McCLURE ENGINEERING Co

STORM WATER MANAGEMENT PLAN

QUIKTRIP STORE #504

6300 HICKMAN ROAD

CITY OF WINDSOR HEIGHTS, COUNTY OF POLK, STATE OF IOWA

FEBRUARY 29, 2016
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MEC PROJECT NUMBER: 20715030

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I HEREBY CERTIFY THAT THIS ENGINEERING DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT PERSONAL SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF IOWA.

PRELIMINARY

RANDY G. ZERR, P.E. DATE

MY LICENSE RENEWAL DATE IS DECEMBER 31, 2017
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1360 NW 121ST STREET, SUITE A, CLIVE, IA 50325

PROJECT: QuikTrip Store #504 PROJ. NO. 20715030
SUBJECT: Storm Water Summary DATE: 03/12/16 DESIGNED: RGZ CHECKED:

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Section 1 – Project Description and Summary

QuikTrip Store #504

City of Windsor Heights, County of Polk, State of Iowa

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Project Description:

Pre-Developed Site Conditions

The existing site is comprised of part of Lots 1 and 2, Windsor Crossing Plat 1, and is also located in the Northeast Quarter (NE 1/4) of Section 36, Township 79 North, Range 25 West of the Fifth Principal Meridian in the City of Windsor Heights, County of Polk, State of Iowa. The site is generally bounded on the north by Hickman Road (U.S. Highway 6), on the east by 63rd Street (Iowa Highway 28), on the south by residential properties and on the west by a commercial property. The situs address is 6300 Hickman Road.

The existing site consists of 2.07 acres (90,253 square feet) of existing bituminous/concrete/gravel pavements (approximately 24,857 square feet) and weed/grass mixtures (approximately 65,312 square feet). The site generally drains from the northwest to the southeast and is within the North Walnut Creek watershed. Refer to the Pre-Developed Map.

The entire site lies within the limits of flood Zone X, defined as areas determined to be outside the 500-year floodplain, as indicated by the Flood Insurance Rate Map (FIRM) that was prepared by the Federal Emergency Management Administration (FEMA) for the City of Windsor Heights, Polk County, Iowa, Community Number 190687, Panel Number 0001 B (Only Panel Printed), and with a revised map date of October 16, 1992.

Post-Developed Site Conditions

The proposed site improvements include, but are not limited to, the construction of one (1) 5,858 square foot convenience store, canopied fueling islands, and associated parking lot. The existing drainage patterns will be maintained as much as possible. Once construction activities are completed, it is anticipated that the impervious and pervious areas will approximately equate to 71.2% (64,233 square feet) and 28.8% (26,020 square feet), respectively. One (1) storm water detention facility was designed to provide storm water management for the proposed building site and to limit the impact of runoff onto adjacent properties. For this report, the existing storm sewer manhole east of the site and along the west side of 63rd Street was considered the design (discharge) point (POST). The said manhole is part of an existing reinforced concrete pipe (RCP) storm sewer system that ultimately discharges north of the site and north of Hickman Road. Refer to the Post-Developed Map.

Undetained Site Conditions

There are three (3) on-site areas that are not able to be detained. Either overdetention will be provided for and/or the difference between the on-site, undetained flow rate will be equivalent to the flow rate from the off-site bypas runoff. For modeling purposes, these areas have been combined into one (1) an-site, undetained area (DB UND). Refer to the Post-Developed Map.

Off-Site Conditions

There is one (1) existing off-site drainage area that contributes additional storm water runoff to the site. This area (DB 1 OFF) equates to 1.43 acres and drains towards and through the existing site and will be routed through the on-site detention basin as bypass flow. Refer to the Pre-Developed and Post-Developed Maps.

Pre- and Post-Developed Runoff Analysis:

The proposed detention basin was designed using Hydraflow Hydrographs Extension for AutoCAD Civil 3D 2014 Version 10.3 utilizing the SCS Method. Procedures for the SCS Method for basin routing are outlined in Section 2B-5 of the 2015 SUDAS Design Manual. The drainage basins were analyzed for the 1- through 100-year storm events. The 5- through 100-year storm post-developed runoff will be detained and released at the 5-year pre-developed rate. Runoff coefficients and curve numbers were taken from the Statewide Urban Design and Specifications (SUDAS) Section 2B-4.

The allowable release rate was calculated to be 10 cfs (100-year off-site developed peak discharge of 7.1 cfs + 5-year on-site pre-developed peak discharge of 2.9 cfs). Detention Basin UG DETENTION will detain the majority of the on-site runoff. The developed 100-year discharge rate, at the design point (POST), was calculated to be 7.2 cfs which is less than the allowable release rate of 10 cfs. Considering that there are no known existing off-site detention facilities to detain said off-site flow and no known existing on-site detention facilities to detain said on-site flows, any excess flows will be considered negligible.

Storm Water Runoff Quality:

Storm water runoff water quality is required and is being provided for. Fuel dispensing facilities are capable of contributing greater concentrations of pollutants. QuikTrip Corporation is concerned about the potential for pollutants to infiltrate on-site and/or off-site soils, so a corporate policy has been put into place that requires all under ground detention facilities to be watertight systems that allow no infiltration. Therefore, a proprietary storm water quality filtration unit is being proposed for this redevelopment to treat water quality. The water quality treatment unit, from Oldcastle Stormwater Solutions (formerly known as Kristar Enterprises), will be used to remove suspended solids, petroleum hydrocarbons, and other pollutants from storm water runoff. The system is capable of removing over 80% of the net annual Total Suspended Solids (TSS). A separate oil chamber is included in the unit to prevent the introduction of trapped oil and floatable contaminants to the downstream storm drainage system. For this site, the DVS-72S model was selected. Refer to the Oldcastle Stormwater Solutions section for product information.

QuikTrip Corporation will be responsible for the proper inspection and maintenance of the proposed water quality treatment unit. In accordance with the Clean Water Act (CWA) and the National Pollutant Discharge Elimination System (NPDES) regulations, Best Management Practices (BMPs) are to be inspected every 90 days and cleaned and maintained as needed. During the construction stage, visual inspections and sediment depth inspections are to be performed on a 30-day cycle. Post construction, the DVS-72S Dual Vortex Separator is to be inspected and maintained per the Oldcastle Stormwater Solutions Dual Vortex Separator Inspection and Maintenance Guide. Refer to the Oldcastle Stormwater Solutions section for product information.

Storm Sewer Analysis:

The on-site storm sewer pipes were designed using the Rational Method to convey the 5- and 100-year storm events. Area intake capacities were verified for both the 5-year and 100-year storm events. If the intakes become inoperable, the runoff will pond, head up, and should eventually flow towards and into the proposed under ground detention basin or into 63rd Street and/or Hickman Road.

Storm Detention Analysis:

Detention for this site will consist of one (1) under ground detention basin compromised of 48-inch diameter ADS High-Density Polyethylene (HDPE) pipe located north of and east of the proposed building.

Assumptions:

Impervious vs. Pervious Areas

	Impervious Area		Pervious Area		Total Area	
	S.F.	%	S.F.	%	S.F.	Ac.
Existing	24,857	27.5%	65,396	72.5%	90,253	2.07
Proposed	64,233	71.2%	26,020	28.8%	90,253	2.07

Note: Total area only contains on-site areas (both detainable and undetainable) and does not include any off-site drainage areas.

Hydrologic Soil Groups - From Polk County Soil Survey:

Map Unit Symbol	Soil Group Name	Hydrologic Soil Group
4000	Urban land	C
4138B	Clarion-Urban land complex (2%-5% slopes)	B
4138C	Clarion-Urban land complex (5%-9% slopes)	B

NOTE: For this report, the Hydrologic Soil Group C was used.

Rainfall - From Table 2B-2.06: Section 5 - Central Iowa

Storm Recurrence Interval	24 hr. Rainfall (in.)
1-year	2.67
2-year	3.08
5-year	3.81
100-year	7.12

Time of Concentrations:

The existing site contains impervious surtaces as well as pervious surtaces. The proposed site will be developed with the majority of the surfaces being impervious. It has been assumed that the peak flow for the detention basin will occur at a longer time of concentration versus the on-site storm sewer peak flows which will occur at a shorter time of concentration. The shorter time of concentration produces slightly more conservative results which adds in a factor of safety.

For detention calculations, a time of concentration of:

-- 18.6 minutes was calculated for the existing, off-site (DB 1 OFF) condition.
-- 18.8 minutes was calculated for the pre-developed, on-site (DB PRE 1) condition.

-- 15 minutes was assumed for the post-developed, detained (DB 1 and DB 2) conditions.
-- 15 minutes was assumed for the post-developed, undetained (DB UND) condition.

For storm water sewer sizing calculations, a time of concentration of:

-- 5 minutes was assumed for the post-developed condition.

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Runoff Coefficients

Land Use or Surface Characteristics	C Soils	
	5-yr	100-yr
Meadow (Pre-Settlement)	0.30	0.55
Open Space (Fair Condition, Grass Cover 50% to 75%)	0.45	0.65
Streets and Roads (Paved, Curbs, and Storm Sewers)	0.95	0.98
Commercial and Business	0.85	0.90

Pre-Developed Condition

Design Year	Drainage Area ID	Meadow (%)	Open Spaces (%)	Streets and Roads (%)	Total Area (s.f.)	Total Area (ac.)	Composite C Factor
5	DB PRE 1	100%	0%	0%	90,253	2.07	0.30
100	DB PRE 1	100%	0%	0%	90,253	2.07	0.55
5	DB PRE 1 OFF	0%	77%	23%	52,902	1.21	0.57
100	DB PRE 1 OFF	0%	77%	23%	52,902	1.21	0.73

DB PRE 1 = Pre-developed On-Site Drainage Area (Subject Property)
DB 1 OFF = Existing Off-Site Drainage Area (Bypass Flow onto Subject Property)

Post-Developed Condition

Design Year	Drainage Area ID	Open Space (%)	Streets and Roads (%)	Comercial and Business (%)	Total Area (s.f.)	Total Area (ac.)	Composite C Factor
5	DB 1	5%	0%	95%	67,845	1.56	0.83
100	DB 1	5%	0%	95%	67,845	1.56	0.89
5	DB 1 UND	90%	0%	10%	22,408	0.51	0.49
100	DB 1 UND	90%	0%	10%	22,408	0.51	0.68
5	DB 1 OFF	77%	23%	0%	52,902	1.21	0.57
100	DB 1 OFF	77%	23%	0%	52,902	1.21	0.73

DB 1 = Post-developed On-Site Drainage Area that is Detained (Subject Property)
DB 1 UND = Post-developed On-Site Drainage Area that is Undetained (Subject Property)
DB 1 OFF = Existing Off-Site Drainage Area (Bypass Flow onto Subject Property)

Runoff Curve Numbers:

Land Use or Surface Characteristics	C Soils
Meadow (Pre-Settlement)	71
Open Spaces (Fair Condition)	79
Streets and Roads (Paved, Curbs, and Storm Sewers)	98
Commercial and Business	94

Pre-Developed Condition

Drainage Area ID	Meadow (%)	Open Spaces (%)	Streets and Roads (%)	Total Area (s.f.)	Total Area (ac.)	Composite CN
DB PRE 1	100%	0%	0%	90,253	2.07	71
DB 1 OFF	0%	77%	23%	52,902	1.21	83

DB PRE 1 = Pre-developed On-Site Drainage Area (Subject Property)
DB 1 OFF = Existing Off-Site Drainage Area (Bypass Flow onto Subject Property)

Post-Developed Condition

Drainage Area ID	Open Space (%)	Streets and Roads (%)	Commercial and Business (%)	Total Area (s.f.)	Total Area (ac.)	Composite CN
DB 1	5%	0%	95%	67,845	1.56	93
DB 1 UND	90%	0%	10%	22,408	0.51	81
DB 1 OFF	77%	23%	0%	52,902	1.21	83

DB 1 = Post-developed On-Site Drainage Area that is Detained (Subject Property)
DB 1 UND = Post-developed On-Site Drainage Area that is Undetained (Subject Property)
DB 1 OFF = Existing Off-Site Drainage Area (Bypass Flow onto Subject Property)

Storm Water Runoff Summary:

	A.	B.	C.	D.	E.	F.	G.
Rainfall Return Frequency (yr.)	Existing Off-Site Runoff Rate DB 1 OFF (cfs)	Pre-Developed Undetained Runoff Rate DB PRE 1 (cfs)	Post-Developed Undetained Runoff Rate DB 1 (cfs)	Post-Developed Allowable Release Rate DB 1+DB 1 OFF (cfs)	Post-Developed Detention Basin Outlet Rate DB 1+DB 1 OFF (cfs)	Post-Developed Undetained Runoff Rate DB 1 UND (cfs)	Post-Developed (Post Const.) Release Rate POST (cfs)
1	1.6	1.2	3.0	***2.8***	*2.5*	0.7	***2.8***
2	2.1	1.8	3.7	***3.9***	*2.8*	0.9	***3.3***
5	3.0	2.9	5.0	***5.9***	*3.2*	1.3	***4.1***
100	7.1	9.2	11	***10***	*5.2*	3.1	***7.2***

Refer to the Pre-Developed and Post-Developed hydrographs for additional information.

A. This runoff rate reflects the off-site, existing condition that will is considered bypass.
B. This runoff rate reflects the on-site, pre-developed condition.
C. This runoff rate reflects the on-site, post-developed condition if no detention facilities were constructed.
D. This runoff rate reflects the allowable release rate from the site (DB PRE 1 Q_5 + DB 1 OFF Q_{100}).
E. This runoff rate reflects what is released from the detention basin prior to entering the public storm system.
F. This runoff rate reflects the on-site, post-developed undetained condition.
G. This runoff rate reflects the ultimate release rate from the site considering off-site bypass, on-site detained runoff, and on-site undetained runoff.

100-Year Post-Developed Allowable Release Rate = 10 cfs (DB PRE 1 Q_5 + DB 1 OFF Q_{100})

100-Year Post-Developed Actual Release Rate = 7.2 cfs (Referred to as "POST" within the Post-Developed Hydraflow Hydrographs hardcopies)

Detention Basin (UG DETENTION) Summary:

Refer to the attached Hydraflow Hydrograph reports for a detailed summary of the detention basin.

Basin Number	Drainage Area (ac.)	Orifice Opening (in. dia.)	Peak Outflow (cfs)	Outlet Elevation * (ft.)	100-Year Elevation * (ft.)	Volume 100-Year (cu. ft.)	Top of Pipe Elevation * (ft.)	Freeboard (ft.)
UG DETENTION	1.56	10.25	5.2	938.55	942.50	19,594	942.7	0.2

* Mean sea level

The outlet structure for the under ground detention basin will consist of a Nyloplast Drain Basin with Weir that will have an orifice opening equaling 10.25-inches in diameter. This opening will control the peak outflow rate of 5.2 cfs. Said outflow will enter the water quality unit and, after treatment, will discharge into the existing 36-inch reinforced concrete pipe (RCP) public storm sewer along 63rd Street.

Detention Basin (UG DETENTION) Provided Volume:

Elevation	Pipe Cross Sectional Area (sq. ft.)	HDPE Pipe Length (ft.)	HDPE Pipe Volume (cu. ft.)	Cumulative Pipe Volume (cu. ft.)	Cumulative Pipe Volume (ac.-ft.)
935.55	0.00	0	0	0	0.00
938.7	0.00	1,620	0	1	0.00
939.7	2.46	1,620	3,985	3,986	0.00
940.7	3.83	1,620	6,205	10,191	0.00
941.7	3.83	1,620	6,205	16,395	0.38
942.7	2.46	1,620	3,985	20,381	0.47

Average End Area Method Used to Calculate basin Volumes (Volume=((A+B)/2)*L)

Detention Basin Outlet Structure and Water Quality Unit Summary:

Oldcastle (Kristar) utilizes a proprietary spreadsheet (calculator) to compute the treated flow rate through the water quality unit. Their current calculator does not contain the Des Moines area rainfall data. Therefore, the closet rainfall data available is Kansas City. Based on the Kansas City data, a 2-year, 1-hour design intensity of 1.51 inches per hour, the water quality flow rate of 2.99 cfs should be treated. The water quality unit specified for this site is the DVS-72 which has a peak treated flow capacity of 4.25 cfs and a total flow capacity of 27 cfs. Based on the 10.25-inch orifice plate opening within the Nyloplast drain basin, which is upstream of the said water quality unit, the release rate from the said drain basin outlets the 1-year, 2-year, 5-year, and 100-year flow rates at 2.2 cfs, 2.6 cfs, 3.1 cfs, and 5.0 cfs, respectively. Therefore, it is assumed that, based on the on-site detainable volume of storm water, the 1.25-inch rainfall event is treated by the said water quality unit.

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Existing Time of Concentration:

Drainage Area: DB 1 OFF

Sheet Flow:

Flow length, L_1 =	100	feet
Land slope, s_1 =	2	% (Avg.)
Manning's n=	0.24	
2-Year 24-hr p_2=	3.08	
Travel time, t_1 =	14.5	minutes

Design Equation:

$$t_1 = \frac{0.007[(n)(L_1)]^{0.8}}{\sqrt{p_2}(s)^{0.4}}$$

Shallow Concentrated Flow:

Flow length, L_2 =	271	feet
Land slope, s_2 =	2.5	% (Avg.)
Ground Cover No. =	3	Table 1
Flow velocity, v_2 =	1.12	ft/sec
Travel time, t_2 =	4.0	minutes

Table 1:

Ground Cover:	No.	Equation
Forest w/ heavy ground litter & meadow	1	$v_2 = (s_2/2)^{1/2} \times 0.36$
Fallow or minimum tillage cultivation	2	$v_2 = (s_2/2)^{1/2} \times 0.66$
Short grass pasture & lawns	3	$v_2 = (s_2/2)^{1/2} \times 1.0$
Nearly bare ground	4	$v_2 = (s_2/2)^{1/2} \times 1.4$
Grassed waterway	5	$v_2 = (s_2/2)^{1/2} \times 2.2$
Paved area & shallow gutter flow	6	$v_2 = (s_2/2)^{1/2} \times 2.8$

Channel Flow:

Flow length, L_3 =		feet
Land slope, s_3 =		%
Manning's n =		
Left Slope =		:1
Bottom Width =		feet
Right Slope =		:1
Flow depth =		feet
Flow area, a =		ft^2
Wetted perim., P_w =		ft
Flow velocity, v_3 =		ft/sec
Travel time, t_3 =	0.0	minutes

Design Equation:

$$v_3 = \frac{1.486(a/P_w)^{2/3}s_3^{1/2}}{n}$$

q=

Pipe Flow:

Flow length, L_4 =		feet
Flow velocity, v_4 =		ft/sec
Travel time, t_4 =	0.0	minutes

Design Equation:

$$t_4 = \frac{L_4}{60(v_4)}$$

Time of Concentration, t_c = 18.6 **minutes**

$$t_c = t_1 + t_2 + t_3 + t_4$$

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Pre-Developed Time of Concentration:

Drainage Area: DB PRE 1

Sheet Flow:

Flow length, L_1 =	100	feet
Land slope, s_1 =	1.5	% (Avg.)
Manning's n=	0.24	
2-Year 24-hr p_2=	3.08	
Travel time, t_1 =	16.3	minutes

Design Equation:

$$t_1 = \frac{0.007[(n)(L_1)]^{0.8}}{\sqrt{p_2}(s)^{0.4}}$$

Shallow Concentrated Flow:

Flow length, L_2 =	182	feet
Land slope, s_2 =	3	% (Avg.)
Ground Cover No. =	3	Table 1
Flow velocity, v_2 =	1.22	ft/sec
Travel time, t_2 =	2.5	minutes

Table 1:

Ground Cover:	No.	Equation
Forest w/ heavy ground litter & meadow	1	$v_2 = (s_2/2)^{1/2} \times 0.36$
Fallow or minimum tillage cultivation	2	$v_2 = (s_2/2)^{1/2} \times 0.66$
Short grass pasture & lawns	3	$v_2 = (s_2/2)^{1/2} \times 1.0$
Nearly bare ground	4	$v_2 = (s_2/2)^{1/2} \times 1.4$
Grassed waterway	5	$v_2 = (s_2/2)^{1/2} \times 2.2$
Paved area & shallow gutter flow	6	$v_2 = (s_2/2)^{1/2} \times 2.8$

Channel Flow:

Flow length, L_3 =		feet
Land slope, s_3 =		%
Manning's n =		
Left Slope =		:1
Bottom Width =		feet
Right Slope =		:1
Flow depth =		feet
Flow area, a =		ft^2
Wetted perim., P_w =		ft
Flow velocity, v_3 =		ft/sec
Travel time, t_3 =	0.0	minutes

Design Equation:

$$v_3 = \frac{1.486(a/P_w)^{2/3}s_3^{1/2}}{n}$$

q=

Pipe Flow:

Flow length, L_4 =		feet
Flow velocity, v_4 =		ft/sec
Travel time, t_4 =	0.0	minutes

Design Equation:

$$t_4 = \frac{L_4}{60(v_4)}$$

Time of Concentration, t_c = 18.8 minutes

$$t_c = t_1 + t_2 + t_3 + t_4$$

Table 2B-3.01: Manning's Roughness Coefficient for Sheet Flow

Surface Description	***n***
Smooth Surface (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated Soils:	
Residue cover ≤ 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[1]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[2]	
Light underbrush	0.40
Dense underbrush	0.80

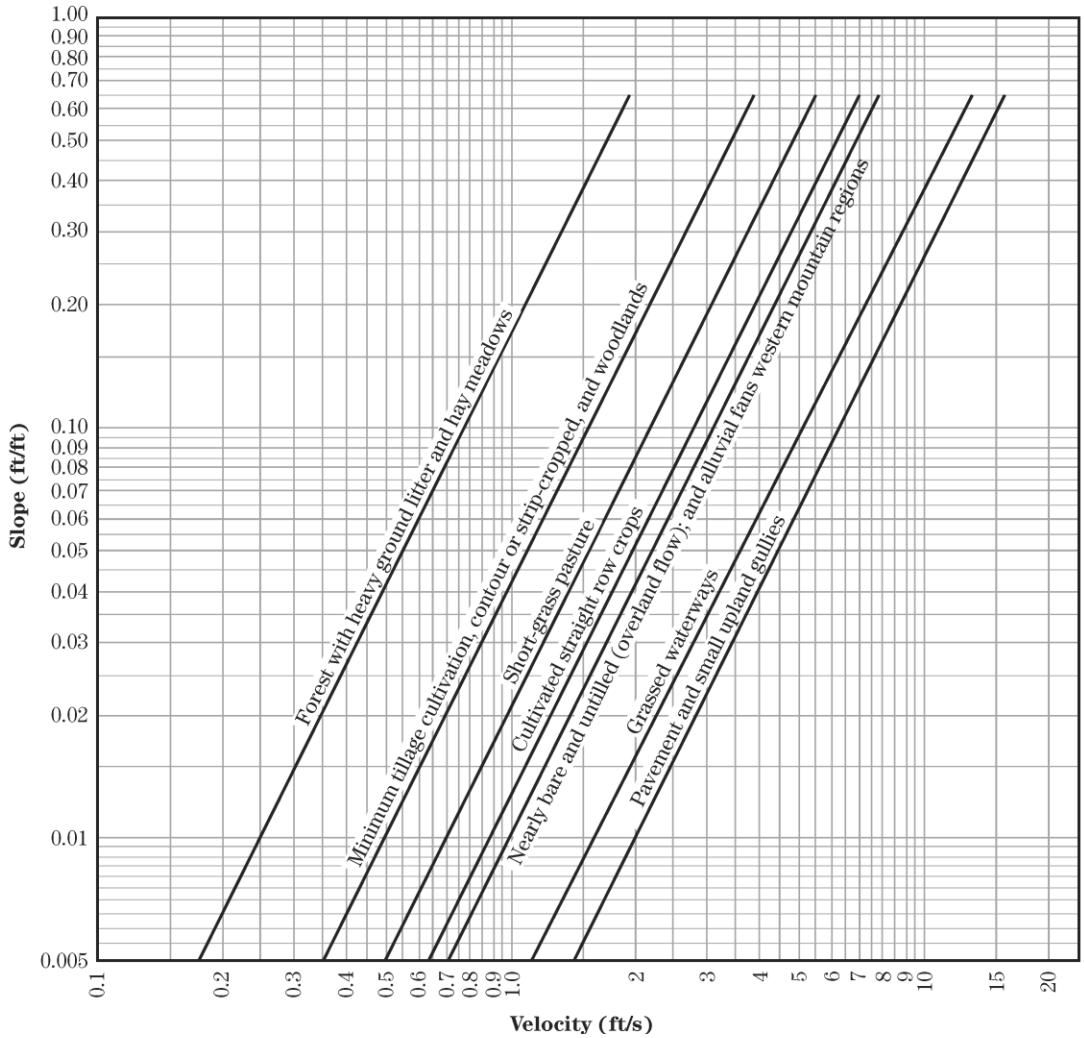
[1] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.

[2] When selecting n, consider cover to a height of about 0.1 foot. This is the only part of the plant cover that will obstruct sheet flow.

2. **Shallow Concentrated Flow:** After approximately 100 feet, sheet flow usually becomes shallow concentrated flow collecting in swales, small rills, and gullies. Shallow concentrated flow is assumed not to have a well-defined channel and has flow depth of 0.1 to 0.5 feet. It is assumed that shallow concentrated flow can be represented by one of seven flow types. These flow types are shown in Figure 2B-3.01 and Table 2B-3.02.

   After estimating average velocity using Figure 2B-3.01 or the equations from Table 2B-3.02, use Equation 2B-3.01 to estimate travel time for the shallow concentrated flow segment.

Figure 2B-3.01: Velocity Versus Slope for Shallow Concentrated Flow



Source: NRCS National Engineerining Handbook, Part 630, Chapter 15

Table 2B-3.02: Equations and Assumptions Developed from Figure 2B-3.01

Flow Type	**Depth (feet)**	**Manning's n**	**Velocity Equation (ft/s)**
Pavement and small upland gullies	0.2	0.025	$V = 20.238(s)^{0.5}$
Grassed waterways (and unpaved urban areas)	0.4	0.050	$V = 16.135(s)^{0.5}$
Nearly bare and untilled (overland flow); and alluvial fans	0.2	0.051	$V = 9.965(s)^{0.5}$
Cultivated straight row crops	0.2	0.058	$V = 8.762(s)^{0.5}$
Short-grass prairie	0.2	0.073	$V = 6.962(s)^{0.5}$
Minimum tillage cultivation, contour or strip-cropped, and woodlands	0.2	0.101	$V = 5.032(s)^{0.5}$
Forest with heavy ground litter and hay meadows	0.2	0.202	$V = 2.516(s)^{0.5}$

Table 2B-3.03: Manning's Roughness Coefficients (n) for Open Channel Flow

Type of Channel and Description	n
A. Closed Conduits Flowing Partly Full	
1. Steel - Riveted and Spiral	0.016
2. Cast Iron - Coated	0.013
3. Cast Iron - Uncoated	0.014
4. Corrugated Metal - Subdrain	0.019
5. Corrugated Metal - Storm Drain	0.024
6. Concrete Culvert, straight and fee of debris	0.011
7. Concrete Culvert, with bends, connections, and some debris	0.013
8. Concrete Sewer with manholes, inlet, etc., straight	0.015
9. Concrete, Unfinished, steel form	0.013
10. Concrete, Unfinished, smooth wood form	0.014
11. Wood - Stave	0.012
12. Clay - Vitrified sewer	0.014
13. Clay - Vitrified sewer with manholes, inlet, etc.	0.015
14. Clay - Vitrified subdrain with open joints	0.016
15. Brick - Glazed	0.013
16. Brick - Lined with cement mortar	0.015
B. Lined or Built-Up Channels	
1. Corrugated Metal	0.025
2. Wood - Planed	0.012
3. Wood - Unplaned	0.013
5. Concrete - Trowel finish	0.013
6. Concrete - Float finish	0.015
7. Concrete - Finished, with gravel on bottom	0.017
8. Concrete - Unfinished	0.017
9. Concrete Bottom Float Finished with sides of:	
a. Random stone in mortar	0.020
b. Cement rubble masonry	0.025
c. Dry ruble or rip rap	0.030
10. Gravel Bottom with sides of:	
a. Formed concrete	0.020
b. Dry rubble or rip rap	0.033
11. Brick - Glazed	0.013
12. Brick - In cement mortar	0.015
13. Masonry Cemented Rubble	0.025
14. Dry Rubble	0.032
15. Smooth Asphalt	0.013
16. Rough Asphalt	0.016
C. Excavated or Dredged Channel	
1. Earth, straight and uniform	
a. Clean, after weather	0.022
b. Gravel, uniform section, clean	0.025
c. With short grass, few weeds	0.027
2. Earth, winding and sluggish	
a. No vegetation	0.025
b. Grass, some weeds	0.030
c. Dense weeds or aquatic plants in deep channels	0.035
d. Earth bottom and rubble sides	0.030
e. Stony bottom and weedy banks	0.040
3. Channels not maintained, weeds and brush uncut	
a. Dense weeds, high as flow depth	0.080
b. Clean bottom, brush on sides	0.050
D. Natural Streams	
1. Clean, straight bank, full stage, no rifts or deep pools	0.030
2. As D.1 above, but some weeds and stones	0.035
3. Winding, some pools and shoals, clean	0.040
4. As D.3 above, but lower stages, more ineffective slope and sections	0.045
5. As D.3 above, but some weeds and stones	0.048
6. As D.4 above, but with stony sections	0.050
7. Sluggish river reaches, rather weedy or with very deep pools	0.070
8. Very weedy reaches	0.100

Source: Chow, V.T. 1959

B. Rainfall Frequency Analysis

In April 2013, the National Oceanic and Atmospheric Administration (NOAA) released "Atlas 14: Precipitation-Frequency Atlas of the United States, Volume 8." Volume 8 of this publication covers the Midwestern States, including Iowa, and supersedes "Bulletin 71: Rainfall Frequency Atlas of the Midwest" (1992) as the most current precipitation data available.

The Atlas 14 results are provided through NOAA's Precipitation Frequency Data Server (http://hdsc.nws.noaa.gov/hdsc/pfds). Based upon user input, the online database generates a precipitation-frequency estimate (PFE) for an individual location from the historical records of approximately 280 precipitation recording stations across the State of Iowa.

The location-specific PFE attribute of Atlas 14 means that precipitation-frequency estimates could be generated for each community or even each individual project, resulting in hundreds or even thousands of PFE's across Iowa. This situation would be both inefficient for designers and impractical for reviewers.

To avoid this dilemma, regional intensity-duration-frequency (IDF) tables corresponding to the nine Iowa climatic sections in Bulletin 71 were developed. Utilizing Atlas 14, PFE's were obtained at each county seat. The county values within each climatic section were then averaged to represent the section as a whole. The resulting IDF values for each climatic section are provided in Tables 2B-2.02 through 2B-2.10 below.

Figure 2B-2.01: Climatic Sectional Codes for Iowa

1 - Northwest
2 - North Central
3 - Northeast
4 - West Central
5 - Central
6 - East Central
7 - Southwest
8 - South Central
9 - Southeast

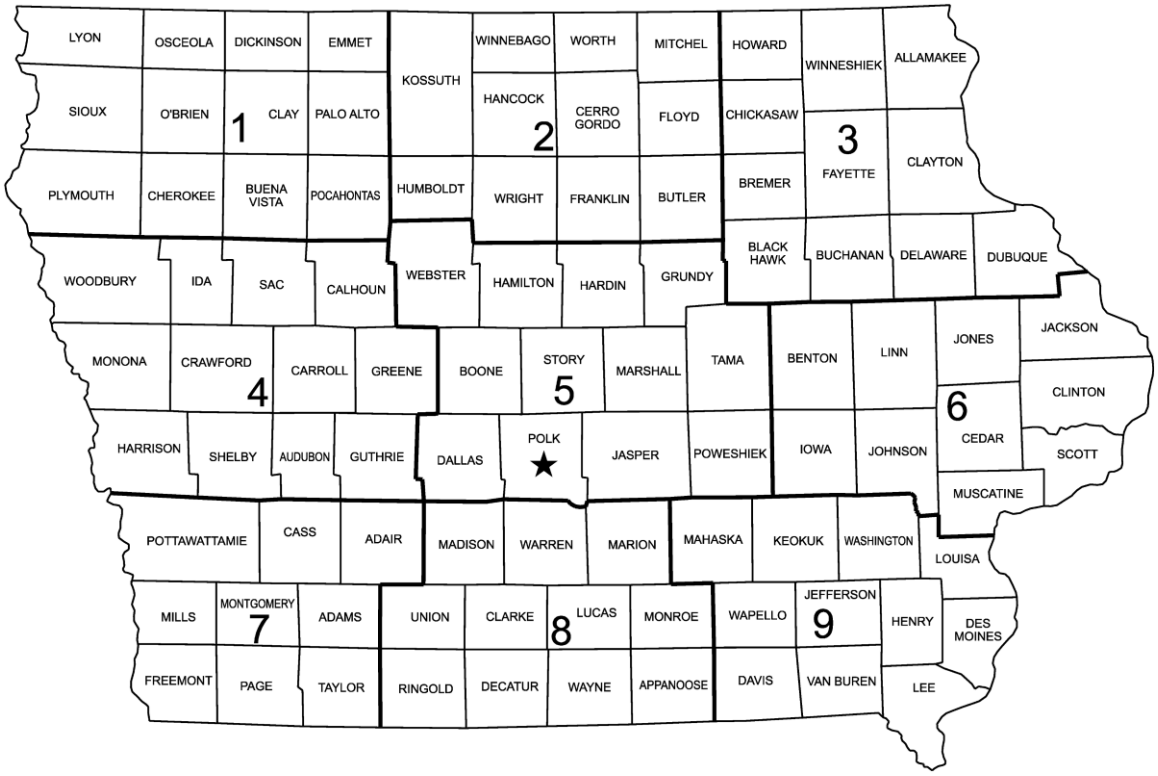
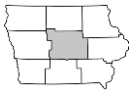


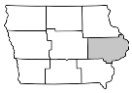
Table 2B-2.06: Section 5 - Central Iowa
Rainfall Depth and Intensity for Various Return Periods



	Return Period															
	1 year		***2 year***		***5 year***		***10 year***		***25 year***		***50 year***		***100 year***		***500 year***	
Duration	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***
5 min	0.39	4.78	0.46	5.59	0.57	6.91	0.67	8.1	0.81	9.76	0.92	11.1	1.04	12.4	1.33	15.9
10 min	0.58	3.51	0.68	4.08	0.84	5.08	0.98	5.92	1.19	7.16	1.35	8.13	1.52	9.15	1.94	11.6
15 min	0.71	2.84	0.83	3.32	1.03	4.12	1.20	4.82	1.45	5.81	1.65	6.61	1.86	7.44	2.37	9.50
30 min	0.99	1.99	1.16	2.33	1.45	2.91	1.70	3.40	2.05	4.11	2.34	4.68	2.63	5.27	3.36	6.73
1 hr	1.29	1.29	1.51	1.51	1.89	1.89	2.23	2.23	2.72	2.72	3.13	3.13	3.55	3.55	4.62	4.62
2 hr	1.58	0.79	1.85	0.92	2.33	1.16	2.76	1.38	3.39	1.69	3.91	1.95	4.46	2.23	5.88	2.94
3 hr	1.75	0.58	2.06	0.68	2.60	0.86	3.09	1.03	3.82	1.27	4.42	1.47	5.07	1.69	6.76	2.25
6 hr	2.05	0.34	2.40	0.40	3.03	0.50	3.61	0.60	4.47	0.74	5.20	0.86	5.98	0.99	8.02	1.33
12 hr	2.34	0.19	2.74	0.22	3.44	0.28	4.07	0.33	5.01	0.41	5.79	0.48	6.62	0.55	8.79	0.73
24 hr	2.67	0.11	3.08	0.12	3.81	0.15	4.46	0.18	5.44	0.22	6.26	0.26	7.12	0.29	9.37	0.39
48 hr	3.06	0.06	3.49	0.07	4.25	0.08	4.94	0.10	5.96	0.12	6.81	0.14	7.71	0.16	10.0	0.20
3 day	3.34	0.04	3.81	0.05	4.63	0.06	5.36	0.07	6.43	0.08	7.31	0.10	8.25	0.11	10.6	0.14
4 day	3.59	0.03	4.09	0.04	4.96	0.05	5.74	0.05	6.86	0.07	7.78	0.08	8.74	0.09	11.1	0.11
7 day	4.25	0.02	4.83	0.02	5.82	0.03	6.69	0.03	7.93	0.04	8.93	0.05	9.98	0.05	12.5	0.07
10 day	4.87	0.02	5.50	0.02	6.58	0.02	7.52	0.03	8.86	0.03	9.94	0.04	11.0	0.04	13.8	0.05

D = Total depth of rainfall for given storm duration (inches)
I = Rainfall intensity for given storm duration (inches/hour)

Table 2B-2.07: Section 6 - East Central Iowa
Rainfall Depth and Intensity for Various Return Periods



	Return Period															
	1 year		***2 year***		***5 year***		***10 year***		***25 year***		***50 year***		***100 year***		***500 year***	
Duration	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***	***D***	***I***
5 min	0.38	4.56	0.44	5.30	0.54	6.56	0.63	7.65	0.76	9.18	0.86	10.3	0.97	11.6	1.23	14.8
10 min	0.55	3.33	0.64	3.87	0.8	4.8	0.93	5.58	1.11	6.70	1.26	7.60	1.42	8.54	1.80	10.8
15 min	0.67	2.70	0.78	3.14	0.97	3.88	1.13	4.53	1.36	5.45	1.54	6.18	1.73	6.94	2.20	8.81
30 min	0.95	1.90	1.11	2.22	1.38	2.76	1.61	3.22	1.94	3.88	2.20	4.40	2.47	4.95	3.14	6.29
1 hr	1.23	1.23	1.44	1.44	1.80	1.80	2.11	2.11	2.58	2.58	2.96	2.96	3.36	3.36	4.37	4.37
2 hr	1.51	0.75	1.77	0.88	2.22	1.11	2.62	1.31	3.22	1.61	3.71	1.85	4.24	2.12	5.60	2.80
3 hr	1.68	0.56	1.96	0.65	2.47	0.82	2.93	0.97	3.63	1.21	4.22	1.40	4.85	1.61	6.50	2.16
6 hr	1.97	0.32	2.30	0.38	2.89	0.48	3.45	0.57	4.3	0.71	5.02	0.83	5.8	0.96	7.87	1.31
12 hr	2.28	0.19	2.65	0.22	3.31	0.27	3.93	0.32	4.88	0.40	5.68	0.47	6.56	0.54	8.87	0.73
24 hr	2.60	0.10	3.01	0.12	3.75	0.15	4.42	0.18	5.44	0.22	6.29	0.26	7.22	0.30	9.64	0.40
48 hr	2.98	0.06	3.43	0.07	4.22	0.08	4.93	0.10	6.01	0.12	6.90	0.14	7.86	0.16	10.3	0.21
3 day	3.28	0.04	3.72	0.05	4.51	0.06	5.24	0.07	6.32	0.08	7.22	0.10	8.19	0.11	10.7	0.14
4 day	3.53	0.03	3.98	0.04	4.78	0.04	5.50	0.05	6.58	0.06	7.49	0.07	8.46	0.08	10.9	0.11
7 day	4.17	0.02	4.67	0.02	5.53	0.03	6.29	0.03	7.39	0.04	8.30	0.04	9.25	0.05	11.6	0.06
10 day	4.75	0.01	5.30	0.02	6.24	0.02	7.04	0.02	8.20	0.03	9.12	0.03	10.0	0.04	12.4	0.05

D = Total depth of rainfall for given storm duration (inches)
I = Rainfall intensity for given storm duration (inches/hour)

Table 2B-4.01: Runoff Coefficients for the Rational Method

Cover Type and Hydrologic Condition		Runoff Coefficients for Hydrologic Soil Group											
		A			***B***			***C***			***D***		
Recurrence Interval		***5***	***10***	***100***	***5***	***10***	***100***	***5***	***10***	***100***	***5***	***10***	***100***
Open Space (lawns, parks, golf courses, cemeteries, etc.)													
Poor condition (grass cover < 50%)		.25	.30	.50	.45	.55	.65	.65	.70	.80	.70	.75	.85
Fair condition (grass cover 50% to 75%)		.10	.10	.15	.25	.30	.50	.45	.55	.65	.60	.65	.75
Good condition (grass cover >75%)		.05	.05	.10	.15	.20	.35	.35	.40	.55	.50	.55	.65
Impervious Areas													
Parking lots, roofs, driveways, etc. (excluding ROW)		.95	.95	.98	.95	.95	.98	.95	.95	.98	.95	.95	.98
Streets and roads:													
Paved; curbs & storm sewers (excluding ROW)		.95	.95	.98	.95	.95	.98	.95	.95	.98	.95	.95	.98
Paved; open ditches (including ROW)		---	---	---	.70	.75	.85	.80	.85	.90	.80	.85	.90
Gravel (including ROW)		---	---	---	.60	.65	.75	.70	.75	.85	.75	.80	.85
Dirt (including ROW)		---	---	---	.55	.60	.70	.65	.70	.80	.70	.75	.85
Urban Districts (excluding ROW)													
Commercial and business (85% impervious)		---	---	---	---	---	---	.85	.85	.90	.90	.90	.95
Industrial (72% impervious)		---	---	---	---	---	---	.80	.80	.85	.80	.85	.90
Residential Districts by Average Lot Size (excluding ROW)[1]													
1/8 acre (36% impervious)		---	---	---	---	---	---	.55	.60	.70	.65	.70	.75
1/4 acre (36% impervious)		---	---	---	---	---	---	.55	.60	.70	.65	.70	.75
1/3 acre (33% impervious)		---	---	---	---	---	---	.55	.60	.70	.65	.70	.75
1/2 acre (20% impervious)		---	---	---	---	---	---	.45	.50	.65	.60	.65	.70
1 acre (11% impervious)		---	---	---	---	---	---	.40	.45	.60	.55	.60	.65
2 acres (11% impervious)		---	---	---	---	---	---	.40	.45	.60	.55	.60	.65
Newly Graded Areas (pervious areas only, no vegetation)													
Agricultural and Undeveloped													
Meadow - protected from grazing (pre-settlement)		.10	.10	.25	.10	.15	.30	.30	.35	.55	.45	.50	.65
Straight Row Crops													
Straight Row (SR)	*Poor Condition*	.33	.39	.55	.52	.58	.71	.70	.74	.84	.78	.81	.89
	Good Condition	.24	.30	.46	.45	.51	.66	.62	.67	.78	.73	.76	.86
SR + Crop Residue (CR)	*Poor Condition*	.31	.37	.54	.50	.56	.70	.67	.72	.82	.75	.79	.87
	Good Condition	.19	.25	.41	.38	.45	.61	.55	.60	.73	.62	.67	.78
Contoured (C).....	*Poor Condition*	.29	.35	.52	.47	.53	.70	.60	.65	.77	.70	.74	.84
	Good Condition	.21	.26	.43	.38	.45	.61	.55	.60	.73	.65	.69	.80
C+CR.....	*Poor Condition*	.27	.33	.50	.45	.51	.66	.57	.63	.75	.67	.72	.82
	Good Condition	.19	.25	.41	.36	.43	.59	.52	.58	.71	.62	.67	.78
Contoured & Terraced (C&T)	*Poor Condition*	.22	.28	.45	.36	.43	.59	.50	.56	.70	.55	.60	.73
	Good Condition	.16	.22	.38	.31	.37	.54	.45	.51	.66	.52	.58	.71
C&T + CR	*Poor Condition*	.13	.19	.35	.31	.37	.54	.45	.51	.66	.52	.58	.71
	Good Condition	.10	.16	.32	.27	.33	.50	.43	.49	.65	.50	.56	.70

[1] The average percent impervious area shown was used to develop composite coefficients.

Note: Rational coefficients were derived from SCS CN method

b. Composite Runoff Analysis: Care should be taken not to average runoff coefficients for large segments that have multiple land uses of a wide variety (i.e., business to agriculture). However, within similar land uses, it is often desirable to develop a composite runoff coefficient based on the percentage of different types of surface in the drainage area. The composite procedure can be applied to an entire drainage area, or to typical sample blocks as a guide to selection of reasonable values of the coefficient for an entire area.

Table 2B-4.03: Runoff Curve Numbers for Urban Areas[1]

Cover Type and Hydrologic Condition	Average Percent Impervious Area[2]	CN's for Hydrologic Soil Group			
		A	*B*	*C*	*D*
Fully Developed Urban Areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.):[3]					
Poor condition (grass cover < 50%)	----------	68	79	86	89
Fair condition (grass cover 50% to 75%)	----------	49	69	79	84
Good condition (grass cover >75%)	----------	39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)	----------	98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)	----------	98	98	98	98
Paved; open ditches (including right-of-way)	----------	83	89	92	93
Gravel (including right-of-way)	----------	76	85	89	91
Dirt (including right-of-way)	----------	72	82	87	89
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town homes)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing Urban Areas					
Newly graded areas (pervious areas only, no vegetation)[4]	----------	77	86	91	94
Idle lands (CN's are determined using cover types similar to those in Table 2B-4.01)					

[1] Average runoff condition and I_a=0.2S

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using Figures 2B-4.01 or 2B-4.02.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's to use for the design of temporary measures during grading and construction should be computed using Figures 2B-4.01 or 2B-4.02 based upon the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Source: NRCS National Engineering Handbook, Part 630, Chapter 9

Table 2B-4.04: Runoff Curve Numbers for Cultivated Agricultural Lands[1]

Cover Description			CN's for Hydrologic Soil Group			
Cover Type	***Treatment***[2]	***Hydrologic Condition***[3]	***A***	***B***	***C***	***D***
Fallow	Bare Soil	---	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row Crops	Straight Row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small Grain	Straight Row (SR)	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	Contoured (C)	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	Contoured & terraced (C&T)	Poor	61	72	79	82
		Good	59	70	78	81
	C&T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close Seeded or Broadcast Legumes or Rotation Meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition and I_a=0.2S
[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.
[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good $\geq$20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Source: NRCS National Engineering Handbook, Part 630, Chapter 9

Table 2B-4.05: Runoff Curve Numbers for Other Agricultural Lands[1]

Cover Description		**CN's for Hydrologic Soil Group**			
Cover Type	***Hydrologic Condition[3]***	***A***	***B***	***C***	***D***
Pasture, grassland, or range - continuous forage for grazing[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow - continuous grass, protected from grazing and generally mowed for hay	---	30	58	71	78
Brush - brush-weed-grass mixture with brush the major element[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods - grass combination (orchard or tree farm)[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30	55	70	77
Farmsteads - buildings, lanes, driveways, and surrounding lots	---	59	74	82	86

[1] Average runoff condition and I_a=0.2S.
[2] *Poor*: <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.
[3] *Poor*: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.
[4] Actual curve number is less than 30; use CN = 30 for runoff computations
[5] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.
[6] *Poor*: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed, but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing and litter and brush adequately cover the soil

2. **SCS Depth of Runoff:** Depth of runoff may be calculated through the SCS Curve Number Method. This method separates total rainfall into direct runoff, retention, and initial abstraction to yield the following equation for rainfall runoff.

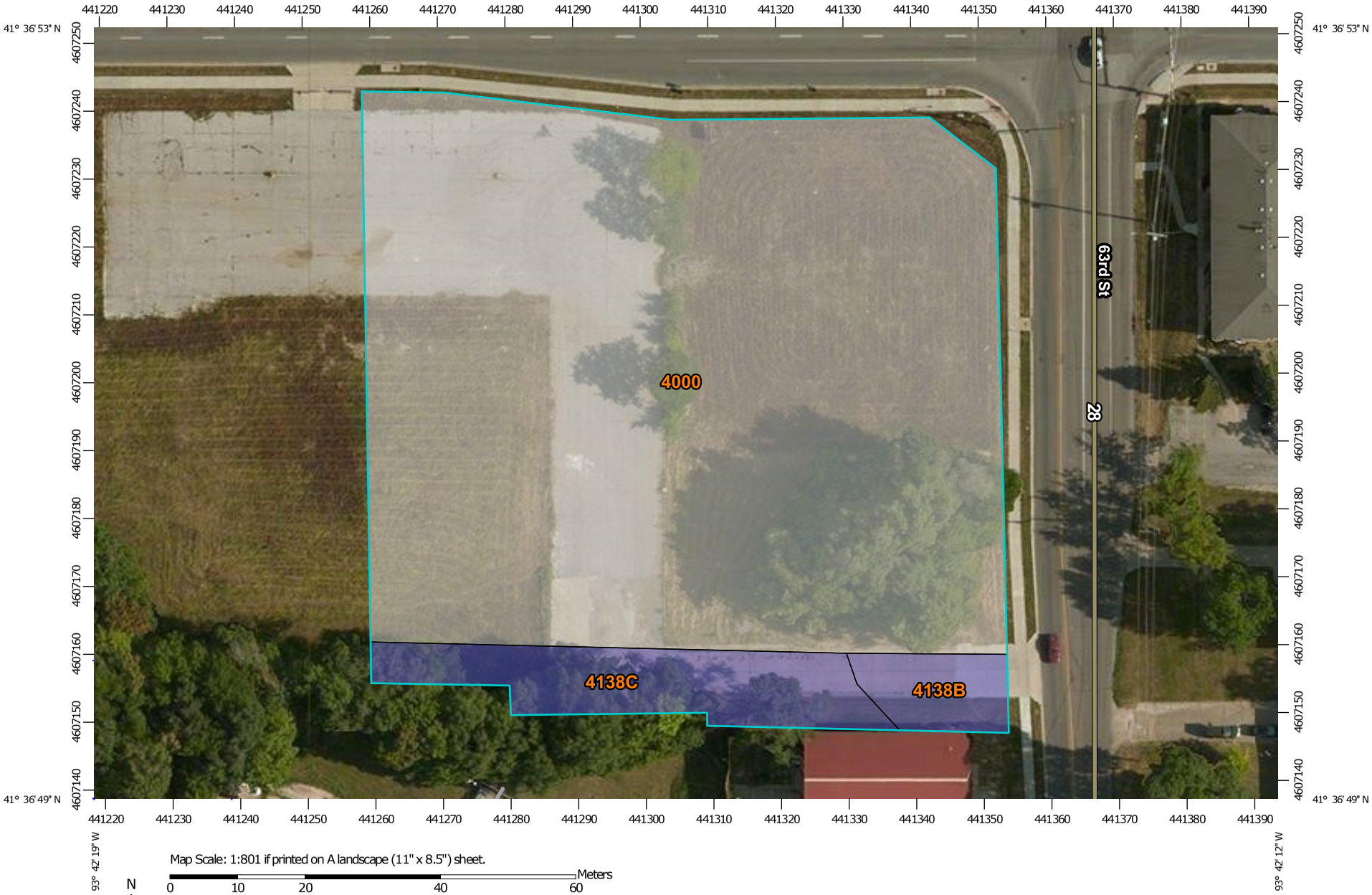
$$Q = \frac{(P-I_a)^2}{(P-I_a)+S}$$ **Equation 2B-4.04**

where:

Q = Depth of direct runoff, in
P = Depth of 24 hour precipitation, in. for design year storm (e.g. 10 year, 24 hour)
S = Potential maximum retention after runoff begins, in
I_a = Initial abstraction, in

The initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration during the early part of the storm. Interception and surface depression storage may be estimated from cover and surface conditions, but infiltration during the early part of the storm is highly variable and dependent on such factors as rainfall intensity, soil crusting, and soil moisture. Establishing a relationship for I_a

Hydrologic Soil Group—Polk County, Iowa
(QT 504)



Map Scale: 1:801 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 10 20 40 60

Feet: 0 35 70 140 210

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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 1:12,000.

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: Polk County, Iowa
Survey Area Data: Version 17, Sep 15, 2015

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

Date(s) aerial images were photographed: Jul 18, 2013—Aug 17, 2013

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.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Polk County, Iowa (IA153)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
4000	Urban land		1.8	89.1%
4138B	Clarion-Urban land complex, 2 to 5 percent slopes	B	0.1	2.8%
4138C	Clarion-Urban land complex, 5 to 9 percent slopes	B	0.2	8.1%
Totals for Area of Interest			**2.1**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

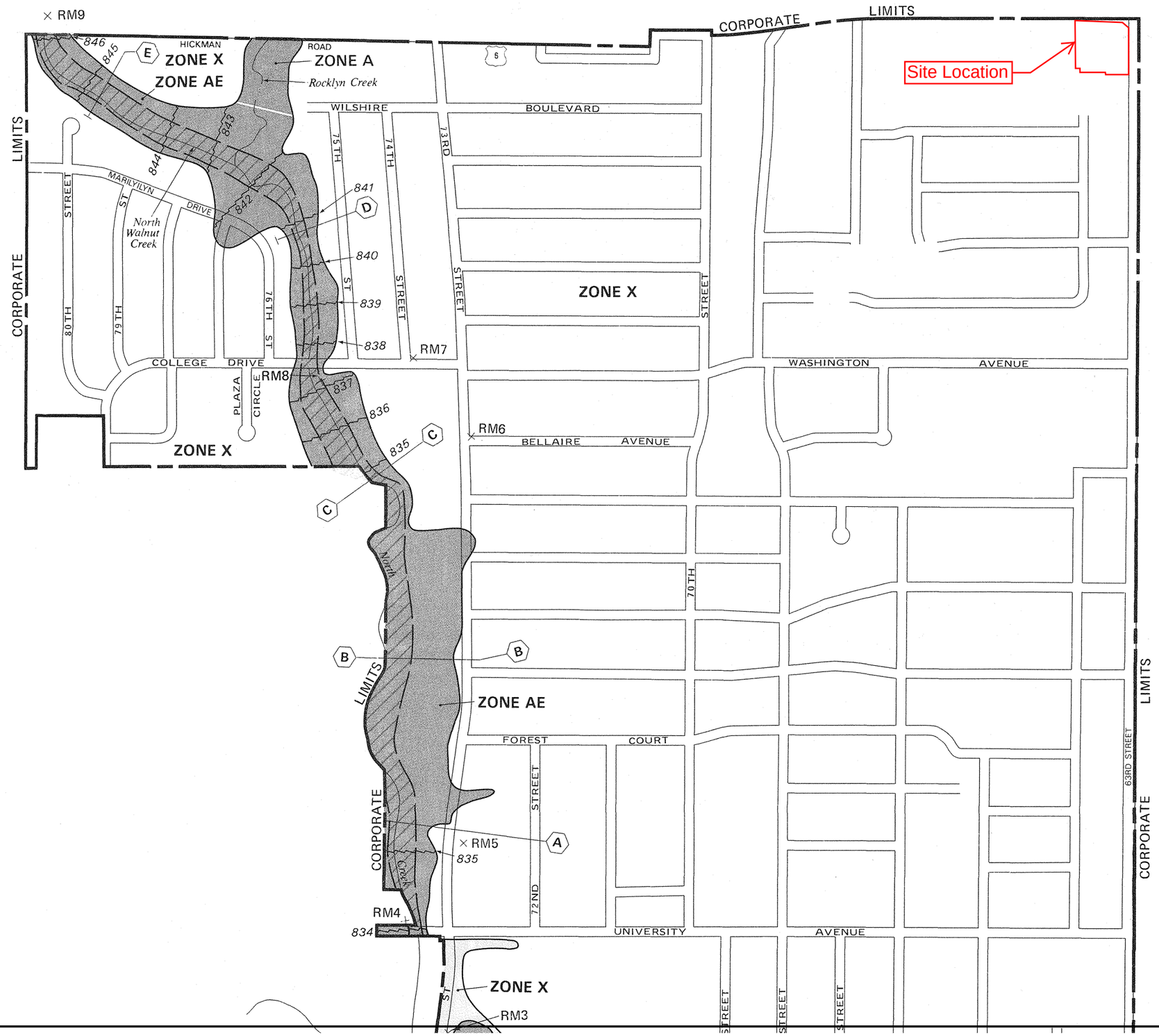
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher



APPROXIMATE SCALE IN FEET

600 0 600

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

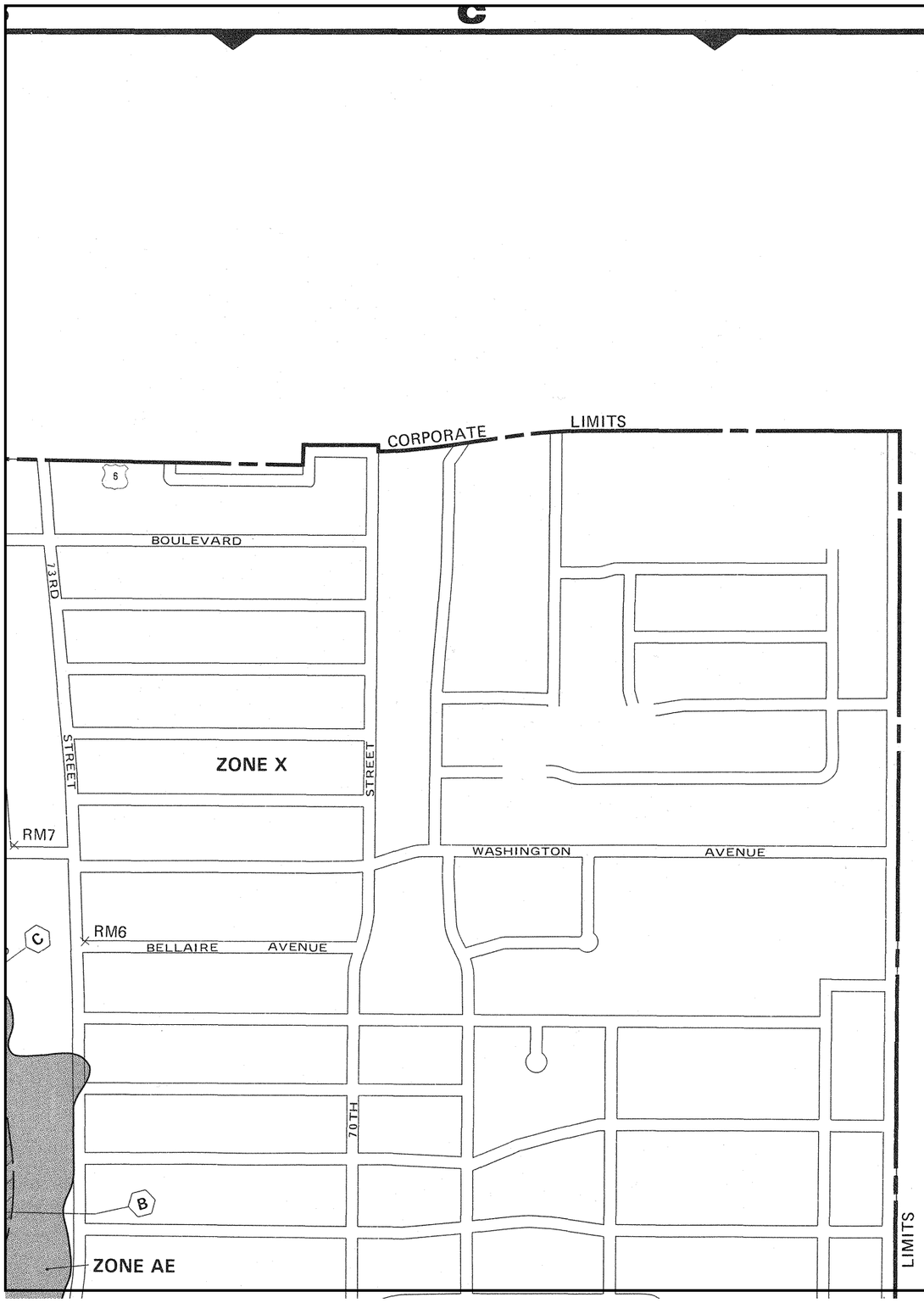
CITY OF
WINDSOR HEIGHTS,
IOWA
POLK COUNTY

(ONLY PANEL PRINTED)

COMMUNITY–PANEL NUMBER:
190687 0001 B
MAP REVISED:
OCTOBER 16, 1992

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

- **ZONE A** No base flood elevations determined.
- **ZONE AE** Base flood elevations determined.
- **ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
- **ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- **ZONE A99** To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.
- **ZONE V** Coastal flood with velocity hazard (wave action); no base flood elevations determined.
- **ZONE VE** Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

- **ZONE X** Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

- **ZONE X** Areas determined to be outside 500-year flood plain.
- **ZONE D** Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zone.

567 — Base Flood Elevation Line; Elevation in Feet*

A — A — Cross Section Line

(EL 19) — Base Flood Elevation in Feet Where Uniform Within Zone*

RM5 × — Elevation Reference Mark

M3.0 • — Mile Mark

*Referenced to the National Geodetic Vertical Datum of 1929

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all planimetric features outside Special Flood Hazard Area or all areas subject to flooding, particularly from local drainage sources of small size.

Areas of Special Flood Hazard (100-year flood) include zones, A, AE, A1–A30, AH, AO, A99, V, VE and V1–V30.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Refer to Floodway Data Table where floodway width is shown at 1/20 inch.

Coastal base flood elevations apply only landward of the shoreline.

This map incorporates approximate boundaries of coastal barriers established under the Coastal Barrier Resources Act (PL 97–348).

Elevation reference marks are described in the Flood Insurance Study Report.

APPROXIMATE SCALE IN FEET

600 0 600

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

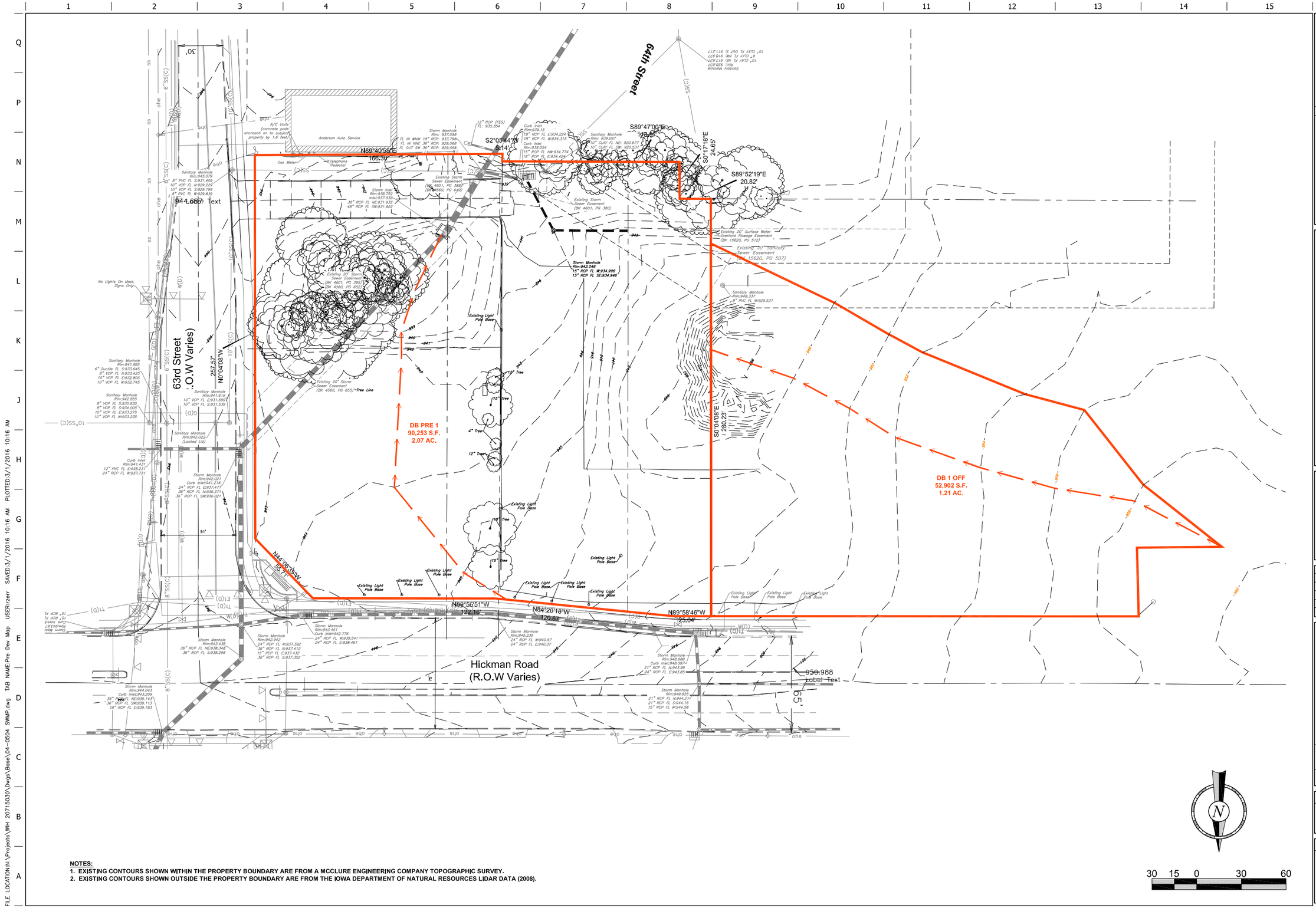
CITY OF
WINDSOR HEIGHTS,
IOWA
POLK COUNTY

(ONLY PANEL PRINTED)

COMMUNITY–PANEL NUMBER:
190687 0001 B
MAP REVISED:
OCTOBER 16, 1992

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



NOTES:

1. EXISTING CONTOURS SHOWN WITHIN THE PROPERTY BOUNDARY ARE FROM A MCCLURE ENGINEERING COMPANY TOPOGRAPHIC SURVEY.
2. EXISTING CONTOURS SHOWN OUTSIDE THE PROPERTY BOUNDARY ARE FROM THE IOWA DEPARTMENT OF NATURAL RESOURCES LIDAR DATA (2008).

30 15 0 30 60

PRELIMINARY

PROJECT NO.: 20215023

McCLURE ENGINEERING Co
building strong communities.
1360 NW 121ST. Street
Clive, Iowa 50325
515-964-1229
fax 515-964-2370

QuikTrip No. 0504

63RD & HICKMAN
WINDSOR HEIGHTS, IA

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PROTOTYPE: P-85 (11/01/15)
DIVISION: 04
VERSION: 001
DESIGNED BY:
DRAWN BY: KSR
REVIEWED BY:

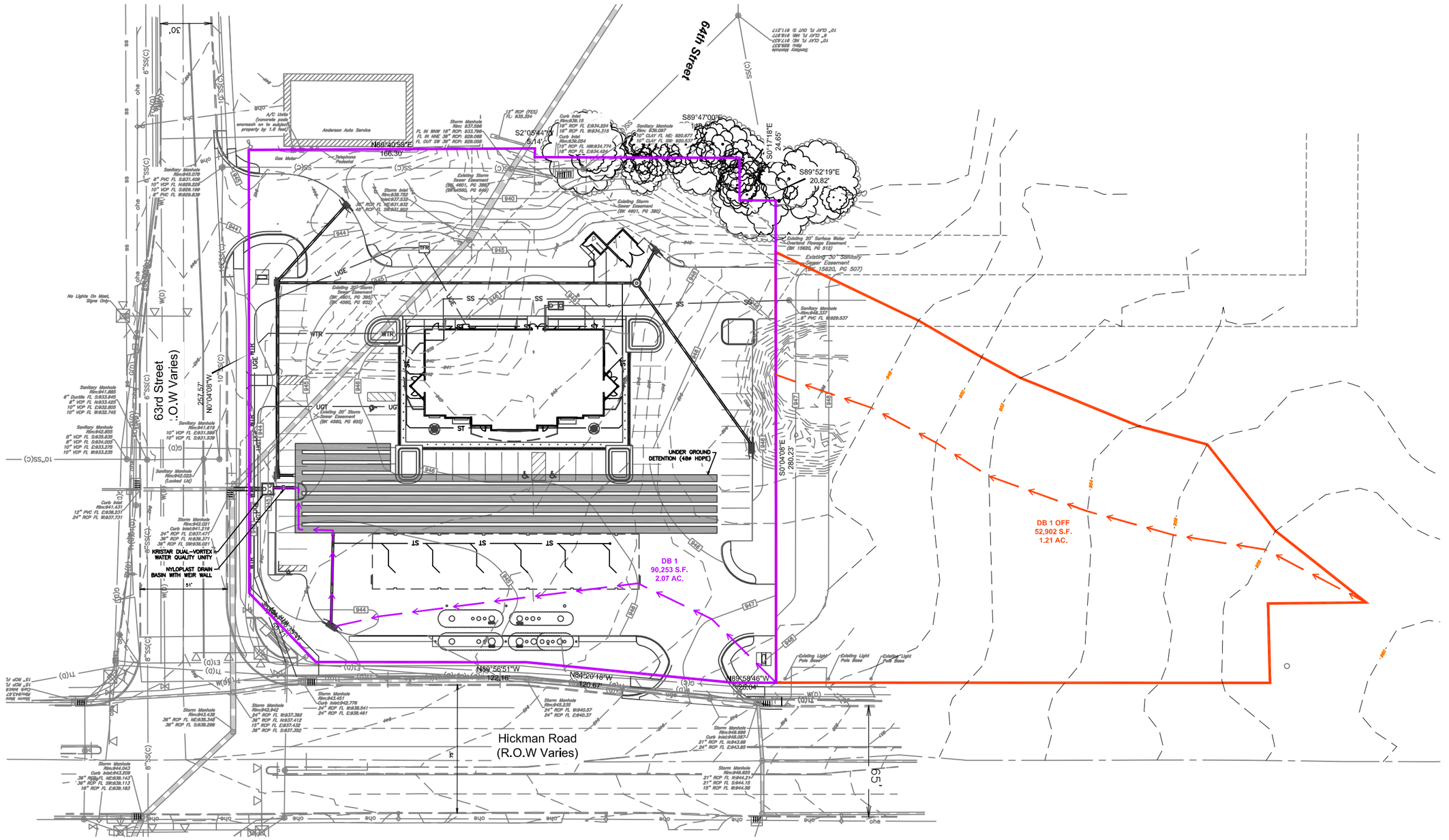
REV	DATE	DESCRIPTION

ORIGINAL ISSUE DATE: 02-29-16

SHEET TITLE:
EXISTING AND PRE-DEVELOPED CONDITION MAP

SHEET NUMBER:
23

FILE LOCATION:N:\Projects\WIH 20715030\Dwgs\Base\04-0504 SWMP.dwg TAB NAME:Pre Dev Map USER:rzerr SAVED:3/1/2016 10:16 AM PLOTTED:3/1/2016 10:16 AM



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PROTOTYPE: P-85 (11/01/15)
DIVISION: 04
VERSION: 001
DESIGNED BY:
DRAWN BY: KSR
REVIEWED BY:

REV	DATE	DESCRIPTION

ORIGINAL ISSUE DATE: 02-29-16

SHEET TITLE:
POST-DEVELOPED CONDITION MAP

SHEET NUMBER:
24

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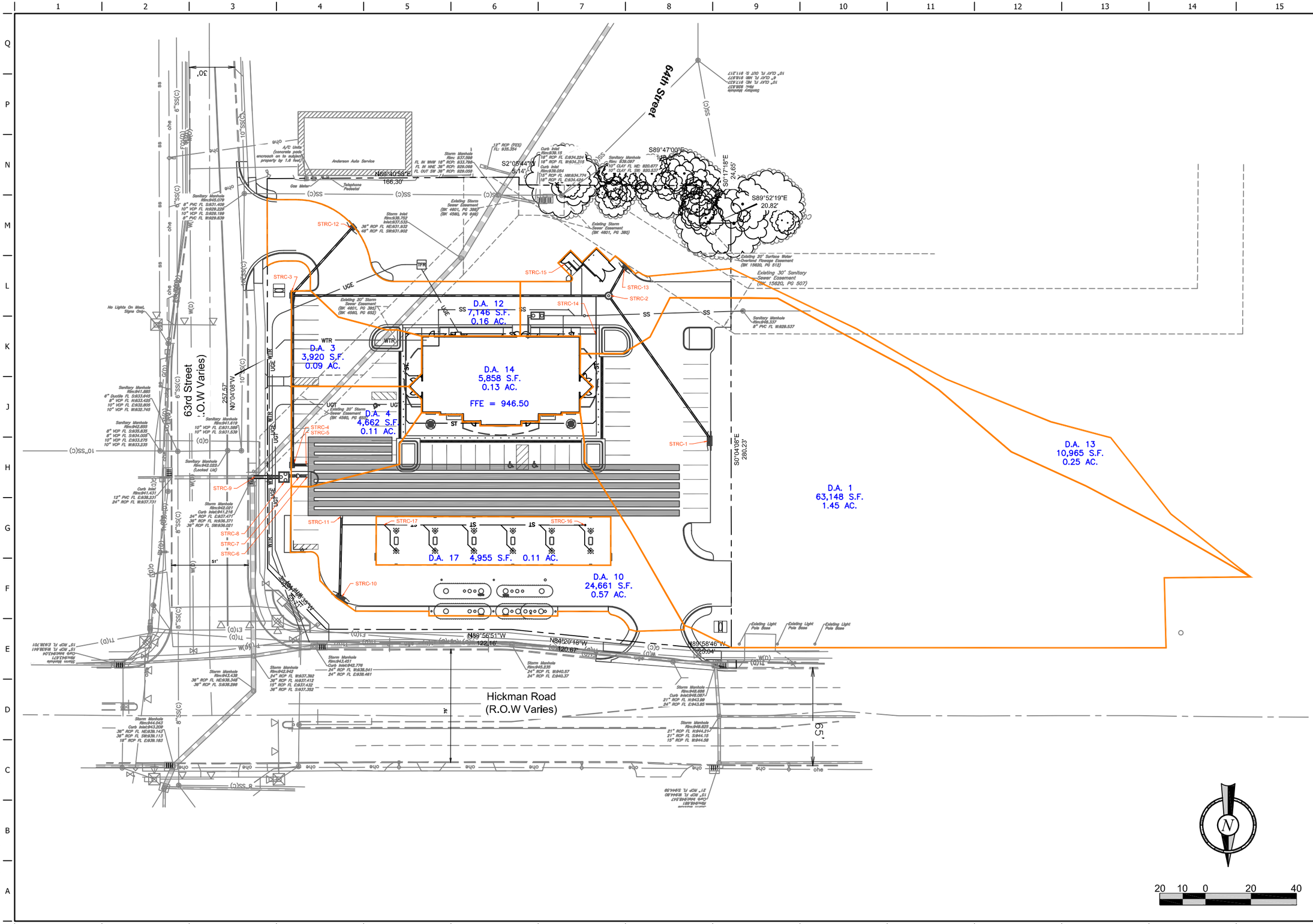

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PROTOTYPE: P-85 (11/01/15)
DIVISION: 04
VERSION: 001
DESIGNED BY:
DRAWN BY: KSR
REVIEWED BY:

REV	DATE	DESCRIPTION

ORIGINAL ISSUE DATE: 01-29-16

SHEET TITLE:

STORM SEWER DRAINAGE MAP

SHEET NUMBER:

25

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Section 2 – Existing and Pre-Developed Runoff Analysis

QuikTrip Store #504

City of Windsor Heights, County of Polk, State of Iowa

McCLURE™
ENGINEERING Co.

Hydraflow Table of Contents

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Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Legend

Hyd.	Origin	Description
1	SCS Runoff	DB 1 OFF

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	1.646	2.114	-------	2.981	-------	-------	-------	7.095	DB 1 OFF

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.646	2	724	5,209	------	------	------	DB 1 OFF

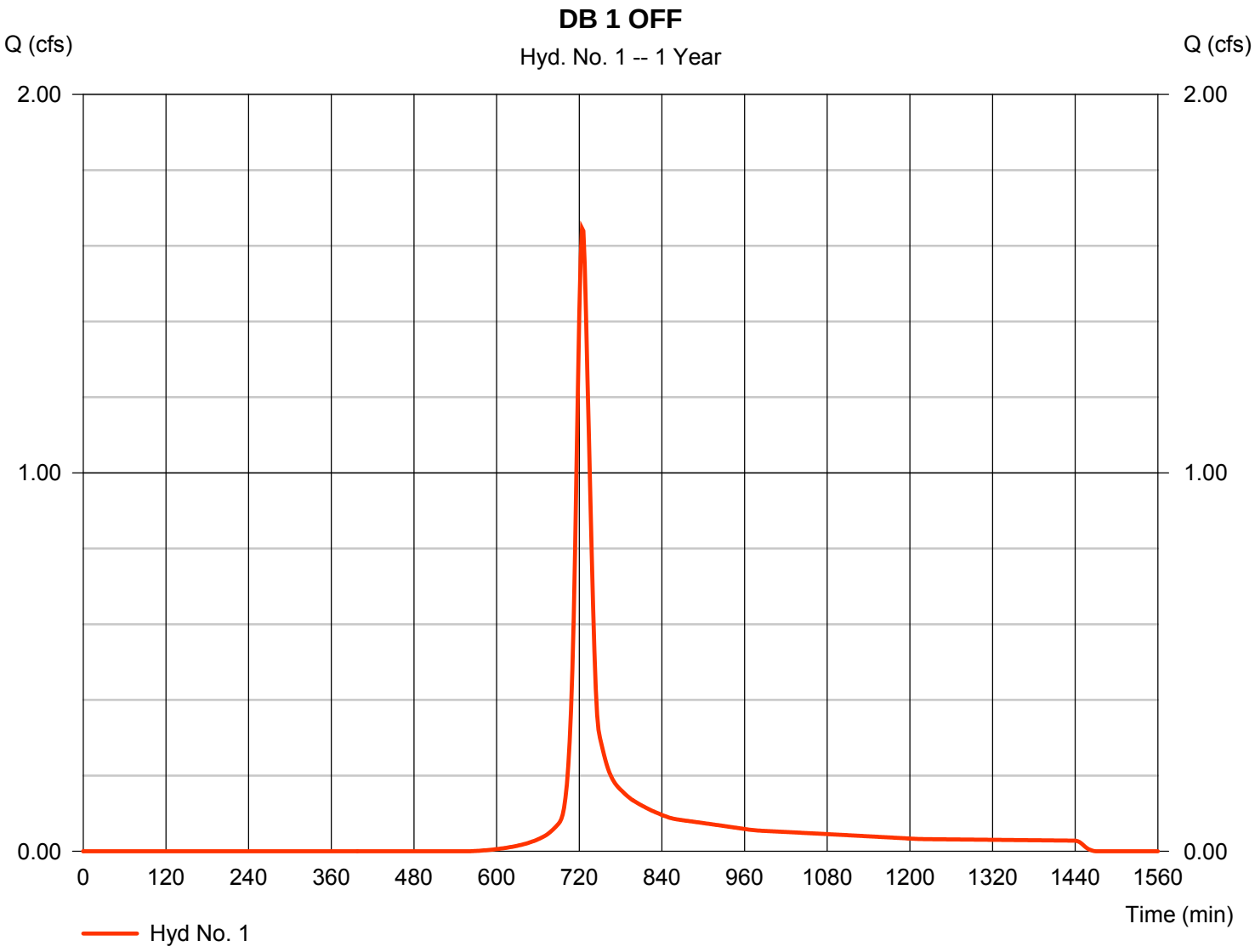
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 1

DB 1 OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 1.646 cfs
Storm frequency	= 1 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 5,209 cuft
Drainage area	= 1.210 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.60 min
Total precip.	= 2.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.114	2	724	6,638	------	------	------	DB 1 OFF

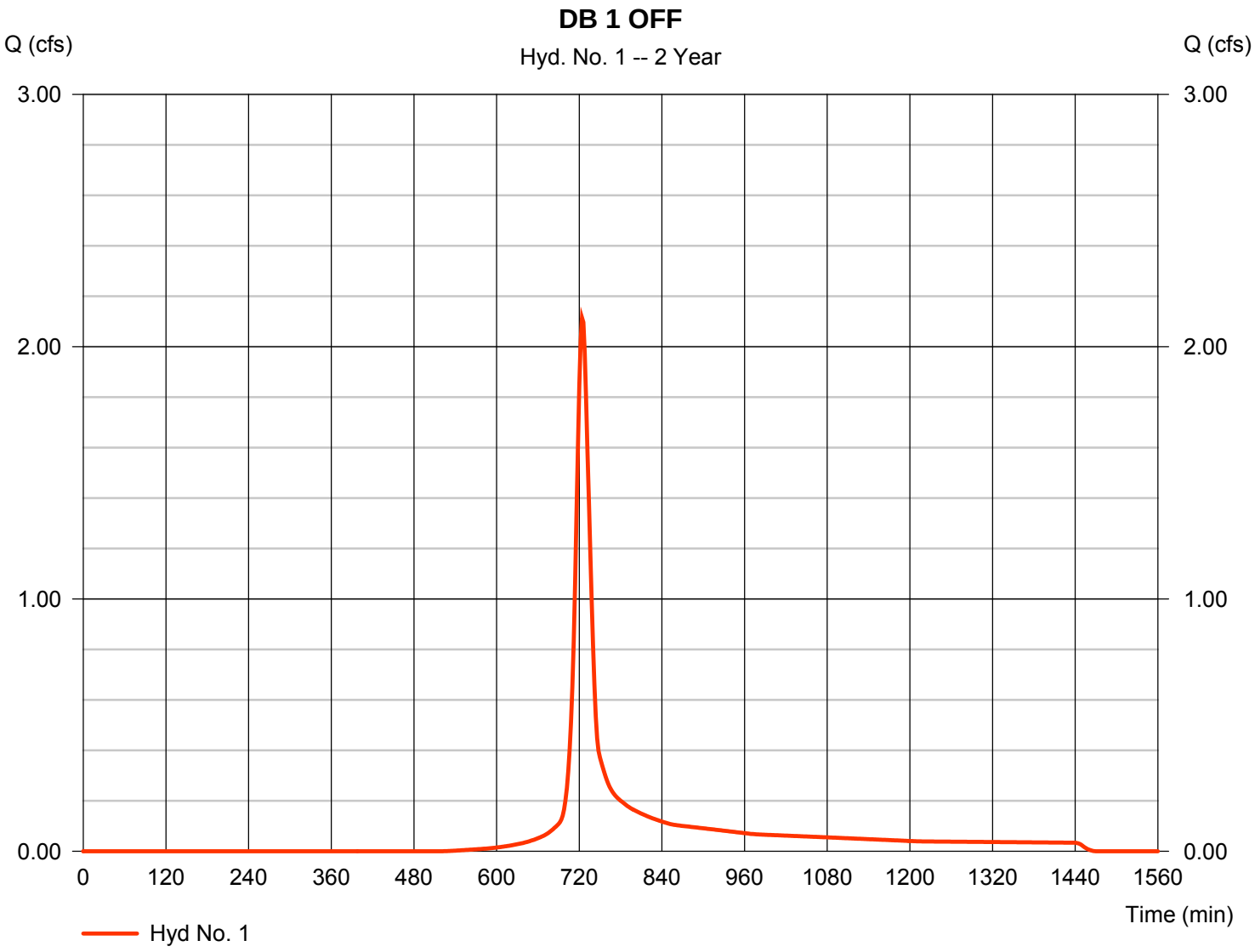
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 1

DB 1 OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 2.114 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 6,638 cuft
Drainage area	= 1.210 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.60 min
Total precip.	= 3.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.981	2	724	9,321	------	------	------	DB 1 OFF

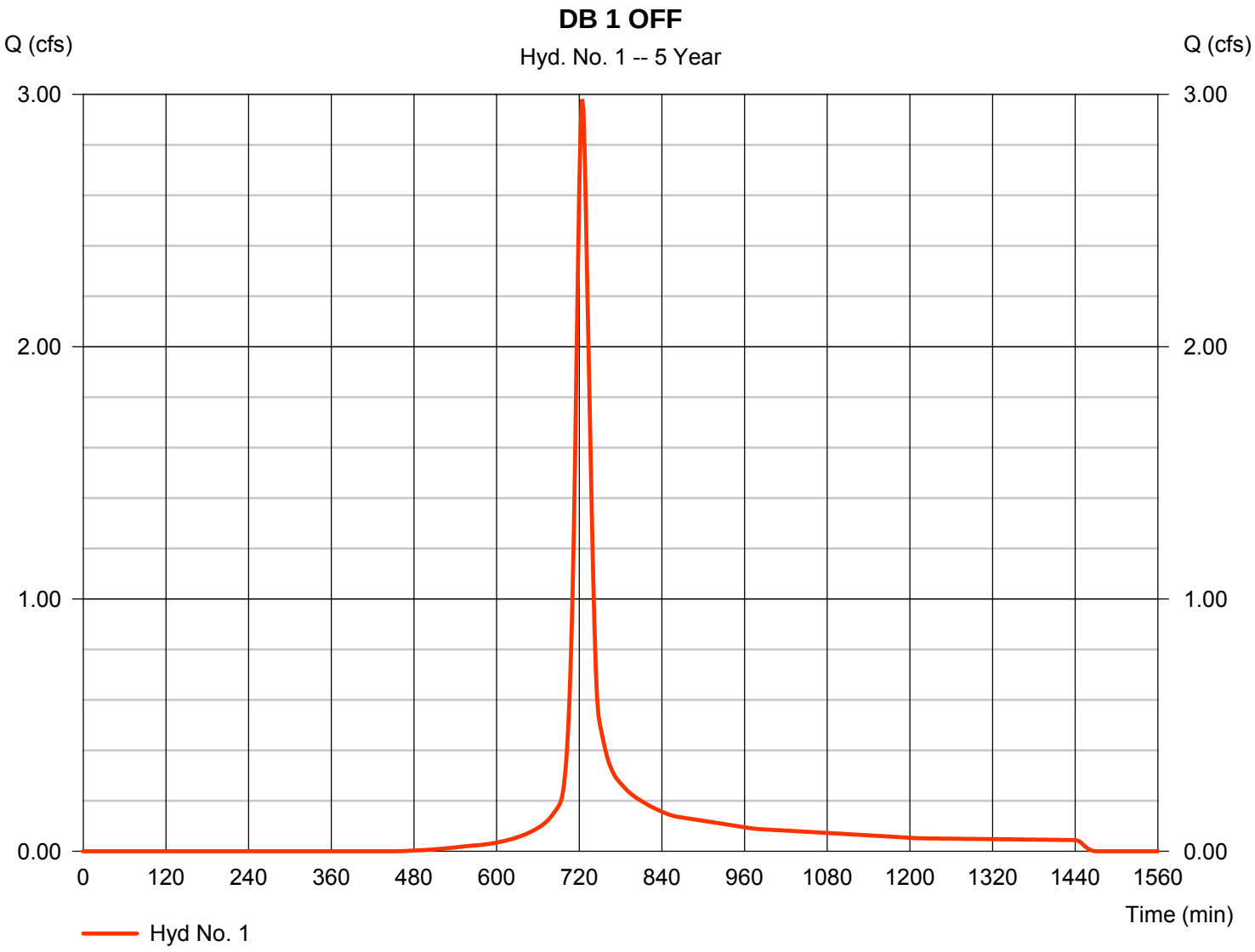
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 1

DB 1 OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 2.981 cfs
Storm frequency	= 5 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 9,321 cuft
Drainage area	= 1.210 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.60 min
Total precip.	= 3.81 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	7.095	2	724	22,581	------	------	------	DB 1 OFF

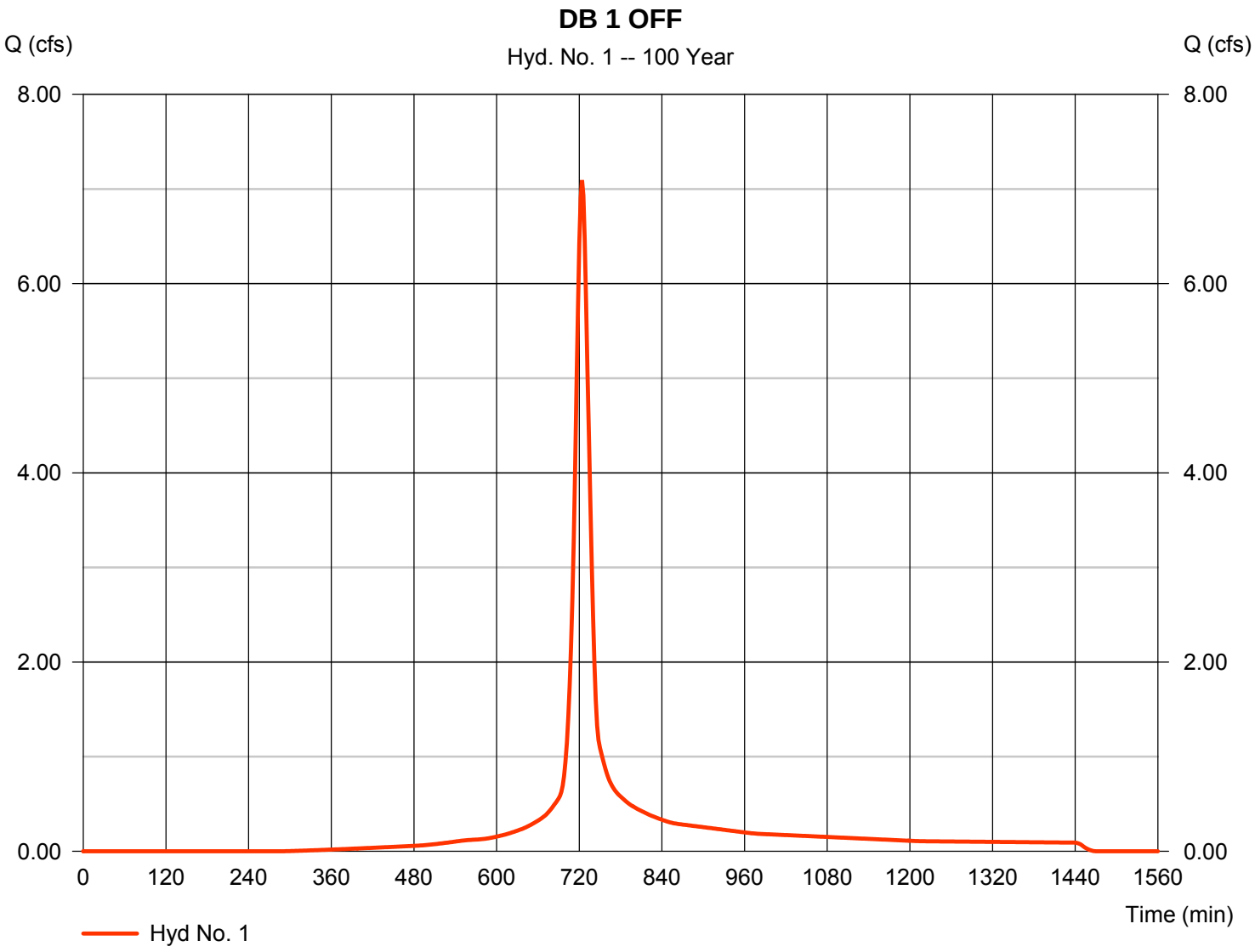
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 1

DB 1 OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 7.095 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 22,581 cuft
Drainage area	= 1.210 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.60 min
Total precip.	= 7.12 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	24.1705	5.1000	0.7018	--------
2	28.3435	5.1000	0.7022	--------
3	0.0000	0.0000	0.0000	--------
5	35.4692	5.3000	0.7016	--------
10	37.2537	4.6000	0.6755	--------
25	41.3346	4.1000	0.6540	--------
50	42.6141	3.5000	0.6290	--------
100	45.5234	3.3000	0.6151	--------

File name: Central Iowa 2014-04-25.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	4.77	3.60	2.94	2.52	2.22	1.99	1.81	1.67	1.55	1.45	1.36	1.29
2	5.59	4.21	3.45	2.95	2.60	2.33	2.12	1.95	1.81	1.70	1.60	1.51
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.91	5.23	4.29	3.68	3.24	2.91	2.65	2.44	2.27	2.12	2.00	1.89
10	8.08	6.09	4.99	4.28	3.78	3.40	3.10	2.86	2.67	2.50	2.35	2.23
25	9.75	7.32	6.00	5.16	4.56	4.11	3.76	3.47	3.24	3.04	2.87	2.72
50	11.09	8.29	6.80	5.85	5.18	4.68	4.29	3.97	3.71	3.49	3.30	3.13
100	12.39	9.27	7.62	6.56	5.82	5.27	4.84	4.48	4.19	3.95	3.73	3.55

Tc = time in minutes. Values may exceed 60.

file name: C:\My Drawings\CDA\2014\1409460\Engineer\SWMP\Hydraflow Hydrographs\Central Iowa 2014-04-25.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	2.67	3.08	0.00	3.81	4.46	5.44	6.26	7.12
SCS 6-Hr	2.05	2.40	0.00	3.03	3.61	4.47	5.20	5.98
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Hydrograph No. 3, Combine, PRE..... 10

5 - Year

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Hydrograph Reports..... 12
Hydrograph No. 1, SCS Runoff, DB 1 PRE..... 12
Hydrograph No. 2, Manual, DB 1 OFF..... 13
Hydrograph No. 3, Combine, PRE..... 14

100 - Year

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Hydrograph No. 1, SCS Runoff, DB 1 PRE..... 16
Hydrograph No. 2, Manual, DB 1 OFF..... 17
Hydrograph No. 3, Combine, PRE..... 18

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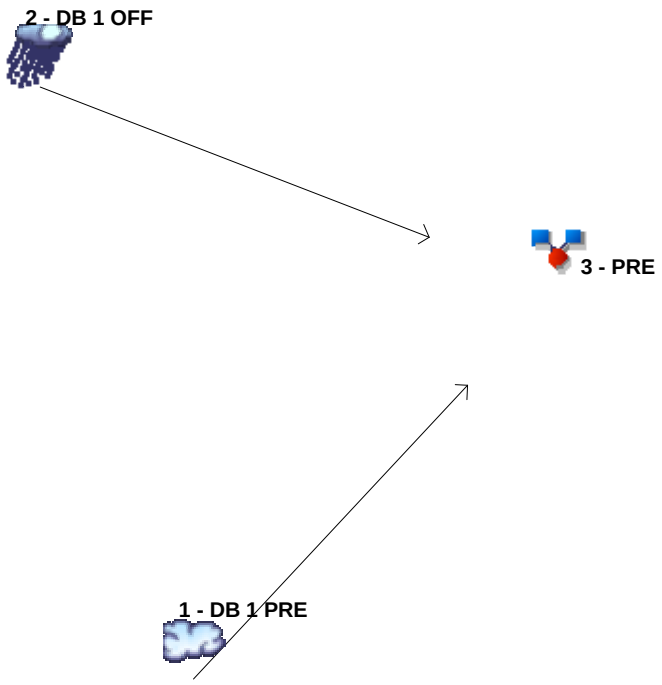
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Legend

Hyd.	Origin	Description
1	SCS Runoff	DB 1 PRE
2	Manual	DB 1 OFF
3	Combine	PRE

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	1.180	1.757	-------	2.902	-------	-------	-------	9.188	DB 1 PRE
2	Manual	------	0.000	0.000	-------	7.090	-------	-------	-------	0.000	DB 1 OFF
3	Combine	1, 2	1.180	1.757	-------	9.965	-------	-------	-------	9.188	PRE

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.180	2	726	4,346	------	------	------	DB 1 PRE
2	Manual	0.000	2	n/a	0	------	------	------	DB 1 OFF
3	Combine	1.180	2	726	4,346	1, 2	------	------	PRE

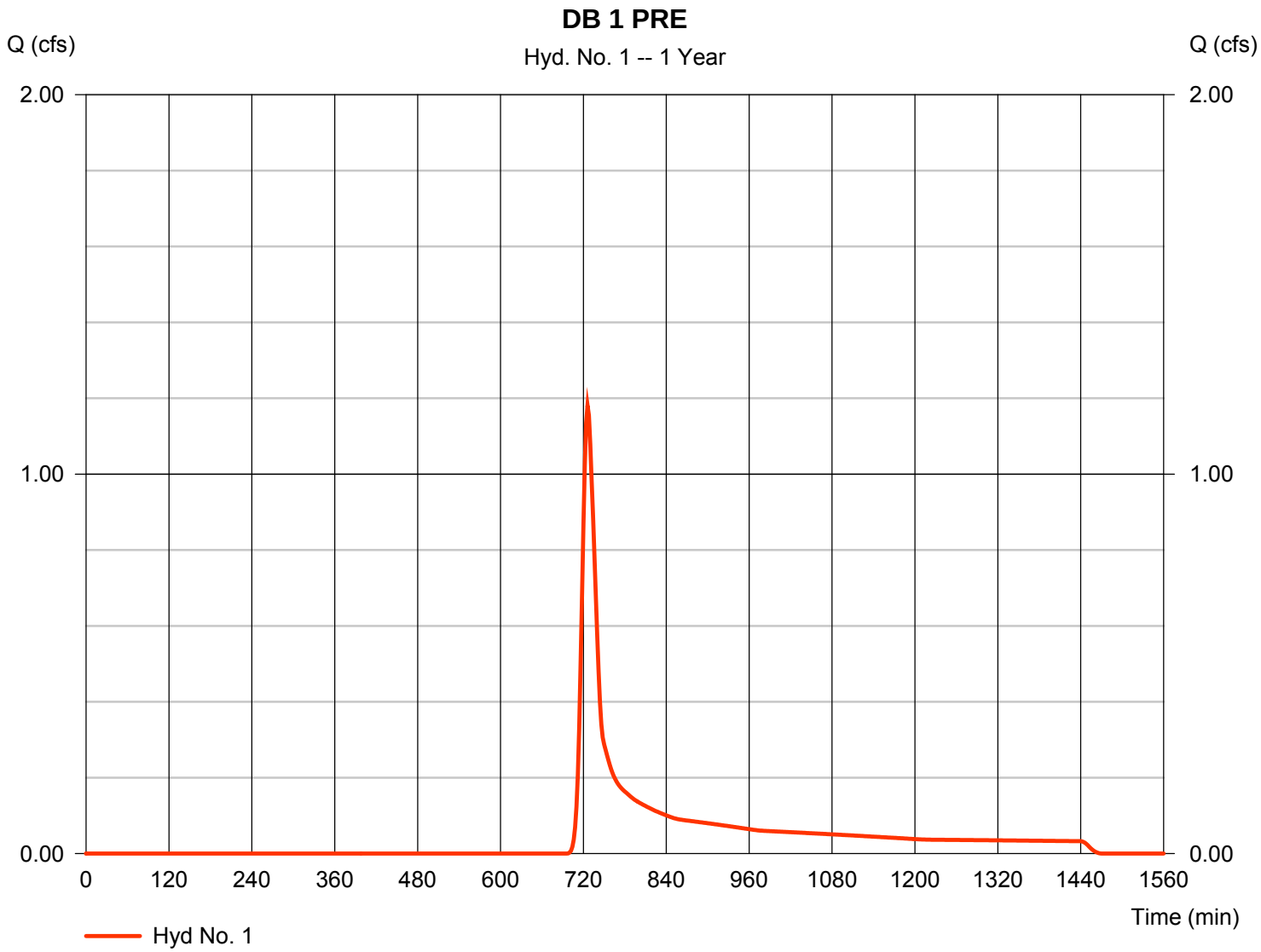
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 1

DB 1 PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 1.180 cfs
Storm frequency	= 1 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 4,346 cuft
Drainage area	= 2.070 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.80 min
Total precip.	= 2.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



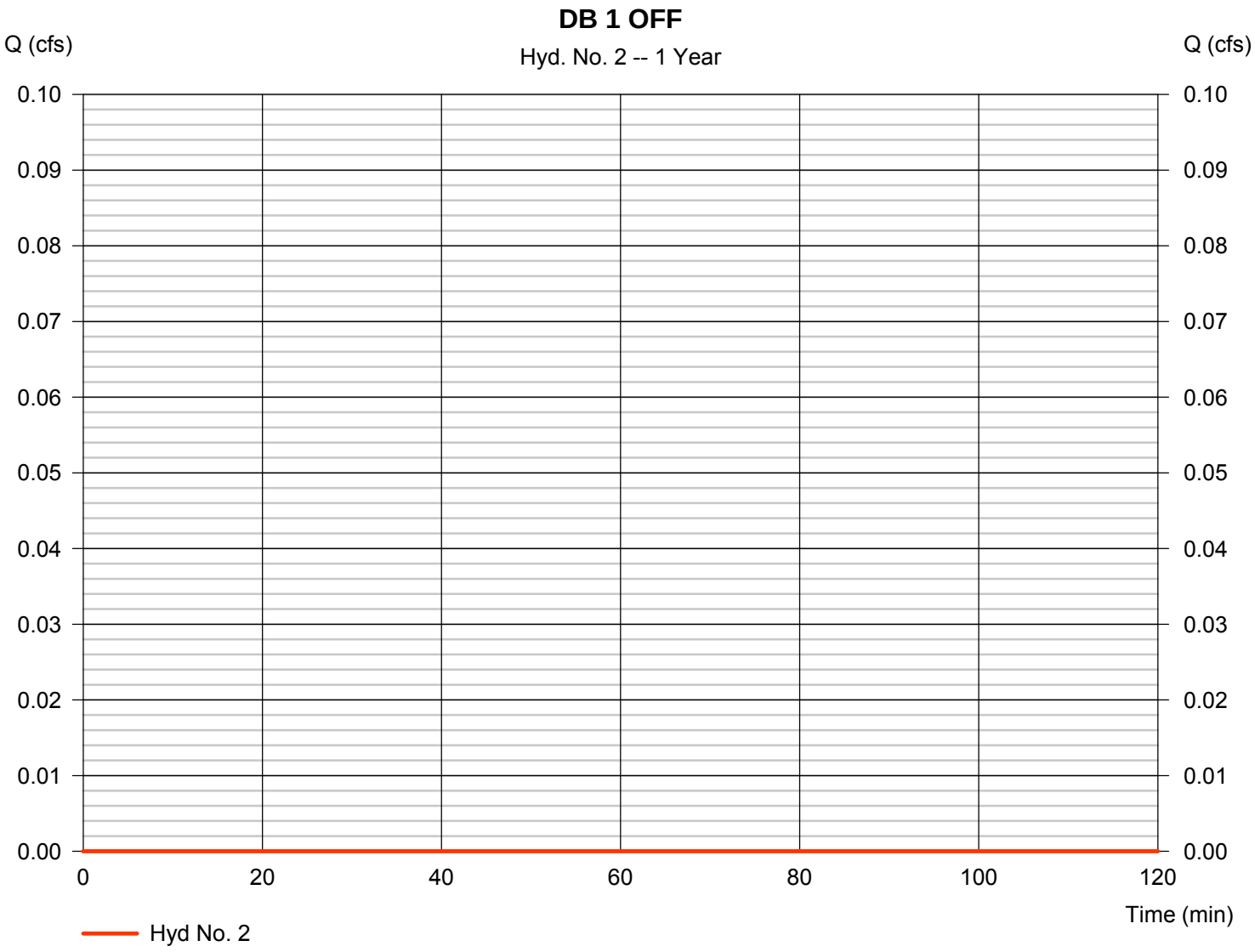
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 2

DB 1 OFF

Hydrograph type	= Manual	Peak discharge	= 0.000 cfs
Storm frequency	= 1 yrs	Time to peak	= n/a
Time interval	= 2 min	Hyd. volume	= 0 cuft



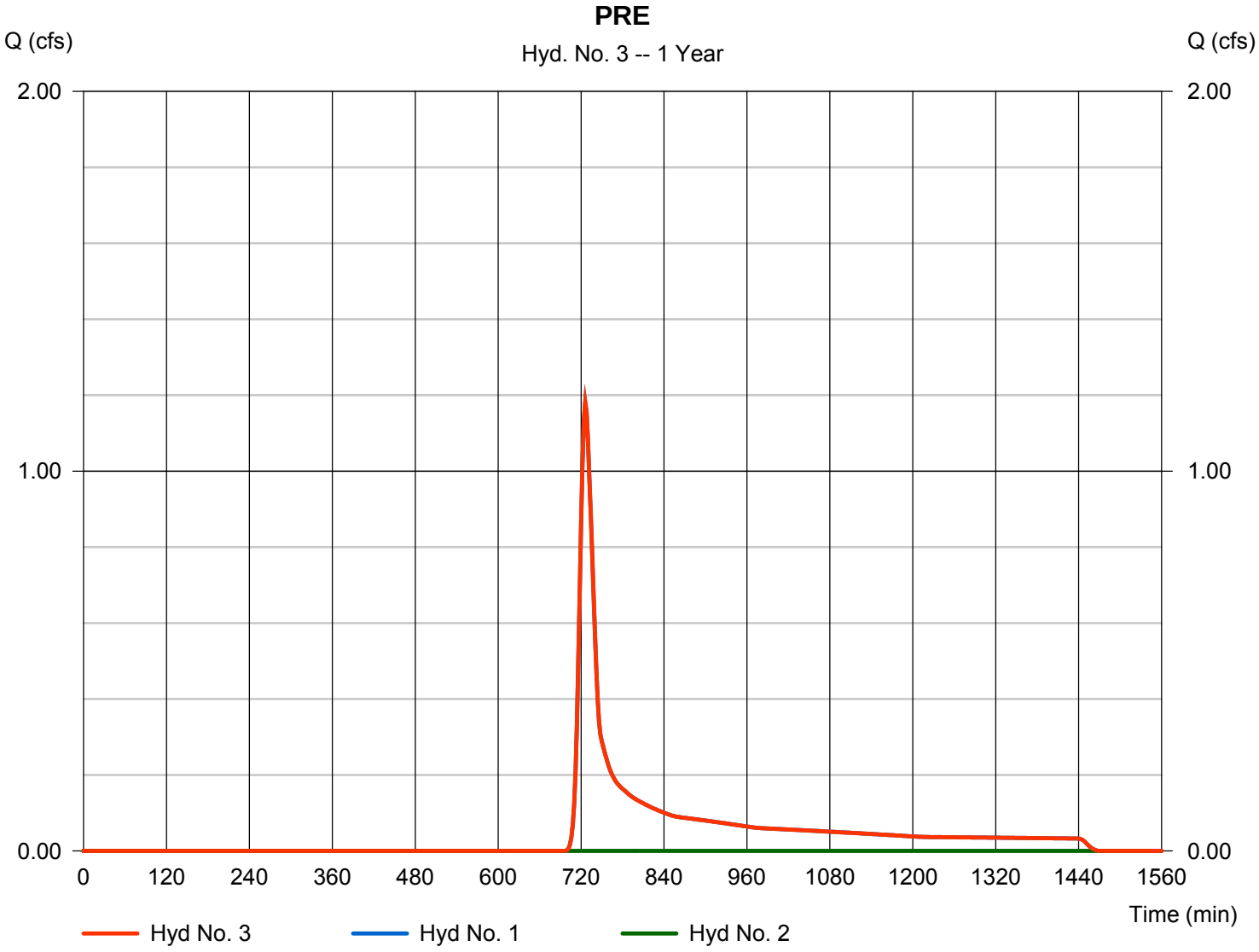
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 3

PRE

Hydrograph type	= Combine	Peak discharge	= 1.180 cfs
Storm frequency	= 1 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 4,346 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 2.070 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	1.757	2	726	6,063	------	------	------	DB 1 PRE
2	Manual	0.000	2	n/a	0	------	------	------	DB 1 OFF
3	Combine	1.757	2	726	6,063	1, 2	------	------	PRE

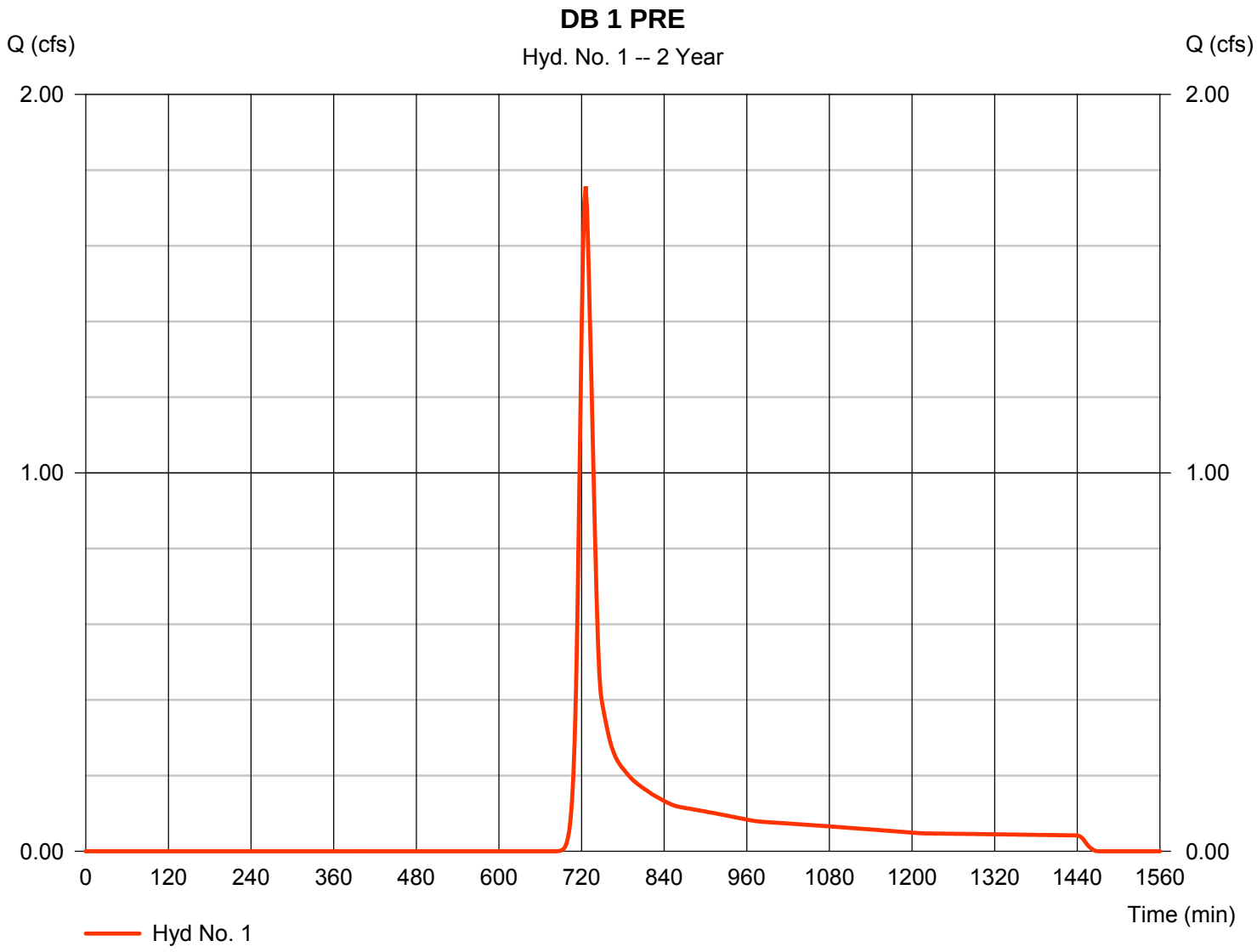
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 1

DB 1 PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 1.757 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 6,063 cuft
Drainage area	= 2.070 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.80 min
Total precip.	= 3.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



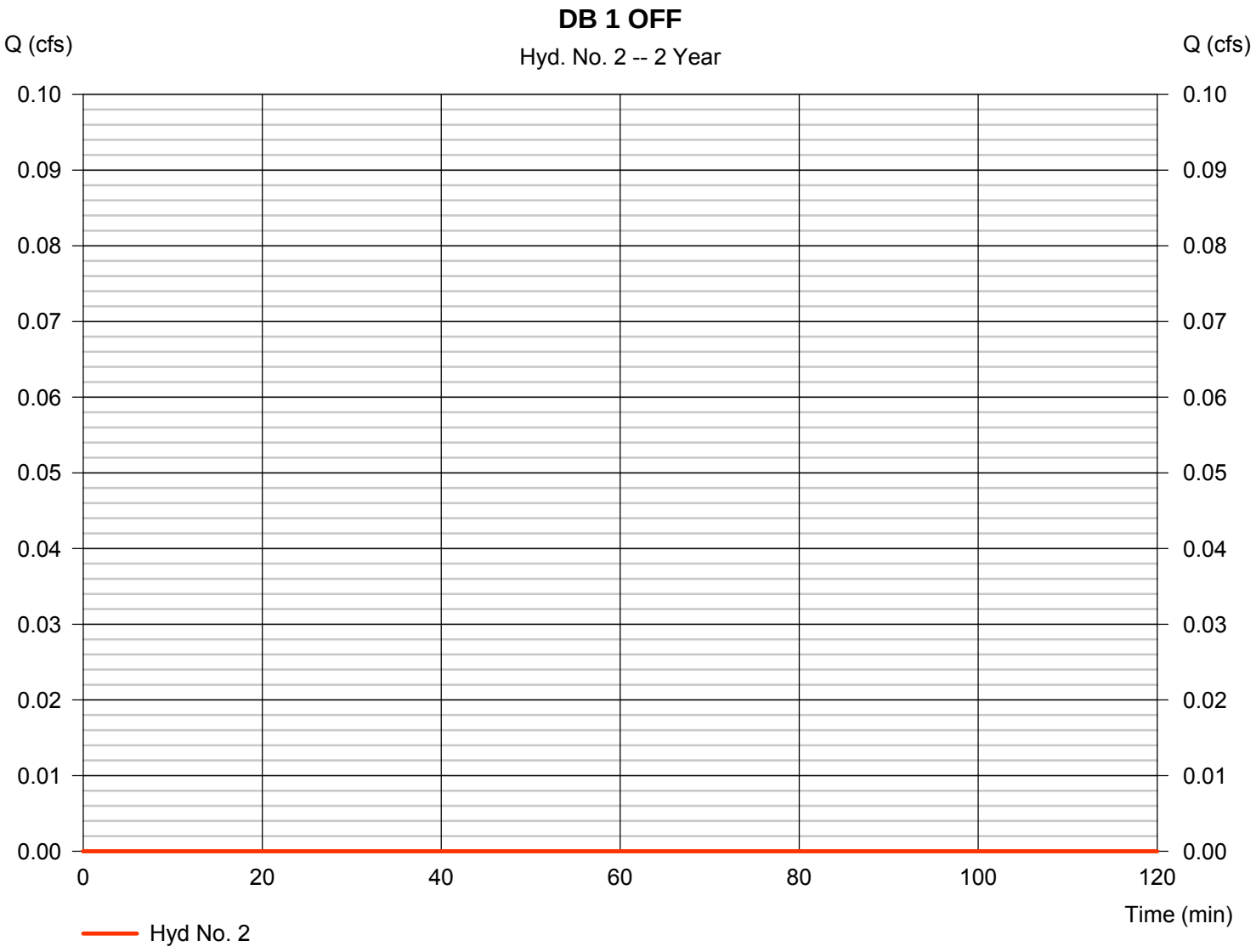
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 2

DB 1 OFF

Hydrograph type	= Manual	Peak discharge	= 0.000 cfs
Storm frequency	= 2 yrs	Time to peak	= n/a
Time interval	= 2 min	Hyd. volume	= 0 cuft



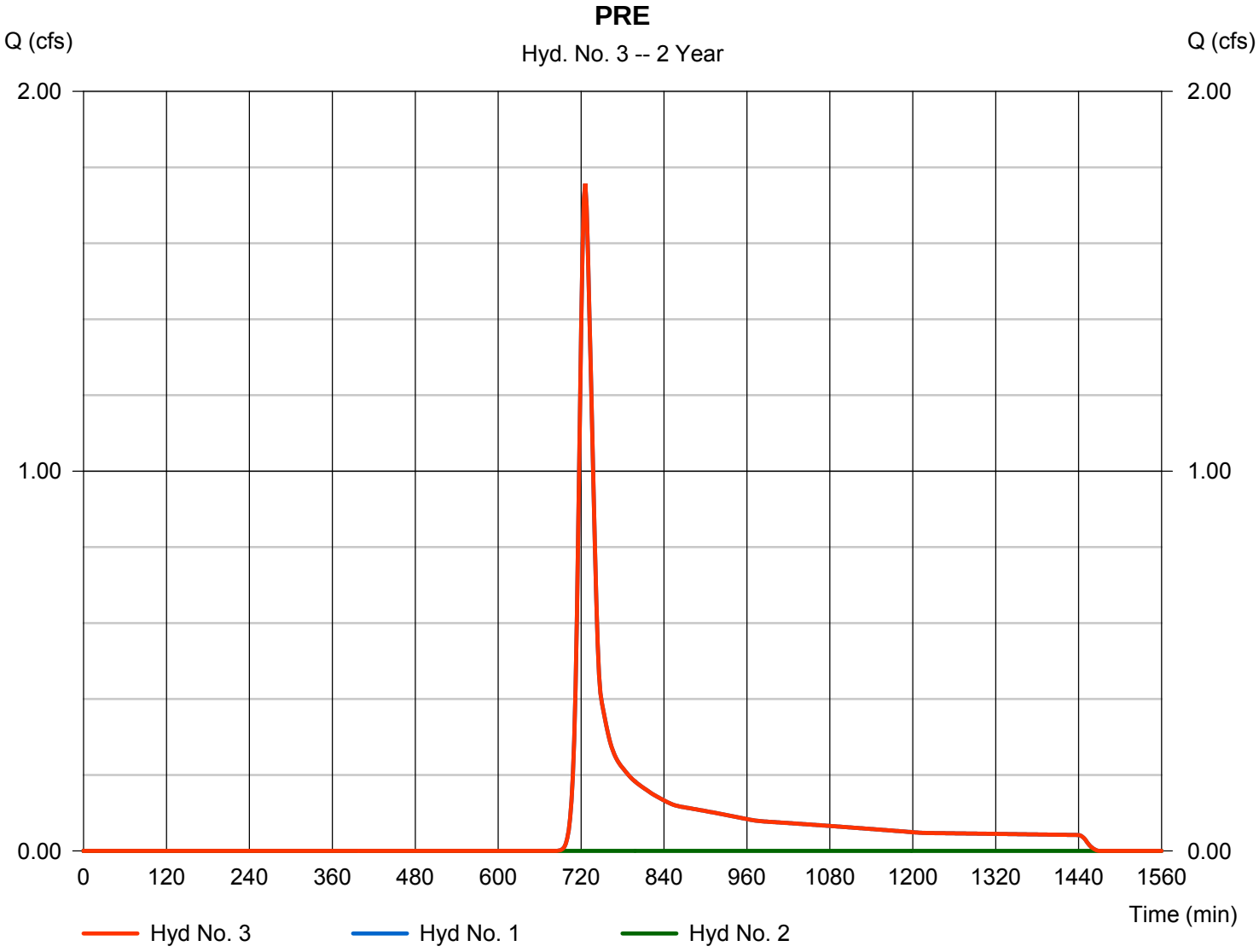
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 3

PRE

Hydrograph type	= Combine	Peak discharge	= 1.757 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 6,063 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 2.070 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	2.902	2	726	9,511	------	------	------	DB 1 PRE
2	Manual	7.090	2	724	22,570	------	------	------	DB 1 OFF
3	Combine	9.965	2	724	32,081	1, 2	------	------	PRE

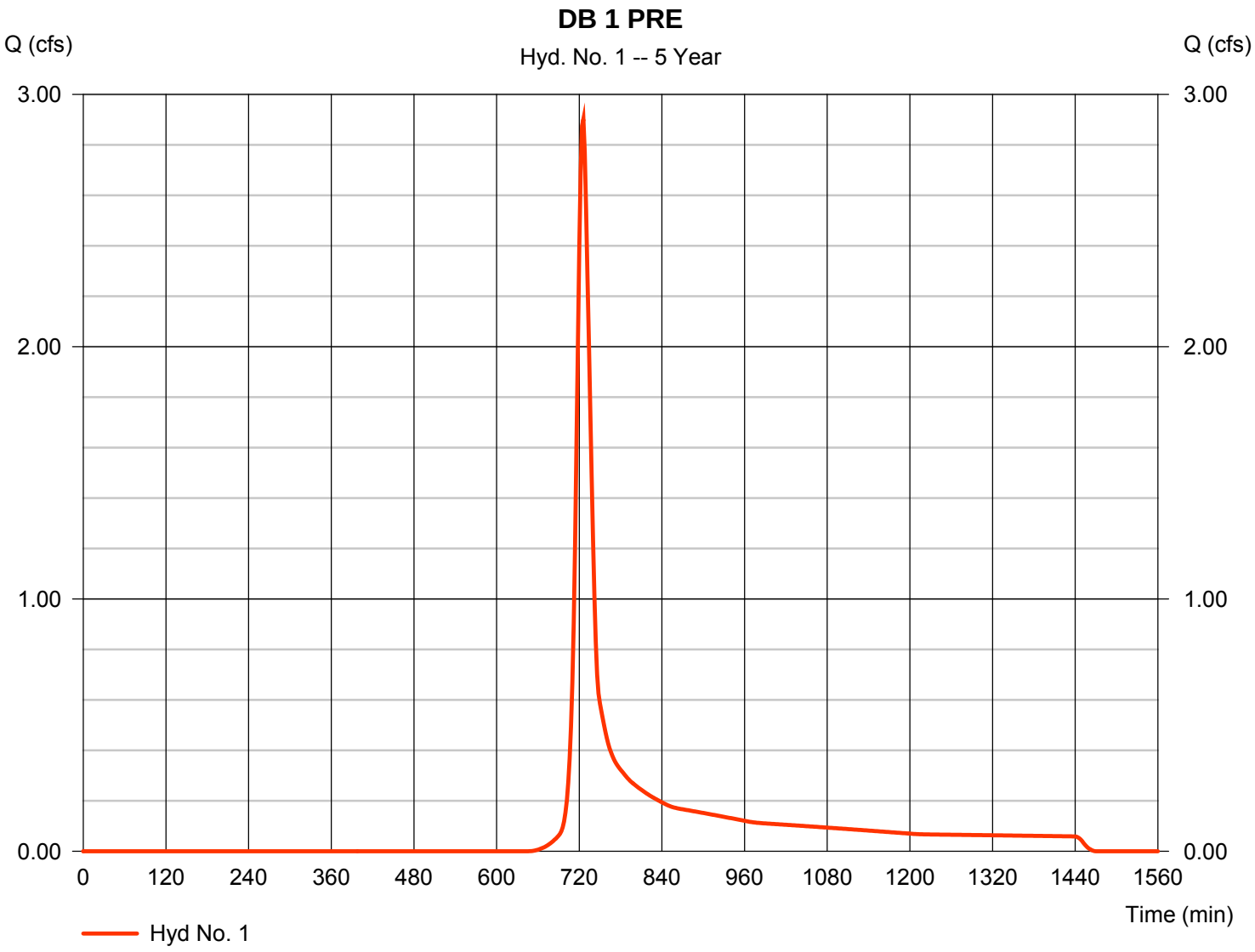
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 1

DB 1 PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 2.902 cfs
Storm frequency	= 5 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 9,511 cuft
Drainage area	= 2.070 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.80 min
Total precip.	= 3.81 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



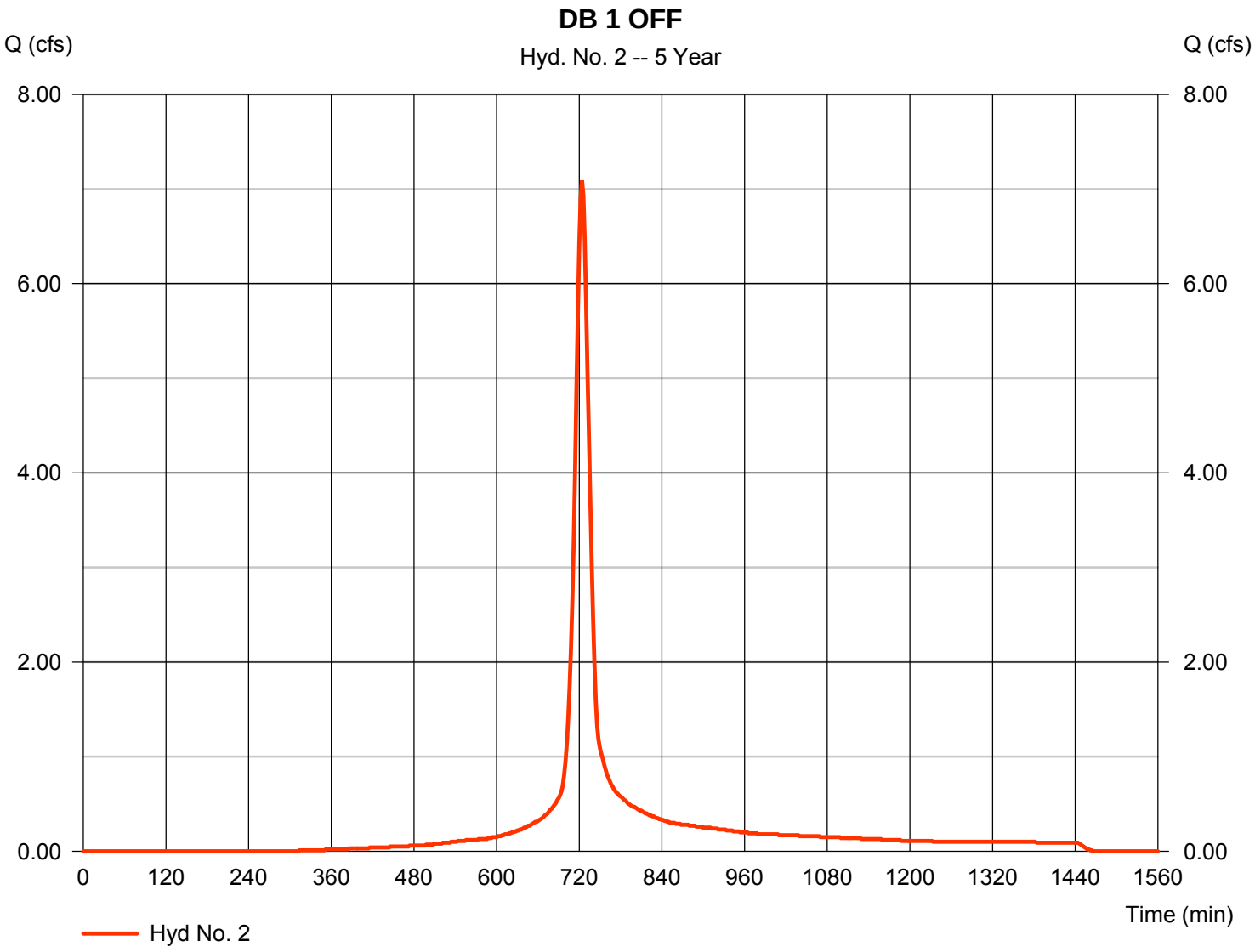
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 2

DB 1 OFF

Hydrograph type	= Manual	Peak discharge	= 7.090 cfs
Storm frequency	= 5 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 22,570 cuft



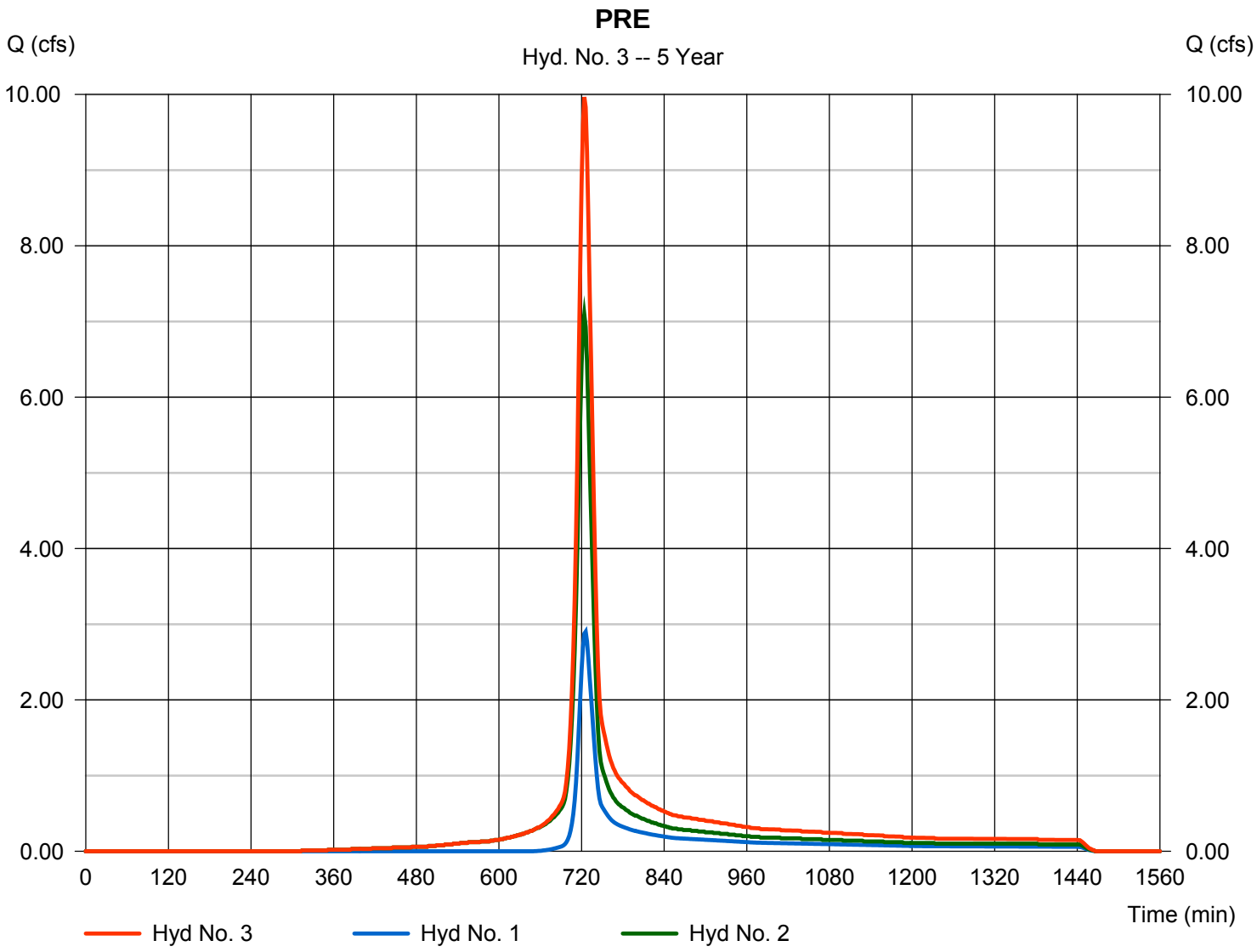
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 3

PRE

Hydrograph type	= Combine	Peak discharge	= 9.965 cfs
Storm frequency	= 5 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 32,081 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 2.070 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	9.188	2	724	28,739	------	------	------	DB 1 PRE
2	Manual	0.000	2	n/a	0	------	------	------	DB 1 OFF
3	Combine	9.188	2	724	28,739	1, 2	------	------	PRE

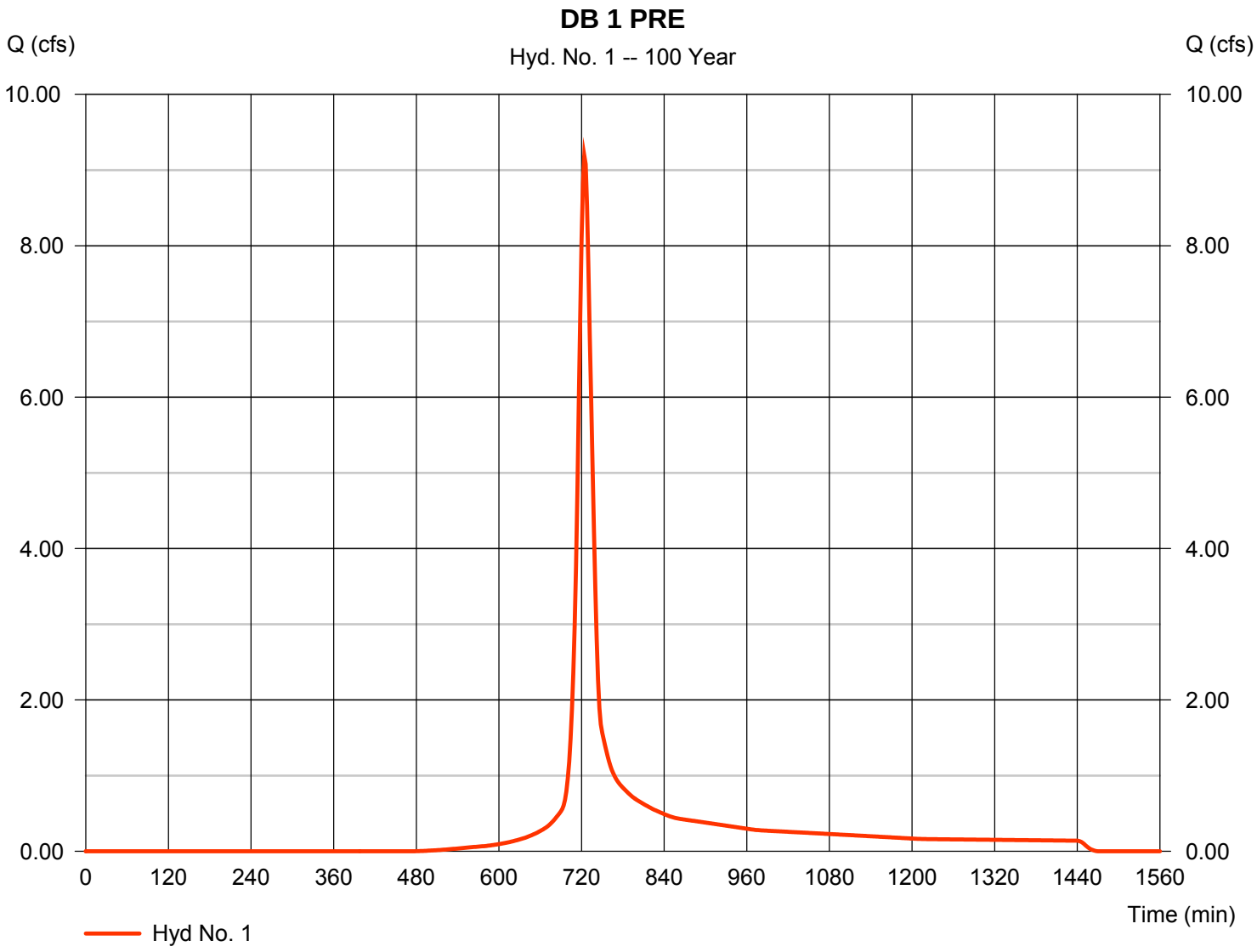
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 1

DB 1 PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 9.188 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 28,739 cuft
Drainage area	= 2.070 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.80 min
Total precip.	= 7.12 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



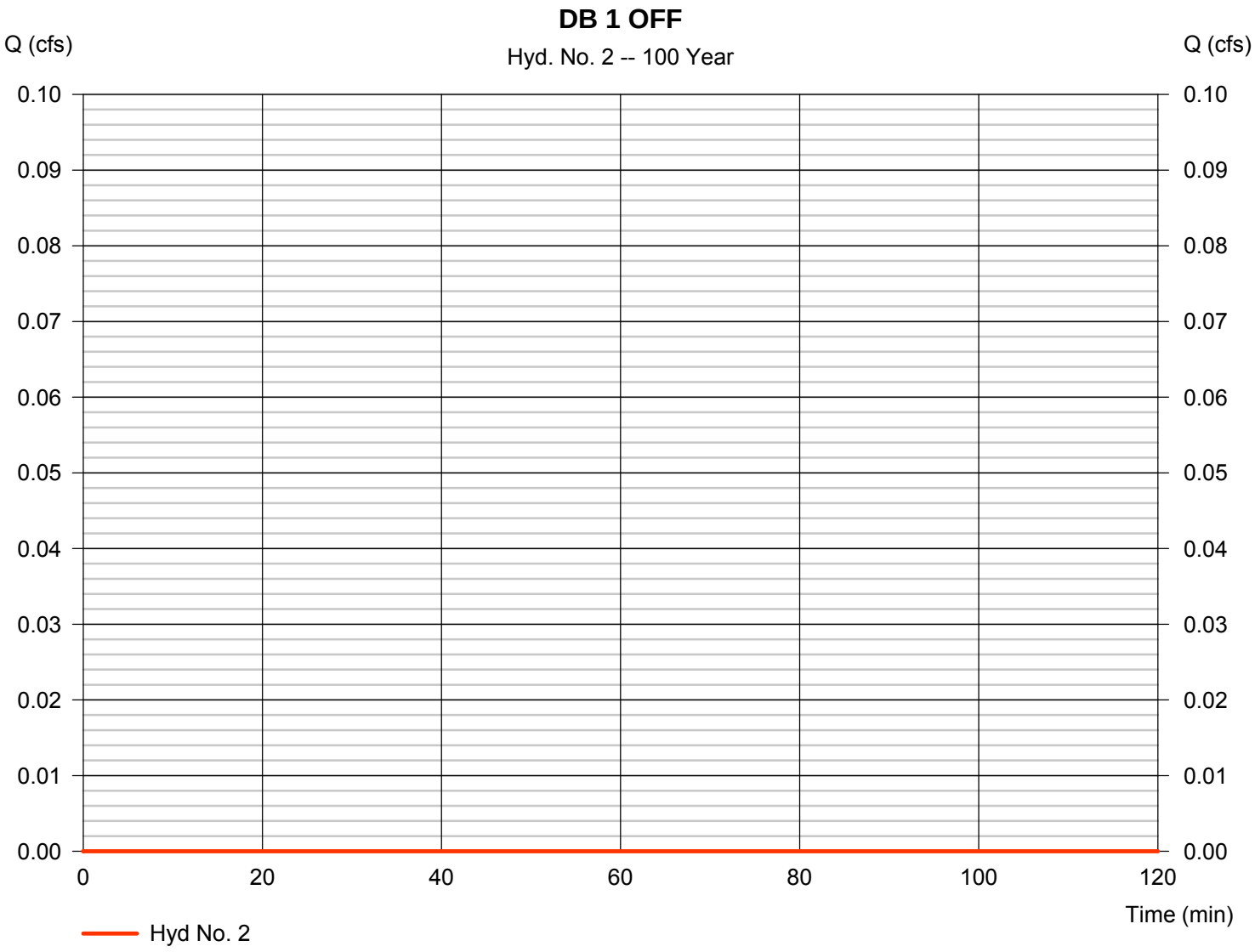
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 2

DB 1 OFF

Hydrograph type	= Manual	Peak discharge	= 0.000 cfs
Storm frequency	= 100 yrs	Time to peak	= n/a
Time interval	= 2 min	Hyd. volume	= 0 cuft



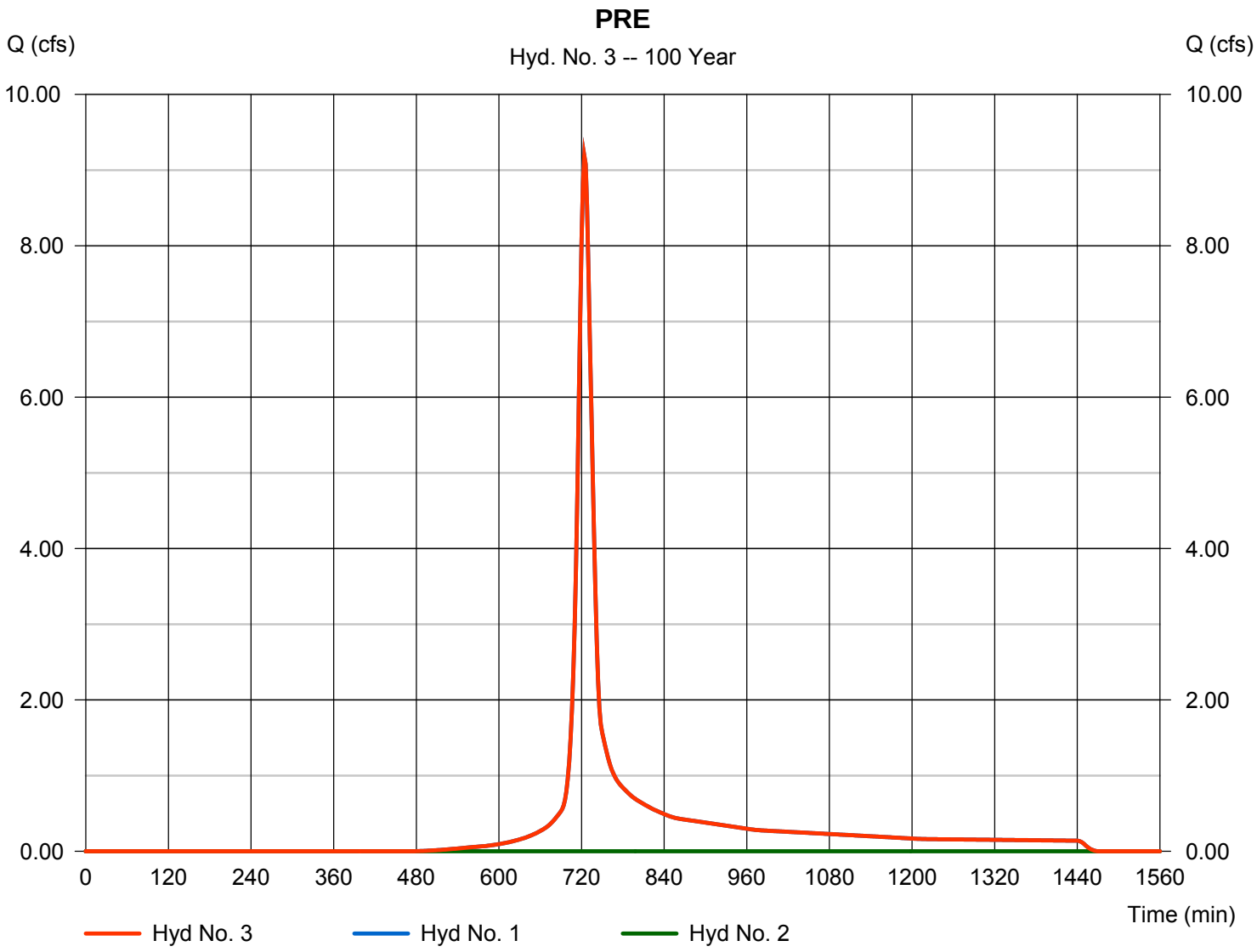
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Friday, 02 / 26 / 2016

Hyd. No. 3

PRE

Hydrograph type	= Combine	Peak discharge	= 9.188 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 28,739 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 2.070 ac



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	24.1705	5.1000	0.7018	--------
2	28.3435	5.1000	0.7022	--------
3	0.0000	0.0000	0.0000	--------
5	35.4692	5.3000	0.7016	--------
10	37.2537	4.6000	0.6755	--------
25	41.3346	4.1000	0.6540	--------
50	42.6141	3.5000	0.6290	--------
100	45.5234	3.3000	0.6151	--------

File name: Central Iowa 2014-04-25.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	4.77	3.60	2.94	2.52	2.22	1.99	1.81	1.67	1.55	1.45	1.36	1.29
2	5.59	4.21	3.45	2.95	2.60	2.33	2.12	1.95	1.81	1.70	1.60	1.51
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.91	5.23	4.29	3.68	3.24	2.91	2.65	2.44	2.27	2.12	2.00	1.89
10	8.08	6.09	4.99	4.28	3.78	3.40	3.10	2.86	2.67	2.50	2.35	2.23
25	9.75	7.32	6.00	5.16	4.56	4.11	3.76	3.47	3.24	3.04	2.87	2.72
50	11.09	8.29	6.80	5.85	5.18	4.68	4.29	3.97	3.71	3.49	3.30	3.13
100	12.39	9.27	7.62	6.56	5.82	5.27	4.84	4.48	4.19	3.95	3.73	3.55

Tc = time in minutes. Values may exceed 60.

file name: C:\My Drawings\CDA\2014\1409460\Engineer\SWMP\Hydraflow Hydrographs\Central Iowa 2014-04-25.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	2.67	3.08	0.00	3.81	4.46	5.44	6.26	7.12
SCS 6-Hr	2.05	2.40	0.00	3.03	3.61	4.47	5.20	5.98
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Section 3 – Post-Developed Runoff Analysis

QuikTrip Store #504

City of Windsor Heights, County of Polk, State of Iowa

McCLURE™
ENGINEERING Co.

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Watershed Model Schematic

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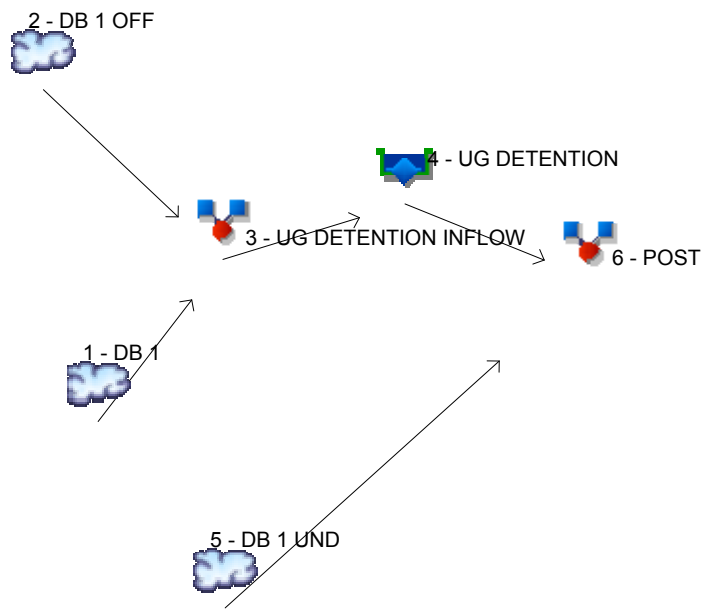


Legend

Hyd.	Origin	Description
1	SCS Runoff	DB 1
2	SCS Runoff	DB 1 OFF
3	Combine	UG DETENTION INFLOW
4	Reservoir	UG DETENTION
5	SCS Runoff	DB 1 UND
6	Combine	POST

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	3.729	4.442	-------	5.705	-------	-------	-------	11.34	DB 1
2	SCS Runoff	------	1.646	2.114	-------	2.981	-------	-------	-------	7.095	DB 1 OFF
3	Combine	1, 2	5.297	6.465	-------	8.574	-------	-------	-------	18.25	UG DETENTION INFLOW
4	Reservoir	3	2.468	2.752	-------	3.220	-------	-------	-------	5.180	UG DETENTION
5	SCS Runoff	------	0.674	0.879	-------	1.263	-------	-------	-------	3.117	DB 1 UND
6	Combine	4, 5	2.858	3.338	-------	4.065	-------	-------	-------	7.197	POST

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	3.729	2	722	10,711	------	------	------	DB 1
2	SCS Runoff	1.646	2	724	5,209	------	------	------	DB 1 OFF
3	Combine	5.297	2	722	15,919	1, 2	------	------	UG DETENTION INFLOW
4	Reservoir	2.468	2	734	15,919	3	939.79	4,527	UG DETENTION
5	SCS Runoff	0.674	2	722	1,923	------	------	------	DB 1 UND
6	Combine	2.858	2	730	17,842	4, 5	------	------	POST

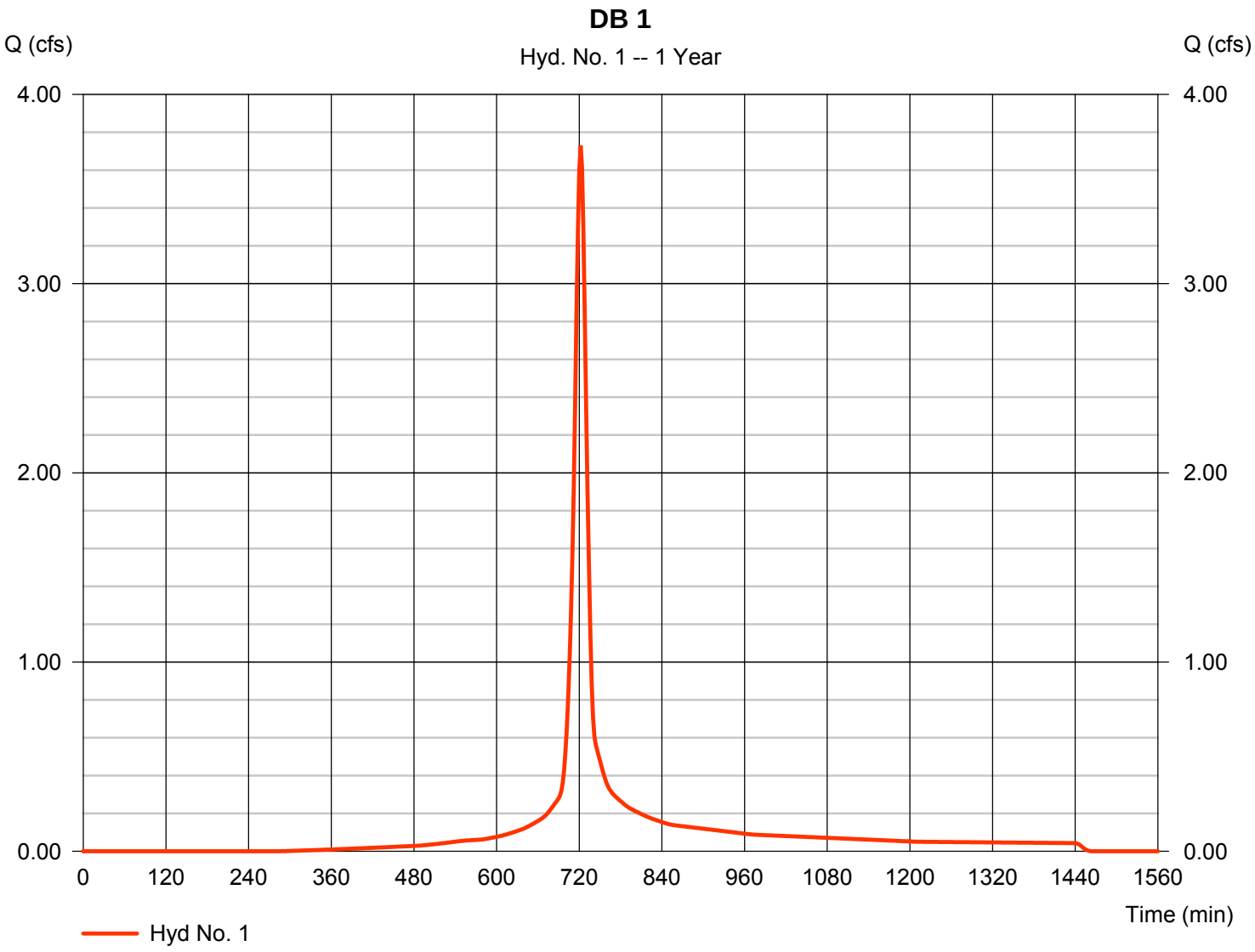
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 1

DB 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.729 cfs
Storm frequency	=	1 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	10,711 cuft
Drainage area	=	1.560 ac	Curve number	=	93
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.00 min
Total precip.	=	2.67 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



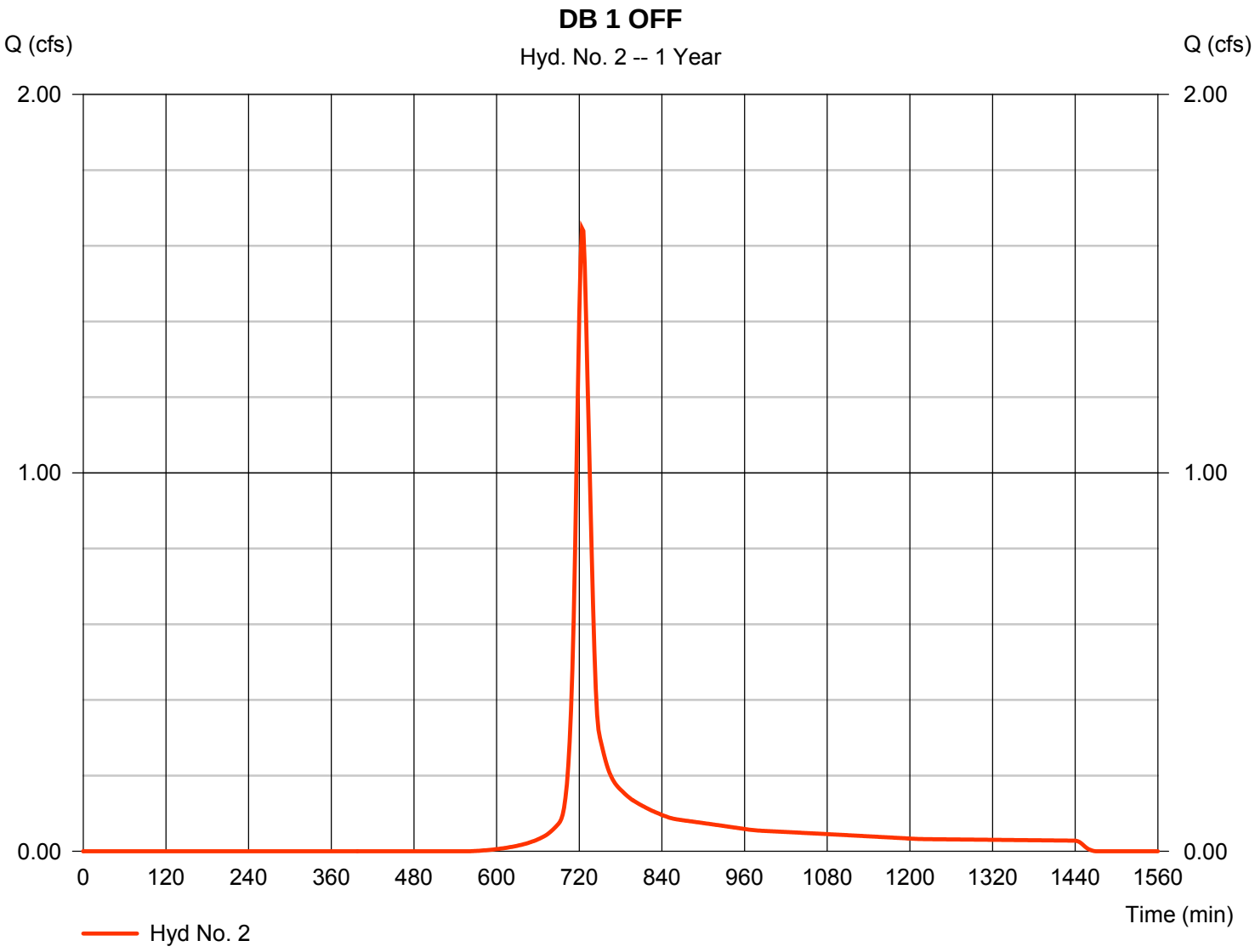
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 2

DB 1 OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 1.646 cfs
Storm frequency	= 1 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 5,209 cuft
Drainage area	= 1.210 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.60 min
Total precip.	= 2.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



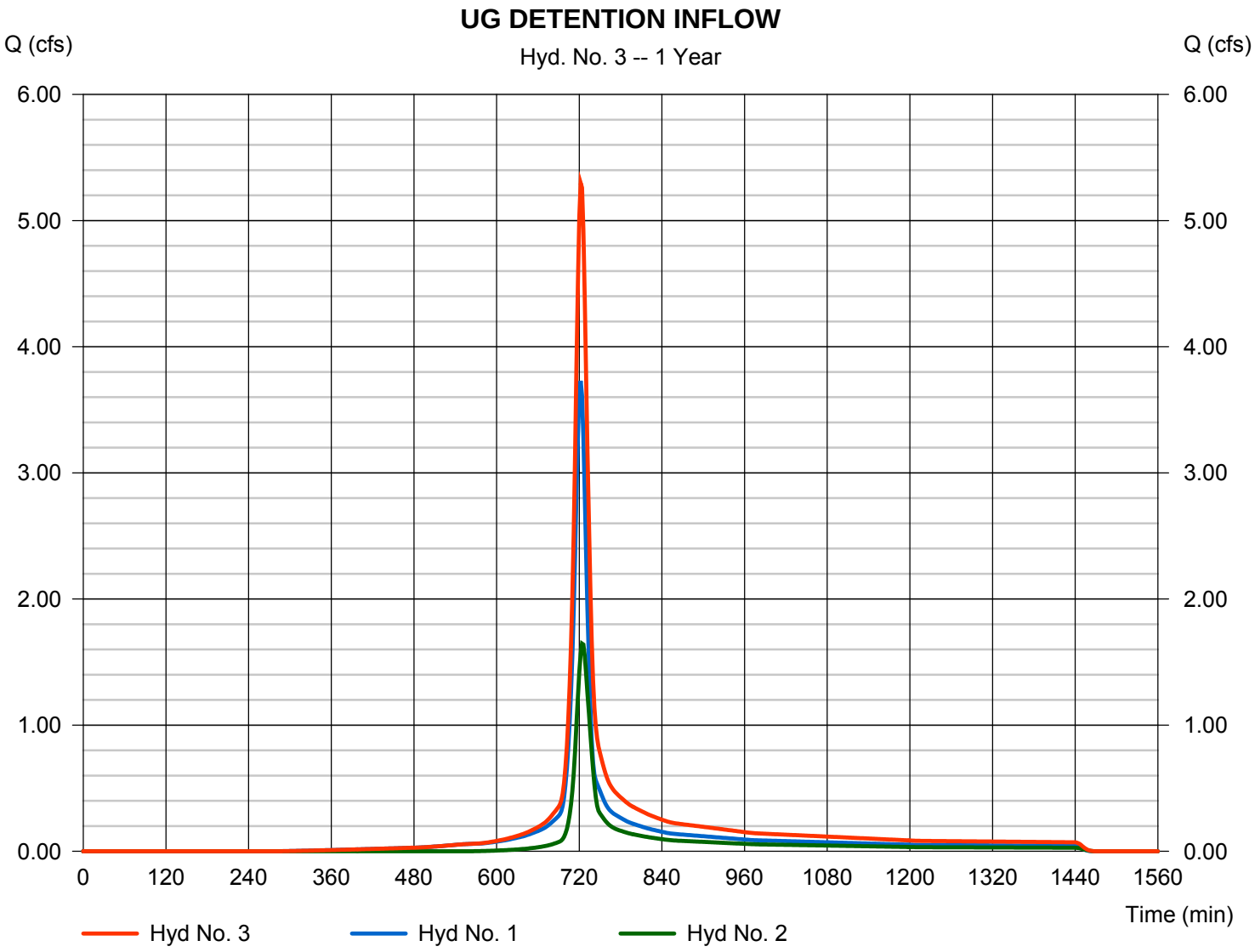
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 3

UG DETENTION INFLOW

Hydrograph type	= Combine	Peak discharge	= 5.297 cfs
Storm frequency	= 1 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 15,919 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 2.770 ac



Hydrograph Report

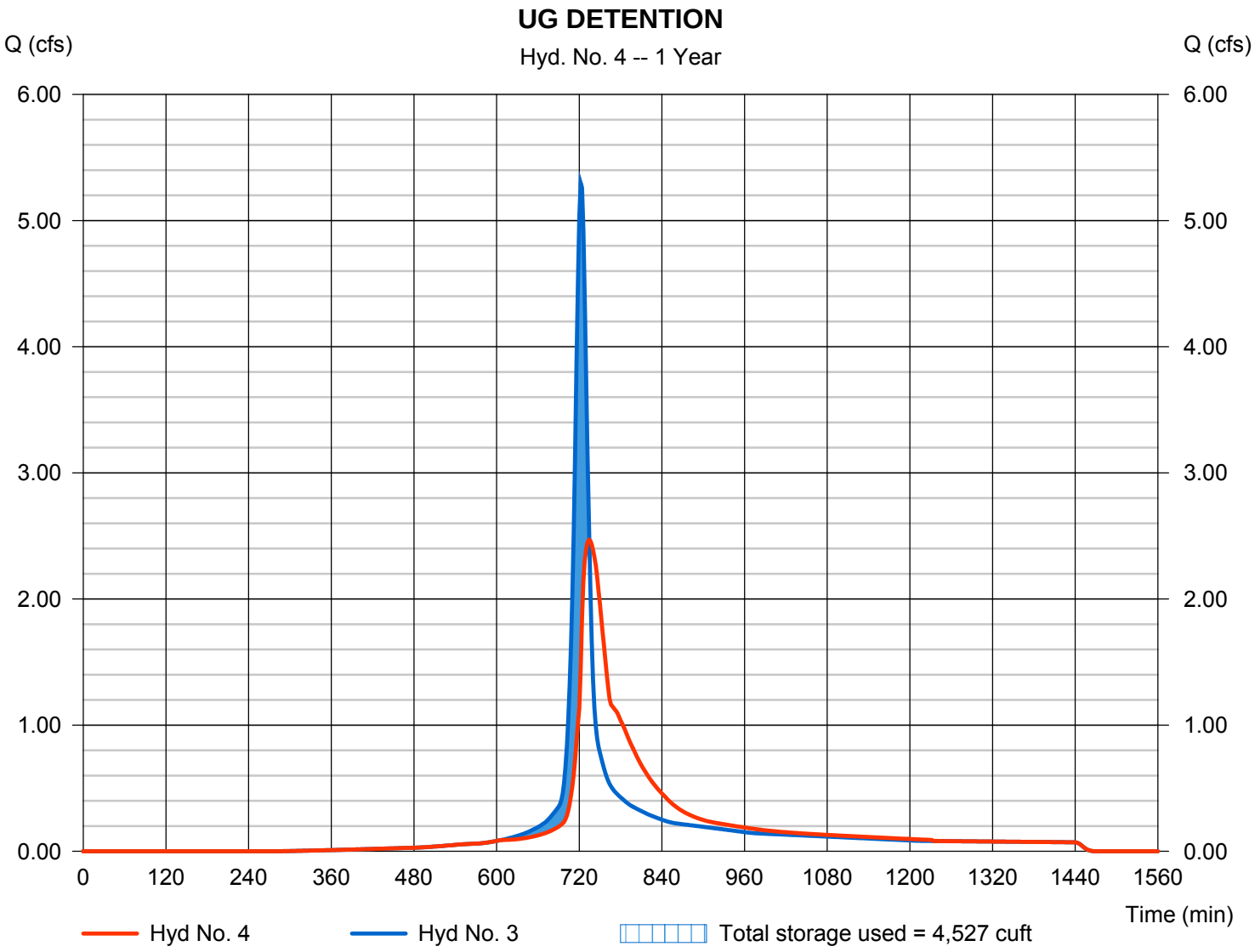
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 4

UG DETENTION

Hydrograph type	= Reservoir	Peak discharge	= 2.468 cfs
Storm frequency	= 1 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 15,919 cuft
Inflow hyd. No.	= 3 - UG DETENTION INFLOW	Max. Elevation	= 939.79 ft
Reservoir name	= UG DETENTION	Max. Storage	= 4,527 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Pond No. 1 - UG DETENTION

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	938.55	n/a	0	0
0.15	938.70	n/a	1	1
1.15	939.70	n/a	3,984	3,985
2.15	940.70	n/a	6,206	10,191
3.15	941.70	n/a	6,204	16,395
4.15	942.70	n/a	3,986	20,381

Culvert / Orifice Structures

		[A]	[B]	[C]	[PrfRsr]
Rise (in)	=	10.25	0.00	0.00	0.00
Span (in)	=	10.25	0.00	0.00	0.00
No. Barrels	=	1	0	0	0
Invert El. (ft)	=	938.55	0.00	0.00	0.00
Length (ft)	=	5.50	0.00	0.00	0.00
Slope (%)	=	2.00	0.00	0.00	n/a
N-Value	=	.013	.013	.013	n/a
Orifice Coeff.	=	0.60	0.60	0.60	0.60
Multi-Stage	=	n/a	No	No	No

Weir Structures

		[A]	[B]	[C]	[D]
Crest Len (ft)	=	0.00	0.00	0.00	0.00
Crest El. (ft)	=	0.00	0.00	0.00	0.00
Weir Coeff.	=	3.33	3.33	3.33	3.33
Weir Type	=	---	---	---	---
Multi-Stage	=	No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	938.55	0.00	---	---	---	---	---	---	---	---	---	0.000
0.15	1	938.70	0.09 ic	---	---	---	---	---	---	---	---	---	0.089
1.15	3,985	939.70	2.24 oc	---	---	---	---	---	---	---	---	---	2.240
2.15	10,191	940.70	3.62 ic	---	---	---	---	---	---	---	---	---	3.621
3.15	16,395	941.70	4.55 ic	---	---	---	---	---	---	---	---	---	4.552
4.15	20,381	942.70	5.32 ic	---	---	---	---	---	---	---	---	---	5.323

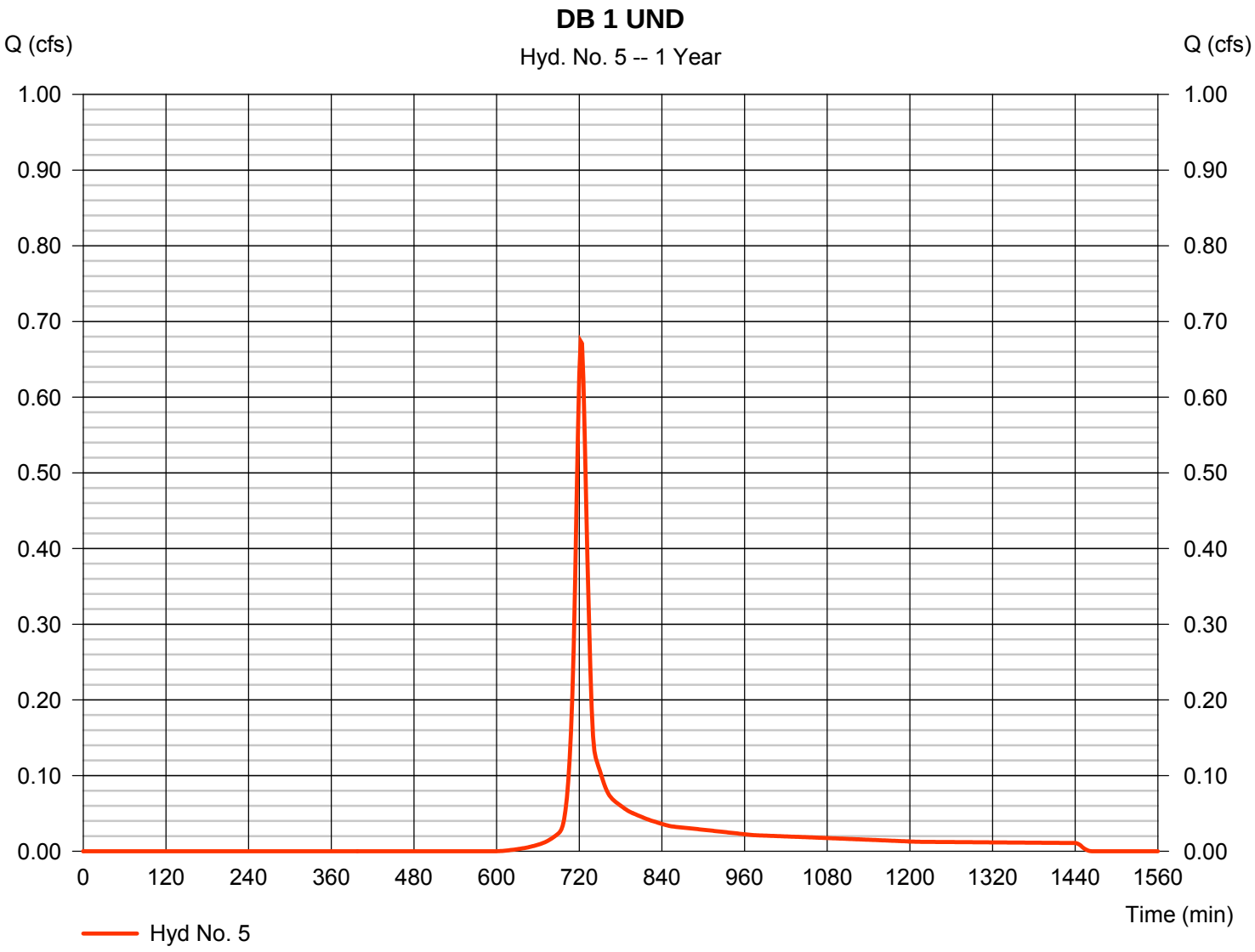
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 5

DB 1 UND

Hydrograph type	= SCS Runoff	Peak discharge	= 0.674 cfs
Storm frequency	= 1 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 1,923 cuft
Drainage area	= 0.510 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 2.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



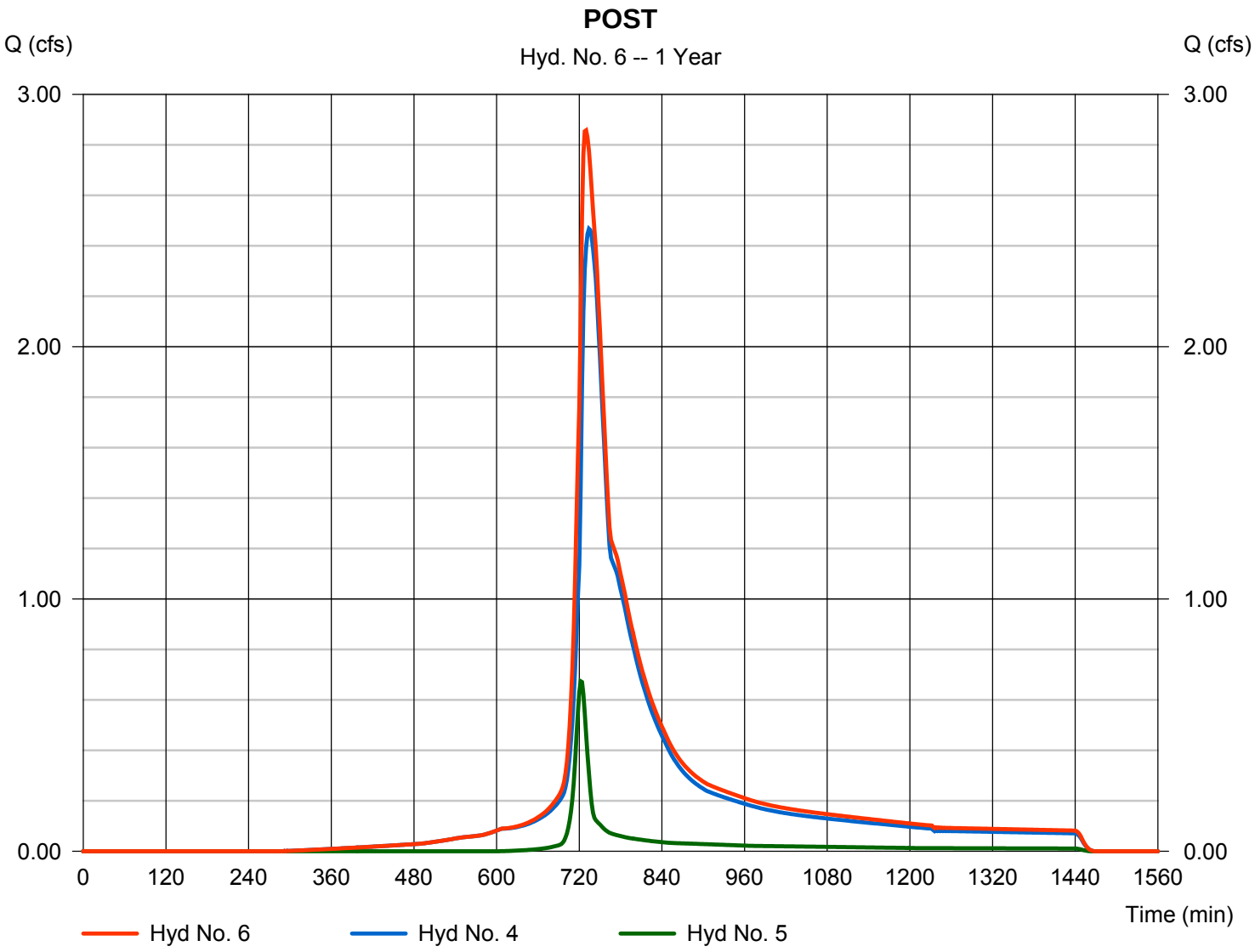
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 6

POST

Hydrograph type	= Combine	Peak discharge	= 2.858 cfs
Storm frequency	= 1 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 17,842 cuft
Inflow hyds.	= 4, 5	Contrib. drain. area	= 0.510 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	4.442	2	722	12,868	------	------	------	DB 1
2	SCS Runoff	2.114	2	724	6,638	------	------	------	DB 1 OFF
3	Combine	6.465	2	722	19,506	1, 2	------	------	UG DETENTION INFLOW
4	Reservoir	2.752	2	736	19,506	3	939.97	5,677	UG DETENTION
5	SCS Runoff	0.879	2	722	2,482	------	------	------	DB 1 UND
6	Combine	3.338	2	726	21,988	4, 5	------	------	POST

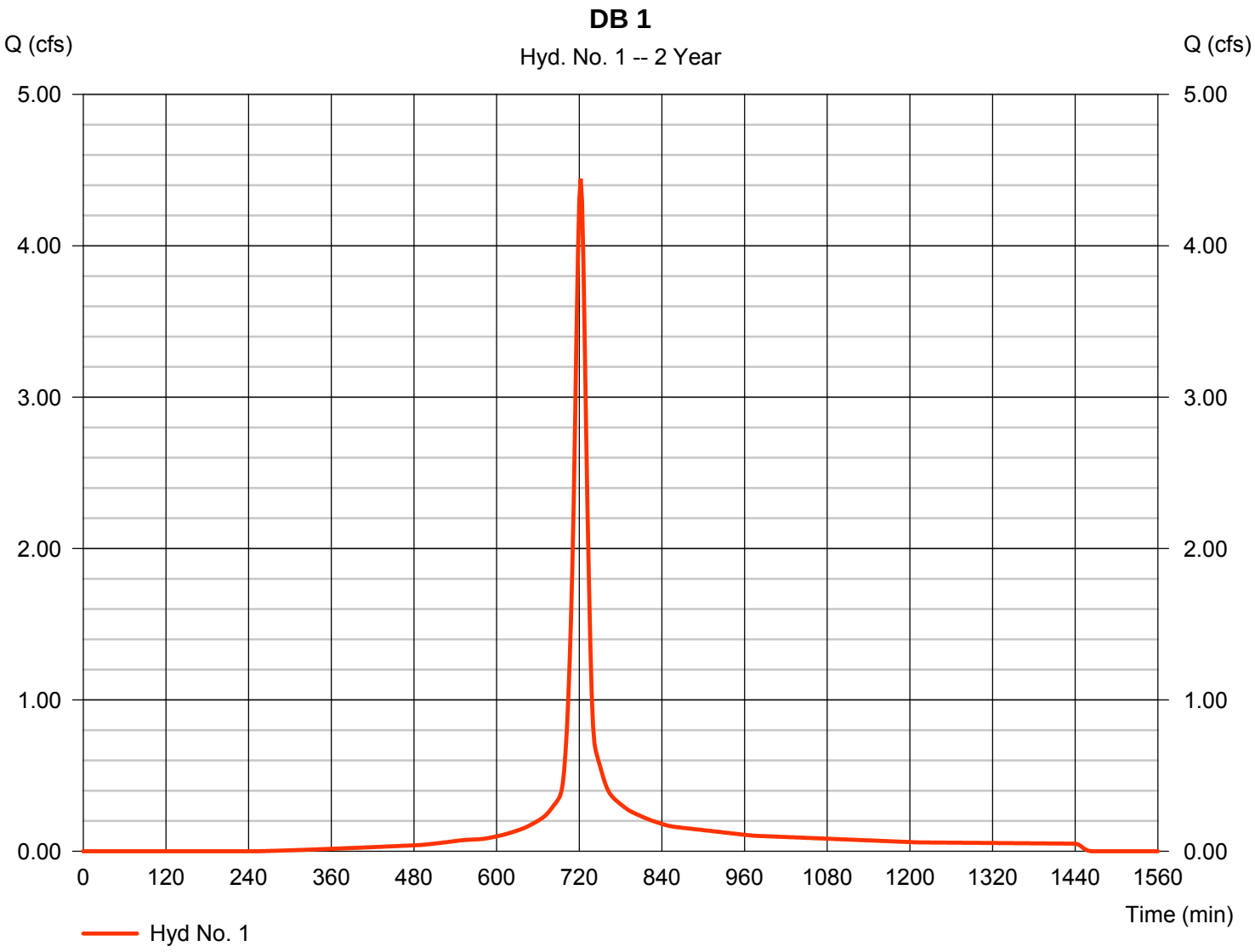
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 1

DB 1

Hydrograph type	= SCS Runoff	Peak discharge	= 4.442 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 12,868 cuft
Drainage area	= 1.560 ac	Curve number	= 93
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 3.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



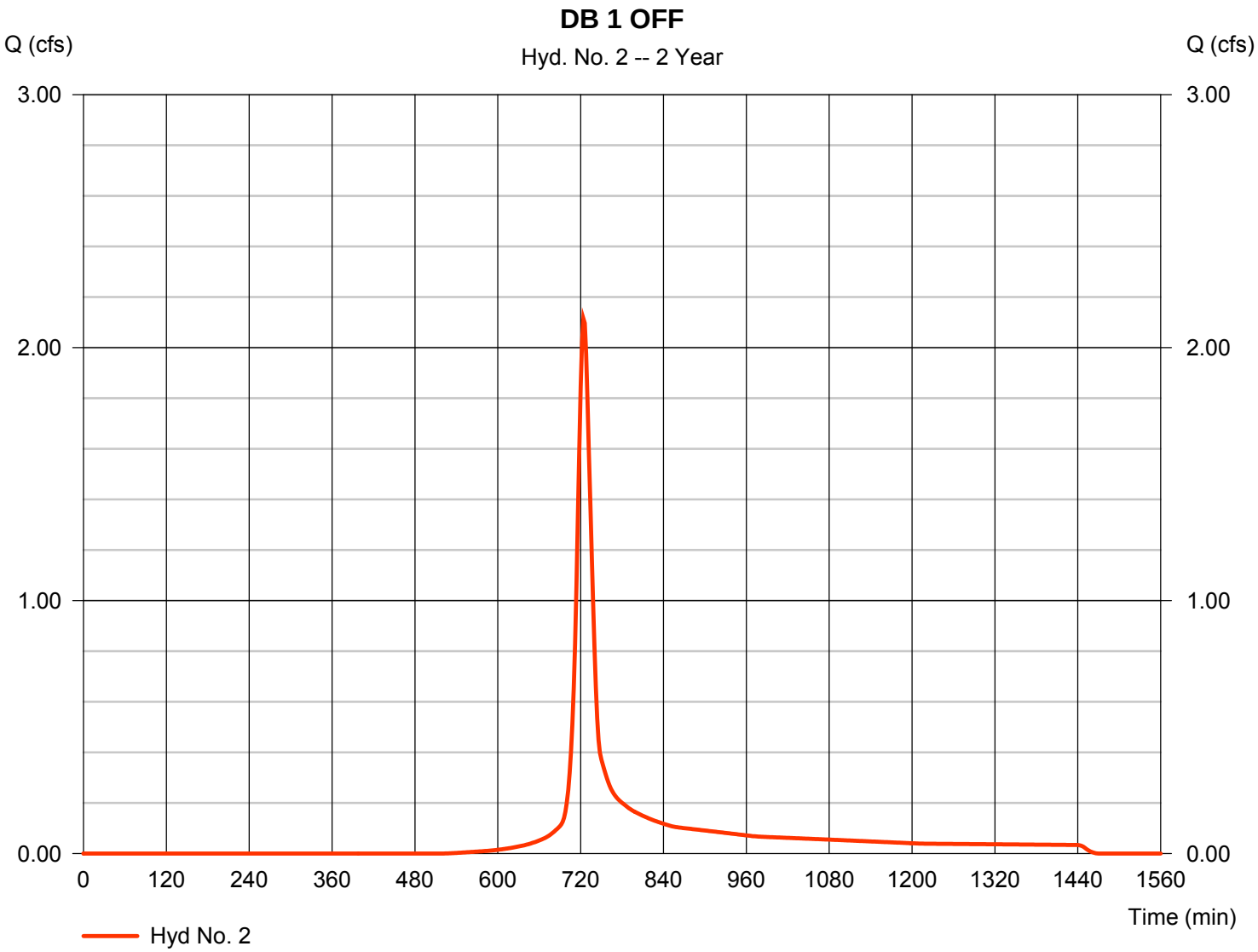
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 2

DB 1 OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 2.114 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 6,638 cuft
Drainage area	= 1.210 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.60 min
Total precip.	= 3.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



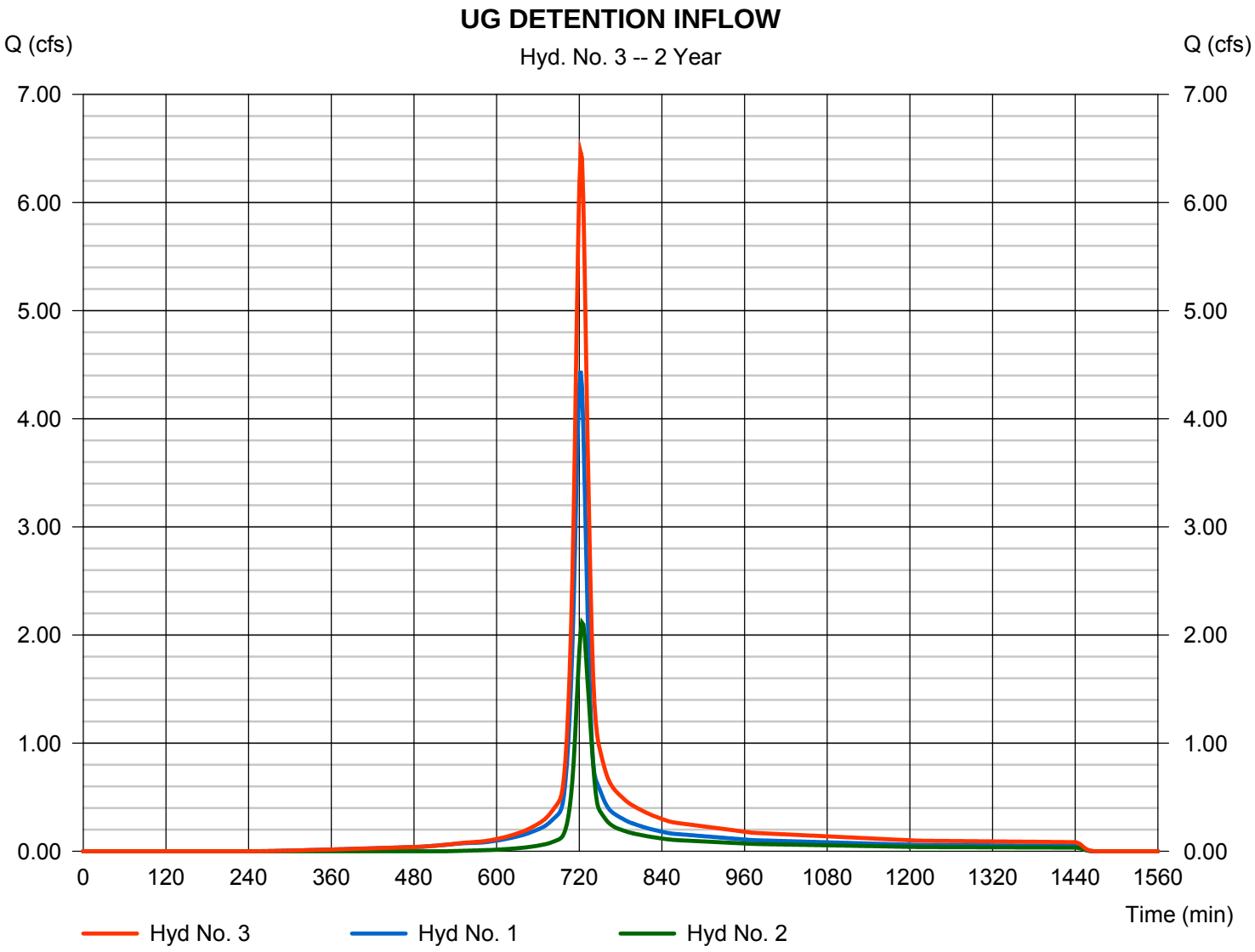
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 3

UG DETENTION INFLOW

Hydrograph type	= Combine	Peak discharge	= 6.465 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 19,506 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 2.770 ac



Hydrograph Report

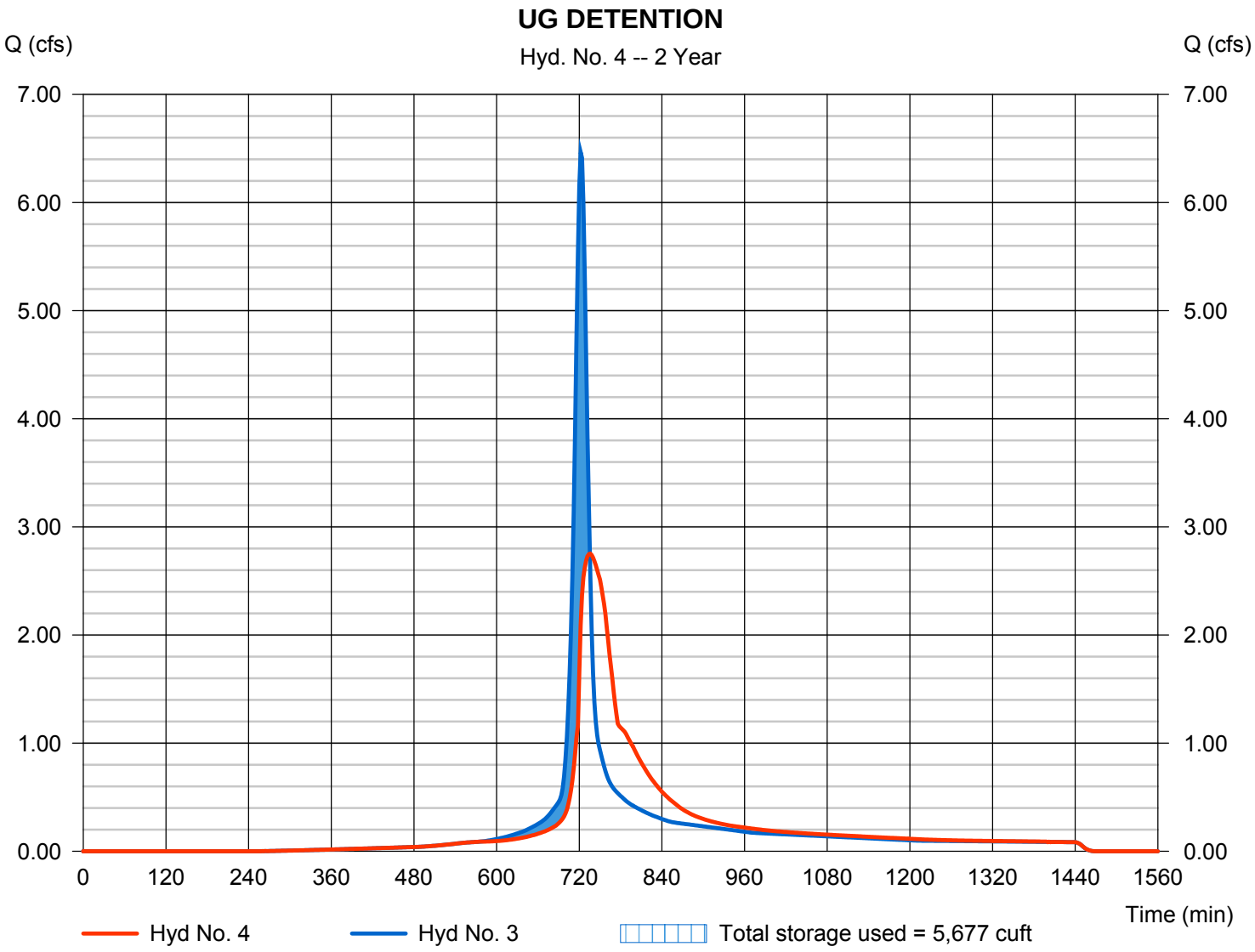
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 4

UG DETENTION

Hydrograph type	= Reservoir	Peak discharge	= 2.752 cfs
Storm frequency	= 2 yrs	Time to peak	= 736 min
Time interval	= 2 min	Hyd. volume	= 19,506 cuft
Inflow hyd. No.	= 3 - UG DETENTION INFLOW	Max. Elevation	= 939.97 ft
Reservoir name	= UG DETENTION	Max. Storage	= 5,677 cuft

Storage Indication method used.



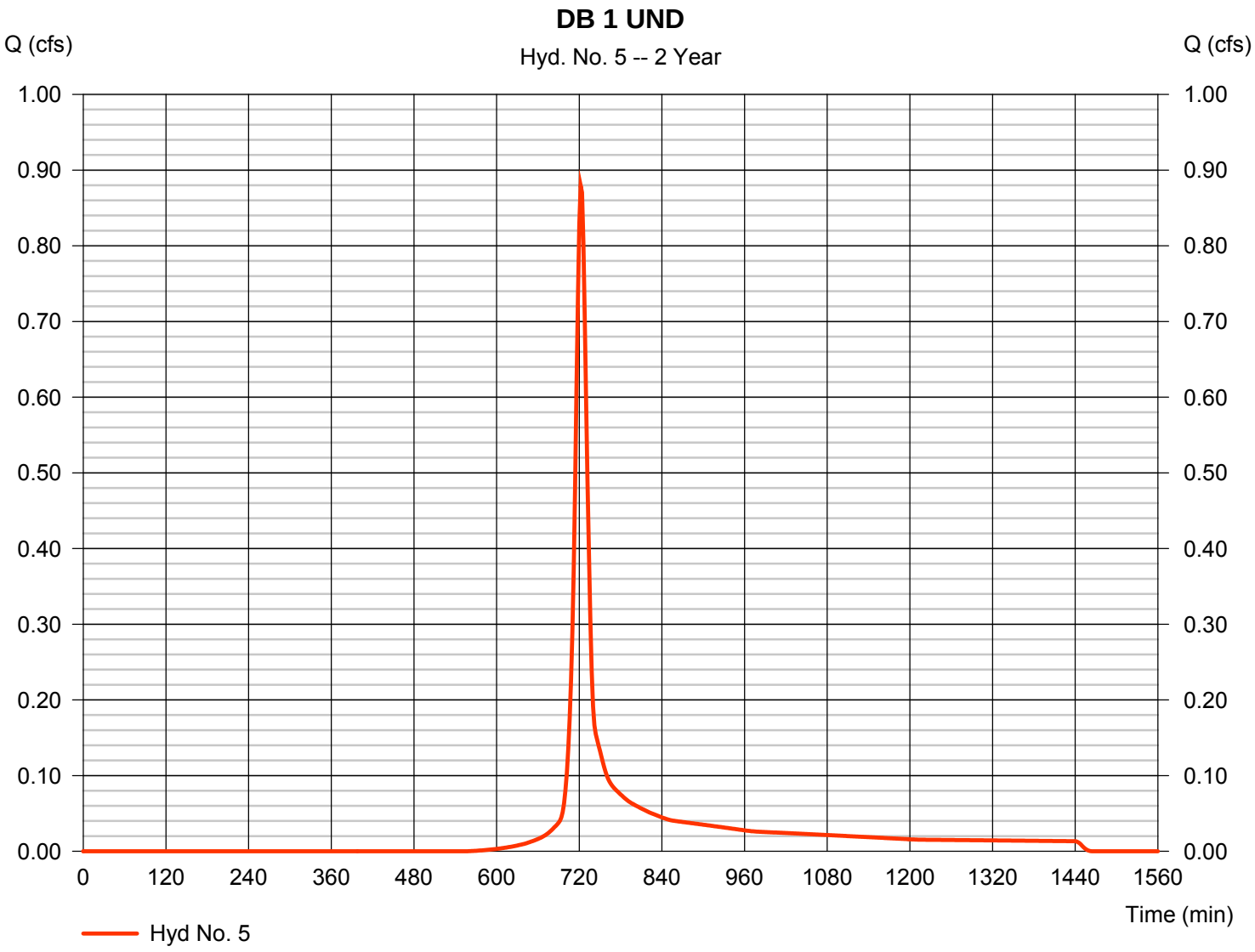
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 5

DB 1 UND

Hydrograph type	= SCS Runoff	Peak discharge	= 0.879 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 2,482 cuft
Drainage area	= 0.510 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 3.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



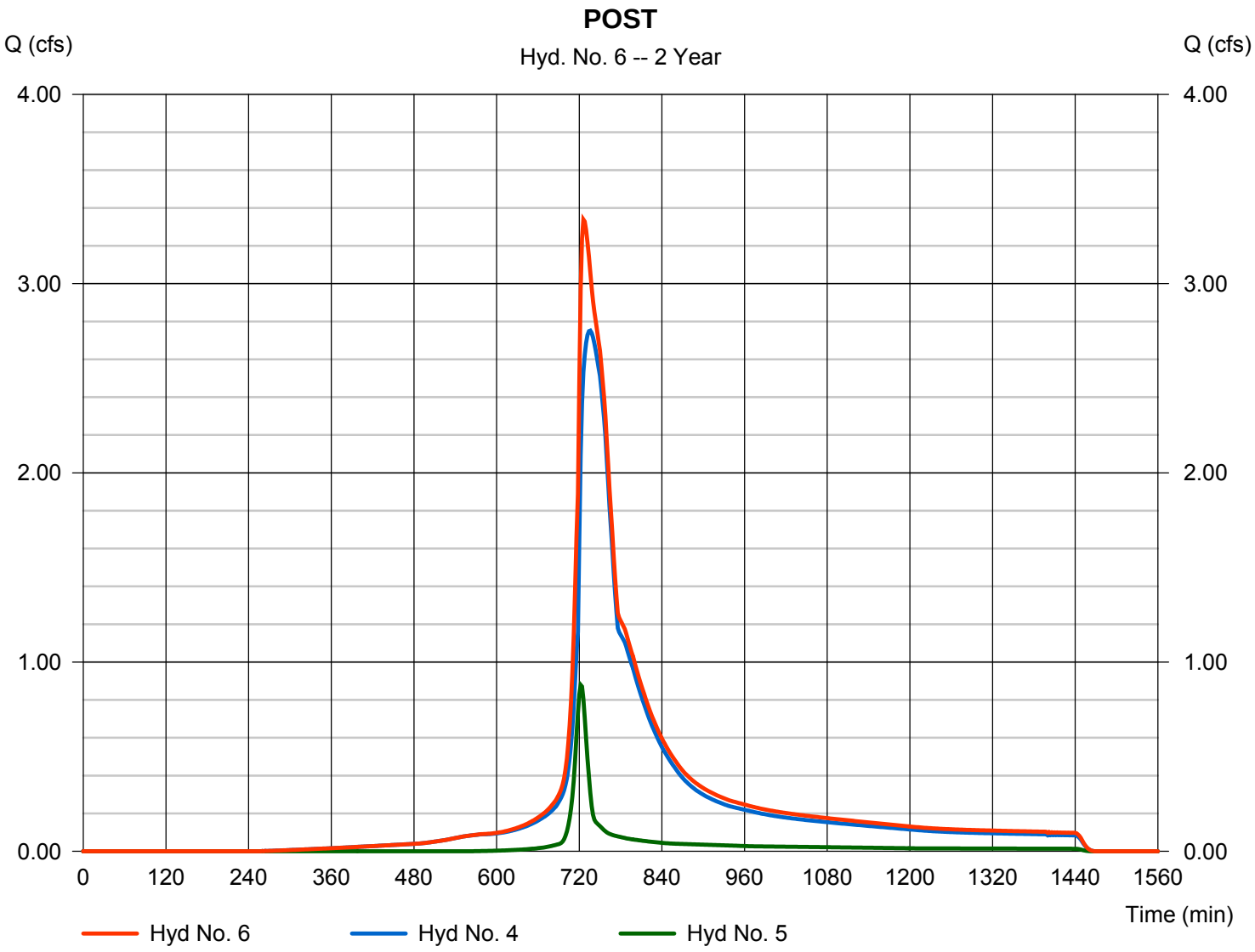
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 6

POST

Hydrograph type	=	Combine	Peak discharge	=	3.338 cfs
Storm frequency	=	2 yrs	Time to peak	=	726 min
Time interval	=	2 min	Hyd. volume	=	21,988 cuft
Inflow hyds.	=	4, 5	Contrib. drain. area	=	0.510 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	5.705	2	722	16,758	------	------	------	DB 1
2	SCS Runoff	2.981	2	724	9,321	------	------	------	DB 1 OFF
3	Combine	8.574	2	722	26,079	1, 2	------	------	UG DETENTION INFLOW
4	Reservoir	3.220	2	736	26,080	3	940.34	7,954	UG DETENTION
5	SCS Runoff	1.263	2	722	3,543	------	------	------	DB 1 UND
6	Combine	4.065	2	726	29,623	4, 5	------	------	POST

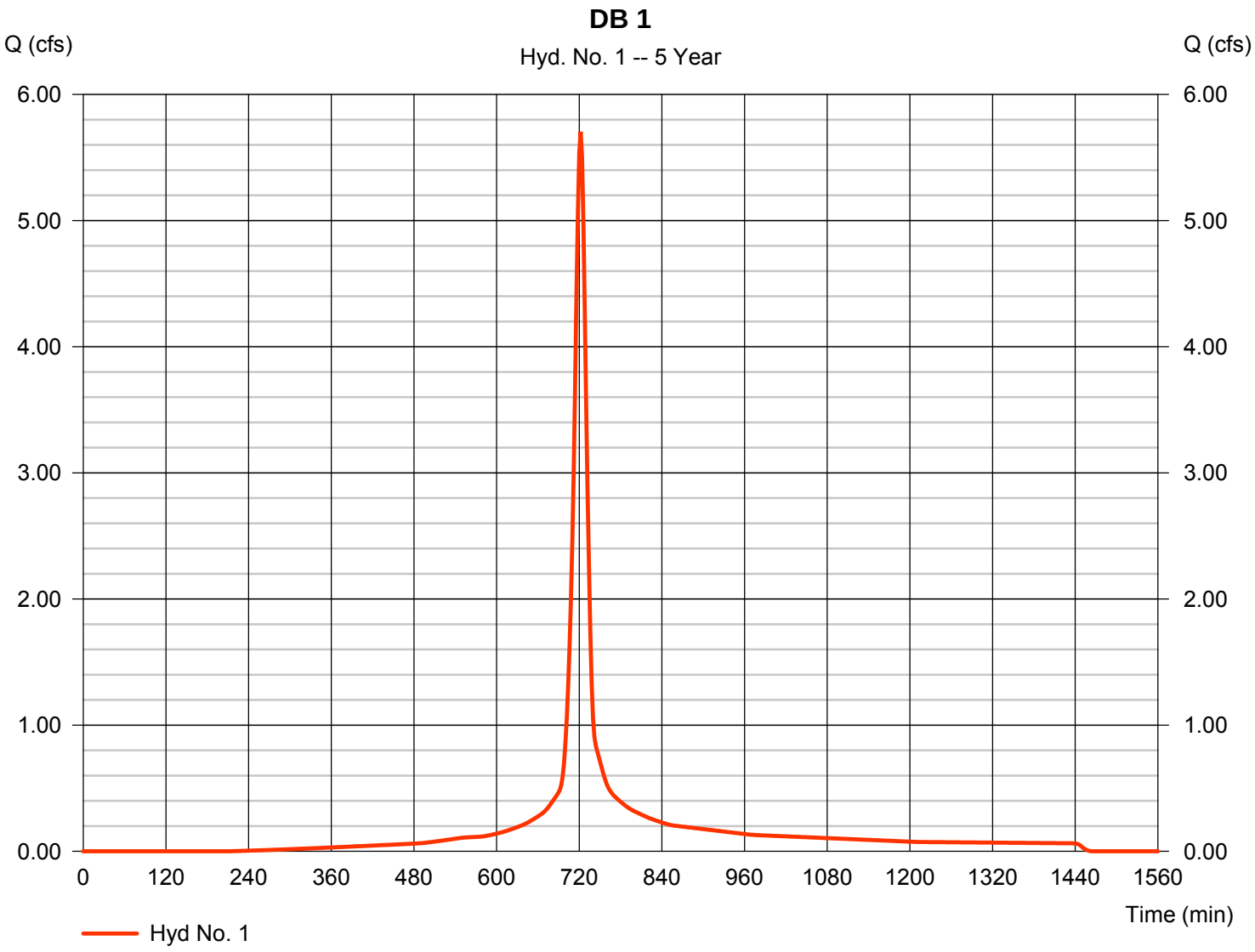
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 1

DB 1

Hydrograph type	= SCS Runoff	Peak discharge	= 5.705 cfs
Storm frequency	= 5 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 16,758 cuft
Drainage area	= 1.560 ac	Curve number	= 93
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 3.81 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



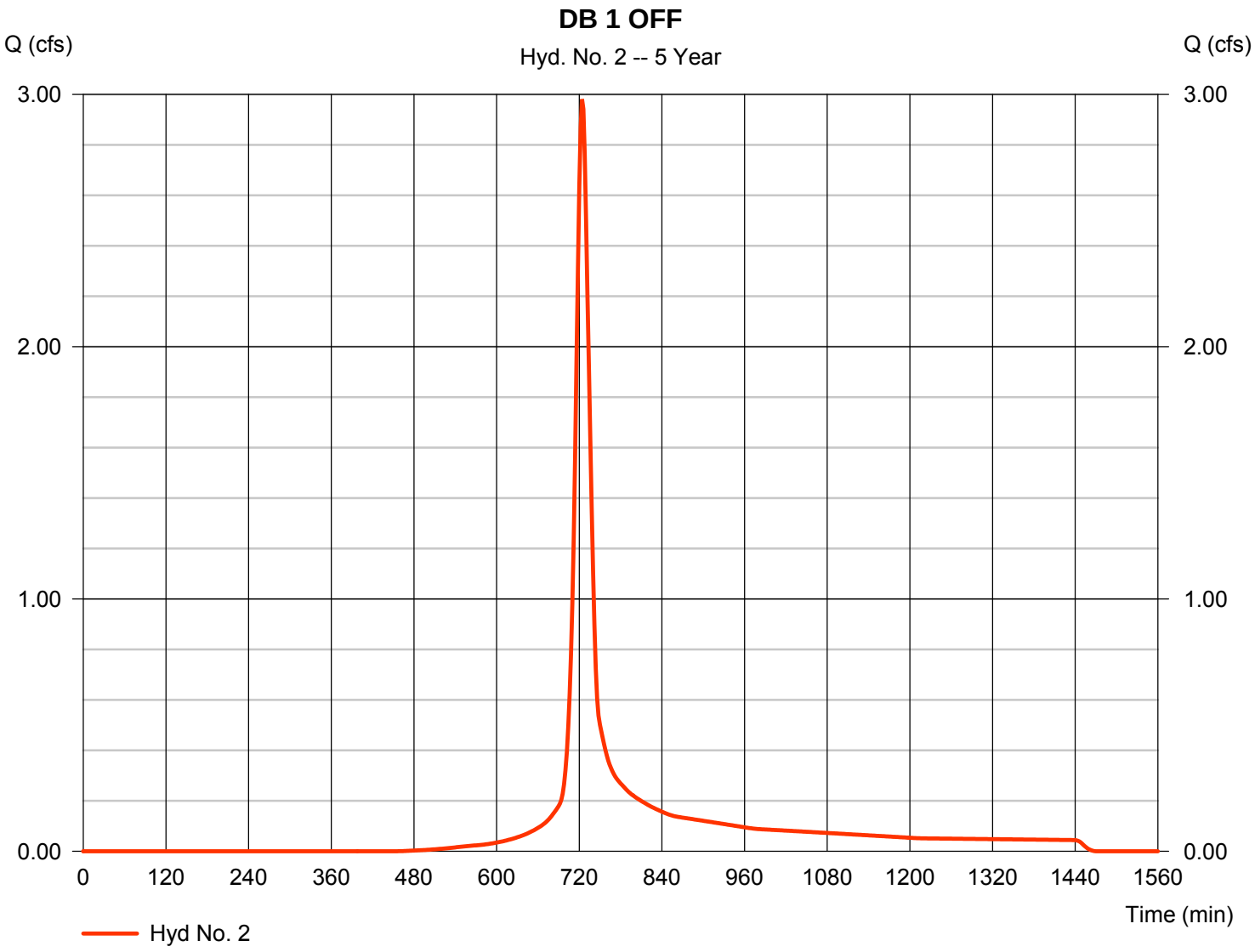
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 2

DB 1 OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 2.981 cfs
Storm frequency	= 5 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 9,321 cuft
Drainage area	= 1.210 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.60 min
Total precip.	= 3.81 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



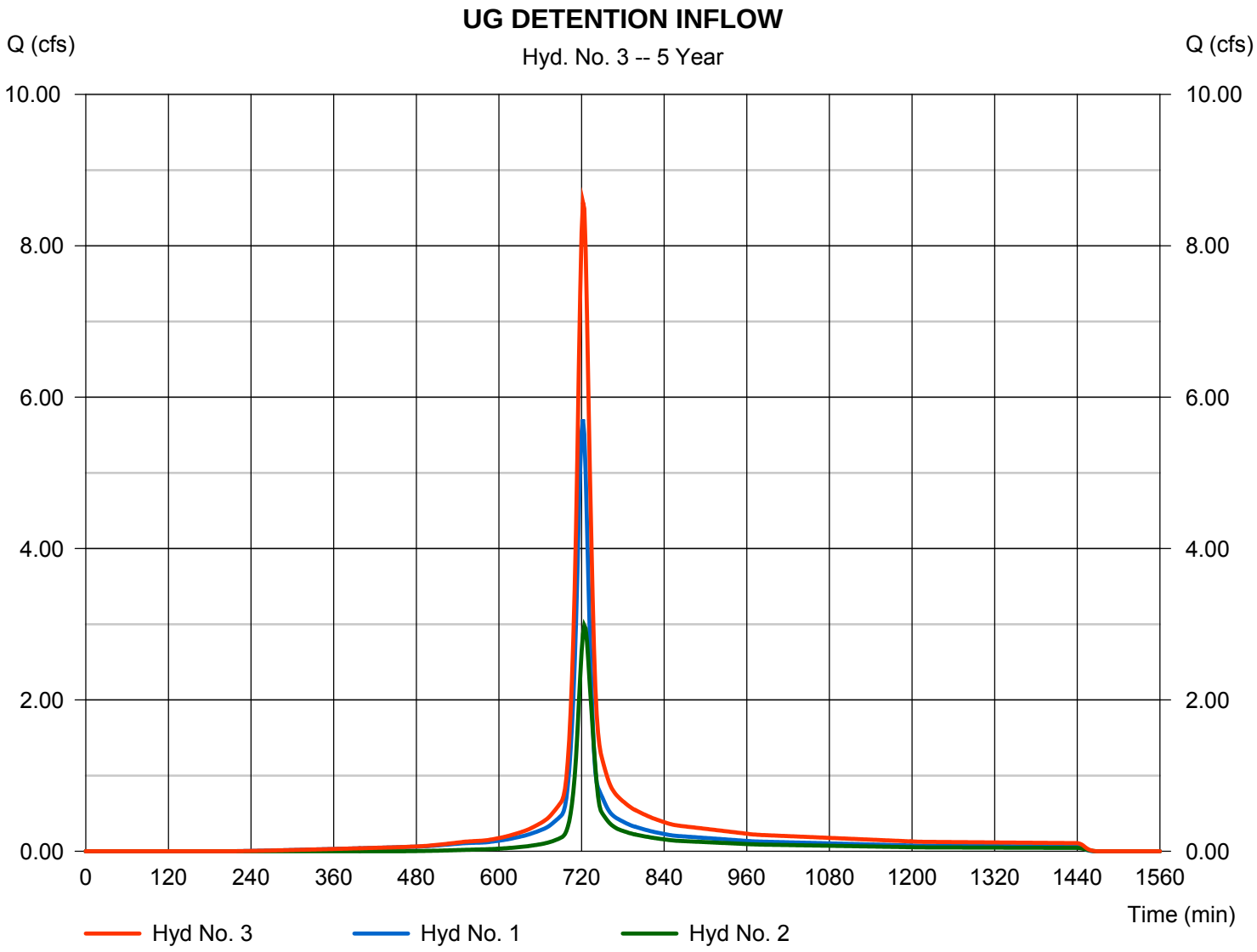
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 3

UG DETENTION INFLOW

Hydrograph type	= Combine	Peak discharge	= 8.574 cfs
Storm frequency	= 5 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 26,079 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 2.770 ac



Hydrograph Report

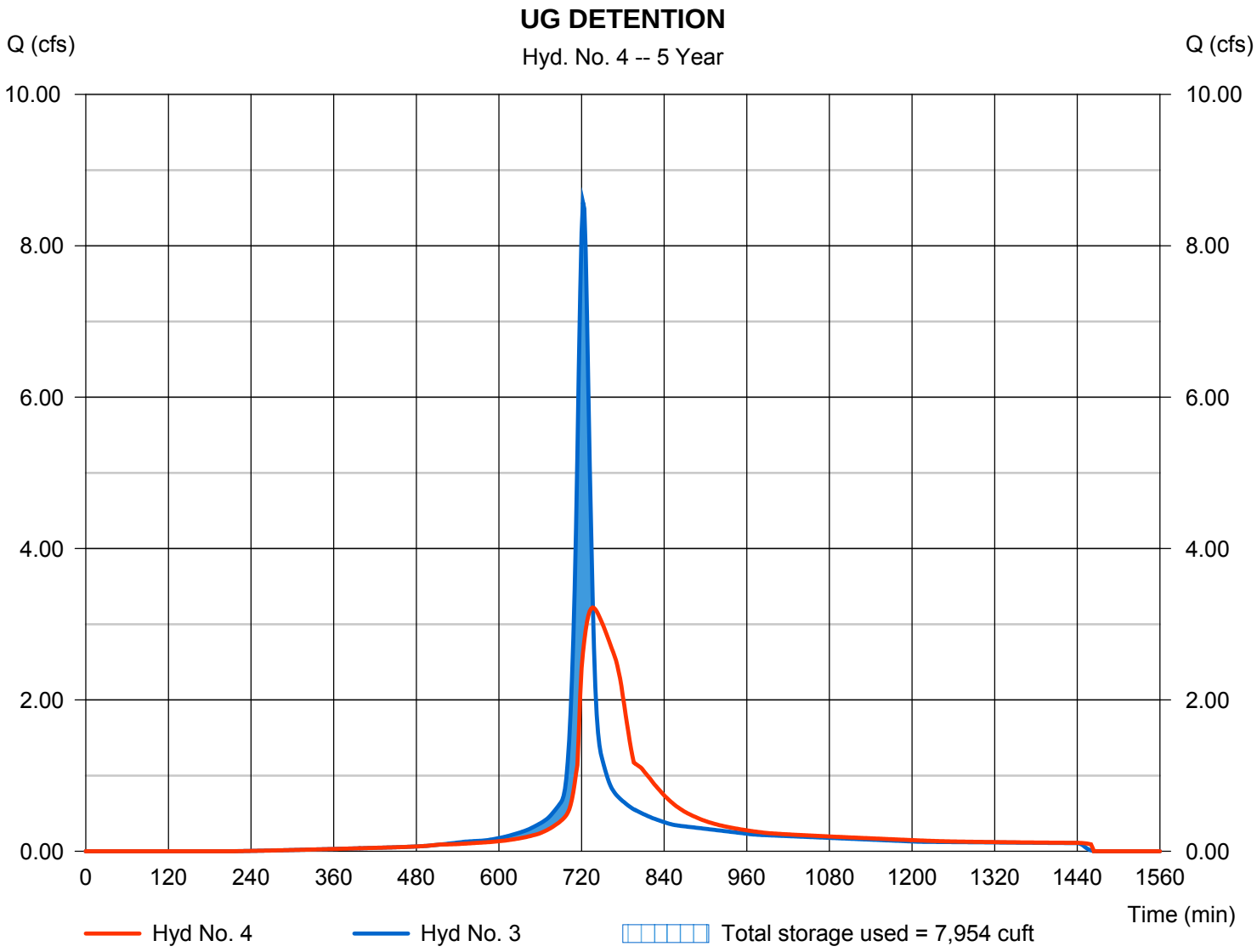
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 4

UG DETENTION

Hydrograph type	=	Reservoir	Peak discharge	=	3.220 cfs
Storm frequency	=	5 yrs	Time to peak	=	736 min
Time interval	=	2 min	Hyd. volume	=	26,080 cuft
Inflow hyd. No.	=	3 - UG DETENTION INFLOW	Max. Elevation	=	940.34 ft
Reservoir name	=	UG DETENTION	Max. Storage	=	7,954 cuft

Storage Indication method used.



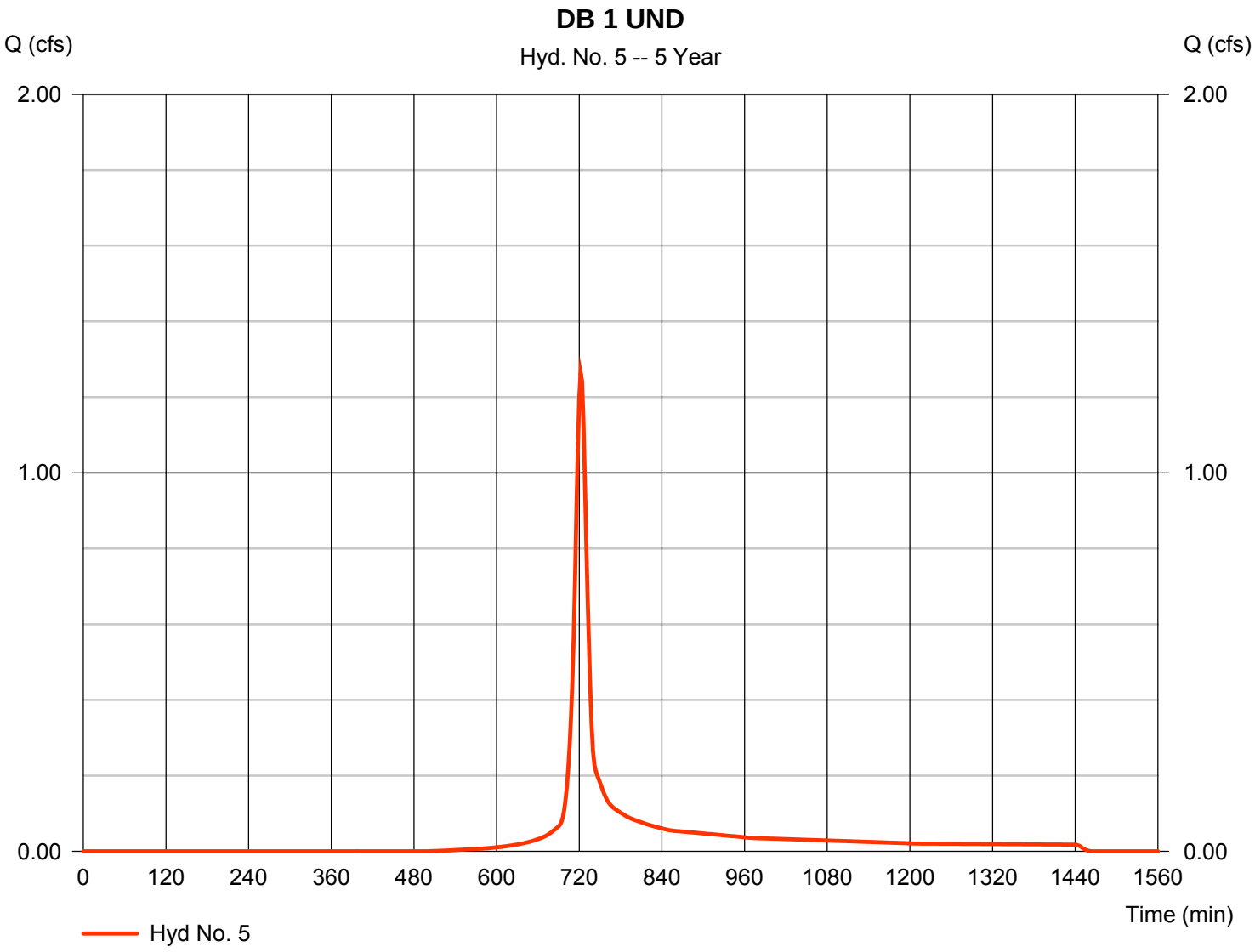
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 5

DB 1 UND

Hydrograph type	= SCS Runoff	Peak discharge	= 1.263 cfs
Storm frequency	= 5 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 3,543 cuft
Drainage area	= 0.510 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 3.81 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



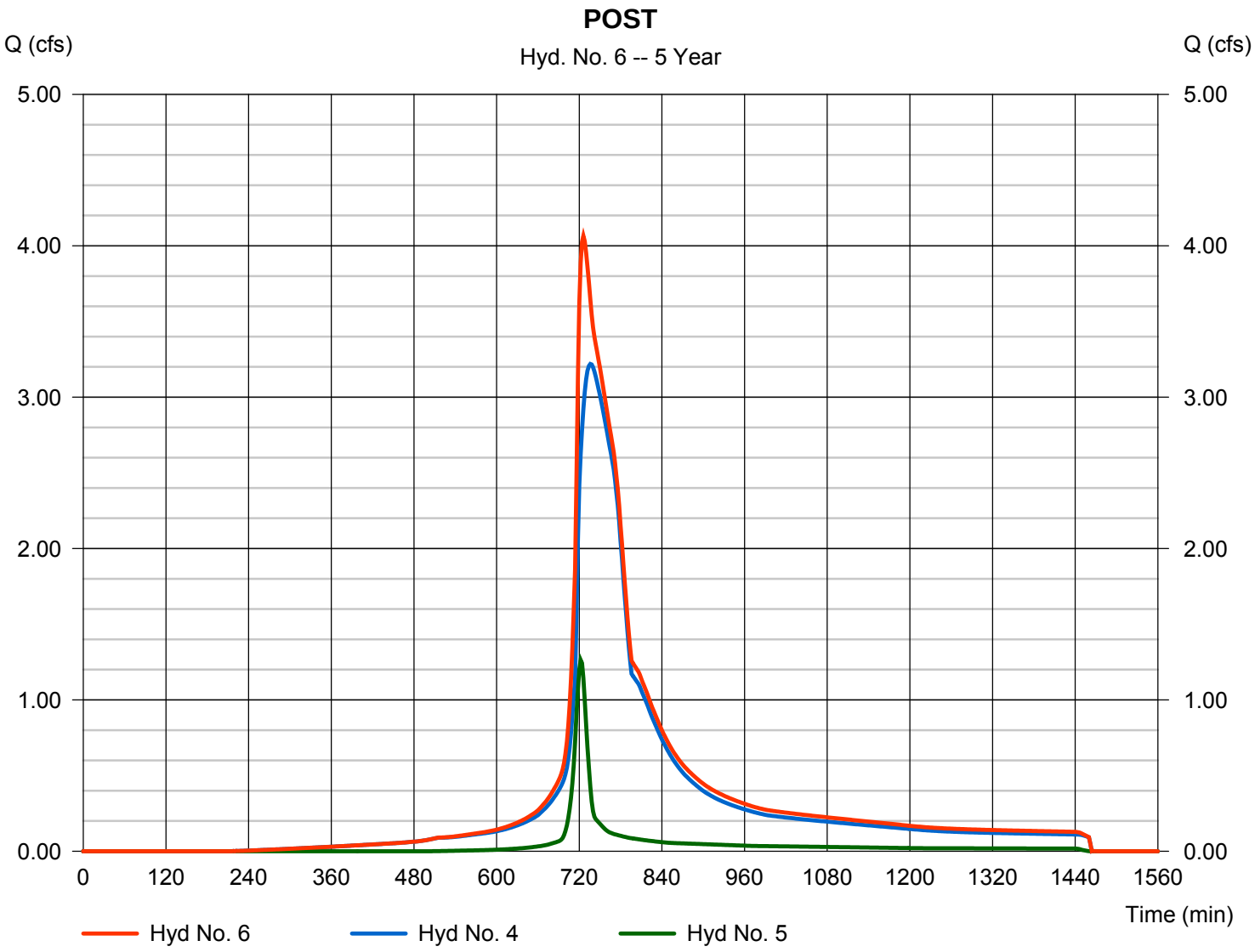
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 6

POST

Hydrograph type	= Combine	Peak discharge	= 4.065 cfs
Storm frequency	= 5 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 29,623 cuft
Inflow hyds.	= 4, 5	Contrib. drain. area	= 0.510 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	11.34	2	722	34,729	------	------	------	DB 1
2	SCS Runoff	7.095	2	724	22,581	------	------	------	DB 1 OFF
3	Combine	18.25	2	722	57,311	1, 2	------	------	UG DETENTION INFLOW
4	Reservoir	5.180	2	738	57,315	3	942.51	19,594	UG DETENTION
5	SCS Runoff	3.117	2	722	8,875	------	------	------	DB 1 UND
6	Combine	7.197	2	724	66,190	4, 5	------	------	POST

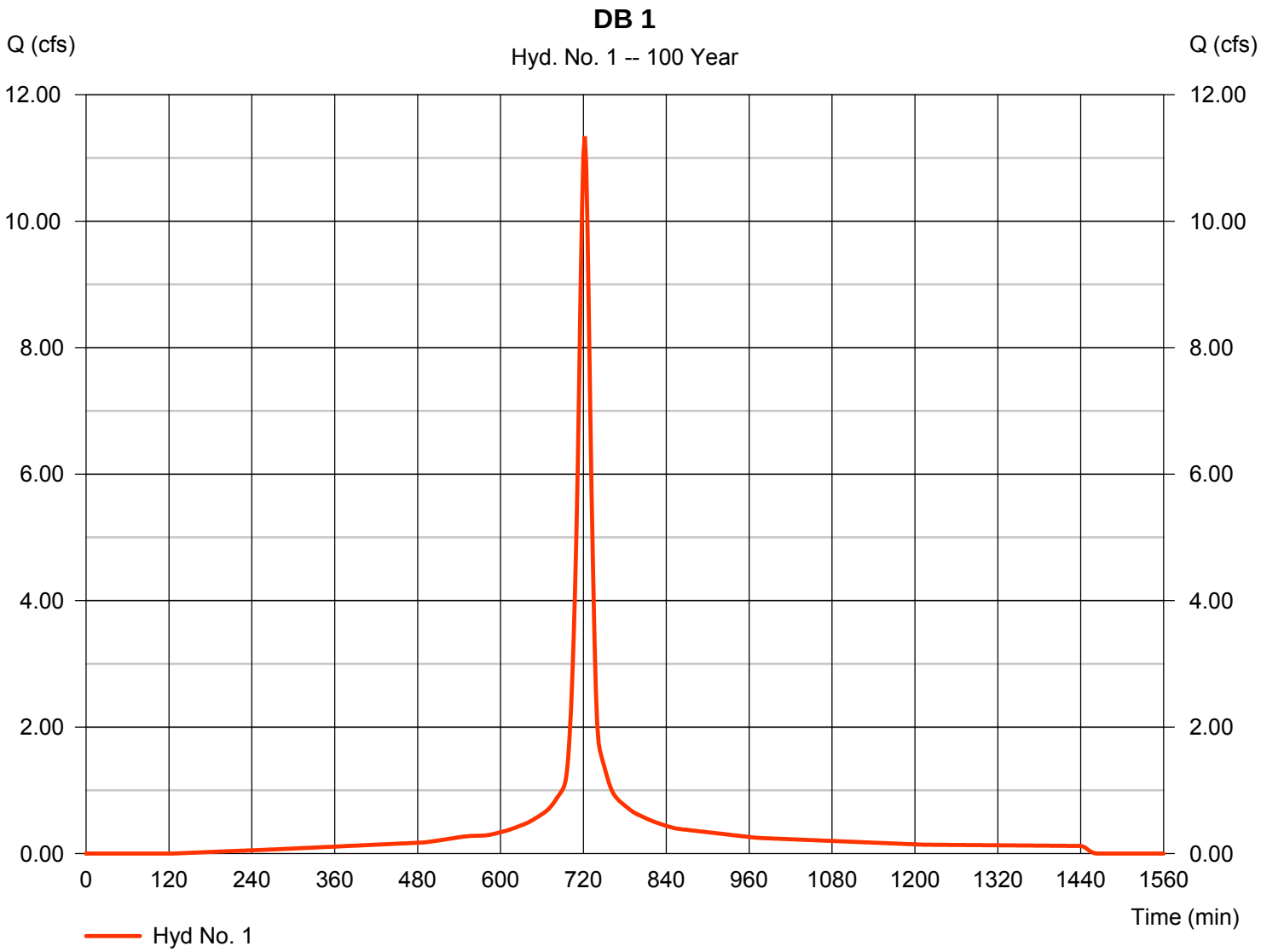
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 1

DB 1

Hydrograph type	= SCS Runoff	Peak discharge	= 11.34 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 34,729 cuft
Drainage area	= 1.560 ac	Curve number	= 93
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 7.12 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



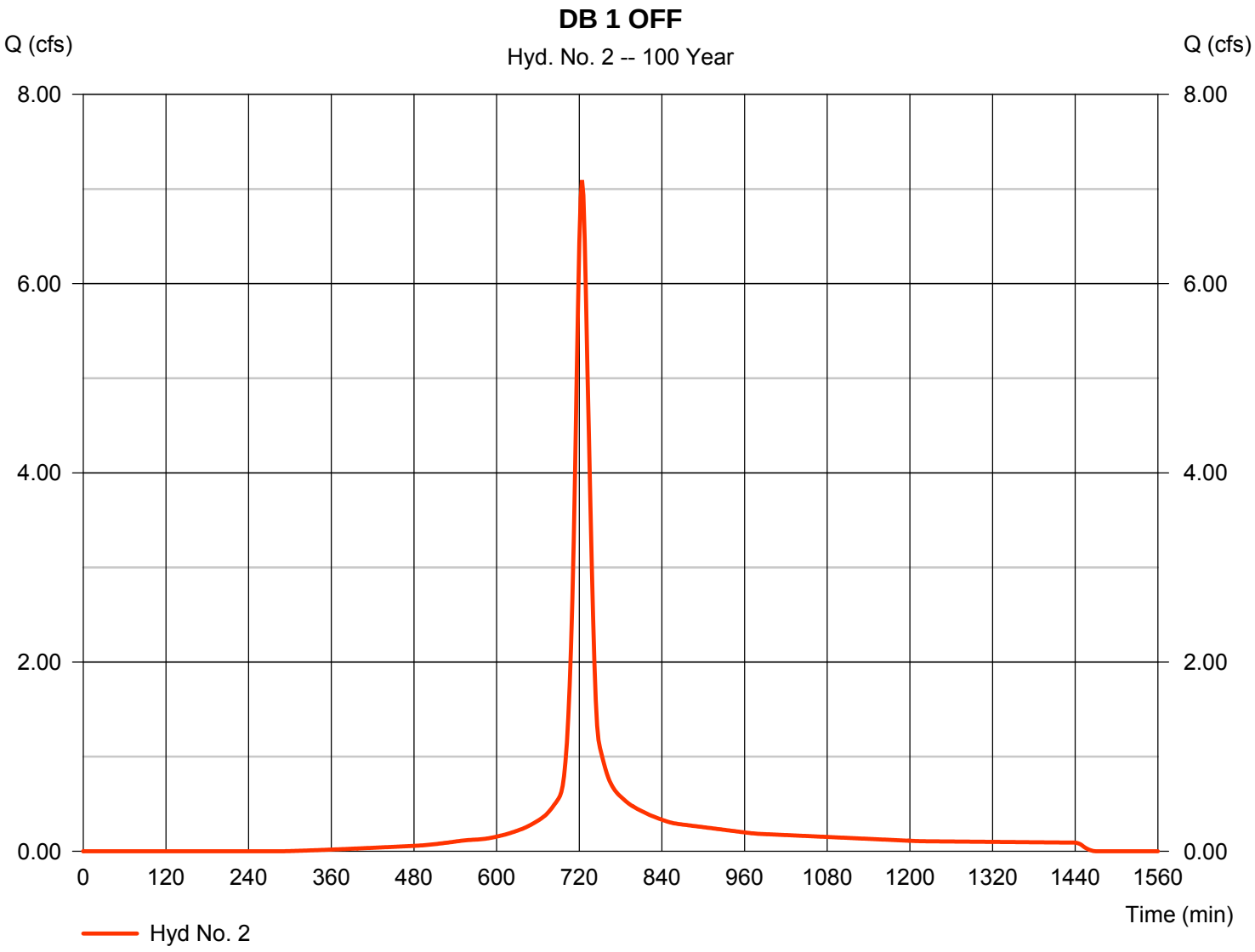
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 2

DB 1 OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 7.095 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 22,581 cuft
Drainage area	= 1.210 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 18.60 min
Total precip.	= 7.12 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



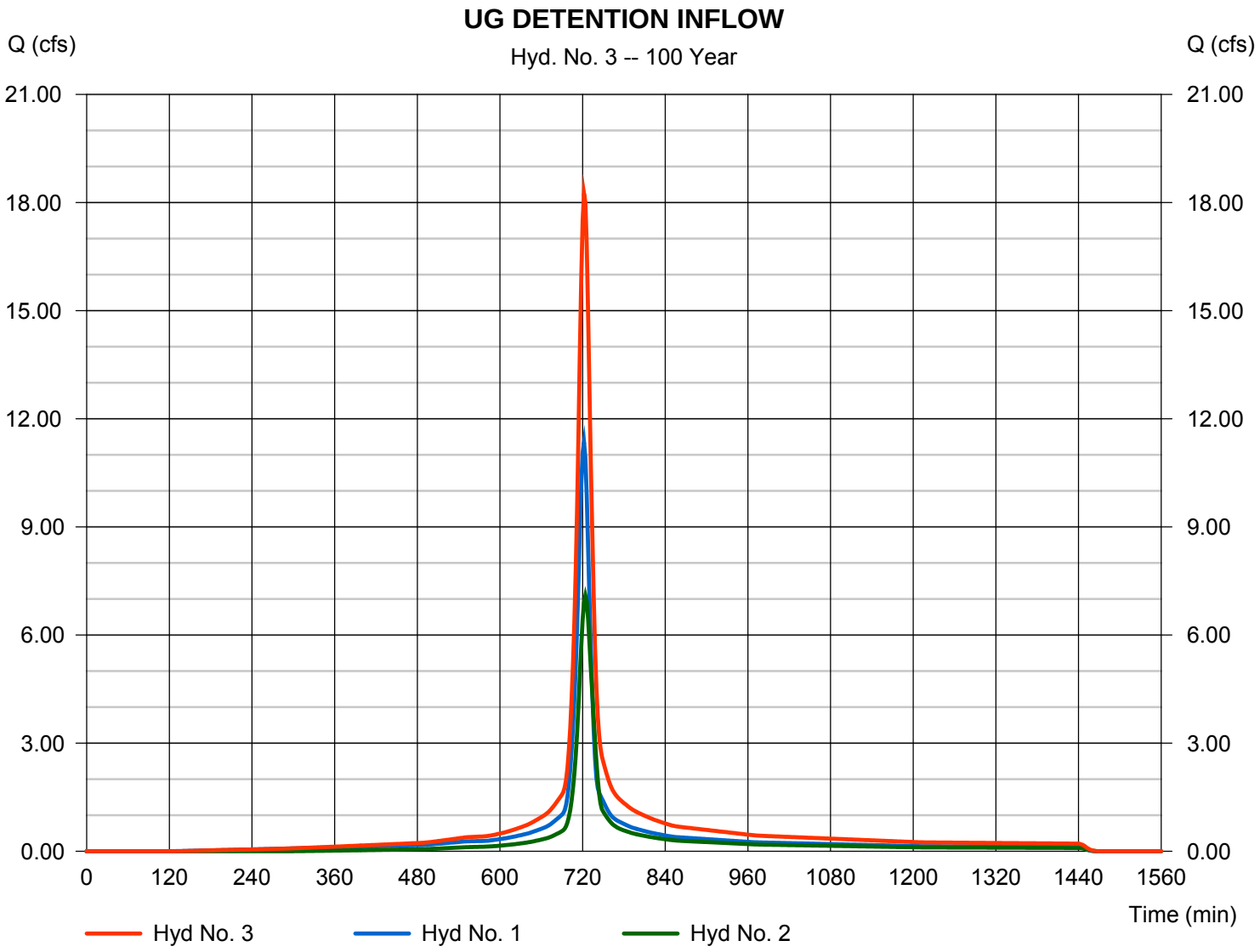
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 3

UG DETENTION INFLOW

Hydrograph type	= Combine	Peak discharge	= 18.25 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 57,311 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 2.770 ac



Hydrograph Report

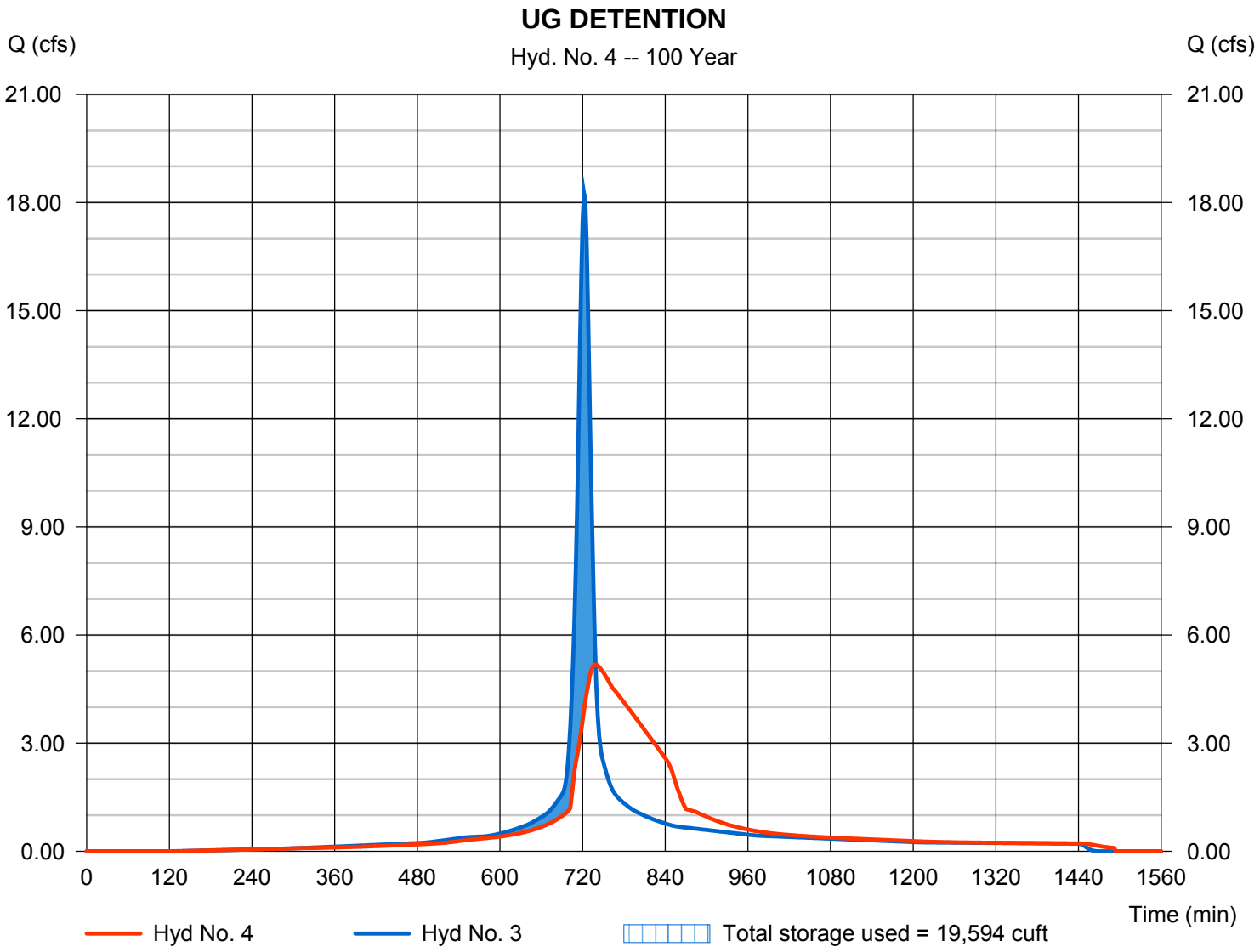
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 4

UG DETENTION

Hydrograph type	= Reservoir	Peak discharge	= 5.180 cfs
Storm frequency	= 100 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 57,315 cuft
Inflow hyd. No.	= 3 - UG DETENTION INFLOW	Max. Elevation	= 942.51 ft
Reservoir name	= UG DETENTION	Max. Storage	= 19,594 cuft

Storage Indication method used.



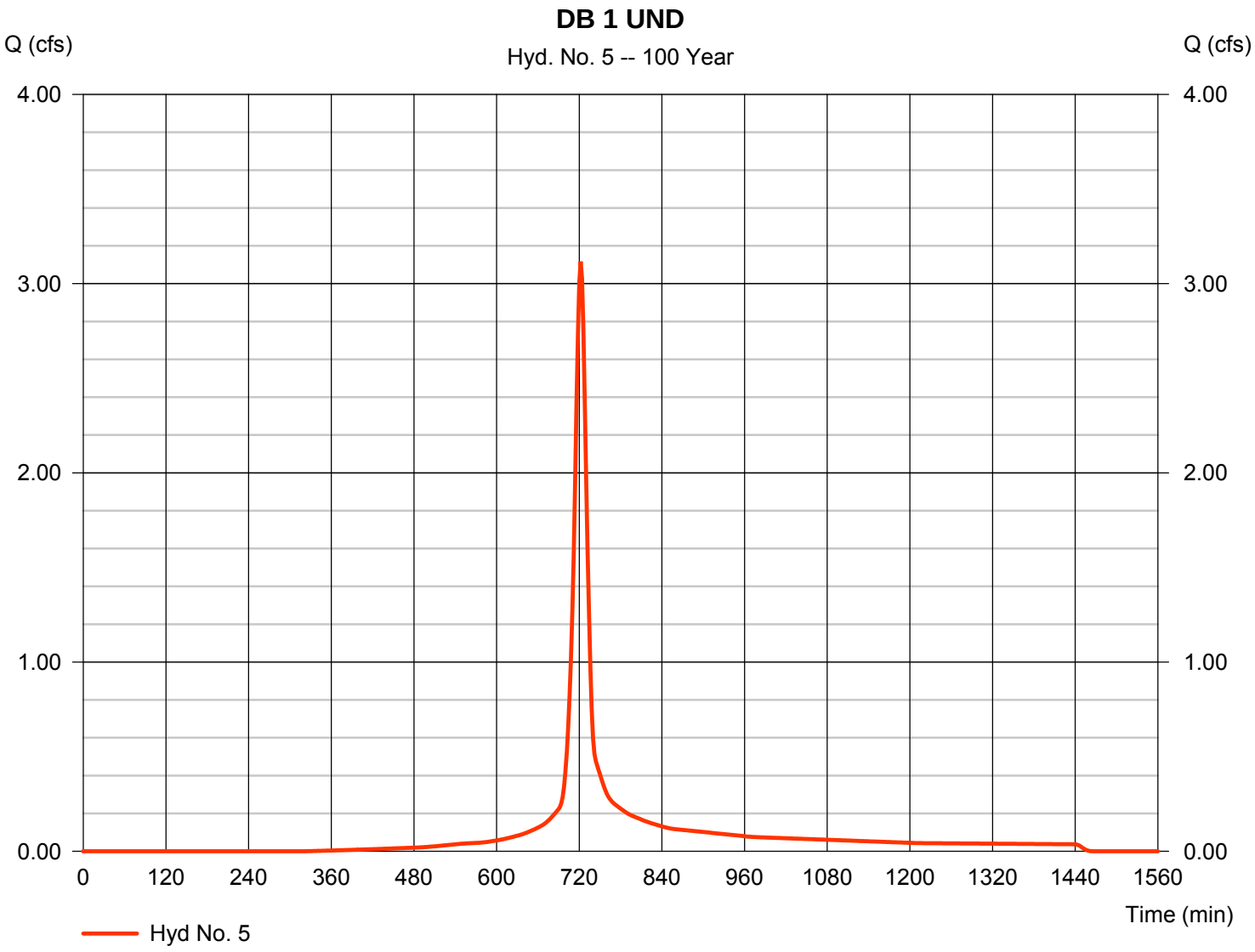
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 5

DB 1 UND

Hydrograph type	= SCS Runoff	Peak discharge	= 3.117 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 8,875 cuft
Drainage area	= 0.510 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 7.12 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



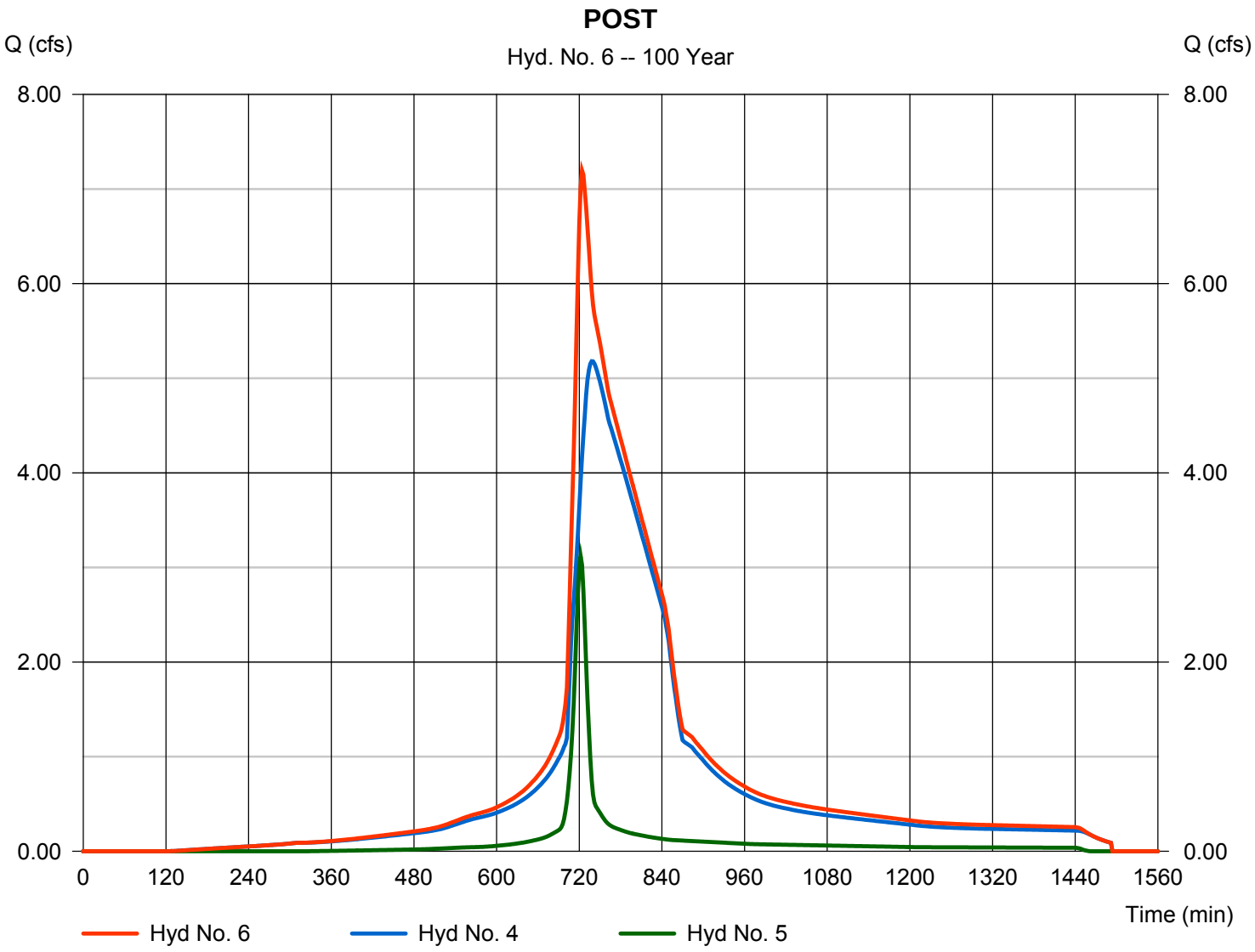
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Sunday, 03 / 13 / 2016

Hyd. No. 6

POST

Hydrograph type	= Combine	Peak discharge	= 7.197 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 66,190 cuft
Inflow hyds.	= 4, 5	Contrib. drain. area	= 0.510 ac



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	24.1705	5.1000	0.7018	--------
2	28.3435	5.1000	0.7022	--------
3	0.0000	0.0000	0.0000	--------
5	35.4692	5.3000	0.7016	--------
10	37.2537	4.6000	0.6755	--------
25	41.3346	4.1000	0.6540	--------
50	42.6141	3.5000	0.6290	--------
100	45.5234	3.3000	0.6151	--------

File name: Central Iowa 2014-04-25.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	4.77	3.60	2.94	2.52	2.22	1.99	1.81	1.67	1.55	1.45	1.36	1.29
2	5.59	4.21	3.45	2.95	2.60	2.33	2.12	1.95	1.81	1.70	1.60	1.51
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.91	5.23	4.29	3.68	3.24	2.91	2.65	2.44	2.27	2.12	2.00	1.89
10	8.08	6.09	4.99	4.28	3.78	3.40	3.10	2.86	2.67	2.50	2.35	2.23
25	9.75	7.32	6.00	5.16	4.56	4.11	3.76	3.47	3.24	3.04	2.87	2.72
50	11.09	8.29	6.80	5.85	5.18	4.68	4.29	3.97	3.71	3.49	3.30	3.13
100	12.39	9.27	7.62	6.56	5.82	5.27	4.84	4.48	4.19	3.95	3.73	3.55

Tc = time in minutes. Values may exceed 60.

Precip. file name: H:\2014\1409460\Engineer\SWMP\Hydraflow Hydrographs\Central Iowa 2014-04-25.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	2.67	3.08	0.00	3.81	4.46	5.44	6.26	7.12
SCS 6-Hr	2.05	2.40	0.00	3.03	3.61	4.47	5.20	5.98
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Section 4 – Storm Sewer Design

QuikTrip Store #504

City of Windsor Heights, County of Polk, State of Iowa

McCLURE™
ENGINEERING Co.

Project Name: QuikTrip Store #504
Project Location: City of Windsor Heights, County of Polk, State of Iowa
Project Number: 20715030

Date: 03-13-2016
Designed By: RGZ
Design Storm: 5 Year

Line Number	Structures From	Structures To	5 Year Runoff Calculations: Direct Area (acre)	Total Area (acre)	C	Tc (min.)	Flow Time (min.)	Intensity (in./hr.)	Tributary Runoff Q (cfs)	Notes	5 Year Intake Location and Type: Location	Type	On-Grade or Sag	Notes	5 Year Intake Spread: Manning's n	Longitudinal Slope (S_L, %)	Transverse Slope (S_X, %)	Width of Flow (T, ft.)	Gutter Runoff Depth (ft.)	Flow Velocity (V, fps)	Notes	5 Year On-Grade Intake Capacity: Frontal/Gutter Flow Ratio (E_G)	Frontal Flow Ratio (R_f)	Side Flow Ratio (R_s)	Efficiency	Reduction Factor	Intercepted Flow (Q_i, cfs)	Bypass Flow (Q_b, cfs)	Bypass Intake Number	Notes	5 Year Sag Intake Capacity: Reduction Factor	Depth of Flow (d, ft.)	Width of Flow (T, ft.)	Notes	Structure and Pipe Description	Pipe Material	Pipe Shape
1	1		1.45		0.57	15.00		4.12	3.41		On-Site	SW-505	Sag	1	0.016	1.50	1.50	12.67	0.26	2.81	10	0.29	1.00	0.49	0.64	0.90	0.00	0.00			80%	0.33	2.65		SW-505		
		2		1.45	0.57	15.00	0.47	4.12	3.41																										24" HDPE	HDPE	Round
	2		0.00		0.83	5.00		6.91	0.00		On-Site	SW-401		2				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							SW-401		
		3		1.84	0.45	15.47	0.87	4.06	3.36																										24" HDPE	HDPE	Round
	3		0.09		0.83	5.00		6.91	0.52		On-Site	SW-501	Sag	3	0.016	2.00	1.50	5.93	0.12	1.95	10	0.54	1.00	0.27	0.67	0.90	0.00	0.00			80%	0.19	2.16		SW-501		
		4		2.09	0.43	16.34	0.46	3.96	3.58																										24" HDPE	HDPE	Round
	4		0.11		0.83	5.00		6.91	0.64		On-Site	SW-501	Sag	3	0.016	2.00	1.50	6.39	0.13	2.06	10	0.51	1.00	0.25	0.63	0.90	0.00	0.00			80%	0.21	2.50		SW-501		
		5		2.20	0.45	16.80	0.03	3.92	3.90	1																									24" HDPE	HDPE	Round
2	6		0.00		0.83	0.00		9.97	0.00		On-Site	STUB		4				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							STUB		
		7		0.00	0.83	0.00	0.00	9.97	0.00																										15" HDPE	HDPE	Round
	7		0.00		0.83	0.00		9.97	0.00		On-Site	NYLOPLAST		5				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							NYLOPLAST		
		8		0.00	0.83	0.00	0.00	9.97	0.00																										15" HDPE	HDPE	Round
	8		0.00		0.83	0.00		9.97	0.00		On-Site	WQU		6				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							WQU		
		9		0.00	0.83	0.00	0.00	9.97	0.00	2																									15" RCP	RCP	Round
3	10		0.57		0.83	5.00		6.91	3.29		On-Site	SW-505	Sag	3	0.016	2.00	1.50	11.84	0.25	3.10	10	0.30	1.00	0.45	0.61	0.90	0.00	0.00			80%	0.32	2.64		SW-505		
		11		0.68	0.56	5.00	0.11	6.91	2.65	1																									15" HDPE	HDPE	Round
4	12		0.16		0.83	5.00		6.91	0.92		On-Site	SW-501	Sag	3	0.016	2.00	1.50	7.35	0.15	2.26	10	0.46	1.00	0.22	0.58	0.90	0.00	0.00			80%	0.25	2.53		SW-501		
		3		0.16	0.56	5.00	0.27	6.91	0.62	1																									15" HDPE	HDPE	Round
5	13		0.25		0.83	5.00		6.91	1.44		On-Site	SW-501	Sag	3	0.016	2.00	1.00	11.20	0.23	2.28	10	0.32	1.00	0.16	0.43	0.90	0.00	0.00			80%	0.30	2.57		SW-501		
		2		0.25	0.56	5.00	0.04	6.91	0.98	1																									15" HDPE	HDPE	Round
6	14		0.13		0.83	5.00		6.91	0.75		On-Site	ROOF		7				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							ROOF		
		3		0.13	0.87	5.00	0.06	6.91	0.79	3																									6" PVC	PVC	Round
7	15		0.01		0.83	5.00		6.91	0.06		On-Site	CAN		8				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							CAN		
		3		0.01	0.87	5.00	0.07	6.91	0.06	4																									4" PVC	PVC	Round
8	16		0.11		0.83	5.00		6.91	0.64		On-Site	CLEANOUT		9				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							CLEANOUT		
		17		0.11	0.87	5.00	0.63	6.91	0.67	5																									8" PVC	PVC	Round

Notes:
1 Parking lot collection system
2 Detention basin outlet system
3 Building roof drain system
4 Can crusher drain system
5 Canopy drain system

Notes:
1 Equivalent to QT double catch basin inlet
2 Equivalent to standard 4-foot diamter manhole
3 Equivalent to QT single catch basin inlet
4 15" HDPE eccentric low stub
5 30" Nyloplast drain basin
6 Kristar water quality unit (model DVS-72S)
7 Building roof drain collection system
8 Can crusher floor drain collection system
9 Canopy drain collection system
10 Average of slopes toward intakes

Notes:

Notes:

McCLURE ENGINEERING CO.

Line Number	Structures From	Structures To	5 Year Pipe Design: Pipe Length (l.f.)	Round Pipe Diameter (in.)	Manning's n	Pipe Slope (%)	Pipe Area (s.f.)	Actual Pipe Flow Q (cfs)	Full Pipe Capacity Q (cfs)	Depth of Flow d (in.)	Full Pipe Velocity V (fps)	Partial Pipe Velocity V (fps)	Notes	5 Year Design Checks: Inlet Control HW/D (ft./ft.)	Headwater Inlet Ctrl. Elev.	Outlet Head, H (ft.)	Headwater Outlet Ctrl. Elev.	Structure Top Elev.	Upstream Flow Line	Downstream Flow Line	Downstream Water Elev.	Hydraulic Grade Elev.	Hydraulic Grade Allow. Elev.	Energy Grade Elev.	Energy Grade Allow. Elev.	Notes	Comments
1	1																	945.70				942.92	944.70	943.30	943.70		
		2	112	24	0.013	0.47	3.14	3.41	15.47	7.66	4.92	3.95		0.69	942.42	0.05	942.92		941.03	940.51	942.87						
	2																	945.50				942.87	944.50	943.24	943.50		
		3	206	24	0.013	0.47	3.14	3.36	15.47	7.60	4.92	3.94		0.69	941.79	0.07	942.87		940.41	939.45	942.80						
	3																	944.90				942.80	943.90	943.17	942.90		
		4	109	24	0.013	0.47	3.14	3.58	15.47	7.85	4.92	4.00		0.70	940.74	0.06	942.80		939.35	938.84	942.74						
	4																	945.20				942.74	944.20	943.12	943.20		
		5	8	24	0.013	0.47	3.14	3.90	15.47	8.22	4.92	4.10		0.70	940.15	0.04	942.74		938.74	938.71	942.70						
																						942.70					Hydraulic Grade Elevation = Bottom of Detention Pipe (938.70) + 4' Pipe Diameter
2	6																	942.70				939.54	941.70	941.40	940.70		
		7	3	15	0.013	4.31	1.23	0.00	13.44	0.00	10.95	0.00		0.67	939.54	0.00	939.39		938.70	938.55	939.39						
	7																	945.30				939.39	944.30	940.25	943.30		
		8	3	15	0.013	2.00	1.23	0.00	9.16	0.00	7.46	0.00		0.67	939.39	0.00	939.37		938.55	938.48	939.37						
	8																	945.00				939.37	944.00	940.49	943.00		
		9	16	15	0.013	2.58	1.23	0.00	10.41	0.00	8.48	0.00		0.67	939.32	0.00	939.37		938.48	938.07	939.37						
																						939.37					Hydraulic Grade Elevation = Flow Line Existing 36" RCP (936.37) from North + 3' Pipe Diameter
3	10																	944.30				942.89	943.30	944.33	942.30		
		11	51	15	0.013	3.31	1.23	2.65	11.78	4.84	9.60	7.74		0.82	941.40	0.19	942.89		940.38	938.70	942.70						
																						942.70					Hydraulic Grade Elevation = Bottom of Detention Pipe (938.70) + 4' Pipe Diameter
4	12																	944.00				942.81	943.00	943.35	942.00		
		3	58	15	0.013	1.26	1.23	0.62	7.28	2.97	5.93	3.62		0.68	940.93	0.01	942.81		940.08	939.35	942.80						
																						942.80					
5	13																	945.50				942.89	944.50	945.61	943.50		
		2	19	15	0.013	6.28	1.23	0.98	16.23	2.49	13.23	7.28		0.69	942.44	0.02	942.89		941.58	940.41	942.87						
																						942.87					
6	14																	946.40				943.65	945.40	944.45	944.40		
		3	24	6	0.013	6.22	0.20	0.79	1.40	3.22	7.15	7.35		1.95	942.88	0.86	943.65		941.90	940.38	942.80						
																						942.80					
7	15																	945.50				942.82	944.50	943.23	943.50		
		3	16	4	0.013	5.48	0.09	0.06	0.45	1.00	5.12	3.57		0.73	941.41	0.03	942.82		941.17	940.30	942.80						
																						942.80					
8	16																	945.90				943.46	944.90	943.76	943.90		
		17	160	8	0.013	1.60	0.35	0.67	1.53	3.69	4.39	4.23		0.89	941.83	0.57	943.46		941.23	938.68	942.89						
																						942.89					

Notes:

Project Name: QuikTrip Store #504
Project Location: City of Windsor Heights, County of Polk, State of Iowa
Project Number: 20715030

Date: 03-13-2016
Designed By: RGZ
Design Storm: 100 Year

Line Number	Structures From	Structures To	100 Year Runoff Calculations: Direct Area (acre)	Total Area (acre)	C	Tc (min.)	Flow Time (min.)	Intensity (in./hr.)	Tributary Runoff Q (cfs)	Notes	100 Year Intake Location and Type: Location	Type	On-Grade or Sag	Notes	100 Year Intake Spread: Manning's n	Longitudinal Slope (S_L, %)	Transverse Slope (S_X, %)	Width of Flow (T, ft.)	Gutter Runoff Depth (ft.)	Flow Velocity (V, fps)	Notes	100 Year On-Grade Intake Capacity: Frontal/Gutter Flow Ratio (E_G)	Frontal Flow Ratio (R_f)	Side Flow Ratio (R_s)	Efficiency	Reduction Factor	Intercepted Flow (Q_i, cfs)	Bypass Flow (Q_b, cfs)	Bypass Intake Number	Notes	100 Year Sag Intake Capacity: Reduction Factor	Depth of Flow (d, ft.)	Width of Flow (T, ft.)	Notes	Structure and Pipe Description	Pipe Material	Pipe Shape
1	1		1.45		0.73	15.00		7.44	7.91		On-Site	SW-505	Sag	1	0.016	1.50	1.50	17.36	0.36	3.47	10	0.21	1.00	0.40	0.53	0.90	0.00	0.00			80%	0.51	2.92		SW-505		
		2		1.45	0.73	15.00	0.38	7.44	7.91																										24" HDPE	HDPE	Round
	2		0.00		0.89	5.00		12.40	0.00		On-Site	SW-401		2				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							SW-401		
		3		1.84	0.57	15.38	0.69	7.36	7.82																										24" HDPE	HDPE	Round
	3		0.09		0.89	5.00		12.40	1.00		On-Site	SW-501	Sag	3	0.016	2.00	1.50	7.57	0.16	2.30	10	0.45	1.00	0.22	0.57	0.90	0.00	0.00			80%	0.25	2.54		SW-501		
		4		2.09	0.54	16.07	0.36	7.21	8.25																										24" HDPE	HDPE	Round
	4		0.11		0.89	5.00		12.40	1.22		On-Site	SW-501	Sag	3	0.016	2.00	1.50	8.16	0.17	2.42	10	0.42	1.00	0.20	0.54	0.90	0.00	0.00			80%	0.28	2.58		SW-501		
		5		2.20	0.56	16.44	0.03	7.14	8.87	1																									24" HDPE	HDPE	Round
2	6		0.00		0.89	0.00		17.82	0.00		On-Site	STUB		4				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							STUB		
		7		0.00	0.89	0.00	0.00	17.82	0.00																										15" HDPE	HDPE	Round
	7		0.00		0.89	0.00		17.82	0.00		On-Site	NYLOPLAST		5				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							NYLOPLAST		
		8		0.00	0.89	0.00	0.00	17.82	0.00																										15" HDPE	HDPE	Round
	8		0.00		0.89	0.00		17.82	0.00		On-Site	WQU		6				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							WQU		
		9		0.00	0.89	0.00	0.00	17.82	0.00	2																									15" RCP	RCP	Round
3	10		0.57		0.89	5.00		12.40	6.32		On-Site	SW-505	Sag	3	0.016	2.00	1.50	15.13	0.31	3.65	10	0.24	1.00	0.37	0.53	0.90	0.00	0.00			80%	0.45	2.84		SW-505		
		11		0.68	0.56	5.00	0.09	12.40	4.76	1																									15" HDPE	HDPE	Round
4	12		0.16		0.89	5.00		12.40	1.77		On-Site	SW-501	Sag	3	0.016	2.00	1.50	9.39	0.20	2.66	10	0.37	1.00	0.18	0.48	0.90	0.00	0.00			80%	0.33	2.66		SW-501		
		3		0.16	0.56	5.00	0.22	12.40	1.12	1																									15" HDPE	HDPE	Round
5	13		0.25		0.89	5.00		12.40	2.77		On-Site	SW-501	Sag	3	0.016	2.00	1.00	14.31	0.30	2.68	10	0.26	1.00	0.12	0.35	0.90	0.00	0.00			80%	0.42	2.69		SW-501		
		2		0.25	0.56	5.00	0.04	12.40	1.75	1																									15" HDPE	HDPE	Round
6	14		0.13		0.89	5.00		12.40	1.44		On-Site	ROOF		7				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							ROOF		
		3		0.13	0.87	5.00	0.05	12.40	1.41	3																									6" PVC	PVC	Round
7	15		0.01		0.89	5.00		12.40	0.11		On-Site	CAN		8				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							CAN		
		3		0.01	0.87	5.00	0.06	12.40	0.11	4																									4" PVC	PVC	Round
8	16		0.11		0.89	5.00		12.40	1.22		On-Site	CLEANOUT		9				0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00							CLEANOUT		
		17		0.11	0.87	5.00	0.55	12.40	1.20	5																									8" PVC	PVC	Round

Notes:
1 Parking lot collection system
2 Detention basin outlet system
3 Building roof drain system
4 Can crusher drain system
5 Canopy drain system

Notes:
1 Equivalent to QT double catch basin inlet
2 Equivalent to standard 4-foot diamter manhole
3 Equivalent to QT single catch basin inlet
4 15" HDPE eccentric low stub
5 30" Nyloplast drain basin
6 Kristar water quality unit (model DVS-72S)
7 Building roof drain collection system
8 Can crusher floor drain collection system
9 Canopy drain collection system
10 Average of slopes toward intakes

Notes:

Notes:

McCLURE ENGINEERING CO.

Line Number	Structures From	Structures To	100 Year Pipe Design: Pipe Length (l.f.)	Round Pipe Diameter (in.)	Manning's n	Pipe Slope (%)	Pipe Area (s.f.)	Actual Pipe Flow Q (cfs)	Full Pipe Capacity Q (cfs)	Depth of Flow d (in.)	Full Pipe Velocity V (fps)	Partial Pipe Velocity V (fps)	Notes	100 Year Design Checks: Inlet Control HW/D (ft./ft.)	Headwater Inlet Ctrl. Elev.	Outlet Head, H (ft.)	Headwater Outlet Ctrl. Elev.	Structure Top Elev.	Upstream Flow Line	Downstream Flow Line	Downstream Water Elev.	Hydraulic Grade Elev.	Hydraulic Grade Allow. Elev.	Energy Grade Elev.	Energy Grade Allow. Elev.	Notes	Comments
1	1																	945.70				943.88	944.70	944.25	943.70		
		2	112	24	0.013	0.47	3.14	7.91	15.47	12.16	4.92	4.95		0.80	942.62	0.28	943.88		941.03	940.51	943.59						
	2																	945.50				943.59	944.50	943.97	943.50		
		3	206	24	0.013	0.47	3.14	7.82	15.47	12.07	4.92	4.93		0.79	941.99	0.39	943.59		940.41	939.45	943.20						
	3																	944.90				943.20	943.90	943.58	942.90		
		4	109	24	0.013	0.47	3.14	8.25	15.47	12.46	4.92	5.00		0.81	940.97	0.31	943.20		939.35	938.84	942.90						
	4																	945.20				942.90	944.20	943.27	943.20		
		5	8	24	0.013	0.47	3.14	8.87	15.47	13.03	4.92	5.09		0.83	940.40	0.20	942.90		938.74	938.71	942.70						
																						942.70					Hydraulic Grade Elevation = Bottom of Detention Pipe (938.70) + 4' Pipe Diameter
2	6																	942.70				939.54	941.70	941.40	940.70		
		7	3	15	0.013	4.31	1.23	0.00	13.44	0.00	10.95	0.00		0.67	939.54	0.00	939.39		938.70	938.55	939.39						
	7																	945.30				939.39	944.30	940.25	943.30		
		8	3	15	0.013	2.00	1.23	0.00	9.16	0.00	7.46	0.00		0.67	939.39	0.00	939.37		938.55	938.48	939.37						
	8																	945.00				939.37	944.00	940.49	943.00		
		9	16	15	0.013	2.58	1.23	0.00	10.41	0.00	8.48	0.00		0.67	939.32	0.00	939.37		938.48	938.07	939.37						
																						939.37					Hydraulic Grade Elevation = Flow Line Existing 36" RCP (936.37) from North + 3' Pipe Diameter
3	10																	944.30				943.33	943.30	944.76	942.30		
		11	51	15	0.013	3.31	1.23	4.76	11.78	6.64	9.60	9.09		1.15	941.82	0.63	943.33		940.38	938.70	942.70						
																						942.70					Hydraulic Grade Elevation = Bottom of Detention Pipe (938.70) + 4' Pipe Diameter
4	12																	944.00				943.24	943.00	943.79	942.00		
		3	58	15	0.013	1.26	1.23	1.12	7.28	3.98	5.93	4.30		0.70	940.95	0.04	943.24		940.08	939.35	943.20						
																						943.20					
5	13																	945.50				943.65	944.50	946.37	943.50		
		2	19	15	0.013	6.28	1.23	1.75	16.23	3.33	13.23	8.62		0.73	942.50	0.06	943.65		941.58	940.41	943.59						
																						943.59					
6	14																	946.40				945.96	945.40	946.75	944.40		
		3	24	6	0.013	6.22	0.20	1.41	1.40	4.96	7.15	8.14		4.80	944.30	2.76	945.96		941.90	940.38	943.20						
																						943.20					
7	15																	945.50				943.29	944.50	943.70	943.50		
		3	16	4	0.013	5.48	0.09	0.11	0.45	1.34	5.12	4.22		0.86	941.45	0.09	943.29		941.17	940.30	943.20						
																						943.20					
8	16																	945.90				945.16	944.90	945.46	943.90		
		17	160	8	0.013	1.60	0.35	1.20	1.53	5.32	4.39	4.85		1.37	942.15	1.83	945.16		941.23	938.68	943.33						
																						943.33					

Notes:

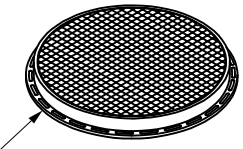
Section 5 – Detention Basin Outlet Structure and Water Quality Unit

QuikTrip Store #504

City of Windsor Heights, County of Polk, State of Iowa

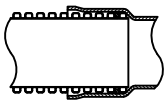
McCLURE™
ENGINEERING Co.

NYLOPLAST DRAIN BASIN WITH WEIR



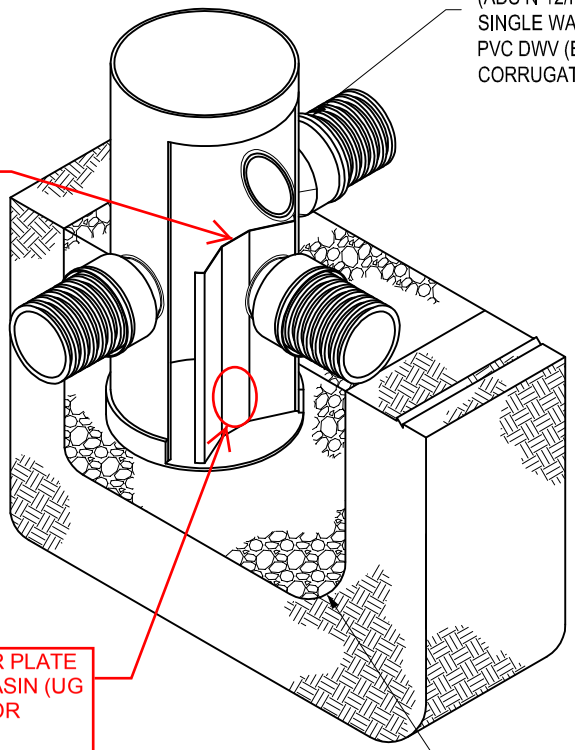
(7) INTEGRATED DUCTILE IRON FRAME & SOLID COVER TO MATCH BASIN O.D.

(5) ADAPTER ANGLES VARIABLE 0° - 360° ACCORDING TO PLANS



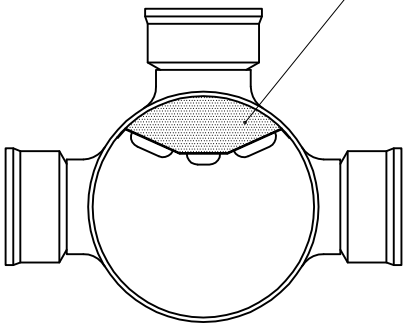
(6) VARIOUS TYPES OF INLET & OUTLET ADAPTERS AVAILABLE: 4" - 30" FOR CORRUGATED HDPE (ADS N-12/HANCOR DUAL WALL, ADS/HANCOR SINGLE WALL), N-12 HP, PVC SEWER (EX: SDR 35), PVC DWV (EX: SCH 40), PVC C900/C905, CORRUGATED & RIBBED PVC

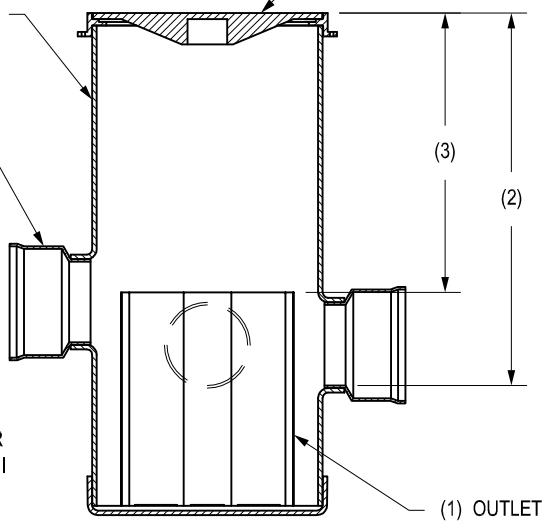
TOP OF WEIR PLATE ELEVATION = 100-YEAR DETAINED WATER SURFACE ELEVATION (REFER TO DETENTION BASIN (UG DETENTION) SUMMARY FOR ELEVATION)



ORIFICE OPENING IN WEIR PLATE (REFER TO DETENTION BASIN (UG DETENTION) SUMMARY FOR ORIFICE OPENING SIZE)

THE BACKFILL MATERIAL SHALL BE CRUSHED STONE OR OTHER GRANULAR MATERIAL MEETING THE REQUIREMENTS OF CLASS I OR CLASS II MATERIAL AS DEFINED IN ASTM D2321. BEDDING & BACKFILL FOR SURFACE DRAINAGE INLETS SHALL BE PLACED & COMPACTED UNIFORMLY IN ACCORDANCE WITH ASTM D2321.





SIDE SECTION & TOP VIEW:
ENLARGED TO SHOW DETAIL

1 - WEIR AVAILABLE FOR ALL 24" - 30" STRUCTURE OPTIONS (CUSTOM BASIN, ROAD & HIGHWAY, & CURB INLET).
2 - DRAIN BASIN TO BE CUSTOM MANUFACTURED ACCORDING TO PLAN DETAILS. RISERS ARE NEEDED FOR BASINS OVER 84" DUE TO SHIPPING RESTRICTIONS SEE DRAWING NO. 7001-110-065.
3 - HEIGHT OF WEIR TO BE DETERMINED BY ENGINEER. **WEIR HEIGHT CANNOT EXCEED 84" DUE TO MANUFACTURING AND SHIPPING RESTRICTIONS.**
4 - WEIR MANUFACTURED TO MINIMIZE LOSS OF OUTLET PIPE OPEN AREA.
5 - ADAPTERS CAN BE MOUNTED ON ANY ANGLE 0° TO 360°. TO DETERMINE MINIMUM ANGLE BETWEEN ADAPTERS SEE DRAWING NO. 7001-110-012.
6 - DRAINAGE CONNECTION STUB JOINT TIGHTNESS SHALL CONFORM TO ASTM D3212 FOR CORRUGATED HDPE (ADS N-12/HANCOR DUAL WALL), N-12 HP, & PVC SEWER (4" - 24").
7 - FRAMES, GRATES, COVERS, HOODS, & BASE PLATES SHALL BE DUCTILE IRON PER ASTM A536 GRADE 70-50-05.

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DRAWN BY EBC	MATERIAL	Nyloplast	3130 VERONA AVE BUFORD, GA 30518 PHN (770) 932-2443 FAX (770) 932-2490 www.nyloplast-us.com
DATE 05-10-06			
REVISED BY CCA	PROJECT NO./NAME	TITLE	DRAIN BASIN WITH WEIR QUICK SPEC INSTALLATION DETAIL
DATE 07-19-13			
DWG SIZE A	SCALE 1:40 SHEET 1 OF 1	DWG NO. 7004-110-058	REV F

FloGard Dual-Vortex
Hydrodynamic Separator Sizing Verification
v1.04

Project Name:	Quik Trip #504
Project Location:	Windsor Heights, IA (SW corner of Hickman Rd & 63rd St)
Unit ID:	1
Design Engineer:	Sertich

Using 2-yr, 1-hr rainfall intensity for Section 5 - Central Iowa = 1.51 in/hr

Project Site Input Data:

Drainage Area (A):	2.07 ac				
Runoff Coefficient (C):	0.95	Model:	DVS-72		
Design Intensity (I):	1.51 in/hr	WQF:	2.99 cfs	Method:	Rational
					0.17
Sediment Size:	OK-110 sand - d50 = 100 um				575
Removal Target:	80%				
Coverage Target:	90%	Basis:	Depth	Rain Gauge:	KS-Kansas City

Average Rainfall Intensity (in/hr)	Probability Frequency[1] (%)	Cumulative Frequency[1] (%)	Flow Rate[2] (cfs)	Minimum Removal Efficiency[3] (%)	Weighted TSS Removal (%)
0.01	31.7%	31.7%	0.000	100.0%	31.7%
0.02	13.4%	45.1%	0.000	100.0%	13.4%
0.03	8.2%	53.3%	0.001	100.0%	8.2%
0.04	7.3%	60.5%	0.001	100.0%	7.3%
0.05	5.2%	65.8%	0.001	100.0%	5.2%
0.06	4.1%	69.8%	0.001	100.0%	4.1%
0.07	2.8%	72.6%	0.001	100.0%	2.8%
0.08	2.6%	75.2%	0.002	100.0%	2.6%
0.09	2.2%	77.4%	0.002	100.0%	2.2%
0.10	2.1%	79.5%	0.002	100.0%	2.1%
0.15	1.6%	81.1%	0.003	100.0%	1.6%
0.20	1.8%	82.9%	0.004	100.0%	1.8%
0.25	1.3%	84.2%	0.005	100.0%	1.3%
0.50	1.7%	85.8%	0.010	100.0%	1.7%
0.75	1.5%	87.3%	0.015	100.0%	1.5%
1.00	0.8%	88.1%	0.020	100.0%	0.8%
1.25	0.9%	89.0%	0.025	100.0%	0.9%
1.50	0.9%	89.9%	0.030	100.0%	0.9%

No removal credit considered above 90% Depth

Net Annual TSS Removal = 89.9%

Available Rain Gauge Data

[1]From 60-min precipitation data (NCDC)
[2]Rational method
[3]Based on independently verified lab testing

Disclaimer: Calculations are best estimate based on information available and are intended only for use by the party to whom they were transmitted and for the project referenced.

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KRISTAR ENTERPRISES, INC.

Sizing Calculations

Tech Bulletin
KS-DVSTB-012506-B

Kristar FloGard® Dual-Vortex Hydrodynamic Separator

See product specifications for standard model details

Simplified sizing calculations based on Total Suspended Solids removal for the **FloGard® Dual-Vortex** Hydrodynamic Separator are done in two ways:

1. Instantaneous removal efficiency may be calculated for a flow rate corresponding to a single rainfall event, such as that corresponding to the 85th percentile 24-hr return storm for a given project location, or

2. Annualized removal efficiency may be calculated based on historical rainfall frequency statistics for a given project location. The flow from the 85th percentile 24-hr event must then be independently compared to the hydraulic treatment capacity for the unit size considered.

A proprietary empirical relation based on third-party verified controlled laboratory testing of the **FloGard® Dual-Vortex** Hydrodynamic Separator is applied to the calculations. Results differ in that the instantaneous removal efficiency corresponds to system performance at a single flow rate only, while the annualized removal efficiency assesses average total suspended solids reduction in runoff over a range of flow rates corresponding to local rainfall frequency characteristics. Both approaches assume negligible effect of concentration variation with flow, and are necessarily based on an assumed particle size distribution.

Example:

Commercial building with large parking lot
Project location = Santa Rosa, CA
Drainage area = 3 ac;
Runoff Coefficient, C = 0.85
I = 0.21 in/hr, equivalent to 85th percentile 24-hr event
Separator model to evaluate = DVS-48

1. Instantaneous removal efficiency

by Rational Method — $Q_m = CIA$
$Q_m = (0.85)(0.21 \text{ in/hr})(3 \text{ ac}) \sim 0.54 \text{ cfs}$

Application to empirical formula for separator yields 72% TSS removal[1]

2. Annualized removal efficiency (simplified)

15-minute precipitation depth statistics from a local gauge are converted to average hourly intensity, which is applied to the drainage area using a Rational Method to obtain a flow rate. The instantaneous removal efficiency at each related flow rate is determined by empirical formula, then weighted according to the fraction of the total annual rainfall represented by the particular storm event. The cumulative total is the summation of all considered rain events.

Kristar Enterprises
360 Sutton Place
Santa Rosa, CA
95407

(800) 579-8819

www.kristar.com

Sizing Calculations

Kristar FloGard® Dual-Vortex Hydrodynamic Separator

15-min Storm Depth (in)	Average Rainfall Intensity (in/hr)	Rainfall Fraction (%)	Cumulative Rainfall (%)	Flow Rate (cfs)	Minimum Removal Efficiency (%)	Weighted TSS Removal (%)	Cumulative Net Annual TSS Removal (%)
0.01	0.04	48.8%	48.8%	0.10	96%	46.7%	46.7%
0.02	0.08	20.9%	69.7%	0.21	91%	19.1%	65.8%
0.03	0.12	10.9%	80.6%	0.31	87%	9.4%	75.2%
0.04	0.16	7.3%	87.9%	0.41	82%	6.0%	81.2%
0.05	0.20	3.6%	91.5%	0.51	77%	2.8%	84.0%
0.06	0.24	2.6%	94.1%	0.62	72%	1.9%	**85.9%**
0.07	0.28	1.6%	95.7%	0.72	66%	1.1%	**87.0%**
0.08	0.32	1.1%	96.8%	0.82	61%	0.7%	**87.7%**
0.09	0.36	0.5%	97.3%	0.93	55%	0.3%	**88.0%**
0.10	0.40	0.7%	98.0%	1.03	49%	0.3%	**88.3%**

For fraction of event occurring with 15-min depth of 0.01 in or less —

15-min Storm Depth[2] = P ≤ 0.01 in
Average Rainfall Intensity = 4P = 4(0.01 in) = 0.04 in/hr
Rainfall Fraction (from gauge data statistical analysis) = f = 48.8%
Flow Rate = Q = CIA = (0.85)(0.04 in/hr)(3 ac) ≈ 0.10 cfs
Empirical formula for model DVS-48 yields Minimum Removal Efficiency = R = 96%[1]
Weighted TSS Removal (WR) = (96%)(48.8%) ≈ 46.7%
Cumulative Net Annual TSS Removal = ∑WR = 46.7%

This process is continued for additional events until the peak flow rate considered exceeds the hydraulic treatment capacity of the unit considered, typically accounting for > 85-90% of the total rainfall. It may be conservatively assumed that R = 0% for larger flows not considered (though the unit will remove some material at these higher flows). The final **Cumulative Net Annual TSS Removal** is then the expected annual average sediment load removal provided by the device, in this case > **80%**.

The peak flow rate for a singular event may then be compared to the hydraulic treatment capacity of the unit considered. For instance, if a required peak treatment flow of 1.2 cfs is determined for the site example above based on a target treatment storm depth of 0.4 in, a DVS-48 with hydraulic treatment capacity (before bypass) of 1.25 cfs would be sufficient.

Kristar can provide project-specific calculations and sizing guidance given basic information such as drainage area, runoff coefficient, site use and location. Product Application forms to facilitate transfer of critical information needed for sizing are available on Kristar's website, www.kristar.com.

(1) Based on a particle size distribution with an approximate mean of 100 µm; approximately 80% of suspended sediment is larger than this average in "typical" urban street or commercial runoff.
(2) NWSFO Hydronet data for Nuuanu Valley, HI (1998)

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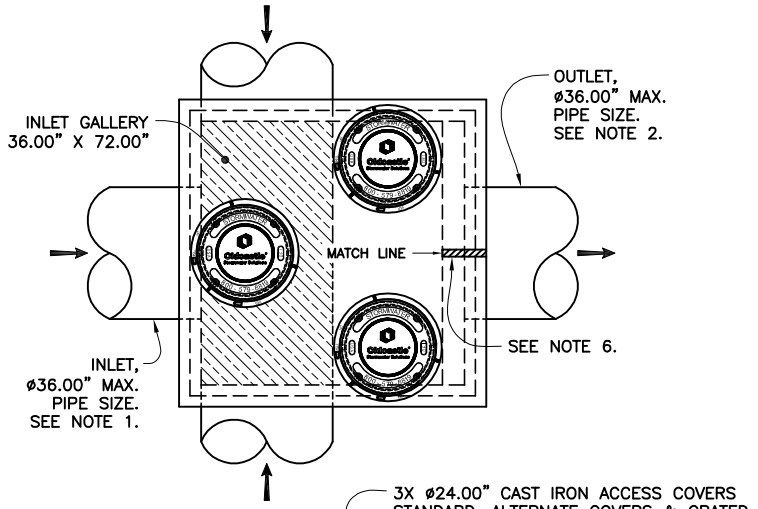
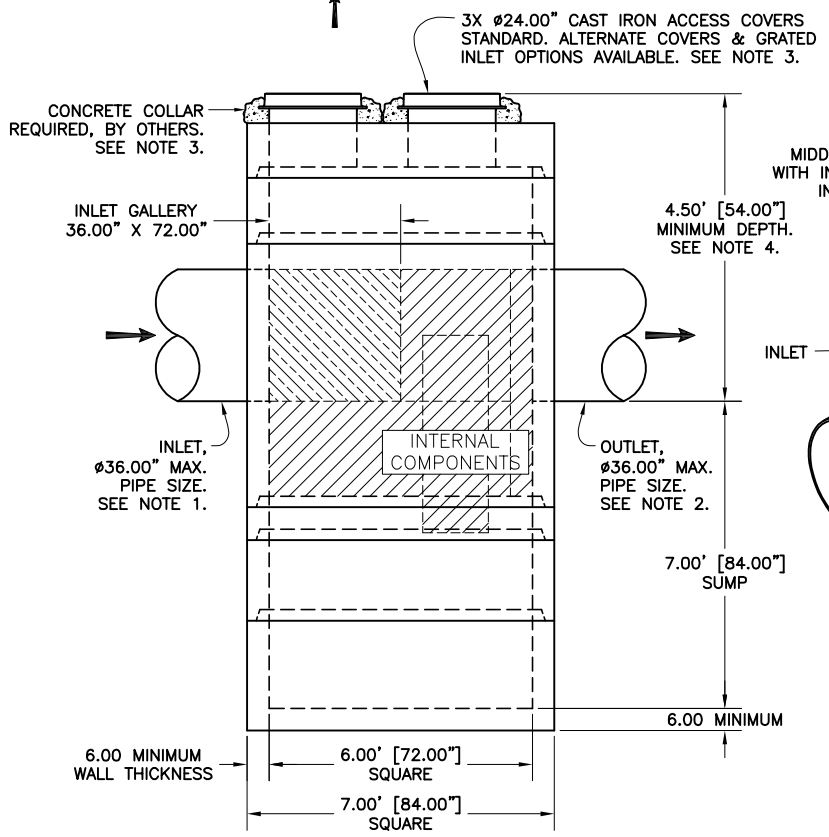
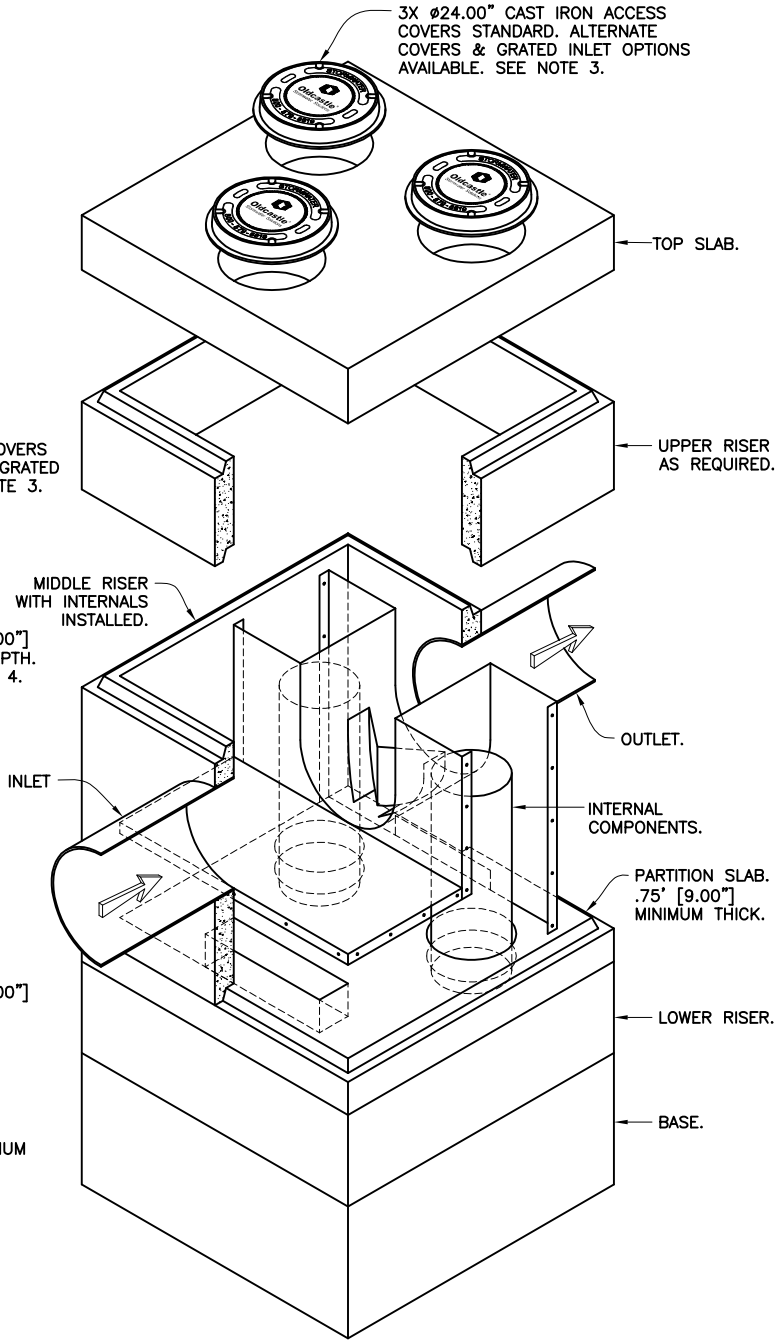
DVS-72S







NOTES:

1. ALL INLET PIPES MUST ENTER SEPARATOR AT INLET GALLERY.
2. STANDARD OUTLET PIPE CONFIGURATION TO EXIT SEPARATOR AT THE CENTER LINE. CUSTOM OUTLET CONFIGURATIONS AVAILABLE UPON REQUEST.
3. BOLTED & GASKETED MANHOLE ACCESS COVER ELEVATION MAY BE ADJUSTED TO GRADE. FIELD POURED CONCRETE COLLAR AS REQUIRED, BY OTHERS. INLET GRATES & ALTERNATE COVER OPTIONS AVAILABLE.
4. FOR DEPTHS LESS THAN THE MINIMUM SHOWN CONTACT OLDCASTLE® STORMWATER SOLUTIONS FOR ENGINEERING ASSISTANCE.
5. CONCRETE COMPONENTS SHALL BE MANUFACTURED IN ACCORDANCE WITH ASTM DESIGNATION C858
6. MATCH LINES PROVIDED TO FACILITATE PROPER ALIGNMENT OF ALL CONCRETE COMPONENTS DURING ASSEMBLY.

Hydrodynamic Separation

DVS-72S

Dual Vortex Separator™

Square Structure

Oldcastle® Stormwater Solutions

7921 Southpark Plaza, Suite 200 | Littleton, CO | 80120 | Ph: 800.579.8819 | oldcastlestormwater.com

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DRAWING NO.	REV	ECO	DATE	
DVS-72S	C	ECO-0136 JPR 7/16/15	JPR 4/25/11	SHEET 1 OF 1

Innovative stormwater management products

KRISTAR

FloGard®
DUAL-VORTEX
Hydrodynamic Separator

Enhanced Gravity Separation in a Compact Configuration

ADVANTAGES

- Fits industry-standard manholes or vaults
- Economical installation
- Ease of maintenance
- Vector control

FEATURES

- Dual vortex efficiency
- Integral high flow bypass
- Flexible design – on line or off line
- Retention of floatables during high flows
- Gasketed/bolted access covers
- Durable stainless steel or fiberglass components

MAINTENANCE FEATURES

- Dual access to sediment storage areas
- Easy access to floatable collection areas
- Modular construction of components
- Large interior work areas
- Recommended inspections – twice per year

HOW IT WORKS

Particle settling is accelerated by tangential flow pattern forces in a highly circuitous path. Through the use of two independent cylindrical separators and control weirs, low flow is initially directed to the first separator while moderate flow overflows the first weir and enters the second separator. Settled particles are collected in the isolated bottom storage area, minimizing re-suspension while floating debris and oils are retained in the separators and upper storage areas. At peak flows, excess flows breach the second control weir and exit the system without impacting treatment flow or re-entraining captured pollutants.

FloGard® DUAL-VORTEX
Hydrodynamic Separator

The FloGard® Dual-Vortex Hydrodynamic Separator offers an innovative and economic alternative for BMP implementation in new and retrofit applications where land area necessitates compact, effective treatment for removal of suspended pollutants from stormwater runoff.

AVAILABLE OPTIONS

- Removable internals
- Square configurations to accept multiple inlet pipes or other special site conditions
- Flume inlet control for grated inlet applications

FloGard DUAL-VORTEX Hydrodynamic Separator Models and Nominal Dimensions (circular configuration)

Model No.	Diameter		Depth (below invert)		Maximum inlet pipe size	
	ft	mm	ft	mm	in	mm
DVS-36	3	914	3.75	1143	12	305
DVS-48	4	1219	5.00	1524	18	457
DVS-60	5	1524	6.25	1905	24	610
DVS-72	6	1829	8.50	2286	36	914
DVS-84	7	2134	9.50	2896	42	1067
DVS-96	8	2438	11.00	3048	48	1220
DVS-120	10	3048	13.50	4115	48	1220
DVS-144	12	3658	16.50	4877	60	1524

KriStar Enterprises, Inc. • 360 Sutton Place • Santa Rosa, CA 95407
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FloGard® Dual-Vortex Hydrodynamic Separator

Characteristics and Capacities (English)

Model	ID	Depth Below Invert	Treated Flow Capacity[1]			Total Flow Capacity[3]	Max. Pipe Size	Sediment Storage	Oil/ Floatable Storage
	ft	*ft*	*67 µm cfs*	*110 µm cfs*	*Peak[2] cfs*	*cfs*	*in*	*yd³*	*gal*
DVS-36	3	3.75	0.12	0.35	0.50	4	12	0.3	18
DVS-48	4	5.00	0.25	0.75	1.25	9	18	0.7	43
DVS-60	5	6.25	0.45	1.30	2.50	16	24	1.3	83
DVS-72	6	8.25	0.70	2.00	4.25	27	36	2.2	141
DVS-84[4]	7	9.50	1.00	3.00	6.50	40	42	3.5	294
DVS-96	8	10.75	1.40	4.20	9.50	57	48	5.3	337
DVS-120[4]	10	13.50	2.50	7.30	16.80	99	48	9.7	917
DVS-144[4]	12	16.00	3.90	11.60	26.40	154	60	15.5	1825

Characteristics and Capacities (Metric)

Model	ID	Depth Below Invert	Treated Flow Capacity[1]			Total Flow Capacity[3]	Max. Pipe Size	Sediment Storage	Oil/ Floatable Storage
	m	*m*	*67 µm L/s*	*110 µm L/s*	*Peak[2] L/s*	*L/s*	*mm*	*m³*	*L*
DVS-36	0.9	1.14	3.5	10	14	113	300	0.23	68
DVS-48	1.2	1.52	7	21	35	255	450	0.54	163
DVS-60	1.5	1.91	13	37	71	453	600	1.00	314
DVS-72	1.8	2.51	20	57	120	765	900	1.70	534
DVS-84[4]	2.1	2.90	30	85	184	1133	1050	2.70	1113
DVS-96	2.4	3.28	40	120	269	1614	1200	4.00	1276
DVS-120[4]	3.0	4.11	70	205	475	2800	1200	7.40	3471
DVS-144[4]	3.7	4.88	110	330	750	4360	1500	11.90	6908

[1]Treated Flow Capacity is based on 80% removal of suspended sediment with the approximate mean particle size shown. The appropriate flow capacity should be selected based on expected site sediment characteristics.
[2] Maximum flow prior to bypass.
[3] Total design flow to the system should not exceed the Peak Flow Capacity.
[4]Call Kristar representative for availability in your area.

Notes: Systems may be sized based on a water quality flow (i.e. 1-inch design storm) or on net annual sediment load removal depending on local regulatory requirements.
Contact Kristar for the most accurate and cost effective sizing for your project location.

When sizing system based on a water quality flow, the required flow to be treated must be less than or equal to the Treated Flow Capacity for the selected unit.

Additional Treated Flow Capacities based on different mean particle sizes are available upon request.

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360 Sutton Place, Santa Rosa, CA, 95407, (800) 579-8819

Dual Vortex Separator

Hydrodynamic Separation

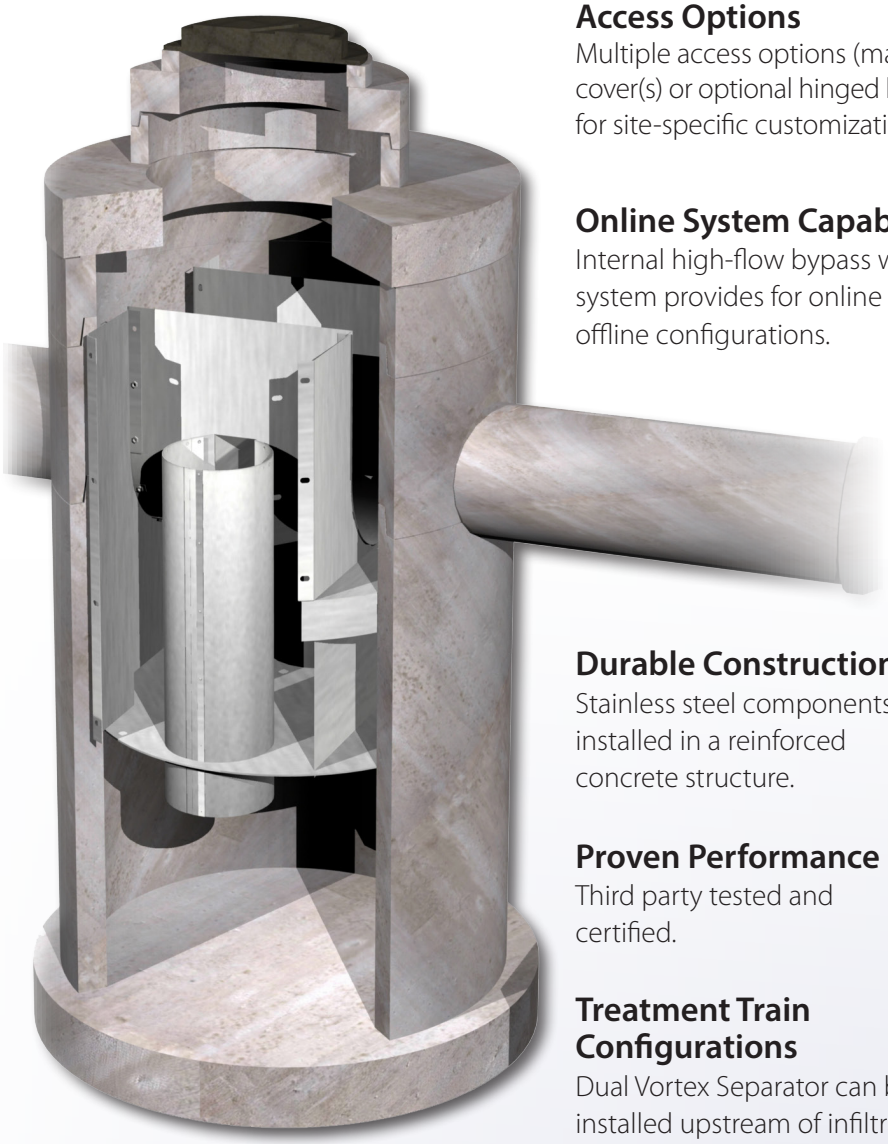
Enhanced gravity separation of stormwater pollutants in a compact configuration

Maintenance Accessible Design
Open access to accumulated floatables and two access points to sediment storage area.

Economical Installation
Prepackaged and provided in a compact manhole or small vault.

Access Options
Multiple access options (manhole cover(s) or optional hinged lid) allow for site-specific customization.

Online System Capability
Internal high-flow bypass weir system provides for online or offline configurations.



Durable Construction
Stainless steel components installed in a reinforced concrete structure.

Proven Performance
Third party tested and certified.

Treatment Train Configurations
Dual Vortex Separator can be installed upstream of infiltration, detention, and retention systems or other treatment BMPs.

Hydrodynamic Separation

The Dual Vortex Separator (DVS) offers an innovative and economic alternative for BMP implementation in new and retrofit applications where space is limited and effective stormwater treatment is required.

The DVS unit can be used to help meet TMDL requirements for removal of sediment, gross solids, petroleum hydrocarbons, and trash. The unit can also be a critical component of a comprehensive LID strategy, providing pretreatment to help increase the service life of detention, retention, and infiltration systems as well as other stormwater treatment BMPs.

NJCAT Corporation for Advanced Technology

Department of Environmental Protection New Jersey

NJCAT VERIFIED
NJDEP CERTIFIED

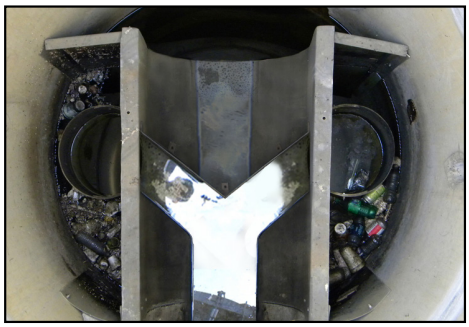
Dual Vortex Separator performance has been verified by NJCAT, one of the most comprehensive, rigorous, and recognized verification programs in the United States, and has been certified by NJDEP.

Oldcastle® Stormwater Solutions

Dual Vortex Separator

How it Works

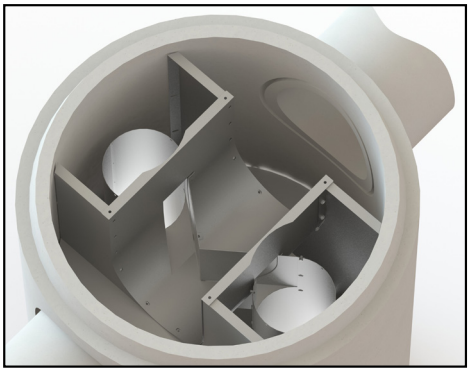
Particle settling is enhanced by centrifugal forces induced by circular flow patterns in the twin vortex chambers and an extended flow path which maximizes hydraulic residence time. Settled solids are collected in an isolated storage area at the bottom of the structure, while floating trash, debris, and petroleum hydrocarbons are retained behind baffles that contain the vortex chambers. During peak runoff events, flow in excess of design treatment flow overtops the bypass weir and exits the system without entering the treatment chambers to interrupt the treatment process or re-entrain captured pollutants.



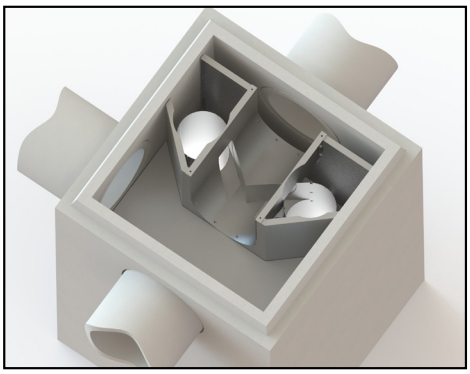
DVS with trapped pollutants

Site-Specific Design

The Dual Vortex Separator is sized to meet site-specific requirements for treatment efficiency. Model selection is typically based on a mean particle size and target removal percentage as prescribed by the jurisdictional agency. Local rainfall data may also be used to support model selection. DVS units may be configured online or offline depending on agency requirements or the hydraulic capacity of the system. Oldcastle Stormwater Solutions' engineering team will help determine the appropriate application for your site.



Round configuration



Square configuration

Models and Nominal Dimensions

Model No.	Structure Diameter (ft.)	Sump Depth* (ft.)	Minimum Rim to Invert Depth (ft.)	Sediment Storage* (cubic feet)	Oil and Floatables Storage (cubic feet)
DVS-36	3	4.5	2.5	11	6
DVS-48	4	5.0	3.0	19	15
DVS-60	5	6.0	3.5	29	29
DVS-72	6	7.0	4.5	42	49
DVS-84	7	8.0	5.0	58	79
DVS-96	8	9.0	5.5	75	116
DVS-120	10	10.5	7.0	118	226
DVS-144	12	12.0	8.0	170	388

**Depth of unit can be increased to add storage capacity*

Optional hinged manhole lid

Available Options

- Square configurations to accept multiple inlet pipes or other special site conditions
- Removable internals
- Flume inlet control for grated inlet applications

Maintenance

- Dual access to sediment storage areas
- Easy access to floatable collection areas
- Modular construction of components
- Large interior work areas
- Recommended inspection frequency- twice per year

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Oldcastle®
Stormwater Solutions

DUAL VORTEX® Separator

INSPECTION AND MAINTENANCE GUIDE

(800) 579-8819

www.oldcastlestormwater.com
www.stormcapture.com

KRISTAR

Description

The Dual Vortex Separator (DVS) is a hydrodynamic stormwater treatment device used to remove pollutants from urban runoff. Impervious surfaces and other urban and suburban landscapes generate a variety of contaminants that can enter stormwater and pollute downstream receiving waters. The DVS is designed to capture and retain sediment as well as floating trash, debris, and oils. The concentration of metals and other constituents associated with the sediment or floating pollutants may also be reduced.

Function

Stormwater runoff enters the DVS unit through an inlet pipe. Influent flow is split evenly between two vortex tubes by a V-shaped weir. The shape and diameter of the vortex tubes promotes circular motion of the incoming stormwater at increased velocities to enhance particle settling through centrifugal force. The system is also designed with an extended flow path to maximize hydraulic residence time which allows increased time to settle out solids. Settled pollutants are collected in an isolated storage area at the bottom of the structure, while floating trash, debris, and petroleum hydrocarbons are retained behind baffles that contain the vortex chambers. During peak runoff events, flow in excess of design treatment flow overtops the bypass weir and exits the system without entering the treatment chambers to interrupt the treatment process or re-entrain captured pollutants. Treatment and bypass flows exit the system through an outlet pipe that is plumbed at the same elevation as the inlet pipe.

Configuration

The internal components of the DVS system are fabricated from stainless steel and mounted in a manhole or vault structure. The system is typically delivered as a complete unit for installation by the contractor. Installation includes excavation, preparation of the base rock, setting the unit, plumbing the inlet and outlet piping, backfill, and placement of the finished surface at grade. Access to the installed system is allowed through ductile iron casting or hatch covers. The number of access points provided is dependent on the size and configuration of the system.

Maintenance Overview

State and Local regulations require all stormwater management systems to be inspected on a regular basis and maintained as necessary to ensure performance and protect downstream receiving waters. Without maintenance, excessive pollutant buildup can limit system performance by reducing the operating capacity and increase the potential for scouring of pollutants during periods of high flow.

Inspection Equipment

The following equipment is helpful when conducting DVS inspections:

- Recording device (pen and paper form, voice recorder, iPad, etc.)
- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Manhole hook or pry bar
- Flashlight
- Tape measure
- Measuring stick or sludge sampler
- Long-handled net (optional)
- Replacement sorbent pads

Inspection Procedures

Inspection is essential to consistent system performance and is easily completed. Inspection is typically conducted a minimum of twice per year but since pollutant transport and deposition varies from site to site, a site-specific maintenance frequency should be established during the first two or three years of operation.

DVS inspections are visual and are conducted without entering the unit. To complete an inspection, safety measures including traffic control should be deployed before the access covers are removed. Once the covers have been removed, the following items should be checked and recorded (see form provided on page 6) to determine whether maintenance is required:

- Inspect the internal components and note whether there are any broken or missing parts. In the unlikely event that internal parts are broken or missing, contact Oldcastle Stormwater Solutions at (800) 579-8819 to determine appropriate corrective action.
- Note whether the inlet or outlet pipe is blocked or obstructed.
- Observe, quantify, and record the accumulation of floating trash and debris in the baffled chambers around the vortex tubes. The significance of accumulated floating trash and debris is a matter of judgment. A long-handled net may be used to retrieve the bulk of trash and debris at the time of inspection if full maintenance due to accumulation of oils or sediment is not yet warranted.
- Observe, quantify, and record the accumulation of oils in the baffled chambers around the vortex tubes. If sorbent pads have been used to absorb free oil and grease, observe and record their condition. Unless the sorbent pads are tethered to the internal baffles, spent pads may be netted and replaced at the time of inspection. The significance of accumulated floating oils is a matter of judgment. However, if there is evidence of an oil or fuel spill, immediate maintenance is warranted.

Inspection Procedures - continued

- Finally, observe, quantify, and record the accumulation of sediment in the sediment storage sump. A calibrated dipstick, tape measure, or sludge sampler may be used to determine the amount of accumulated sediment. The depth of sediment may be determined by calculating the difference between the measurement from the rim of the DVS to the top of the accumulated sediment and the measurment from the rim of the DVS to the bottom of the DVS structure. Finding the top of the accumulated sediment takes some practice and a light touch, but increasing resistance as the measuring device is lowered toward the bottom of the unit indicates the top of the accumulated sediment.

Maintenance

Maintenance should be scheduled if any of the following conditions are identified during the inspection:

- Internal components are broken or missing.
- Inlet or outlet piping is obstructed.
- The accumulation of floating trash and debris that cannot be retrieved with a net and/or oil in the baffled chambers around the vortex tubes is significant.

Maintenance Equipment

The following equipment is helpful when conducting DVS maintenance:

- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Manhole hook or pry bar
- Confined space entry equipment, if needed
- Flashlight
- Tape measure
- Sorbent pads
- Vacuum truck

Maintenance Procedures

Maintenance should be conducted during dry weather when no flow is entering the system. All maintenance, except possibly the attachment of sorbent pads (if required), may be conducted without entering the DVS structure. Once safety measures such as traffic control are deployed, the access covers may be removed and the following activities may be conducted to complete maintenance:

Maintenance Procedures - *continued*

- Remove floating trash, debris, and oils from the water surface using an extension on the end of the boom hose of the vacuum truck. Continue using the vacuum truck to completely dewater the structure through the vortex tubes and evacuate all accumulated sediment from the sediment sump. Some jetting may be required to fully evacuate sediment from the sump. This is easily achieved by inserting a jet hose through the vortex tube opposite the tube used for vacuum hose access.
- If sorbent pads are required and are tethered to the structure, only personnel that are OSHA Confined Space Entry trained and certified may enter the structure to remove and replace the spent pads.
- The structure does not need to be refilled with water after maintenance is complete. The system will fill with water when the next storm event occurs.
- All material removed from the DVS during maintenance must be disposed of in accordance with local regulations. In most cases, the material may be handled in the same manner as disposal of material removed from sumped catch basins or manholes.

Oldcastle®
Stormwater Solutions

Dual Vortex Separator
Inspection and Maintenance Log

DVS Model _____ **Inspection Date** _____

Location _____

Condition of Internal Components Notes:

☐ Good ☐ Damaged ☐ Missing

Inlet or Outlet Blockage or Obstruction Notes:

☐ Yes ☐ No

Floating Trash and Debris Notes:

☐ Significant ☐ Not Significant

Floating Oils Notes:

☐ Significant ☐ Not Significant ☐ Spill

Sediment Depth Notes:

☐ Inches of Sediment: _____

Maintenance Requirement

☐ **Yes – Schedule Maintenance** ☐ **No – Schedule Re-Inspection**