74	>75% Grass cover, Good, HSG C
	23,540	79	Weighted Average
	18,644		79.20% Pervious Area
	4,896		20.80% Impervious Area

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

Subcatchment E1: West Abutter (Bowen Upper Field)



Summary for Subcatchment P1: West Abutter

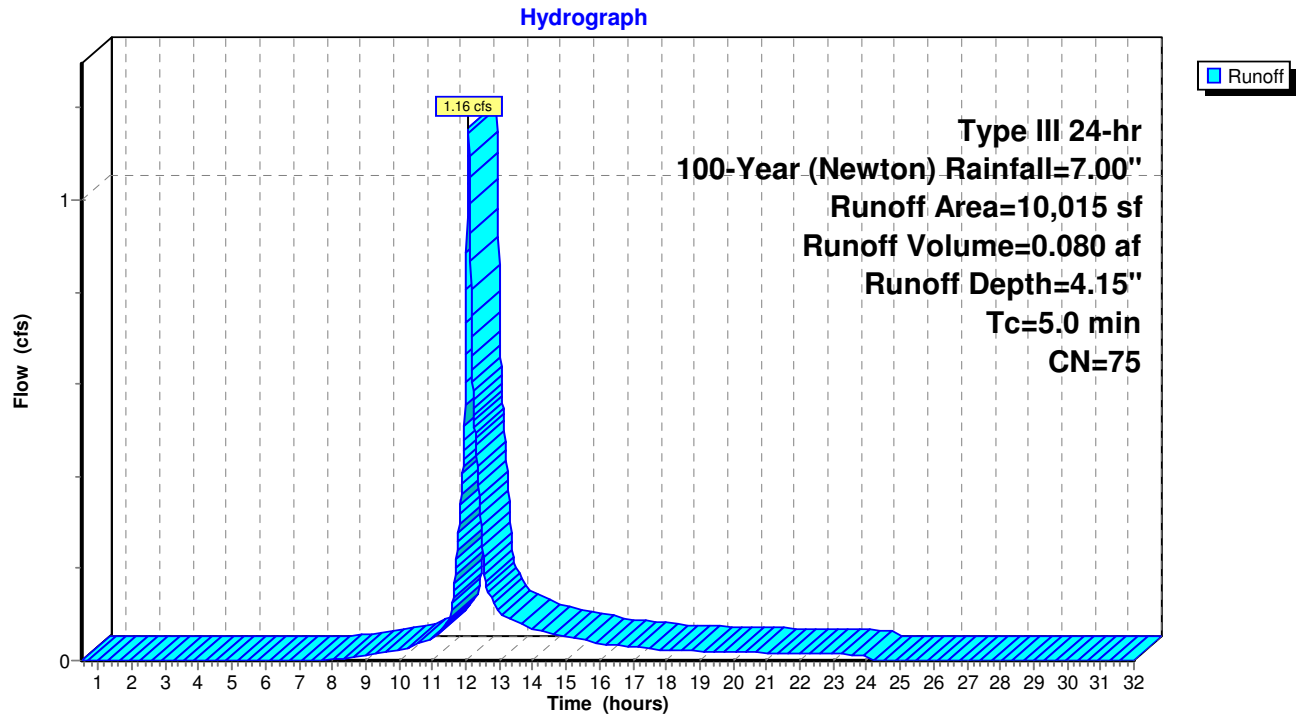
Runoff = 1.16 cfs @ 12.07 hrs, Volume= 0.080 af, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year (Newton) Rainfall=7.00"

	Area (sf)	CN	Description
*	58	98	Patio
*	243	98	Ret. Walls
*	200	98	Ledge
	9,514	74	>75% Grass cover, Good, HSG C
	10,015	75	Weighted Average
	9,514		95.00% Pervious Area
	501		5.00% Impervious Area

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

Subcatchment P1: West Abutter



Summary for Subcatchment PD: Driveway

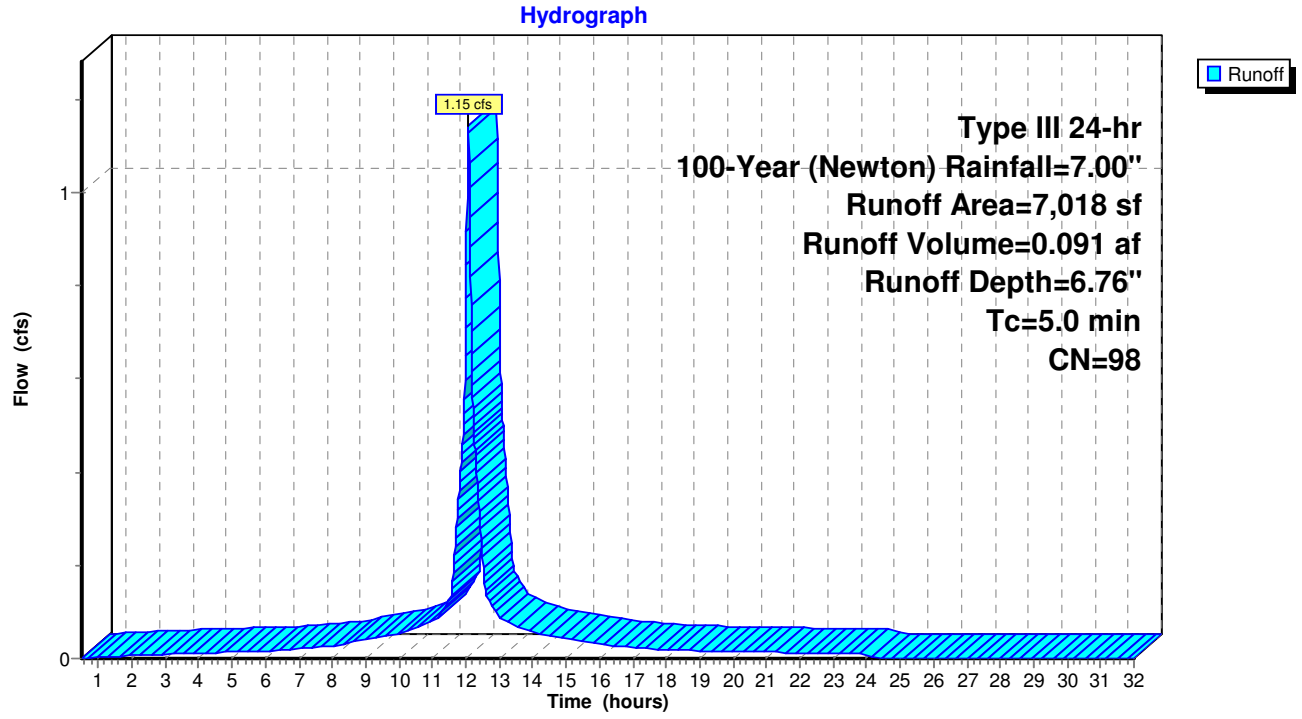
Runoff = 1.15 cfs @ 12.07 hrs, Volume= 0.091 af, Depth= 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year (Newton) Rainfall=7.00"

	Area (sf)	CN	Description
*	5,497	98	Prop. Driveway
*	138	98	Ret. Walls
*	1,383	98	Walks
	7,018	98	Weighted Average
	7,018		100.00% Impervious Area

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

Subcatchment PD: Driveway



Summary for Subcatchment PR1: Prop. Roof-1

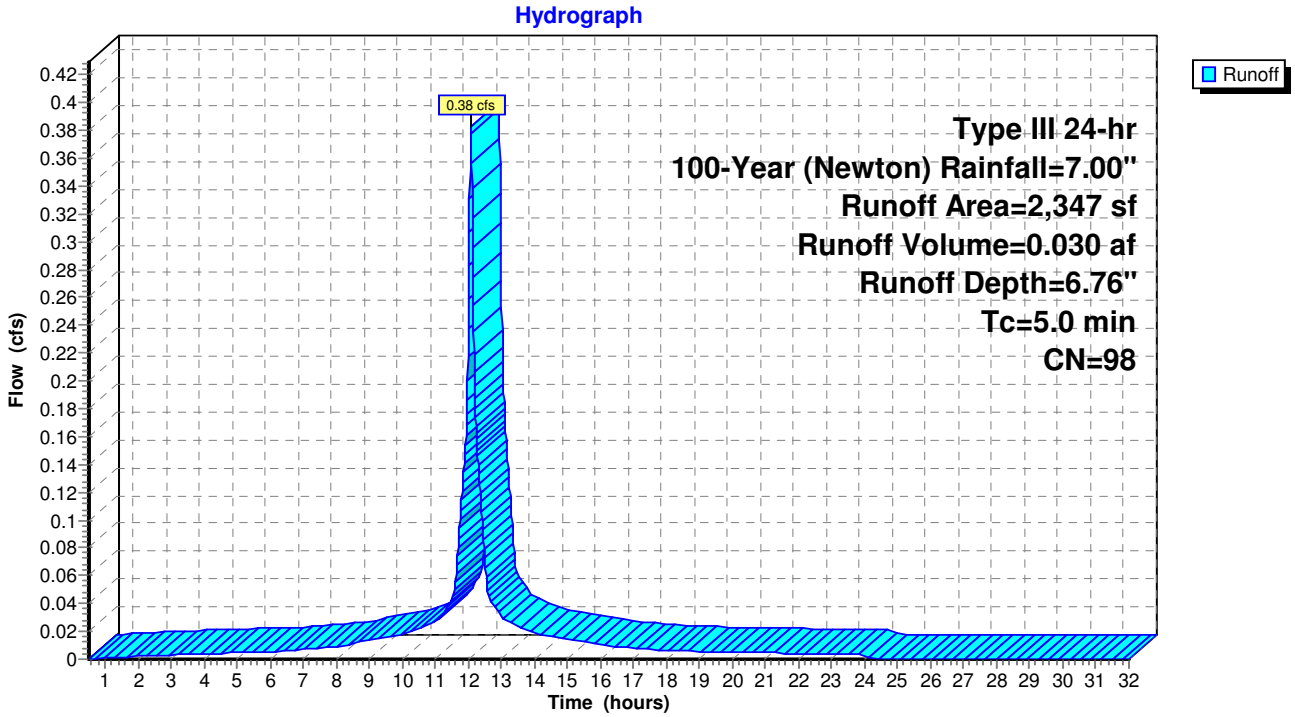
Runoff = 0.38 cfs @ 12.07 hrs, Volume= 0.030 af, Depth= 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year (Newton) Rainfall=7.00"

	Area (sf)	CN	Description
*	2,347	98	Prop. Roof
	2,347		100.00% Impervious Area

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

Subcatchment PR1: Prop. Roof-1



Summary for Subcatchment PR2: Prop. Roof-2

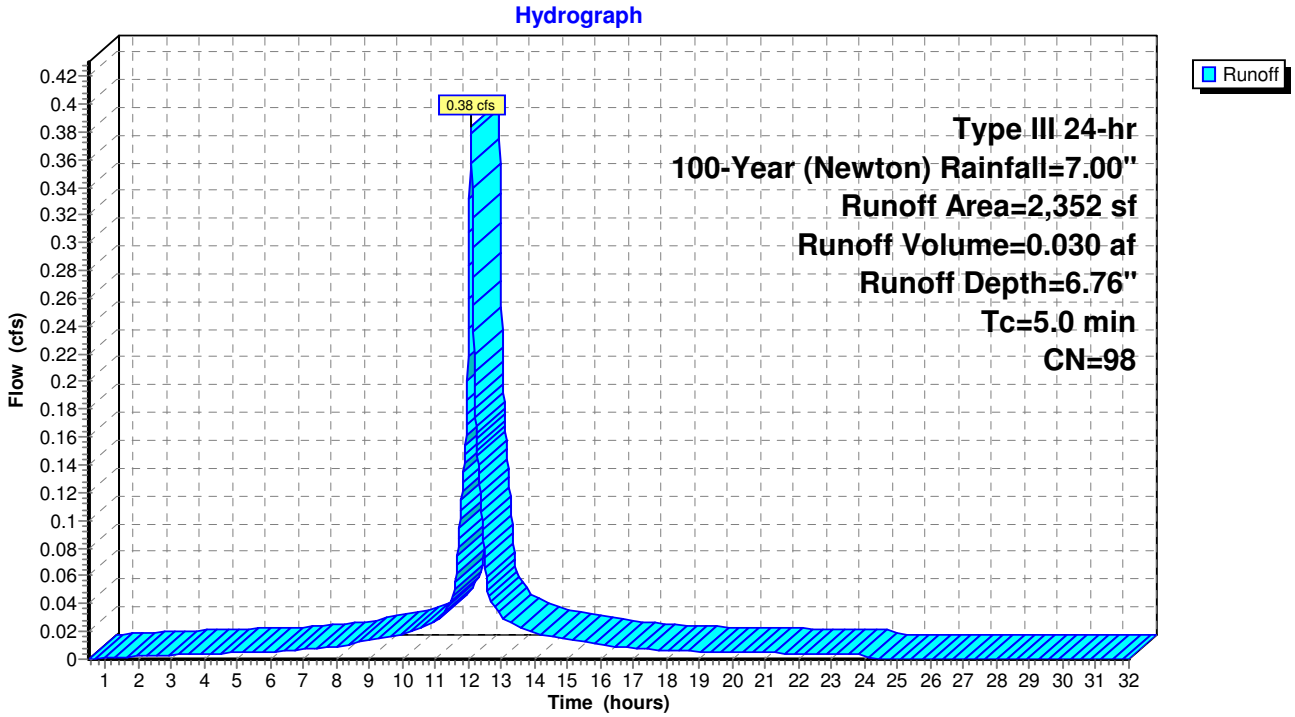
Runoff = 0.38 cfs @ 12.07 hrs, Volume= 0.030 af, Depth= 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year (Newton) Rainfall=7.00"

	Area (sf)	CN	Description
*	2,352	98	Prop. Roof
	2,352		100.00% Impervious Area

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

Subcatchment PR2: Prop. Roof-2

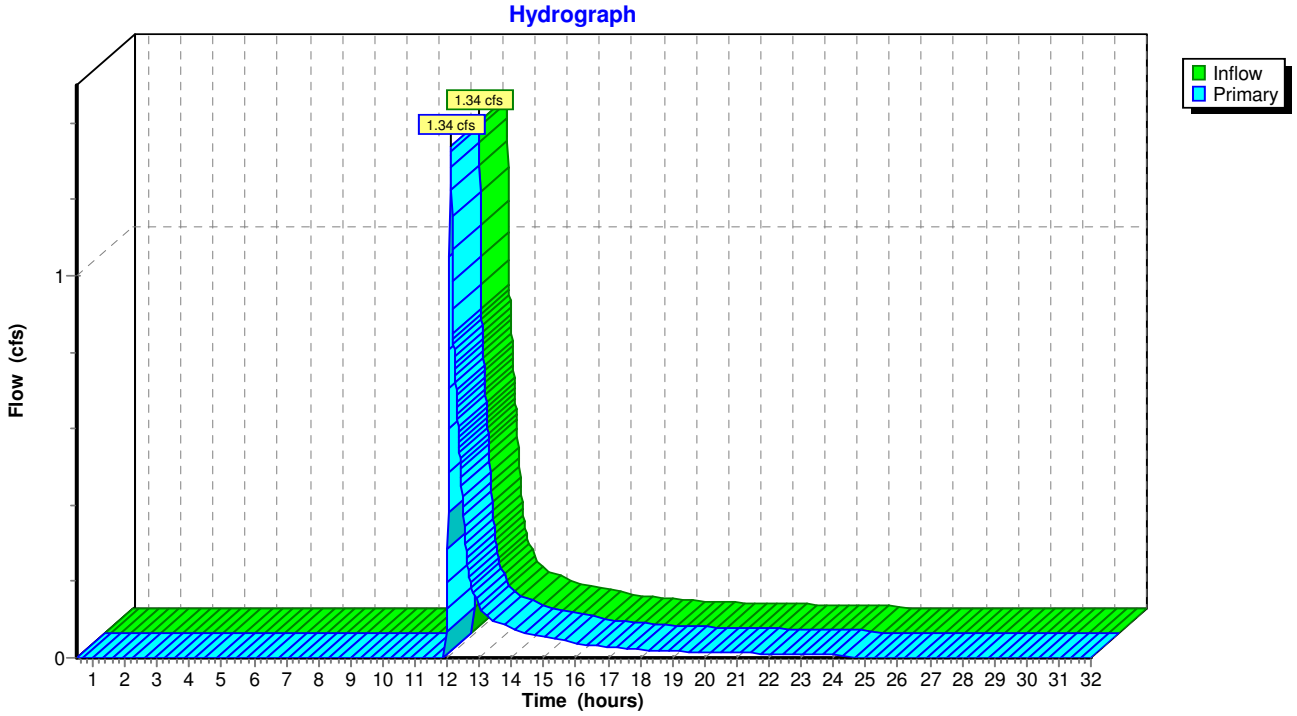


Summary for Pond CD: City Drain

Inflow	=	1.34 cfs @	12.11 hrs, Volume=	0.067 af
Primary	=	1.34 cfs @	12.11 hrs, Volume=	0.067 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs

Pond CD: City Drain



Summary for Pond INF-1: Inf. System #1 Low Profile Galleys

Inflow Area = 0.215 ac,100.00% Impervious, Inflow Depth = 6.76" for 100-Year (Newton) event
Inflow = 1.53 cfs @ 12.07 hrs, Volume= 0.121 af
Outflow = 1.35 cfs @ 12.11 hrs, Volume= 0.083 af, Atten= 12%, Lag= 2.5 min
Discarded = 0.01 cfs @ 2.28 hrs, Volume= 0.016 af
Secondary = 1.34 cfs @ 12.11 hrs, Volume= 0.067 af

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Peak Elev= 237.09' @ 12.11 hrs Surf.Area= 0.024 ac Storage= 0.050 af

Plug-Flow detention time= 226.6 min calculated for 0.083 af (69% of inflow)
Center-of-Mass det. time= 128.5 min (870.5 - 742.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	233.35'	0.017 af	**20.00'W x 52.00'L x 4.00'H Field A** 0.096 af Overall - 0.048 af Embedded = 0.048 af x 35.0% Voids
#2A	234.35'	0.034 af	**Galley 4x4x3** x 48 Inside #1 Inside= 42.0"W x 30.0"H => 8.91 sf x 3.50'L = 31.2 cf Outside= 48.0"W x 36.0"H => 10.81 sf x 4.00'L = 43.2 cf 4 Rows of 12 Chambers
		0.051 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	233.35'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Secondary	236.35'	**8.0" Round 8" CPP (Overflow)** L= 54.4' Ke= 0.200 Inlet / Outlet Invert= 236.35' / 235.00' S= 0.0248 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.01 cfs @ 2.28 hrs HW=233.39' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=1.34 cfs @ 12.11 hrs HW=237.09' (Free Discharge)
↑—**2=8" CPP (Overflow)** (Inlet Controls 1.34 cfs @ 3.84 fps)

Pond INF-1: Inf. System #1 Low Profile Galleys - Chamber Wizard Field A

Chamber Model = Galley 4x4x3 (Concrete Galley, Shea LE-EGLPH, LE-CGLPH or equivalent)
Inside= 42.0"W x 30.0"H => 8.91 sf x 3.50'L = 31.2 cf
Outside= 48.0"W x 36.0"H => 10.81 sf x 4.00'L = 43.2 cf

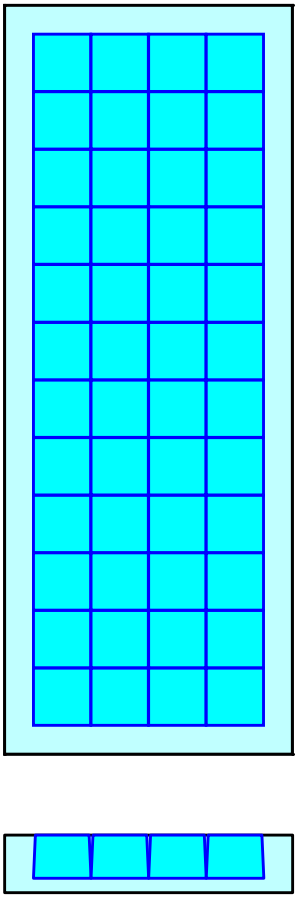
12 Chambers/Row x 4.00' Long = 48.00' Row Length +24.0" End Stone x 2 = 52.00' Base Length
4 Rows x 48.0" Wide + 24.0" Side Stone x 2 = 20.00' Base Width
12.0" Base + 36.0" Chamber Height = 4.00' Field Height

48 Chambers x 31.2 cf = 1,497.2 cf Chamber Storage
48 Chambers x 43.2 cf = 2,075.3 cf Displacement

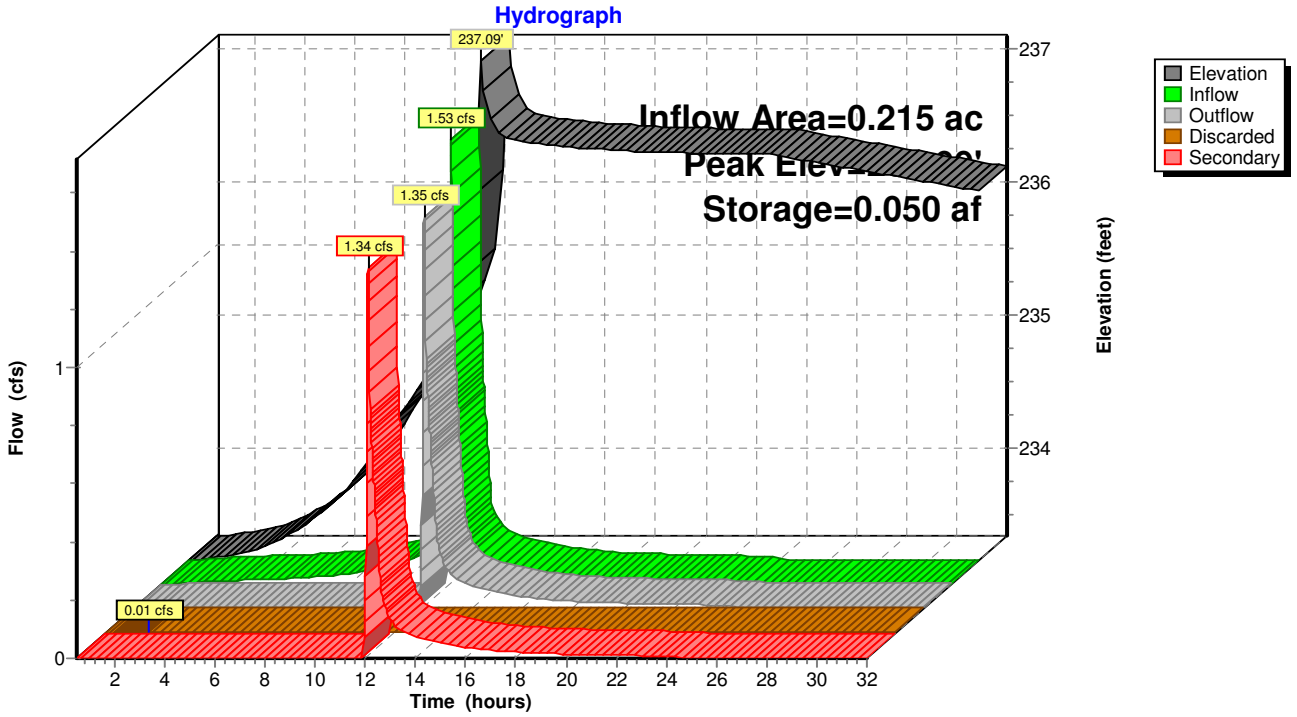
4,160.0 cf Field - 2,075.3 cf Chambers = 2,084.7 cf Stone x 35.0% Voids = 729.6 cf Stone Storage

Chamber Storage + Stone Storage = 2,226.8 cf = 0.051 af
Overall Storage Efficiency = 53.5%
Overall System Size = 52.00' x 20.00' x 4.00'

48 Chambers
154.1 cy Field
77.2 cy Stone



Pond INF-1: Inf. System #1 Low Profile Galleys



Summary for Pond INF-2: Inf. System #2 12"ADS_Perf. Pipe

Inflow Area = 0.054 ac,100.00% Impervious, Inflow Depth = 6.76" for 100-Year (Newton) event
Inflow = 0.38 cfs @ 12.07 hrs, Volume= 0.030 af
Outflow = 0.38 cfs @ 12.08 hrs, Volume= 0.028 af, Atten= 1%, Lag= 0.5 min
Discarded = 0.00 cfs @ 1.44 hrs, Volume= 0.002 af
Secondary = 0.38 cfs @ 12.08 hrs, Volume= 0.026 af

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs
Peak Elev= 230.86' @ 12.08 hrs Surf.Area= 0.003 ac Storage= 0.003 af

Plug-Flow detention time= 91.6 min calculated for 0.028 af (93% of inflow)
Center-of-Mass det. time= 54.4 min (796.5 - 742.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	228.50'	0.003 af	**3.21'W x 42.00'L x 2.71'H Field A** 0.008 af Overall - 0.001 af Embedded = 0.007 af x 35.0% Voids
#2A	229.50'	0.001 af	**ADS N-12 12** x 2 Inside #1 Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf
		0.003 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	228.50'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Secondary	230.50'	**6.0" Round 6" CPP (Overflow)** L= 4.0' Ke= 0.200 Inlet / Outlet Invert= 230.50' / 230.10' S= 0.1000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

Discarded OutFlow Max=0.00 cfs @ 1.44 hrs HW=228.53' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Secondary OutFlow Max=0.38 cfs @ 12.08 hrs HW=230.86' (Free Discharge)
↑—**2=6" CPP (Overflow)** (Inlet Controls 0.38 cfs @ 2.54 fps)

Pond INF-2: Inf. System #2 12"ADS_Perf. Pipe - Chamber Wizard Field A

Chamber Model = ADS N-12 12 (ADS N-12® Pipe)
Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf
Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf

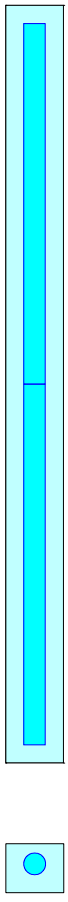
2 Chambers/Row x 20.00' Long = 40.00' Row Length +12.0" End Stone x 2 = 42.00' Base Length
1 Rows x 14.5" Wide + 12.0" Side Stone x 2 = 3.21' Base Width
12.0" Base + 14.5" Chamber Height + 6.0" Cover = 2.71' Field Height

2 Chambers x 16.2 cf = 32.4 cf Chamber Storage
2 Chambers x 20.9 cf = 41.9 cf Displacement

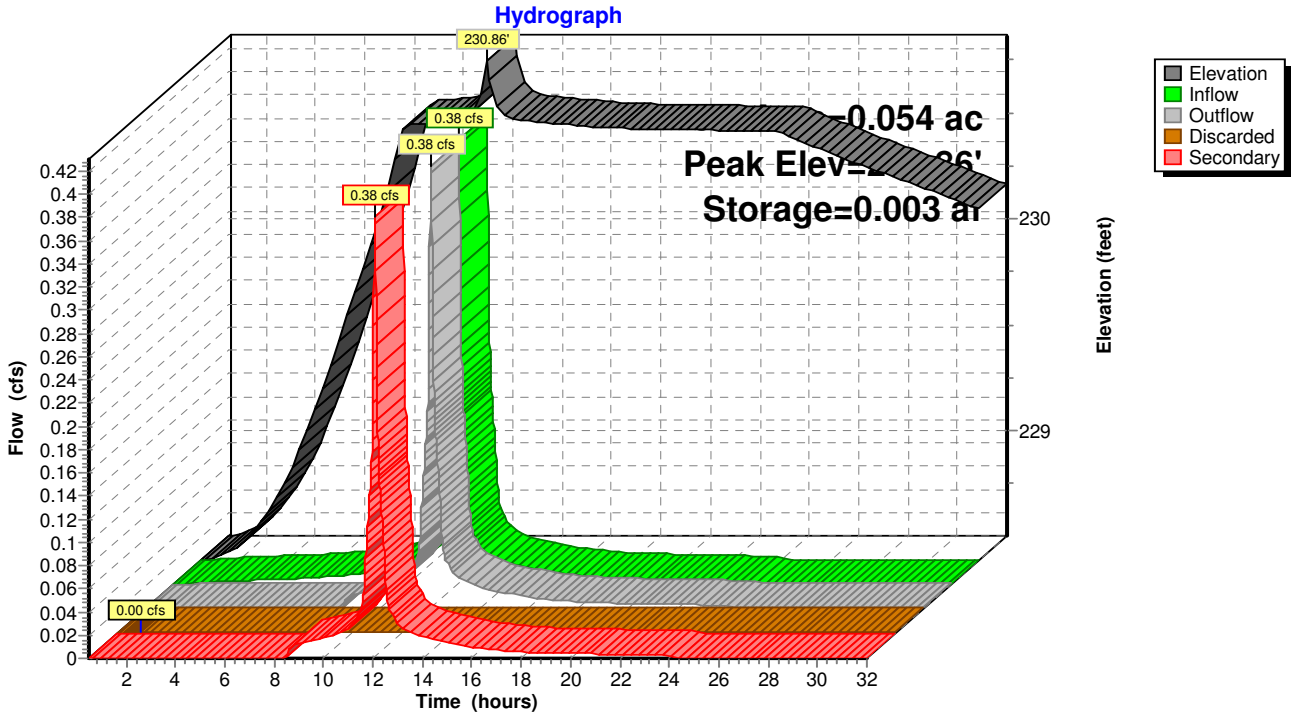
365.1 cf Field - 41.9 cf Chambers = 323.2 cf Stone x 35.0% Voids = 113.1 cf Stone Storage

Chamber Storage + Stone Storage = 145.5 cf = 0.003 af
Overall Storage Efficiency = 39.9%
Overall System Size = 42.00' x 3.21' x 2.71'

2 Chambers
13.5 cy Field
12.0 cy Stone



Pond INF-2: Inf. System #2 12"ADS_Perf. Pipe



Summary for Pond OFLOW: West Abutter

Inflow = 0.38 cfs @ 12.08 hrs, Volume= 0.026 af
Primary = 0.38 cfs @ 12.08 hrs, Volume= 0.026 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.50-32.00 hrs, dt= 0.01 hrs

Pond OFLOW: West Abutter