

Juniata Valley

TETRA TECH, INC.

By: RH Date: 11/18/2016 Subject: Juniata Valley Road
Checked By: JB Date: 11/23/2016 PCSM Design and Evaluation

PURPOSE:

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Juniata Valley Road block valve site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The site is located within Frankstown Township, Blair County, Pennsylvania. Permanent stormwater controls will be developed to satisfy PADEP and Frankstown Township's approved Act 167 Plan.

PCSM DESIGN REQUIREMENTS:

The PCSM design for this project follows the PA Department of Environmental Protection's (PADEP) Pennsylvania Stormwater Best Management Practices Manual (BMP Manual), December 2006; and the standard design criteria from PA Title 25, Chapter 102.8.(g)(2) and (3). The design criteria evaluated for the site are summarized below.

Act 167 Consistency

The Juniata Valley Road block valve site is located in Blair County, which does not have a county-wide Act 167 plan adopted. However, Frankstown Township has enacted the Beaverdam Branch Watershed Act 167 Stormwater Management Plan. This plan requires that the post-development runoff rate be less than or equal to the pre-development rate. The PCSM design at the Juniata Valley Road block valve has been designed for consistency with Frankstown Township's approved Act 167 Plan.

Recommended Volume Control Guideline

Use of Control Guideline 1 is recommended where site conditions offer the opportunity to reduce the increase in runoff volume as follows:

- Do not increase the post-development total runoff volume for all storms equal to or less than the two-year/24-hour event;
- Existing (pre-development) non-forested pervious areas must be considered meadow (good condition) or its equivalent; and
- 20 percent of existing impervious area, when present, shall be considered meadow (good condition) or its equivalent.

Due to the lack of surface infiltration rates at the Juniata Valley Road block valve site, it is not possible to infiltrate the 2-year/24-hour stormwater runoff volume increase. Volume reducing BMPs in the PADEP Stormwater BMP Manual were analyzed on a case-by-case basis but did not meet their respective requirements. As a result, a slow-release BMP has been proposed.

Recommended Peak Rate Control Guideline

The recommended control guideline for peak rate control is:

- Do not increase the peak rate of discharge for the 2-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by the applicable and approved Act 167 plan.
- The Frankstown Township Act 167 rate requirements mirror PADEP's requirements. Therefore, no additional peak rate control is required under the Act 167 Plan.

This site will utilize a slow release BMP to manage the two-year through 100-year peak rate increases. This BMP will also help to increase the time of concentration for the drainage area encompassing the block valve.

Recommended Water Quality Control Guideline

Control Guideline 1 will provide water quality control and stream channel protection as well as flood control protection. The use of a slow-release BMP has been approved by PADEP as an appropriate way to meet the requirements of Control Guideline 1 when onsite infiltration is not feasible.

Infiltration

Infiltration rates for the PCSM BMPs have been determined from site infiltration testing conducted in accordance of the PA BMP Manual. Documentation for infiltration testing and design infiltration rates can be found in Attachment 5 of the Site Restoration/Post Construction Stormwater Management Plan. Infiltration test locations and recommended design rates are also labeled on the PCSM Plan Drawings in Attachment 6.

During the onsite infiltration tests, the depth to seasonal high groundwater and shallow bedrock or another confining layer were evaluated. The post-construction stormwater management facility for the site has been designed to maintain 2 feet of separation between the ponding elevation of the facility and the seasonal high water table and bedrock.

The post-construction stormwater management design utilizes a slow-release BMP to manage runoff volume due to poorly infiltrating soils onsite.

Loading Ratio

The loading ratio guidelines do not apply because the design does not propose an infiltration BMP.

Disturbed Area

To meet Standard Worksheet 10 guidelines, 90% of the disturbed area is contained by the proposed PCSM BMPs.

Karst Topography

The Juniata Valley Road block valve site is located within the vicinity of known depressions or sinkholes. Several design principles were incorporated to minimize the risk of sinkholes to the maximum extent practicable, including reducing the proposed impervious area to the maximum extent practicable.

Stormwater runoff from the site is managed using a slow-release BMP. This type of BMP will mimic the normal baseflow hydrology. This BMP will collect, store and filter captured runoff through a water quality

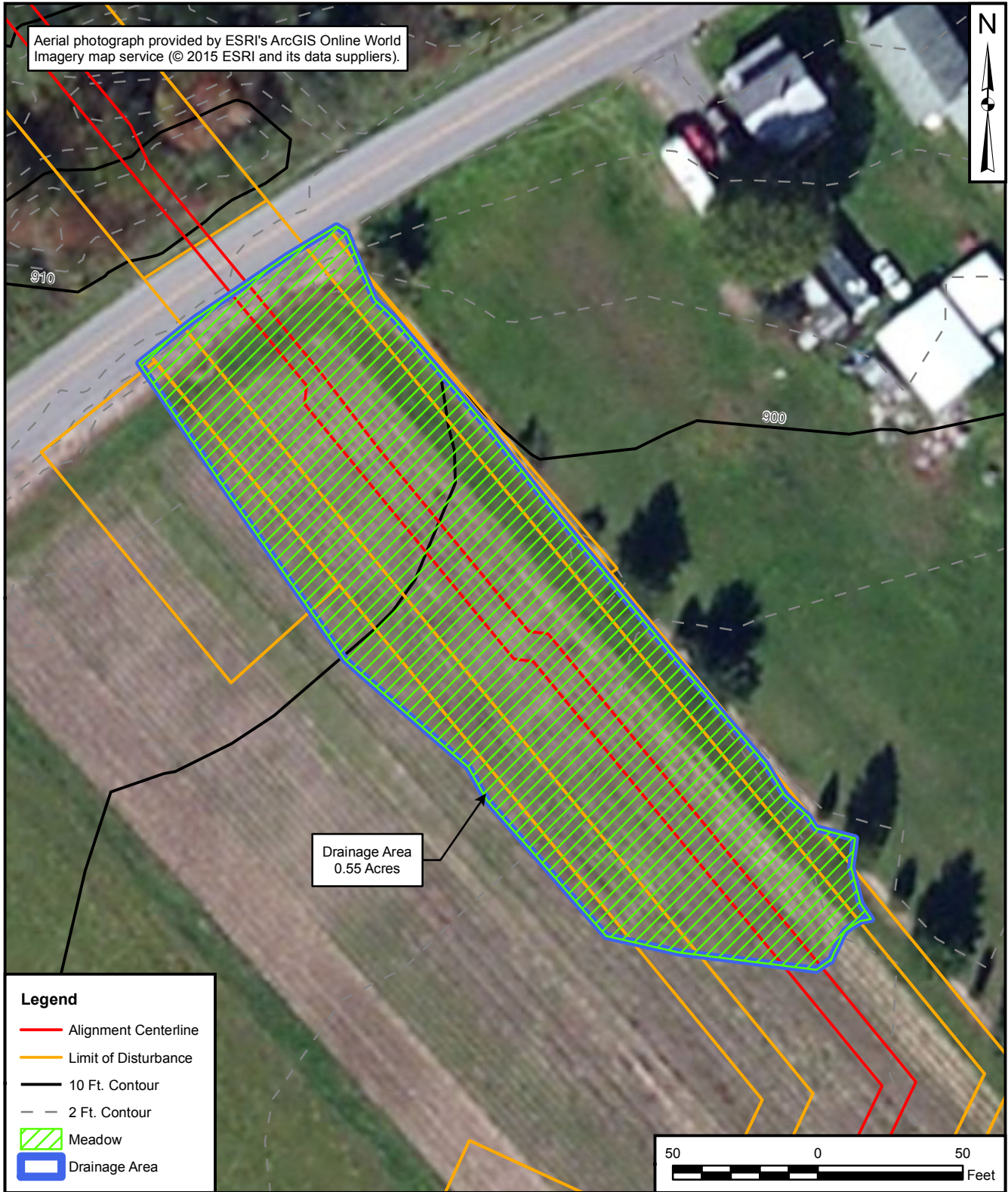
media and slowly release the treated volume through an underdrain. Utilization of a slow-release BMP will reduce the risks associated with karst topography.

Additional post-construction inspection and maintenance will be required onsite as documented in the Sinkhole Repair Plan in Attachment 2. In areas of known karst terrain, stormwater BMPs shall be inspected at regular intervals of at least once every quarter for the first two years following installation and then at regular periods thereafter. Inspections shall also be made after every storm event greater than 1 inch during the establishment period. Inspections shall consist of an examination of any noticeable subsidence, surface depressions, or sinkholes. Inspections shall include an evaluation of all inlet and outlet structures and document any areas to be cleaned, maintained, or repaired.

Special Protection Watershed







Juniata Valley Road block valve is not located within a special protection watershed, so antidegradation requirements do not apply.

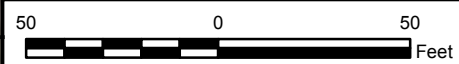
Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2015 ESRI and its data suppliers).



Drainage Area
0.55 Acres

Legend

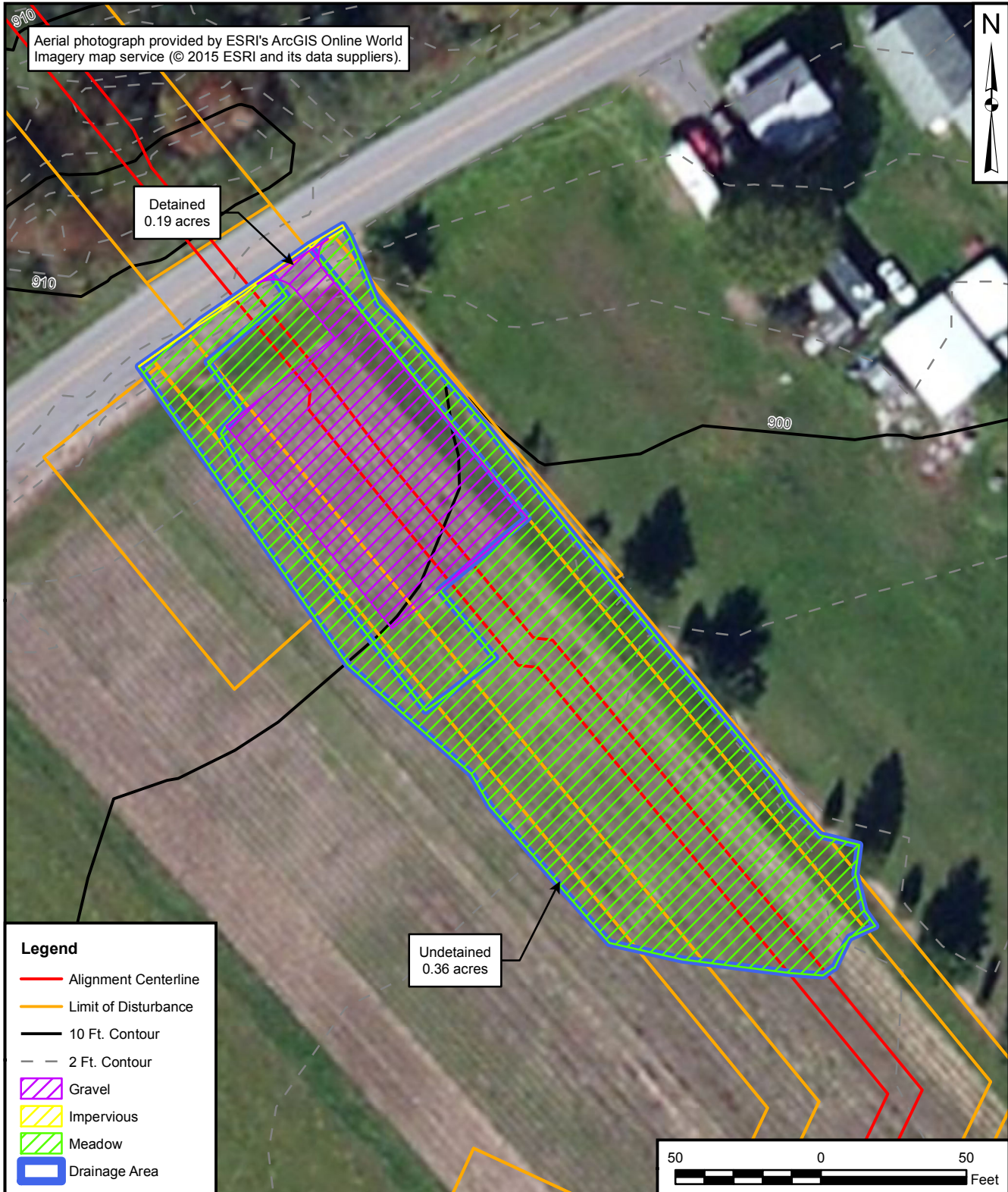
-  Alignment Centerline
-  Limit of Disturbance
-  10 Ft. Contour
-  2 Ft. Contour
-  Meadow
-  Drainage Area






PRE-DEVELOPMENT DRAINAGE AREA MAP
 JUNIATA VALLEY ROAD
 PENNSYLVANIA PIPELINE PROJECT
 SUNOCO LOGISTICS, L.P.
 BLAIR COUNTY, PENNSYLVANIA

DRAWN BY: S. PAXTON 05/19/16	
CHECKED BY: J. BRODY 11/09/16	
APPROVED BY:	
CONTRACT NUMBER: 112IC05958	
FIGURE NUMBER	REV
1	0

Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2015 ESRI and its data suppliers).

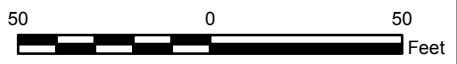


Legend

-  Alignment Centerline
-  Limit of Disturbance
-  10 Ft. Contour
-  2 Ft. Contour
-  Gravel
-  Impervious
-  Meadow
-  Drainage Area

Undetained
0.36 acres

Detained
0.19 acres



POST-DEVELOPMENT DRAINAGE AREA MAP
 JUNIATA VALLEY ROAD
 PENNSYLVANIA PIPELINE PROJECT
 SUNOCO LOGISTICS, L.P.
 BLAIR COUNTY, PENNSYLVANIA

DRAWN BY: S. PAXTON 05/19/16
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FIGURE NUMBER	2	REV	0
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NOAA Atlas 14, Volume 2, Version 3
Location name: Frankstown Twp, Pennsylvania,
USA*



Latitude: 40.4358°, Longitude: -78.3001°
Elevation: 899.95 ft**



* source: ESRI Maps
 ** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
 NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.310 (0.279-0.345)	0.370 (0.334-0.412)	0.451 (0.405-0.501)	0.515 (0.461-0.571)	0.599 (0.532-0.662)	0.664 (0.588-0.732)	0.729 (0.642-0.804)	0.797 (0.697-0.877)	0.892 (0.772-0.979)	0.963 (0.826-1.06)
10-min	0.481 (0.433-0.536)	0.578 (0.521-0.644)	0.702 (0.630-0.779)	0.794 (0.711-0.881)	0.915 (0.814-1.01)	1.01 (0.891-1.11)	1.10 (0.967-1.21)	1.19 (1.04-1.31)	1.31 (1.14-1.44)	1.40 (1.20-1.54)
15-min	0.590 (0.530-0.657)	0.707 (0.637-0.787)	0.861 (0.773-0.956)	0.977 (0.875-1.08)	1.13 (1.01-1.25)	1.25 (1.10-1.37)	1.36 (1.20-1.50)	1.48 (1.29-1.63)	1.64 (1.42-1.80)	1.75 (1.50-1.92)
30-min	0.781 (0.702-0.870)	0.946 (0.852-1.05)	1.18 (1.06-1.31)	1.36 (1.22-1.51)	1.60 (1.42-1.77)	1.78 (1.58-1.96)	1.97 (1.73-2.17)	2.16 (1.89-2.38)	2.42 (2.10-2.66)	2.63 (2.25-2.88)
60-min	0.953 (0.857-1.06)	1.16 (1.05-1.29)	1.48 (1.33-1.64)	1.73 (1.55-1.92)	2.07 (1.84-2.29)	2.35 (2.08-2.59)	2.63 (2.32-2.90)	2.93 (2.56-3.23)	3.35 (2.90-3.68)	3.69 (3.17-4.04)
2-hr	1.10 (0.980-1.23)	1.33 (1.19-1.49)	1.70 (1.51-1.90)	1.99 (1.77-2.22)	2.40 (2.12-2.68)	2.74 (2.40-3.04)	3.10 (2.69-3.44)	3.48 (3.00-3.85)	4.03 (3.43-4.46)	4.47 (3.77-4.95)
3-hr	1.19 (1.06-1.33)	1.43 (1.29-1.61)	1.81 (1.62-2.02)	2.12 (1.89-2.36)	2.56 (2.27-2.84)	2.92 (2.57-3.23)	3.31 (2.89-3.66)	3.72 (3.23-4.11)	4.32 (3.70-4.76)	4.81 (4.08-5.29)
6-hr	1.48 (1.33-1.66)	1.78 (1.61-1.99)	2.23 (2.00-2.48)	2.59 (2.32-2.88)	3.11 (2.77-3.45)	3.55 (3.13-3.92)	4.00 (3.51-4.42)	4.50 (3.91-4.96)	5.21 (4.47-5.73)	5.80 (4.92-6.36)
12-hr	1.82 (1.65-2.05)	2.19 (1.98-2.46)	2.73 (2.45-3.05)	3.17 (2.84-3.54)	3.82 (3.39-4.25)	4.36 (3.85-4.84)	4.95 (4.33-5.48)	5.59 (4.84-6.17)	6.52 (5.57-7.18)	7.30 (6.16-8.03)
24-hr	2.23 (2.04-2.45)	2.68 (2.45-2.94)	3.33 (3.05-3.65)	3.87 (3.53-4.24)	4.65 (4.22-5.08)	5.30 (4.79-5.78)	5.99 (5.38-6.53)	6.74 (6.01-7.33)	7.82 (6.89-8.51)	8.70 (7.61-9.48)
2-day	2.54 (2.33-2.79)	3.05 (2.80-3.34)	3.79 (3.47-4.15)	4.40 (4.02-4.81)	5.28 (4.80-5.76)	6.01 (5.44-6.56)	6.80 (6.11-7.42)	7.65 (6.82-8.34)	8.87 (7.82-9.68)	9.88 (8.61-10.8)
3-day	2.70 (2.49-2.95)	3.24 (2.99-3.53)	4.00 (3.69-4.37)	4.64 (4.26-5.05)	5.55 (5.08-6.04)	6.32 (5.74-6.86)	7.13 (6.44-7.74)	8.00 (7.17-8.69)	9.24 (8.19-10.1)	10.3 (9.00-11.2)
4-day	2.86 (2.65-3.11)	3.42 (3.17-3.72)	4.22 (3.91-4.59)	4.88 (4.50-5.29)	5.83 (5.36-6.31)	6.62 (6.05-7.16)	7.45 (6.76-8.06)	8.34 (7.52-9.04)	9.61 (8.57-10.4)	10.7 (9.39-11.6)
7-day	3.38 (3.15-3.64)	4.04 (3.76-4.35)	4.92 (4.58-5.30)	5.62 (5.22-6.05)	6.60 (6.11-7.11)	7.39 (6.81-7.94)	8.20 (7.52-8.82)	9.04 (8.24-9.74)	10.2 (9.22-11.0)	11.1 (9.97-12.0)
10-day	3.93 (3.67-4.21)	4.66 (4.36-5.01)	5.60 (5.23-6.00)	6.34 (5.92-6.80)	7.37 (6.86-7.90)	8.19 (7.59-8.78)	9.03 (8.33-9.68)	9.88 (9.06-10.6)	11.1 (10.1-11.9)	12.0 (10.8-12.9)
20-day	5.38 (5.09-5.69)	6.34 (6.00-6.71)	7.40 (7.00-7.84)	8.22 (7.76-8.70)	9.29 (8.75-9.82)	10.1 (9.49-10.7)	10.9 (10.2-11.5)	11.6 (10.9-12.4)	12.6 (11.7-13.4)	13.3 (12.4-14.2)
30-day	6.71 (6.37-7.07)	7.87 (7.46-8.29)	9.04 (8.57-9.52)	9.94 (9.41-10.5)	11.1 (10.5-11.7)	11.9 (11.3-12.5)	12.7 (12.0-13.4)	13.5 (12.7-14.2)	14.5 (13.6-15.3)	15.2 (14.2-16.1)
45-day	8.51 (8.08-8.95)	9.95 (9.45-10.5)	11.3 (10.7-11.9)	12.3 (11.7-12.9)	13.5 (12.8-14.2)	14.3 (13.6-15.1)	15.1 (14.3-15.9)	15.8 (15.0-16.7)	16.7 (15.8-17.6)	17.3 (16.3-18.2)
60-day	10.2 (9.77-10.7)	11.9 (11.4-12.5)	13.4 (12.8-14.0)	14.4 (13.8-15.1)	15.7 (15.0-16.4)	16.6 (15.8-17.4)	17.4 (16.6-18.2)	18.1 (17.2-18.9)	18.9 (17.9-19.8)	19.4 (18.4-20.4)

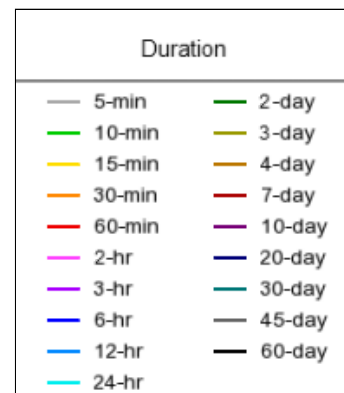
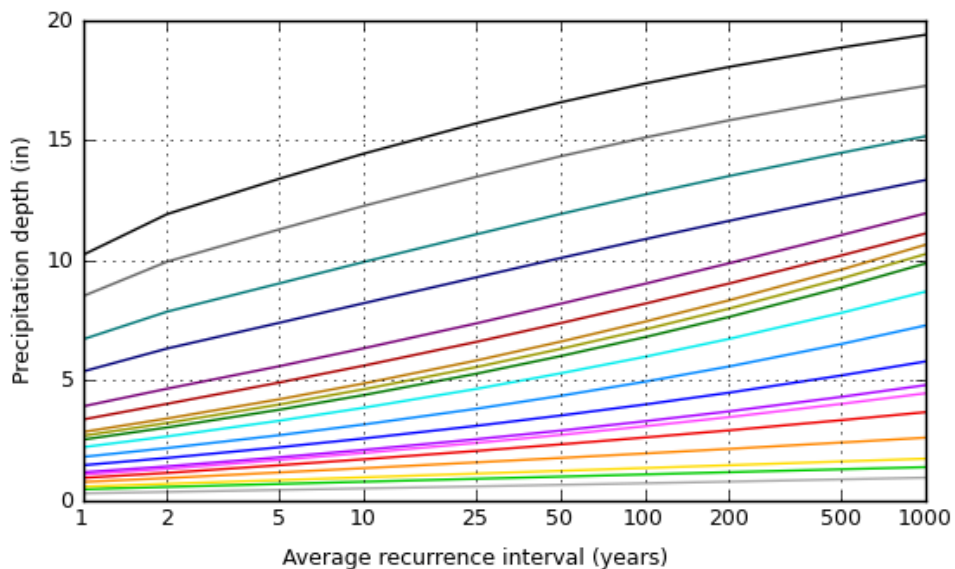
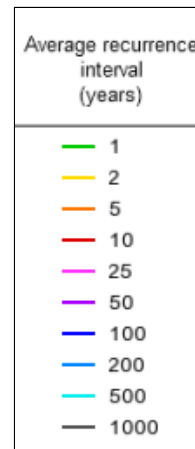
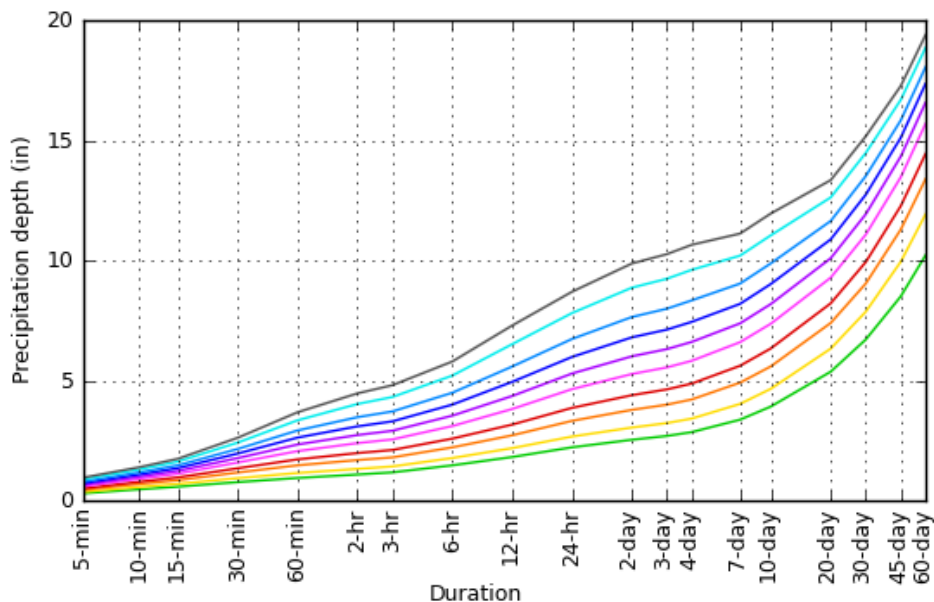
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

PF graphical

PDS-based depth-duration-frequency (DDF) curves

Latitude: 40.4358°, Longitude: -78.3001°

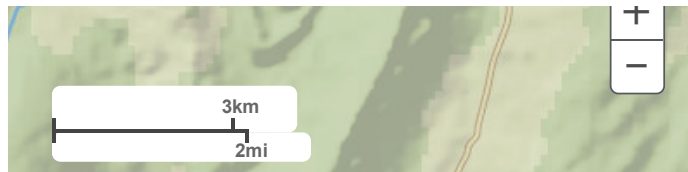


[Back to Top](#)

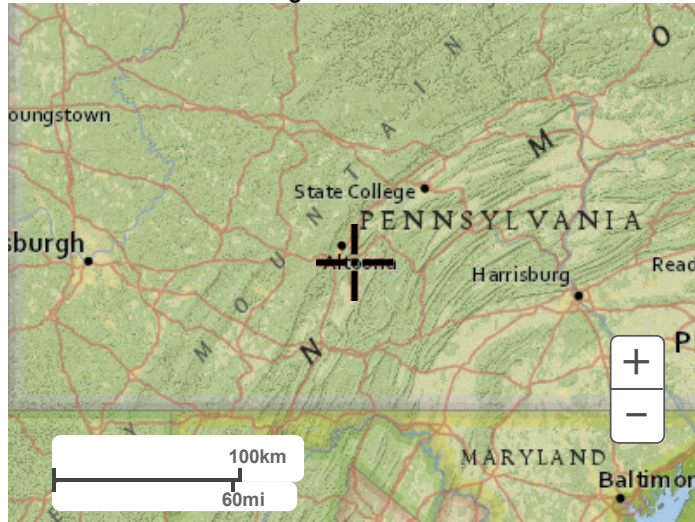
Maps & aerials

Small scale terrain

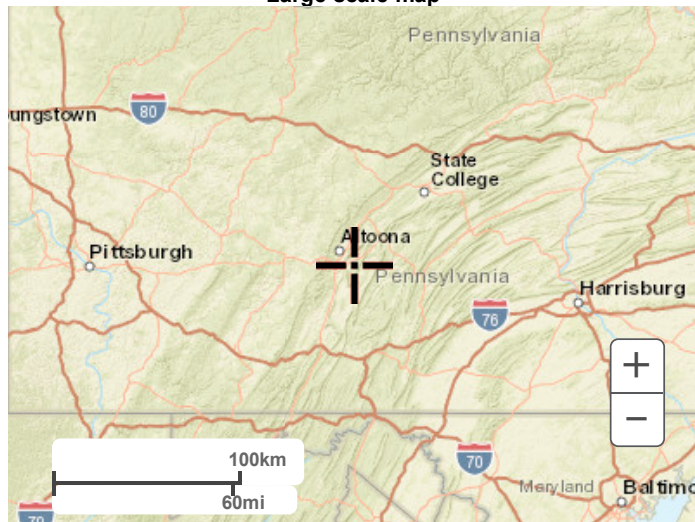




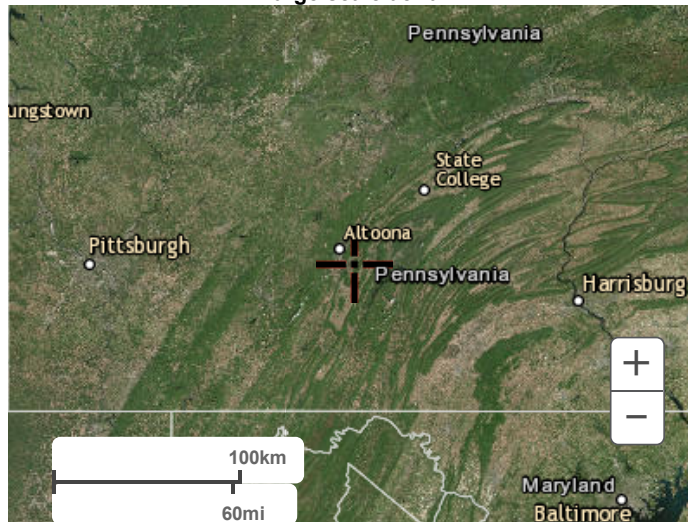
Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

WORKSHEET 1. GENERAL SITE INFORMATION

Date: November 11, 2016

Project Name: Juniata Valley Road

Municipality: Frankstown

County: Blair

Total Area (acres): 0.55

Major River Basin: Susquehanna River

Watershed: Frankstown Branch - Juniata River

Sub Basin: Little Juniata River

Nearest Surface Water to Receive Runoff: Unnamed Tributary to Frankstown Branch

Chapter 93 - Designated Water Use: Warm Water Fishes (WWF)

Impaired according to Chapter 303(d) list? YES
List Causes of Impairment: NO
Industrial Point Source - Suspended Solids

Is Project Subject to, or Part of:

Municipal Separate Storm Sewer System (MS4) Requirements YES

NO

Existing or Planned drinking water supply? YES

NO

If yes, distance from proposed discharge (miles): _____

Approved Act 167 Plan? YES

NO

Existing River Conservation Plan? YES

NO

WORKSHEET 4. CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

PROJECT: Juniata Valley Road
 Drainage Area: 0.55 acres
 2-Year Rainfall: 2.68 in

Total Site Area: 0.52 acres
 Protected Site Area: N/A acres
 Managed Site Area: 0.52 acres

Existing Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ³ (ft ³)
Meadow	B	6,534	0.15	58	7.24	1.45	0.18	97
Meadow	C	9,583	0.22	71	4.08	0.82	0.58	466
Meadow	D	6,534	0.15	78	2.82	0.56	0.91	494
TOTAL:		22,651	0.52					1,057

Developed Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff ¹ (in)	Runoff Volume ³ (ft ³)
Impervious-Gravel	B	436	0.01	85	1.76	0.35	1.32	48
Impervious-Gravel	C	5,663	0.13	89	1.24	0.25	1.61	761
Impervious-Gravel	D	436	0.01	91	0.99	0.20	1.77	64
Meadow	B	6,098	0.14	58	7.24	1.45	0.18	91
Meadow	C	3,920	0.09	71	4.08	0.82	0.58	191
Meadow	D	6,098	0.14	78	2.82	0.56	0.91	461
TOTAL:		22,651	0.52					1,616

2-Year Volume Increase (ft ³):	559
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2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

1. Runoff (in) = $Q = (P - 0.2S) / (P + 0.8S)$ where
 P = 2-Year Rainfall (in)
 S = $(1000/CN) - 10$

2. Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
 Q = Runoff (in)
 Area = Land use area (sq. ft.)

Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.

Worksheet 5. Structural BMP Volume Credits

PROJECT: Juniata Valley Road
 SUB-BASIN: _____

Required Control Volume (ft³) - from Worksheet 4: 559
 Non-structural Volume Credit (ft³) - from Worksheet 3: N/A
 (maximum is 25% of required volume)
 Structural Volume Reqmt (ft³): 559
 (Required Control Volume minus Non-structural Credit)

Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 6	Area (ft ²)	Volume Reduction Permanently Removed (ft ³)
6.4.1 Porous Pavement		
6.4.2 Infiltration Basin		
6.4.3 Infiltration Bed		
6.4.4 Infiltration Trench		
6.4.5 Rain Garden/Bioretenion		
6.4.6 Dry Well/Seepage Pit		
6.4.7 Constructed Filter		
6.4.8 Vegetated Swale		
6.4.9 Vegetated Filter Strip		
6.4.10 Berm		
6.5.1 Vegetated Roof		
6.5.2 Capture and Re-Use		
6.6.1 Constructed Wetlands		
6.6.2 Wet Pond/Retention Basin		
6.7.1 Riparian Buffer/Riparian Forest Buffer Restoration		
6.7.2 Landscape Restoration/Reforestation		
6.7.3 Soil Amendment		
6.8.1 Level Spreader		
6.8.2 Special Storage Areas		
Other: Slow Release Concept	90	630
Total Structural Volume (ft³):		630
Structural Volume Requirement (ft³):		559
VOLUME CREDIT DETERMINATION		DIFFERENCE:
		-71

- 1 Detained area runoff volume from Hydraflow = 781 cf
- 2 Storage volume of the BMP = 630 cf
- 3 Infiltrated volume within 72 hours after the 2-yr/24-hr event
 (Infiltration Rate/12) x Infiltration Area x 72 hrs = 778 cf

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary "yes" rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the

PRIMARY BMPs FOR NITRATE:

	YES	NO
NS BMP 5.4.2 - Protect / Conserve / Enhance Riparian Buffers	<input type="checkbox"/>	<input type="checkbox"/>
NS BMP 5.5.4 - Cluster Uses at Each Site	<input type="checkbox"/>	<input type="checkbox"/>
NS BMP 5.6.1 - Minimize Total Disturbed Area	<input checked="" type="checkbox"/>	<input type="checkbox"/>
NS BMP 5.6.3 - Re-Vegetate / Re-Forest Disturbed Areas (Native Species)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
NS BMP 5.9.1 - Street Sweeping / Vacuuming	<input type="checkbox"/>	<input type="checkbox"/>
Structural BMP 6.7.1 - Riparian Buffer Restoration	<input type="checkbox"/>	<input type="checkbox"/>
Structural BMP 6.7.2 - Landscape Restoration	<input type="checkbox"/>	<input type="checkbox"/>

SECONDARY BMPs FOR NITRATE:

NS BMP 5.4.1 - Protect Sensitive / Special Value Features	<input type="checkbox"/>	<input type="checkbox"/>
NS BMP 5.4.3 - Protect / Utilize Natural Drainage Features	<input type="checkbox"/>	<input type="checkbox"/>
NS BMP 5.6.2 - Minimize Soil Compaction	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Structural BMP 6.4.5 - Rain Garden / Bioretention	<input type="checkbox"/>	<input type="checkbox"/>
Structural BMP 6.4.8 - Vegetated Swale	<input type="checkbox"/>	<input type="checkbox"/>
Structural BMP 6.4.9 - Vegetated Filter Strip	<input type="checkbox"/>	<input type="checkbox"/>
Structural BMP 6.6.1 - Constructed Wetland	<input type="checkbox"/>	<input type="checkbox"/>
Structural BMP 6.7.1 - Riparian Buffer Restoration	<input type="checkbox"/>	<input type="checkbox"/>
Structural BMP 6.7.2 - Landscape Restoration	<input type="checkbox"/>	<input type="checkbox"/>
Structural BMP 6.7.3 - Soils Amendment/Restoration	<input checked="" type="checkbox"/>	<input type="checkbox"/>

TIME OF CONCENTRATION ADJUSTMENT

POST CONSTRUCTION TC TO BMP (DETAINED TC) BEFORE ADJUSTMENT 3.6 MIN

STRUCTURAL VOLUME PROVIDED BY BMP 630 CF

RATES OF RUNOFF TO THE BMP (FROM HYDRAFLOW REPORT)

Storm Event	Q (CFS)
2 YR/24 HR	0.416
10 YR/24 HR	0.757
50 YR/24 HR	1.187
100 YR/24 HR	1.398

ADDITIONAL RESIDENCE TIME (MIN) = (STRUCTURAL VOLUME PROVIDED BY BMP / RATE OF RUNOFF TO BMP) / 60

Storm Event	Q (CFS)	Additional Residence Time (min.)
2 YR/24 HR	0.416	25.240
10 YR/24 HR	0.757	13.871
50 YR/24 HR	1.187	8.846
100 YR/24 HR	1.398	7.511

ADJUSTED TC = POST CONSTRUCTION TC TO BMP BEFORE ADJUSTMENT + ADDITIONAL RESIDENCE TIME

Storm Event	Q (CFS)	Additional Residence Time (min.)	Adjusted Time of Concentration (min.)
2 YR/24 HR	0.416	25.240	28.840
10 YR/24 HR	0.757	13.871	17.471
50 YR/24 HR	1.187	8.846	12.446
100 YR/24 HR	1.398	7.511	11.111

Underdrain Dewatering Rate Calculation

Project: Juniata

BMP: 1

Filter Media				
Layer	Media	Thickness - T (ft)	Min. Infiltration Rate - K (ft/min) ¹	Flow Rate (cfs) ²
1	Clean Gravel	N/A	2	N/A
2	Coarse Sand	N/A	0.02	N/A
3	Fine Sand	2	0.002	0.00300
4	Other ³	N/A	N/A	N/A
Minimum Flow Rate (cfs)				0.003

1. From Principles of Geotechnical Engineering Third Edition, Braja Das, 1994
2. $Q=KA(Hm+T/T)$
 A = Area (square feet) = 90
 Hm = Head above media (feet) = 2
3. Infiltration rate measured in field or laboratory

Perforated Pipe				
Pipe	Perforation Area (square inch) ⁴	# Perforations per Foot - N	Pipe Length - L (ft)	Flow Rate (cfs) ⁵
1	1.00	1	30	1.47
2	N/A	N/A	N/A	N/A
Total Flow Rate (cfs)				1.47

4. Reference: [PVC: certainteed.com](http://PVC.certainteed.com) [HDPE: ads-pipe.com](http://HDPE.ads-pipe.com)
5. $Q= N*L*cAo\sqrt{2GH}$
 c = Orifice Coefficient = 0.6
 Ao= Perforation Area (sq. ft.) 0.007
 G= Grav. Accel. (ft/sec²) 32.2
 H= Average Head (ft) = 3.5

Pipe Discharge				
Pipe	Pipe Diameter - D (in)	Pipe Roughness Coefficient -n	Pipe Slope - S ⁶	Flow Rate (cfs) ⁷
1	4	0.012	0.011111111	0.22
2	N/A	N/A	N/A	N/A
Total Flow Rate (cfs)				0.22

6. For flat pipe, use hydraulic grade (pipe diameter/pipe length) for the pipe slope
7. From Manning's equation (attach separate calculation worksheet)

Limiting flow rate from combined underdrain system - Ql (cfs) =	0.003
Detained volume based on 2-year/24-hour storm (cu-ft) =	630
Total Dewatering Volume including volume in voids(cu-ft) =	702
Dewatering Time (sec) = 2HA/Ql =	234,000
Dewatering Time (hrs) =	65.00

Underdrain Outlets Report

Label	Solve For	Friction Method	Roughness Coefficient
Circular Pipe - 1	Full Flow Capacity	Manning Formula	0.012
Slow Release Outlet	Full Flow Capacity	Manning Formula	0.012

Channel Slope (ft/ft)	Normal Depth (ft)	Diameter (ft)	Discharge (ft ³ /s)
0.03000	0.33	0.33	0.36
0.01111	0.33	0.33	0.22

Flow Area (ft ²)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Top Width (ft)
0.09	1.05	0.08	0.00
0.09	1.05	0.08	0.00

Critical Depth (ft)	Percent Full (%)	Critical Slope (ft/ft)	Velocity (ft/s)
0.31	100.0	0.02593	4.09
0.26	100.0	0.01202	2.49

Velocity Head (ft)	Specific Energy (ft)	Froude Number	Maximum Discharge (ft ³ /s)
0.26	0.59	0.00	0.38
0.10	0.43	0.00	0.23

Discharge Full (ft ³ /s)	Slope Full (ft/ft)	Flow Type	Notes
-------------------------------------	--------------------	-----------	-------

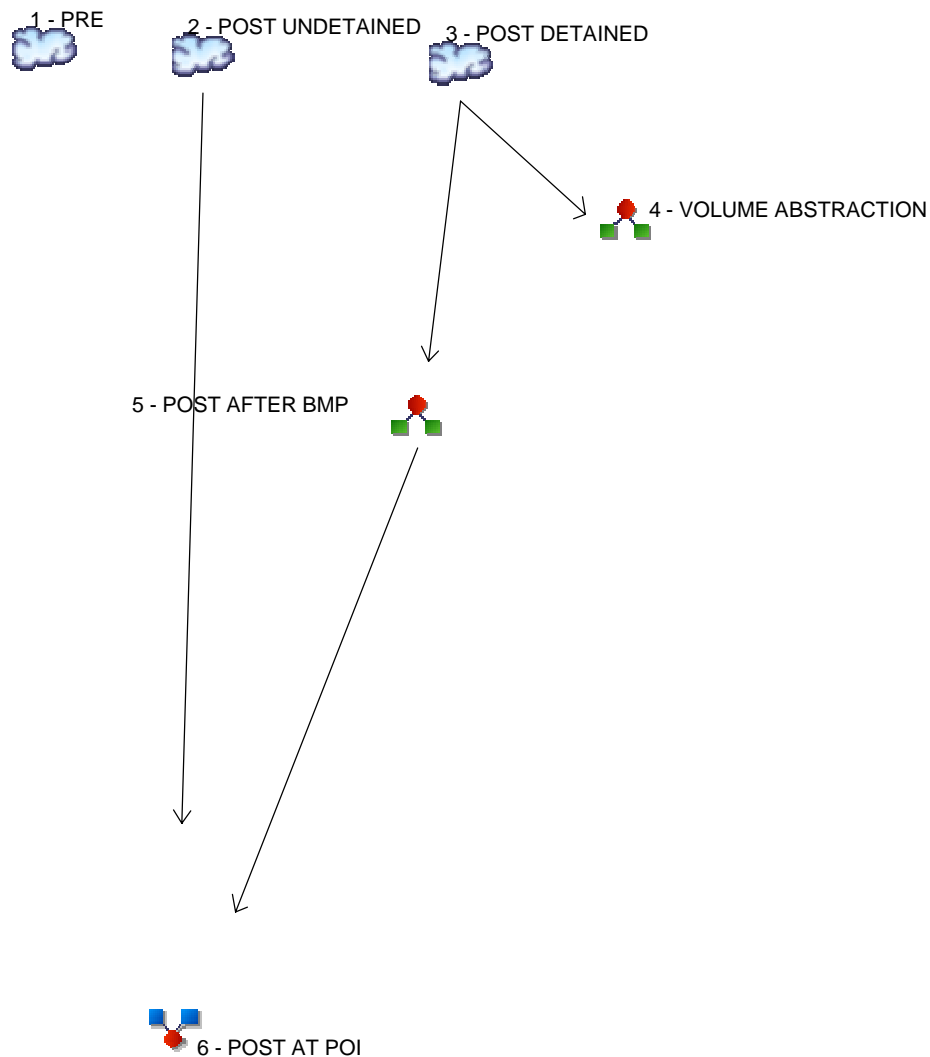
Underdrain Outlets Report

Discharge Full (ft ³ /s)	Slope Full (ft/ft)	Flow Type	Notes
0.36	0.03000	SubCritical	
0.22	0.01111	SubCritical	

Messages

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Legend

Hyd. Origin	Description
1 SCS Runoff	PRE
2 SCS Runoff	POST UNDETAINED
3 SCS Runoff	POST DETAINED
4 Diversion1	VOLUME ABSTRACTION
5 Diversion2	POST AFTER BMP
6 Combine	POST AT POI

Hydrograph Return Period Recap

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.463	-----	-----	1.196	-----	2.233	2.770	PRE
2	SCS Runoff	-----	-----	0.245	-----	-----	0.664	-----	1.266	1.579	POST UNDETAINED
3	SCS Runoff	-----	-----	0.416	-----	-----	0.757	-----	1.187	1.398	POST DETAINED
4	Diversion1	3	-----	0.416	-----	-----	0.757	-----	0.828	0.686	VOLUME ABSTRACTION
5	Diversion2	3	-----	0.008	-----	-----	0.519	-----	1.187	1.398	POST AFTER BMP
6	Combine	2, 5	-----	0.245	-----	-----	1.161	-----	2.382	2.897	POST AT POI

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.463	1	718	1,041	-----	-----	-----	PRE
2	SCS Runoff	0.245	1	719	598	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	0.416	1	717	781	-----	-----	-----	POST DETAINED
4	Diversion1	0.416	1	717	630	3	-----	-----	VOLUME ABSTRACTION
5	Diversion2	0.008	1	989	151	3	-----	-----	POST AFTER BMP
6	Combine	0.245	1	719	748	2, 5	-----	-----	POST AT POI
Juniata West.gpw					Return Period: 2 Year			Tuesday, 10 / 25 / 2016	

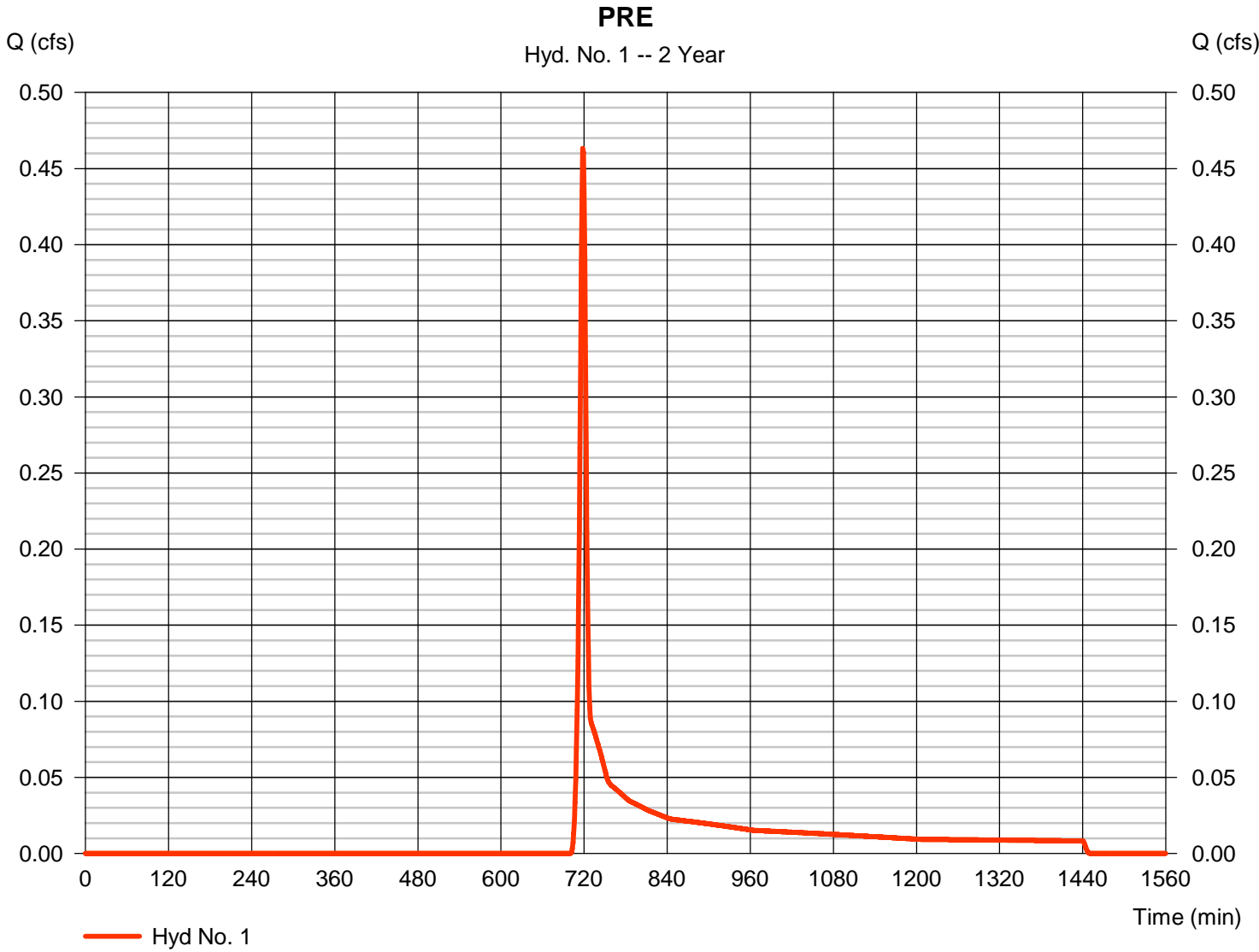
Hydrograph Report

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 0.463 cfs
Storm frequency	= 2 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 1,041 cuft
Drainage area	= 0.550 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 5.70 min
Total precip.	= 2.68 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 58) + (0.230 x 71) + (0.160 x 78)] / 0.550



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 1

PRE

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.68	0.00	0.00	
Land slope (%)	= 10.26	0.00	0.00	
Travel Time (min)	= 4.66	+ 0.00	+ 0.00	= 4.66
Shallow Concentrated Flow				
Flow length (ft)	= 56.00	0.00	0.00	
Watercourse slope (%)	= 3.31	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=2.94	0.00	0.00	
Travel Time (min)	= 0.32	+ 0.00	+ 0.00	= 0.32
Channel Flow				
X sectional flow area (sqft)	= 16.00	0.00	0.00	
Wetted perimeter (ft)	= 28.00	0.00	0.00	
Channel slope (%)	= 1.81	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=4.59	0.00	0.00	
Flow length (ft)	211.0	0.0	0.0	
Travel Time (min)	= 0.77	+ 0.00	+ 0.00	= 0.77
Total Travel Time, Tc				5.70 min

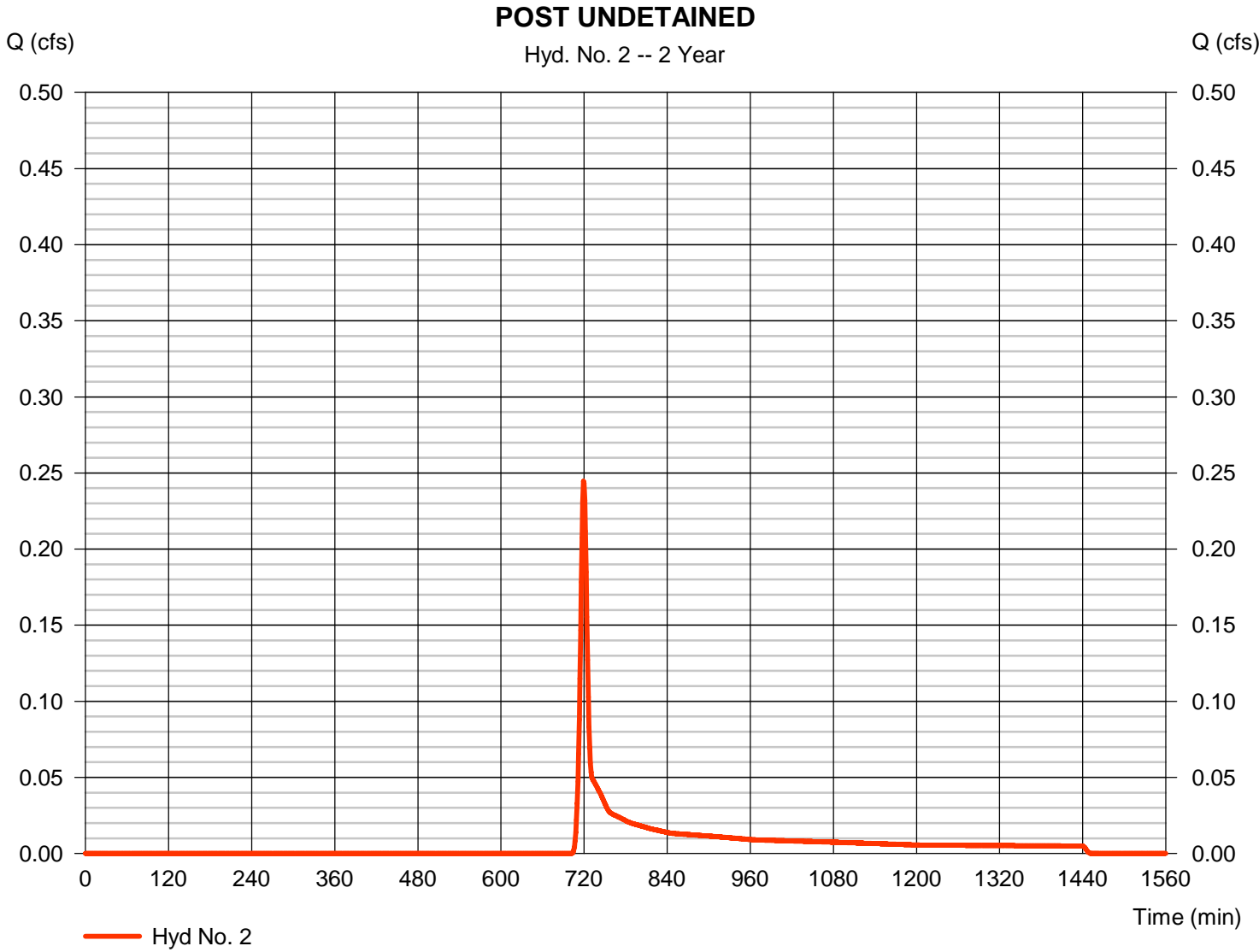
Hydrograph Report

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.245 cfs
Storm frequency	= 2 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 598 cuft
Drainage area	= 0.360 ac	Curve number	= 68*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 2.68 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 71) + (0.150 x 58) + (0.140 x 78)] / 0.360



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 2

POST UNDETAINED

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.68	0.00	0.00	
Land slope (%)	= 8.00	0.00	0.00	
Travel Time (min)	= 5.14	+ 0.00	+ 0.00	= 5.14
Shallow Concentrated Flow				
Flow length (ft)	= 244.00	0.00	0.00	
Watercourse slope (%)	= 2.30	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=2.45	0.00	0.00	
Travel Time (min)	= 1.66	+ 0.00	+ 0.00	= 1.66
Channel Flow				
X sectional flow area (sqft)	= 16.00	0.00	0.00	
Wetted perimeter (ft)	= 28.00	0.00	0.00	
Channel slope (%)	= 1.81	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=4.59	0.00	0.00	
Flow length (ft)	{{0}}211.0	0.0	0.0	
Travel Time (min)	= 0.77	+ 0.00	+ 0.00	= 0.77
Total Travel Time, Tc				7.60 min

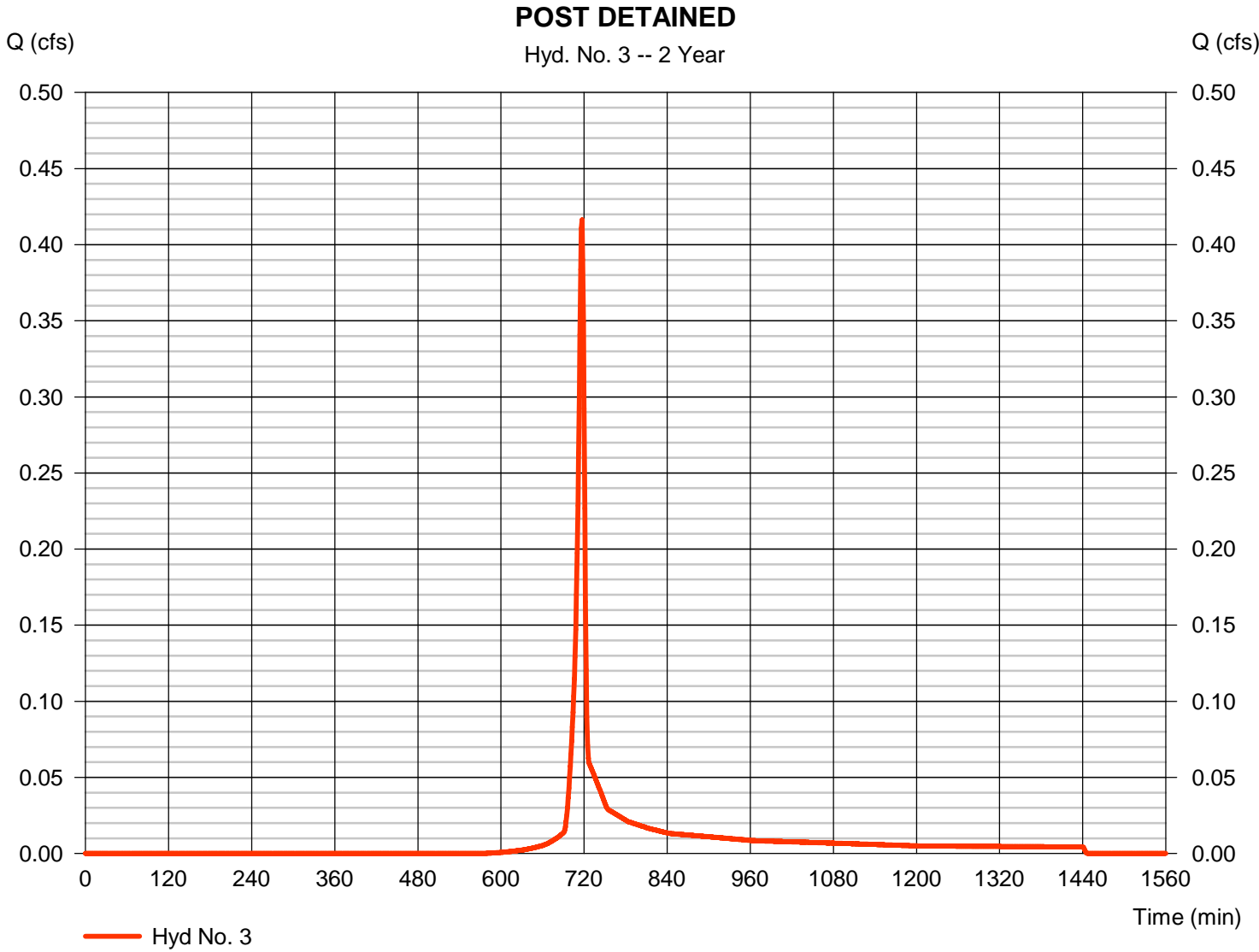
Hydrograph Report

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.416 cfs
Storm frequency	= 2 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 781 cuft
Drainage area	= 0.190 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 3.60 min
Total precip.	= 2.68 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.130 x 89) + (0.030 x 71) + (0.020 x 58) + (0.010 x 78)] / 0.190



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 3

POST DETAINED

<u>Description</u>	<u>A</u>		<u>B</u>		<u>C</u>	<u>Totals</u>
Sheet Flow						
Manning's n-value	= 0.130		0.011		0.011	
Flow length (ft)	= 50.0		0.0		0.0	
Two-year 24-hr precip. (in)	= 2.68		0.00		0.00	
Land slope (%)	= 9.00		0.00		0.00	
Travel Time (min)	= 3.00	+	0.00	+	0.00	= 3.00
Shallow Concentrated Flow						
Flow length (ft)	= 67.00		23.00		0.00	
Watercourse slope (%)	= 5.90		4.30		0.00	
Surface description	= Paved		Unpaved		Paved	
Average velocity (ft/s)	=4.94		3.35		0.00	
Travel Time (min)	= 0.23	+	0.11	+	0.00	= 0.34
Channel Flow						
X sectional flow area (sqft)	= 0.09		0.00		0.00	
Wetted perimeter (ft)	= 1.05		0.00		0.00	
Channel slope (%)	= 3.00		0.00		0.00	
Manning's n-value	= 0.015		0.015		0.015	
Velocity (ft/s)	=3.32		0.00		0.00	
Flow length (ft)	{{0}}50.0		0.0		0.0	
Travel Time (min)	= 0.25	+	0.00	+	0.00	= 0.25
Total Travel Time, Tc						3.60 min

Hydrograph Report

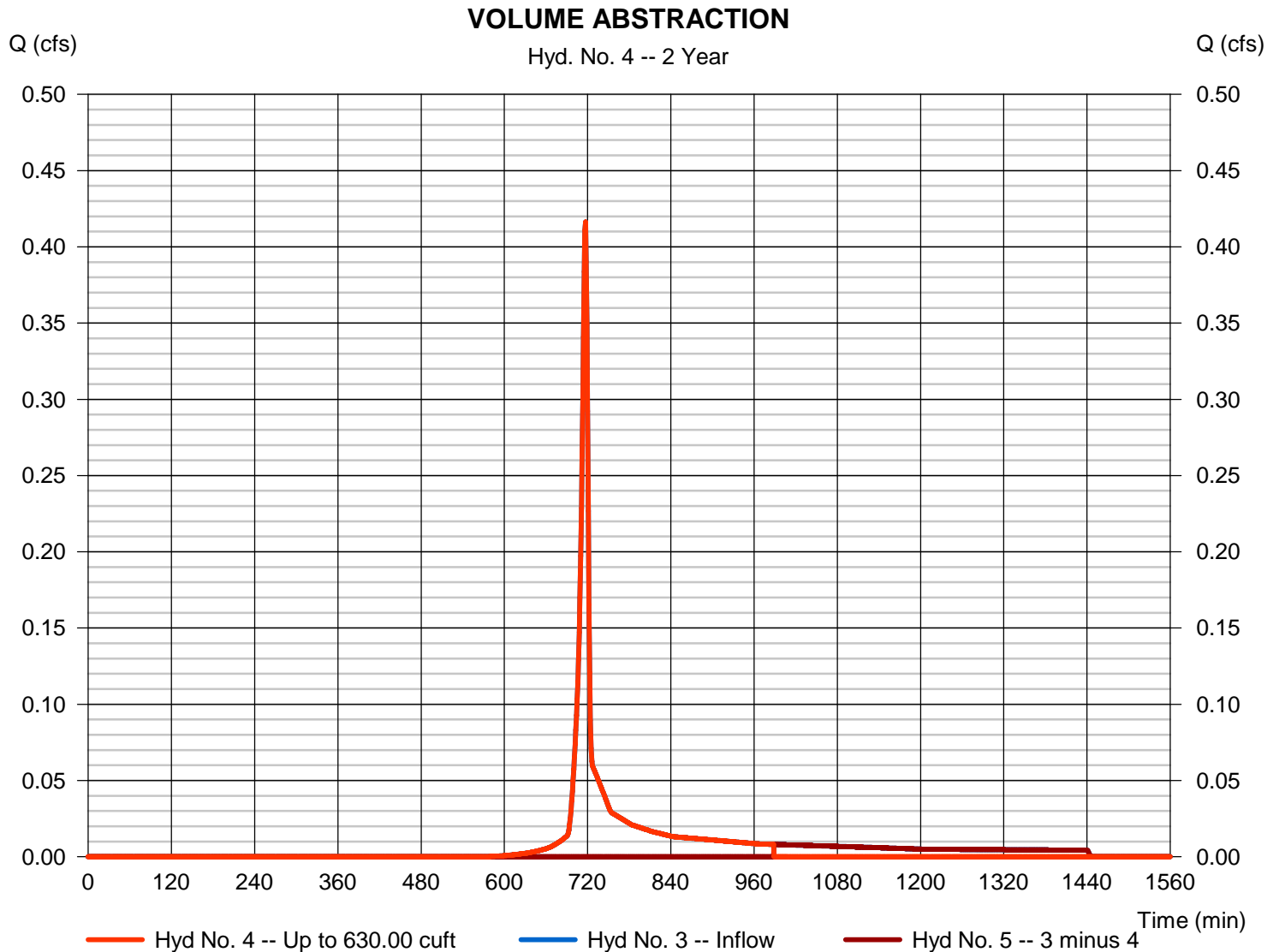
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Tuesday, 10 / 25 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.416 cfs
Storm frequency	= 2 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 630 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft

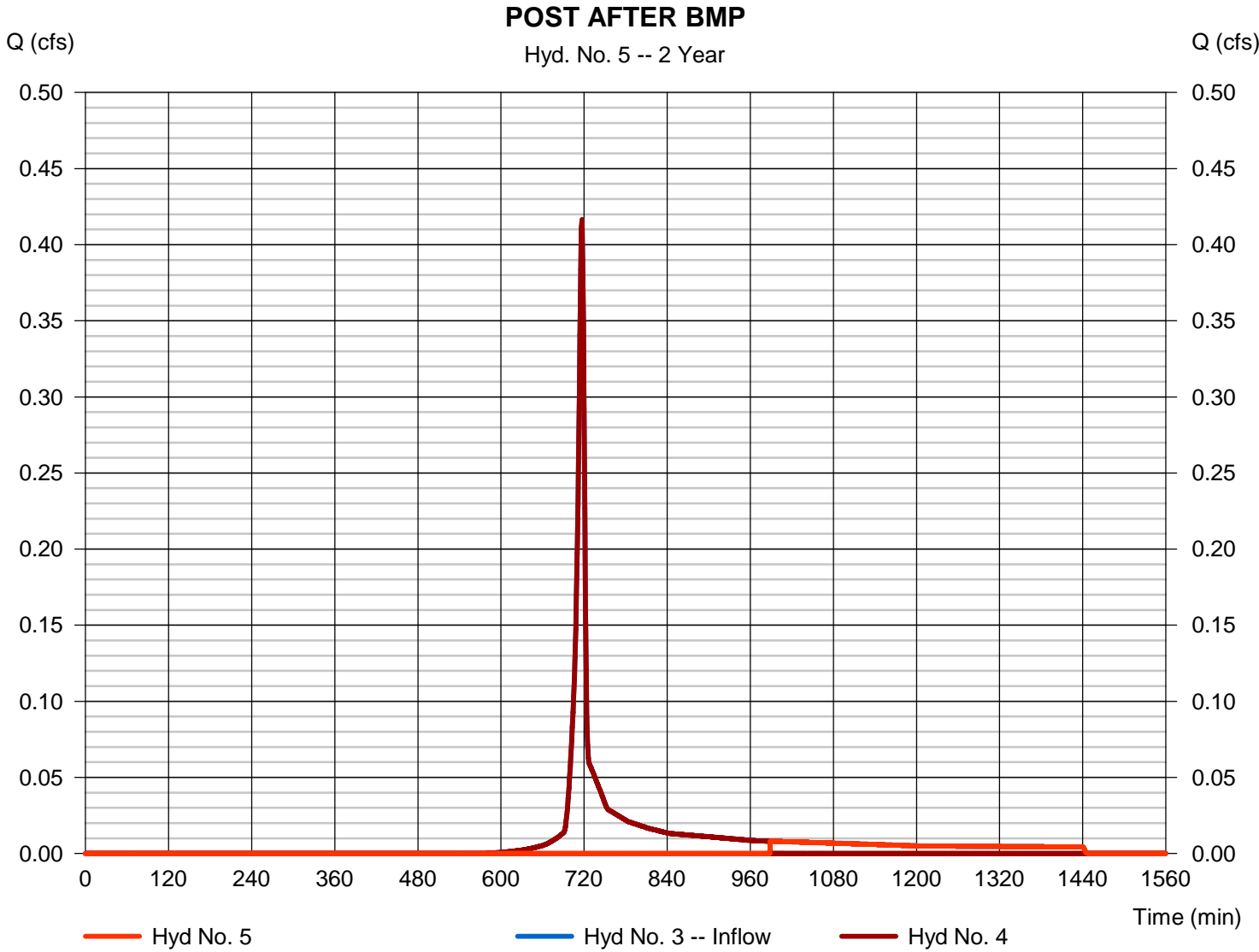


Hydrograph Report

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 0.008 cfs
Storm frequency	= 2 yrs	Time to peak	= 989 min
Time interval	= 1 min	Hyd. volume	= 151 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

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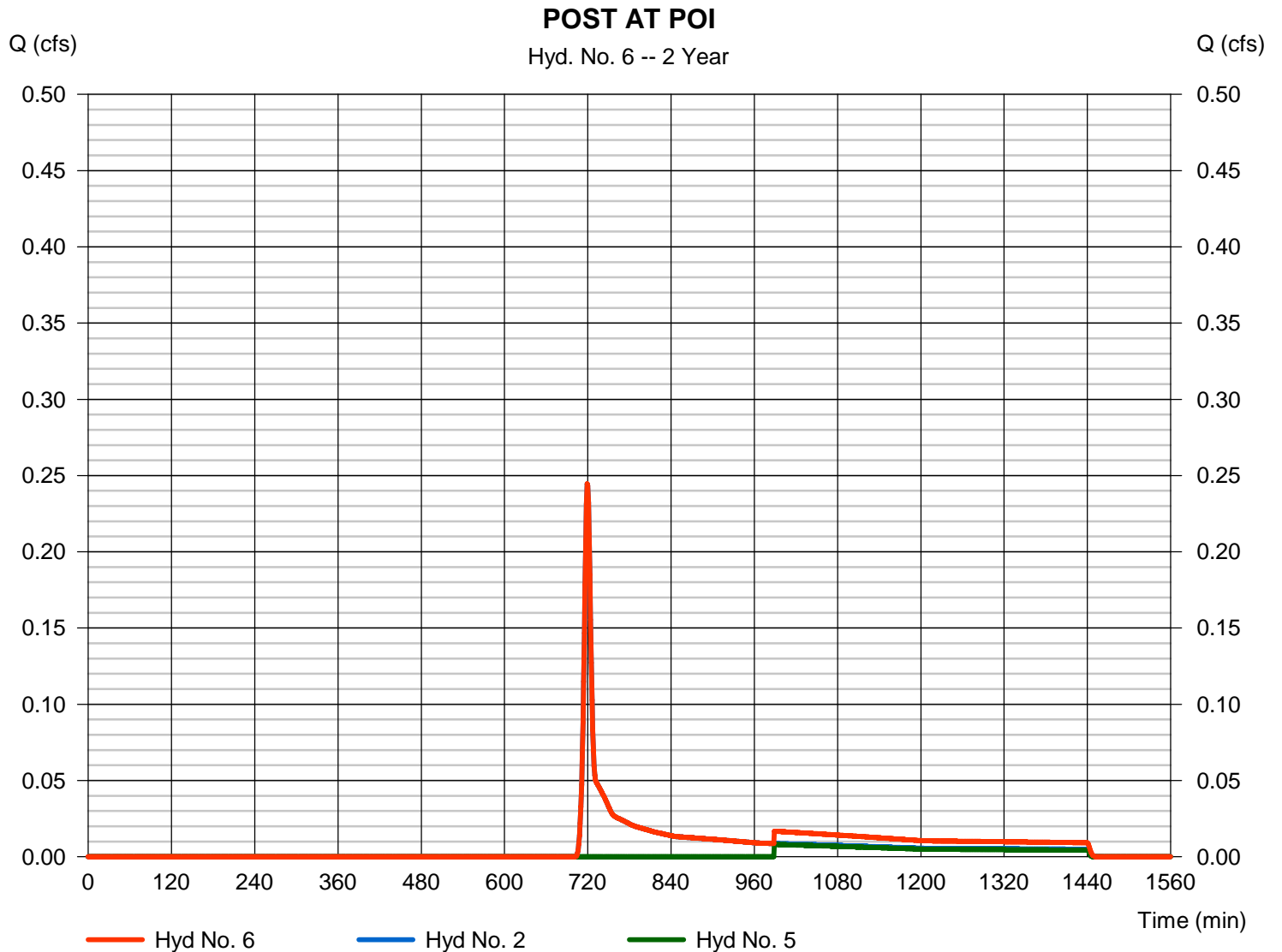
Tuesday, 10 / 25 / 2016

Hyd. No. 6

POST AT POI

Hydrograph type = Combine
Storm frequency = 2 yrs
Time interval = 1 min
Inflow hyds. = 2, 5

Peak discharge = 0.245 cfs
Time to peak = 719 min
Hyd. volume = 748 cuft
Contrib. drain. area = 0.360 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description	
1	SCS Runoff	1.196	1	718	2,435	-----	-----	-----	PRE	
2	SCS Runoff	0.664	1	719	1,432	-----	-----	-----	POST UNDETAINED	
3	SCS Runoff	0.757	1	717	1,443	-----	-----	-----	POST DETAINED	
4	Diversion1	0.757	1	717	634	3	-----	-----	VOLUME ABSTRACTION	
5	Diversion2	0.519	1	720	809	3	-----	-----	POST AFTER BMP	
6	Combine	1.161	1	720	2,240	2, 5	-----	-----	POST AT POI	
Juniata West.gpw					Return Period: 10 Year			Tuesday, 10 / 25 / 2016		

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

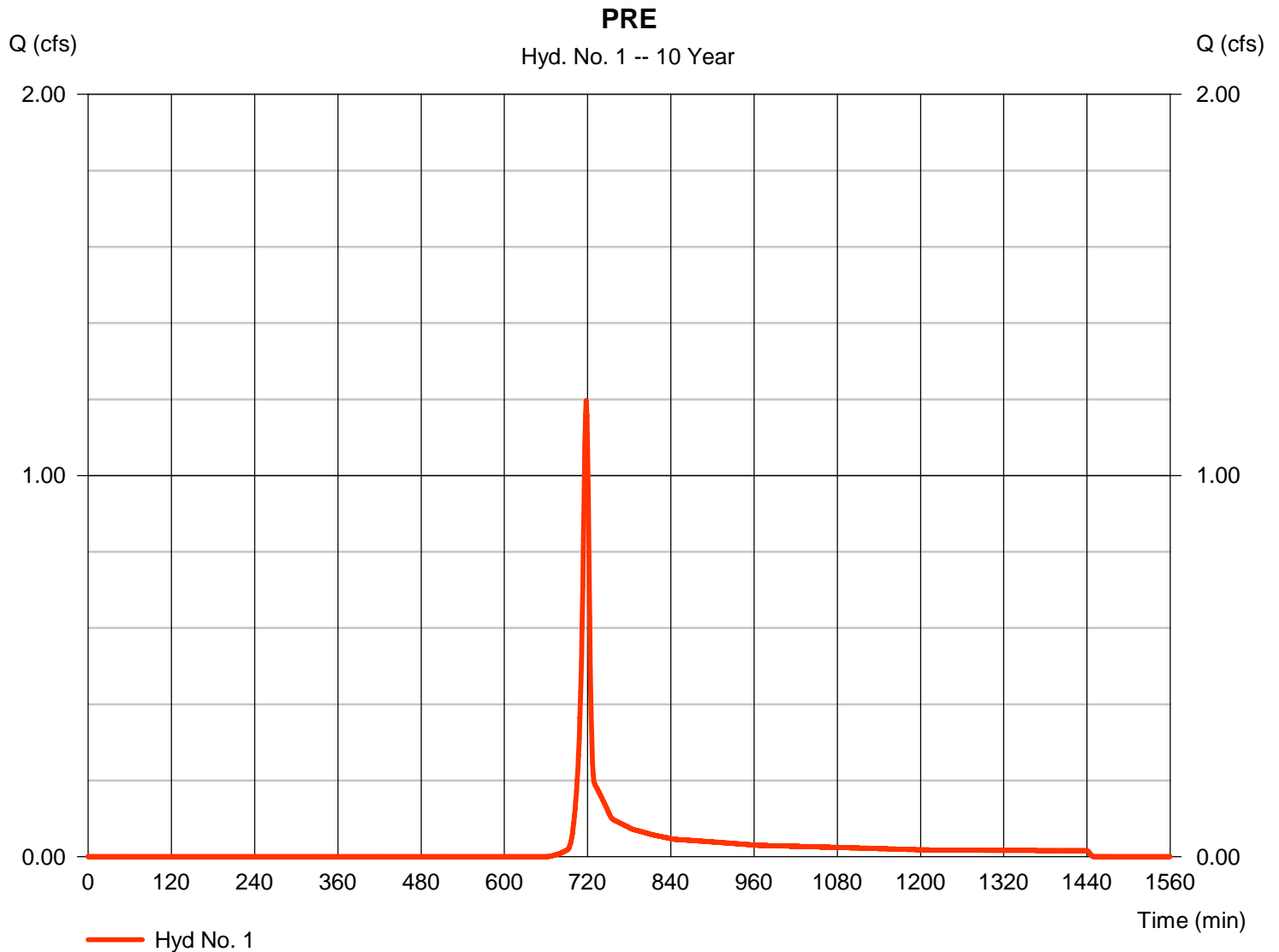
Tuesday, 10 / 25 / 2016

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 1.196 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 2,435 cuft
Drainage area	= 0.550 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 5.70 min
Total precip.	= 3.87 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 58) + (0.230 x 71) + (0.160 x 78)] / 0.550



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

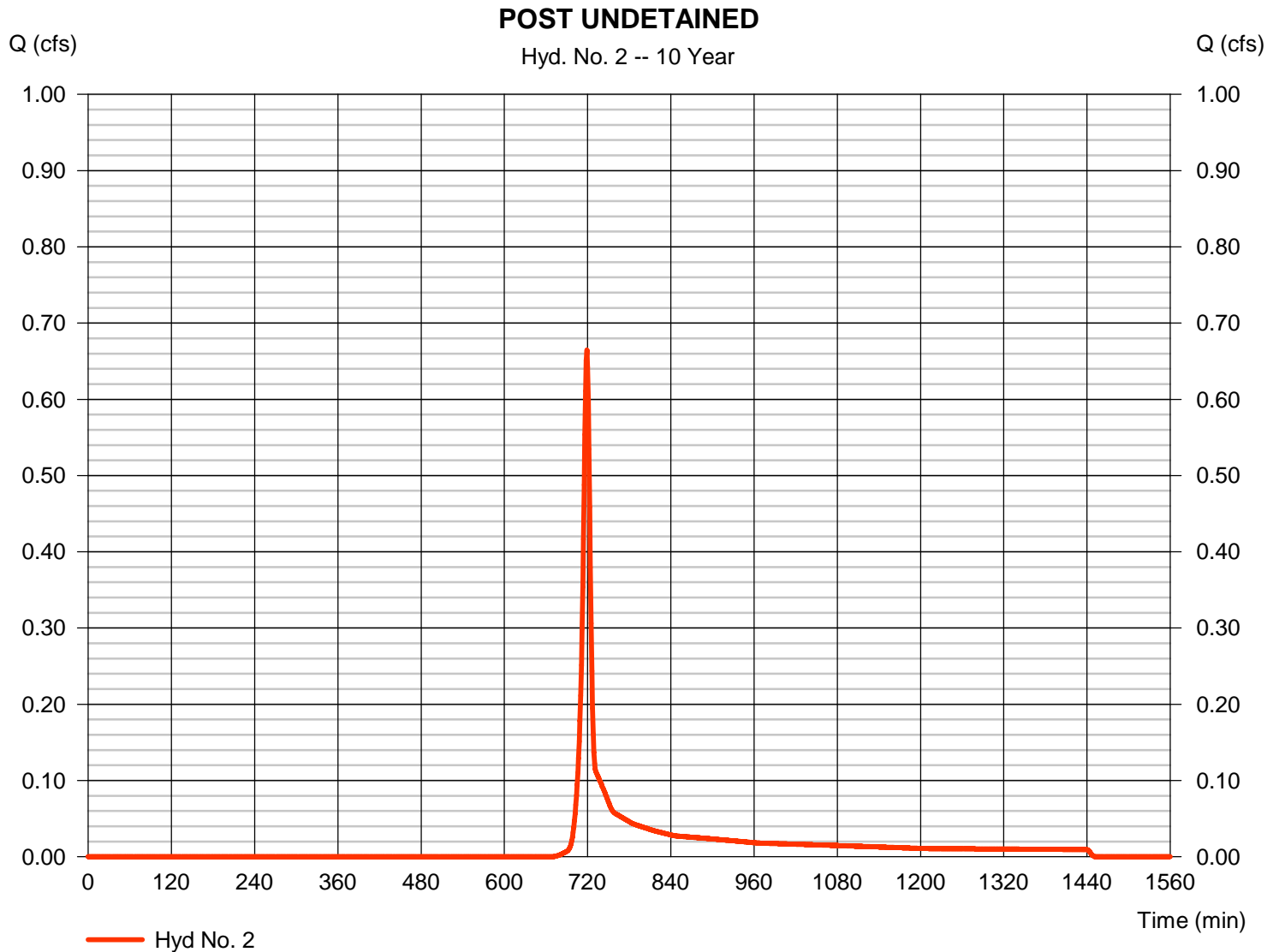
Tuesday, 10 / 25 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.664 cfs
Storm frequency	= 10 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 1,432 cuft
Drainage area	= 0.360 ac	Curve number	= 68*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 3.87 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 71) + (0.150 x 58) + (0.140 x 78)] / 0.360



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

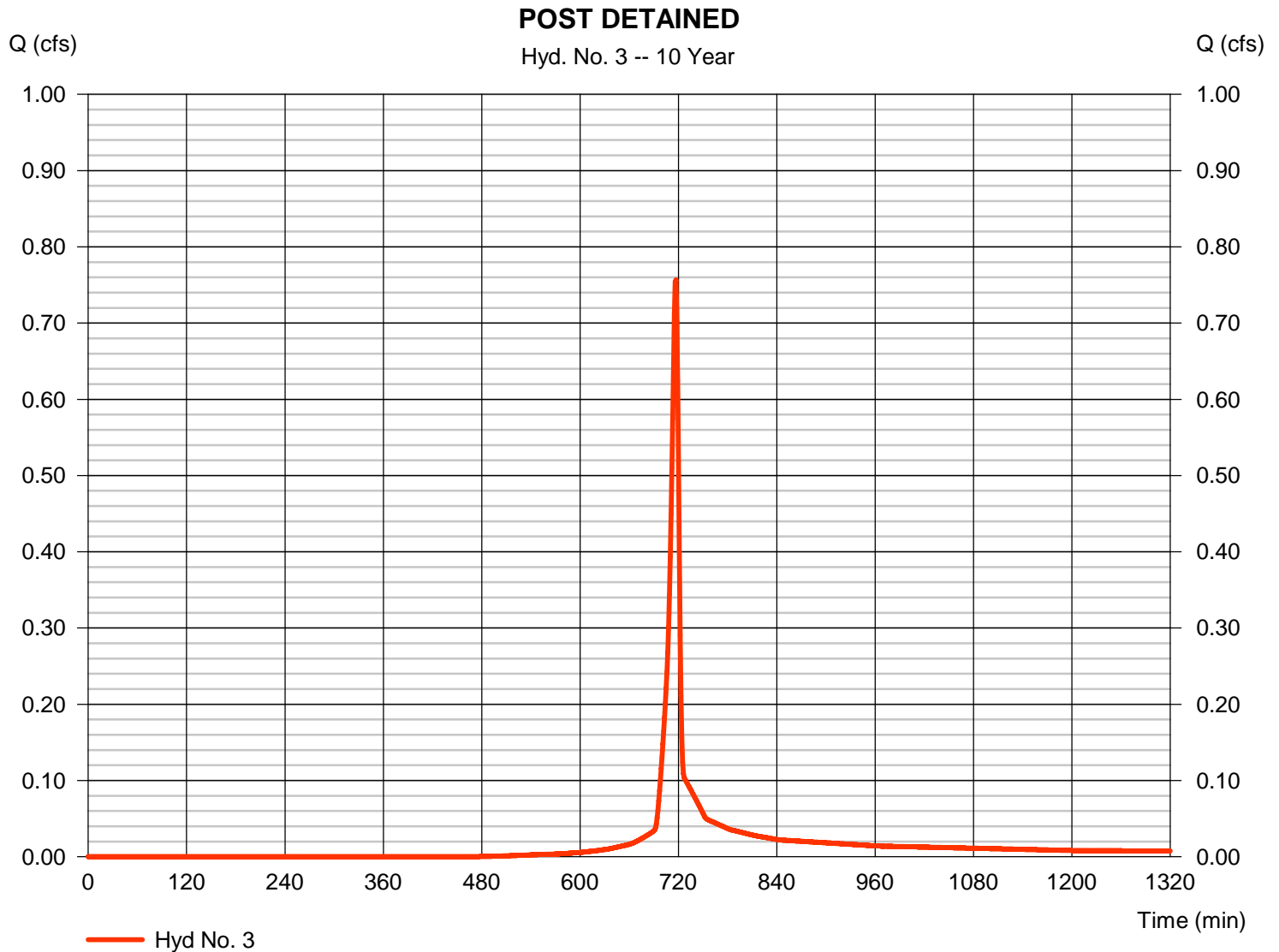
Tuesday, 10 / 25 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.757 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 1,443 cuft
Drainage area	= 0.190 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 3.60 min
Total precip.	= 3.87 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.130 x 89) + (0.030 x 71) + (0.020 x 58) + (0.010 x 78)] / 0.190



Hydrograph Report

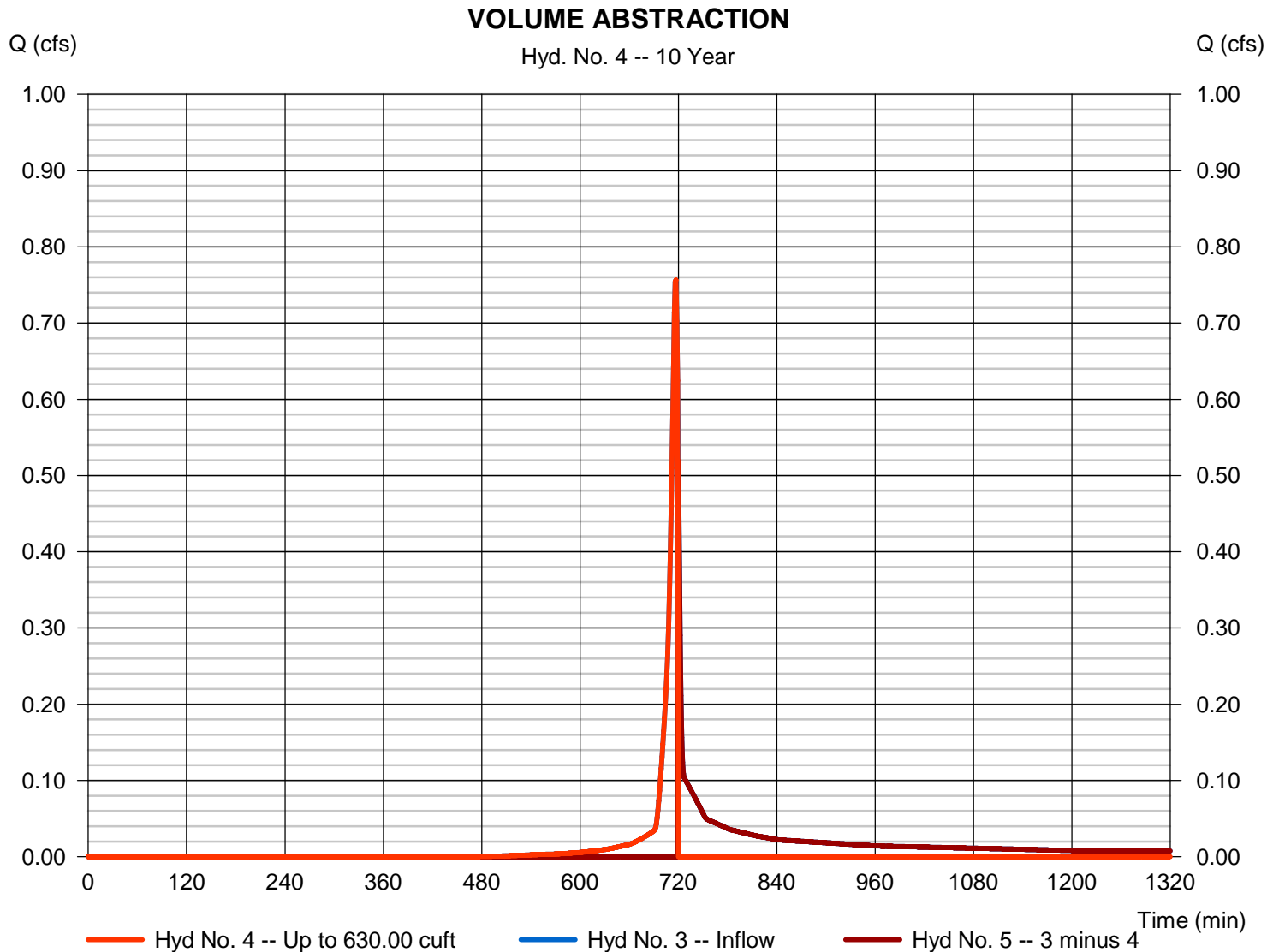
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Tuesday, 10 / 25 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.757 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 634 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

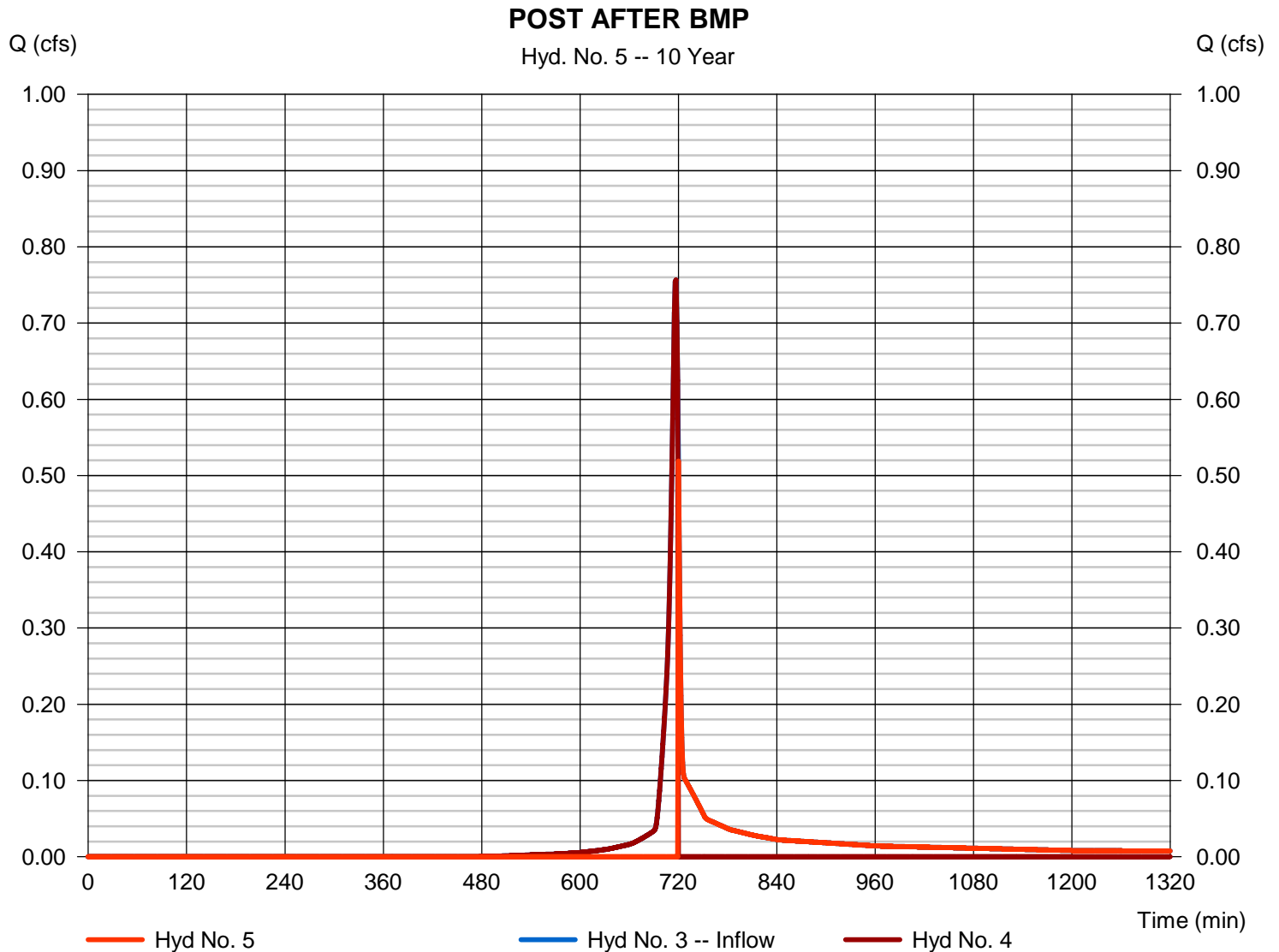
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 0.519 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 809 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

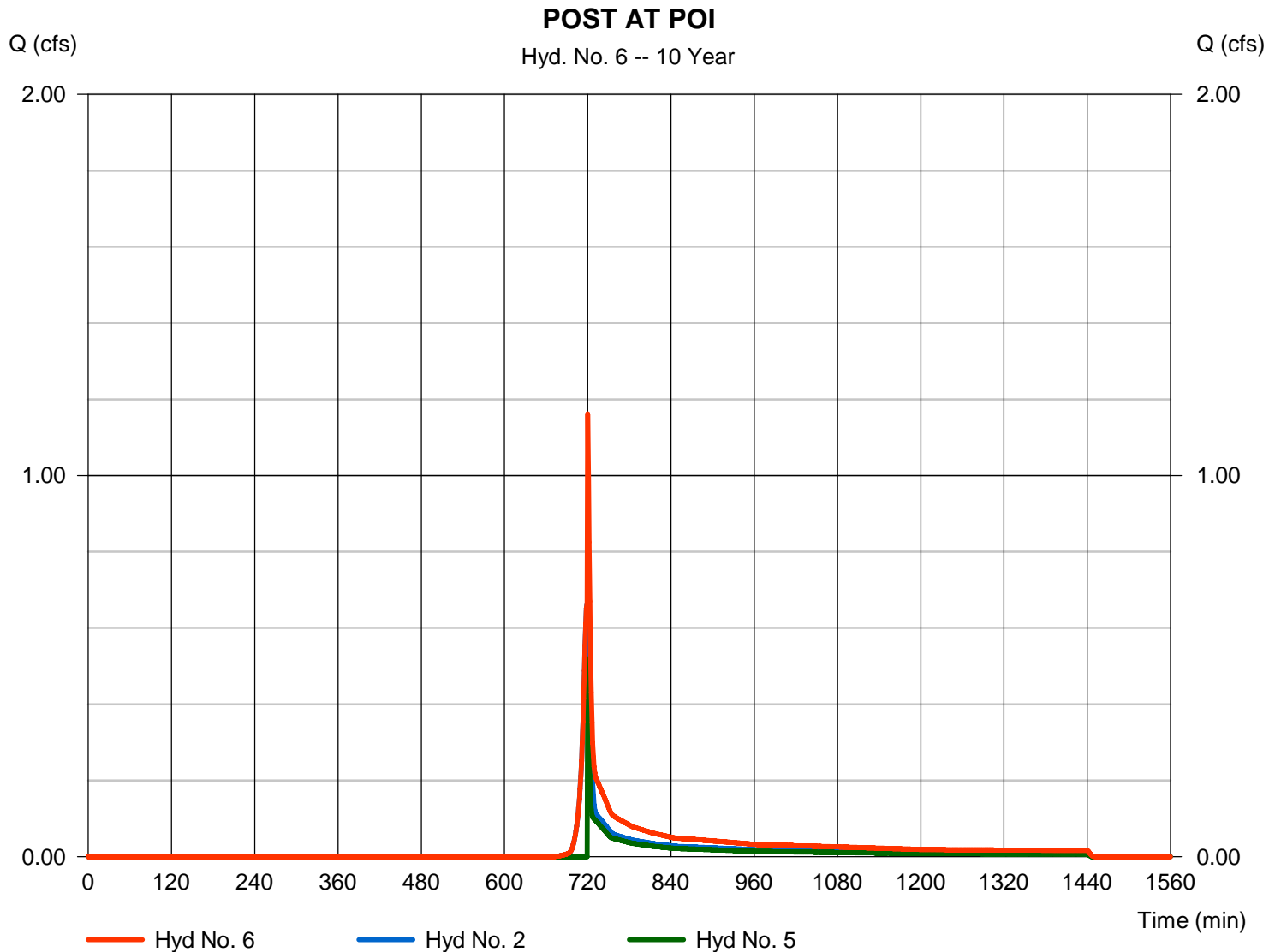
Tuesday, 10 / 25 / 2016

Hyd. No. 6

POST AT POI

Hydrograph type = Combine
 Storm frequency = 10 yrs
 Time interval = 1 min
 Inflow hyds. = 2, 5

Peak discharge = 1.161 cfs
 Time to peak = 720 min
 Hyd. volume = 2,240 cuft
 Contrib. drain. area = 0.360 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description	
1	SCS Runoff	2.233	1	718	4,485	-----	-----	-----	PRE	
2	SCS Runoff	1.266	1	719	2,671	-----	-----	-----	POST UNDETAINED	
3	SCS Runoff	1.187	1	716	2,310	-----	-----	-----	POST DETAINED	
4	Diversion1	0.828	1	712	653	3	-----	-----	VOLUME ABSTRACTION	
5	Diversion2	1.187	1	716	1,657	3	-----	-----	POST AFTER BMP	
6	Combine	2.382	1	717	4,328	2, 5	-----	-----	POST AT POI	
Juniata West.gpw					Return Period: 50 Year			Tuesday, 10 / 25 / 2016		

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

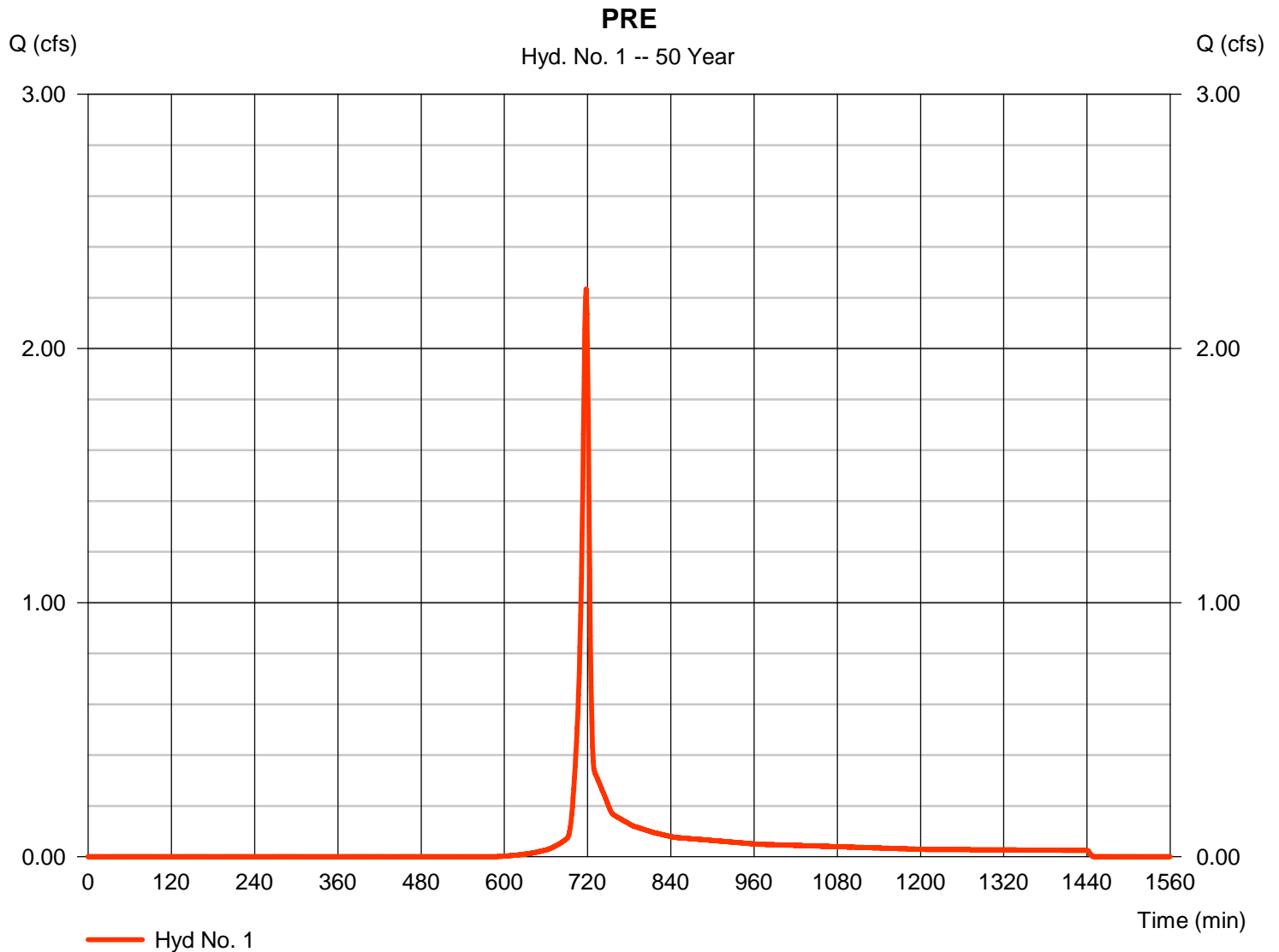
Tuesday, 10 / 25 / 2016

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 2.233 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 4,485 cuft
Drainage area	= 0.550 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 5.70 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 58) + (0.230 x 71) + (0.160 x 78)] / 0.550



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

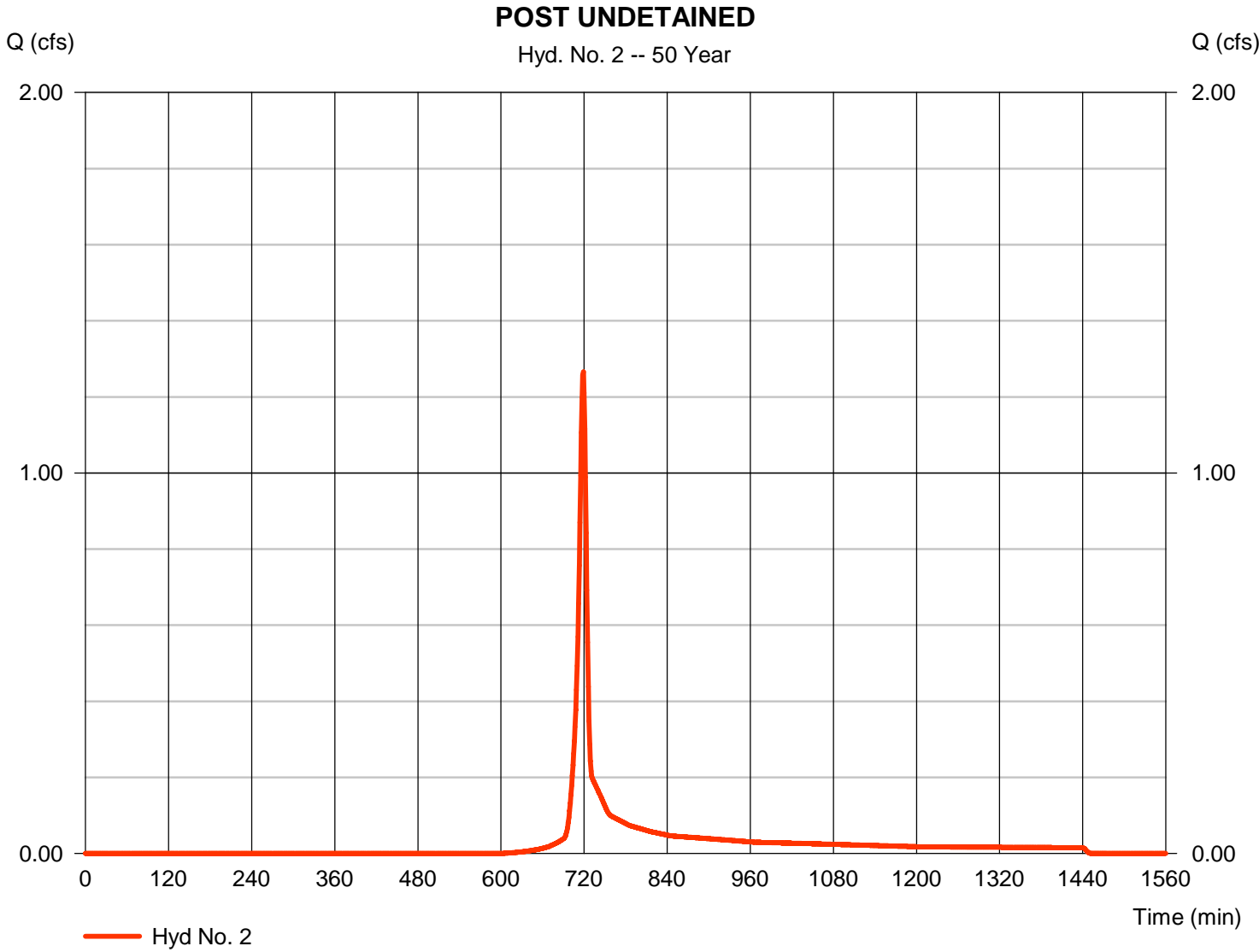
Tuesday, 10 / 25 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 1.266 cfs
Storm frequency	= 50 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 2,671 cuft
Drainage area	= 0.360 ac	Curve number	= 68*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 71) + (0.150 x 58) + (0.140 x 78)] / 0.360



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

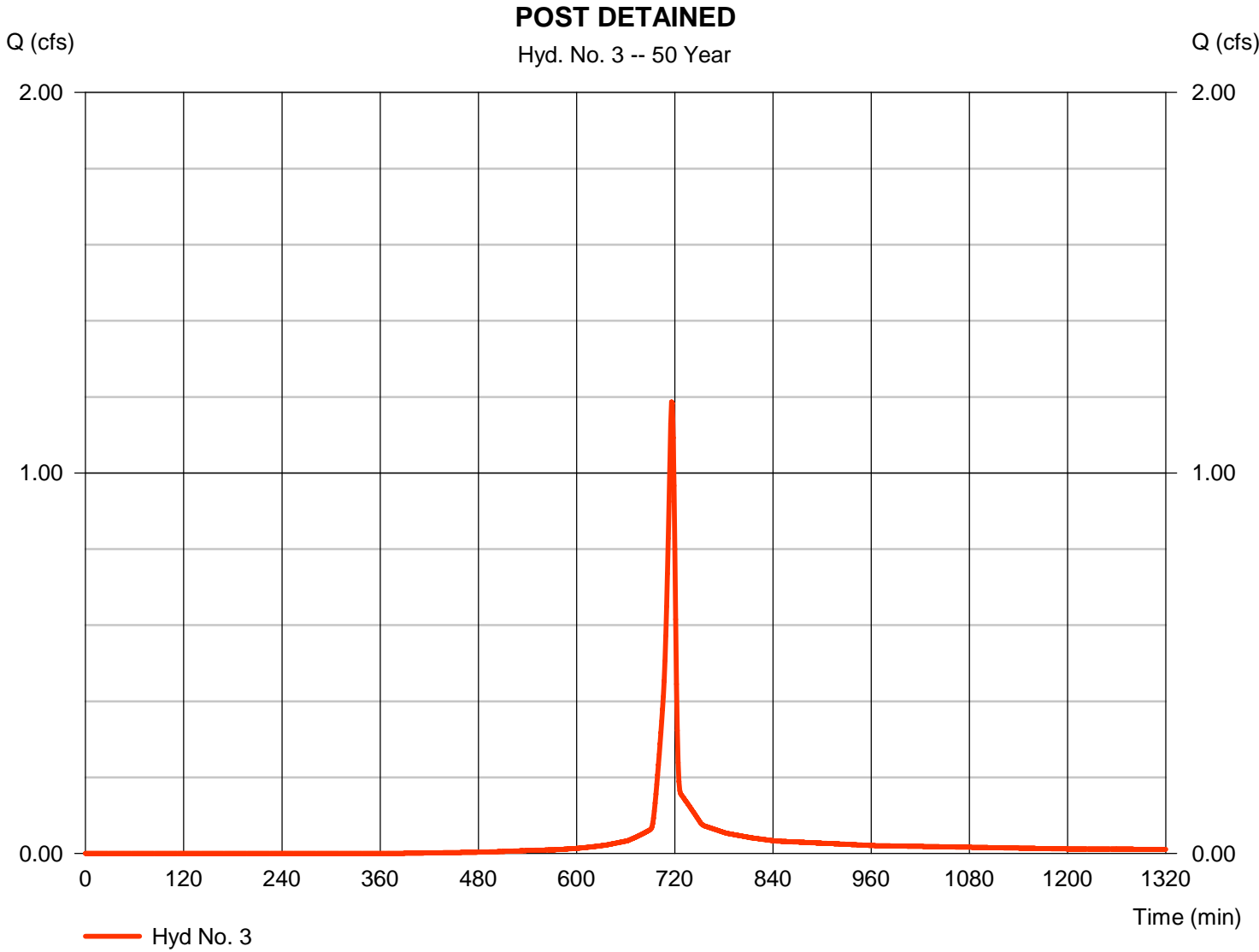
Tuesday, 10 / 25 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 1.187 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 1 min	Hyd. volume	= 2,310 cuft
Drainage area	= 0.190 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 3.60 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.130 x 89) + (0.030 x 71) + (0.020 x 58) + (0.010 x 78)] / 0.190



Hydrograph Report

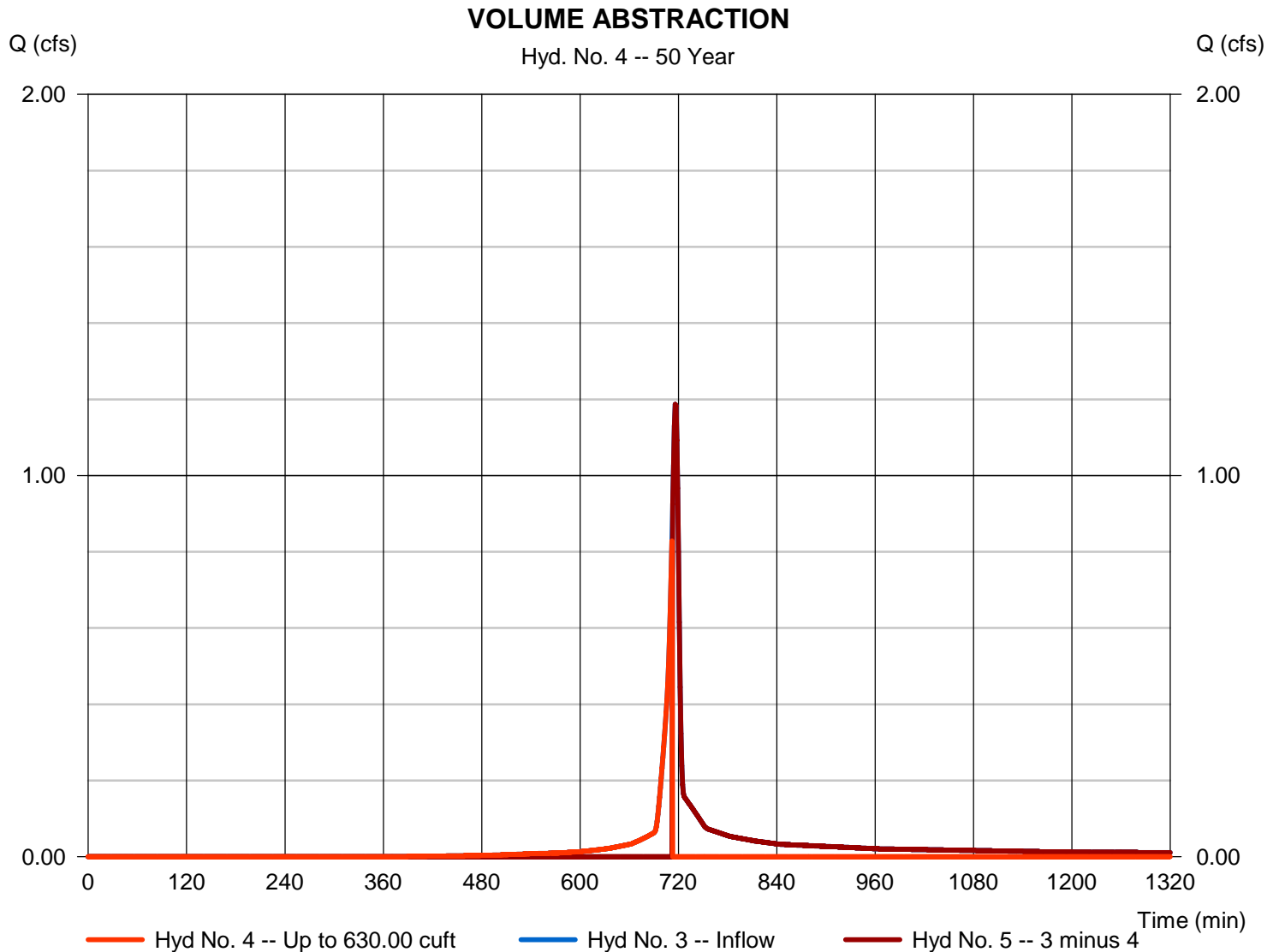
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.828 cfs
Storm frequency	= 50 yrs	Time to peak	= 712 min
Time interval	= 1 min	Hyd. volume	= 653 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

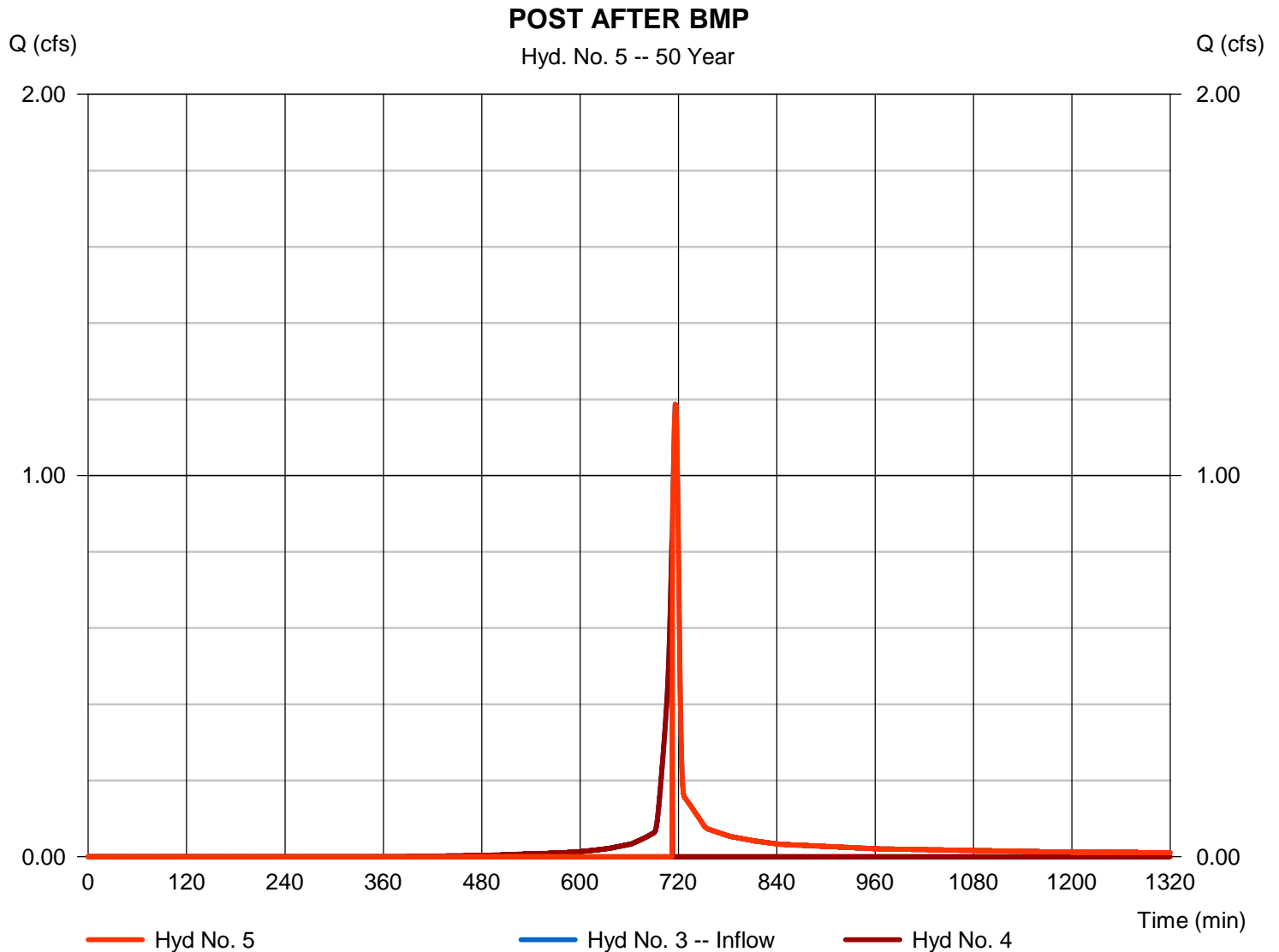
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 1.187 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 1 min	Hyd. volume	= 1,657 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

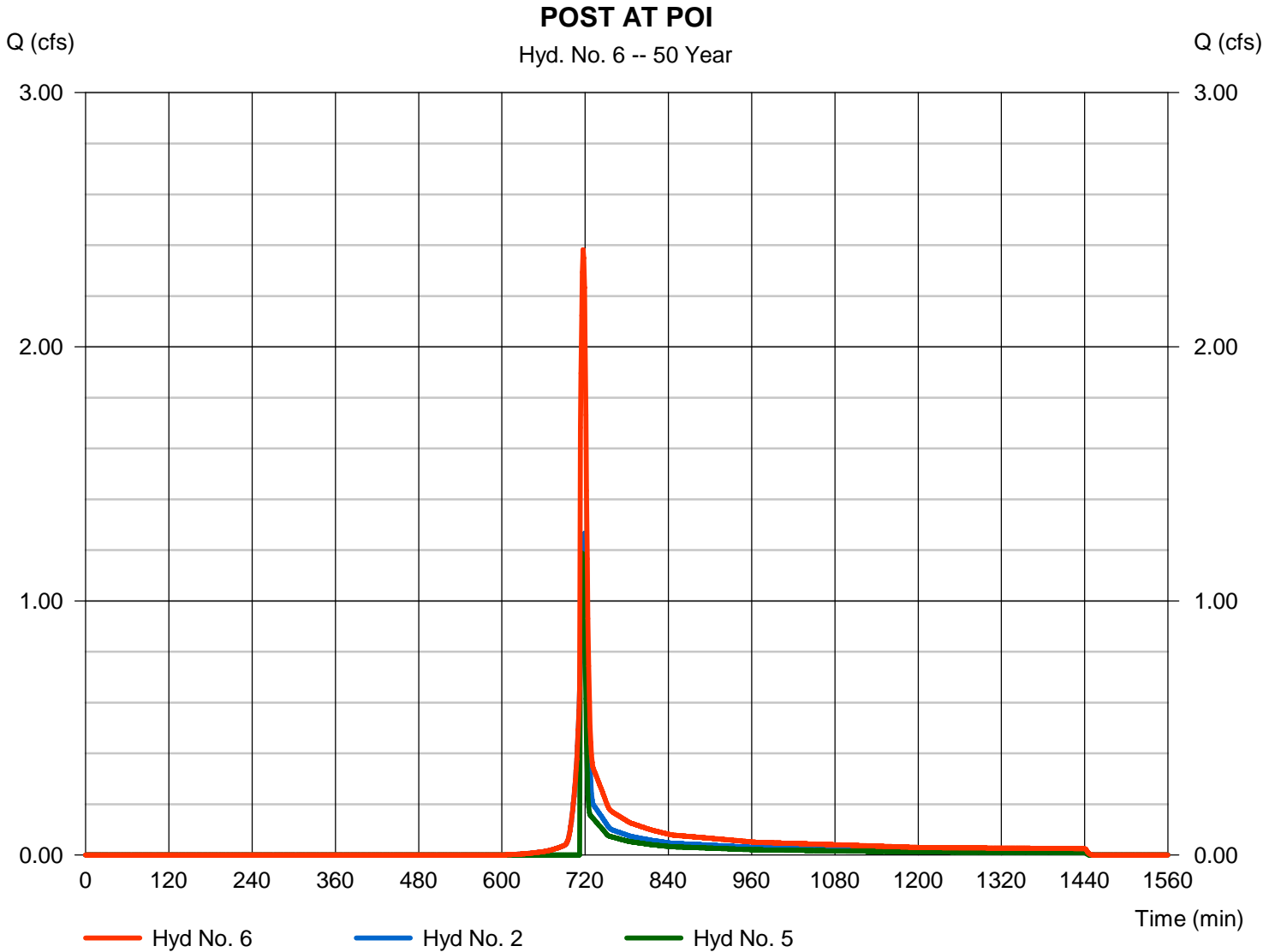
Tuesday, 10 / 25 / 2016

Hyd. No. 6

POST AT POI

Hydrograph type = Combine
Storm frequency = 50 yrs
Time interval = 1 min
Inflow hyds. = 2, 5

Peak discharge = 2.382 cfs
Time to peak = 717 min
Hyd. volume = 4,328 cuft
Contrib. drain. area = 0.360 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description	
1	SCS Runoff	2.770	1	718	5,569	-----	-----	-----	PRE	
2	SCS Runoff	1.579	1	719	3,330	-----	-----	-----	POST UNDETAINED	
3	SCS Runoff	1.398	1	716	2,744	-----	-----	-----	POST DETAINED	
4	Diversion1	0.686	1	709	657	3	-----	-----	VOLUME ABSTRACTION	
5	Diversion2	1.398	1	716	2,087	3	-----	-----	POST AFTER BMP	
6	Combine	2.897	1	717	5,417	2, 5	-----	-----	POST AT POI	
Juniata West.gpw					Return Period: 100 Year			Tuesday, 10 / 25 / 2016		

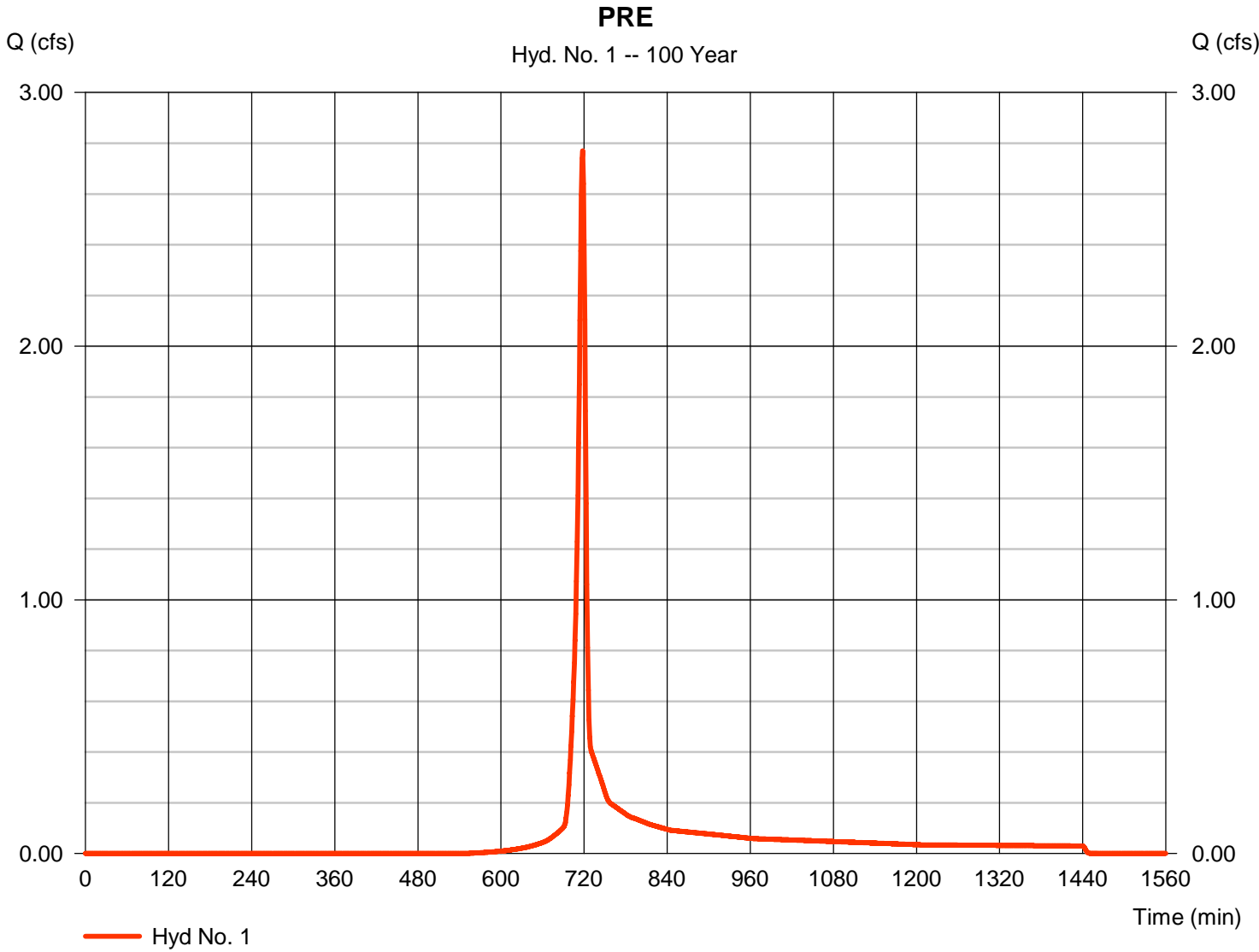
Hydrograph Report

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 2.770 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 5,569 cuft
Drainage area	= 0.550 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 5.70 min
Total precip.	= 5.99 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 58) + (0.230 x 71) + (0.160 x 78)] / 0.550



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

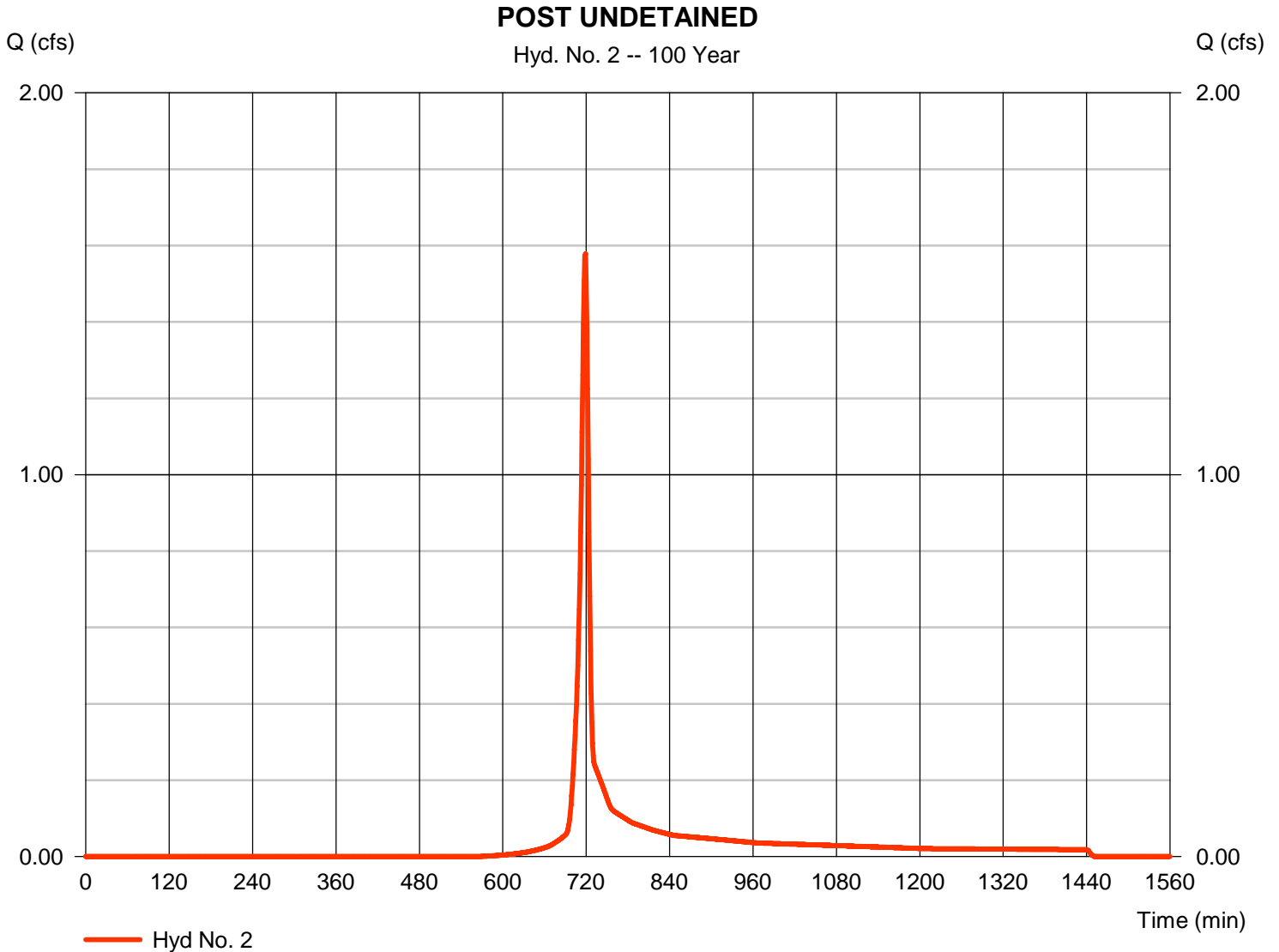
Tuesday, 10 / 25 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 1.579 cfs
Storm frequency	= 100 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 3,330 cuft
Drainage area	= 0.360 ac	Curve number	= 68*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 5.99 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 71) + (0.150 x 58) + (0.140 x 78)] / 0.360



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

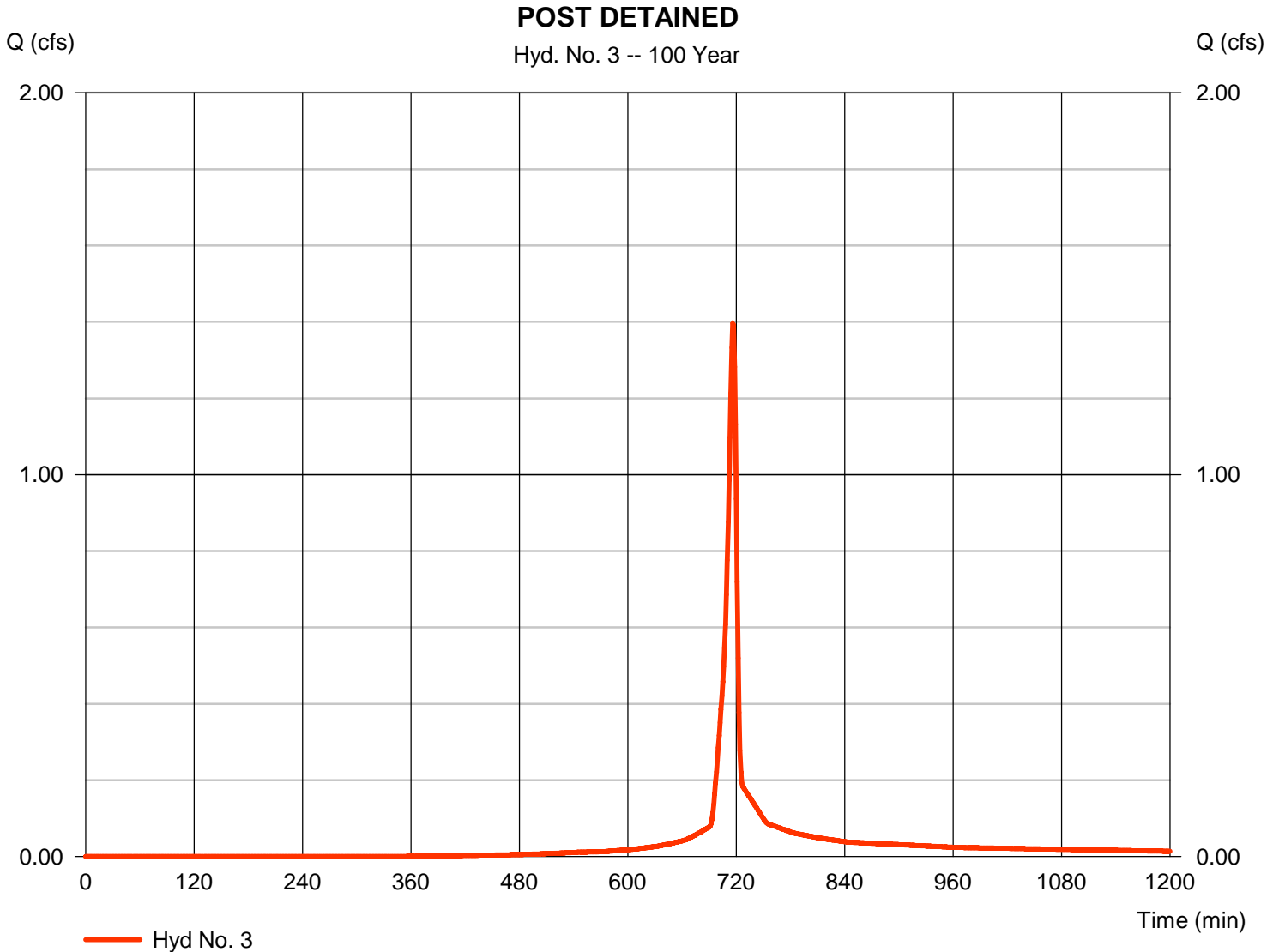
Tuesday, 10 / 25 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 1.398 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 1 min	Hyd. volume	= 2,744 cuft
Drainage area	= 0.190 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 3.60 min
Total precip.	= 5.99 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.130 x 89) + (0.030 x 71) + (0.020 x 58) + (0.010 x 78)] / 0.190



Hydrograph Report

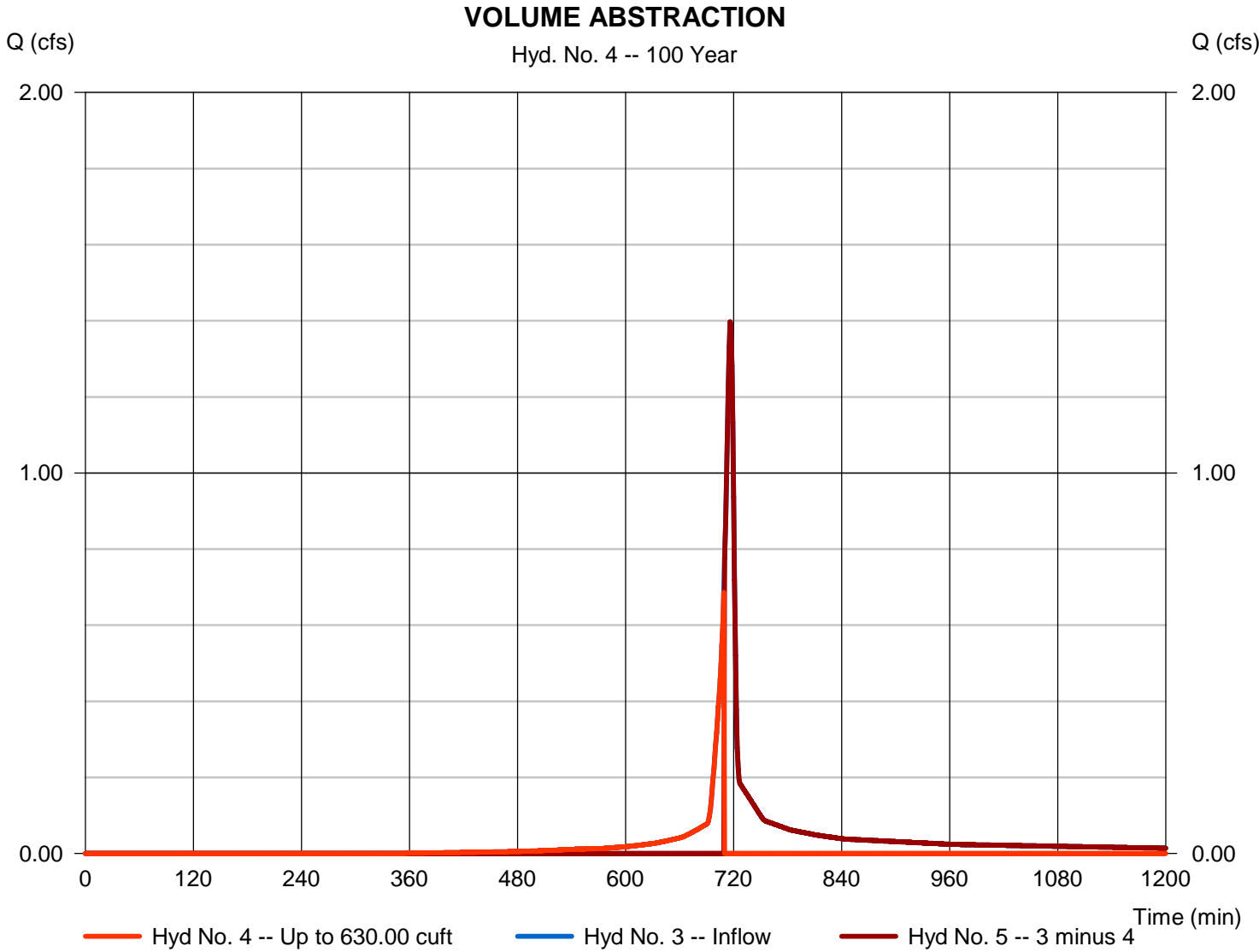
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.686 cfs
Storm frequency	= 100 yrs	Time to peak	= 709 min
Time interval	= 1 min	Hyd. volume	= 657 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

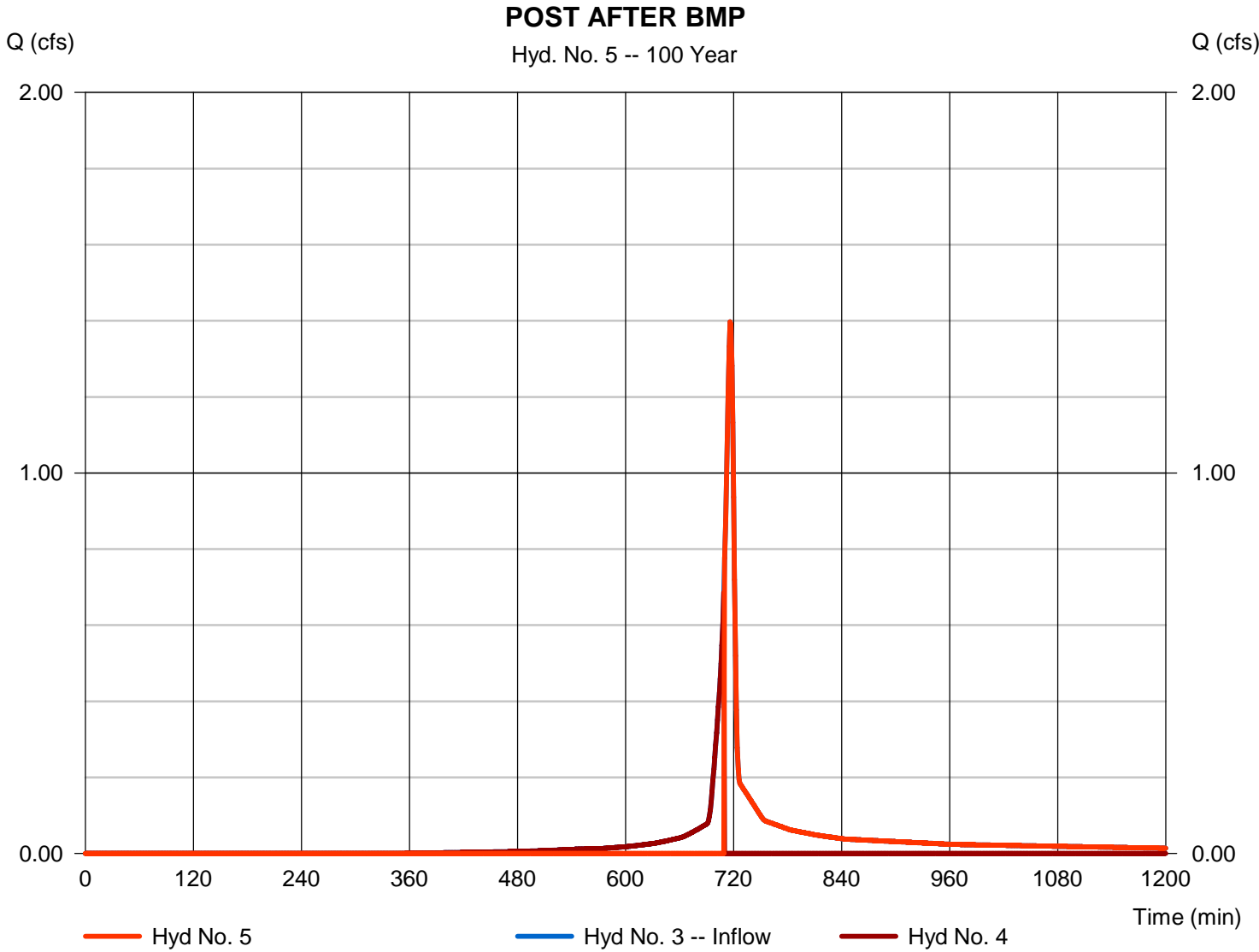
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 1.398 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 1 min	Hyd. volume	= 2,087 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

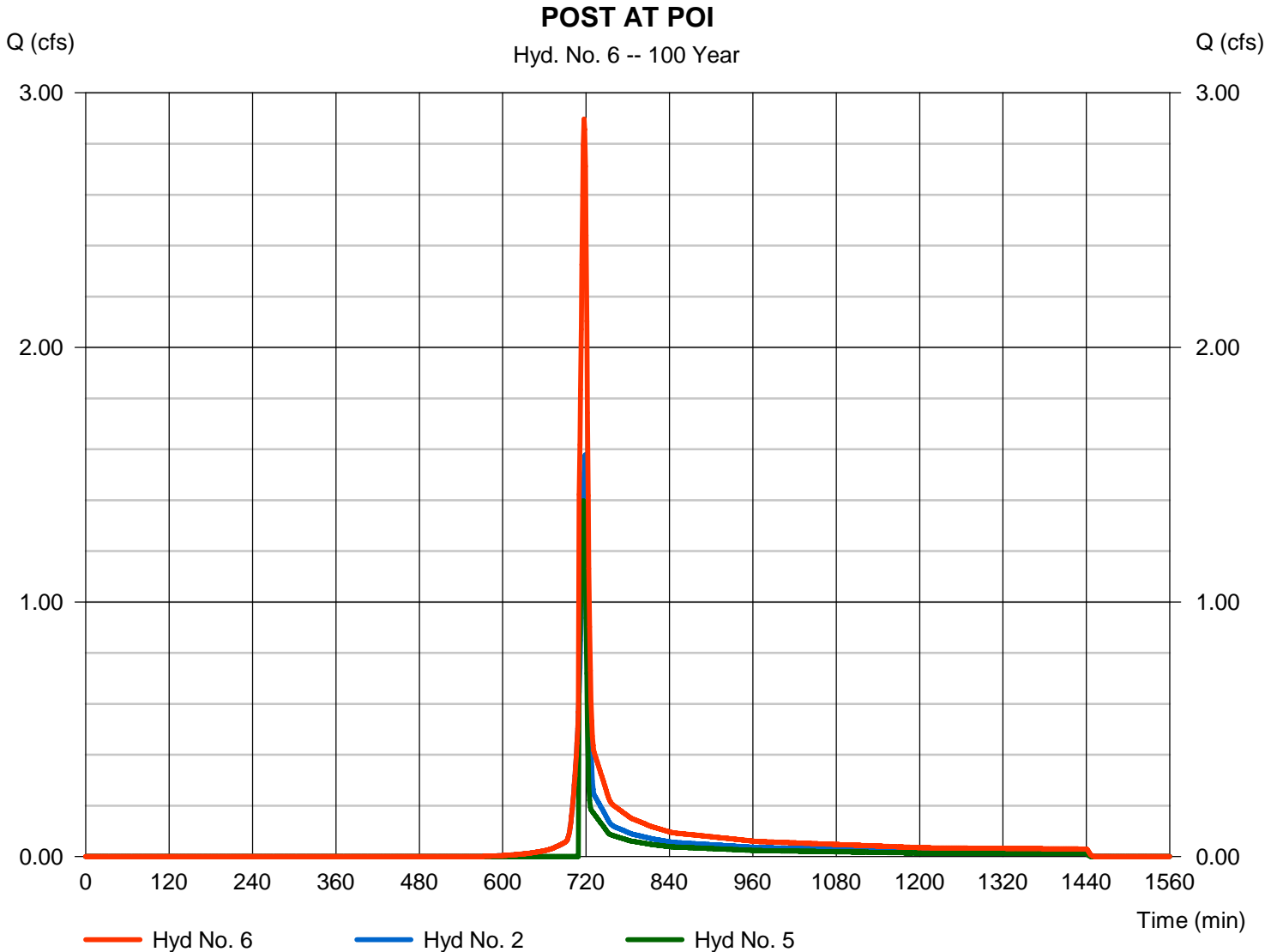
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 6

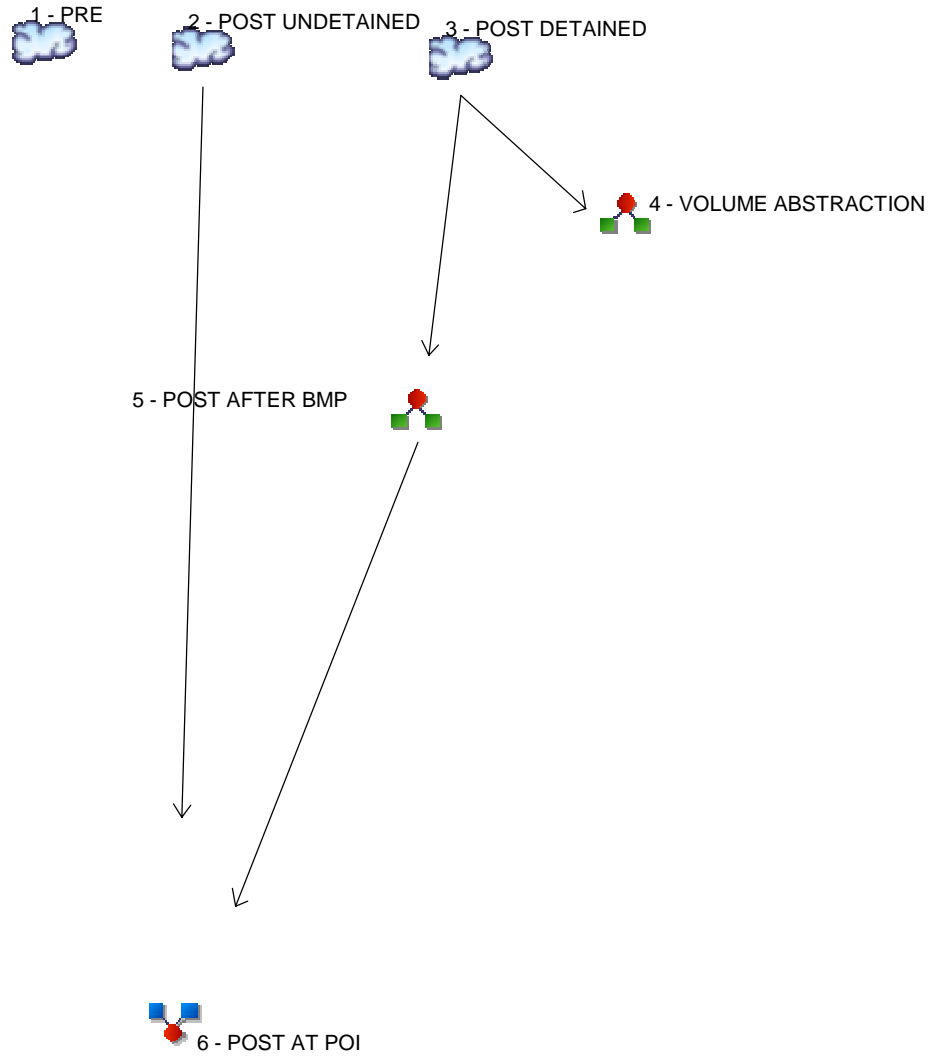
POST AT POI

Hydrograph type	= Combine	Peak discharge	= 2.897 cfs
Storm frequency	= 100 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 5,417 cuft
Inflow hyds.	= 2, 5	Contrib. drain. area	= 0.360 ac



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Legend

Hyd. Origin	Description
1	SCS Runoff PRE
2	SCS Runoff POST UNDETAINED
3	SCS Runoff POST DETAINED
4	Diversion1 VOLUME ABSTRACTION
5	Diversion2 POST AFTER BMP
6	Combine POST AT POI

Hydrograph Return Period Recap

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	0.463	-----	-----	-----	-----	-----	-----	PRE
2	SCS Runoff	-----	-----	0.245	-----	-----	-----	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	-----	-----	0.192	-----	-----	-----	-----	-----	-----	POST DETAINED
4	Diversion1	3	-----	0.192	-----	-----	-----	-----	-----	-----	VOLUME ABSTRACTION
5	Diversion2	3	-----	0.008	-----	-----	-----	-----	-----	-----	POST AFTER BMP
6	Combine	2, 5	-----	0.245	-----	-----	-----	-----	-----	-----	POST AT POI

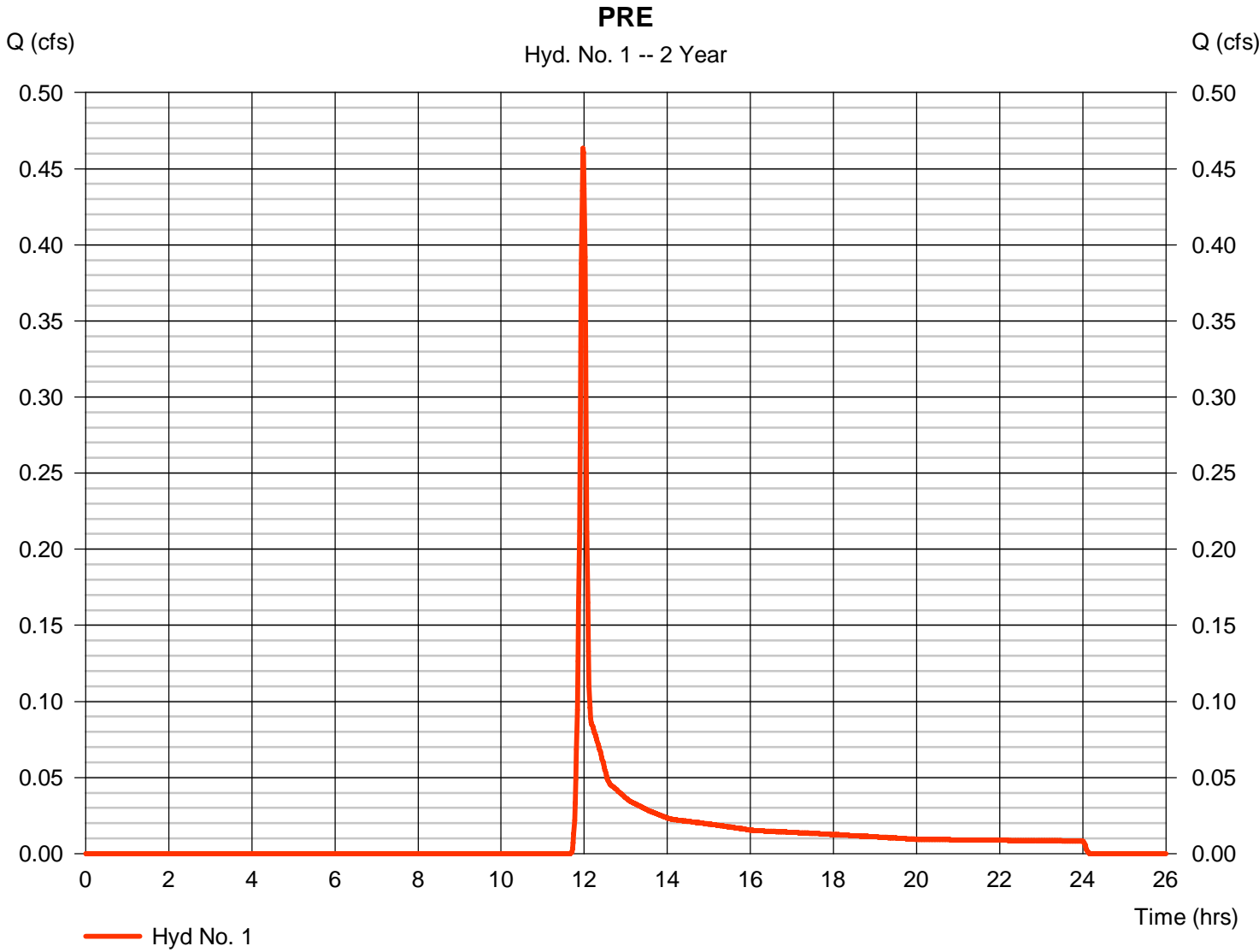
Hydrograph Report

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 0.463 cfs
Storm frequency	= 2 yrs	Time to peak	= 11.97 hrs
Time interval	= 1 min	Hyd. volume	= 1,041 cuft
Drainage area	= 0.550 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 5.70 min
Total precip.	= 2.68 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 58) + (0.230 x 71) + (0.160 x 78)] / 0.550



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 1

PRE

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.68	0.00	0.00	
Land slope (%)	= 10.26	0.00	0.00	
Travel Time (min)	= 4.66	+ 0.00	+ 0.00	= 4.66
Shallow Concentrated Flow				
Flow length (ft)	= 56.00	0.00	0.00	
Watercourse slope (%)	= 3.31	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=2.94	0.00	0.00	
Travel Time (min)	= 0.32	+ 0.00	+ 0.00	= 0.32
Channel Flow				
X sectional flow area (sqft)	= 16.00	0.00	0.00	
Wetted perimeter (ft)	= 28.00	0.00	0.00	
Channel slope (%)	= 1.81	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=4.59	0.00	0.00	
Flow length (ft)	211.0	0.0	0.0	
Travel Time (min)	= 0.77	+ 0.00	+ 0.00	= 0.77
Total Travel Time, Tc				5.70 min

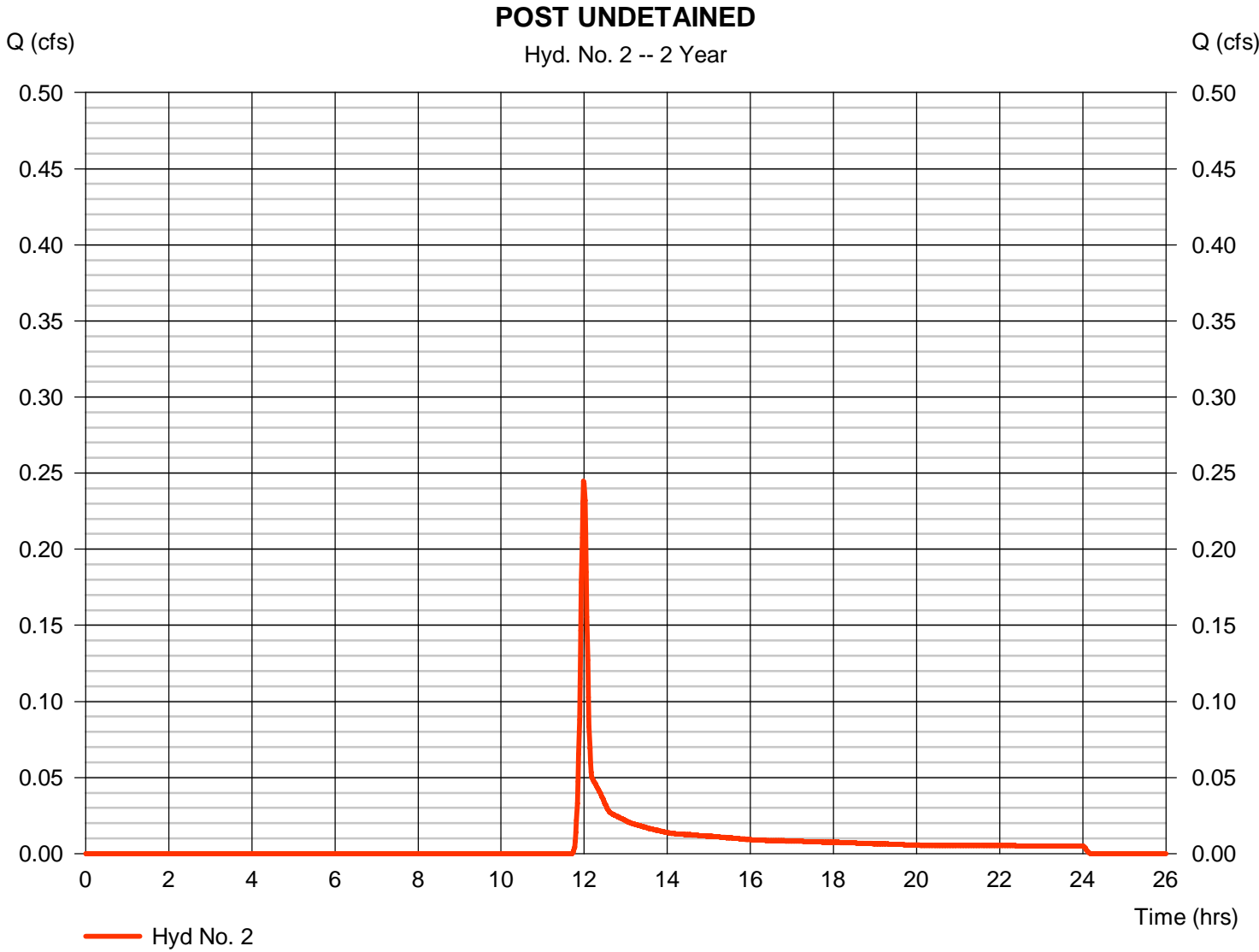
Hydrograph Report

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.245 cfs
Storm frequency	= 2 yrs	Time to peak	= 11.98 hrs
Time interval	= 1 min	Hyd. volume	= 598 cuft
Drainage area	= 0.360 ac	Curve number	= 68*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 2.68 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 71) + (0.150 x 58) + (0.140 x 78)] / 0.360



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 2

POST UNDETAINED

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.68	0.00	0.00	
Land slope (%)	= 8.00	0.00	0.00	
Travel Time (min)	= 5.14	+ 0.00	+ 0.00	= 5.14
Shallow Concentrated Flow				
Flow length (ft)	= 244.00	0.00	0.00	
Watercourse slope (%)	= 2.30	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=2.45	0.00	0.00	
Travel Time (min)	= 1.66	+ 0.00	+ 0.00	= 1.66
Channel Flow				
X sectional flow area (sqft)	= 16.00	0.00	0.00	
Wetted perimeter (ft)	= 28.00	0.00	0.00	
Channel slope (%)	= 1.81	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=4.59	0.00	0.00	
Flow length (ft)	211.0	0.0	0.0	
Travel Time (min)	= 0.77	+ 0.00	+ 0.00	= 0.77
Total Travel Time, Tc				7.60 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

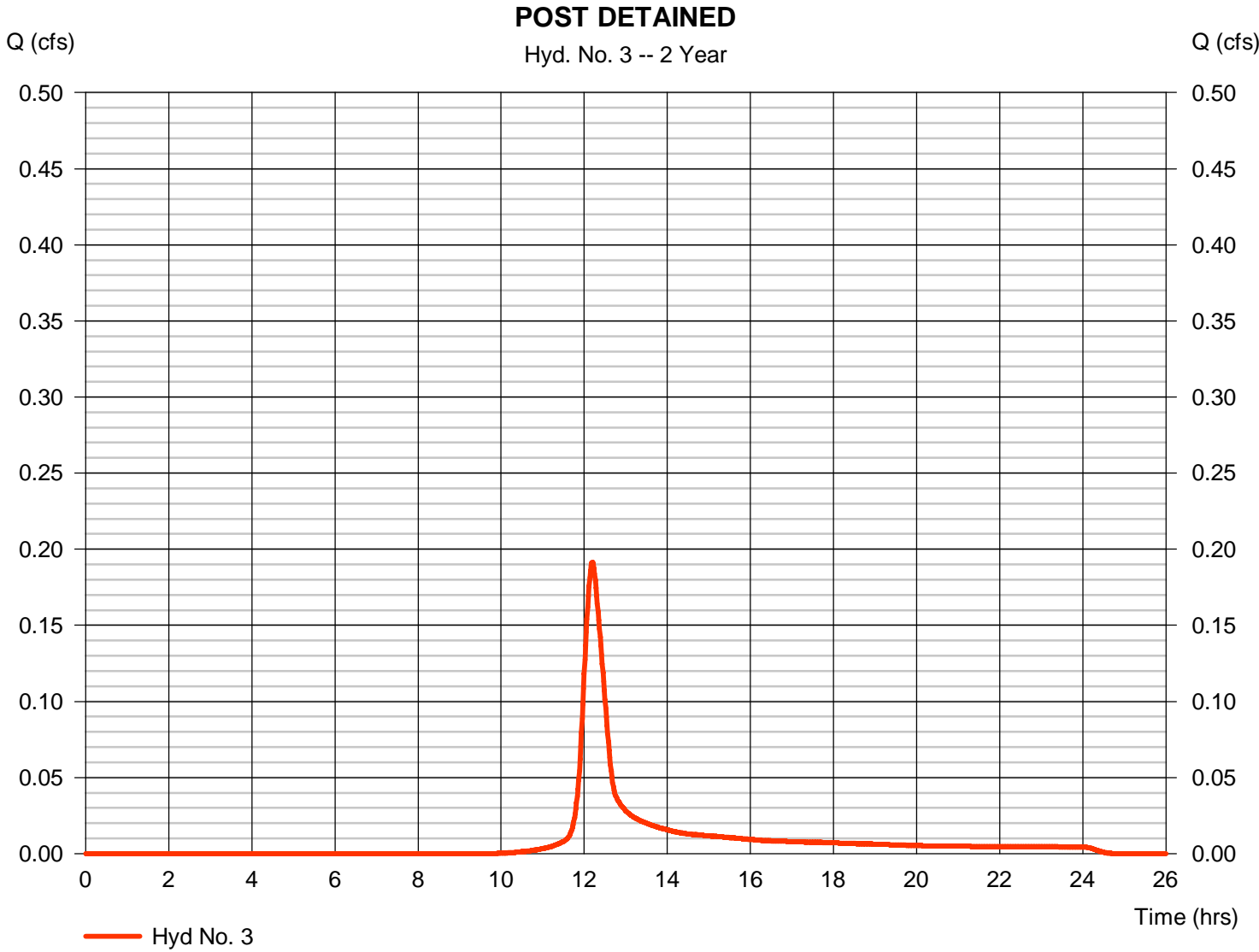
Tuesday, 10 / 25 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.192 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.20 hrs
Time interval	= 1 min	Hyd. volume	= 781 cuft
Drainage area	= 0.190 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 28.80 min
Total precip.	= 2.68 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.130 x 89) + (0.030 x 71) + (0.020 x 58) + (0.010 x 78)] / 0.190

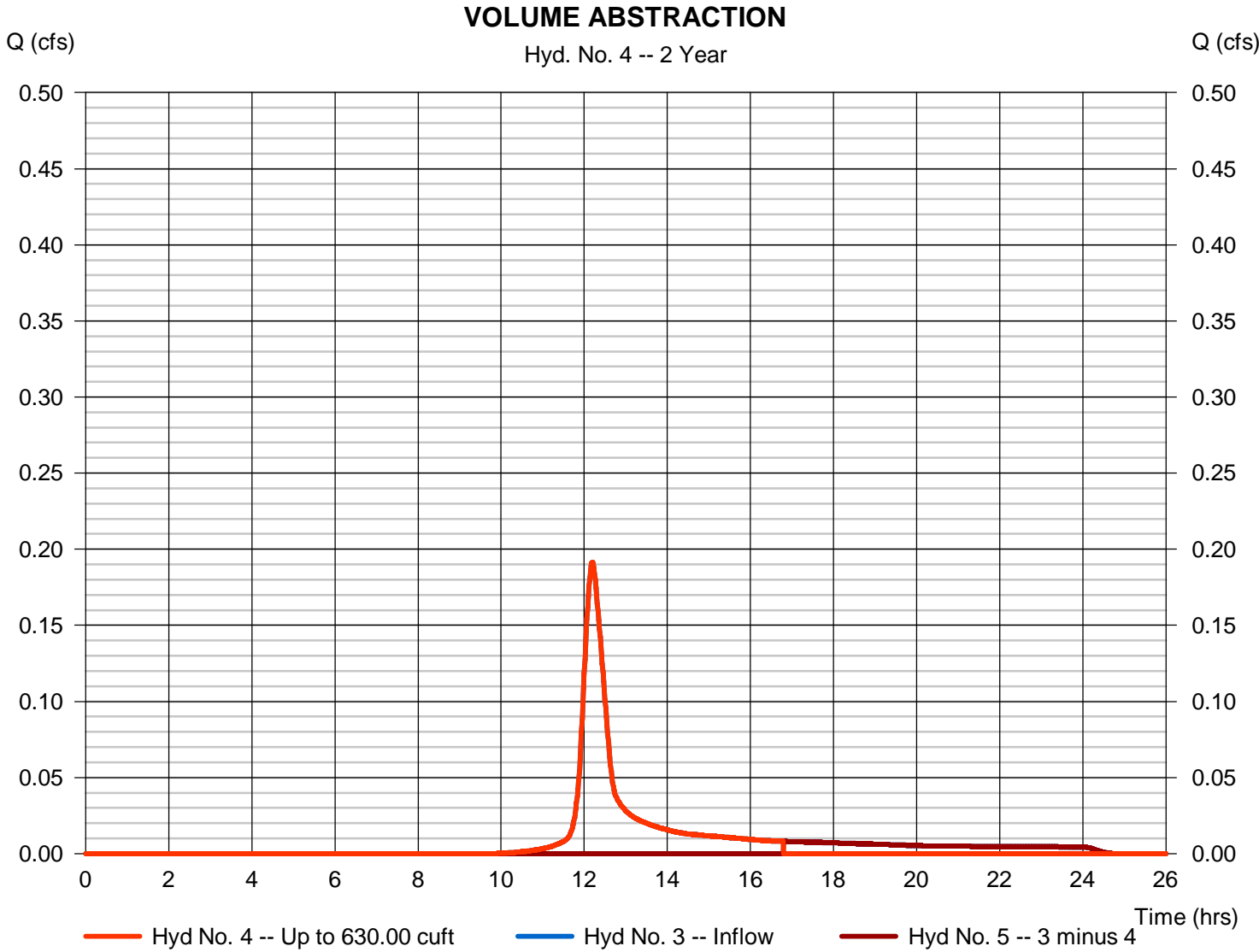


Hydrograph Report

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.192 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.20 hrs
Time interval	= 1 min	Hyd. volume	= 630 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

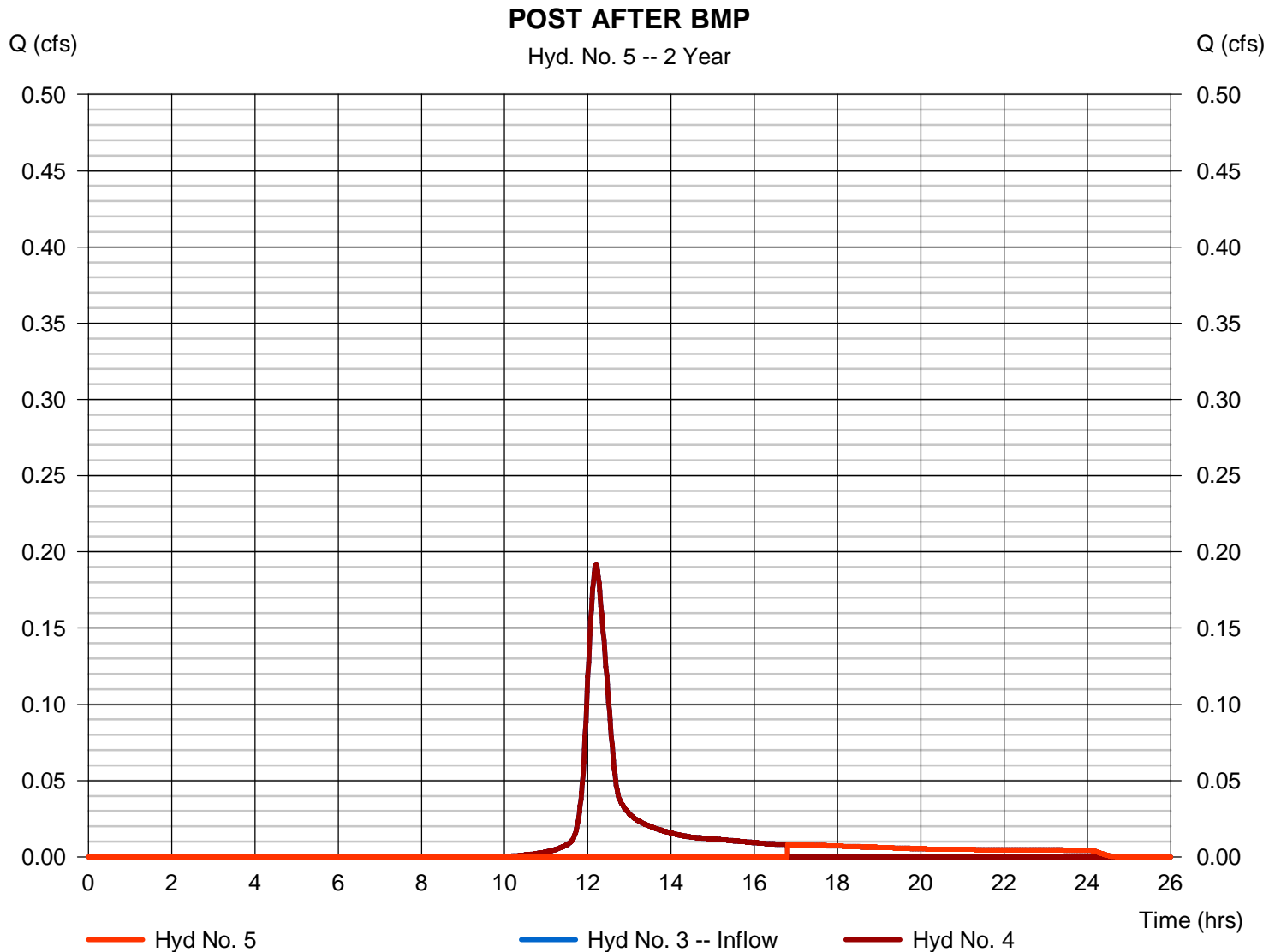
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 0.008 cfs
Storm frequency	= 2 yrs	Time to peak	= 16.80 hrs
Time interval	= 1 min	Hyd. volume	= 150 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

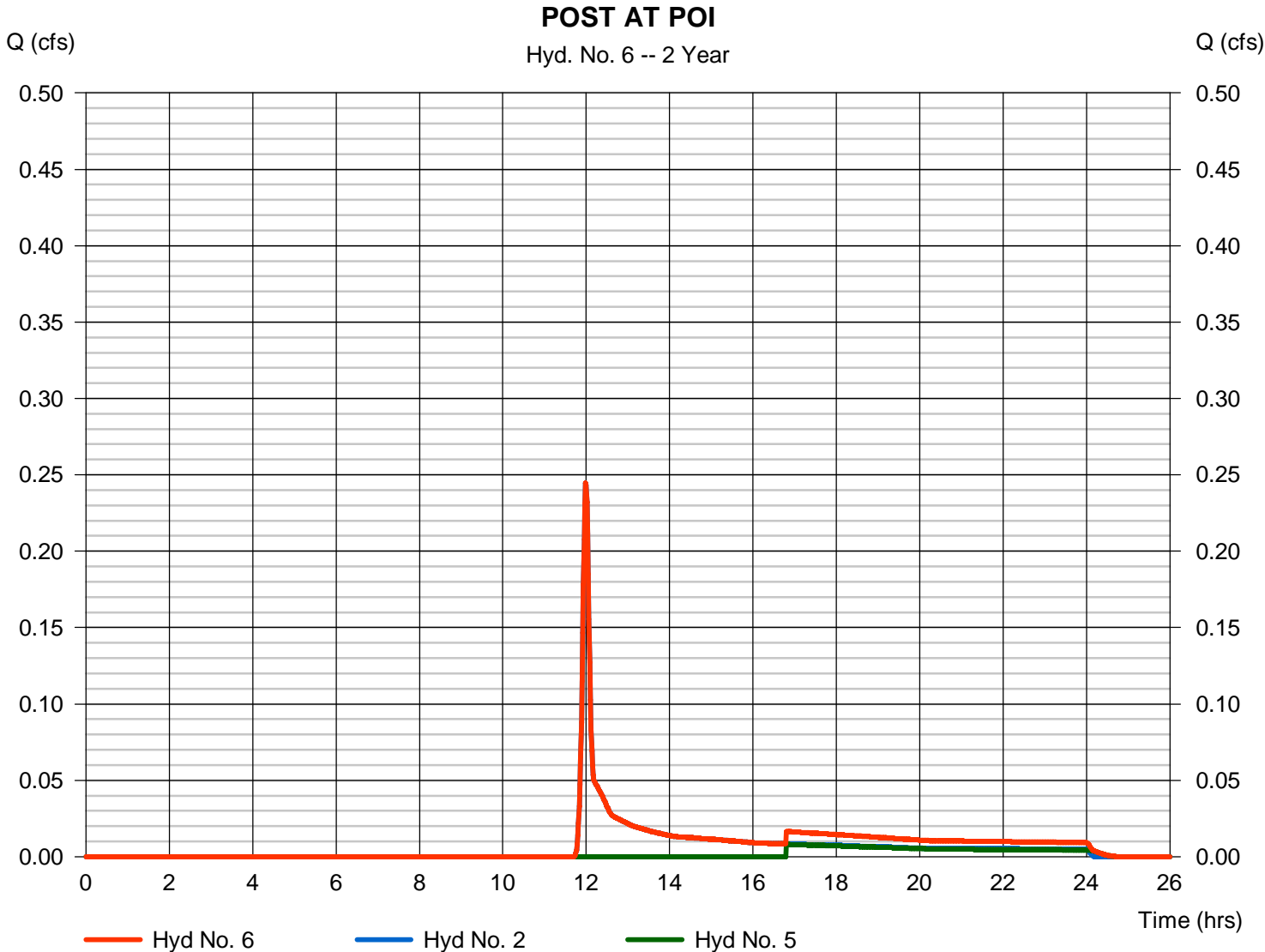
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 6

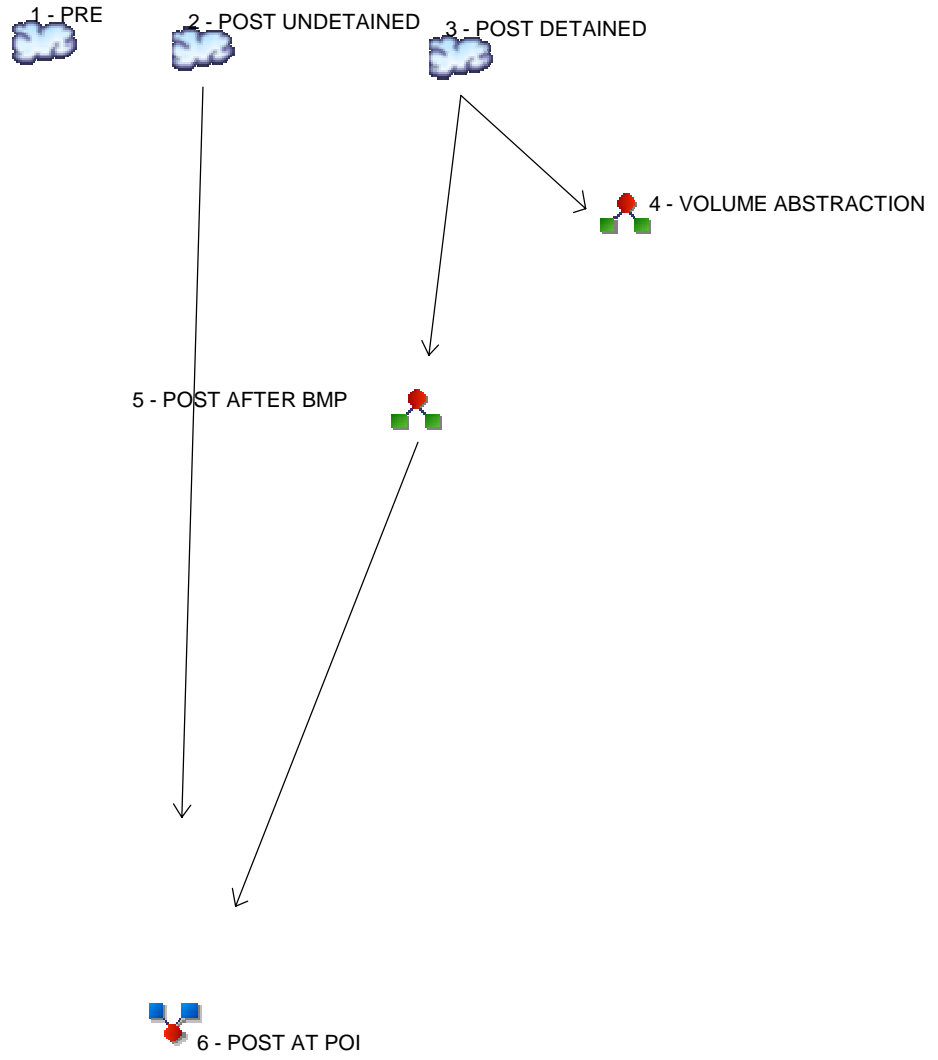
POST AT POI

Hydrograph type	= Combine	Peak discharge	= 0.245 cfs
Storm frequency	= 2 yrs	Time to peak	= 11.98 hrs
Time interval	= 1 min	Hyd. volume	= 748 cuft
Inflow hyds.	= 2, 5	Contrib. drain. area	= 0.360 ac



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Legend

Hyd. Origin	Description
1	SCS Runoff PRE
2	SCS Runoff POST UNDETAINED
3	SCS Runoff POST DETAINED
4	Diversion1 VOLUME ABSTRACTION
5	Diversion2 POST AFTER BMP
6	Combine POST AT POI

Hydrograph Return Period Recap

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	1.196	-----	-----	-----	PRE
2	SCS Runoff	-----	-----	-----	-----	-----	0.664	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	-----	-----	-----	-----	-----	0.482	-----	-----	-----	POST DETAINED
4	Diversion1	3	-----	-----	-----	-----	0.482	-----	-----	-----	VOLUME ABSTRACTION
5	Diversion2	3	-----	-----	-----	-----	0.300	-----	-----	-----	POST AFTER BMP
6	Combine	2, 5	-----	-----	-----	-----	0.664	-----	-----	-----	POST AT POI

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	1.196	1	718	2,435	-----	-----	-----	PRE
2	SCS Runoff	0.664	1	719	1,432	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	0.482	1	724	1,427	-----	-----	-----	POST DETAINED
4	Diversion1	0.482	1	724	649	3	-----	-----	VOLUME ABSTRACTION
5	Diversion2	0.300	1	733	777	3	-----	-----	POST AFTER BMP
6	Combine	0.664	1	719	2,209	2, 5	-----	-----	POST AT POI

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

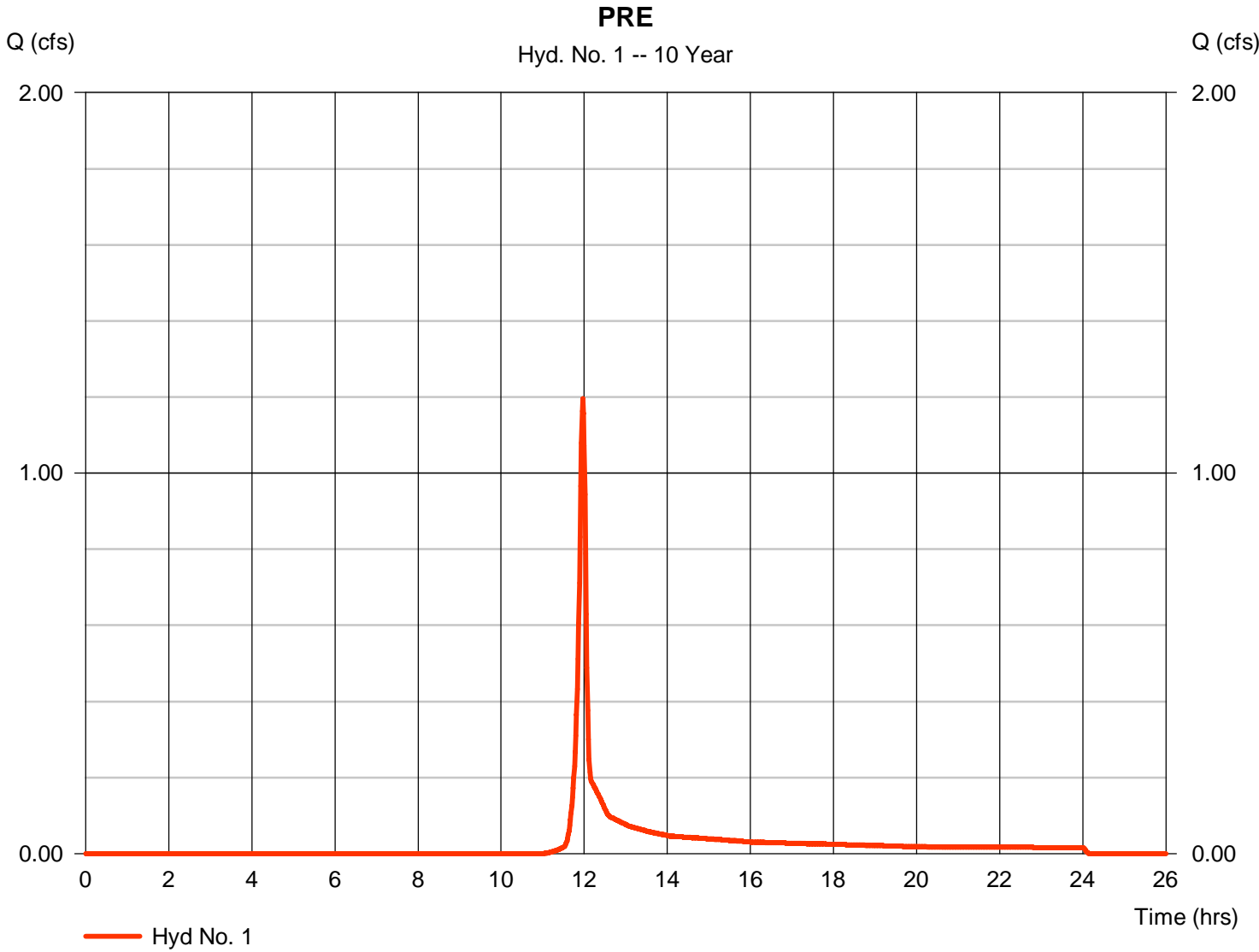
Tuesday, 10 / 25 / 2016

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 1.196 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.97 hrs
Time interval	= 1 min	Hyd. volume	= 2,435 cuft
Drainage area	= 0.550 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 5.70 min
Total precip.	= 3.87 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 58) + (0.230 x 71) + (0.160 x 78)] / 0.550



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 1

PRE

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.68	0.00	0.00	
Land slope (%)	= 10.26	0.00	0.00	
Travel Time (min)	= 4.66	+ 0.00	+ 0.00	= 4.66
Shallow Concentrated Flow				
Flow length (ft)	= 56.00	0.00	0.00	
Watercourse slope (%)	= 3.31	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=2.94	0.00	0.00	
Travel Time (min)	= 0.32	+ 0.00	+ 0.00	= 0.32
Channel Flow				
X sectional flow area (sqft)	= 16.00	0.00	0.00	
Wetted perimeter (ft)	= 28.00	0.00	0.00	
Channel slope (%)	= 1.81	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=4.59	0.00	0.00	
Flow length (ft)	211.0	0.0	0.0	
Travel Time (min)	= 0.77	+ 0.00	+ 0.00	= 0.77
Total Travel Time, Tc				5.70 min

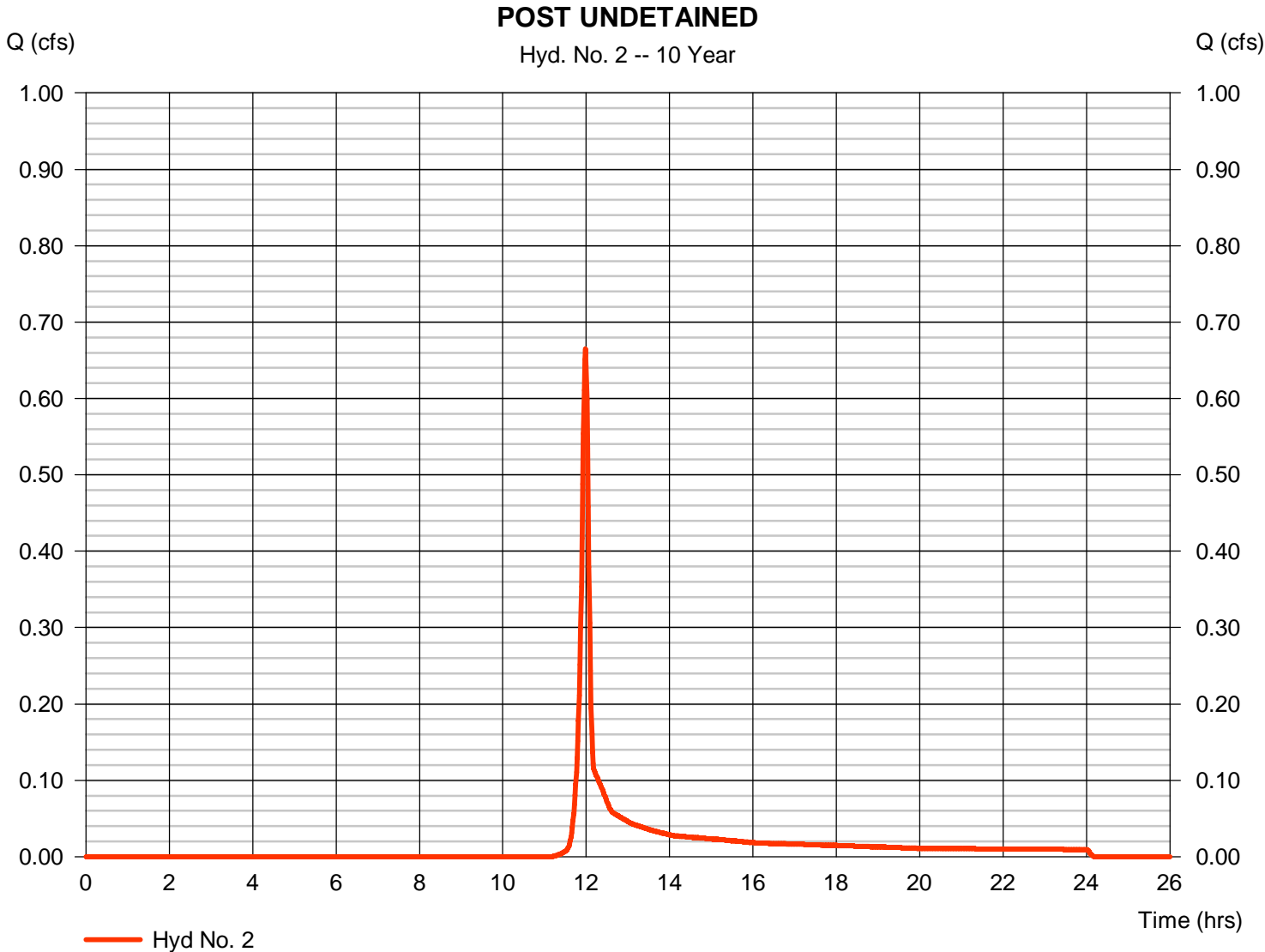
Hydrograph Report

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.664 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.98 hrs
Time interval	= 1 min	Hyd. volume	= 1,432 cuft
Drainage area	= 0.360 ac	Curve number	= 68*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 3.87 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 71) + (0.150 x 58) + (0.140 x 78)] / 0.360



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 2

POST UNDETAINED

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.68	0.00	0.00	
Land slope (%)	= 8.00	0.00	0.00	
Travel Time (min)	= 5.14	+ 0.00	+ 0.00	= 5.14
Shallow Concentrated Flow				
Flow length (ft)	= 244.00	0.00	0.00	
Watercourse slope (%)	= 2.30	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=2.45	0.00	0.00	
Travel Time (min)	= 1.66	+ 0.00	+ 0.00	= 1.66
Channel Flow				
X sectional flow area (sqft)	= 16.00	0.00	0.00	
Wetted perimeter (ft)	= 28.00	0.00	0.00	
Channel slope (%)	= 1.81	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=4.59	0.00	0.00	
Flow length (ft)	211.0	0.0	0.0	
Travel Time (min)	= 0.77	+ 0.00	+ 0.00	= 0.77
Total Travel Time, Tc				7.60 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

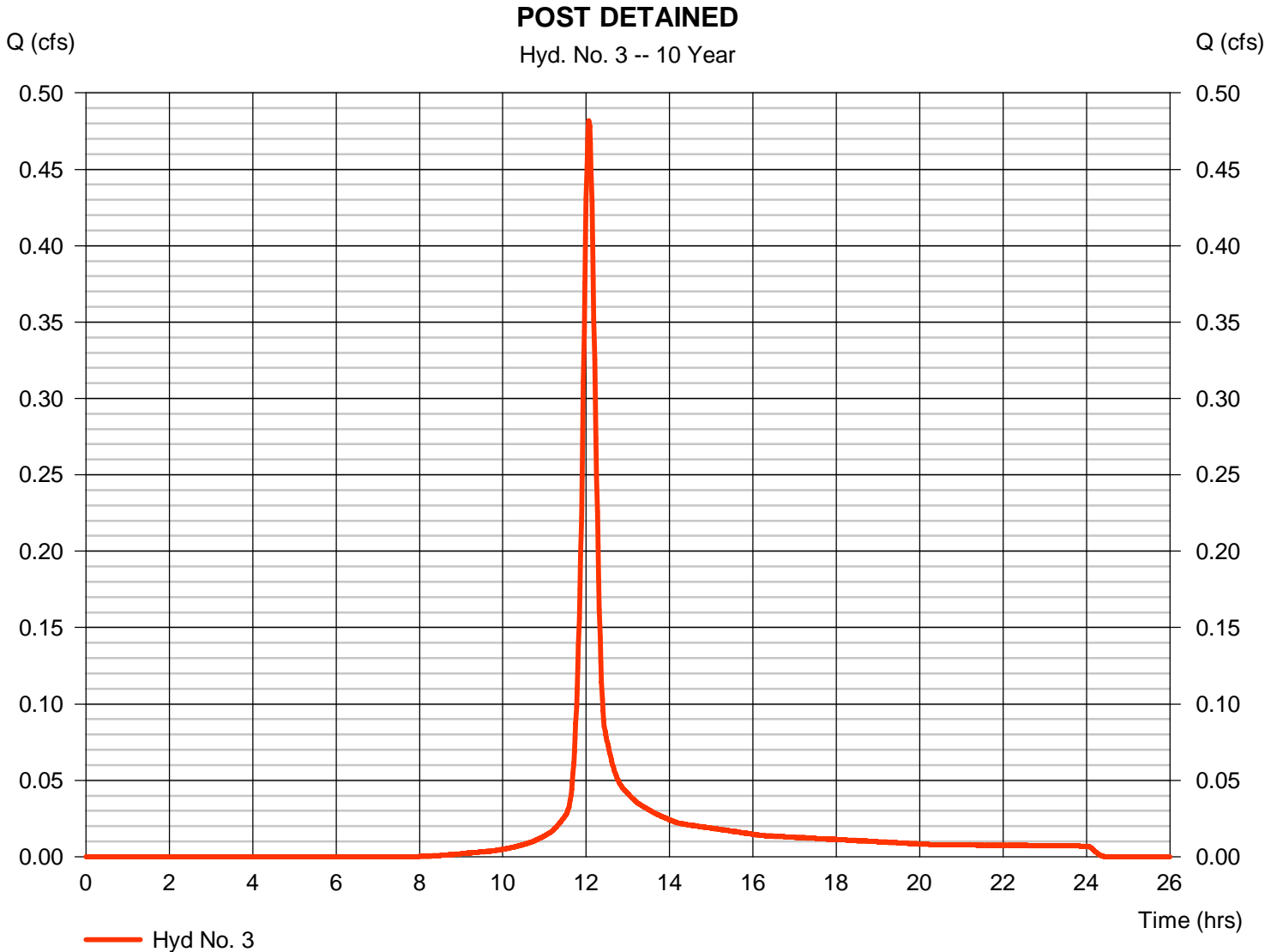
Tuesday, 10 / 25 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.482 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 1 min	Hyd. volume	= 1,427 cuft
Drainage area	= 0.190 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 17.50 min
Total precip.	= 3.87 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.130 x 89) + (0.030 x 71) + (0.020 x 58) + (0.010 x 78)] / 0.190



Hydrograph Report

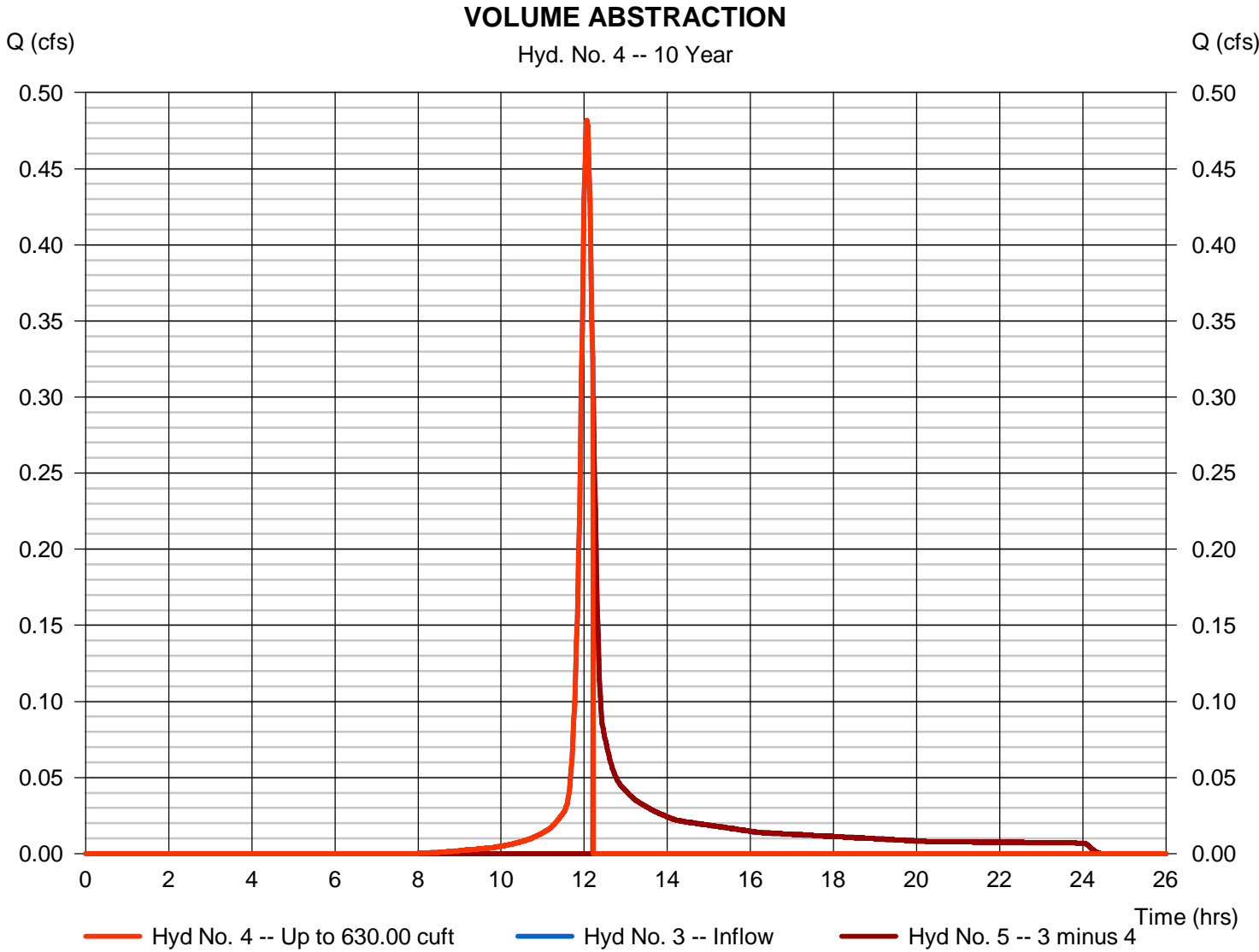
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.482 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 1 min	Hyd. volume	= 649 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

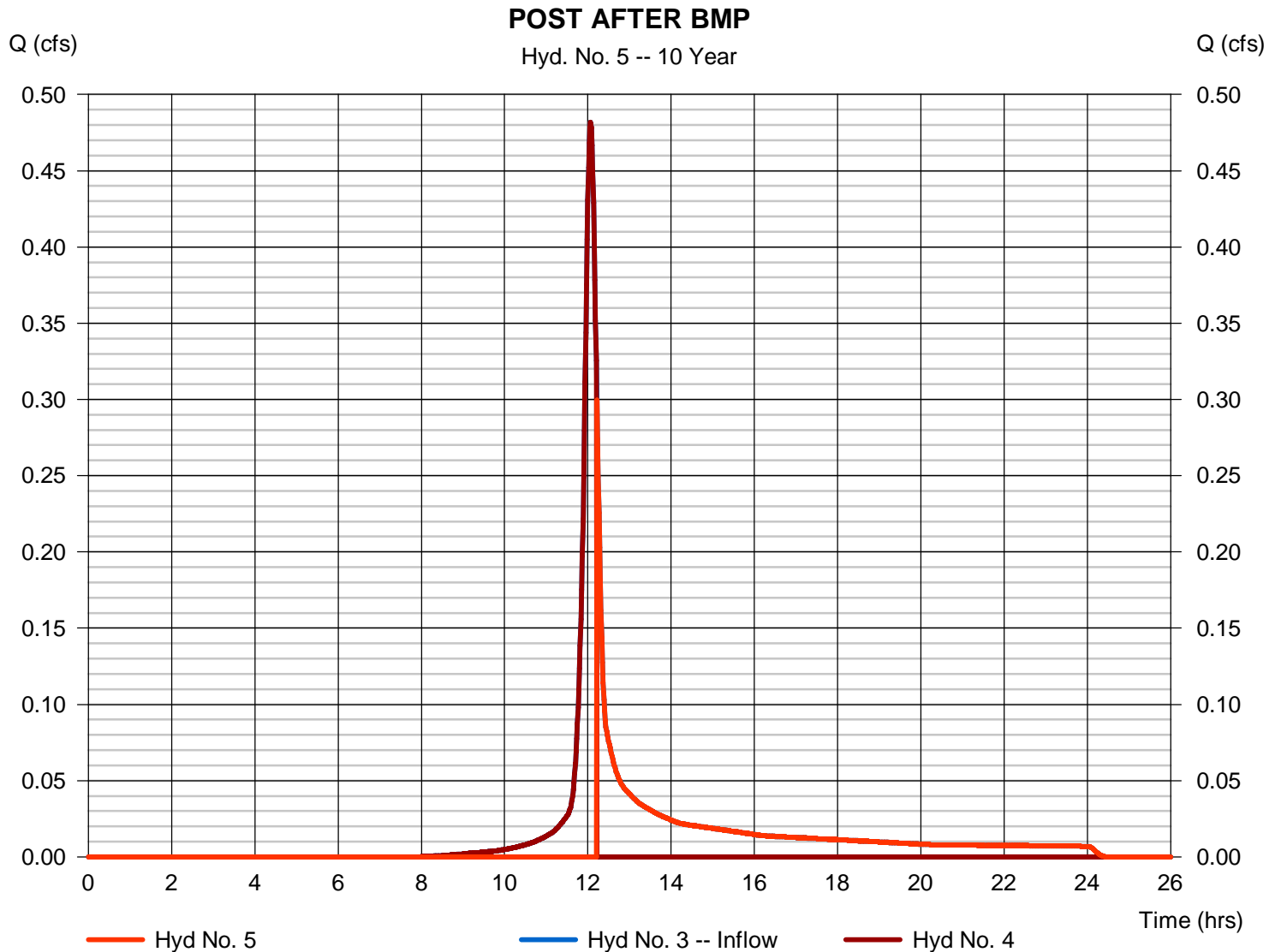
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 0.300 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.22 hrs
Time interval	= 1 min	Hyd. volume	= 777 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

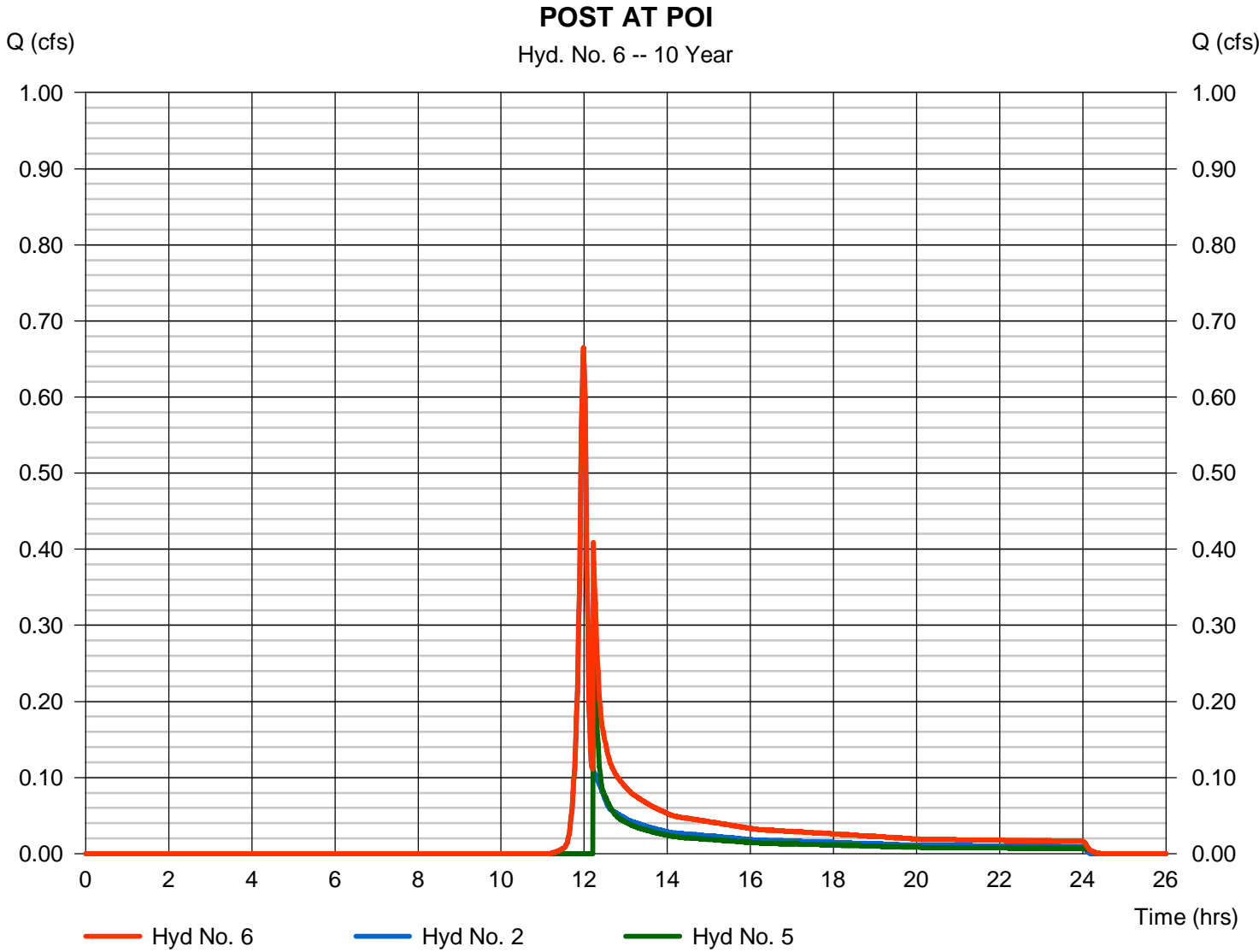
Tuesday, 10 / 25 / 2016

Hyd. No. 6

POST AT POI

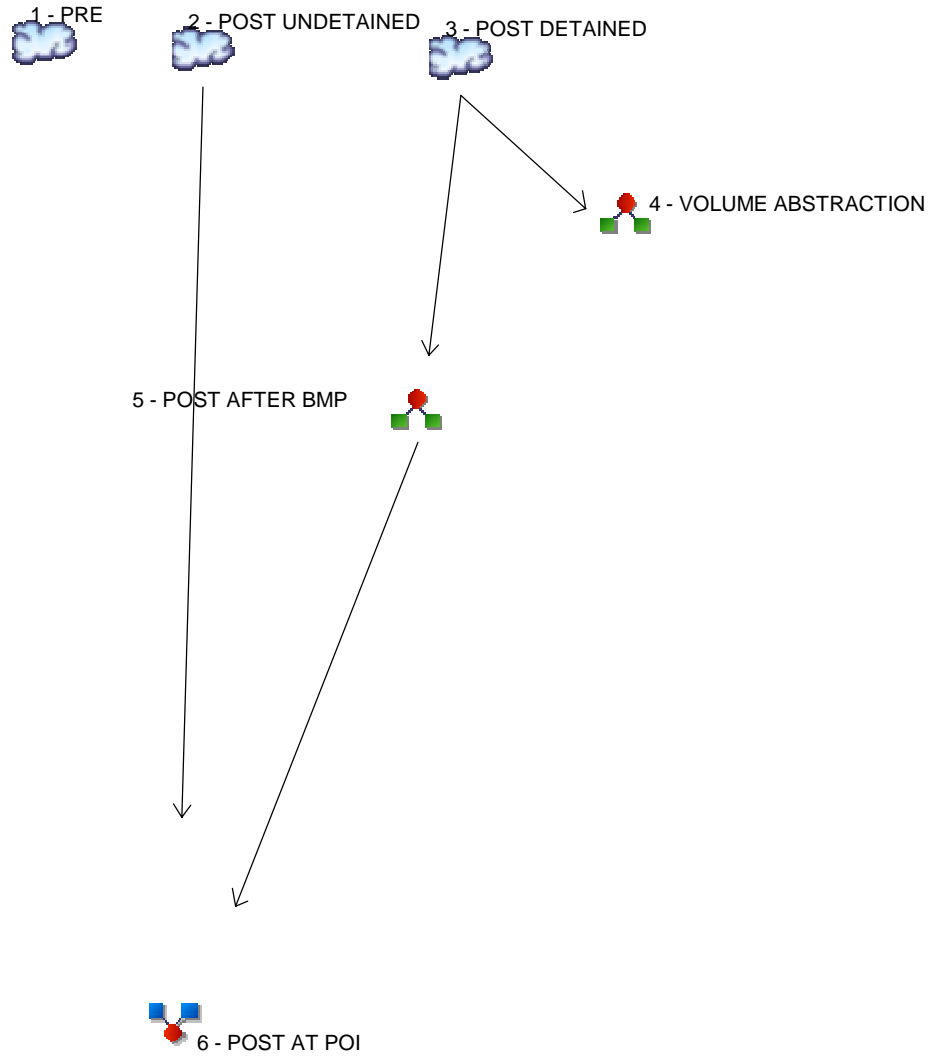
Hydrograph type = Combine
Storm frequency = 10 yrs
Time interval = 1 min
Inflow hyds. = 2, 5

Peak discharge = 0.664 cfs
Time to peak = 11.98 hrs
Hyd. volume = 2,209 cuft
Contrib. drain. area = 0.360 ac



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Legend

Hyd. Origin	Description
1	SCS Runoff PRE
2	SCS Runoff POST UNDETAINED
3	SCS Runoff POST DETAINED
4	Diversion1 VOLUME ABSTRACTION
5	Diversion2 POST AFTER BMP
6	Combine POST AT POI

Hydrograph Return Period Recap

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	2.233	-----	PRE
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	1.266	-----	POST UNDETAINED
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	0.890	-----	POST DETAINED
4	Diversion1	3	-----	-----	-----	-----	-----	-----	0.757	-----	VOLUME ABSTRACTION
5	Diversion2	3	-----	-----	-----	-----	-----	-----	0.890	-----	POST AFTER BMP
6	Combine	2, 5	-----	-----	-----	-----	-----	-----	2.120	-----	POST AT POI

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	2.233	1	718	4,485	-----	-----	-----	PRE
2	SCS Runoff	1.266	1	719	2,671	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	0.890	1	721	2,274	-----	-----	-----	POST DETAINED
4	Diversion1	0.757	1	717	632	3	-----	-----	VOLUME ABSTRACTION
5	Diversion2	0.890	1	721	1,641	3	-----	-----	POST AFTER BMP
6	Combine	2.120	1	719	4,312	2, 5	-----	-----	POST AT POI

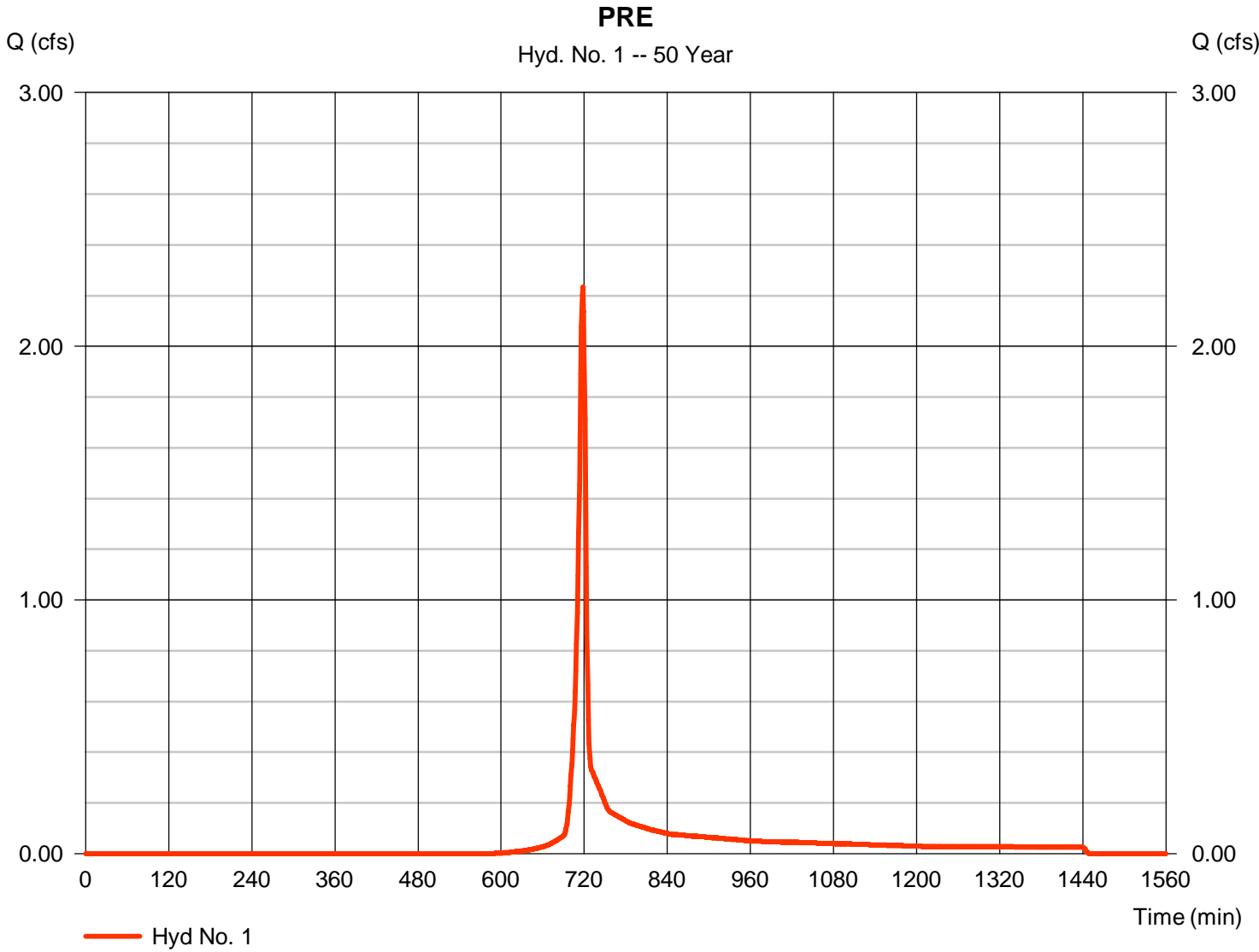
Hydrograph Report

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 2.233 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 4,485 cuft
Drainage area	= 0.550 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 5.70 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 58) + (0.230 x 71) + (0.160 x 78)] / 0.550



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 1

PRE

<u>Description</u>	<u>A</u>		<u>B</u>		<u>C</u>		<u>Totals</u>
Sheet Flow							
Manning's n-value	= 0.240		0.011		0.011		
Flow length (ft)	= 50.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.68		0.00		0.00		
Land slope (%)	= 10.26		0.00		0.00		
Travel Time (min)	= 4.66	+	0.00	+	0.00	=	4.66
Shallow Concentrated Flow							
Flow length (ft)	= 56.00		0.00		0.00		
Watercourse slope (%)	= 3.31		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.94		0.00		0.00		
Travel Time (min)	= 0.32	+	0.00	+	0.00	=	0.32
Channel Flow							
X sectional flow area (sqft)	= 16.00		0.00		0.00		
Wetted perimeter (ft)	= 28.00		0.00		0.00		
Channel slope (%)	= 1.81		0.00		0.00		
Manning's n-value	= 0.030		0.015		0.015		
Velocity (ft/s)	=4.59		0.00		0.00		
Flow length (ft)	{{0}}211.0		0.0		0.0		
Travel Time (min)	= 0.77	+	0.00	+	0.00	=	0.77
Total Travel Time, Tc							5.70 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

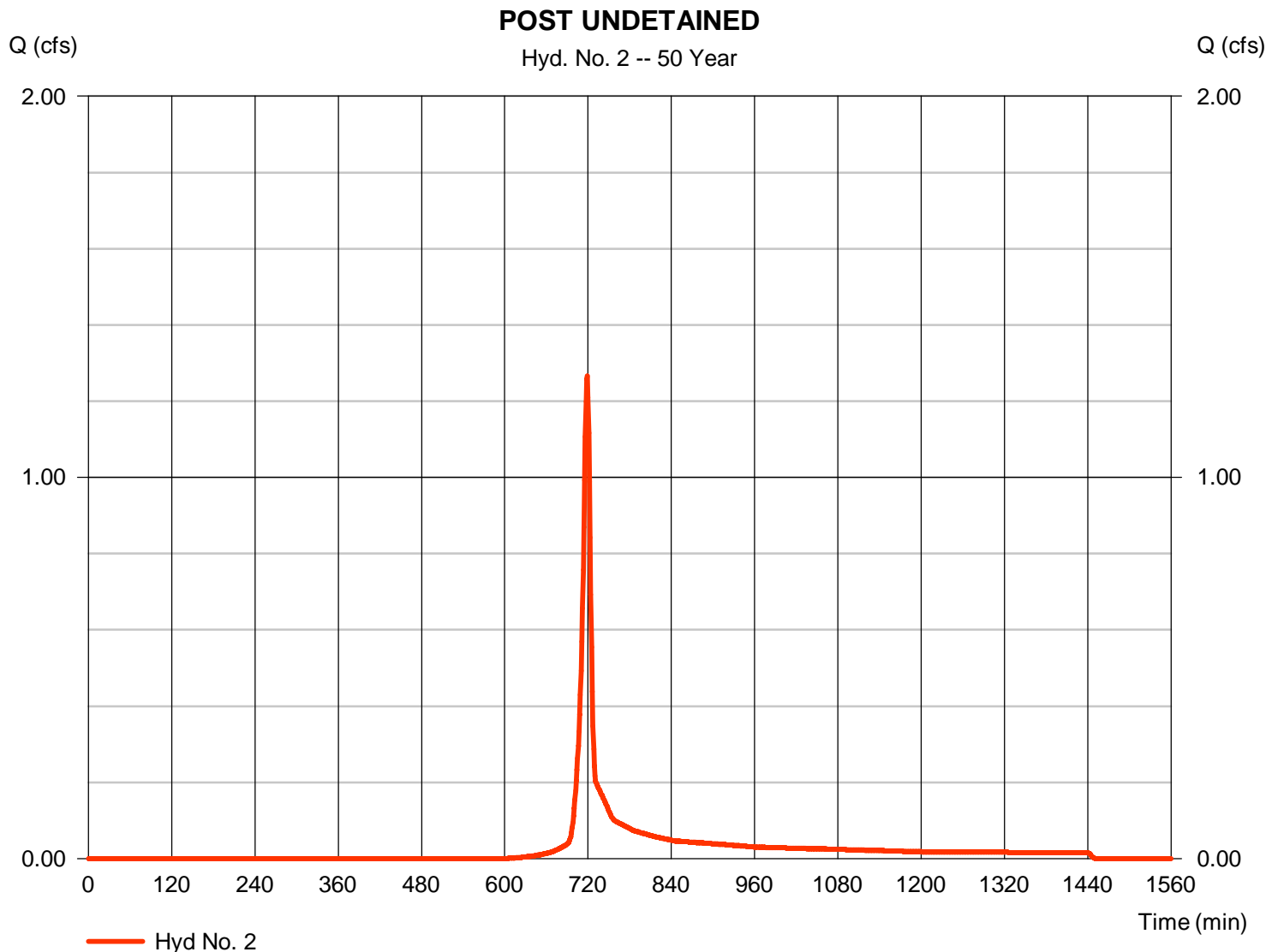
Tuesday, 10 / 25 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 1.266 cfs
Storm frequency	= 50 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 2,671 cuft
Drainage area	= 0.360 ac	Curve number	= 68*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 71) + (0.150 x 58) + (0.140 x 78)] / 0.360



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 2

POST UNDETAINED

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.68	0.00	0.00	
Land slope (%)	= 8.00	0.00	0.00	
Travel Time (min)	= 5.14	+ 0.00	+ 0.00	= 5.14
Shallow Concentrated Flow				
Flow length (ft)	= 244.00	0.00	0.00	
Watercourse slope (%)	= 2.30	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=2.45	0.00	0.00	
Travel Time (min)	= 1.66	+ 0.00	+ 0.00	= 1.66
Channel Flow				
X sectional flow area (sqft)	= 16.00	0.00	0.00	
Wetted perimeter (ft)	= 28.00	0.00	0.00	
Channel slope (%)	= 1.81	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=4.59	0.00	0.00	
Flow length (ft)	{{0}}211.0	0.0	0.0	
Travel Time (min)	= 0.77	+ 0.00	+ 0.00	= 0.77
Total Travel Time, Tc				7.60 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

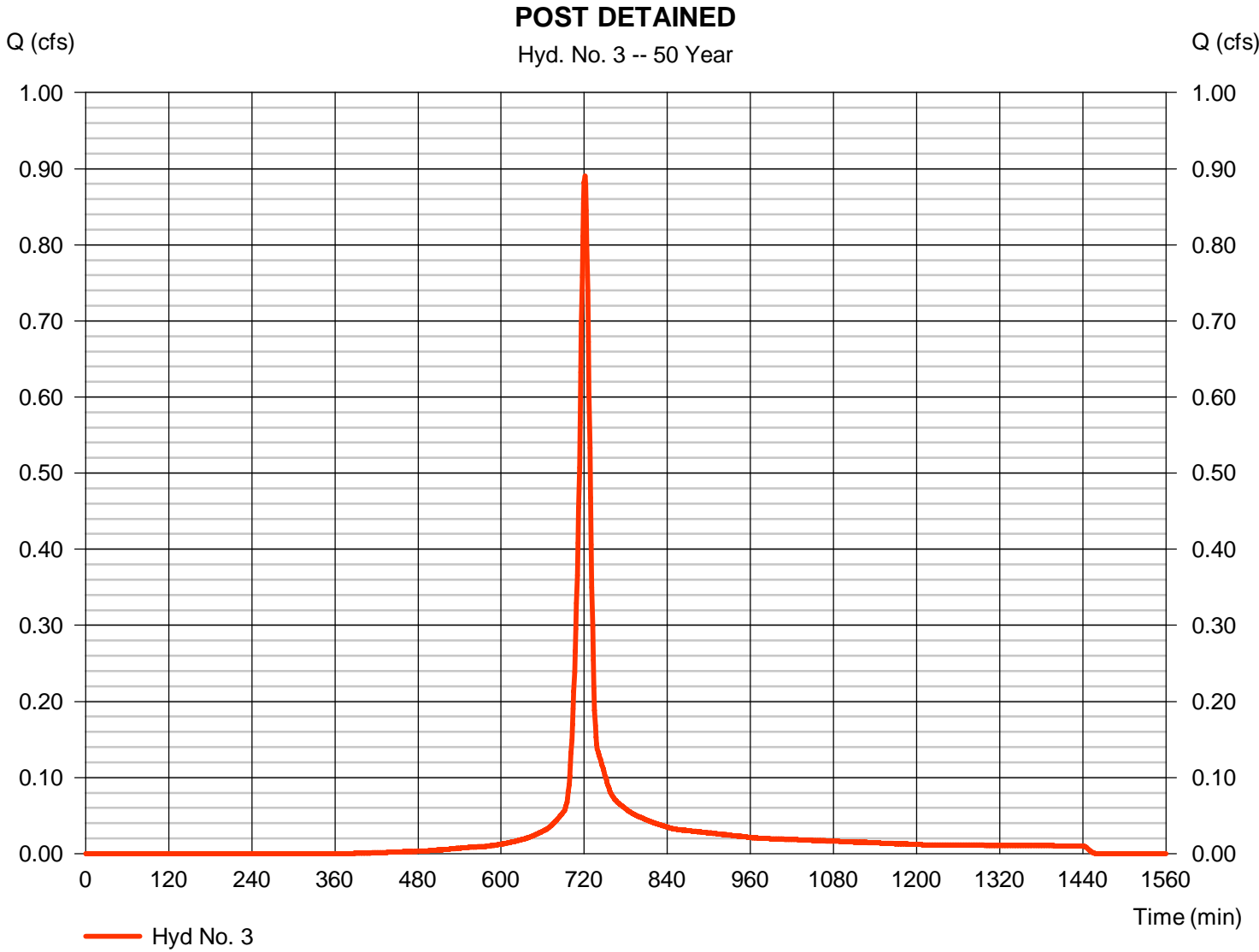
Tuesday, 10 / 25 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.890 cfs
Storm frequency	= 50 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 2,274 cuft
Drainage area	= 0.190 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 12.50 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.130 x 89) + (0.030 x 71) + (0.020 x 58) + (0.010 x 78)] / 0.190



Hydrograph Report

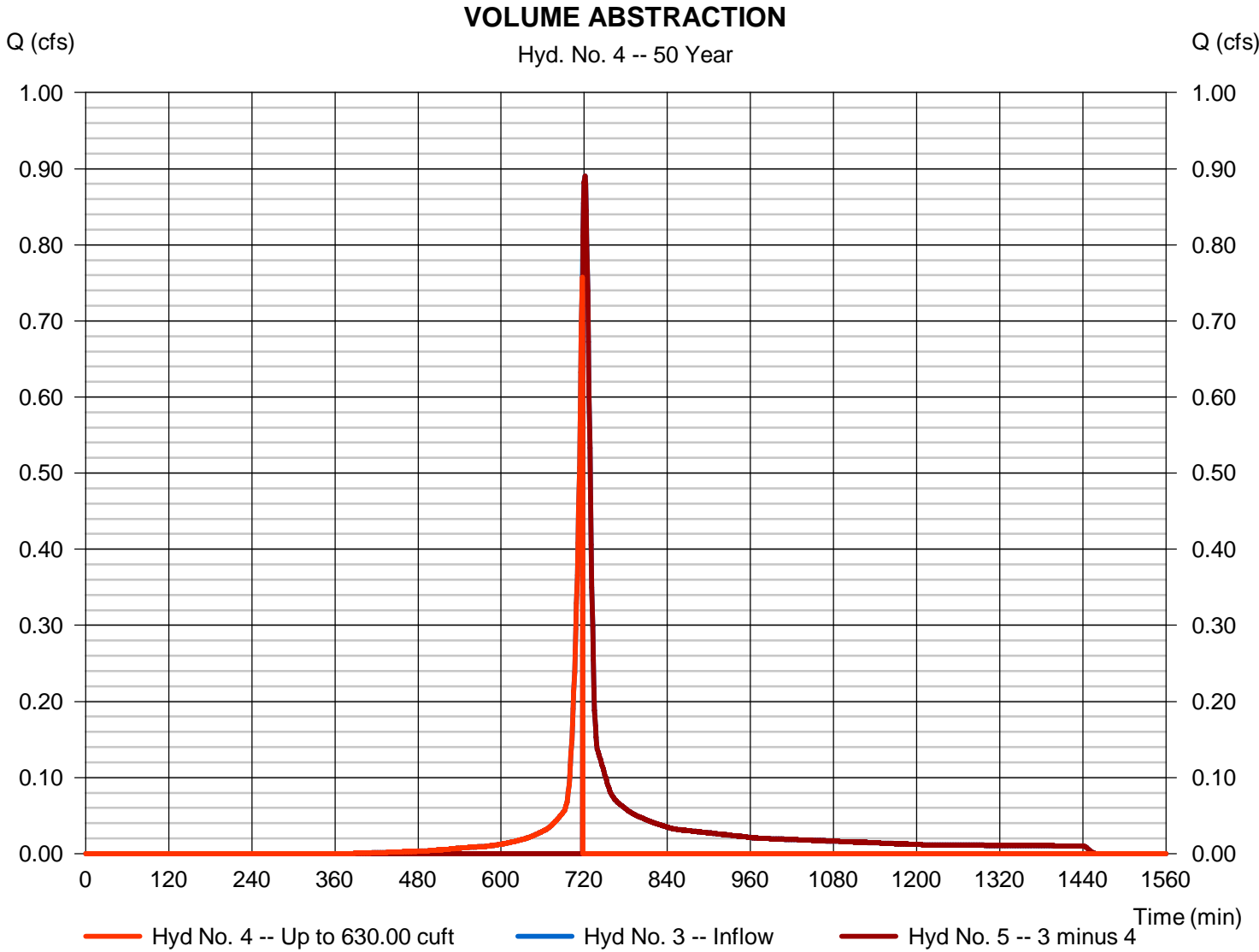
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.757 cfs
Storm frequency	= 50 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 632 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

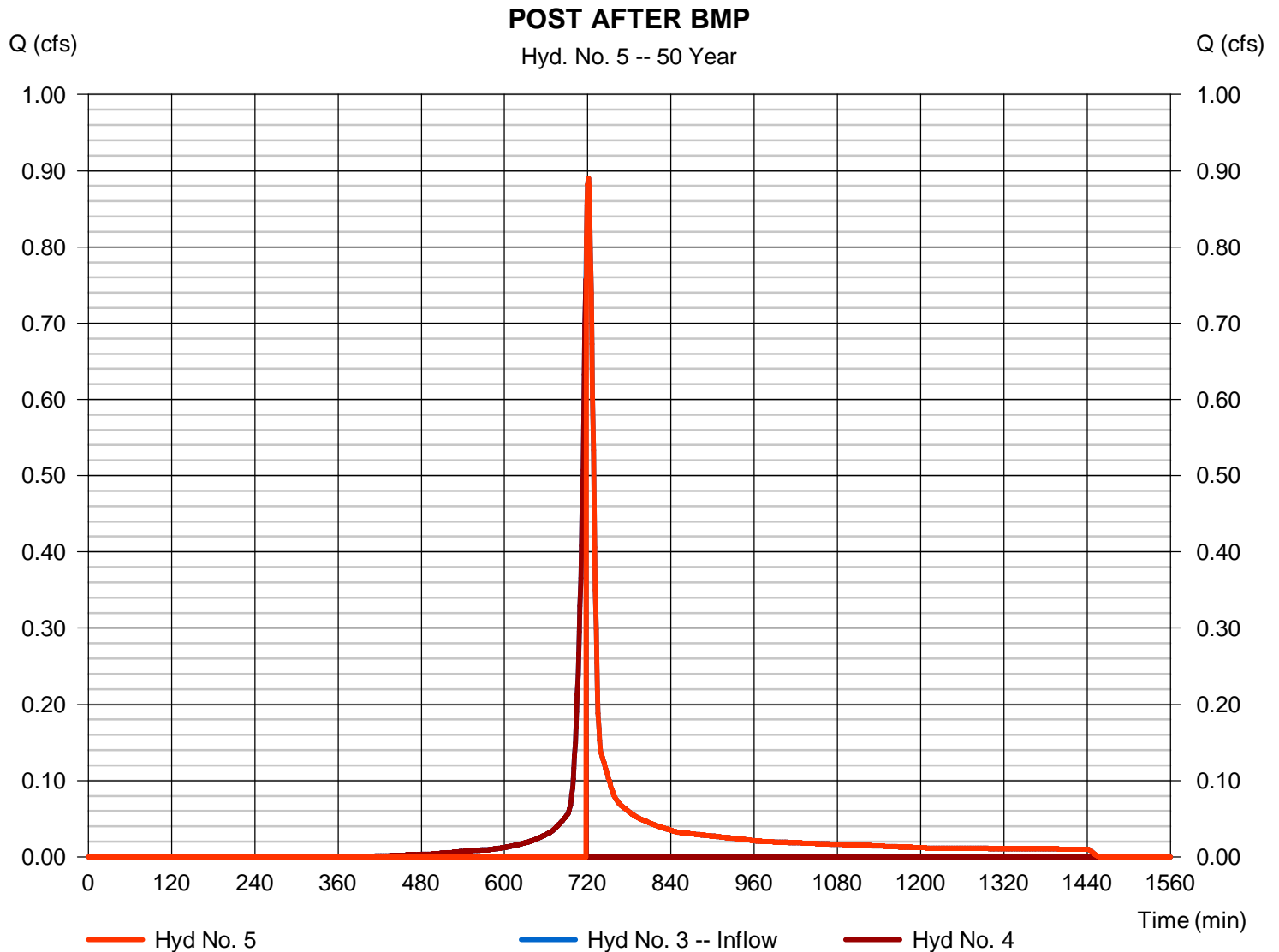
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 0.890 cfs
Storm frequency	= 50 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 1,641 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

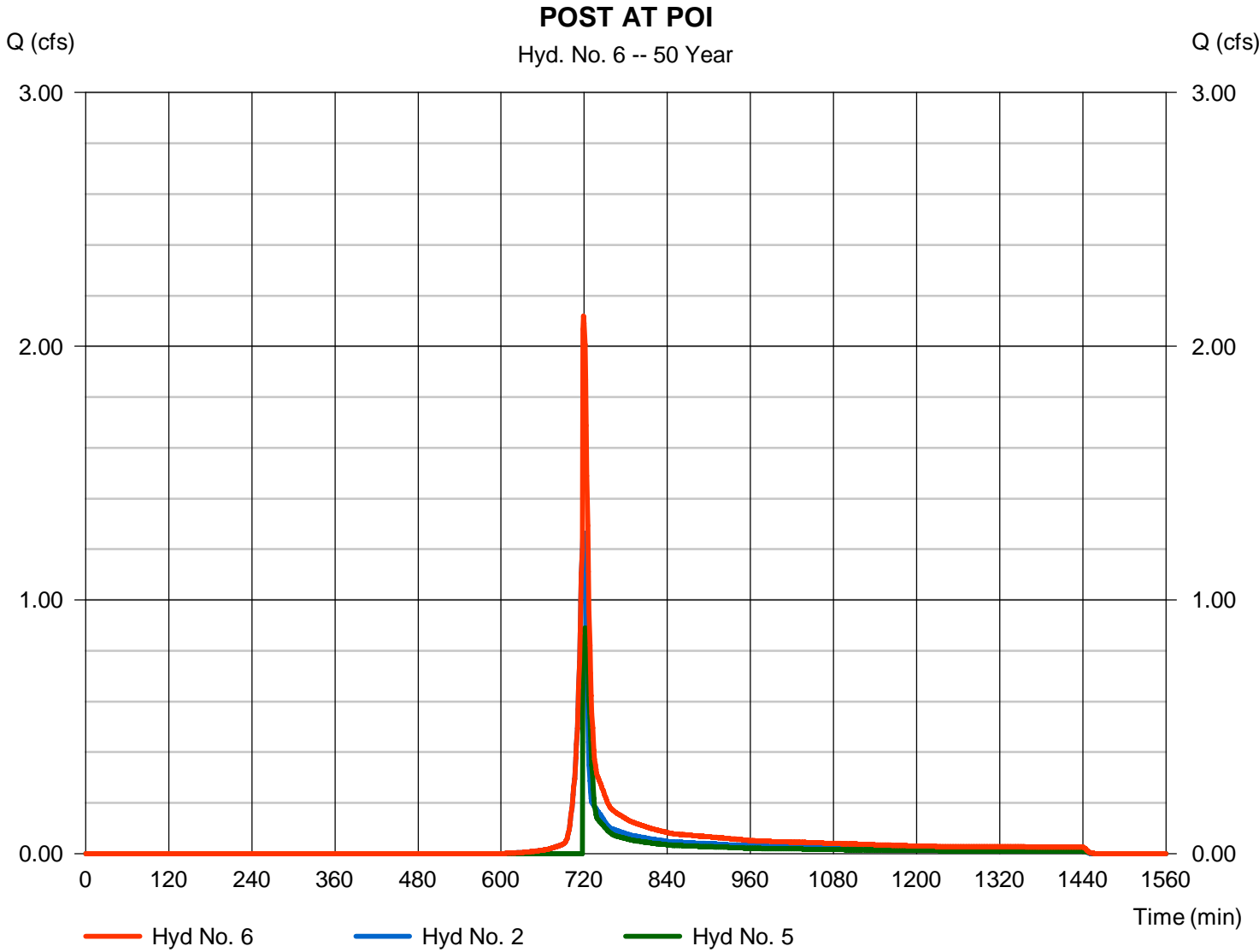
Tuesday, 10 / 25 / 2016

Hyd. No. 6

POST AT POI

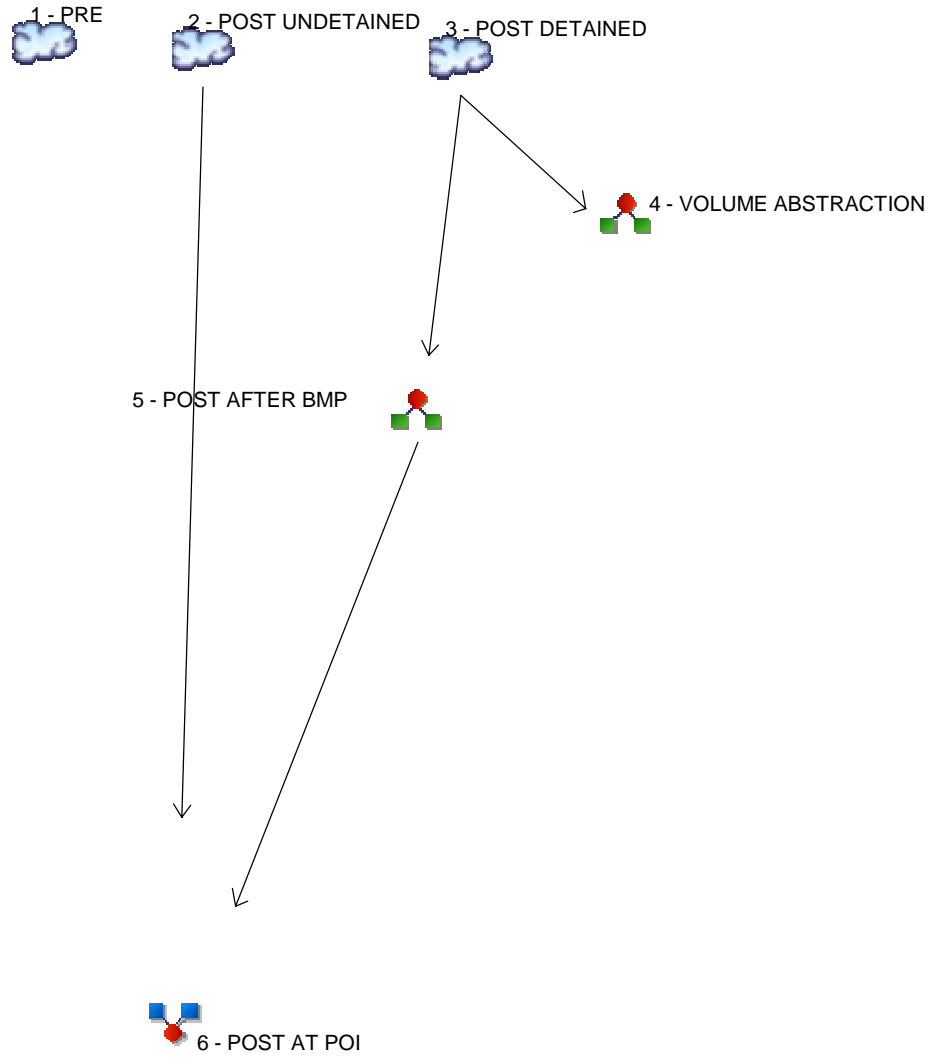
Hydrograph type = Combine
Storm frequency = 50 yrs
Time interval = 1 min
Inflow hyds. = 2, 5

Peak discharge = 2.120 cfs
Time to peak = 719 min
Hyd. volume = 4,312 cuft
Contrib. drain. area = 0.360 ac



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Legend

Hyd. Origin	Description
1	SCS Runoff PRE
2	SCS Runoff POST UNDETAINED
3	SCS Runoff POST DETAINED
4	Diversion1 VOLUME ABSTRACTION
5	Diversion2 POST AFTER BMP
6	Combine POST AT POI

Hydrograph Return Period Recap

Hydroflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	2.770	PRE
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	1.579	POST UNDETAINED
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	1.134	POST DETAINED
4	Diversion1	3	-----	-----	-----	-----	-----	-----	-----	0.688	VOLUME ABSTRACTION
5	Diversion2	3	-----	-----	-----	-----	-----	-----	-----	1.134	POST AFTER BMP
6	Combine	2, 5	-----	-----	-----	-----	-----	-----	-----	2.695	POST AT POI

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	2.770	1	718	5,569	-----	-----	-----	PRE
2	SCS Runoff	1.579	1	719	3,330	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	1.134	1	720	2,793	-----	-----	-----	POST DETAINED
4	Diversion1	0.688	1	713	654	3	-----	-----	VOLUME ABSTRACTION
5	Diversion2	1.134	1	720	2,138	3	-----	-----	POST AFTER BMP
6	Combine	2.695	1	719	5,468	2, 5	-----	-----	POST AT POI

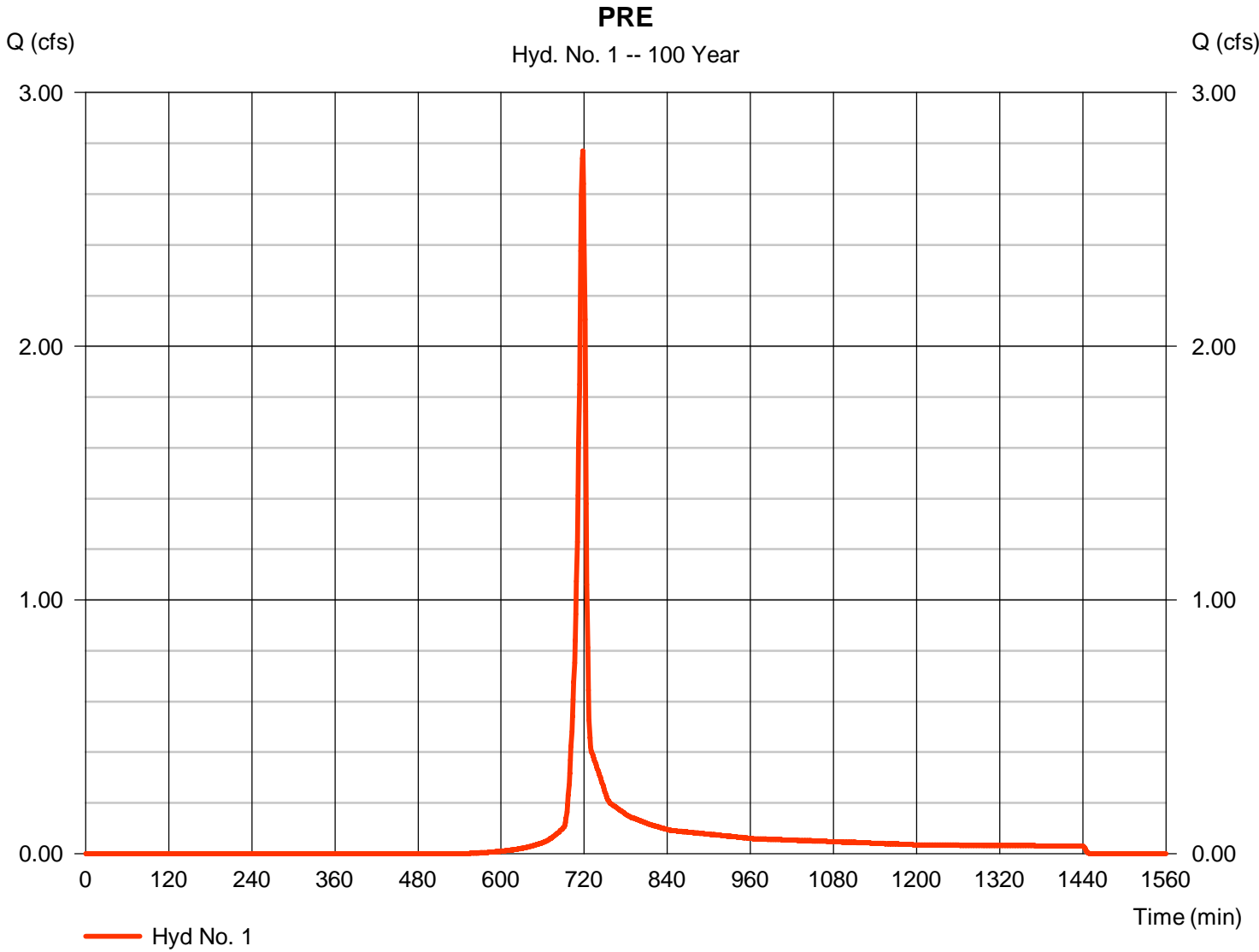
Hydrograph Report

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 2.770 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 5,569 cuft
Drainage area	= 0.550 ac	Curve number	= 69*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 5.70 min
Total precip.	= 5.99 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 58) + (0.230 x 71) + (0.160 x 78)] / 0.550



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 1

PRE

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.68	0.00	0.00	
Land slope (%)	= 10.26	0.00	0.00	
Travel Time (min)	= 4.66	+ 0.00	+ 0.00	= 4.66
Shallow Concentrated Flow				
Flow length (ft)	= 56.00	0.00	0.00	
Watercourse slope (%)	= 3.31	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=2.94	0.00	0.00	
Travel Time (min)	= 0.32	+ 0.00	+ 0.00	= 0.32
Channel Flow				
X sectional flow area (sqft)	= 16.00	0.00	0.00	
Wetted perimeter (ft)	= 28.00	0.00	0.00	
Channel slope (%)	= 1.81	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=4.59	0.00	0.00	
Flow length (ft)	211.0	0.0	0.0	
Travel Time (min)	= 0.77	+ 0.00	+ 0.00	= 0.77
Total Travel Time, Tc				5.70 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

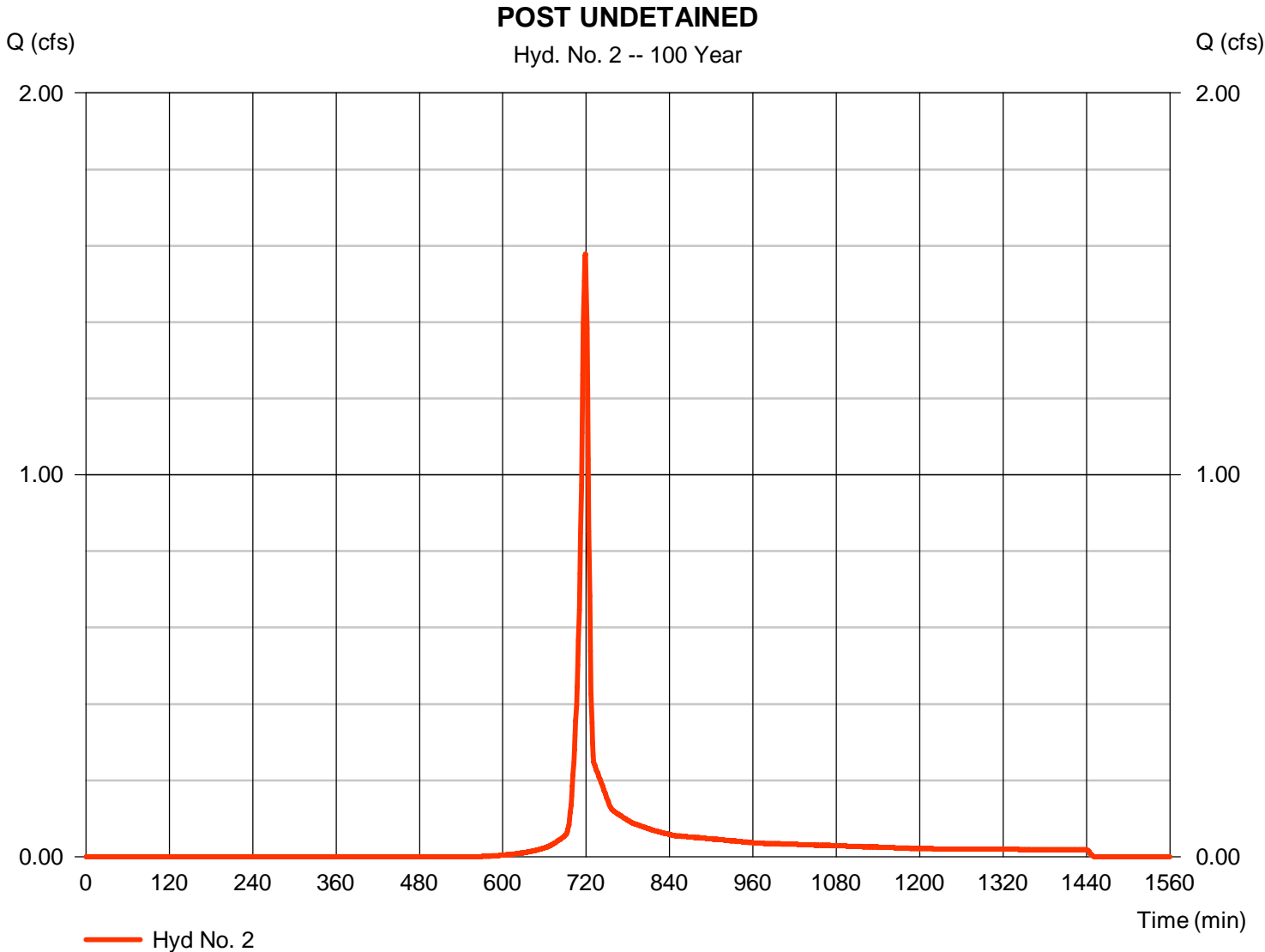
Tuesday, 10 / 25 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 1.579 cfs
Storm frequency	= 100 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 3,330 cuft
Drainage area	= 0.360 ac	Curve number	= 68*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.60 min
Total precip.	= 5.99 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 71) + (0.150 x 58) + (0.140 x 78)] / 0.360



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No. 2

POST UNDETAINED

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.240	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 2.68	0.00	0.00	
Land slope (%)	= 8.00	0.00	0.00	
Travel Time (min)	= 5.14	+ 0.00	+ 0.00	= 5.14
Shallow Concentrated Flow				
Flow length (ft)	= 244.00	0.00	0.00	
Watercourse slope (%)	= 2.30	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=2.45	0.00	0.00	
Travel Time (min)	= 1.66	+ 0.00	+ 0.00	= 1.66
Channel Flow				
X sectional flow area (sqft)	= 16.00	0.00	0.00	
Wetted perimeter (ft)	= 28.00	0.00	0.00	
Channel slope (%)	= 1.81	0.00	0.00	
Manning's n-value	= 0.030	0.015	0.015	
Velocity (ft/s)	=4.59	0.00	0.00	
Flow length (ft)	211.0	0.0	0.0	
Travel Time (min)	= 0.77	+ 0.00	+ 0.00	= 0.77
Total Travel Time, Tc				7.60 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

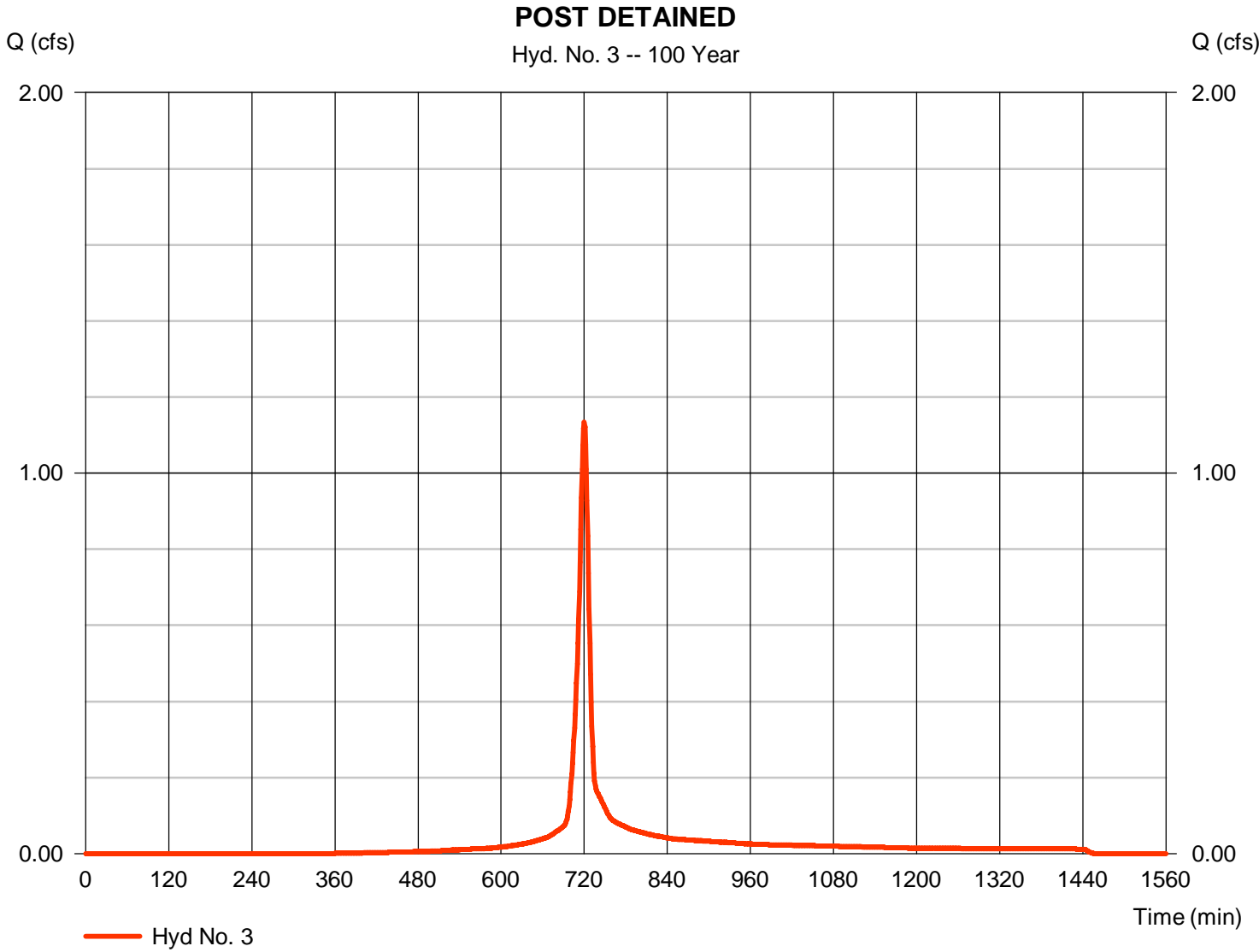
Tuesday, 10 / 25 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 1.134 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 2,793 cuft
Drainage area	= 0.190 ac	Curve number	= 82*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.10 min
Total precip.	= 5.99 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.130 x 89) + (0.030 x 71) + (0.020 x 58) + (0.010 x 78)] / 0.190



Hydrograph Report

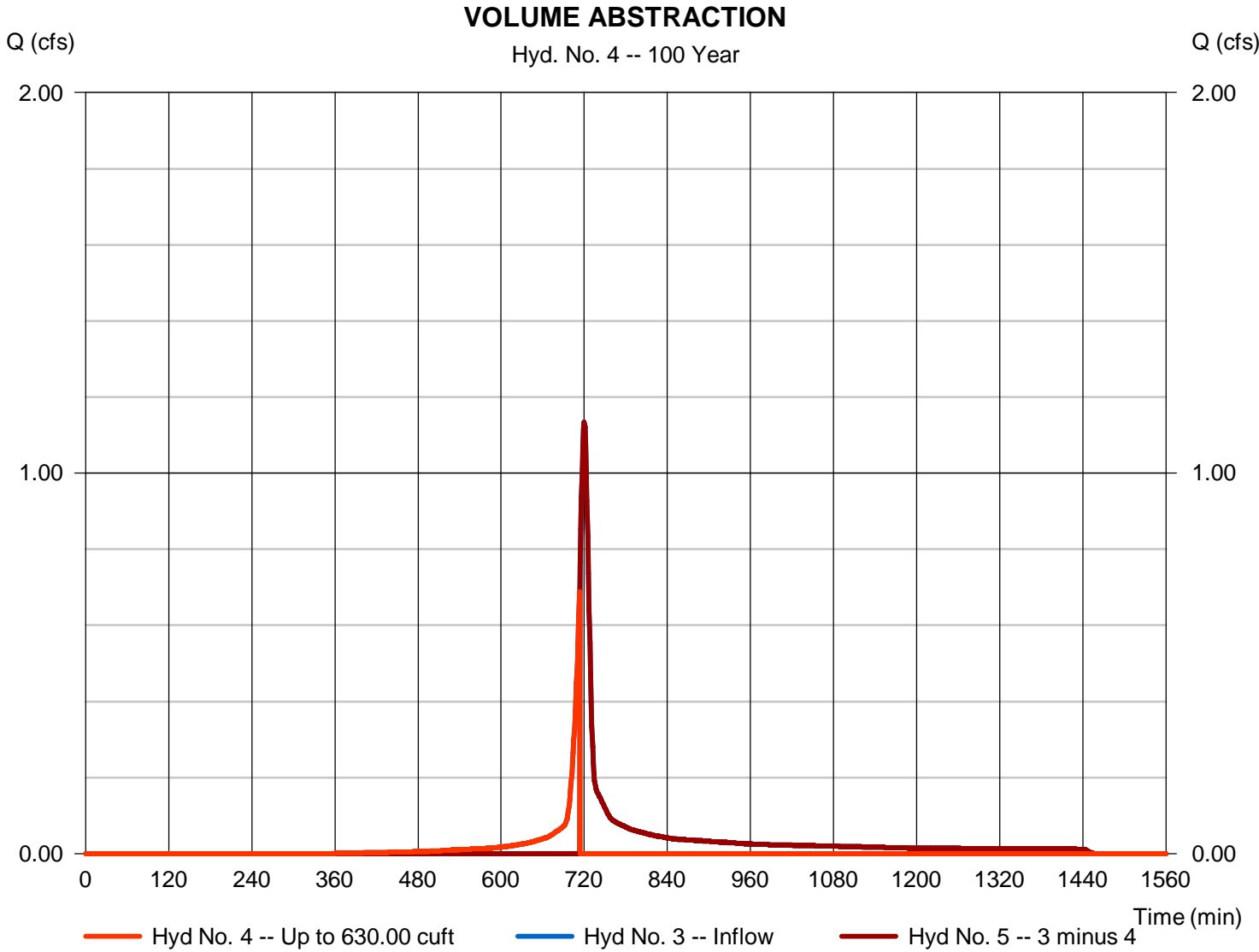
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.688 cfs
Storm frequency	= 100 yrs	Time to peak	= 713 min
Time interval	= 1 min	Hyd. volume	= 654 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

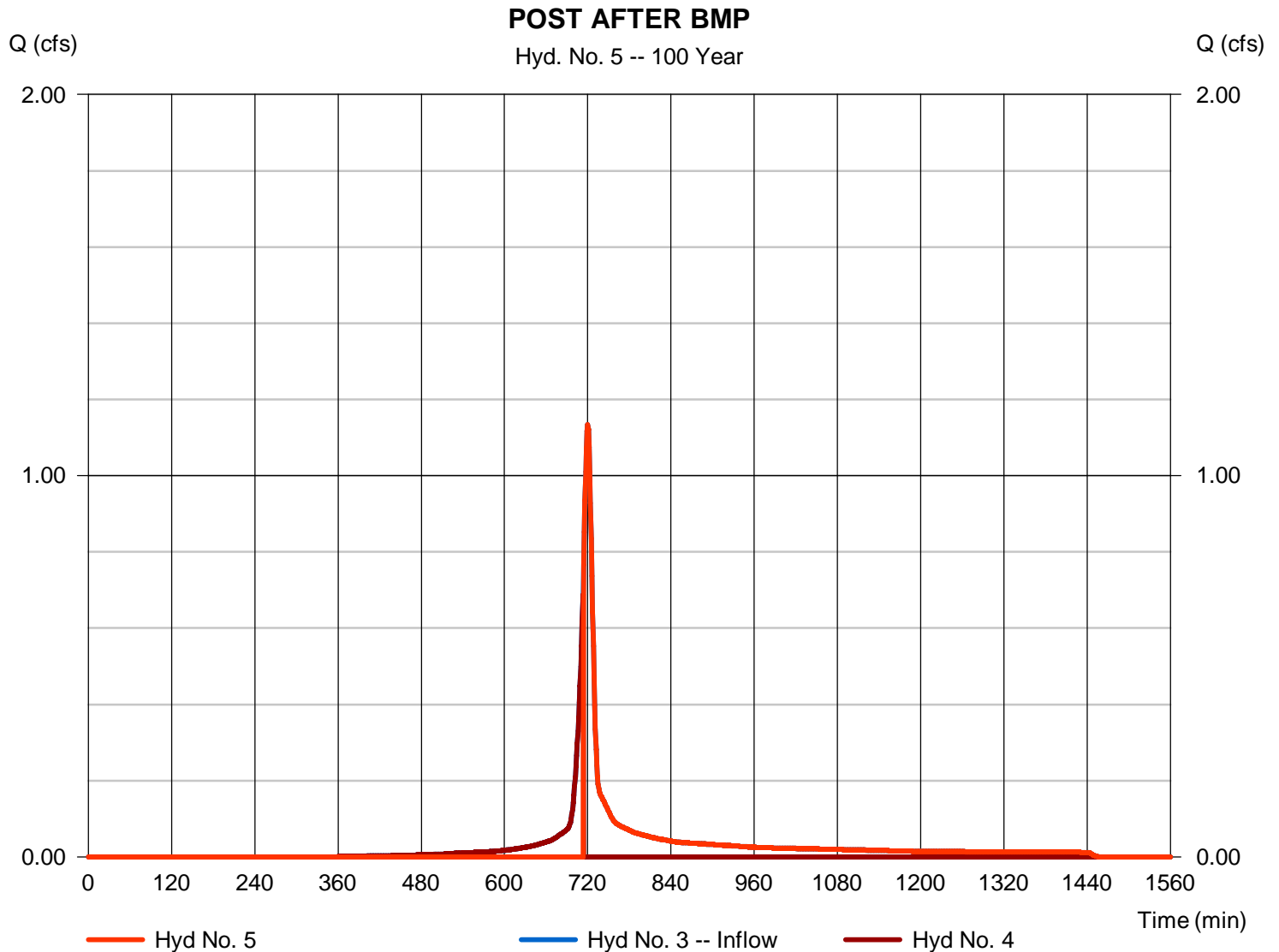
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 1.134 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 2,138 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 630.00 cuft



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Tuesday, 10 / 25 / 2016

Hyd. No. 6

POST AT POI

Hydrograph type = Combine
Storm frequency = 100 yrs
Time interval = 1 min
Inflow hyds. = 2, 5

Peak discharge = 2.695 cfs
Time to peak = 719 min
Hyd. volume = 5,468 cuft
Contrib. drain. area = 0.360 ac

