

Creek Road

TETRA TECH, INC.

By: RH Date: 11/9/2016 Subject: Creek Road
Checked By: JB Date: 11/14/2016 PCSM Design and Evaluation

PURPOSE:

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Creek Road block valve as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The site is located within North Middleton Township, Cumberland County, Pennsylvania. Permanent stormwater controls will be developed to satisfy PADEP and Cumberland County'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 Creek Road block valve is located within the Lower Conodoguinet Creek watershed which has a 100% release rate. All other design standards within Cumberland County's approved Act 167 Plan are consistent with the requirements in PADEP's Stormwater BMP Manual. The PCSM design at the Creek Road block valve has been designed for consistency with Cumberland County'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 presence of rapid surface infiltration rates and shallow bedrock surrounding the Creek 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).

- Cumberland County's approved Act 167 plan establishes release rate requirements for various watersheds throughout the county. The Creek Road block valve site is located in the Conodoguinet Creek watershed, which has 100% release rates.

This site will utilize a slow-release trench with a downslope compacted berm to manage the two-year through 100-year peak rate increases. The proposed BMP will increase the post-construction 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

Onsite infiltration testing was 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. Due to the presence of shallow bedrock, it is not possible to maintain 2 feet of separation between a volume-reducing BMP and bedrock.

The post-construction stormwater management design utilizes a slow-release BMP to manage runoff volume due to inconsistent infiltration onsite due to the presence of shallow bedrock.

Loading Ratio

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 detained by the proposed PCSM BMP.

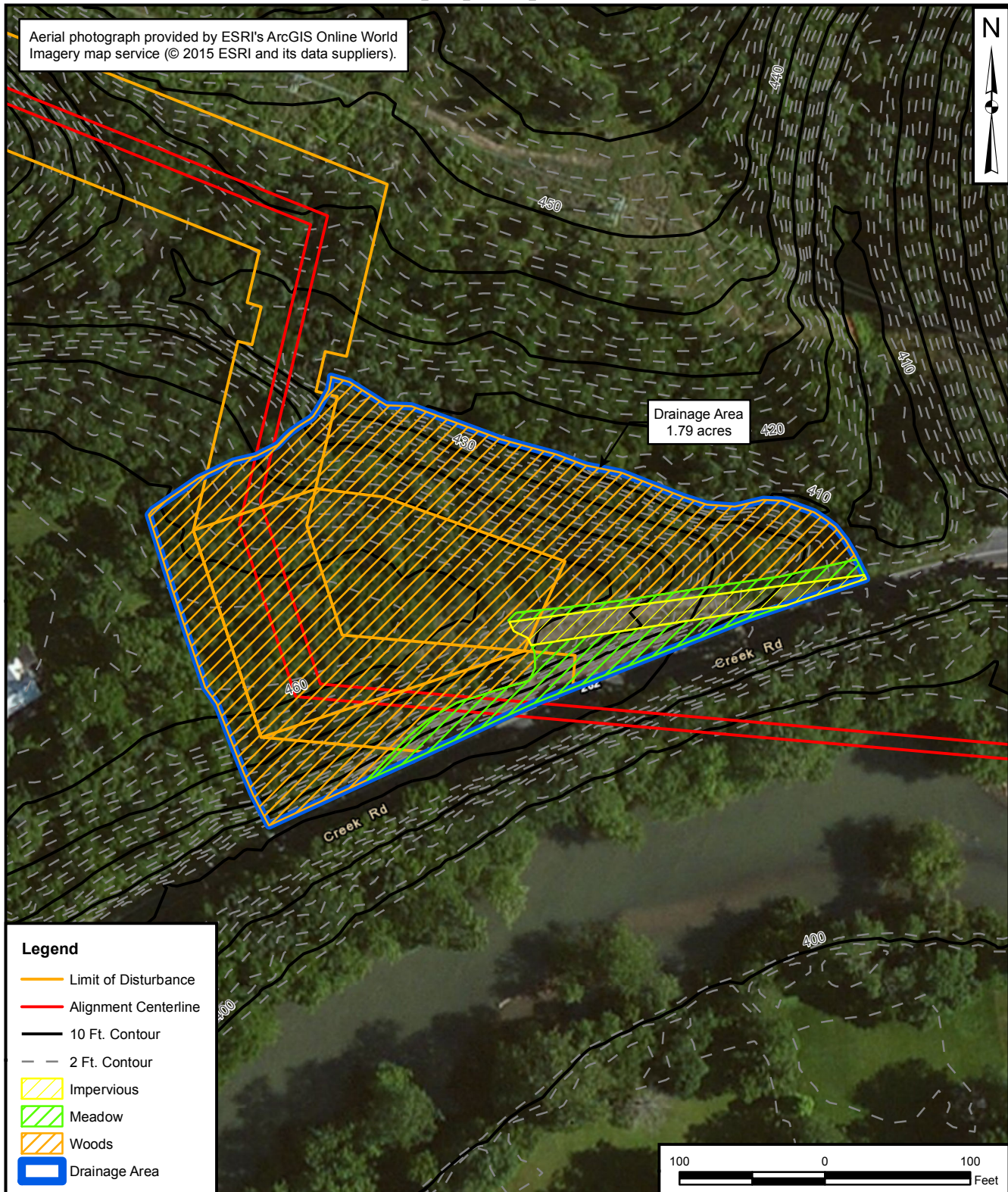
Karst Topography

The Creek Road block valve is not located in an area of karst terrain.

Special Protection Watershed

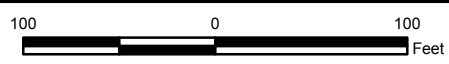
Creek Road block valve is not located within a special protection watershed, so antidegradation requirements do not apply.

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



Drainage Area
1.79 acres

- Legend**
- Limit of Disturbance
 - Alignment Centerline
 - 10 Ft. Contour
 - 2 Ft. Contour
 - Impervious
 - Meadow
 - Woods
 - Drainage Area

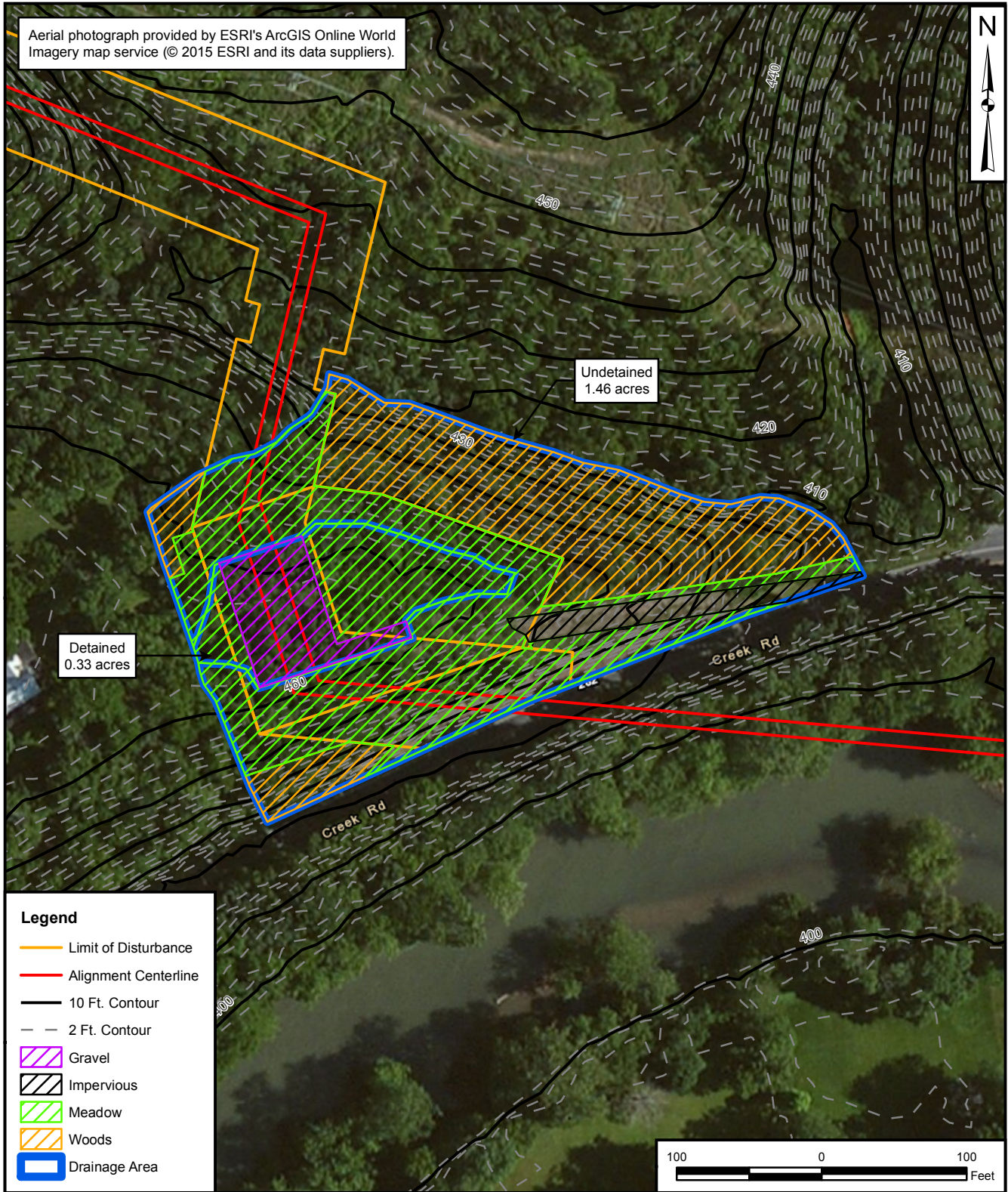


PRE-DEVELOPMENT DRAINAGE AREA MAP
CREEK ROAD
PENNSYLVANIA PIPELINE PROJECT
SUNOCO LOGISTICS, L.P.
CUMBERLAND COUNTY, PENNSYLVANIA

DRAWN BY: S. PAXTON 05/21/16
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

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



POST-DEVELOPMENT DRAINAGE AREA MAP
CREEK ROAD
PENNSYLVANIA PIPELINE PROJECT
SUNOCO LOGISTICS, L.P.
CUMBERLAND COUNTY, PENNSYLVANIA

DRAWN BY: S. PAXTON 05/21/16	
CHECKED BY: J. BRODY 11/09/16	
APPROVED BY:	
CONTRACT NUMBER: 112IC05958	
FIGURE NUMBER	REV
2	0



NOAA Atlas 14, Volume 2, Version 3
Location name: North Middleton Twp,
Pennsylvania, USA*
Latitude: 40.2424°, Longitude: -77.1916°
Elevation: 455.84 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

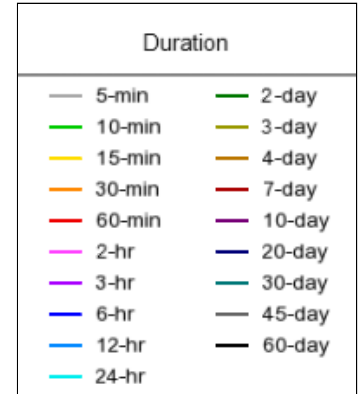
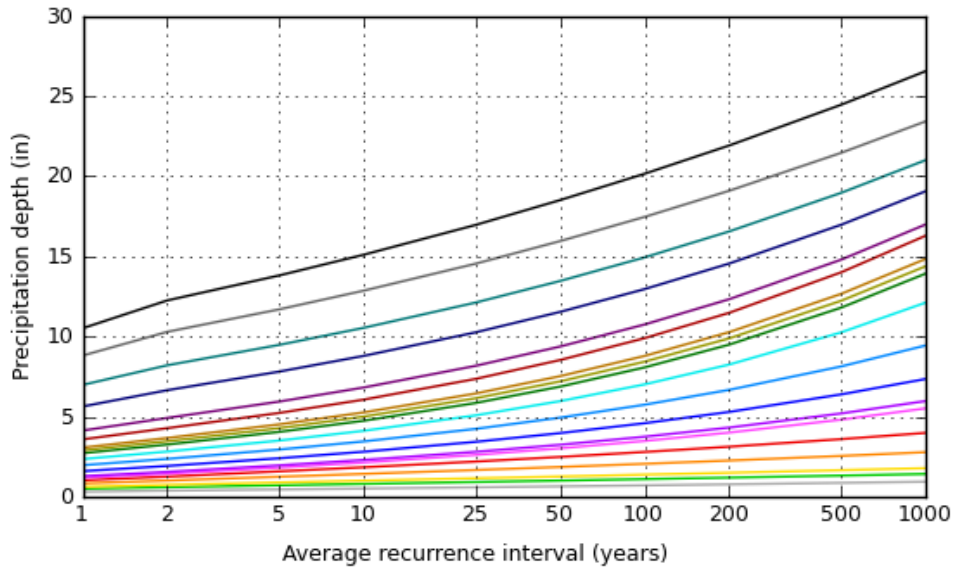
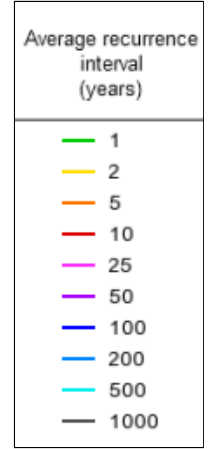
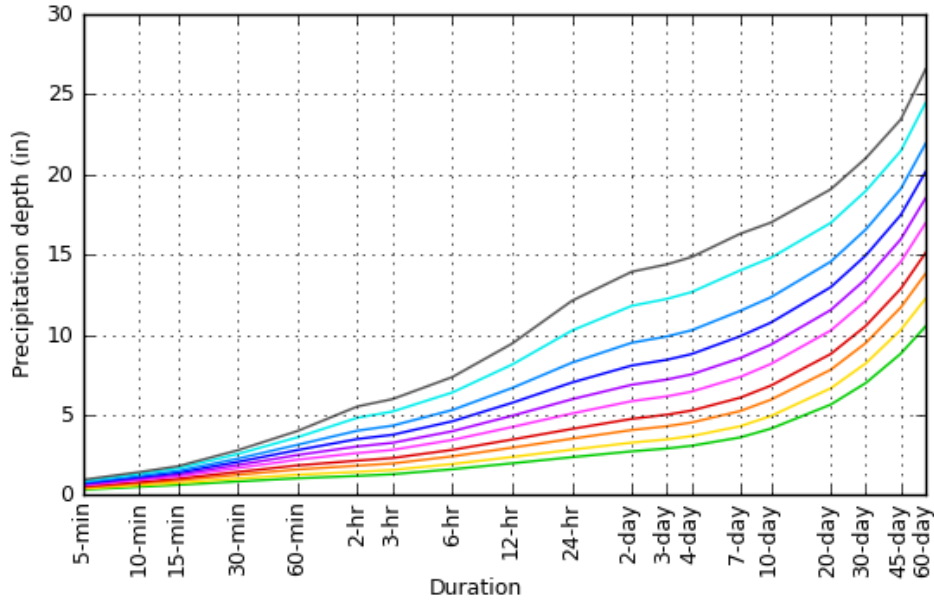
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.319 (0.284-0.361)	0.380 (0.337-0.430)	0.456 (0.404-0.515)	0.514 (0.454-0.579)	0.592 (0.521-0.665)	0.652 (0.571-0.732)	0.713 (0.623-0.800)	0.778 (0.675-0.870)	0.871 (0.748-0.973)	0.941 (0.803-1.05)
10-min	0.503 (0.448-0.570)	0.602 (0.534-0.681)	0.719 (0.637-0.813)	0.807 (0.714-0.909)	0.924 (0.813-1.04)	1.01 (0.888-1.14)	1.10 (0.965-1.24)	1.20 (1.04-1.34)	1.32 (1.14-1.48)	1.42 (1.22-1.59)
15-min	0.623 (0.554-0.704)	0.745 (0.661-0.843)	0.897 (0.795-1.01)	1.01 (0.891-1.14)	1.16 (1.02-1.30)	1.27 (1.11-1.42)	1.39 (1.21-1.55)	1.50 (1.30-1.68)	1.66 (1.43-1.86)	1.79 (1.52-2.00)
30-min	0.839 (0.747-0.949)	1.01 (0.900-1.15)	1.25 (1.11-1.41)	1.43 (1.27-1.61)	1.67 (1.47-1.88)	1.86 (1.63-2.09)	2.06 (1.80-2.31)	2.26 (1.96-2.53)	2.55 (2.19-2.85)	2.78 (2.38-3.11)
60-min	1.04 (0.922-1.17)	1.26 (1.12-1.42)	1.59 (1.41-1.79)	1.84 (1.63-2.08)	2.20 (1.94-2.47)	2.49 (2.18-2.79)	2.80 (2.44-3.14)	3.13 (2.71-3.50)	3.60 (3.09-4.02)	3.99 (3.40-4.46)
2-hr	1.19 (1.05-1.34)	1.44 (1.27-1.62)	1.82 (1.61-2.06)	2.14 (1.89-2.41)	2.61 (2.29-2.93)	3.02 (2.63-3.38)	3.49 (3.02-3.89)	4.01 (3.44-4.47)	4.81 (4.09-5.36)	5.52 (4.65-6.14)
3-hr	1.29 (1.15-1.47)	1.55 (1.38-1.77)	1.96 (1.74-2.24)	2.30 (2.03-2.61)	2.81 (2.46-3.17)	3.25 (2.83-3.67)	3.75 (3.25-4.22)	4.32 (3.71-4.85)	5.20 (4.42-5.83)	5.98 (5.02-6.70)
6-hr	1.60 (1.43-1.82)	1.93 (1.71-2.19)	2.40 (2.14-2.73)	2.81 (2.49-3.18)	3.43 (3.02-3.87)	3.97 (3.47-4.46)	4.59 (3.98-5.14)	5.30 (4.56-5.92)	6.39 (5.43-7.13)	7.35 (6.17-8.19)
12-hr	1.97 (1.75-2.25)	2.37 (2.09-2.69)	2.95 (2.60-3.35)	3.46 (3.04-3.91)	4.24 (3.70-4.77)	4.94 (4.28-5.55)	5.75 (4.94-6.44)	6.67 (5.68-7.45)	8.13 (6.83-9.06)	9.44 (7.83-10.5)
24-hr	2.35 (2.16-2.60)	2.82 (2.59-3.12)	3.51 (3.22-3.87)	4.12 (3.75-4.52)	5.08 (4.59-5.55)	5.97 (5.35-6.48)	7.02 (6.24-7.58)	8.25 (7.26-8.88)	10.3 (8.89-11.0)	12.1 (10.4-12.9)
2-day	2.72 (2.48-3.02)	3.26 (2.97-3.63)	4.05 (3.68-4.50)	4.75 (4.30-5.27)	5.85 (5.26-6.46)	6.87 (6.13-7.56)	8.07 (7.14-8.85)	9.50 (8.32-10.4)	11.8 (10.2-12.8)	13.9 (11.9-15.1)
3-day	2.89 (2.65-3.20)	3.47 (3.17-3.84)	4.28 (3.91-4.74)	5.01 (4.55-5.53)	6.15 (5.56-6.75)	7.20 (6.46-7.89)	8.43 (7.50-9.21)	9.89 (8.71-10.8)	12.2 (10.6-13.3)	14.4 (12.3-15.6)
4-day	3.07 (2.82-3.38)	3.67 (3.37-4.05)	4.52 (4.15-4.98)	5.27 (4.81-5.79)	6.45 (5.86-7.05)	7.53 (6.79-8.22)	8.79 (7.87-9.58)	10.3 (9.10-11.2)	12.7 (11.1-13.7)	14.8 (12.8-16.0)
7-day	3.58 (3.31-3.94)	4.28 (3.96-4.71)	5.23 (4.82-5.74)	6.06 (5.57-6.64)	7.36 (6.72-8.04)	8.54 (7.74-9.30)	9.90 (8.91-10.8)	11.5 (10.2-12.5)	14.0 (12.3-15.1)	16.3 (14.2-17.6)
10-day	4.13 (3.84-4.50)	4.92 (4.58-5.36)	5.94 (5.52-6.46)	6.82 (6.32-7.40)	8.17 (7.52-8.84)	9.38 (8.58-10.1)	10.8 (9.77-11.6)	12.3 (11.1-13.3)	14.8 (13.2-15.9)	17.0 (15.0-18.3)
20-day	5.64 (5.31-6.02)	6.65 (6.26-7.10)	7.81 (7.34-8.33)	8.79 (8.24-9.36)	10.3 (9.59-10.9)	11.5 (10.7-12.2)	13.0 (12.0-13.7)	14.6 (13.4-15.4)	17.0 (15.5-18.0)	19.1 (17.3-20.2)
30-day	6.98 (6.60-7.43)	8.21 (7.75-8.72)	9.48 (8.94-10.1)	10.5 (9.93-11.2)	12.1 (11.4-12.8)	13.5 (12.6-14.3)	14.9 (13.9-15.8)	16.6 (15.4-17.5)	19.0 (17.4-20.1)	21.0 (19.2-22.3)
45-day	8.81 (8.38-9.32)	10.3 (9.78-10.9)	11.7 (11.1-12.3)	12.9 (12.2-13.6)	14.5 (13.8-15.3)	16.0 (15.1-16.8)	17.5 (16.4-18.4)	19.1 (17.9-20.1)	21.5 (20.0-22.6)	23.4 (21.7-24.7)
60-day	10.5 (10.0-11.1)	12.3 (11.7-12.9)	13.8 (13.2-14.5)	15.1 (14.4-15.9)	17.0 (16.1-17.8)	18.5 (17.5-19.4)	20.2 (19.0-21.2)	21.9 (20.6-23.0)	24.5 (22.9-25.7)	26.6 (24.7-28.0)

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.

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PF graphical

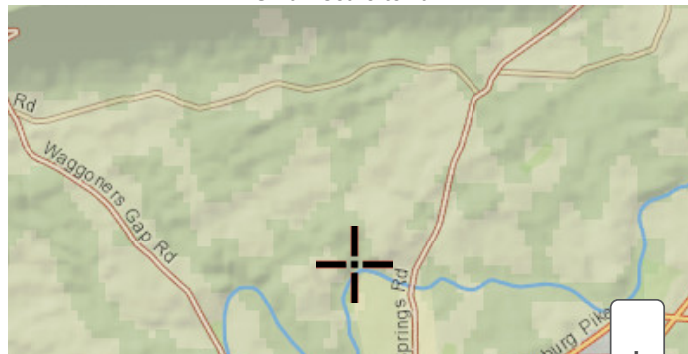
PDS-based depth-duration-frequency (DDF) curves
Latitude: 40.2424°, Longitude: -77.1916°

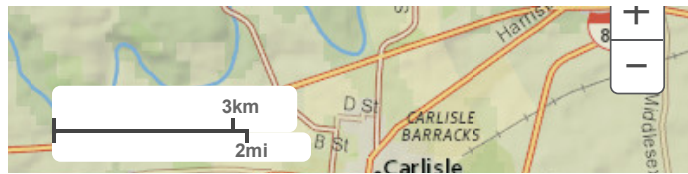


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Maps & aerials

Small scale terrain

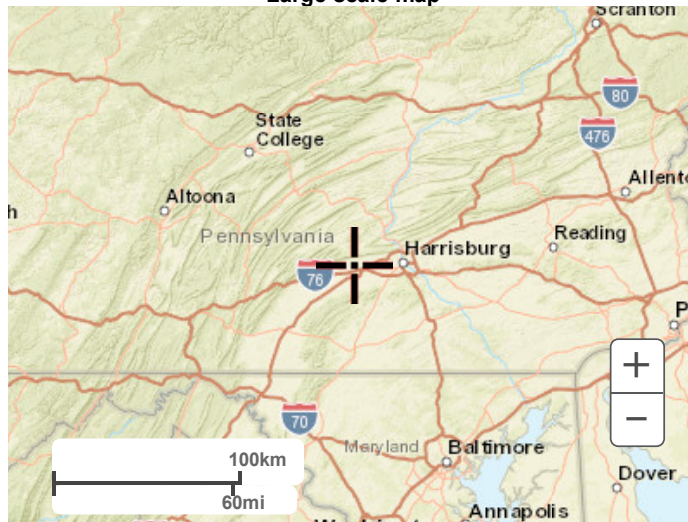




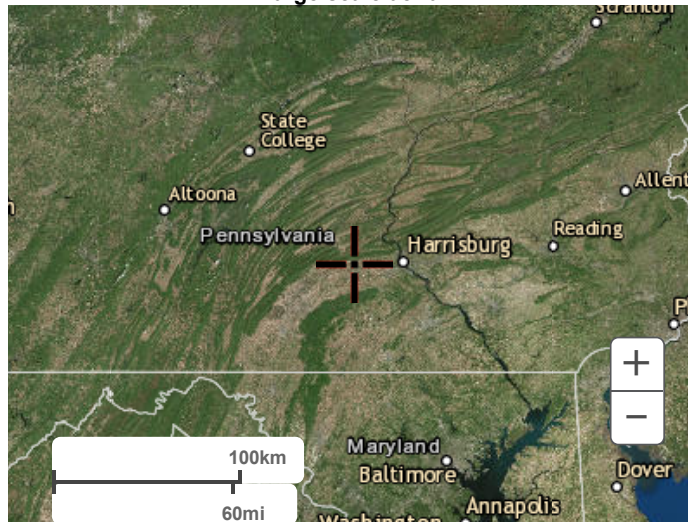
Large scale terrain



Large scale map



Large scale aerial



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WORKSHEET 1. GENERAL SITE INFORMATION

Date: November 23, 2016

Project Name: Creek Road

Municipality: North Middleton

County: Cumberland

Total Area (acres): 1.79

Major River Basin: Susquehanna River

Watershed: Lower Susquehanna River

Sub Basin: Lower Conodoguinet Creek

Nearest Surface Water to Receive Runoff: Conodoguinet Creek

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

Impaired according to Chapter 303(d) list? YES
List Causes of Impairment: NO

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 2. Sensitive Natural Resources

INSTRUCTIONS

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

See pre-development drainage area map

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

Woodlands - 0.81 acres

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

0.00 acres


4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? Yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies	N/A		
Floodplains	N/A		
Riparian Areas	N/A		
Wetlands	N/A		
Woodlands	Yes	0.81	
Natural Drainage Ways	N/A		
Steep Slopes, 15% - 25%	N/A		
Steep Slopes, over 25%	N/A		
Other:			
Other:			
TOTAL EXISTING:		0.81	0.00

Worksheet 3. Nonstructural BMP Credits

PROTECTED AREA

1.1 Area of Protected Sensitive/Special Value Features (see WS 2)	0.00 Ac.
1.2 Area of Riparian Forest Buffer Protection	0.00 Ac.
3.1 Area of Minimum Disturbance/Reduced Grading	0.00 Ac
TOTAL	0.00 Ac

Site Area	Minus	Protected Area	=	Stormwater Management Area
0.87	-	0	=	0.87
				<p>This is the area that requires stormwater management</p> 

VOLUME CREDITS

3.1 Minimum Soil Compaction (See Chapter 8, page 22 – SW BMP Manual)

Lawn _____ ft² x 1/4" x 1/12 = _____ ft³

Meadow _____ ft² x 1/3" x 1/12 = _____ ft³

3.3 Protect Existing Trees (See Chapter 8, page 23 – SW BMP Manual)

For Trees within 100 feet of impervious area:

Tree Canopy _____ ft² x 1/2" x 1/12 = _____ ft³

5.1 Disconnect Roof Leaders to Vegetated Areas (See Chapter 8 page 25 – SW BMP Manual)

For runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area _____ ft² x 1/3" x 1/12 = _____ ft³

For all other disconnected roof areas

Roof Area _____ ft² x 1/4" x 1/12 = _____ ft³

5.2 Disconnect Non-Roof impervious to Vegetated Areas (See Chapter 8, page 26 – SW BMP Manual)

For Runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Area _____ ft² x 1/3" x 1/12 = _____ ft³

For all other disconnected roof areas

Impervious Area _____ ft² x 1/4" x 1/12 = _____ ft³

TOTAL NON-STRUCTURAL VOLUME CREDIT* _____ ft³

*For use on Worksheet 5

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

PROJECT: Creek Road
 Drainage Area: 1.79 acres
 2-Year Rainfall: 2.82 in

Total Site Area: 0.67 acres
 Protected Site Area: N/A acres
 Managed Site Area: 0.67 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	436	0.01	58	7.24	1.45	0.22	8
Meadow	C	1,002	0.02	71	4.08	0.82	0.66	55
Meadow	D	1,437	0.03	78	2.82	0.56	1.00	120
Woods	B	0	0.00	55	8.18	1.64	0.15	0
Woods	C	5,881	0.14	70	4.29	0.86	0.62	302
Woods	D	29,142	0.67	77	2.99	0.60	0.95	2,303
TOTAL:		37,897	0.87					2,788

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	D	6,098	0.14	91	0.99	0.20	1.90	968
Meadow	B	436	0.01	58	7.24	1.45	0.22	8
Meadow	C	6,970	0.16	71	4.08	0.82	0.66	383
Meadow	D	24,394	0.56	78	2.82	0.56	1.00	2,038
TOTAL:		37,897	0.87					3,396

2-Year Volume Increase (ft ³):	608
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2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

- Runoff (in) = $Q = (P - 0.2S) / (P + 0.8S)$ where
 P = 2-Year Rainfall (in)
 S = $(1000/CN) - 10$
- 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. The use of a weighted CN value for volume calculations is not acceptable.

Worksheet 5. Structural BMP Volume Credits

PROJECT: Creek Road
 SUB-BASIN: _____

Required Control Volume (ft³) - from Worksheet 4: 608
 Non-structural Volume Credit (ft³) - from Worksheet 3: N/A
 (maximum is 25% of required volume)
 Structural Volume Reqmt (ft³) 608
 (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	429	1,215
Total Structural Volume (ft³):		1,215
Structural Volume Requirement (ft³):		608
DIFFERENCE:		-607

VOLUME CREDIT DETERMINATION

- 1 Detained area runoff volume from Hydraflow = 1,538 cf
- 2 Storage volume of the BMP = 1,215 cf
- 3 Infiltrated volume within 72 hours after the 2-yr/24-hr event
 (Infiltration Rate/12) x Infiltration Area x 72 hrs = 1,215 cf

Potential infiltrated volume = 3,629 cf. Since this is greater than the storage volume, only the storage volume can be used and assumed to infiltrate within 72 hours.

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"/>

Underdrain Dewatering Rate Calculation

Project: Creek

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	0.01430
4	Other ³	N/A	N/A	N/A
Minimum Flow Rate (cfs)				0.014

1. From Principles of Geotechnical Engineering Third Edition, Braja Das, 1994
2. $Q=KA(Hm+T)/T$
 $A = \text{Area (square feet)} = 429$
 $Hm = \text{Head above media (feet)} = 2$
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	143	7.03
2	N/A	N/A	N/A	N/A
Total Flow Rate (cfs)				7.03

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

Pipe Discharge				
Pipe	Pipe Diameter - D (in)	Pipe Roughness Coefficient -n	Pipe Slope - S ⁶	Flow Rate (cfs) ⁷
1	4	0.012	0.002331002	0.09
2	N/A	N/A	N/A	N/A
Total Flow Rate (cfs)				0.09

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) =	0.014
Detained volume based on 2-year/24-hour storm (cu-ft) =	1,215
Total Dewatering Volume including volume in voids(cu-ft) =	1,558
Dewatering Time (sec) = 2HA/Ql =	108,965
Dewatering Time (hrs) =	30.27

TIME OF CONCENTRATION ADJUSTMENT

POST CONSTRUCTION TC TO BMP (DETAINED TC) BEFORE ADJUSTMENT 6.4 MIN

STRUCTURAL VOLUME PROVIDED BY BMP 1,215 CF

RATES OF RUNOFF TO THE BMP (FROM HYDRAFLOW REPORT)

Storm Event	Q (CFS)
2 YR/24 HR	0.762
10 YR/24 HR	1.363
50 YR/24 HR	2.242
100 YR/24 HR	2.742

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	0.762	26.575
10 YR/24 HR	1.363	14.857
50 YR/24 HR	2.242	9.032
100 YR/24 HR	2.742	7.385

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	0.762	26.575	32.975
10 YR/24 HR	1.363	14.857	21.257
50 YR/24 HR	2.242	9.032	15.432
100 YR/24 HR	2.742	7.385	13.785

Underdrain Report

Label	Solve For	Friction Method	Roughness Coefficient
Underdrain	Full Flow Capacity	Manning Formula	0.012
Channel Slope (ft/ft)	Normal Depth (ft)	Diameter (ft)	Discharge (ft ³ /s)
0.00500	0.33	0.33	0.15
Flow Area (ft ²)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Top Width (ft)
0.09	1.05	0.08	0.00
Critical Depth (ft)	Percent Full (%)	Critical Slope (ft/ft)	Velocity (ft/s)
0.21	100.0	0.00897	1.67
Velocity Head (ft)	Specific Energy (ft)	Froude Number	Maximum Discharge (ft ³ /s)
0.04	0.38	0.00	0.16
Discharge Full (ft ³ /s)	Slope Full (ft/ft)	Flow Type	Notes
0.15	0.00500	SubCritical	

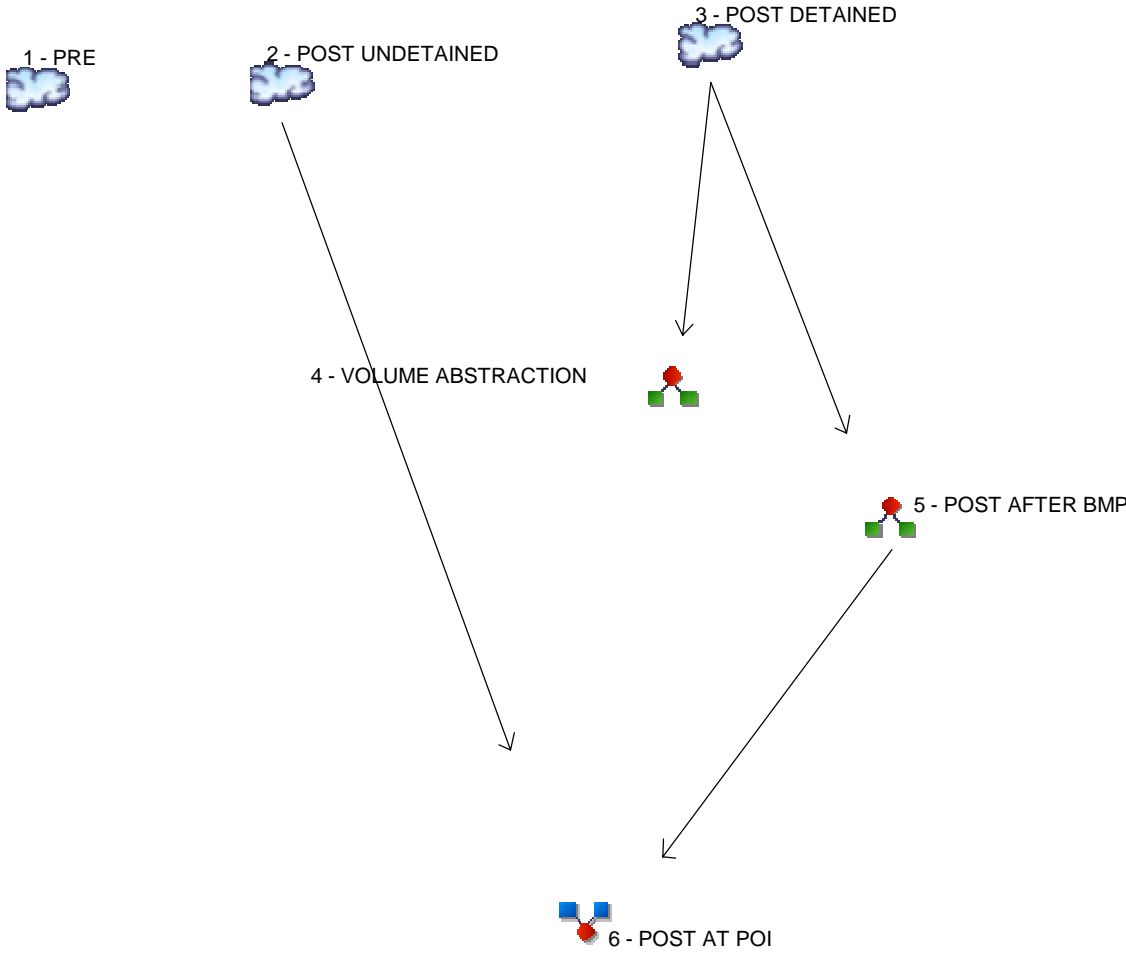
Messages

Underdrain Report

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	-----	-----	2.510	-----	-----	5.196	-----	9.506	12.05	PRE
2	SCS Runoff	-----	-----	2.048	-----	-----	4.238	-----	7.754	9.831	POST UNDETAINED
3	SCS Runoff	-----	-----	0.762	-----	-----	1.363	-----	2.242	2.742	POST DETAINED
4	Diversion1	3	-----	0.762	-----	-----	1.363	-----	1.266	1.040	VOLUME ABSTRACTION
5	Diversion2	3	-----	0.017	-----	-----	1.062	-----	2.242	2.742	POST AFTER BMP
6	Combine	2, 5	-----	2.048	-----	-----	5.300	-----	9.932	12.49	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	2.510	2	720	5,821	-----	-----	-----	PRE	
2	SCS Runoff	2.048	2	720	4,748	-----	-----	-----	POST UNDETAINED	
3	SCS Runoff	0.762	2	716	1,538	-----	-----	-----	POST DETAINED	
4	Diversion1	0.762	2	716	1,217	3	-----	-----	VOLUME ABSTRACTION	
5	Diversion2	0.017	2	944	321	3	-----	-----	POST AFTER BMP	
6	Combine	2.048	2	720	5,069	2, 5	-----	-----	POST AT POI	
Creek Road.gpw					Return Period: 2 Year			Sunday, 10 / 23 / 2016		

Hydrograph Report

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

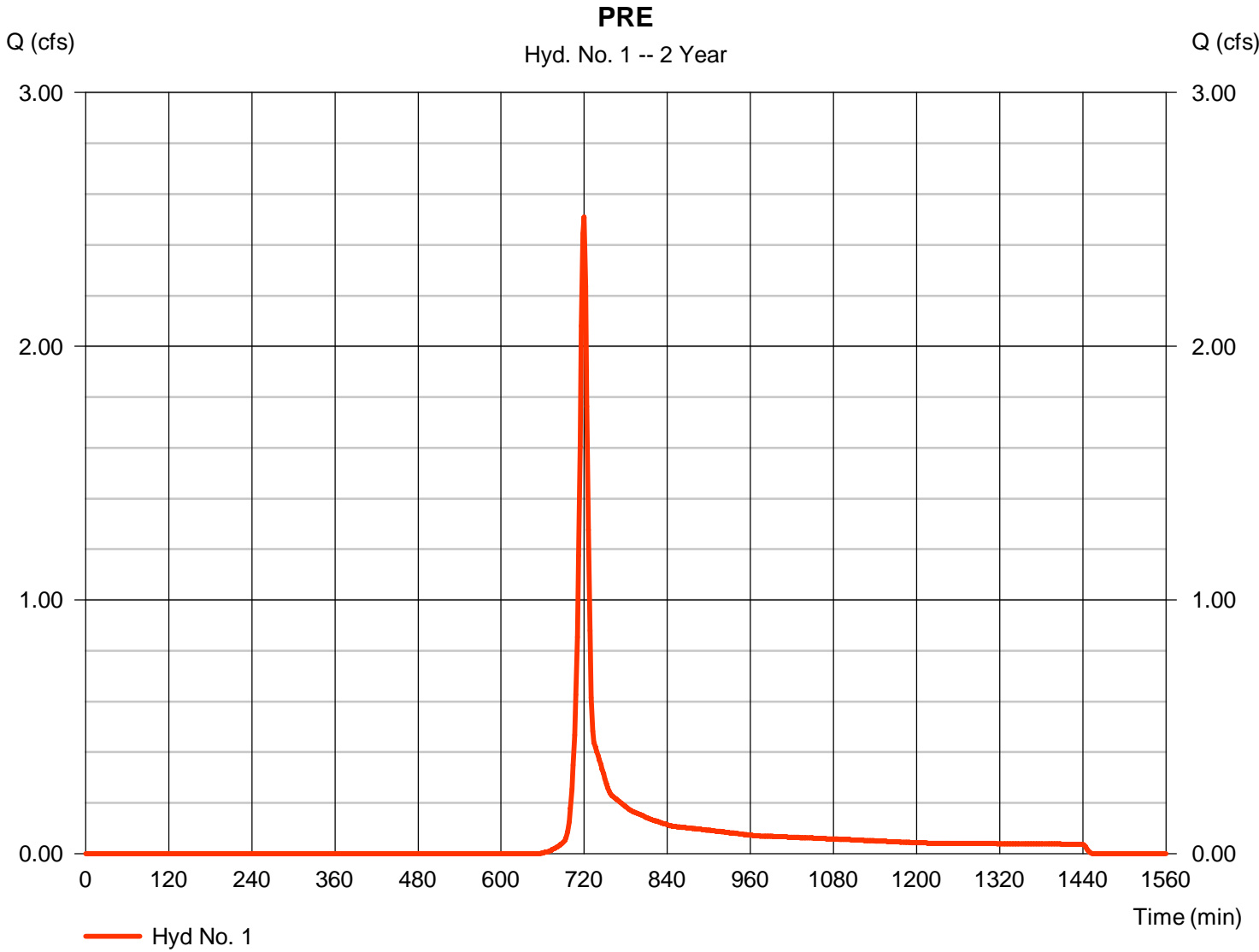
Sunday, 10 / 23 / 2016

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 2.510 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 5,821 cuft
Drainage area	= 1.790 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 2.82 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.020 x 55) + (0.340 x 70) + (1.190 x 77) + (0.080 x 71) + (0.080 x 78)] / 1.790



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)	= 2.82	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 6.62	+ 0.00	+ 0.00	= 6.62
Shallow Concentrated Flow				
Flow length (ft)	= 167.00	0.00	0.00	
Watercourse slope (%)	= 21.60	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=7.50	0.00	0.00	
Travel Time (min)	= 0.37	+ 0.00	+ 0.00	= 0.37
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{{0}}0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				7.00 min

Hydrograph Report

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

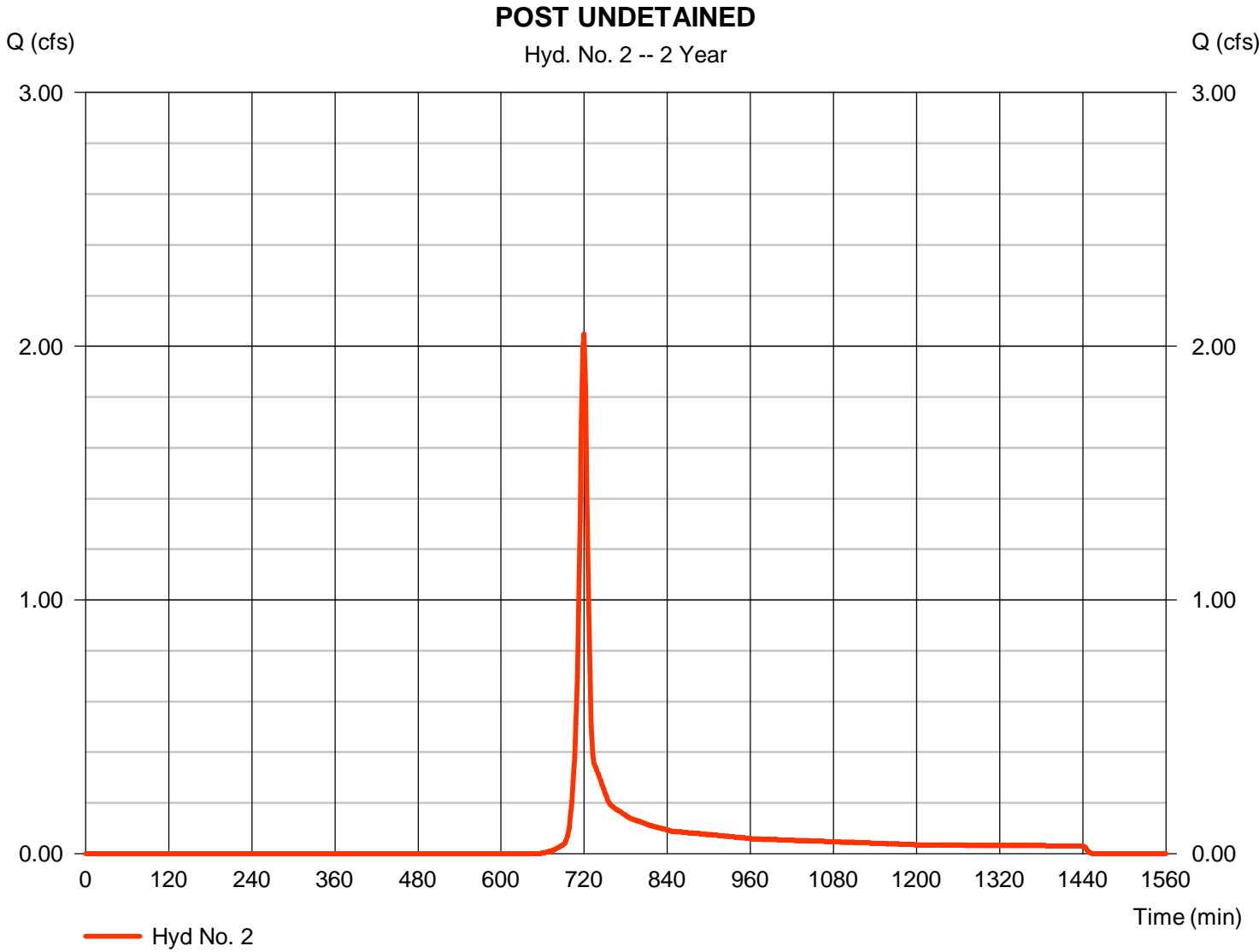
Sunday, 10 / 23 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 2.048 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 4,748 cuft
Drainage area	= 1.460 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 2.82 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.030 x 58) + (0.220 x 70) + (0.570 x 77) + (0.180 x 71) + (0.380 x 78)] / 1.460



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)	= 2.82	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 6.62	+ 0.00	+ 0.00	= 6.62
Shallow Concentrated Flow				
Flow length (ft)	= 167.00	0.00	0.00	
Watercourse slope (%)	= 21.60	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=7.50	0.00	0.00	
Travel Time (min)	= 0.37	+ 0.00	+ 0.00	= 0.37
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	({0})0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				7.00 min

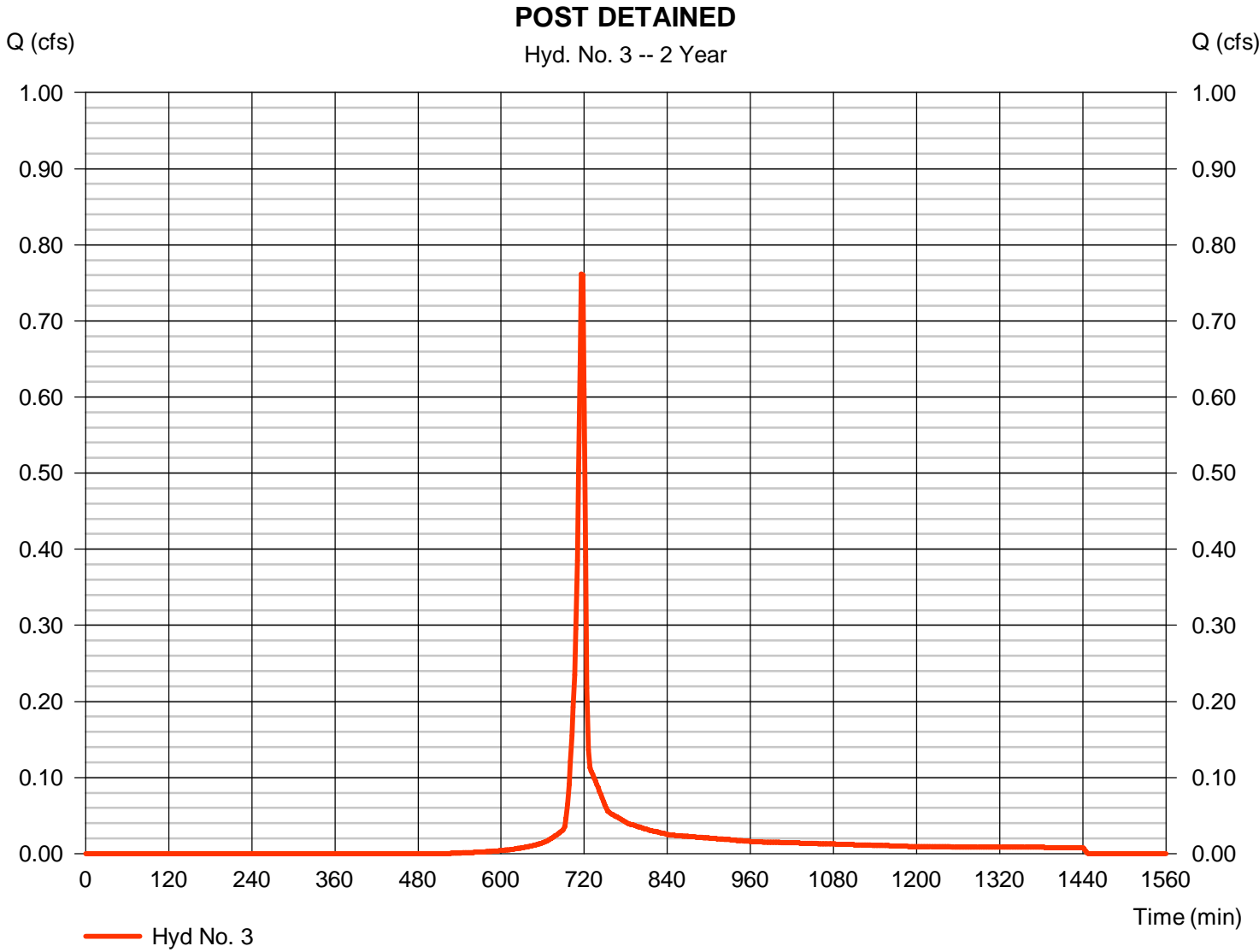
Hydrograph Report

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.762 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 1,538 cuft
Drainage area	= 0.330 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.40 min
Total precip.	= 2.82 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.140 x 91) + (0.190 x 78)] / 0.330



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	= 0.240		0.011		0.011			
Flow length (ft)	= 50.0		0.0		0.0			
Two-year 24-hr precip. (in)	= 2.82		0.00		0.00			
Land slope (%)	= 6.00		0.00		0.00			
Travel Time (min)	= 5.63	+	0.00	+	0.00	=	5.63	
Shallow Concentrated Flow								
Flow length (ft)	= 7.00		0.00		0.00			
Watercourse slope (%)	= 1.00		0.00		0.00			
Surface description	= Paved		Paved		Paved			
Average velocity (ft/s)	=2.03		0.00		0.00			
Travel Time (min)	= 0.06	+	0.00	+	0.00	=	0.06	
Channel Flow								
X sectional flow area (sqft)	= 0.09		0.00		0.00			
Wetted perimeter (ft)	= 1.05		0.00		0.00			
Channel slope (%)	= 0.50		0.00		0.00			
Manning's n-value	= 0.012		0.015		0.015			
Velocity (ft/s)	=1.69		0.00		0.00			
Flow length (ft)	{{0}}70.0		0.0		0.0			
Travel Time (min)	= 0.69	+	0.00	+	0.00	=	0.69	
Total Travel Time, Tc							=	6.40 min

Hydrograph Report

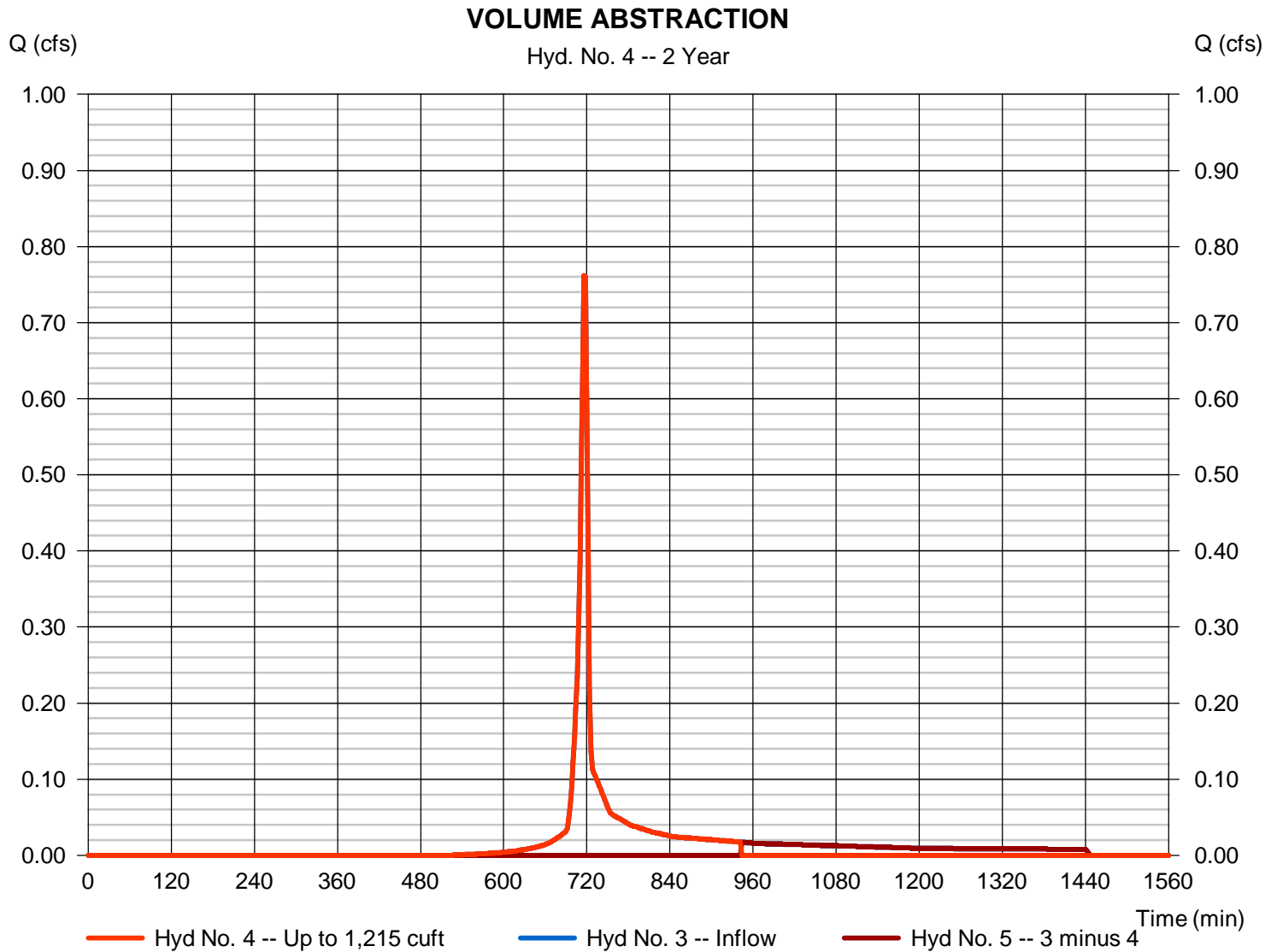
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Sunday, 10 / 23 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.762 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 1,217 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

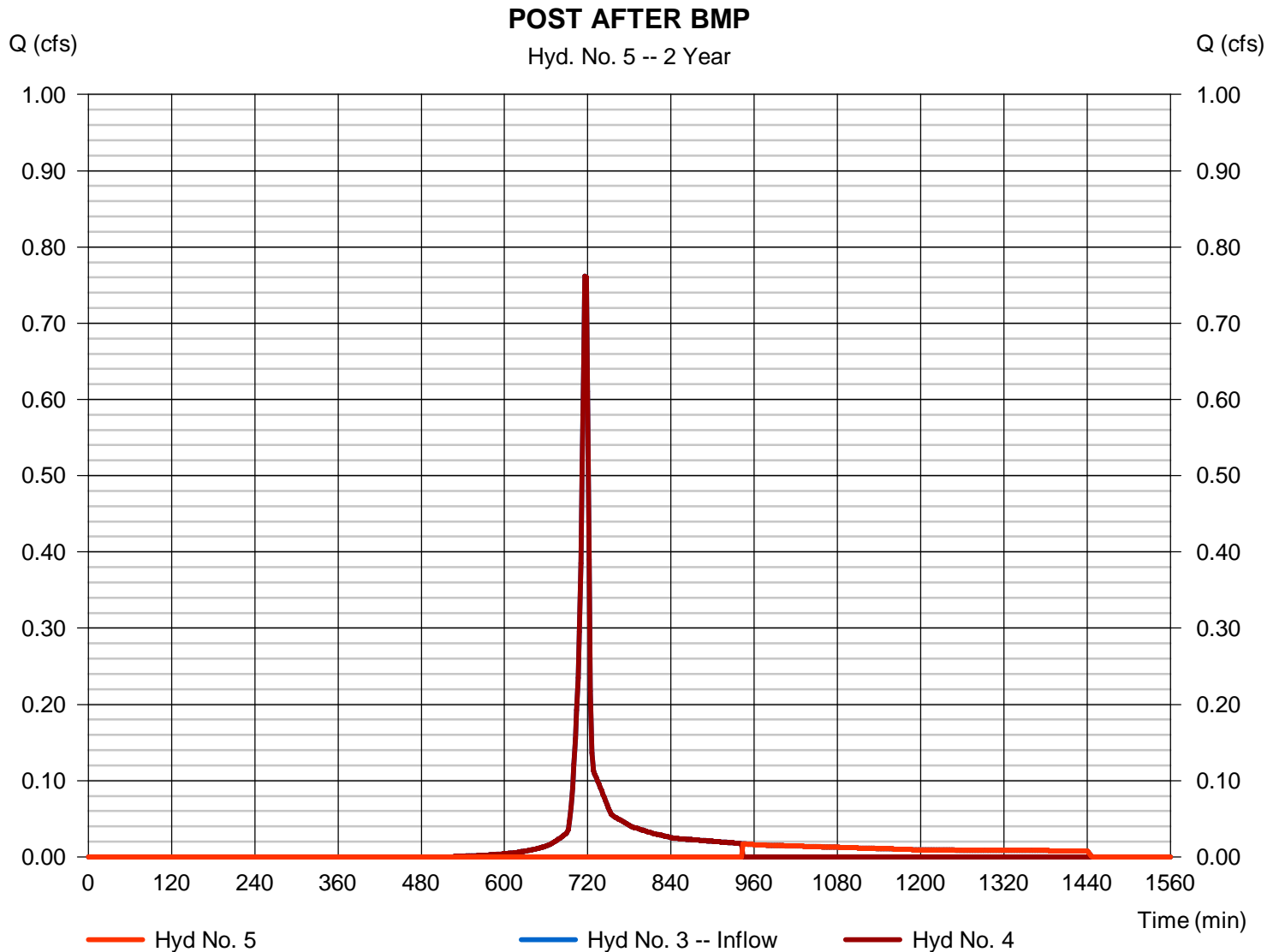
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Sunday, 10 / 23 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 0.017 cfs
Storm frequency	= 2 yrs	Time to peak	= 944 min
Time interval	= 2 min	Hyd. volume	= 321 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

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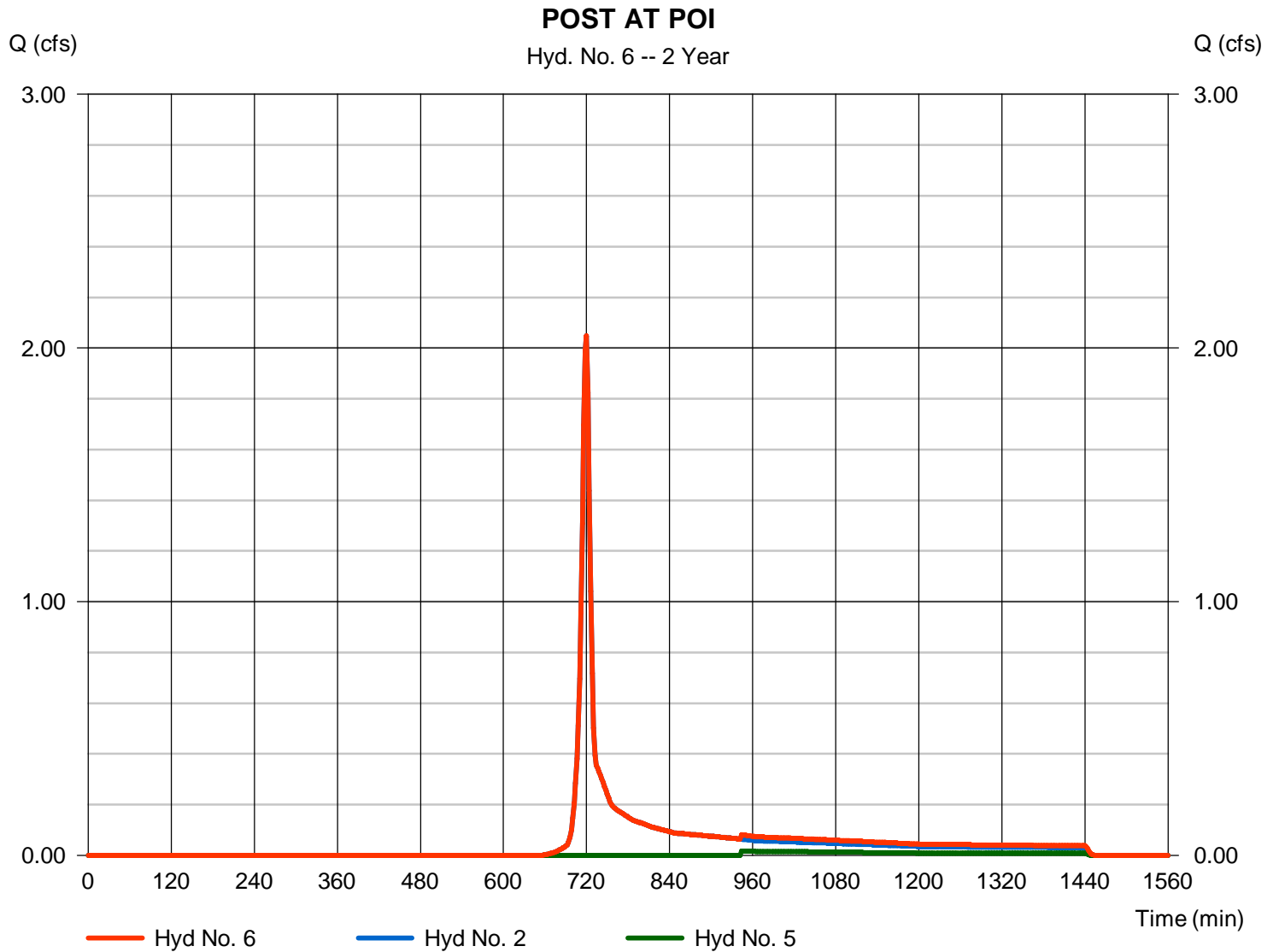
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Hyd. No. 6

POST AT POI

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

Peak discharge = 2.048 cfs
Time to peak = 720 min
Hyd. volume = 5,069 cuft
Contrib. drain. area = 1.460 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	5.196	2	720	11,897	-----	-----	-----	PRE	
2	SCS Runoff	4.238	2	720	9,704	-----	-----	-----	POST UNDETAINED	
3	SCS Runoff	1.363	2	716	2,782	-----	-----	-----	POST DETAINED	
4	Diversion1	1.363	2	716	1,217	3	-----	-----	VOLUME ABSTRACTION	
5	Diversion2	1.062	2	720	1,565	3	-----	-----	POST AFTER BMP	
6	Combine	5.300	2	720	11,268	2, 5	-----	-----	POST AT POI	
Creek Road.gpw					Return Period: 10 Year			Sunday, 10 / 23 / 2016		

Hydrograph Report

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

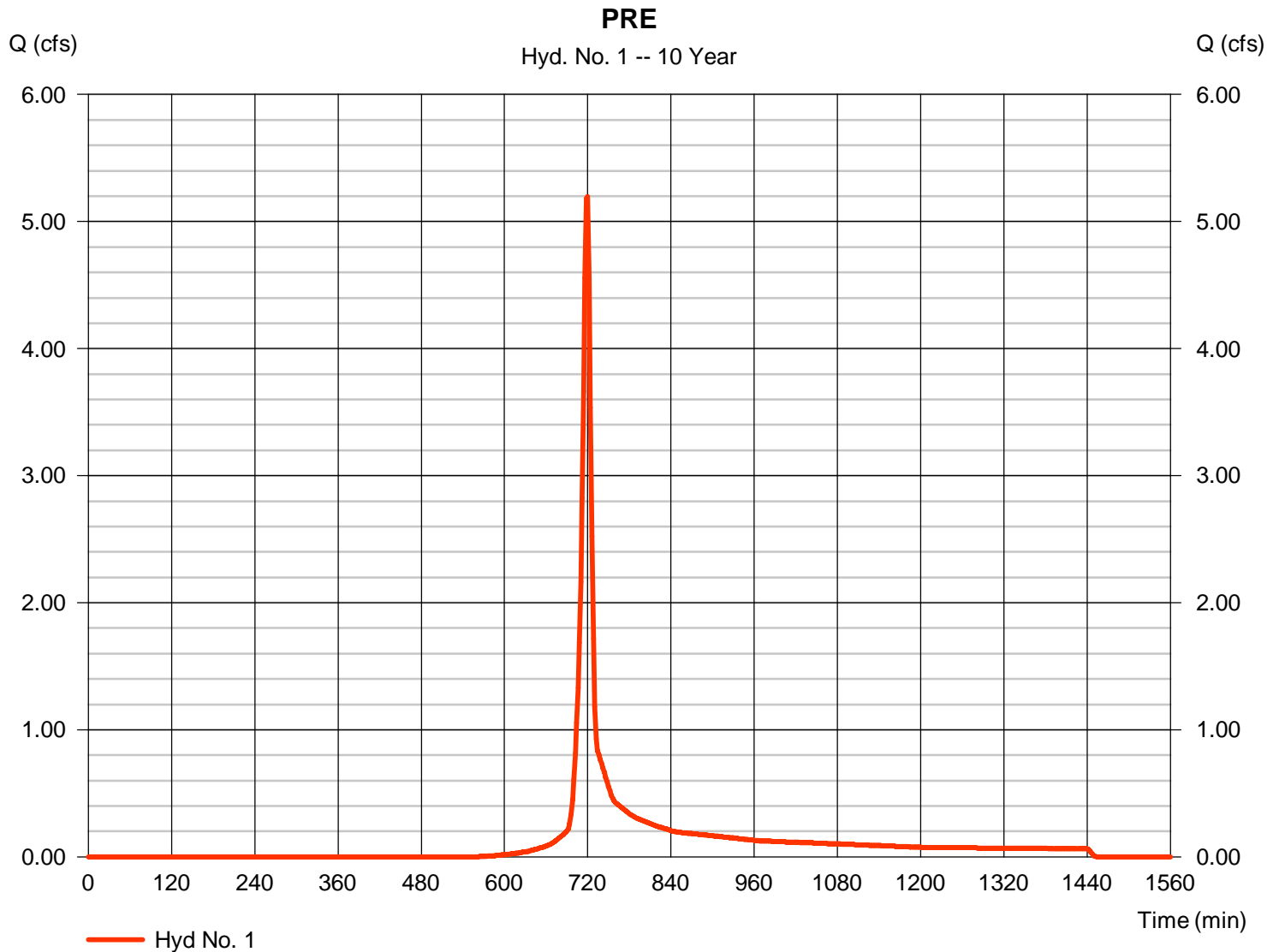
Sunday, 10 / 23 / 2016

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 5.196 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 11,897 cuft
Drainage area	= 1.790 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 4.12 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.020 x 55) + (0.340 x 70) + (1.190 x 77) + (0.080 x 71) + (0.080 x 78)] / 1.790



Hydrograph Report

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

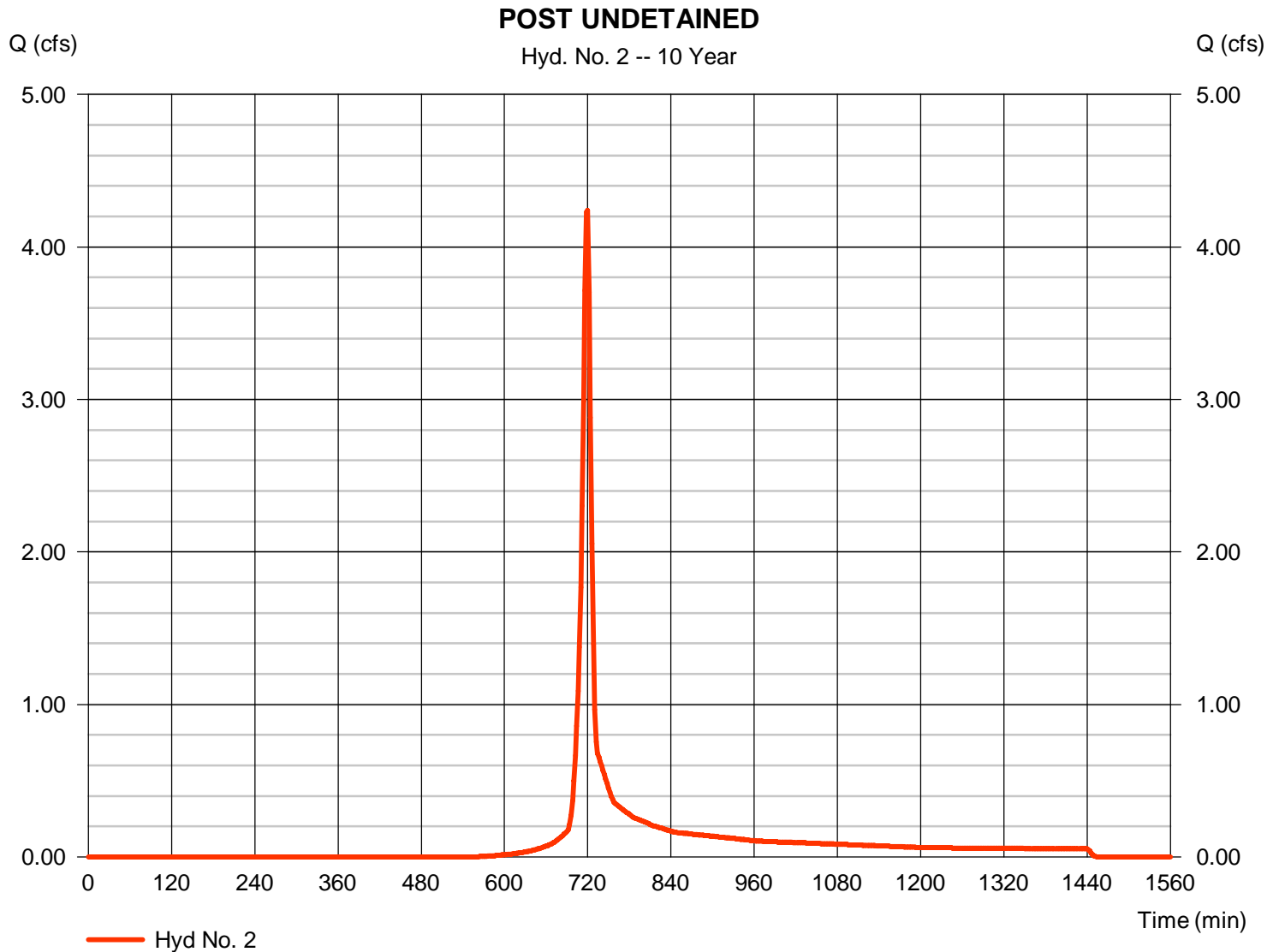
Sunday, 10 / 23 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 4.238 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 9,704 cuft
Drainage area	= 1.460 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 4.12 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.030 x 58) + (0.220 x 70) + (0.570 x 77) + (0.180 x 71) + (0.380 x 78)] / 1.460



Hydrograph Report

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

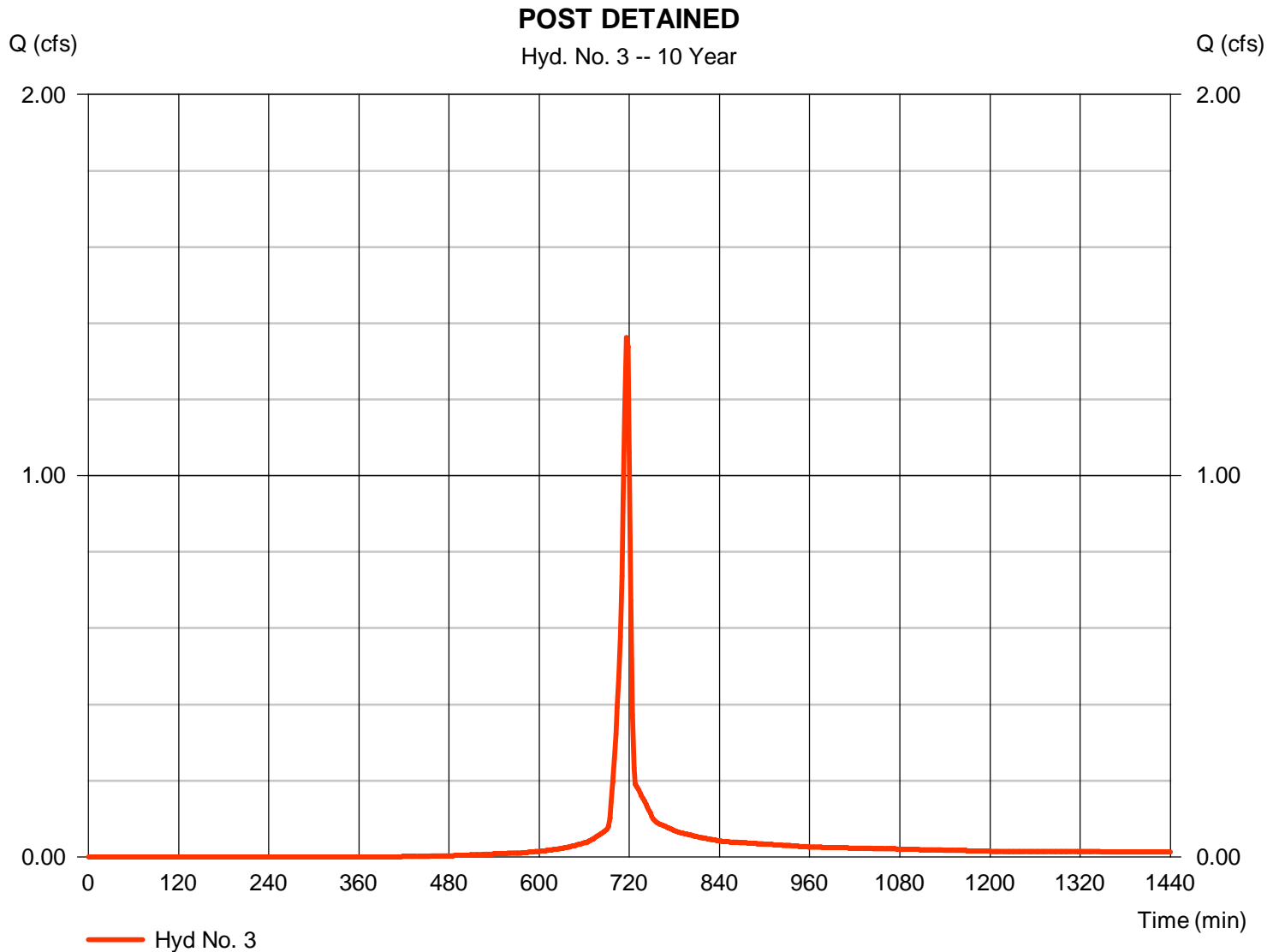
Sunday, 10 / 23 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 1.363 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 2,782 cuft
Drainage area	= 0.330 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.40 min
Total precip.	= 4.12 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.140 x 91) + (0.190 x 78)] / 0.330



Hydrograph Report

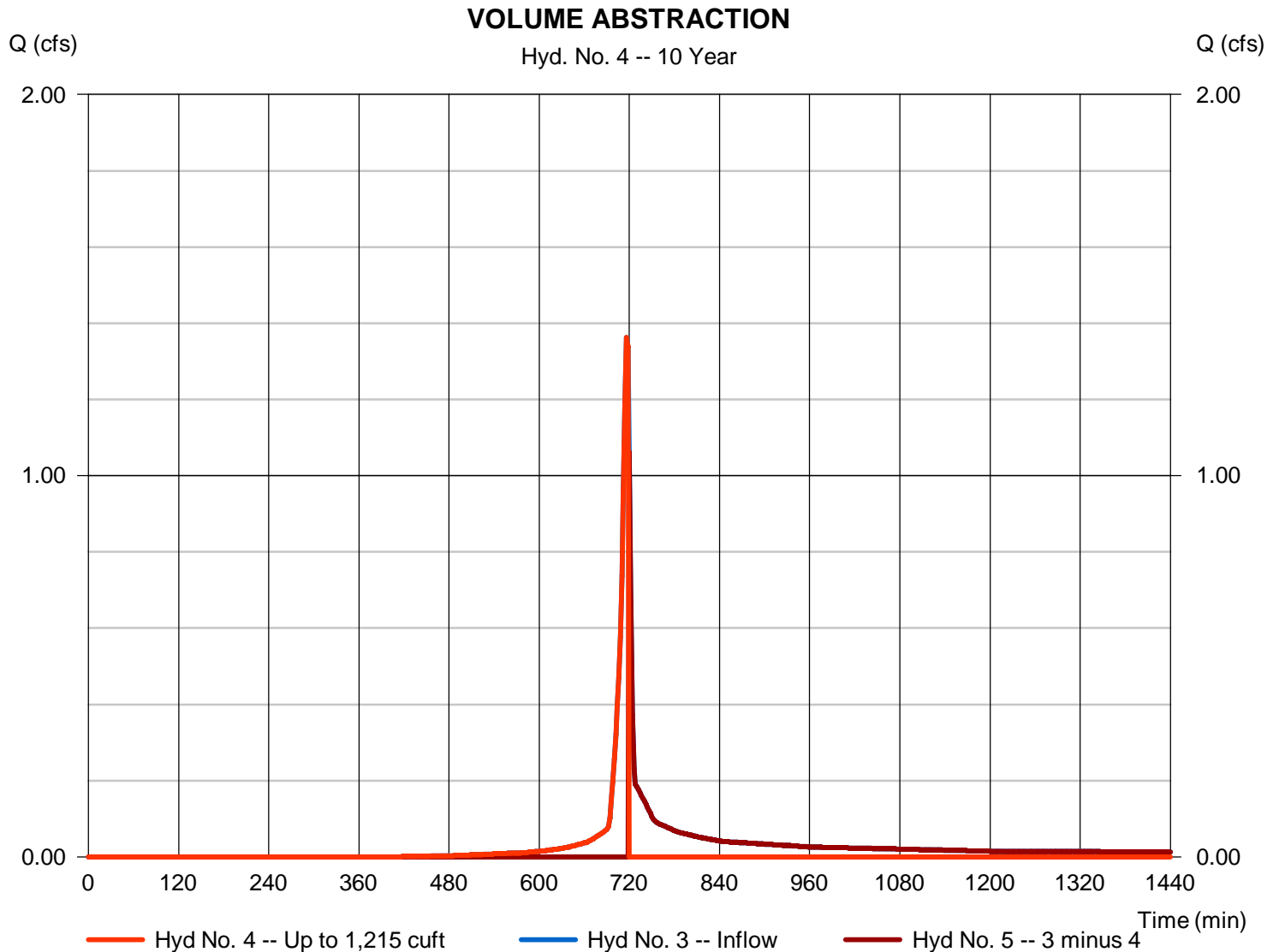
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Sunday, 10 / 23 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 1.363 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 1,217 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

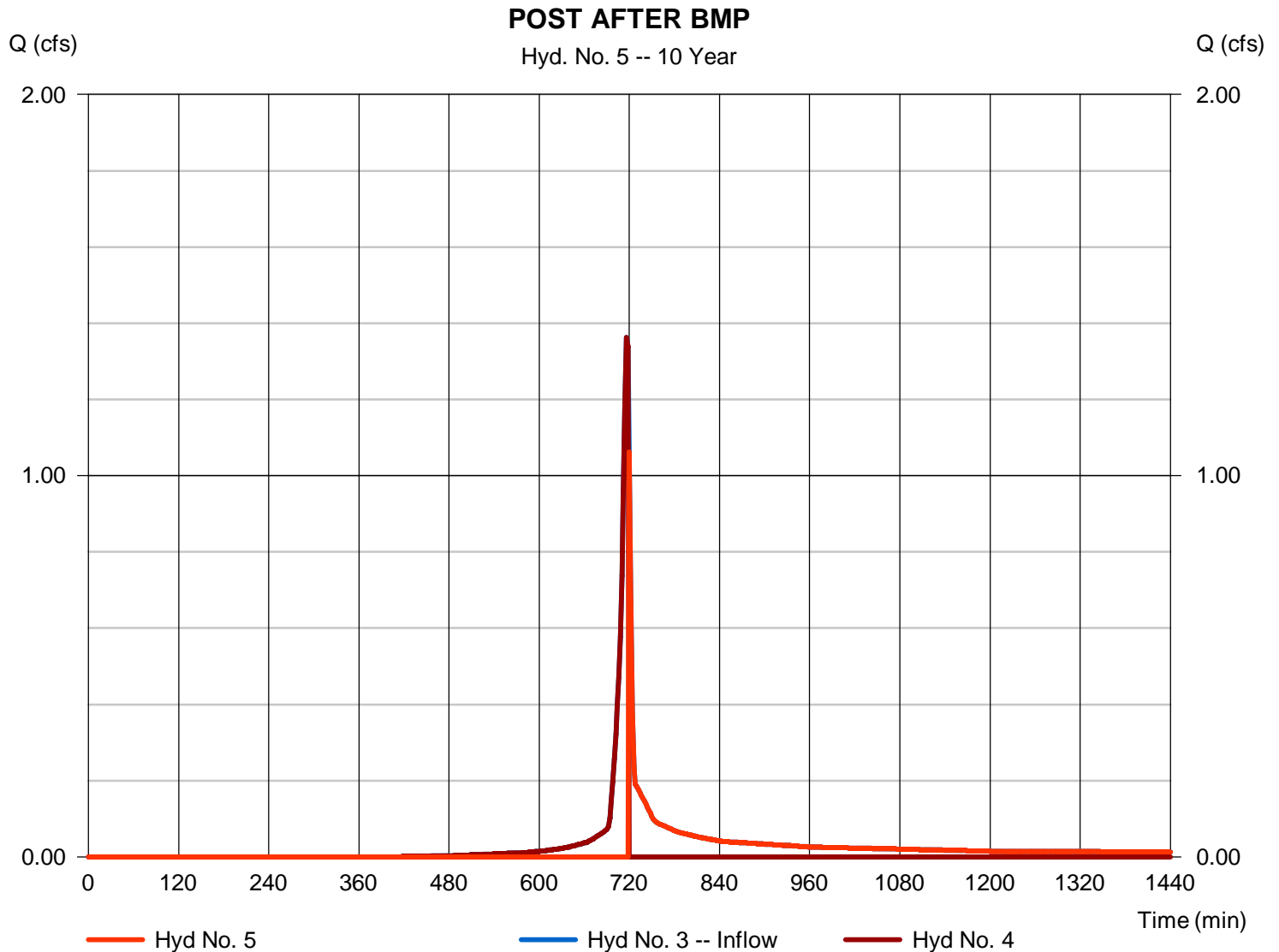
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Sunday, 10 / 23 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 1.062 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 1,565 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

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

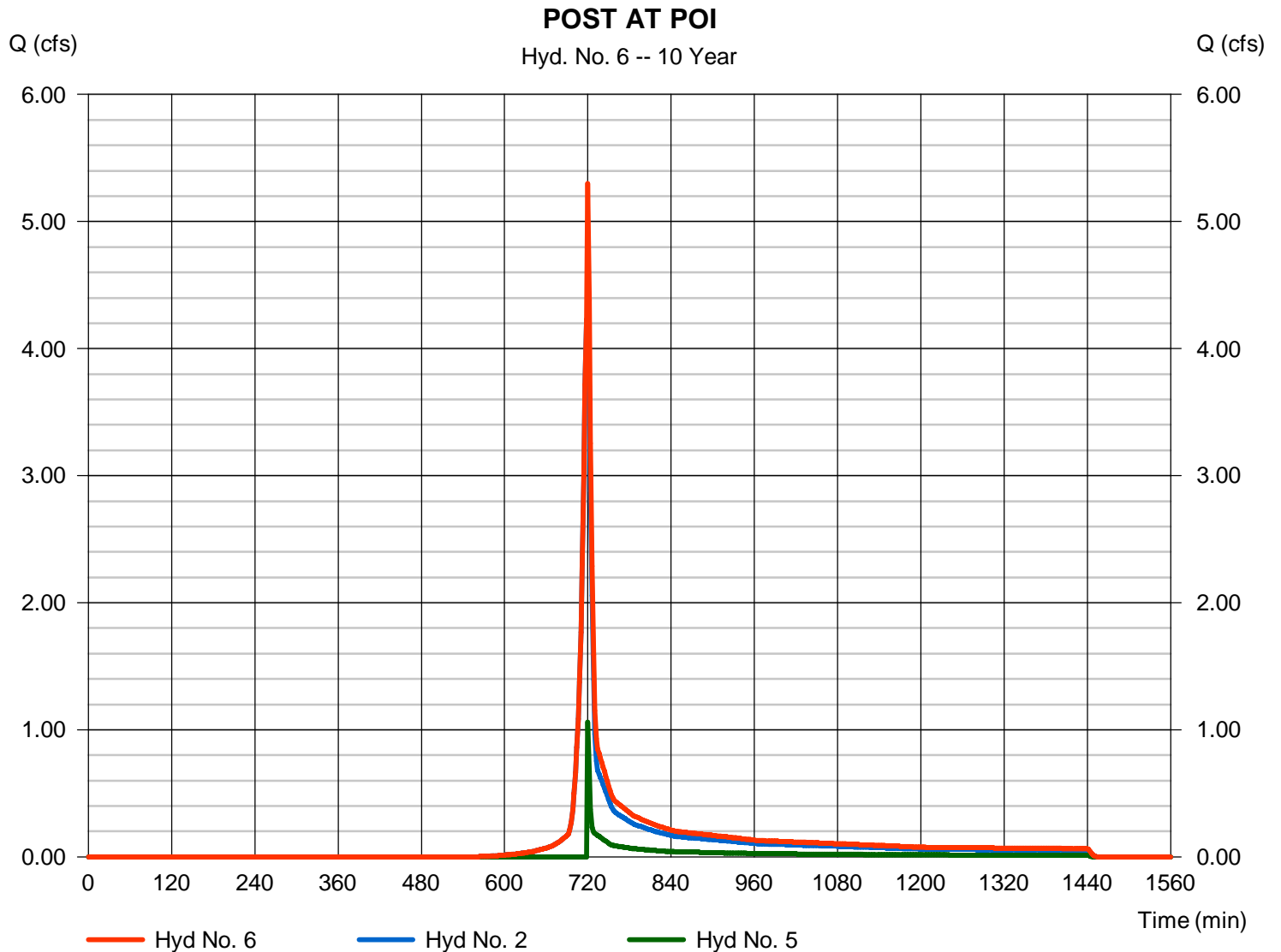
Sunday, 10 / 23 / 2016

Hyd. No. 6

POST AT POI

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

Peak discharge = 5.300 cfs
Time to peak = 720 min
Hyd. volume = 11,268 cuft
Contrib. drain. area = 1.460 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	9.506	2	718	21,795	-----	-----	-----	PRE	
2	SCS Runoff	7.754	2	718	17,777	-----	-----	-----	POST UNDETAINED	
3	SCS Runoff	2.242	2	716	4,681	-----	-----	-----	POST DETAINED	
4	Diversion1	1.266	2	710	1,276	3	-----	-----	VOLUME ABSTRACTION	
5	Diversion2	2.242	2	716	3,405	3	-----	-----	POST AFTER BMP	
6	Combine	9.932	2	718	21,182	2, 5	-----	-----	POST AT POI	
Creek Road.gpw					Return Period: 50 Year			Sunday, 10 / 23 / 2016		

Hydrograph Report

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

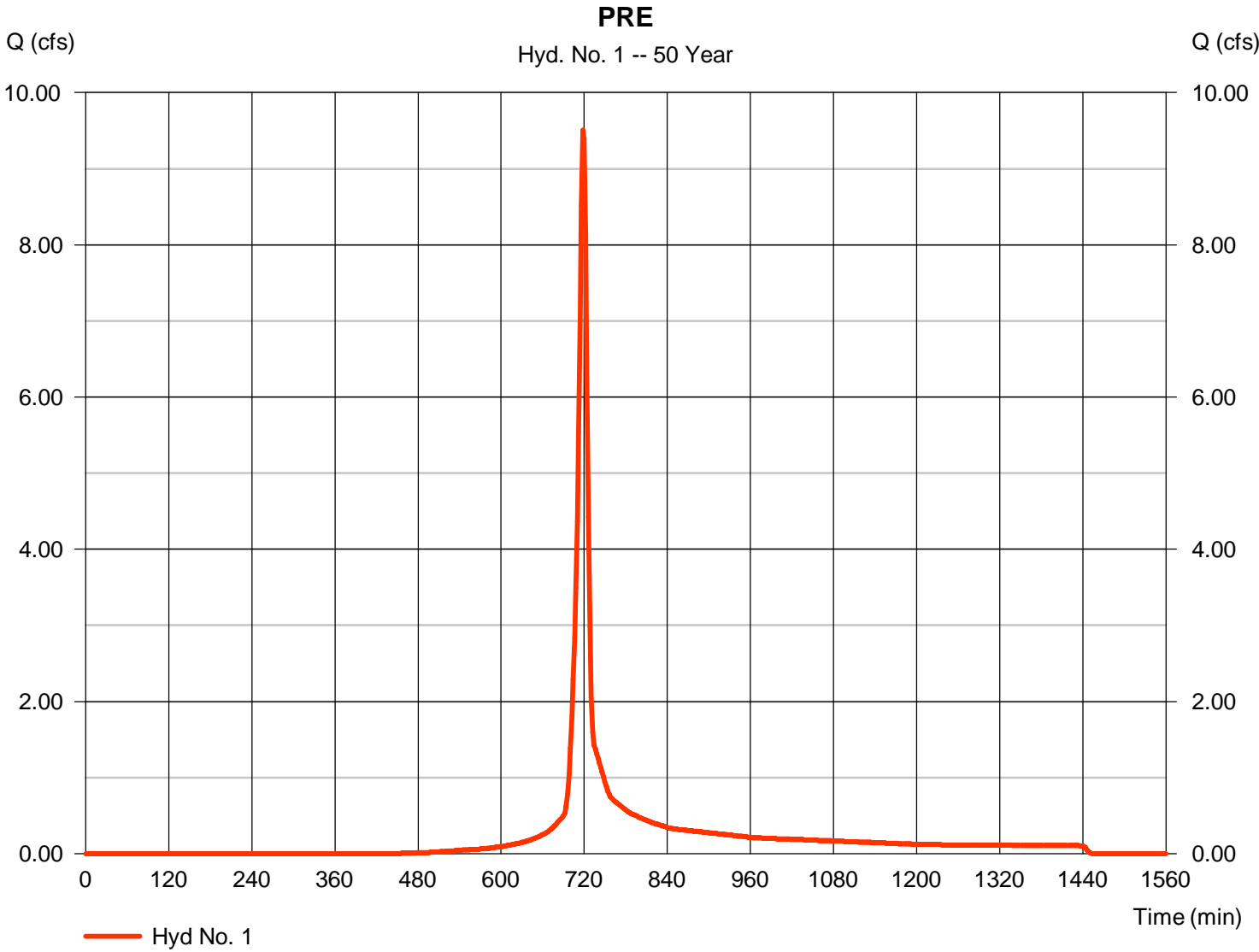
Sunday, 10 / 23 / 2016

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 9.506 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 21,795 cuft
Drainage area	= 1.790 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 5.97 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.020 x 55) + (0.340 x 70) + (1.190 x 77) + (0.080 x 71) + (0.080 x 78)] / 1.790



Hydrograph Report

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

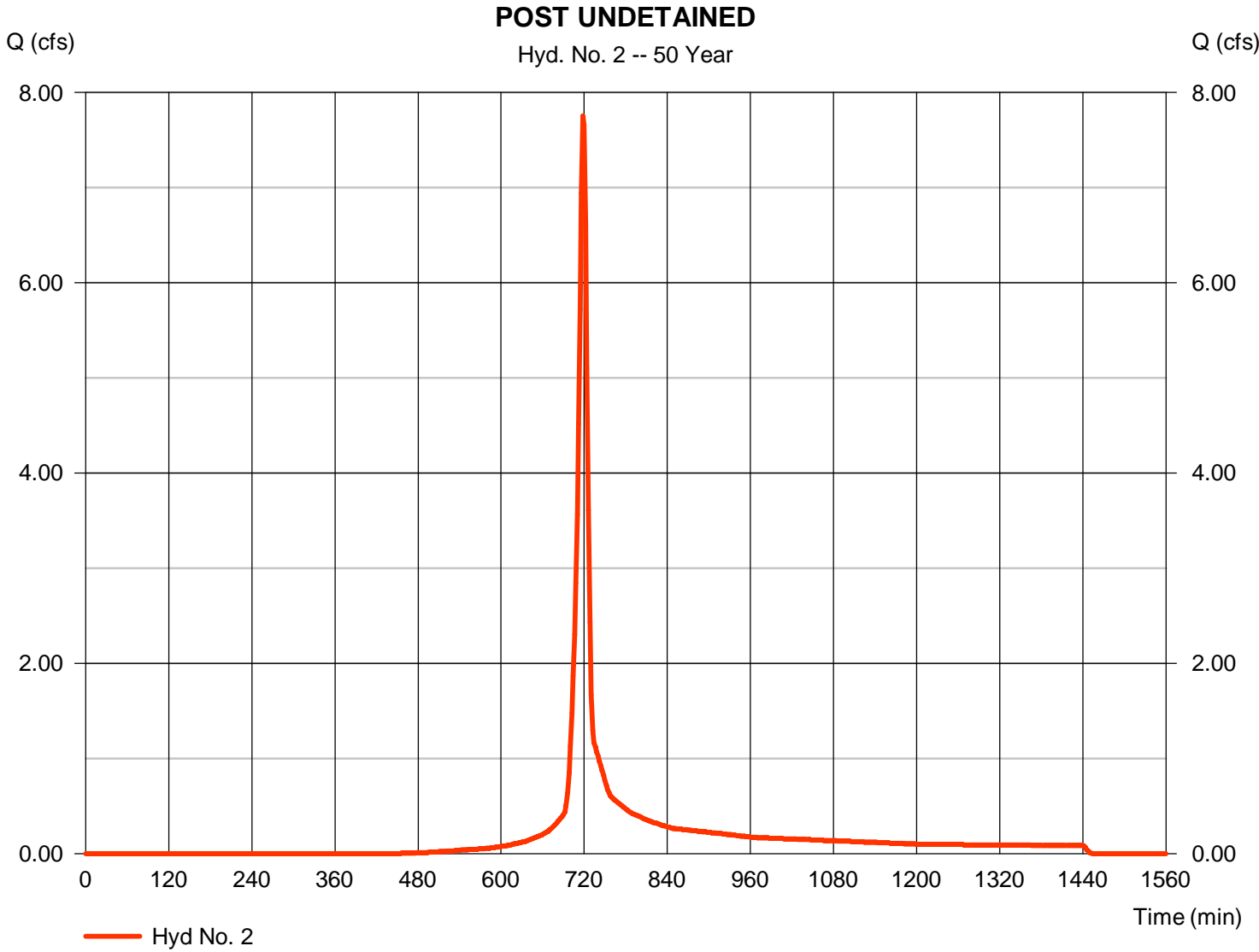
Sunday, 10 / 23 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 7.754 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 17,777 cuft
Drainage area	= 1.460 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 5.97 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.030 x 58) + (0.220 x 70) + (0.570 x 77) + (0.180 x 71) + (0.380 x 78)] / 1.460



Hydrograph Report

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

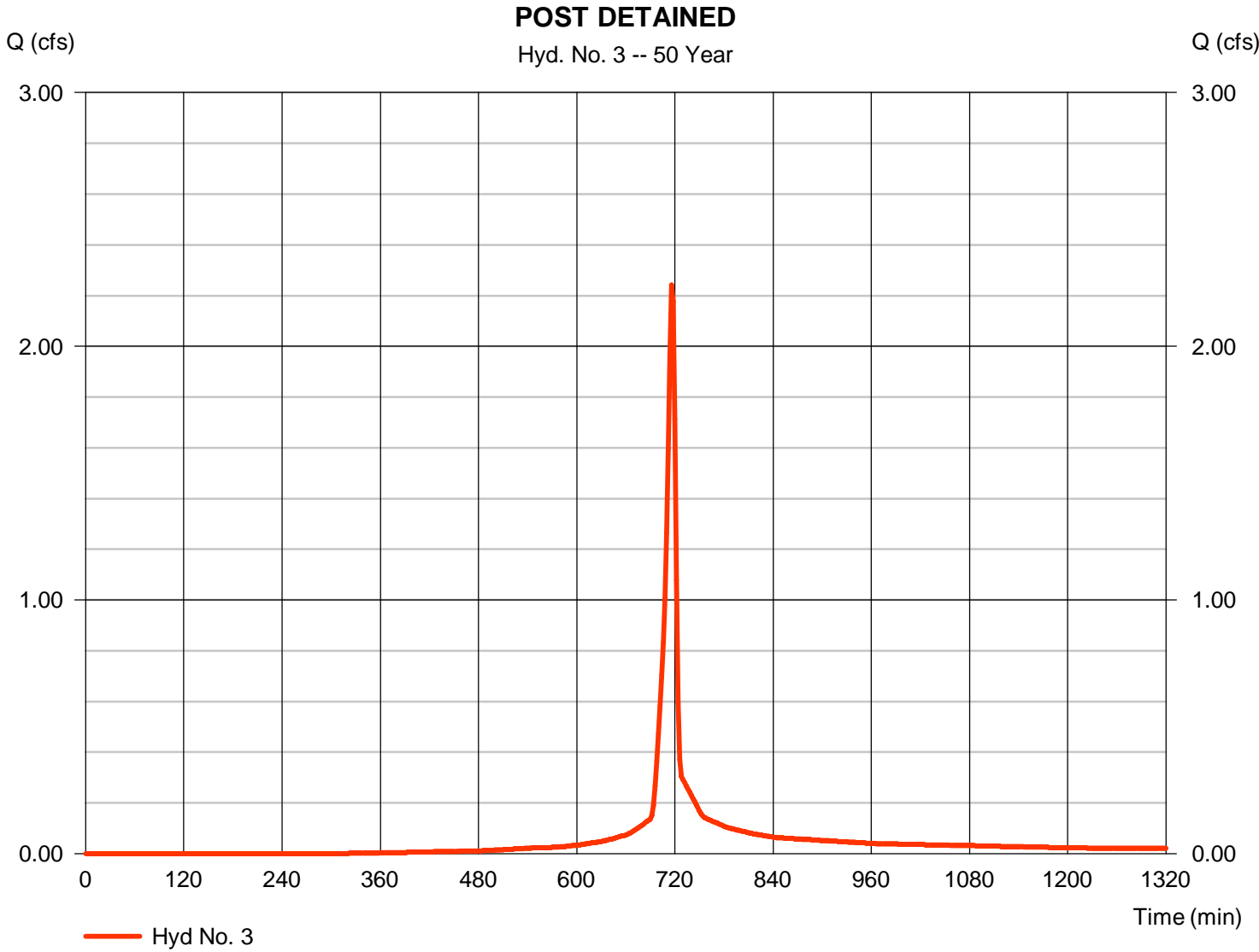
Sunday, 10 / 23 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 2.242 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 4,681 cuft
Drainage area	= 0.330 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.40 min
Total precip.	= 5.97 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.140 x 91) + (0.190 x 78)] / 0.330



Hydrograph Report

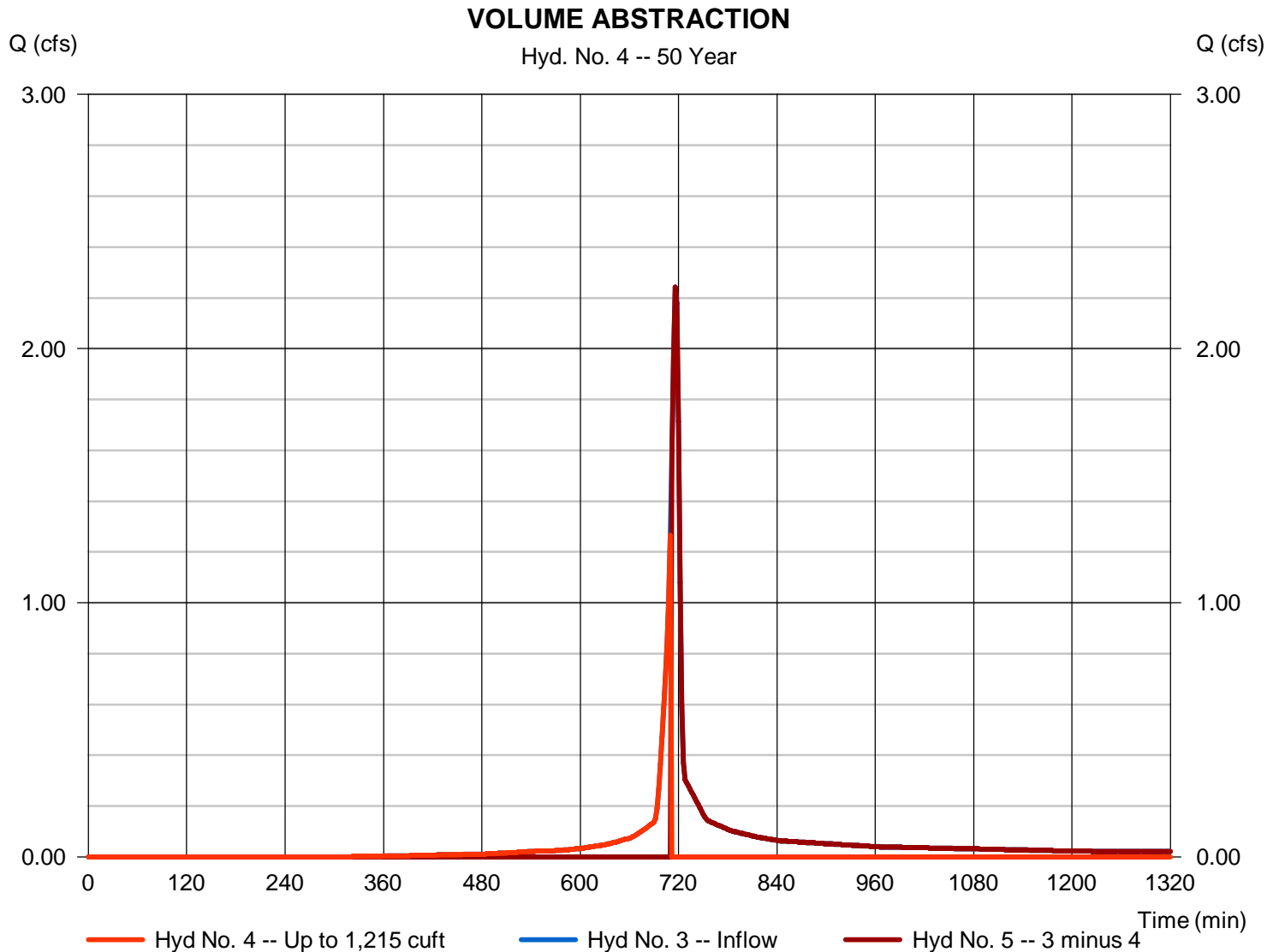
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 1.266 cfs
Storm frequency	= 50 yrs	Time to peak	= 710 min
Time interval	= 2 min	Hyd. volume	= 1,276 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

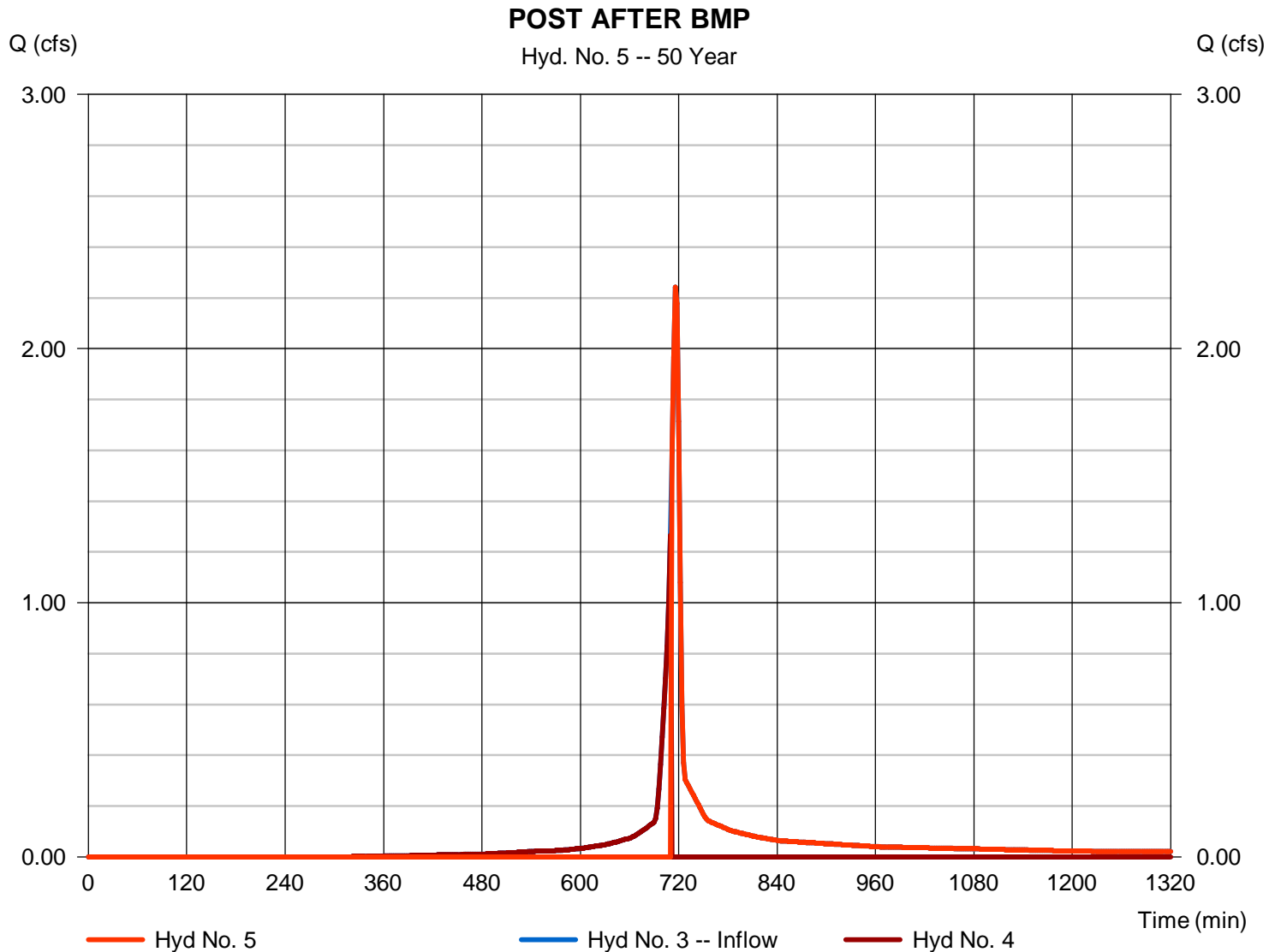
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 2.242 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 3,405 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

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

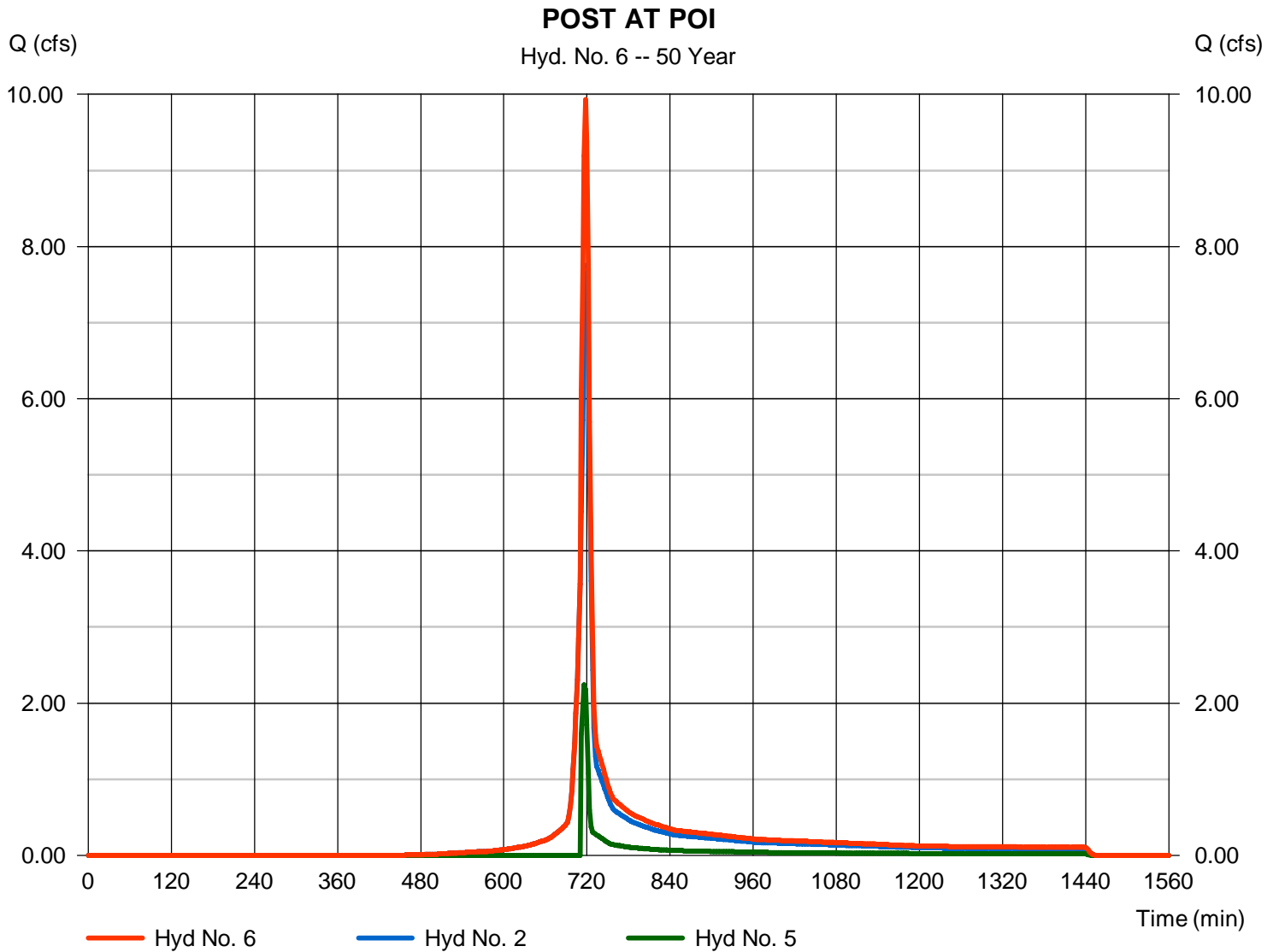
Sunday, 10 / 23 / 2016

Hyd. No. 6

POST AT POI

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

Peak discharge = 9.932 cfs
Time to peak = 718 min
Hyd. volume = 21,182 cuft
Contrib. drain. area = 1.460 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	12.05	2	718	27,779	-----	-----	-----	PRE	
2	SCS Runoff	9.831	2	718	22,657	-----	-----	-----	POST UNDETAINED	
3	SCS Runoff	2.742	2	716	5,794	-----	-----	-----	POST DETAINED	
4	Diversion1	1.040	2	706	1,336	3	-----	-----	VOLUME ABSTRACTION	
5	Diversion2	2.742	2	716	4,457	3	-----	-----	POST AFTER BMP	
6	Combine	12.49	2	718	27,115	2, 5	-----	-----	POST AT POI	
Creek Road.gpw					Return Period: 100 Year			Sunday, 10 / 23 / 2016		

Hydrograph Report

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

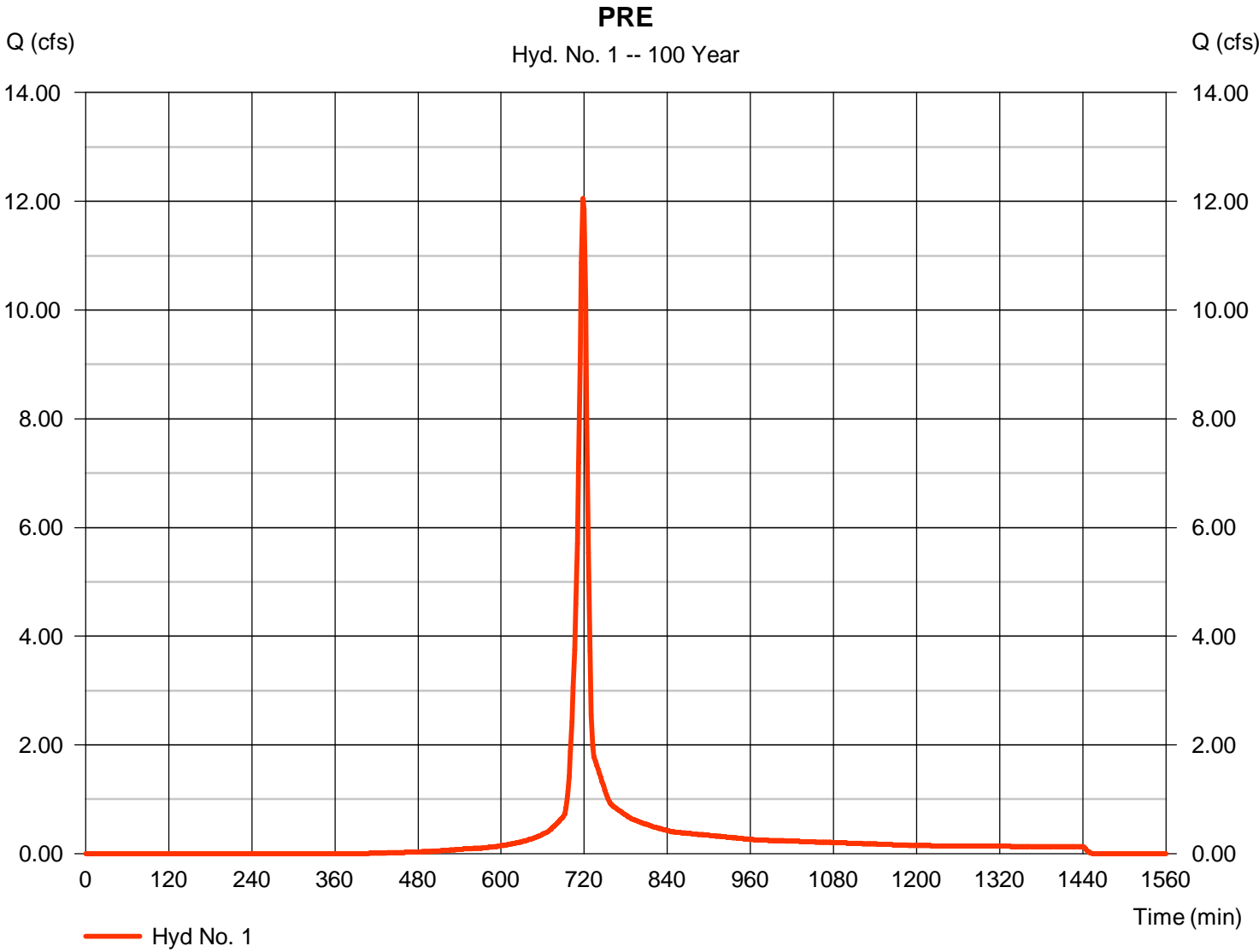
Sunday, 10 / 23 / 2016

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 12.05 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 27,779 cuft
Drainage area	= 1.790 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 7.02 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.020 x 55) + (0.340 x 70) + (1.190 x 77) + (0.080 x 71) + (0.080 x 78)] / 1.790



Hydrograph Report

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

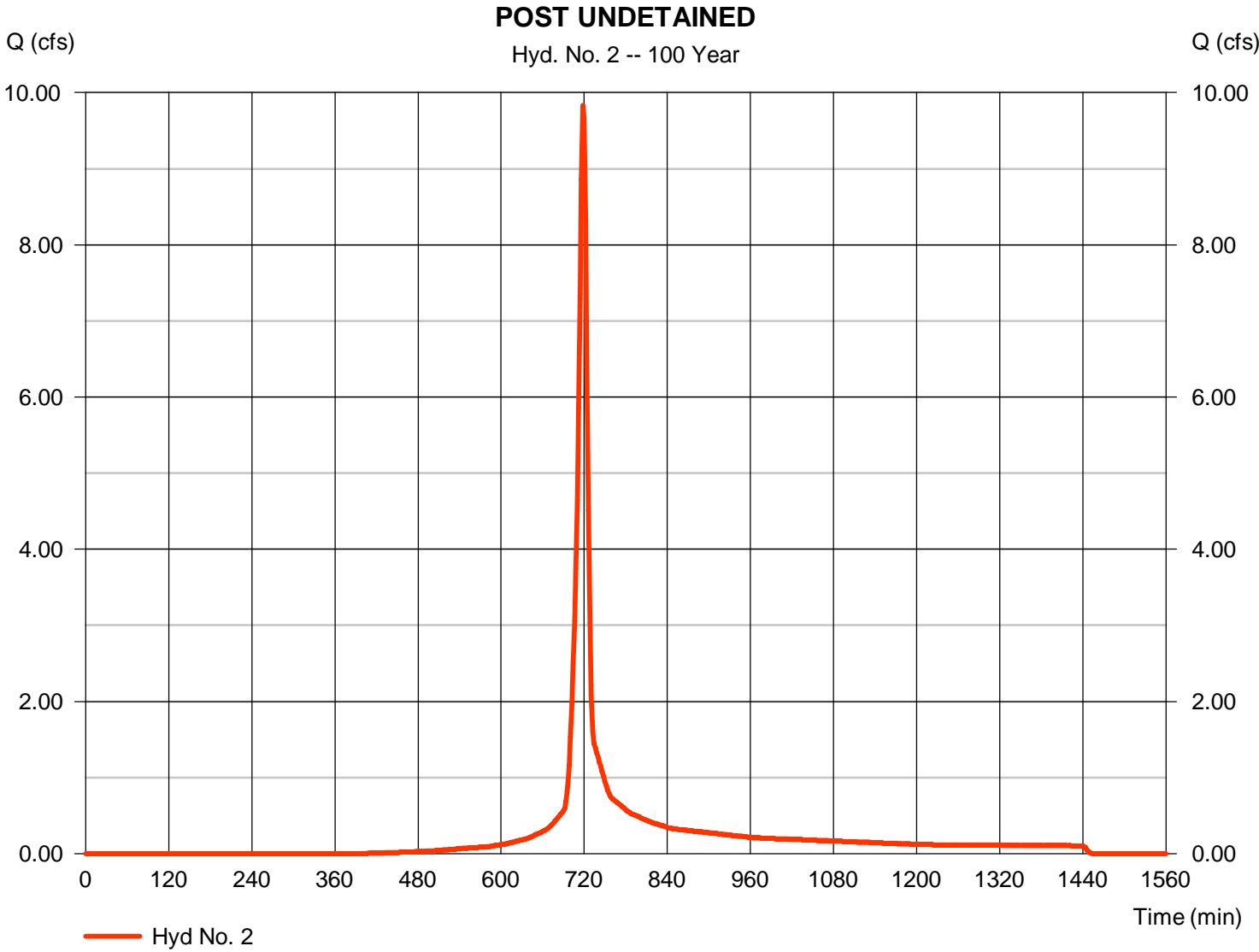
Sunday, 10 / 23 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 9.831 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 22,657 cuft
Drainage area	= 1.460 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 7.02 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.030 x 58) + (0.220 x 70) + (0.570 x 77) + (0.180 x 71) + (0.380 x 78)] / 1.460



Hydrograph Report

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

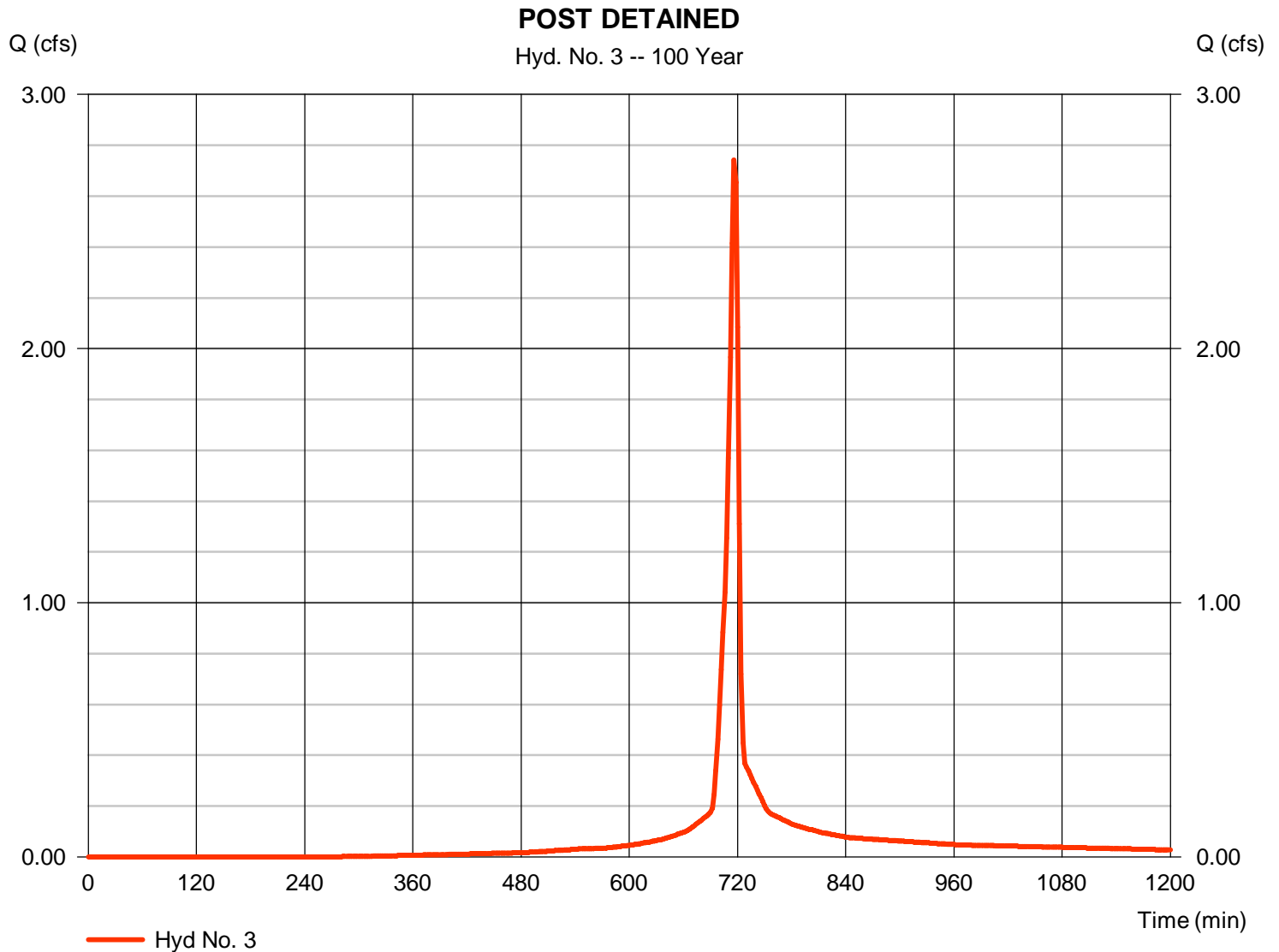
Sunday, 10 / 23 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 2.742 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 5,794 cuft
Drainage area	= 0.330 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.40 min
Total precip.	= 7.02 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = $[(0.140 \times 91) + (0.190 \times 78)] / 0.330$



Hydrograph Report

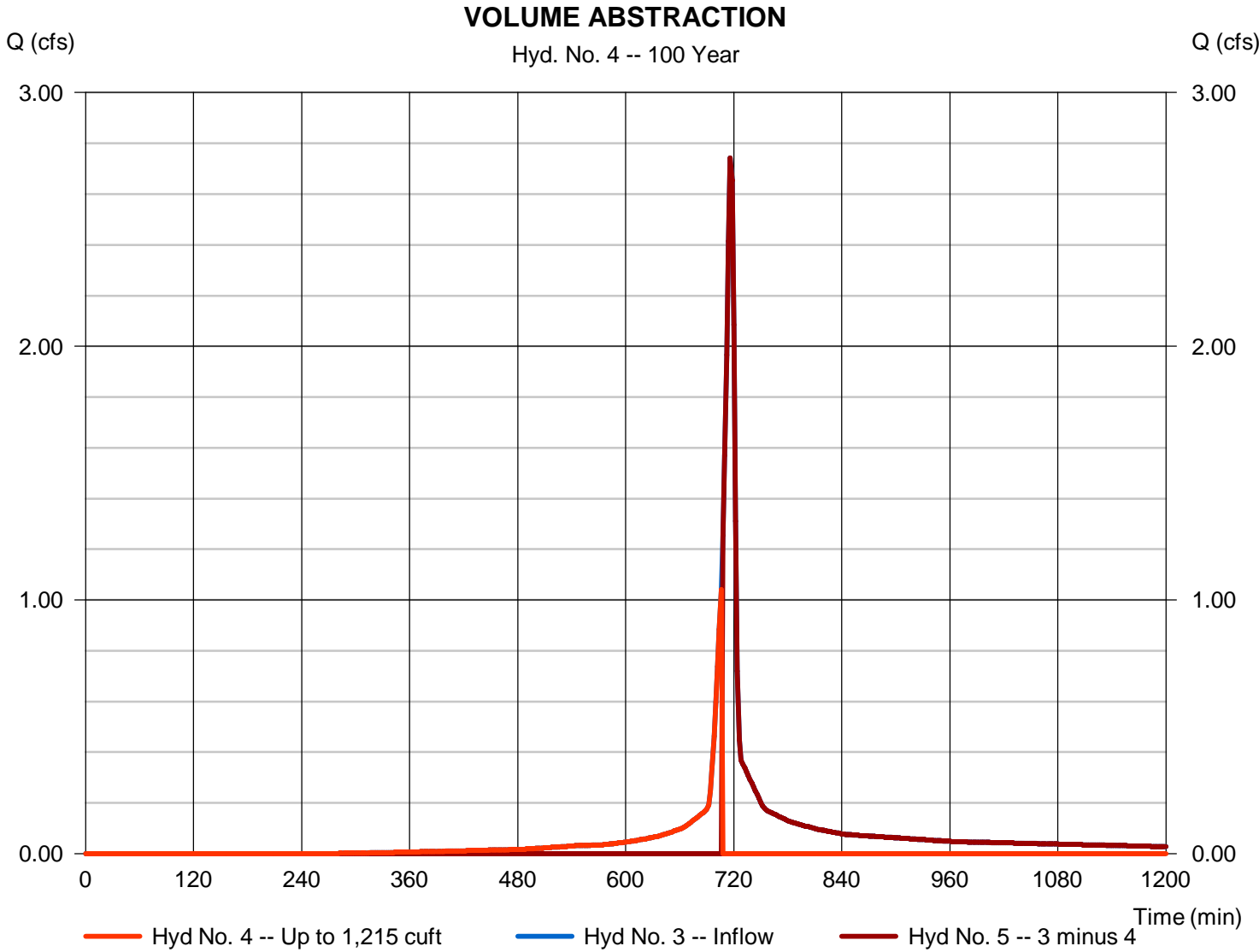
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 1.040 cfs
Storm frequency	= 100 yrs	Time to peak	= 706 min
Time interval	= 2 min	Hyd. volume	= 1,336 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

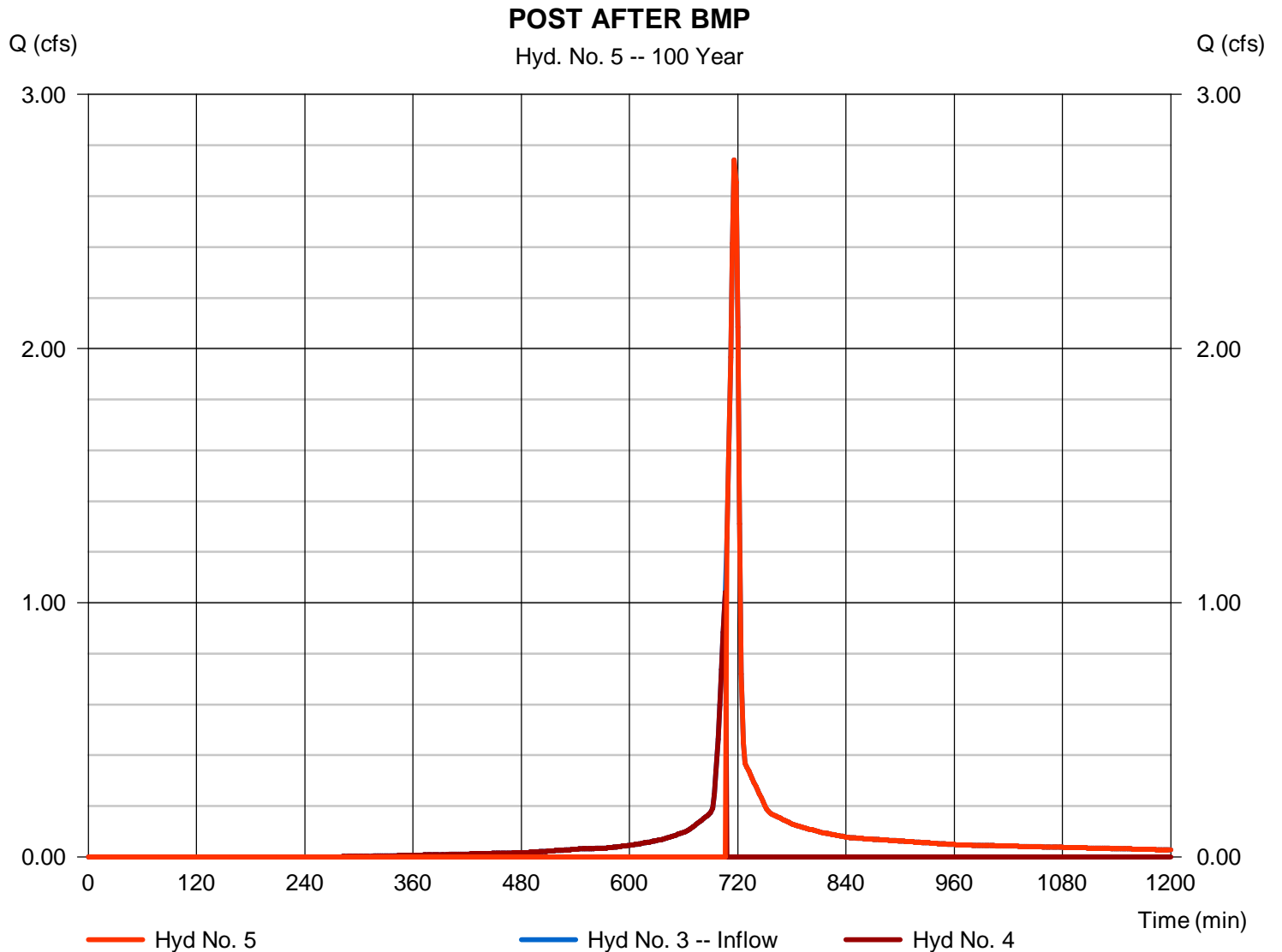
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 2.742 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 4,457 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

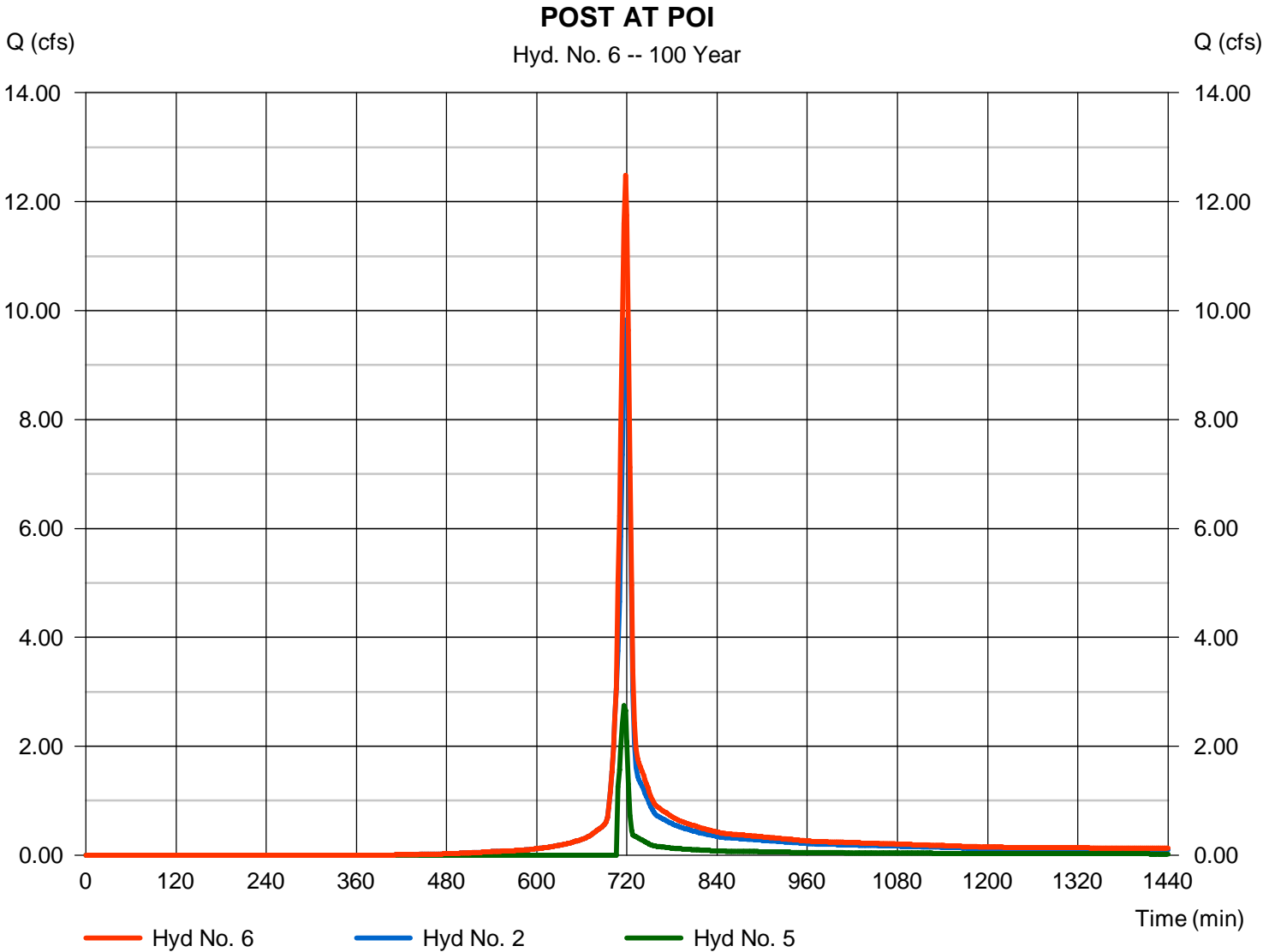
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 6

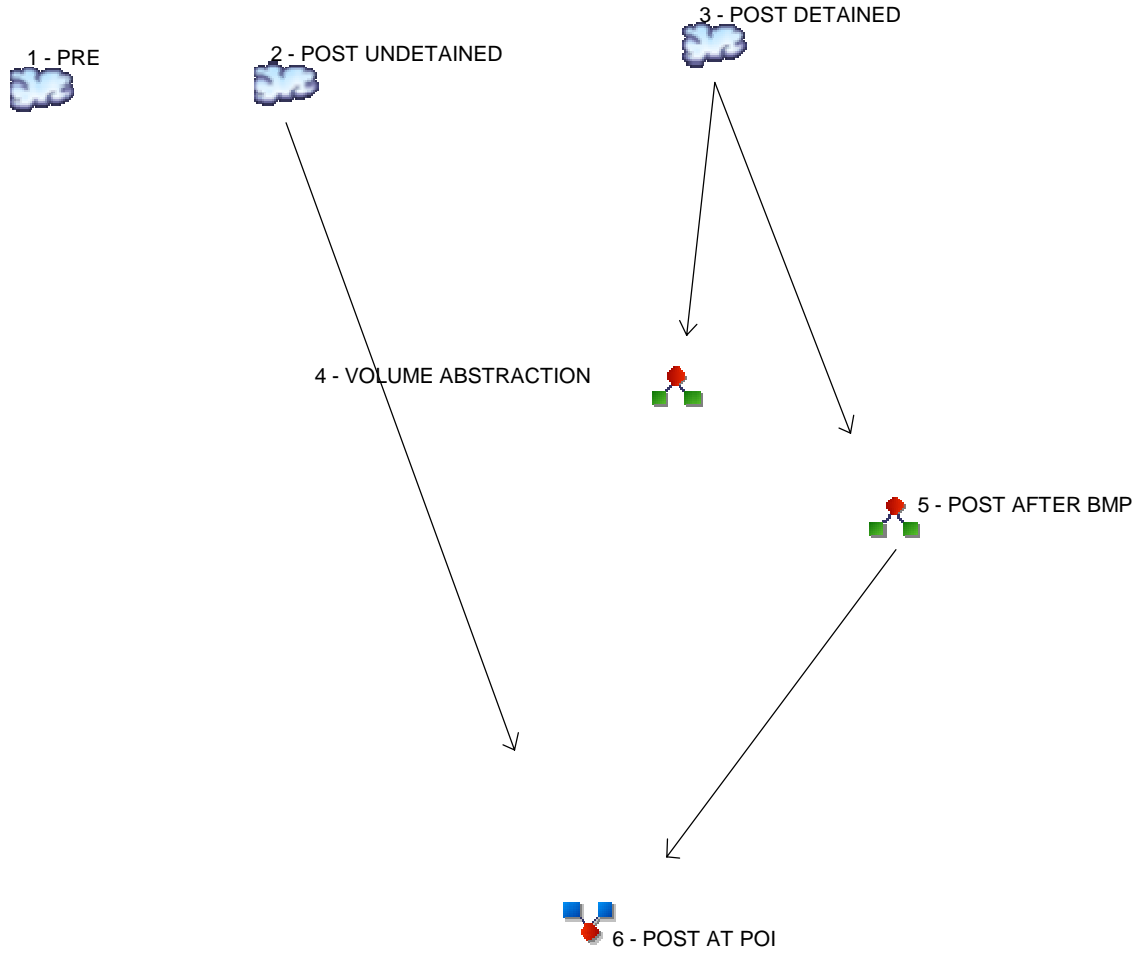
POST AT POI

Hydrograph type	= Combine	Peak discharge	= 12.49 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 27,115 cuft
Inflow hyds.	= 2, 5	Contrib. drain. area	= 1.460 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	-----	-----	2.510	-----	-----	-----	-----	-----	-----	PRE
2	SCS Runoff	-----	-----	2.048	-----	-----	-----	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	-----	-----	0.381	-----	-----	-----	-----	-----	-----	POST DETAINED
4	Diversion1	3	-----	0.381	-----	-----	-----	-----	-----	-----	VOLUME ABSTRACTION
5	Diversion2	3	-----	0.024	-----	-----	-----	-----	-----	-----	POST AFTER BMP
6	Combine	2, 5	-----	2.048	-----	-----	-----	-----	-----	-----	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	2.510	2	720	5,821	-----	-----	-----	PRE
2	SCS Runoff	2.048	2	720	4,748	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	0.381	2	734	1,661	-----	-----	-----	POST DETAINED
4	Diversion1	0.381	2	734	1,218	3	-----	-----	VOLUME ABSTRACTION
5	Diversion2	0.024	2	890	443	3	-----	-----	POST AFTER BMP
6	Combine	2.048	2	720	5,191	2, 5	-----	-----	POST AT POI

Hydrograph Report

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

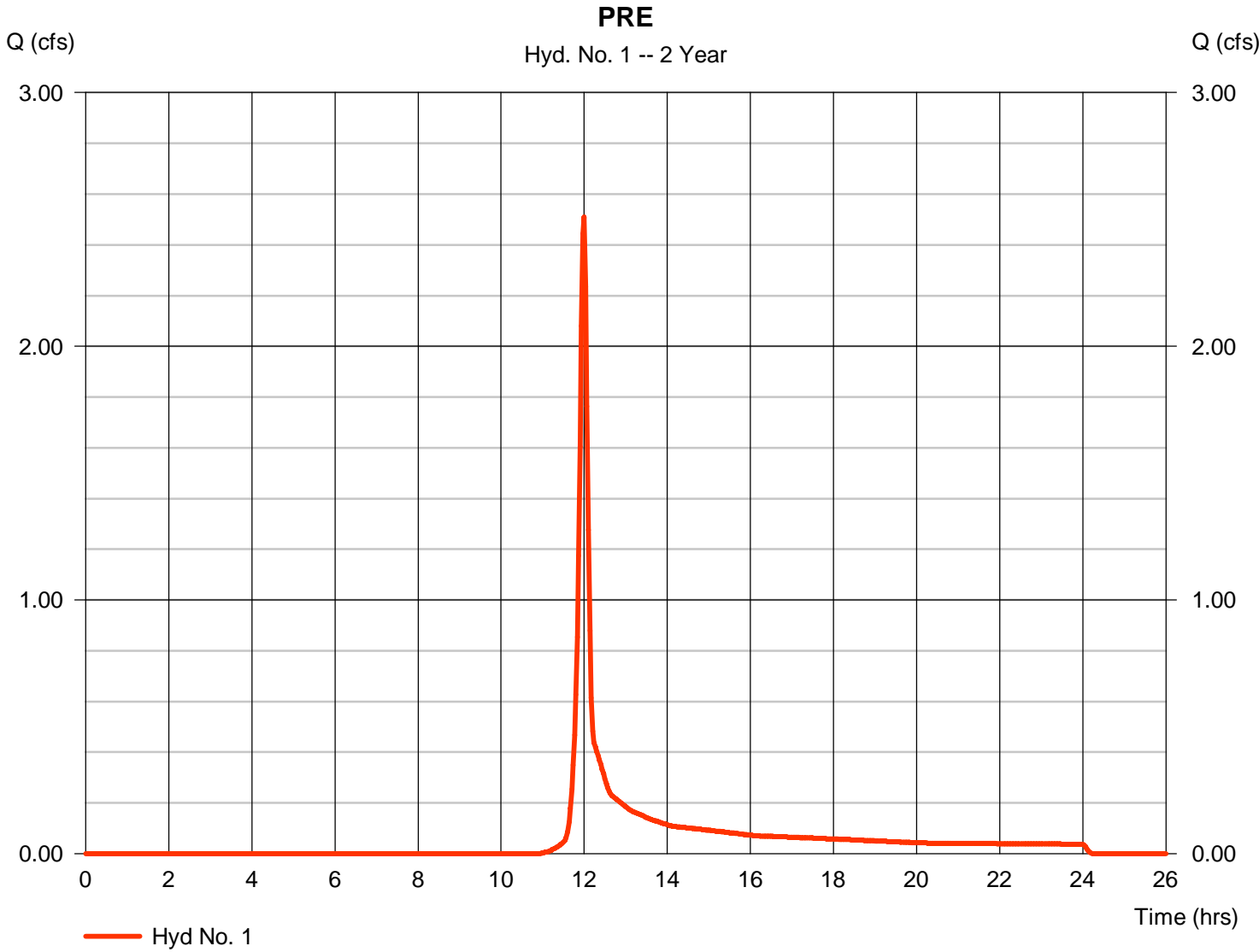
Sunday, 10 / 23 / 2016

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 2.510 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 5,821 cuft
Drainage area	= 1.790 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 2.82 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.020 x 55) + (0.340 x 70) + (1.190 x 77) + (0.080 x 71) + (0.080 x 78)] / 1.790



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)	= 2.82	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 6.62	+ 0.00	+ 0.00	= 6.62
Shallow Concentrated Flow				
Flow length (ft)	= 167.00	0.00	0.00	
Watercourse slope (%)	= 21.60	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=7.50	0.00	0.00	
Travel Time (min)	= 0.37	+ 0.00	+ 0.00	= 0.37
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{{0}}0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				7.00 min

Hydrograph Report

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

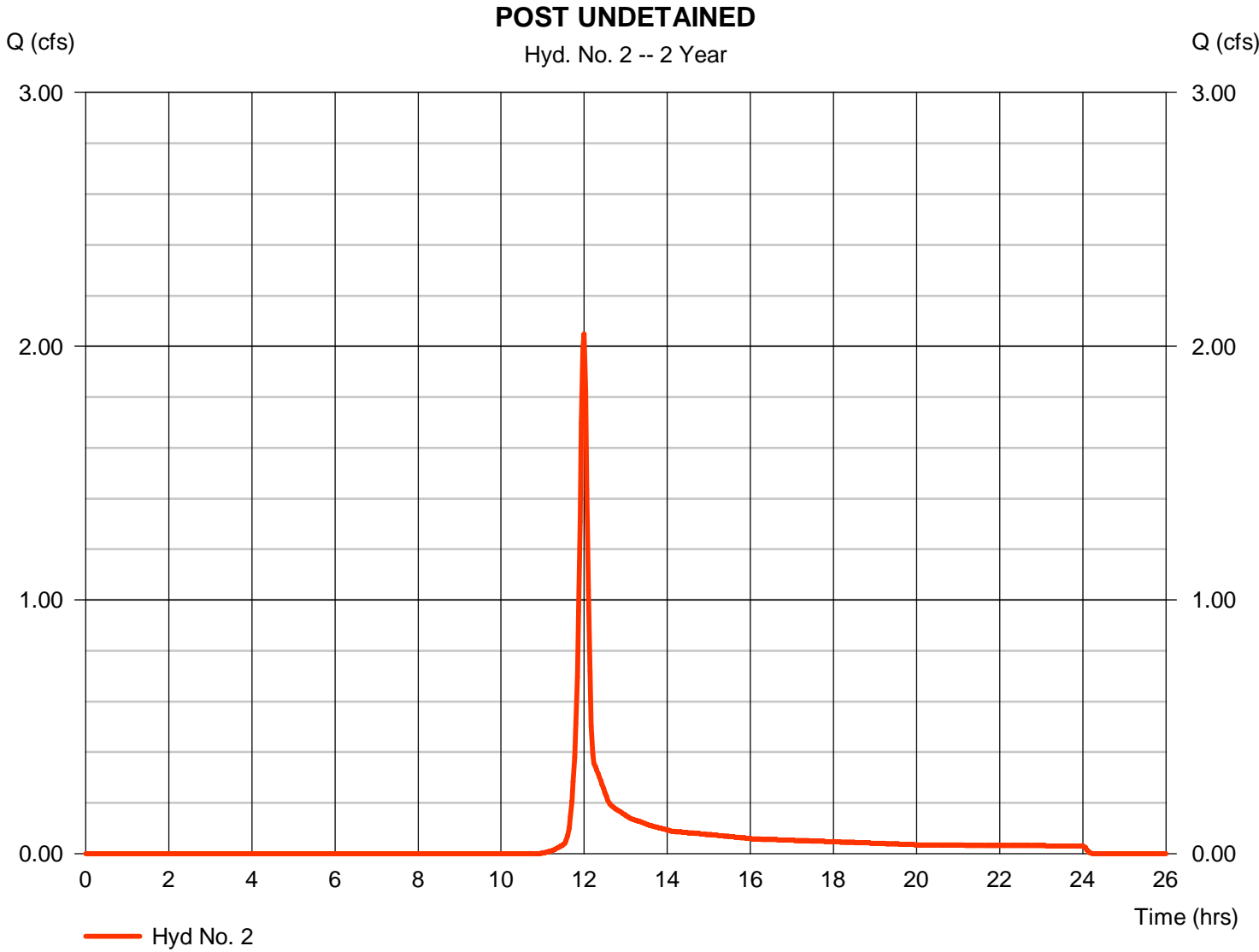
Sunday, 10 / 23 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 2.048 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.00 hrs
Time interval	= 2 min	Hyd. volume	= 4,748 cuft
Drainage area	= 1.460 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 2.82 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.030 x 58) + (0.220 x 70) + (0.570 x 77) + (0.180 x 71) + (0.380 x 78)] / 1.460



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)	= 2.82	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 6.62	+ 0.00	+ 0.00	= 6.62
Shallow Concentrated Flow				
Flow length (ft)	= 167.00	0.00	0.00	
Watercourse slope (%)	= 21.60	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=7.50	0.00	0.00	
Travel Time (min)	= 0.37	+ 0.00	+ 0.00	= 0.37
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				7.00 min

Hydrograph Report

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

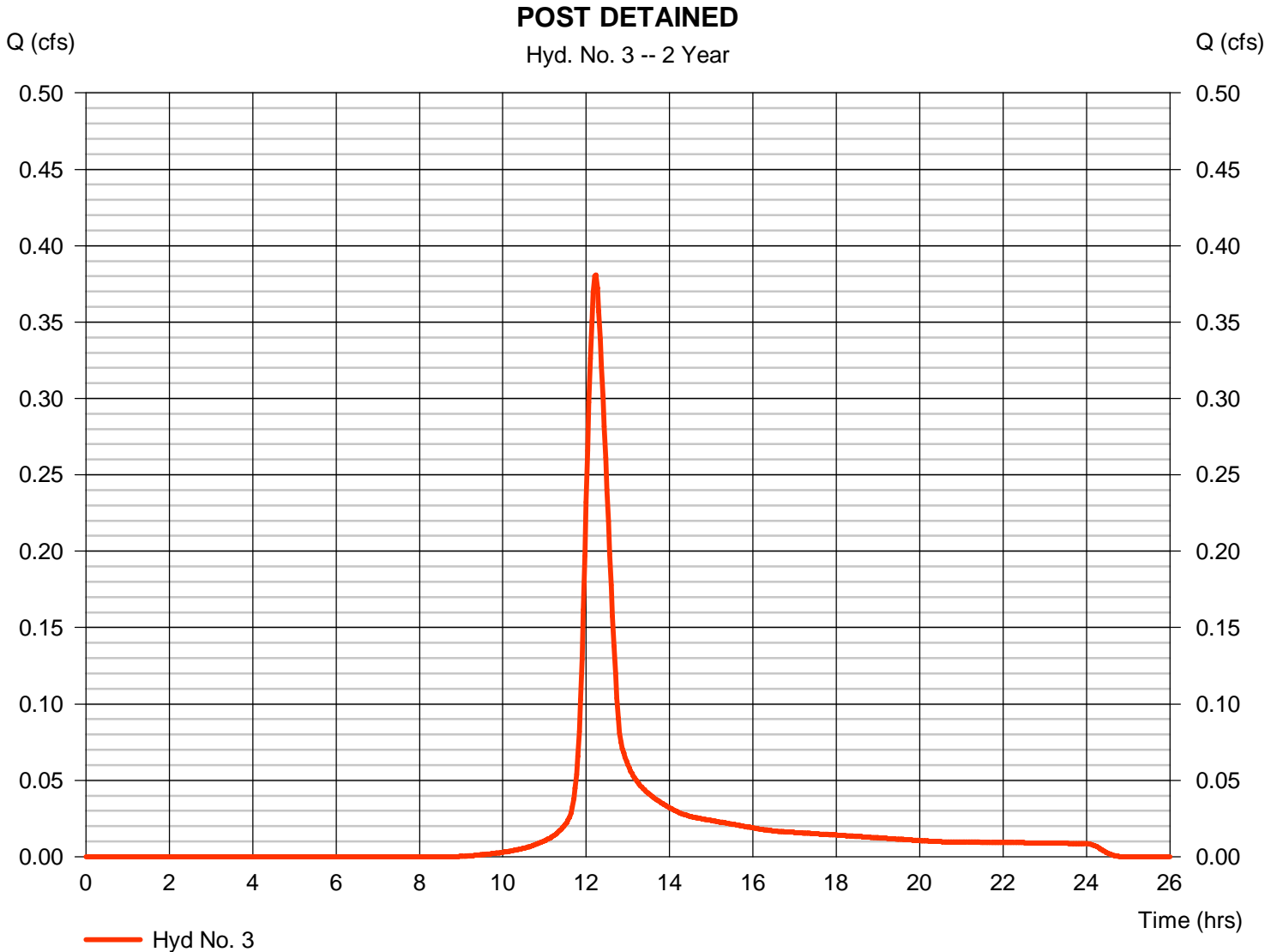
Sunday, 10 / 23 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.381 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.23 hrs
Time interval	= 2 min	Hyd. volume	= 1,661 cuft
Drainage area	= 0.330 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 32.98 min
Total precip.	= 2.82 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.140 x 91) + (0.190 x 78)] / 0.330



Hydrograph Report

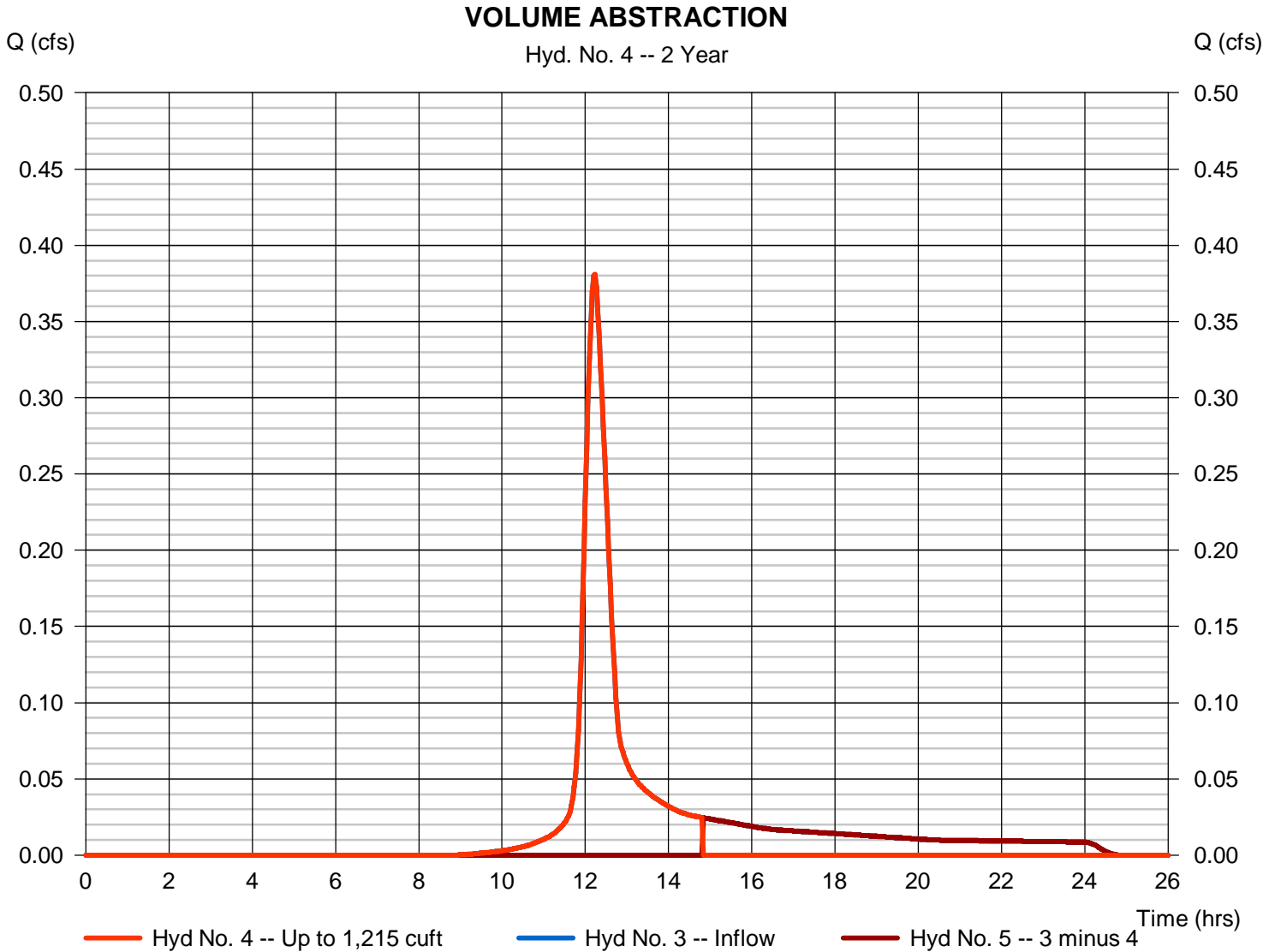
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.381 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.23 hrs
Time interval	= 2 min	Hyd. volume	= 1,218 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

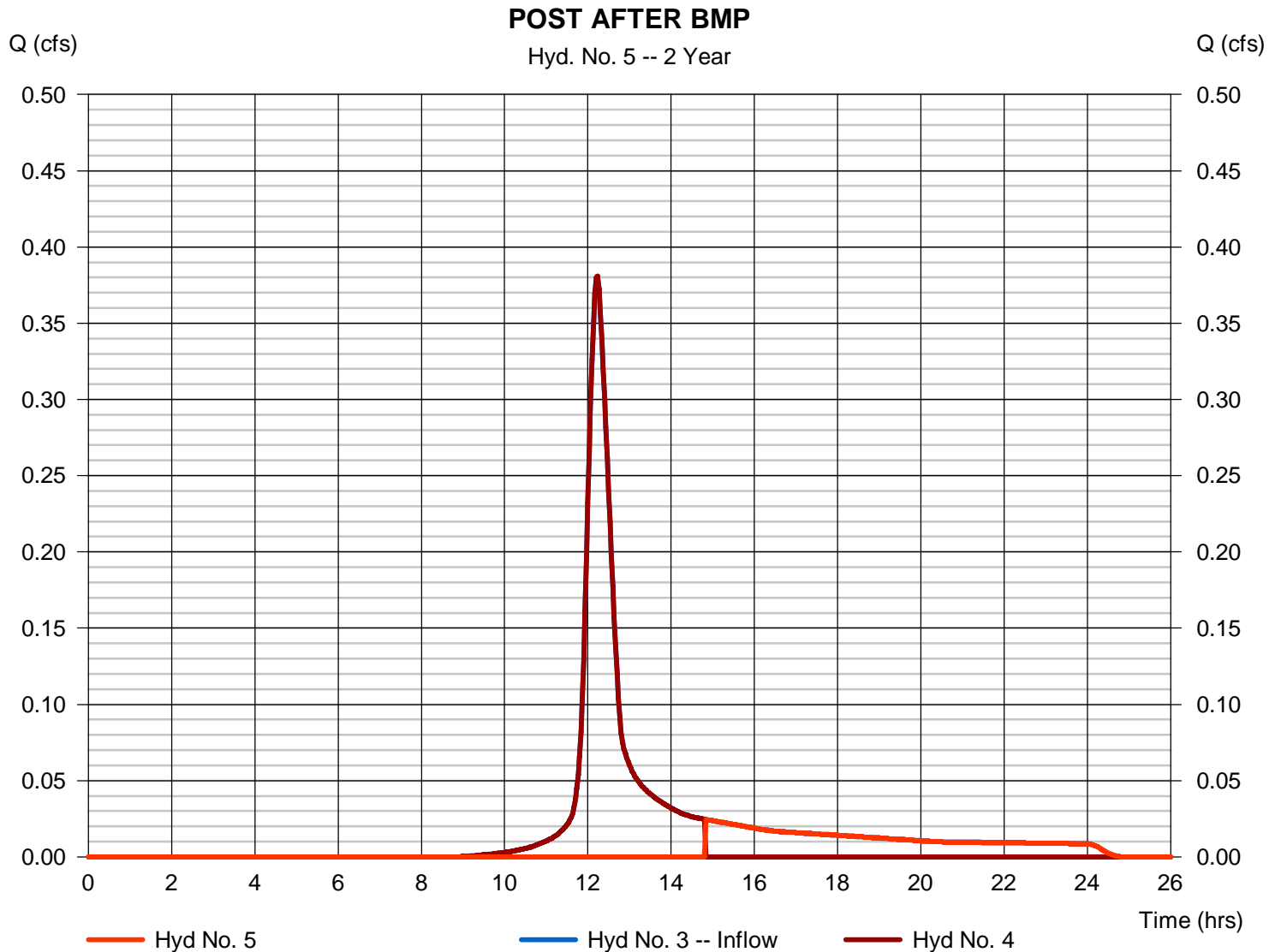
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 0.024 cfs
Storm frequency	= 2 yrs	Time to peak	= 14.83 hrs
Time interval	= 2 min	Hyd. volume	= 443 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

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

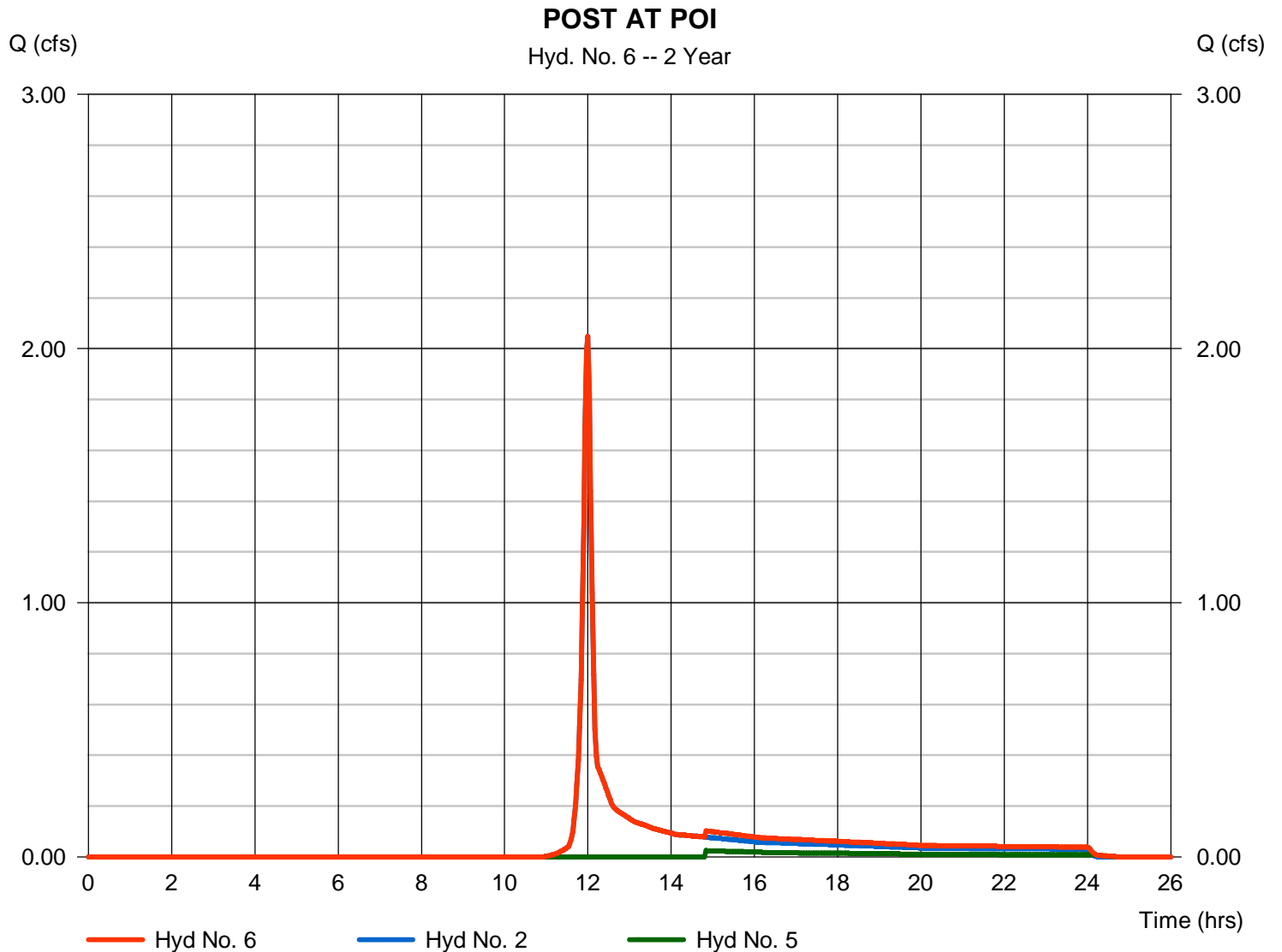
Sunday, 10 / 23 / 2016

Hyd. No. 6

POST AT POI

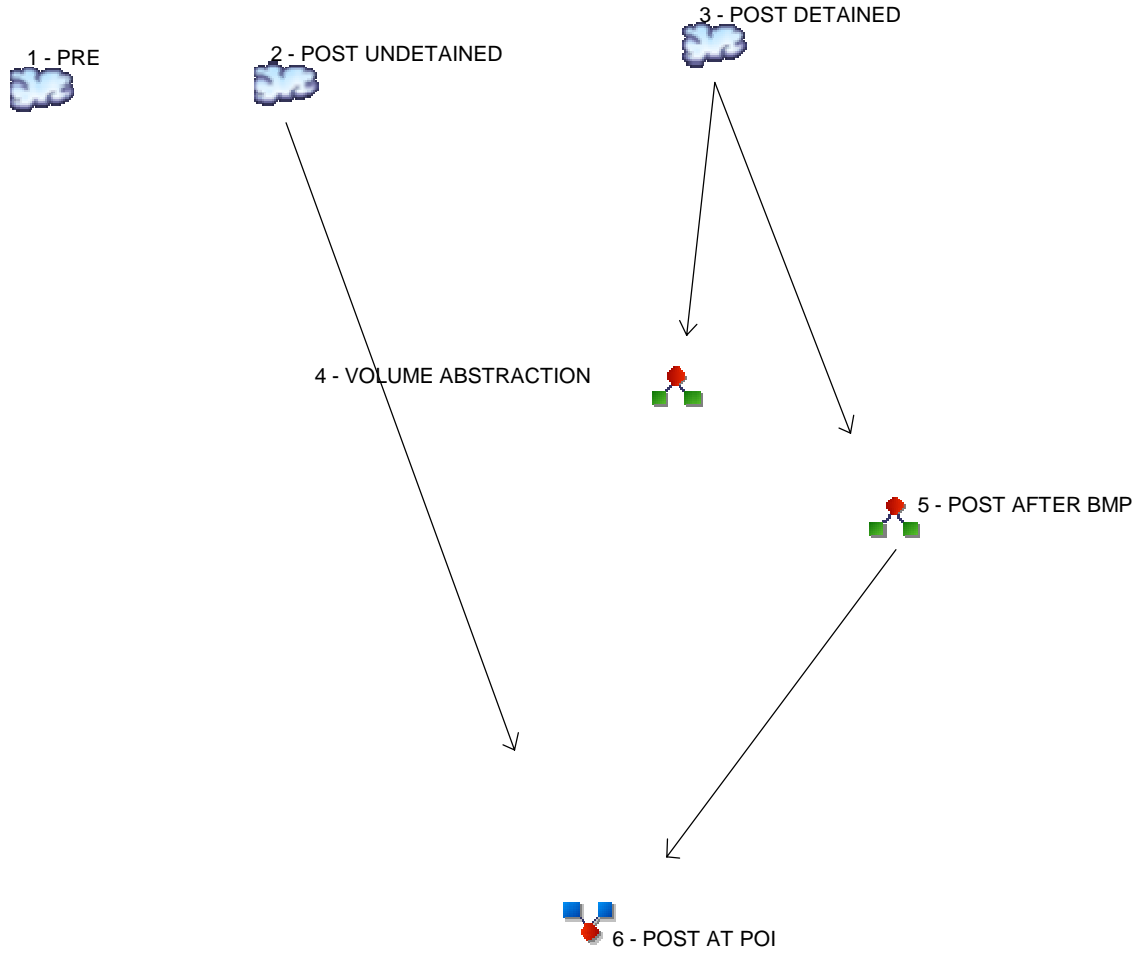
Hydrograph type = Combine
Storm frequency = 2 yrs
Time interval = 2 min
Inflow hyds. = 2, 5

Peak discharge = 2.048 cfs
Time to peak = 12.00 hrs
Hyd. volume = 5,191 cuft
Contrib. drain. area = 1.460 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	-----	-----	-----	-----	-----	5.196	-----	-----	-----	PRE
2	SCS Runoff	-----	-----	-----	-----	-----	4.238	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	-----	-----	-----	-----	-----	0.875	-----	-----	-----	POST DETAINED
4	Diversion1	3	-----	-----	-----	-----	0.875	-----	-----	-----	VOLUME ABSTRACTION
5	Diversion2	3	-----	-----	-----	-----	0.691	-----	-----	-----	POST AFTER BMP
6	Combine	2, 5	-----	-----	-----	-----	4.238	-----	-----	-----	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	5.196	2	720	11,897	-----	-----	-----	PRE
2	SCS Runoff	4.238	2	720	9,704	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	0.875	2	726	3,020	-----	-----	-----	POST DETAINED
4	Diversion1	0.875	2	726	1,283	3	-----	-----	VOLUME ABSTRACTION
5	Diversion2	0.691	2	734	1,737	3	-----	-----	POST AFTER BMP
6	Combine	4.238	2	720	11,441	2, 5	-----	-----	POST AT POI

Hydrograph Report

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

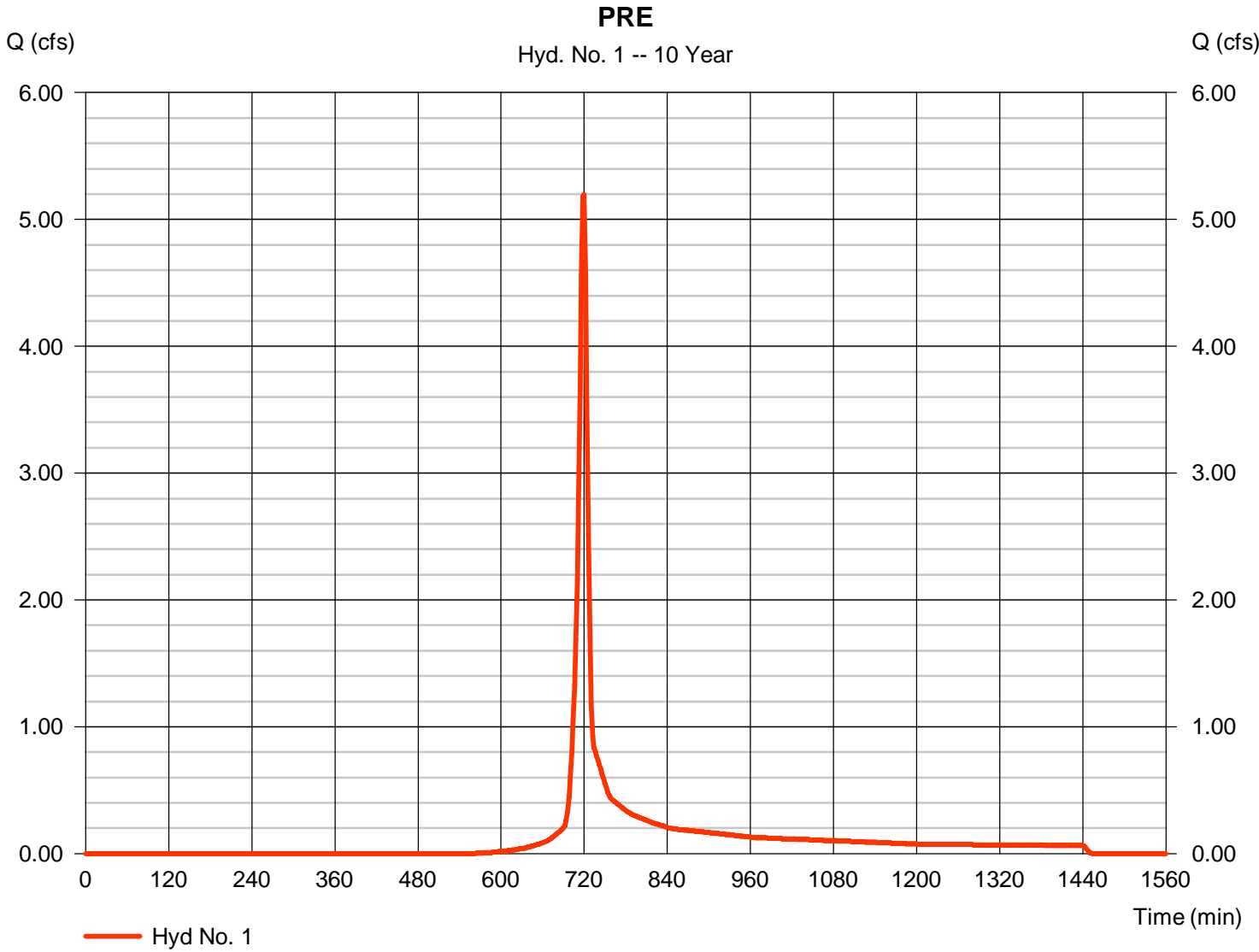
Sunday, 10 / 23 / 2016

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 5.196 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 11,897 cuft
Drainage area	= 1.790 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 4.12 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.020 x 55) + (0.340 x 70) + (1.190 x 77) + (0.080 x 71) + (0.080 x 78)] / 1.790



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)	= 2.82	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 6.62	+ 0.00	+ 0.00	= 6.62
Shallow Concentrated Flow				
Flow length (ft)	= 167.00	0.00	0.00	
Watercourse slope (%)	= 21.60	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=7.50	0.00	0.00	
Travel Time (min)	= 0.37	+ 0.00	+ 0.00	= 0.37
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{{0}}0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				7.00 min

Hydrograph Report

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

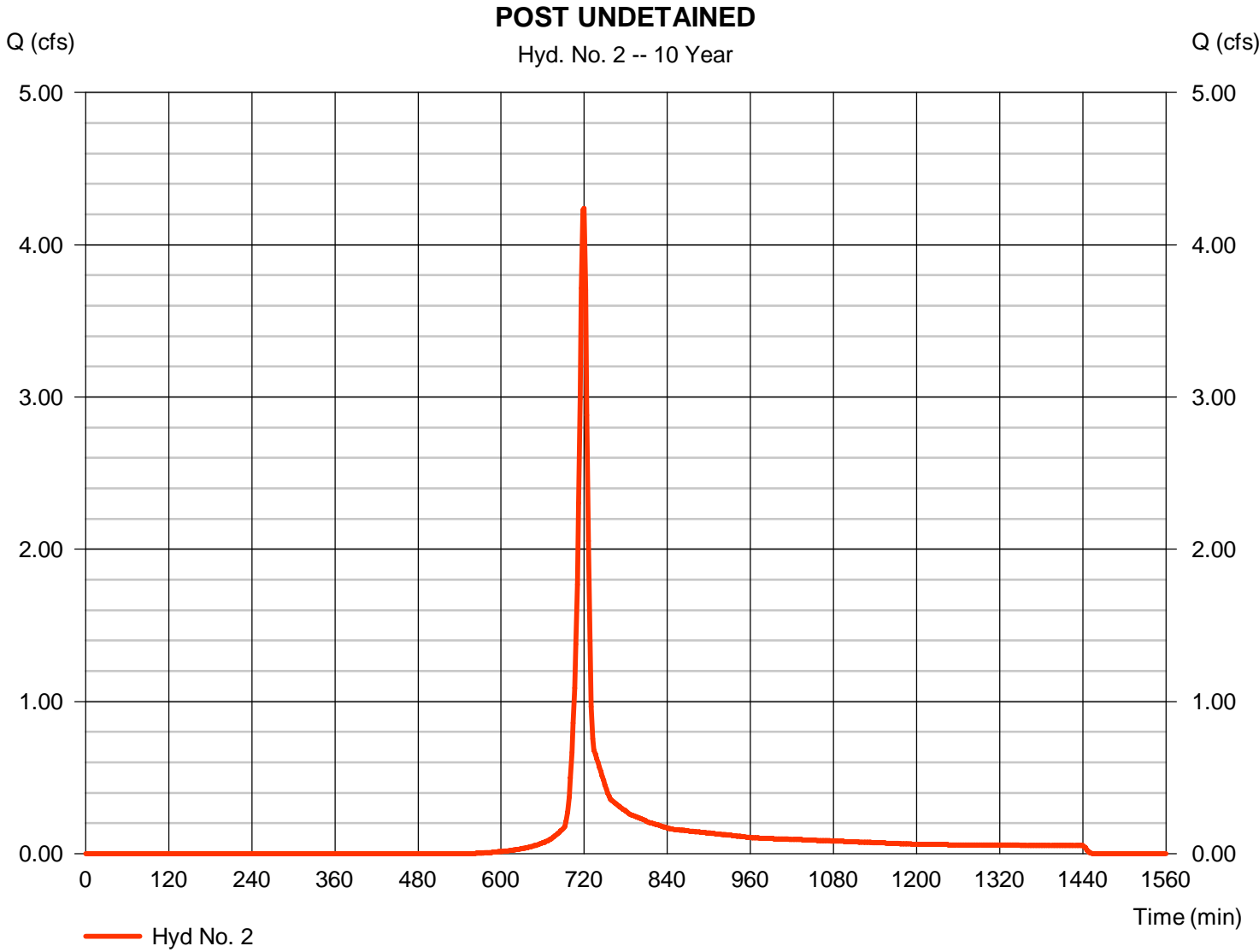
Sunday, 10 / 23 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 4.238 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 9,704 cuft
Drainage area	= 1.460 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 4.12 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.030 x 58) + (0.220 x 70) + (0.570 x 77) + (0.180 x 71) + (0.380 x 78)] / 1.460



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)	= 2.82	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 6.62	+ 0.00	+ 0.00	= 6.62
Shallow Concentrated Flow				
Flow length (ft)	= 167.00	0.00	0.00	
Watercourse slope (%)	= 21.60	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=7.50	0.00	0.00	
Travel Time (min)	= 0.37	+ 0.00	+ 0.00	= 0.37
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				7.00 min

Hydrograph Report

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

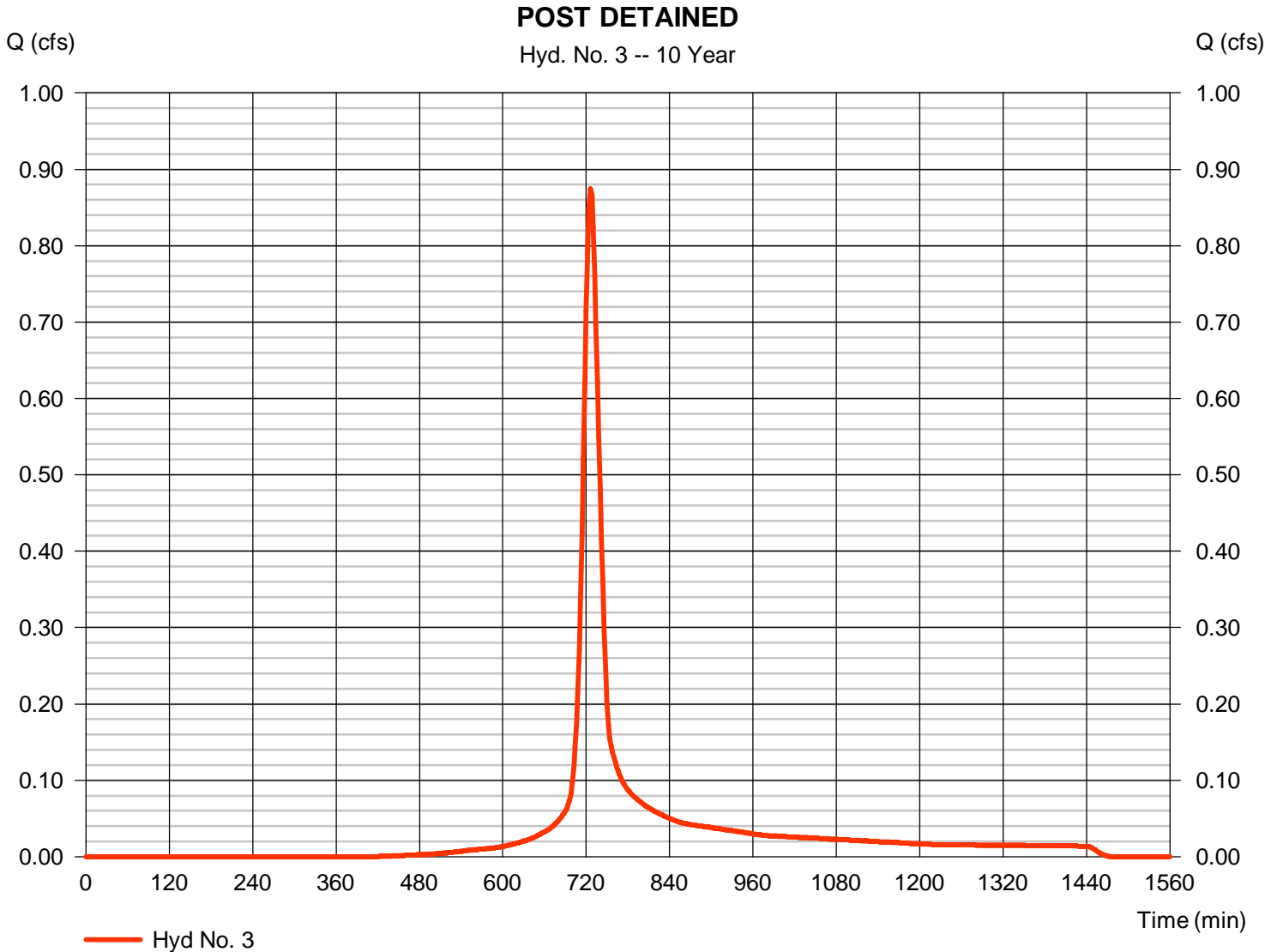
Sunday, 10 / 23 / 2016

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 0.875 cfs
Storm frequency	= 10 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 3,020 cuft
Drainage area	= 0.330 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 21.30 min
Total precip.	= 4.12 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.140 x 91) + (0.190 x 78)] / 0.330



Hydrograph Report

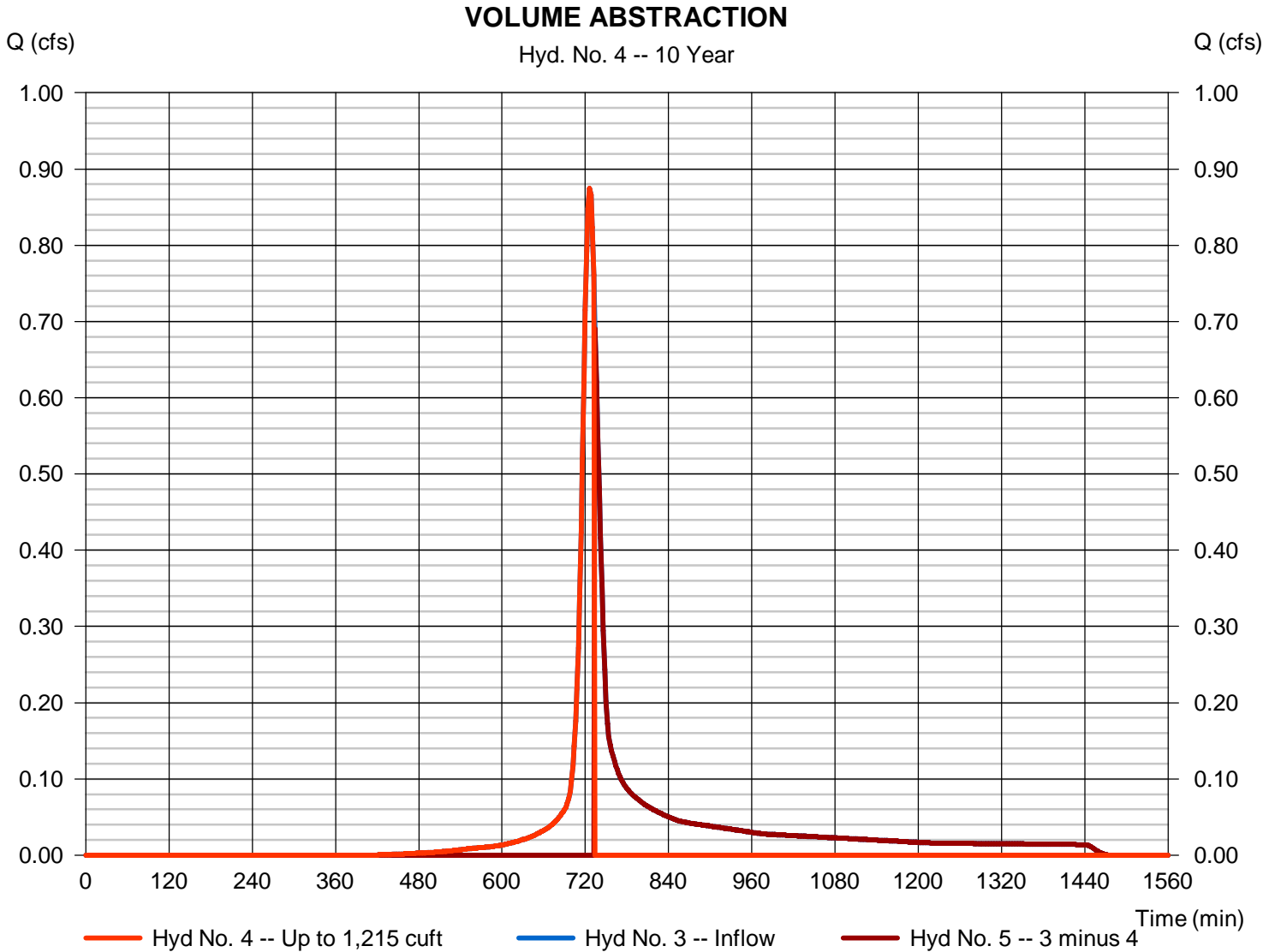
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.875 cfs
Storm frequency	= 10 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 1,283 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

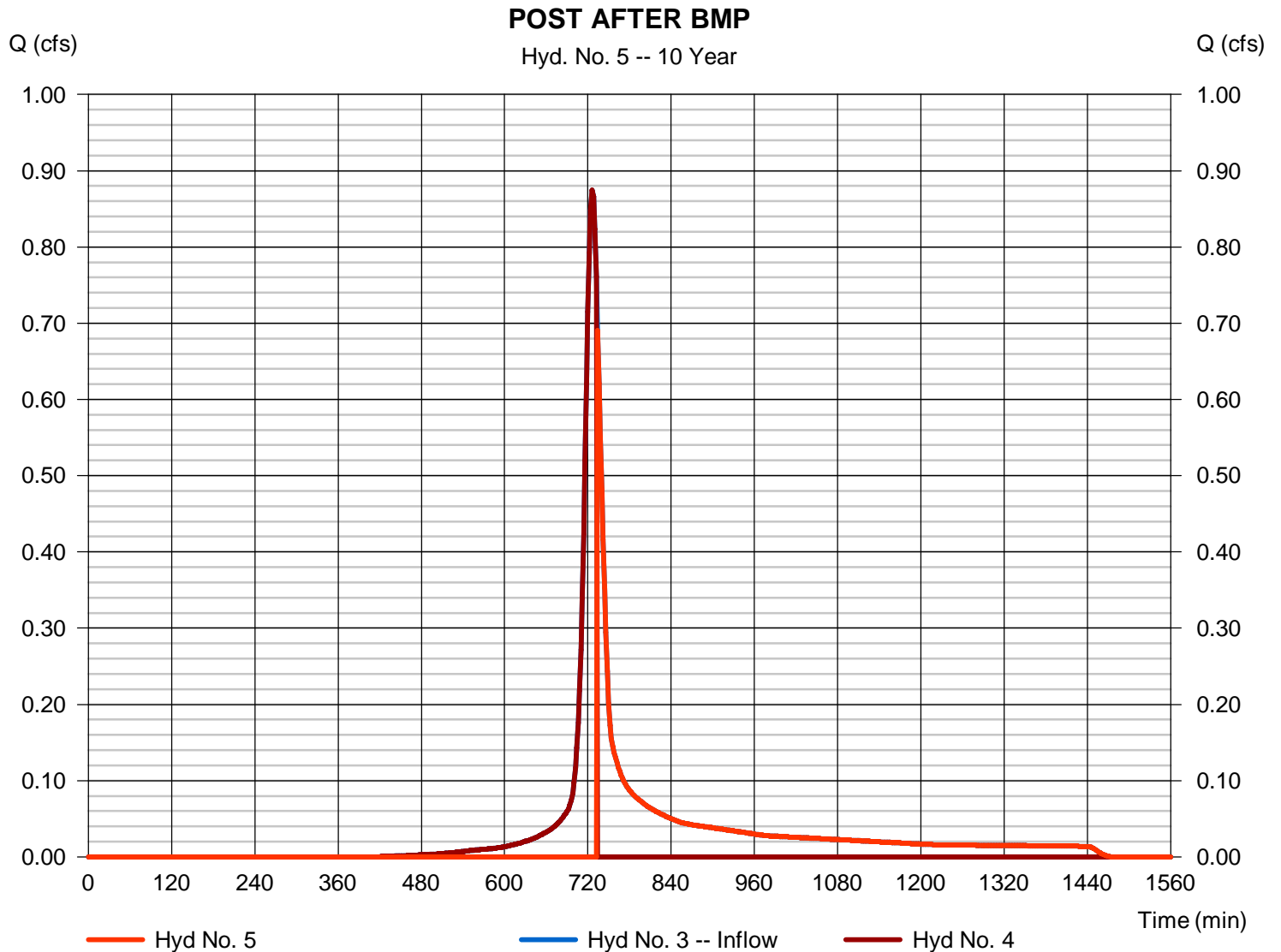
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 0.691 cfs
Storm frequency	= 10 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 1,737 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

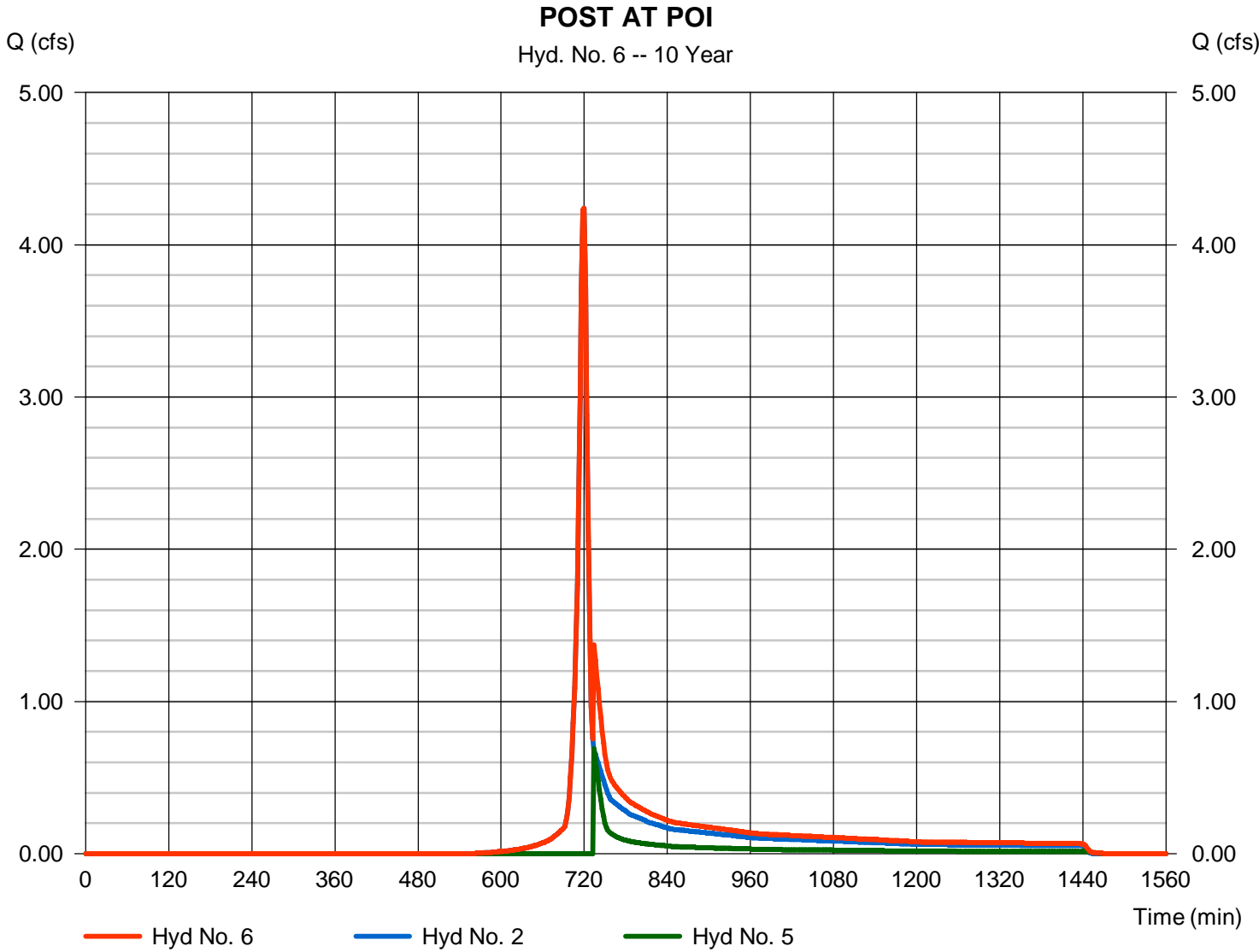
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 6

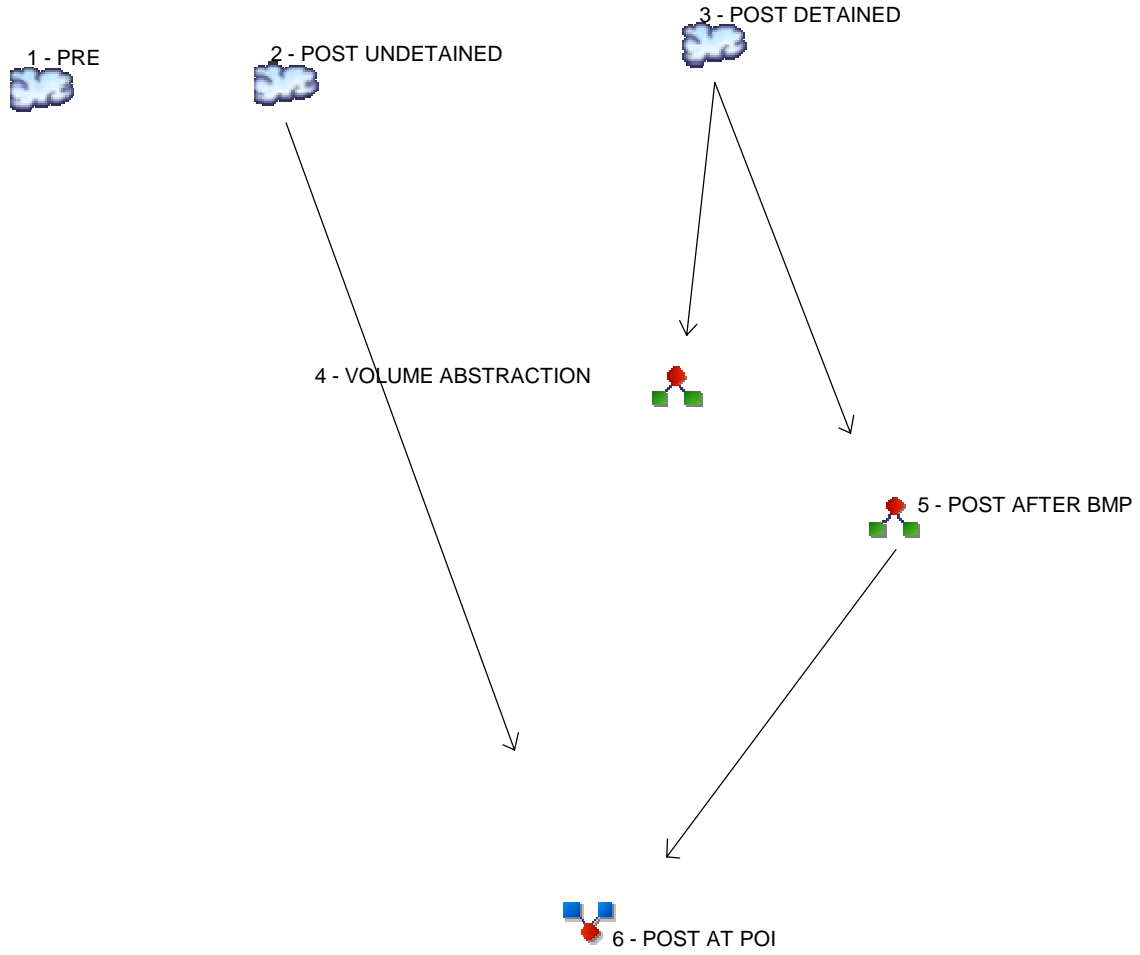
POST AT POI

Hydrograph type	= Combine	Peak discharge	= 4.238 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 11,441 cuft
Inflow hyds.	= 2, 5	Contrib. drain. area	= 1.460 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	-----	-----	-----	-----	-----	-----	-----	9.506	-----	PRE
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	7.754	-----	POST UNDETAINED
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	1.707	-----	POST DETAINED
4	Diversion1	3	-----	-----	-----	-----	-----	-----	1.289	-----	VOLUME ABSTRACTION
5	Diversion2	3	-----	-----	-----	-----	-----	-----	1.707	-----	POST AFTER BMP
6	Combine	2, 5	-----	-----	-----	-----	-----	-----	9.308	-----	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	9.506	2	718	21,795	-----	-----	-----	PRE
2	SCS Runoff	7.754	2	718	17,777	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	1.707	2	722	4,869	-----	-----	-----	POST DETAINED
4	Diversion1	1.289	2	716	1,316	3	-----	-----	VOLUME ABSTRACTION
5	Diversion2	1.707	2	722	3,553	3	-----	-----	POST AFTER BMP
6	Combine	9.308	2	720	21,330	2, 5	-----	-----	POST AT POI

Hydrograph Report

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

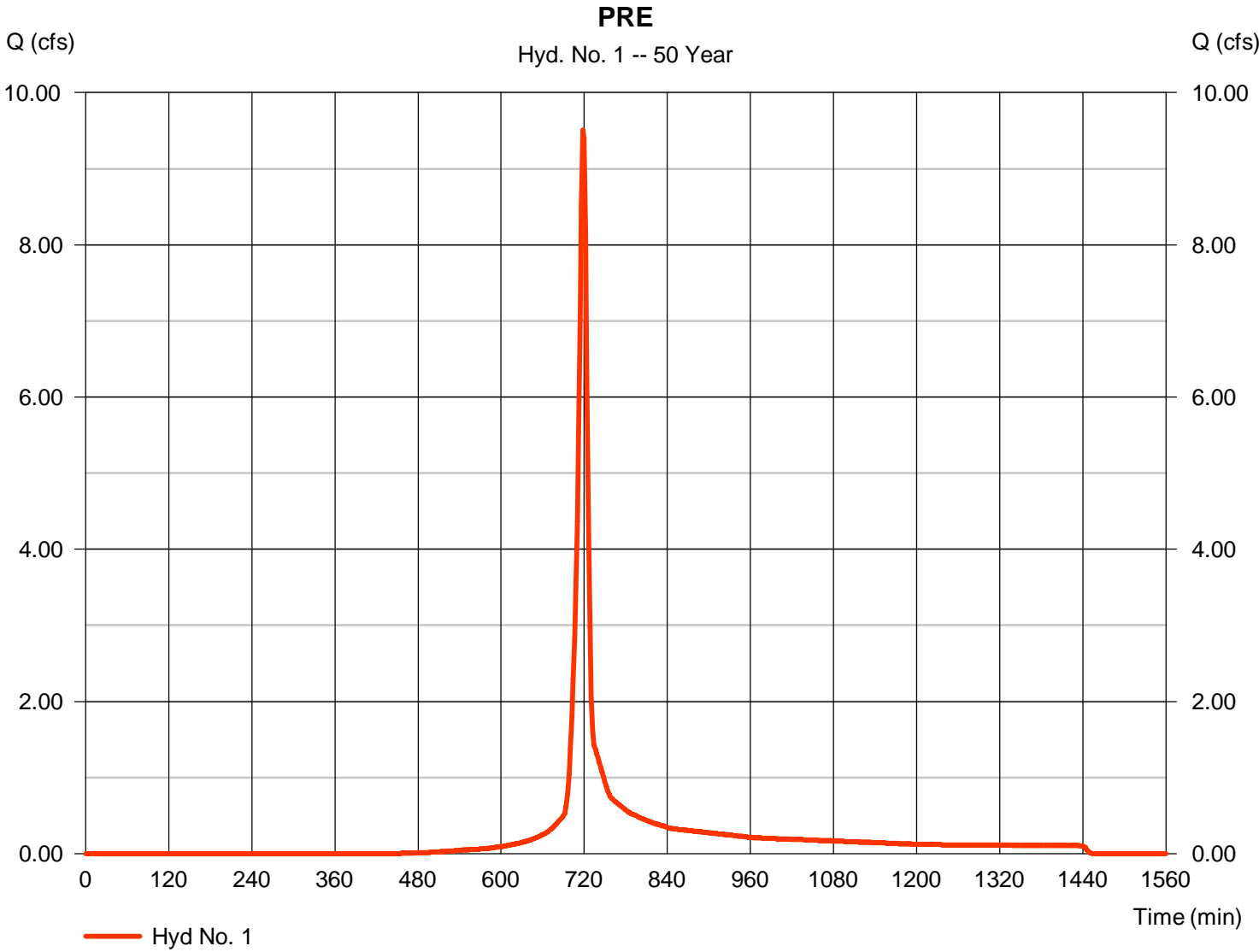
Sunday, 10 / 23 / 2016

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 9.506 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 21,795 cuft
Drainage area	= 1.790 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 5.97 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.020 x 55) + (0.340 x 70) + (1.190 x 77) + (0.080 x 71) + (0.080 x 78)] / 1.790



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)	= 2.82	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 6.62	+ 0.00	+ 0.00	= 6.62
Shallow Concentrated Flow				
Flow length (ft)	= 167.00	0.00	0.00	
Watercourse slope (%)	= 21.60	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=7.50	0.00	0.00	
Travel Time (min)	= 0.37	+ 0.00	+ 0.00	= 0.37
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{{0}}0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				7.00 min

Hydrograph Report

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

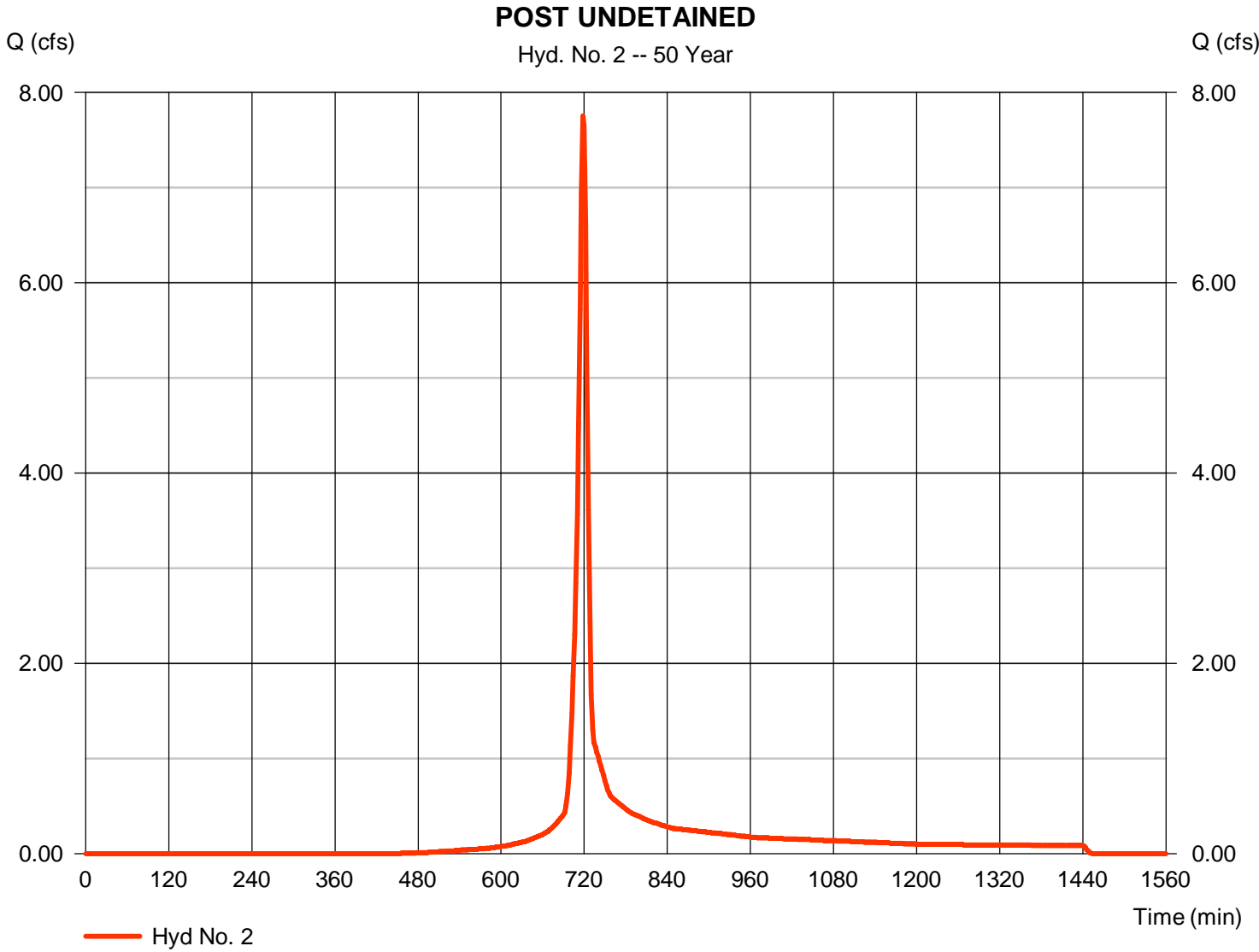
Sunday, 10 / 23 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 7.754 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 17,777 cuft
Drainage area	= 1.460 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 5.97 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.030 x 58) + (0.220 x 70) + (0.570 x 77) + (0.180 x 71) + (0.380 x 78)] / 1.460



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)	= 2.82		0.00		0.00		
Land slope (%)	= 4.00		0.00		0.00		
Travel Time (min)	= 6.62	+	0.00	+	0.00	=	6.62
Shallow Concentrated Flow							
Flow length (ft)	= 167.00		0.00		0.00		
Watercourse slope (%)	= 21.60		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=7.50		0.00		0.00		
Travel Time (min)	= 0.37	+	0.00	+	0.00	=	0.37
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00		0.00		0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc							7.00 min

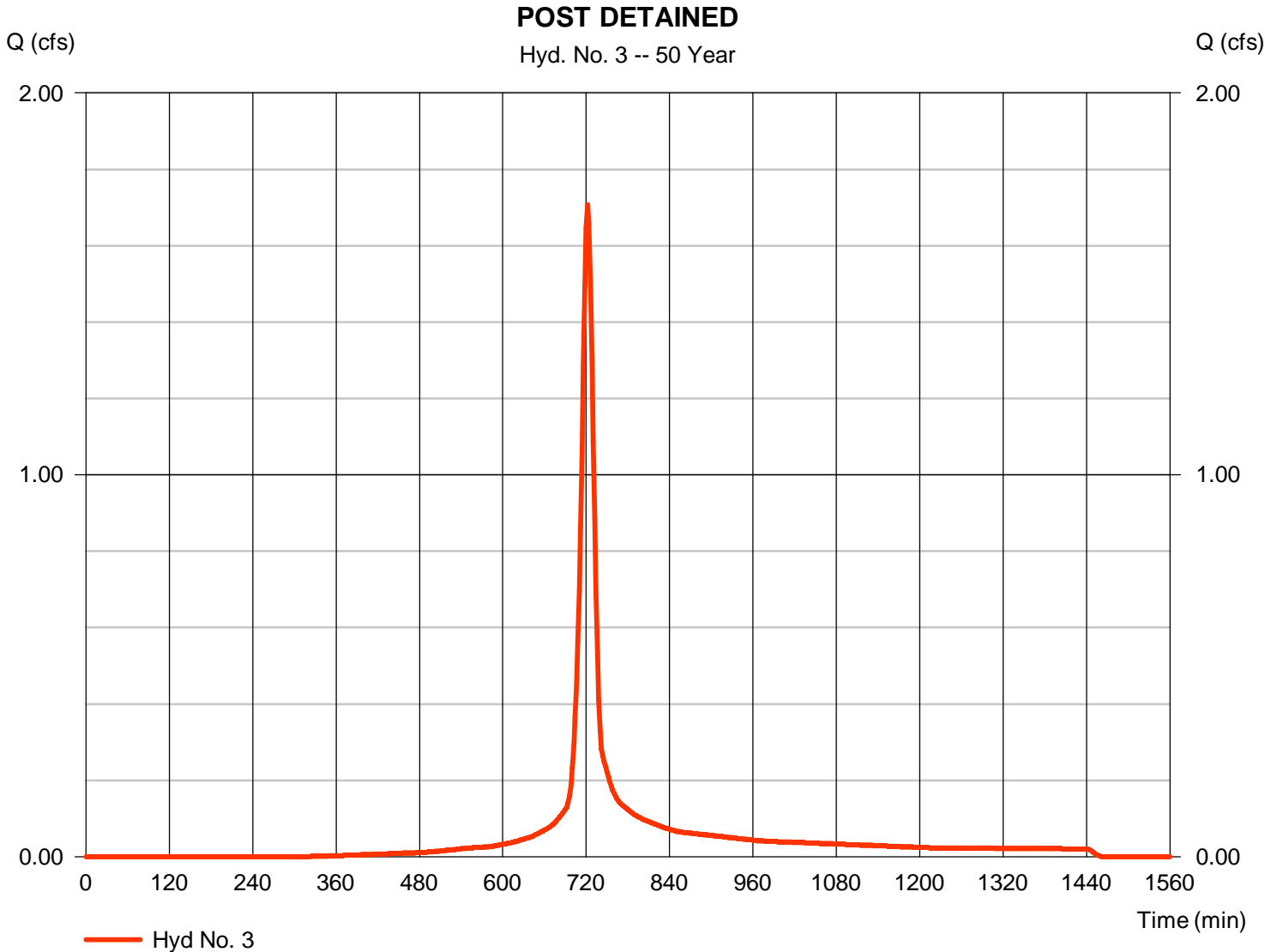
Hydrograph Report

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 1.707 cfs
Storm frequency	= 50 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 4,869 cuft
Drainage area	= 0.330 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.43 min
Total precip.	= 5.97 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.140 x 91) + (0.190 x 78)] / 0.330



Hydrograph Report

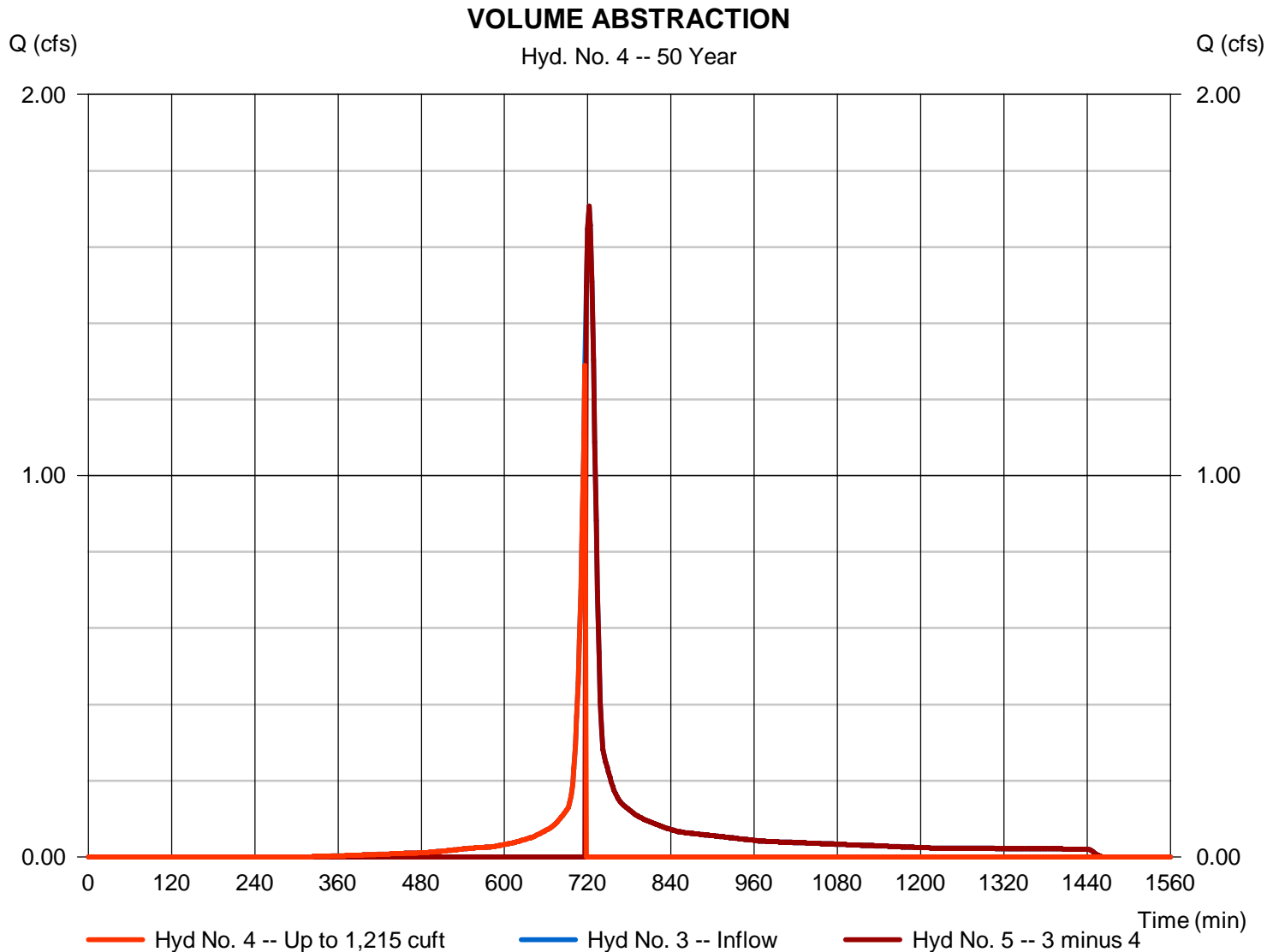
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 1.289 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 1,316 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

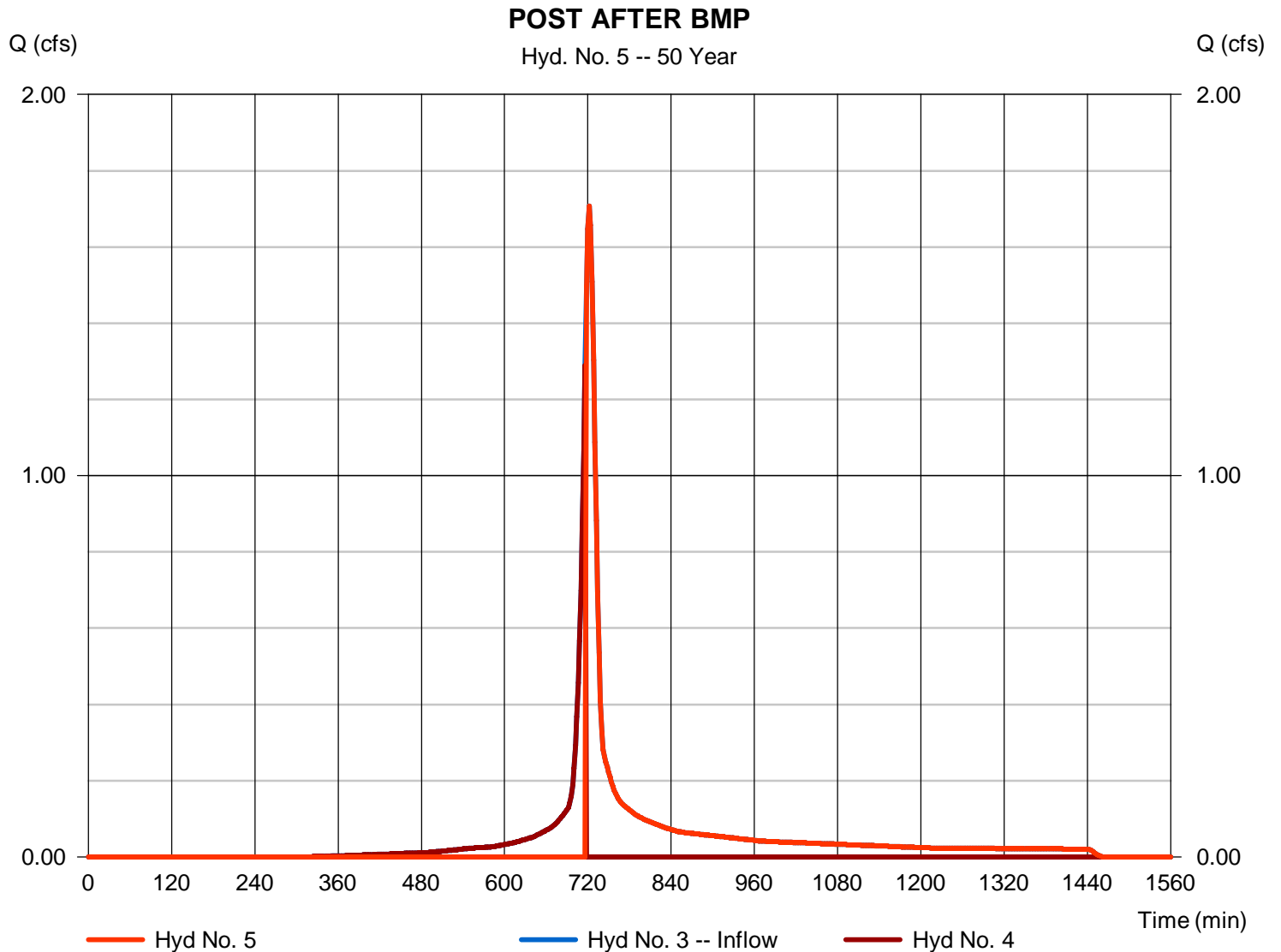
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 1.707 cfs
Storm frequency	= 50 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 3,553 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

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

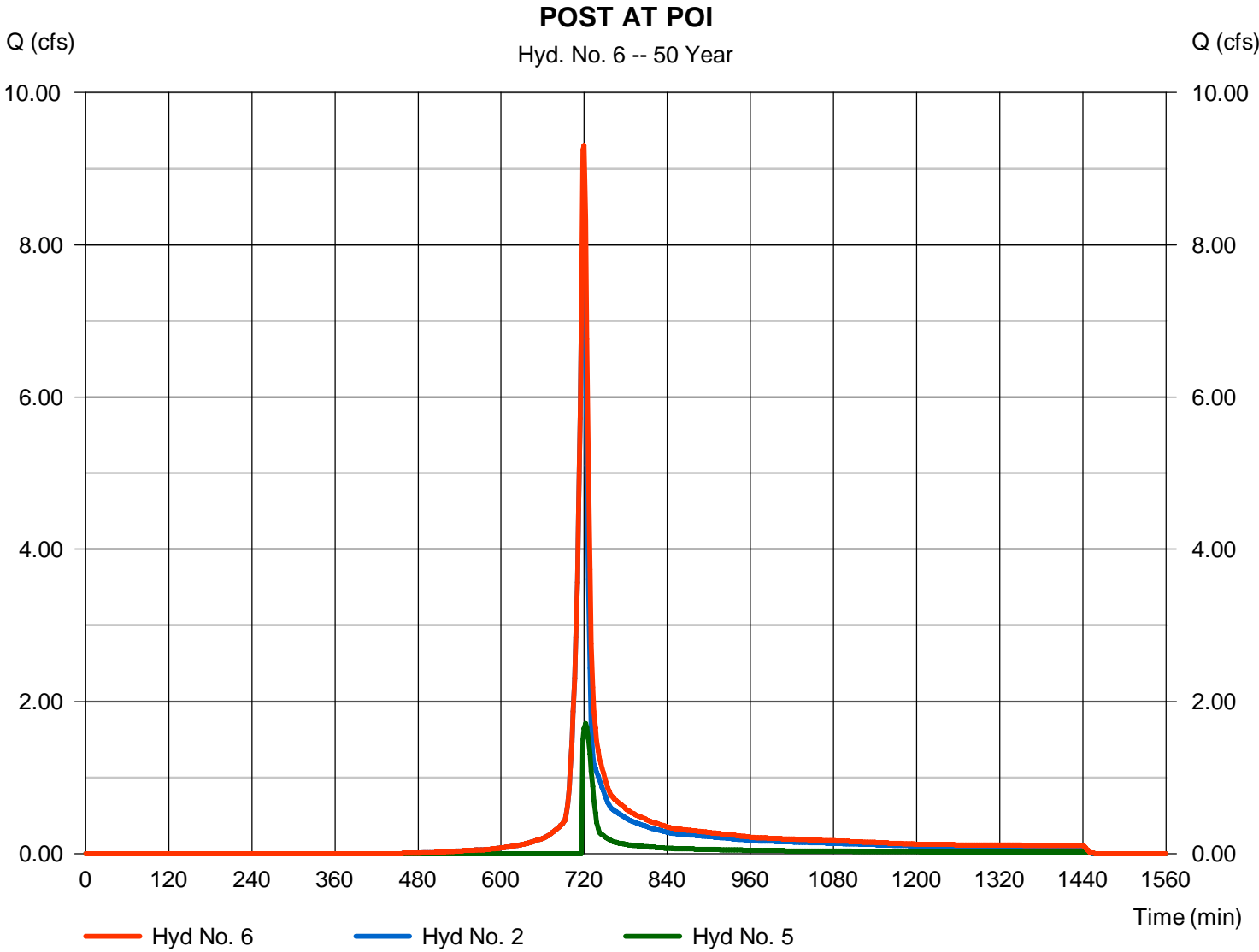
Sunday, 10 / 23 / 2016

Hyd. No. 6

POST AT POI

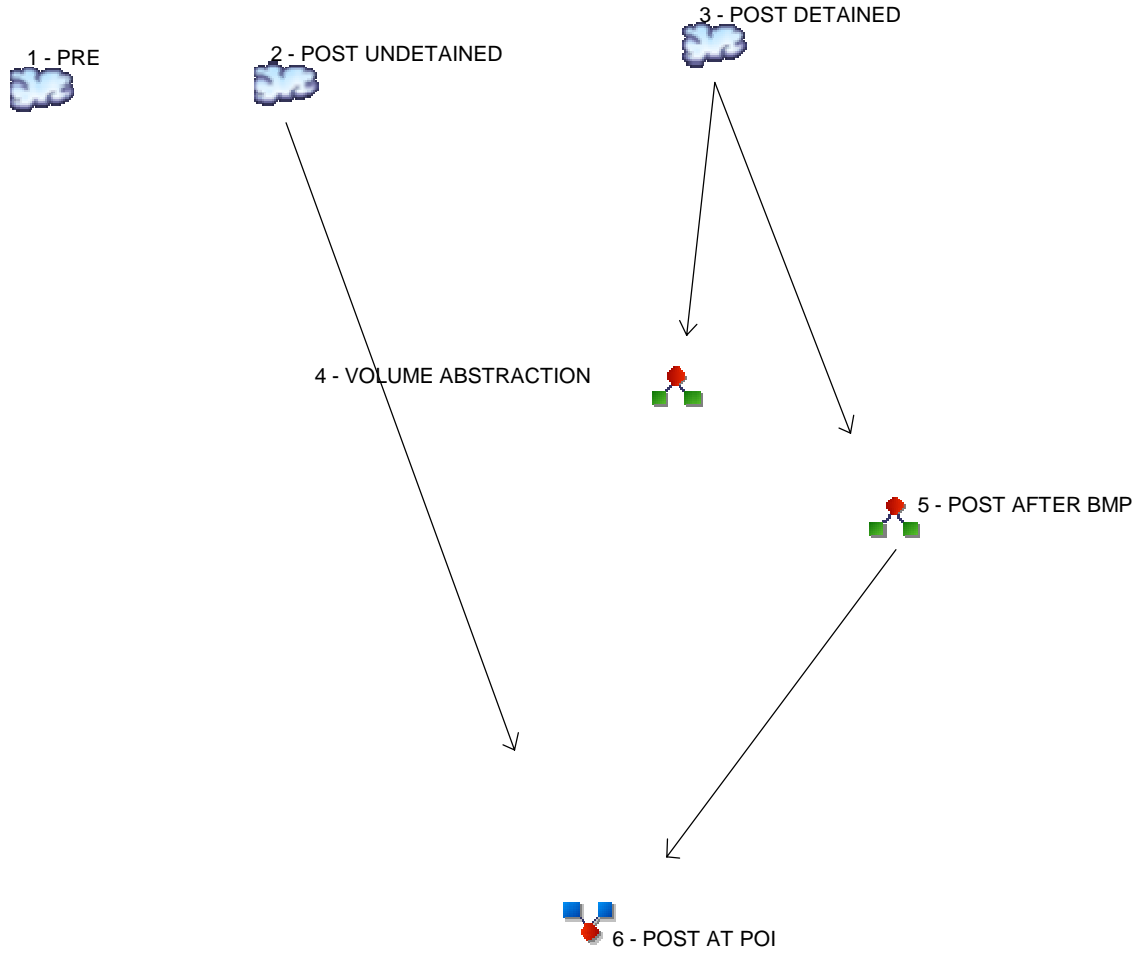
Hydrograph type = Combine
Storm frequency = 50 yrs
Time interval = 2 min
Inflow hyds. = 2, 5

Peak discharge = 9.308 cfs
Time to peak = 720 min
Hyd. volume = 21,330 cuft
Contrib. drain. area = 1.460 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	-----	-----	-----	-----	-----	-----	-----	-----	12.05	PRE
2	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	9.831	POST UNDETAINED
3	SCS Runoff	-----	-----	-----	-----	-----	-----	-----	-----	2.093	POST DETAINED
4	Diversion1	3	-----	-----	-----	-----	-----	-----	-----	0.876	VOLUME ABSTRACTION
5	Diversion2	3	-----	-----	-----	-----	-----	-----	-----	2.093	POST AFTER BMP
6	Combine	2, 5	-----	-----	-----	-----	-----	-----	-----	11.69	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	12.05	2	718	27,779	-----	-----	-----	PRE
2	SCS Runoff	9.831	2	718	22,657	-----	-----	-----	POST UNDETAINED
3	SCS Runoff	2.093	2	722	6,025	-----	-----	-----	POST DETAINED
4	Diversion1	0.876	2	710	1,246	3	-----	-----	VOLUME ABSTRACTION
5	Diversion2	2.093	2	722	4,780	3	-----	-----	POST AFTER BMP
6	Combine	11.69	2	720	27,437	2, 5	-----	-----	POST AT POI

Hydrograph Report

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

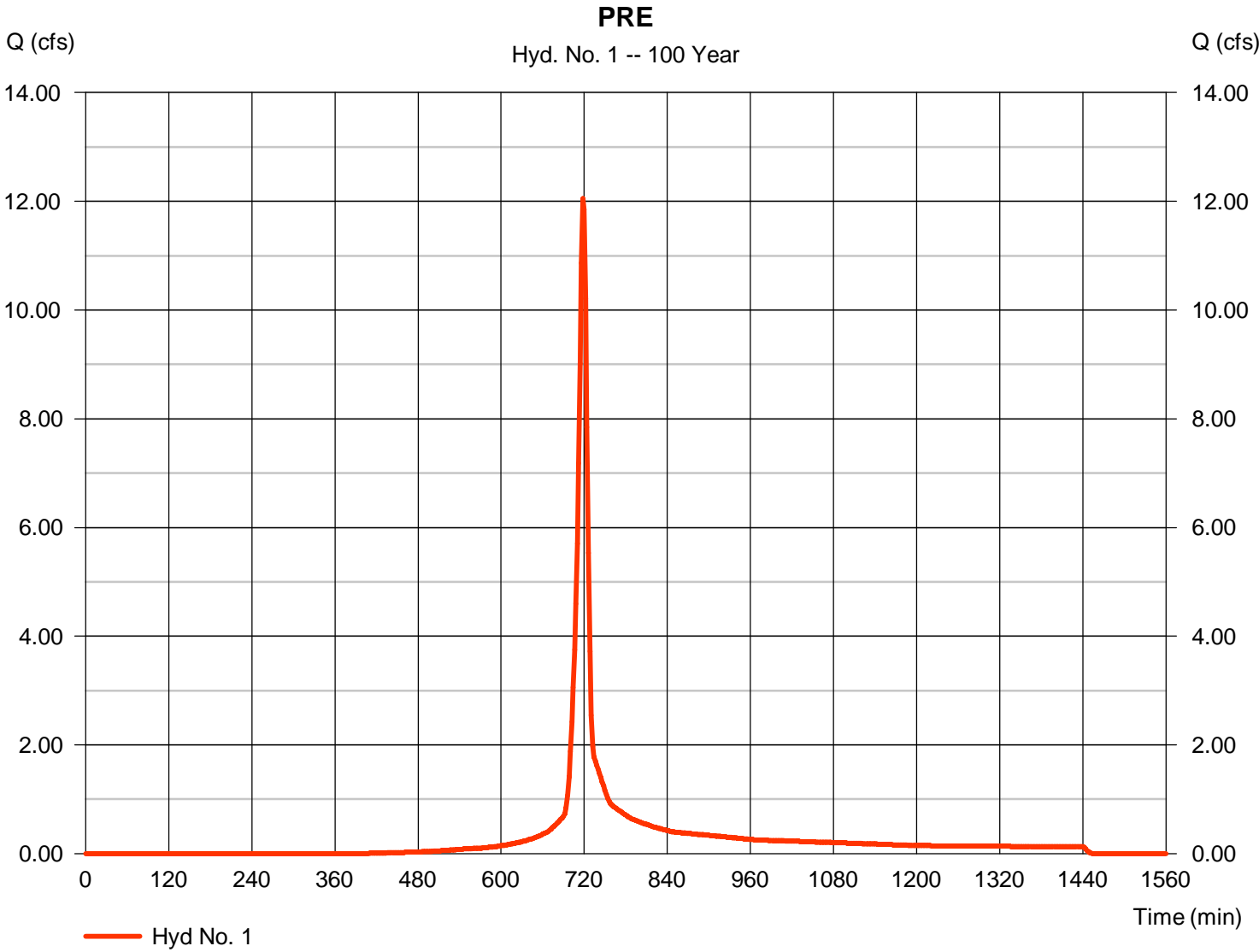
Sunday, 10 / 23 / 2016

Hyd. No. 1

PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 12.05 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 27,779 cuft
Drainage area	= 1.790 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 7.02 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.020 x 55) + (0.340 x 70) + (1.190 x 77) + (0.080 x 71) + (0.080 x 78)] / 1.790



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)	= 2.82	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 6.62	+ 0.00	+ 0.00	= 6.62
Shallow Concentrated Flow				
Flow length (ft)	= 167.00	0.00	0.00	
Watercourse slope (%)	= 21.60	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=7.50	0.00	0.00	
Travel Time (min)	= 0.37	+ 0.00	+ 0.00	= 0.37
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				7.00 min

Hydrograph Report

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

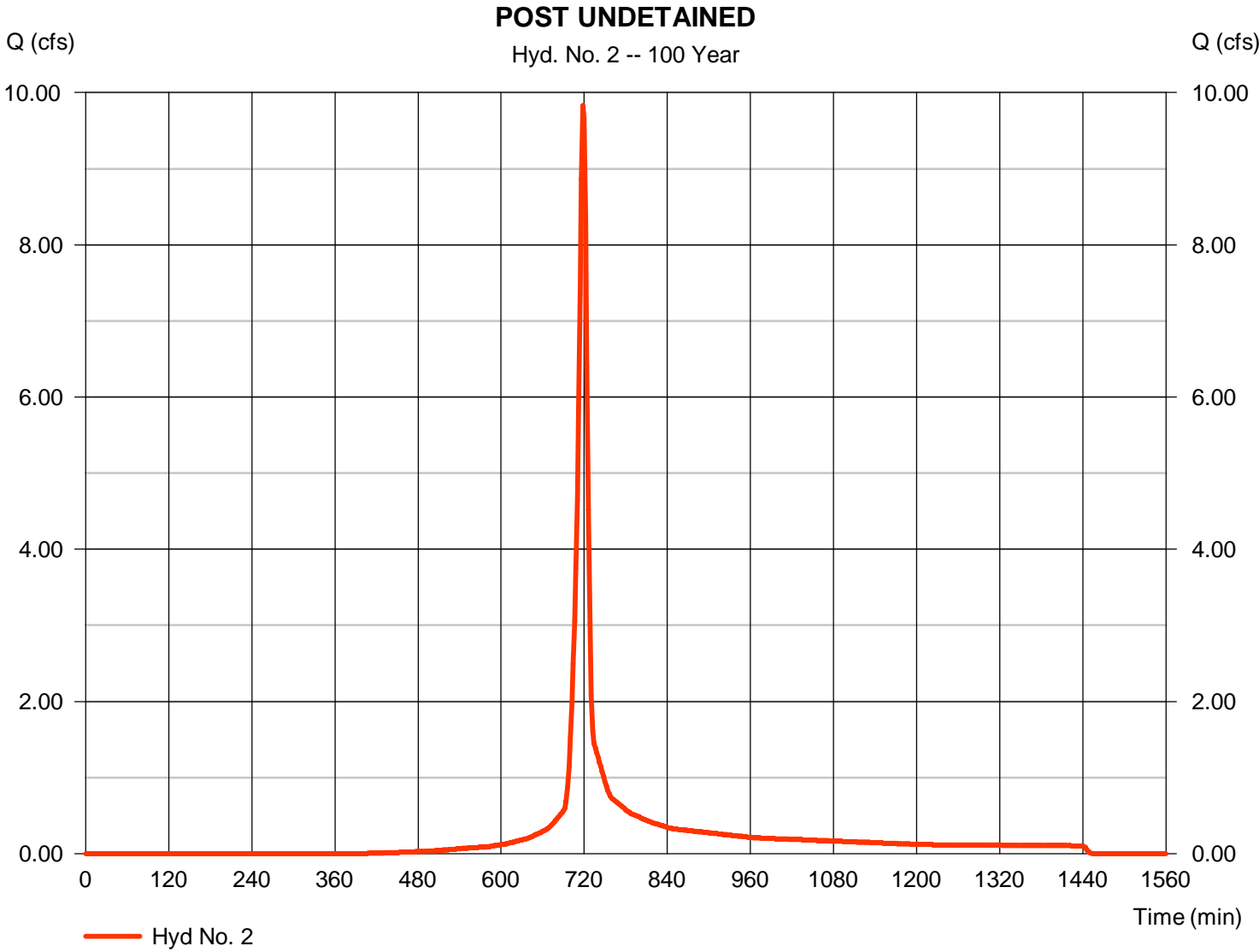
Sunday, 10 / 23 / 2016

Hyd. No. 2

POST UNDETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 9.831 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 22,657 cuft
Drainage area	= 1.460 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 7.02 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.080 x 98) + (0.030 x 58) + (0.220 x 70) + (0.570 x 77) + (0.180 x 71) + (0.380 x 78)] / 1.460



TR55 Tc Worksheet

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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)	= 2.82	0.00	0.00	
Land slope (%)	= 4.00	0.00	0.00	
Travel Time (min)	= 6.62	+ 0.00	+ 0.00	= 6.62
Shallow Concentrated Flow				
Flow length (ft)	= 167.00	0.00	0.00	
Watercourse slope (%)	= 21.60	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=7.50	0.00	0.00	
Travel Time (min)	= 0.37	+ 0.00	+ 0.00	= 0.37
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				7.00 min

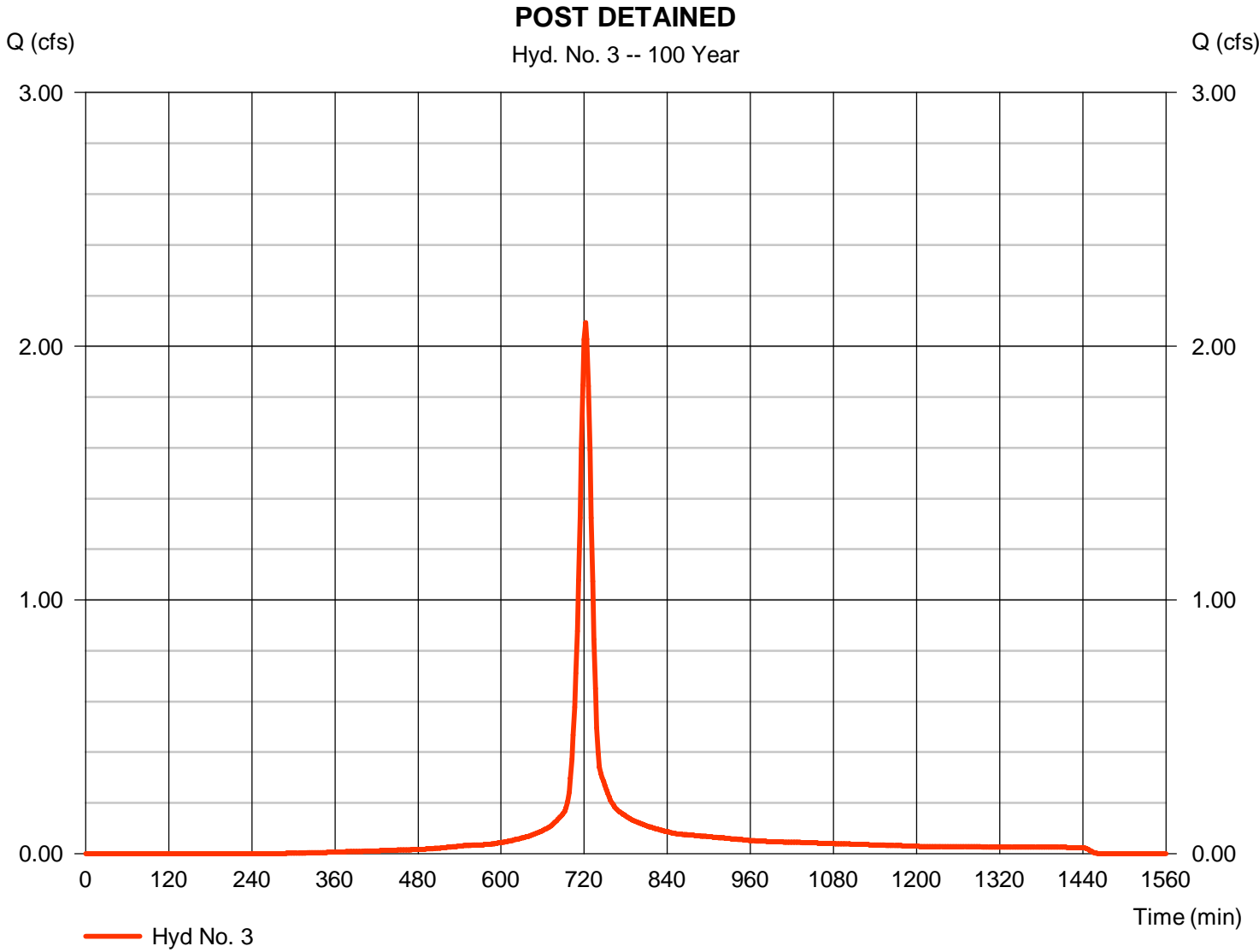
Hydrograph Report

Hyd. No. 3

POST DETAINED

Hydrograph type	= SCS Runoff	Peak discharge	= 2.093 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 6,025 cuft
Drainage area	= 0.330 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.80 min
Total precip.	= 7.02 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.140 x 91) + (0.190 x 78)] / 0.330



Hydrograph Report

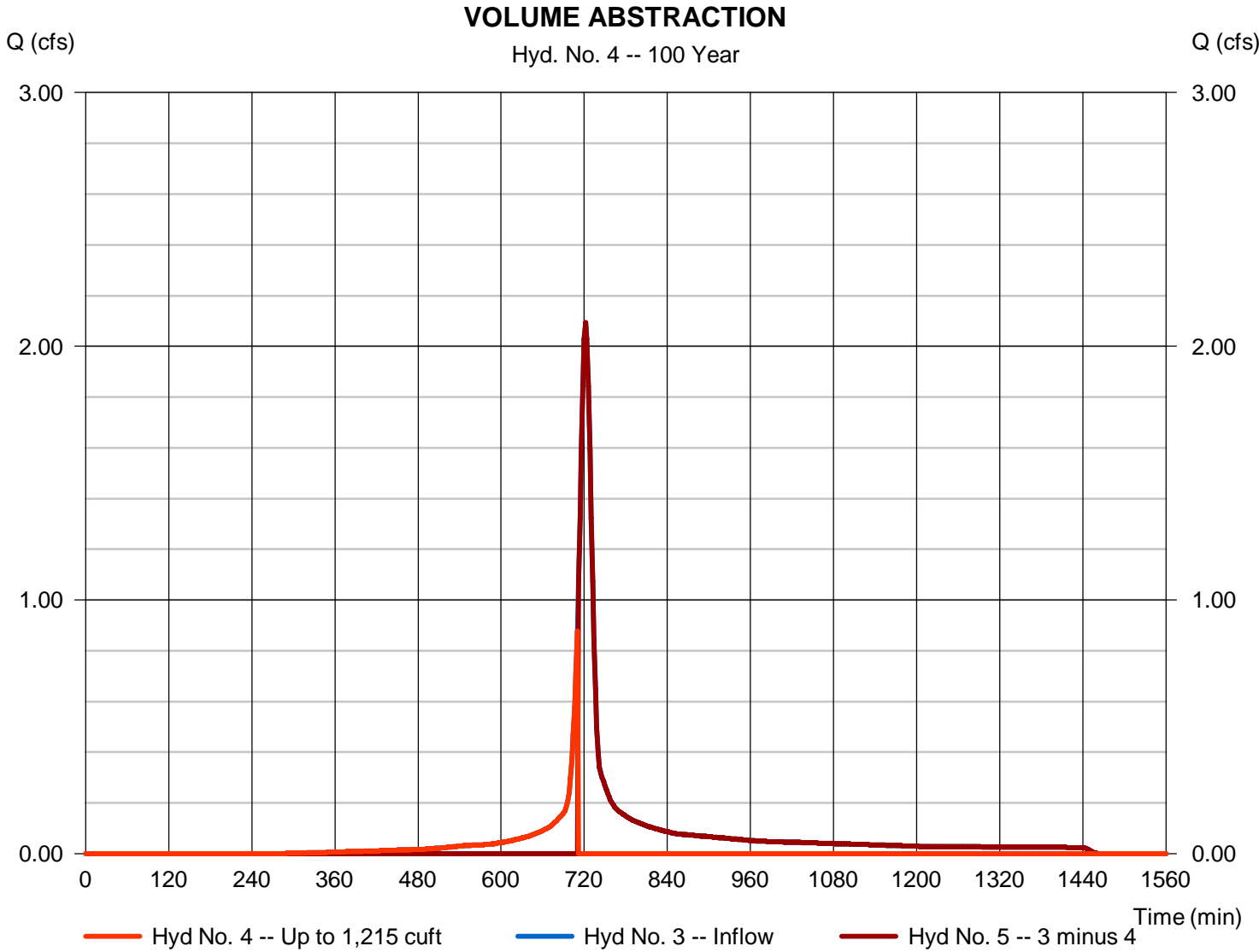
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

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Hyd. No. 4

VOLUME ABSTRACTION

Hydrograph type	= Diversion1	Peak discharge	= 0.876 cfs
Storm frequency	= 100 yrs	Time to peak	= 710 min
Time interval	= 2 min	Hyd. volume	= 1,246 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 5
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

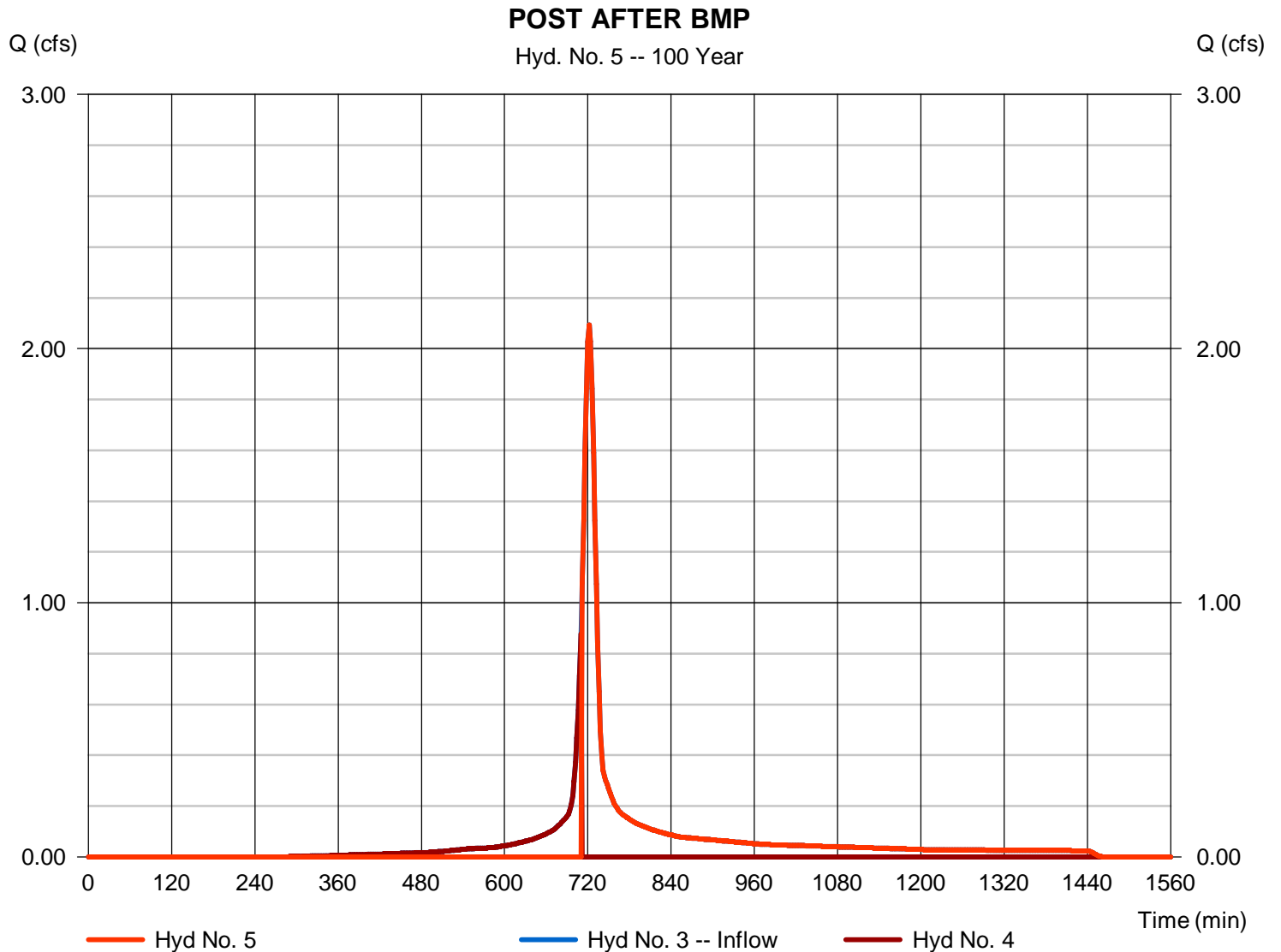
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Sunday, 10 / 23 / 2016

Hyd. No. 5

POST AFTER BMP

Hydrograph type	= Diversion2	Peak discharge	= 2.093 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 4,780 cuft
Inflow hydrograph	= 3 - POST DETAINED	2nd diverted hyd.	= 4
Diversion method	= First Flush Volume	Volume Up To	= 1,215 cuft



Hydrograph Report

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

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Hyd. No. 6

POST AT POI

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

Peak discharge = 11.69 cfs
Time to peak = 720 min
Hyd. volume = 27,437 cuft
Contrib. drain. area = 1.460 ac

