KOONTZ RD

WORKSHEET 1. GENERAL SITE INFORMATION

Date: October 21, 2016

Project Name: Koontz Rd

Municipality: Loyalhanna Township

County: Westmoreland

Total Area (acres): 2.10

Major River Basin: Ohio

Watershed: Loyalhanna Creek

Sub Basin: Loyalhanna Creek

Nearest Surface Water to Receive Runoff: Lower Loyalhanna Creek (Serviceberry Run)

Ch. 93 - Designated Water Use: HQ-WWF

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

Is Project Subject to, or Part of:

Municipal Separate Storm Sewer System (MS4) Requirements	YES	
	NO	X
Existing or Planned drinking water supply?	YES	
	NO	X
If yes, distance from proposed discharge (miles):		
Approved Act 167 Plan?	YES	
	NO	X
Existing River Conservation Plan?	YES	
	NO	X

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.

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

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

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			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands			
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Other:	Yes	2.1	1.34
Other:			
TOTAL EXISTING:	Yes	2.1	1.34

WORKSHEET 3. NONSTRUCTURAL BMP CREDITS

PROTECED AREA

1.1 Area of Protected Sensitive/Special Value Features (see WS 2) 1.34 **Ac.**

1.2 Area of Riparian Forest Buffer Protection 0 **Ac.**

3.1 Area of Minimum Disturbance/Reduced Grading 0 **Ac.**

TOTAL 1.34 **Ac.**

Site Area	minus	Protected Area	=	Stormwater Management Area
2.1	-	1.34	=	0.76
				This is the area that requires stormwater management

VOLUME CREDITS

3.1 Minimum Soil Compaction

Lawn _____ ft^2 x 1/4 in x 1/12 = _____ **ft^3**

Meadow _____ ft^2 x 1/3 in x 1/12 = _____ **ft^3**

3.3 Protected Existing Trees

For trees within 100 feet of impervious area:

Tree canopy _____ ft^2 x 1/2 in x 1/12 = _____ **ft^3**

5.1 Disconnect Roof Leaders to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area _____ ft^2 x 1/3 in x 1/12 = _____ **ft^3**

For all other disconnected roof areas

Roof Area _____ ft^2 x 1/4 in x 1/12 = _____ **ft^3**

5.2 Disconnect Non-Roof impervious to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Areas _____ ft^2 x 1/3 in x 1/12 = _____ **ft^3**

For all other disconnected roof areas

Impervious Areas _____ ft^2 x 1/4 in x 1/12 = _____ **ft^3**

TOTAL NON-STRUCTURAL VOLUME CREDIT* **ft^3**

** For use on Workseet 5*

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

PROJECT: Koontz Rd
Drainage Area: 2.10 acres
2-Year Rainfall: 2.44 in

Total Site Area: 2.10 acres
Protected Site Area: 1.34 acres
Managed Site Area: 0.76 acres

Existing Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff [1] (in)	Runoff Volume[2] (ft^3)
Meadow	C	9874	0.23	71	4.08	0.82	0.46	380
80% Existing Gravel	C	1177	0.03	89	1.24	0.25	1.40	138
Meadow (20% Gravel)	C	294	0.01	71	4.08	0.82	0.46	11
Woods	C	1168	0.03	70	4.29	0.86	0.43	42
Meadow	C/D	17950	0.41	78	2.82	0.56	0.75	1,121
80% Existing Gravel	C/D	2582	0.06	91	0.99	0.20	1.56	335
Meadow (20% Gravel)	C/D	645	0.01	78	2.82	0.56	0.75	40
TOTAL:		**33,690**	**0.77**					**2,066**

Developed Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff [1] (in)	Runoff Volume[2] (ft^3)
Meadow	C	10123	0.23	71	4.08	0.82	0.46	389
Gravel	C	2411	0.06	89	1.24	0.25	1.40	282
Meadow	C/D	13239	0.30	78	2.82	0.56	0.75	827
Gravel	C/D	7938	0.18	91	0.99	0.20	1.56	1,029
TOTAL:		**33,711**	**0.77**					**2,527**

2-Year Volume Increase (ft^3):	**461**

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volum

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

2. Runoff Volume (CF) = Q x Area x 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: Koontz Rd
SUB-BASIN:

Required Control Volume (ft^3) - *from Worksheet 4:* 461

Non-structural Volume Credit (ft3) - *from Worksheet 3:* - N/A

Structural Volume Reqmt (ft^3) 461
(Required Control Volume minus Non-structural Credit)

	Proposed BMP	Area (ft^2)	Storage Volume (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/Bioretention		
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	2,400	1,617
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 Restoration		
6.7.2	Landscape Restoration/Reforestation		
6.7.3	Soil Amendment		
6.8.1	Level Spreader		
6.8.2	Special Storage Areas		
Other:			

Total Structural Volume Provided (ft^3): 1,617

Structural Volume Requirement (ft^3): 461

DIFFERENCE: -1,156

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 equivalent) "provided across the site" is taken to mean the specifications for that BMP set forward in Sections 5 and 6 are satisfied.

Proposed BMPs from PA Stormwater Best Management Practices Manual Chapter 5 & 6

	Yes	No
Primary BMPs for Nitrate:		
NS BMP 5.4.2 – Protect/Conserve/Enhance Riparian Buffers		
NS BMP 5.5.4 – Cluster Uses at Each Site		
NS BMP 5.6.1 – Minimize Total Disturbed Area	X	
NS BMP 5.6.3 – Re-Vegetate/Re-Forest Disturbed Areas (Native Species)	X	
NS BMP 5.9.1 – Street Sweeping/Vacuuming		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Secondary BMPs for Nitrate:		
NS BMP 5.4.1 – Protect Sensitive/Special Value Features		
NS BMP 5.4.3 – Protect/Utilize Natural Drainage Features		
NS BMP 5.6.2 – Minimize Soil Compaction	X	
Structural BMP 6.4.5 – Rain Garden/Bioretention		
Structural BMP 6.4.8 – Vegetated Swale		
Structural BMP 6.4.9 – Vegetated Filter Strip		
Structural BMP 6.6.1 – Constructed Wetland		
Structural BMP 6.7.1 – Riparian Buffer Restoration		
Structural BMP 6.7.2 – Landscape Restoration		
Structural BMP 6.7.3 – Soils Amendment/Restoration		

STANDARD WORKSHEET #11
Channel Design Data

PROJECT NAME: Sunoco PA Pipeline Project - PCSMP
LOCATION: Koontz Road, Westmoreland County, PA
DONE BY: RJM DATE: 10/21/2016
CHECKED BY: LMD DATE: 1/27/2017

CHANNEL OR CHANNEL SECTION		DD-1				
TEMPORARY OR PERMANENT?	(T OR P)	P				
DESIGN STORM	(2, 5, 10, OR 100 YR)	100				
ACRES	(AC)	1.07				
MULTIPLIER	(1.6, 2.25, or 2.75) [1]	N/A				
Q_r (REQUIRED CAPACITY)	(CFS)	4.75				
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	4.75				
S (BED SLOPE)[3]	(FT/FT)	0.06				
DESIGN METHOD FOR PROTECTIVE LINING[5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		V				
PROTECTIVE LINING[2]		NAG P300				
n (MANNING'S COEFFICIENT)[2]		0.081				
V_a (ALLOWABLE VELOCTY)	(FPS)	5.00				
V (CALCULATED AT FLOW DEPTH)	(FPS)	2.56				
t_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	N/A				
t_d (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	N/A				
CHANNEL BOTTOM WIDTH	(FT)	1				
CHANNEL LEFT SIDE SLOPE	(_LH:1V)	2				
CHANNEL RIGHT SIDE SLOPE	(_RH:1V)	2				
D (TOTAL DEPTH)	(FT)	1.50				
CHANNEL TOP WIDTH @ D	(FT)	7.00				
d (CALCULATED FLOW DEPTH)	(FT)	0.75				
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	4.00				
BOTTOM WIDTH : FLOW DEPTH RATIO	(12:1 MAX)	1.33				
d_{50} STONE SIZE	(IN)	N/A				
A (CROSS-SECTIONAL AREA)	(SQ. FT.)	1.88				
R (HYDRAULIC RADIUS)		0.43				
S_c (CRITICAL SLOPE)	(FT/FT)	0.138				
$.7S_c$	(FT/FT)	0.096				
$1.3S_c$	(FT/FT)	0.179				
STABLE FLOW?	(Y/N)	Y				
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	N/A				
FREEBOARD BASED ON STABLE FLOW	(FT)	0.75				
MINIMUM REQUIRED FREEBOARD[4]		0.5				

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft or 1/4 Total Channel Depth, whichever is greater.,
5. Permissible velocity lining design methods is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

PCSM - DESIGN CALCULATIONS
KOONTZ RD

TETRA TECH, INC.

By:	RJM	Date:	10/21/16	Subject:	Sunoco PA Pipeline Project	Sheet No.:	of
Chkd. By:	LMD	Date:	1/27/17		Koontz Rd	Proj. No.:	112IC05958

Post Construction Stormwater Management Plan - Design Calculations
Koontz Road

PURPOSE

The purpose of these calculations is to design a Post-Construction Stormwater Management (PCSM) Plan for the Koontz Road Block Valve Site as part of the Sunoco Pipeline L.P. Pennsylvania Pipeline Project. The Koontz Road Block Valve Site is located in Loyalhanna Township,Westmoreland County, PA. Permanent stormwater controls will be developed to satisfy PADEP and local stormwater control regulations. *(No applicable Act 167 or local regulations)*

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).

Chapter 3 of the BMP Manual, Stormwater Management Principles and Recommended Control Guidelines, outlines the recommended control guidelines referenced for this design, as follows:

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.

This site will utilize an infiltration berm to manage the two-year/24-hour volume increase.

Recommended Peak Rate Control Guideline

The recommended control guideline for peak rate control is:

• Do not increase the peak rate of discharge for the 1-year through 100-year events (at minimum); as necessary, provide additional peak rate control as required by applicable and approved Act 167 plans. *(No applicable Act 167 Plans)*

This site will utilize an infiltration berm to manage the one-year through 100-year peak rate increases. These BMPs, in conjunction with diversion channels and collection channels, will also help to increase the time of concentration.

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 PCSM Package.

Loading Ratio

In general, the following Loading Ratio guidelines are recommended:
• Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.

Disturbed Area

To meet PADEP PCSM Worksheet 10 guidelines, 90% of the disturbed area must be contained by BMP's.

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RAINFALL DEPTHS

SCS Storms: Storm routing for all storm events will be performed using the TR-55 SCS method with a 24-hour, Type II rainfall distribution. The following depths were obtained from the NOAA Point Precipitation Frequency Estimates for the site (Reference #6, Attachment A):

Storm Frequency	Depth (Inches)
2-yr	2.44
10-yr	3.43
50-yr	4.57
100-yr	5.11

RUNOFF VOLUME CALCULATION

2-YEAR DESIGN STORM RUNOFF VOLUME

The change in runoff volume for a 2-yr storm event will be calculated for the project area.

2-Year Rainfall (P) 2.44 in

Total Site Area : 2.1 acres
Protected Site Area: 1.34 acres
Stormwater Management Area 0.76 acres

Pre-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C	0.227	71	4.08	0.82	0.46	380
80% Existing Gravel	C	0.027	89	1.24	0.25	1.40	138
Meadow (20% Gravel)	C	0.007	71	4.08	0.82	0.46	11
Woods	C	0.027	70	4.29	0.86	0.43	42
Meadow	C/D	0.412	78	2.82	0.56	0.75	1,121
80% Existing Gravel	C/D	0.059	91	0.99	0.20	1.56	335
Meadow (20% Gravel)	C/D	0.015	78	2.82	0.56	0.75	40
Total		0.77					2,066

Post-Development Condition within LOD

Cover Type/Condition	Soil Type	Area (ac)	CN	S	Ia	Q (in)	Runoff Volume (cf)
Meadow	C	0.23	71	4.08	0.82	0.46	389
Gravel	C	0.06	89	1.24	0.25	1.40	282
Meadow	C/D	0.30	78	2.82	0.56	0.75	827
Gravel	C/D	0.18	91	0.99	0.20	1.56	1,029
Total		0.77					2,527

2-Year Volume Increase (cf):	**461**

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1. Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where [eq. 2-3, Ref. #2]

   P = 2-Year Rainfall (in)

   S = (1000/CN)-10

2. Runoff Volume (CF) = Q x Area x 1/12

   Q = Runoff (in)

   Area = Land use area (sq. ft.)

IMPERVIOUS LOADING RATE

	Area (ac)	Area (sf)
Detained Impervious Area (Gravel & Pavement):	0.24	9102.45
Maximum Impervious Ratio:	5	:1
Minimum Infiltration Area (sf):		1,820
Design Infiltration Area (sf):		2,400
Design Impervious Ratio:	3.8	:1

TOTAL WATERSHED LOADING RATE

	Area (ac)	Area (sf)
Detained Watershed Area (to Infiltration BMP):	0.48	21064.70
Maximum Total Watershed Ratio Ratio:	8	:1
Minimum Infiltration Area (sf):		2,633
Design Infiltration Area (sf):		2,400
Design Total Watershed Ratio:	8.8	:1

A diversion channel has been added along the northeast side of the pad to minimize the drainage area to the infiltration berm.

DISTURBED AREA

To meet Worksheet #10 guidelines, 90% of the disturbed area must be detained by BMP's. The infiltration berm for the Koontz Road Block Valve Site will be located along the southern edge of the pad and 100 percent of the disturbed area will be detained by the BMP.

INFILTRATION RATE

The design infiltration rate is determined from an average of the results within the footprint and approved vicinity of the proposed infiltration berm.

Design Infiltration Rate (in/hr) - *Infiltration Berm 1*	**3.5**

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VOLUME CALCULATION FOR STRUCTURAL BMPs

Infiltration Berm 1

Storage Volume

Width (ft)	Length (ft)	Cross Section Area	Surface Area (sf)	Depth to Overflow (ft)	Storage Volume (cf)
16	150	13.6	2,400	2.00	2040

VOLUME CREDIT FOR STRUCTURAL BMPs

The Volume Credit for each structural BMP will be the minimum of the following three volumes: Runoff to BMP from a 2 year-24 hour storm event, Storage Volume of the BMP, Infiltration Volume of the BMP within 72 hours.

Infiltration BMP	2-Year Runoff Volume (cf)	Storage Volume (cf)	Infiltration Volume - 72 Hours (cf)	Structural Volume Credit (cf)
Infiltration Berm 1	1617	2040	2040	1617
			Total Structural Credit (cf) (Worksheet 5)	**1617**

Note: The Infiltration Volume is capped by the Storage Volume of the BMP.

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WATERSHED CHARACTERISTICS

The total watershed area for the project site is 2.10 acres. Based upon the soil survey of Westmoreland County, Pennsylvania (Ref. #3, Attachment B), the primary soil types within the watershed area are of the Cavode silt loam (CaB), Gilpin-Weikert channery silt loam (GwF), and Wharton silt loam (WrC) series which are primarily classified as HSG C/D, C, and C/D, respectively. See the project drawings for watershed mapping.

Pre-Development Condition

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	CaB	Meadow	78	0.57
C/D	WrC	Meadow	78	0.70
C/D	WrC	Woods	77	0.04
C/D	WrC	Existing Gravel (80%)	91	0.06
C/D	WrC	Meadow (20% Gravel)	78	0.01
C	GwF	Meadow	71	0.44
C	GwF	Existing Gravel (80%)	89	0.03
C	GwF	Meadow (20% Gravel)	71	0.01
C	GwF	Woods	70	0.25
			Totals	2.11

CN	75

Post-Development Condition

Diversion (Undetained)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	CaB	Meadow	78	0.57
C/D	WrC	Meadow	78	0.44
C/D	WrC	Woods	77	0.03
C	GwF	Meadow	71	0.03
			Totals	1.07

CN	78

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Infiltration Berm 1 (Detained)

Hydrologic Group	Soil Name	Cover Description	Curve Number	Area (acres)
C/D	WrC	Meadow	78	0.15
C/D	WrC	Gravel	90	0.18
C/D	WrC	Woods	77	0.01
C	GwF	Meadow	71	0.41
C	GwF	Gravel	89	0.06
C	GwF	Woods	70	0.22
			Totals	1.03

CN	76

PEAK FLOW CALCULATIONS

The infiltration berms were designed using the Time of Concentration Adjustment method.

HYDRAULIC PATHS

Times of concentration and travel times were evaluated for the pre-development condition as well as post-development conditions (Ref. #2). TR55 methodology was used to determine the T_c as presented in the AutoCAD Civil 3D Hydraflow Hydrographs computer output (Attachement C).

TIME OF CONCENTRATION ADJUSTMENT

The 'Peak Flow for Post-Dev. at the BMP (cfs)' is calculated from the BMP watershed with the Point of Interest at the BMP. The 'Volume Control BMP Storage' is the minimum value of the runoff volume to the BMP or the BMP Storage Volume.

Infiltration Berm 1

Storm Event (Yr.)	Peak Flow Post-Dev. At the BMP (cfs)	Volume Control BMP Storage (cf)	Additional Residence Time (min.)	Post Development Time of Concentration (w/o BMPs) (min.)	Adjusted Time Of Concentration (min.)
2	0.80	1,651	34.2	5.8	40.0
10	1.47	2,040	23.1	5.8	28.9
50	2.29	2,040	14.8	5.8	20.6
100	2.69	2,040	12.6	5.8	18.4

$$Additional\ Residence\ Time\ (min.) = \frac{Storage\ Volume\ (cf)}{Peak\ Flow\ {}^{w}/_{o}\ BMP} * \frac{1\ min}{60\ sec}$$

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STORMWATER POND ROUTING

The computer programs AutoCAD Civil 3D Hydraflow Hydrographs Extension (Reference #7) was used to calculate the peak runoff during the pre-development conditions, post-development conditions without BMPs, and post-development conditions with BMPs. The peak discharge for each condition was calculated for the 2-yr, 10-yr, 50-yr, and 100-yr - 24-hr storm events. The following table summarizes the peak discharges for all conditions and the resulting changes. As demonstrated by the table, all the post-development conditions with BMPs produced discharges that were less than the peak runoffs from the pre-development conditions Hydraflow documentation is included in Attachment C.

	Pre-Development	Post-Development			
Storm Frequency	**Peak Runoff (cfs)**	**Peak Outflow (No BMP) (cfs)**	**Watershed Runoff Vol. (with BMPs) (cf)**	**Peak Outflow (with BMP) (cfs)**	**Change (cfs)**
2-yr	1.85	2.3	5,424	1.37	-0.47
10-yr	3.99	4.7	10,626	3.13	-0.87
50-yr	6.78	7.8	17,545	5.96	-0.82
100-yr	8.19	9.3	20,799	7.61	-0.58

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Chkd. By:	LMD	Date:	1/27/2017		Koontz Rd	Proj. No.:	112IC05958

REFERENCES

1) Erosion and Sediment Pollution Control Program Manual, Pennsylvania Department of Environmental Protection, Office of Water Management, March 2012.

2) Urban Hydrology for Small Watersheds, Technical Release Number 55 (TR-55), United States Department of Agriculture, Soil Conservation Service, 2nd Edition, June 1986.

3) Soil Survey of Westmoreland County, PA, United States Department of Agriculture, Soil Conservation Service, September 2016.

4) Handbook of Hydraulics - Sixth Edition, Brater and King, McGraw-Hill Book Company, 1976.

5) Introduction to Hydraulics and Hydrology with Applications for Stormwater Management - 2nd Edition, Gribbin, Delmar: A Division of Thomson Learning, 2002.

6) NOAA, Point Precipitation Frequency Estimates, Pennsylvania 40.4381 N 79.457 W 1086.77 ft.

7) Hydraflow Hydrographs Extension, AutoCAD Civil 3D, Autodesk, Inc, 2007-2016.

8) Pennsylvania Stormwater Best Management Practices Manual, Pennsylvania Department of Environmental Protection, December 2006.

ATTACHMENT A

NOAA PRECIPITATION FREQUENCY ESTIMATES

NOAA Atlas 14, Volume 2, Version 3
Location name: Loyalhanna Twp, Pennsylvania, USA*
Latitude: 40.4381°, Longitude: -79.457°
Elevation: 1086.77 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	**0.314** (0.283-0.346)	**0.374** (0.338-0.413)	**0.453** (0.409-0.500)	**0.514** (0.463-0.566)	**0.592** (0.533-0.651)	**0.652** (0.584-0.716)	**0.709** (0.634-0.778)	**0.770** (0.685-0.844)	**0.850** (0.751-0.931)	**0.910** (0.800-0.995)
10-min	**0.487** (0.440-0.537)	**0.584** (0.528-0.645)	**0.703** (0.636-0.776)	**0.793** (0.715-0.874)	**0.905** (0.815-0.996)	**0.988** (0.886-1.09)	**1.07** (0.954-1.17)	**1.15** (1.02-1.26)	**1.25** (1.10-1.37)	**1.32** (1.17-1.45)
15-min	**0.597** (0.540-0.659)	**0.714** (0.646-0.789)	**0.864** (0.781-0.953)	**0.976** (0.880-1.07)	**1.12** (1.01-1.23)	**1.22** (1.10-1.34)	**1.33** (1.19-1.46)	**1.43** (1.27-1.57)	**1.56** (1.38-1.71)	**1.66** (1.46-1.81)
30-min	**0.790** (0.714-0.871)	**0.955** (0.864-1.06)	**1.18** (1.07-1.30)	**1.35** (1.22-1.49)	**1.58** (1.42-1.74)	**1.75** (1.57-1.92)	**1.92** (1.71-2.10)	**2.09** (1.85-2.29)	**2.31** (2.04-2.53)	**2.48** (2.18-2.71)
60-min	**0.965** (0.872-1.06)	**1.17** (1.06-1.30)	**1.48** (1.34-1.64)	**1.72** (1.55-1.90)	**2.05** (1.84-2.25)	**2.30** (2.06-2.53)	**2.56** (2.29-2.81)	**2.83** (2.52-3.10)	**3.20** (2.83-3.50)	**3.49** (3.07-3.81)
2-hr	**1.12** (1.02-1.23)	**1.36** (1.24-1.49)	**1.71** (1.56-1.88)	**2.00** (1.81-2.19)	**2.38** (2.16-2.60)	**2.69** (2.43-2.94)	**3.02** (2.71-3.28)	**3.36** (3.00-3.64)	**3.83** (3.39-4.14)	**4.20** (3.70-4.54)
3-hr	**1.20** (1.09-1.31)	**1.45** (1.32-1.59)	**1.81** (1.65-2.00)	**2.11** (1.92-2.32)	**2.53** (2.29-2.77)	**2.87** (2.58-3.14)	**3.22** (2.89-3.51)	**3.60** (3.20-3.91)	**4.12** (3.64-4.47)	**4.54** (3.98-4.92)
6-hr	**1.43** (1.30-1.59)	**1.72** (1.57-1.91)	**2.15** (1.95-2.38)	**2.49** (2.26-2.76)	**2.99** (2.70-3.29)	**3.40** (3.06-3.73)	**3.82** (3.42-4.19)	**4.28** (3.80-4.68)	**4.93** (4.33-5.38)	**5.45** (4.75-5.93)
12-hr	**1.72** (1.56-1.91)	**2.06** (1.87-2.29)	**2.54** (2.31-2.82)	**2.94** (2.66-3.26)	**3.53** (3.18-3.89)	**4.01** (3.59-4.41)	**4.52** (4.02-4.96)	**5.07** (4.48-5.54)	**5.87** (5.13-6.39)	**6.52** (5.65-7.08)
24-hr	**2.04** (1.90-2.21)	**2.44** (2.27-2.64)	**2.98** (2.77-3.22)	**3.43** (3.18-3.70)	**4.05** (3.75-4.37)	**4.57** (4.21-4.91)	**5.11** (4.69-5.48)	**5.67** (5.18-6.08)	**6.47** (5.87-6.92)	**7.11** (6.41-7.59)
2-day	**2.38** (2.22-2.57)	**2.83** (2.64-3.06)	**3.44** (3.20-3.71)	**3.92** (3.65-4.22)	**4.60** (4.27-4.95)	**5.15** (4.76-5.53)	**5.72** (5.26-6.13)	**6.31** (5.78-6.74)	**7.12** (6.49-7.59)	**7.76** (7.04-8.27)
3-day	**2.56** (2.39-2.75)	**3.04** (2.84-3.26)	**3.66** (3.42-3.92)	**4.16** (3.88-4.45)	**4.85** (4.51-5.19)	**5.41** (5.01-5.77)	**5.98** (5.52-6.38)	**6.57** (6.05-7.00)	**7.38** (6.76-7.85)	**8.02** (7.31-8.52)
4-day	**2.74** (2.56-2.93)	**3.24** (3.04-3.47)	**3.87** (3.63-4.14)	**4.39** (4.11-4.68)	**5.10** (4.75-5.43)	**5.66** (5.27-6.02)	**6.24** (5.79-6.63)	**6.84** (6.32-7.26)	**7.65** (7.03-8.11)	**8.28** (7.58-8.78)
7-day	**3.28** (3.09-3.49)	**3.87** (3.64-4.12)	**4.57** (4.30-4.86)	**5.12** (4.81-5.45)	**5.87** (5.50-6.24)	**6.46** (6.05-6.86)	**7.06** (6.58-7.48)	**7.66** (7.12-8.11)	**8.45** (7.83-8.95)	**9.05** (8.36-9.58)
10-day	**3.79** (3.59-4.00)	**4.46** (4.23-4.72)	**5.21** (4.94-5.51)	**5.81** (5.50-6.13)	**6.61** (6.24-6.97)	**7.22** (6.81-7.61)	**7.84** (7.37-8.26)	**8.46** (7.92-8.90)	**9.26** (8.64-9.74)	**9.87** (9.18-10.4)
20-day	**5.32** (5.05-5.60)	**6.23** (5.92-6.58)	**7.18** (6.83-7.58)	**7.93** (7.53-8.37)	**8.91** (8.45-9.39)	**9.67** (9.15-10.2)	**10.4** (9.83-10.9)	**11.1** (10.5-11.7)	**12.0** (11.3-12.7)	**12.7** (11.9-13.4)
30-day	**6.70** (6.39-7.03)	**7.83** (7.47-8.23)	**8.94** (8.53-9.40)	**9.81** (9.35-10.3)	**11.0** (10.4-11.5)	**11.8** (11.2-12.4)	**12.6** (12.0-13.2)	**13.4** (12.7-14.1)	**14.5** (13.7-15.2)	**15.2** (14.3-15.9)
45-day	**8.59** (8.22-8.99)	**10.0** (9.58-10.5)	**11.3** (10.8-11.8)	**12.3** (11.7-12.9)	**13.6** (12.9-14.2)	**14.5** (13.8-15.1)	**15.4** (14.6-16.1)	**16.2** (15.4-16.9)	**17.2** (16.3-18.0)	**17.9** (17.0-18.7)
60-day	**10.4** (9.95-10.8)	**12.0** (11.6-12.6)	**13.5** (12.9-14.1)	**14.6** (14.0-15.2)	**16.0** (15.3-16.7)	**17.0** (16.2-17.7)	**17.9** (17.1-18.7)	**18.8** (17.9-19.6)	**19.8** (18.9-20.7)	**20.5** (19.5-21.4)

[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.

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ATTACHMENT B

USDA SOILS MAP & PROPERTIES

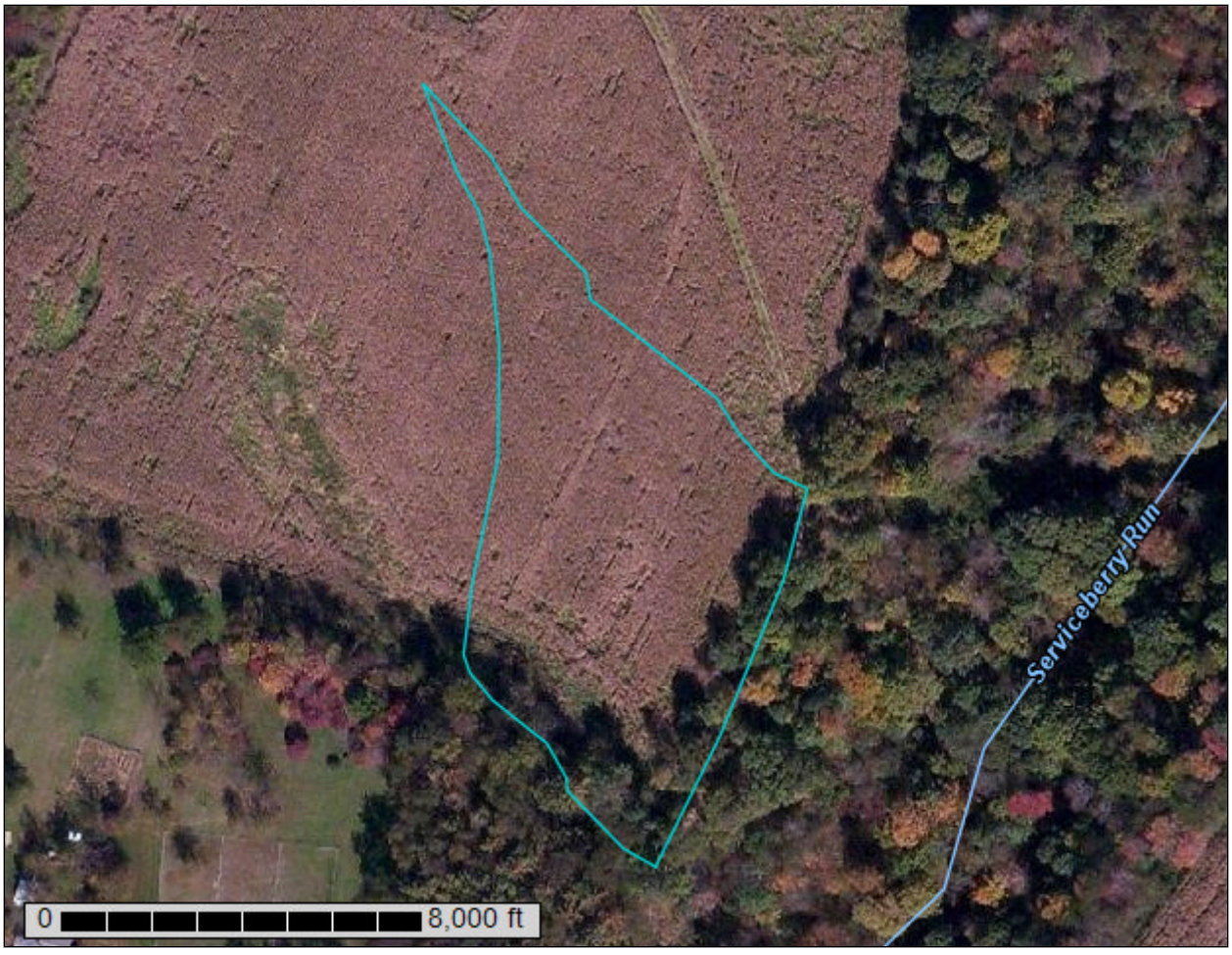
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

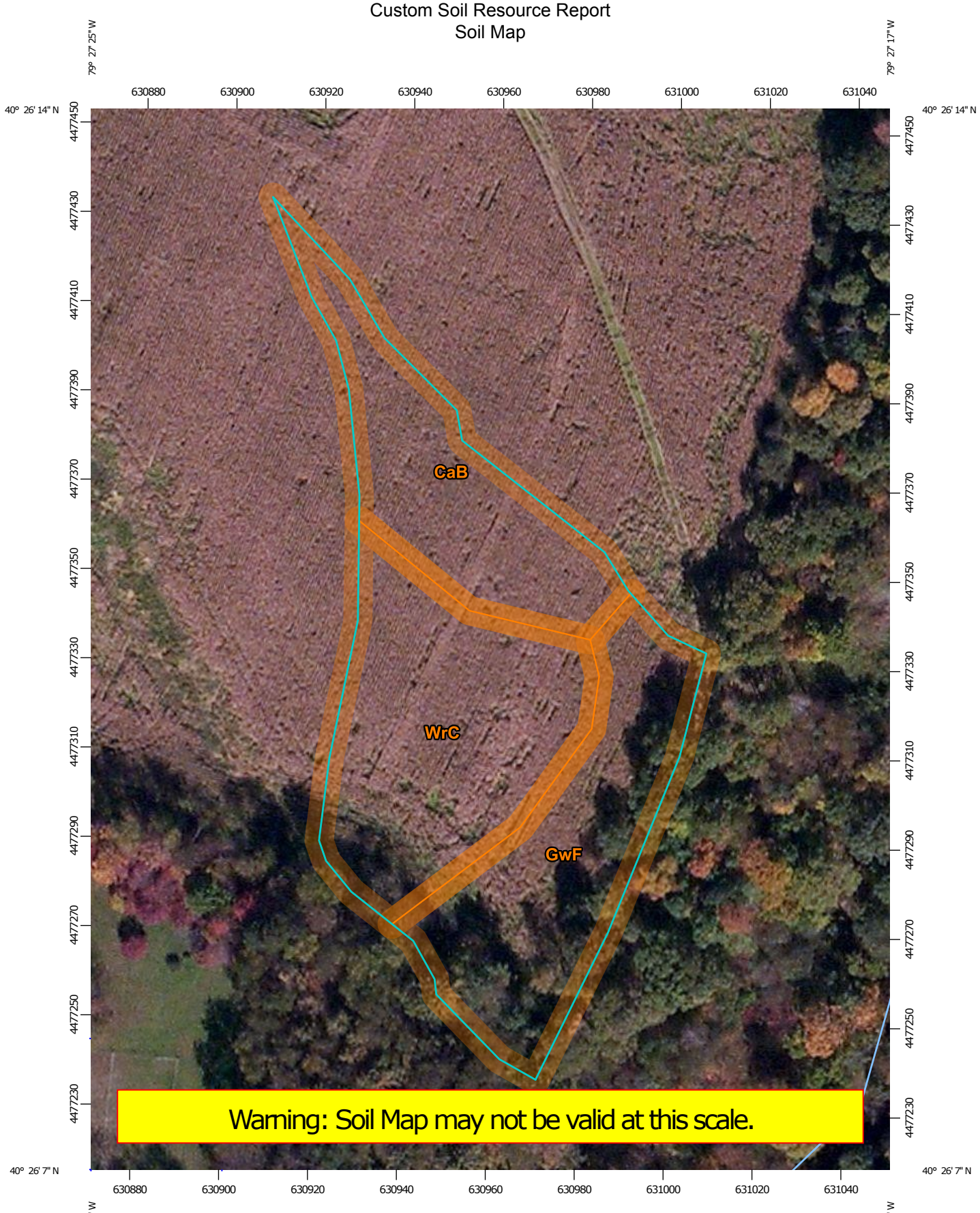
A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Westmoreland County, Pennsylvania



October 7, 2016

Custom Soil Resource Report
Soil Map



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

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Westmoreland County, Pennsylvania
Survey Area Data: Version 9, Nov 16, 2015

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

Date(s) aerial images were photographed: Mar 27, 2011—Oct 9, 2011

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

Map Unit Legend

Westmoreland County, Pennsylvania (PA129)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
CaB	Cavode silt loam, 3 to 8 percent slopes	0.6	26.9%
GwF	Gilpin-Weikert channery silt loams, 25 to 60 percent slopes	0.7	34.2%
WrC	Wharton silt loam, 8 to 15 percent slopes	0.8	38.9%
Totals for Area of Interest		**2.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments

on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Westmoreland County, Pennsylvania

CaB—Cavode silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: l8s4
Elevation: 1,000 to 1,700 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 41 to 62 degrees F
Frost-free period: 130 to 160 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Cavode and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cavode

Setting

Landform: Hills
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear, concave
Across-slope shape: Concave
Parent material: Acid clayey residuum weathered from clayey shale

Typical profile

Ap - 0 to 10 inches: silt loam
Btg - 10 to 47 inches: silty clay loam
BCg - 47 to 57 inches: channery silt loam
R - 57 to 61 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 40 to 90 inches to lithic bedrock
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Gilpin

Percent of map unit: 10 percent
Landform: Hills

Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Brinkerton

Percent of map unit: 5 percent
Landform: Draws, hills
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: Yes

GwF—Gilpin-Weikert channery silt loams, 25 to 60 percent slopes

Map Unit Setting

National map unit symbol: l8q3
Elevation: 800 to 1,700 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 41 to 62 degrees F
Frost-free period: 130 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Gilpin and similar soils: 60 percent
Weikert and similar soils: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gilpin

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Acid fine-loamy residuum weathered from shale and siltstone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oe - 1 to 2 inches: moderately decomposed plant material
A - 2 to 8 inches: channery silt loam
Bt - 8 to 24 inches: channery silt loam
C - 24 to 30 inches: very channery loam
R - 30 to 35 inches: bedrock

Properties and qualities

Slope: 25 to 60 percent

Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Hydric soil rating: No

Description of Weikert

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Nose slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Acid loamy residuum weathered from shale and siltstone

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 5 inches: channery silt loam
Bw - 5 to 15 inches: very channery silt loam
C - 15 to 18 inches: extremely channery silt loam
R - 18 to 28 inches: bedrock

Properties and qualities

Slope: 25 to 65 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Shelocta

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear, convex
Hydric soil rating: No

Wharton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

WrC—Wharton silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2t5mm
Elevation: 620 to 2,160 feet
Mean annual precipitation: 37 to 51 inches
Mean annual air temperature: 47 to 53 degrees F
Frost-free period: 161 to 205 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Wharton and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wharton

Setting

Landform: Hills
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Fine-loamy residuum weathered from shale and siltstone

Typical profile

Ap - 0 to 9 inches: silt loam
Bt1 - 9 to 16 inches: silt loam
Bt2 - 16 to 22 inches: silt loam
Bt3 - 22 to 31 inches: silt loam
BC - 31 to 46 inches: silty clay loam
C - 46 to 69 inches: channery silty clay loam
Cr - 69 to 79 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent

Depth to restrictive feature: 40 to 71 inches to paralithic bedrock
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: About 16 to 28 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Gilpin

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Rarden

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Ernest

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

ATTACHMENT C
KOONTZ RD
HYDRAFLOW RESULTS

ATTACHMENT C-1
KOONTZ RD
2 Year-24 Hour Storm

Watershed Model Schematic

1 - Koontz Rd - PRE

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

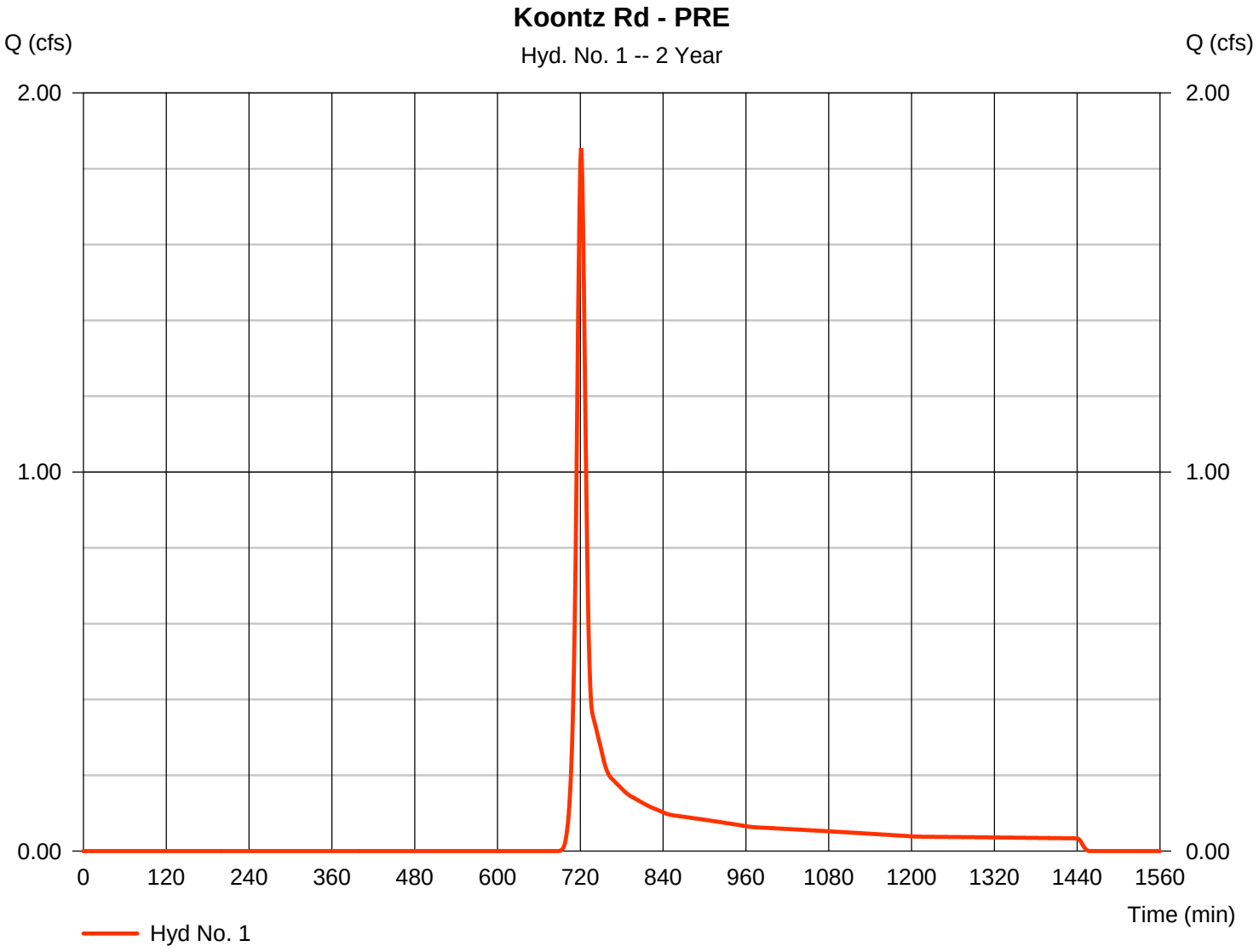
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	1.854	1	721	4,801	------	------	------	Koontz Rd - PRE

Hydrograph Report

Hyd. No. 1

Koontz Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.854 cfs
Storm frequency	=	2 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	4,801 cuft
Drainage area	=	2.110 ac	Curve number	=	75
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.70 min
Total precip.	=	2.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 1

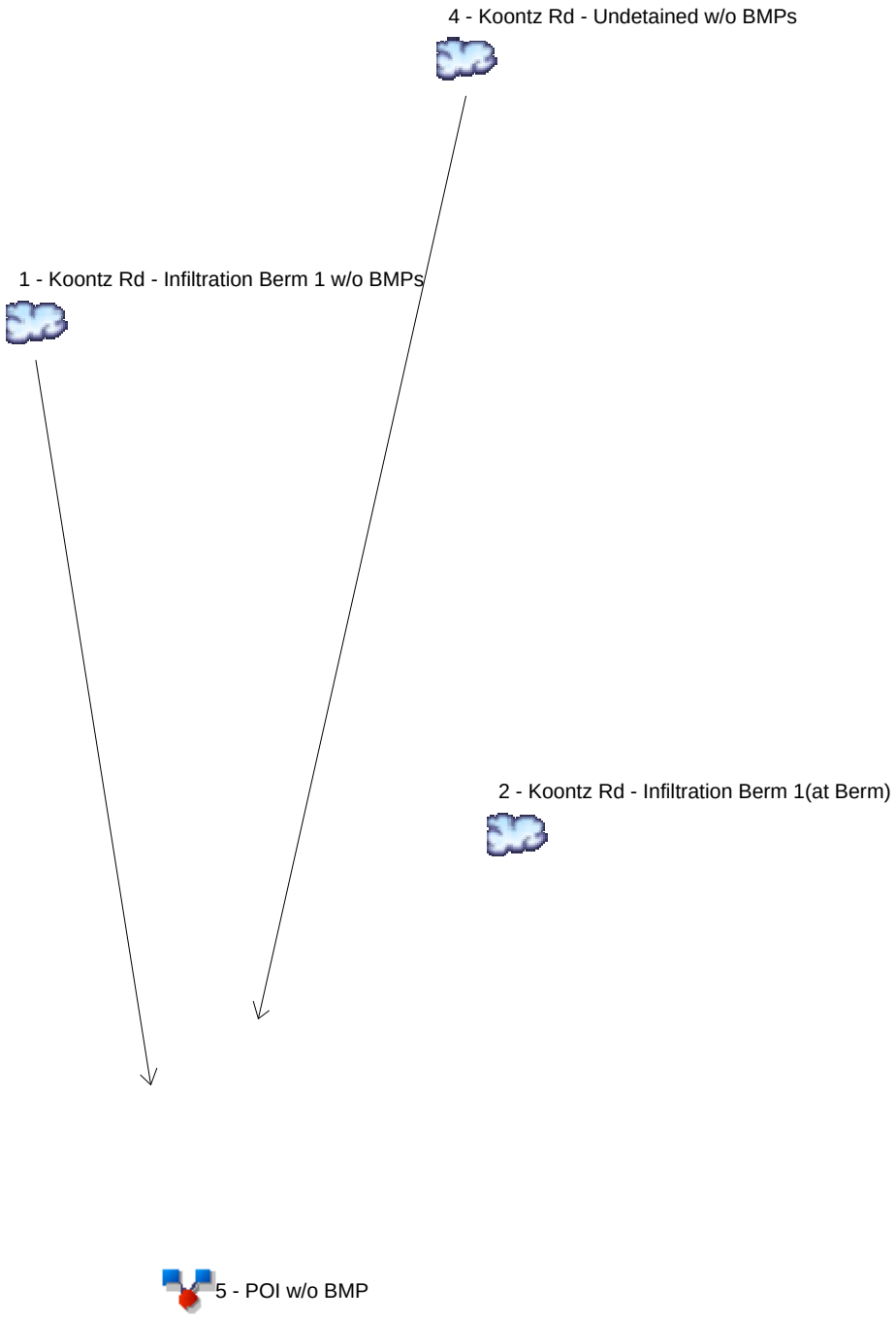
Koontz Rd - PRE

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 345.00		260.00		0.00		
Watercourse slope (%)	= 6.00		15.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=3.95		6.25		0.00		
Travel Time (min)	**= 1.45**	**+**	**0.69**	**+**	**0.00**	**=**	**2.15**
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 ..... 11.70 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

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	1.228	1	718	2,539	------	------	------	Koontz Rd - Infiltration Berm 1 w/o B
2	SCS Runoff	0.804	1	718	1,617	------	------	------	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	1.187	1	721	2,962	------	------	------	Koontz Rd - Undetained w/o BMPs
5	Combine	2.319	1	719	5,501	1, 4	------	------	POI w/o BMP

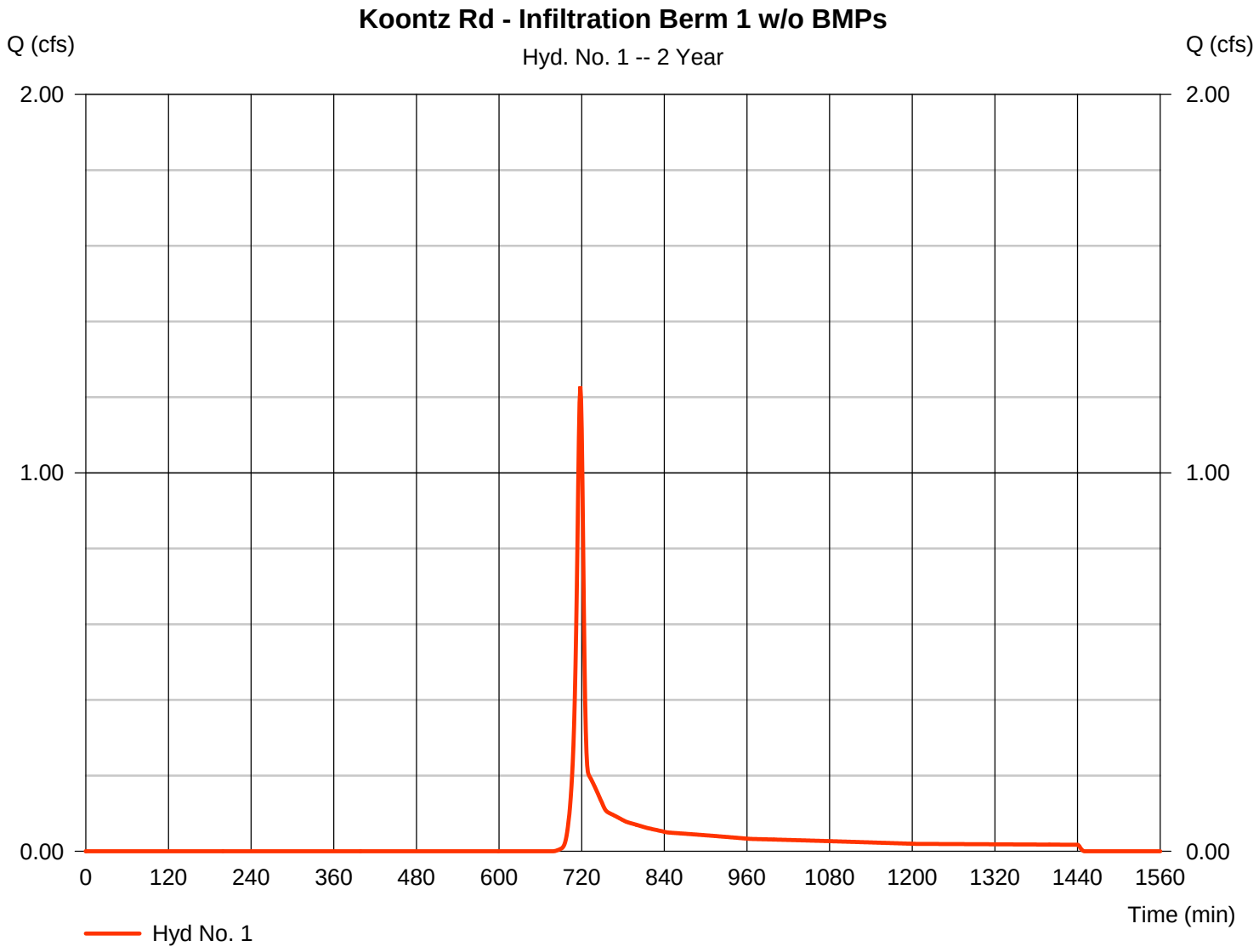
Hydrograph Report

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/o BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.228 cfs
Storm frequency	=	2 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	2,539 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.80 min
Total precip.	=	2.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030



TR55 Tc Worksheet

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/o BMPs

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.240		0.011		
Flow length (ft)	= 56.0		44.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		2.44		0.00		
Land slope (%)	= 5.40		9.00		0.00		
Travel Time (min)	**= 0.59**	**+**	**4.64**	**+**	**0.00**	**=**	**5.23**
Shallow Concentrated Flow							
Flow length (ft)	= 30.00		187.00		0.00		
Watercourse slope (%)	= 10.00		17.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=5.10		6.65		0.00		
Travel Time (min)	**= 0.10**	**+**	**0.47**	**+**	**0.00**	**=**	**0.57**
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**

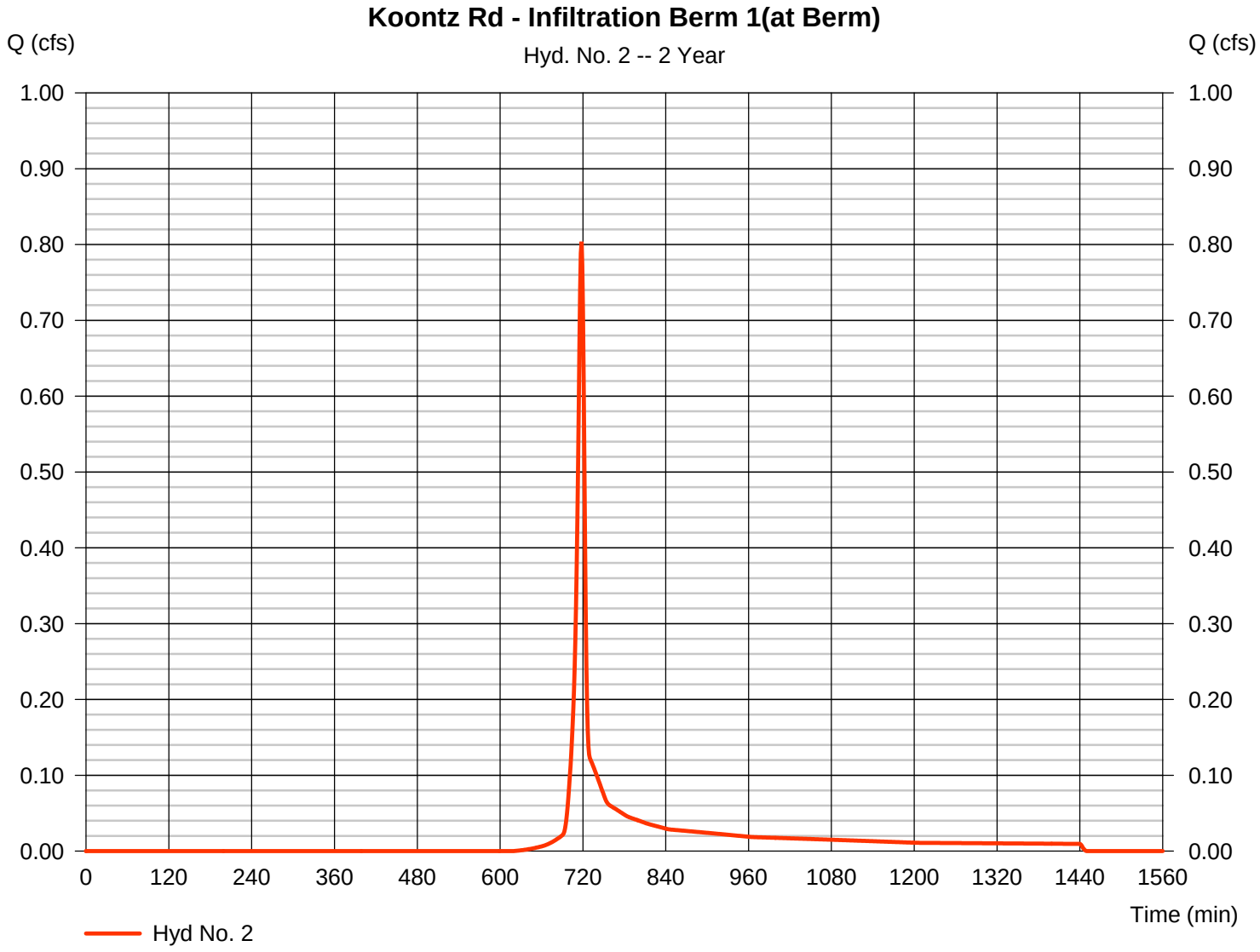
Total Travel Time, Tc ..... 5.80 min

Hydrograph Report

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.804 cfs
Storm frequency	=	2 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	1,617 cuft
Drainage area	=	0.480 ac	Curve number	=	81
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.30 min
Total precip.	=	2.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.240		0.011		
Flow length (ft)	= 56.0		44.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		2.44		0.00		
Land slope (%)	= 5.40		9.00		0.00		
Travel Time (min)	**= 0.59**	**+**	**4.64**	**+**	**0.00**	**=**	**5.23**
Shallow Concentrated Flow							
Flow length (ft)	= 30.00		0.00		0.00		
Watercourse slope (%)	= 10.00		0.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=5.10		0.00		0.00		
Travel Time (min)	**= 0.10**	**+**	**0.00**	**+**	**0.00**	**=**	**0.10**
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**

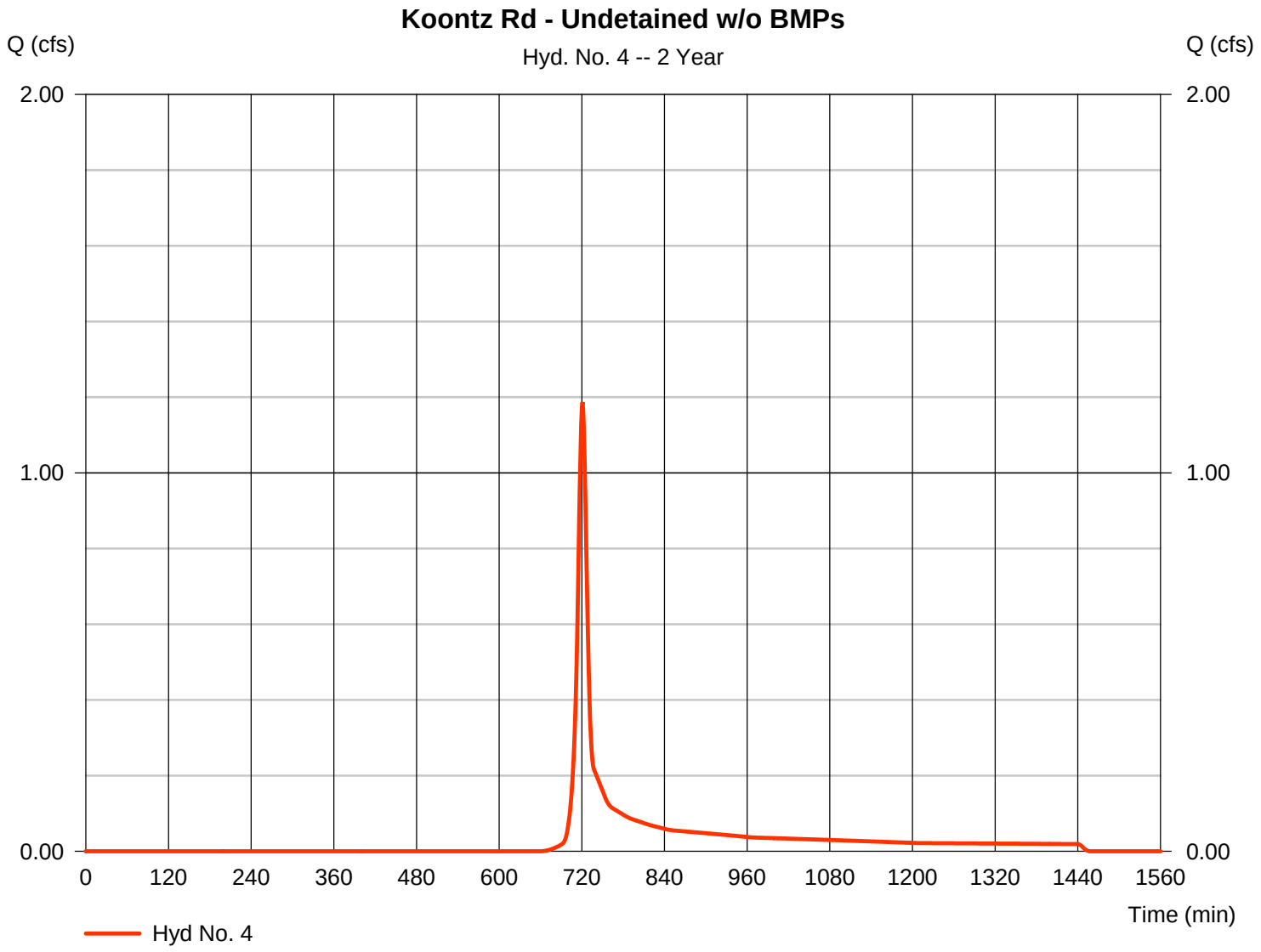
Total Travel Time, Tc ..... 5.30 min

Hydrograph Report

Hyd. No. 4

Koontz Rd - Undetained w/o BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.187 cfs
Storm frequency	=	2 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	2,962 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	2.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 4

Koontz Rd - Undetained w/o BMPs

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 290.00		0.00		0.00		
Watercourse slope (%)	= 6.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.95		0.00		0.00		
Travel Time (min)	**= 1.22**	**+**	**0.00**	**+**	**0.00**	**=**	**1.22**
Channel Flow							
X sectional flow area (sqft)	= 7.50		7.50		0.00		
Wetted perimeter (ft)	= 8.71		8.71		0.00		
Channel slope (%)	= 6.00		12.00		0.00		
Manning's n-value	= 0.026		0.026		0.015		
Velocity (ft/s)	=12.70						
			17.96				
					0.00		
Flow length (ft)	({0})224.0		240.0		0.0		
Travel Time (min)	**= 0.29**	**+**	**0.22**	**+**	**0.00**	**=**	**0.52**

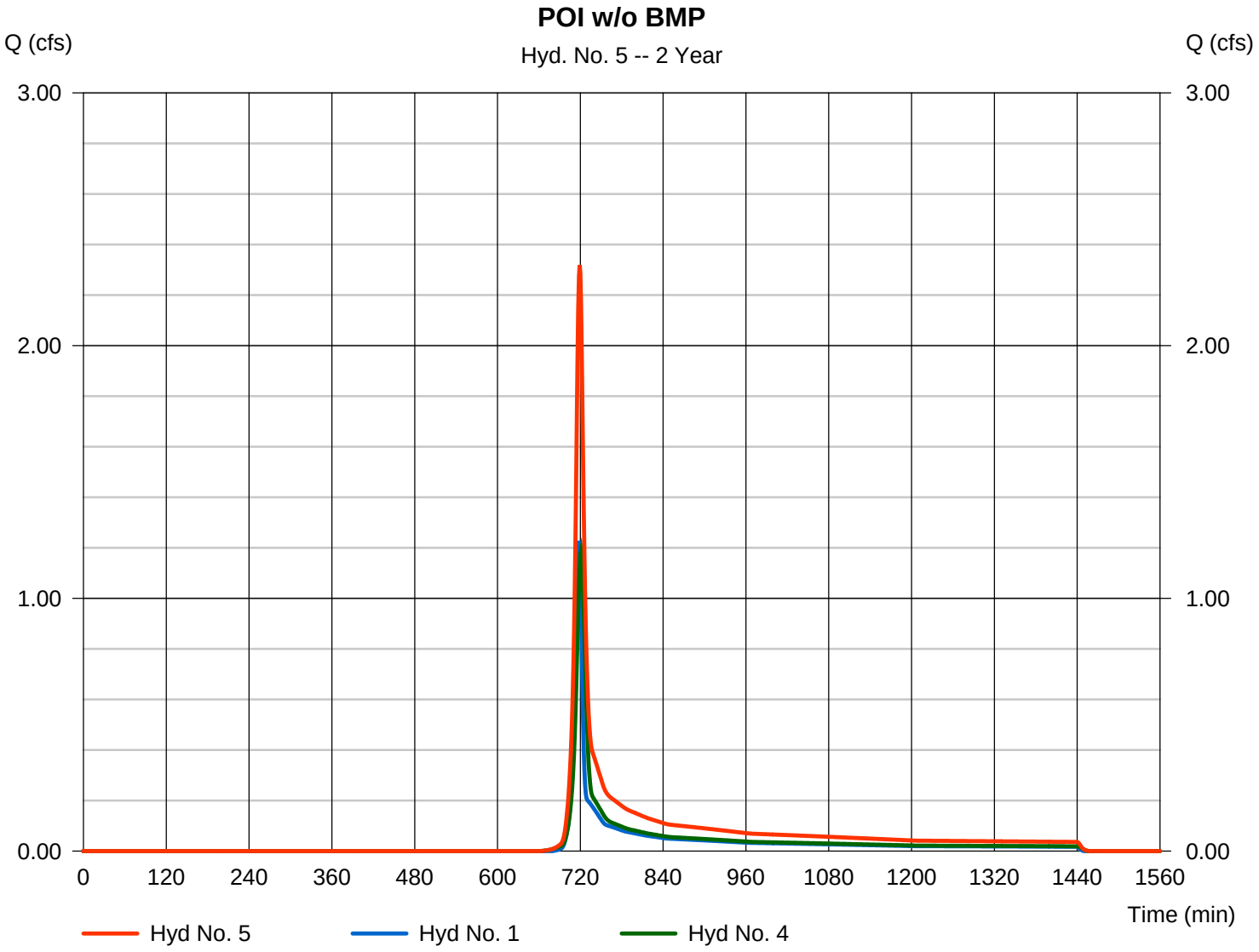
Total Travel Time, Tc ..... 11.30 min

Hydrograph Report

Hyd. No. 5

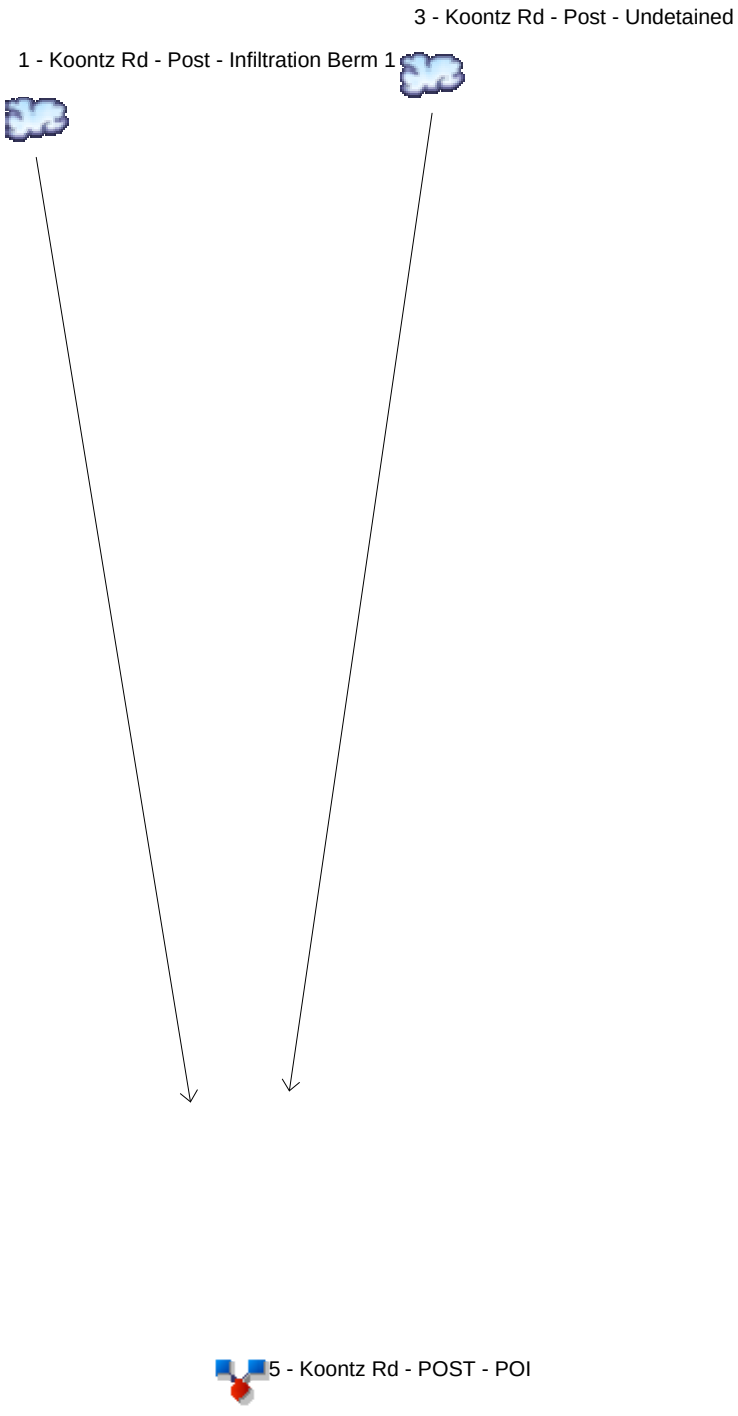
POI w/o BMP

Hydrograph type	=	Combine	Peak discharge	=	2.319 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	5,501 cuft
Inflow hyds.	=	1, 4	Contrib. drain. area	=	2.100 ac



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

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	0.447	1	739	2,462	------	------	------	Koontz Rd - Post - Infiltration Berm 1
3	SCS Runoff	1.187	1	721	2,962	------	------	------	Koontz Rd - Post - Undetained
5	Combine	1.374	1	721	5,424	1, 3,	------	------	Koontz Rd - POST - POI

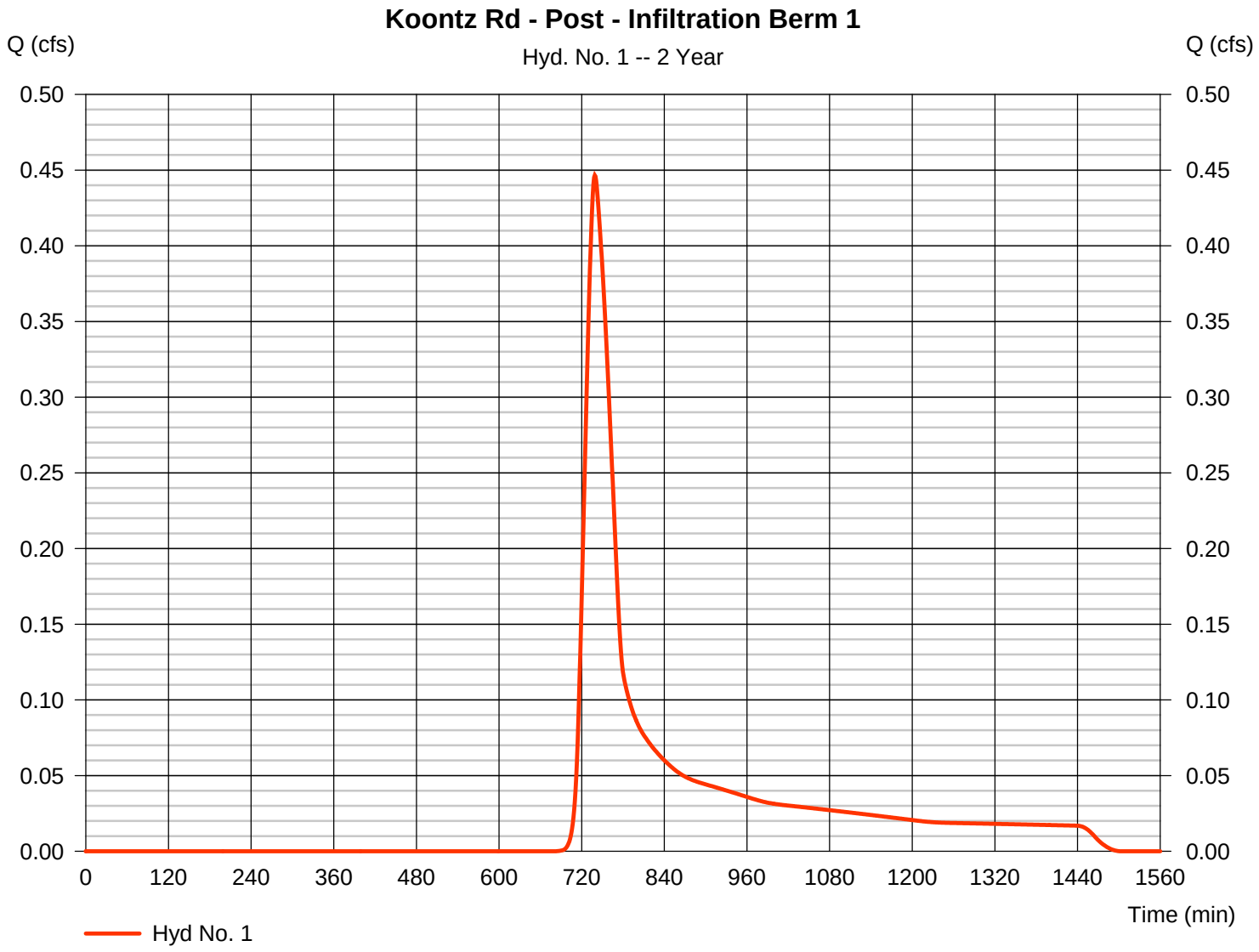
Hydrograph Report

Hyd. No. 1

Koontz Rd - Post - Infiltration Berm 1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.447 cfs
Storm frequency	= 2 yrs	Time to peak	= 739 min
Time interval	= 1 min	Hyd. volume	= 2,462 cuft
Drainage area	= 1.030 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 40.00 min
Total precip.	= 2.44 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030

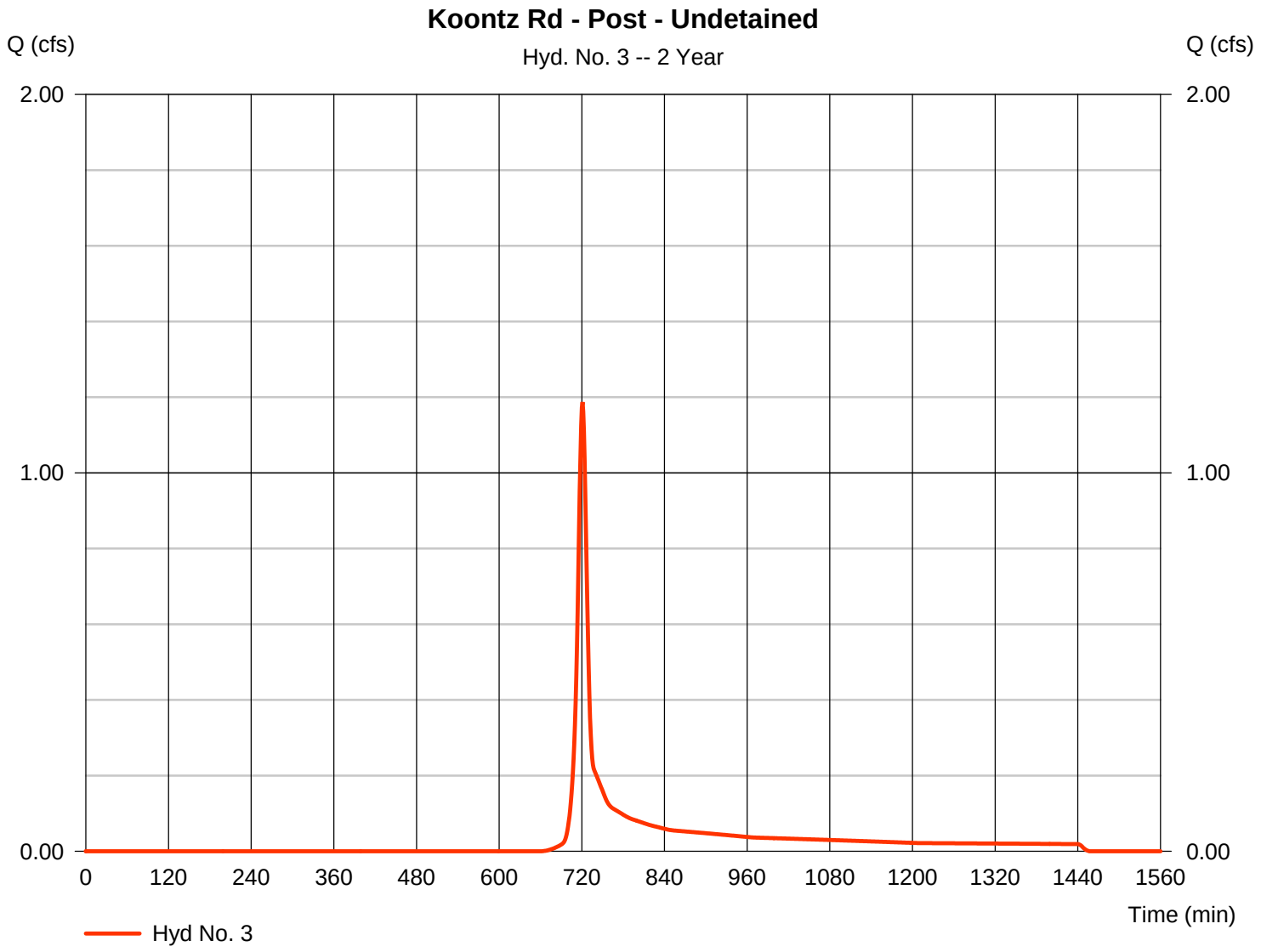


Hydrograph Report

Hyd. No. 3

Koontz Rd - Post - Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.187 cfs
Storm frequency	=	2 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	2,962 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	2.44 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 3

Koontz Rd - Post - Undetained

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 290.00		0.00		0.00		
Watercourse slope (%)	= 6.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.95		0.00		0.00		
Travel Time (min)	**= 1.22**	**+**	**0.00**	**+**	**0.00**	**=**	**1.22**
Channel Flow							
X sectional flow area (sqft)	= 7.50		7.50		0.00		
Wetted perimeter (ft)	= 8.71		8.71		0.00		
Channel slope (%)	= 6.00		12.00		0.00		
Manning's n-value	= 0.026		0.026		0.015		
Velocity (ft/s)	=12.70						
			17.96				
					0.00		
Flow length (ft)	({0})224.0		240.0		0.0		
Travel Time (min)	**= 0.29**	**+**	**0.22**	**+**	**0.00**	**=**	**0.52**

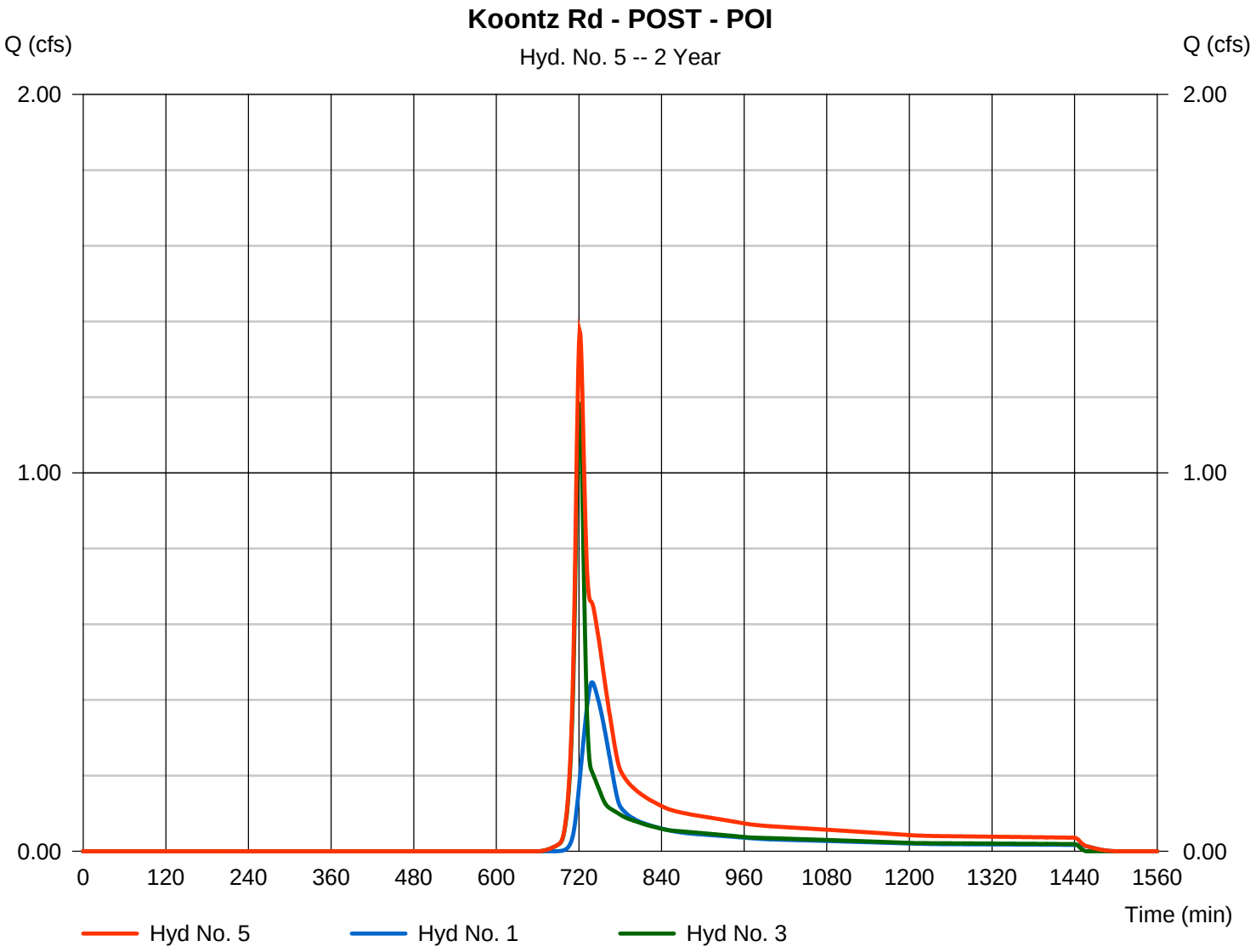
Total Travel Time, Tc ..... 11.30 min

Hydrograph Report

Hyd. No. 5

Koontz Rd - POST - POI

Hydrograph type	= Combine	Peak discharge	= 1.374 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 5,424 cuft
Inflow hyds.	= 1, 3	Contrib. drain. area	= 2.100 ac



ATTACHMENT C-2
KOONTZ RD
10 Year-24 Hour Storm

Watershed Model Schematic

1 - Koontz Rd - PRE

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

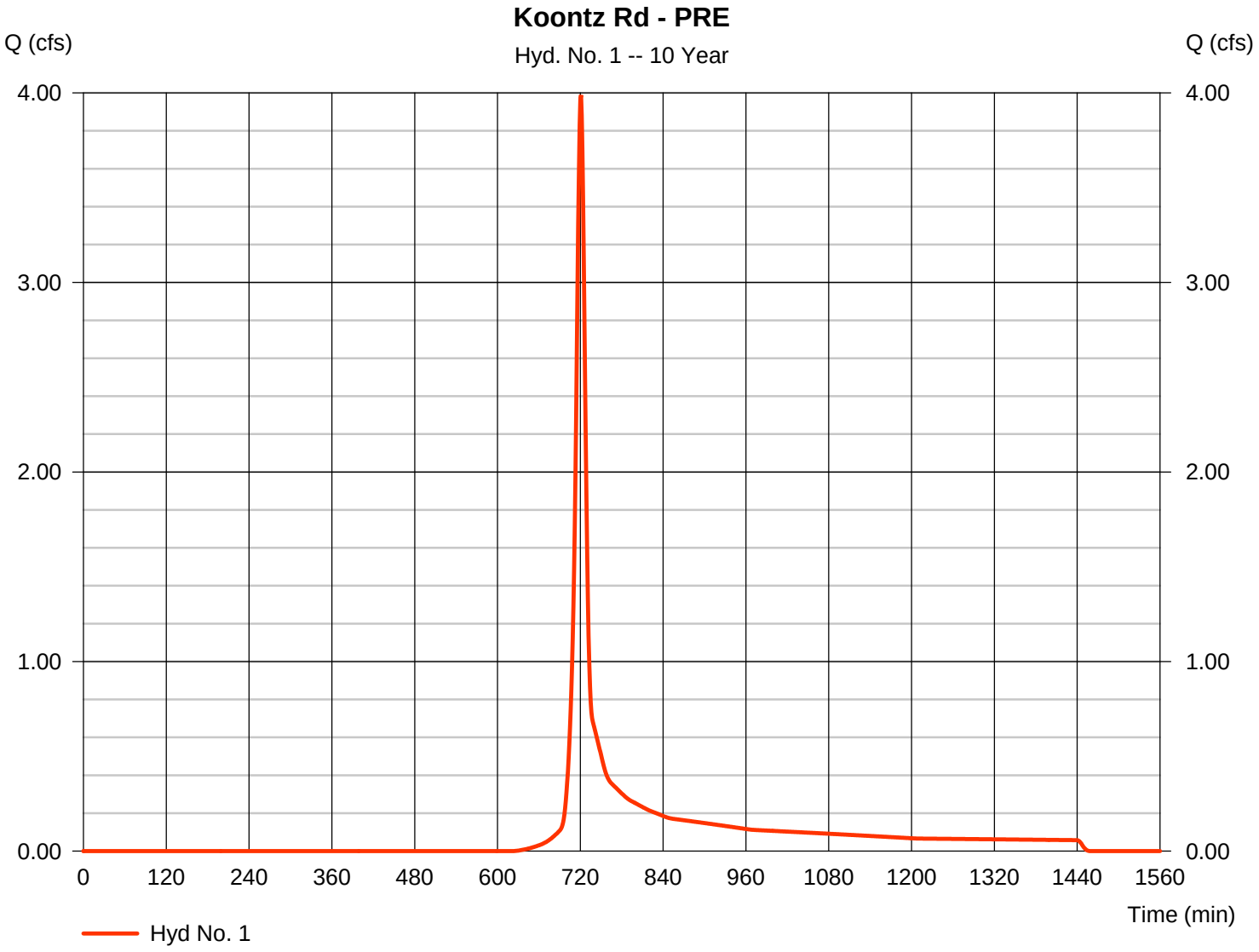
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	3.989	1	721	9,765	------	------	------	Koontz Rd - PRE

Hydrograph Report

Hyd. No. 1

Koontz Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.989 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	9,765 cuft
Drainage area	=	2.110 ac	Curve number	=	75
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.70 min
Total precip.	=	3.43 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 1

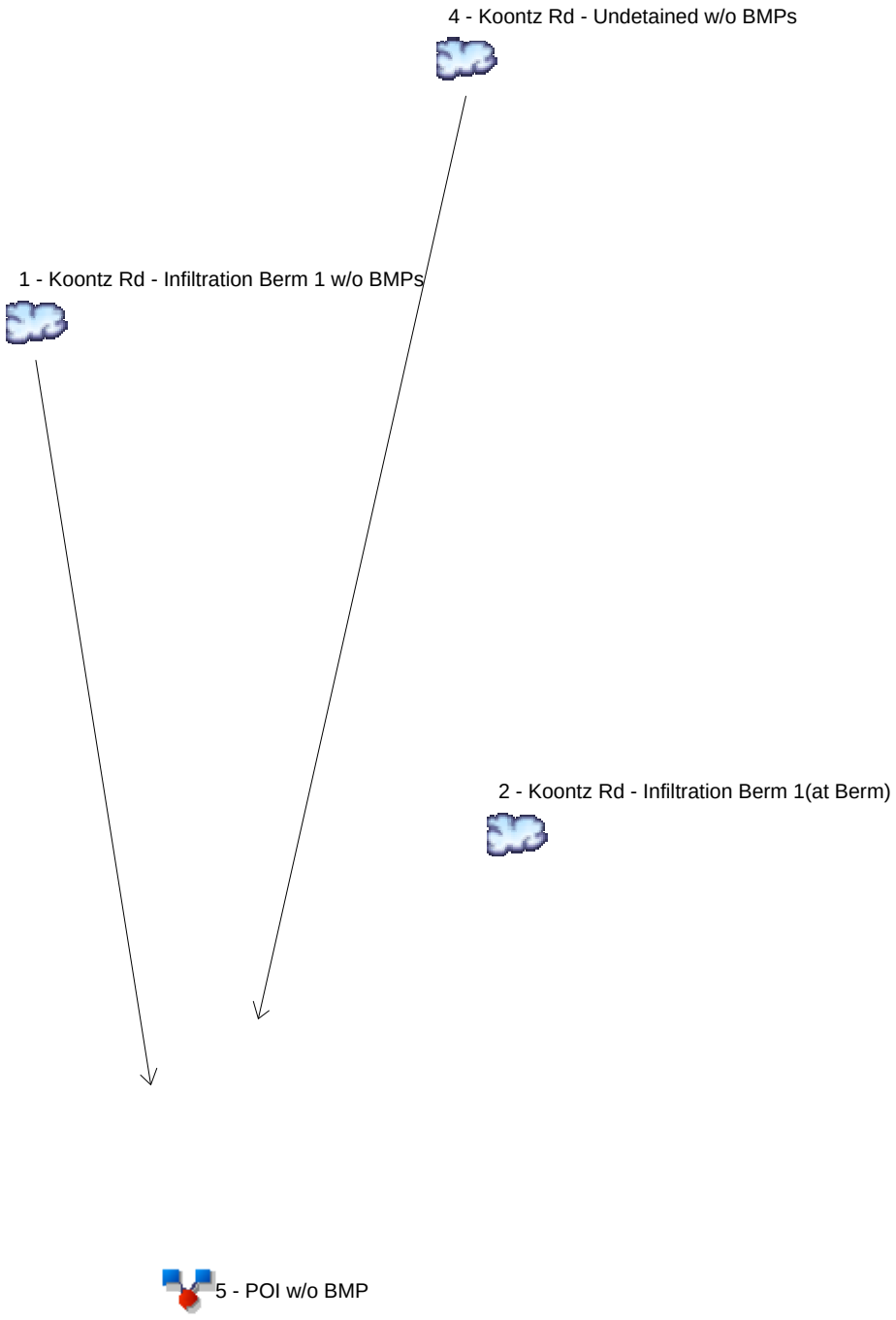
Koontz Rd - PRE

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 345.00		260.00		0.00		
Watercourse slope (%)	= 6.00		15.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=3.95		6.25		0.00		
Travel Time (min)	**= 1.45**	**+**	**0.69**	**+**	**0.00**	**=**	**2.15**
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 ..... 11.70 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

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	2.523	1	718	5,069	------	------	------	Koontz Rd - Infiltration Berm 1 w/o B
2	SCS Runoff	1.473	1	718	2,969	------	------	------	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	2.351	1	721	5,710	------	------	------	Koontz Rd - Undetained w/o BMPs
5	Combine	4.698	1	719	10,780	1, 4	------	------	POI w/o BMP

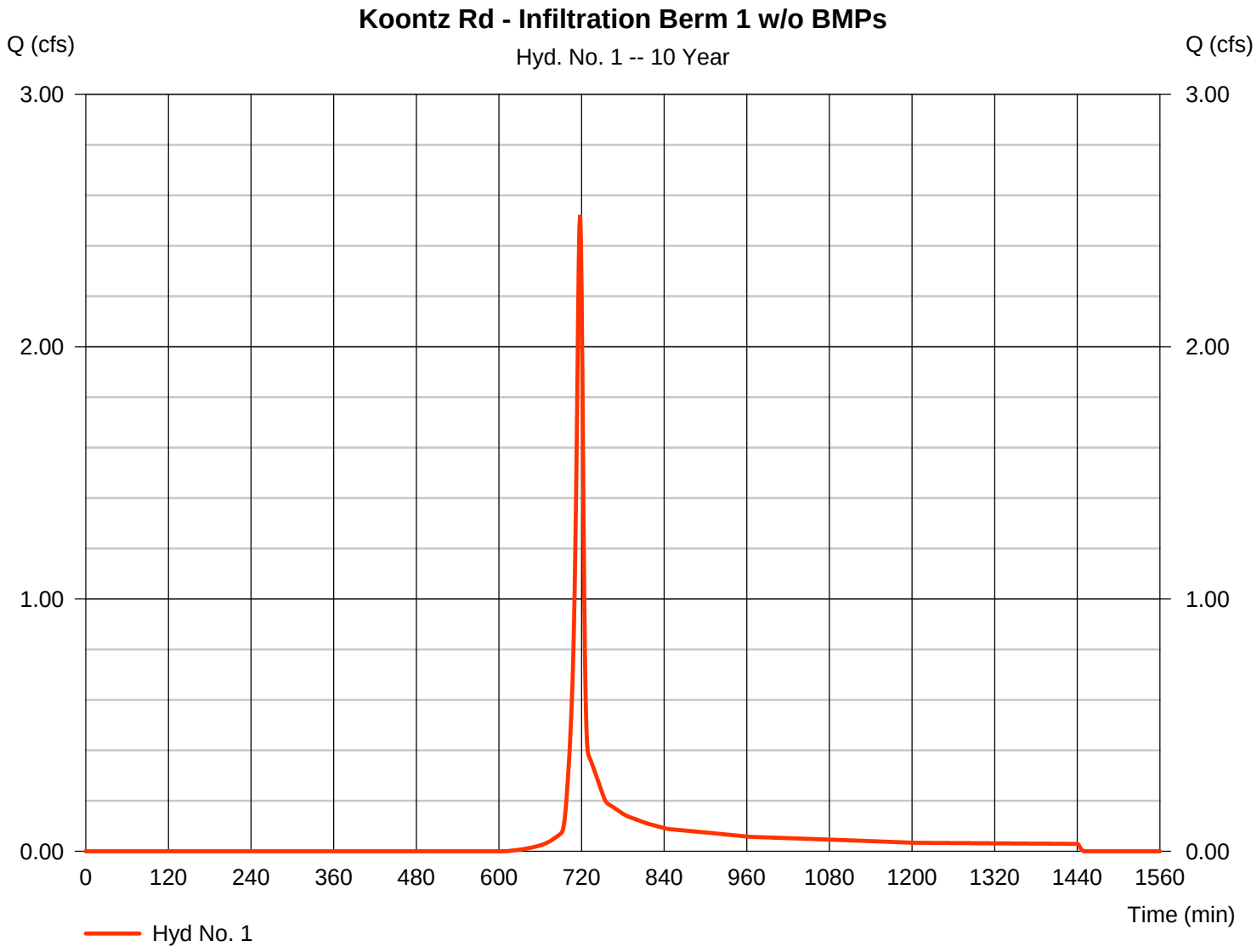
Hydrograph Report

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/o BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.523 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	5,069 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.80 min
Total precip.	=	3.43 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030



TR55 Tc Worksheet

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/o BMPs

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.240		0.011		
Flow length (ft)	= 56.0		44.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		2.44		0.00		
Land slope (%)	= 5.40		9.00		0.00		
Travel Time (min)	**= 0.59**	**+**	**4.64**	**+**	**0.00**	**=**	**5.23**
Shallow Concentrated Flow							
Flow length (ft)	= 30.00		187.00		0.00		
Watercourse slope (%)	= 10.00		17.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=5.10		6.65		0.00		
Travel Time (min)	**= 0.10**	**+**	**0.47**	**+**	**0.00**	**=**	**0.57**
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**

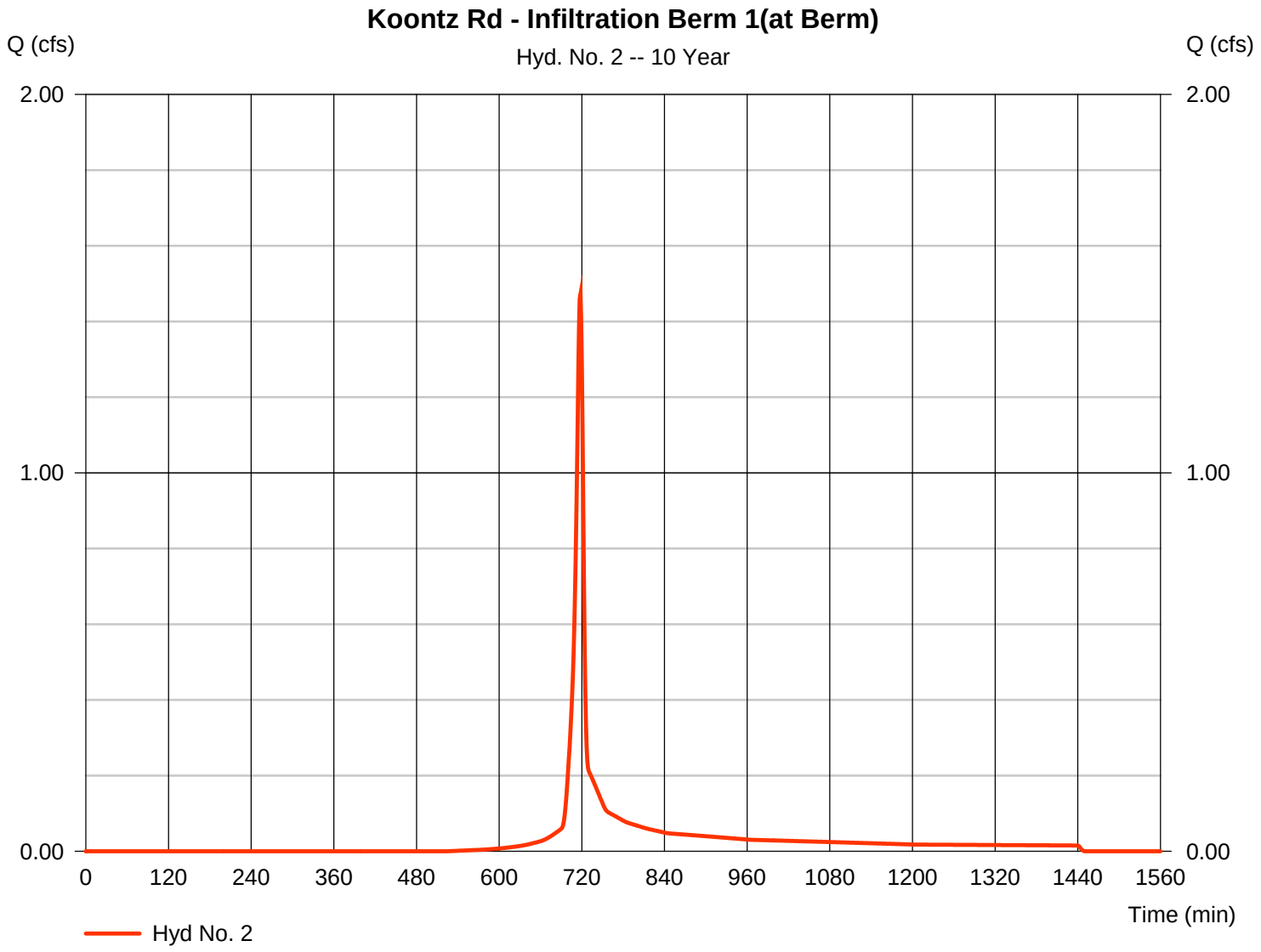
Total Travel Time, Tc ..... 5.80 min

Hydrograph Report

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.473 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	2,969 cuft
Drainage area	=	0.480 ac	Curve number	=	81
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.30 min
Total precip.	=	3.43 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.240		0.011		
Flow length (ft)	= 56.0		44.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		2.44		0.00		
Land slope (%)	= 5.40		9.00		0.00		
Travel Time (min)	**= 0.59**	**+**	**4.64**	**+**	**0.00**	**=**	**5.23**
Shallow Concentrated Flow							
Flow length (ft)	= 30.00		0.00		0.00		
Watercourse slope (%)	= 10.00		0.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=5.10		0.00		0.00		
Travel Time (min)	**= 0.10**	**+**	**0.00**	**+**	**0.00**	**=**	**0.10**
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**

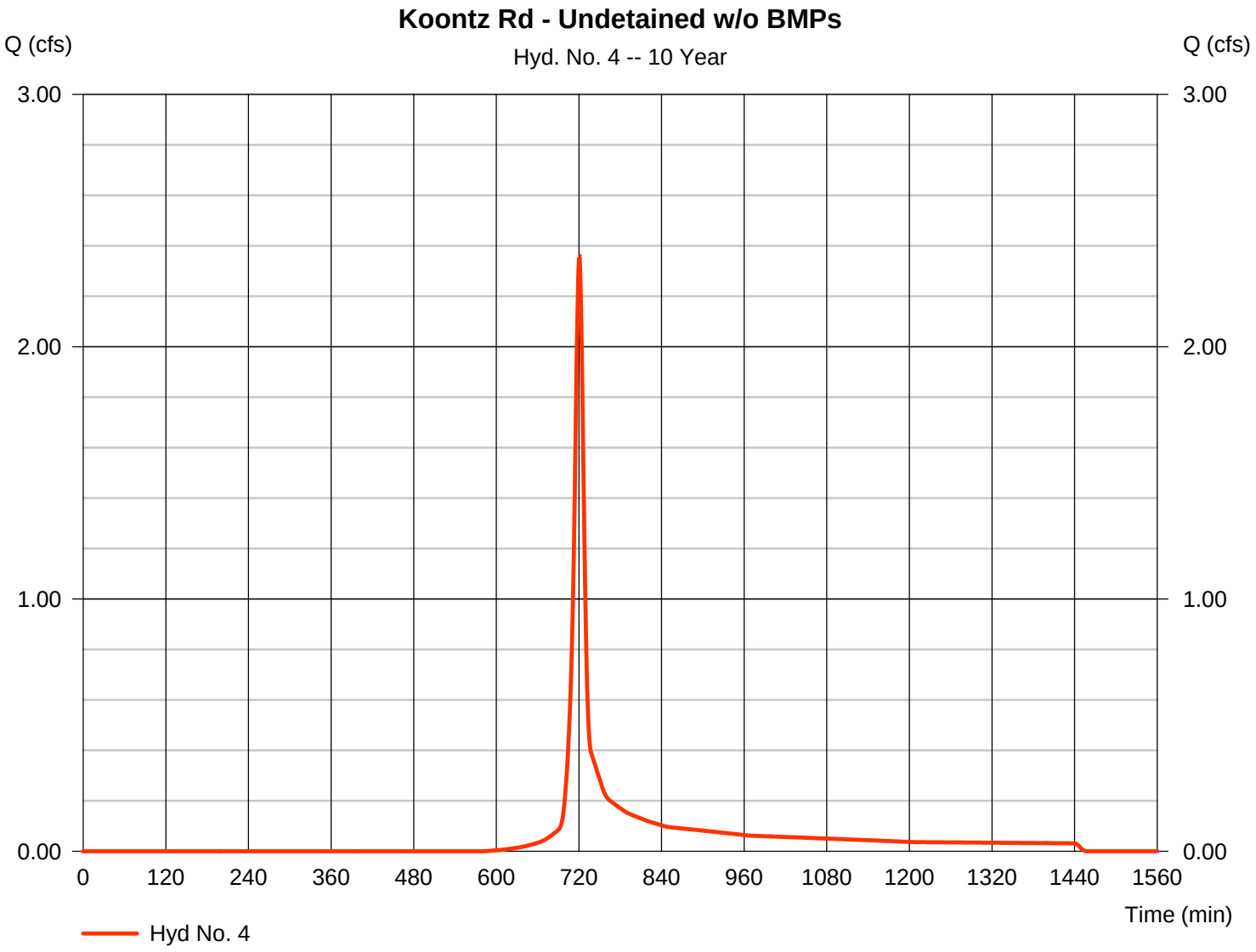
Total Travel Time, Tc ..... 5.30 min

Hydrograph Report

Hyd. No. 4

Koontz Rd - Undetained w/o BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.351 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	5,710 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	3.43 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 4

Koontz Rd - Undetained w/o BMPs

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 290.00		0.00		0.00		
Watercourse slope (%)	= 6.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.95		0.00		0.00		
Travel Time (min)	**= 1.22**	**+**	**0.00**	**+**	**0.00**	**=**	**1.22**
Channel Flow							
X sectional flow area (sqft)	= 7.50		7.50		0.00		
Wetted perimeter (ft)	= 8.71		8.71		0.00		
Channel slope (%)	= 6.00		12.00		0.00		
Manning's n-value	= 0.026		0.026		0.015		
Velocity (ft/s)	=12.70						
			17.96				
					0.00		
Flow length (ft)	({0})224.0		240.0		0.0		
Travel Time (min)	**= 0.29**	**+**	**0.22**	**+**	**0.00**	**=**	**0.52**

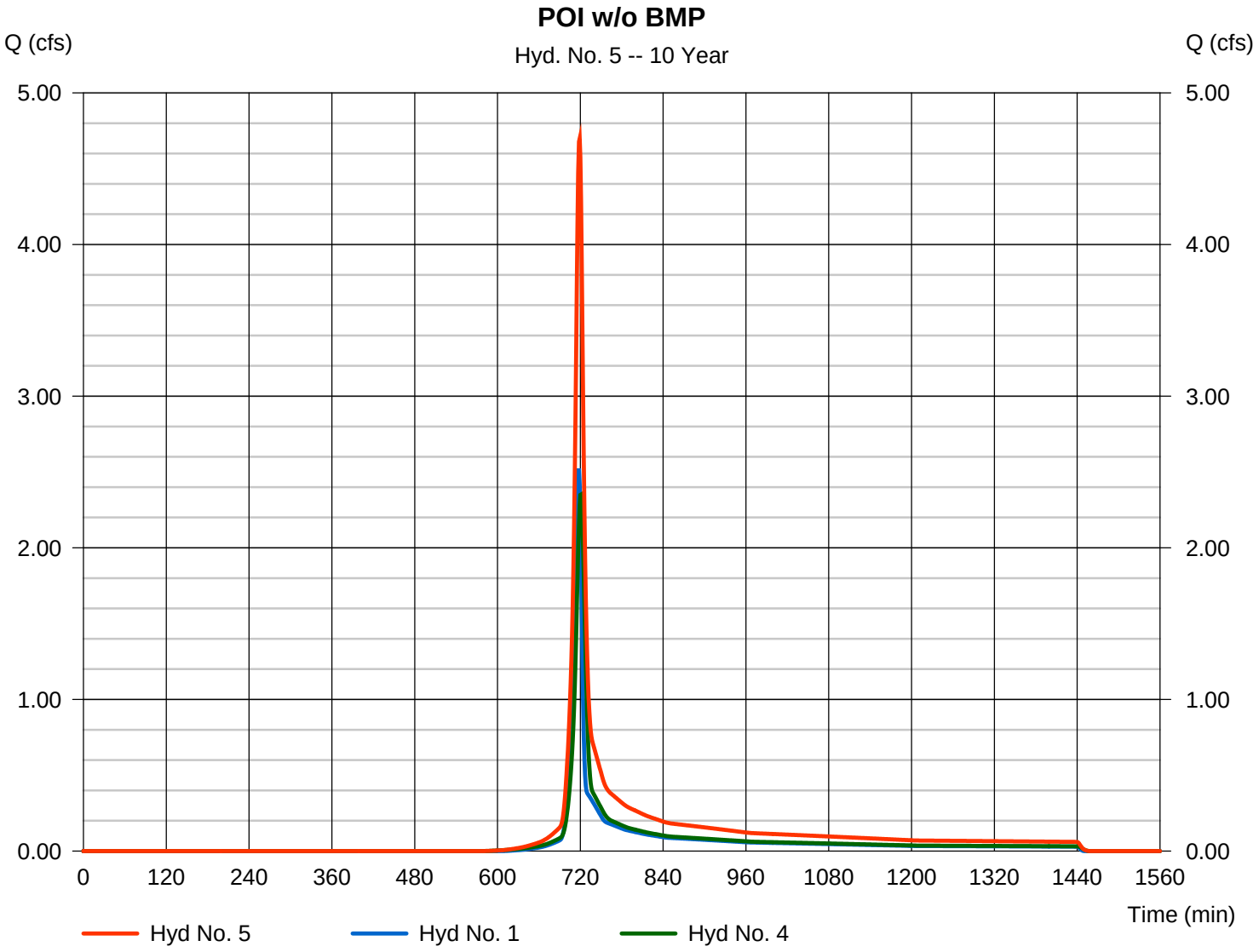
Total Travel Time, Tc ..... 11.30 min

Hydrograph Report

Hyd. No. 5

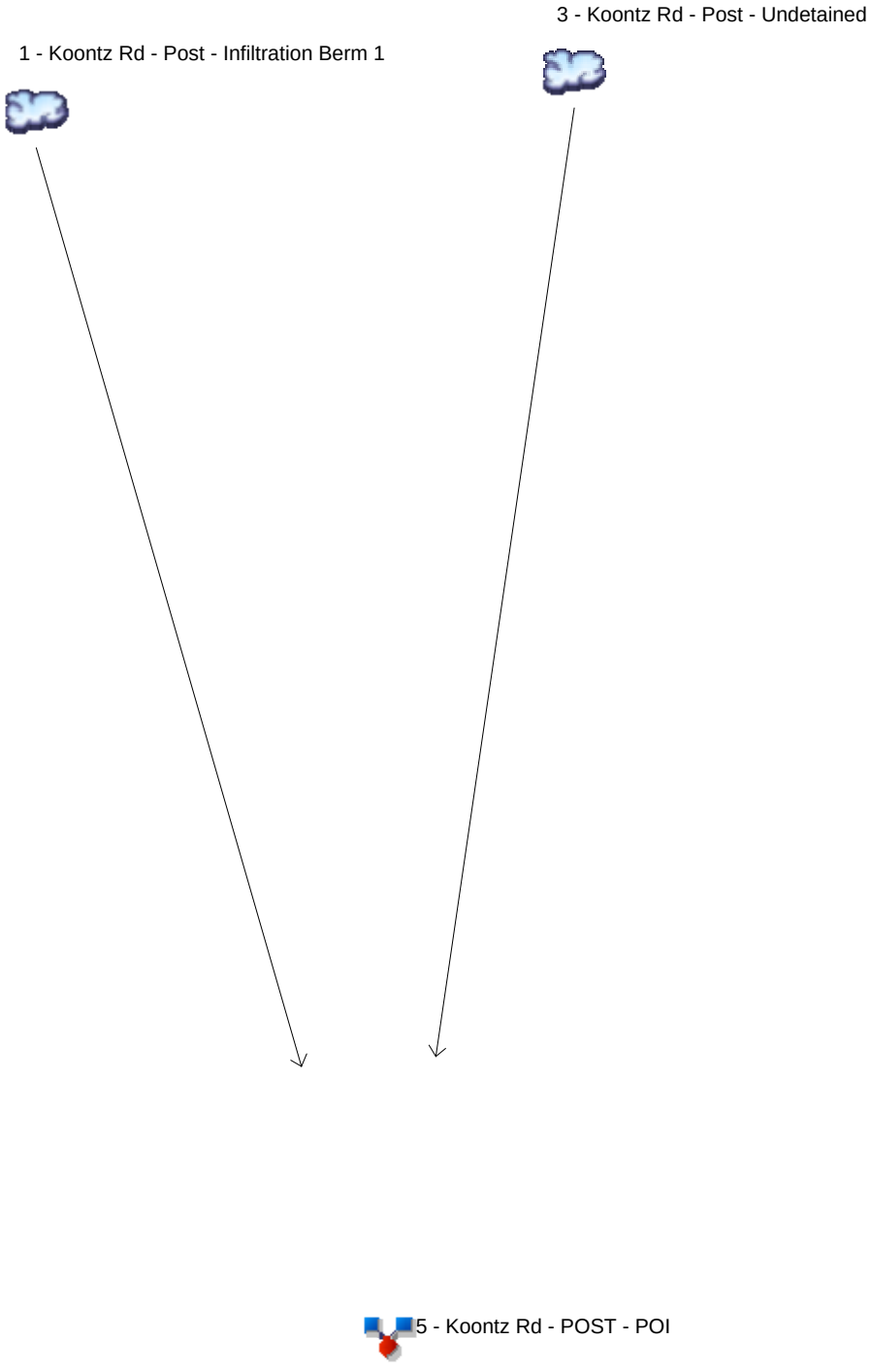
POI w/o BMP

Hydrograph type	=	Combine	Peak discharge	=	4.698 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	10,780 cuft
Inflow hyds.	=	1, 4	Contrib. drain. area	=	2.100 ac



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

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	1.190	1	732	4,916	------	------	------	Koontz Rd - Post - Infiltration Berm 1
3	SCS Runoff	2.351	1	721	5,710	------	------	------	Koontz Rd - Post - Undetained
5	Combine	3.125	1	721	10,626	1, 3,	------	------	Koontz Rd - POST - POI

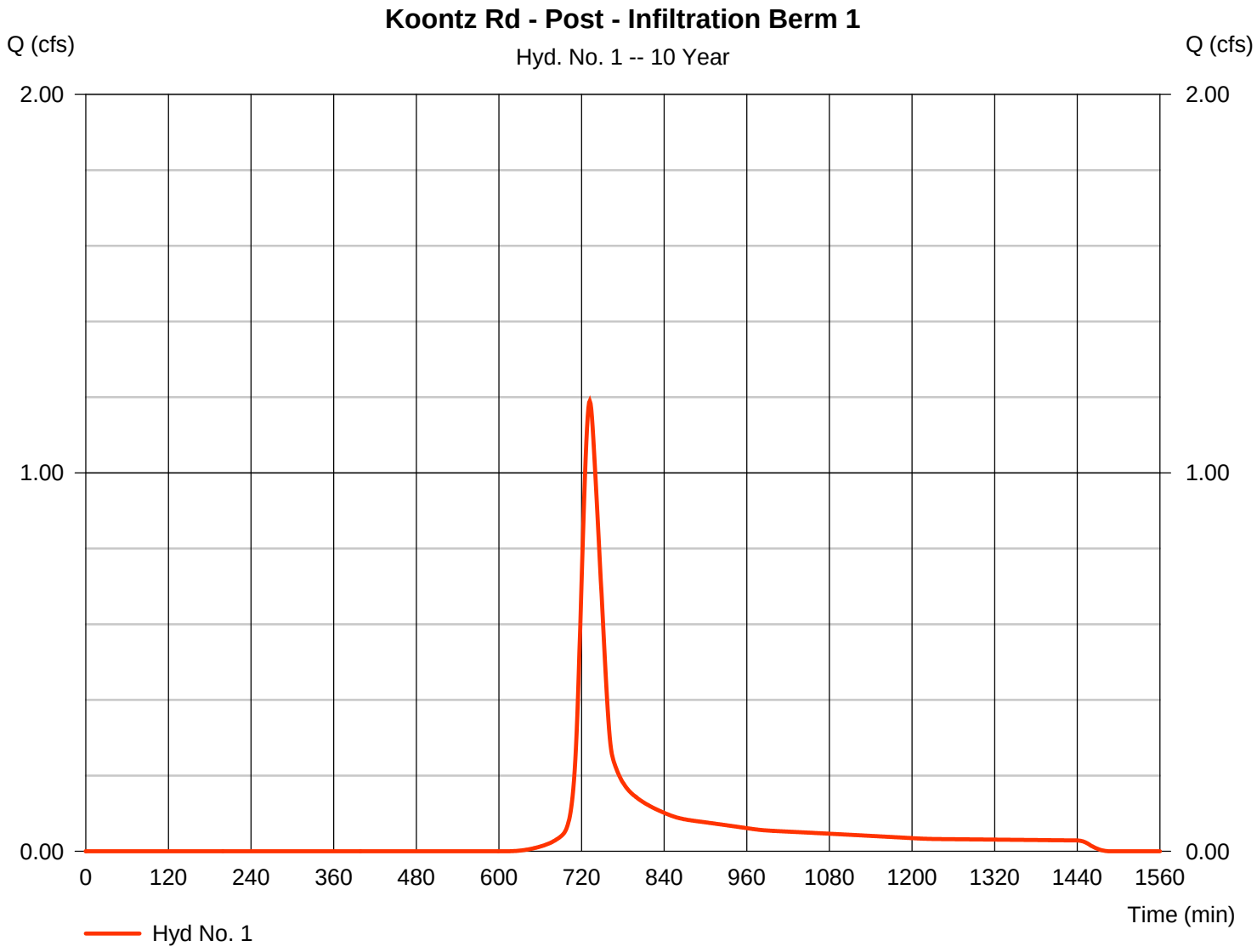
Hydrograph Report

Hyd. No. 1

Koontz Rd - Post - Infiltration Berm 1

Hydrograph type	= SCS Runoff	Peak discharge	= 1.190 cfs
Storm frequency	= 10 yrs	Time to peak	= 732 min
Time interval	= 1 min	Hyd. volume	= 4,916 cuft
Drainage area	= 1.030 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 28.90 min
Total precip.	= 3.43 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030

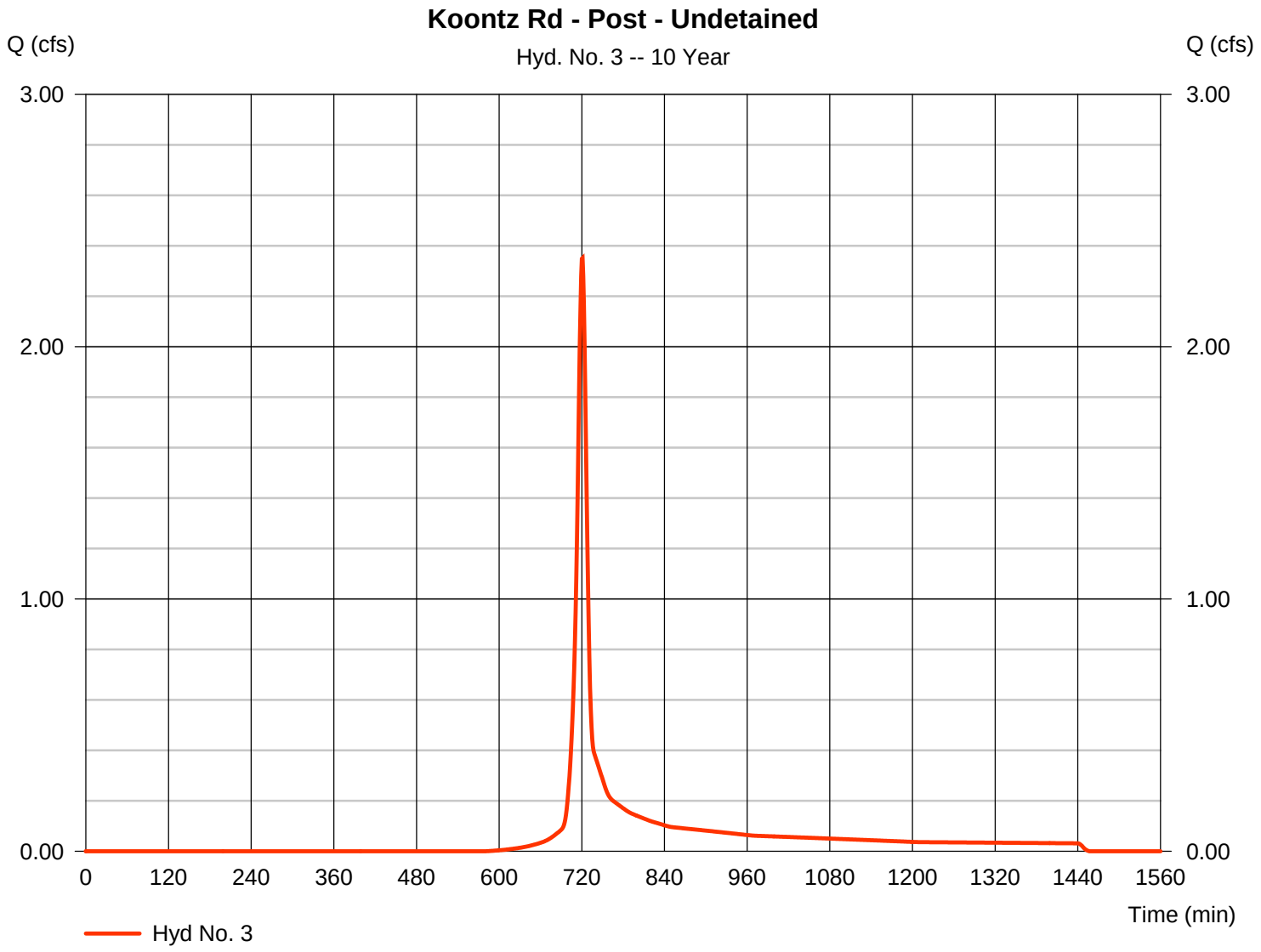


Hydrograph Report

Hyd. No. 3

Koontz Rd - Post - Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.351 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	5,710 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	3.43 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 3

Koontz Rd - Post - Undetained

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 290.00		0.00		0.00		
Watercourse slope (%)	= 6.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.95		0.00		0.00		
Travel Time (min)	**= 1.22**	**+**	**0.00**	**+**	**0.00**	**=**	**1.22**
Channel Flow							
X sectional flow area (sqft)	= 7.50		7.50		0.00		
Wetted perimeter (ft)	= 8.71		8.71		0.00		
Channel slope (%)	= 6.00		12.00		0.00		
Manning's n-value	= 0.026		0.026		0.015		
Velocity (ft/s)	=12.70						
			17.96				
					0.00		
Flow length (ft)	({0})224.0		240.0		0.0		
Travel Time (min)	**= 0.29**	**+**	**0.22**	**+**	**0.00**	**=**	**0.52**

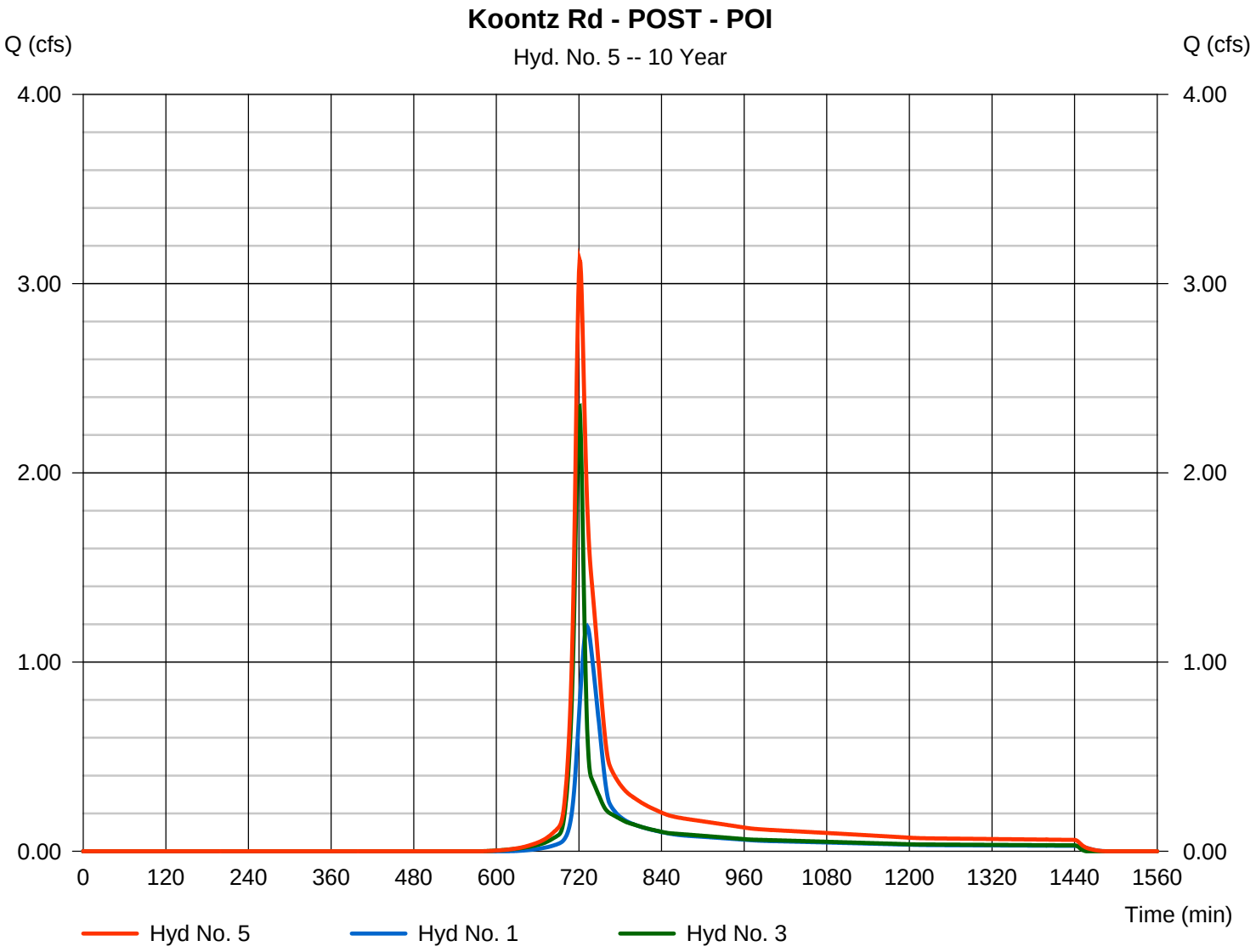
Total Travel Time, Tc ..... 11.30 min

Hydrograph Report

Hyd. No. 5

Koontz Rd - POST - POI

Hydrograph type	= Combine	Peak discharge	= 3.125 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 10,626 cuft
Inflow hyds.	= 1, 3	Contrib. drain. area	= 2.100 ac



ATTACHMENT C-3
KOONTZ RD
50 Year-24 Hour Storm

Watershed Model Schematic

1 - Koontz Rd - PRE

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

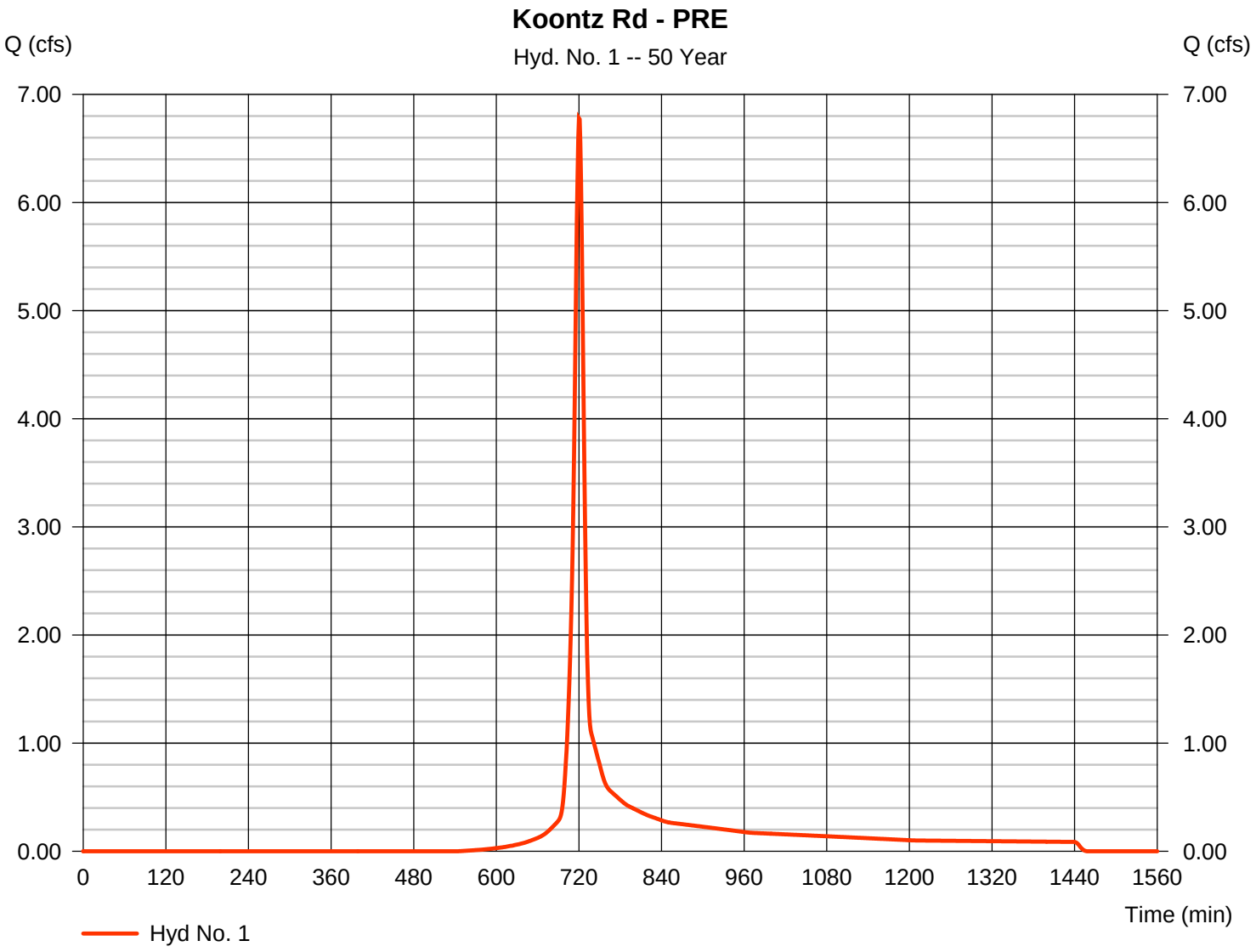
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	6.779	1	720	16,414	------	------	------	Koontz Rd - PRE

Hydrograph Report

Hyd. No. 1

Koontz Rd - PRE

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.779 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	16,414 cuft
Drainage area	=	2.110 ac	Curve number	=	75
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.70 min
Total precip.	=	4.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 1

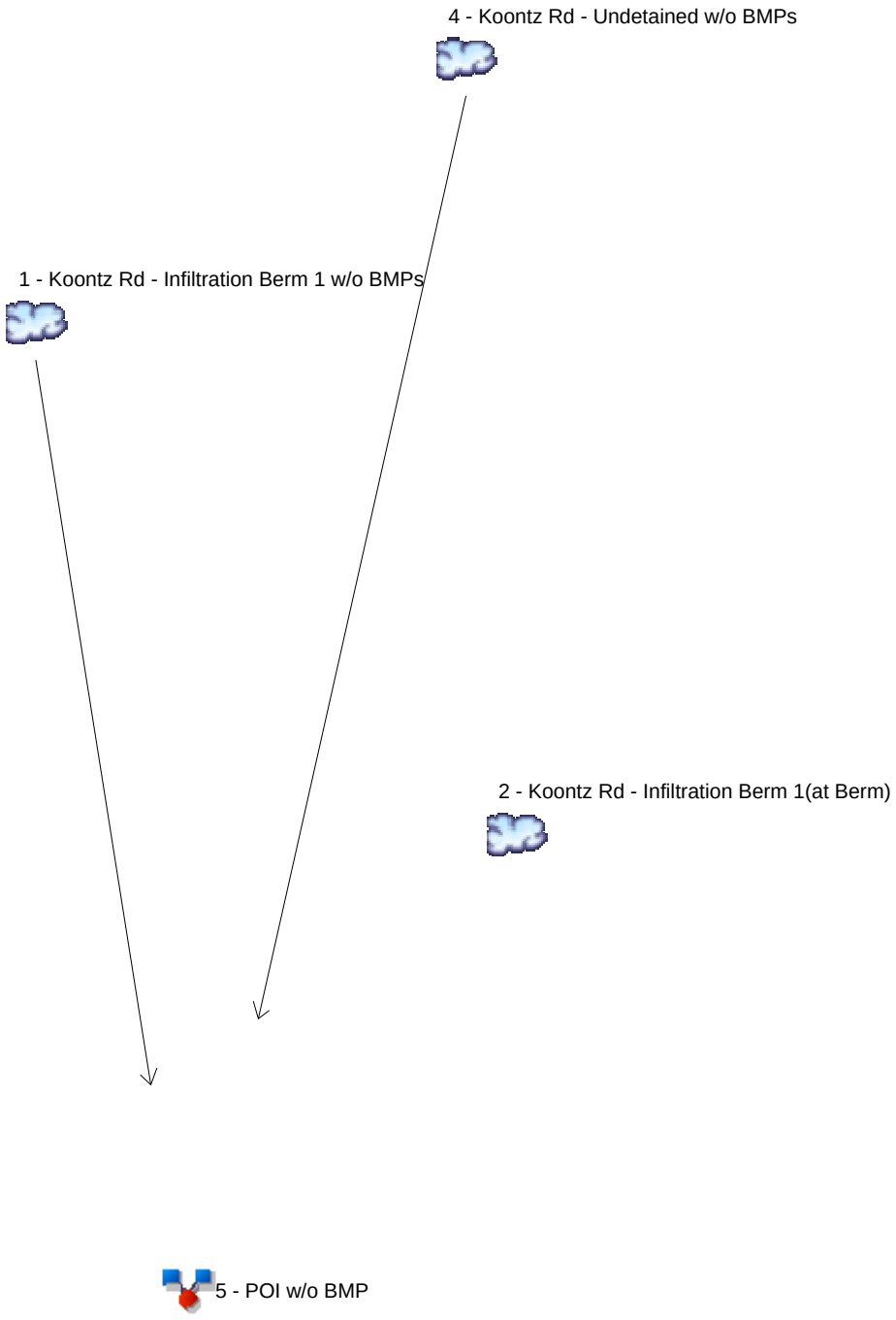
Koontz Rd - PRE

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 345.00		260.00		0.00		
Watercourse slope (%)	= 6.00		15.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=3.95		6.25		0.00		
Travel Time (min)	**= 1.45**	**+**	**0.69**	**+**	**0.00**	**=**	**2.15**
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 ..... 11.70 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

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	4.183	1	718	8,428	------	------	------	Koontz Rd - Infiltration Berm 1 w/o B
2	SCS Runoff	2.293	1	718	4,687	------	------	------	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	3.843	1	720	9,294	------	------	------	Koontz Rd - Undetained w/o BMPs
5	Combine	7.760	1	718	17,722	1, 4	------	------	POI w/o BMP

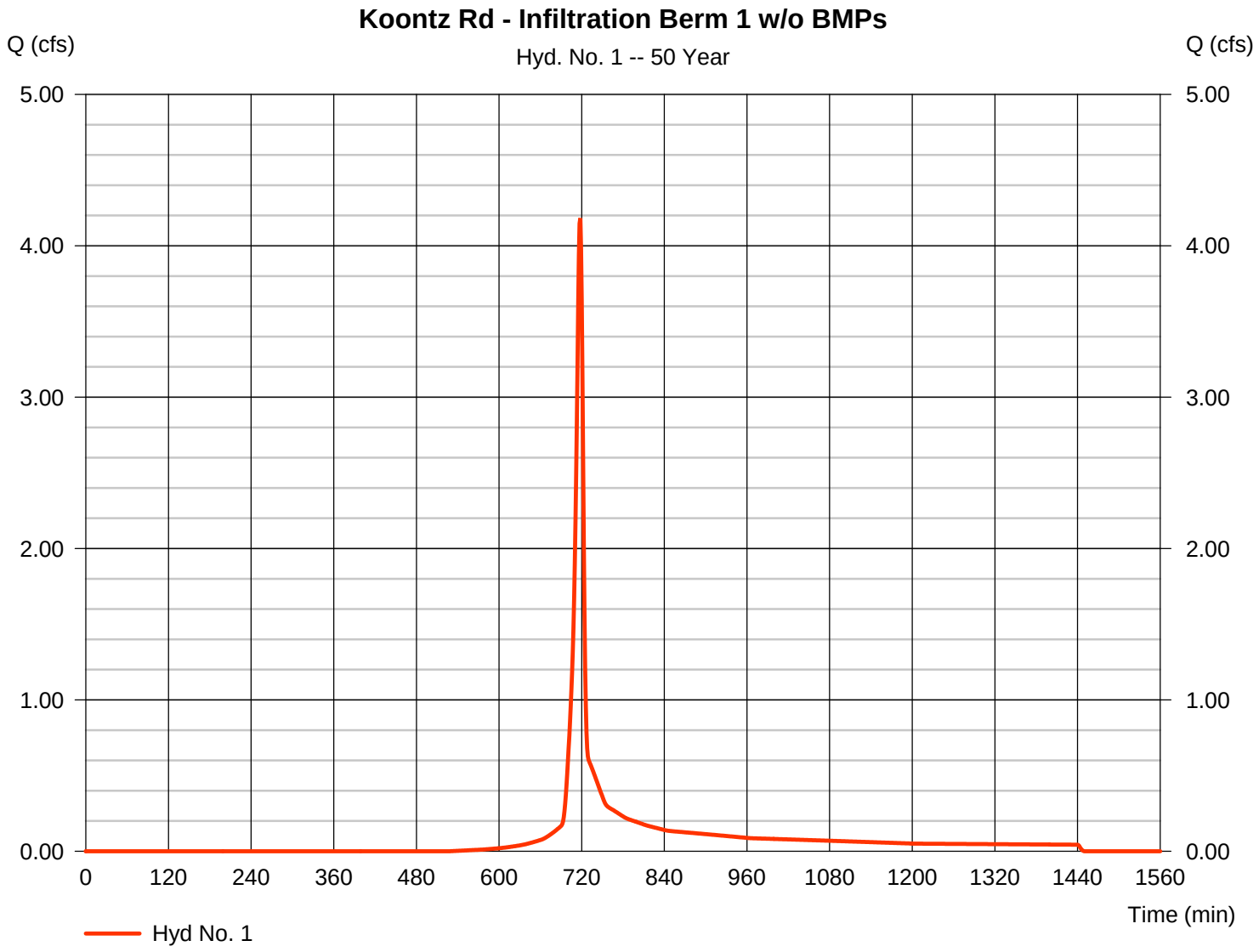
Hydrograph Report

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/o BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.183 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	8,428 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.80 min
Total precip.	=	4.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030



TR55 Tc Worksheet

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/o BMPs

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.240		0.011		
Flow length (ft)	= 56.0		44.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		2.44		0.00		
Land slope (%)	= 5.40		9.00		0.00		
Travel Time (min)	**= 0.59**	**+**	**4.64**	**+**	**0.00**	**=**	**5.23**
Shallow Concentrated Flow							
Flow length (ft)	= 30.00		187.00		0.00		
Watercourse slope (%)	= 10.00		17.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=5.10		6.65		0.00		
Travel Time (min)	**= 0.10**	**+**	**0.47**	**+**	**0.00**	**=**	**0.57**
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**

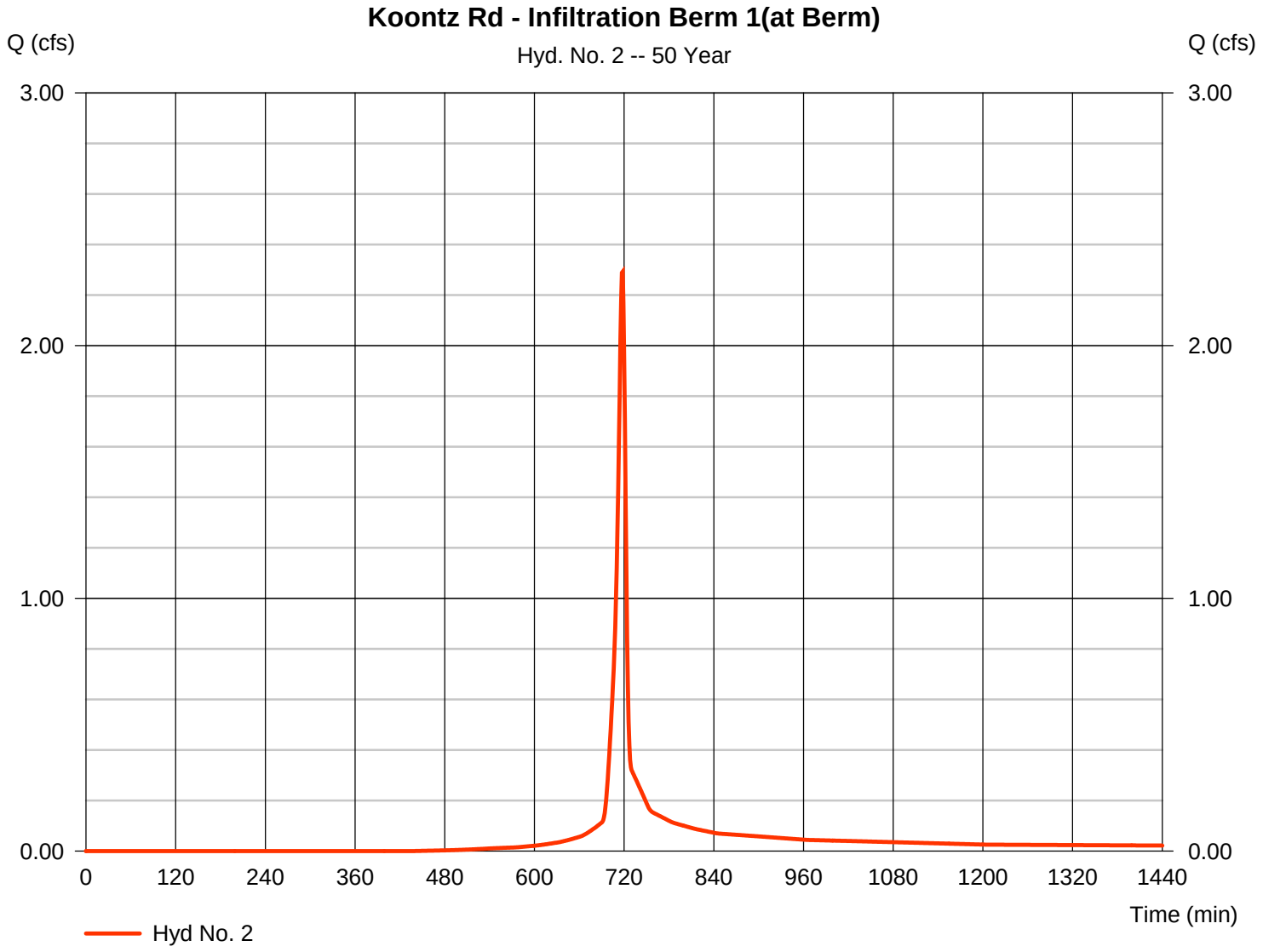
Total Travel Time, Tc ..... 5.80 min

Hydrograph Report

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.293 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	4,687 cuft
Drainage area	=	0.480 ac	Curve number	=	81
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.30 min
Total precip.	=	4.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.240		0.011		
Flow length (ft)	= 56.0		44.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		2.44		0.00		
Land slope (%)	= 5.40		9.00		0.00		
Travel Time (min)	**= 0.59**	**+**	**4.64**	**+**	**0.00**	**=**	**5.23**
Shallow Concentrated Flow							
Flow length (ft)	= 30.00		0.00		0.00		
Watercourse slope (%)	= 10.00		0.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=5.10		0.00		0.00		
Travel Time (min)	**= 0.10**	**+**	**0.00**	**+**	**0.00**	**=**	**0.10**
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**

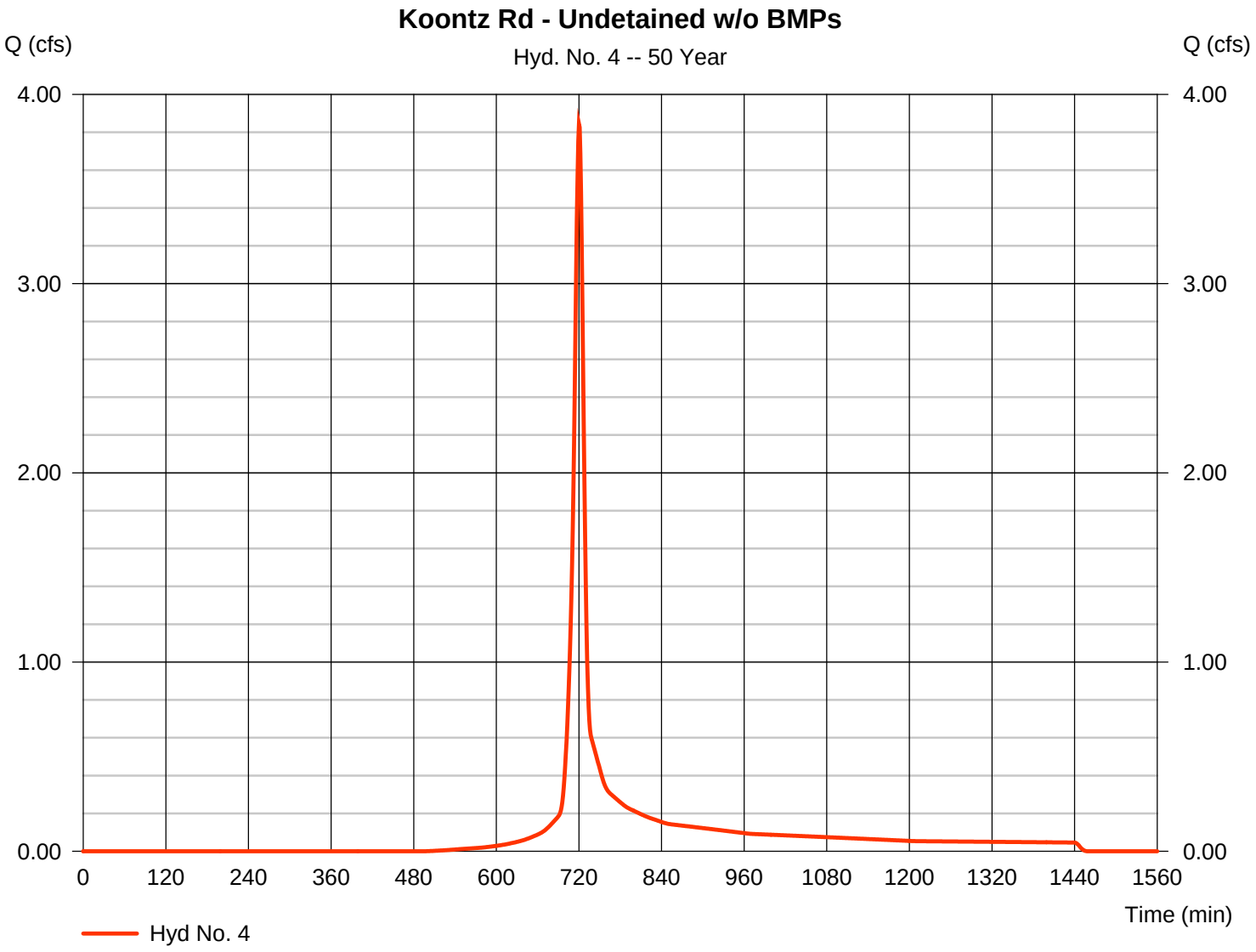
Total Travel Time, Tc ..... 5.30 min

Hydrograph Report

Hyd. No. 4

Koontz Rd - Undetained w/o BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.843 cfs
Storm frequency	=	50 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	9,294 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	4.57 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 4

Koontz Rd - Undetained w/o BMPs

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 290.00		0.00		0.00		
Watercourse slope (%)	= 6.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.95		0.00		0.00		
Travel Time (min)	**= 1.22**	**+**	**0.00**	**+**	**0.00**	**=**	**1.22**
Channel Flow							
X sectional flow area (sqft)	= 7.50		7.50		0.00		
Wetted perimeter (ft)	= 8.71		8.71		0.00		
Channel slope (%)	= 6.00		12.00		0.00		
Manning's n-value	= 0.026		0.026		0.015		
Velocity (ft/s)	=12.70						
			17.96				
					0.00		
Flow length (ft)	({0})224.0		240.0		0.0		
Travel Time (min)	**= 0.29**	**+**	**0.22**	**+**	**0.00**	**=**	**0.52**

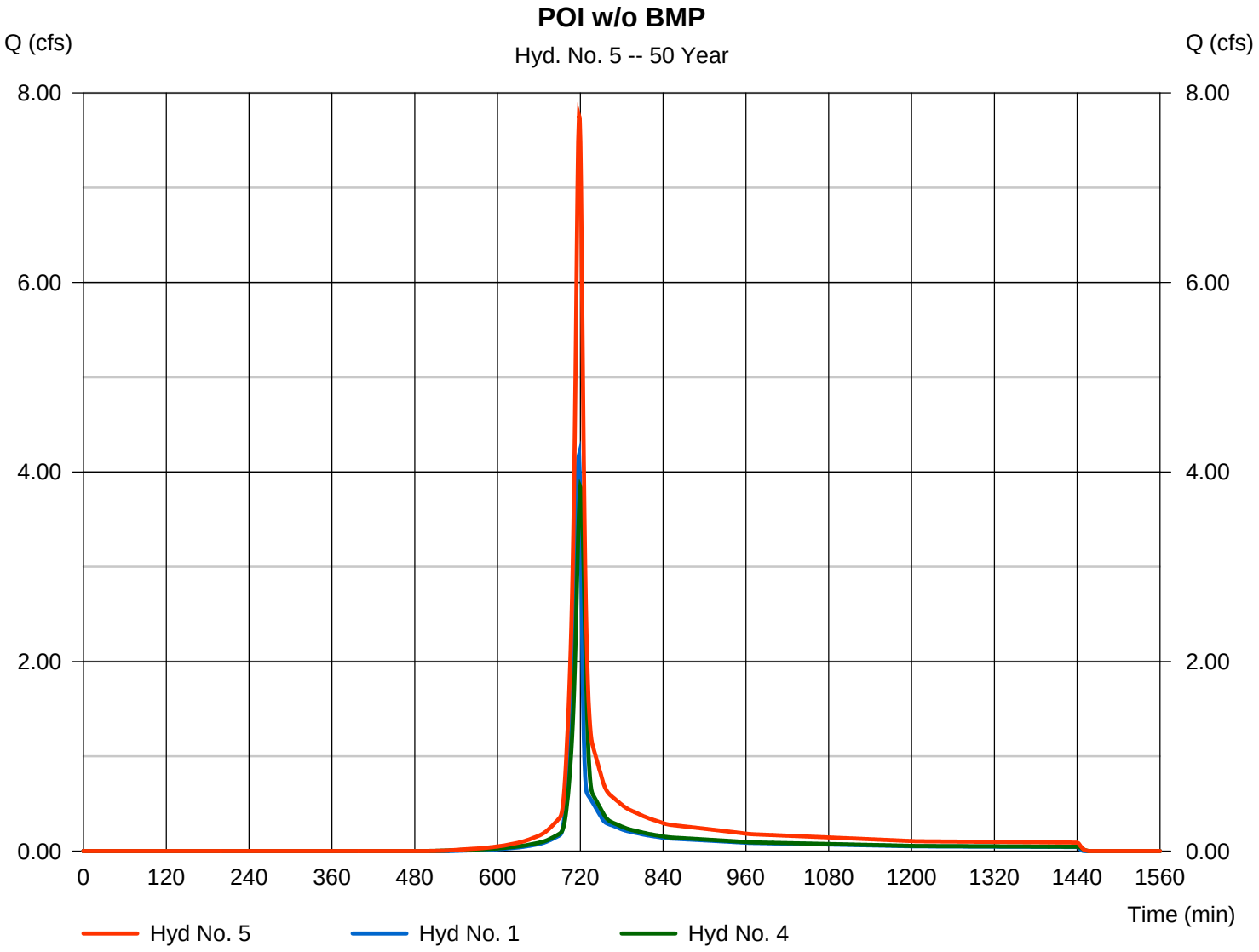
Total Travel Time, Tc ..... 11.30 min

Hydrograph Report

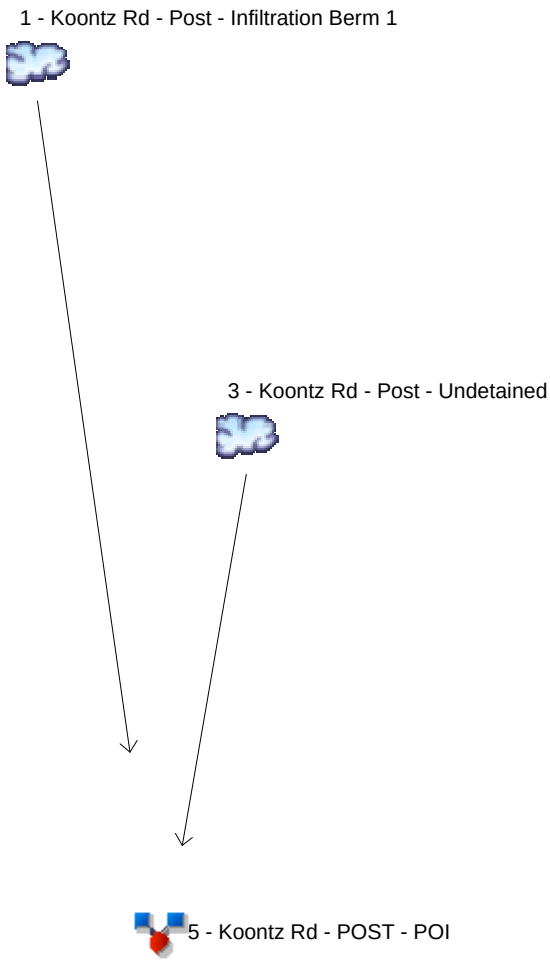
Hyd. No. 5

POI w/o BMP

Hydrograph type	=	Combine	Peak discharge	=	7.760 cfs
Storm frequency	=	50 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	17,722 cuft
Inflow hyds.	=	1, 4	Contrib. drain. area	=	2.100 ac



Watershed Model Schematic



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

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	2.498	1	726	8,251	------	------	------	Koontz Rd - Post - Infiltration Berm 1
3	SCS Runoff	3.843	1	720	9,294	------	------	------	Koontz Rd - Post - Undetained
5	Combine	5.960	1	721	17,545	1, 3,	------	------	Koontz Rd - POST - POI

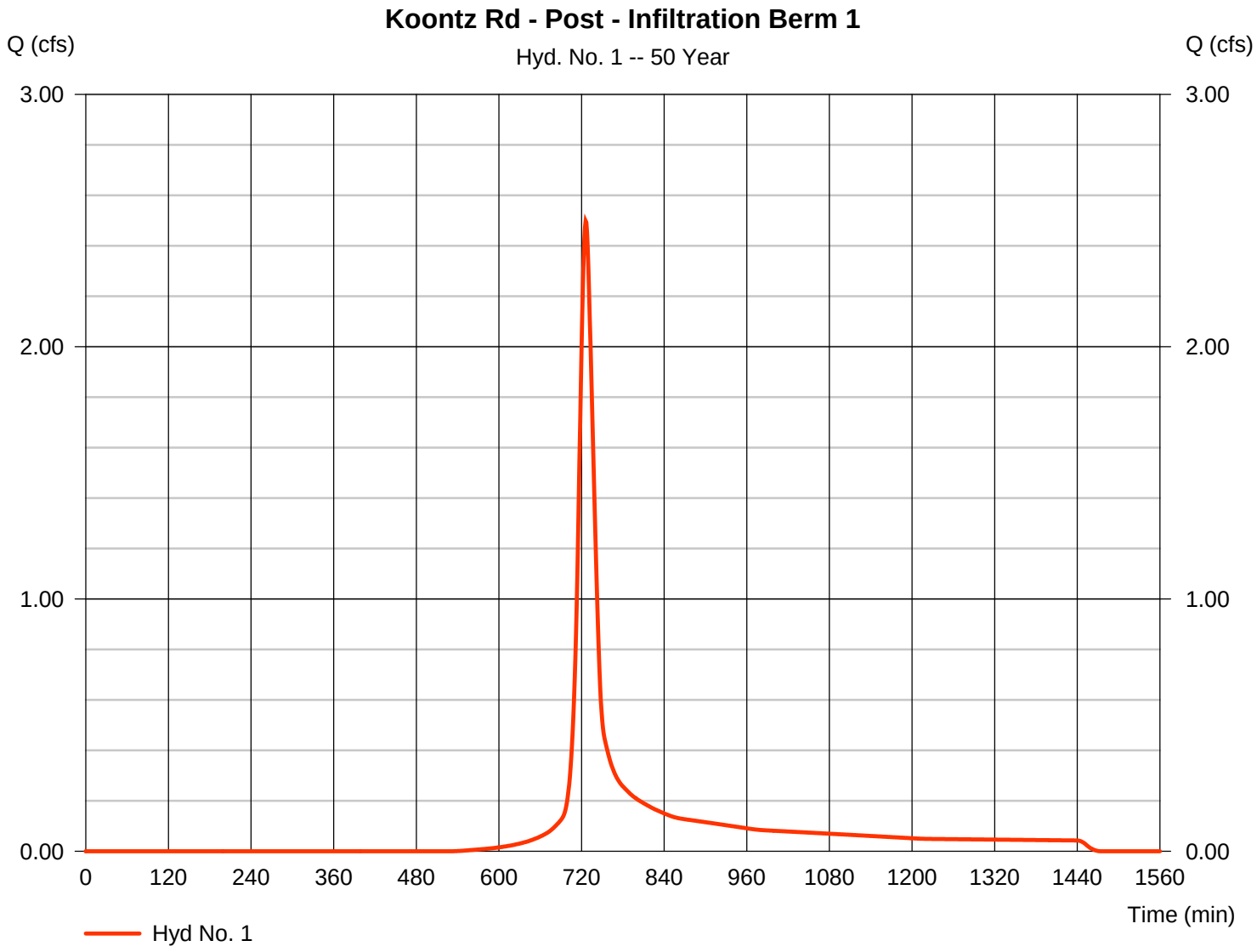
Hydrograph Report

Hyd. No. 1

Koontz Rd - Post - Infiltration Berm 1

Hydrograph type	= SCS Runoff	Peak discharge	= 2.498 cfs
Storm frequency	= 50 yrs	Time to peak	= 726 min
Time interval	= 1 min	Hyd. volume	= 8,251 cuft
Drainage area	= 1.030 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 20.60 min
Total precip.	= 4.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030

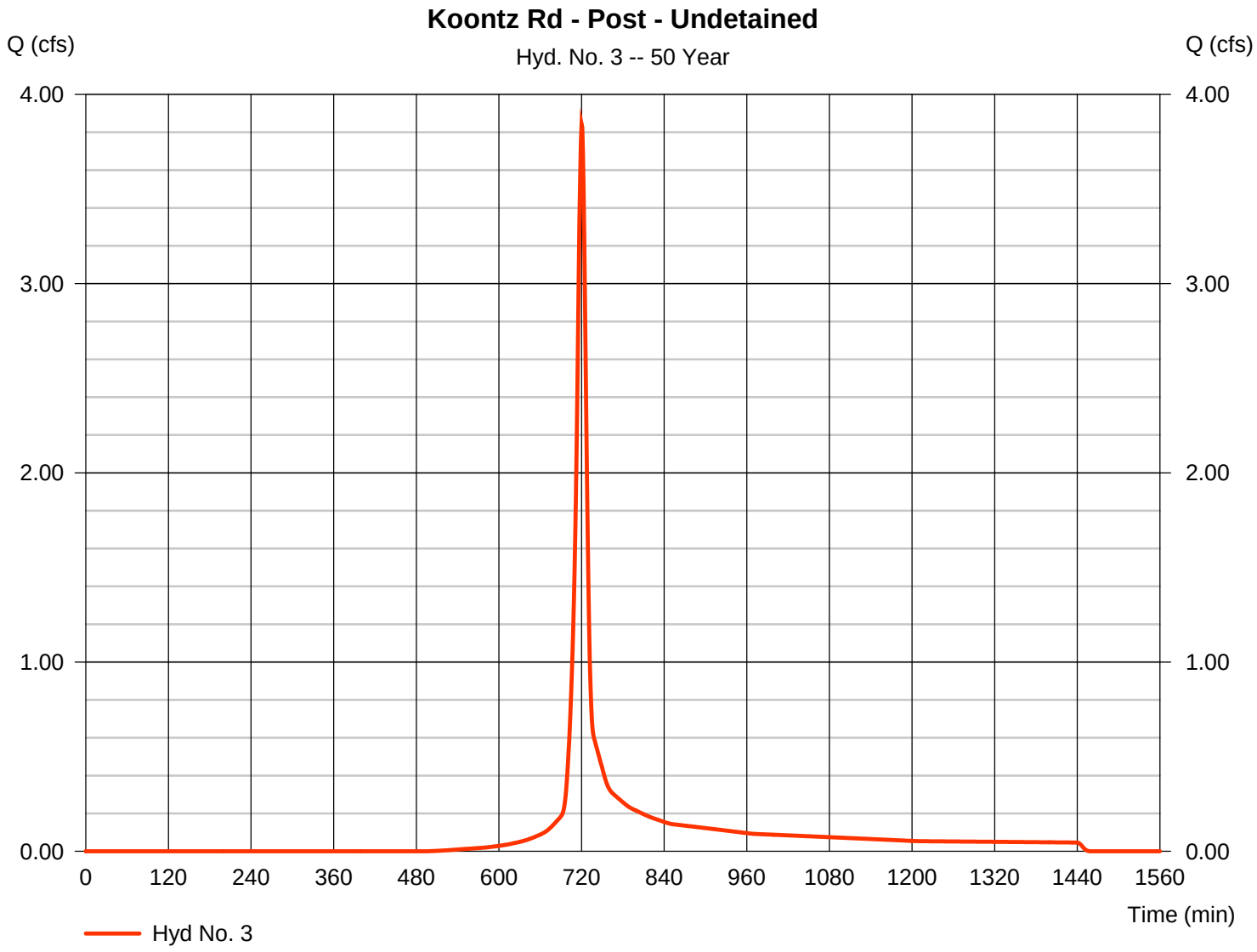


Hydrograph Report

Hyd. No. 3

Koontz Rd - Post - Undetained

Hydrograph type	= SCS Runoff	Peak discharge	= 3.843 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 9,294 cuft
Drainage area	= 1.070 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.30 min
Total precip.	= 4.57 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 3

Koontz Rd - Post - Undetained

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 290.00		0.00		0.00		
Watercourse slope (%)	= 6.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.95		0.00		0.00		
Travel Time (min)	**= 1.22**	**+**	**0.00**	**+**	**0.00**	**=**	**1.22**
Channel Flow							
X sectional flow area (sqft)	= 7.50		7.50		0.00		
Wetted perimeter (ft)	= 8.71		8.71		0.00		
Channel slope (%)	= 6.00		12.00		0.00		
Manning's n-value	= 0.026		0.026		0.015		
Velocity (ft/s)	=12.70						
			17.96				
					0.00		
Flow length (ft)	({0})224.0		240.0		0.0		
Travel Time (min)	**= 0.29**	**+**	**0.22**	**+**	**0.00**	**=**	**0.52**

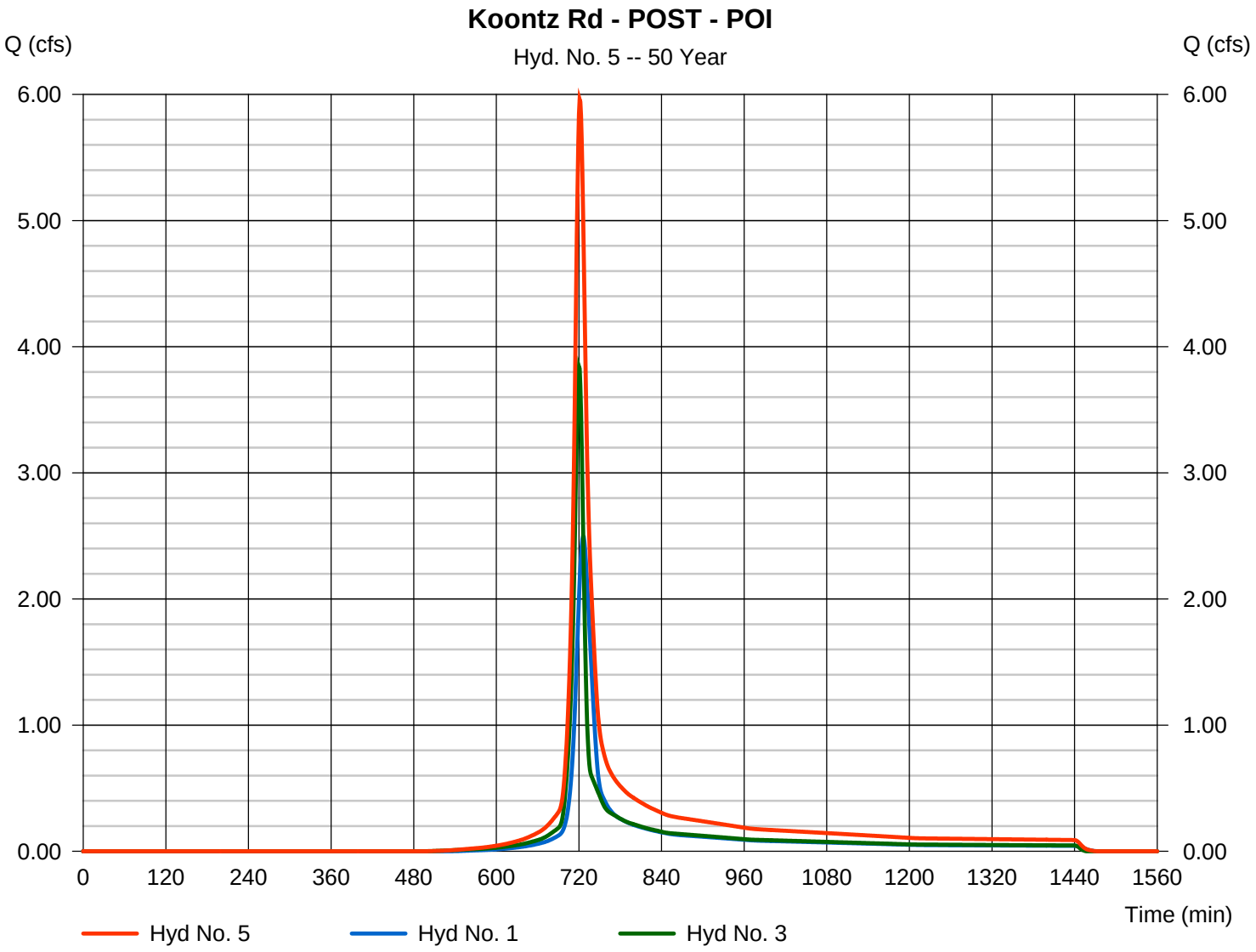
Total Travel Time, Tc ..... 11.30 min

Hydrograph Report

Hyd. No. 5

Koontz Rd - POST - POI

Hydrograph type	= Combine	Peak discharge	= 5.960 cfs
Storm frequency	= 50 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 17,545 cuft
Inflow hyds.	= 1, 3	Contrib. drain. area	= 2.100 ac



ATTACHMENT C-4
KOONTZ RD
100 Year-24 Hour Storm

Watershed Model Schematic

1 - Koontz Rd - PRE

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

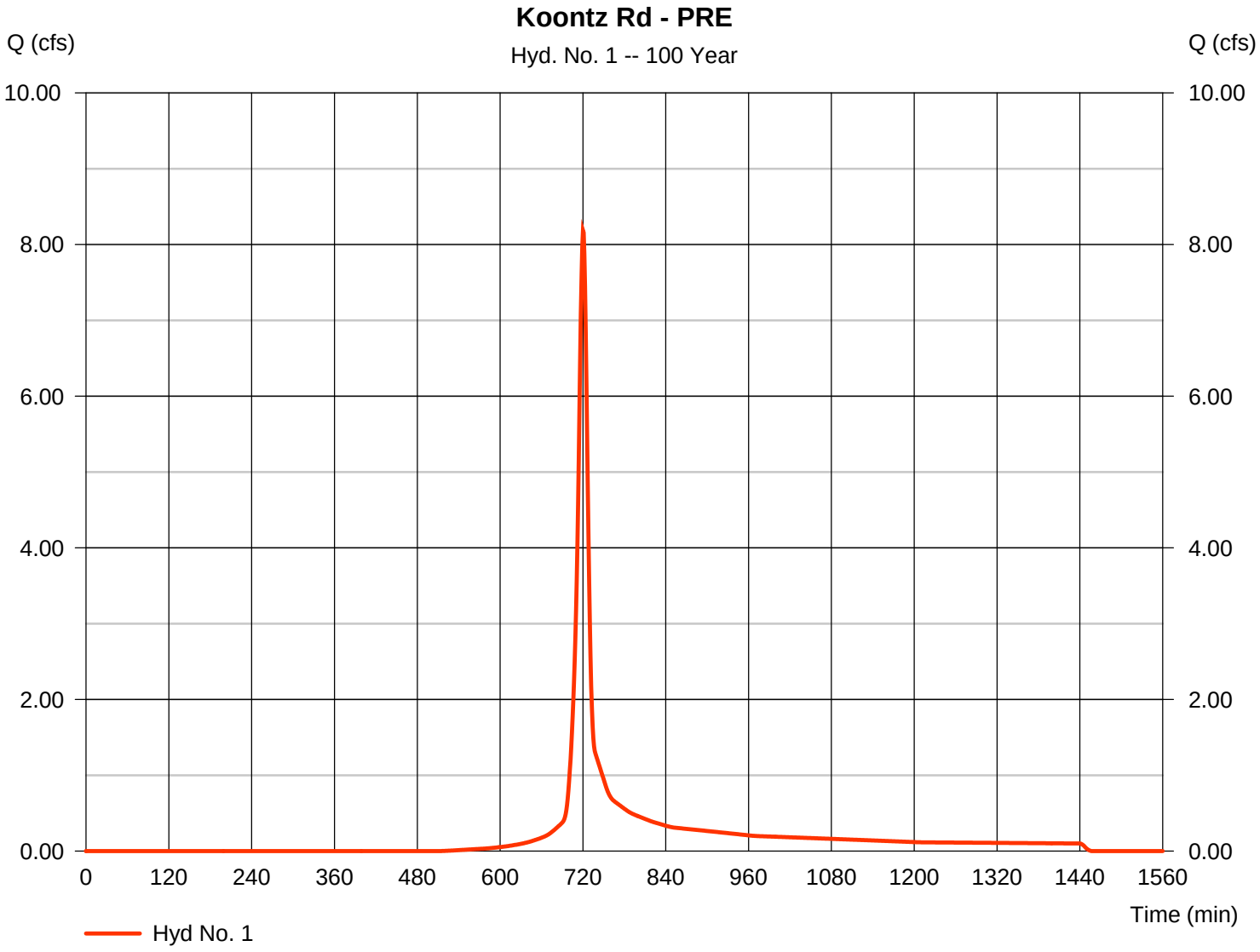
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	8.185	1	720	19,792	------	------	------	Koontz Rd - PRE

Hydrograph Report

Hyd. No. 1

Koontz Rd - PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 8.185 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 19,792 cuft
Drainage area	= 2.110 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.70 min
Total precip.	= 5.11 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 1

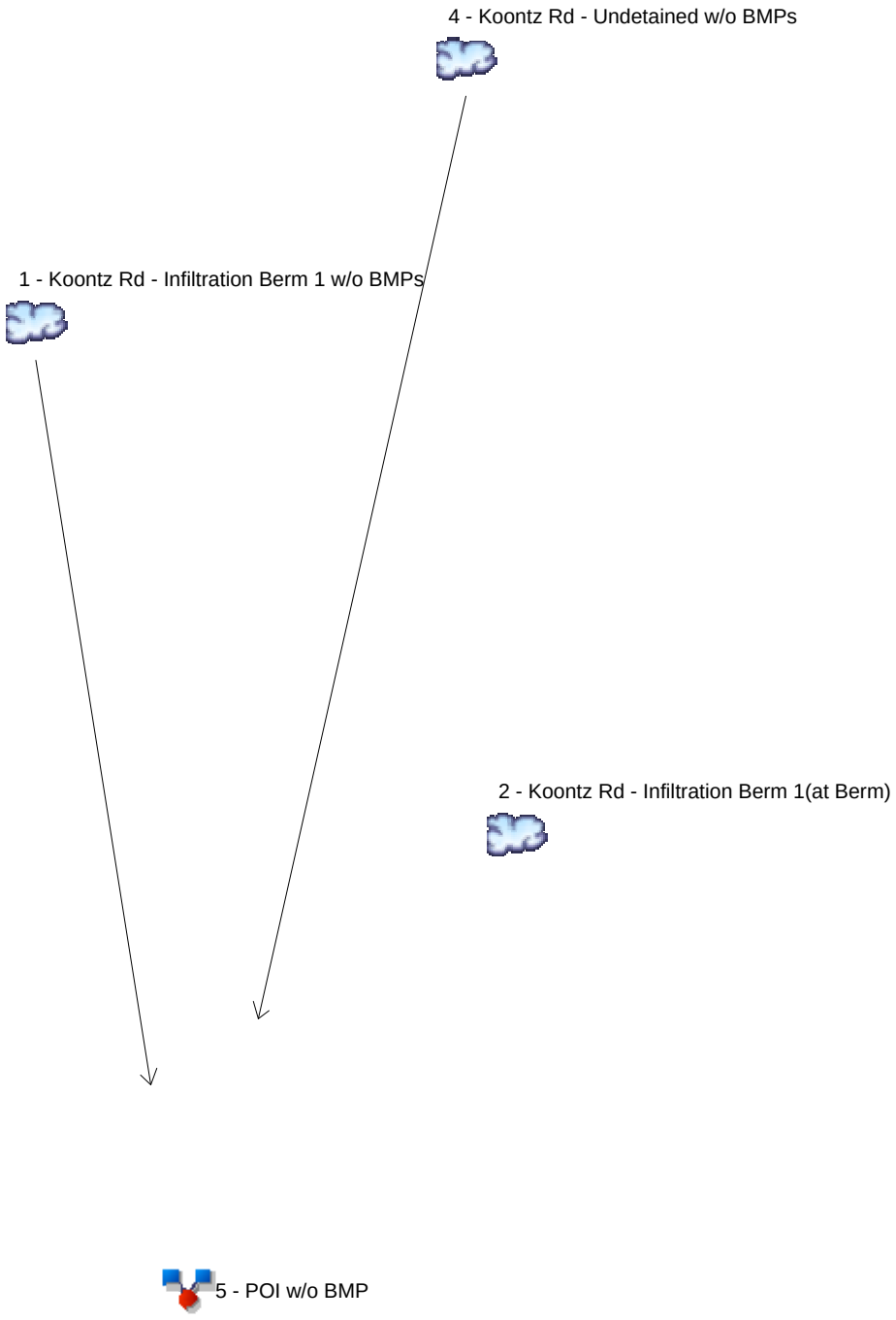
Koontz Rd - PRE

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 345.00		260.00		0.00		
Watercourse slope (%)	= 6.00		15.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=3.95		6.25		0.00		
Travel Time (min)	**= 1.45**	**+**	**0.69**	**+**	**0.00**	**=**	**2.15**
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 ..... 11.70 min

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

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	5.004	1	718	10,127	------	------	------	Koontz Rd - Infiltration Berm 1 w/o B
2	SCS Runoff	2.690	1	717	5,539	------	------	------	Koontz Rd - Infiltration Berm 1(at Ber
4	SCS Runoff	4.579	1	720	11,091	------	------	------	Koontz Rd - Undetained w/o BMPs
5	Combine	9.285	1	718	21,218	1, 4	------	------	POI w/o BMP

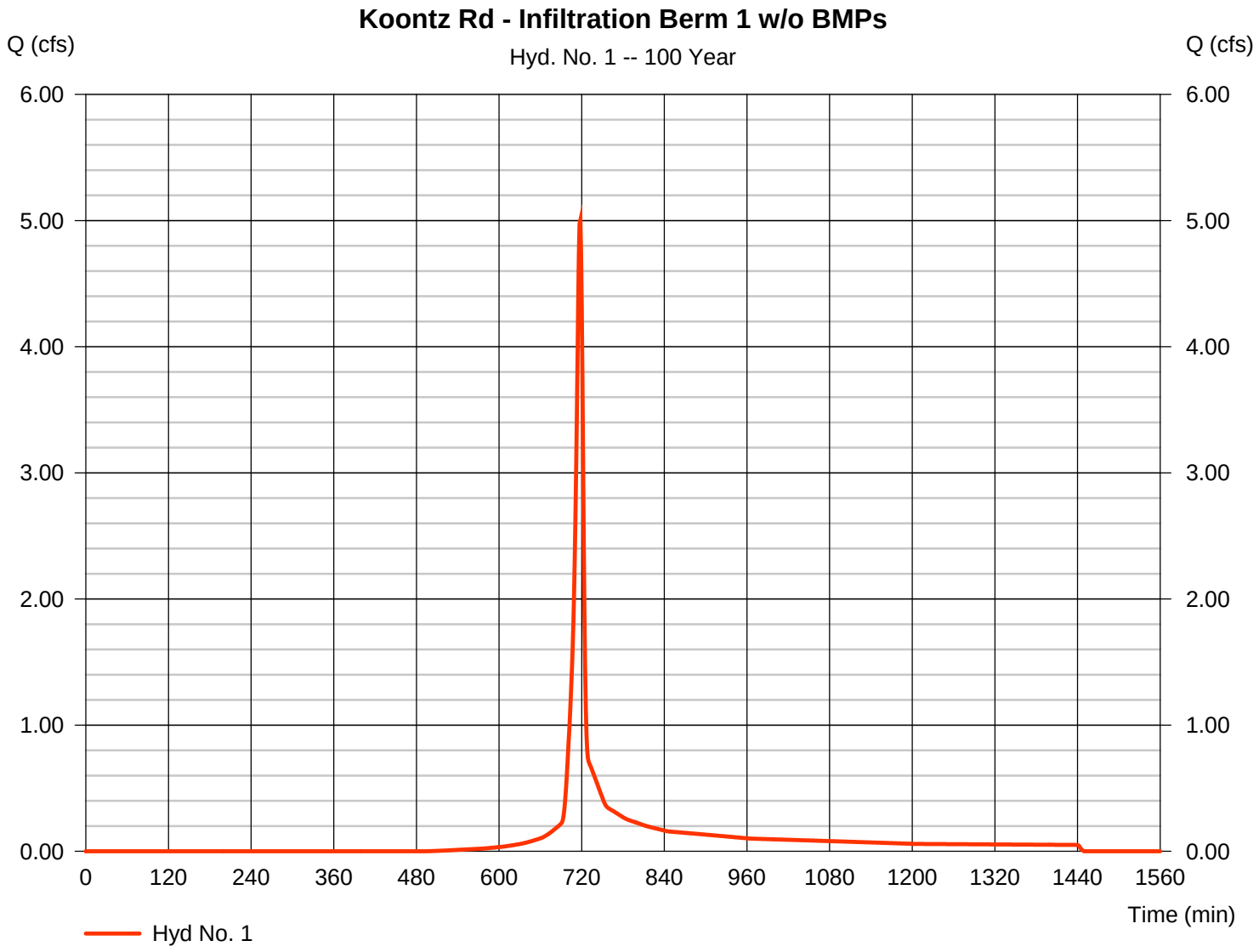
Hydrograph Report

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/o BMPs

Hydrograph type	= SCS Runoff	Peak discharge	= 5.004 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 10,127 cuft
Drainage area	= 1.030 ac	Curve number	= 76*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 5.80 min
Total precip.	= 5.11 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030



TR55 Tc Worksheet

Hyd. No. 1

Koontz Rd - Infiltration Berm 1 w/o BMPs

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.240		0.011		
Flow length (ft)	= 56.0		44.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		2.44		0.00		
Land slope (%)	= 5.40		9.00		0.00		
Travel Time (min)	**= 0.59**	**+**	**4.64**	**+**	**0.00**	**=**	**5.23**
Shallow Concentrated Flow							
Flow length (ft)	= 30.00		187.00		0.00		
Watercourse slope (%)	= 10.00		17.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=5.10		6.65		0.00		
Travel Time (min)	**= 0.10**	**+**	**0.47**	**+**	**0.00**	**=**	**0.57**
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**

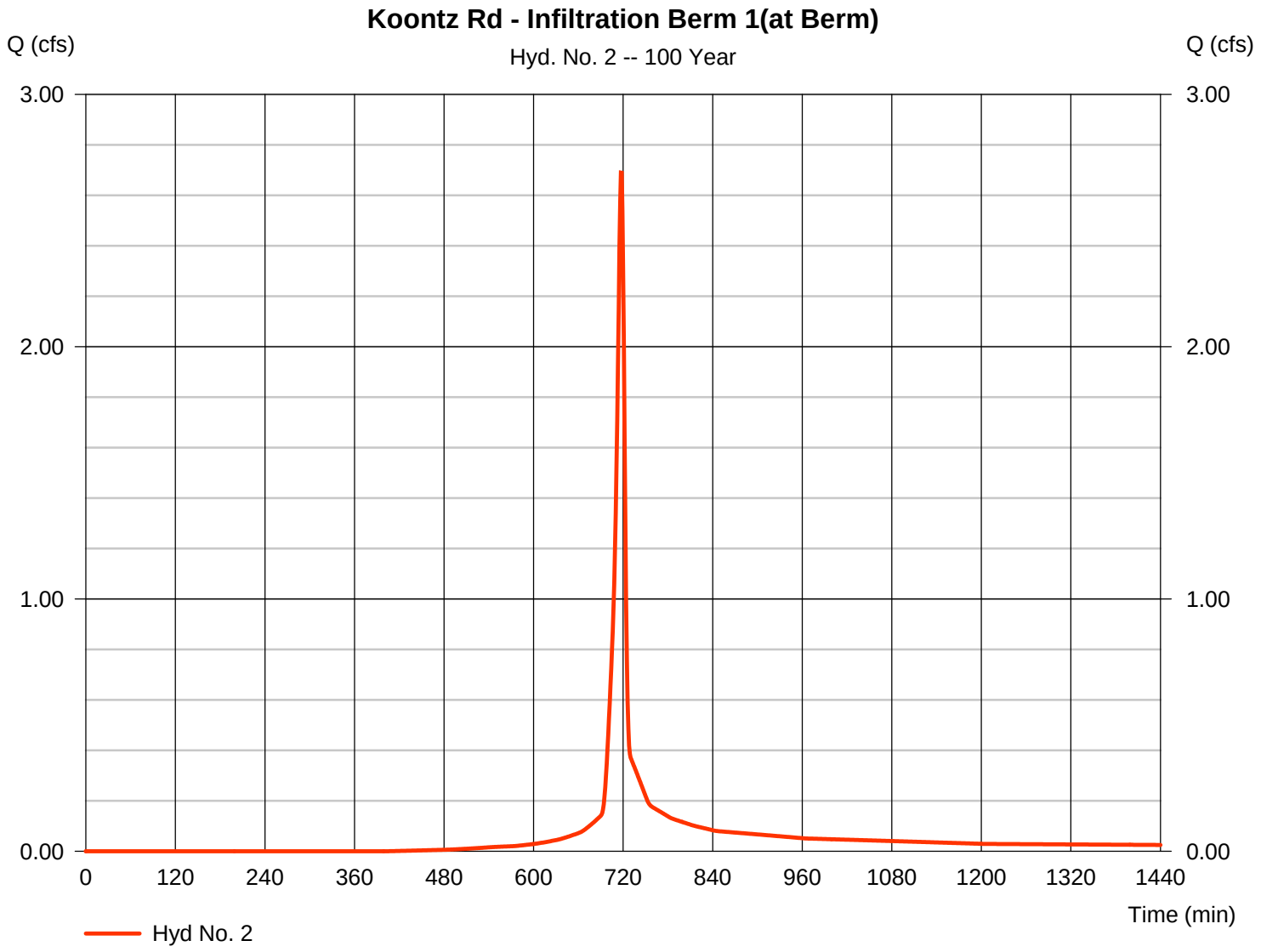
Total Travel Time, Tc ..... 5.80 min

Hydrograph Report

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.690 cfs
Storm frequency	=	100 yrs	Time to peak	=	717 min
Time interval	=	1 min	Hyd. volume	=	5,539 cuft
Drainage area	=	0.480 ac	Curve number	=	81
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.30 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 2

Koontz Rd - Infiltration Berm 1(at Berm)

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.011		0.240		0.011		
Flow length (ft)	= 56.0		44.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		2.44		0.00		
Land slope (%)	= 5.40		9.00		0.00		
Travel Time (min)	**= 0.59**	**+**	**4.64**	**+**	**0.00**	**=**	**5.23**
Shallow Concentrated Flow							
Flow length (ft)	= 30.00		0.00		0.00		
Watercourse slope (%)	= 10.00		0.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=5.10		0.00		0.00		
Travel Time (min)	**= 0.10**	**+**	**0.00**	**+**	**0.00**	**=**	**0.10**
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**

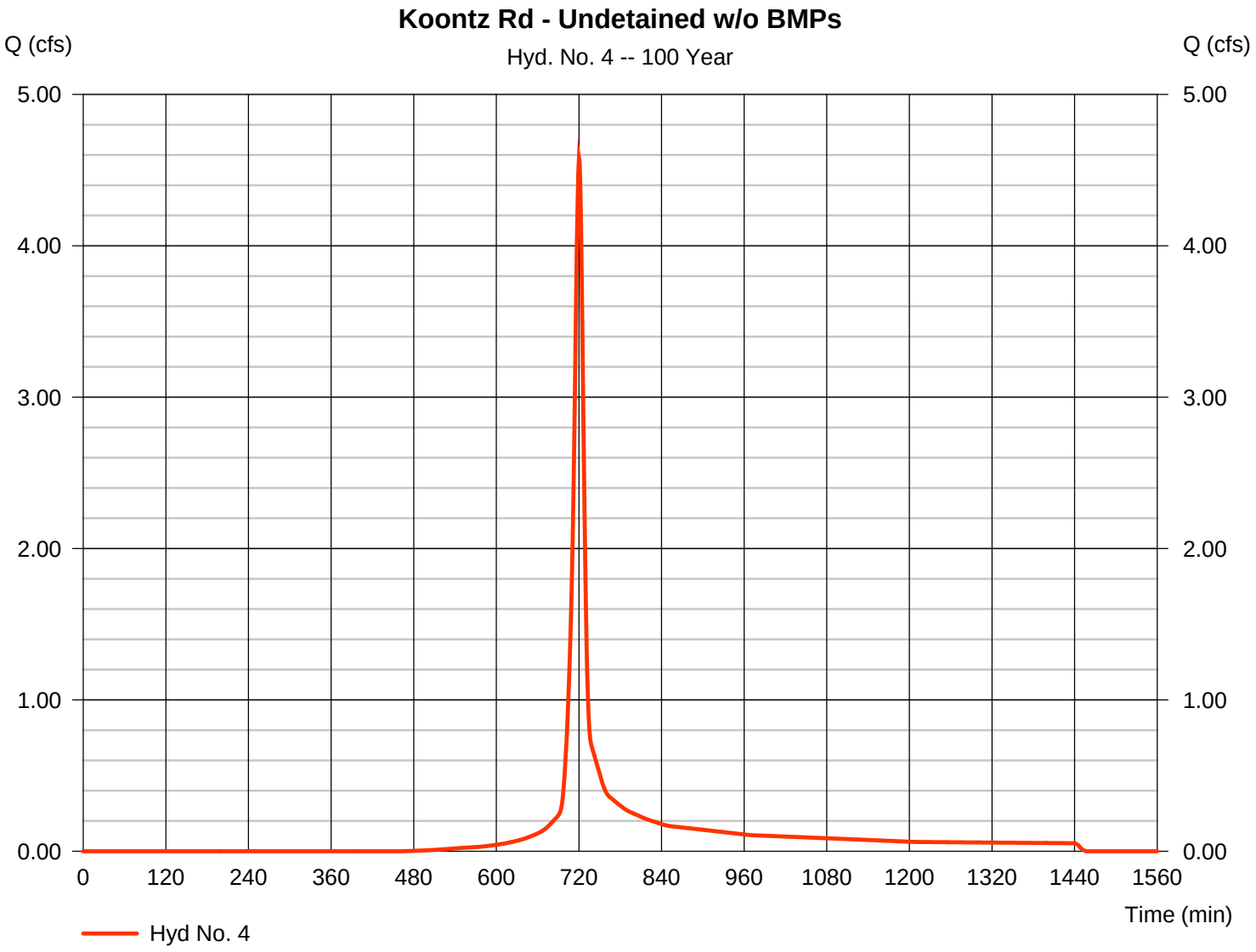
Total Travel Time, Tc ..... 5.30 min

Hydrograph Report

Hyd. No. 4

Koontz Rd - Undetained w/o BMPs

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.579 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	11,091 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 4

Koontz Rd - Undetained w/o BMPs

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 290.00		0.00		0.00		
Watercourse slope (%)	= 6.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.95		0.00		0.00		
Travel Time (min)	**= 1.22**	**+**	**0.00**	**+**	**0.00**	**=**	**1.22**
Channel Flow							
X sectional flow area (sqft)	= 7.50		7.50		0.00		
Wetted perimeter (ft)	= 8.71		8.71		0.00		
Channel slope (%)	= 6.00		12.00		0.00		
Manning's n-value	= 0.026		0.026		0.015		
Velocity (ft/s)	=12.70						
			17.96				
					0.00		
Flow length (ft)	({0})224.0		240.0		0.0		
Travel Time (min)	**= 0.29**	**+**	**0.22**	**+**	**0.00**	**=**	**0.52**

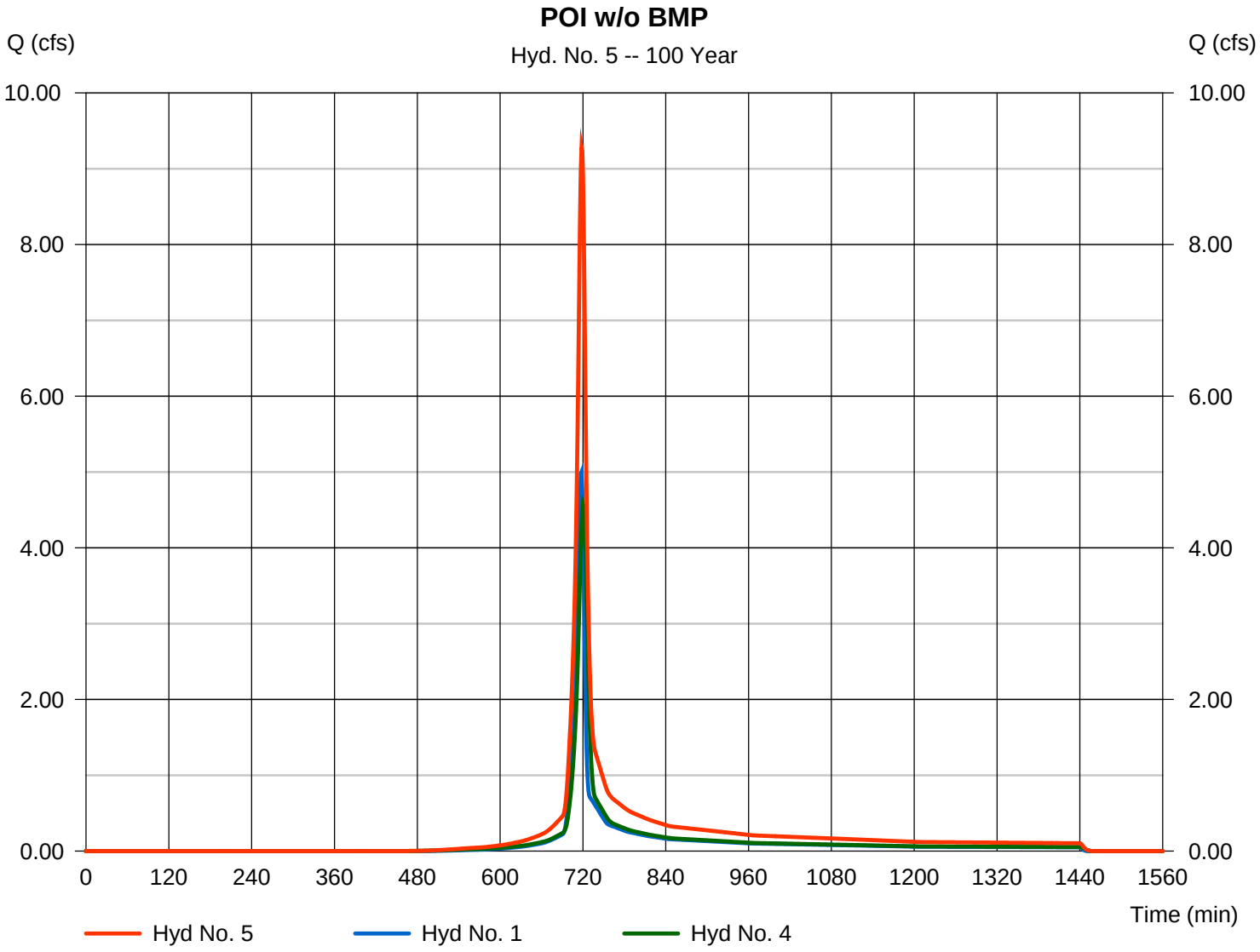
Total Travel Time, Tc ..... 11.30 min

Hydrograph Report

Hyd. No. 5

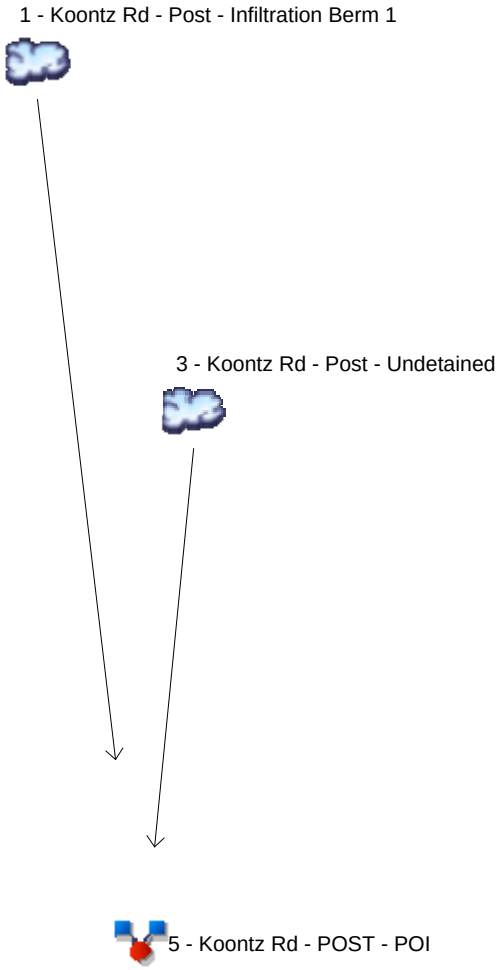
POI w/o BMP

Hydrograph type	=	Combine	Peak discharge	=	9.285 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	21,218 cuft
Inflow hyds.	=	1, 4	Contrib. drain. area	=	2.100 ac



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5

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	3.277	1	724	9,708	------	------	------	Koontz Rd - Post - Infiltration Berm 1
3	SCS Runoff	4.579	1	720	11,091	------	------	------	Koontz Rd - Post - Undetained
5	Combine	7.613	1	721	20,799	1, 3,	------	------	Koontz Rd - POST - POI

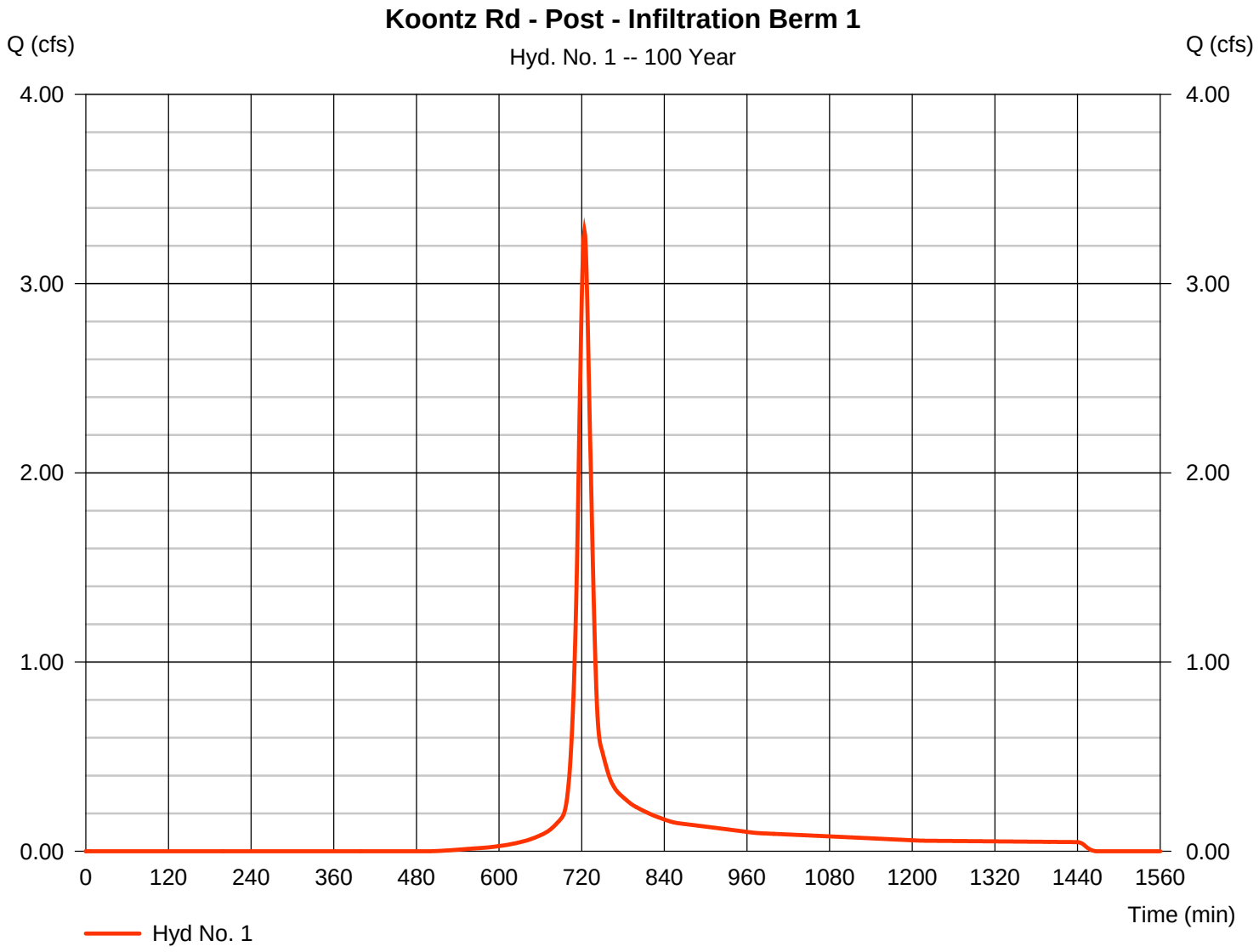
Hydrograph Report

Hyd. No. 1

Koontz Rd - Post - Infiltration Berm 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.277 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	1 min	Hyd. volume	=	9,708 cuft
Drainage area	=	1.030 ac	Curve number	=	76*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	18.40 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.600 x 75) + (0.400 x 75) + (0.150 x 90) + (0.360 x 71) + (0.090 x 89) + (0.300 x 70)] / 1.030

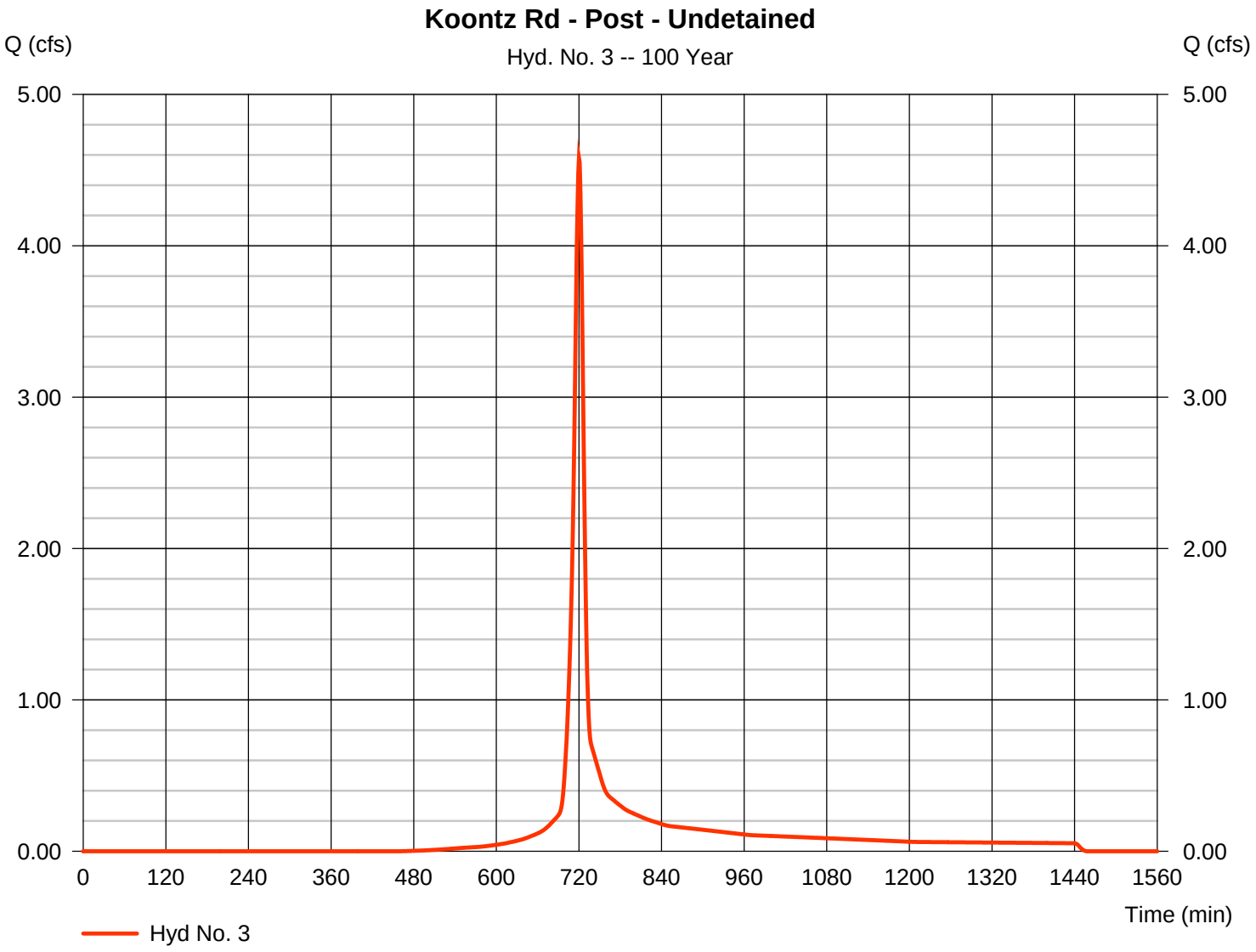


Hydrograph Report

Hyd. No. 3

Koontz Rd - Post - Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.579 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	11,091 cuft
Drainage area	=	1.070 ac	Curve number	=	78
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	11.30 min
Total precip.	=	5.11 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



TR55 Tc Worksheet

Hyd. No. 3

Koontz Rd - Post - Undetained

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.44		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 9.54**	**+**	**0.00**	**+**	**0.00**	**=**	**9.54**
Shallow Concentrated Flow							
Flow length (ft)	= 290.00		0.00		0.00		
Watercourse slope (%)	= 6.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.95		0.00		0.00		
Travel Time (min)	**= 1.22**	**+**	**0.00**	**+**	**0.00**	**=**	**1.22**
Channel Flow							
X sectional flow area (sqft)	= 7.50		7.50		0.00		
Wetted perimeter (ft)	= 8.71		8.71		0.00		
Channel slope (%)	= 6.00		12.00		0.00		
Manning's n-value	= 0.026		0.026		0.015		
Velocity (ft/s)	=12.70						
			17.96				
					0.00		
Flow length (ft)	({0})224.0		240.0		0.0		
Travel Time (min)	**= 0.29**	**+**	**0.22**	**+**	**0.00**	**=**	**0.52**

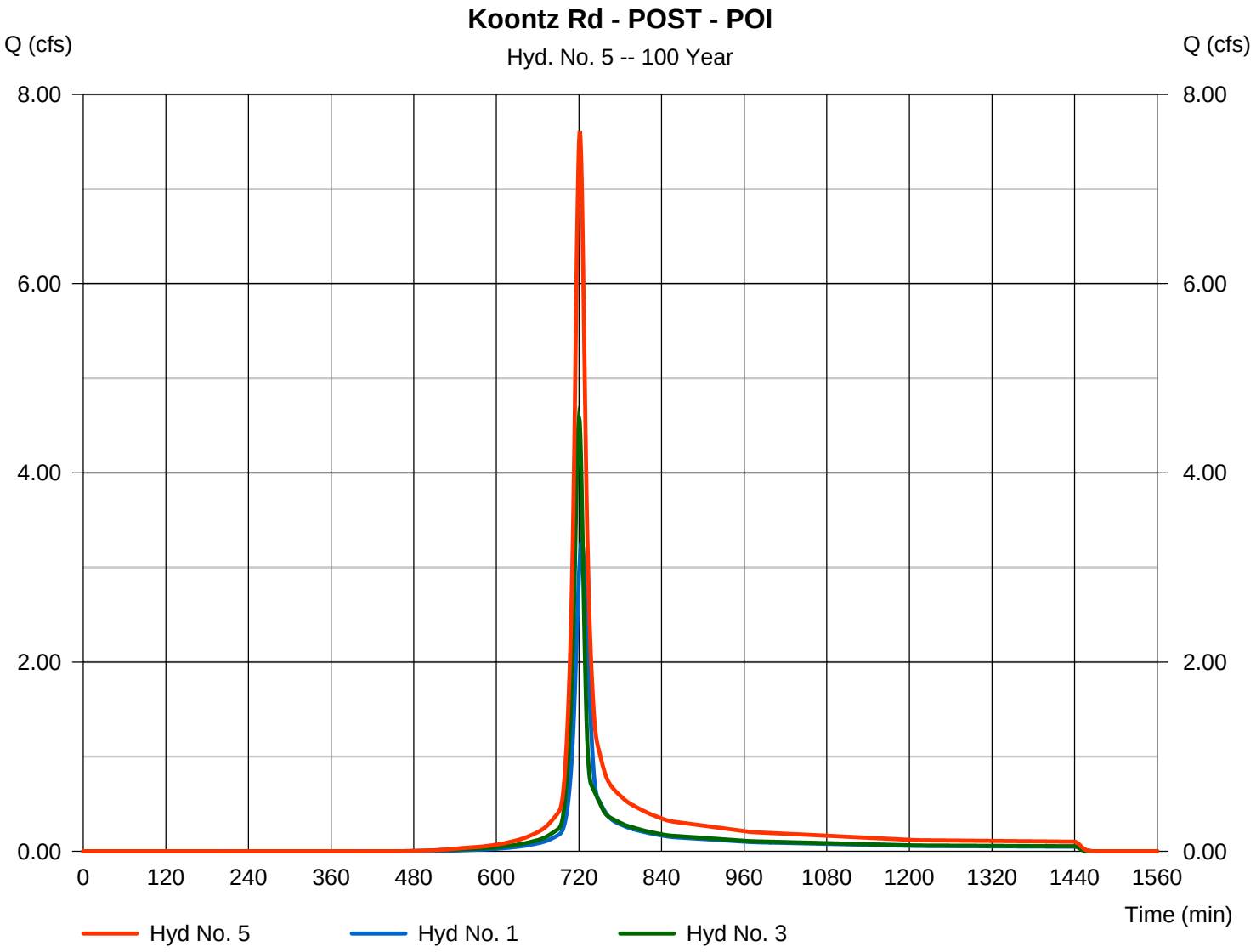
Total Travel Time, Tc ..... 11.30 min

Hydrograph Report

Hyd. No. 5

Koontz Rd - POST - POI

Hydrograph type	= Combine	Peak discharge	= 7.613 cfs
Storm frequency	= 100 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 20,799 cuft
Inflow hyds.	= 1, 3	Contrib. drain. area	= 2.100 ac



ATTACHMENT D
KOONTZ RD
DIVERSION CHANNEL DESIGN

TETRA TECH, INC.

By: RJM Date: 10/21/16 Subject: Sunoco PA Pipeline Project Sheet No.: of
Chkd. By: LMD Date: 01/27/17 Koontz Rd Proj. No.: 112IC05958

P:\SE Projects\2016\Sunoco\112IC05958\Spread 2 - Rev 1\Engineering\1 - Koontz Road (formerly Loyalhanna Lake West)\[Koontz Rd BMP Design Rev Feb2017 Tc C

DIVERSION DITCH DESIGN

DESIGN DISCHARGE

Channel	Design Discharge (cfs)
DD-1*	4.75

DD-1 is designated as the watershed labeled as "Koontz Rd - Post - Undetained" from Attachment C. The design discharge is the 100-year 24-hour storm runoff from the watershed.

CHANNEL LINING

The collection channels will be vegetated and lined with a North American Green Synthetic Lining, or approved equivalent if needed for stability. The North American Green Erosion Control Materials Design Software, Version 5.0 was used to analyze the channel lining stability and hydraulic characteristics of the channel.

FREEBOARD

Channel	Velocity (ft/s)	Depth (ft)	Minimum Required Freeboard (ft)	Minimum Required Depth (ft)
DD-1	2.56	0.75	0.50	1.25

CHANNEL CONFIGURATION SUMMARY

Channel	Bed Slope (%)	Bottom Width (ft)	Side Slopes (_LH:1V)	Side Slopes (_RH:1V)	Channel Lining	Total Depth (ft)
DD-1	6%	1	2	2	NAG P300	1.50

Notes:

1. Channel velocities and flow depths were obtained from the included computer output .
2. The channel section characteristics resulting in the largest total depth were used.

LEVEL SPREADER DESIGN

CHANNEL DESIGNATION	ENERGY DISSIPATOR TYPE	LENGTH (ft)	Downslope Protection	Q (cfs)
DD-1	Earthen Level Spreader	**109**	Grass/Rock	7.1

$$Q = C_w \times L \times H^{3/2}$$ (Ref #5)

Q = Flow (cfs)
L = Length of Level Spreader (ft)
C_w = Weir Coefficient 3.27
H = Driving Head (ft) 0.07 Based on V(allowable) = 1.33

$$V = 1.5 \times C_w \times H^{1/2}$$ (Ref #5)

V = Allowable velocity at the Level Spreader (fps)
Grass/Ticket = 1.33
Gravel = 1.5 (Table G.2, Ref #5)
Mulch (trees, Shrubs) = 0.67

Tensar International Corporation
5401 St. Wendel-Cynthiana Road
Poseyville, Indiana 47633
Tel. 800.772.2040
Fax 812.867.0247
www.nagreen.com

Erosion Control Materials Design Software
Version 5.0

Project Name: 112IC05958 Sunoco
Project Number: 103213
Channel Name: Koontz Rd - DD1

Discharge	4.75
Peak Flow Period	0.3
Channel Slope	0.06
Channel Bottom Width	1
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegtation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

P300 - Class C - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
P300 Unvegetated	Straight	4.75 cfs	4.86 ft/s	0.49 ft	0.034	3 lbs/ft2	1.85 lbs/ft2	1.63	STABLE	E
P300 Reinforced Vegetation	Straight	4.75 cfs	2.56 ft/s	0.75 ft	0.081	8 lbs/ft2	2.79 lbs/ft2	2.87	STABLE	E
Underlying Substrate	Straight	4.75 cfs	2.56 ft/s	0.75 ft	--	2 lbs/ft2	0.107 lbs/ft2	18.63	STABLE	--