ACORN
ENGINEERING, INC.

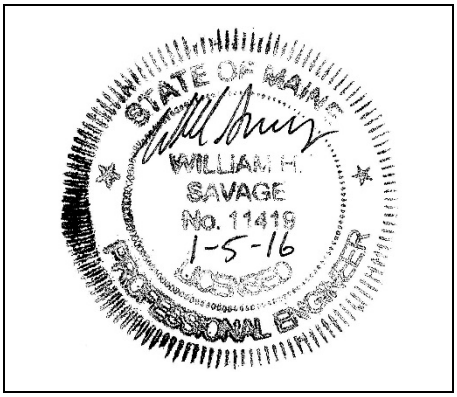
STORMWATER MANAGEMENT REPORT

Prepared For:

Peninsula Property Development, LLC
31 Fore Street Redevelopment
31 Fore Street
Portland, Maine 04101

Prepared By:

Acorn Engineering, Inc.
158 Danforth Street
Portland, Maine 04102



January 2016

INTRODUCTION

Acorn Engineering, Inc. has been retained by Peninsula Property Development, LLC to provide civil engineering services for the proposed redevelopment of 31 Fore Street. The proposed project is a residential 4-unit redevelopment of an existing 3-unit building. The existing 3-story, wood frame building will be removed as part of the construction of the urban infill development.

A stormwater analysis will be prepared to demonstrate that the project will meet the following requirements of the City of Portland (the City):

- City of Portland Land Use Ordinance Chapter 14, Article V. Site Plan Section 14-523. Required Approvals and Applicability (F) Level III Site Plan Review.
- City of Portland Technical Manual – Section 5 – Portland Stormwater Management Standards and Maine DEP Chapter 500 Stormwater Management.

The proposed project will include the redevelopment of existing impervious area including rooftops, sidewalks, and gravel driveways with parking. The current course of action is to provide water quality treatment to the stormwater through filtration utilizing a Maine Department of Environmental Protection – Rain Garden (Bioretention Cell) approved stormwater Best Management Practice (BMP). This development shall incorporate green infrastructure to provide water quality treatment for no less than 95% of the new impervious area and 80% of the developed area.

The stormwater analysis is documented with supporting calculations and reports attached to this narrative.

EXISTING CONDITIONS

The proposed project site is located on the southeasterly corner of the intersection of Waterville and Fore Street. Portland has zoned this area as an R-6 Residential Zone. A boundary plan has been prepared by Owen Haskell, Inc. of Falmouth, Maine dated 9/24/15 and revised 10/17/15.

Abutting Uses:

- North R-6 Zone – Multi-Family Residential
- West R-6 Zone - Multi-Family Residential
- South R-6 Zone - Multi-Family Residential
- East B6 Zone – Portland Company

The project area is previously developed and comprised of grassed areas, rooftops, sidewalks, gravel driveways with parking. From south to north the grades are approximately 10% up to an existing retaining wall. The project area presently drains towards the intersection of Waterville and Fore Street before entering the municipal storm drain system.

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The project team is not aware of the presence of any existing significant natural features located on the site. Given the urban setting, existing free-draining soils and steep slopes a field inventory of significant natural feature was not undertaken. The project is not located within a watershed classified as an Urban Impaired Stream.

PROPOSED DEVELOPMENT

The proposed project is a residential 4-unit redevelopment of an existing 3-unit building. The existing 3-story, wood frame building will be removed as part of the construction of the urban infill development. To minimize the development's footprint and impervious area the project will include a parking garage beneath the building that will include 6 parking spaces, bicycle parking and solid waste/recycling storage area.

The moderate change in grade will be incorporated into the building design by terracing the building into the slope. Terracing will be completed through stepped foundations and reuse of the existing retaining walls. The proposed pedestrian access off of Fore Street will access the first floor above the garage level while the garage level will be accessed from the low point on Waterville Street setback the maximum distance from the intersection. Structural Integrity Consulting Engineering will provide the foundation/retaining wall design for the building permit application. The parcel will be landscaped with trees, shrubs and ornamental grasses.

The development will be served by the Portland Water District, underground power/cable/communications, natural gas and the municipal sewer system. The project anticipates incorporating Maine DEP approved stormwater Best Management Practices to meet the General and Flooding Standards.

GENERAL STANDARDS - WATER QUALITY

The development shall provide water quality treatment for no less than 95% of the new impervious area and 80% of the developed area. The project includes the redevelopment of existing impervious area including rooftops, asphalt and gravel driveways and parking. The entire parcel is previously developed and as such the will not create any new developed area. Water quality treatment shall be provided through the use of a Rain Garden meeting the specifications of a Maine DEP Bioretention Cell. From herein the Bioretention Cell shall be referred to as a Rain Garden.

The rain garden was sized to meet or exceed the requirements set forth within the MDEP Volume III: BMPs Technical Design Manual Section 7.2. Filtration BMPs have been shown to be very effective at removing a wide range of pollutants from stormwater runoff. The stormwater runoff shall first flow into the rain garden whose plants and storage area shall provide initial treatment. The stormwater shall be detained above the surface before flowing vertically through the soil filter layer. The treated stormwater shall then be collected within perforated pipes and released slowly by the outlet control at an attenuated rate. Larger storm events shall overflow into an oversized horizontal atrium grate.

The treatment of the impervious surface is as follows:

Table 1 - Impervious Treatment Area Table					
	Existing Impervious Area (SF)	Proposed Total Impervious Area (SF)	Net change in Impervious Area (SF)	Proposed Impervious Area with Treatment (SF)	% Overall New Imp. Area Treated
Rain Garden	2,070	2,842	772	2,457	318%

As shown above the project anticipates meeting and exceeding the required treatment for new impervious surfaces through the use of the rain garden BMP.

According to the requirements for a rain garden as defined in the Volume III: BMPs Technical Design Manual, Chapter 7.2, the surface area of the filter shall be no less than the sum of 7% of the tributary impervious area and 3% of the tributary vegetated area. The filter area is calculated by the following formula:

[(Imp. SF x 0.07) + (Veg. SF x 0.03)] = Filter Area (SF)

Please refer to Table 2 below.

Table 2 – Total Filter Surface Area, displays the proposed Rain Garden sizing requirements, actual size and the percentage of required area.

Table 2 –Total Filter Surface Area			
	Required Filter Area (SF)	Actual Filter Area (SF)	Percentage of Required Area (%)
Rain Garden	170	175	102%

The outflow from the Rain Garden is then tributary to the municipal stormwater system. As shown, the size of the soil filter area will meet and exceed the surface area requirements. Values from the HydroCAD calculations attached to this report.

In accordance with the Volume III: BMPs Technical Design Manual, a water quality volume of 1.0 inches times the tributary impervious area plus 0.4 inches times the tributary disturbed area is required to be treated by the Rain Garden. The water quality volume is calculated by the following formula:

$$\left(\frac{\text{Imp. SF x 1.0"}}{\text{12"/1'}}\right) + \left(\frac{\text{Veg. SF x 0.4"}}{\text{12"/1'}}\right) = \text{Treatment Volume (CF)}$$

The proposed water quality volume is as follows:

Table 3 - Water Quality Volume Table				
	Disturbed Area (SF)	Impervious Area (SF)	Treatment Volume Required (CF)	Treatment Volume Provided (CF)
Rain Garden	0	2,842	**236**	**256**

As shown, the size of the combined water quality volume will meet and exceed the treatment volume requirements. Values from the HydroCAD calculations are attached to this report.

Provided the infiltration rates of the water quality volume through the soil filter are variable a water quality outlet is modeled to provide the required minimum 24-hour release time. This is completed by adjusting the rainfall amount in HydroCAD until the inflow volume is equal to or greater than the calculated treatment volume. The storm events are modeled as type III, 24-hour storm events in HydroCAD.

A vertical orifice is modeled in HydroCAD at the outlet control structure. The orifice diameter is sized to detain the stormwater for an approximate period of 24 hours. The orifice shall be placed at the end of the outfall pipe into the municipal catch basin. The orifice is intended to be a PVC cap placed on the outfall pipe (no glue) with the orifice drilled into the cap eccentrically. The PVC cap can be easily inspected, removed or replaced if necessary. The orifice for the water quantity volume is then set above the peak elevation determined for the water quality volume.

FLOODING STANDARD – WATER QUANTITY

The proposed project was modeled using HydroCAD to verify that the post-development conditions do not exceed the pre-development conditions. A 24-hour SCS Type III storm distribution for the 2, 10, and 25 year storm events were used. The corresponding rainfall amounts for these storms are 3.10", 4.60", and 5.80" respectively.

Due to the numerous variables, and inherent inaccuracies with the modeling program used to calculate stormwater runoff it is custom at Acorn Engineering, Inc. to round to the nearest whole number. However due to the small size of the project the stormwater runoff shall be rounded to the nearest tenth of a cubic feet per second (cfs).

Time of Concentration (T_c)

In our initial submission a time of concentration (T_c) of 5 minutes was applied to each subcatchment for both the pre and post-development condition, given the urban setting, and moderate slopes. This was a conservative approach that in the post-development condition would result in the two separate subcatchments peak flow rates combining at the reach at the same time. Using different Tc's can result in a multiple peak flow rates and can result in an overall lower combined peak flow.

Curve Number

Conservative curve number (CN) runoff values were used within the subcatchment for the landscaped area. The stormwater calculations used the following CN values in the post development condition for vegetated areas, as follows:

- 75% Grass Cover, Good
- Woods/Grass Combination Good

Given the landscaping plan is to design a densely planted perennial gardens the Woods/Grass Combination was deemed an appropriate CN value for the projected portion of the project area to receive landscaping.

Pre-development Calculations

The pre-development condition was modeled as one subcatchment to determine the net impact of the development.

- Subcatchment 1 – The subcatchment area is defined by the property line to the intersection of Waterville and Fore Street.

A Pre-development Watershed Map developed for this project can be viewed in Attachment A, and a copy of the HydroCAD calculations is included within Attachment C, or this report. Peak flow rates for the storm events are as follows:

Table 4 – Pre-Development Peak Stormwater Flows			
Drainage Area	**2 – Year Storm Event (cfs)**	**10 – Year Storm Event (cfs)**	**25 – Year Storm Event (cfs)**
POI #1	0.1	0.2	0.3

Post-development Calculations:

The one predevelopment subcatchment was broken into two separate subcatchments for the post-development condition.

- Subcatchment 1 – This is comprised of the building's roof and a small portion of the driveway.
- Subcatchment 2 – This is comprised of the landscaped area, patio and internal sidewalks.

The post development calculations include changes to the land use, and the compensation provided by the detention facility. The following table represents comparison of predevelopment and post-development condition peak runoff rates for the proposed development and tributary area.

Table 5 – Comparison of Peak Flows						
Drainage Area	**2 – Year Storm Event (cfs)**		**10 – Year Storm Event (cfs)**		**25 – Year Storm Event (cfs)**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
POI #1	0.1	0.1	0.2	0.2	0.3	0.3

As shown in Table 5 the net impact of the post development peak flows shall remain at or below the predevelopment levels. A Post-development Watershed Map developed for this project can be viewed in Attachment B, and a copy of the HydroCAD calculations is included within Attachment C of this report.

SOILS

Onsite soil information includes the following:

- Soil Conservation Service Medium Intensity Soil Survey for Cumberland County

Given the soils information, listed above, no onsite wastewater is proposed, the applicant does not intend to perform a more intense hydric soil boundary delineation because the waiver requirements set forth in the City of Portland Technical Manual – Section 7 – Soil Survey, Rev. 6/17/12 are met.

The area within and surrounding the project includes soils types listed in the table below. The susceptibility of soils to erosion is indicated on a relative "K" scale of values over a range of 0.02 to 0.69. Higher "K" values indicate more erodible soils.

Table 3 - "K" Value		
Soils Type	**Subsurface**	**Substratum**
Hinckley	.17	.17

The soil "K" values for the soils, listed above, show a low susceptibility to erosion. The site's susceptibility to erosion is from the Soil Conservation Service Medium Intensity Soil Survey for Cumberland County. Although soil "K" values for the soils show a low susceptibility to erosion, implementation of the proposed Erosion & Sedimentation Measures by the contractor will be of the utmost importance, given the long sustained slopes.

Conclusion

The proposed development was designed to meet the requirements implemented by the MDEP under the Stormwater Management Statute (38 M.R.S.A. § 420-D) as well as the City of Portland Technical Manual – Section 5 – Portland Stormwater Management Standards. As a result the design of the proposed development and stormwater system does not anticipate to create erosion, drainage or runoff problems either in the development or with respect to adjoining properties.

Attachments

Attachment A: Pre Development Watershed Map
Attachment B: Post Development Watershed Map
Attachment C: HydroCAD Calculations

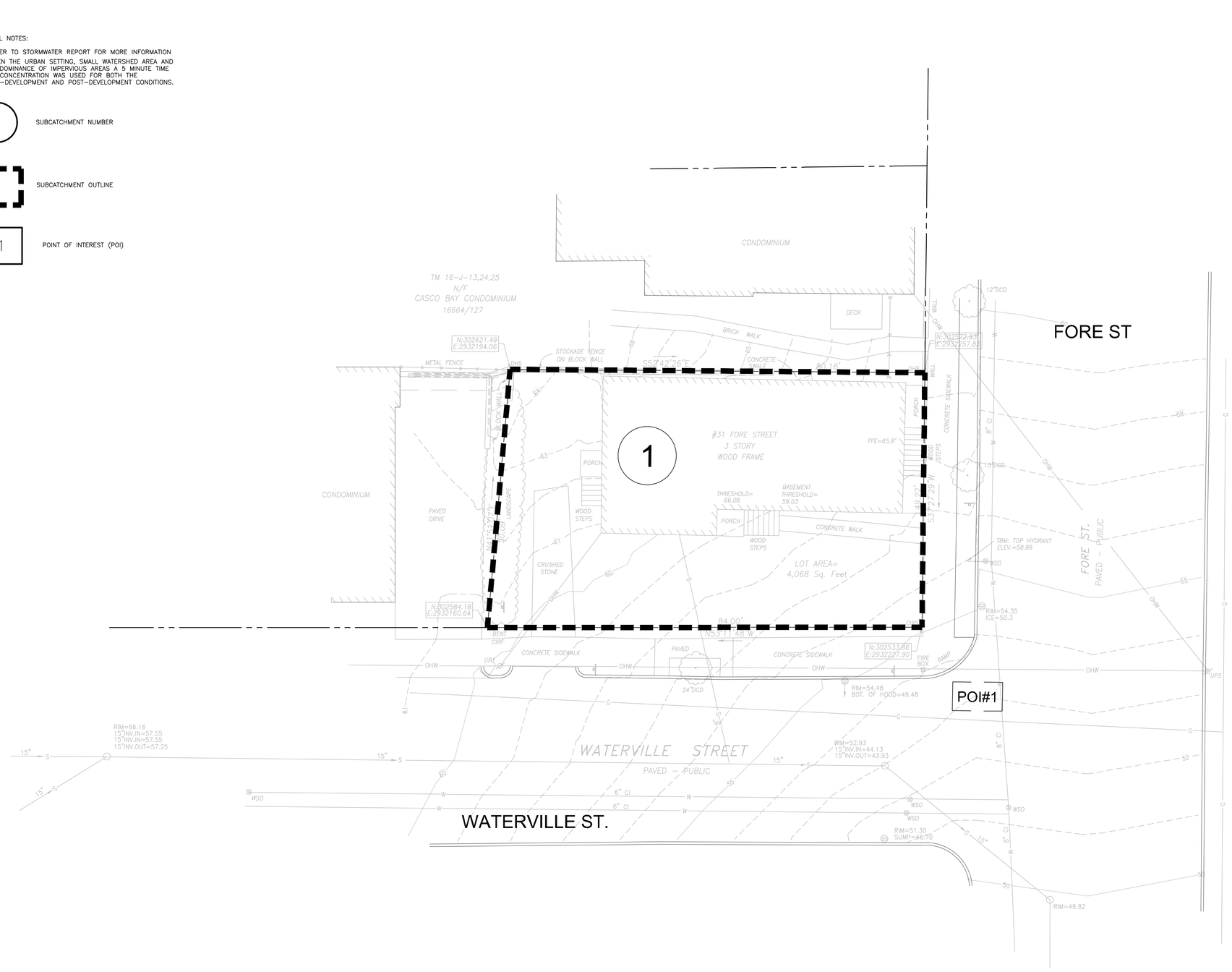
GENERAL NOTES:

1. REFER TO STORMWATER REPORT FOR MORE INFORMATION
2. GIVEN THE URBAN SETTING, SMALL WATERSHED AREA AND PREDOMINANCE OF IMPERVIOUS AREAS A 5 MINUTE TIME OF CONCENTRATION WAS USED FOR BOTH THE PRE-DEVELOPMENT AND POST-DEVELOPMENT CONDITIONS.

1 — SUBCATCHMENT NUMBER

SUBCATCHMENT OUTLINE

1 — POINT OF INTEREST (POI)



FINAL APPLICATION
NOT ISSUED FOR CONSTRUCTION

ISSUED FOR	BY	DATE
PRELIM. APPLICATION	WHS	1/5/16
FINAL APPLICATION	WHS	3/1/16

REVISION	REV.	DATE

DRAWING NAME: PRE-DEVELOPMENT STORMWATER PLAN

PROJECT NAME: 31 FORE STREET REDEVELOPMENT

CLIENT: PENINSULA PROPERTY DEVELOPMENT, LLC.
59 MOODY STREET, PORTLAND, MAINE 04101

ACORN ENGINEERING, INC.

ACORN ENGINEERING, INC.
158 DANFORTH STREET, PORTLAND MAINE 04102
(207) 775-2655

FILE:	1068_DETAILS
DATE:	12/28/15
JN:	1068
SCALE:	NTS
DESIGNED BY:	WHS
DRAWN BY:	WHS
CHECKED BY:	WHS

STATE OF MAINE
WILLIAM H. SAVAGE
No. 11418
3-1-16
REGISTERED PROFESSIONAL ENGINEER

DRAWING NO.
PRE

GENERAL NOTES:

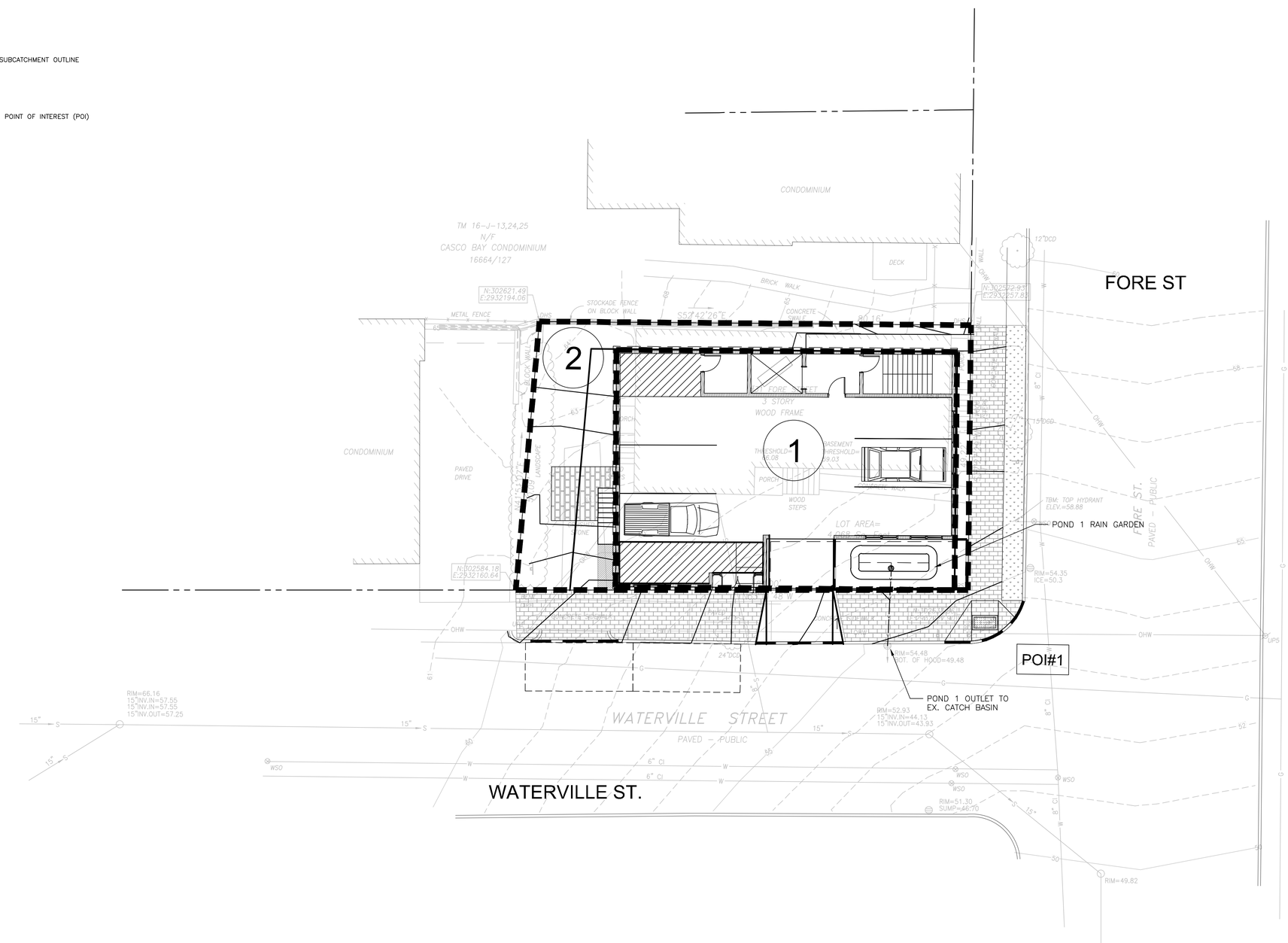
1. REFER TO STORMWATER REPORT FOR MORE INFORMATION
2. GIVEN THE URBAN SETTING, SMALL WATERSHED AREA AND PREDOMINANCE OF IMPERVIOUS AREAS A 5 MINUTE TIME OF CONCENTRATION WAS USED FOR BOTH THE PRE-DEVELOPMENT AND POST-DEVELOPMENT CONDITIONS.

1 SUBCATCHMENT NUMBER

SUBCATCHMENT OUTLINE

1 POINT OF INTEREST (POI)

0 10 20 FEET



FINAL APPLICATION
NOT ISSUED FOR CONSTRUCTION

ISSUED FOR	BY	DATE
PRELIM. APPLICATION	WHS	1/5/16
FINAL APPLICATION	WHS	3/1/16

REVISION	REV.	DATE

DRAWING NAME: **POST-DEVELOPMENT STORMWATER PLAN**

PROJECT NAME: **31 FORE STREET REDEVELOPMENT**

CLIENT: PENINSULA PROPERTY DEVELOPMENT, LLC.
59 MOODY STREET, PORTLAND MAINE 04101

ACORN ENGINEERING, INC.
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158 DANFORTH STREET, PORTLAND MAINE 04102
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STATE OF MAINE
WILLIAM H. SAVAGE
No. 11418
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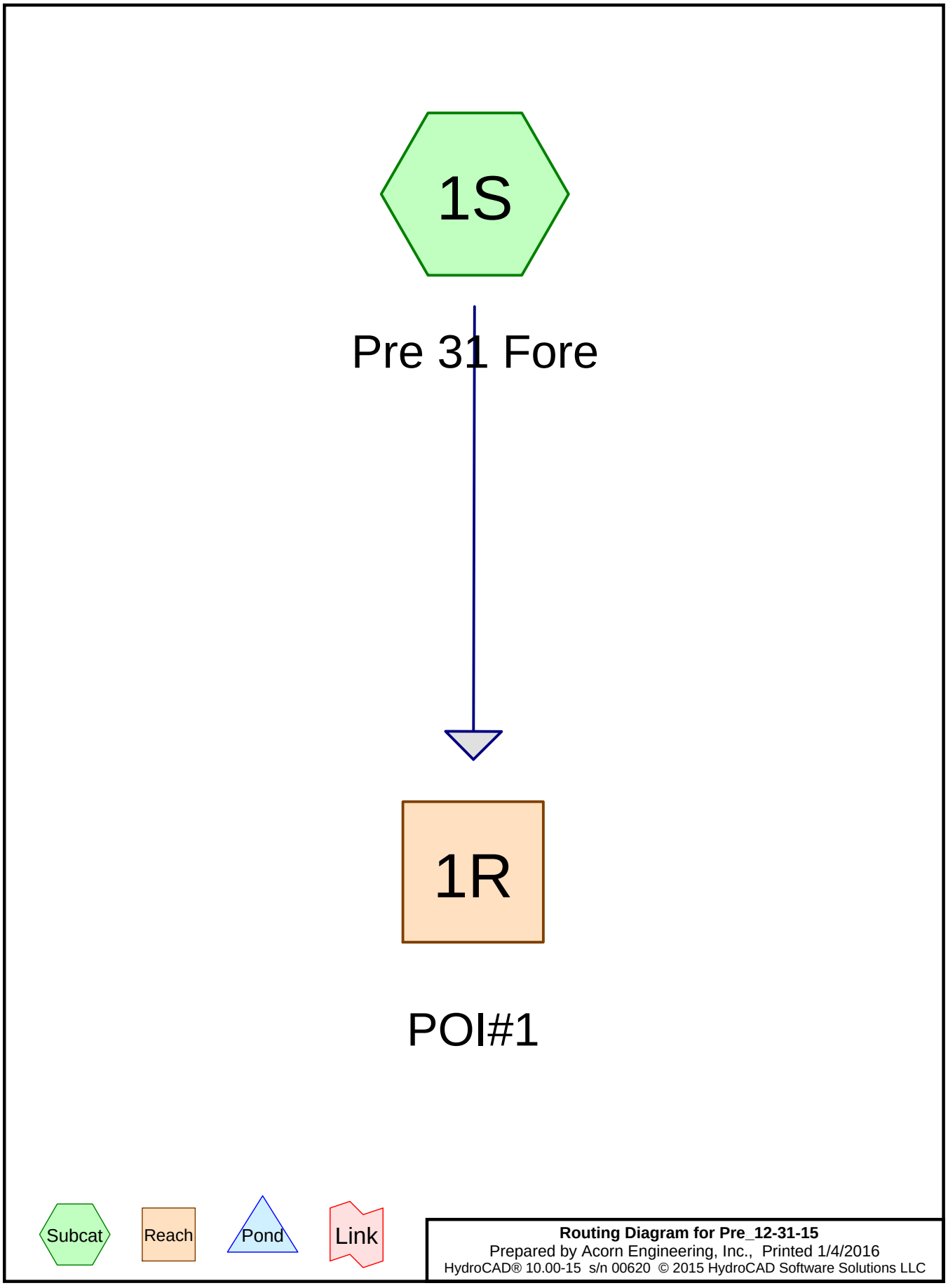
REGISTERED PROFESSIONAL ENGINEER

DRAWING NO.
POST



Routing Diagram for Pre_12-31-15
Prepared by Acorn Engineering, Inc., Printed 1/4/2016

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.046	39	>75% Grass cover, Good, HSG A (1S)
0.037	98	Building (1S)
0.005	96	Gravel Parking (1S)
0.006	98	Stairs/Sidewalks (1S)
0.093	**69**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.046	HSG A	1S
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.048	Other	1S
0.093		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.046	0.000	0.000	0.000	0.000	0.046	>75% Grass cover, Good	1S
0.000	0.000	0.000	0.000	0.037	0.037	Building	1S
0.000	0.000	0.000	0.000	0.005	0.005	Gravel Parking	1S
0.000	0.000	0.000	0.000	0.006	0.006	Stairs/Sidewalks	1S
0.046	**0.000**	**0.000**	**0.000**	**0.048**	**0.093**	**TOTAL AREA**	

Time span=1.00-36.00 hrs, dt=0.02 hrs, 1751 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre 31 Fore Runoff Area=4,068 sf 45.97% Impervious Runoff Depth=0.72"
Tc=5.0 min CN=69 Runoff=0.07 cfs 0.006 af

Reach 1R: POI#1 Inflow=0.07 cfs 0.006 af
Outflow=0.07 cfs 0.006 af

Total Runoff Area = 0.093 ac Runoff Volume = 0.006 af Average Runoff Depth = 0.72"
54.03% Pervious = 0.050 ac 45.97% Impervious = 0.043 ac

Summary for Subcatchment 1S: Pre 31 Fore

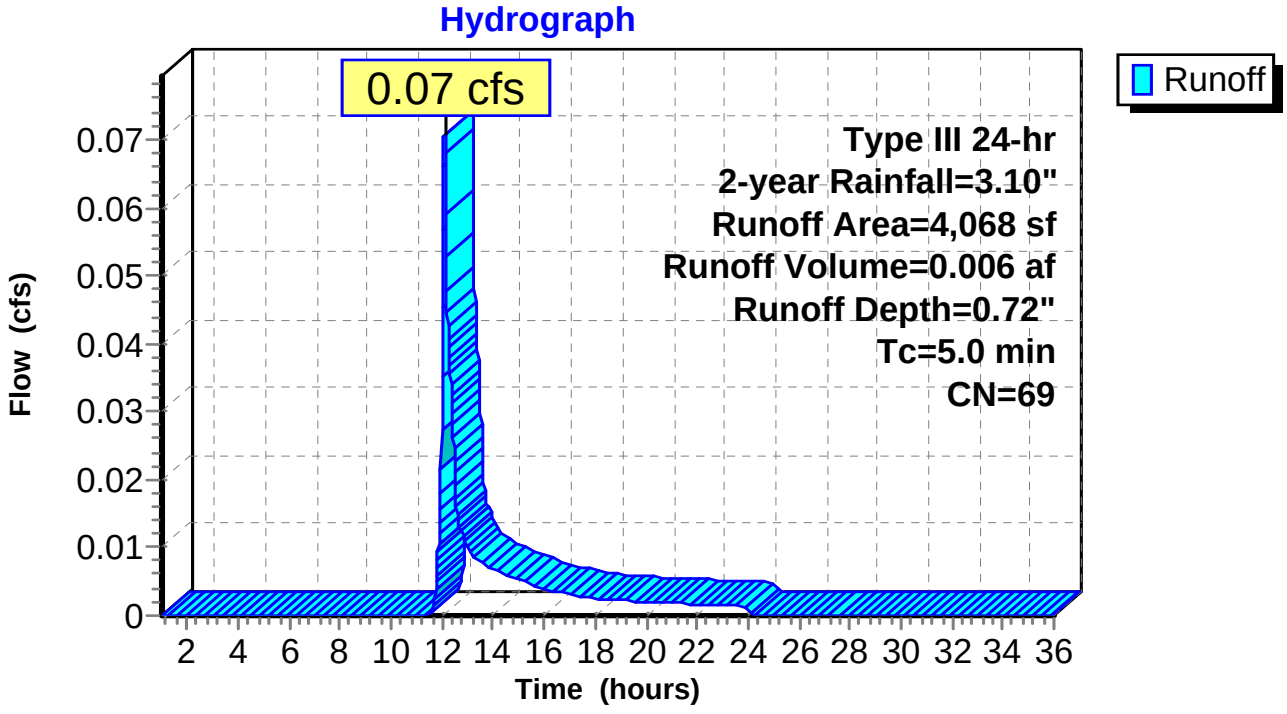
Runoff = 0.07 cfs @ 12.09 hrs, Volume= 0.006 af, Depth= 0.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 2-year Rainfall=3.10"

	Area (sf)	CN	Description
*	1,590	98	Building
*	280	98	Stairs/Sidewalks
*	200	96	Gravel Parking
	1,998	39	>75% Grass cover, Good, HSG A
	4,068	69	Weighted Average
	2,198		54.03% Pervious Area
	1,870		45.97% Impervious Area

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

Subcatchment 1S: Pre 31 Fore



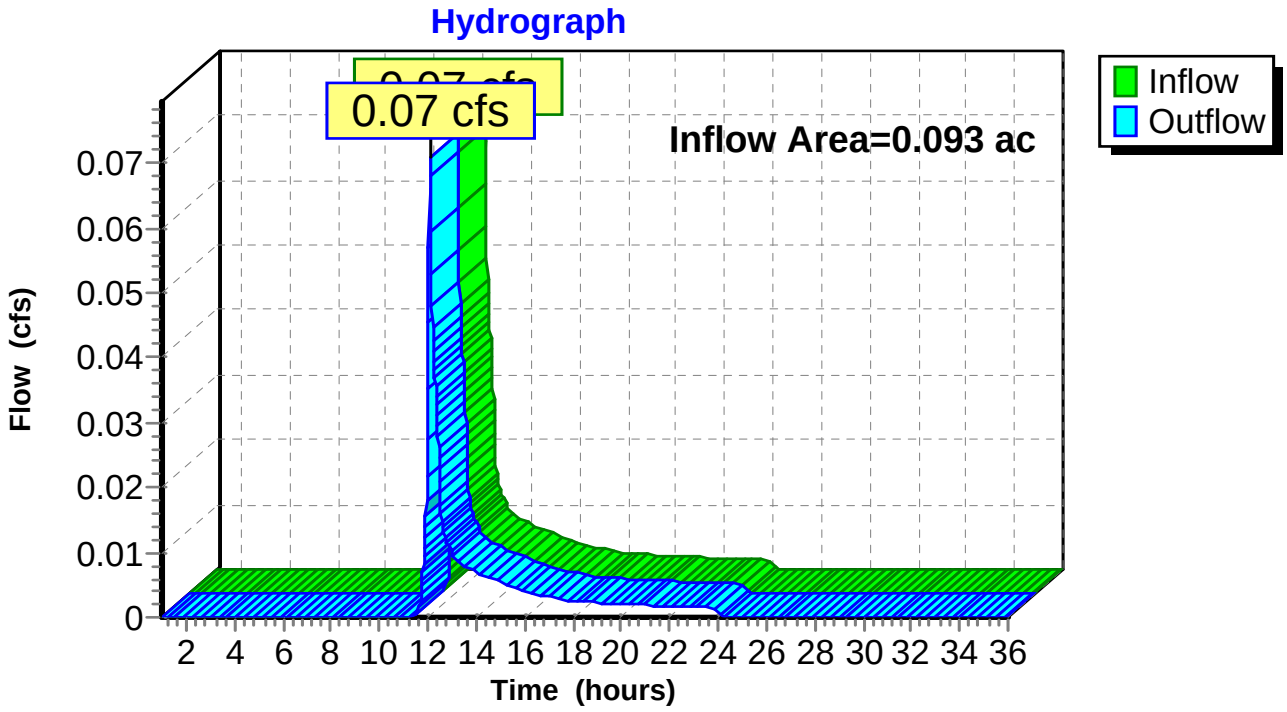
Summary for Reach 1R: POI#1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.093 ac, 45.97% Impervious, Inflow Depth = 0.72" for 2-year event
Inflow = 0.07 cfs @ 12.09 hrs, Volume= 0.006 af
Outflow = 0.07 cfs @ 12.09 hrs, Volume= 0.006 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-36.00 hrs, dt= 0.02 hrs

Reach 1R: POI#1



Time span=1.00-36.00 hrs, dt=0.02 hrs, 1751 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre 31 Fore Runoff Area=4,068 sf 45.97% Impervious Runoff Depth=1.67"
Tc=5.0 min CN=69 Runoff=0.18 cfs 0.013 af

Reach 1R: POI#1 Inflow=0.18 cfs 0.013 af
Outflow=0.18 cfs 0.013 af

Total Runoff Area = 0.093 ac Runoff Volume = 0.013 af Average Runoff Depth = 1.67"
54.03% Pervious = 0.050 ac 45.97% Impervious = 0.043 ac

Summary for Subcatchment 1S: Pre 31 Fore

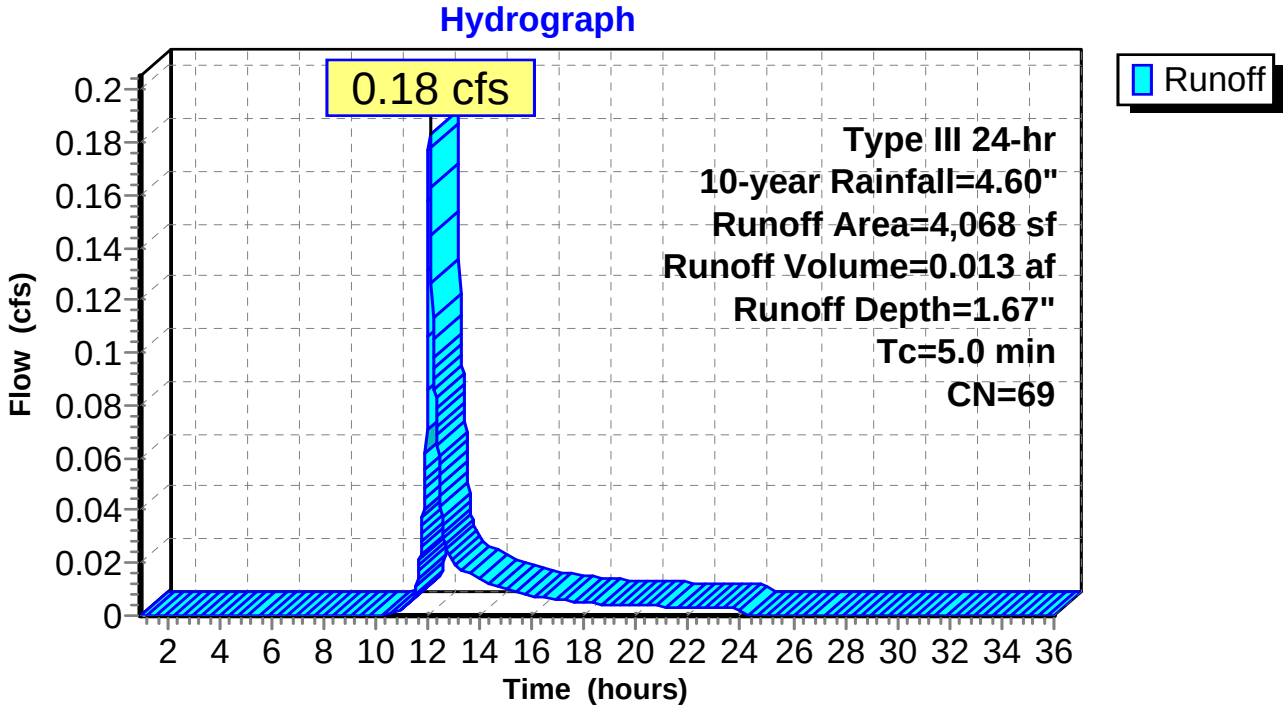
Runoff = 0.18 cfs @ 12.08 hrs, Volume= 0.013 af, Depth= 1.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 10-year Rainfall=4.60"

	Area (sf)	CN	Description
*	1,590	98	Building
*	280	98	Stairs/Sidewalks
*	200	96	Gravel Parking
	1,998	39	>75% Grass cover, Good, HSG A
	4,068	69	Weighted Average
	2,198		54.03% Pervious Area
	1,870		45.97% Impervious Area

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

Subcatchment 1S: Pre 31 Fore



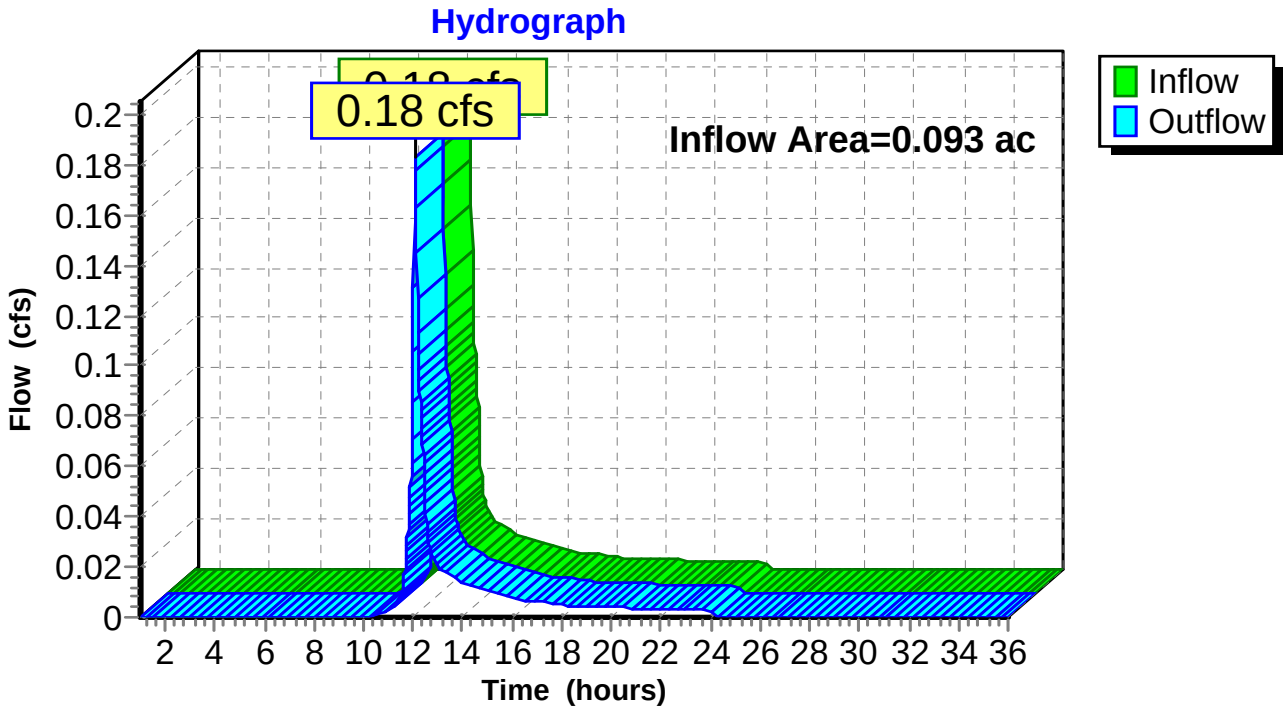
Summary for Reach 1R: POI#1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.093 ac, 45.97% Impervious, Inflow Depth = 1.67" for 10-year event
Inflow = 0.18 cfs @ 12.08 hrs, Volume= 0.013 af
Outflow = 0.18 cfs @ 12.08 hrs, Volume= 0.013 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-36.00 hrs, dt= 0.02 hrs

Reach 1R: POI#1



Time span=1.00-36.00 hrs, dt=0.02 hrs, 1751 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre 31 Fore Runoff Area=4,068 sf 45.97% Impervious Runoff Depth=2.56"
Tc=5.0 min CN=69 Runoff=0.29 cfs 0.020 af

Reach 1R: POI#1 Inflow=0.29 cfs 0.020 af
Outflow=0.29 cfs 0.020 af

Total Runoff Area = 0.093 ac Runoff Volume = 0.020 af Average Runoff Depth = 2.56"
54.03% Pervious = 0.050 ac 45.97% Impervious = 0.043 ac

Summary for Subcatchment 1S: Pre 31 Fore

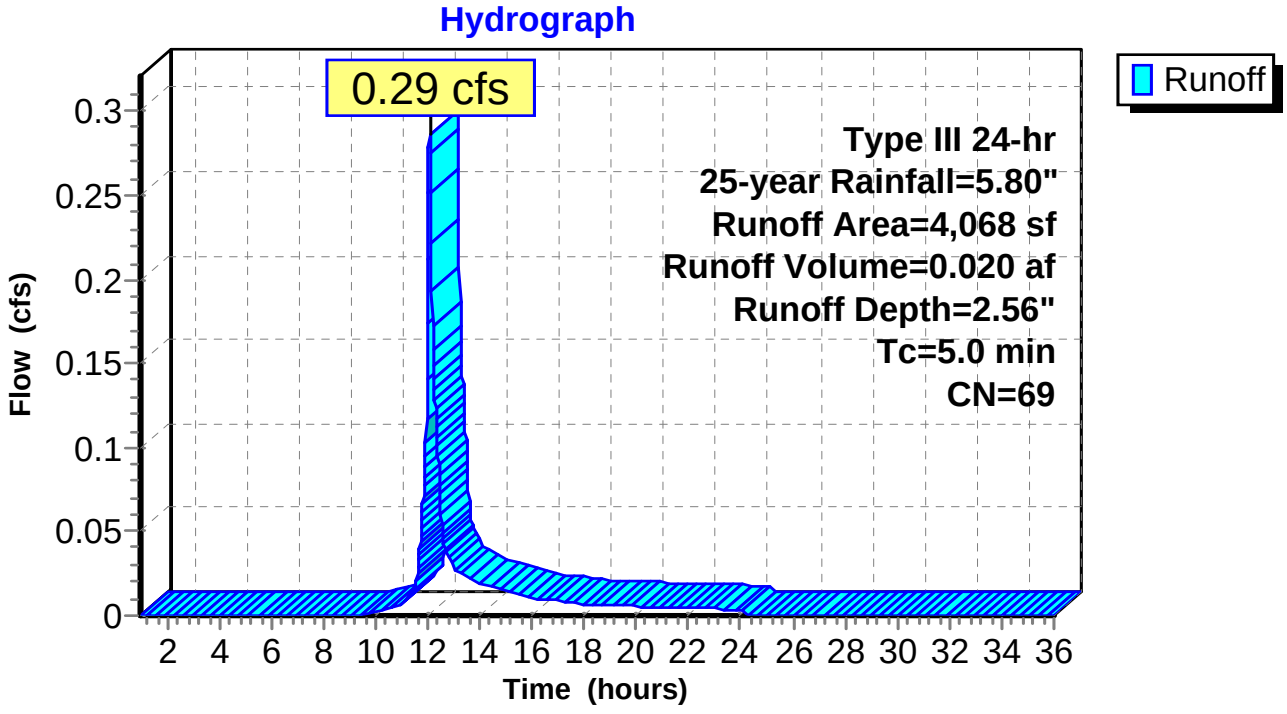
Runoff = 0.29 cfs @ 12.08 hrs, Volume= 0.020 af, Depth= 2.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 25-year Rainfall=5.80"

	Area (sf)	CN	Description
*	1,590	98	Building
*	280	98	Stairs/Sidewalks
*	200	96	Gravel Parking
	1,998	39	>75% Grass cover, Good, HSG A
	4,068	69	Weighted Average
	2,198		54.03% Pervious Area
	1,870		45.97% Impervious Area

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

Subcatchment 1S: Pre 31 Fore



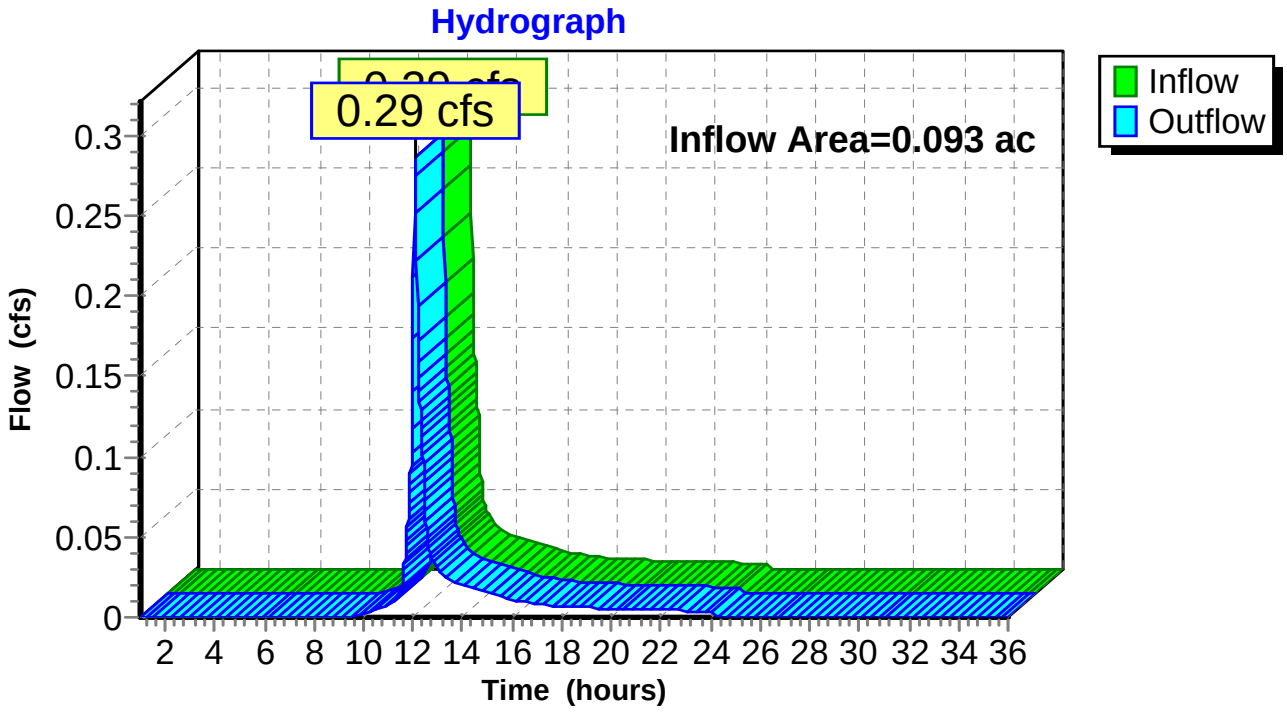
Summary for Reach 1R: POI#1

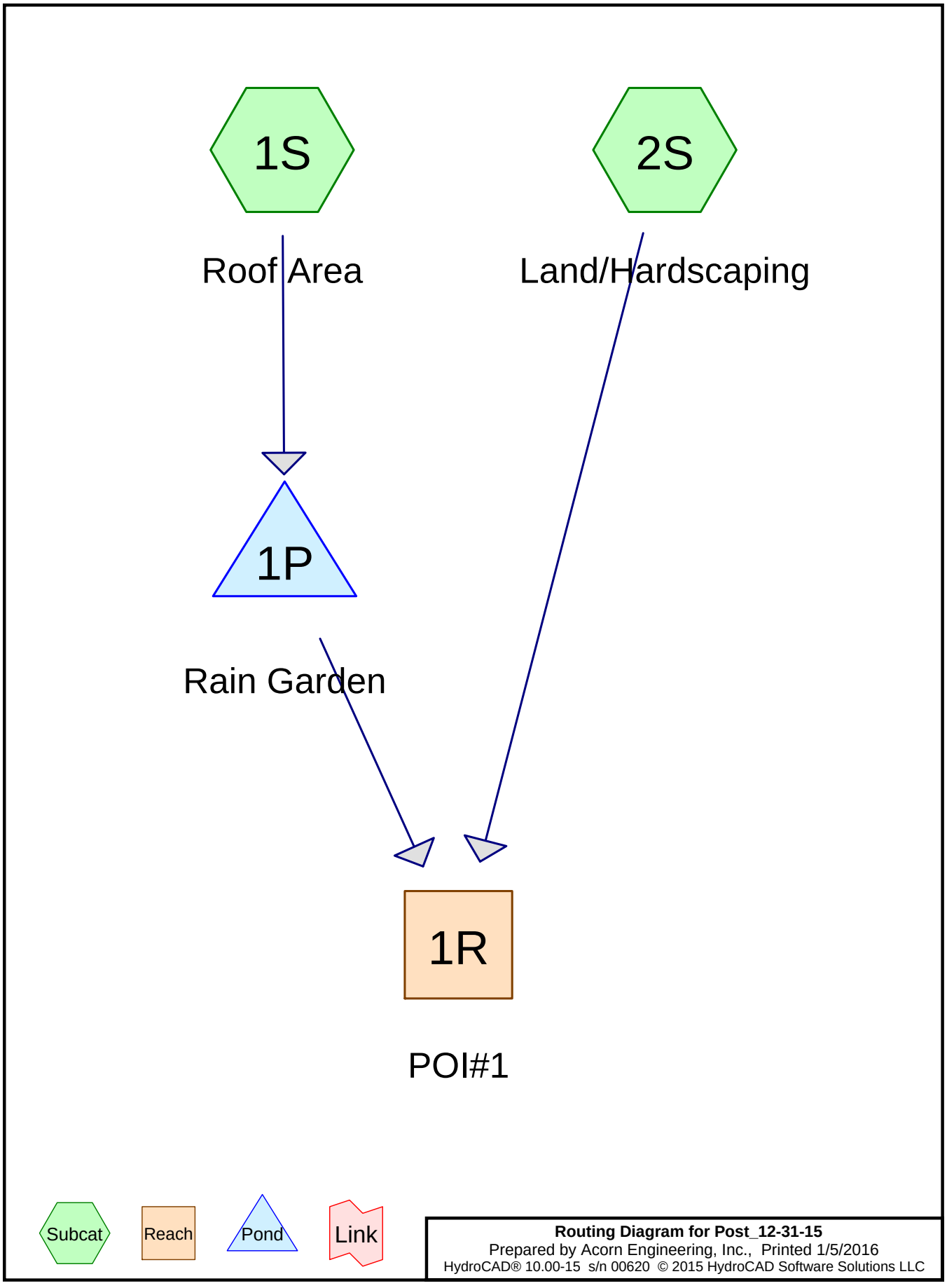
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.093 ac, 45.97% Impervious, Inflow Depth = 2.56" for 25-year event
Inflow = 0.29 cfs @ 12.08 hrs, Volume= 0.020 af
Outflow = 0.29 cfs @ 12.08 hrs, Volume= 0.020 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-36.00 hrs, dt= 0.02 hrs

Reach 1R: POI#1





Routing Diagram for Post_12-31-15
Prepared by Acorn Engineering, Inc., Printed 1/5/2016
HydroCAD® 10.00-15 s/n 00620 © 2015 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.021	39	>75% Grass cover, Good, HSG A (2S)
0.056	98	Building (1S)
0.003	98	Patio (2S)
0.008	98	Stairs/Sidewalks (2S)
0.007	32	Woods/grass comb., Good, HSG A (2S)
0.096	**80**	**TOTAL AREA**

Soil Listing (all nodes)

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

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.021	0.000	0.000	0.000	0.000	0.021	>75% Grass cover, Good	2S
0.000	0.000	0.000	0.000	0.056	0.056	Building	1S
0.000	0.000	0.000	0.000	0.003	0.003	Patio	2S
0.000	0.000	0.000	0.000	0.008	0.008	Stairs/Sidewalks	2S
0.007	0.000	0.000	0.000	0.000	0.007	Woods/grass comb., Good	2S
0.028	**0.000**	**0.000**	**0.000**	**0.068**	**0.096**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	1P	51.00	50.90	10.0	0.0100	0.010	6.0	0.0	0.0

Time span=0.00-36.00 hrs, dt=0.02 hrs, 1801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Roof Area Runoff Area=2,457 sf 100.00% Impervious Runoff Depth=2.87"
Tc=5.0 min CN=98 Runoff=0.18 cfs 0.013 af

Subcatchment 2S: Land/Hardscaping Runoff Area=1,711 sf 28.35% Impervious Runoff Depth=0.20"
Tc=5.0 min CN=54 Runoff=0.00 cfs 0.001 af

Reach 1R: POI#1 Inflow=0.09 cfs 0.014 af
Outflow=0.09 cfs 0.014 af

Pond 1P: Rain Garden Peak Elev=54.63' Storage=94 cf Inflow=0.18 cfs 0.013 af
Outflow=0.09 cfs 0.013 af

Total Runoff Area = 0.096 ac Runoff Volume = 0.014 af Average Runoff Depth = 1.77"
29.41% Pervious = 0.028 ac 70.59% Impervious = 0.068 ac

Summary for Subcatchment 1S: Roof Area

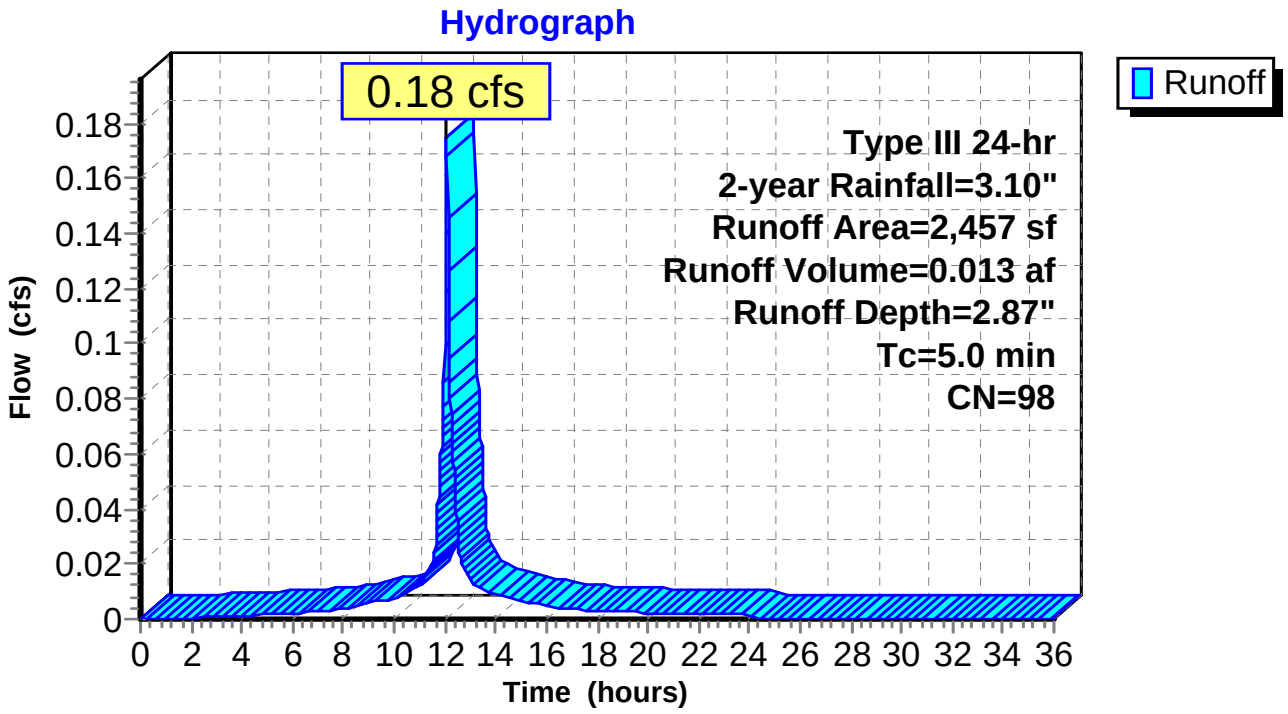
Runoff = 0.18 cfs @ 12.07 hrs, Volume= 0.013 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 2-year Rainfall=3.10"

	Area (sf)	CN	Description
*	2,457	98	Building
	2,457		100.00% Impervious Area

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

Subcatchment 1S: Roof Area



Summary for Subcatchment 2S: Land/Hardscaping

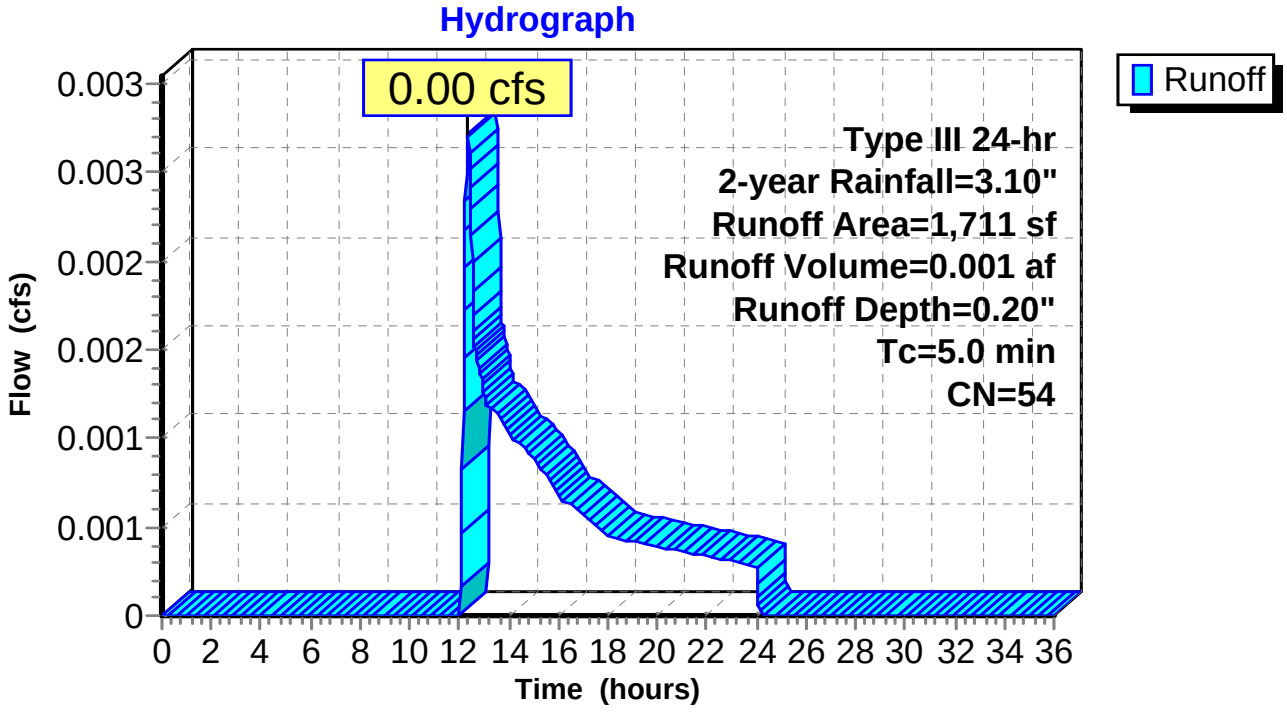
Runoff = 0.00 cfs @ 12.36 hrs, Volume= 0.001 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 2-year Rainfall=3.10"

	Area (sf)	CN	Description
*	365	98	Stairs/Sidewalks
*	120	98	Patio
	926	39	>75% Grass cover, Good, HSG A
	300	32	Woods/grass comb., Good, HSG A
	1,711	54	Weighted Average
	1,226		71.65% Pervious Area
	485		28.35% Impervious Area

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

Subcatchment 2S: Land/Hardscaping



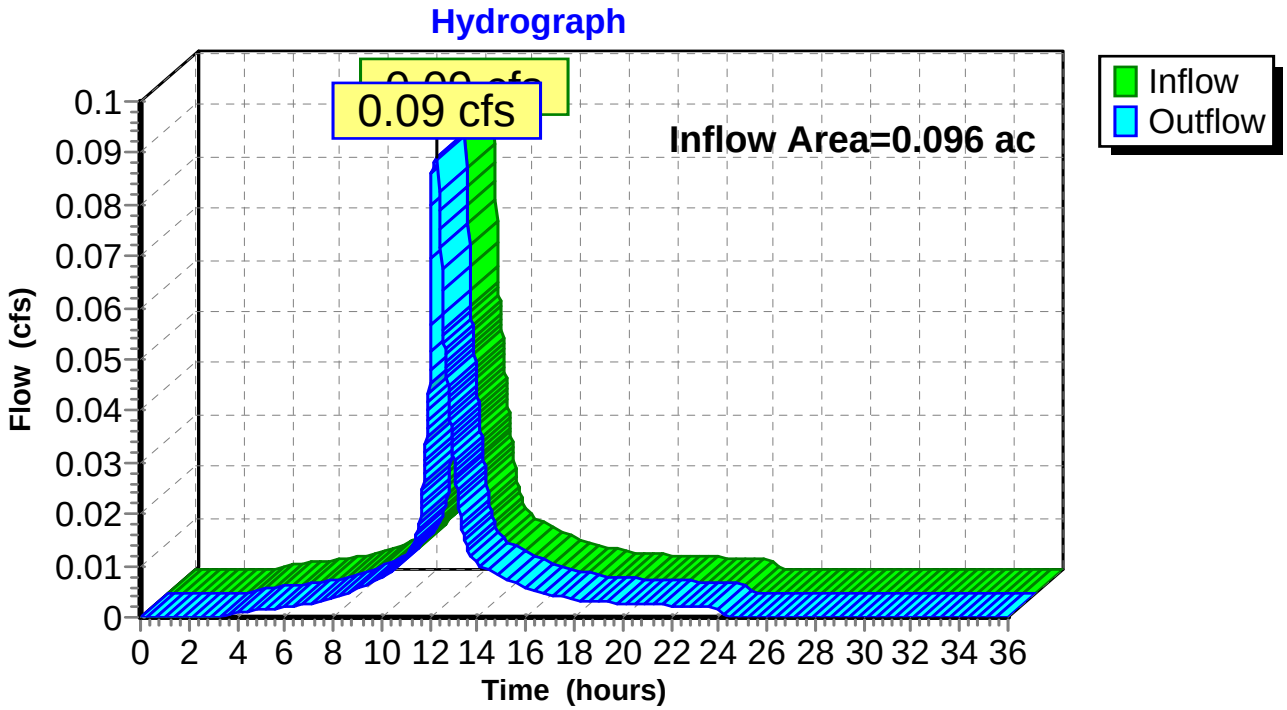
Summary for Reach 1R: POI#1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.096 ac, 70.59% Impervious, Inflow Depth = 1.76" for 2-year event
Inflow = 0.09 cfs @ 12.27 hrs, Volume= 0.014 af
Outflow = 0.09 cfs @ 12.27 hrs, Volume= 0.014 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs

Reach 1R: POI#1



Summary for Pond 1P: Rain Garden

Inflow Area = 0.056 ac,100.00% Impervious, Inflow Depth = 2.87" for 2-year event
Inflow = 0.18 cfs @ 12.07 hrs, Volume= 0.013 af
Outflow = 0.09 cfs @ 12.20 hrs, Volume= 0.013 af, Atten= 50%, Lag= 7.7 min
Primary = 0.09 cfs @ 12.20 hrs, Volume= 0.013 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Peak Elev= 54.63' @ 12.20 hrs Surf.Area= 319 sf Storage= 94 cf

Plug-Flow detention time= 19.6 min calculated for 0.013 af (99% of inflow)
Center-of-Mass det. time= 15.0 min (771.2 - 756.1)

Volume	Invert	Avail.Storage	Storage Description
#1	54.50'	256 cf	**Water Quality Volume (Prismatic)** Listed below (Recalc)
#2	52.50'	20 cf	**Loam/Soil Filter Media (Prismatic)** Listed below (Recalc) 200 cf Overall x 10.0% Voids
#3	51.00'	60 cf	**Crushed Stone (Prismatic)** Listed below (Recalc) 150 cf Overall x 40.0% Voids
		336 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
54.50	100	0	0
55.00	175	69	69
56.00	200	188	256

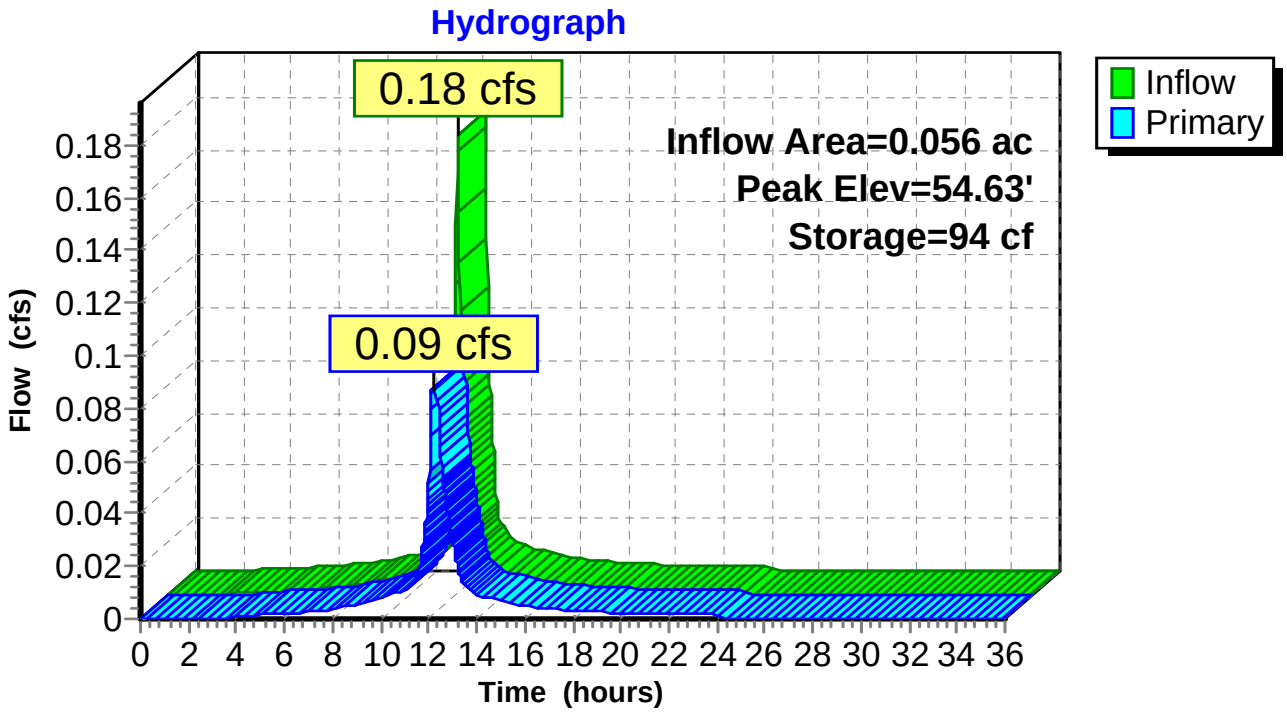
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.50	100	0	0
54.50	100	200	200

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	100	0	0
52.50	100	150	150

Device	Routing	Invert	Outlet Devices
#1	Primary	51.00'	**6.0" Round Culvert** L= 10.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 51.00' / 50.90' S= 0.0100 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.20 sf
#2	Device 1	55.00'	**6.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	51.10'	**0.3" Vert. Orifice/Grate** C= 0.600
#4	Device 1	51.10'	**1.3" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.09 cfs @ 12.20 hrs HW=54.63' (Free Discharge)
└─**1=Culvert** (Passes 0.09 cfs of 1.53 cfs potential flow)
  └─**2=Orifice/Grate** (Controls 0.00 cfs)
  └─**3=Orifice/Grate** (Orifice Controls 0.00 cfs @ 9.03 fps)
  └─**4=Orifice/Grate** (Orifice Controls 0.08 cfs @ 8.97 fps)

Pond 1P: Rain Garden



Time span=0.00-36.00 hrs, dt=0.02 hrs, 1801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Roof Area Runoff Area=2,457 sf 100.00% Impervious Runoff Depth=4.36"
Tc=5.0 min CN=98 Runoff=0.26 cfs 0.021 af

Subcatchment 2S: Land/Hardscaping Runoff Area=1,711 sf 28.35% Impervious Runoff Depth=0.73"
Tc=5.0 min CN=54 Runoff=0.02 cfs 0.002 af

Reach 1R: POI#1 Inflow=0.15 cfs 0.023 af
Outflow=0.15 cfs 0.023 af

Pond 1P: Rain Garden Peak Elev=55.04' Storage=156 cf Inflow=0.26 cfs 0.021 af
Outflow=0.14 cfs 0.020 af

Total Runoff Area = 0.096 ac Runoff Volume = 0.023 af Average Runoff Depth = 2.87"
29.41% Pervious = 0.028 ac 70.59% Impervious = 0.068 ac

Summary for Subcatchment 1S: Roof Area

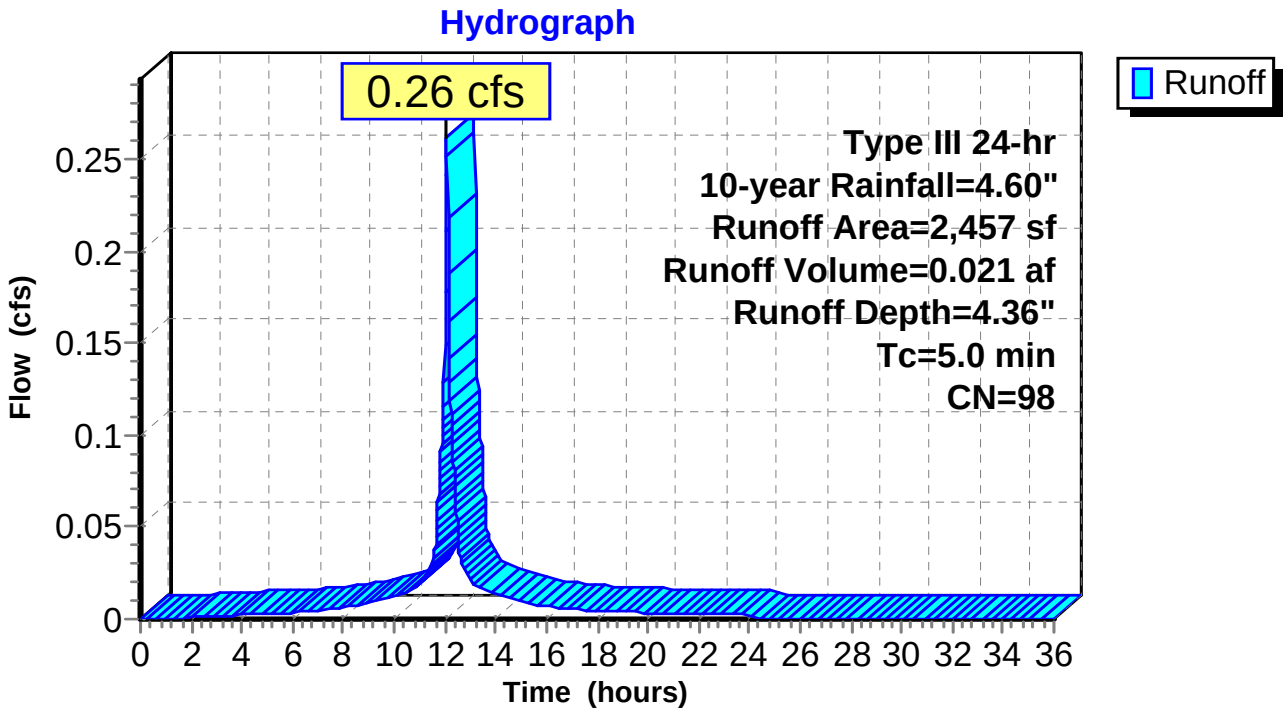
Runoff = 0.26 cfs @ 12.07 hrs, Volume= 0.021 af, Depth= 4.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 10-year Rainfall=4.60"

	Area (sf)	CN	Description
*	2,457	98	Building
	2,457		100.00% Impervious Area

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

Subcatchment 1S: Roof Area



Summary for Subcatchment 2S: Land/Hardscaping

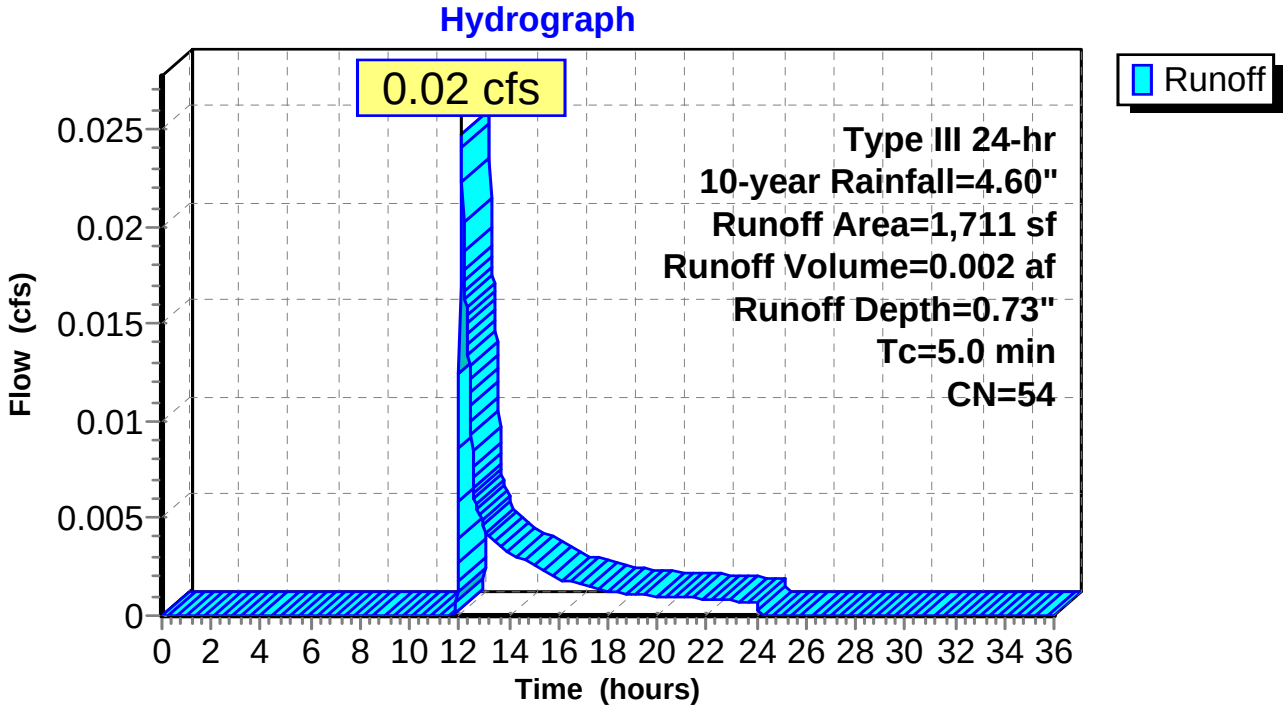
Runoff = 0.02 cfs @ 12.10 hrs, Volume= 0.002 af, Depth= 0.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 10-year Rainfall=4.60"

	Area (sf)	CN	Description
*	365	98	Stairs/Sidewalks
*	120	98	Patio
	926	39	>75% Grass cover, Good, HSG A
	300	32	Woods/grass comb., Good, HSG A
	1,711	54	Weighted Average
	1,226		71.65% Pervious Area
	485		28.35% Impervious Area

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

Subcatchment 2S: Land/Hardscaping



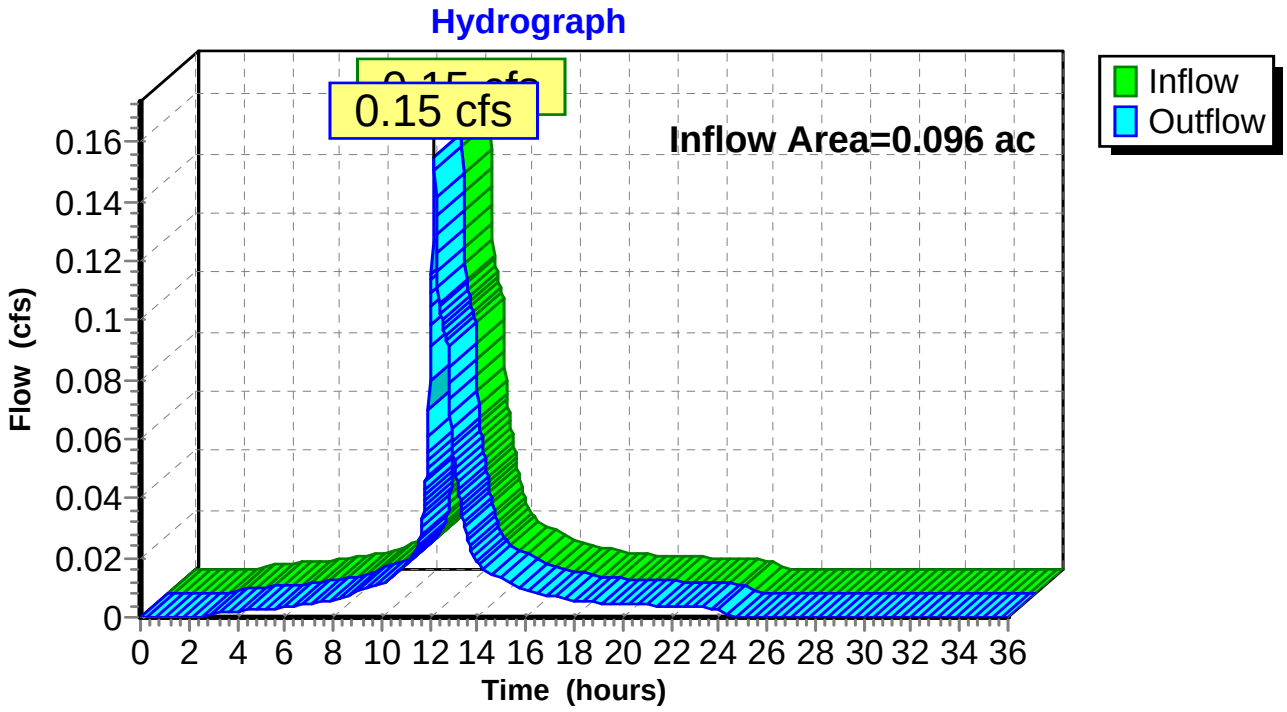
Summary for Reach 1R: POI#1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.096 ac, 70.59% Impervious, Inflow Depth = 2.86" for 10-year event
Inflow = 0.15 cfs @ 12.19 hrs, Volume= 0.023 af
Outflow = 0.15 cfs @ 12.19 hrs, Volume= 0.023 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs

Reach 1R: POI#1



Summary for Pond 1P: Rain Garden

Inflow Area = 0.056 ac,100.00% Impervious, Inflow Depth = 4.36" for 10-year event
Inflow = 0.26 cfs @ 12.07 hrs, Volume= 0.021 af
Outflow = 0.14 cfs @ 12.19 hrs, Volume= 0.020 af, Atten= 48%, Lag= 7.2 min
Primary = 0.14 cfs @ 12.19 hrs, Volume= 0.020 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Peak Elev= 55.04' @ 12.19 hrs Surf.Area= 376 sf Storage= 156 cf

Plug-Flow detention time= 18.9 min calculated for 0.020 af (99% of inflow)
Center-of-Mass det. time= 15.9 min (764.4 - 748.5)

Volume	Invert	Avail.Storage	Storage Description
#1	54.50'	256 cf	**Water Quality Volume (Prismatic)** Listed below (Recalc)
#2	52.50'	20 cf	**Loam/Soil Filter Media (Prismatic)** Listed below (Recalc) 200 cf Overall x 10.0% Voids
#3	51.00'	60 cf	**Crushed Stone (Prismatic)** Listed below (Recalc) 150 cf Overall x 40.0% Voids
		336 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
54.50	100	0	0
55.00	175	69	69
56.00	200	188	256

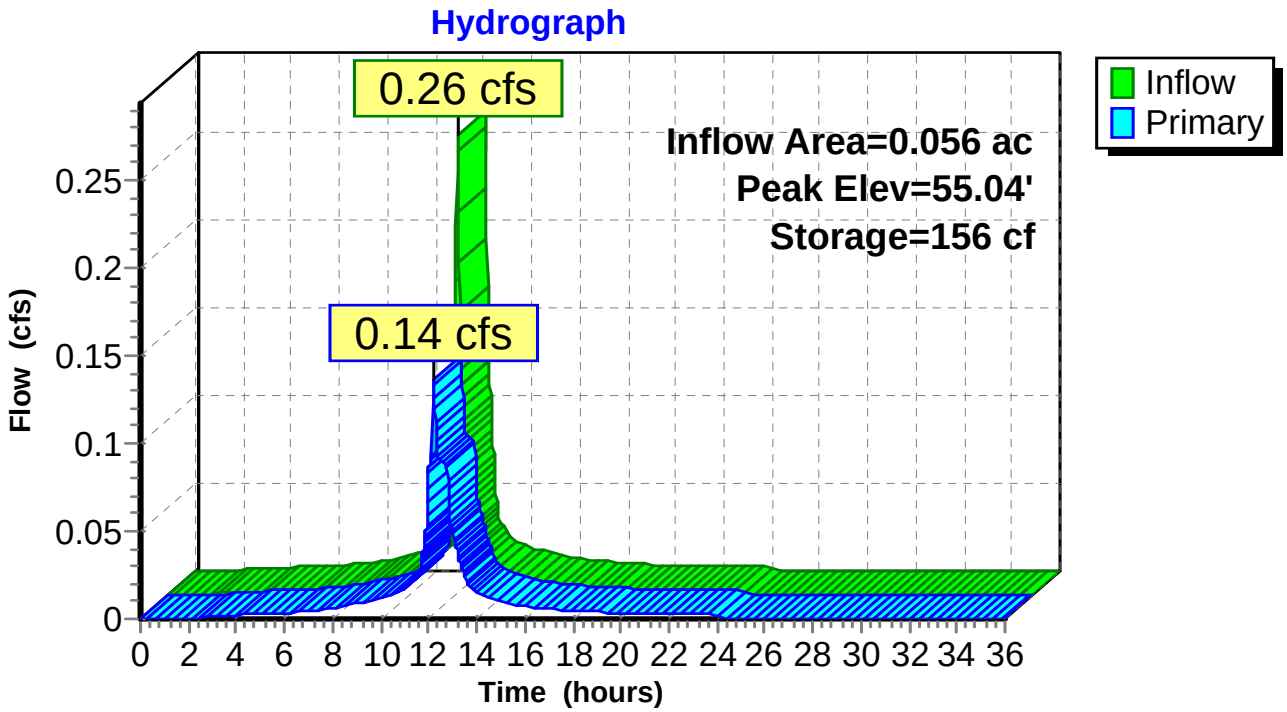
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.50	100	0	0
54.50	100	200	200

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	100	0	0
52.50	100	150	150

Device	Routing	Invert	Outlet Devices
#1	Primary	51.00'	**6.0" Round Culvert** L= 10.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 51.00' / 50.90' S= 0.0100 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.20 sf
#2	Device 1	55.00'	**6.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	51.10'	**0.3" Vert. Orifice/Grate** C= 0.600
#4	Device 1	51.10'	**1.3" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.13 cfs @ 12.19 hrs HW=55.04' (Free Discharge)
└**1=Culvert** (Passes 0.13 cfs of 1.62 cfs potential flow)
  └**2=Orifice/Grate** (Weir Controls 0.04 cfs @ 0.63 fps)
  └**3=Orifice/Grate** (Orifice Controls 0.00 cfs @ 9.54 fps)
  └**4=Orifice/Grate** (Orifice Controls 0.09 cfs @ 9.49 fps)

Pond 1P: Rain Garden



Time span=0.00-36.00 hrs, dt=0.02 hrs, 1801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Roof Area Runoff Area=2,457 sf 100.00% Impervious Runoff Depth=5.56"
Tc=5.0 min CN=98 Runoff=0.33 cfs 0.026 af

Subcatchment 2S: Land/Hardscaping Runoff Area=1,711 sf 28.35% Impervious Runoff Depth=1.33"
Tc=5.0 min CN=54 Runoff=0.05 cfs 0.004 af

Reach 1R: POI#1 Inflow=0.33 cfs 0.030 af
Outflow=0.33 cfs 0.030 af

Pond 1P: Rain Garden Peak Elev=55.11' Storage=168 cf Inflow=0.33 cfs 0.026 af
Outflow=0.28 cfs 0.026 af

Total Runoff Area = 0.096 ac Runoff Volume = 0.030 af Average Runoff Depth = 3.82"
29.41% Pervious = 0.028 ac 70.59% Impervious = 0.068 ac

Summary for Subcatchment 1S: Roof Area

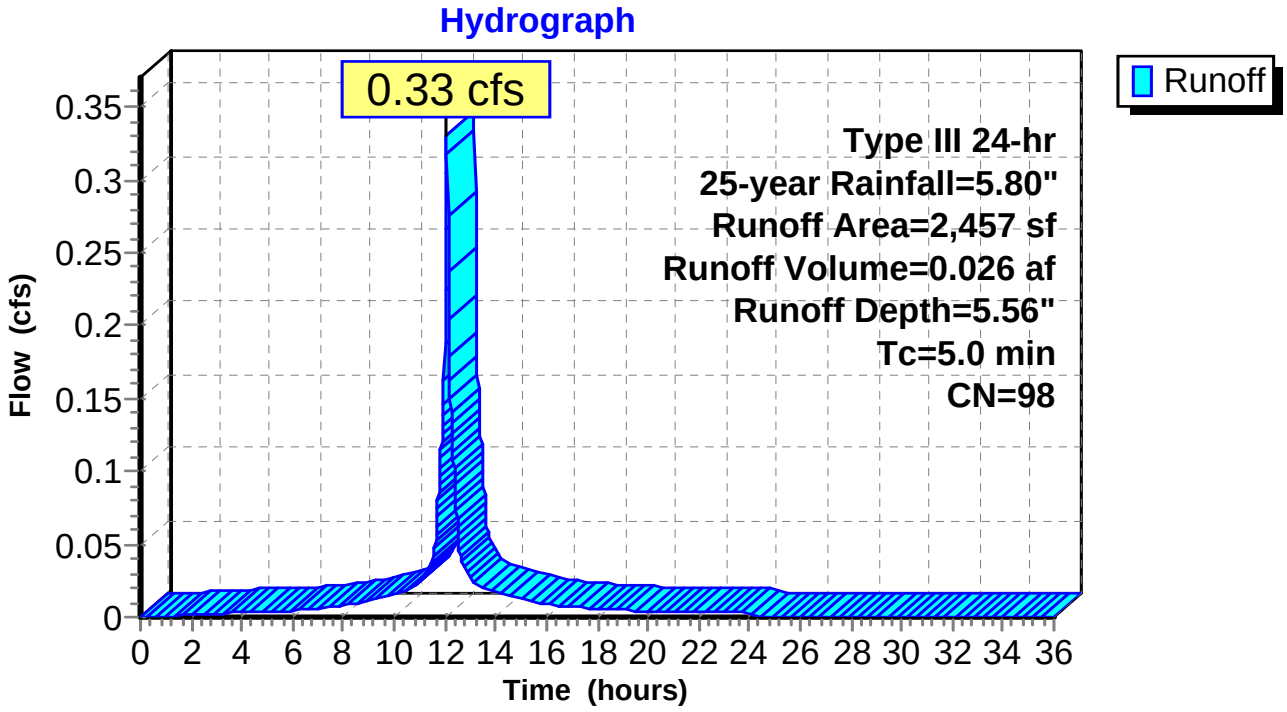
Runoff = 0.33 cfs @ 12.07 hrs, Volume= 0.026 af, Depth= 5.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 25-year Rainfall=5.80"

	Area (sf)	CN	Description
*	2,457	98	Building
	2,457		100.00% Impervious Area

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

Subcatchment 1S: Roof Area



Summary for Subcatchment 2S: Land/Hardscaping

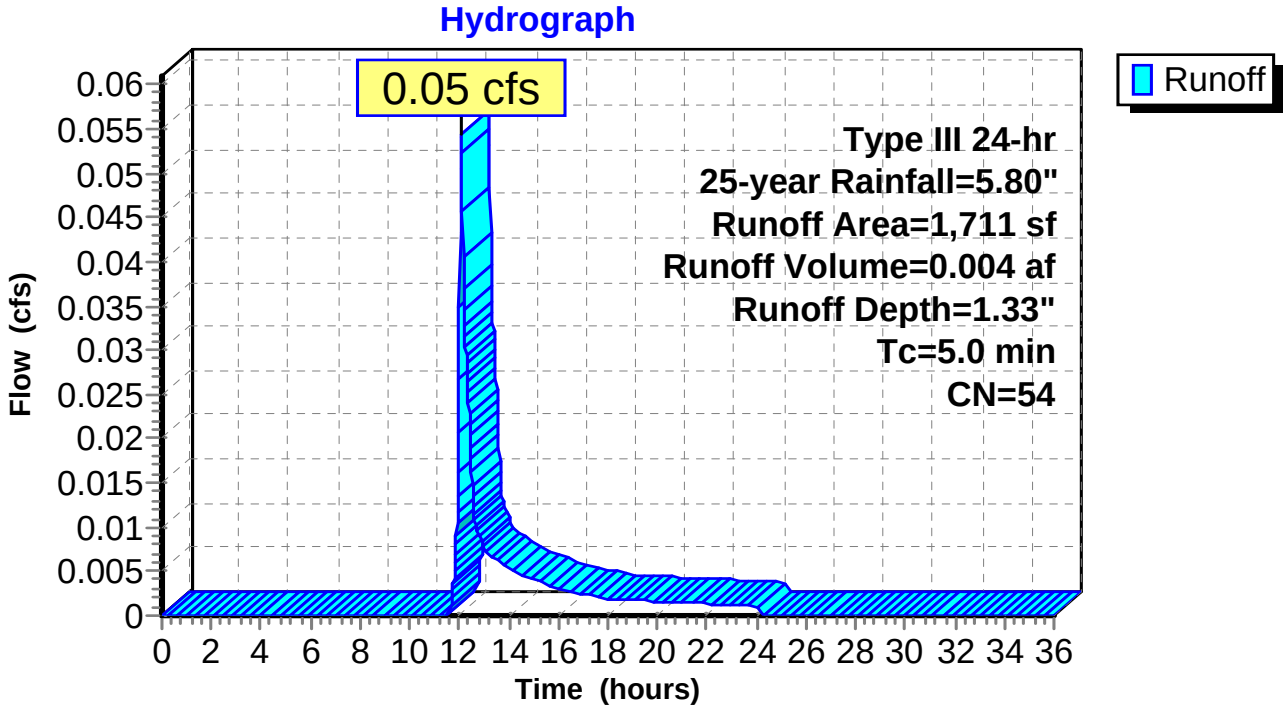
Runoff = 0.05 cfs @ 12.09 hrs, Volume= 0.004 af, Depth= 1.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 25-year Rainfall=5.80"

	Area (sf)	CN	Description
*	365	98	Stairs/Sidewalks
*	120	98	Patio
	926	39	>75% Grass cover, Good, HSG A
	300	32	Woods/grass comb., Good, HSG A
	1,711	54	Weighted Average
	1,226		71.65% Pervious Area
	485		28.35% Impervious Area

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

Subcatchment 2S: Land/Hardscaping



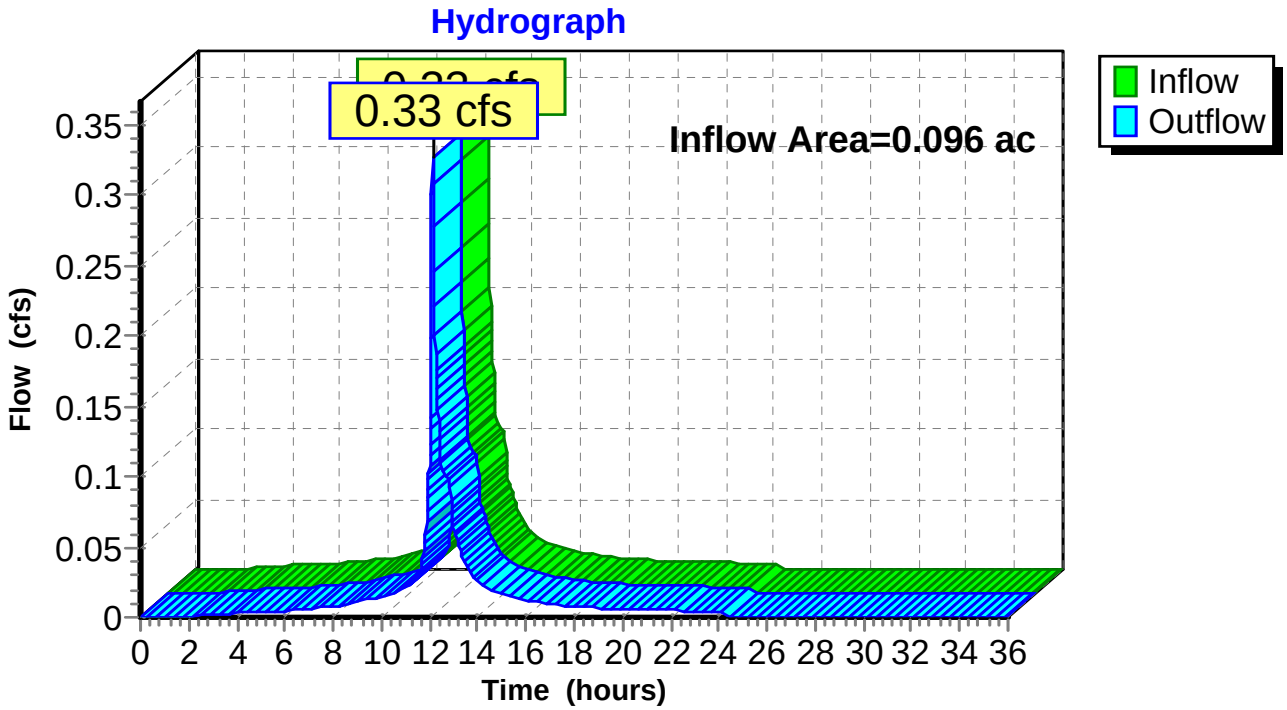
Summary for Reach 1R: POI#1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.096 ac, 70.59% Impervious, Inflow Depth = 3.81" for 25-year event
Inflow = 0.33 cfs @ 12.12 hrs, Volume= 0.030 af
Outflow = 0.33 cfs @ 12.12 hrs, Volume= 0.030 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs

Reach 1R: POI#1



Summary for Pond 1P: Rain Garden

Inflow Area = 0.056 ac,100.00% Impervious, Inflow Depth = 5.56" for 25-year event
Inflow = 0.33 cfs @ 12.07 hrs, Volume= 0.026 af
Outflow = 0.28 cfs @ 12.12 hrs, Volume= 0.026 af, Atten= 16%, Lag= 3.2 min
Primary = 0.28 cfs @ 12.12 hrs, Volume= 0.026 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Peak Elev= 55.11' @ 12.12 hrs Surf.Area= 378 sf Storage= 168 cf

Plug-Flow detention time= 17.1 min calculated for 0.026 af (100% of inflow)
Center-of-Mass det. time= 14.7 min (759.4 - 744.7)

Volume	Invert	Avail.Storage	Storage Description
#1	54.50'	256 cf	**Water Quality Volume (Prismatic)** Listed below (Recalc)
#2	52.50'	20 cf	**Loam/Soil Filter Media (Prismatic)** Listed below (Recalc) 200 cf Overall x 10.0% Voids
#3	51.00'	60 cf	**Crushed Stone (Prismatic)** Listed below (Recalc) 150 cf Overall x 40.0% Voids
		336 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
54.50	100	0	0
55.00	175	69	69
56.00	200	188	256

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.50	100	0	0
54.50	100	200	200

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	100	0	0
52.50	100	150	150

Device	Routing	Invert	Outlet Devices
#1	Primary	51.00'	**6.0" Round Culvert** L= 10.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 51.00' / 50.90' S= 0.0100 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.20 sf
#2	Device 1	55.00'	**6.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	51.10'	**0.3" Vert. Orifice/Grate** C= 0.600
#4	Device 1	51.10'	**1.3" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.27 cfs @ 12.12 hrs HW=55.11' (Free Discharge)
└─**1=Culvert** (Passes 0.27 cfs of 1.64 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 0.18 cfs @ 1.07 fps)
  └─**3=Orifice/Grate** (Orifice Controls 0.00 cfs @ 9.62 fps)
  └─**4=Orifice/Grate** (Orifice Controls 0.09 cfs @ 9.57 fps)

Pond 1P: Rain Garden