Hydrology Study

High Street
Phase 1 Package

Dunwoody, Georgia

Prepared for:

City of Dunwoody
4800 Ashford Dunwoody Road
Dunwoody, Georgia 30346

Prepared by:

Kimley-Horn and Associates, Inc.

August 16th, 2019

Hydrology Study

For

High Street

211 Perimeter Center Parkway
Dunwoody, DeKalb County, GA

Prepared For:

City of Dunwoody
4800 Ashford Dunwoody Road
Dunwoody, Georgia 30346

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I. EXECUTIVE SUMMARY

I. Executive Summary

The existing 211 Perimeter Center Parkway office development in the City of Dunwoody, Georgia, includes multiple office and commercial buildings, a parking deck, and surface parking. The existing 211 building will remain, along with the existing parking deck, while others will be demolished in future phases and replaced with new mixed use development and associated parking. The development is located on a 34.86-acre parcel of land at the northwest corner of the intersection of Peachtree Center Parkway and Hammond Drive and extends north along Perimeter Center Parkway to the existing overhead MARTA crossing. Please refer to the vicinity map located in Appendix A, Exhibit 1.

The City of Dunwoody requires the release rates for the proposed development be maintained at lower than the existing rates for the 2, 5, 10, 25, 50, and 100-year, 24-hour frequency storms. Per the City of Dunwoody ordinance Chapter 16, Article II, Division 5, Sec. 16-94 (2b) "*The community development director is authorized to waive the detention storage requirements of subsection (2)a.2. for sites that discharge directly into piped stormwater drainage systems, larger streams, rivers, wetlands, lakes, estuaries, tidal water or other situations where flows will not have a negative impact on stream bank stability or channel integrity.*". The downstream analysis modeled in this report also shows no adverse impacts from the exit to the point in the drainage basin where the project is 10 percent of the total drainage basin area.

The Hanover Perimeter Multi-family Residential Development and Perimeter Town Center Property, located on the western edge of the Perimeter Creek directly adjacent to the proposed site, were analyzed in the same manner in which this report is formatted. A master hydrology study was performed, permitted, and approved for the overall Perimeter Town Center property in 2009. That study was most recently revised on April 24, 2009. The Hanover Perimeter Multi-family Development was permitted and approved on June 13, 2016. In both of those studies it was proven that implementing stormwater detention and channel protection measures were detrimental to the flow rates of the overall basin and subsequently were not necessary.

High Street – Phase 1 outfalls into Perimeter Creek. Thus, the following study will consider two different scenarios for future development in order to determine the optimal design that will have no adverse impact on the adjacent creek. One of the two scenarios will analyze a design including detention, channel protection, and water quality for the future development in accordance with the regulating stormwater ordinances. This scenario will result in on-site post-developed flow rates that are lower than Pre-Development flow rates for the contributing Phase 1 basin, but will increase post-developed flows at the downstream Points of Analysis due to the contribution of off-site basins. Thus the implementation of detention will have an adverse effect on Perimeter Creek by increasing peak flow rates where the existing culvert discharges to the section of open channel flow and into existing culverts routed under Hammond Drive. In the second/proposed scenario, only water quality measures will be provided for the future development in order to eliminate this adverse effect created by detaining the on-site peak.

Four (4) on-site basins and seven (7) offsite basins comprise the 775.66-acre overall drainage basin that will be analyzed in this study. A summary of all basin conditions are given in Table 1. The Pre-Development conditions basin maps are shown in Exhibits 3, and existing conditions land use map is shown in Exhibit 5. Basin maps for Post-Developed conditions are included in Exhibits 4.

Table 1. Summary of Conditions.

Sub-Area Description (Hydrograph No.)	CN	Area, acre	T_c, minute
Pre-developed (On-Site)			
PRE DB1	78	22.02	20.7
PRE DB2 - ON	89	3.72	16.3
PRE DB3 - ON	80	2.54	15.9
PRE DB4	60	6.58	22.1
TOTAL		34.86	
Pre-developed (Off-Site)			
PRE DB2 – OFF	98	1.08	5.0
PRE DB3 – OFF	69	0.32	5.0
OFF BASIN 1	88	532.7	76.9
OFF BASIN 2	90	142.1	42.0
OFF BASIN 3	82	33.7	31.5
OFF BASIN 4	75	29.0	27.1
OFF BASIN 5	98	1.9	5.0
TOTAL		740.80	
Sub-Area Description (Hydrograph No.)	CN	Area, acre	T_c, minute
Post-developed (On-Site)			
POST DB1	87	24.12	14.6
POST DB2 - ON	92	1.96	5.0
POST DB3 - ON	81	2.20	11.3
POST DB4	60	6.58	22.9
TOTAL		34.86	
Post-developed (Off-Site)			
POST DB2 – OFF	98	1.08	5.0
POST DB3 – OFF	69	0.32	5.0
OFF BASIN 1	88	532.7	76.9
OFF BASIN 2	90	142.1	42.0
OFF BASIN 3	82	33.7	31.5
OFF BASIN 4	75	29.0	27.1
OFF BASIN 5	98	1.9	5.0
TOTAL		740.80	

There are four Points of Analysis (POA) associated with the proposed site. They are labeled POA 1 through POA 4. POA 1 is the point at which the proposed Phase 1 site flow enter a section of open channel stream and thus will serve as the principal measuring point to ensure the integrity of the existing channel. POA 2 is the eventual outfall for all flows entering the existing dual 14’x 8.5’ Box Culverts routing under Hammond Drive. POA 3 & 4 are existing outfall points that are routed under Perimeter Center Parkway. The size of the contributing basin areas will be reduced by the proposed development.

The summary of flows at the four POAs are shown in Tables 2 - 5 for the 2 5, 10, 25, 50 and 100-year, 24 hour frequency storm events. These tables demonstrate that the post-developed condition, providing water quality only, will release less than allowable of the required storm events, thus meeting the stormwater requirements of the City of Dunwoody.

The "Pre-Dev vs. Detained" table below demonstrates that if detention and channel protection requirements are provided for the proposed development, Perimeter Creek at the point where the culverts discharge to a small section of open channel flow and the point at which the culvert eventually discharge under Hammond Drive will experience increased peak flow rates. However, as shown in the "Pre-Dev vs. WQ Only" table below, if detention and channel protection requirements are waived for the site and only water quality measures are provided, peak flow rates for the adjacent creek will be decreased.

Table 2. Summary of Flows: Pre-Dev vs. Detained

POA 1				
Return Frequency	*PRE-DEV (ft^3/s)*	*POST-DEV DETAINED (ft^3/s)*	*POST DEV DETAINED vs. PRE-DEV(ft^3/s)*	*POST < PRE (ft^3/s)*
2-year	953.46	951.21	-2.25	Yes
5-year	1177.38	1183.51	+6.13	No
10-year	1401.65	1408.90	+7.25	No
25-year	1700.34	1707.01	+6.67	No
50-year	1923.94	1929.78	+5.84	No
100-year	2147.35	2151.83	+4.48	No
POA 2				
Return Frequency	*PRE-DEV (ft^3/s)*	*POST-DEV DETAINED (ft^3/s)*	*POST DEV DETAINED vs. PRE-DEV(ft^3/s)*	*POST < PRE (ft^3/s)*
2-year	976.85	973.42	-3.43	Yes
5-year	1209.04	1213.28	+4.24	No
10-year	1443.02	1446.62	+3.60	No
25-year	1755.07	1755.80	+0.73	No
50-year	1989.38	1987.01	-2.37	Yes
100-year	2223.55	2217.58	-5.97	Yes

Table 3. Summary of Flows: Pre-Dev vs. WQ Only

POA 1				
Return Frequency	*PRE-DEV (ft^3/s)*	*POST-DEV WQ ONLY (ft^3/s)*	*POST DEV WQ ONLY vs. PRE-DEV(ft^3/s)*	*POST < PRE (ft^3/s)*
2-year	953.46	952.84	-0.62	Yes
5-year	1177.38	1176.11	-1.27	Yes
10-year	1401.65	1399.71	-1.94	Yes

25-year	1700.34	1697.47	-2.87	Yes
50-year	1923.94	1920.21	-3.73	Yes
100-year	2147.35	2142.36	-4.99	Yes
POA 2				
Return Frequency	*PRE-DEV* *(ft^3/s)*	*POST-DEV* *WQ ONLY* *(ft^3/s)*	*POST DEV* *WQ ONLY vs.* *PRE-DEV(ft^3/s)*	*POST < PRE* *(ft^3/s)*
2-year	976.85	975.20	-1.65	Yes
5-year	1209.04	1206.39	-2.65	Yes
10-year	1443.02	1438.22	-4.80	Yes
25-year	1755.07	1747.24	-7.83	Yes
50-year	1989.38	1978.64	-10.74	Yes
100-year	2223.55	2210.22	-13.33	Yes

Table 4. Summary of Flows at POA - 3

Return Frequency	*Qpre* *(ft^3/s)*	*Qpost* *(ft^3/s)*	*Qpost < Qpre?* *(ft^3/s)*
2-year	17.43	15.87	Yes
5-year	21.15	18.96	Yes
10-year	24.87	22.03	Yes
25-year	29.81	26.10	Yes
50-year	33.51	29.15	Yes
100-year	37.19	32.19	Yes

Table 5. Summary of Flows at POA – 4

Return Frequency	*Qpre* *(ft^3/s)*	*Qpost* *(ft^3/s)*	*Qpost < Qpre?* *(ft^3/s)*
2-year	8.32	7.54	Yes
5-year	10.77	9.71	Yes
10-year	13.27	11.92	Yes
25-year	16.66	14.90	Yes
50-year	19.22	17.15	Yes
100-year	21.78	19.41	Yes

II. HYDROLOGY REPORT

II. Hydrology Report

1.0 Background

1.1 Project Description

The existing 211, 219, and 223 Perimeter Center Parkway office development in the City of Dunwoody, Georgia, includes multiple office and commercial buildings, a parking deck, and surface parking. The proposed project is a multi-phase, mixed-use, development. The existing 211 building will remain, along with the associated parking deck. Phase 1 of the proposed project includes the demolition of existing surface parking. The scope of the is phase 1 package is to construct four blocks of mixed-use development, associated parking decks, private internal street, stormwater conveyance, and all associated utilities. The development is located on a 34.86-acre parcel of land at the northwest corner of the intersection of Hammond Drive and Peachtree Center Parkway and extends north along Perimeter Center Parkway to the existing overhead MARTA crossing. Please refer to the vicinity map located in Appendix A, Exhibit 1.

1.2 Objectives

The City of Dunwoody requires the release rates for the proposed development be maintained at lower than the existing rates for the 2, 5, 10, 25, 50, and 100-year, 24-hour frequency storms. Per the City of Dunwoody ordinance Chapter 16, Article II, Division 5, Sec. 16-94 (2b) "*The community development director is authorized to waive the detention storage requirements of subsection (2)a.2. for sites that discharge directly into piped stormwater drainage systems, larger streams, rivers, wetlands, lakes, estuaries, tidal water or other situations where flows will not have a negative impact on stream bank stability or channel integrity.*". The downstream analysis modeled in this report shows no adverse impacts from the exit to the point in the drainage basin where the project is 10 percent of the total drainage basin area for the Water Quality only strategy.

The Hanover Perimeter Multi-family Residential Development and Perimeter Town Center Property, located on the western edge of the Perimeter Creek directly adjacent to the proposed site, were analyzed in the same manner in which this report is formatted. A master hydrology study was performed, permitted, and approved for the overall Perimeter Town Center property in 2009. That study was most recently revised on April 24, 2009. The Hanover Perimeter Multi-family Development was permitted and approved on June 13, 2016. In both of those studies it was proven that implementing stormwater detention and channel protection measures were detrimental to the flow rates of the overall basin and subsequently were not necessary.

High Street – Phase 1 outfalls into Perimeter Creek. Thus, the following study will consider two different scenarios for future development in order to determine the optimal design that will have no adverse impact on the adjacent creek. One of the two scenarios will analyze a design including detention, channel protection, and water quality for the future development in accordance with the regulating stormwater ordinances. This scenario will result in on-site post-developed flow rates that are lower than Pre-Development flow rates for the proposed Phase 1 sub-basin but will increase post-developed flows at the downstream Points of Analysis' due to the contribution and peaking times of off-site basins. Thus, the implementation of detention will have an adverse effect on Perimeter Creek by increasing peak flow rates where the existing culvert discharges to the section of open channel flow and into existing culverts routed under Hammond Drive. In the second & proposed scenario, only Water Quality measures will be provided for the future development in order to eliminate this adverse effect created by detaining the on-site peak.

1.3 Scope and Strategy

This report will address the future development of the High Street – Phase 1 property. The majority of current site runoff drains to the west-southwest boundary and discharges into Perimeter Creek which ultimately flows into Nancy Creek to the south. The remaining northeastern portion of the site flows to the east, under Perimeter Center Parkway, into existing concrete lined drainage channel, and eventually into an existing 14' x 8' Corrugated Metal Elliptical Pipe that routes back under Perimeter Center Parkway and discharges at the west-southwest boundary into Perimeter Creek along with the remainder of the site runoff. The primary Point of Analysis for the Phase 1 development that this report addresses is where the runoff exits existing dual 84" Corrugated Metal Pipes into a short section of open channel flow before entering into dual 14' x 8.5' Box Culverts that exit the southwestern property line under Hammond Drive. This point serves as the means to ensure the integrity of existing creek and support the proposed waiver from channel protection and detention requirements. Due to the proposed program being multi-phased, a Point of Analysis is included at the most southwestern extent of the subject property to analyze the eventual point where the entirety of the proposed development runoff converges before exiting the property under Hammond Drive into Perimeter Creek. A mapped flood plain (panel 13089C0011J) currently existing north of POA 2 and within the existing concrete channel off-site adjacent to Perimeter Mall.

Existing conditions will be based on current site conditions with hydrologic type B soils. According to data taken from the United States Department of Agriculture website (http://websoilsurvey.nrcs.usda.gov/app/), the High Street site is largely recorded as type B soil. A large portion of the site is classified as Ud soil due to its urban nature. Please see the soil map found in Exhibit 6 in Appendix A of this report. Soils throughout the overall 775.66-acre basin are primarily hydrologic type B soils but also include a small amount of type C soils. The ratio of recorded type B soils to recorded type C soils throughout the overall basin is 93% type B soils (Exhibit 6B). This same ratio will be assumed for all Ud soils throughout the basin in order to perform necessary CN calculations. In some cases, within this report, type C soils have been omitted from calculations for certain basins if the small amount of type C area causes no change to the basin's CN value. Thus, the on-site basins assume only type B soil. The same soil type assumptions will be used for the post-developed conditions as well.

Refer to the Basin Maps in Appendix A of this report for exhibits showing the existing conditions and post-developed conditions of the site.

1.4 Model Development

This hydrology study utilizes Hydraflow Hydrographs to model the pre-developed and post-developed drainage conditions. The program uses SCS methodology to calculate the drainage flows for the 2, 5, 10, 25, 50, and 100-year storm events. The Hydraflow reports attached in Appendix B include both input and results for the pre-developed and post-developed conditions. The City of Atlanta precipitation data was used in Hydraflow to generate the stormwater flows and intensities. This rainfall information is provided in Appendix A, Exhibit 7.

The time of concentration, T_c, was calculated through using TR-55 methodology and is also reported in the Hydraflow Output in Appendix B. A minimum time of concentration of 5 minutes was used.

2.0 Pre-developed Conditions

2.1 Overview

The overall existing site includes three office buildings, a parking structure, and associated surface parking lots. The 211 office building and 211 parking structure will remain and be incorporate into Phase 1 of development. A portion of the surface parking and associated landscape islands will be demolished.

In the existing condition, there is a 4.10-acre area of the site that is currently detained. The drainage basin includes the existing 211 Office Building and parking garage. A retroactive curve number of 55 is used for the extents of the said area to account for native conditions (see Table 6 “Existing Detained”). The southern portion of the site is a grassed area that generally slopes towards Perimeter Creek. The creek is adjacent to the western portion of the overall property.

2.2 On-site Drainage

There are four on-site basins that are studied for the pre-developed site conditions.

- *PRE DB1* contains onsite area that is routed via pipe to existing dual 84” CMPs. Said pipes eventually discharge to a short section of open channel flow at POA 1 before being collected into dual 14’ x 8.5’ Box culverts that route under Hammond Drive and continue into Perimeter Creek (POA 2). A portion of this drainage basin accounts for the 4.10-acre area described above that is currently detained via over excavated landscape islands. A curve number of 55 is applied to this area to retroactively bringing the basin back to native conditions.

- *PRE DB2-ON* contains onsite area that, along with offsite basin *PRE DB2-OFF*, discharge via 24” CMP routed under Perimeter Center Parkway. This runoff is collected in an existing concrete lined channel and eventually routes back under Perimeter Center Parkway and discharges at POA 1 via 14’ x 8’ Elliptical CMP headwall.
- *PRE DB3-ON* contains onsite area that along with offsite basin *PRE DB3-OFF* discharge via 24” CMP routed under the existing MARTA Tracks. Similar to *PRE DB2*, this runoff is also collected in an existing concrete lined channel and eventually routes back under Perimeter Center Parkway and discharges at POA 1 via 14’ x 8’ Elliptical CMP headwall.
- *PRE DB-4* contains onsite grassed area that is currently undetained. This area generally sloped southwest to the section of open channel flow that is collected into the existing 14’ x 8.5’ Box culverts and is routed under Hammond Drive (POA 2). This is the only onsite basin that does not contribute to POA 1.

2.3 Off-site Drainage

- *PRE DB2-OFF* contains onsite area that along with offsite basin *PRE DB2-ON* discharge via 24” CMP routed under Perimeter Center Parkway. This runoff is collected in an existing concrete lined channel and eventually routes back under Perimeter Center Parkway and discharges at POA 1 via 14’ x 8’ Elliptical CMP headwall.
- *PRE DB3-OFF* contains onsite area that along with offsite basin *PRE DB3-ON* discharge via 24” CMP routed under the existing MARTA Tracks. Similar to *PRE DB2*, this runoff is also collected in an existing concrete lined channel and eventually routes back under Perimeter Center Parkway and discharges at POA 1 via 14’ x 8’ Elliptical CMP headwall.

The areas and curve number calculations are shown for each sub-basin in Table 6. An offsite basin map is included in Exhibit 2 in Appendix A, while existing conditions of onsite basins are shown in Exhibit 3 in Appendix A. Curve numbers are selected, based on hydrologic soil group type, from Table 2.1.5-1 of the Georgia Stormwater Management Manual (GSMM). This table has been included in Appendix A. The times of concentration, Tc, calculations for the existing conditions on-site and offsite flows are shown in Table 7. These curve numbers and times of concentration values are also included in Exhibits 2 and 3 in Appendix A.

Table 6. Existing Conditions Curve Number.

Sub-Basin Description	CN	Area (acre)
Pre DB1		
Existing Detained	55	4.10

Woods, good cover	55	2.47
Open Space, Good condition	61	4.26
Impervious	98	11.19
TOTAL	**78.0**	**22.02**
Pre DB2 - ON		
Woods, good cover	55	0.48
Open Space, Good condition	61	0.36
Impervious	98	2.88
TOTAL	**89**	**3.72**
Pre DB2 - OFF		
Impervious	98	1.08
TOTAL	**98**	**1.08**
Pre DB3 - ON		
Woods, good cover	55	0.69
Open Space, Good condition	61	0.47
Impervious	98	1.38
TOTAL	**80**	**2.54**
Pre DB3 - OFF		
Woods, good cover	55	0.14
Open Space, Good condition	61	0.09
Impervious	98	0.09
TOTAL	**69**	**0.32**
Pre DB4		
Woods, good cover	55	1.29
Open Space, Good condition	61	5.29
TOTAL	**60**	**6.58**

Table 7. Existing Conditions T_c.

Sub-Basin Description	Overland Flow, min	Shallow Concentrated Flow, min	Open Channel Flow, min	T_c, min
Pre DB1	18.23	1.62	0.89	20.7
Pre DB2 - ON	15.11	1.16	0.06	16.3
Pre DB2 - OFF	N/A	N/A	N/A	5(MIN.)
Pre DB3 - ON	9.49	1.26	0.52	11.3
Pre DB3 - OFF	N/A	N/A	N/A	5(MIN.)
Pre DB4 - ON	14.14	7.99	-	22.1

3.0 Post-developed Conditions

3.1 Overview

The High Street – Phase 1 development will include the demolition of existing surface parking and the construction of new mixed-use development including parking. Water quality measures do not currently exist on-site, but will be implement in the proposed development via proprietary devices.

As discussed in Section 1.2, two different scenarios have been considered in order to select the most suitable design that will eliminate adverse effects that the future development might have on the creek located immediately to the west of the property.

Scenario 1 (Detained) - All on-site runoff is modeled to be detained according to the current City of Dunwoody stormwater ordinance which requires the on-site release rates for the proposed development be maintained at lower than existing flow rates for the 2, 5, 10, 25, 50, and 100-year, 24 hour frequency storms. In addition, channel protection is modeled to be provided as required by the stormwater ordinance. A theoretical 100' wide x 500' long x 7' deep 350,000 CF underground vault is modeled as a means to meet stormwater requirement for the contributing area of Phase 1 development. The calculations relative to channel protection, orifice sizing, and stage storage are included in Exhibit 11.

Scenario 2 (Water Quality Only) - Detention and channel protection will not be proposed in the future development in order to avoid adverse effects that would be caused by detaining the on-site peak.

3.2 On-site Drainage

There are four on-site basins that are being studied for the post-developed site conditions.

- *POST DB1* contains onsite area that is routed via proposed pipe to existing dual 84" CMPs and eventually discharge to a short section of open channel flow at POA 1 before being collected into dual 14' x 8.5' Box culverts routing under Hammond Drive and continuing into Perimeter Creek (POA 2).
- *POST DB2-ON* contains onsite area that along with offsite basin *POST DB2-OFF* discharge via 24" CMP routed under Perimeter Center Parkway (POA 3). This runoff is collected in an existing concrete lined channel that eventually routes back under Perimeter Center Parkway and discharges at POA 1 via 14' x 8' Elliptical CMP headwall.
- *POST DB3-ON* contains onsite area that along with offsite basin *POST DB3-OFF* discharge via 24" CMP routed under the existing MARTA Tracks (POA 4). Similar to *PRE DB2*, this runoff is also collected in an existing concrete lined channel and eventually routes back under Perimeter Center Parkway and discharges at POA 1 via 14' x 8' Elliptical CMP headwall.

- *POST DB-4* contains proposed a temporary stockpile This area is generally sloped southwest to the section of open channel flow that is collected into the existing 14’ x 8.5’ Box culverts and is routed under Hammond Drive (POA 2). This is the only onsite basin that does not contribute to POA 1.

3.3 Off-site Drainage

- *POST DB2-OFF* contains onsite area that along with offsite basin *POST DB2-ON* discharge via 24” CMP routed under Perimeter Center Parkway. This runoff is collected in an existing concrete lined channel and eventually routes back under Perimeter Center Parkway and discharges at POA 1 via 14’ x 8’ Elliptical CMP headwall.
- *POST DB3-OFF* contains onsite area that along with offsite basin *POST DB3-ON* discharge via 24” CMP routed under the existing MARTA Tracks. Similar to *POST DB2,* this runoff is also collected in an existing concrete lined channel and eventually routes back under Perimeter Center Parkway and discharges at POA 1 via 14’ x 8’ Elliptical CMP headwall.

The areas and curve number calculations are shown for each sub-basin in Table 8. An offsite basin map is included in Exhibit 2 in Appendix A, while existing conditions onsite basins are shown in Exhibit 4 in Appendix A. Curve numbers are selected, based on hydrologic soil group type, from Table 2.1.5-1 of the Georgia Stormwater Management Manual (GSMM). This table has been included in Appendix A. The times of concentration, Tc, calculations for the existing conditions on-site and offsite flows are shown in Table 9. These curve numbers and times of concentration values are also included in Exhibits 2 and 4 in Appendix A.

Table 8. Proposed Condition Curve Number

Sub-Basin Description	CN	Area (acre)
POST DB1		
Woods, good cover	55	2.18
Open Space, Good condition	61	4.56
Impervious	98	17.38
TOTAL	**87**	**24.12**
POST DB2 - ON		
Open Space, Good condition	61	0.34
Impervious	98	1.62
TOTAL	**92**	**1.96**
POST DB2 - OFF		
Impervious	98	1.08
TOTAL	**98**	**1.08**
POST DB3 - ON		
Woods, good cover	55	0.79

Open Space, Good condition	61	0.12
Impervious	98	1.29
TOTAL	**81**	**2.20**
POST DB3 - OFF		
Woods, good cover	55	0.14
Open Space, Good condition	61	0.09
Impervious	98	0.09
TOTAL	**69**	**0.32**
POST DB4		
Woods, good cover	55	1.29
Open Space, Good condition	61	5.29
TOTAL	**60**	**6.58**

Table 9. Proposed Conditions T_c.

Sub-Basin Description	Overland Flow, min	Shallow Concentrated Flow, min	Open Channel Flow, min	T_c, min
POST DB1	9.58	1.07	3.97	14.6
POST DB2 - ON	-	-	-	5(MIN.)
POST DB2 - OFF	-	-	-	5(MIN.)
POST DB3 - ON	9.49	1.26	0.52	11.3
POST DB3 - OFF	-	-	-	5(MIN.)
POST DB4	14.86	8.07	-	22.9

4.0 Macro-Study Off-site Drainage

This study proposes the waiver from channel protection and detention requirements due to the negative impacts on the existing watercourse that would result from detaining the on-site peak events. In order to study the Points of Analysis in the appropriate manner, five offsite Macro-basins have been included to demonstrate the overall peaking factor for the entire basin contributing to the existing culverts on-site and routed under Hammond Drive. The analysis points are cataloged as POA 1 and POA 2 respectively. SCS methodology is used to calculate the drainage flows for the 2, 5, 10, 25, 50, and 100-year storm events. Methodology for calculating the Curve Numbers and Time of Concentration for said basins can be seen below in Tables 10 and 11.

Table 10. Macro Basin Curve Numbers

SCS METHOD								
Drainage Area Name	Drainage Location	Watershed Area (ac)	Cover Description *	Hydrologic Soil Group	Curve Number (CN)	Area (ac)	Percent Area	Composite Curve Number (CN)
PRE-DEVELOPMENT								
OFF BASIN 1	POA	532.7	Commercial and Business	B	92	370.3	69.5%	63.95
			Commercial and Business	C	94	11.1	2.1%	1.96
			Low Density Residential	B	72	5.5	1.0%	0.74
			Middle Density Residential	B	75	96.0	18.0%	13.52
			Middle Density Residential	C	83	3.9	0.7%	0.61
			High Density Residential	B	85	42.1	7.9%	6.72
			High Density Residential	C	90	3.8	0.7%	0.64
						532.7		88
OFF BASIN 2	POA	142.1	Commercial and Business	B	92	120.7	84.9%	78.14
			Commercial and Business	C	94	1.6	1.1%	1.06
			Industrial	B	88	6.3	4.4%	3.90
			High Density Residential	B	85	2.6	1.8%	1.56
			High Density Residential	C	90	1.1	0.8%	0.70
			Low Density Residential	B	72	9.8	6.9%	4.97
						142.1		90
OFF BASIN 3	POA	33.7	Commercial and Business	B	92	8.6	25.5%	23.48
			Industrial	B	88	4.1	12.2%	10.71
			High Density Residential	B	85	6.4	19.0%	16.14
			High Density Residential	C	90	1.3	3.9%	3.47
			Low Density Residential	B	72	12.6	37.4%	26.92
			Low Density Residential	C	81	0.7	2.1%	1.68
						33.7		82
OFF BASIN 4	POA	29.0	Commercial and Business	B	92	7.1	21.1%	19.38
			High Density Residential	B	85	21.9	65.0%	55.24
						29.0		75
OFF BASIN 5	POA	1.9	Roadway	B	98	1.9	100.0%	98.00
						1.9		98.00

Table 11. Macro Basin Time of Concentration

Watershed Name	Outfall Location	Type of Flow	K	Flow Length, L (ft)	N*	Slope, s (ft/ft)	Travel Time (min)
OFFSITE BASIN 1	POA	Overland	0.828	3950	0.13	0.033	34.53
		Channelized	0.0078	7420	----	0.011	42.30
				Time of Concentration (min) =			76.90
OFFSITE BASIN 2	POA	Overland	0.828	2015	0.13	0.030	25.78
		Channelized	0.0078	3460	----	0.029	16.19
				Time of Concentration (min) =			42.00
OFFSITE BASIN 3	POA	Overland	0.828	1405	0.13	0.041	20.25
		Channelized	0.0078	2180	----	0.030	11.19
				Time of Concentration (min) =			31.50
OFFSITE BASIN 4	POA	Overland	0.828	575	0.13	0.030	14.36
		Channelized	0.0078	2525	----	0.029	12.70
				Time of Concentration (min) =			27.10
OFFSITE BASIN 5	POA	Channelized	0.0078	790	----	0.049	4.24
				Time of Concentration (min) =			5.00
*Assumes Overland Flow is over 70% Impervious Surface (0.02) and 30% Pervious/Grass (0.40)							

5.0 Summary of Flows

The summary of flows for existing conditions and the post-developed conditions are shown in Table 15 for the 2, 5, 10, 25, 50, and 100-year, 24 hour frequency storm events. If detention and channel protection are provided for the Phase 1 development, Perimeter Creek at the southwest corner of the site will experience increased peak flow rates (Table 12). However, if detention and channel protection requirements are waived for the Phase 1 site and only water quality measures are provided, peak flow rates for the adjacent creek will be decreased (Table 13). Therefore, the proposed design will include only water quality measures.

Table 12. Summary of Flows: Pre-Dev vs. Detained

POA 1				
Return Frequency	*PRE-DEV (ft^3/s)*	*POST-DEV DETAINED (ft^3/s)*	*POST DEV DETAINED vs. PRE-DEV(ft^3/s)*	*POST < PRE (ft^3/s)*
2-year	953.46	951.21	-2.25	Yes
5-year	1177.38	1183.51	+6.13	No
10-year	1401.65	1408.90	+7.25	No
25-year	1700.34	1707.01	+6.67	No

50-year	1923.94	1929.78	+5.84	No
100-year	2147.35	2151.83	+4.48	No
POA 2				
Return Frequency	*PRE-DEV (ft^3/s)*	*POST-DEV DETAINED (ft^3/s)*	*POST DEV DETAINED vs. PRE-DEV(ft^3/s)*	*POST < PRE (ft^3/s)*
2-year	976.85	973.42	-3.43	Yes
5-year	1209.04	1213.28	+4.24	No
10-year	1443.02	1446.62	+3.60	No
25-year	1755.07	1755.80	+0.73	No
50-year	1989.38	1987.01	-2.37	Yes
100-year	2223.55	2217.58	-5.97	Yes

Table 13. Summary of Flows: Pre-Dev vs. WQ Only

POA 1				
Return Frequency	*PRE-DEV (ft^3/s)*	*POST-DEV WQ ONLY (ft^3/s)*	*POST DEV WQ ONLY vs. PRE-DEV(ft^3/s)*	*POST < PRE (ft^3/s)*
2-year	953.46	952.84	-0.62	Yes
5-year	1177.38	1176.11	-1.27	Yes
10-year	1401.65	1399.71	-1.94	Yes
25-year	1700.34	1697.47	-2.87	Yes
50-year	1923.94	1920.21	-3.73	Yes
100-year	2147.35	2142.36	-4.99	Yes
POA 2				
Return Frequency	*PRE-DEV (ft^3/s)*	*POST-DEV WQ ONLY (ft^3/s)*	*POST DEV WQ ONLY vs. PRE-DEV(ft^3/s)*	*POST < PRE (ft^3/s)*
2-year	976.85	975.20	-1.65	Yes
5-year	1209.04	1206.39	-2.65	Yes
10-year	1443.02	1438.22	-4.80	Yes
25-year	1755.07	1747.24	-7.83	Yes
50-year	1989.38	1978.64	-10.74	Yes
100-year	2223.55	2210.22	-13.33	Yes

Table 14. Summary of Flows at POA - 3

Return Frequency	*Qpre* *(ft^3/s)*	*Qpost* *(ft^3/s)*	*Qpost < Qpre?* *(ft^3/s)*
2-year	17.43	15.87	Yes
5-year	21.15	18.96	Yes
10-year	24.87	22.03	Yes
25-year	29.81	26.10	Yes
50-year	33.51	29.15	Yes
100-year	37.19	32.19	Yes

Table 15. Summary of Flows at POA - 4

Return Frequency	*Qpre* *(ft^3/s)*	*Qpost* *(ft^3/s)*	*Qpost < Qpre?* *(ft^3/s)*
2-year	8.32	7.54	Yes
5-year	10.77	9.71	Yes
10-year	13.27	11.92	Yes
25-year	16.66	14.90	Yes
50-year	19.22	17.15	Yes
100-year	21.78	19.41	Yes

6.0 Additional Requirements

6.1 Water Quality

Per the City of Dunwoody's requirements, water quality improvements that comply with the state of Georgia are required if over 5,000 square-feet of new or replaced impervious area is proposed. The water quality for the site is being treated for onsite flow of the areas proposed to be redevelopment as part of Phase 1 (Exhibit 9).

The state of Georgia requires the treatment of the first 1.2" of rainfall from a site for a given storm event to remove 80% of the average annual post-development TSS per the *Georgia Stormwater Management Manual*. Water quality volume is calculated based on the first 1.2" of rainfall volume from the onsite. The required water quality volume for the drainage basins are shown in the Site Water Quality Calculations below.

SITE WATER QUALITY CALCULATIONS (1.2" STORM)

Site: PHASE 1 - DB 1 WQ
Total DA (AC) = 14.74
Impervious DA (AC) = 12.68 ASSUME 86%

P = Rainfall, in inches (Use 1" or 0.9" for the Water Quality Storm) P = 1.2 inch
I = Percent Impervious I = 86.0%

WEIGHTED VOLUMETRIC RUNOFF COEFFICIENT

Rv = Weighted Volumetric Runoff Coefficient

$$Rv = 0.05 + 0.009(I)$$

Rv = 0.82

RUNOFF VOLUME

Qa = Runoff Volume (Watershed Inches)

Qa = 0.99 watershed inches

WATER QUALITY VOLUME

WQv = Water Quality Volume

$$WQv = \frac{[(P)(Qa)(A)]}{12} \times \frac{43{,}560\ ft^2}{acre}$$

WQv = 52907 cft

CURVE NUMBER

CN = Curve Number

$$CN = \frac{1000}{[10 + (5)(P) + (10)(Qa) - 10\sqrt{(Qa)^2 + 1.25(Qa)(P)}]}$$

CN = 98

TIME OF CONCENTRATION

Tc = Time of Concentration (Calculated from TR-55) Tc = 0.08333 hours

INITIAL ABSTRACTION

Ia = Initial Abstraction Ia = 0.040

Ia / P Ia / P = 0.033

Use Ia / P and Tc on Exhibit 4-II in the TR-55 manual to find the unit peak discharge (qu) for SCS type II rainfall distribution. qu = 1000 csm/in

PEAK DISCHARGE FOR WATER QUALITY STORM

Qp = Peak Discharge

$$Qp = (qu)(A)(Qa)$$

Qp = 22.77 cfs

Source: 2000 Maryland Stormwater Design Manual Volumes I & II

SITE WATER QUALITY CALCULATIONS (1.2" STORM)

Site: DB 2 - ON WQ
Total DA (AC) = 1.96
Impervious DA (AC) = 1.62

P = Rainfall, in inches (Use 1" or 0.9" for the Water Quality Storm) — P = 1.2 inch
I = Percent Impervious — I = 82.7%

WEIGHTED VOLUMETRIC RUNOFF COEFFICIENT

Rv = Weighted Volumetric Runoff Coefficient

[redacted]

Rv = 0.79

RUNOFF VOLUME

Qa = Runoff Volume (Watershed Inches)

Qa = 0.95 watershed inches

WATER QUALITY VOLUME

WQv = Water Quality Volume

$$WQv = \frac{[(P)(Qa)(A)]}{12} \times \frac{43{,}560\ ft^2}{acre}$$

WQv = **6778** cft

CURVE NUMBER

CN = Curve Number

$$CN = \frac{1000}{[10 + (5)(P) + (10)(Qa) - 10\sqrt{(Qa)^2 + 1.25(Qa)(P)}]}$$

CN = **98**

TIME OF CONCENTRATION

Tc = Time of Concentration (Calculated from TR-55) — Tc = 0.08333 hours

INITIAL ABSTRACTION

Ia = Initial Abstraction — Ia = 0.048

Ia / P — Ia / P = 0.040

Use Ia / P and Tc on Exhibit 4-II in the TR-55 manual to find the unit peak discharge (qu) for SCS type II rainfall distribution. — qu = 1000 csm/in

PEAK DISCHARGE FOR WATER QUALITY STORM

Qp = Peak Discharge

$$Qp = (qu)(A)(Qa)$$

Qp = **2.92** cfs

Source: 2000 Maryland Stormwater Design Manual Volumes I & II

The proposed devices are the CDS-5678-10-C and CDS5640-10-C respectively, by Contech Engineered Solutions. Details of the proposed devices as well as the third-party testing data, which shows that the device can achieve 80% TSS removal, can be found in Appendix B. From these documents and the above, it can be determined that the proposed design provides 80% TSS removal for the area of development.

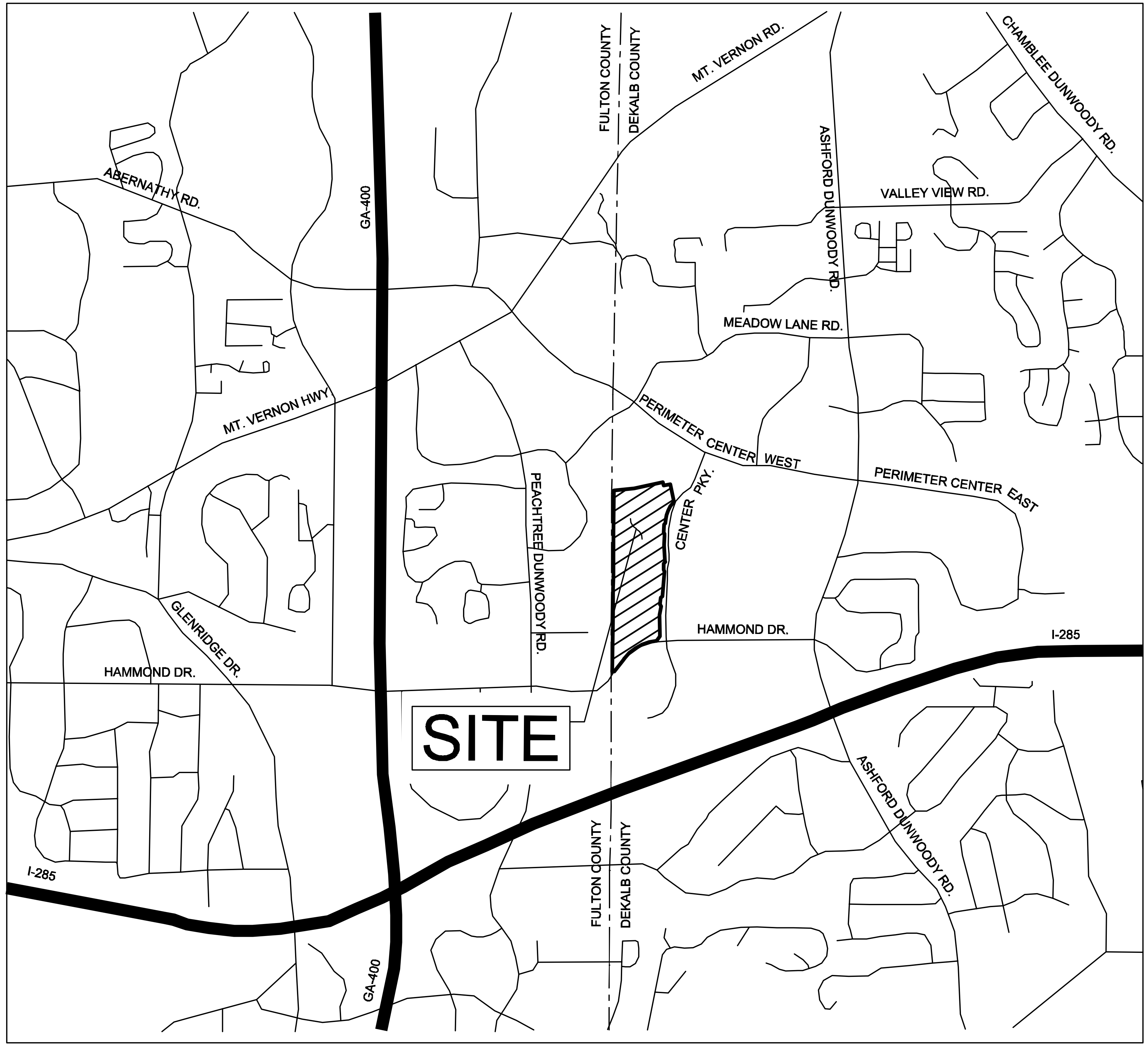
6.2 10% Analysis

The downstream analysis will analyze the stormwater quantity at the point where the onsite drainage area comprises 10% of the total drainage area. The site area is 34.86 acres; therefore the 10% drainage basin must be at least 348.6-acres. The Point of Analysis used within this study encompasses a drainage area of 775.67-acres. Therefore, results and flow summaries shown within this report are sufficient for determining adverse effects that might be caused by the proposed development upon the receiving watercourse. As discussed previously in the flow summaries of Section 5.0, the use of detention and channel protection on the High Street Phase 1 property will result in increased peak flows for Perimeter Creek at the southwest corner of the site. To avoid these adverse impacts and to improve upon existing conditions, only water quality measures are proposed for Phase 1 of development.

6.3 Water Quality Devices Inspection and Maintenance

The Contech Engineered Solutions water quality devices should be inspected and maintained regularly by the owner to ensure that both are structurally sound and free from debris. The Contech water quality device and the stormwater pond should be inspected for sediment accumulation. These facilities should be inspected, at minimum, bi-annually.

APPENDIX A
BASIN MAPS AND EXHIBITS



Kimley»Horn

11770 AMBER PARK DRIVE, SUITE 600 ALPHARETTA, GEORGIA 30009
PHONE: (770) 619-4280 www.kimley-horn.com

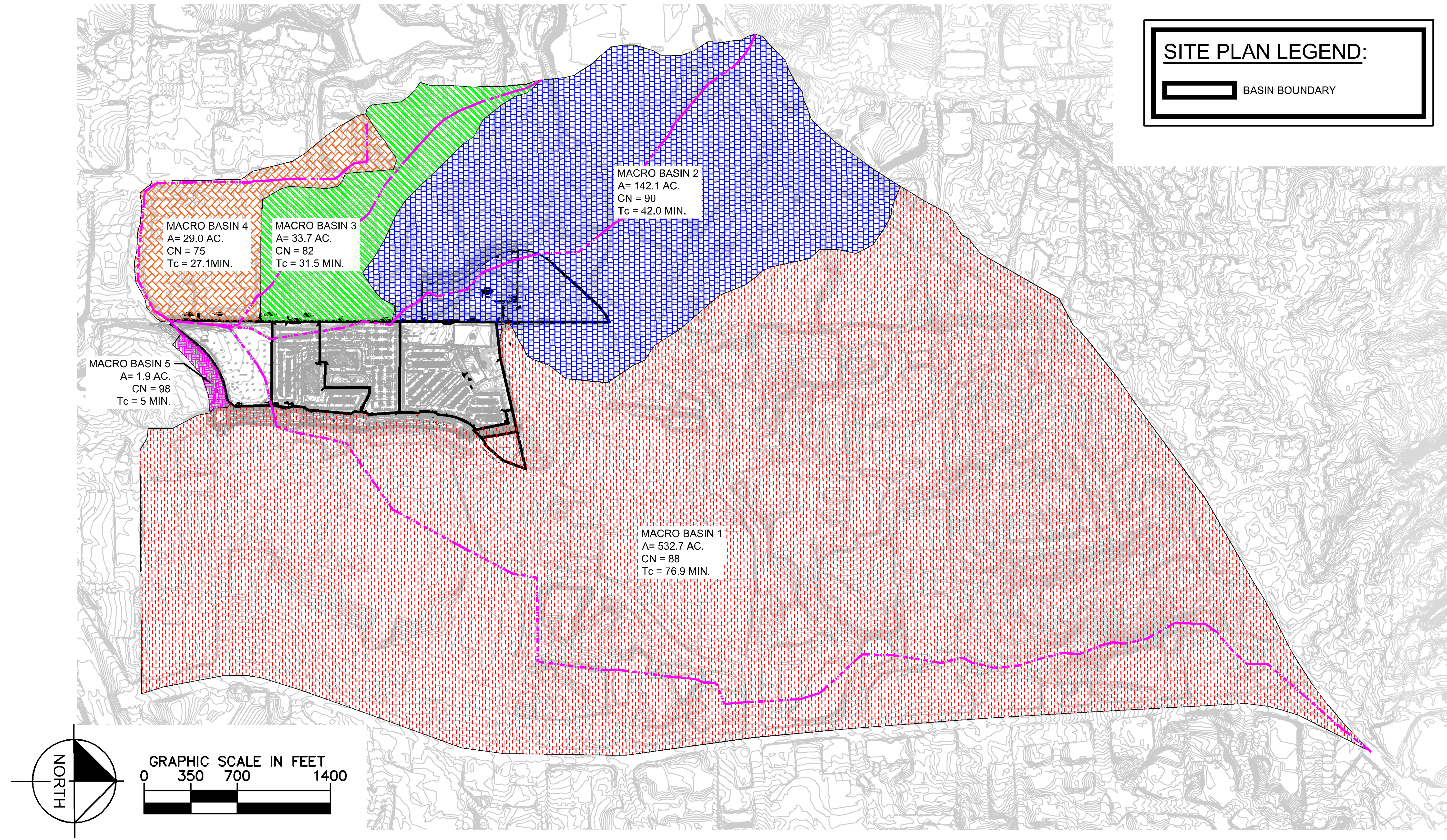
TITLE
VICINITY MAP

PROJECT
HIGH STREET - PHASE 1

CLIENT
HIGH STREET DEVELOPMENT LLC

EXHIBIT 1

DATE: AUGUST 16, 2019



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Kimley»Horn
11770 AMBER PARK DRIVE, SUITE 600 ALPHARETTA, GEORGIA 30009
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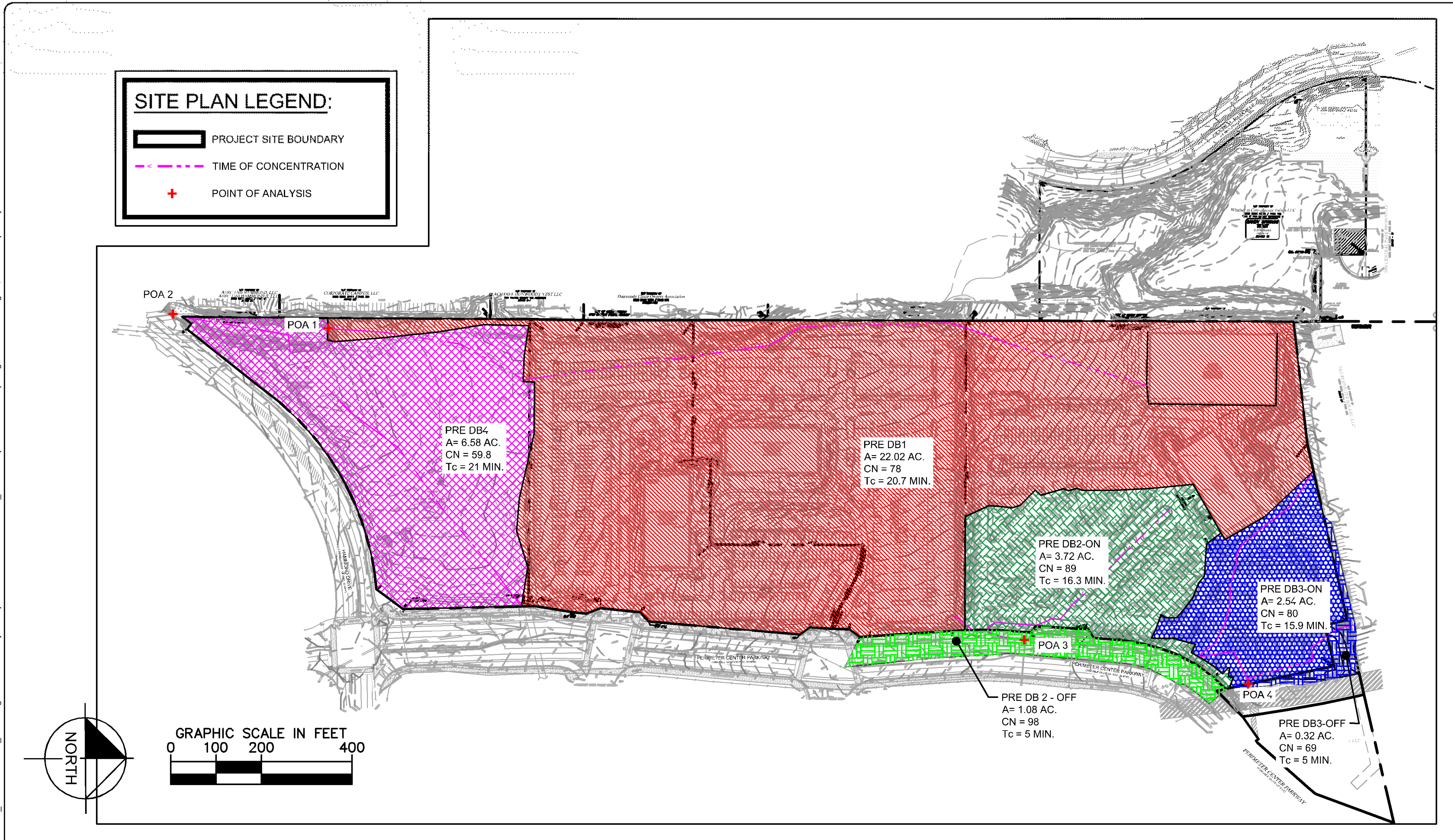
TITLE
OFFSITE BASIN MAP

PROJECT
HIGH STREET - PHASE 1

CLIENT
HIGH STREET DEVELOPMENT LLC

EXHIBIT 2

DATE: AUGUST 16, 2019



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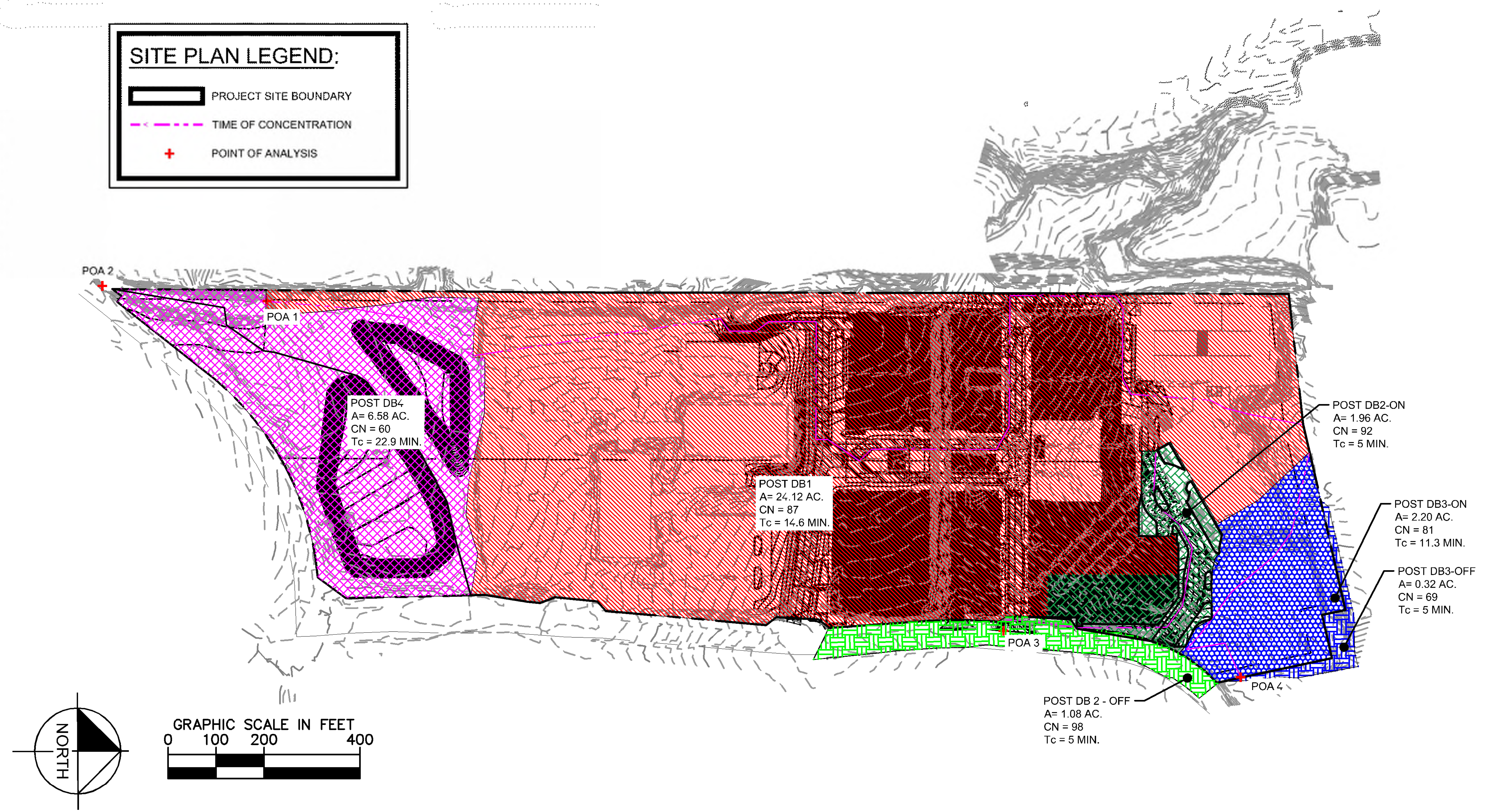
TITLE
PRE DEVELOPMENT BASIN MAP

PROJECT
HIGH STREET - PHASE 1

CLIENT
HIGH STREET DEVELOPMENT LLC

EXHIBIT 3

DATE: AUGUST 16, 2019



K:\ALP_PRJ\019473000_GID - High Street\ENG\Hydro\Report\Phase 1\CAD\Exhibit 4_Post development Basin Map.dwg Layout1 Aug 19, 2019 4:19pm by: derek.ziltrau r

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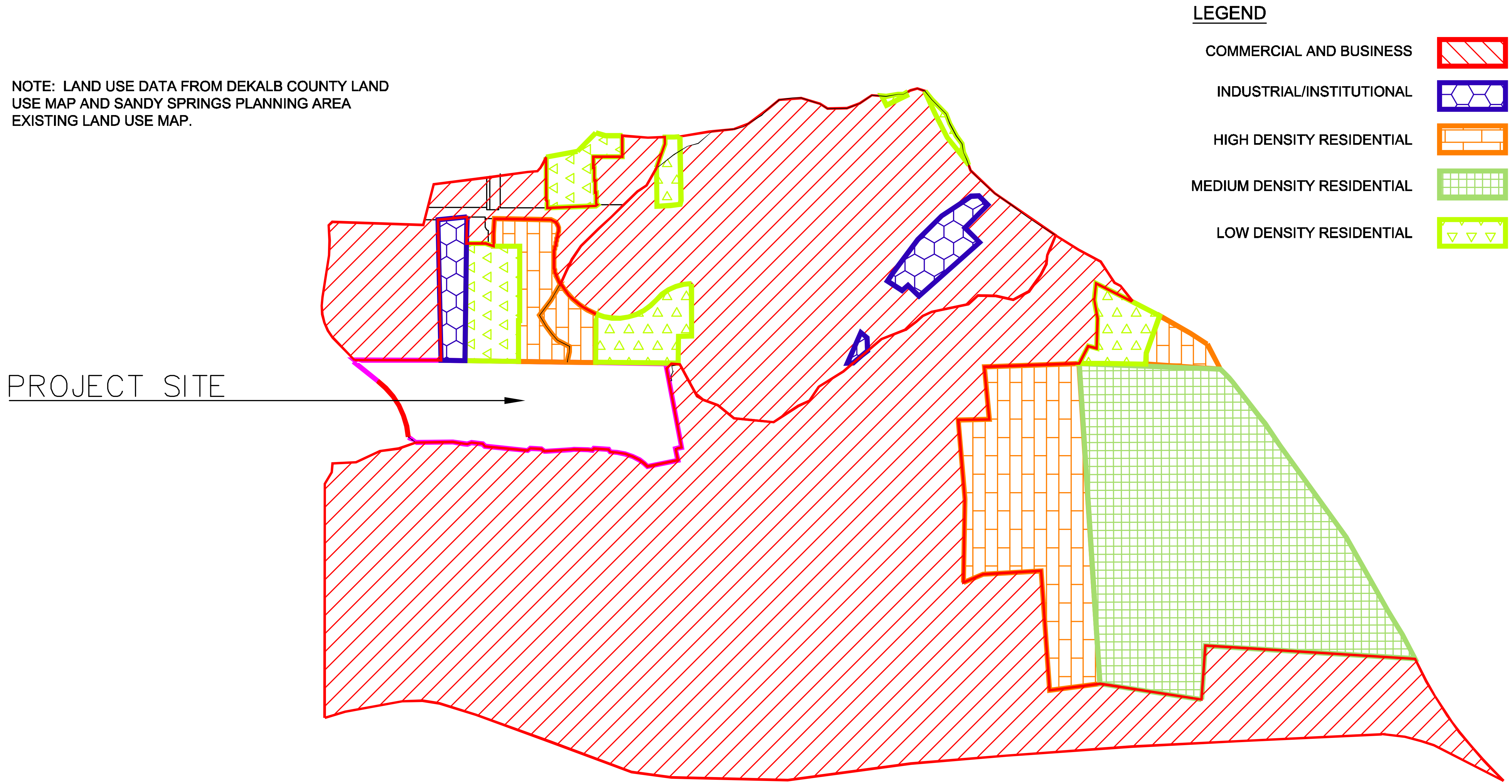
TITLE	PROJECT	CLIENT	
POST DEVELOPMENT BASIN MAP	HIGH STREET - PHASE 1	HIGH STREET DEVELOPMENT LLC	EXHIBIT 4 DATE: AUGUST 16, 2019

NOTE: LAND USE DATA FROM DEKALB COUNTY LAND USE MAP AND SANDY SPRINGS PLANNING AREA EXISTING LAND USE MAP.



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TITLE
EXISTING CONDITION LAND USE MAP

PROJECT
HIGH STREET - PHASE 1

CLIENT
HIGH STREET DEVELOPMENT LLC

EXHIBIT 5

DATE: AUGUST 16, 2019

EXHIBIT 6 - Hydrologic Soils Map

Hydrologic Soil Group—DeKalb County, Georgia, and Fulton County, Georgia

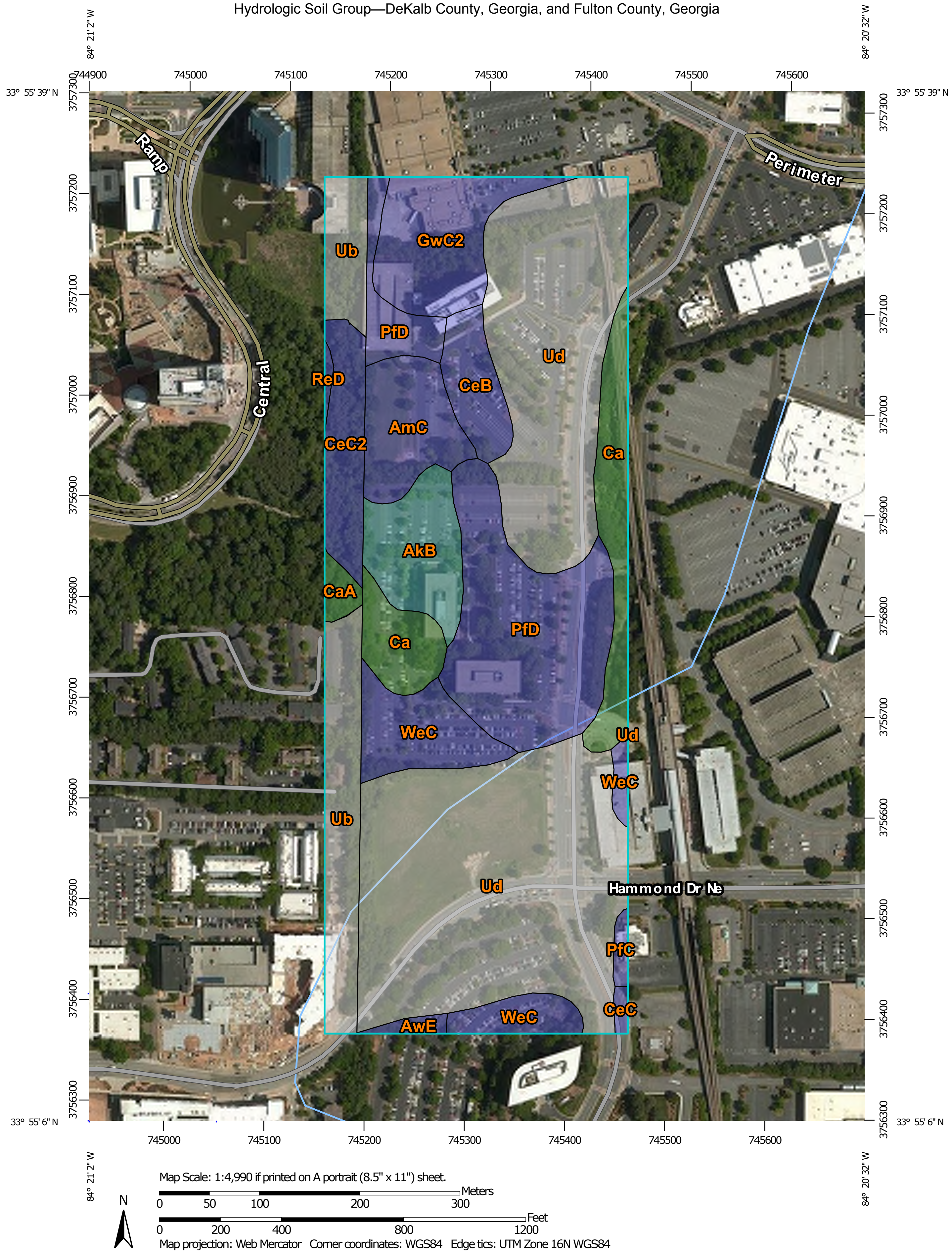


EXHIBIT 6 - Hydrologic Soils Map

Hydrologic Soil Group—DeKalb County, Georgia, and Fulton County, Georgia

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 scales ranging from 1:12,000 to 1:15,800.

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: DeKalb County, Georgia
Survey Area Data: Version 7, Sep 19, 2014

Soil Survey Area: Fulton County, Georgia
Survey Area Data: Version 10, Sep 19, 2014

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: May 4, 2014—Jun 18, 2014

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 — DeKalb County, Georgia (GA089)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
AkB	Altavista fine sandy loam, 2 to 6 percent slopes	C	2.9	4.6%
AmC	Appling sandy loam, 6 to 10 percent slopes	B	2.8	4.4%
AwE	Ashlar-Wedowee complex, 10 to 25 percent slopes	B	0.3	0.4%
Ca	Cartecay silt loam, frequently flooded	A/D	4.4	6.8%
CeB	Cecil sandy loam, 2 to 6 percent slopes	B	1.7	2.7%
CeC	Cecil sandy loam, 6 to 10 percent slopes	B	0.2	0.2%
GwC2	Gwinnett sandy clay loam, 2 to 10 percent slopes, eroded	B	3.9	6.0%
PfC	Pacolet sandy loam, 2 to 10 percent slopes	B	0.2	0.4%
PfD	Pacolet sandy loam, 10 to 15 percent slopes	B	9.0	14.1%
Ud	Urban land		26.6	41.7%
WeC	Wedowee sandy loam, 6 to 10 percent slopes	B	3.9	6.1%
Subtotals for Soil Survey Area			**55.8**	**87.5%**
Totals for Area of Interest			**63.8**	**100.0%**

Hydrologic Soil Group— Summary by Map Unit — Fulton County, Georgia (GA121)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
CaA	Cartecay-Toccoa complex, 0 to 2 percent slopes, occasionally flooded	A/D	0.4	0.7%
CeC2	Cecil sandy loam, 6 to 10 percent slopes, moderately eroded	B	2.3	3.6%
ReD	Rion sandy loam, 10 to 15 percent slopes	B	0.1	0.2%
Ub	Urban land		5.2	8.1%
Subtotals for Soil Survey Area			**8.0**	**12.5%**
Totals for Area of Interest			**63.8**	**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.

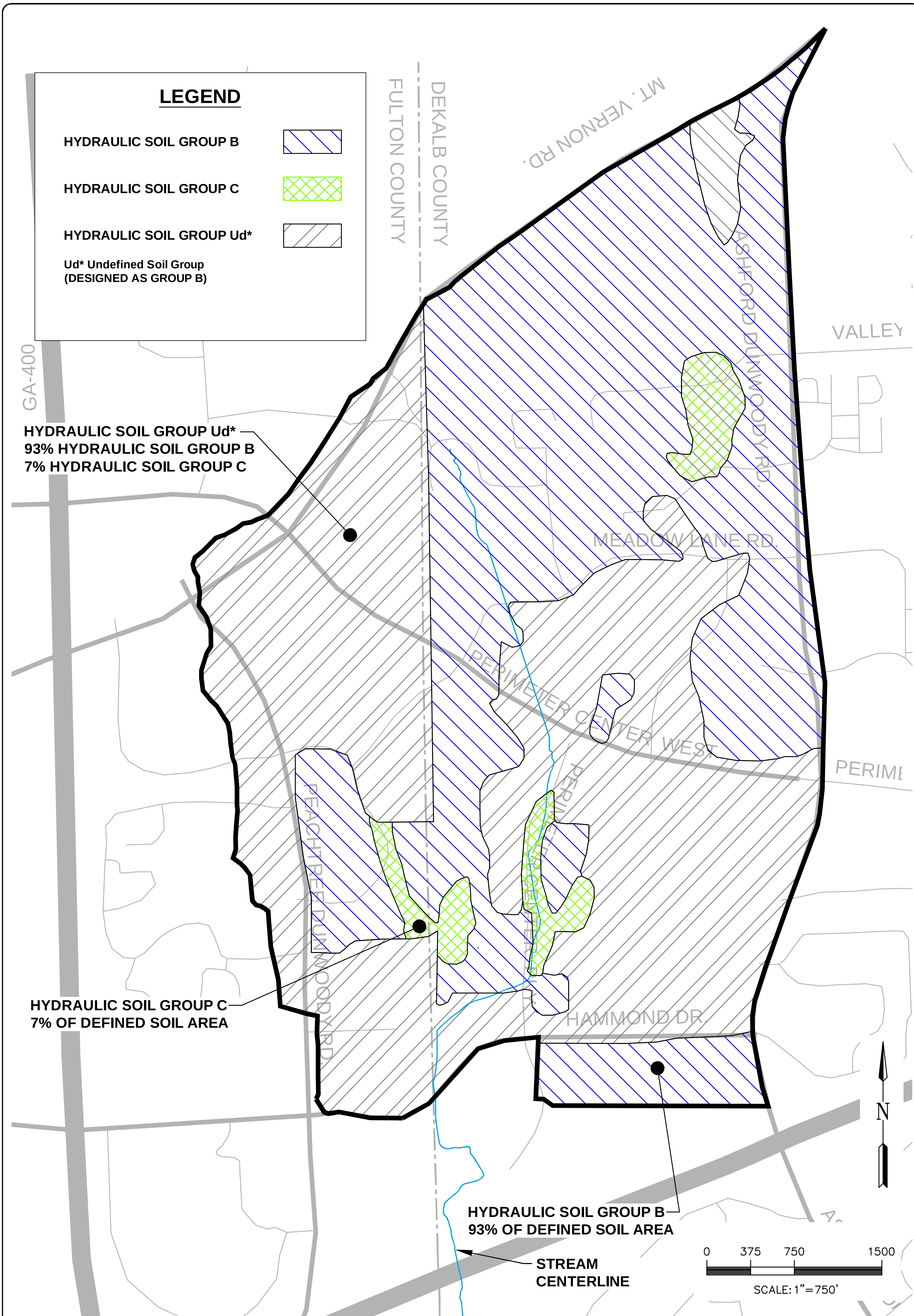
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher



Kimley»Horn
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10 ROSWELL STREET, SUITE 210, ALPHARETTA, GEORGIA 30009
PHONE: 720-825-0744
WWW.KIMLEY-HORN.COM

MACRO HYDROLOGIC SOIL MAP

Date: 8/16/19 | Project No.: 019473000 | Scale: AS SHOWN

PROJECT: HIGH STREET

CLIENT: HIGH STREET LLC

EXHIBIT 6B

EXHIBIT 7 - Georgia Stormwater Management Manual Table 2.1.5-1

Table 2.1.5-1 Runoff Curve Numbers[1]

Cover description: Cover type and hydrologic condition		Average percent impervious area[2]	Curve numbers for hydrologic soil groups: A	B	C	D
Cultivated land:	without conservation treatment		72	81	88	91
	with conservation treatment		62	71	78	81
Pasture or range land:	poor condition		68	79	86	89
	good condition		39	61	74	80
Meadow: good condition			30	58	71	78
Wood or forest land:	thin stand, poor cover		45	66	77	83
	good cover		25	55	70	77
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 drains (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 houses)		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 and Newly graded areas (pervious areas only, no vegetation)			77	86	91	94

[1] Average runoff condition, and $I_a = 0.2S$

[2] The average percent impervious area shown was used to develop the composite CNs. 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. If the impervious area is not connected, the SCS method has an adjustment to reduce the effect.

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

EXHIBIT 8 - City of Atlanta Rainfall Data

Table A-2
Atlanta

Hours	Minutes	Return Period 1	2	5	10	25	50	100
	n	0.75129	0.8542	0.7846	0.7768	0.7475	0.7519	0.7378
	a	35.11	66.20	62.28	69.74	72.79	83.83	87.36
	b	7	12	12	13	13	14	14
Hours	Minutes	Rainfall Intensity						
0.08	5	5.43	5.89	6.74	7.38	8.39	9.16	9.95
	6	5.11	5.61	6.45	7.08	8.06	8.81	9.58
	7	4.84	5.35	6.18	6.80	7.75	8.50	9.24
	8	4.59	5.12	5.94	6.55	7.48	8.20	8.93
	9	4.37	4.91	5.71	6.32	7.22	7.93	8.64
	10	4.18	4.72	5.51	6.10	6.99	7.68	8.38
	11	4.00	4.55	5.32	5.91	6.77	7.45	8.13
	12	3.84	4.38	5.15	5.72	6.56	7.24	7.90
	13	3.70	4.23	4.98	5.55	6.37	7.03	7.68
	14	3.57	4.09	4.83	5.39	6.20	6.84	7.48
0.25	15	3.44	3.96	4.69	5.24	6.03	6.67	7.28
	16	3.33	3.84	4.56	5.10	5.87	6.50	7.10
	17	3.23	3.73	4.44	4.97	5.73	6.34	6.93
	18	3.13	3.62	4.32	4.84	5.59	6.19	6.77
	19	3.04	3.52	4.21	4.72	5.46	6.05	6.62
	20	2.95	3.43	4.11	4.61	5.33	5.91	6.48
	21	2.87	3.34	4.01	4.51	5.22	5.79	6.34
	22	2.80	3.26	3.92	4.41	5.10	5.67	6.21
	23	2.73	3.18	3.83	4.31	5.00	5.55	6.09
	24	2.66	3.10	3.74	4.22	4.90	5.44	5.97
	25	2.60	3.03	3.66	4.13	4.80	5.33	5.85
	26	2.54	2.96	3.59	4.05	4.71	5.23	5.75
	27	2.48	2.90	3.52	3.97	4.62	5.14	5.64
	28	2.43	2.83	3.45	3.90	4.53	5.05	5.54
	29	2.38	2.77	3.38	3.82	4.45	4.96	5.45
0.50	30	2.33	2.72	3.32	3.75	4.38	4.87	5.36
	31	2.28	2.66	3.26	3.69	4.30	4.79	5.27
	32	2.24	2.61	3.20	3.62	4.23	4.71	5.18
	33	2.20	2.56	3.14	3.56	4.16	4.64	5.10
	34	2.16	2.52	3.09	3.50	4.09	4.56	5.02
	35	2.12	2.47	3.04	3.45	4.03	4.49	4.95
	36	2.08	2.43	2.99	3.39	3.97	4.43	4.87
	37	2.05	2.38	2.94	3.34	3.91	4.36	4.80
	38	2.01	2.34	2.89	3.29	3.85	4.30	4.73
	39	1.98	2.30	2.85	3.24	3.80	4.24	4.67
	40	1.95	2.27	2.81	3.19	3.74	4.18	4.60
	41	1.92	2.23	2.76	3.15	3.69	4.12	4.54
	42	1.89	2.19	2.72	3.10	3.64	4.06	4.48
	43	1.86	2.16	2.68	3.06	3.59	4.01	4.42
	44	1.83	2.13	2.65	3.02	3.54	3.96	4.37
0.75	45	1.80	2.09	2.61	2.98	3.50	3.91	4.31
	46	1.78	2.06	2.58	2.94	3.45	3.86	4.26
	47	1.75	2.03	2.54	2.90	3.41	3.81	4.21
	48	1.73	2.00	2.51	2.86	3.37	3.76	4.16
	49	1.71	1.98	2.48	2.83	3.33	3.72	4.11
	50	1.68	1.95	2.44	2.79	3.29	3.68	4.06
	51	1.66	1.92	2.41	2.76	3.25	3.63	4.02
	52	1.64	1.90	2.38	2.72	3.21	3.59	3.97
	53	1.62	1.87	2.35	2.69	3.18	3.55	3.93
	54	1.60	1.85	2.33	2.66	3.14	3.51	3.88
	55	1.58	1.82	2.30	2.63	3.11	3.47	3.84
	56	1.56	1.80	2.27	2.60	3.07	3.44	3.80
	57	1.54	1.78	2.25	2.57	3.04	3.40	3.76
	58	1.53	1.76	2.22	2.54	3.01	3.36	3.72
	59	1.51	1.74	2.20	2.52	2.98	3.33	3.69
1	60	1.49	1.72	2.17	2.49	2.95	3.30	3.65
2	120	0.96	1.14	1.40	1.58	1.84	2.02	2.21
3	180	0.68	0.81	1.01	1.14	1.32	1.46	1.61
6	360	0.39	0.48	0.60	0.69	0.80	0.90	0.97
12	720	0.23	0.28	0.36	0.41	0.47	0.53	0.58
24	1440	0.14	0.17	0.20	0.23	0.27	0.30	0.33

K:\ALP_PRJ\019473000_GID - High Street\ENG\Hyro\Report\Phase 1\CAD\Exhibit 9_WaterQuality Exhibit.dwg Layout1 Aug 19, 2019 5:37pm by: derek.ziltrauer

Kimley»Horn
11770 AMBER PARK DRIVE, SUITE 600 ALPHARETTA, GEORGIA 30009
PHONE: (770) 619-4280 www.kimley-horn.com

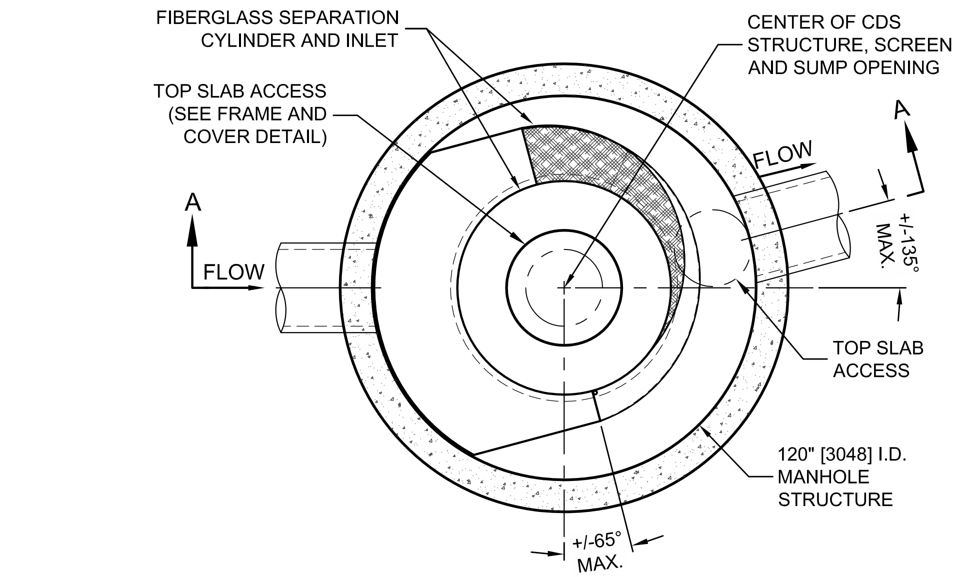
TITLE
WATER QUALITY SITE REVIEW TOOL MAP

PROJECT
HIGH STREET - PHASE 1

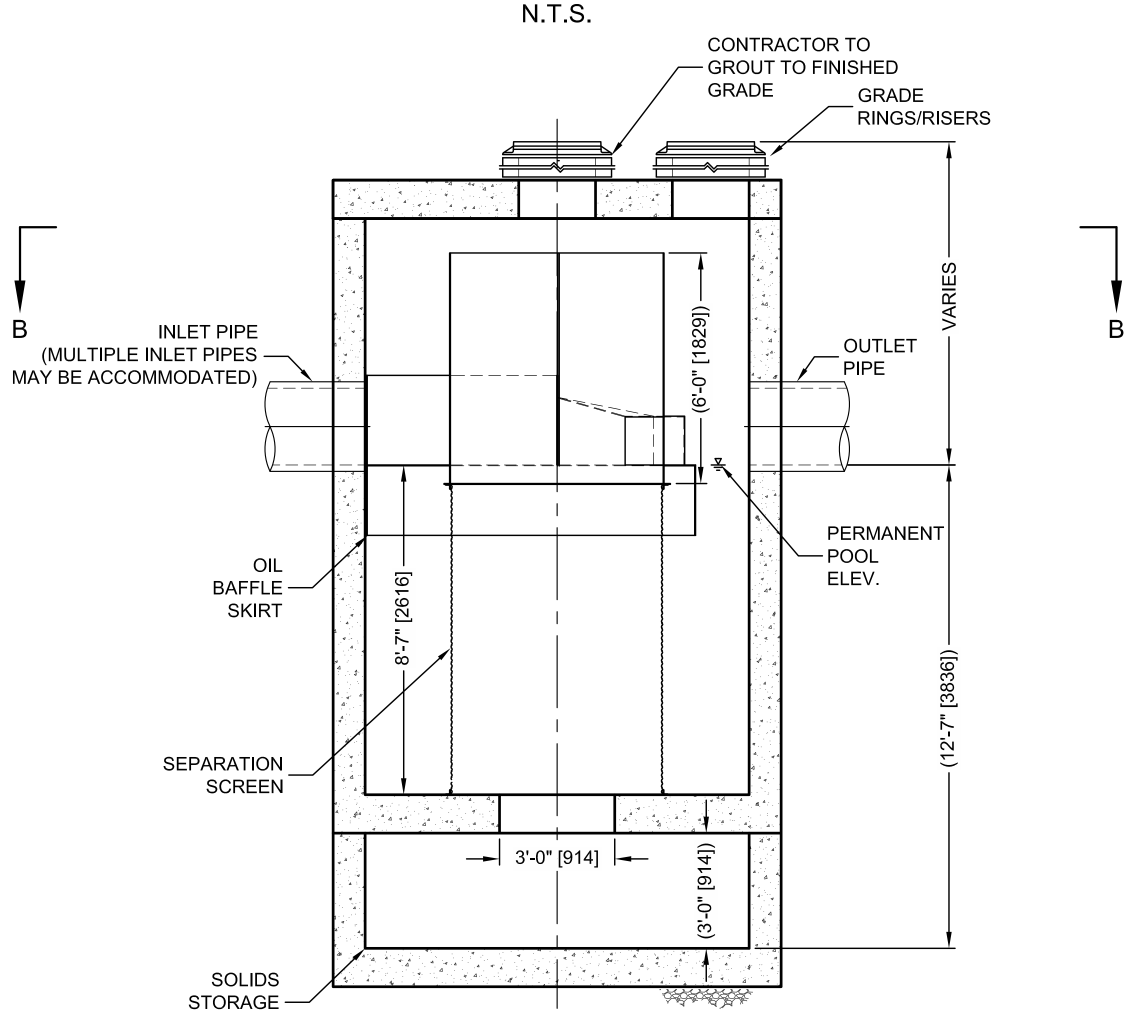
CLIENT
HIGH STREET DEVELOPMENT LLC

EXHIBIT 9

DATE: AUGUST 16, 2019



PLAN VIEW B-B
N.T.S.



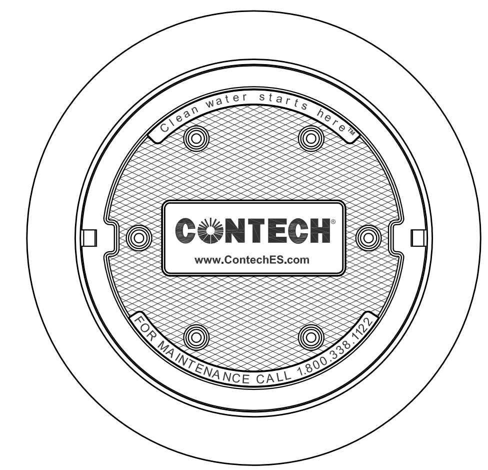
ELEVATION A-A
N.T.S.

CDS5678-10-C DESIGN NOTES

CDS5678-10-C RATED TREATMENT CAPACITY IS 25.0 CFS [708.0 L/s], OR PER LOCAL REGULATIONS. MAXIMUM HYDRAULIC INTERNAL BYPASS CAPACITY IS 50.0 CFS [1416 L/s]. IF THE SITE CONDITIONS EXCEED 50.0 CFS [1416 L/s], AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

THE STANDARD CDS5678-10-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES
SEPARATE OIL BAFFLE (SINGLE INLET PIPE REQUIRED FOR THIS CONFIGURATION)
SEDIMENT WEIR FOR NJDEP / NJCAT CONFORMING UNITS



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			A.5-WQMH
WATER QUALITY FLOW RATE (CFS OR L/s)			21.96
PEAK FLOW RATE (CFS OR L/s)			90.3
RETURN PERIOD OF PEAK FLOW (YRS)			100
SCREEN APERTURE (2400 OR 4700)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	956.50'	RCP	48"
INLET PIPE 2	*	*	*
OUTLET PIPE	956.40'	RCP	48"
RIM ELEVATION			*
ANTI-FLOTATION BALLAST		WIDTH	HEIGHT
		*	*

NOTES/SPECIAL REQUIREMENTS:

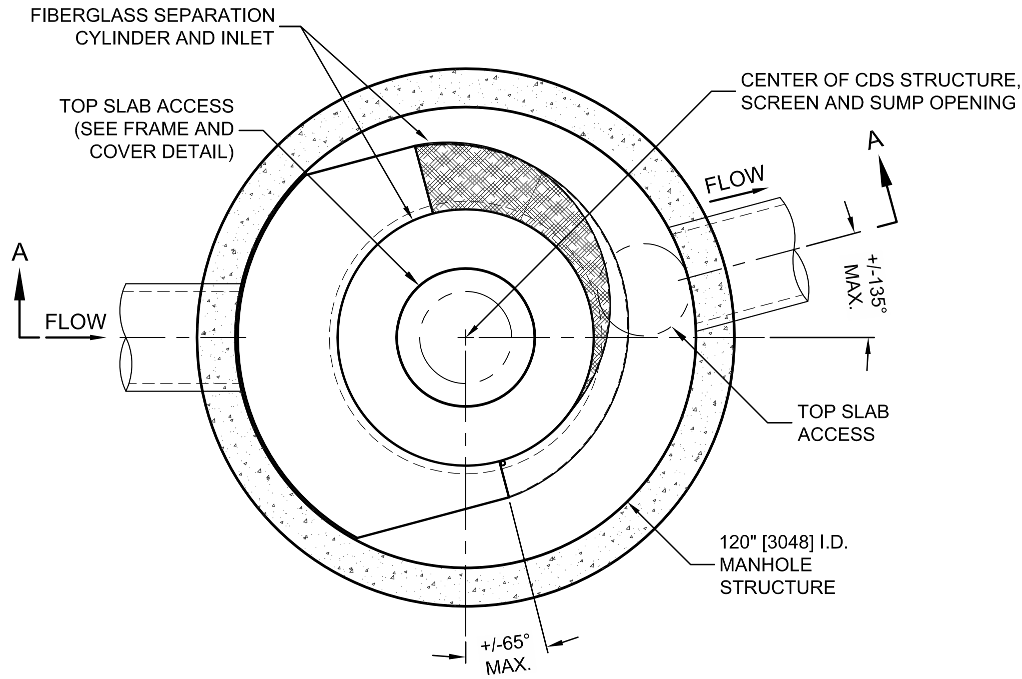
* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECHENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET HS20 (AASHTO M 306) LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

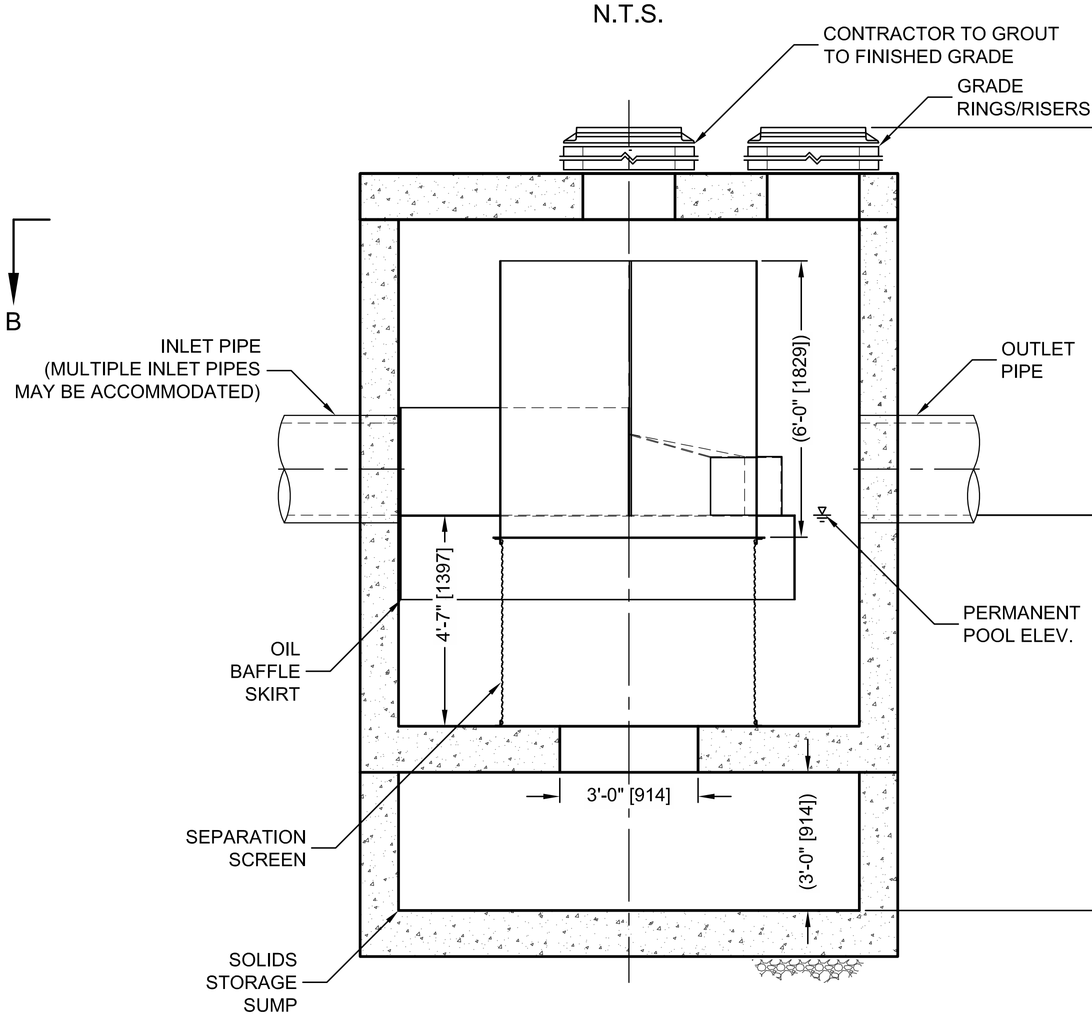
INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH
ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS5678-10-C
INLINE CDS
STANDARD DETAIL



PLAN VIEW B-B
N.T.S.



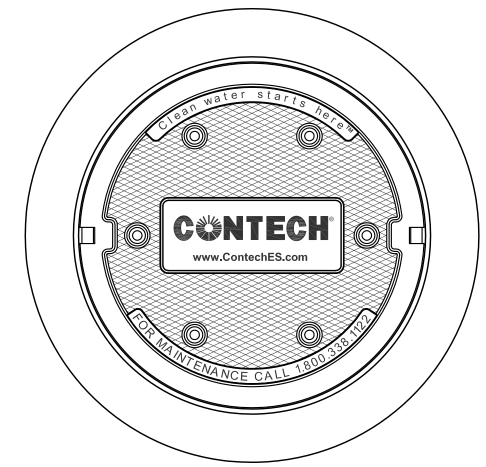
ELEVATION A-A
N.T.S.

CDS5640-10-C DESIGN NOTES

CDS5640-10-C RATED TREATMENT CAPACITY IS 9.0 CFS [254.9 L/s], OR PER LOCAL REGULATIONS. MAXIMUM HYDRAULIC INTERNAL BYPASS CAPACITY IS 50.0 CFS [1416 L/s]. IF THE SITE CONDITIONS EXCEED 50.0 CFS [1416 L/s], AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

THE STANDARD CDS5640-10-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES
SEPARATE OIL BAFFLE (SINGLE INLET PIPE REQUIRED FOR THIS CONFIGURATION)
SEDIMENT WEIR FOR NJDEP / NJCAT CONFORMING UNITS



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			B.2-WQMH
WATER QUALITY FLOW RATE (CFS OR L/s)			3.62
PEAK FLOW RATE (CFS OR L/s)			19.64
RETURN PERIOD OF PEAK FLOW (YRS)			100
SCREEN APERTURE (2400 OR 4700)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	965.56'	RCP	24"
INLET PIPE 2	*	*	*
OUTLET PIPE	965.46'	RCP	24"
RIM ELEVATION			*
ANTI-FLOTATION BALLAST		WIDTH	HEIGHT
		*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET HS20 (AASHTO M 306) LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
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CONTECH
ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS5640-10-C
INLINE CDS
STANDARD DETAIL

I:\STORMWATER\COMMOPS\22 CDS\40 STANDARD DRAWINGS\INLINE (CDS-C)\DWG\CDS5640-10-C-DTL.DWG 5/13/2014 6:07 PM

EXHIBIT 11 THEORETICAL VAULT SIZING

Kimley»Horn

Project Name: High Street - Phase 1

Project Number: 19473000

Basin: Post-Developed Basin 1

Designed By: DMZ

Date: 8/20/2019

Channel Protection Design Calculations

Drainage Basin Information

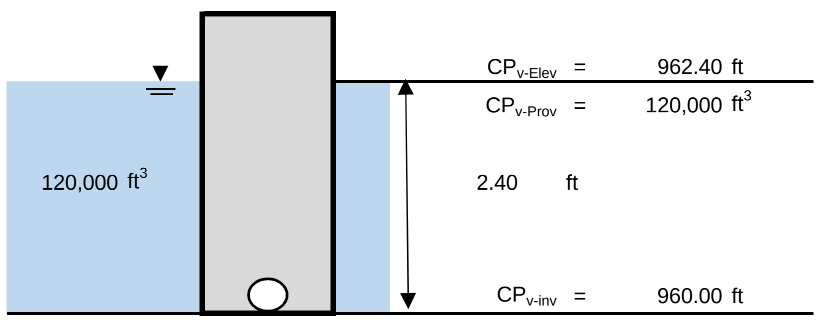
Drainage Area	=	24.12	acres
Curve Number (CN)	=	87	(From Basin Delineation)
1-yr 24-hr Rainfall (P_{24hr})	=	3.36	in (per NOAA PFDS or GSMM Appendix A)

Channel Protection Volume

S	Soil Retention	$S = 1000/CN - 10$	=	1.494	in
I_a	Initial Abstraction	$I_a = 0.2 * S$	=	0.299	in
I_a/P_{24hr}	Initial Abstraction to Rainfall Ratio		=	0.089	
Q_d	Total Runoff (TR-55)	$Q_d = (P_{24hr} - I_a)^2/((P_{24hr} - I_a) + S)$	=	2.057	in
q_u	Unit Peak Discharge (GSMM Table 2.1.5-6)		=	1,000	csm/in
q_o/q_i	Ratio of Peak Outflow to Peak Inflow	$q_o/q_i = 12.03\ x\ q_u^{-0.9406}$	=	0.018	
V_s/V_r	Ratio of Storage Volume to Runoff Volume	$V_s/V_r = 0.682 - 1.43(q_o/q_i) + 1.43(q_o/q_i)^2 - 0.804(q_o/q_i)^3$	=	0.657	
CP_v	Channel Protection Volume	$CP_v = V_s/V_r\ x\ A\ x\ Q_d$	=	118,271	ft^3

Channel Protection Stage Storage Elevations

Elevation ft, MSL	Inc. Vol ft3	Storage ft3
960.00	0	0
961.00	50,000	50,000
963.00	100,000	150,000
965.00	100,000	250,000
967.00	100,000	350,000
969.00	100,000	450,000
969.00	0	450,000



Channel Protection Orifice

$Q_{avg-CPv}$	Stage Storage Average Release Rate	$Q_{avg} = CP_v/(24hr\ x\ 3600\ sec/hr)$	=	1.389	ft^3/s
$h_{avg-CPv}$	CP_v Average Hydraulic Head	$h_{avg-CPv} = (CP_{v-Elev} - CP_{v-inv})/2$	=	1.20	ft
A	Area of Orifice	$A = \frac{Q_{avg-CPv}}{0.6\ x\ \sqrt{2\ x\ g\ x\ h_{avg-CPv}}}$	=	0.263	ft^2
φ Req	Required Orifice Diameter	$\phi_{Req} = \sqrt{4\ x\ A/\pi}$	=	6.95	in
φ Prov	Provided Orifice Diameter		=	6.88	in
h_{CPv}	Hydraulic Head at Orifice Centroid	$h_{CPv} = CP_{v-Elev} - CP_{v-inv} - \phi/2$	=	2.11	ft
Q_{CPv}	CP_v Peak Release Rate	$Q_{CPv} = 0.6\ x\ A\ x\ \sqrt{2\ x\ g\ x\ h_{CPv}}$	=	1.843	ft^3/s

APPENDIX B
WATER QUALITY DEVICE REPORT

FB environmental

Independent Review of CDS 2015 Product Evaluation

Report by
FB Environmental Associates, Inc.
97A Exchange St.
Portland ME 04101

Introduction

FB Environmental Associates, Inc. (FB Environmental), was hired by Contech Construction Products, Inc. (Contech), in 2009 to serve as an independent reviewer of the CDS 2015 test unit. The CDS 2015 is a stormwater treatment device with a design flow of 0.7 cubic feet per second. It is intended to remove pollutants, including suspended solids, from stormwater. Flow up to the treatment design capacity is guided by a diversion weir into a separation chamber for treatment. The primary methods used to remove pollutants are swirl concentration, a continuous deflective separation screen, and an oil baffle. Flows which exceed the treatment design capacity flow around the separation chamber. A diagram of a CDS unit is shown in Figure 1.

Tests were conducted under controlled conditions, and repeated three times at each flow level, with FB Environmental serving as a third-party, independent reviewer. Our role was to observe all test runs and sample collection, review data records and calculations, and state whether tests conformed to the written protocol provided by Contech.

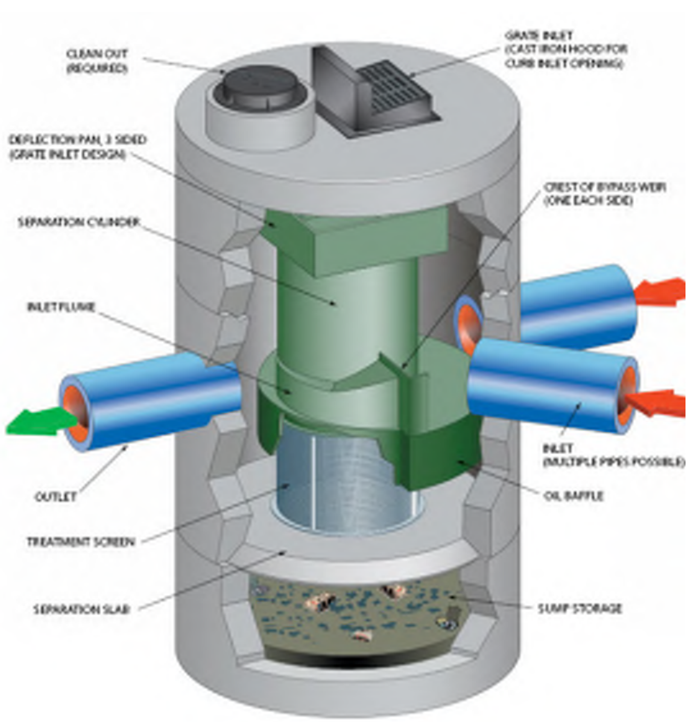


Figure 1: Design and construction of the CDS unit.

Procedure

Contaminant

A commercial sand product, OK-110, was used to provide a standardized contaminant for solids removal testing. This product was manufactured by the US Silica Company[1] and the materials used for testing originated from the Mill Creek, OK plant. OK-110 is a natural silica sand product (SG=2.65) consisting of unground sand that has been processed to produce a distribution of particles between 50-µm and 200-µm with a d50 of approximately 105-µm. A particle size distribution for OK-110 is shown in Figure 2, revealing a texture (USDA scale) consisting of 100% sand, 0% silt, and 0% clay-sized particles.

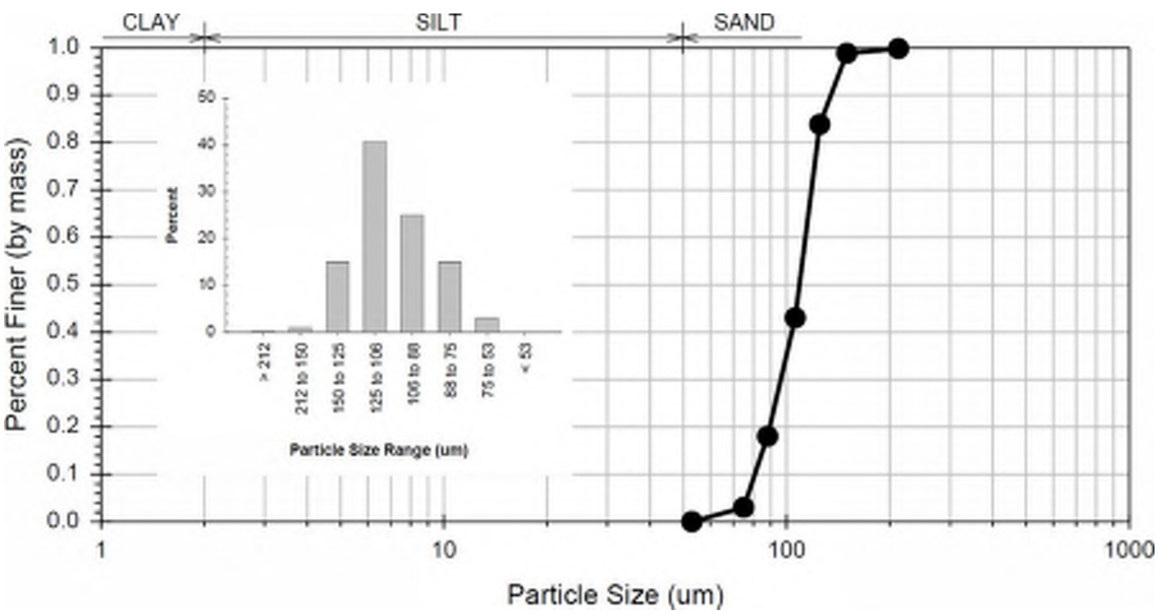


Figure 2: Particle size distribution of OK-110 based upon manufacturer's specifications (US Silica, ND).

Test Apparatus

Removal Efficiency Testing

The CDS consists of a swirl concentrator and deflective screen and is shown in Figure 1. During operation, water enters the CDS unit's diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed. All flows up to the system's design capacity enter the separation chamber, while higher flows are bypassed. Treated water moves through 2400-micron screen aperture openings, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

A CDS 2015 was used for testing. This unit consisted of a 5-ft diameter welded aluminum structure with a maximum depth of 4.17-ft between the floor of the sump and the invert of the

[1] U.S. Silica Company, P.O. Box 187, Berkeley Springs, WV 25411; (800) 243-7500; www.u-s-silica.com

inlet pipe. The diameter of the inlet and outlet pipes of the test system were 12-in and entered and exited the system as shown in Figure 3.

As shown in Figure 3, the CDS test unit was tested using a recirculation system. Water is pumped through the test unit and into the catch tank. Water is recirculated directly from the 6.0-ft x 12.0-ft x 3.0-ft (LxWxD) aluminum catch tank by a 10-hp submersible pump, directly back into the influent line, Figure 3. Flow was controlled by a calibrated butterfly valve placed on the influent line that was operated to produce a steady state flow condition. Flow was measured with an electromagnetic flow meter, Sea Metrics WMX-Series Industrial Magmeter. All piping consisted of schedule 40 PVC.

OK-110 was injected as concentrated slurry downward into the influent pipe via a slurry injection port located 5-ft upstream of the test unit, and kept from recirculating within the test apparatus by filtering the effluent as it passed through the catch tank. The slurry injection system is detailed in Figure 4. Slurry was produced in a 1200-L conical bottom, polyethylene (PE) tank (Chem-Tainer). The conical bottom design ensured the continuous circulation of materials within the slurry tank. Suspension of solids within the slurry tank was maintained by a 1-hp, electric mixer with dual 5-in propellers (INDCO Model CL1-T). The propeller design maximized the vertical circulation of solids within the tank and ensured the homogeneity of the mixture. Four evenly spaced, vertically oriented baffles, measuring 42-in x 3.0-in x 0.5-in (LxWxThickness), affixed to the sidewalls of the slurry tank prevented mixer-induced vortexing.

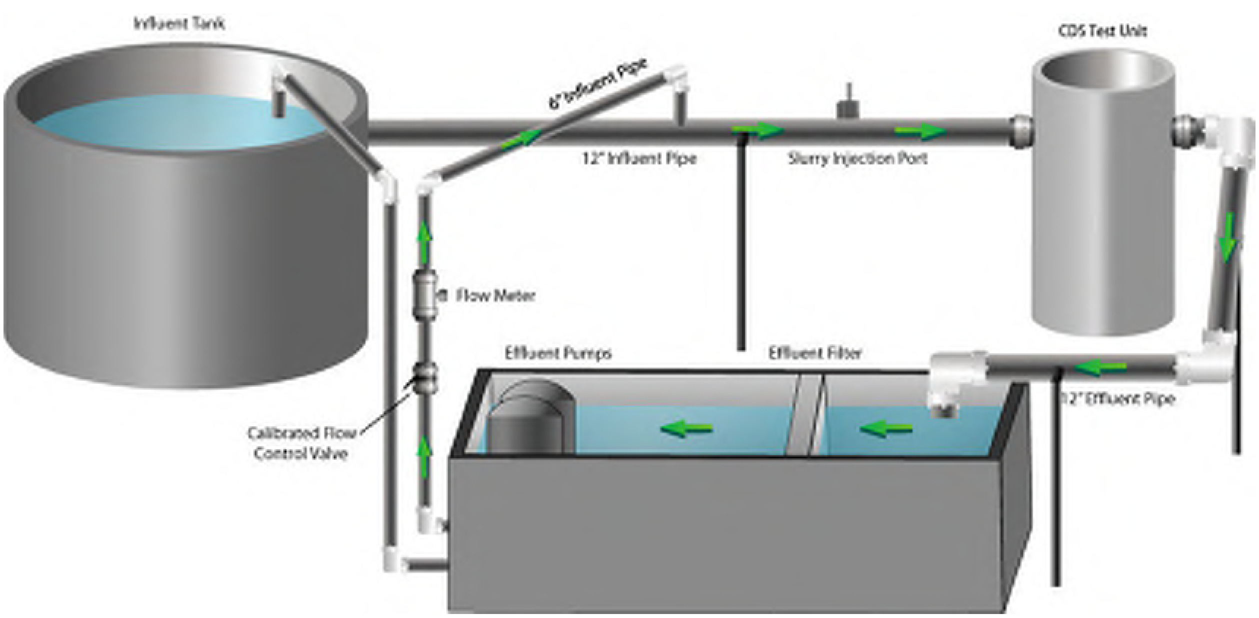


Figure 3: Diagram of the test facility, with flow pathways indicated by arrows. The CDS 2015 unit. (Figure courtesy of Contech Construction Products, Inc.)

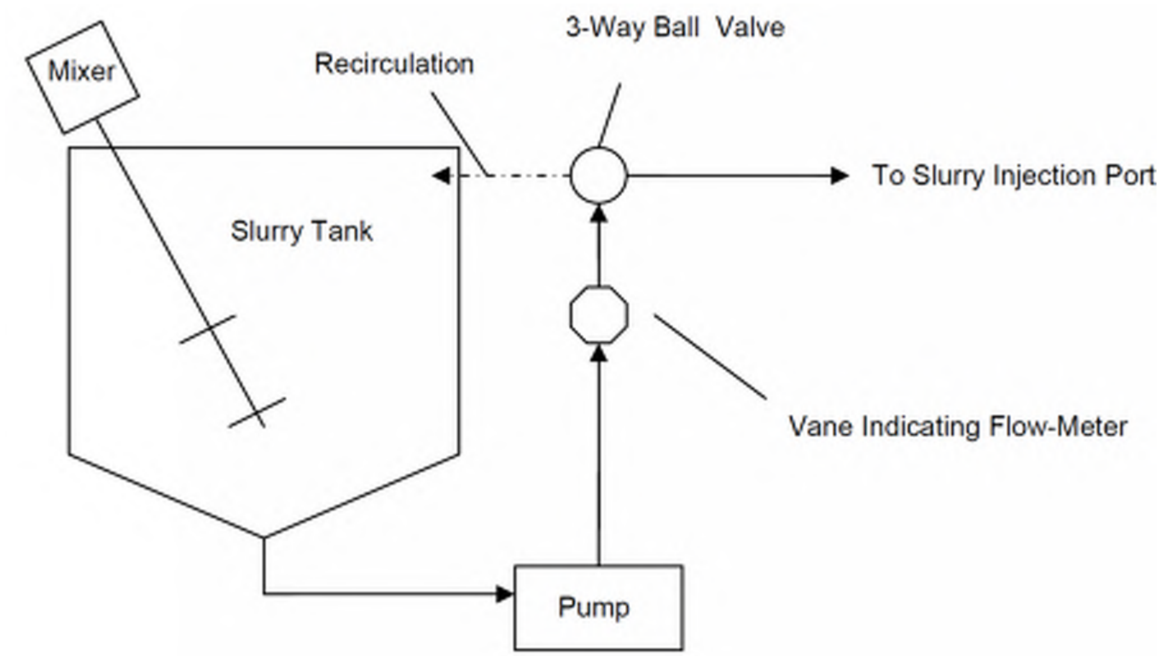


Figure 4: Schematic diagram of the slurry injection system. Arrows indicate flow pathway. (Figure courtesy of Contech Construction Products, Inc.)

A peristaltic pump (Randolph Austin) was used to inject slurry into the slurry injection port at a flow rate of 7 gpm to 15 gpm. The pump also served to circulate water through the underlying manifold of the slurry tank before injection so as to eliminate any possibility of sediment accumulation in the manifold. A one-inch, three-way ball valve was used to divert the slurry recirculating through the slurry tank manifold to the injection port via an injection manifold consisting of one-inch wire-reinforced PVC tubing and a vane-indicator flow meter (ERDCO See-Flow 3222-03T0). Influent samples were collected by reversing the ball valve to recirculate the slurry into a 500 ml sample bottle prior to injection, as seen in Figure 4.

Effluent was sampled directly by sweeping a 500-mL sample bottle through the free discharge from the effluent pipe. Effluent from the CDS outlet pipe freely discharged into the catch tank and was pumped back to the influent line after passing through the filter bags. The effluent filter consisted of a plate containing eighteen 7-in dia. x 34-in long, 50-µm nominal-rated, polypropylene felt filter bags. Background samples were collected by dipping a 500 ml bottle into the furthest bay of the catch tank downstream from the filters.

The operational procedure for removal efficiency testing consisted of performing multiple runoff simulations (sims). Prior to each sim, a new slurry solution was prepared by filling the drained and cleaned slurry tank with 1200-L of tap water, activating the pump and mixer, and adding the predetermined quantity of OK-110 material. Slurry was allowed to mix and recirculate in the slurry tank for several minutes before use. Each sim was begun by commencing influent and effluent return flows at a predetermined flow rate. After attaining a steady-state flow condition, slurry injection was started at a predetermined flow rate and the temperature of water in the test apparatus was measured. The system was then given 3 residence times to equilibrate before the first set of corresponding background, slurry, and effluent samples were taken at 1-min intervals until a total of six sets had been collected. Following the collection of the last set of performance assessment samples, slurry injection and flow to the test unit were stopped. The test unit was drained and emptied of captured sediment between simulations.

Discrete influent, effluent, and background sample sets were collected for solids analysis. For this document, a set is defined as a collection of background, influent, and effluent sample pairs corresponding to a specific sim. Sample handling was performed in accordance with standard handling techniques. All samples to be tested for solids were promptly refrigerated and analyzed following collection. Maine Environmental Laboratory[2] performed analysis according to ASTM method D3977—essentially a "whole sample" variation of EPA method 160.2.

Re-suspension Testing
A CDS 2015 was used for testing. This unit consisted of a 5-ft diameter welded aluminum structure with a maximum depth of 4.83-ft between the floor of the sump and the invert of the inlet pipe. The difference in depth between the removal efficiency testing and the re-suspension testing is due to the inclusion of an 8-in aluminum insert in the latter tests, to better simulate the concrete insert found in most field deployments. The diameter of the inlet and outlet pipes of the test system were 12-in, and entered and exited the system as shown in Figure 3.

Re-suspension testing was conducted with a false floor installed into the sump to efficiently represent the 50% and 100% sediment storage capacity conditions. The false floor was constructed of plywood and supported by cement blocks. It was then sealed with plastic sheeting and waterproof tape. The floor was installed 3-in below the target sediment depth and 3-in of OK-110 material was loaded onto the floor to bring the top of the sediment pile to the appropriate elevation for each trial.

For the CDS 2015, the 50% sediment storage capacity is defined as 12.6-in, with a distance of 45.44-in between the top of the sediment pile and the invert of the influent pipe. The 100% sediment storage capacity is defined as 16.1-in, with a distance of 41.9-in between the top of the sediment pile and the invert of the influent pipe.

During re-suspension testing no sediment was injected into the unit and only background and effluent samples were collected. During each trial, flow was introduced and allowed to stabilize before sampling in one minute increments. A total of 6 effluent samples and 1 background sample were collected at each flow rate. Re-suspension tests began at the lowest target flow rate.

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[2] Maine Environmental Laboratory, 1 Main St, Yarmouth, ME 04096

Once sampling was complete, the flow rate was increased and the sampling process was repeated. This continued until the maximum flow rate was achieved.

The operational procedure for re-suspension testing consisted of performing two runoff simulations (sims), one at sediment storage at 50% of capacity, the other at 100%. Each sim was begun by commencing effluent return flows at a predetermined flow rate. After attaining a steady-state flow condition using clean influent, flow rate and temperature of water in the test apparatus was measured. The system was then given 3 residence times to equilibrate before the first set of effluent and background samples were taken at 1-min intervals. After each set of six samples, the flow rate was increased and sampling was conducted again. The initial target flow rate was set at 0.1 cfs, and increasing through the following series: 0.28, 0.63, 0.88, 1.22, 1.47, 1.76, and 1.92 cfs. These flows correspond to the target flows of the removal efficiency testing. Actual measured flow rates are presented in Table 2. Following the collection of the last set of re-suspension samples, flow to the test unit was stopped. The test unit was drained, emptied, inspected, and refilled with OK-110 to the appropriate sediment storage capacity between simulations.

Since the invert of the effluent pipe was several feet above the water surface elevation of the catch tank, effluent was sampled directly from the discharge of the effluent pipe. All sampling was conducted in the presence of an observer from FB Environmental.

Results and Discussion

Removal Efficiency Testing

The testing plan was successfully carried out. All 21 test runs were completed, three at each of the seven stated treatment capacities, with results presented in Table 1. Measured flow rates were between 0.12 and 1.8 cfs, corresponding to between 17% and 257% of the CDS 2015 treatment capacity. Influent concentration averaged 313 mg/L, compared to a target concentration of 300 mg/L. Reported influent and effluent values are averages of grab samples taken once per minute for six minutes immediately after the calculated detention time at the appropriate flow rate.

Data integrity was very good. Six grab samples were taken of influent, effluent, and background TSS concentrations during each test run, for a total of 126 samples each, and a combined total of 378 grab samples. During the course of sampling, a total of five influent samples were considered outliers. No more than one grab sample per sample run was excluded, and a maximum of 2 out of 18 possible influent samples (over three test runs) were rejected for any given target treatment capacity. Dixon's Q-test was used to confirm outlier status. Removal of these outliers resulted in a more conservative statement of removal efficiency, since their TSS figures were higher than the corrected average influent concentration in every case. Three effluent samples and three background samples were lost during processing (e.g., accidental spill). There were a total of 11 missing and excluded samples out of a possible 387, for an overall data completeness of 97%.

Removal efficiencies were calculated by using the following equation:

RE = ((influent solids concentration) – (effluent solids concentration)) / (influent solids concentration).

Of the 123 background samples collected, 112 (91%) were below the limit of detection of 4 mg/L. Only 5 of the 21 test runs had any background samples with detectable TSS. The maximum concentration was 8 mg/L, and the highest average value for a test run was 6.5 mg/L. High background levels would indicate that the filter plate between the effluent and the intake for recycled clean water was leaking, and would lead to an underestimation of TSS removal efficiency. The data indicate this was not a significant problem during this product evaluation.

Figure 5 shows a strong a linear relationship between flow rate and removal efficiency. The relationship is both strong (R^2=0.975) and significant ($p<0.001$).

Table 1: Observed performance of removal of OK-110 material by the CDS Model 2015 under "maintained" conditions (sediment storage at 0% capacity).

Actual Treatment Capacity	Measured Flow Rate (cfs)	Influent Concentration TSS (mg/L)	Effluent Concentration TSS (mg/L)	Removal Efficiency
20%	0.14	292	0	100%
17%	0.12	303	0	100%
19%	0.13	262	0	100%
43%	0.30	305	11	97%
44%	0.31	309	10	97%
44%	0.31	309	12	96%
87%	0.61	299	53	82%
80%	0.56	333	51	85%
83%	0.58	327	59	82%
133%	0.93	303	128	58%
136%	0.95	295	115	61%
131%	0.92	294	120	59%
163%	1.14	341	162	52%
169%	1.18	298	153	49%
167%	1.17	320	152	53%
210%	1.47	323	194	40%
210%	1.47	323	194	40%
210%	1.47	324	202	38%
257%	1.80	325	227	30%
250%	1.75	326	231	29%
257%	1.80	355	226	36%

Table 2: Observed re-suspension performance of the CDS Model 2015 using influent with zero TSS, and sediment storage capacity at 50% and 100% of capacity. ND means below detection limit.

Sediment Storage at 50% Capacity			Sediment Storage at 100% Capacity		
Treatment Capacity	Average Influent Flow Q (cfs)	Effluent Concentration TSS (mg/L)	Treatment Capacity	Average Influent Flow Q (cfs)	Effluent Concentration TSS (mg/L)
14%	0.10	ND	17%	0.12	ND
40%	0.28	ND	40%	0.28	ND
90%	0.63	ND	84%	0.59	ND
126%	0.88	ND	126%	0.88	ND
174%	1.22	ND	170%	1.19	ND
210%	1.47	ND	209%	1.46	ND
251%	1.76	ND	250%	1.75	ND
274%	1.92	ND	273%	1.91	7

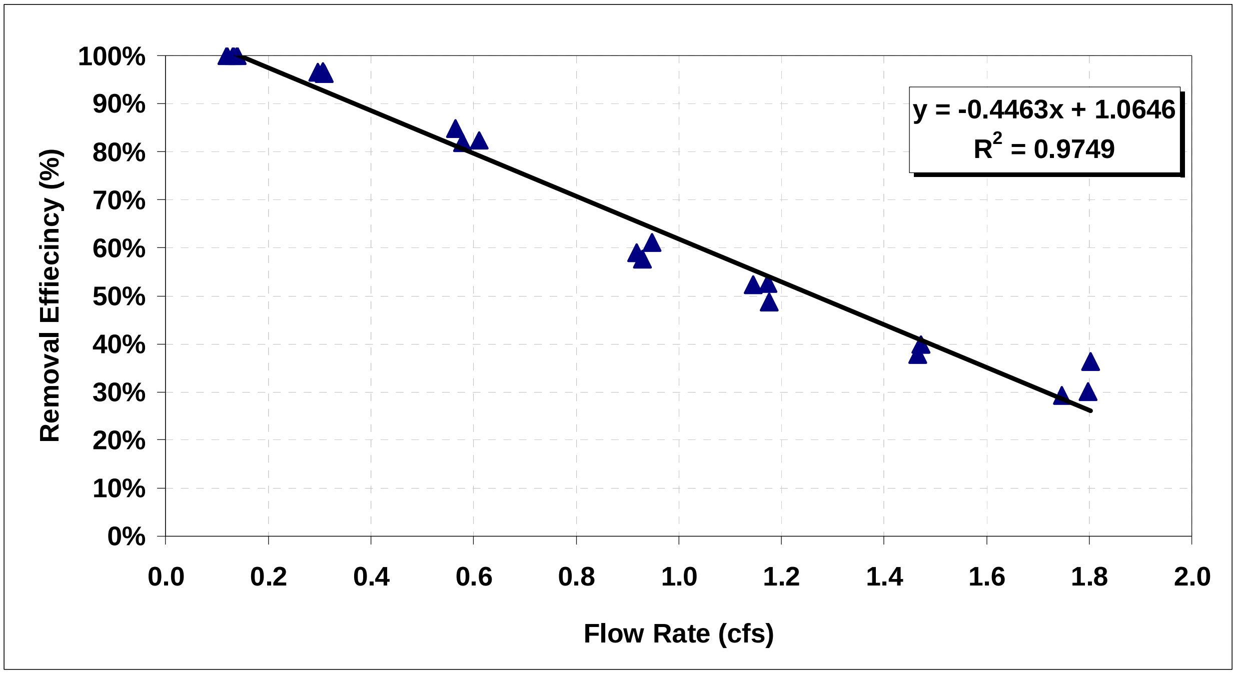

Figure 5: Observed TSS removal efficiency of the CDS 2015 under "maintained" conditions (sediment storage at 0% of capacity) using OK-110 silica.

Re-suspension Testing

The results of re-suspension testing at 50% and 100% of the sediment storage capacity are shown in Table 2. As seen in Table 2, at 50% sediment storage capacity, effluent concentration remained at or below the limit of analytical detection (4 mg/L) across the range of flows from 0.09 cfs to1.92 cfs. At 100% sediment storage capacity, effluent concentration was below the limit of detection for flow of 0.12 cfs to 1.75 cfs. Only at 1.91 cfs (corresponding to 273% of the design capacity) was there detectable TSS, averaging 7 mg/L.

Background sediment concentrations were below the limit of detection throughout both re-suspension trials and were not used to adjust effluent concentrations.

Conclusion

Removal Efficiency Testing

This test successfully measured CDS Model 2015 performance at influent flows from 17% to 257% of design flow, with influent TSS concentrations in the range of 300 mg/L. A strong and highly significant linear relationship between flow and removal efficiency was demonstrated. Removal efficiency ranged from 100% to approximately 30% across tested conditions, as shown in Figure 5.

Re-suspension Testing
The re-suspension test indicated that there is no observable re-suspension of TSS with the sediment storage capacity at 50% and 100% of capacity, except for a small amount (7 mg/L TSS) at very high flows (273% of design capacity) of the CDS 2015 when the sediment storage sump was 100% full.

A representative from FB Environmental, an independent, third-party reviewer, observed every sample run, as indicated in Table 3. Original data files from Maine Environmental Laboratory and subsequent spreadsheets and calculations were examined as well. FB Environmental reviewed sample plans, verified measurements, witnessed all sample collections, checked data against signed laboratory analysis reports, and performed the statistical analysis presented in this report. The data collected meet a high standard for completeness, and the results are deemed to accurately represent the total suspended solids removal efficiency and storage of the model CDS 2015 under the stated conditions.

Table 3: Testing schedule, lab analysis date, and reviewer.

Date Sampled	Date Lab Tests	Test[4]	Test Run	FB Environmental Reviewer
7/20/2009	8/5/2009	CDS 125	1	Fred Dillon
7/27/2009	7/31/2009	CDS 125	2	Fred Dillon
7/28/2009	8/3/2009	CDS 125	3	Fred Dillon
7/30/2009	8/6/2009	CDS 100	1	Fred Dillon
7/31/2009	8/6/2009	CDS 100	2	Fred Dillon
8/3/2009	8/12/2009	CDS 100	3	Fred Dillon
8/4/2009	8/12/2009	CDS 75	1	Fred Dillon
8/6/2009	8/13/2009	CDS 75	2	Fred Dillon
8/7/2009	8/13/2009	CDS 75	3	Fred Dillon
8/10/2009	8/26/2009	CDS 50	1	Cayce Dalton
8/11/2009	8/26/2009	CDS 50	2	Forrest Bell
8/13/2009	8/26/2009	CDS 50	3	Cayce Dalton
8/13/2009	8/31/2009	CDS 25	1	Cayce Dalton
8/14/2009	8/31/2009	CDS 25	2	Forrest Bell
8/17/2009	9/1/2009	CDS 25	3	Cayce Dalton
8/18/2009	9/1/2009	CDS 10	1	Forrest Bell
8/19/2009	9/3/2009	CDS 10	2	Cayce Dalton
8/20/2009	9/3/2009	CDS 10	3	Cayce Dalton
9/2/2009	9/15/2009	CDS 150	1	Cayce Dalton
9/3/2009	9/15/2009	CDS 150	2	Cayce Dalton
9/4/2009	9/17/2009	CDS 150	3	Forrest Bell
9/28/2009	10/9/2009	CDS 50 washout	1	Cayce Dalton
10/20/2009	10/26/2009	CDS 100 washout	1	Cayce Dalton

[4] Test refers to unit (CDS 2015) together with the identifier used during laboratory analyses. These identifiers are incremental, so that CDS 10 refers to test runs at 20% capacity, and CDS 125 refers to test runs at 250% capacity. Washout refers to re-suspension testing.

I have reviewed and approve this report, entitled "Independent Review of CDS 2015 Product Evaluation."

November 5, 2009

Forrest Bell | Date
Principal of FB Environmental
97A Exchange St., Portland ME 04101

Continuous Deflection Separation CDS™ System technology submittal

3740 Davinci Court, Suite 450, Norcross, GA 30092

This Submittal is based on, and includes portions of the
CONTECH STORMWATER SOLUTIONS
APPLICATION TO:
WASHINGTON STATE DEPARTMENT of ECOLOGY
WATER QUALITY PROGRAM
For GENERAL USE DESIGNATION –
Of The Continuous Deflective Separation (CDS™) Technology

April 2007 (Revised June 2007)
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1. Video animation file: "CDS Internal Velocities - FRAMER.EXE"., depicting flow velocities in the separation chamber. Spencer, S., Wells, S. and Berger, C. (2002) "Particle Removal using Continuous Deflection Separation", Portland State University

2. Video animation file: "Modified inline.avi"., animation of the operation of an "inline" CDS Unit

3. Video animation file: "New Planview.avi"., Planview of the flow through an "Offline" CDS Unit

4. Video animation file: "Hydraulic_W_Indeo.avi"., Three dimensional depiction of the flow path through an "Offline" CDS Unit.

5. Video animation file: "Full_Precast.avi"., Three dimensional depiction of construction installation sequence of "Offline" CDS unit components and the flow path through the unit

Appendix B – Project Profile

Appendix C – Particle Size Distribution Report (MACTEC Engineering and Consulting Inc.)

Appendix D – PMSU Test Summary & Analytical Results (TSS) Example

Appendix E – Oil and Grease Removal Studies

Slominski, S, Wells, S. (2003) Oil and Grease Removal using Continuos Deflection Separation with an Oil Baffle, Portland State University (PSU)

Stenstrom, M., Lau, S.L., (1998) Oil and Grease Removal by Floating Sorbent in a CDS Device, University of California, Los Angeles (UCLA)

Appendix F – Example, Site Specific Operation & Maintenance Manual

Appendix G – Field Studies of CDS Unit Performance

Strynchuck, J., Royal, J. and England, G., The Use of a CDS Unit for Sediment Control in Brevard County, Brevard County Surface Water Improvement

Walker T.A., Allison R.A., Wong T.H.F. and Wootton R.M. (1999), *Removal of Suspended Solids and Associated Pollutants by a CDS Gross Pollutant Trap*, Technical Report 99/2, Cooperative Research Centre for Catchment Hydrology

Executive Summary

0.1 Applicability of Evaluations

CONTECH Stormwater Solutions is requesting within this application to evaluate the CDS performance based on previously completed laboratory and field tests.

Laboratory tests were conducted in conformance with Washington State Department of Ecology's (WASDOE's) testing and evaluation protocols. A broad range of particles sizes made up the gradation of sediment used in the solids removal performance evaluations. The results of these evaluations conclusively show that CDS units are capable of removing 80% of the coarse total suspended solids (TSS, d_{50}=125-μm). A simplistic mass weighted analytical method was employed to verify this performance capacity.

0.2 Current Submittal Objective

This submittal package is prepared to support the detailed performance review and approval of CDS stormwater treatment unit. This submittal includes detailed discussions of the completed evaluation tests and quantified pollutant removal performance evaluations of CDS stormwater treatment units as well as cost, maintenance, construction and installations.

CONTECH Stormwater Solutions is requesting the approval of the CDS units listed in the following table based on the demonstrated performance capacity.

Table 1 CDS Model and Design Treatment Flow Rate Capacities

Precast	CDS Model Numbers	Design Treatment Flow Capacity (cfs)
Inline	PMIU20_15_4	0.7
	PMIU20_15	0.7
	PMSU20_15_4	0.7
	PMSU20_15	0.7
	PMSU20_20	1.1
	PMSU20_25	1.6
	PMSU30_20	2.0
	PMSU30_30	3.0
	PMSU40_30	4.5
	PMSU40_40	6.0
Offline	PSWC20_15	0.7
	PSWC20_20	1.1
	PSWC20_25	1.6
	PSWC30_20	2.0
	PSWC30_30	3.0
	PSWC40_30	4.5
	PSWC40_40	6.0
	PSWC56_40	9.0
	PSWC56_53	14.0
	PSWC56_68	19.0
	PSWC56_78	25.0
Offline	PSW30_30	3.0
	PSW50_42	9.0
	PSW50_50	11.0
	PSW70_70	26.0
	PSW100_60	30.0
	PSW100_80	46.0
	PSW100_100	64.0

PMIU – Precast Manhole Inlet Unit
PMSU – Precast Manhole Storm water Unit
PSW – Precast Storm Water unit
PSWC – Precast Storm Water Concentric unit
CDS units can be left-handed or right-handed configuration.

Table 1a CDS Unit Capacities and Physical Features

Model* Designation			Treatment Capacity Range		Screen Diameter & Height		Sump Capacity (yd^3)	Depth Below Pipe Invert (ft)	Foot Print Diameter (ft)
			cfs	MGD	(ft)	(ft)			
Precast**	Inline	PMIU20_15 (Drop-in Inlet)	0.7	0.5	2.0	1.5	0.9	5.0	4.8
		PMSU20_15_4	0.7	0.5	2.0	1.5	0.9	5.0	4.8
		PMSU20_15	0.7	0.5	2.0	1.5	1.5	5.0	6.0
		PMSU20_20	1.1	0.7	2.0	2.0	1.5	5.6	6.0
		PMSU20_25	1.6	1	2.0	2.5	1.5	5.9	6.0
		PMSU30_20	2	1.3	3.0	2.0	2	6.0	7.3
		PMSU30_30	3	1.9	3.0	3.0	2.1	6.9	7.3
		PMSU40_30	4.5	3	4.0	3.0	5.6	8.6	9.5
		PMSU40_40	6	3.9	4.0	4.0	5.6	9.6	9.5
	Offline	PSWC30_20	2	1.3	3.0	2.0	3.1	7.0	7.2
		PSW30_30	3	1.9	3.0	3.0	1.5	6.9	5.4
		PSWC30_30	3	1.9	3.0	3.0	2.3	7.2	7.3
		PSWC40_30	4.5	3	4.0	3.0	5.6	8.5	8.3
		PSWC40_40	6	3.9	4.0	4.0	5.6	9.6	8.3
		PSW50_42	9	5.8	5.0	4.2	1.9	9.6	8.0
		PSWC56_40	9	5.8	5.6	4.0	5.6	9.6	9.5
		PSW50_50	11	7.1	5.0	5.0	1.6	10.3	8.0
		PSWC56_53	14	9	5.6	5.3	5.6	10.3	9.5
		PSWC56_68	19	12	5.6	6.8	5.6	12.6	9.5
		PSWC56_78	25	16	5.6	7.8	5.6	13.6	9.5
		PSW70_70	26	17	7.0	7.0	3.6	14.0	10.5
		PSW100_60	30	19	10.0	6.0	5.7 or 11.6	12.0	
		PSW100_80	50	32	10.0	8.0	5.7 or 11.6	14.0	17.5
		PSW100_100	64	41	10.0	10.0	5.7 or 11.6	16.0	

*CDS Model Prefixes
PMIU = Precast Manhole Insert Unit
PMSU = Precast Manhole Stormwater Unit
PSWC = Precast Stormwater Concentric
PSW = Precast Stormwater Concentric
*CDS Model Suffixes
Precast (P), and Stormwater (SW)

**CDS Technologies can customize units to meet specific design flows and sump capacities.

***Sump Capacities and Depth Below Pipe Invert can vary due to specific site design

0.3 Project Specific SQTS Design, Review & Approval Process Request

This submittal serves as a formal request to approve specially designed Stormwater Quality Treatment System (SQTS) that adhere to the 80 percent (%) minimum removal requirement of the mean particle size d_{50}=125-µm material. CONTECT does not anticipate frequent review requests for specially designed units, but there may be the need to generate special designs of cast-in-place units or large diameter manhole units in 10, 12-feet (ft) or larger diameter precast manhole units or CDS units configured in square vertical shafts to meet both the project needs as well as the pollutant removal requirements of municipal or private developments.

With your willingness to review specially designed CDS units not listed on Table 1, units that would be designed for unique project applications could be considered for future approval. Significant capital savings that are typically derived from large economy of scale designs, such as cast-in-place CDS units could then be realized. CDS can provide specially designed units able to meet the TSS removal goal and treat flows well in excess of 100-cfs (2,850-L/s). Additionally, physical site constraints that may originate from utility conflicts may possibly be easily addressed with a CDS unit configured in large diameter manholes or vertically installed box culvert sections.

The ability of the Continuous Deflective Separation (CDS) Technology to meet specific project needs should not be constrained by only those units listed in Table 1. The application of the CDS water treatment unit process is entirely scalable and can be deployed in a variety of configurations to meet specified solids removal requirements.

1.0 Purpose of Application

The purpose of this application is to seek approval for the use of Continuous Deflective Separation (CDS) treatment system provided by **CONTECH Stormwater Solutions**.

This report contains laboratory studies demonstrating that the CDS technology achieves the following numerical treatment performance goals for TSS removal and oil treatment:

- 80% removal of coarser (125-µm mean size) total suspended solids for influent concentration > 100-mg/L but less than 200-mg/L.

- Control of oil: no ongoing or recurring visible sheen, and a maximum daily average total petroleum hydrocarbon concentration ≤ 10-mg/L, and a maximum of 15-mg/L for discrete samples.

This report is structured with supporting performance evaluation test information provided in Section 6 of this report, which explicitly demonstrates the ability to achieve the numerical treatment performance goals listed above.

This report also contains the following discussion sections: Company information, unit process descriptions and its functionality, unit applications, sizing, design, construction, cost, operational & maintenance and safety issues.

2.0 The CDS Treatment System

2.1 Company Profile

CDS Technologies, Inc. (CONTECH Stormwater Solutions now) designs, manufactures, installs and maintains Continuous Deflective Separation water pollution control devices. These devices are designed for separating solids from liquids using a non-blocking, indirect screening technology. Used in storm water systems, they aim to prevent pollutants carried in storm water runoff from reaching receiving waters. The CDS technology is also being applied in the treatment of combined sewer overflows and industrial waste.

The CDS technology was initially developed in Australia in 1992 to address gross pollutants in storm water runoff and has since proven capable of swirl concentration fine solids. The technology operates under both national and international patents and continues to be refined and improved as a result of new research to enhance fine solids and oil and grease removal.

The CDS technology was introduced in the United States with a July 1997 installation in Brevard County Florida. The technology has been widely accepted with over 6,200 installations in the United States and Canada and over 7,000 CDS units worldwide. There are over 1,380 installations in Washington and Oregon.

CDS Technologies, Inc. is an established public company recently purchased in December 2006 by CONTECH Stormwater Solutions here in the United States. In addition to the 18

CDS offices throughout the United States with the US headquarters located in Morgan Hill, CA, CONTECH Stormwater Solutions has more than doubled the offices and staff of CDS. The CDS staff includes professional engineers and engineers in training with expertise in civil, hydraulic, mechanical, chemical and water quality engineering and technical sales personnel.

2.2 CDS Technology Assessment

Continuous Deflective Separation (CDS) is an innovative technology and has been the subject of independent research: University of California Los Angles (UCLA); Portland State University (PSU); Monash University, Australia and the Co-operative Research Centre for Catchment Hydrology (CRCCH), Australia. The PSU and UCLA work provides the primary basis for oil and grease removal performance claims.

This submission draws on the experience gained from thousands of practical, functioning field applications of the CDS technology and independent field evaluations to describe the pollutant removal and retention features of the CDS device. More than 20 different independent laboratory and field evaluations of the technology have been undertaken in Australia and the United States. A number of these studies were undertaken to assess the physical and chemical characteristics of the pollutants captured in the CDS sump. Additional field evaluations are underway by the Multi-State TARP (The Technology Acceptance Reciprocity Partnership) program and in various locations across the States.

High trapping efficiencies for suspended solids and gross solids (litter and debris) are reported from laboratory tests (eg. Woodward-Clyde 1998., Wells, et al 1999 and 2002 Wong et al., 1996) and field performance monitoring results of the CDS unit by Allison et al., (1998), Walker et al., (1999) and Caltrans (2001 and 2002). Control of oil is reported from laboratory studies by Stenstrom (1998) at UCLA and Slominski and Wells (2003) at PSU.

Field monitoring studies of the CDS Technology at Coburg Australia, and Brevard County, Florida are also presented to demonstrate the effectiveness in watershed applications.

2.3 CDS Separation Technology

The CDS Technology employs multiple primary clarification treatment processes to remove pollutants from storm runoff flows in a very small footprint: Deflective Screening / Filtration, Swirl Concentration, Diffusion Sedimentation and Baffling.

Treatment flows are introduced into the deflective separation chamber as a tangential flow introduced smoothly along the circumference of the stainless steel screen cylinder by the CDS unit's inlet structure located above the cylindrical screen. A balanced set of hydraulics is produced in the separation chamber. These balanced hydraulics provide washing flows across the stainless steel screen surface that prevent any clogging of the apertures in the expanded metal screen as well as establish the hydraulic regiment necessary to separate solids through continuous deflective separation and swirl concentration separation. Though this flow regime is initially similar in appearance to a vortex, it should be understood that the

CDS separation process is not employing the vortex separation process as they exist in a classic, smooth walled cylinder vortex unit with a centrally located underdrain. The CDS Separation process is more than a gravity based separation process.

The following figure illustrates that screened water from the CDS unit's separation chamber exits radially.

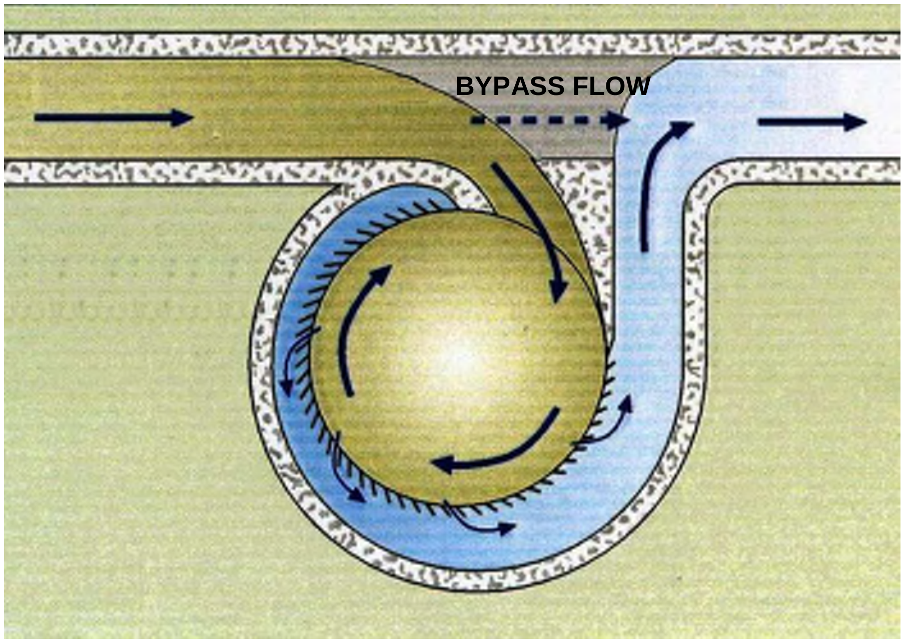


Figure 1 Typical "Offline" CDS Model PSW, PSWC or CSW system shown diverting flows from main storm water channel into its separation chamber.

The continuous deflective separation process produces a low energy, quiescent zone in the middle of the swirling chamber, which is opposite of a vortex separation process. In a simple gravity based vortex system, rotational velocities increase closer to the center of the unit. The quiescent zone in a CDS unit enables effective settlement of fine particles through a much wider range of flow rates than could otherwise be achieved using a simple settling tank in the same footprint. Particles within the diverted treatment flow are retained by the deflective screening chamber and are maintained in a circular motion that diminishes as in the center of the unit, which is best defined as enhanced swirl concentration and screening. Particles heavier than water (specific gravity>1) ultimately settle into the sump located below the separation chamber.

The pollutants captured in the sump located below the screening, swirl concentration separation chamber are isolated from high velocity bypass flows through the unit preventing the scouring loss of trapped pollutants. Scouring losses typically occur in those structural BMP's that are designed with the deposition zone of settled material integral to the treatment flow path. All CDS units have sumps to accommodate the storage of deposition material below the separation chamber to prevent scouring. This CDS sump is cut off from the separation chamber by a hydraulic shear plain at the bottom of the separation chamber, which minimizes the influence of scouring velocities.

A turbulent boundary layer at the screen face impedes small particles from crossing the screen. The detailed configuration and orientation of the expanded screen causes particles to be deflected towards the center of the screen chamber where the quiescent zone (stagnant core) exists. This impedance produced by the turbulent boundary layer and the deflective force assists in overcoming centripetal forces that are exerted on entrained particles enveloped in the screening separation chamber.

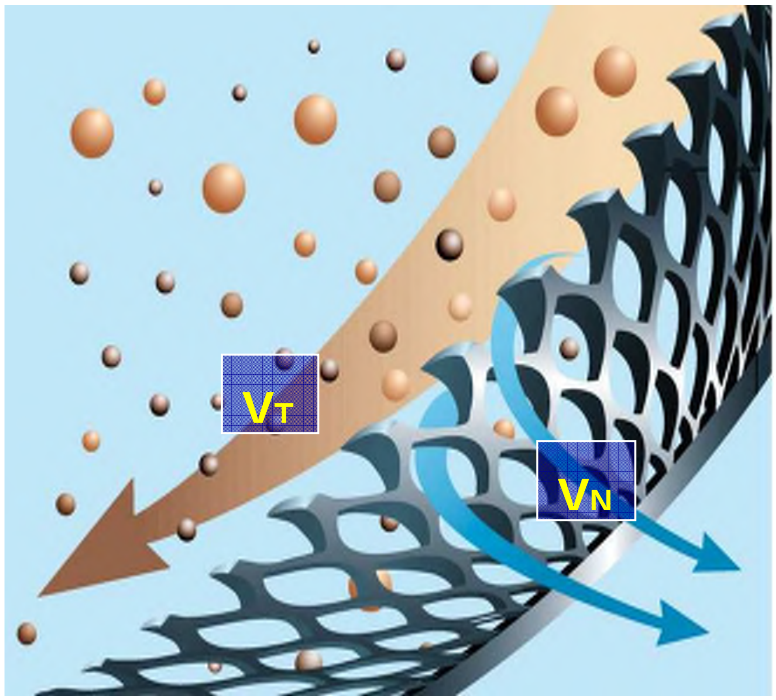


Figure 2 Illustration of Fluid Velocity Flows in CDS Unit Screening Mechanism
(V_T – Tangential velocity, V_N – Normal Velocity, perpendicular to the screen)

This turbulent boundary layer and deflective force make the CDS system materially superior to classic smooth walled swirl concentrators. The CDS separation process employs two additional separation forces that are not available in the simple, gravity based smooth walled swirl concentrators, which predominately rely on toroidal forces to separate solids from liquids in swirl chamber. These toroidal forces are also present in equal or greater magnitude within a CDS unit.

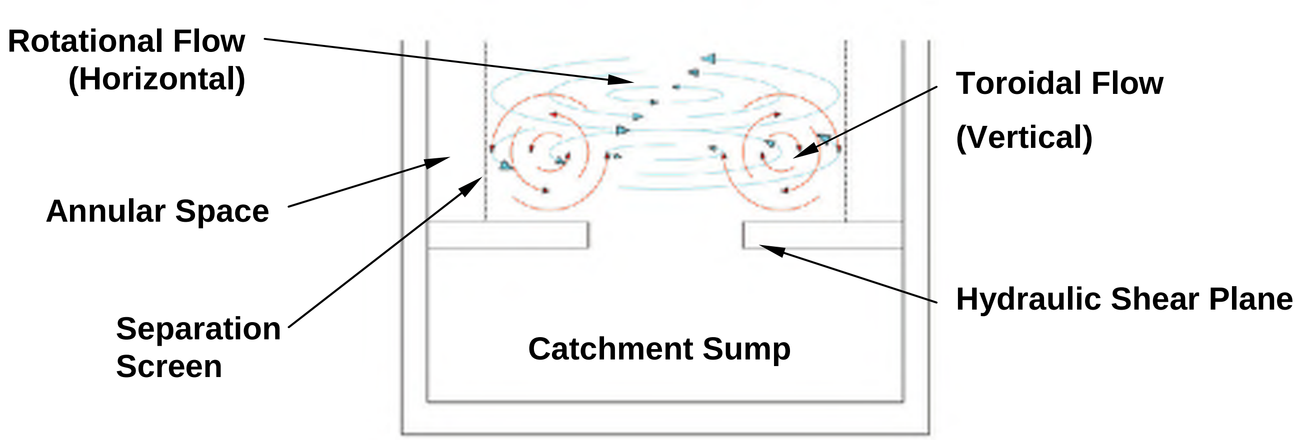


Figure 3 Toroidal Pattern in a CDS Unit

As shown in Figure 3, the toroidal flow motion within the separation chamber of a CDS unit is shown as the red circular flow lines. These toroidal flow forces are perpendicular to the horizontal rotation flow at the screen face and assist in moving particles to the center of the CDS treatment chamber until they settle into the sump.

Treated water flows through the entire screen cylinder surface area to exit this separation chamber. This is a very large flow path area, which results in very low exit velocities (under-flowrate) from the CDS separation chamber.

This low underflow rate greatly enhances the separation capacity of the CDS solids separation process beyond that of a basic smooth cylinder walled vortexing unit. Besides the quiescence zone in the middle of the swirl separation chamber, low flow velocities also occur in the annular and volute spaces behind the screen. The flow passing through the stainless steel separation screen is greatly dispersed / diffused. The flow velocity is very low immediately after crossing the screen face into the annular space behind the screen. It has extremely low velocities in relationship to the entrance, separation chamber and exit velocities. Straight, simple sedimentation settling occurs in this annular space behind the screen before the flow passes beneath the oil baffle and exits the unit. In summary, CDS technology brings together this multitude of primary clarification treatment processes (patented continuous deflective separation, swirl concentration, toroidal separation, separated sump zone, indirect screening, sedimentation and baffling) in one treatment device, which provides the most effective and efficient stormwater treatment.

CDS Separation Screen – Blockage-Free, Self-Cleaning

As mentioned above, the patented continuous deflective separation system is a unique treatment process associated only with the CDS unit and no other structural BMP. This patented process consists of a perforated stainless steel expanded metal screen that is either concentrically or eccentrically located in the separation chamber portion of the unit. This screen cylinder filters stormwater while also enhancing the swirl concentration efficiency of the unit. The perforations in the separation screen are typically elongated in shape and are aligned with the longer axis in the vertical direction. The typical perforation size for use in urban storm water systems is 2400 and 4700-µm.

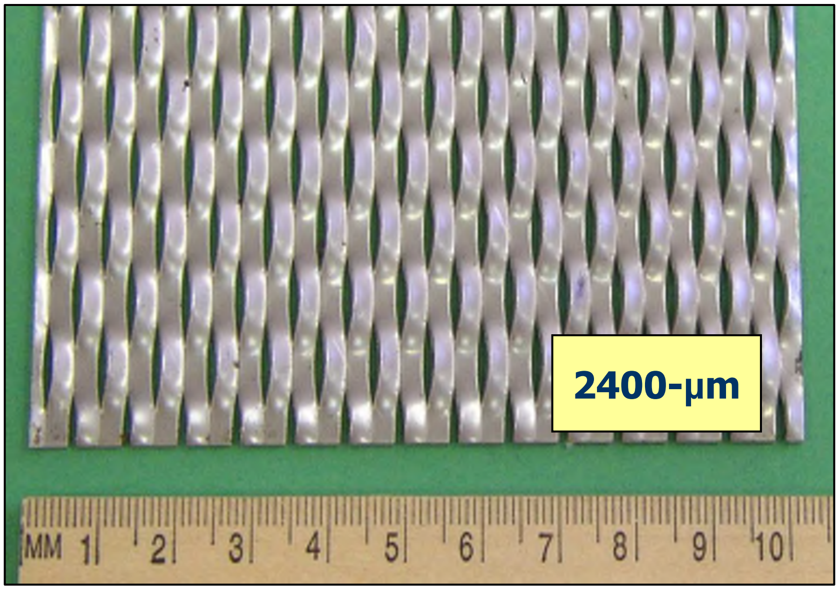


Figure 4 Photo of 2400-µm Screen Section, ASTM 316L Stainless Steel

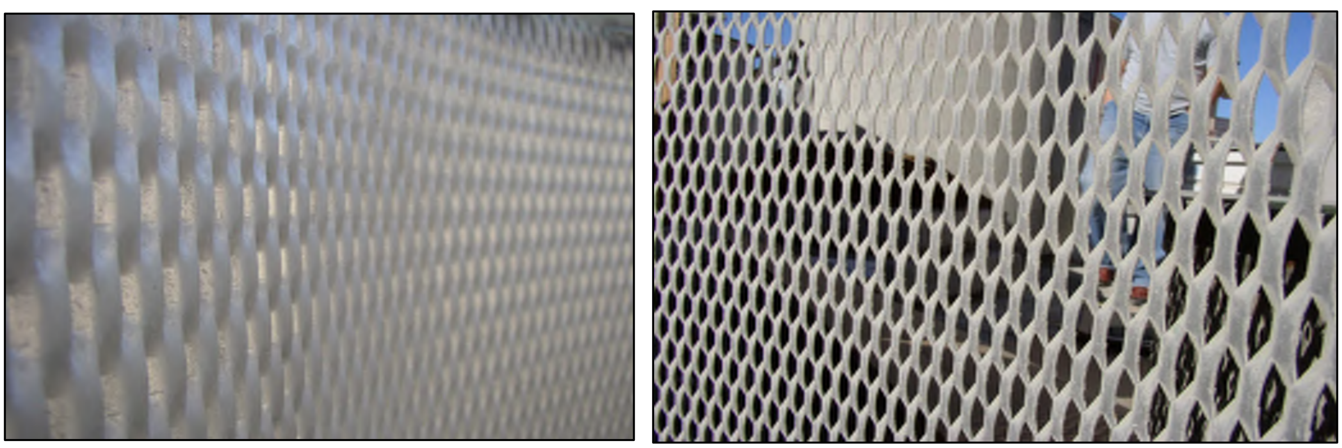


Figure 5 Screen Cylinder (In Field)

Review of the screen cylinder photo shown on the left side of the Figure 5 shows how the flow is introduced on the backside, the blind side of the expanded metal screen cylinder to produce the patented continuous deflect flow pattern. The photo on the right shows the screen openings from a view point opposite the direction of flow in the screen cylinder.

The tangential inflows, cause a rotational motion within the separation chamber that is balanced to exceed the radial flow rate through the screen. The continuous motion in the separation chamber ensures that the tangential force on pollutants that keeps them in rotation is greater than the radial force produced by the flow through the screen. This ensures that the screen is free of blocking by gross solids and can allow flow to reach the outlet. This balanced flow condition will also be discussed in terms of shear stresses caused by shear velocity on the screen as the mechanism for removing material from the screen surface.

Measurements of surface velocities in the swirling chamber (Wong & Wootton, 1995) indicate that the circumferential velocities increase with the radial distance from the center of the chamber (Figure 6). The main flow mode in the chamber behaves like a rotating hollow cylinder. A particle on the outer diameter of this rotating hollow cylinder, which would be right at the inside face of the screen cylinder would experience centrifugal force. Any object in the flow near the screen surface, with a density greater than that of water, will be forced outwards and be pressed against screen. In addition the drag forces associated with the flow component through the perforated screen cylinder will influence objects near the screen; however, these are considered to be negligible in magnitude compared to the centrifugal forces. This centrifugal force is effectively superseded by the combination of the balanced hydraulics producing a rotational force, boundary layer effect, deflect force and toroidal flows.

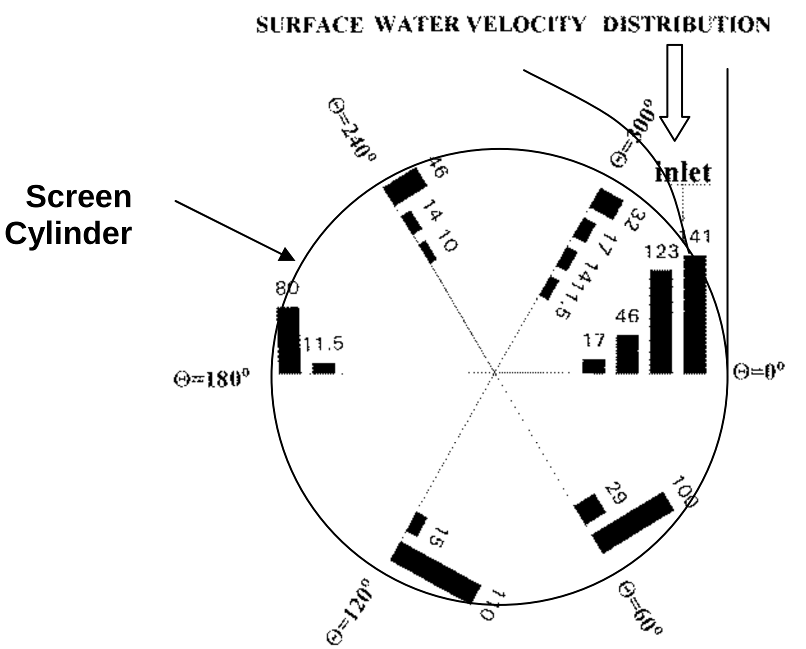


Figure 6 Surface velocity distributions within the separation chamber of a CDS unit, (Wong & Wootton, 1995)

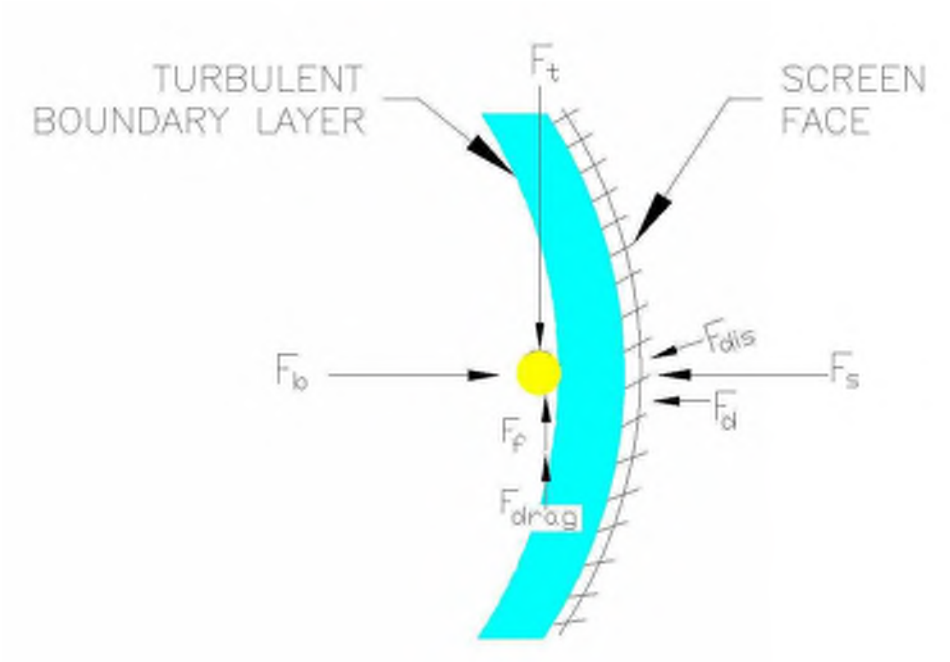


Figure 7 Schematic Drawing - Forces on An Object Near the CDS Screen

Figure 7 illustrates the forces that act on a particle as it travels across the surface of the screen. Illustrating these forces assist in better understanding the non-blocking aspect of the CDS separation system. The particle is influenced by the circular motion of the water inside the chamber forcing the particle outwards, but is prevented from moving to the outside of the chamber by the perforated screen, which appears as a solid wall to particle. Due to the orientation of the expanded metal apertures, the approaching particle within the rotational flow sees only a solid wall rather than the openings, see right most photo of Figure 5. Particles are driven over the screen face by the balanced inflow, which is the tangential flow around the inside of the screen chamber, tangential force (F_t). This rotating motion of the flow inside the screening cylinder produces a centrifugal force (F_b) on the particle, which if left un-opposed, would act to eventually block the screen with debris. This force centrifugal force (F_b), is resisted by an equal but opposite centripetal force (F_s) exerted on the particle by the screen face. The slanted orientation of the expanded metal screen also produces a small deflection force (F_d) on the particle. The turbulent boundary layer generated by the flow over the rough screen face also services to impede particles from crossing the screen face. This turbulent boundary layer has a displacement effect / force (F_{dis}), which also acts against the centrifugal force (F_b). Finally, there also exists drag (F_{drag}) and friction forces friction force (F_f) that act against tangential force (F_t) exerted on the particle.

The particle is kept in motion because the tangential drag force (F_t) is greater than the drag and friction forces (F_{drag} & F_f). The dimensions of the chamber ensure that the ratio between F_t and F_f is always in favour of F_t, regardless of the position of the object around the chamber screen.

Again, it should be understood that the CDS separation process is very much opposite to a vortex in which the rotational velocities are greatest at the center and the entire body of water is rotating. The CDS unit's center is quiescent and the rotational velocities increase as you get further from the center. Unfortunately, the nuances of that differentiate these two treatment flow processes though obvious are too often incorrectly categorized by most people not fully knowledgeable of the definition of these different flow regimes and treatment hydraulics and many find it simply easier to call both processes vortexes or simply categorize such treatment devices as hydrodynamic separators.

Minimal Operational Head

The head loss affected by the CDS system was thoroughly monitored during storm events by Allison et al (1998) by using flow depth probes, upstream, downstream and along the by-pass channel of the system. The analysis reported that the head loss coefficient is in the order of 1.3, which is less than a typical junction pit. It has been established that the actual head loss under system design flow varies as a function of the velocity head = "$V^2/2g$". The headloss coefficient "K_{CDS}" can vary from as low as 0.75 to as much as 8 or more during extremely high velocity flows. For planning purposes it is normally suggested to start with an initial headloss coefficient assumption of K_{CDS} = 1.3 and V is the design flow velocity in the collection system pipeline without the CDS storm water treatment unit. The small head losses make the CDS system suitable for a range of applications including low-lying areas as well as steeper watersheds.

Additionally, a hydraulic analysis should be done for each CDS installation. This hydraulic analysis should ensure diversion and bypass flows do not unduly exacerbate flooding potential in the storm water collection system upstream of the BMP.

3.0 CDS Unit Configurations

CDS units are available in three different types of configurations and can have either an internal or external diversion weir: Off-line models designated by PSW, PSWC & CSW prefixes have external diversion weirs constructed in a diversion structure installed within the pipeline alignment. This diversion structure is located adjacent to the Off-line CDS unit. In-line models prefaced by PMSU, and Drop-Inlet units denoted by PMIU prefixes have their diversion weirs manufactured as integral components within the units. Figure 8, provides an illustration of a typical Offline PSW, PSWC & CSW model CDS unit, Figure 9 is an illustration of our Inline PMSU model unit and Figure 9 shows our Drop-Inlet storm water treatment units.

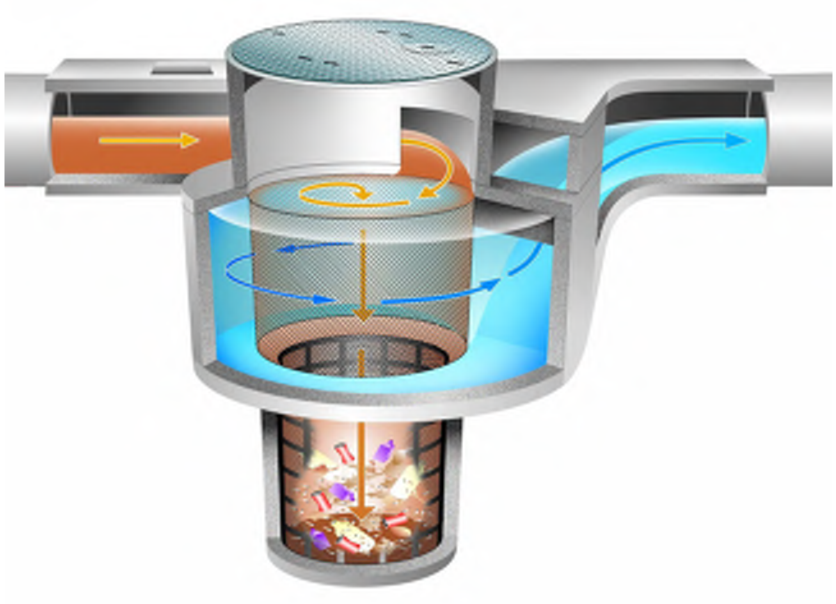


Figure 8 “Offline” configuration, CDS models with prefix: PSW, PSWC or CSW

Off-line Unit: These CDS units are available in precast reinforced concrete modules for all applications processing flows up to 64-cfs (1,813-L/s or 1.8-m^3/s). The diversion weir box structure can be designed to accommodate multiple inlet pipes and bypass very large flood flows. For applications requiring larger flow processing, units are designed complete with construction specifications for cast in place construction.

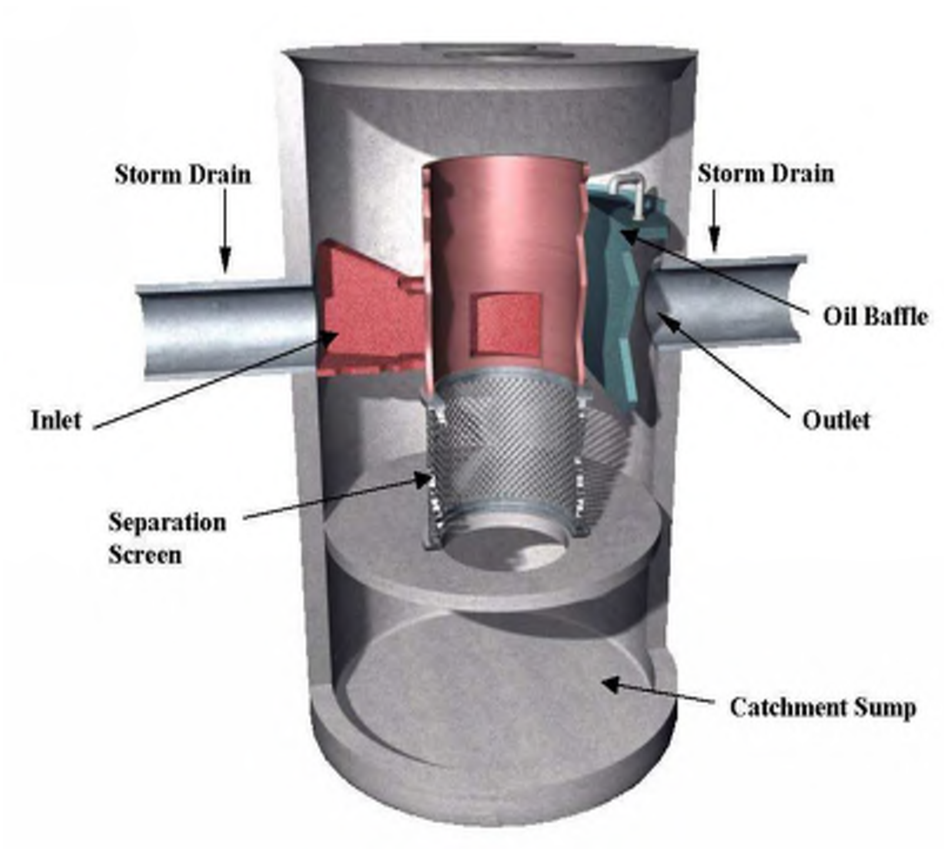


Figure 9 Inline Model PMSU CDS Unit

In-line Unit: These smaller pre-manufactured units are sized to process typical drainage flows of 0.7 to 6-cfs (20 to 171-L/s) from new and existing urban developments. These typical PMSU CDS unit can be placed within new or retrofitted into existing storm water collection systems. Its remarkably small manhole footprint takes little space and requires no supporting infrastructure. These typical PMSU units are ideal for treating runoff from parking lots and vehicle maintenance yards. Larger PMSU units sized to treat flows up to 15-cfs (428-L/s) with bypass capacities greater than 30-cfs (855-L/s) have frequently been designed for deployment inside 10 and 12-foot (3,048 and 3,657-mm) diameter manhole structures. Though not typical, CDS PMSUs are also available to treat/screen and bypass much larger flows. In early 2007, CDS manufactured and installed two PMSU100_100 In-Line units Los Angeles, CA, each having 64-cfs (1.8-m^3/s), treatment / screening capacities with bypass flow capacities of several hundred cubic feet per second up to 700-cfs.

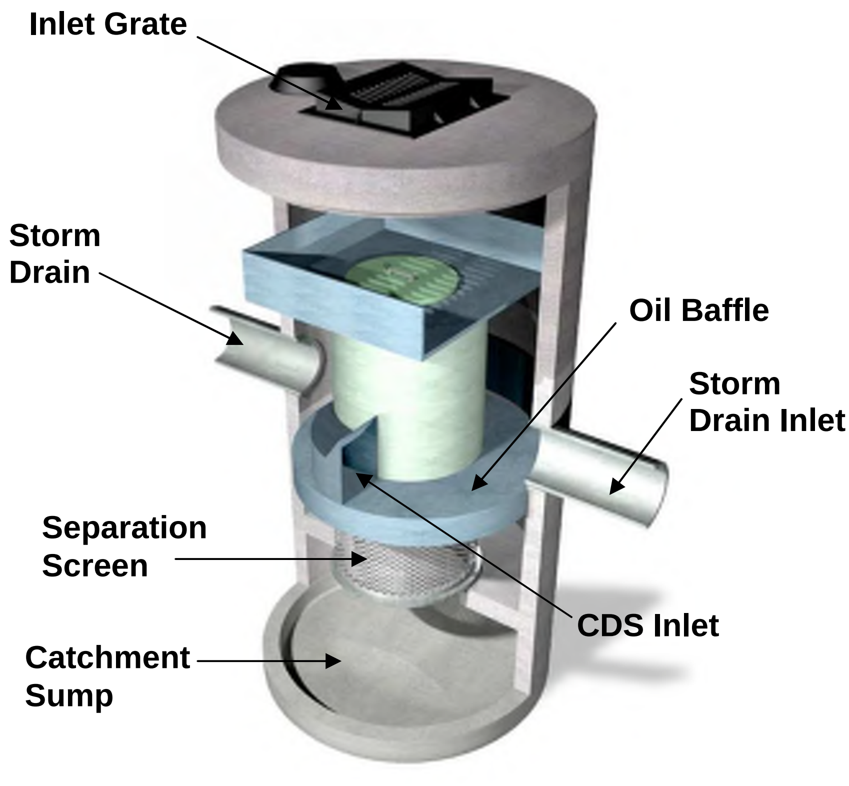


Figure 10 Drop-In (grated inlet), PMIU prefix designated CDS Unit

Drop-in Unit: this pre-manufactured drop-inlet, (PMIU prefix) unit is designed to process flows of 0.7-cfs (20-L/s) or less and is ideal for small drainage areas such as parking lots. This unit is configured inside a small diameter precast manhole that enables the PMIU unit to function as a typical drop-inlet and would be installed in lieu of a catch basin or storm drain inlet.

4.0 Applications of the CDS Technology

CDS technology offers highly efficient separation and capture of gross pollutants, suspended solids, sediment, floatable and neutrally buoyant material for storm water treatment applications. Removal of free oil and grease can be achieved with a standard, conventional oil baffle installed in all CDS units. Oil and grease removal efficiency can be further enhanced when sorbents are applied in the separation chamber.

CDS units are most commonly used as a stand-alone application serving existing development, new and redevelopment projects or as a pre-treatment, primary clarifier for a storm water BMP treatment train. At a minimum, CDS units capture sediments, the pollutants that attach themselves to sediments, oil and grease, and gross pollutants such as styrofoam containers, plastic, paper, vegetation including leaves, cigarette butts, packaging, and syringes that are transported by runoff. Removal of all these pollutants is essential to ensure the effective operation of the unit process BMPs that require pre-treatment to ensure their effective operation such as filtration and infiltration systems, ponds, wetlands, swales and coalescing plate oil/water separators. Each of these secondary treatment BMPs require the removal of majority mass of the suspended sediment and gross pollutants if they can be expected to perform beneficially.

CDS units are certainly beneficial as stand alone treatment units, but a treatment train consisting of primary and second-stage treatment processes is a much more holistic stormwater management approach to maximizing the effectiveness of BMP measures.

CDS units can be installed in-line or at the end of the pipe systems that directly discharge into natural waterways. The units are installed underground with only a small footprint therefore being suitable for prominent urban areas where space is at a premium.

The following list provides some of the storm water applications of CDS units:

- Treatment of storm water runoff from residential, commercial and industrial land uses to remove: *suspended solids and sediments, oil and grease, trash and debris, including vegetation floatable and neutrally buoyant materials*

- Watershed application by providing treatment of storm water runoff to achieve compliance with an element of a comprehensive storm water management program by capturing: *TMDL specific pollutants and pollutants from developments within the watershed where BMPs have not been implemented or are not effective.*

- Treatment of storm water runoff from parking lots and vehicle service and storage facilities to remove: *suspended solids and sediments, trash and debris, oil and greases controlled with a conventional oil baffle within the separation chamber. Enhanced oil and grease removal can be achieved using oil sorbents added to the separation chamber.*

- Pre-treatment (i.e. groundwater recharge, infiltration systems, oil/water separators, storm water reuse treatment systems, diversions to sanitary sewer systems, swales, detention basins and constructed wetlands) to remove: *suspended solids and sediments, trash and debris, including vegetation.*

- Protect storm water pumping facilities from damage by capturing: *rocks, coarse & medium sediment, grit, trash and debris*.

There is a wide range of CDS storm water units available that can treat design flow rates of up to 300-cfs (8.550-m^3/s) serving areas up to 1,500-acres (607-hectares) in size. This large hydraulic capacity of the CDS system provides opportunities for watershed applications:

- Providing a cost effective technology and opportunity to displace multiple small capacity BMPs within a catchment.

- Providing a regional solution to address pollutants from new and existing development.

- That is cheaper to maintain than multiple small capacity BMPs providing greater assurance of maintenance.

5.0 Sizing Methodology

Systems can be sized based on a water quality flow (e.g. 1 inch storm) or on a net annual basis depending on the local regulatory requirement. In Douglas County each system would be designed for site specific requirements in accordance with the Georgia Storm Water Management Manual GSWMM.

6.0 CDS Performance Reviews

The following application sections provide performance evaluation tests, which demonstrate that the CDS device is able to meet the following numerical performance goals:

1. Solids removal performance goal:

   80% removal of coarse (125-µm - mean size, d_{50}= 50-µm) total suspended solids for influent concentrations that are greater than 100-mg/L, but less than 200-mg/L. For influent concentrations less than 100-mg/L, the facilities are intended to achieve the effluent goal of 20-mg/L total suspended solids.

2. For Oil Treatment:

   The oil control menu facility choices are intended to achieve the goals of no ongoing or recurring visible sheen, and a daily average total petroleum hydrocarbon concentration no greater than 10-mg/L, and a maximum of 15-mg/L for a discrete (grab) sample.

6.1 Solid's Removal Performance - Application of CDS PMSU20_20 Unit Controlled Test to Washington Department of Ecology Evaluation

In an effort to meet the increasing demands of the established and pending accreditation programs throughout the United States, a CDS PMSU20_20 hydrodynamic separation unit with 2400-µm and 4700-µm screen cylinders was tested at the University of Florida, Gainesville facility from June to July, 2006.

This full scale CDS unit was configured and plumbed on the site to enable it being evaluated under controlled laboratory conditions of pumped influent and the controlled addition of sediment.

Our goal in conducting this evaluation was to generate research quality performance data of unquestionable veracity that would enable the distribution of reliable documentation on the performance of the CDS separation process to address specific particle removal requirements throughout the nation.

This evaluation program provides verified performance removal results on a broad range of particles sizes.

The present testing results from this controlled study is able to support the definitive removal performance claim:

- 80% removal of total suspended solids with d_{50} of 125-µm.

Figure 11 shows a constructed Particle Size Distribution with d_{50} of 125-µm. This PSDs will be used to demonstrate the CDS performance of 80% removal of coarse total suspended solids at water quality design flow rate based on the performance evaluation data developed using various test sands.

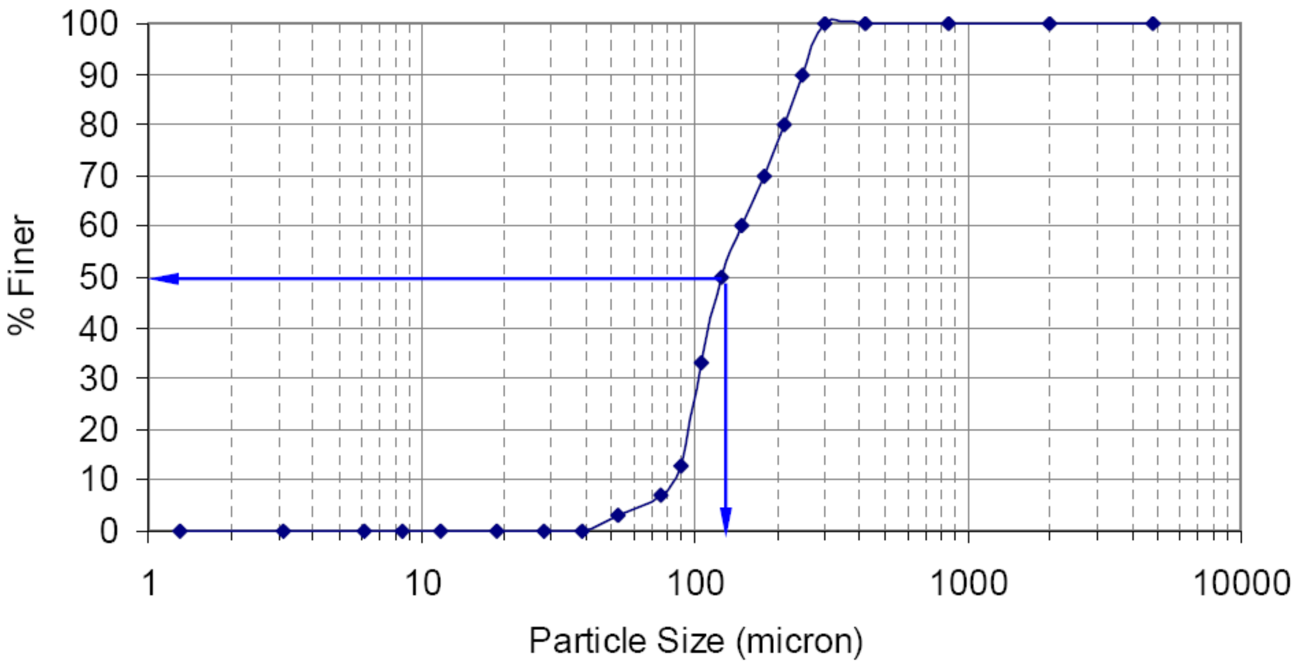


Figure 11 Particle Size Distributions for Ecology Defined PSD (d_{50} = 125-µm)

Particle Size Distribution of Testing Material

Two different sediment gradations of silica sand material were tested in the PMSU20_20 unit for this performance evaluation. The particle size distributions of these test sand mixtures were analyzed using standard method "Gradation ASTM D-422 with Hydrometer" by MACTEC Engineering and Consulting Inc. in Jacksonville, FL, a certified laboratory.

<u>"UF Sediment" Test Material</u>: One gradation of sand material used in the recent CDS performance evaluation is the result of combining three (3) different U.S. Silica Sand products commercial referred to as: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". The final mix of

these three sands used in the test is referred to in this report as "UF Sediment". Analysis of the three different grab samples of the UF sand mixture (UF mix No.1, No. 2 and No. 3) is a very fine gradation (d_{50} = 20 to 30-µm) covering a wide size range (uniform coefficient C_u averaged at 10.6).

<u>*OK-110 Test Material*</u>: The other material tested was OK-110 silica sand, which is also a commercial product of U.S. Silica Sand. The gradation analysis of this material shows that 99.9% of the OK-110 sand is finer than 250-µm, with a d_{50} of 106-µm.

Laboratory Testing Protocol

Test runs were conducted to quantify the CDS PMSU20_20 unit (1.1-cfs capacity) performance at the following flow rates:

Table 2 Test Flow Rates

% of Design Flow Rate	Actual Flow Rate (gpm)
1	5
5	25
10	49
15	74
35	173
50	247
75	371
100	494
125	618

These tests were conducted using influent concentrations of 200-mg/L.

Solids were mixed with tap water and the slurry was fed into the CDS test unit at a designated feeding rate using a peristatic pump.

Six samples were taken at the effluent locations at equal time intervals across the entire duration of each test run. These samples were then poured into a Dekaport Cone sample splitter (Figure 13) to obtain sub-samples for TSS and PSD analysis. Using a cone splitter ensures representative sub-sampling. Replicate effluent samples for each run were randomly selected from the sub-samples and delivered to Test America Analytical Testing, Portland, Oregon for TSS analysis.

Additionally, particle size analyses for effluent samples were conducted immediately after the test run by CDS staff. A Portable Model Laser In-Situ Scattering and Transmissometry (LISST) (Figure 13) particle size analyzer (manufactured by Sequoia Scientific, Inc., Bellevue, Washington) was utilized.

Figure 12 Dekaport Cone sample splitter

Figure 13 LISST Portable Particle Analyzer for PSD analysis

Laboratory Testing Results

The target influent concentration was 200-mg/L. The concentration of the influent solid mass referred to as (TSS) is calculated using the measured slurry feed rate and the measured water inflow rate, and the duration of runs. Effluent quality from CDS unit was analyzed using Ecology TSS method by Test America, Portland, OR.

Cumulative testing results for UF Sediment and OK-110 sands over the entire range of test flow rates are summarized in Figure 14.

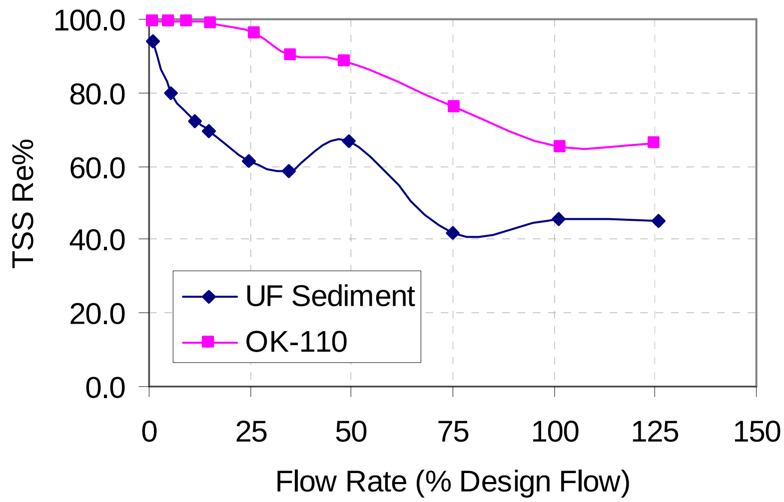


Figure 14 Cumulative Measured TSS removal – Analytical results for PMSU20_20 Test 2400-micron Screen, TSS=200-mg/L (UF Sediment & OK-110 sand)

It is noted that there are two abnormalities in the TSS Removal curves shown above:

- One variation exist only in the UF Sediment curve that shows a TSS removal performance (Re%) increase spike at 50% of the design flow rate. This variation was due to the influent solids feed concentration of 278-mg/L instead of the desired 200-mg/L, which leans some validity to the argument that higher influent solids concentrations lead to the reporting of higher removal efficiencies for swirl concentrators.

- The second abnormality exists in both curves, which both show a flatting as well as slight upward slope of the removal curve at the higher inflow rates from 80 to 125% of the design treatment rate. This slight increase, as well as leveling of removal performance at higher flow rates is counter intuitive to the known performance curves of all other classic smooth walled swirl concentrators. However, this slight increase and leveling off of removal efficiencies was also document by CDS in a limited evaluation supervised by Professor Scott Wells and his graduate student Spencer Slominski, Department of Civil Engineering in a May, 2003 performance test of the sub 100-µm silica particles at Portland State University. Given the repeated measurement of this slight increase and flattening of the removal performance curve at higher flow rates, CONTECH Stormwater Solutions is evaluating design modifications that will hopefully enhance this unique capacity of the Continuous Deflective Separation technology that will translate into a more efficient solids removal unit in the near future.

In order to evaluate the existing CDS unit's performance for the Ecology defined PSDs, the following analyses was conducted.

The solid mass that was added into the CDS test unit was pre-weighed in grams (g). Influent concentrations (mg/L) associated with each particle size gradation was determined by the total influent concentration (200-mg/L) and the percentage (% finer) for each particle size gradation from the PSD provided by MACTAC.

Effluent TSS was measured using Ecology TSS method by Test America Laboratory. Effluent concentration (mg/L) associated with discrete particle size gradations were determined by the total effluent mass (TSS) and the particle size distribution (% for each gradation) analyzed using the LISST portable particle analyzer. Use of the LISST enables the measurement of discrete particle gradations.

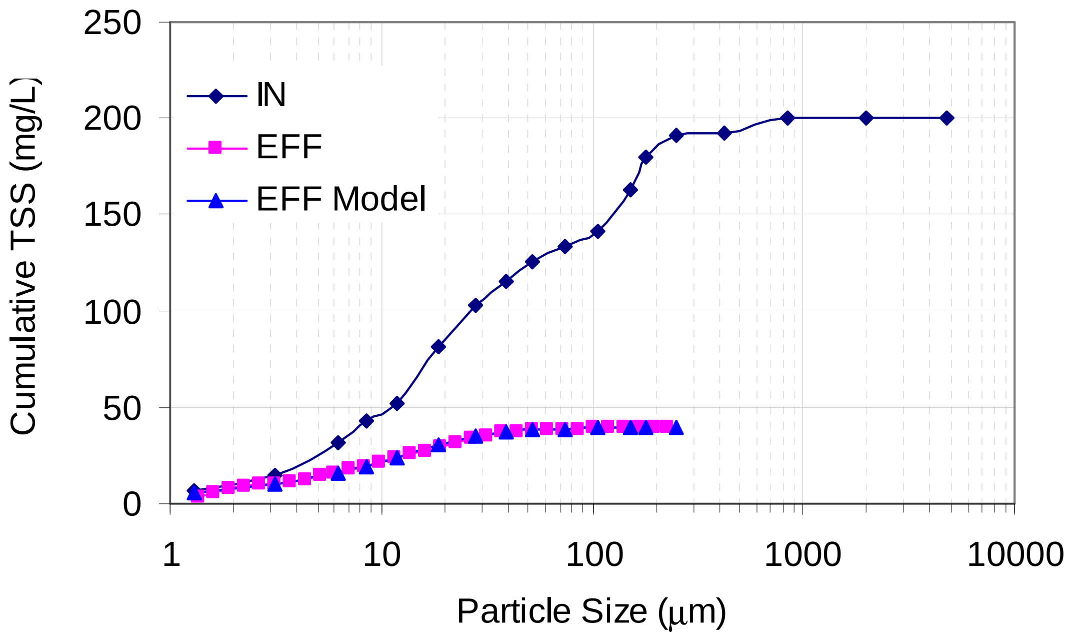


Figure 15 Influent and Effluent PSDs (PMSU20_20 Test 2400-micron Screen, TSS=200-mg/L, 5% flow rate, UF Sediment)

As shown in Figure 15, the cumulative influent TSS curve is developed through the actual measured influent TSS and influent PSD (from PSD report, MACTEC). Effluent cumulative TSS curve is developed from measurements provided by the LISST portable particle analyzer results, which can measure particles as large as 250-µm.

A fitted regression curve has also been developed to model the effluent cumulative TSS and is shown on the graph in Figure 15. Incremental TSS removals for specific particle sizes were calculated. Since particles less than 250-µm represents 95.5% of the UF Sediment, it is a valid model for particles no larger than 250-µm.

Table 3 Example: Incremental TSS Removal calculation from PSDs (PMSU20_20 unit, 2400-micron screen, 5% design flow rate)

Sieve Size	Influent				Effluent		Re% (Incremental)
	UF Sediment		Incremental TSS (mg/L)	Cumulative TSS (mg/L)	*Cumulative TSS (mg/L)	Incremental TSS (mg/L)	
(µm)	% Finer	% Incremental	200				
4760	100.0	0.0	0.00	200.0			
2000	100.0	0.0	0.07	200.0			
850	100.0	3.5	7.07	199.9			
425	96.4	0.9	1.80	192.9			
250	95.5	5.8	11.60	191.1	39.16	0.00	100.00
180	89.7	8.4	16.87	179.5	39.16	0.00	100.00
150	81.3	10.8	21.67	162.6	39.16	0.01	99.94
106	70.5	3.6	7.27	140.9	39.15	0.13	98.26
75	66.8	4.1	8.27	133.7	39.02	0.63	92.36
52.1	62.7	4.7	9.47	125.4	38.39	1.32	86.05
38.7	58.0	6.8	13.53	115.9	37.07	2.51	81.46
28.1	51.2	10.4	20.80	102.4	34.56	4.50	78.35
18.9	40.8	15.0	29.93	81.6	30.06	6.28	79.02
11.8	25.8	4.2	8.33	51.7	23.78	4.23	49.24
8.5	21.7	5.9	11.73	43.3	19.55	3.61	69.26
6.2	15.8	8.4	16.73	31.6	15.94	5.91	64.68
3.1	7.4	4.2	8.33	14.9	10.03	4.08	51.00
1.3	3.3	3.3	6.53	6.5	5.95	5.95	8.97

*Cumulative TSS for effluent in this column for the corresponding particle sizes of influent is calculated from the regression curve developed from LISST portable PSD data.

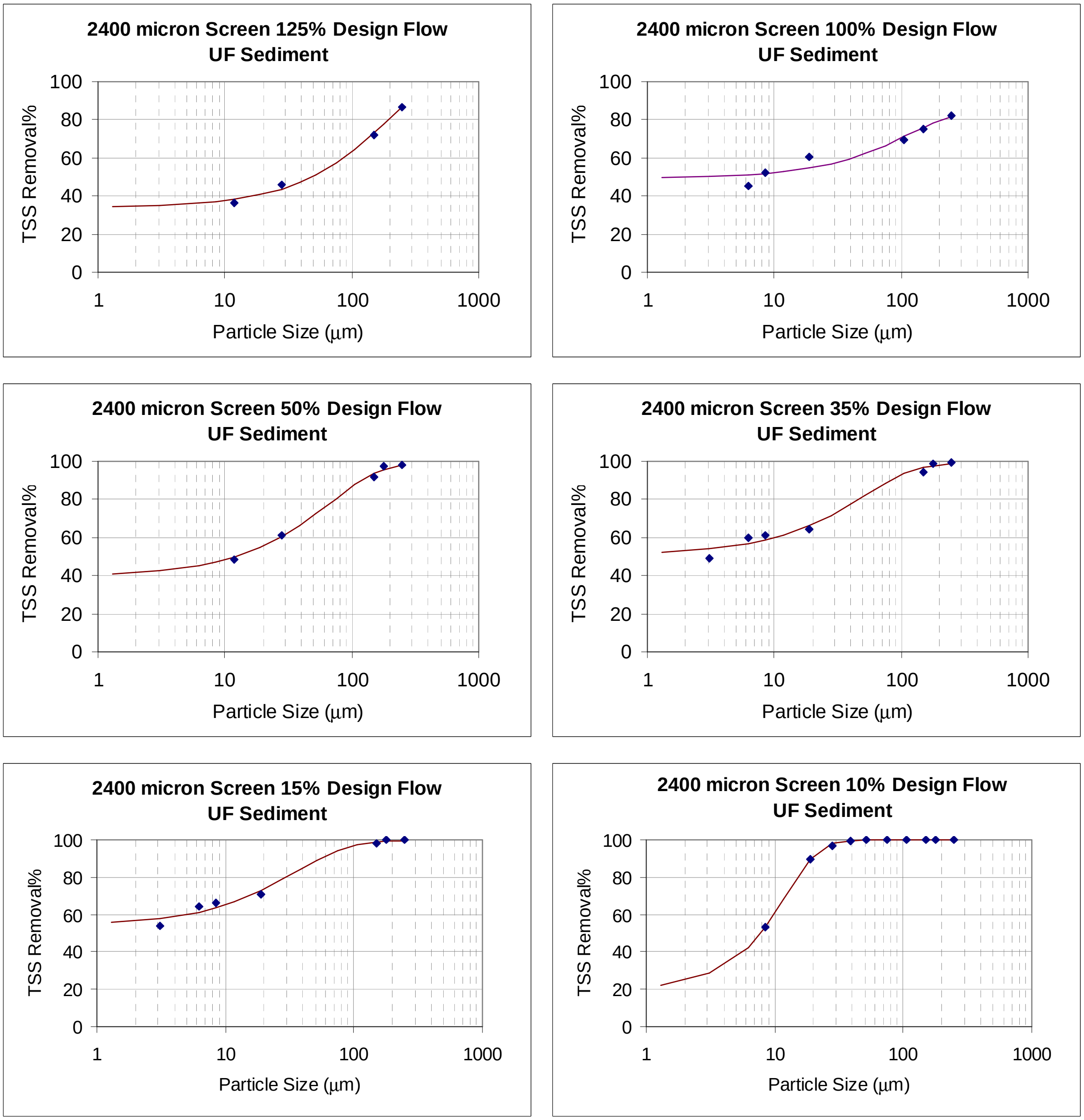
Additionally, the following criteria have been applied to examine the validity of the particle separation efficiency of each particle size gradation.

- Separation efficiency of each size class of particles can not exceed 100%.
- Separation efficiency of fine particles can not be higher than that of coarse particles under same influent flowrate.

CDS Unit Performance Model Development and Calibration

TSS removal as a function of particle size for various flow rates was obtained as illustrated in Table 3 above. The TSS removal % is plotted against particle size (Figure 16). Meanwhile, a regression analysis was used to develop a fitting curve for the scattered data points.

Below, Figure 16 shows the regression results plotted as a solid line curve against the measured data points for UF Sediment TSS removal as a function of particle size for each test flow rate using a 2400-micron screen in the CDS unit.



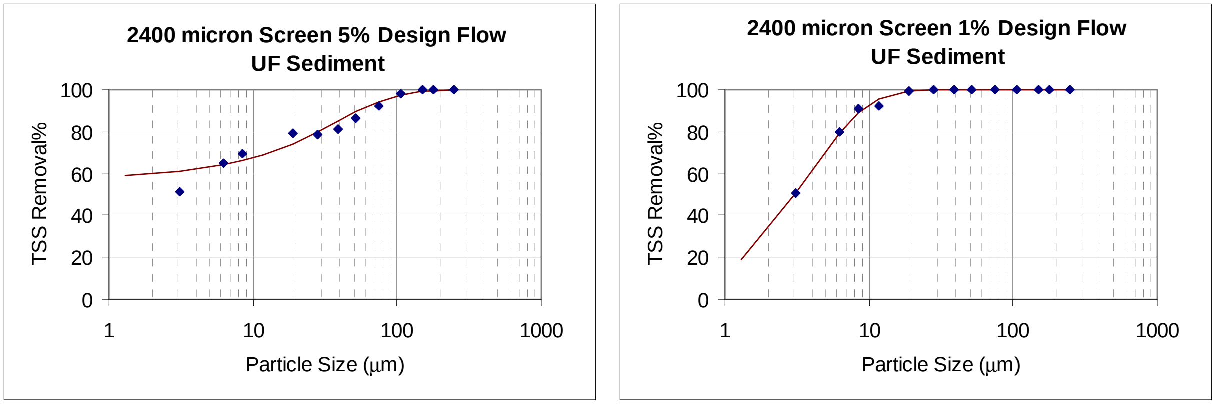


Figure 16 CDS Unit Performance – TSS Removal as a function of particle size for various flows (Data and Model Curves for 2400-micron screen unit)

* Result from 75% design flow is not available due to the LISST PSD data process error.

In the above regression analysis, a sigmoid function was used to model the TSS removal as a function of particle size for various flow rates. The mathematical form of the sigmoid function is shown as in the following equation:

$$y = \frac{a}{1+e^{-\left(\frac{x-x_0}{b}\right)}} + y_0 \qquad (1)$$

Where: y = TSS Removal (%) x = particle size: 10 to 250-µm

&

Parameters; a, b, x_0 and y_0 were determined for each flow rates.

The parameters obtained under each flow rate are summarized as follows:

Parameters	*125%*	*100%*	*50%*	*35%*	*15%*	*10%*	*5%*	*1%*
A	*753.74*	*2133.97*	*706.08*	*663.51*	*549.42*	*99.83*	*1602.12*	*1747.10*
B	*174.66*	*67.06*	*61.72*	*47.30*	*33.44*	*5.14*	*36.57*	*3.46*
y_0	*-648.92*	*-2034.93*	*-606.86*	*-564.77*	*-449.94*		*-1502.33*	*-1647.32*
x_0	*-395.34*	*-208.07*	*-147.34*	*-121.03*	*-80.58*	*7.81*	*-132.00*	*-9.16*

For the Ecology defined PSD (Figure 11), TSS removal under each flow rate can then be calculated.

Below, Figure 17 shows the comparison of TSS removal efficiencies determined using the calibrated model along with the measure TSS removal results from the analytical lab. For the TSS removal efficiency using the developed model, only particles greater than 10-microns are considered, because of less confidence for the accuracy of the PSD analysis for particles less than 10-microns using current instruments and methods.

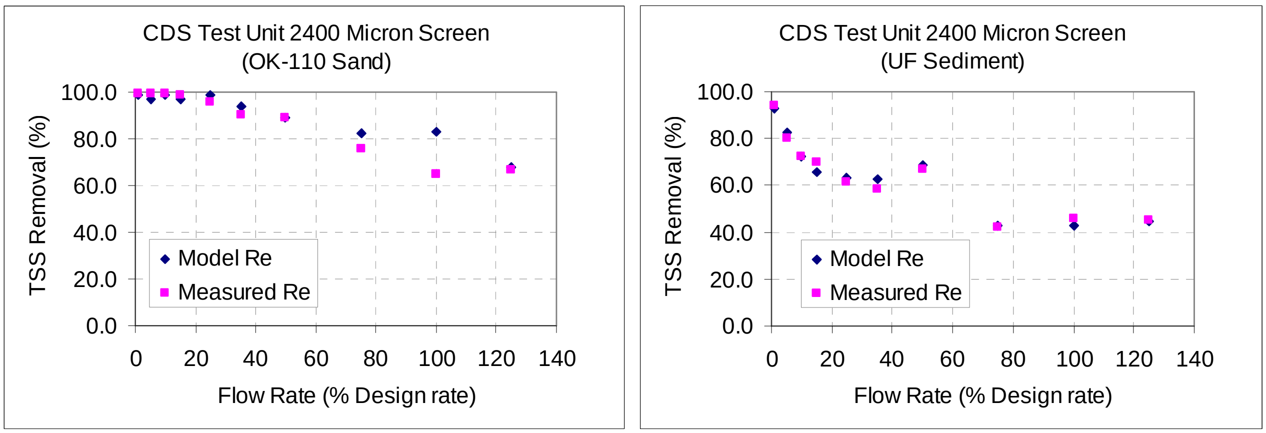


Figure 17 CDS Unit Performance Model Calibration (2400-µm screen) TSS Removal calculated from the model compared with analytical results from the lab for two test sands: OK-110 and UF Sediment

As seen in Figure 17, the TSS removal (%) calculated from the developed model is compared with the actual measured values for both UF Sediment (d_{50}=30-µm) and U.S. silica OK-110 sand (d_{50}=106-µm) test. The plotted data shows the same removal performance trends for each sediment tested, which is reduced TSS removal efficiency with increased flow rate under same influent concentrations. For the UF Sediment, the differences between the model results and actual measured values are all within an acceptable error (<10%).

The differences between the model results and actual measured values for the OK-110 sand are all within an acceptable error (<10%) except for one test (100% run, 1.1-cfs, 30-L/s inflow rate), see the left graph of Figure 17. At this single flow rate, the discrepancy between measured result and modeled result is significant. It is only for the OK-110 sand run at this single flow rate that the model overestimates the removal efficiency. Otherwise the calibrated model correlates well with the finer UF Sediment test material and all other measured removal performance of the OK-110 sand. Additional tests will be conducted to evaluate the TSS removal at this flow (100% design flow rate) using the OK-110 sand and further refine the regression model for this more coarse material.

CDS Unit Performance Curve (2400 micron screen unit)

The calibrated model derived from the discrete measurements of removal efficiencies of specific particle sizes over a range of flows from 1% to 125% of the treatment design capacity of the CDS unit were applied to the constructed Ecology PSDs with d_{50} of 125-µm as shown in Figure 11 to determine the cumulative TSS removal. The TSS removal of a CDS unit configured with a 2400-micron screen as a function of flow rate is presented for this PSDs below in Figures 18.

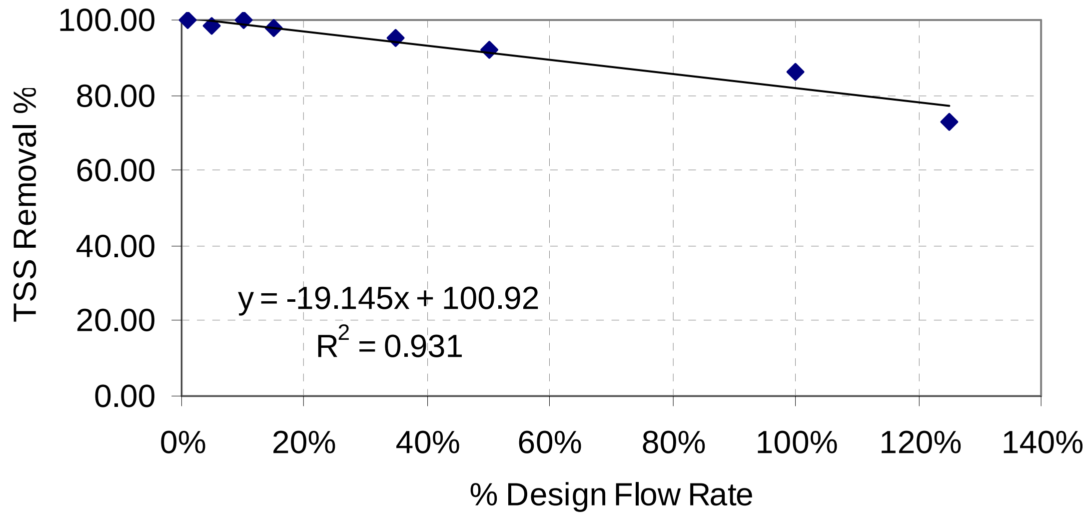


Figure 18 CDS Unit (2400-micron Screen) Performance for Constructed Ecology PSD d_{50}=125-µm

As shown in Figure 18 above, at 100% design flow rate and influent concentration of 200-mg/L, a CDS unit with 2400-micron screen achieves 81.8% TSS removal for coarse suspended solids (d_{50} = 125-µm).

<u>Demonstrated Performance Goal Achievement:</u>

The CDS unit with a 2400-micron screen has demonstrated the ability to achieve 80% for d_{50} = 125-µm coarse suspended solids at the design flow rate for influent concentrations that are greater than 100-mg/L, but less than 200-mg/L.

CDS Unit Performance Curve (4700 micron screen unit)

Similarly, the measured removal efficiency of the CDS unit on a specific particle size was value weighted to match the percentage of that particle size in the Ecology PSD. The TSS removal of a CDS unit configured with a 4700-micron screen as a function of flow rate is presented for this PSDs below in Figures 19.

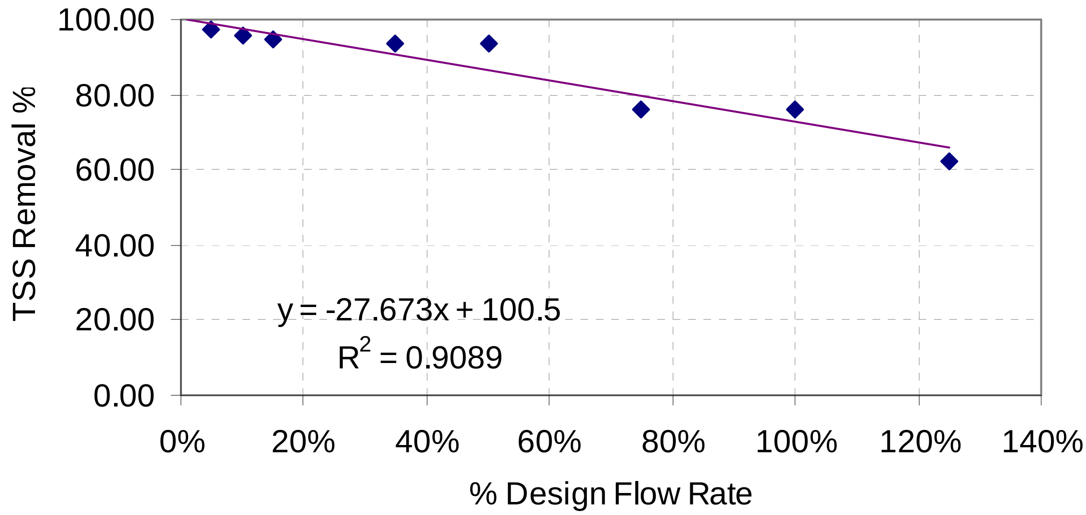


Figure 19 CDS Unit (4700-micron Screen) Performance for Constructed Ecology PSD d_{50}=125-µm

Performance Goal Achievement:

The CDS unit with a 4700-micron screen has the ability to achieve TSS removal of 72.8% for d_{50} = 125-µm coarse suspended solids at the design flow rate for influent concentrations that are greater than 100-mg/L, but less than 200-mg/L.

6.2 Oil and Grease (O & G) Removal

A number of studies have characterized the concentration of oil, grease and total petroleum hydrocarbons (TPH) in stormwater runoff from various land uses.

The Oregon Association of Clean Water Agencies (ACWA) reported oil and grease levels from multiple land uses runoff for the period 1991-1996 shown in Table 4.

Table 4 Oil & Grease Concentrations for Various Land-Use Types

Land Use	Median Concentration (mg/L)	Concentration Range (mg/L)
Residential	1.2	ND* – 12.6
Commercial	2.4	ND – 18
Industrial	2.0	ND – 107.6 (12 mg/L next highest)
Mixed	1.0	ND – 28

*ND – Non-detectable

There are several other prominent storm water researchers and field studies that looked into oil and grease in storm water. Pitt (2004) reported the median concentration of oil and grease was 4-mg/L and the average concentration at 24-mg/L through analysis of 1,834 samples in the nationwide MS4 Stormwater Quality Database. Caltran's (2002) studies showed that the average concentrations of oil and grease from highway runoff flow was about 4-mg/L where average annual daily traffic (AADT) volumes are greater than 30,000 and 22-mg/L where AADT volumes are less than 30,000. It is thought (Currier 2005) that lower concentrations are more common and likely the result of gradual build-up on paved surfaces from leaking vehicles. Extremely high but rare concentrations are suspected to result from spills or illegal disposal (Currier 2005).

Laboratory Studies – Oil and Grease Removal with Standard CDS Unit without Sorbent, Portland State University 2003

Scott and Slominski at Portland State University (2003) conducted tests on a CDS Model PMSU 20_20, 1.1-cfs (494-gpm) treatment capacity unit equipped with a 2400-µm screen and a conventional oil baffle. Tests were conducted at 25, 50 and 75 percent of the unit's hydraulic capacity, 125, 250 and 375-gpm respectively. These tests were run to determine removal efficiency of a CDS unit, equipped with a conventional / standard oil baffle on used motor oil at influent concentrations of 10, 25 and 50-mg/L. Summary of the test are shown below in Tables 5 through 7.

Table 5 Summary of Oil and Grease Tests Influent Concentrations: 7 to 11-mg/L

Flow Rate (gpm)	Flow Rate (%)	Influent Concentration (mg/L)	Effluent Concentration (mg/L)	Removal Efficiency (Re %)
125	25	7.2	3.5	51
250	50	9.9	2.0	80
375	75	10.5	7.5	29

Table 6 Summary of Oil and Grease Tests Influent Concentrations: 18 to 23-mg/L

Flow Rate (gpm)	Flow Rate (%)	Influent Concentration (mg/L)	Effluent Concentration (mg/L)	Removal Efficiency (Re %)
125	25	18.3	1.5	92
250	50	22.8	5.0	78
375	75	21.9	16	27

Table 7 Summary of Oil and Grease Tests Influent Concentrations: 45 to 47-mg/L

Flow Rate (gpm)	Flow Rate (%)	Influent Concentration (mg/L)	Effluent Concentration (mg/L)	Removal Efficiency (Re %)
125	25	46.2	3.5	92
250	50	45.6	7.5	84
375	75	46.9	27	42

As shown in Tables 5 and 6 above, when the influent concentration is less than 25-mg/L, the effluent concentration is less than 10-mg/L for flow rates up to 375-gpm (0.834-cfs), which is approximately 75.9% of the 1.1-cfs treatment capacity of the test unit.

Demonstrated Performance Goal: This PSU study along with the recorded typical concentrations of oil and grease concentrations in storm water shows that the CDS unit can be designed to achieve an effluent concentration less than 10-mg/L.

This PSU evaluation also included an oil spill test that was performed at a flow rate of 50-gpm, which is approximately 10% of the treatment design capacity of the tested CDS unit. This spill test consisted of twenty gallons of used motor oil being added into the unit over a time period of four minutes. This gave an influent concentration of approximately 82,000-mg/L.

No recirculation was required for this test, so sampling was only conducted at the effluent side of the unit. An initial sample was taken before the addition of oil to the unit, and after the background sample, additional samples were collected at one-minute intervals from the outlet for the duration of the test. The test lasted twenty-five minutes which is equivalent to two (2) tank turnovers after all the oil had been added.

Samples were analyzed by Columbia Inspection, Inc. according to the EPA 1664a protocol. The detection limit using in this method is 2-mg/L. Non-detect (ND) results were reported as being at half of the detection limit or 1-mg/L.

For this spill test, the average percent capture was 94.5% with a standard deviation of 2.3%. This gave a recovery range of 83.9% to 99.0% for this test. The unit performed extremely well in the oil spill test, with the peak oil concentration in the effluent occurring right as the addition of oil to the unit stopped. The peak effluent concentration was less then 90-mg/L, which accounts for less then 0.11% of the total amount of oil added to the unit.

If the concentration of the effluent for each sampling interval was assumed to be that of the sample taken at the beginning of the one minute interval duration, a total mass of approximately 148-grams can be assumed to have come out of the unit during this test. When compared to the input of over 65,000-gram this shows a capture more then 99.75% of the oil dumped into the unit. This would be a very effective means of containing an oil spill.

Laboratory Studies – Oil and Grease Removal with Sorbents in CDS Units University of California, Los Angeles (UCLA)

Studies by Stenstrom and Lau (1998) demonstrated that the CDS unit with sorbents can achieve 80 to 90 percent of oil and grease removal at concentrations ranging from 13.6-mg/L to 41.1-mg/L. Test results showed that the effluent oil and grease concentrations were less than 10-mg/L.

The conventional oil baffle was not installed within the CDS unit during this evaluation. The objective of this study was to evaluate the effectiveness of various sorbent material to control the typically low concentrations of free oil and grease found in urban stormwater runoff when applied within the separation chamber of a CDS unit. The sorbents were allowed to float on the surface of the separation chamber of the CDS device. Different amounts of each sorbent were used because of the varying properties of the sorbents (density and surface area).

A series of nine (9) laboratory experiments were performed on a CDS unit having a preliminary design treatment capacity of 125-gpm (0.28-cfs) to determine its ability to remove free oil and grease using sorbents (Stenstrom and Lau, 1998). One control experiment was performed without a sorbent. Again, it needs to be explicitly understood that the conventional oil baffle was not installed in this unit during these tests and the purpose of the these series of tests were to determine the efficiency of various commercially available oil sorbents to remove the typically low concentrations of oil and grease from stormwater when added to a CDS unit.

Tests were performed using a 2400-micron screen for 30 minute duration at 125-gpm (approximately 40% of the CDS unit's nominal flow capacity). Used motor oil having a Specific Gravity = 0.86 (SG=0.86)) was introduced into the feed of the CDS at concentrations of approximately 25-mg/L, which is generally the upper limit of oil and grease concentrations found in stormwater runoff. Oil and grease were measured at various times (influent / effluent) to determine the removal efficiency. Background oil and grease was measured as well as oil and grease released from the sorbents after the influent oil and grease was reduced to zero.

Prior to the beginning of each test, the freeboard of the CDS unit was wiped clean and a small amount of new sorbent was used to remove any oil that remained from the previous test. This sorbent was removed prior to the beginning of the test. A weighed amount of test sorbent was then dumped into the separation chamber of the CDS unit. Sorbents were removed using a large fine mesh sieve.

Five commercially available sorbents were evaluated. Two sorbents were found particularly effective and they are:

1. OARS™ (AbTech Industries, 4110N. Scottsdale Rd., Suite 235, Scottsdale, AZ 85251)

2. Rubberizer™ (Haz-Mat Response Technologies, Inc., 4626 Santa Fe Street, San Diego, CA 92109)

The experiments were conducted with sufficient sorbent to cover the top of the CDS unit. Results from the sorbent laboratory study (Stenstrom and Lau, 1998) are shown below:

Table 8 Performance of Oil and Grease Removal – Sobents in the CDS Units

Sorbent Type	Sorbent Mass (g)	Influent Concentration (mg/L)	Effluent Concentration (mg/L)	Percent Removal (%)	Flow Rate (gpm)
OARS	2600	19.6	2.7	86	125
OARS	2600	24.0	4.3	82	190
OARS	2600	30.7	1.7	94	75
OARS[1]	2600	21.0	3.5	83	125
Rubberizer	1030	27.2	3.9	86	125

The sorbents generally retained the sorbed oil and grease. Effluent concentration of oil for the OARS™ sorbent was less than 1.0-mg/L. Effluent concentration of oil for the Rubberizer™ sorbent was higher (1.96-mg/L). This may have resulted from the higher mass of removed oil and grease per unit mass of sorbent (approximately three times higher).

The overall conclusion from this UCLA oil and grease control testing was that the CDS unit is effective at removing oil and grease from stormwater. CDS units are equipped with a conventional oil baffle to capture and retain oil, grease and other Total Petroleum Hydrocarbons (TPH) pollutants as they are transported through the storm drain system during dry weather (gross spills) and wet weather flows. CDS units with the addition of oil sorbents can ensure the permanent removal of the free oil and grease from the stormwater runoff.

Oil and Grease Field Monitoring – Caltrans

Monitoring of two fiberglass CDS units for 17 events at two sites by Caltrans (2002) showed that TPH-heavy oil levels in runoff ranged from 0.66 to 2.3-mg/L at the Orcas Avenue site and 1.1 to 8.6-mg/L at the Filmore Street site. Effluent values for TPH-Heavy oil averaged 1.78-mg/L at the Orcas site and 4.14-mg/L at the Filmore site.

The monitoring at Filmore site (10 events) only found one detectable level (0.44-mg/L) for TPH-diesel, and the concentration in the effluent for that event was non-detectable. The monitoring at Orcas Avenue site (7 events) found no detectable level for TPH-diesel, and the concentration in the effluent was non-detectable for all events.

The monitoring at Filmore site (10 events) only found no detectable level for TPH-gasoline, and the concentration in the effluent for that event was non-detectable as well. The monitoring at Orcas Avenue site (7 events) found one detectable level (0.17-mg/L) for TPH-gasoline, and the concentration in the effluent for that event was 0.23-mg/L.

6.3 Field Monitoring of CDS Unit – Performance on TSS

6.3.1 Brevard County CDS Unit Monitoring

Brevard County Surface Water Improvement in July 1997 installed a CDS PSW50_42, 9-cfs capacity treatment unit serving a 61.5-acre catchment that includes 6.7-acres of highway, 19.9-acres of industrial park, 23.4-acres of vacant land and 11.4-acres of commercial property. Over an 18-month period five (5) storm events were monitored for pH, TSS, BOD, COD, turbidity and Total Phosphorus. Samples of sediment collected in the sump were analysed for 61 parameters. Strynchuck et al. reported an average of 52% removal for the total suspended solids.

The monitoring result for storm #5 is illustrated in Table 9.

Table 9 Storm # 5 Water Quality Analysis - CDS Performance on Total Suspended Solids (TSS) in Brevard County Study

Sample Set #	Total Suspended Solids		
	Influent mg/L	Effluent mg/L	Removal %
#1	49	11	78
#2	59	19	68
#3	23	21	9
#4	39	15	62
#5	35	13	63

This field study is one of the earliest BMP monitoring studies in the United States. Sampling was accomplished using autosamplers placed upstream and downstream of the CDS unit. The first three storms were monitored using flow weighted composite samples and the last two used discrete samples collected by the auto samplers. This monitoring effort experienced significant difficulties with equipment failure. Storm event 5 was the only event in which all equipment operated correctly and accurate flow was measured. Observations by the authors of this report during the sampling period confirmed deficiencies with the sampling equipment installation and placement of sample intakes and agreed with the report's conclusion that data collected during the initial four events were not representative.

In addition, due to the inefficiency of the sampling techniques and analytical method (TSS method), influent samples were not representatives and the true sediment removal rate was not able to be obtained because the bedload was not sampled. Cleanout of the units showed that approximately 3,582 pounds of sediments and 34 cubic feet of trash and debris were removed from the CDS sump on two occasions during the 18-month period.

6.3.2 Cooperative Research Centre Case Studies - Gross Pollutants

Cooperative Research Centre (CRC) for Catchment Hydrology conducted several monitoring programs to test the performance of various storm water gross pollutants trapping devices.

In the Stormwater Gross Pollutants Industrial Report (Allison R. et al. 1997), the results demonstrate that CDS devices are efficient gross pollutant traps. During three months of monitoring, practically all gross pollutants transported by the stormwater were trapped by the CDS device (i.e. 100 percent removal rate). In addition, the device appears to cause minimal interference to flow in the stormwater drain, and is therefore suitable for most urban areas. CDS devices require infrequent cleaning (about once every 3 months) at one location within a catchment.

Figure 20 Gross Pollutants Captured in the CDS Units Sump

In the report From Roads to Rivers, Gross Pollutant Removal from Urban Waterways (Allison, R. et al 1999), an extensive 18-month field study was completed on determining transportation of pollutants in storm water and the trapping efficiency of various storm water treatment systems under real service conditions. The performance of CDS devices was assessed in terms of its trapping efficiency for gross pollutants, its influence on the water quality parameters in the Stormwater, the hydraulic characteristics of the unit, and the required maintenance for long term operation. The field studies suggest that CDS unit is an efficient gross pollutant trap. During 12 months of monitoring 100% material greater than the minimum aperture size of the separation screen (4.7-mm) was retained in the separation chamber and the hydraulic impedance of the unit appears to be quite low compared to other trapping techniques.

6.3.3 Coburg, Australia Study - TSS

Walker et al. (1999) conducted a detailed study of the effectiveness of the CDS device for removal of suspended solids and associated pollutants.

The Coburg research catchment is situated approximately five miles north of Melbourne's central business district in Victoria, Australia. The research catchment covers an area of approximately 50 hectares (124 acres) of the inner city suburb of Coburg, which consists of 35% commercial and 65% residential land use.

The CDS unit in this catchment was the site of numerous CRCCH (Cooperative Research Center for Catchment Hydrology) and associated industry studies described by Allison et al. (1998). The Coburg City Council has continued to carry out typical municipal street litter management and stormwater system maintenance practices in the research catchment during the monitoring period.

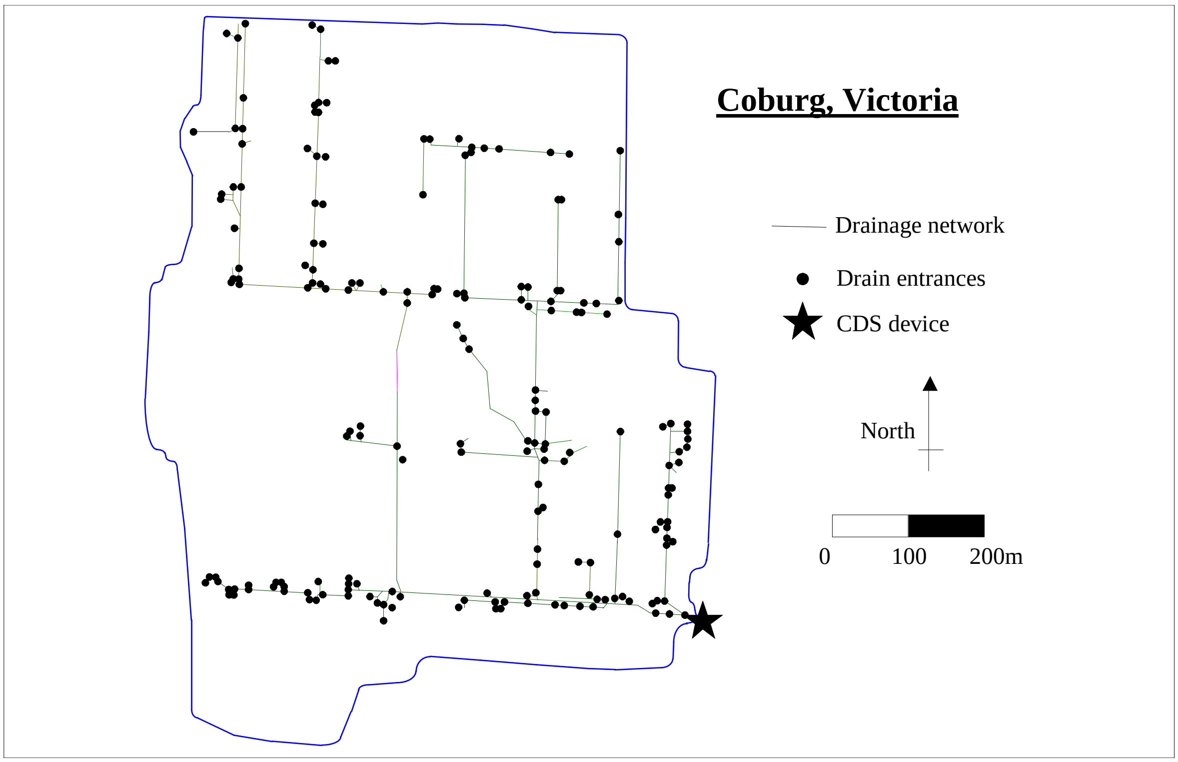


Figure 21 Drainage configuration in Coburg Research Catchment

A total of 15 storm events were monitored during a 22-month monitoring period. Storm events monitored ranged from 1 mm to 5 mm in rainfall depth. Samples at upstream and downstream of CDS units were taken using ISCO automatic water samplers. Inflow TSS concentrations were observed to be as high as 570-mg/L. Analyses of inflow and outflow TSS data indicated that the CDS unit effectively reduced TSS concentration levels above 75-mg/L with an average removal of 70%. TSS removal was more variable for inflow concentrations less than 75-mg/L. An estimated annual TSS load removal is 65%.

Given the limitations of the auto sampler, it was anticipated that sediment particles larger than 1-mm are unlikely to be picked up during sampling.

Particle size distribution analyses were not conducted in the above study. However, earlier studies on the gross pollutant removals using same CDS unit (Allison et al. 1998) indicated that 70% of the captured material in the CDS sump was less than 400-µm in size.

Demonstrated Performance: Though the correlation of field data to support solids removal performance claims for the specifically defined PSDs d_{50}=125-µm appears beyond the information acquisition scope of these previous studies, field monitoring of CDS unit clearly demonstrated that the CDS unit can removal nearly all gross pollutants and a significant portion of finer pollutants.

7.0 Design, Construction, Operation and Maintenance

7.1 Structural Design

All CDS units are designed to withstand equivalent fluid pressures that the unit may experience during its life. The water table at the installation site should be known, or a conservative estimate will be made on the maximum expected. Units are analyzed and designed conservatively, assuming that it is empty and full buoyant force acting on it. The foundation material is designed to provide adequate support for the structure's weight without allowing differential settlement.

In areas with solely pedestrian traffic, lightweight covers can be used to reduce the weight of lids and the time taken to remove for cleaning. For installations that will be traffic bearing, covers are designed with adequate strength to withstand vehicular traffic loads and comply with structural design standards.

All cast in place concrete designs are based on using structural concrete with minimum ultimate strength of 3,000 pounds per square inch (psi) or 20.7 Mega Pascal (MPa), with steel reinforcement having a minimum ultimate yield strength of 60,000 psi (413.7-MPa).

CDS units are designed to have a life of 50-years before replacement. The screens are the only component that may require replacement if they should become damaged due to passive galvanic corrosion or possibly as a result of large rocks, logs, etc entering the separation chamber and damaging the screen. If this should occur the screen panels can be easily replaced. CDS will provide assistance in these rare events.

7.2 Construction

High quality construction, use of precast techniques for standard units with design flows up to 64-cfs (1.81-m^3/s), short product lead times, and safe installation techniques mean CDS units are installed quickly and efficiently. Typically an installation can be performed on-site within a week depending on the complexity of the installation and contractors' experience. CDS has developed a relationship with Hanson Pipe and Concrete to manufacture the CDS units that results in lead time that are less than four weeks for the Pacific Northwest. The construction of CDS units in standard precast manhole, inline configuration, allows for this separation technology to be applied to retrofitting situations where existing storm lines are very deep. CDS has designed, manufacture and installed units for pipe invert depths of 40-feet. CDS Technologies provides technical support in the installation to ensure construction is performed according to the design.

An advantage of the CDS system is the ability to construct the separation chamber off-line from the main storm water flows, thus reducing the time the construction site is exposed to flows through the conveyance network. Once the separation chamber is in place, the conveyance system can be broken into, the diversion weir installed and the unit becomes operational.

7.3 Construction Materials

CDS units are available in pre-cast reinforced concrete modules for flows up to 64-cfs (1.81-m^3/s). For the most economical treatment of flows between 50 and 150-cfs, (1.41 to 4.24-m^3/s), two (2) precast units are typically configured in parallel, on either side of a diversion structure. For applications requiring larger flow processing up to 300-cfs (8.5-m^3/s), units are designed complete with construction specifications for cast in place construction.

7.4 Modular Pre-cast Process

Pre-casting reinforced concrete units was identified as the preferred construction technique for stormwater and sanitary sewer overflows for several reasons: construction period could be reduced to about a third of that required for in-situ construction; costs and quality could be more closely controlled; and there is greater product uniformity.

7.5 Pre-assembled Screens

Screens are pre-assembled under controlled conditions to ensure consistent and reliable performance and are constructed of ASTM 316L grade stainless steel.

7.6 Issues during Construction

A complete survey of existing utility services (such as electricity and telephone lines) is required prior to installation of a CDS unit. As the systems are installed underground unexpected utility services can delay construction times and add to installation costs.

A geotechnical report of the site is recommended to ensure the development of an adequate engineer’s installation estimate. If a geotechnical report is not available then budgeting consideration should be made for the construction phase to allow for potential additional costs to be borne by the purchaser. The costs for shoring, rock excavation and control and disposal of ground water intrusion into the excavation are typically set out in contract documents prior to commencement of work.

7.7 Costs

CDS units are best defined as an infrastructure capital investment, intended to provide easier less expensive maintenance than other BMPs, because of reduced life-cycle costs. In addition the large capacities of the CDS systems provide a lower unit cost per volume treated.

7.8 Operation and Maintenance

Captured materials in the CDS unit sump can be removed in three ways depending on the site condition and unit size, suction via a vacuum truck (typically for smaller units), a containment basket that can be lifted out of the unit or removal by an excavator (large units). Vacuum trucks are the most frequently used method of cleaning small CDS units. When baskets are used, the basket is placed in the containment sump and cleaned by a truck-mounted hydraulic crane used to lift the basket out of the sump. An excavator is used on very large units.

Maintenance is limited to removal of accumulated sediments and floatables. It is typically performed on as needed basis, dependant on the rainfall during a given period as well as the characteristics of the catchment (such as the pollutant loads). In a catchment with high leaf litter loads and where controls of total phosphorous and volatile sediments are objectives then strategic cleanout following leaf fall should be conducted.

The optimum maintenance frequency is determined during the first year after installation when pollutant build-up is monitored. Once accumulated pollutants in the containment sump reach a critical level (typically 85% of the sump depth) the device should be scheduled for cleaning. Experience from the first year of operation allows an estimate to be made of the required long-term maintenance frequency. The time or man-hours required to perform maintenance will depend on the size of the unit, method of cleanout: vacuum or basket, availability of sites to dispose of decanted water and solids and the experience of maintenance personnel. Experience indicates that smaller sized units can be cleaned in 20 to 30-minutes while very large units that have accumulated tons of material can take a full workday.

Should a CDS unit not be maintained for an extended period and becomes full of solids, the drainage system can still operate effectively because of the by-pass system. The by-pass system will simply be engaged earlier and flow directed over the diversion weir. In addition, collected pollutants will be retained within the separation chamber and prevented from washing downstream, until such time as the device is cleaned.

For new installations a check of the condition of the unit after every runoff event for the first 30 days is recommended. Checking includes a visual inspection to ascertain that the unit is functioning properly and measuring the amount of deposition that has occurred in the unit. This can be done with a "dip stick" that is calibrated so the depth of deposition can be tracked. Based on the behaviour of the unit relative to storm events, inspections can be scheduled on projections using storm events versus pollutant build-up.

For ongoing operations during the wet season, units should be included on a regular inspection schedule once every thirty days would be the initial recommendation until pollutant loading is calibrated. The floatables should be removed and the sump cleaned when the sump is above 85% full. At least once a year, the unit should be pumped down and the screen inspected for damage and to ensure that it is properly fastened. Ideally, the screen should be power washed for the inspection. This inspection can be performed from the ground surface and does not require confined space entry. The only time that confined space entry is required is that rare incident when the screen is damaged and requires replacement. Properly trained people equipped with required safety gear will be required to enter the unit to perform replacement of the damaged screen panel.

Vendor Maintenance

Upon request, CDS Technologies will provide maintenance services for customers based on actual costs plus 15%. CDS generally contracts with experienced private companies that have vacuum truck capabilities and provides oversight during the cleanout operations. CDS will also obtain the necessary approvals for disposal of decant water and solids in compliance with all local, state and federal regulatory requirements, certification of compliance with those requirements and a report of the complete operation.

Safety Issues

CDS units are generally located below ground, fitted with traffic rated lids. Tamper-proof lids are available, to prevent unauthorized entry. In open channel installations, exclusion bars at the entry and exit to the system prevent access into the CDS units. Because the CDS technology uses indirect screening, dangerous items such as hypodermic needles do not become lodged in the units' screens, so do not require manual handling to remove them.

CDS units require a minimum of manual handling, meaning that maintenance personnel are exposed to fewer health risks from broken glass, used hypodermic needles and pathogens. Only during the rare replacement of damaged screens are personnel required to enter the separation chamber.

Disposal of Pollutants

CDS units retain all gross pollutants - fast food packaging, plastic bottles, food scraps, glass, syringes with needles and vegetation - as well as sediments and potentially spilled oils and greases. The disposal of these material and sorbents when applied is required to be performed in an approved manor – depending on the location, local and state regulations governing waste disposal.

8.0 Summary

The independent laboratory and field monitoring studies provided in this application demonstrate that the CDS technology achieves the following performance goals.

- CDS unit has demonstrated the capability to capture 100% gross pollutants and all litter, debris or neutrally buoyant materials at various land use types.

- CDS unit has demonstrated 80% removal of coarse (125-µm mean size) total suspended solids.

- CDS unit equipped with a standard oil baffle achieves a daily average TPH concentration no greater than 10 mg/L.

Cost-effective treatment system

- Large hydraulic treatment capacity allows regional solutions addressing pollutants from both existing and new development and displacing small capacity BMPs.

- Inexpensive to install and maintain than multiple small capacity BMPs providing greater assurance of maintenance.

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APPENDIX C
HYDRAFLOW MODEL OUTPUT – WQ ONLY

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	536.69	2	760	4,118,357	------	------	------	MACRO BASIN 1
2	SCS Runoff	233.10	2	738	1,206,774	------	------	------	MACRO BASIN 2
3	SCS Runoff	47.45	2	734	206,561	------	------	------	MACRO BASIN 3
4	Combine	722.28	2	754	5,531,692	1, 2, 3	------	------	OFF POA 1
5	SCS Runoff	30.29	2	732	126,709	------	------	------	MACRO BASIN 4
6	SCS Runoff	8.625	2	716	20,218	------	------	------	OFF BASIN 5
8	SCS Runoff	32.10	2	728	113,239	------	------	------	PRE DB1
9	SCS Runoff	10.36	2	722	29,335	------	------	------	PRE DB2-ON
10	SCS Runoff	4.903	2	716	11,493	------	------	------	PRE DB2-OFF
11	Combine	13.72	2	718	40,828	9, 10	------	------	PRE POA 3
13	SCS Runoff	5.568	2	720	14,510	------	------	------	PRE DB3-ON
14	SCS Runoff	0.466	2	718	949	------	------	------	PRE DB3-OFF
15	Combine	5.959	2	720	15,459	13, 14	------	------	PRE POA 4
16	SCS Runoff	2.173	2	730	11,486	------	------	------	PRE DB4
18	SCS Runoff	62.42	2	722	175,603	------	------	------	POST DB1
19	Reservoir	1.695	2	958	171,532	18	962.39	119,556	FALSE PHASE 1 VAULT
20	SCS Runoff	7.874	2	716	16,695	------	------	------	POST DB2-ON
21	SCS Runoff	4.903	2	716	11,493	------	------	------	POST DB2-OFF
22	Combine	12.78	2	716	28,188	20, 21	------	------	POST POA 3
24	SCS Runoff	5.056	2	720	13,143	------	------	------	POST DB3-ON
25	SCS Runoff	0.466	2	718	949	------	------	------	POST DB3-OFF
26	Combine	5.446	2	720	14,092	24, 25	------	------	POST POA 4
28	SCS Runoff	2.173	2	730	11,486	------	------	------	POST DB4
30	Combine	731.08	2	752	5,701,221	4, 8, 11, 15,	------	------	PRE POA 1
31	Combine	731.25	2	754	5,749,572	4, 18, 22, 26,	------	------	POST POA 1
33	Combine	746.88	2	752	5,859,631	5, 6, 16, 30,	------	------	PRE POA 2
34	Combine	746.84	2	752	5,907,988	5, 6, 28, 31,	------	------	POST POA 2

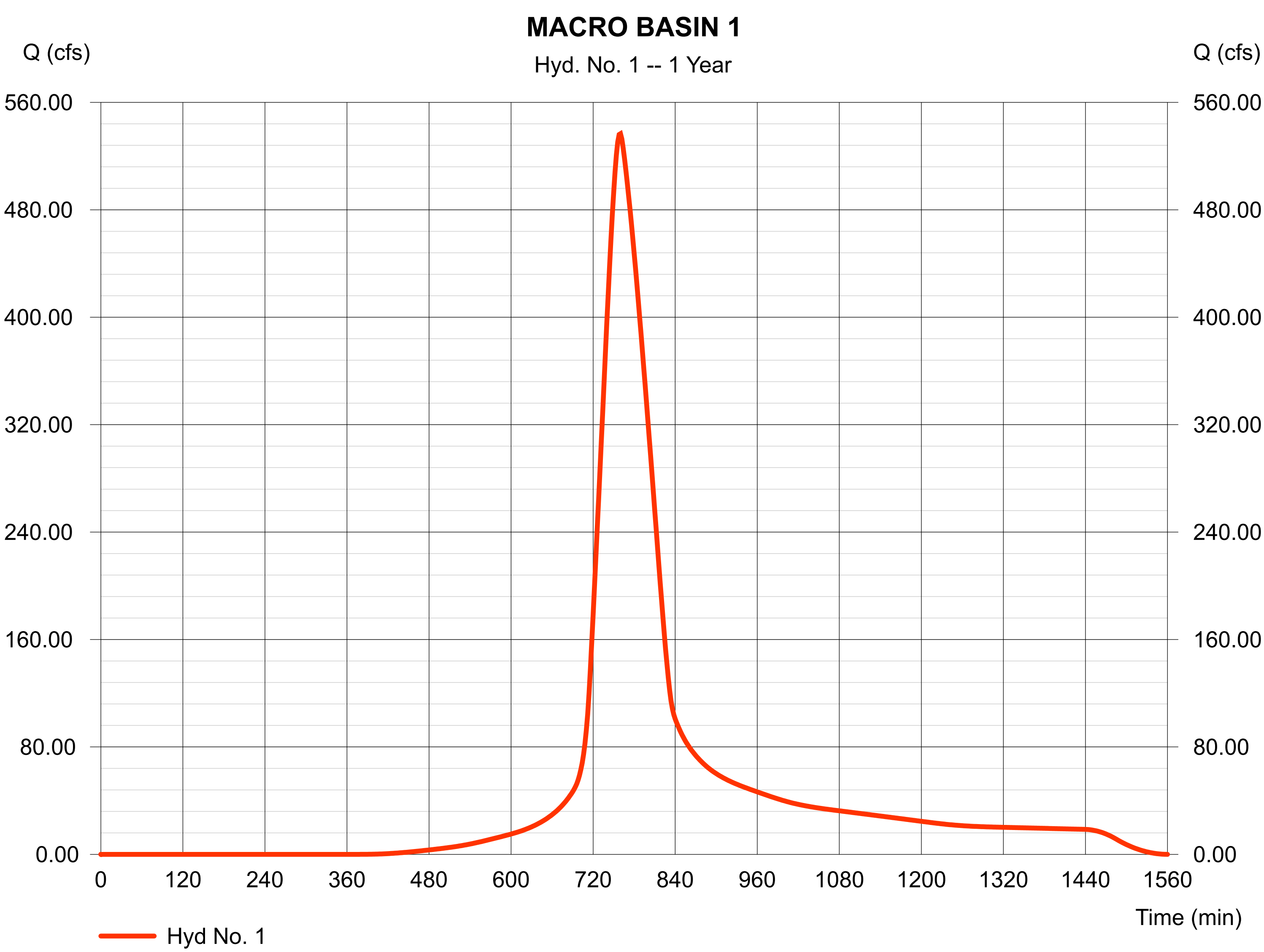
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 1

MACRO BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 536.69 cfs
Storm frequency	= 1 yrs	Time to peak	= 760 min
Time interval	= 2 min	Hyd. volume	= 4,118,357 cuft
Drainage area	= 532.700 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 76.90 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



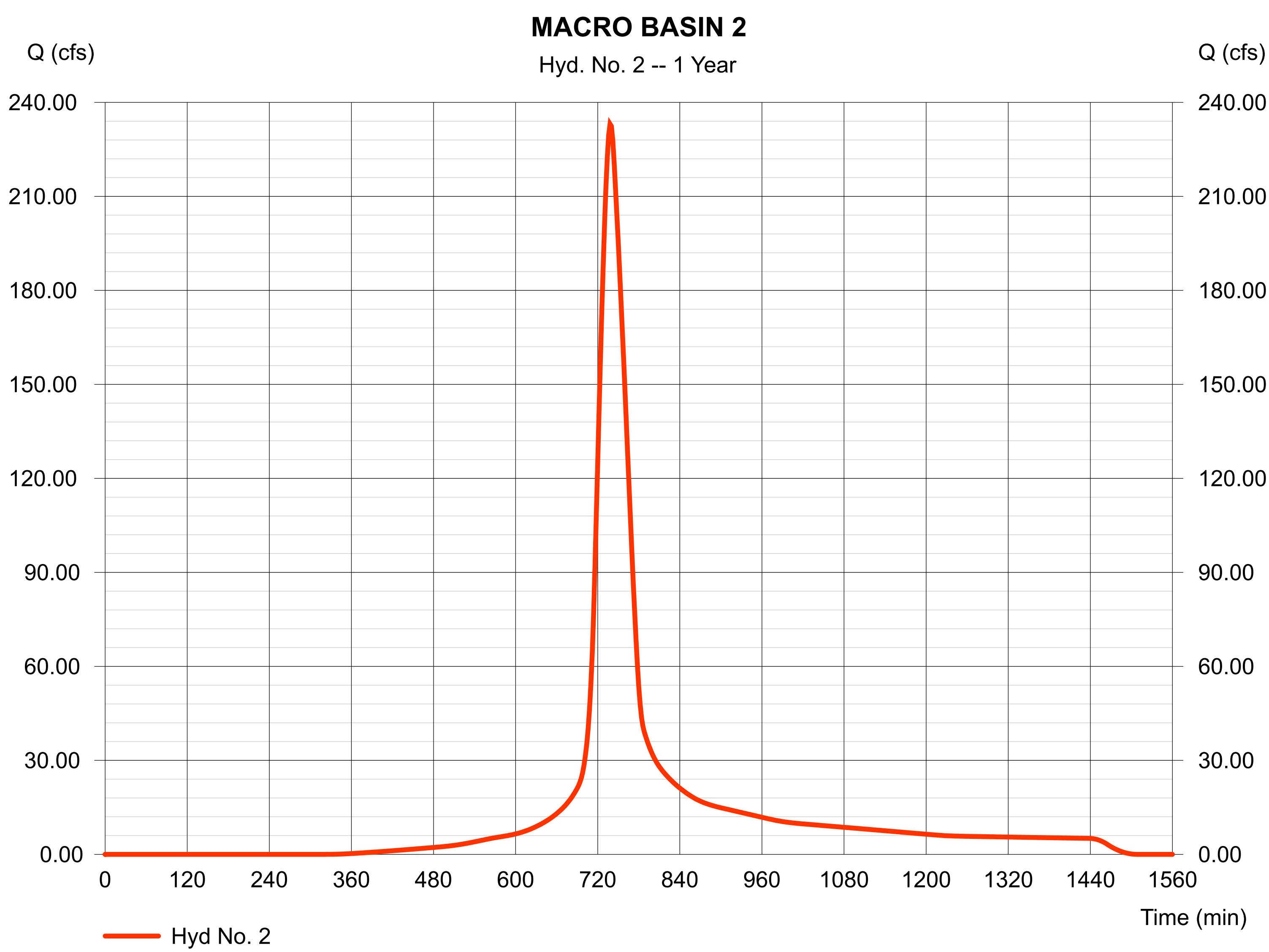
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 2

MACRO BASIN 2

Hydrograph type	= SCS Runoff	Peak discharge	= 233.10 cfs
Storm frequency	= 1 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 1,206,774 cuft
Drainage area	= 142.100 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 42.00 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



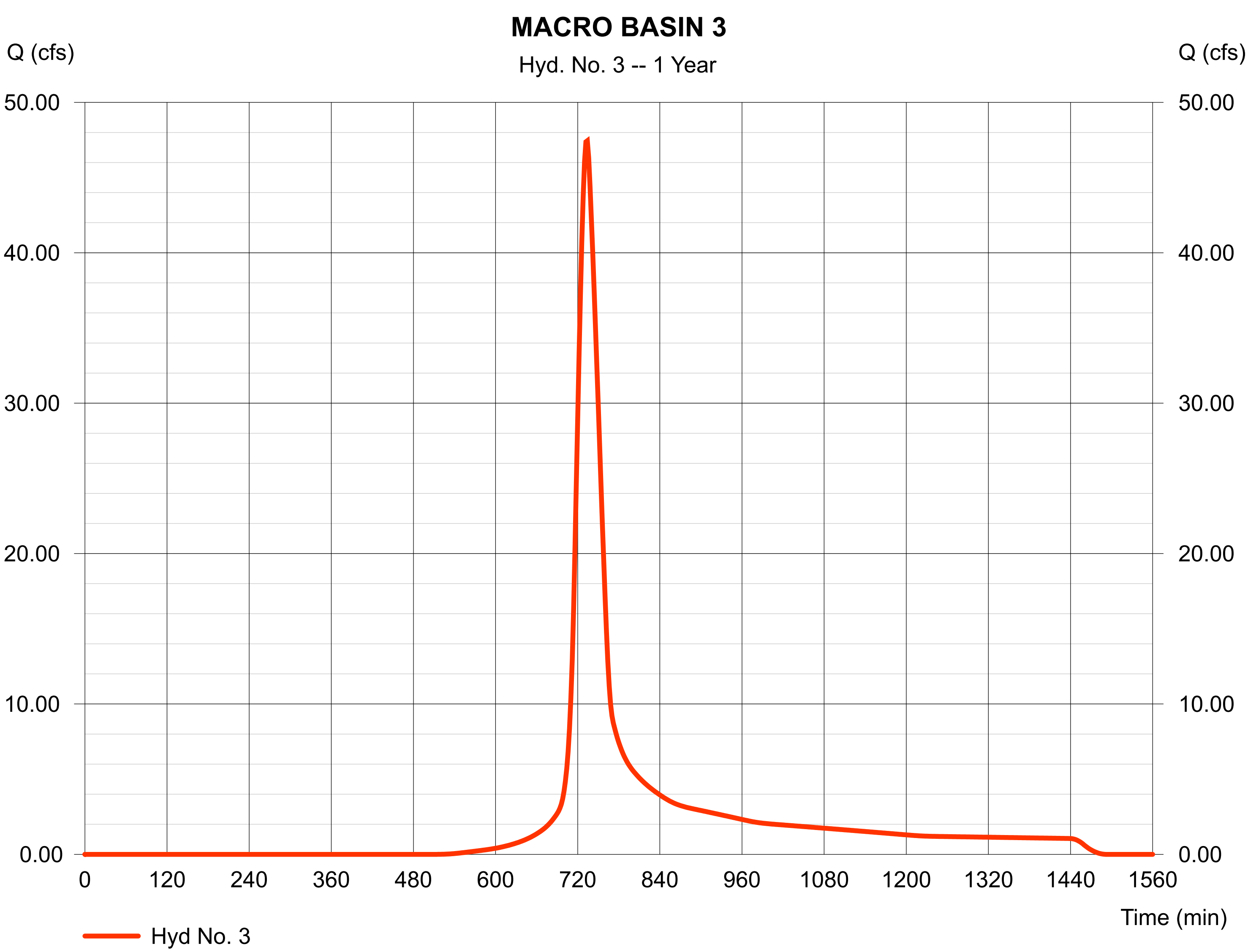
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 3

MACRO BASIN 3

Hydrograph type	= SCS Runoff	Peak discharge	= 47.45 cfs
Storm frequency	= 1 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 206,561 cuft
Drainage area	= 33.700 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 31.50 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



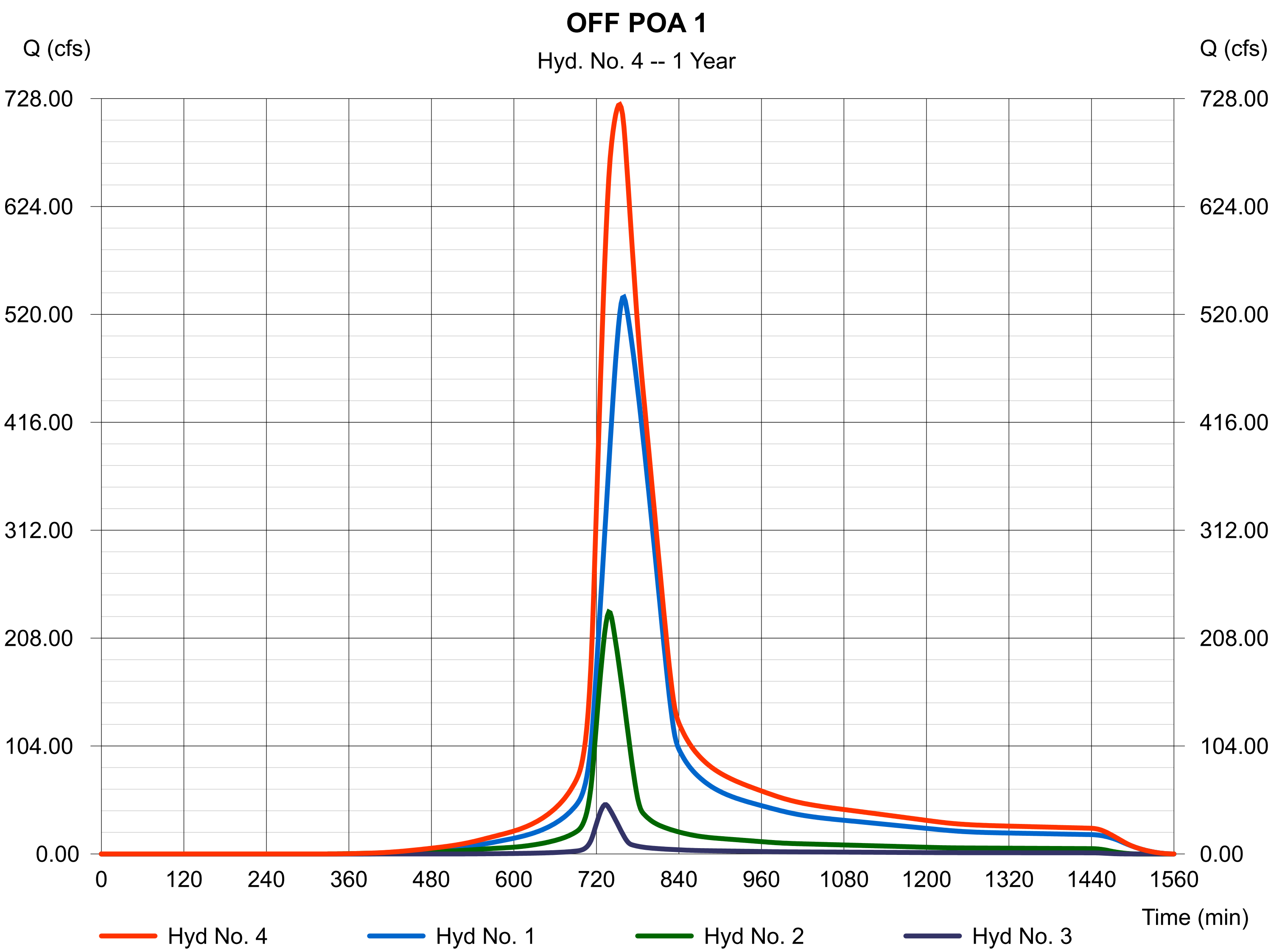
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 4

OFF POA 1

Hydrograph type	= Combine	Peak discharge	= 722.28 cfs
Storm frequency	= 1 yrs	Time to peak	= 754 min
Time interval	= 2 min	Hyd. volume	= 5,531,692 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 708.500 ac



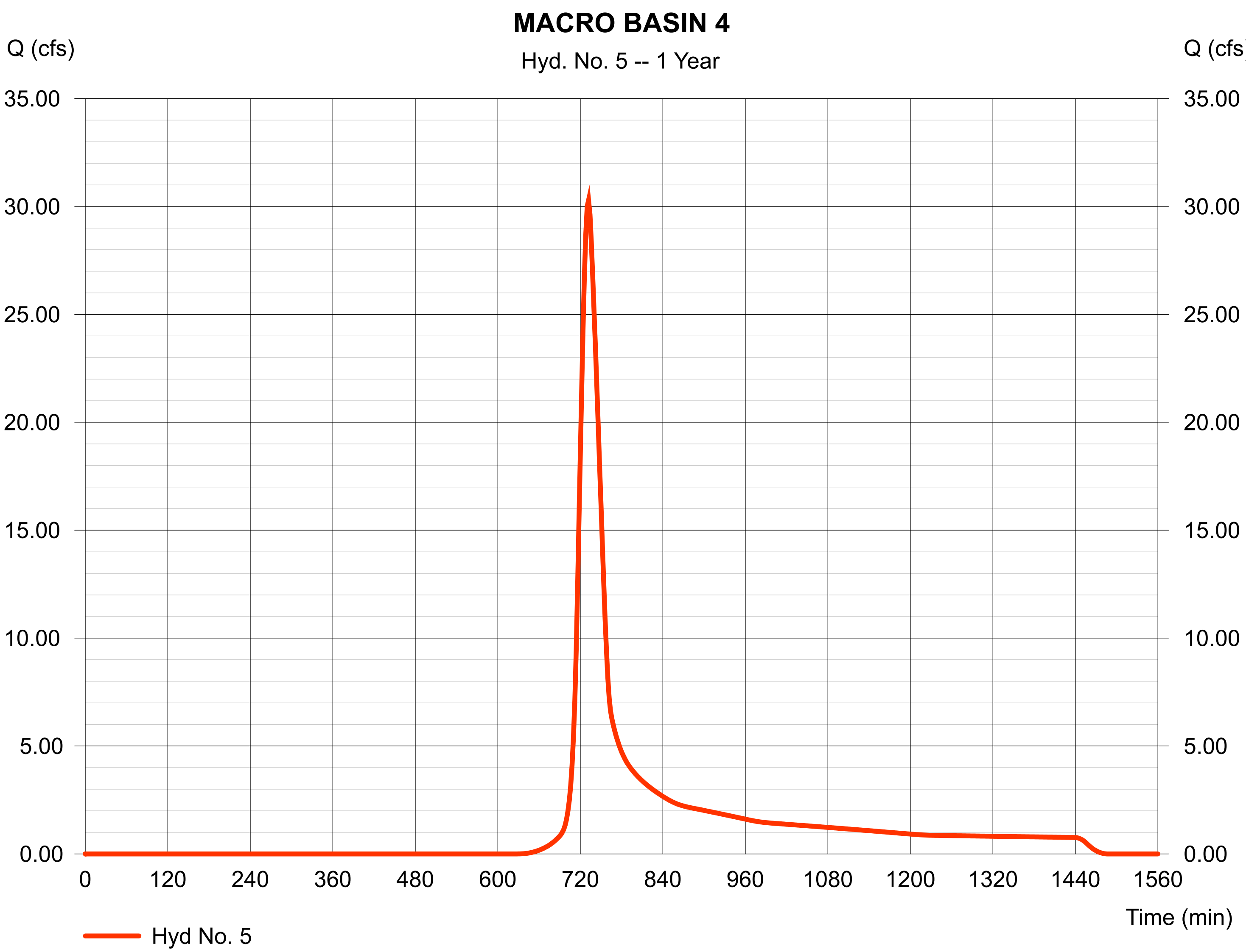
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 5

MACRO BASIN 4

Hydrograph type	= SCS Runoff	Peak discharge	= 30.29 cfs
Storm frequency	= 1 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 126,709 cuft
Drainage area	= 29.000 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 27.10 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



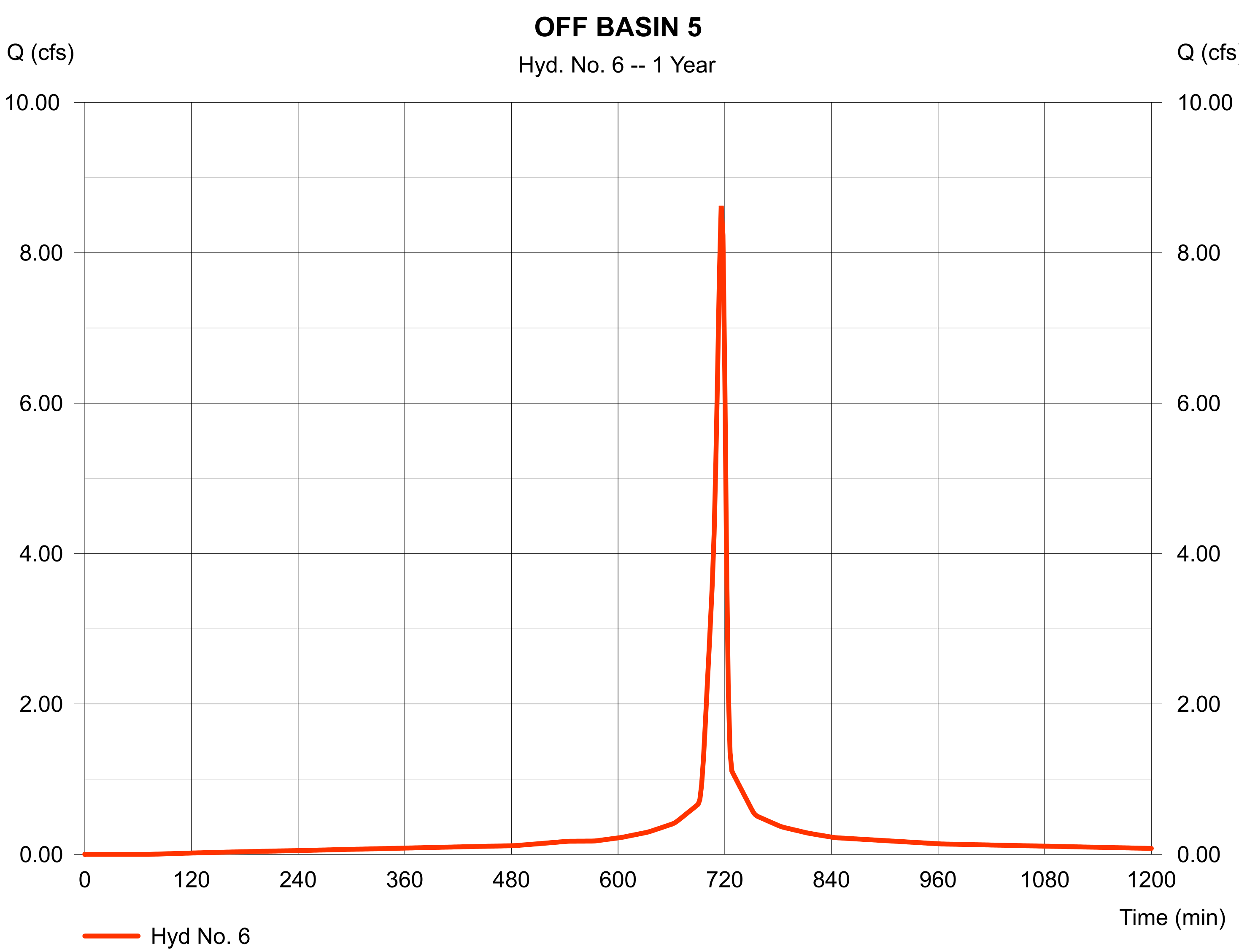
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 6

OFF BASIN 5

Hydrograph type	= SCS Runoff	Peak discharge	= 8.625 cfs
Storm frequency	= 1 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 20,218 cuft
Drainage area	= 1.900 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

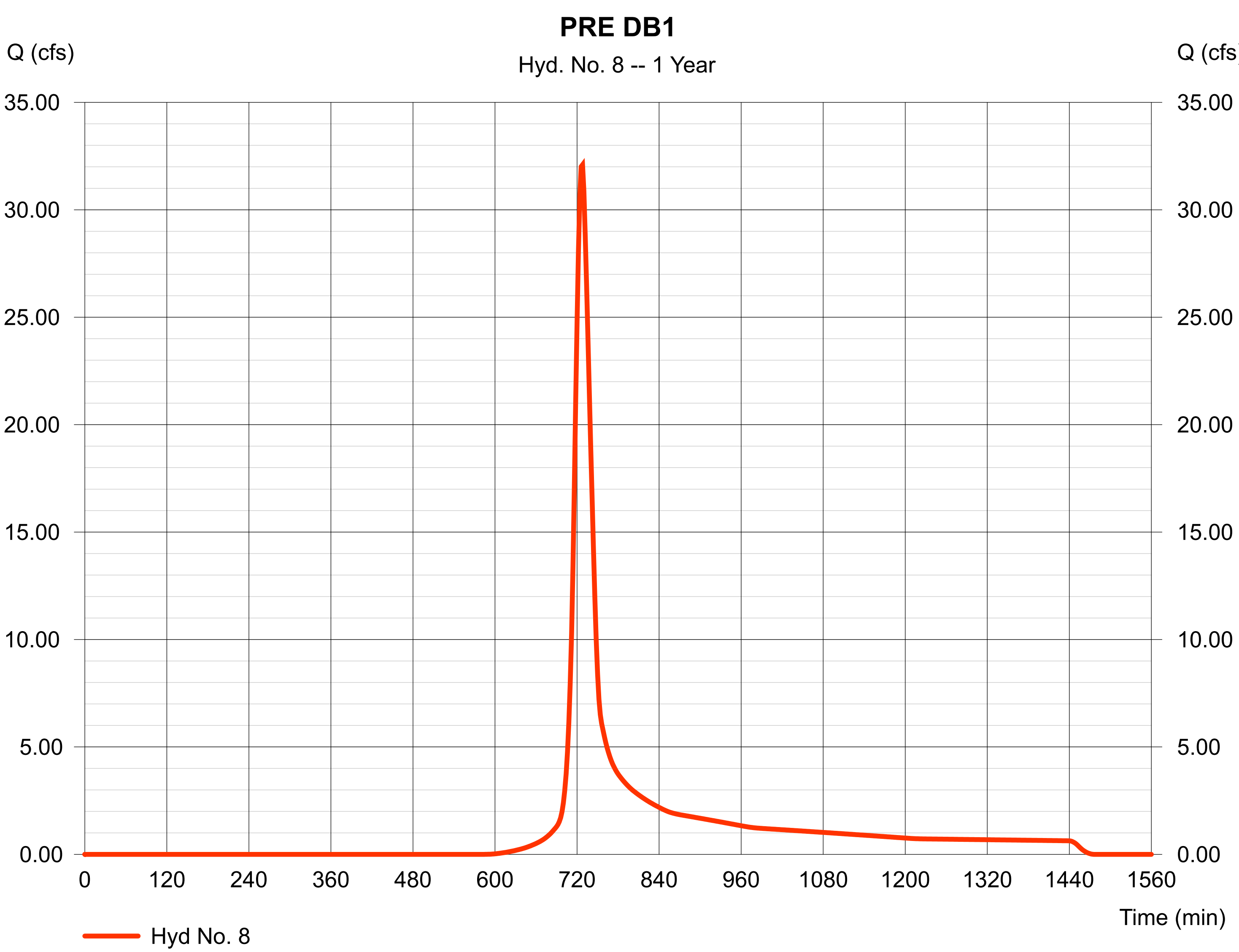
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 8

PRE DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 32.10 cfs
Storm frequency	= 1 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 113,239 cuft
Drainage area	= 22.020 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 20.73 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 22.020



Hydrograph Report

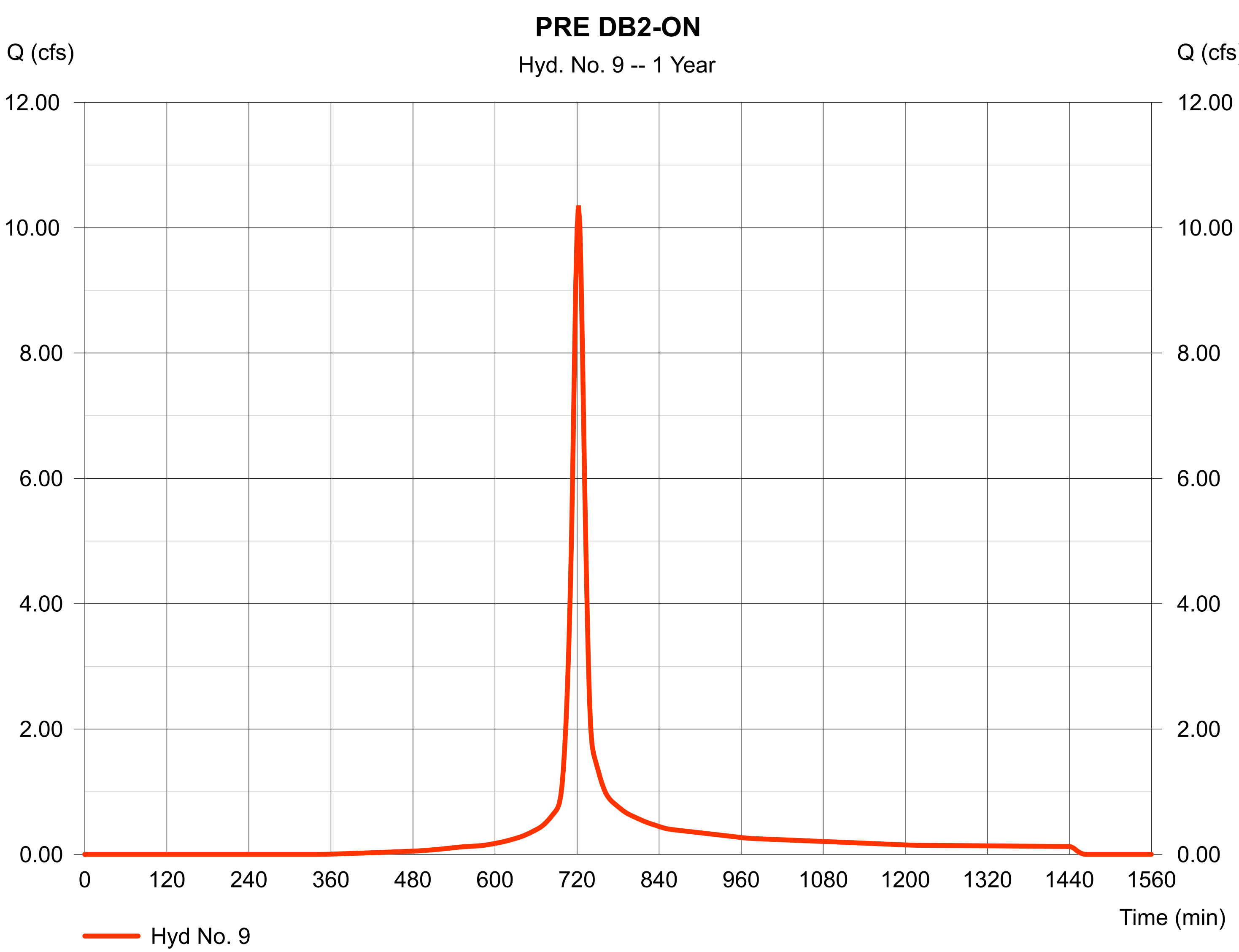
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 9

PRE DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 10.36 cfs
Storm frequency	= 1 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 29,335 cuft
Drainage area	= 3.720 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.33 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 3.720



Hydrograph Report

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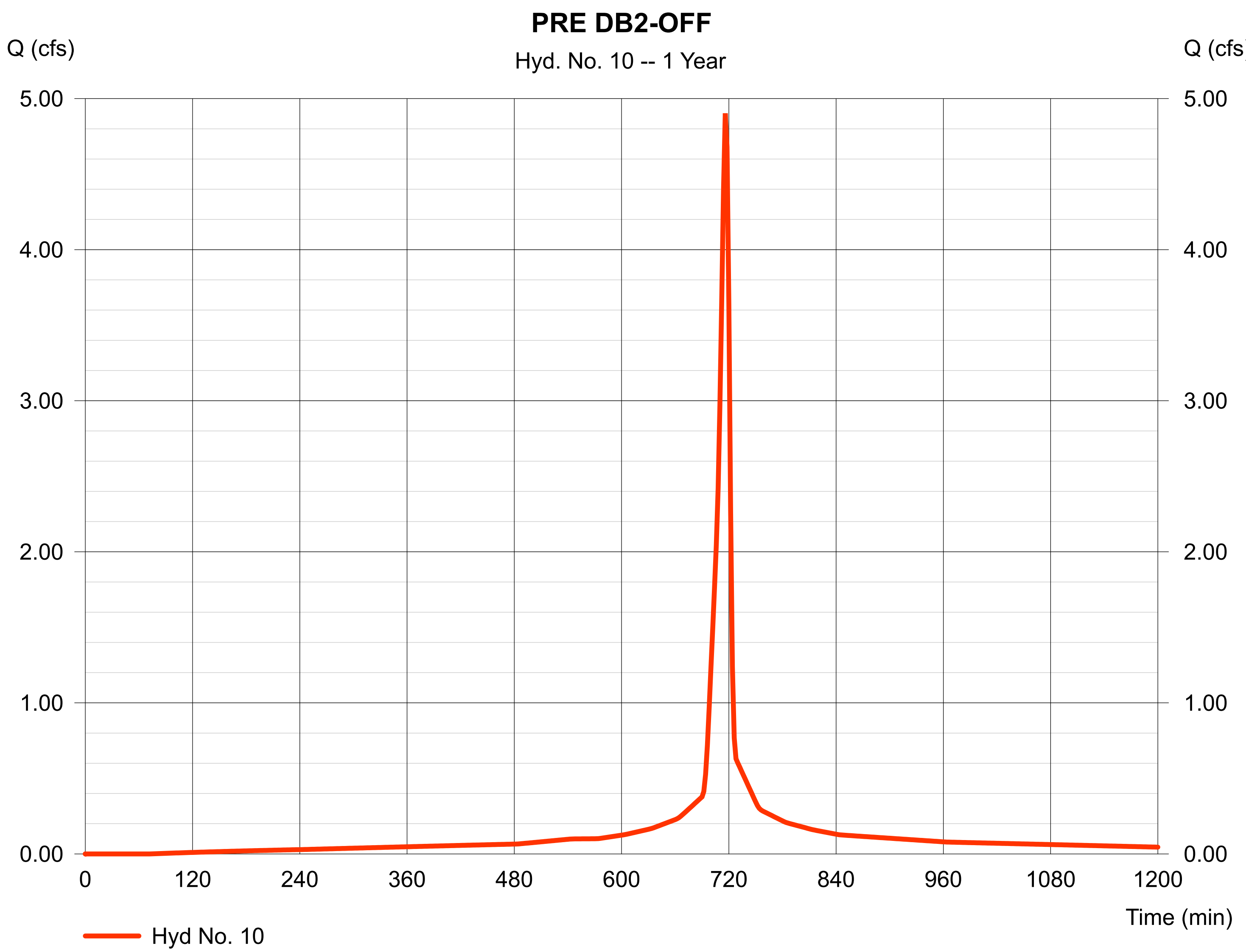
Hyd. No. 10

PRE DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 4.903 cfs
Storm frequency	= 1 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 11,493 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



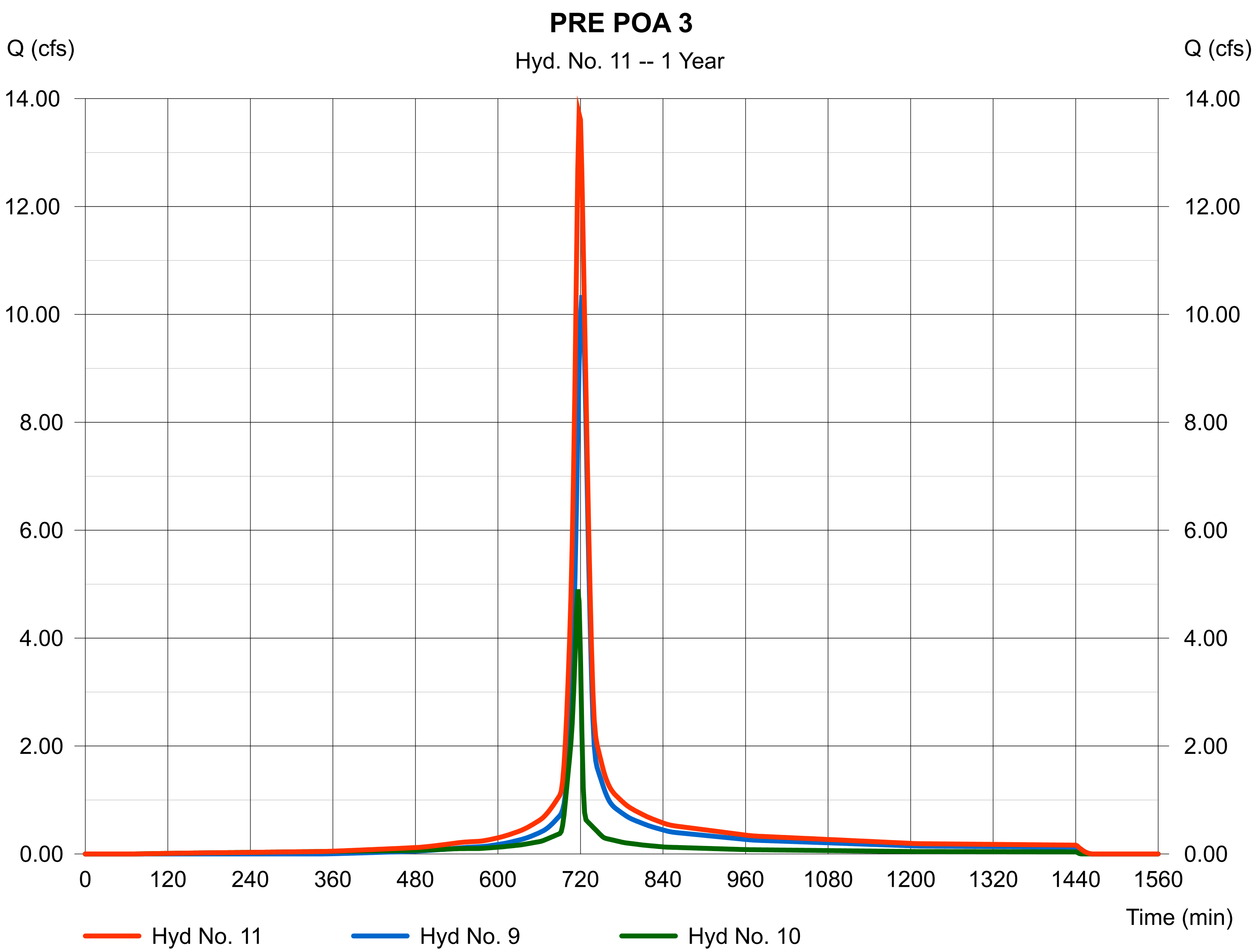
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 11

PRE POA 3

Hydrograph type	= Combine	Peak discharge	= 13.72 cfs
Storm frequency	= 1 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 40,828 cuft
Inflow hyds.	= 9, 10	Contrib. drain. area	= 4.800 ac



Hydrograph Report

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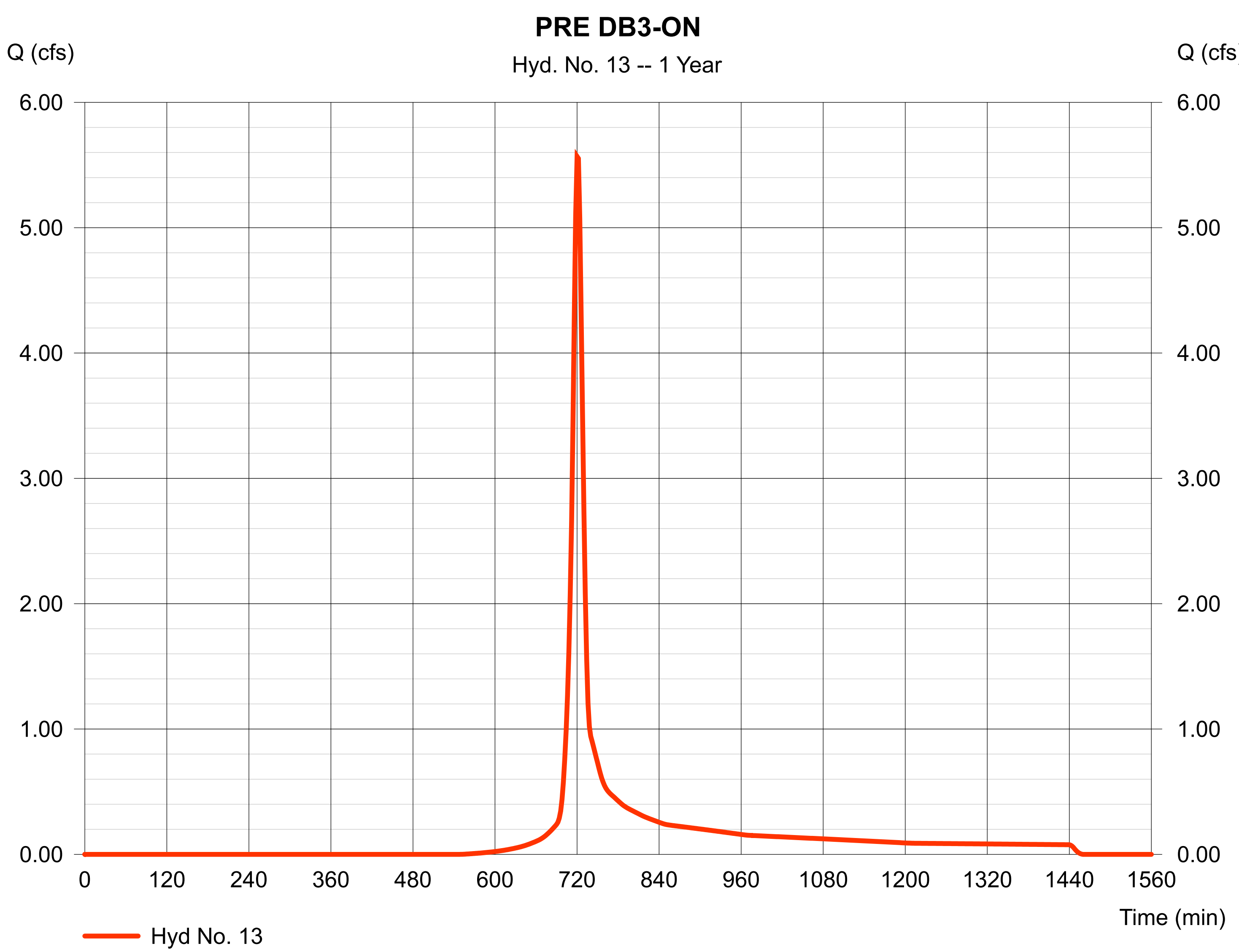
Hyd. No. 13

PRE DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 5.568 cfs
Storm frequency	= 1 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 14,510 cuft
Drainage area	= 2.540 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 55) + (0.570 x 61) + (2.130 x 98)] / 2.540



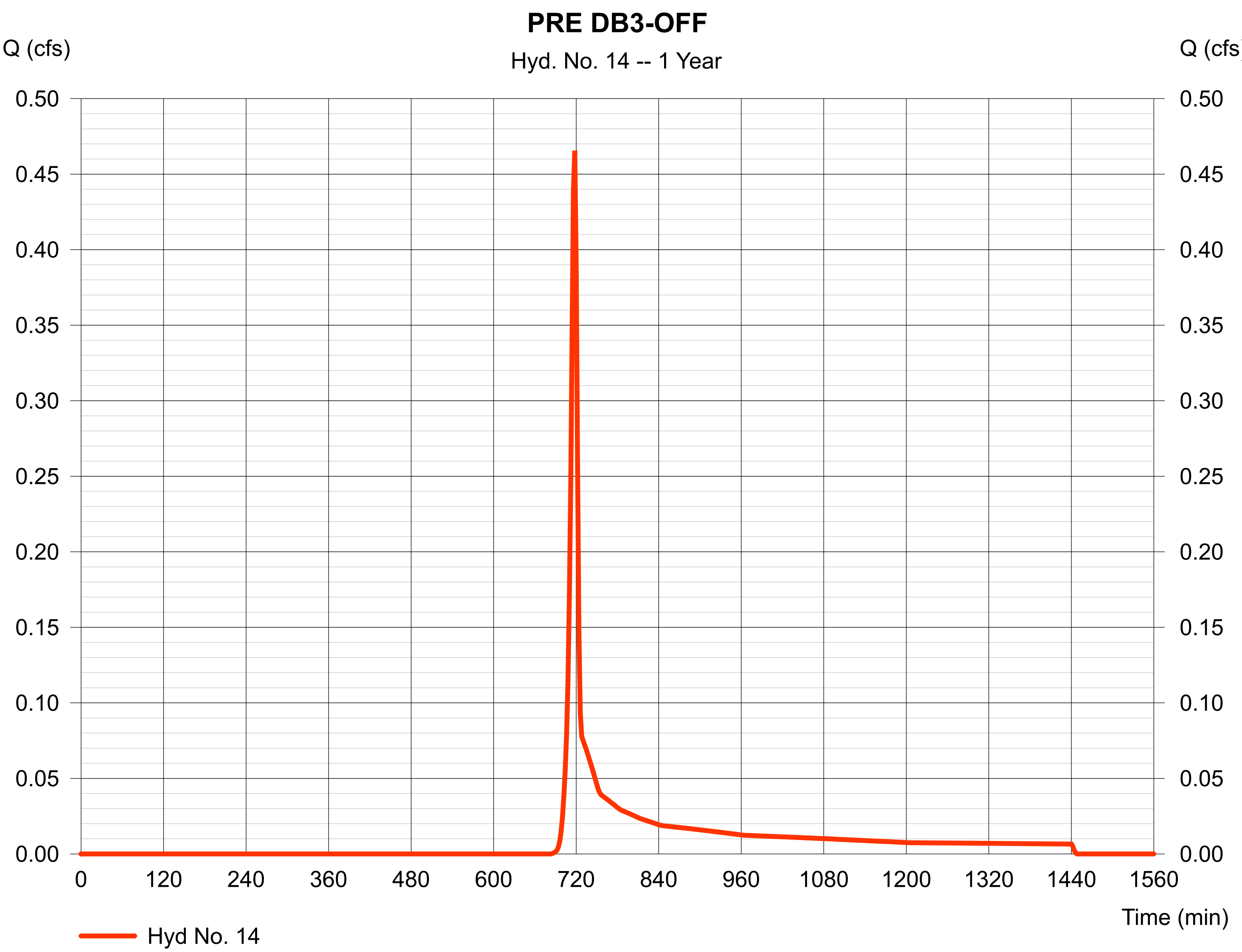
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 14

PRE DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 0.466 cfs
Storm frequency	= 1 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 949 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



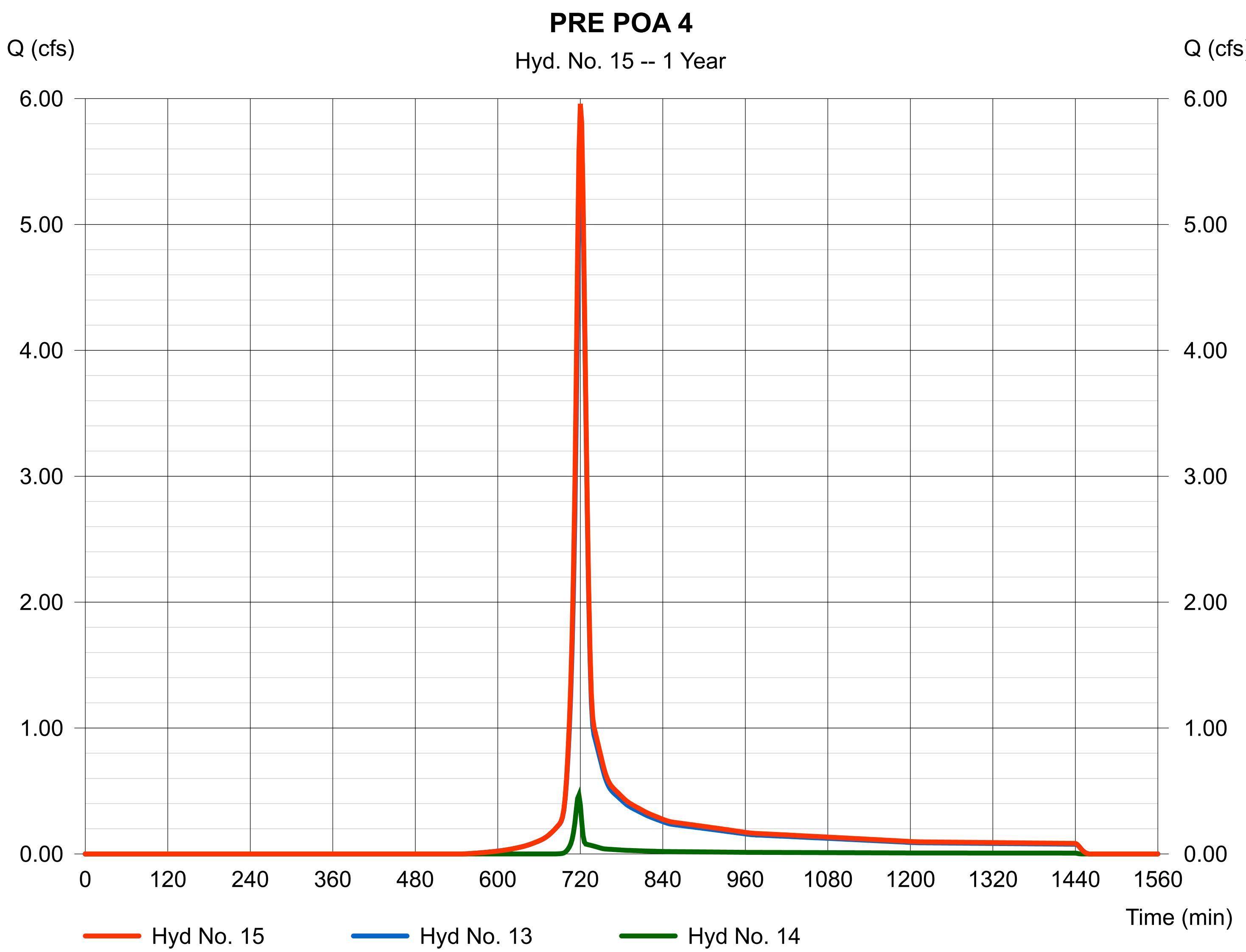
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 15

PRE POA 4

Hydrograph type	= Combine	Peak discharge	= 5.959 cfs
Storm frequency	= 1 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 15,459 cuft
Inflow hyds.	= 13, 14	Contrib. drain. area	= 2.860 ac



Hydrograph Report

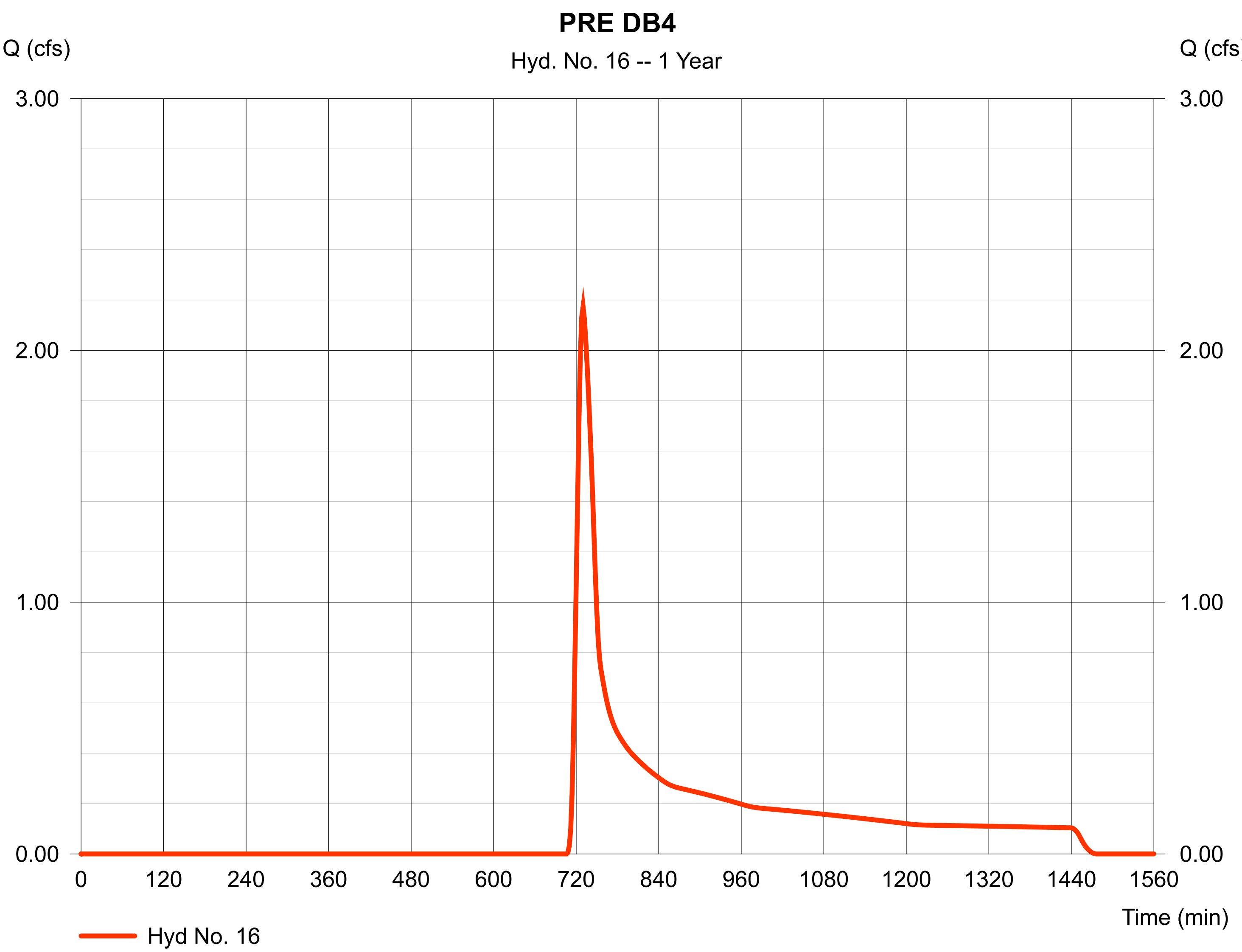
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 16

PRE DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 2.173 cfs
Storm frequency	= 1 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 11,486 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.12 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.160 x 61) + (1.840 x 55)] / 6.580



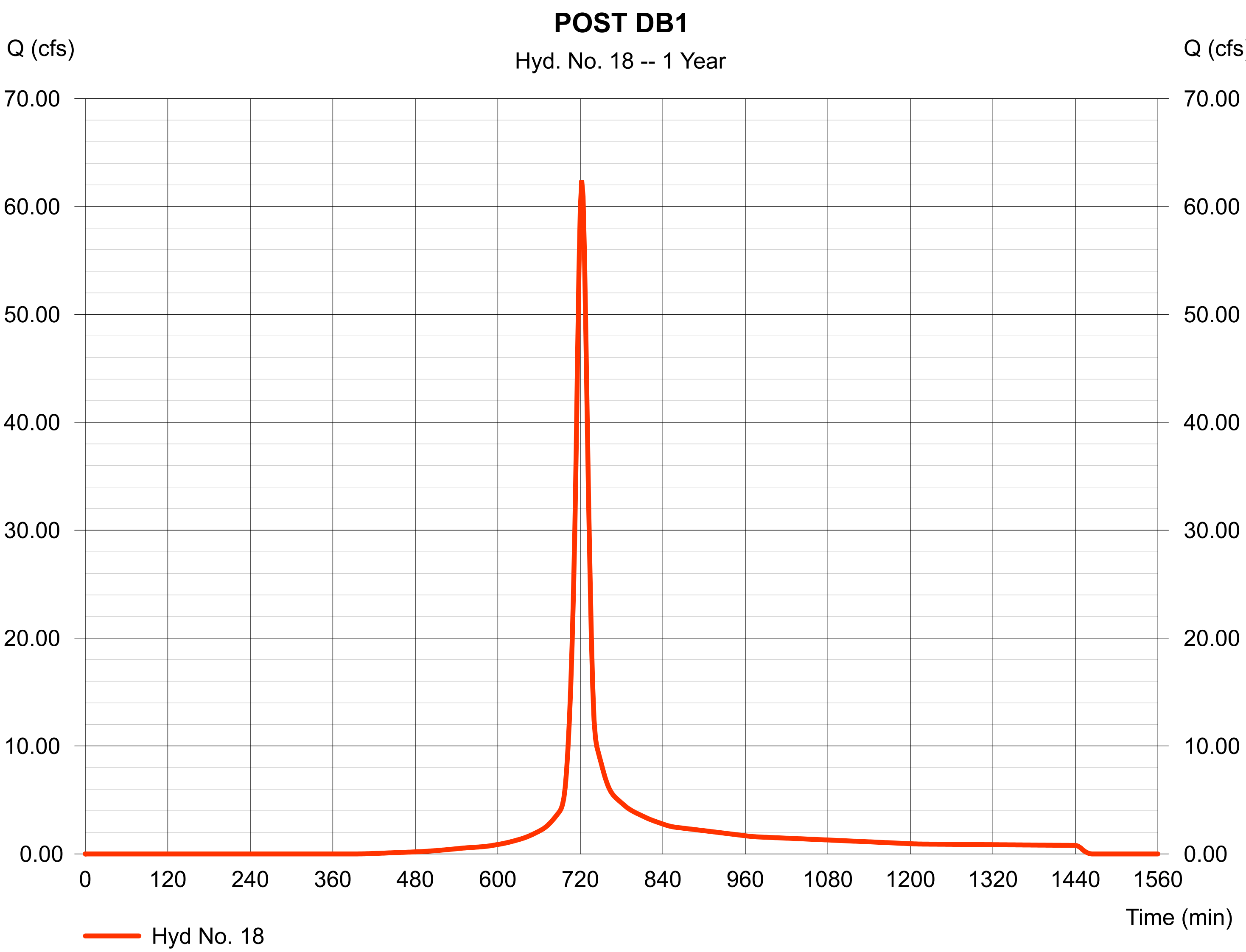
Hydrograph Report

Hyd. No. 18

POST DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 62.42 cfs
Storm frequency	= 1 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 175,603 cuft
Drainage area	= 24.120 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.62 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 98) + (0.310 x 55) + (0.510 x 61)] / 24.120



Hydrograph Report

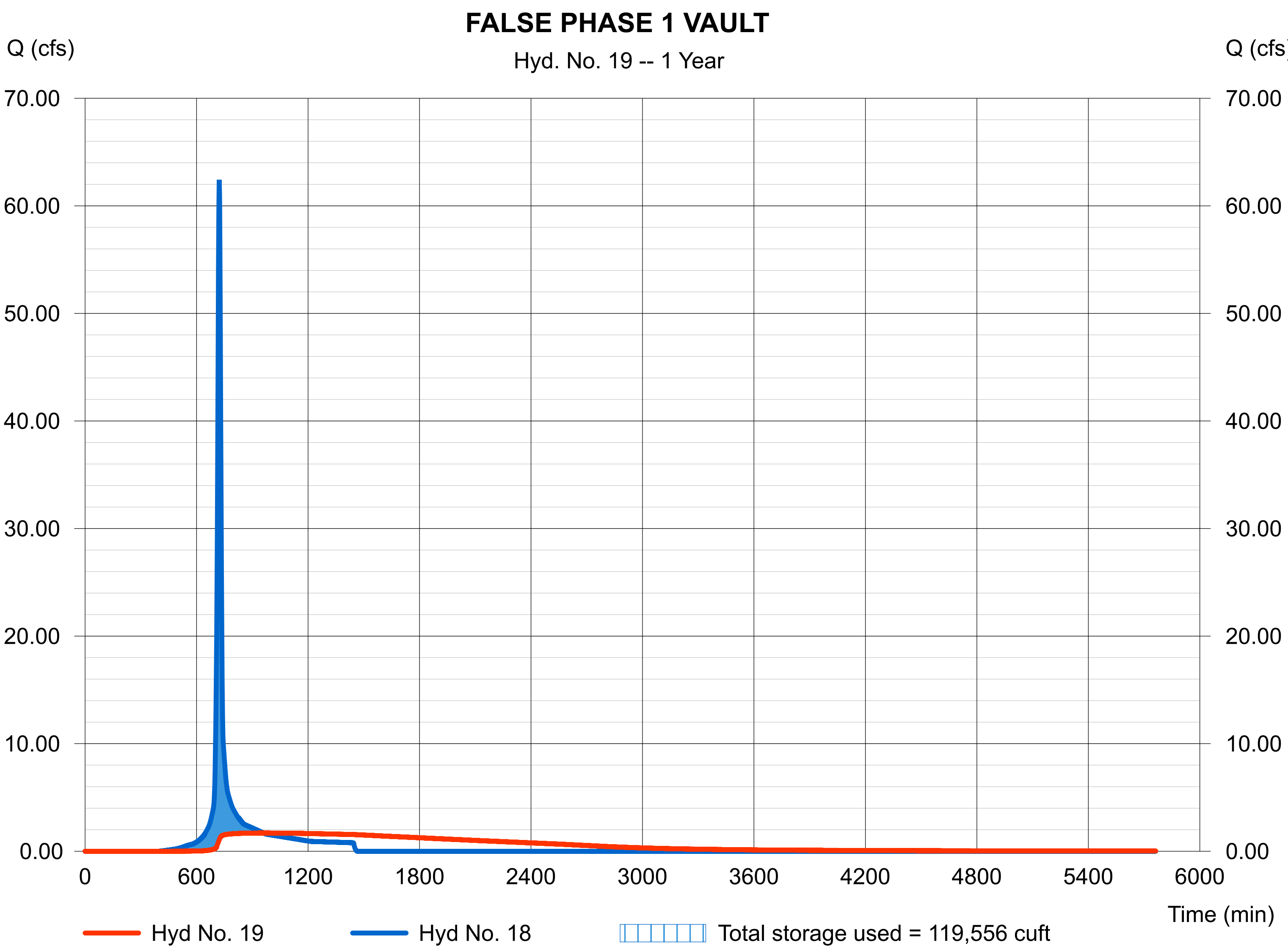
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 19

FALSE PHASE 1 VAULT

Hydrograph type	= Reservoir	Peak discharge	= 1.695 cfs
Storm frequency	= 1 yrs	Time to peak	= 958 min
Time interval	= 2 min	Hyd. volume	= 171,532 cuft
Inflow hyd. No.	= 18 - POST DB1	Max. Elevation	= 962.39 ft
Reservoir name	= FALSE POND	Max. Storage	= 119,556 cuft

Storage Indication method used.



Hydrograph Report

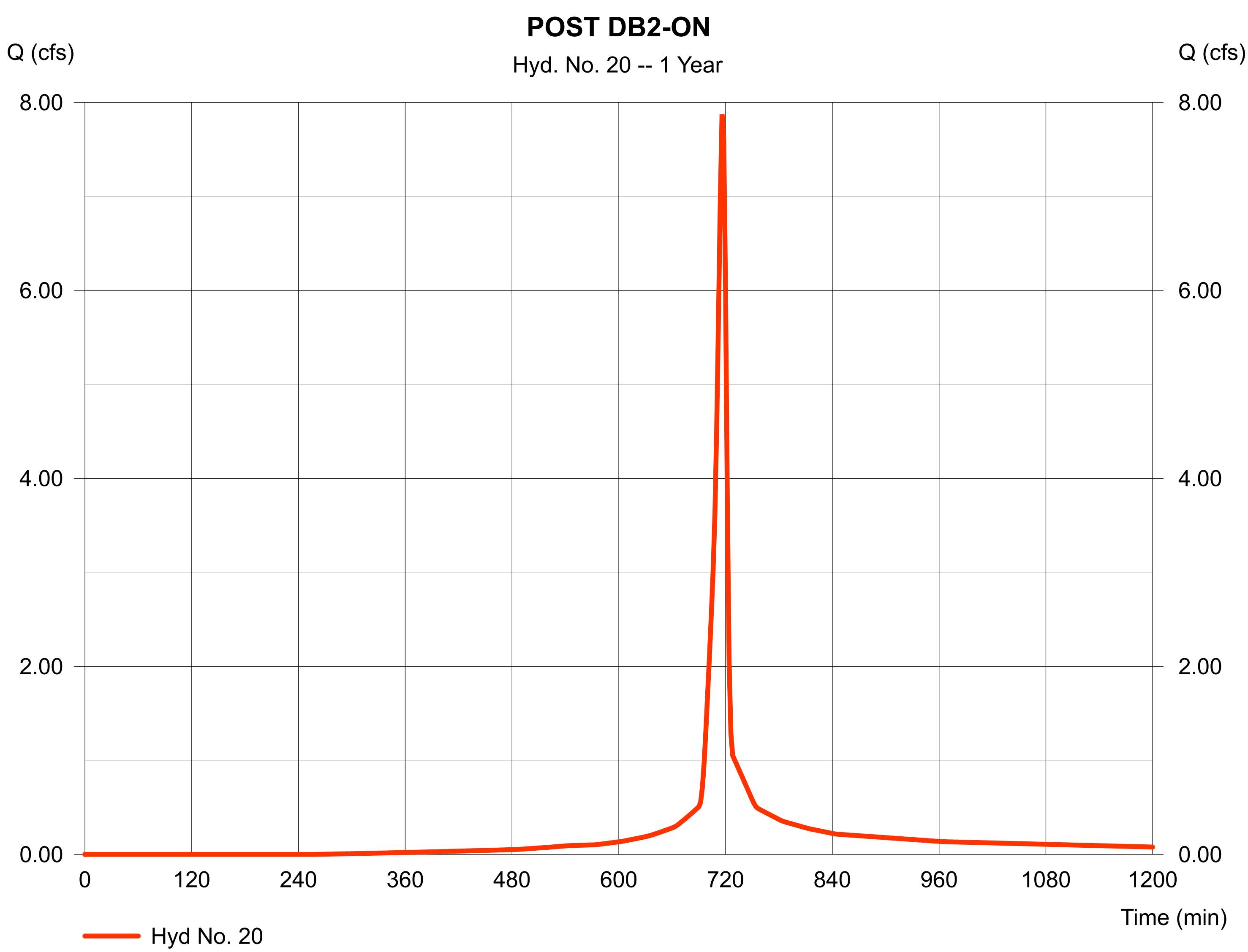
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 20

POST DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 7.874 cfs
Storm frequency	= 1 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 16,695 cuft
Drainage area	= 1.960 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.090 x 61) + (0.280 x 85) + (13.450 x 98) + (1.000 x 55)] / 1.960



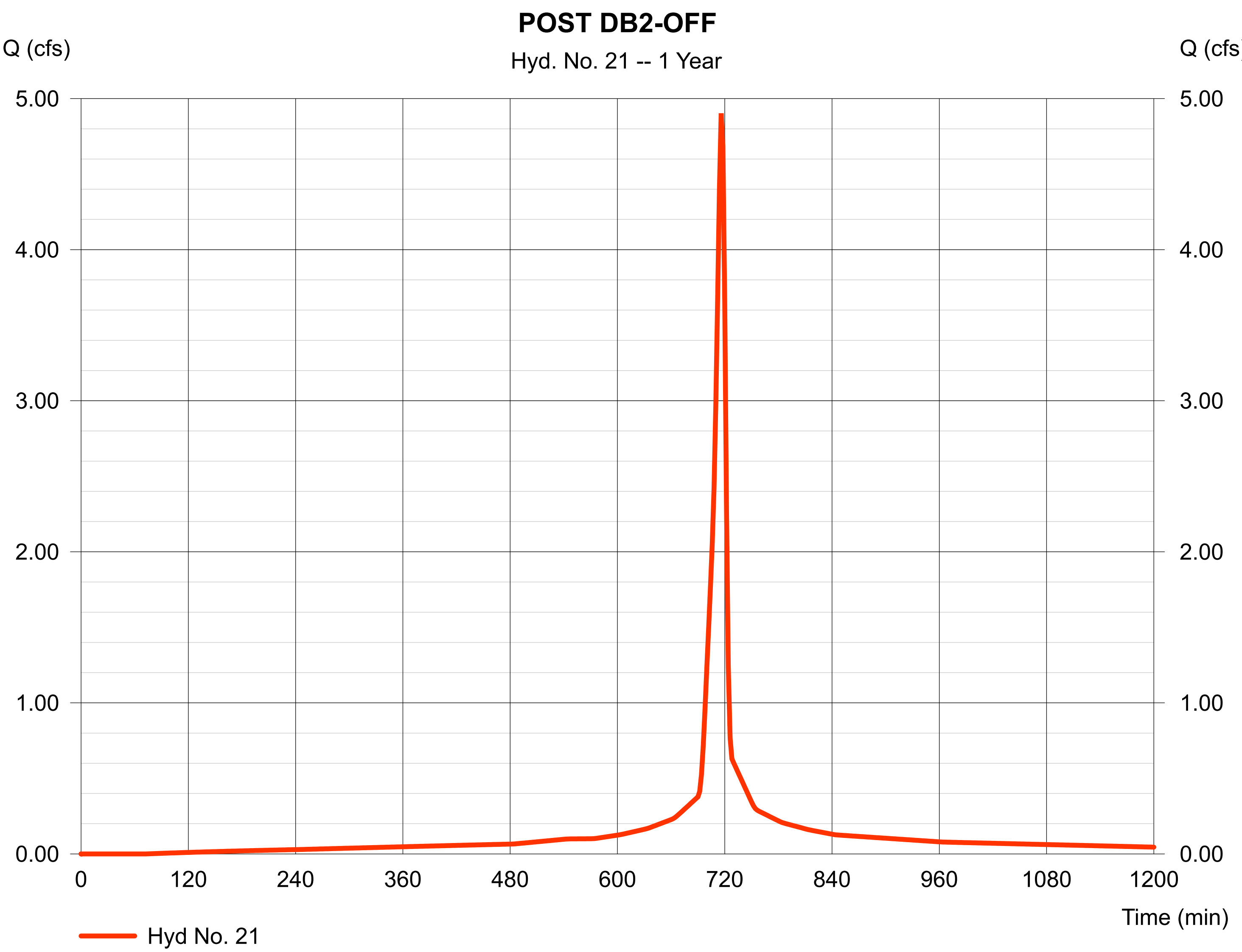
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 21

POST DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 4.903 cfs
Storm frequency	= 1 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 11,493 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



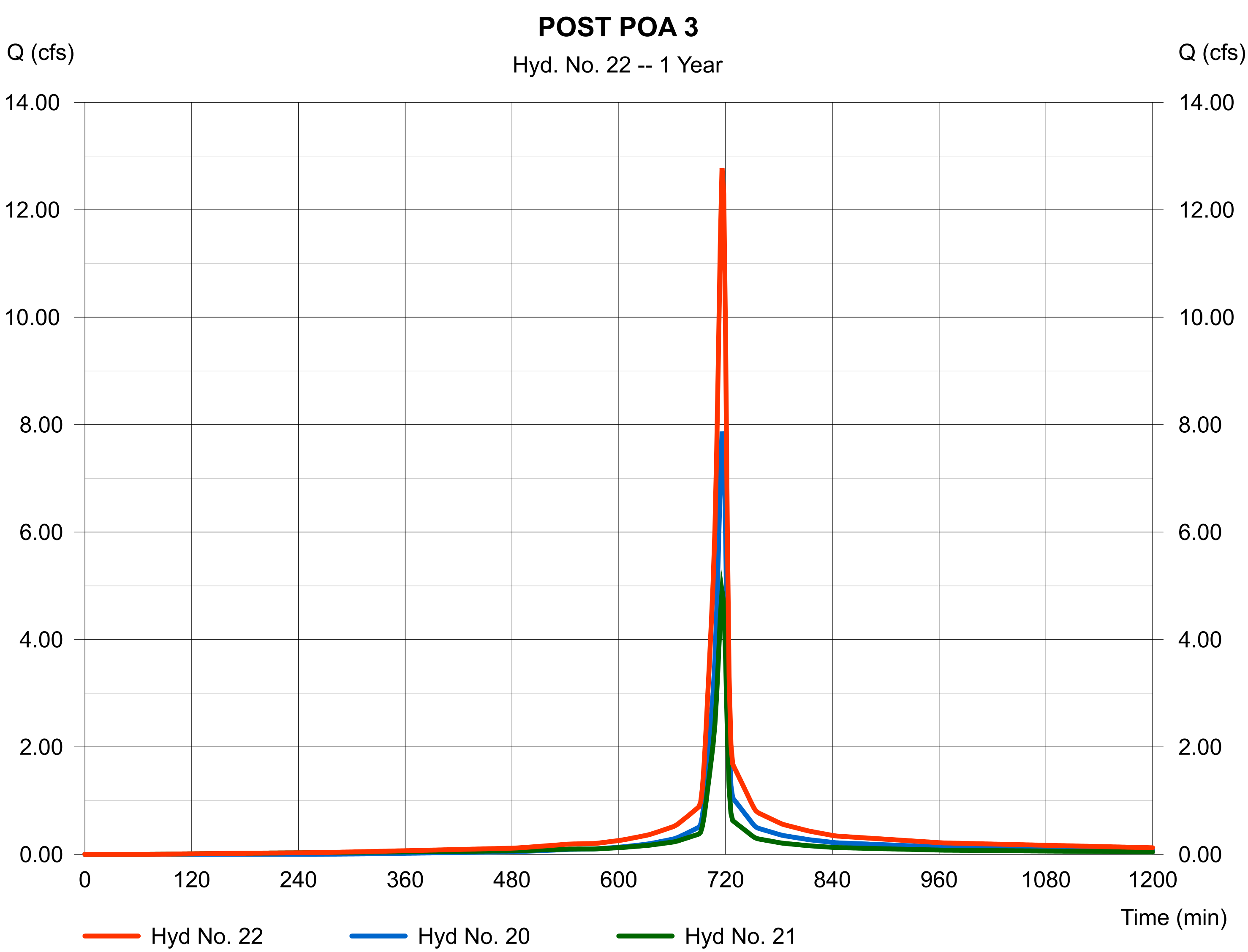
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 22

POST POA 3

Hydrograph type	= Combine	Peak discharge	= 12.78 cfs
Storm frequency	= 1 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 28,188 cuft
Inflow hyds.	= 20, 21	Contrib. drain. area	= 3.040 ac



Hydrograph Report

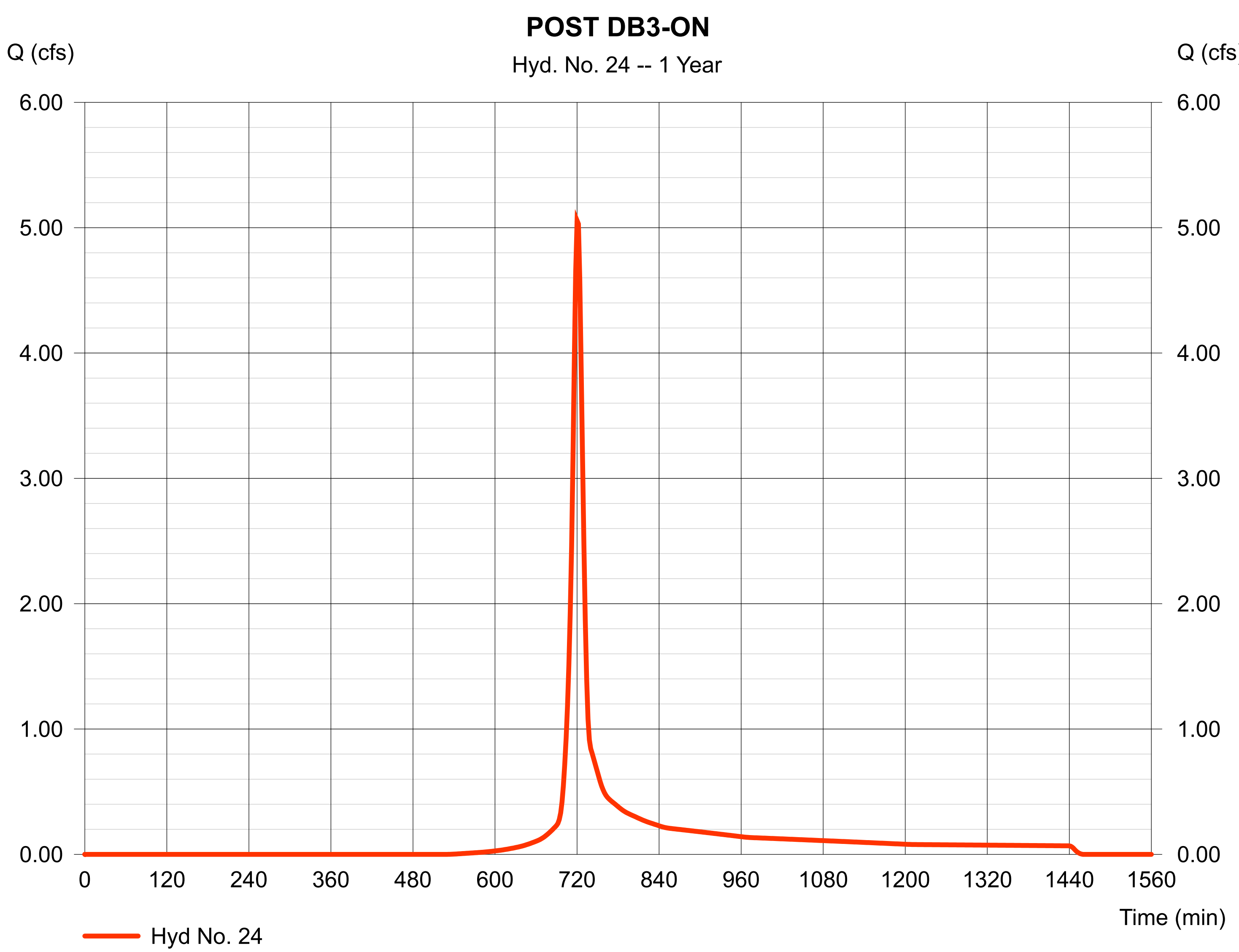
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 24

POST DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 5.056 cfs
Storm frequency	= 1 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 13,143 cuft
Drainage area	= 2.200 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (2.810 x 61) + (10.490 x 98)] / 2.200



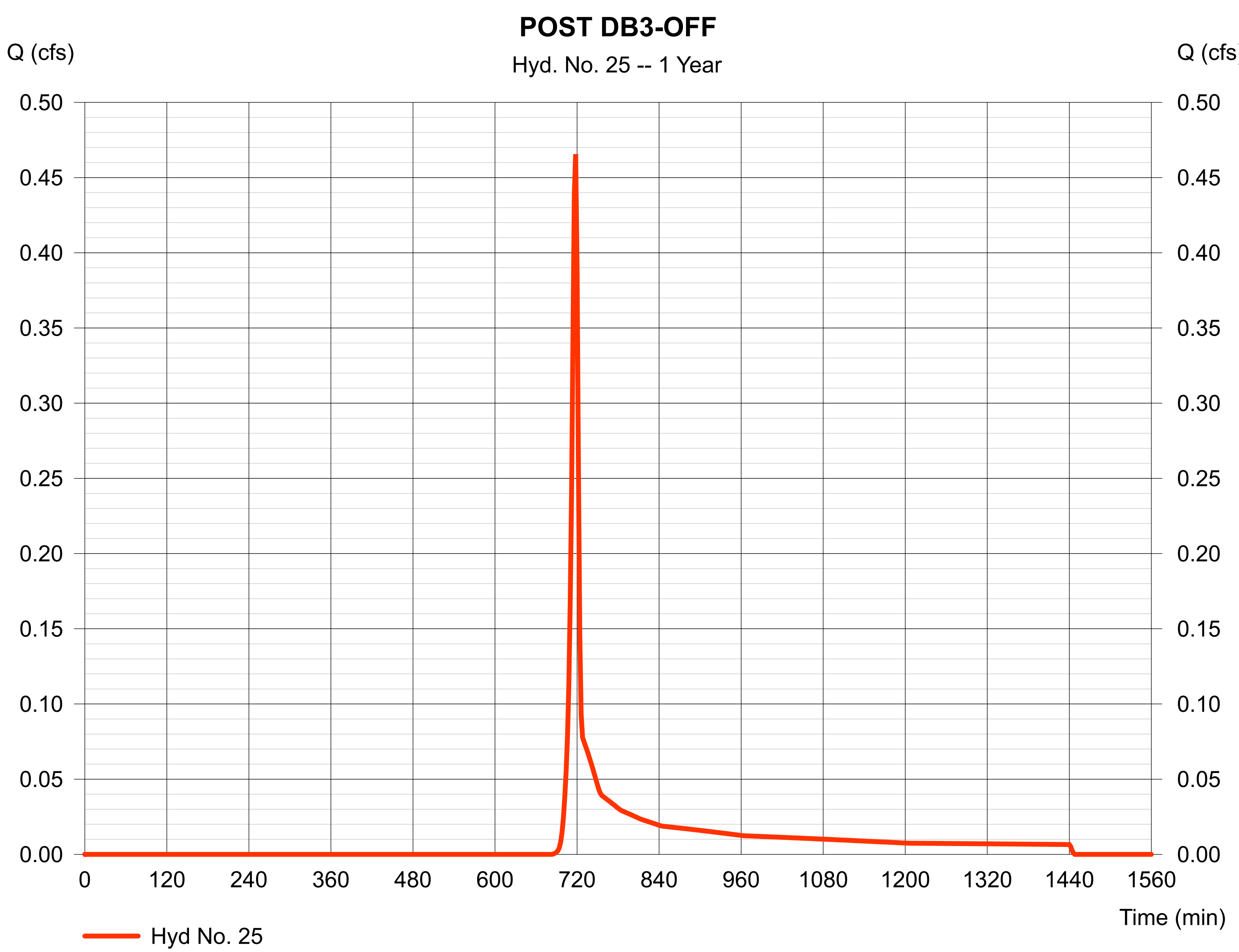
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 25

POST DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 0.466 cfs
Storm frequency	= 1 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 949 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



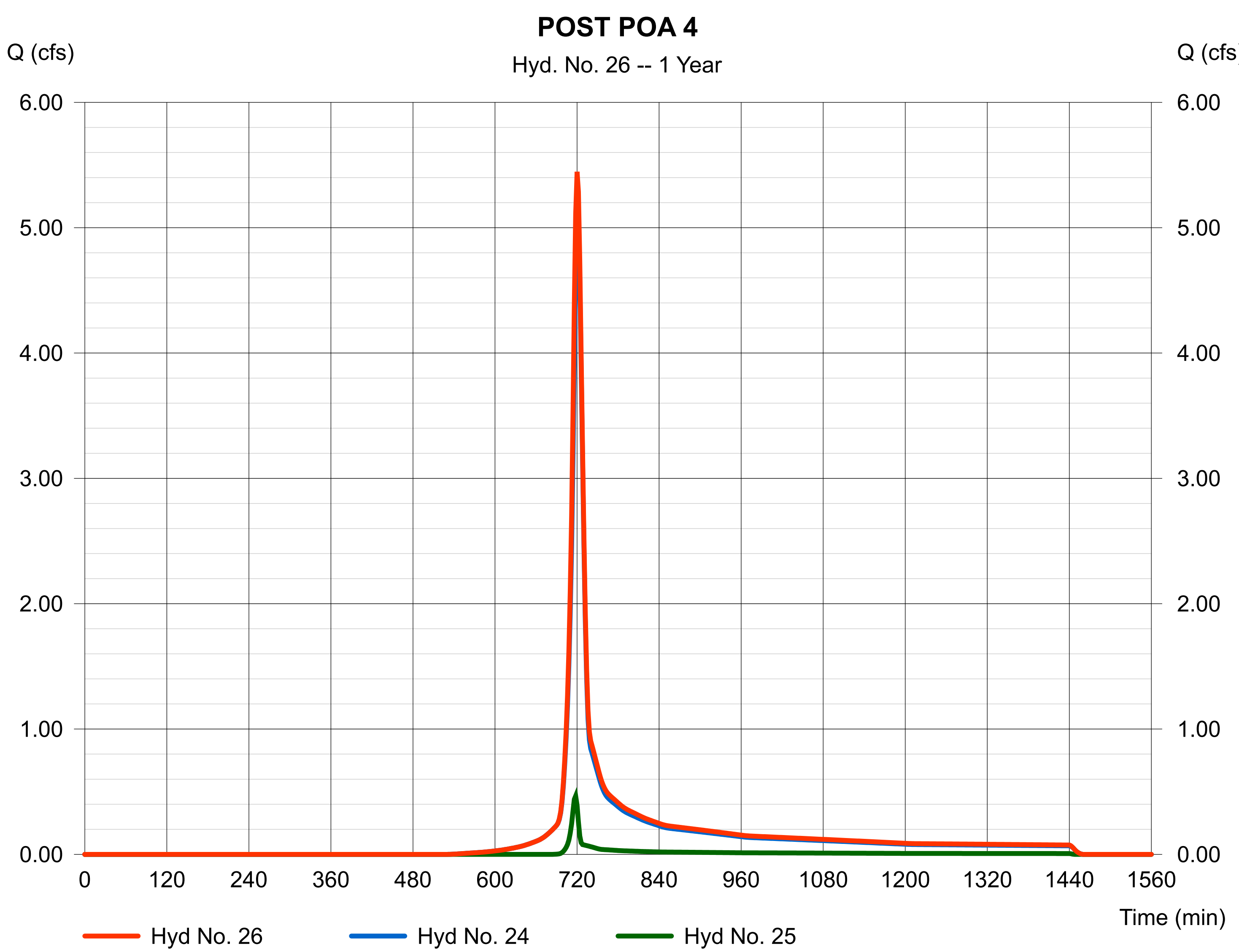
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 26

POST POA 4

Hydrograph type	= Combine	Peak discharge	= 5.446 cfs
Storm frequency	= 1 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 14,092 cuft
Inflow hyds.	= 24, 25	Contrib. drain. area	= 2.520 ac



Hydrograph Report

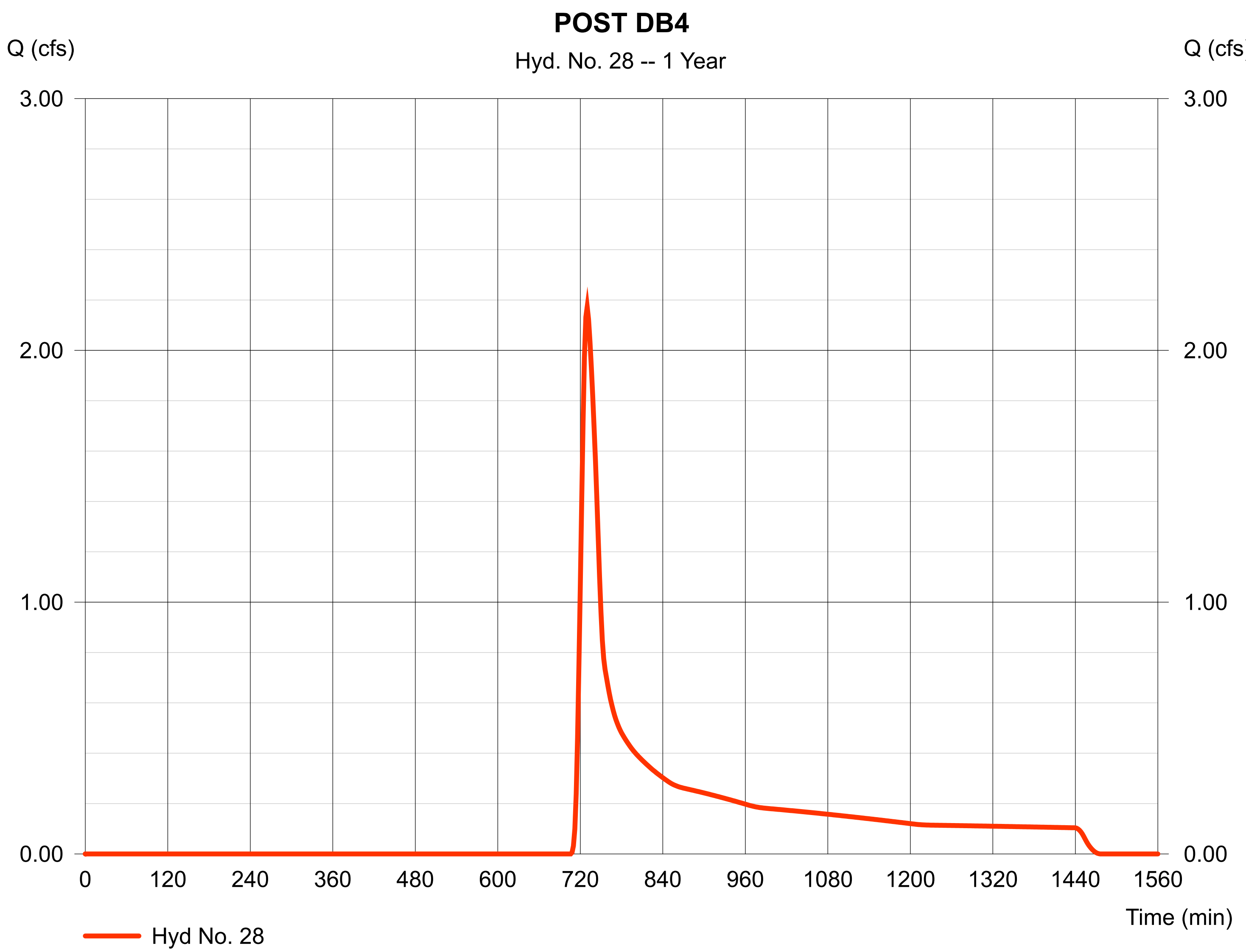
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 28

POST DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 2.173 cfs
Storm frequency	= 1 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 11,486 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.94 min
Total precip.	= 3.36 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.520 x 98) + (4.480 x 61)] / 6.580



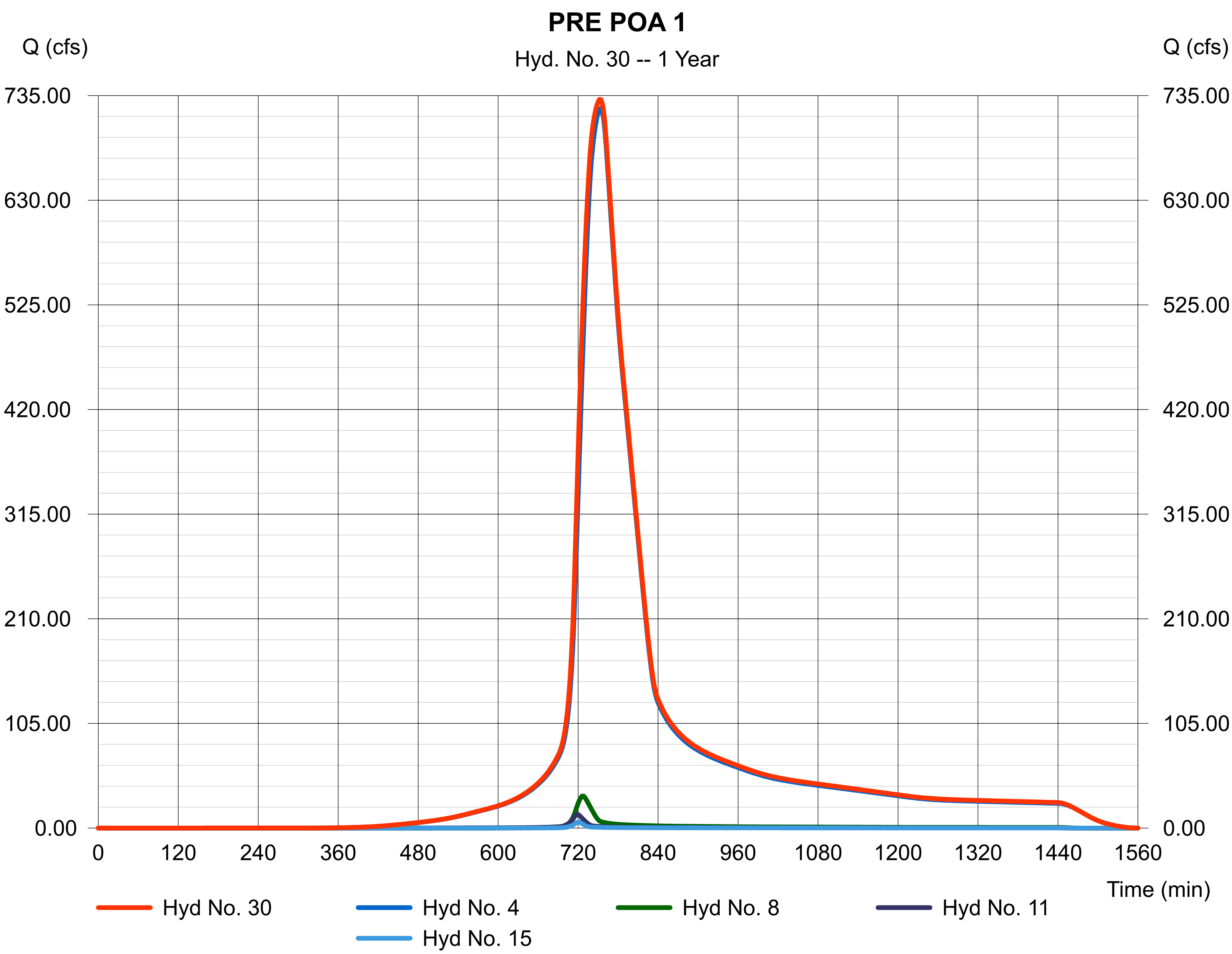
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 30

PRE POA 1

Hydrograph type	= Combine	Peak discharge	= 731.08 cfs
Storm frequency	= 1 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 5,701,221 cuft
Inflow hyds.	= 4, 8, 11, 15	Contrib. drain. area	= 22.020 ac



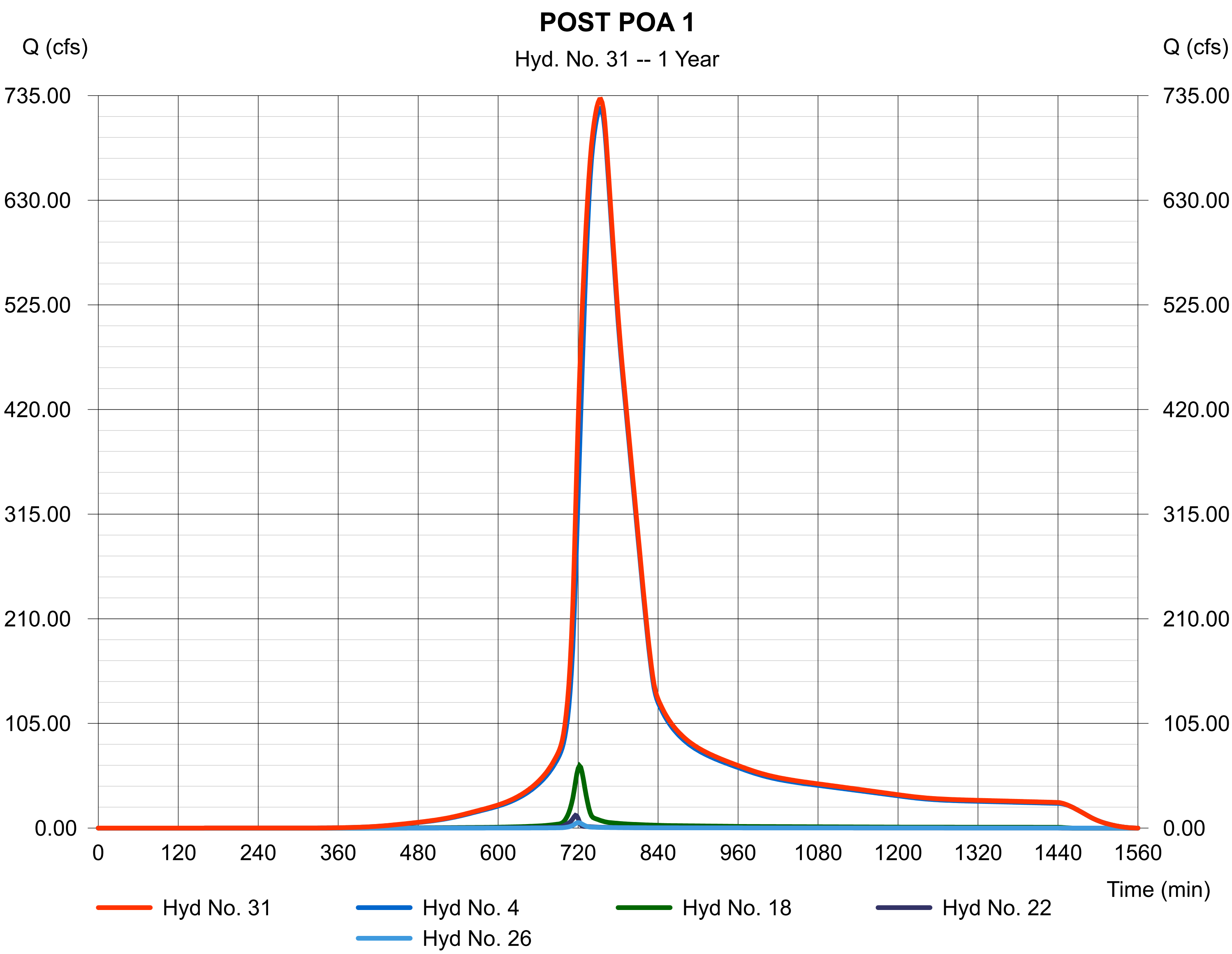
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 31

POST POA 1

Hydrograph type	= Combine	Peak discharge	= 731.25 cfs
Storm frequency	= 1 yrs	Time to peak	= 754 min
Time interval	= 2 min	Hyd. volume	= 5,749,572 cuft
Inflow hyds.	= 4, 18, 22, 26	Contrib. drain. area	= 24.120 ac



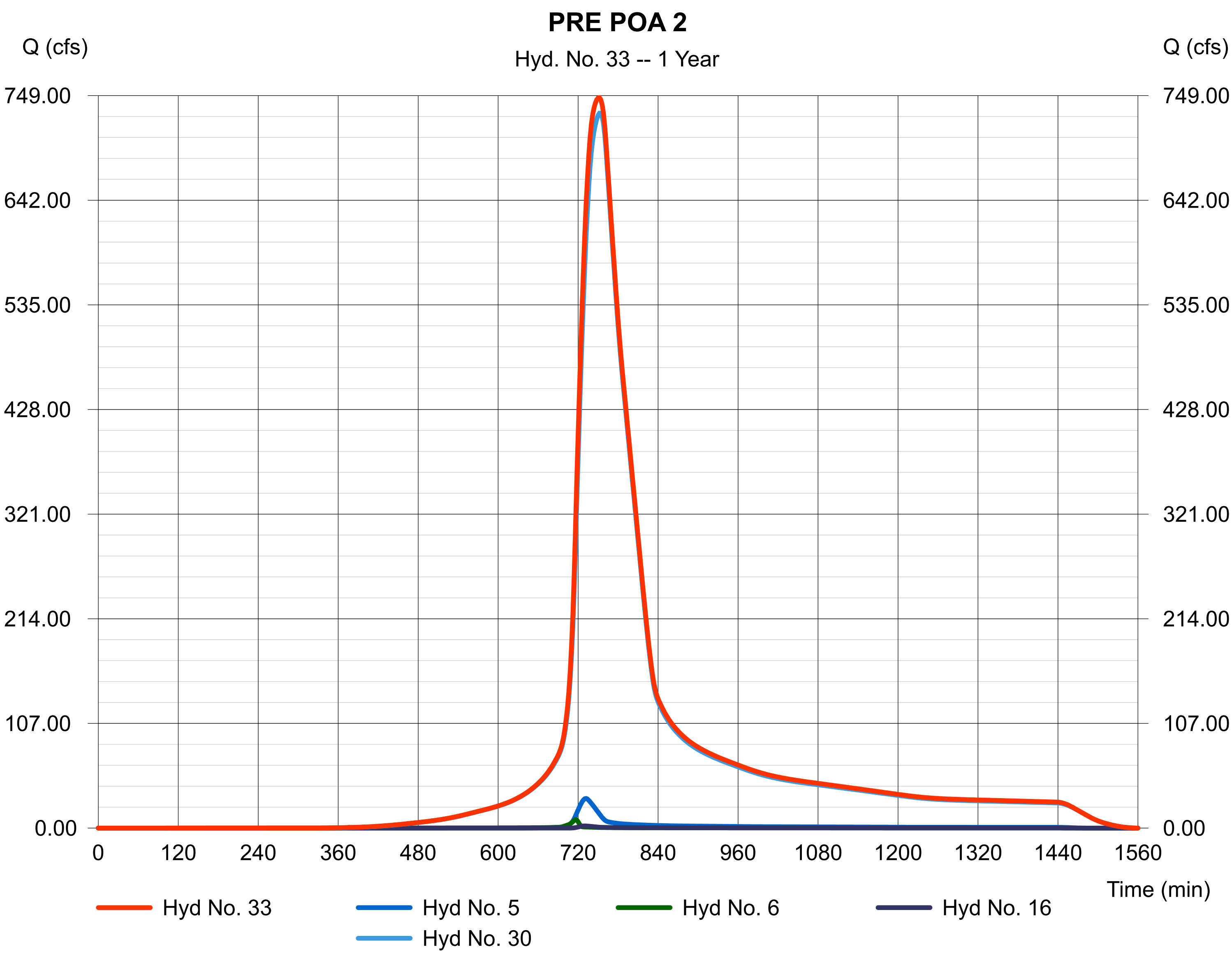
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 33

PRE POA 2

Hydrograph type	= Combine	Peak discharge	= 746.88 cfs
Storm frequency	= 1 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 5,859,631 cuft
Inflow hyds.	= 5, 6, 16, 30	Contrib. drain. area	= 37.480 ac



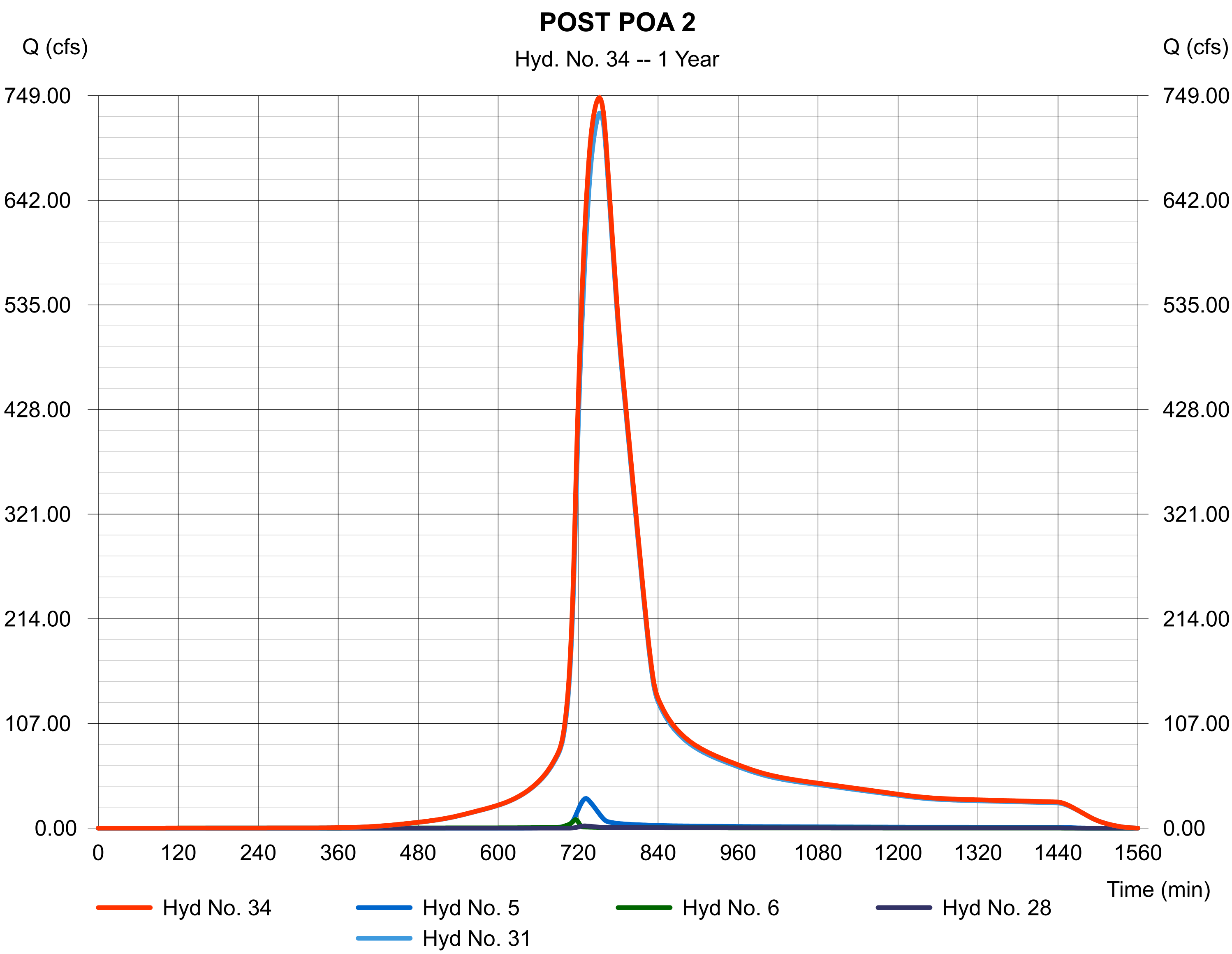
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 34

POST POA 2

Hydrograph type	= Combine	Peak discharge	= 746.84 cfs
Storm frequency	= 1 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 5,907,988 cuft
Inflow hyds.	= 5, 6, 28, 31	Contrib. drain. area	= 37.480 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	700.87	2	760	5,391,185	------	------	------	MACRO BASIN 1
2	SCS Runoff	299.40	2	738	1,559,810	------	------	------	MACRO BASIN 2
3	SCS Runoff	65.02	2	732	281,348	------	------	------	MACRO BASIN 3
4	Combine	940.84	2	754	7,232,342	1, 2, 3	------	------	OFF POA 1
5	SCS Runoff	44.52	2	732	181,791	------	------	------	MACRO BASIN 4
6	SCS Runoff	10.51	2	716	24,861	------	------	------	OFF BASIN 5
8	SCS Runoff	45.59	2	726	158,723	------	------	------	PRE DB1
9	SCS Runoff	13.34	2	722	38,158	------	------	------	PRE DB2-ON
10	SCS Runoff	5.973	2	716	14,132	------	------	------	PRE DB2-OFF
11	Combine	17.43	2	718	52,290	9, 10	------	------	PRE POA 3
13	SCS Runoff	7.730	2	720	20,043	------	------	------	PRE DB3-ON
14	SCS Runoff	0.717	2	718	1,436	------	------	------	PRE DB3-OFF
15	Combine	8.320	2	720	21,479	13, 14	------	------	PRE POA 4
16	SCS Runoff	4.482	2	728	19,482	------	------	------	PRE DB4
18	SCS Runoff	81.66	2	722	231,356	------	------	------	POST DB1
19	Reservoir	8.627	2	758	227,188	18	962.66	133,028	FALSE PHASE 1 VAULT
20	SCS Runoff	9.900	2	716	21,310	------	------	------	POST DB2-ON
21	SCS Runoff	5.973	2	716	14,132	------	------	------	POST DB2-OFF
22	Combine	15.87	2	716	35,442	20, 21	------	------	POST POA 3
24	SCS Runoff	6.954	2	720	18,027	------	------	------	POST DB3-ON
25	SCS Runoff	0.717	2	718	1,436	------	------	------	POST DB3-OFF
26	Combine	7.544	2	720	19,463	24, 25	------	------	POST POA 4
28	SCS Runoff	4.482	2	728	19,482	------	------	------	POST DB4
30	Combine	953.46	2	752	7,464,833	4, 8, 11, 15,	------	------	PRE POA 1
31	Combine	952.84	2	752	7,518,601	4, 18, 22, 26,	------	------	POST POA 1
33	Combine	976.84	2	750	7,690,967	5, 6, 16, 30,	------	------	PRE POA 2
34	Combine	975.20	2	752	7,744,737	5, 6, 28, 31,	------	------	POST POA 2

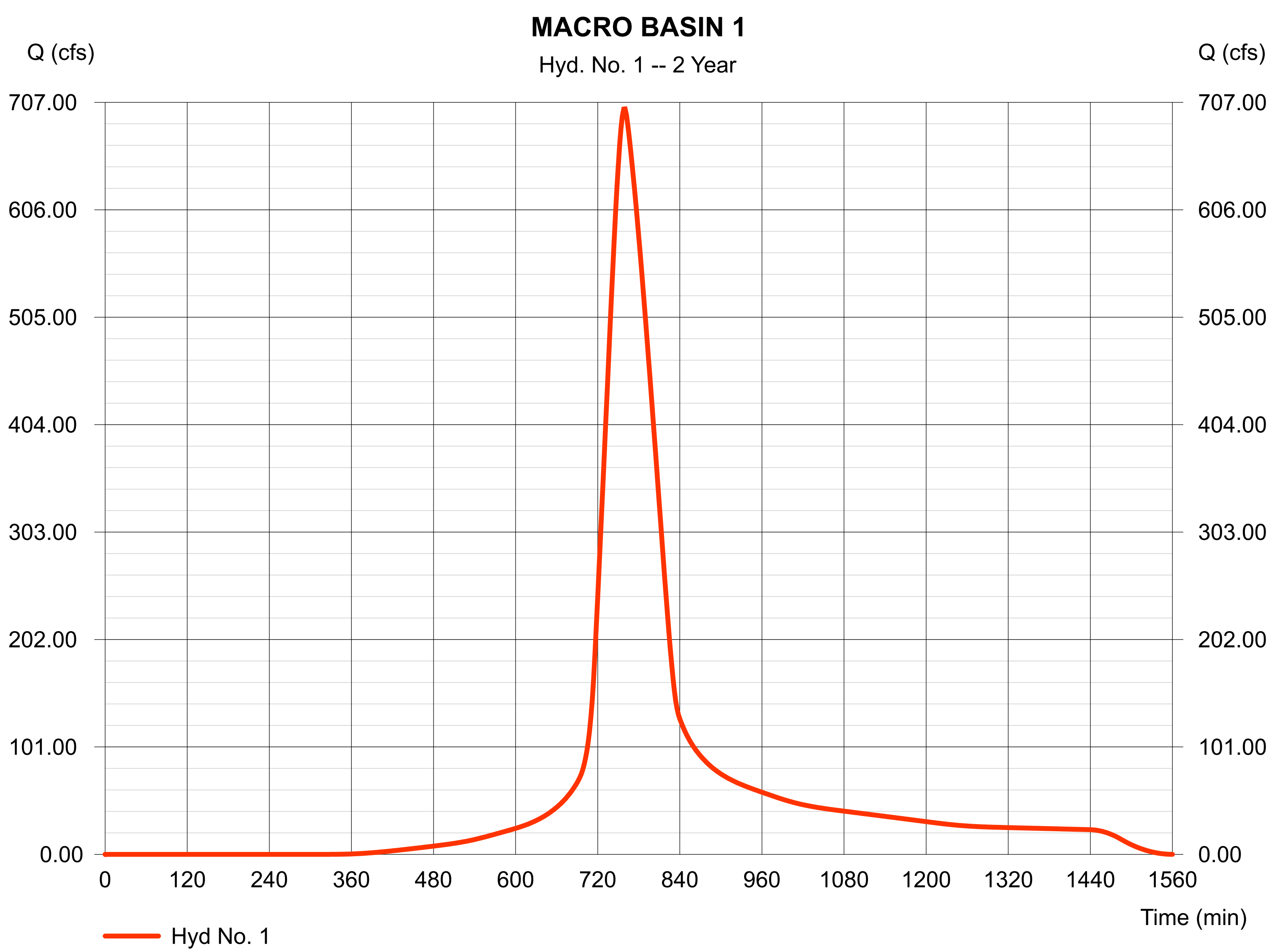
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 1

MACRO BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 700.87 cfs
Storm frequency	= 2 yrs	Time to peak	= 760 min
Time interval	= 2 min	Hyd. volume	= 5,391,185 cuft
Drainage area	= 532.700 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 76.90 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



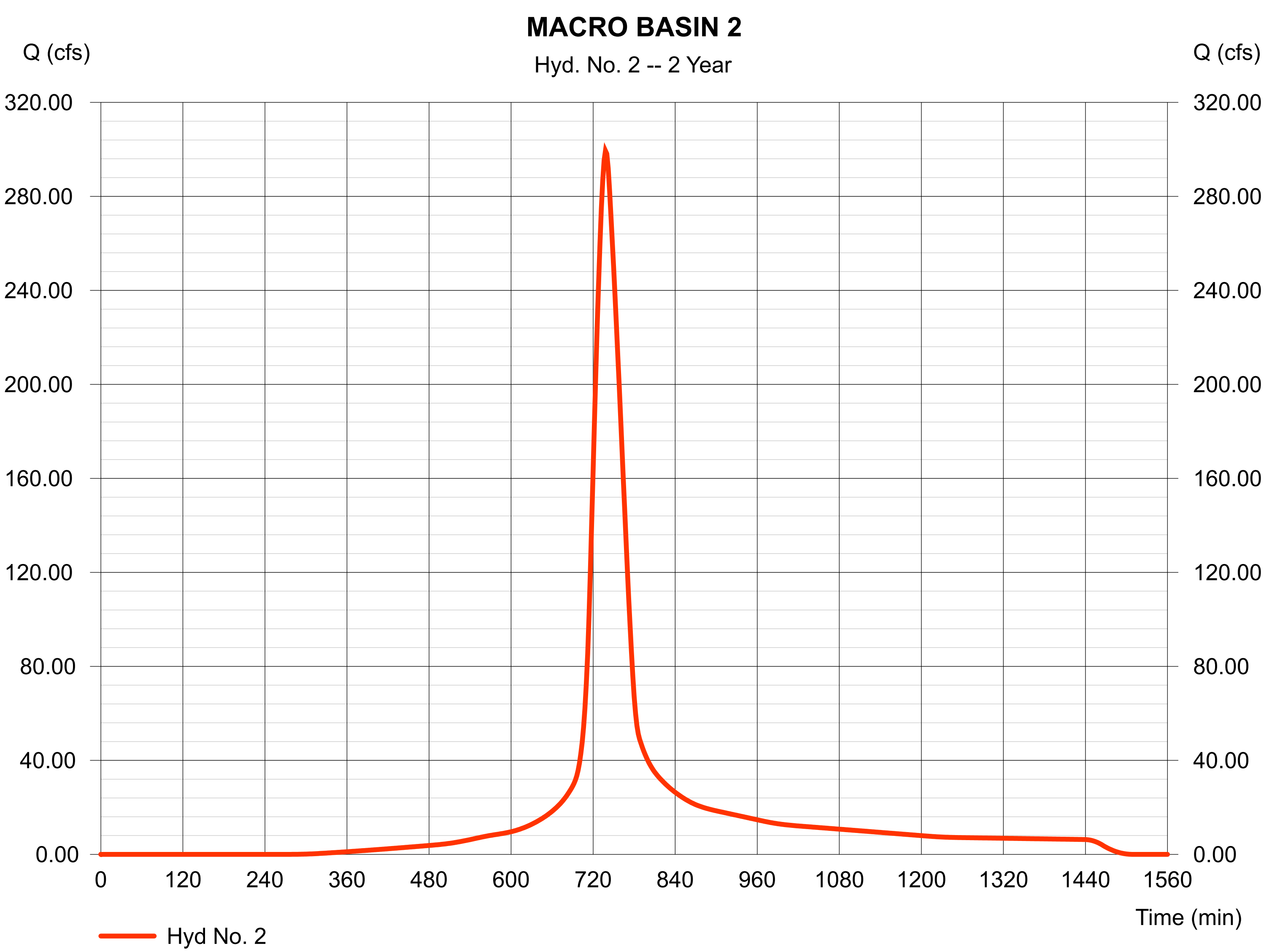
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 2

MACRO BASIN 2

Hydrograph type	= SCS Runoff	Peak discharge	= 299.40 cfs
Storm frequency	= 2 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 1,559,810 cuft
Drainage area	= 142.100 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 42.00 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



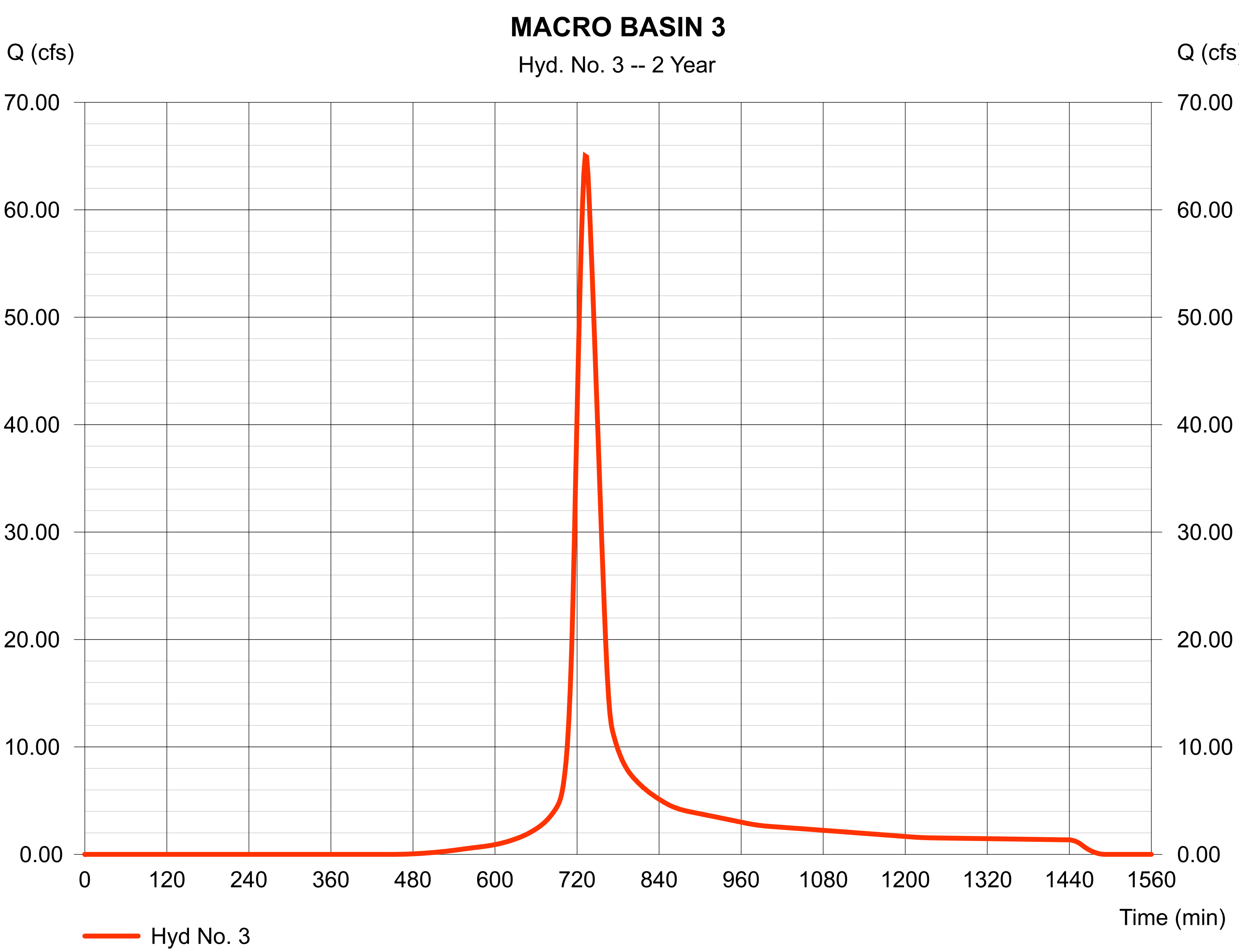
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 3

MACRO BASIN 3

Hydrograph type	= SCS Runoff	Peak discharge	= 65.02 cfs
Storm frequency	= 2 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 281,348 cuft
Drainage area	= 33.700 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 31.50 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

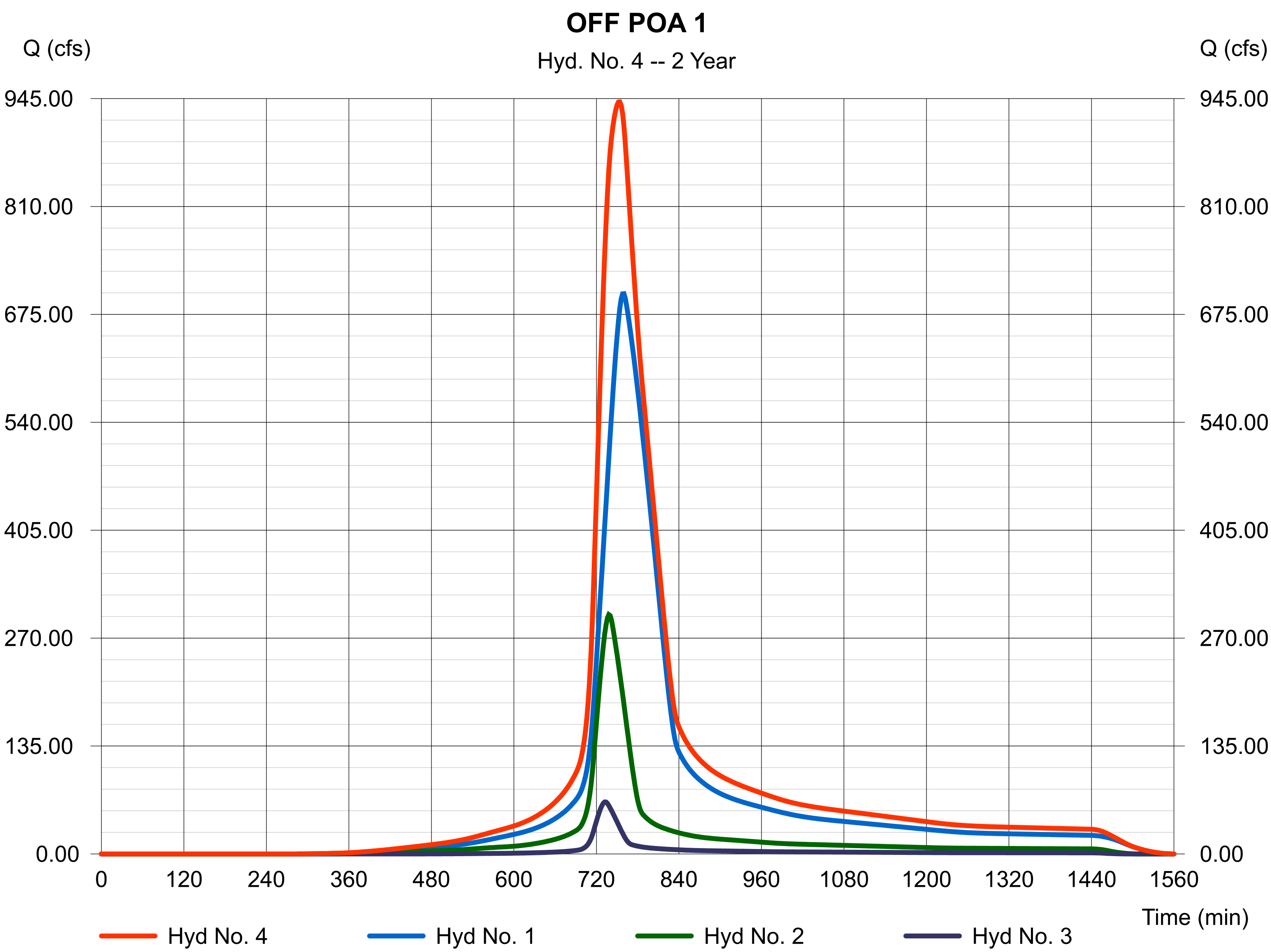


Hydrograph Report

Hyd. No. 4

OFF POA 1

Hydrograph type	= Combine	Peak discharge	= 940.84 cfs
Storm frequency	= 2 yrs	Time to peak	= 754 min
Time interval	= 2 min	Hyd. volume	= 7,232,342 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 708.500 ac



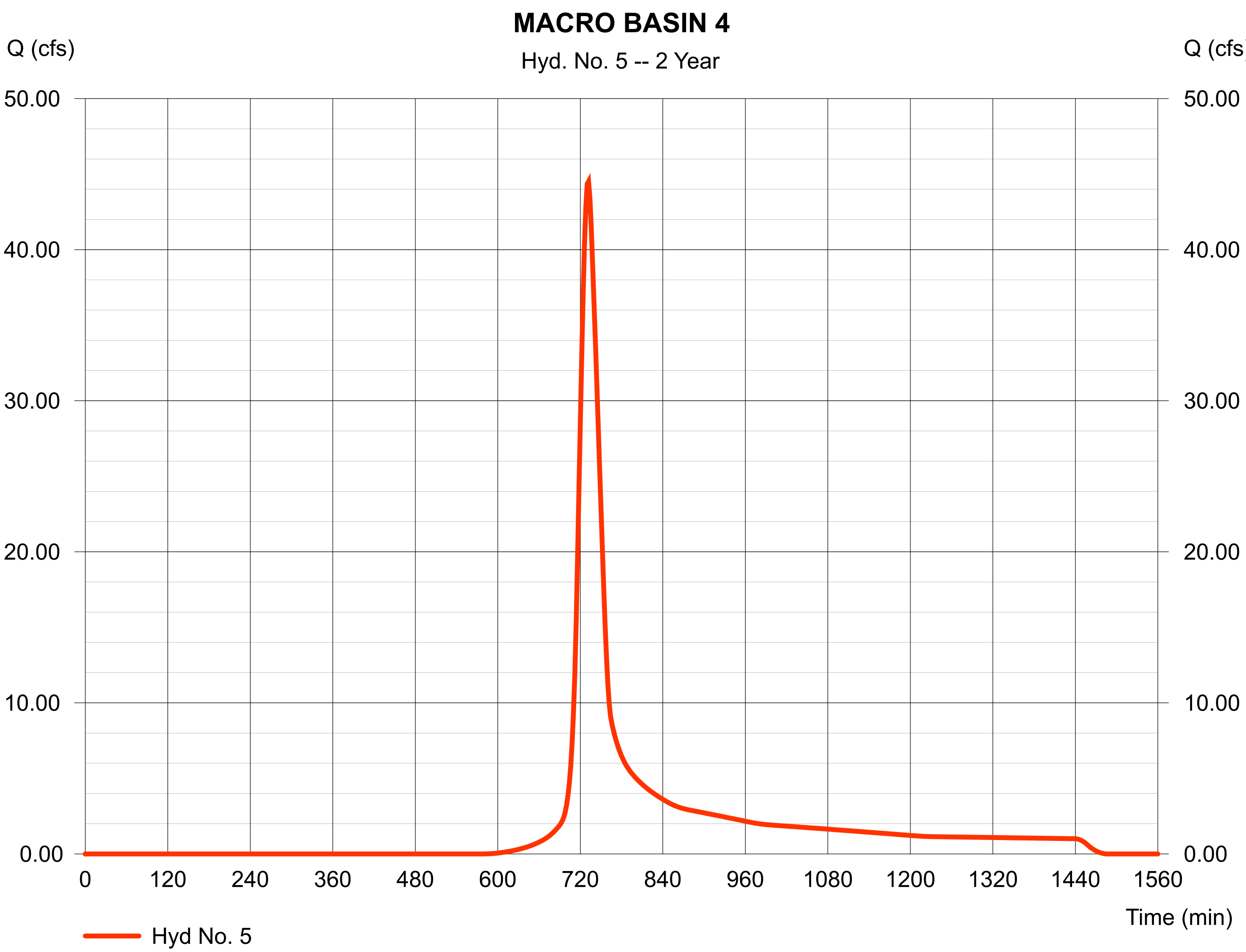
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 5

MACRO BASIN 4

Hydrograph type	= SCS Runoff	Peak discharge	= 44.52 cfs
Storm frequency	= 2 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 181,791 cuft
Drainage area	= 29.000 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 27.10 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



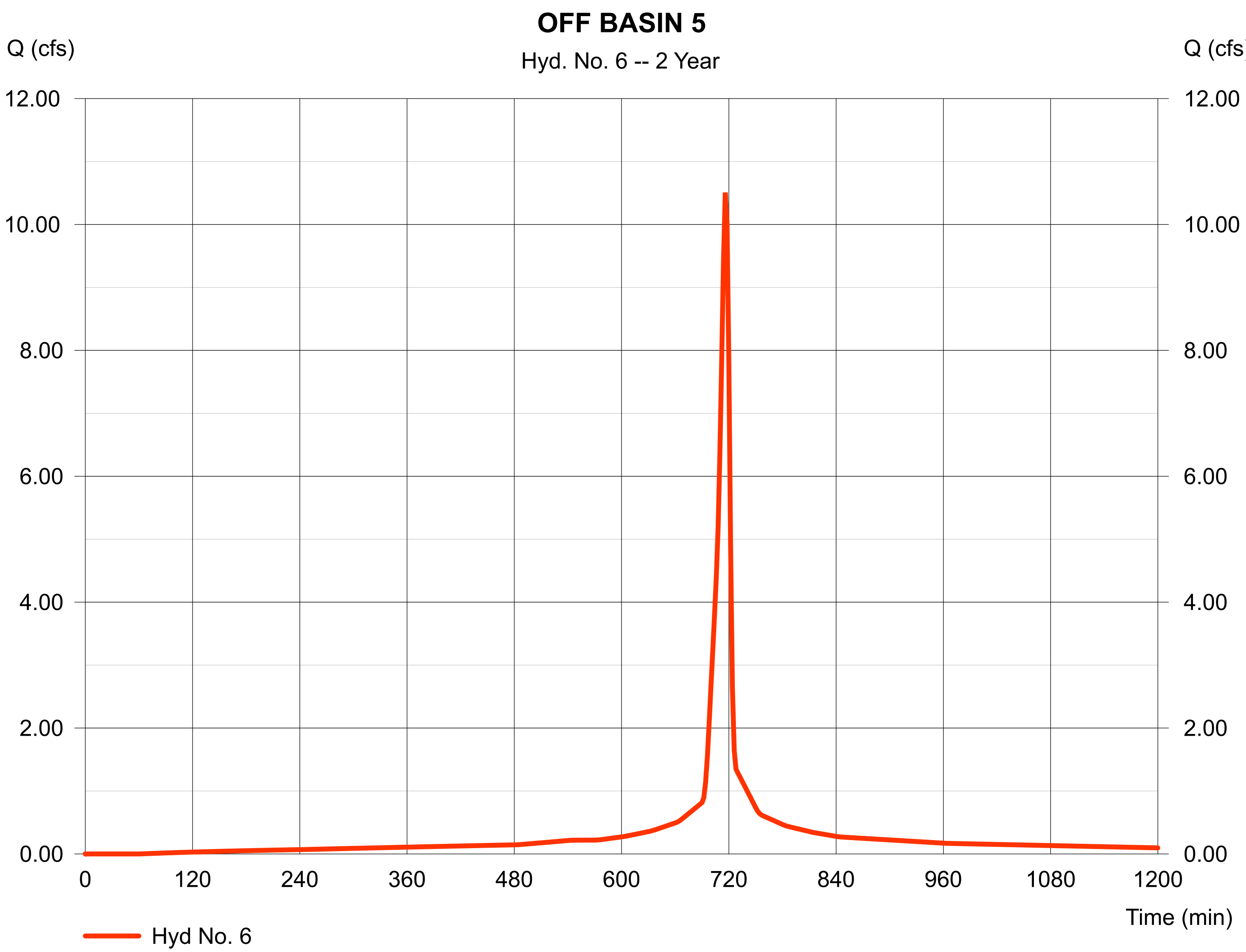
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 6

OFF BASIN 5

Hydrograph type	= SCS Runoff	Peak discharge	= 10.51 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 24,861 cuft
Drainage area	= 1.900 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

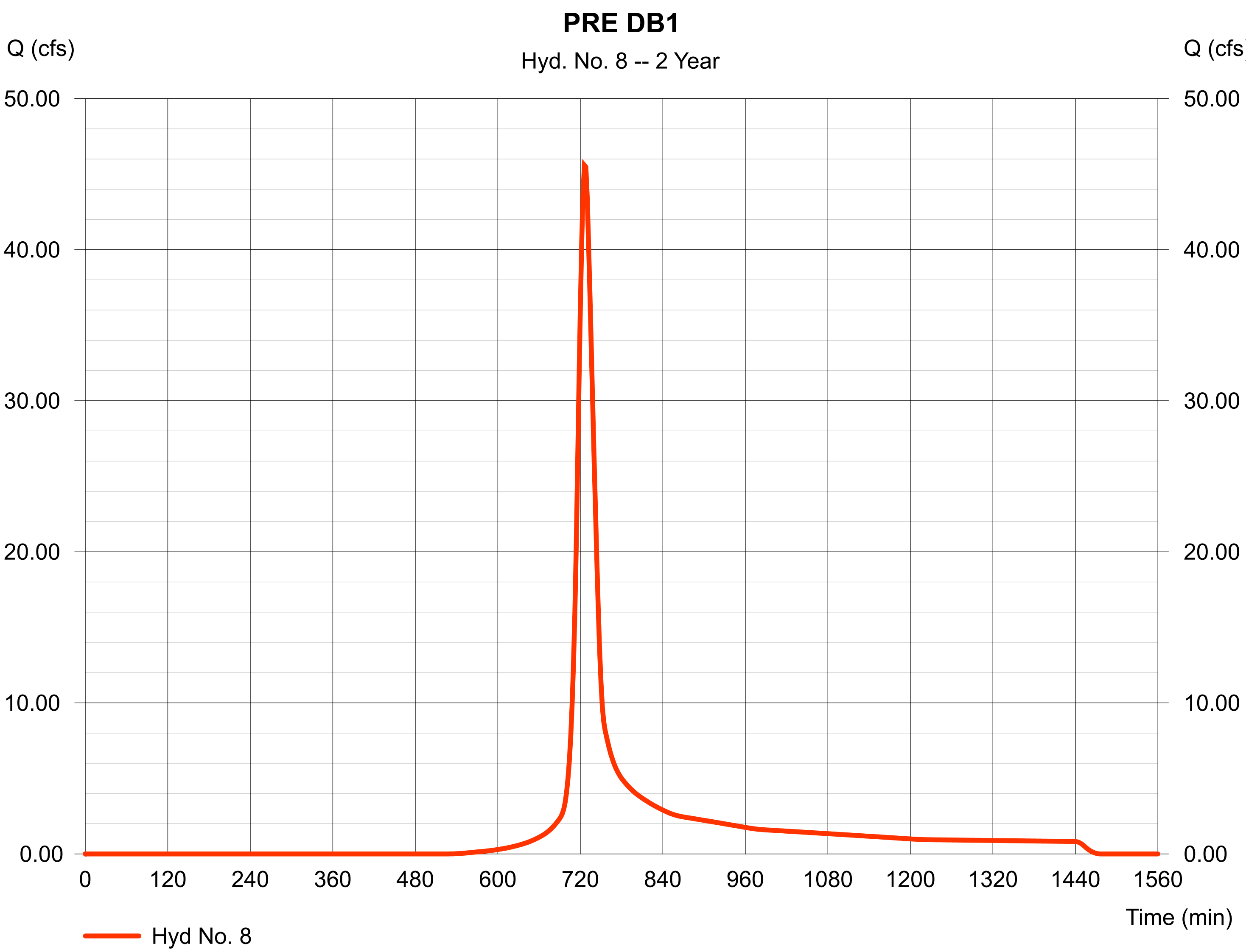
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 8

PRE DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 45.59 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 158,723 cuft
Drainage area	= 22.020 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 20.73 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 22.020



Hydrograph Report

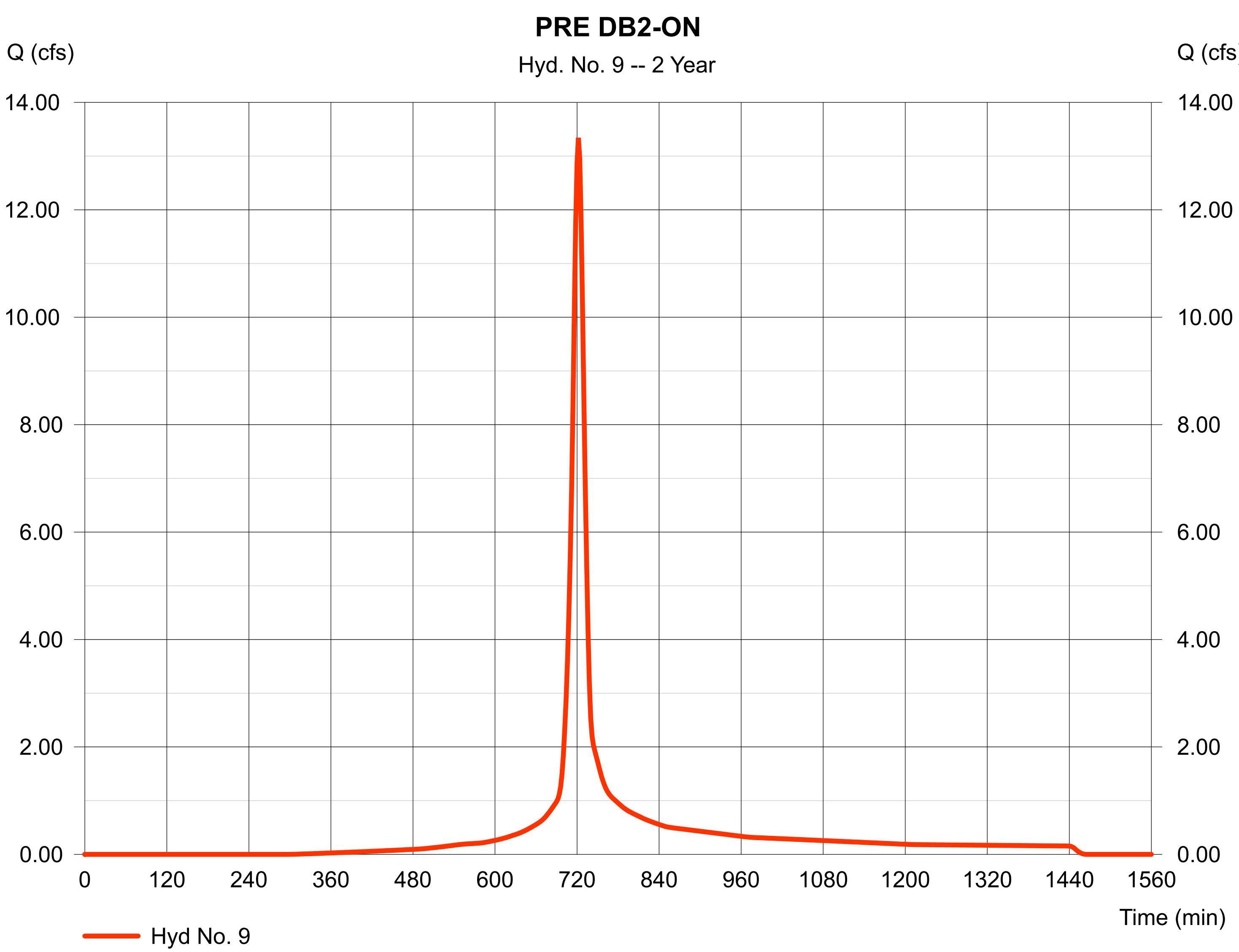
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 9

PRE DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 13.34 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 38,158 cuft
Drainage area	= 3.720 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.33 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 3.720



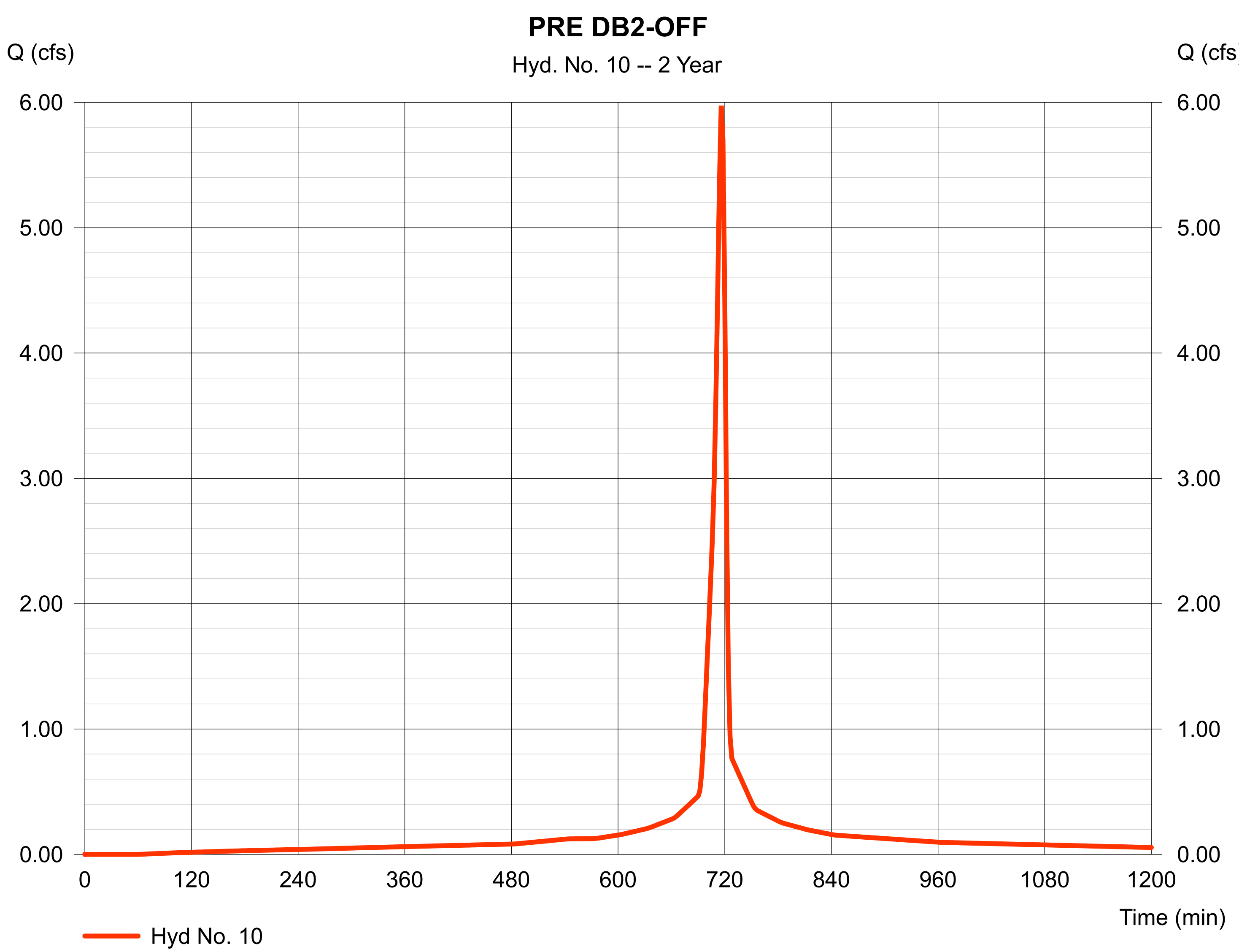
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 10

PRE DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 5.973 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 14,132 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



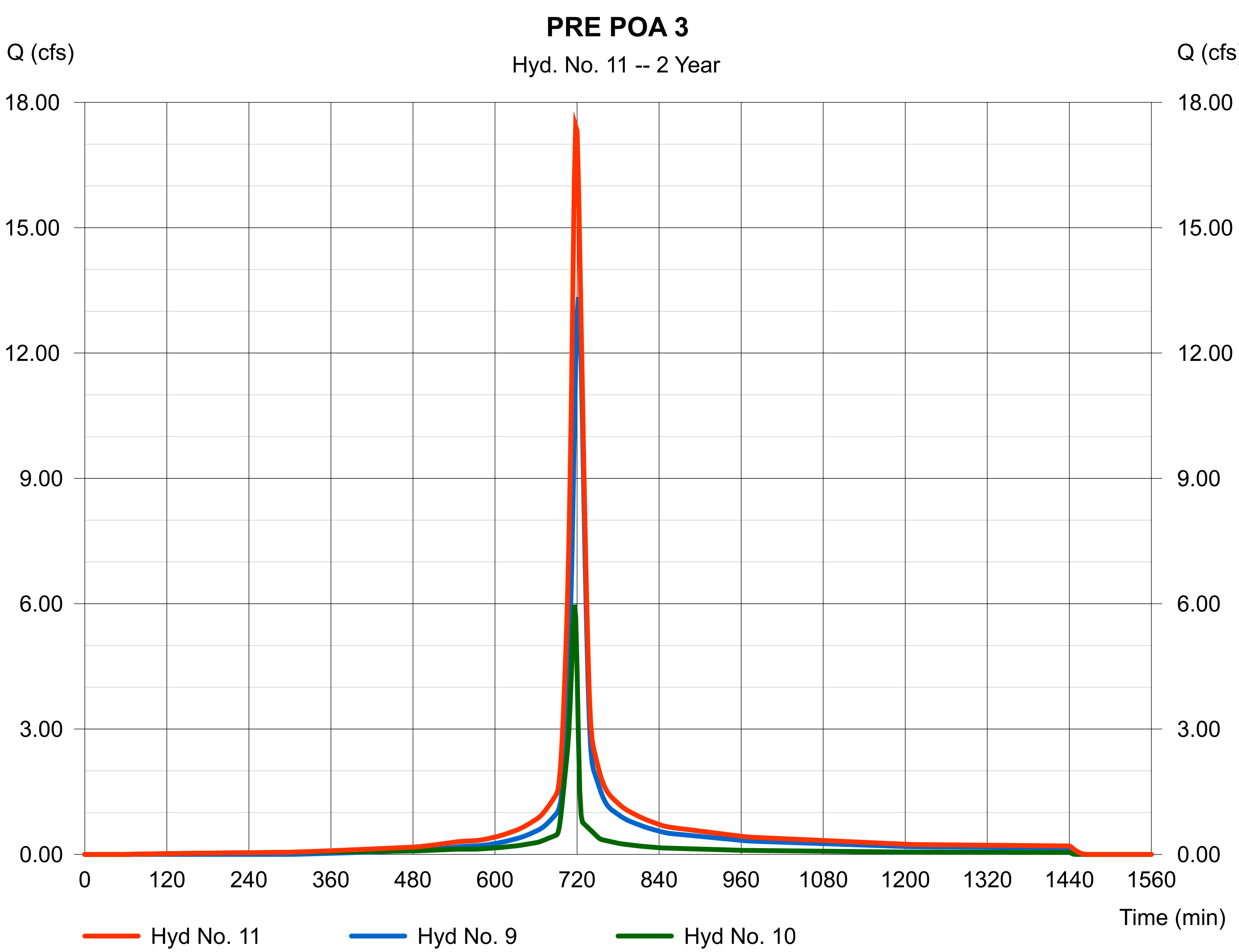
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 11

PRE POA 3

Hydrograph type	= Combine	Peak discharge	= 17.43 cfs
Storm frequency	= 2 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 52,290 cuft
Inflow hyds.	= 9, 10	Contrib. drain. area	= 4.800 ac



Hydrograph Report

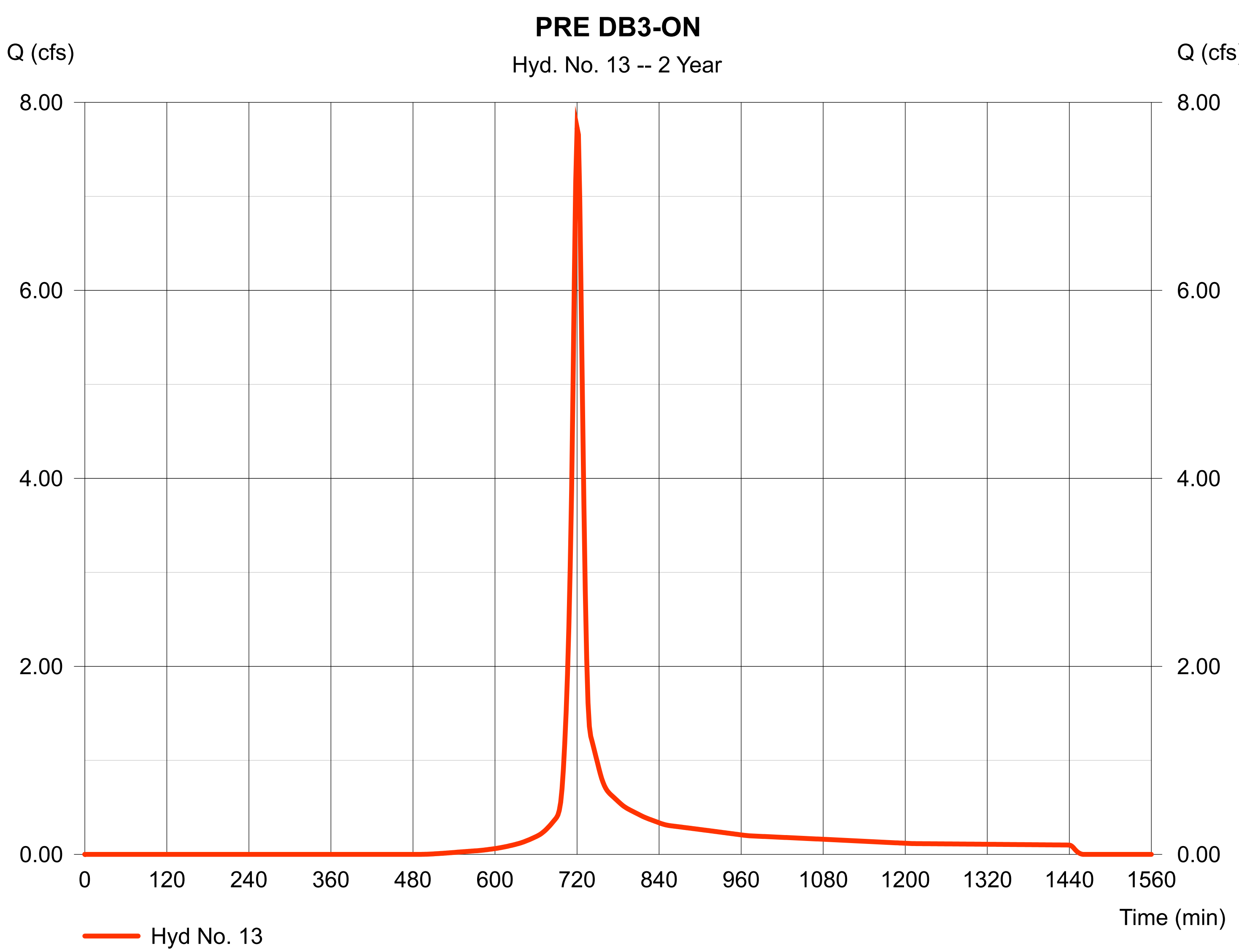
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 13

PRE DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 7.730 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 20,043 cuft
Drainage area	= 2.540 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 55) + (0.570 x 61) + (2.130 x 98)] / 2.540



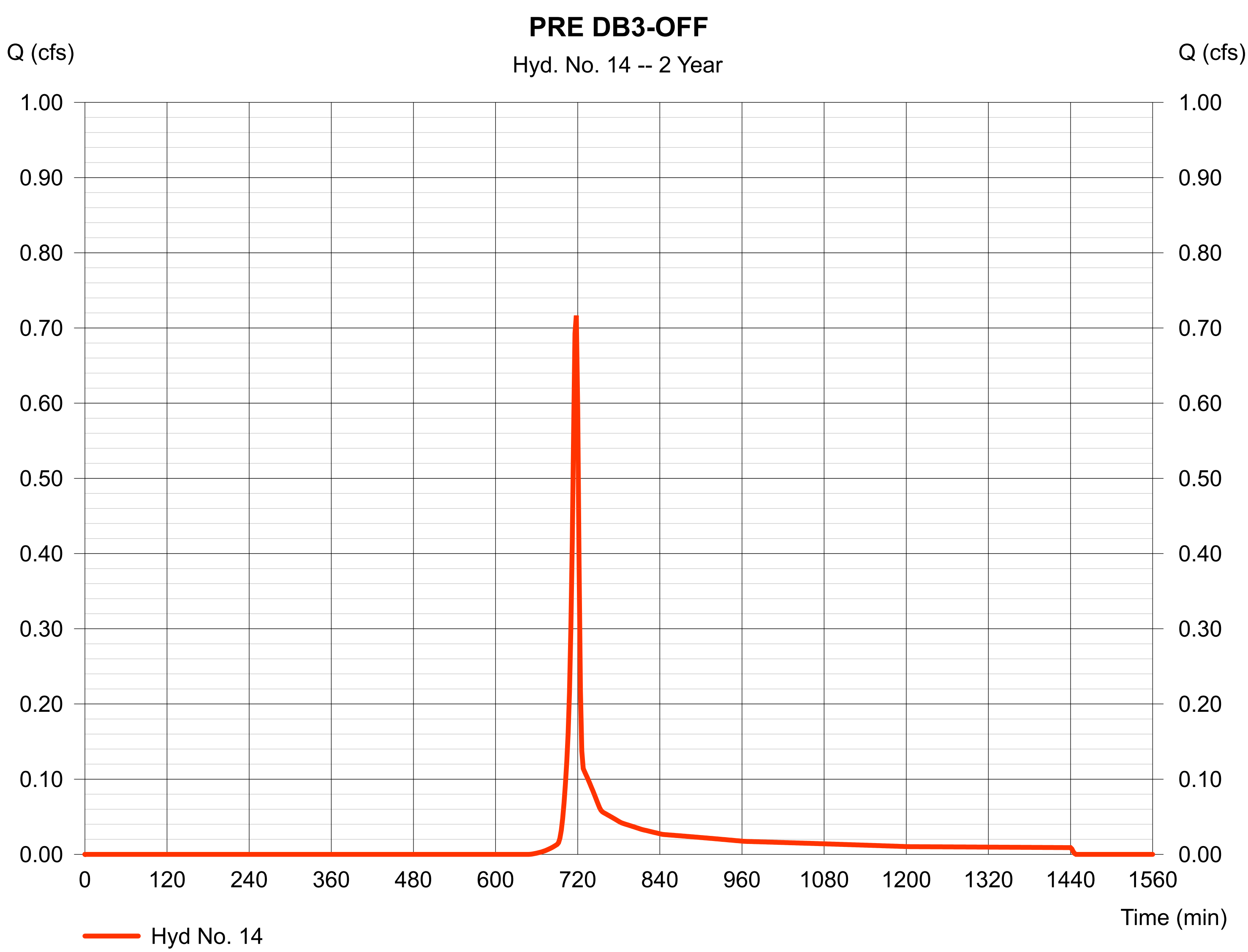
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 14

PRE DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 0.717 cfs
Storm frequency	= 2 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 1,436 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



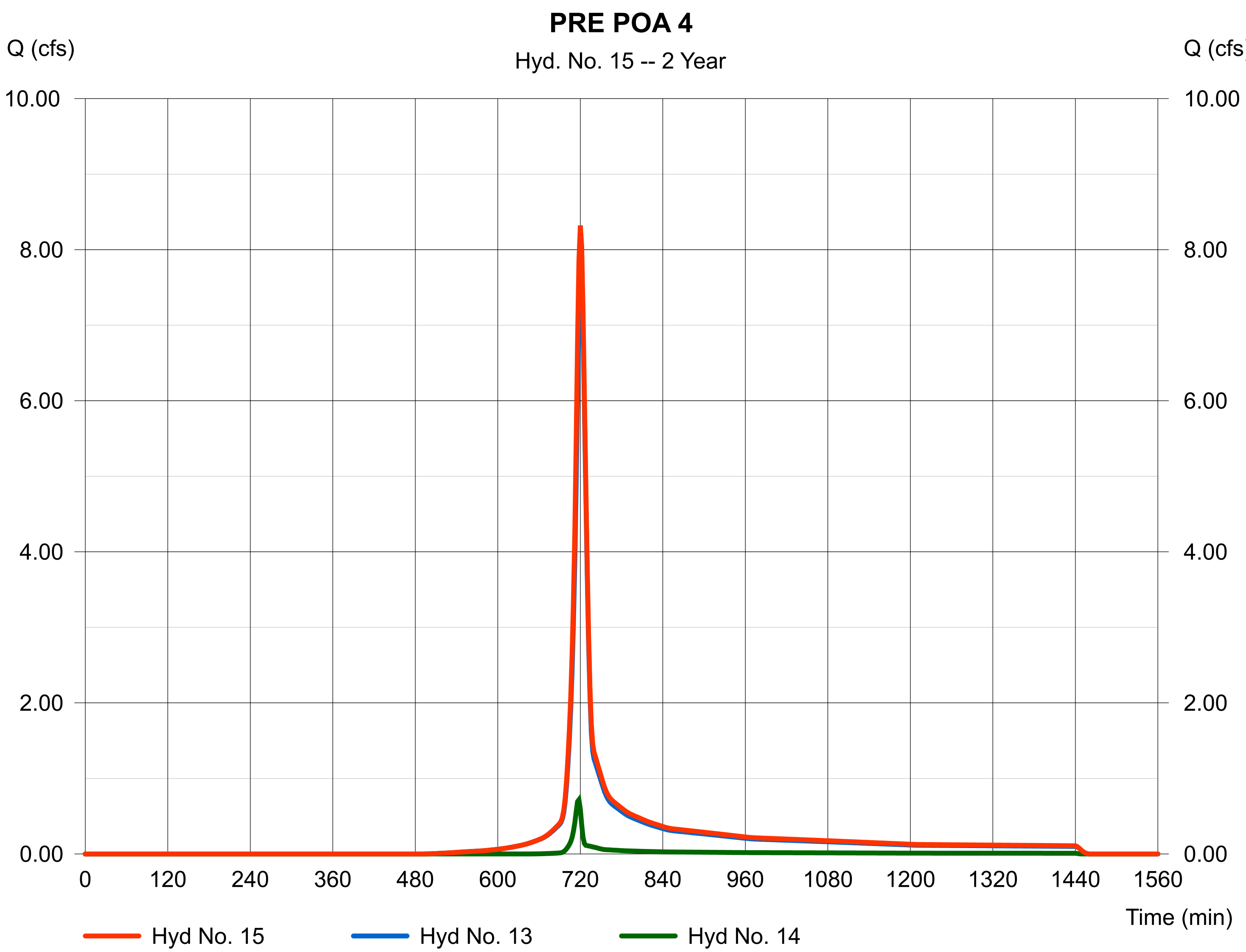
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 15

PRE POA 4

Hydrograph type	= Combine	Peak discharge	= 8.320 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 21,479 cuft
Inflow hyds.	= 13, 14	Contrib. drain. area	= 2.860 ac



Hydrograph Report

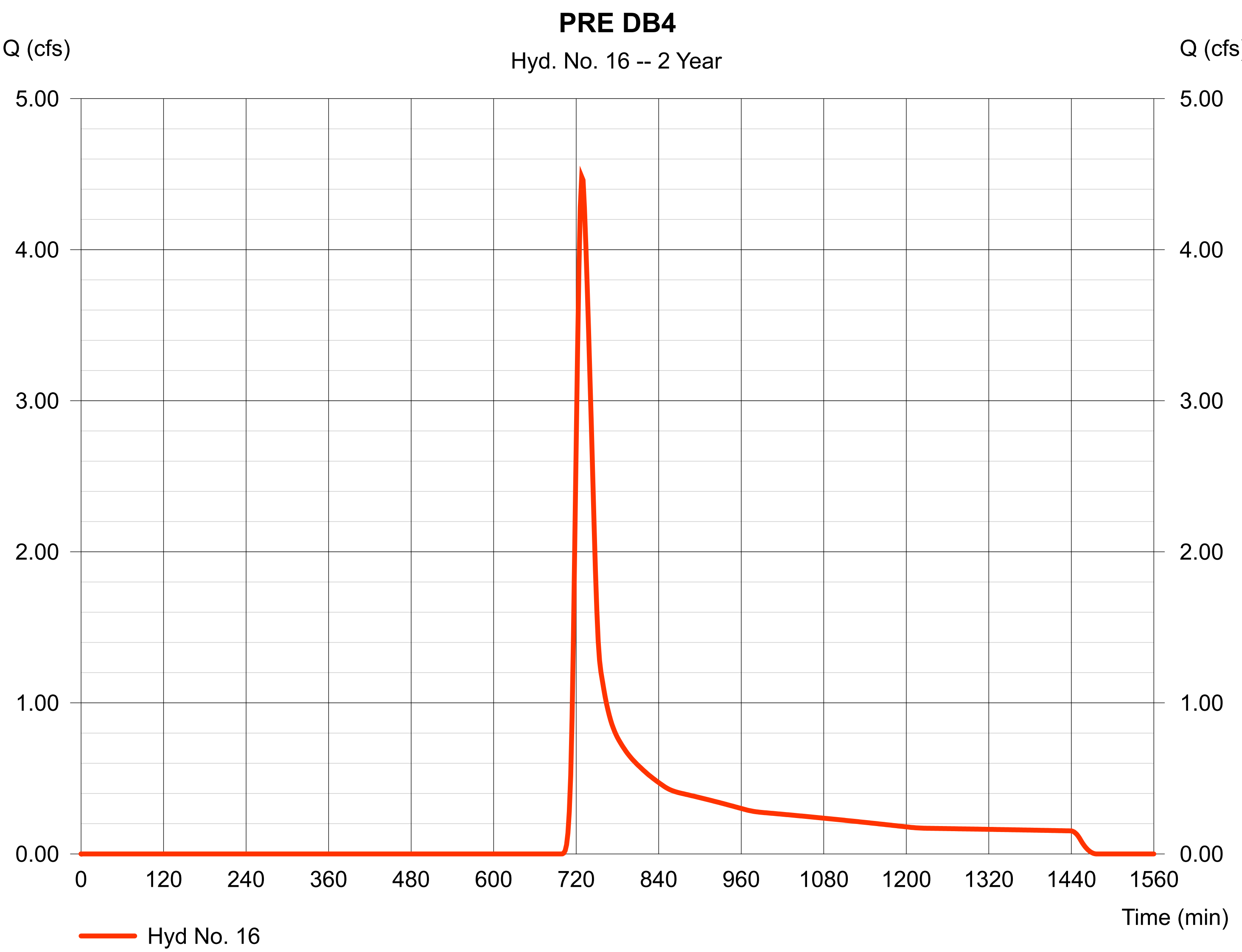
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 16

PRE DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 4.482 cfs
Storm frequency	= 2 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 19,482 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.12 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.160 x 61) + (1.840 x 55)] / 6.580



Hydrograph Report

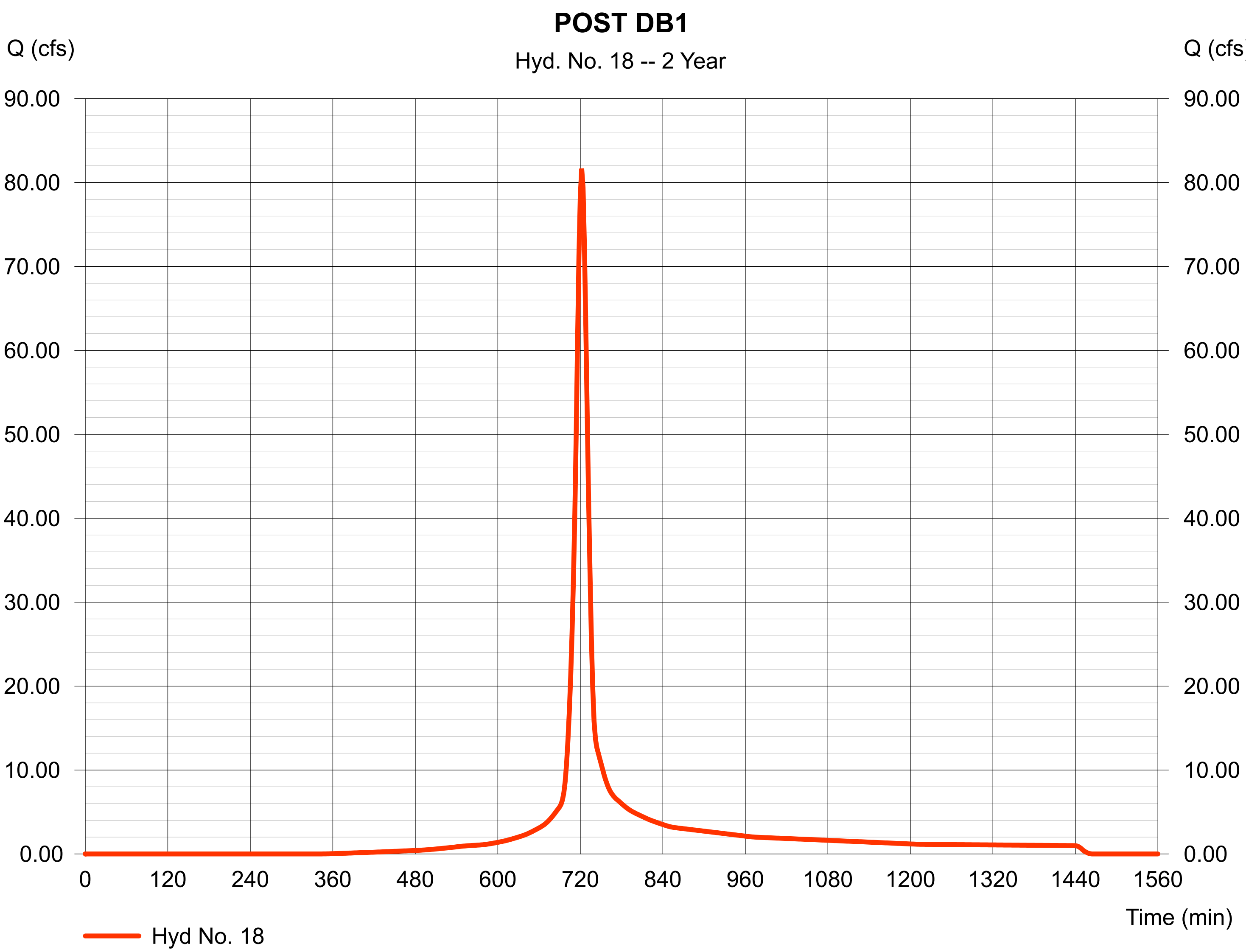
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 18

POST DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 81.66 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 231,356 cuft
Drainage area	= 24.120 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.62 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 98) + (0.310 x 55) + (0.510 x 61)] / 24.120



Hydrograph Report

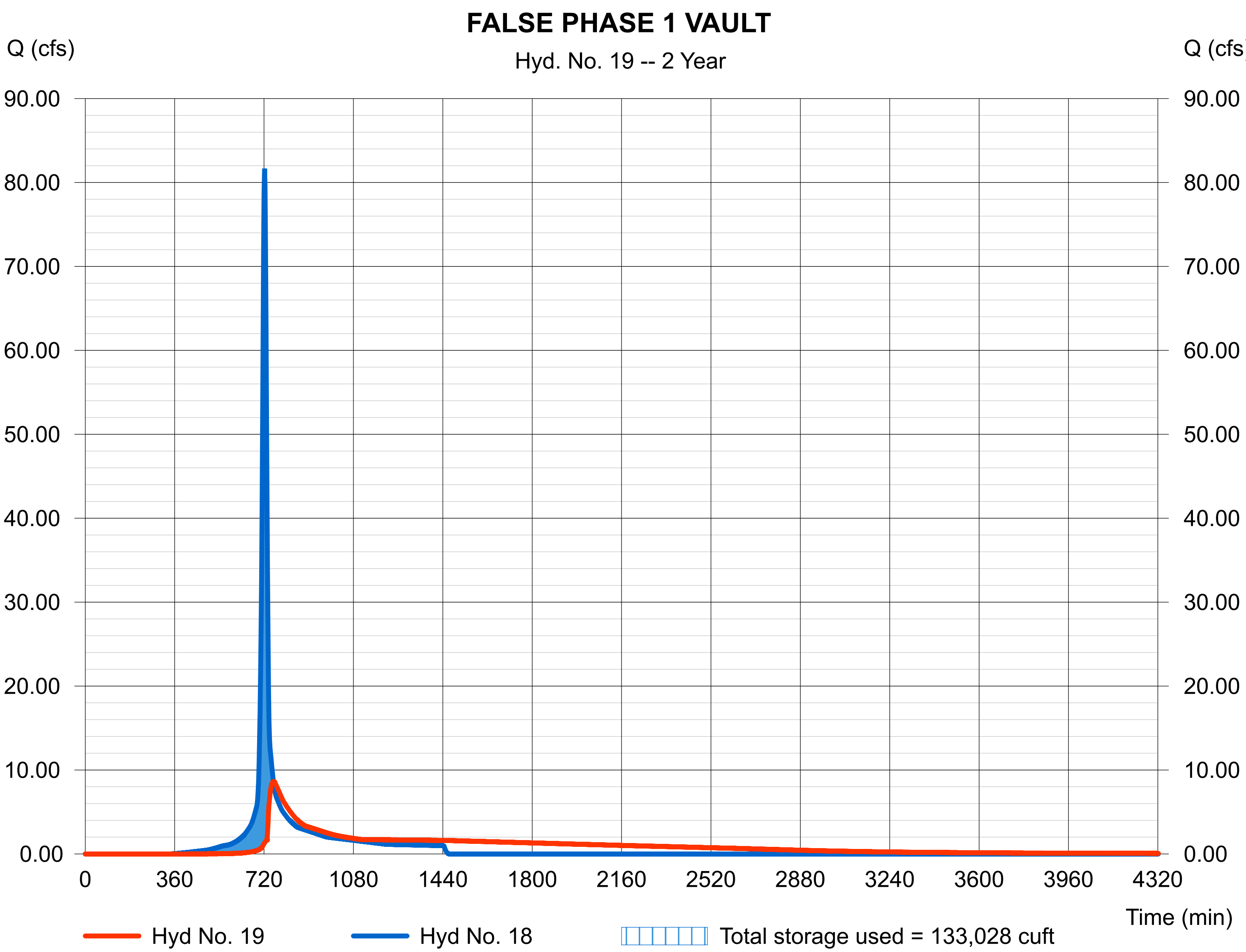
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 19

FALSE PHASE 1 VAULT

Hydrograph type	= Reservoir	Peak discharge	= 8.627 cfs
Storm frequency	= 2 yrs	Time to peak	= 758 min
Time interval	= 2 min	Hyd. volume	= 227,188 cuft
Inflow hyd. No.	= 18 - POST DB1	Max. Elevation	= 962.66 ft
Reservoir name	= FALSE POND	Max. Storage	= 133,028 cuft

Storage Indication method used.



Hydrograph Report

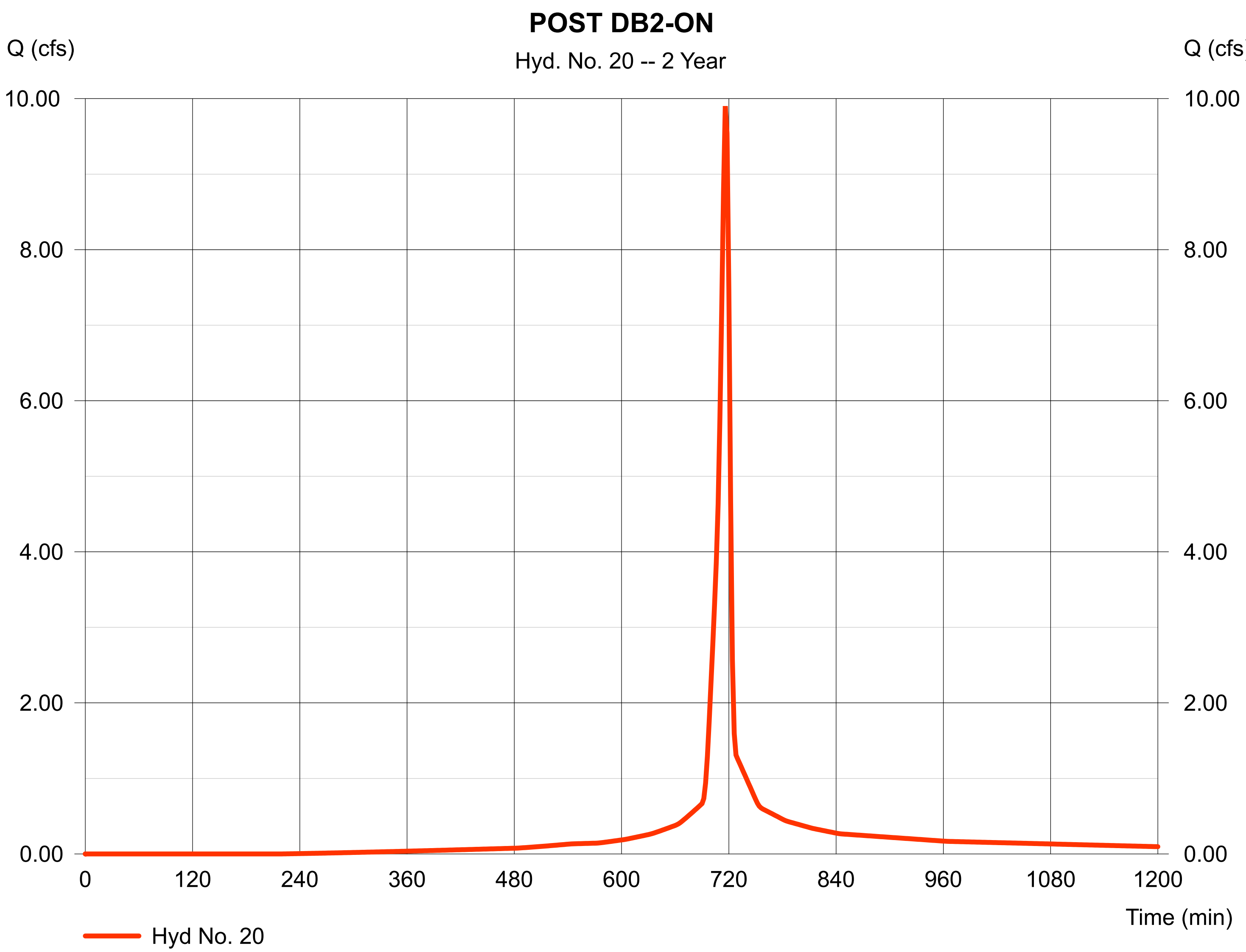
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 20

POST DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 9.900 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 21,310 cuft
Drainage area	= 1.960 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.090 x 61) + (0.280 x 85) + (13.450 x 98) + (1.000 x 55)] / 1.960



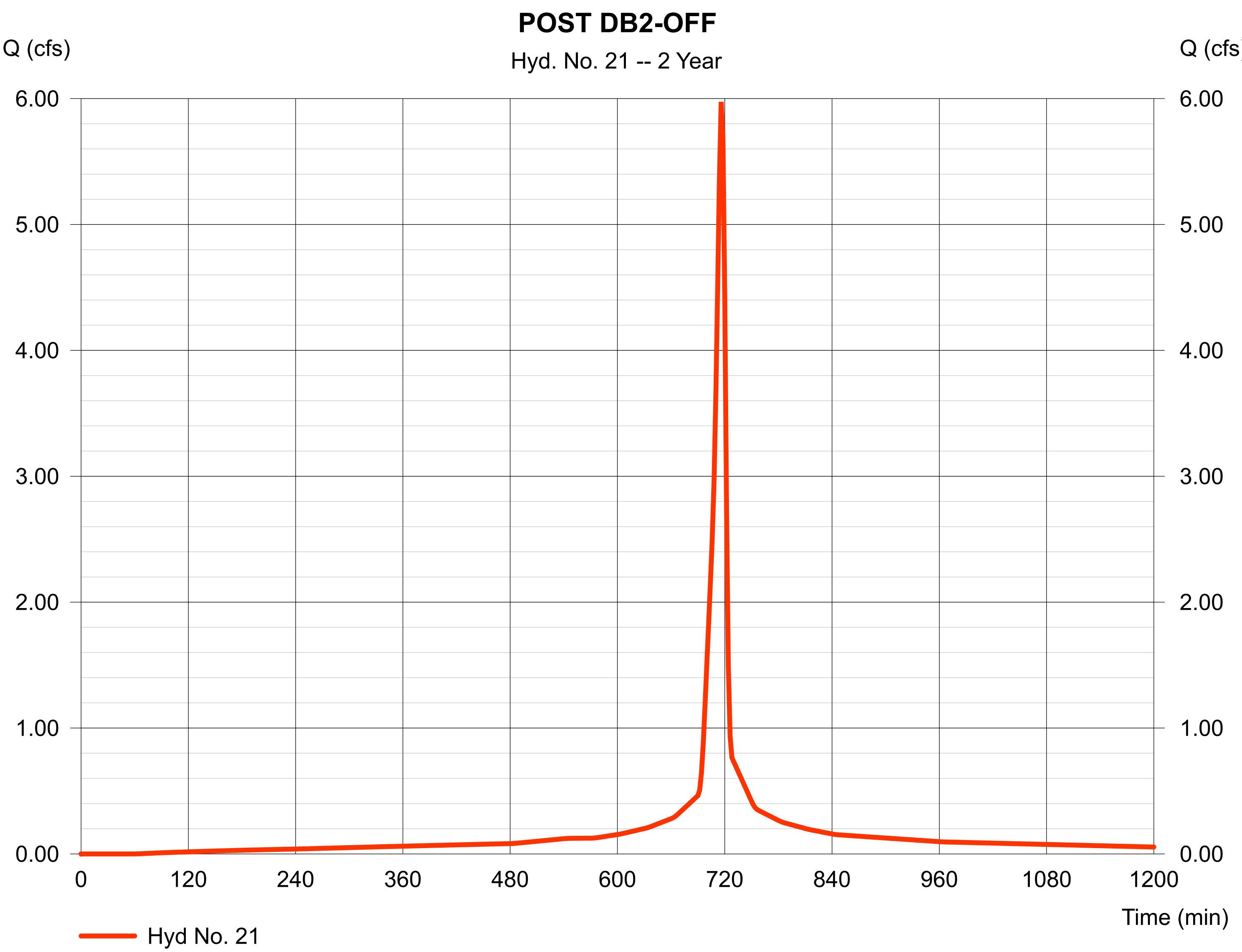
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 21

POST DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 5.973 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 14,132 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



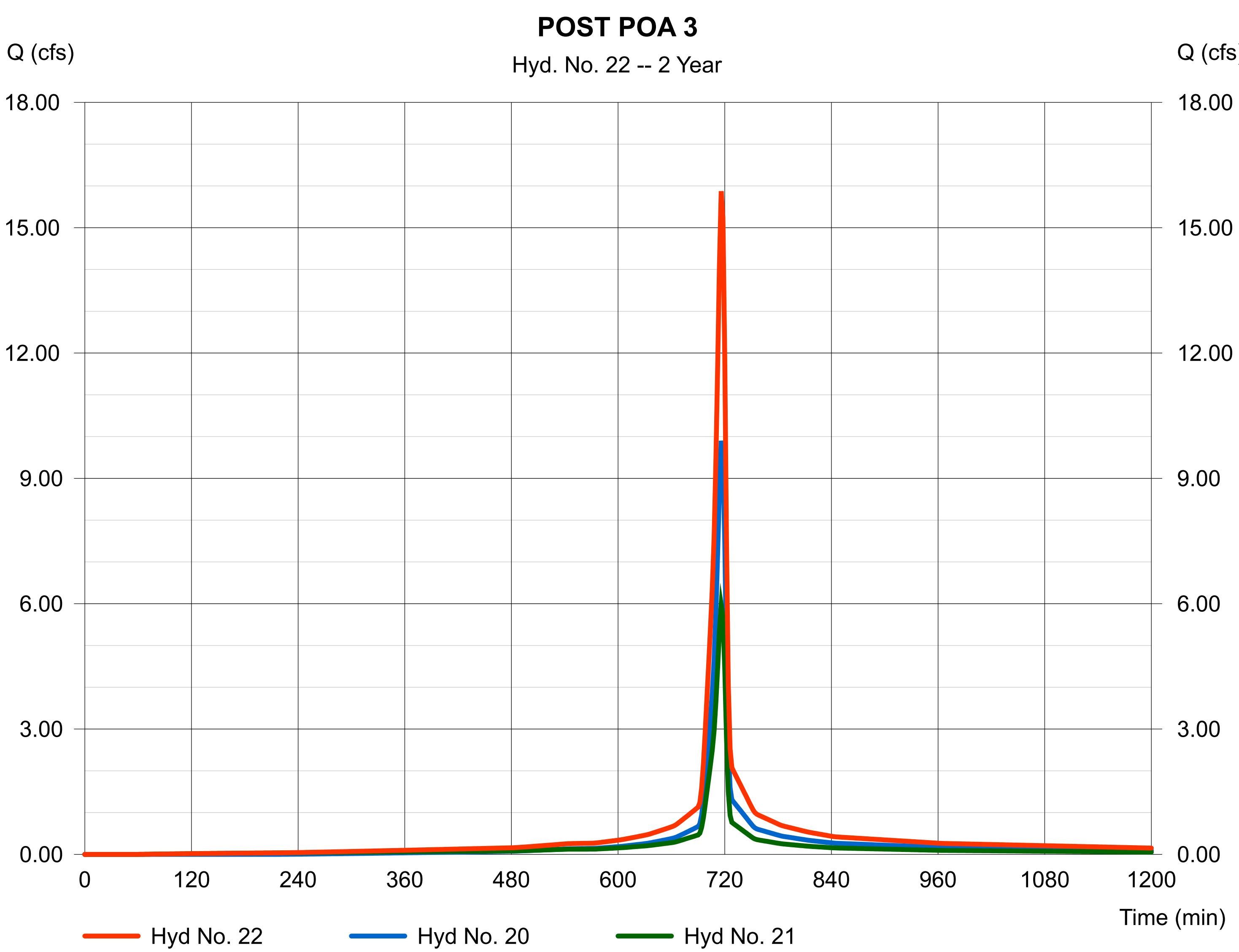
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 22

POST POA 3

Hydrograph type	= Combine	Peak discharge	= 15.87 cfs
Storm frequency	= 2 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 35,442 cuft
Inflow hyds.	= 20, 21	Contrib. drain. area	= 3.040 ac



Hydrograph Report

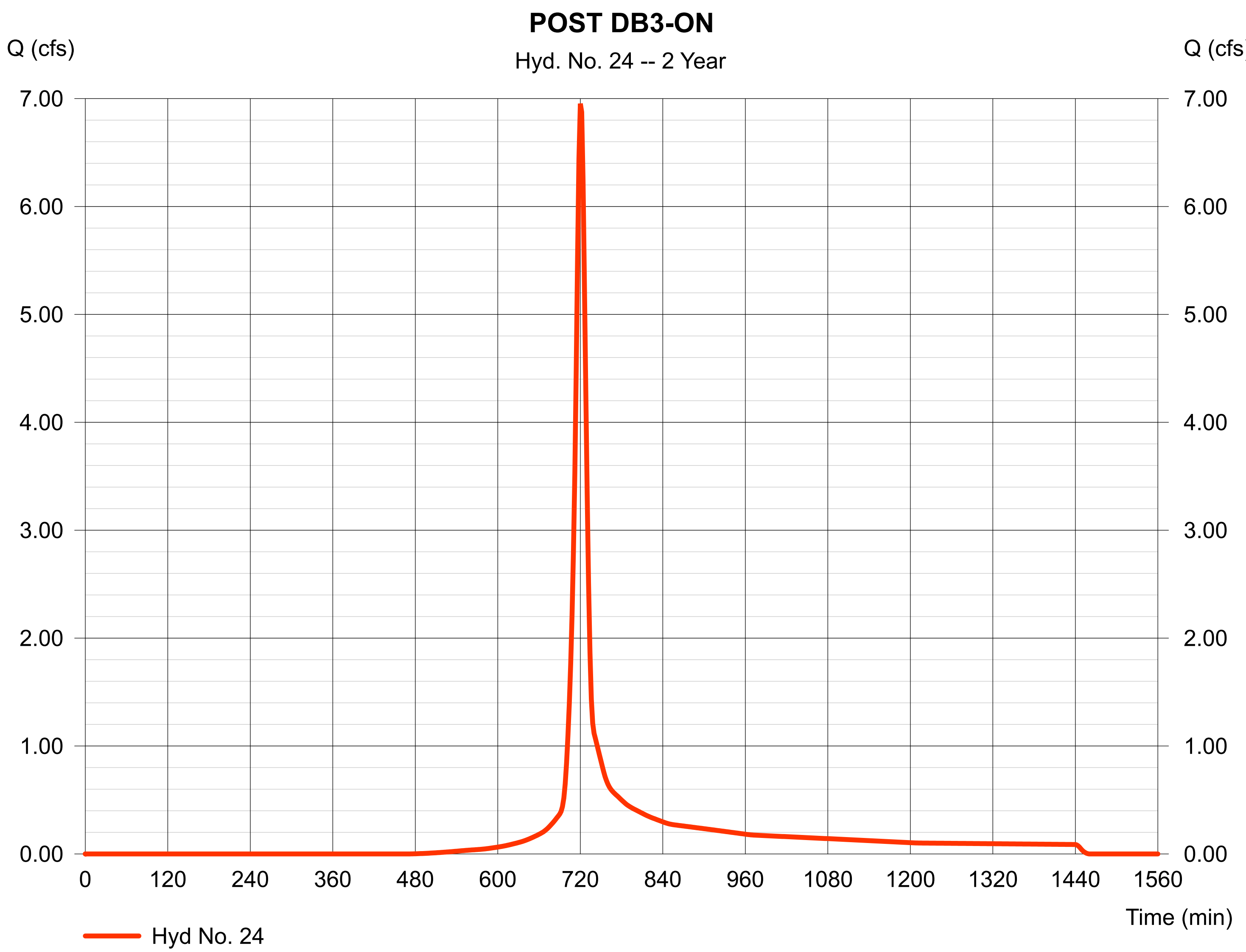
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 24

POST DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 6.954 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 18,027 cuft
Drainage area	= 2.200 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (2.810 x 61) + (10.490 x 98)] / 2.200



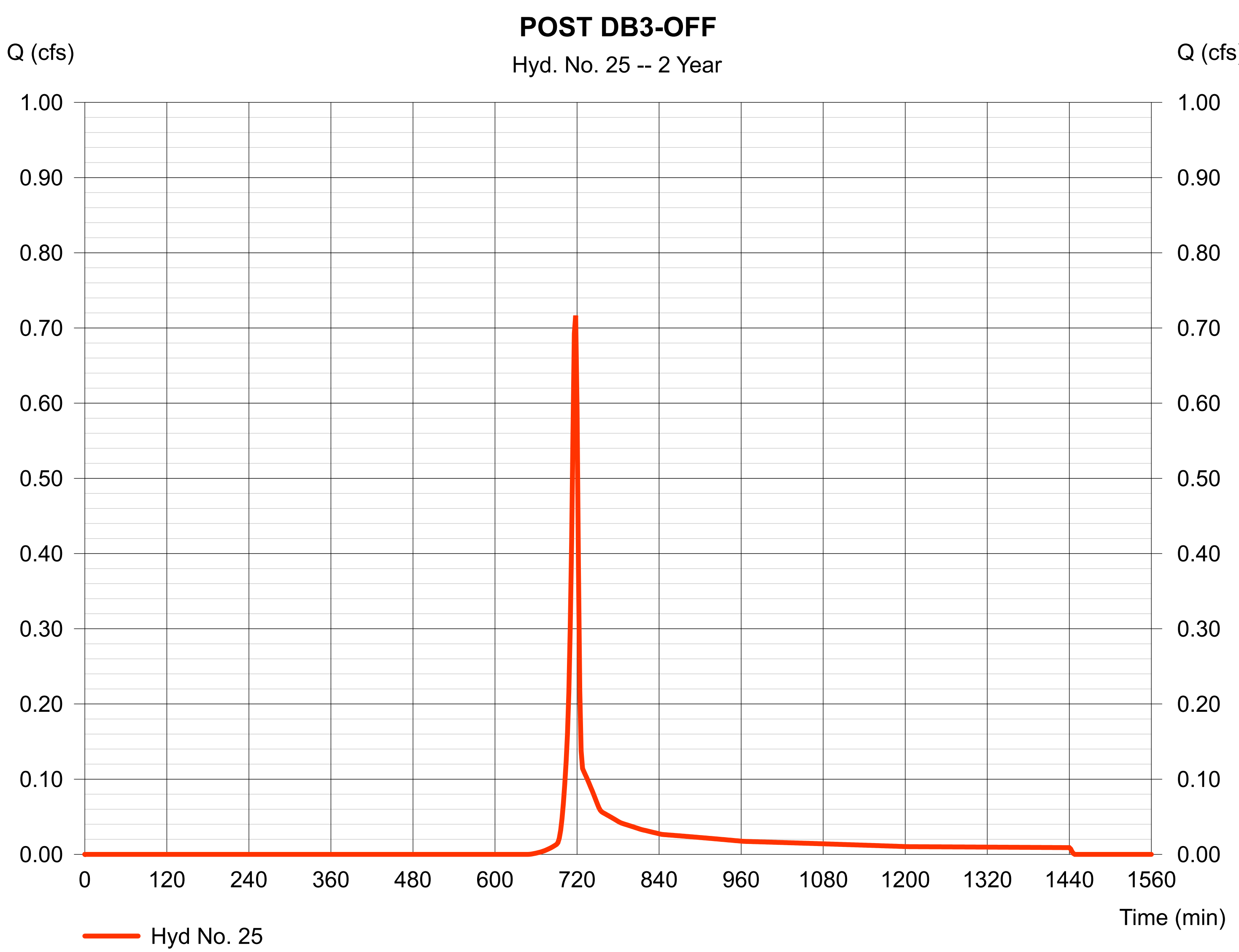
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 25

POST DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 0.717 cfs
Storm frequency	= 2 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 1,436 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



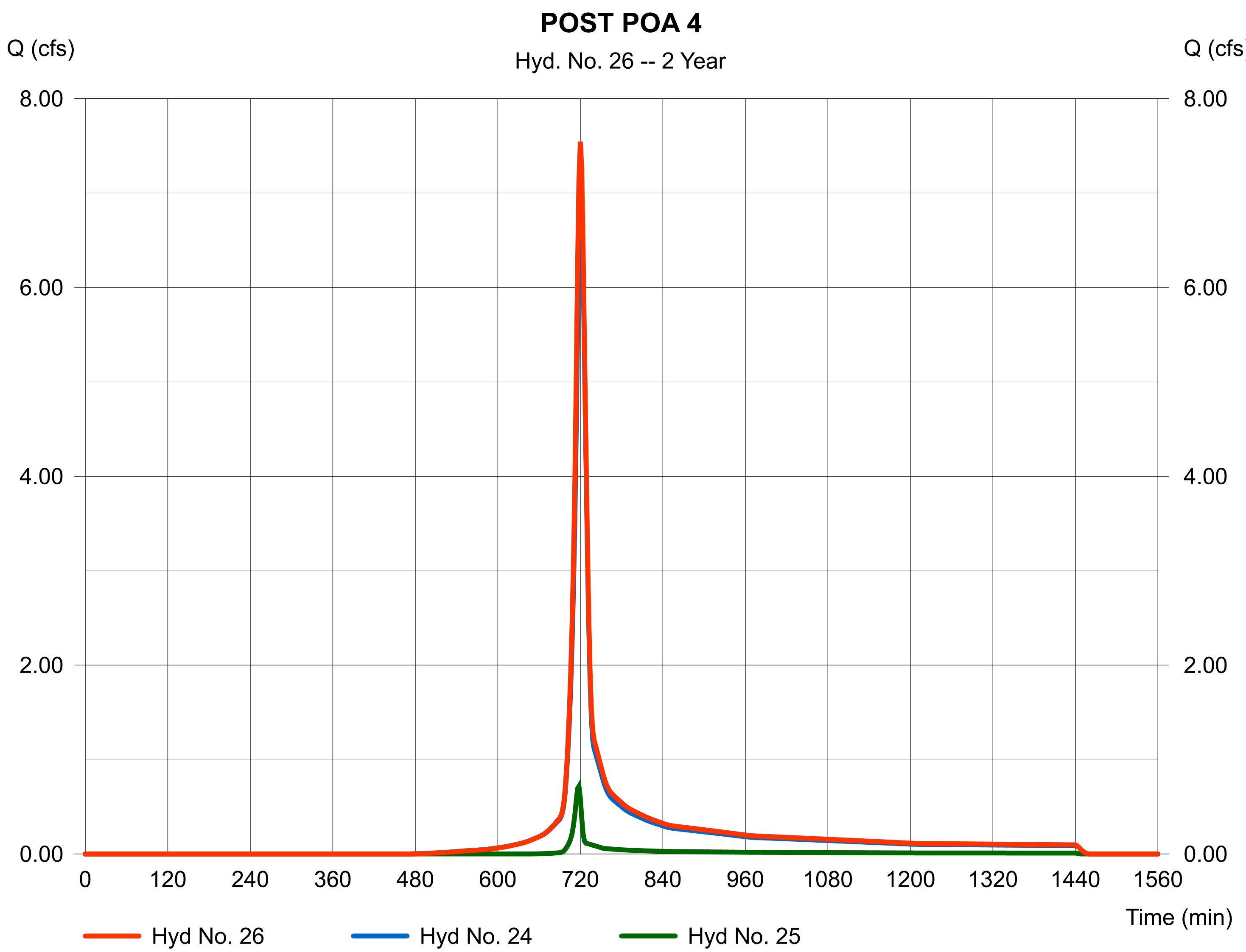
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 26

POST POA 4

Hydrograph type	= Combine	Peak discharge	= 7.544 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 19,463 cuft
Inflow hyds.	= 24, 25	Contrib. drain. area	= 2.520 ac



Hydrograph Report

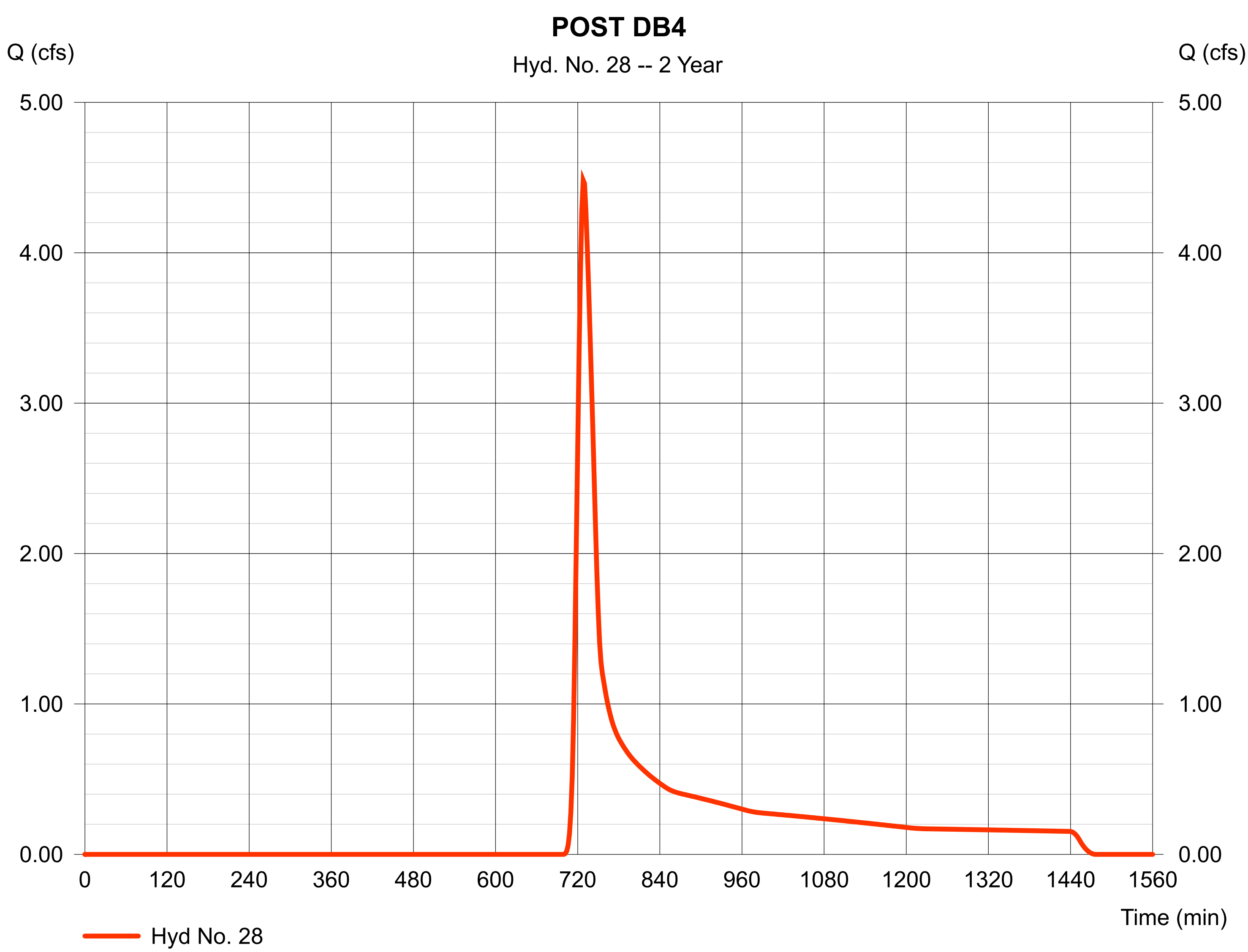
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 28

POST DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 4.482 cfs
Storm frequency	= 2 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 19,482 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.94 min
Total precip.	= 4.08 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.520 x 98) + (4.480 x 61)] / 6.580



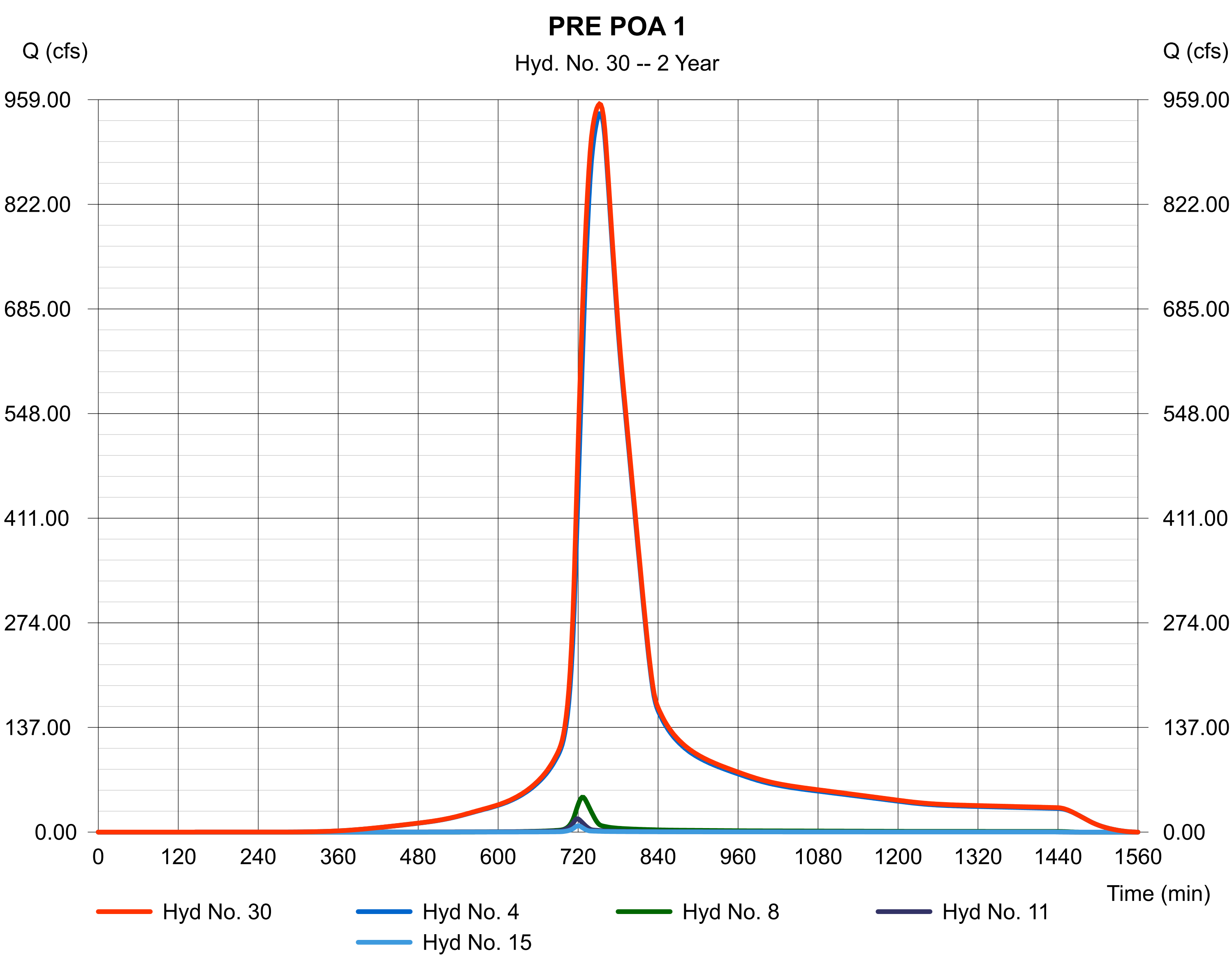
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 30

PRE POA 1

Hydrograph type	= Combine	Peak discharge	= 953.46 cfs
Storm frequency	= 2 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 7,464,833 cuft
Inflow hyds.	= 4, 8, 11, 15	Contrib. drain. area	= 22.020 ac



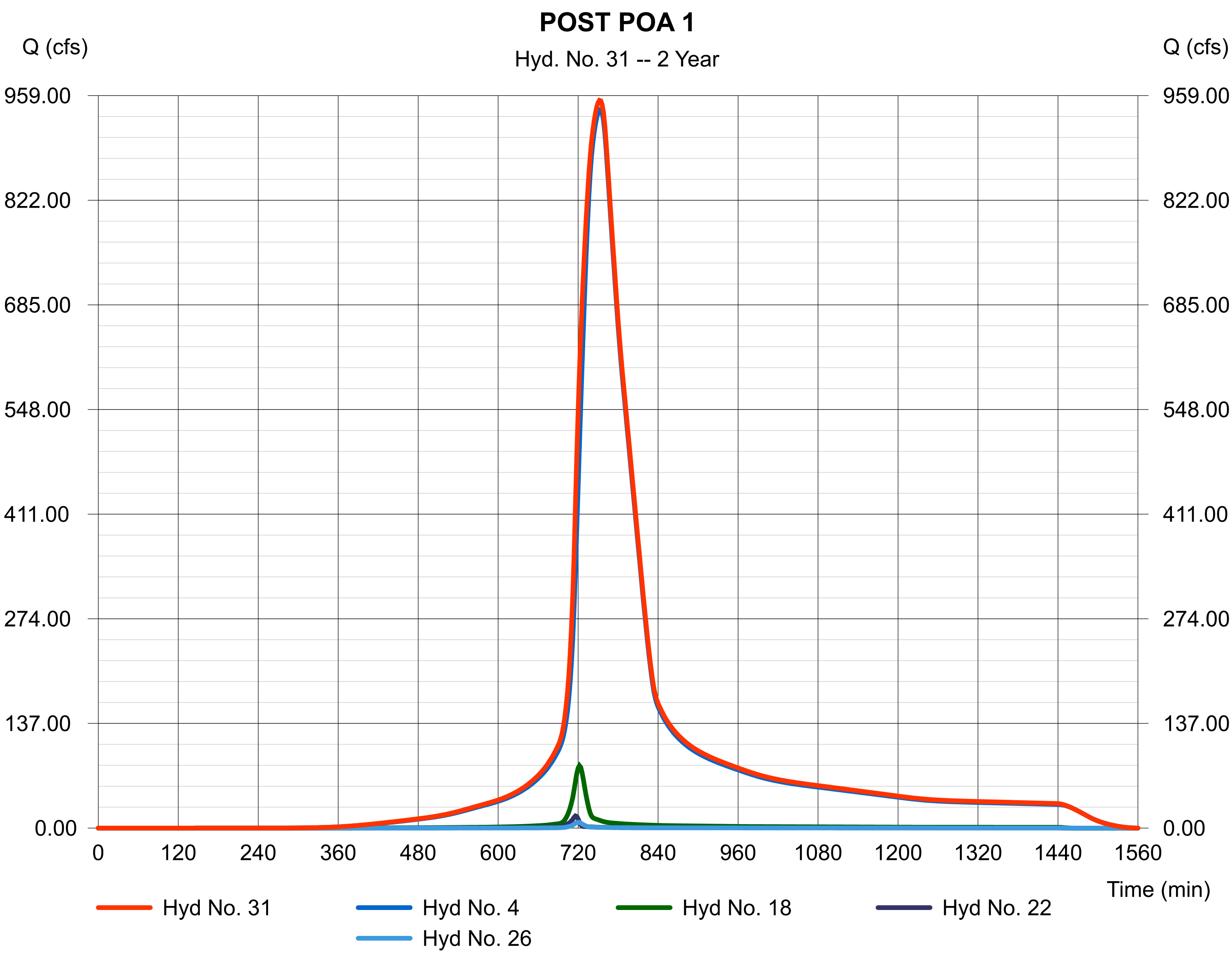
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 31

POST POA 1

Hydrograph type	= Combine	Peak discharge	= 952.84 cfs
Storm frequency	= 2 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 7,518,601 cuft
Inflow hyds.	= 4, 18, 22, 26	Contrib. drain. area	= 24.120 ac



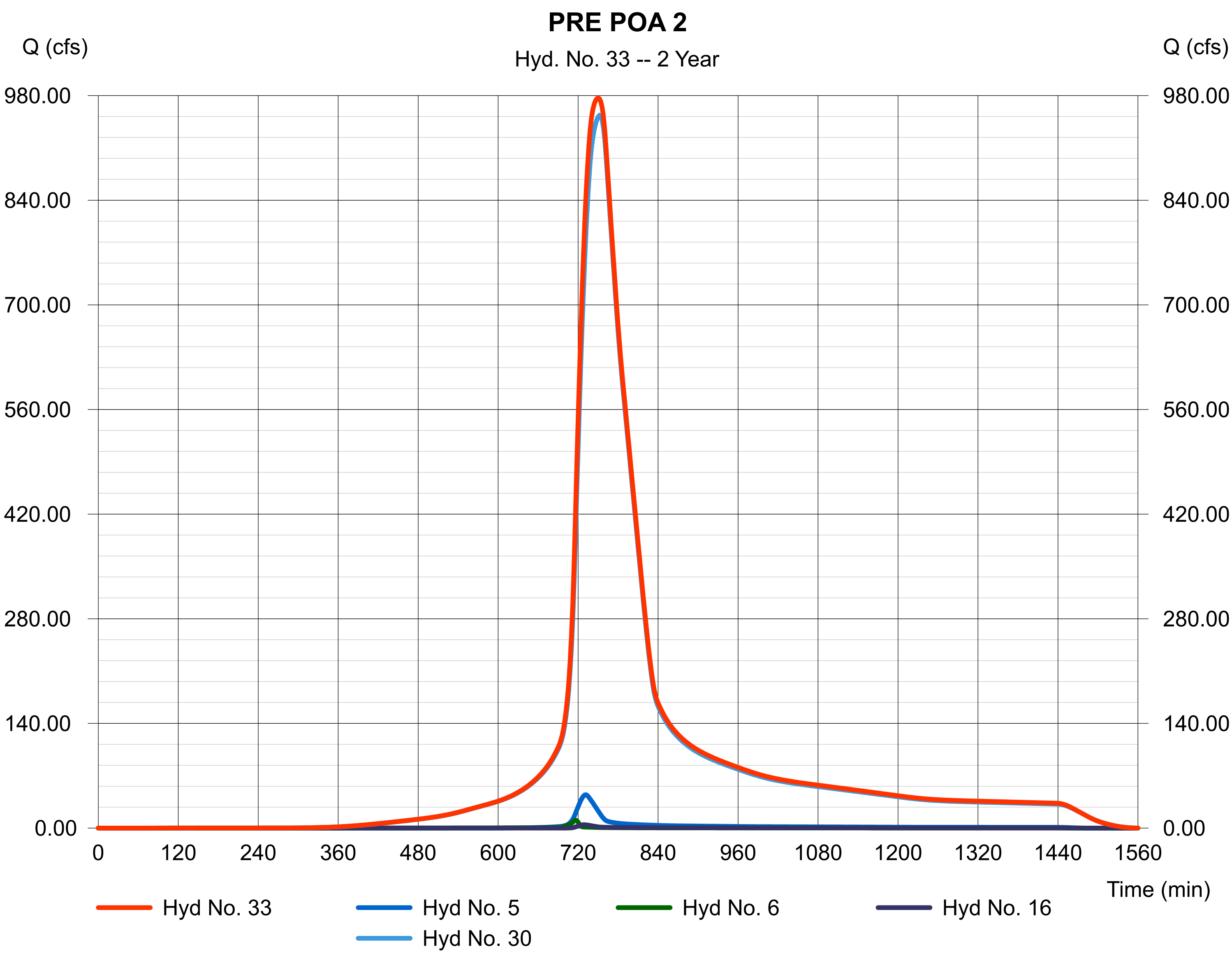
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 33

PRE POA 2

Hydrograph type	= Combine	Peak discharge	= 976.84 cfs
Storm frequency	= 2 yrs	Time to peak	= 750 min
Time interval	= 2 min	Hyd. volume	= 7,690,967 cuft
Inflow hyds.	= 5, 6, 16, 30	Contrib. drain. area	= 37.480 ac



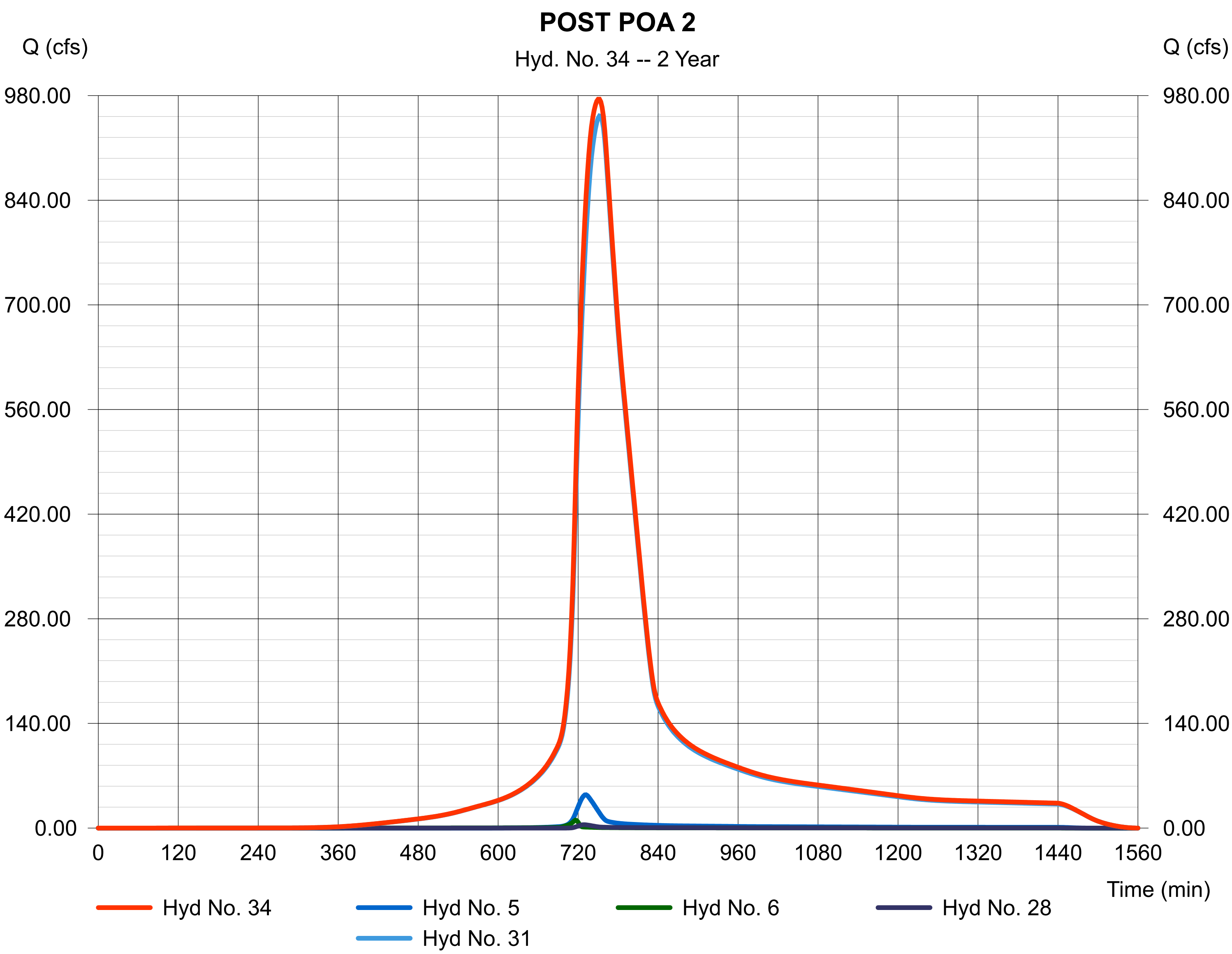
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 34

POST POA 2

Hydrograph type	= Combine	Peak discharge	= 975.20 cfs
Storm frequency	= 2 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 7,744,737 cuft
Inflow hyds.	= 5, 6, 28, 31	Contrib. drain. area	= 37.480 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	866.61	2	758	6,691,347	------	------	------	MACRO BASIN 1
2	SCS Runoff	365.71	2	738	1,918,398	------	------	------	MACRO BASIN 2
3	SCS Runoff	83.17	2	732	359,297	------	------	------	MACRO BASIN 3
4	Combine	1161.39	2	752	8,969,047	1, 2, 3	------	------	OFF POA 1
5	SCS Runoff	59.62	2	732	240,868	------	------	------	MACRO BASIN 4
6	SCS Runoff	12.39	2	716	29,507	------	------	------	OFF BASIN 5
8	SCS Runoff	59.80	2	726	206,880	------	------	------	PRE DB1
9	SCS Runoff	16.33	2	722	47,144	------	------	------	PRE DB2-ON
10	SCS Runoff	7.042	2	716	16,773	------	------	------	PRE DB2-OFF
11	Combine	21.15	2	718	63,917	9, 10	------	------	PRE POA 3
13	SCS Runoff	9.965	2	720	25,854	------	------	------	PRE DB3-ON
14	SCS Runoff	0.987	2	718	1,975	------	------	------	PRE DB3-OFF
15	Combine	10.77	2	720	27,829	13, 14	------	------	PRE POA 4
16	SCS Runoff	7.327	2	728	28,833	------	------	------	PRE DB4
18	SCS Runoff	101.01	2	722	288,481	------	------	------	POST DB1
19	Reservoir	20.61	2	740	284,250	18	963.06	152,807	FALSE PHASE 1 VAULT
20	SCS Runoff	11.91	2	716	25,974	------	------	------	POST DB2-ON
21	SCS Runoff	7.042	2	716	16,773	------	------	------	POST DB2-OFF
22	Combine	18.96	2	716	42,747	20, 21	------	------	POST POA 3
24	SCS Runoff	8.908	2	720	23,136	------	------	------	POST DB3-ON
25	SCS Runoff	0.987	2	718	1,975	------	------	------	POST DB3-OFF
26	Combine	9.713	2	720	25,111	24, 25	------	------	POST POA 4
28	SCS Runoff	7.327	2	728	28,833	------	------	------	POST DB4
30	Combine	1177.37	2	752	9,267,672	4, 8, 11, 15,	------	------	PRE POA 1
31	Combine	1176.11	2	752	9,325,387	4, 18, 22, 26,	------	------	POST POA 1
33	Combine	1209.04	2	748	9,566,881	5, 6, 16, 30,	------	------	PRE POA 2
34	Combine	1206.39	2	750	9,624,595	5, 6, 28, 31,	------	------	POST POA 2

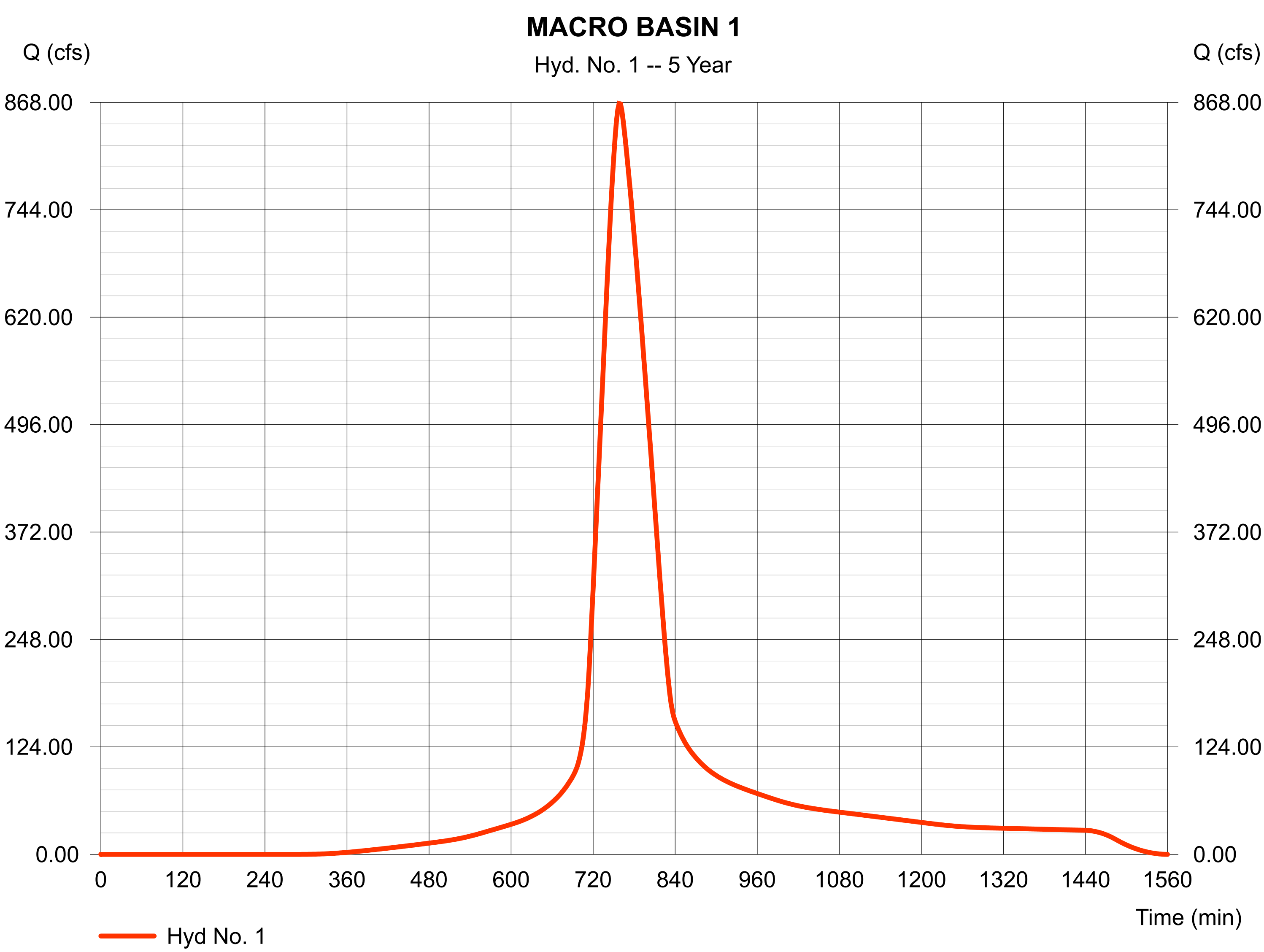
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 1

MACRO BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 866.61 cfs
Storm frequency	= 5 yrs	Time to peak	= 758 min
Time interval	= 2 min	Hyd. volume	= 6,691,347 cuft
Drainage area	= 532.700 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 76.90 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



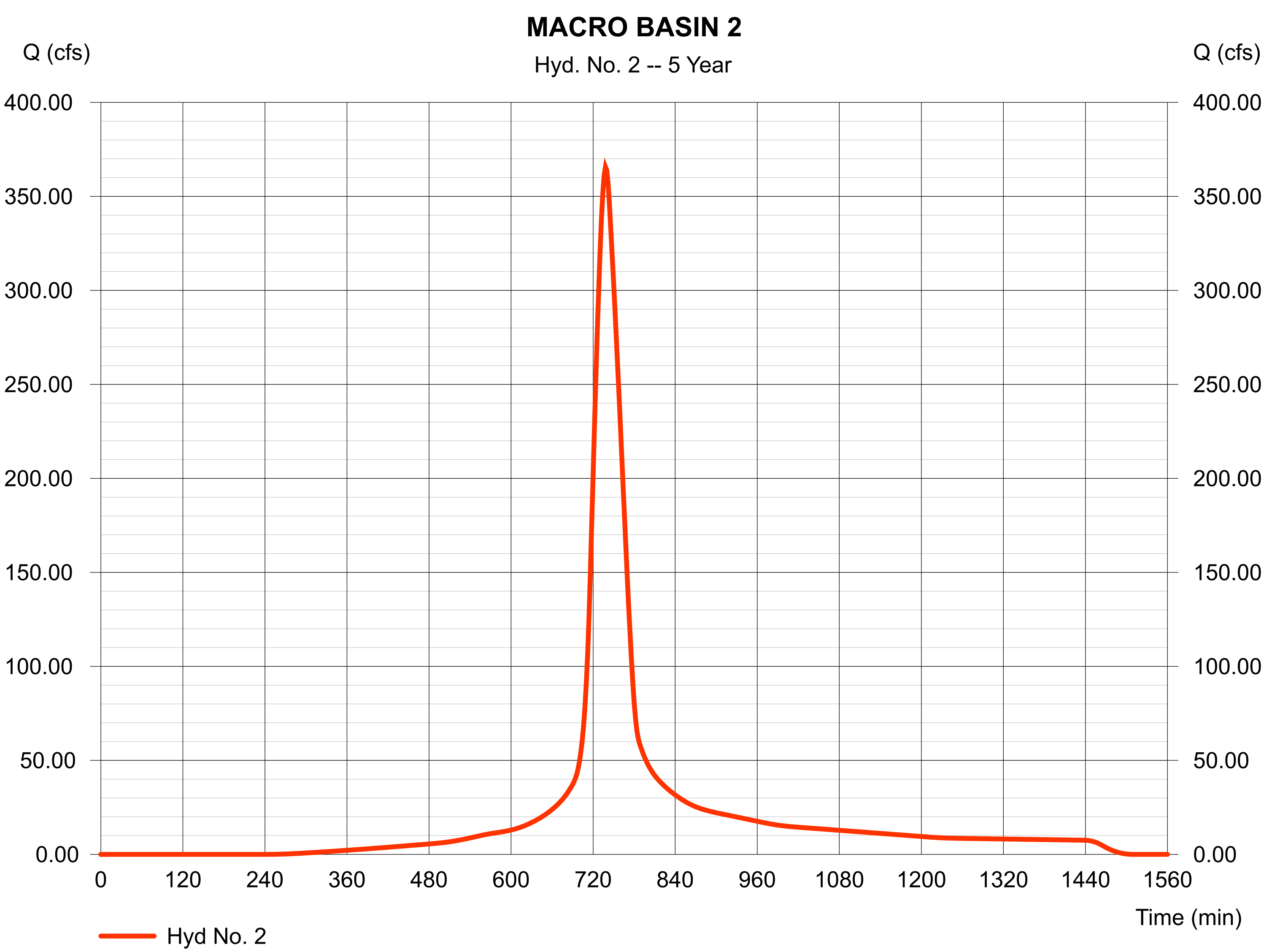
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 2

MACRO BASIN 2

Hydrograph type	= SCS Runoff	Peak discharge	= 365.71 cfs
Storm frequency	= 5 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 1,918,398 cuft
Drainage area	= 142.100 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 42.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



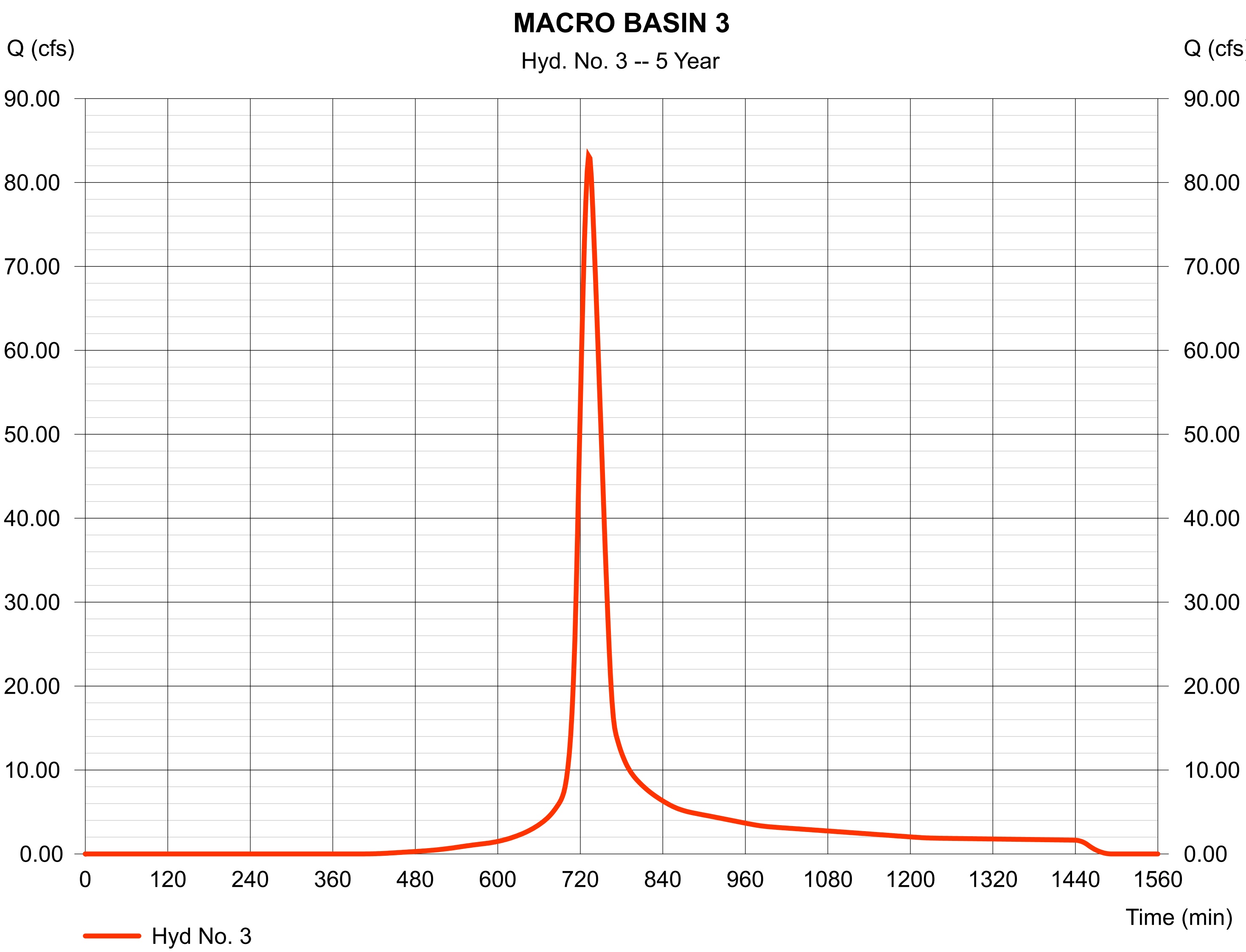
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 3

MACRO BASIN 3

Hydrograph type	= SCS Runoff	Peak discharge	= 83.17 cfs
Storm frequency	= 5 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 359,297 cuft
Drainage area	= 33.700 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 31.50 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



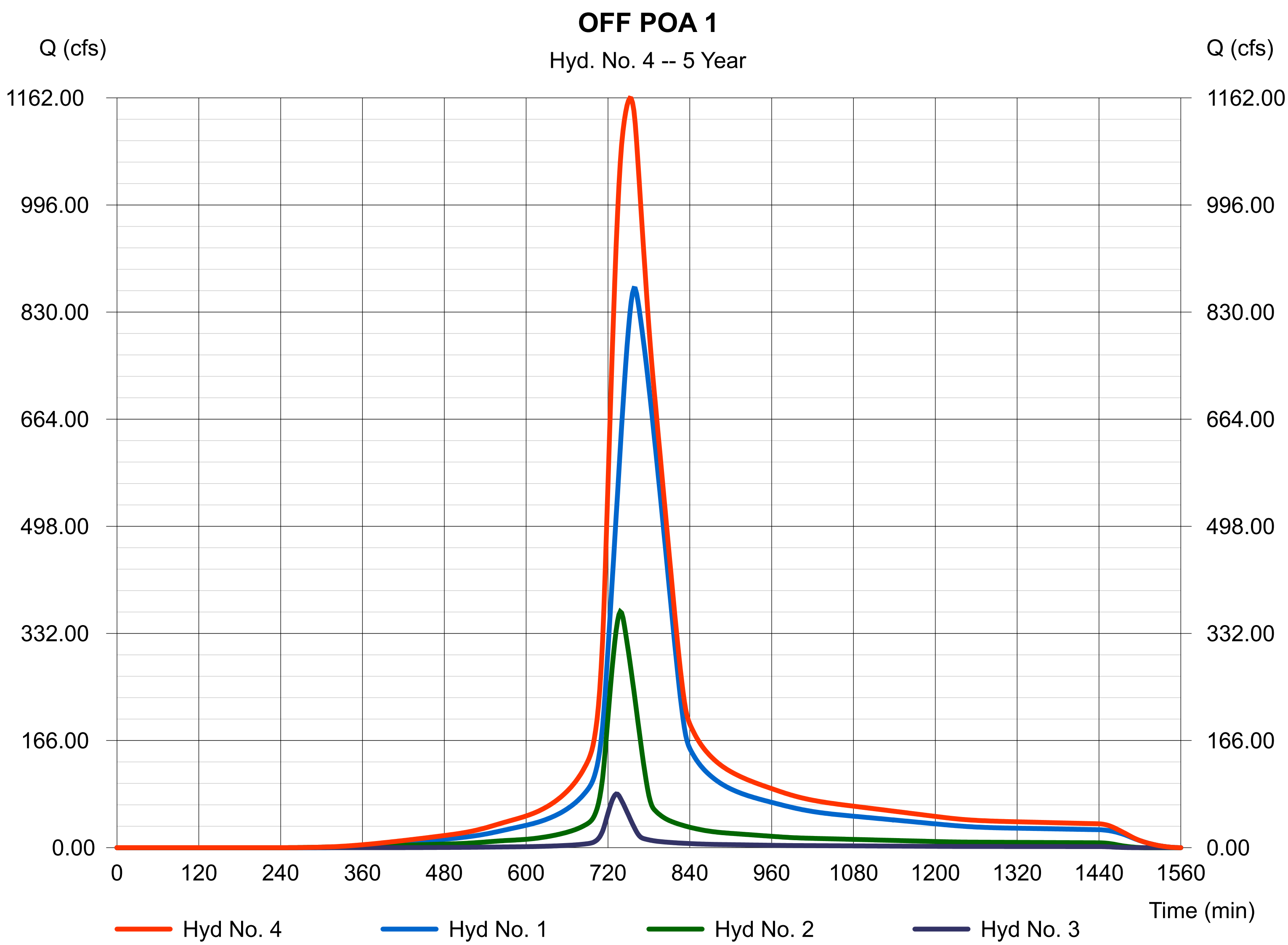
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 4

OFF POA 1

Hydrograph type	= Combine	Peak discharge	= 1161.39 cfs
Storm frequency	= 5 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 8,969,047 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 708.500 ac



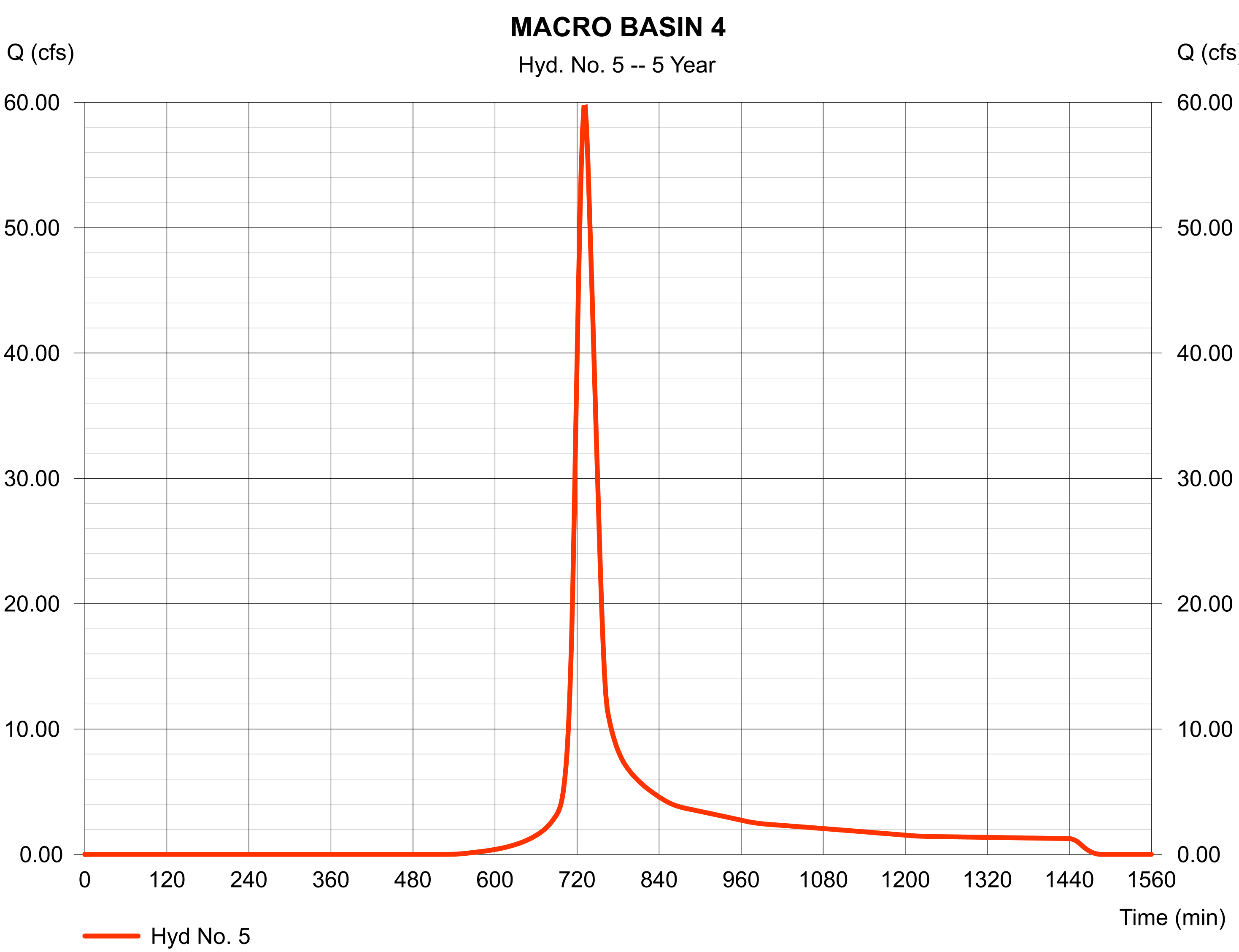
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 5

MACRO BASIN 4

Hydrograph type	= SCS Runoff	Peak discharge	= 59.62 cfs
Storm frequency	= 5 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 240,868 cuft
Drainage area	= 29.000 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 27.10 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



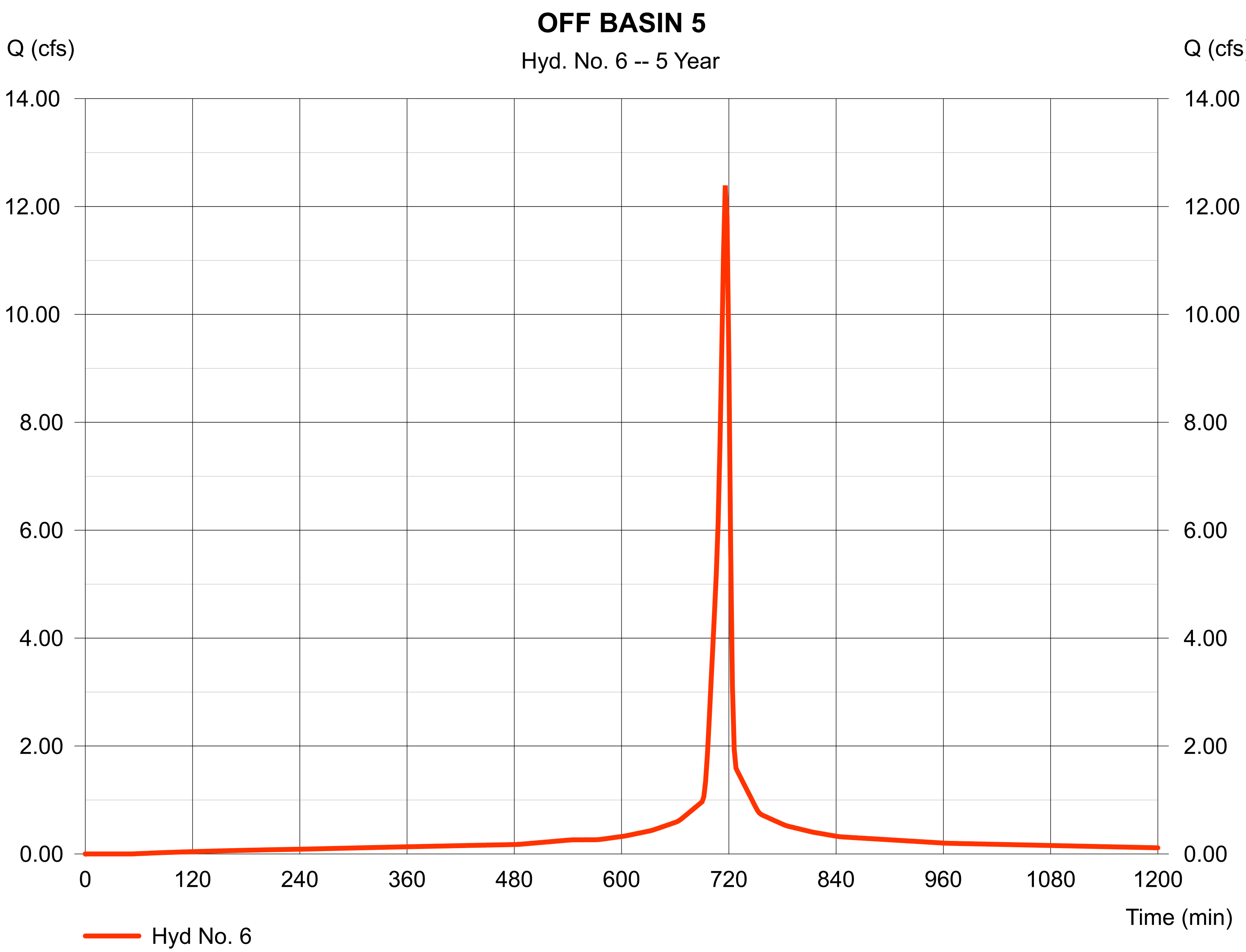
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 6

OFF BASIN 5

Hydrograph type	= SCS Runoff	Peak discharge	= 12.39 cfs
Storm frequency	= 5 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 29,507 cuft
Drainage area	= 1.900 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

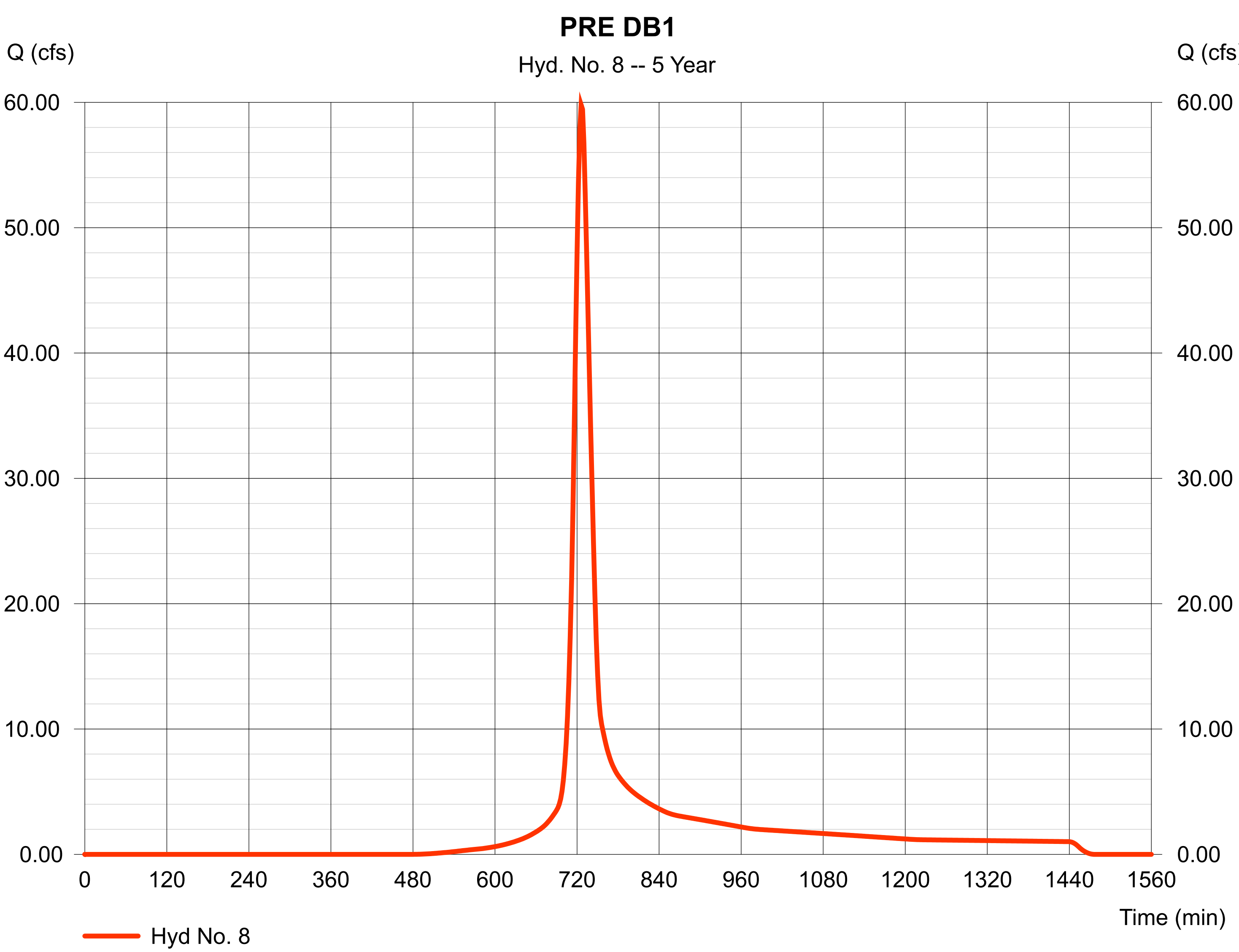
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 8

PRE DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 59.80 cfs
Storm frequency	= 5 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 206,880 cuft
Drainage area	= 22.020 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 20.73 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 22.020



Hydrograph Report

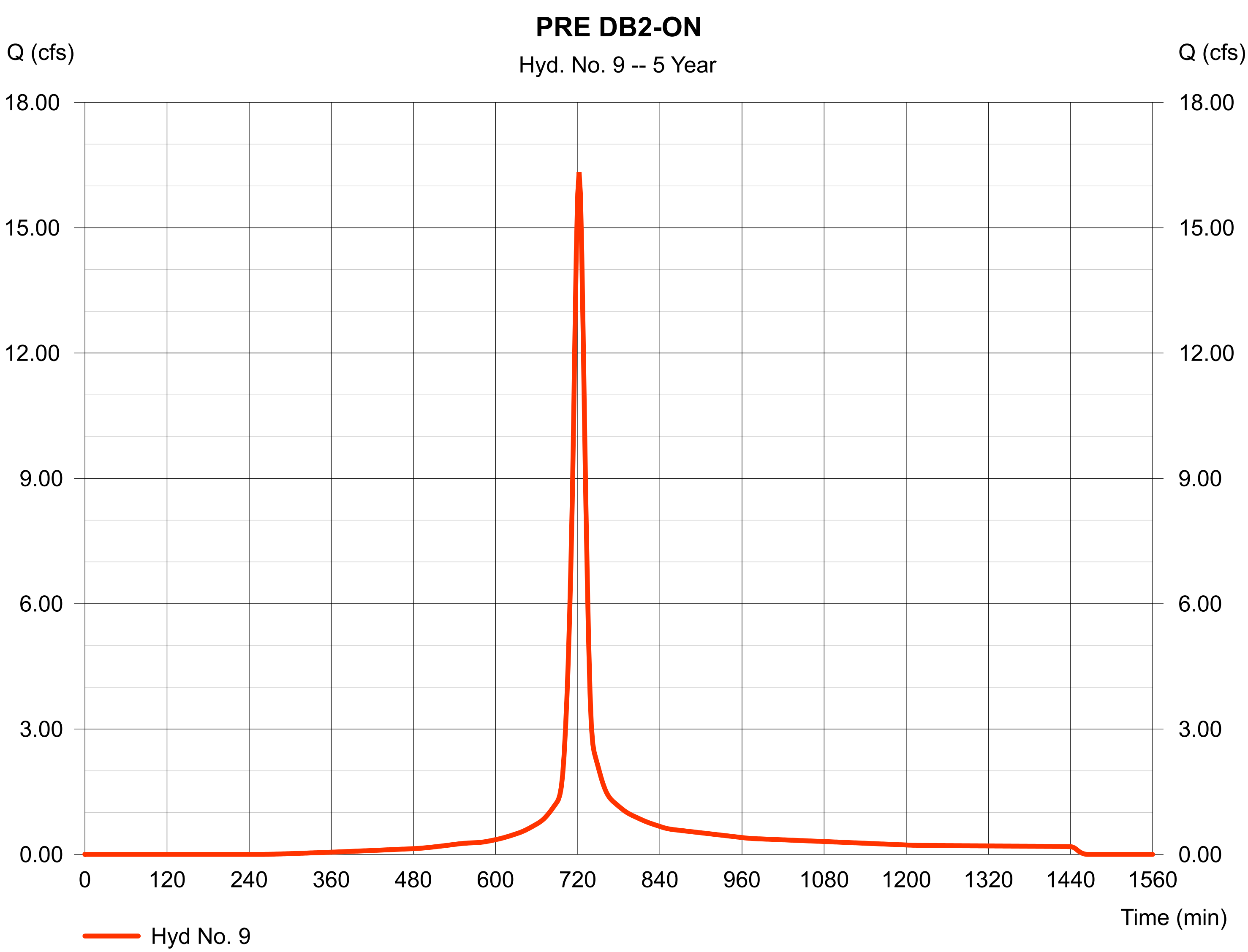
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 9

PRE DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 16.33 cfs
Storm frequency	= 5 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 47,144 cuft
Drainage area	= 3.720 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.33 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 3.720



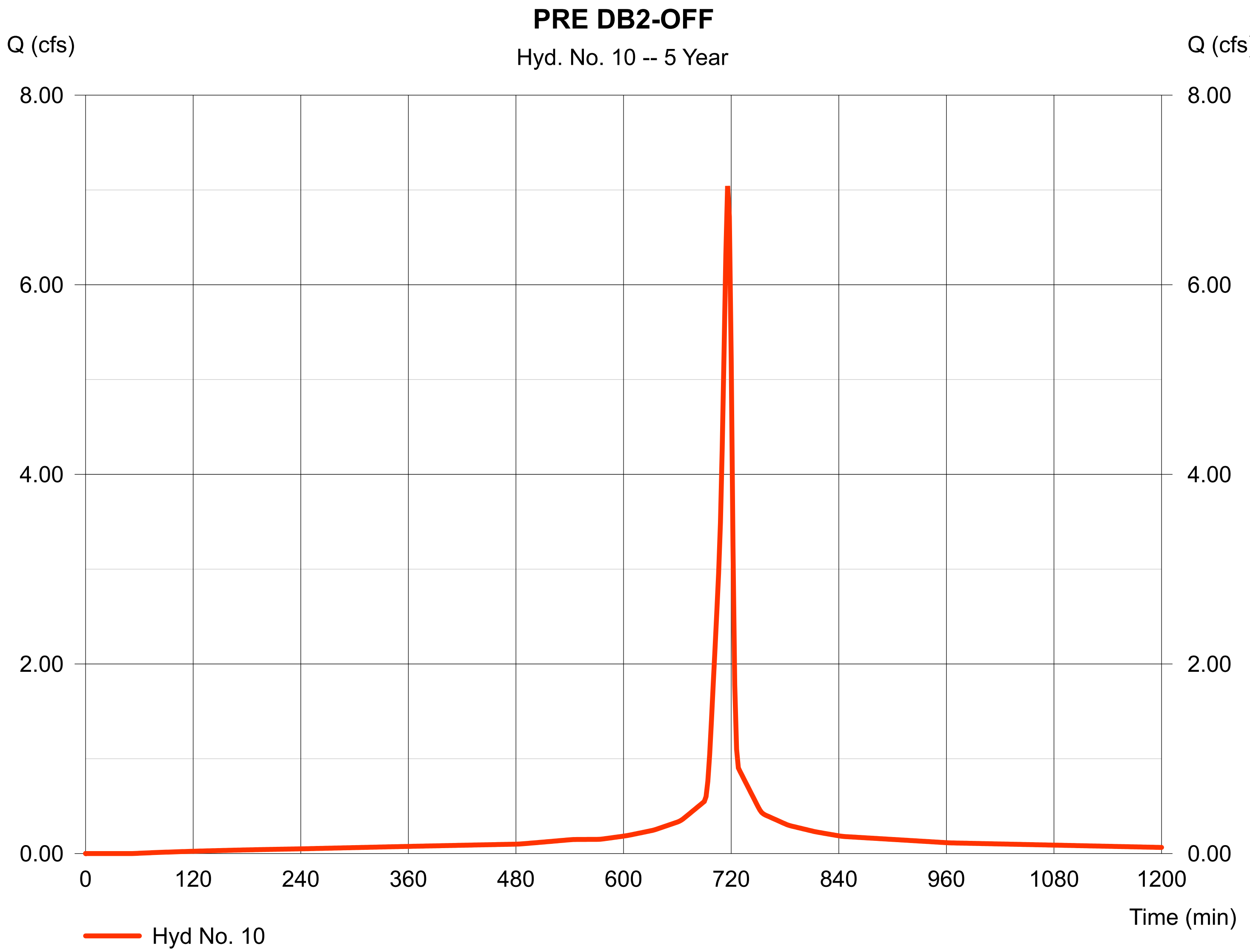
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 10

PRE DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 7.042 cfs
Storm frequency	= 5 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 16,773 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



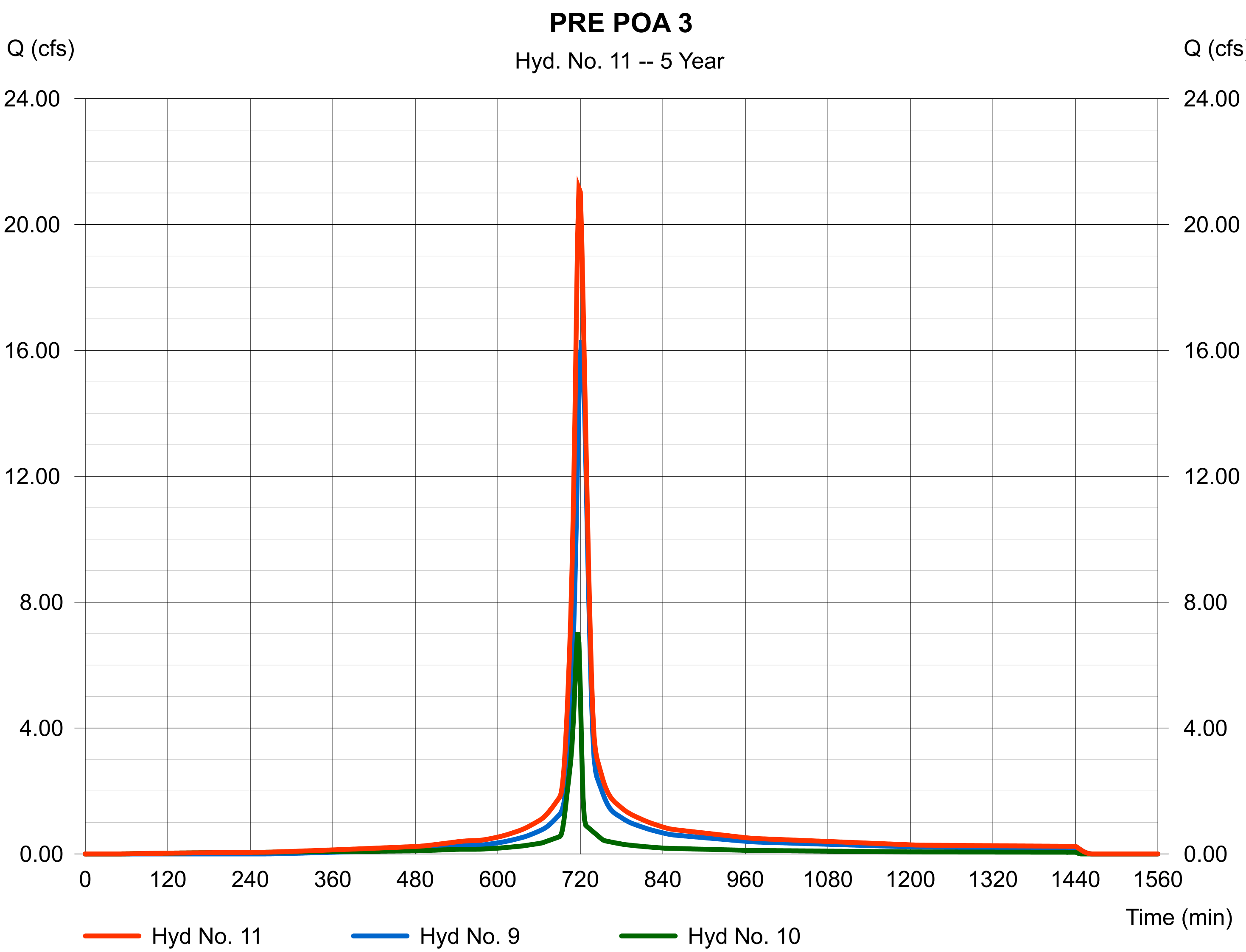
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 11

PRE POA 3

Hydrograph type	= Combine	Peak discharge	= 21.15 cfs
Storm frequency	= 5 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 63,917 cuft
Inflow hyds.	= 9, 10	Contrib. drain. area	= 4.800 ac



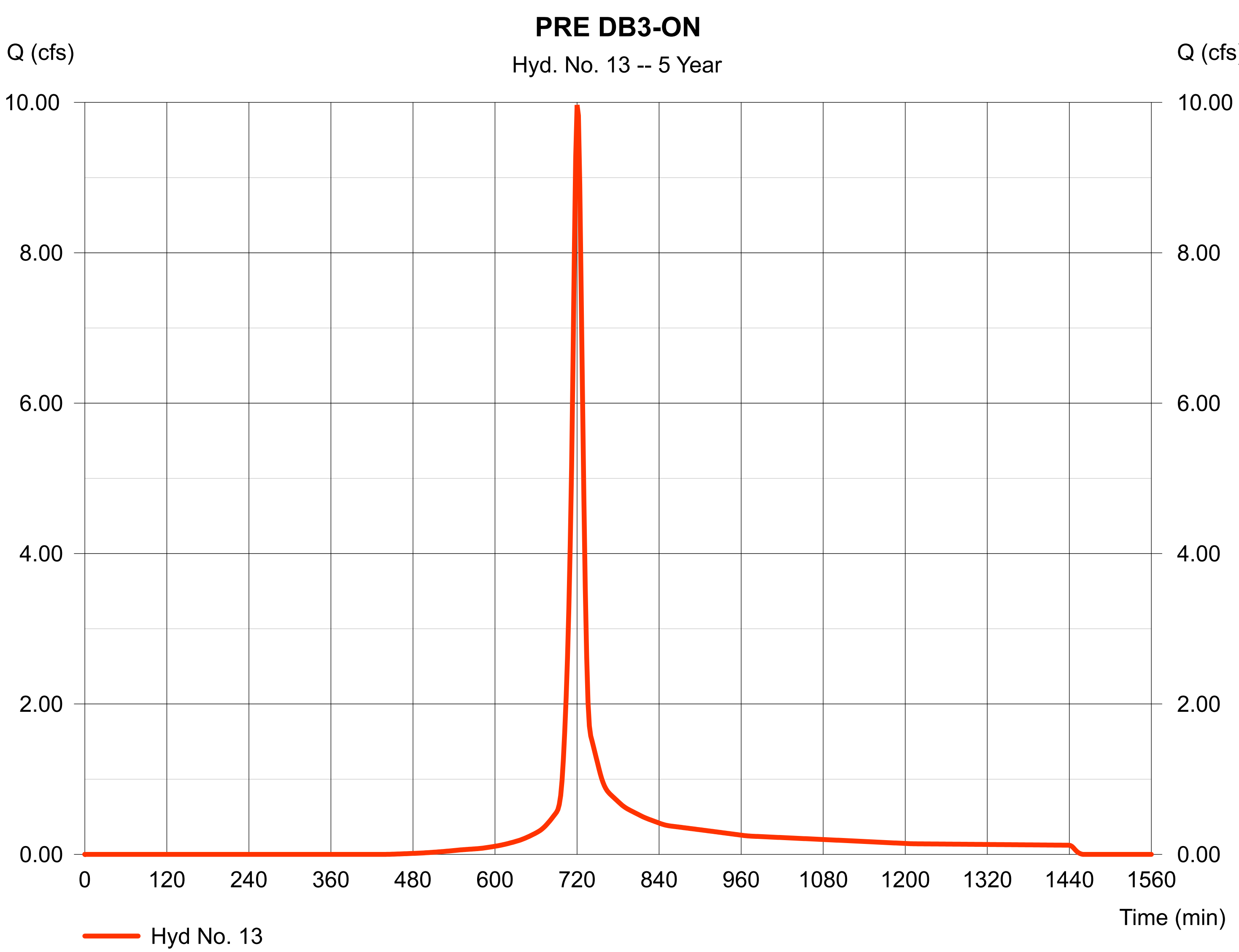
Hydrograph Report

Hyd. No. 13

PRE DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 9.965 cfs
Storm frequency	= 5 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 25,854 cuft
Drainage area	= 2.540 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 55) + (0.570 x 61) + (2.130 x 98)] / 2.540



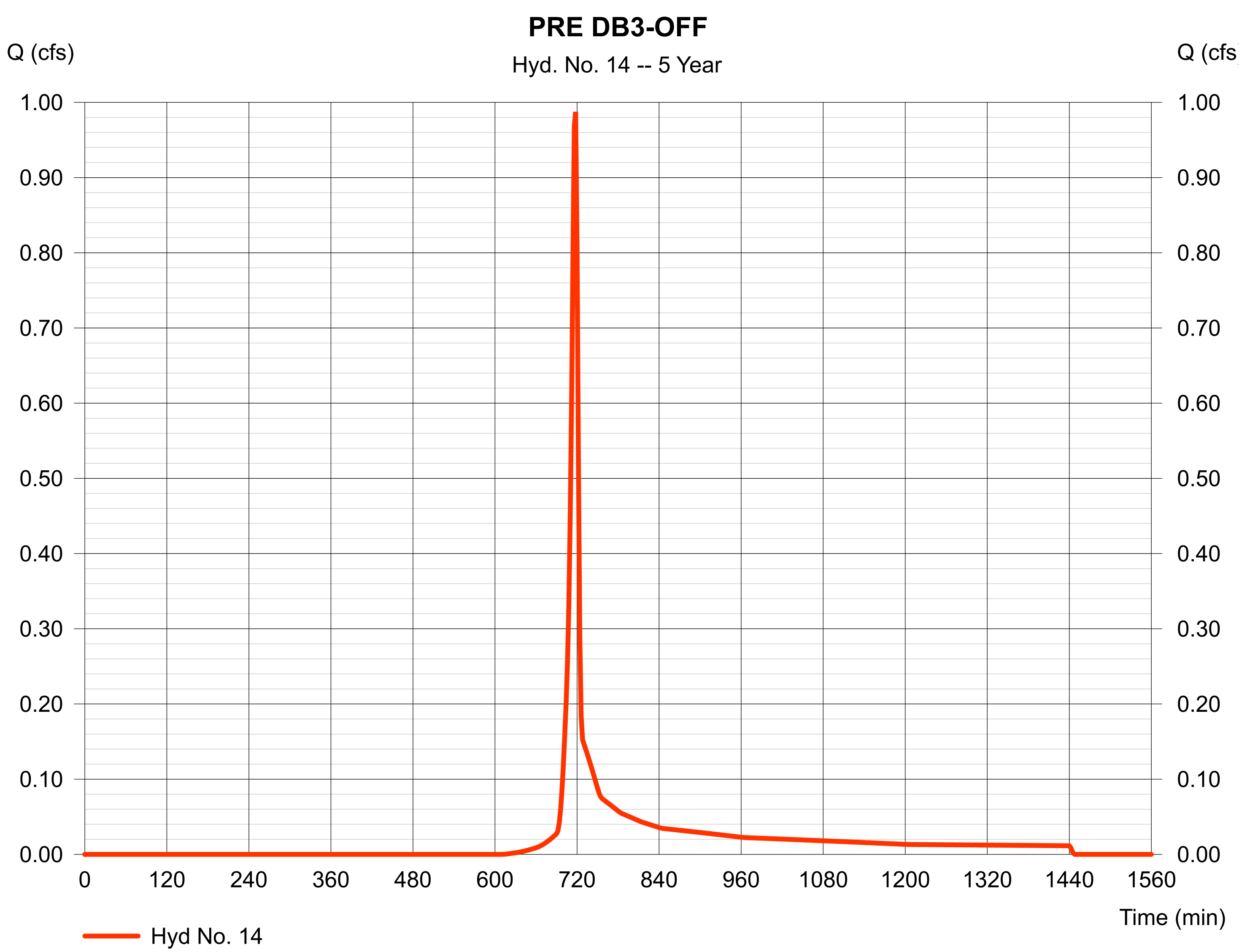
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 14

PRE DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 0.987 cfs
Storm frequency	= 5 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 1,975 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



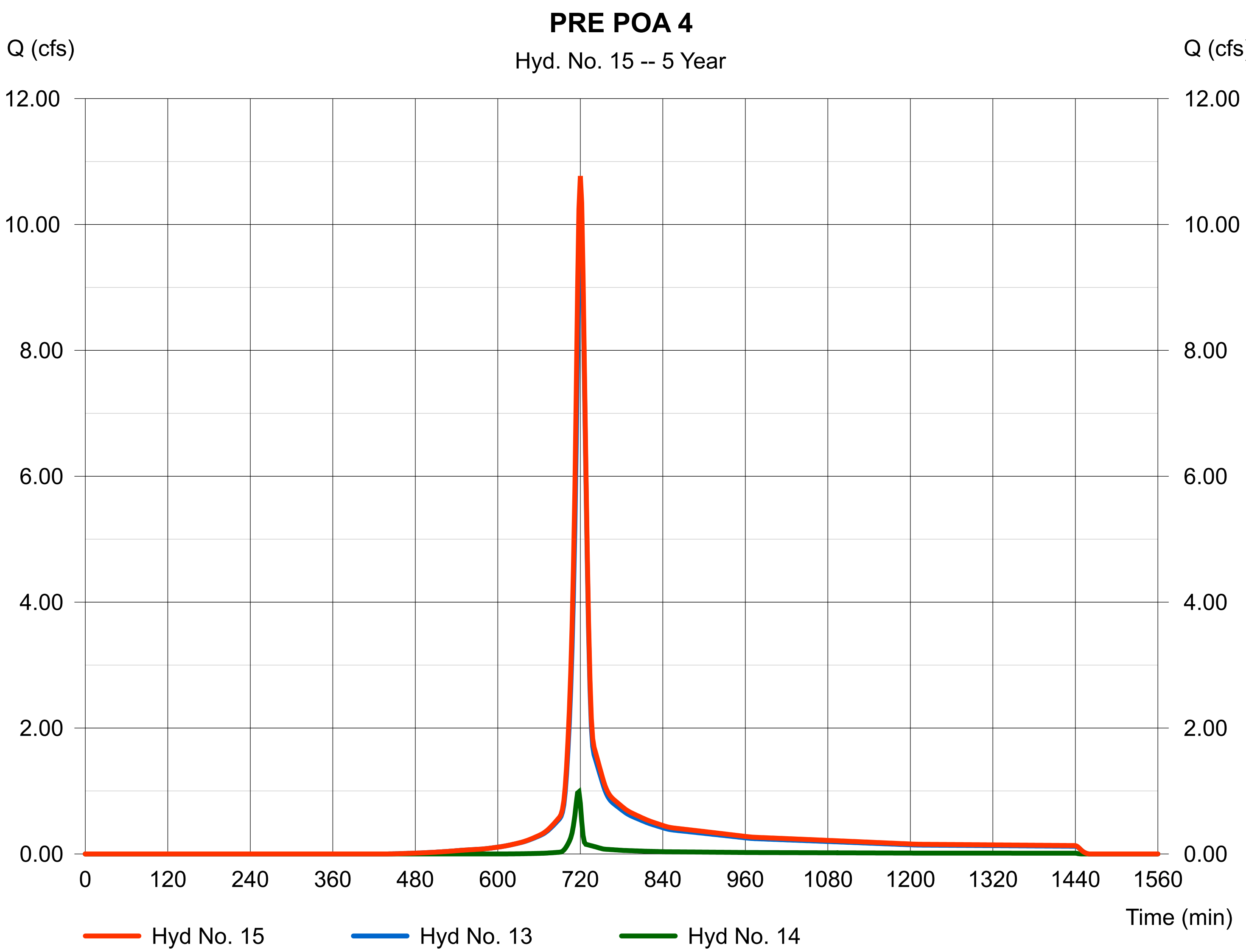
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 15

PRE POA 4

Hydrograph type	= Combine	Peak discharge	= 10.77 cfs
Storm frequency	= 5 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 27,829 cuft
Inflow hyds.	= 13, 14	Contrib. drain. area	= 2.860 ac



Hydrograph Report

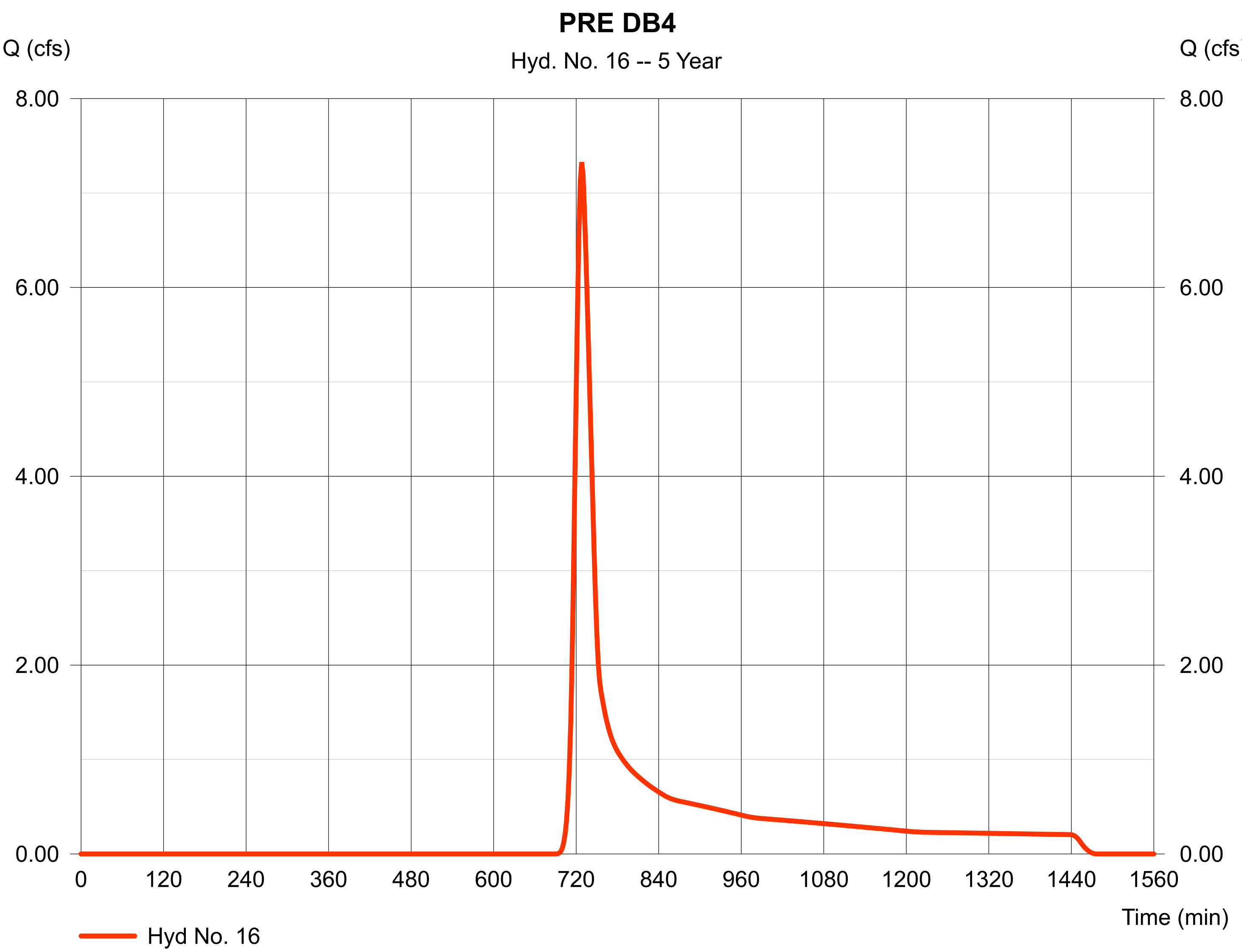
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 16

PRE DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 7.327 cfs
Storm frequency	= 5 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 28,833 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.12 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.160 x 61) + (1.840 x 55)] / 6.580



Hydrograph Report

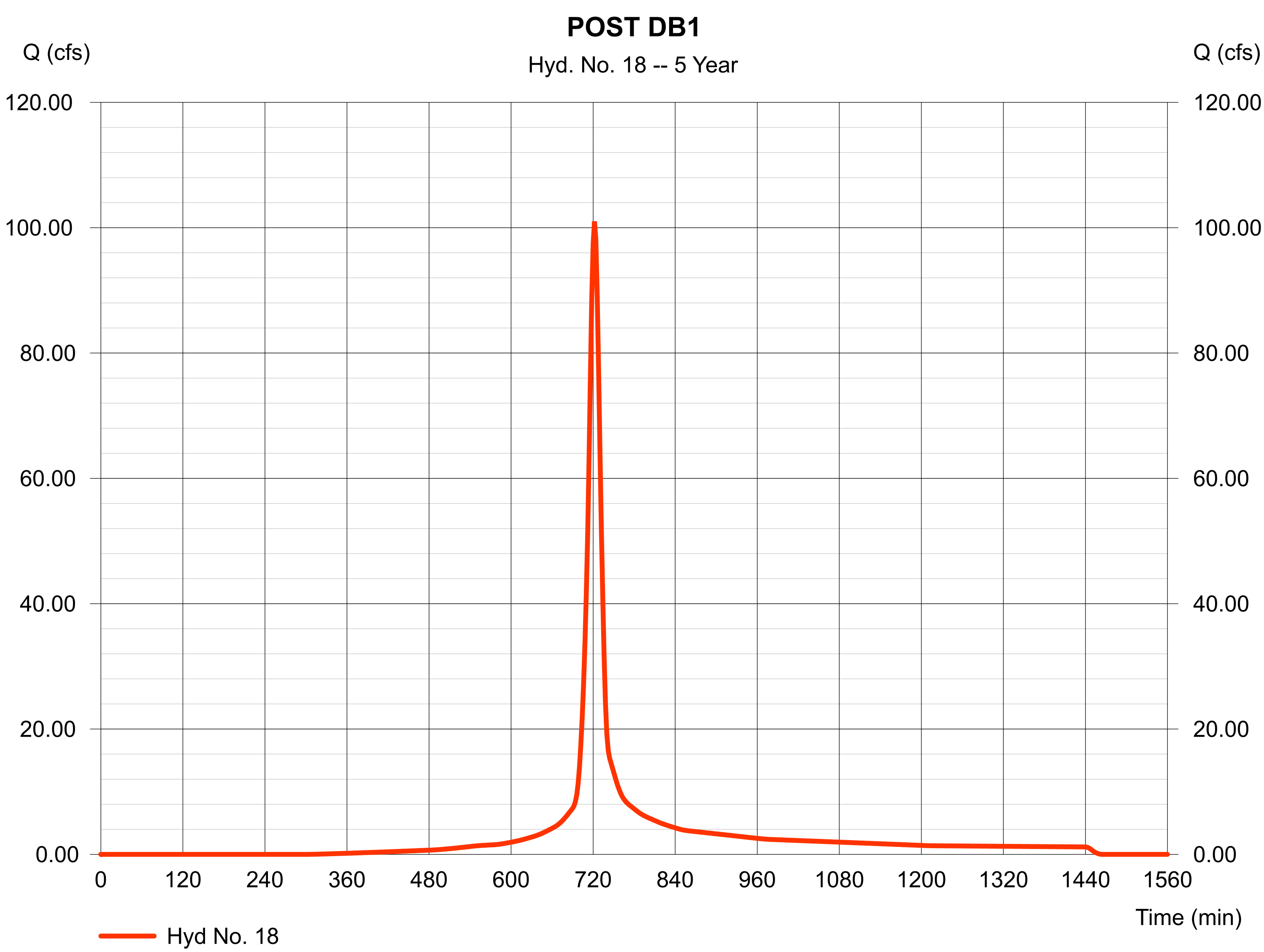
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 18

POST DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 101.01 cfs
Storm frequency	= 5 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 288,481 cuft
Drainage area	= 24.120 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.62 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 98) + (0.310 x 55) + (0.510 x 61)] / 24.120



Hydrograph Report

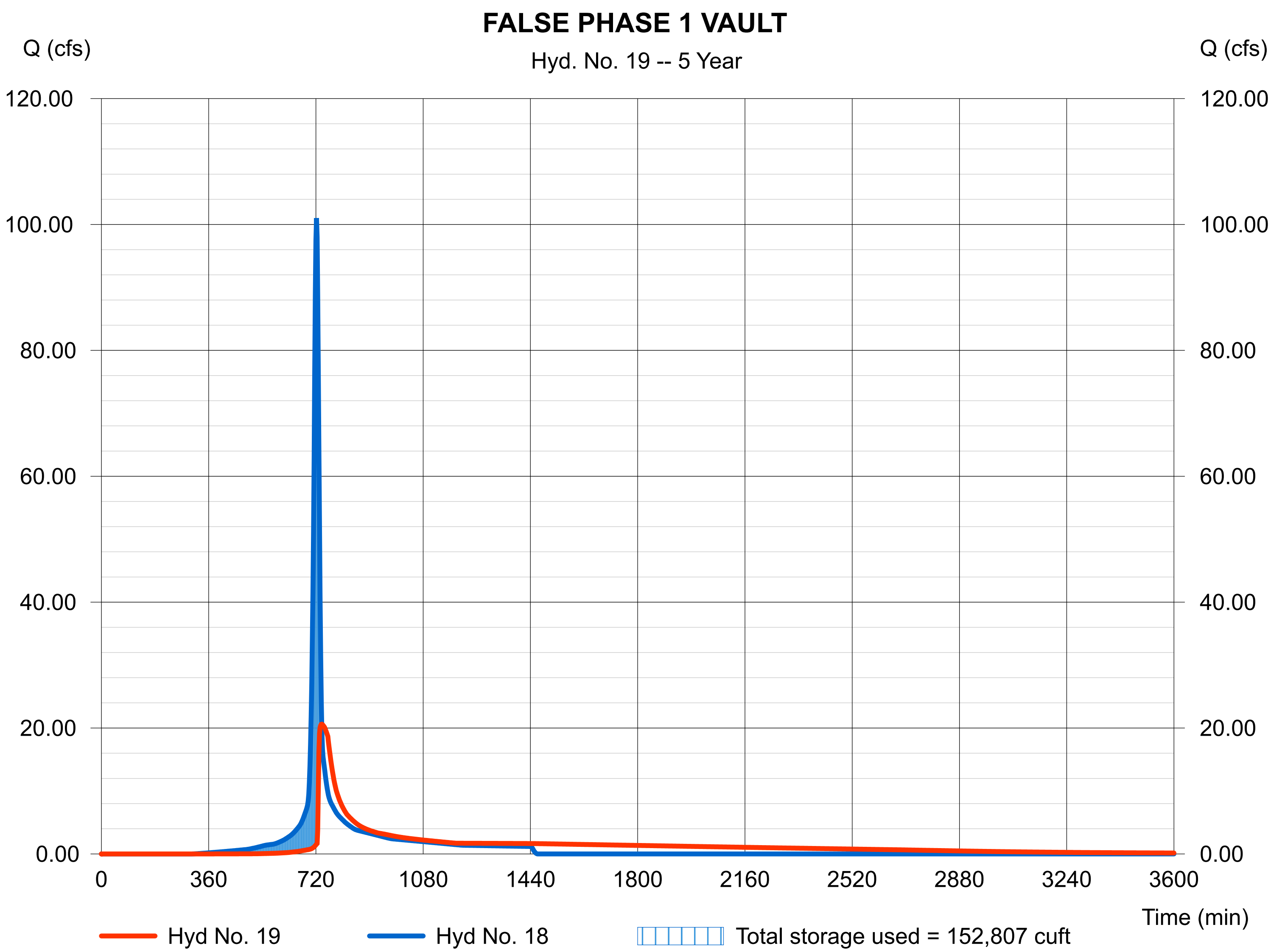
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 19

FALSE PHASE 1 VAULT

Hydrograph type	= Reservoir	Peak discharge	= 20.61 cfs
Storm frequency	= 5 yrs	Time to peak	= 740 min
Time interval	= 2 min	Hyd. volume	= 284,250 cuft
Inflow hyd. No.	= 18 - POST DB1	Max. Elevation	= 963.06 ft
Reservoir name	= FALSE POND	Max. Storage	= 152,807 cuft

Storage Indication method used.



Hydrograph Report

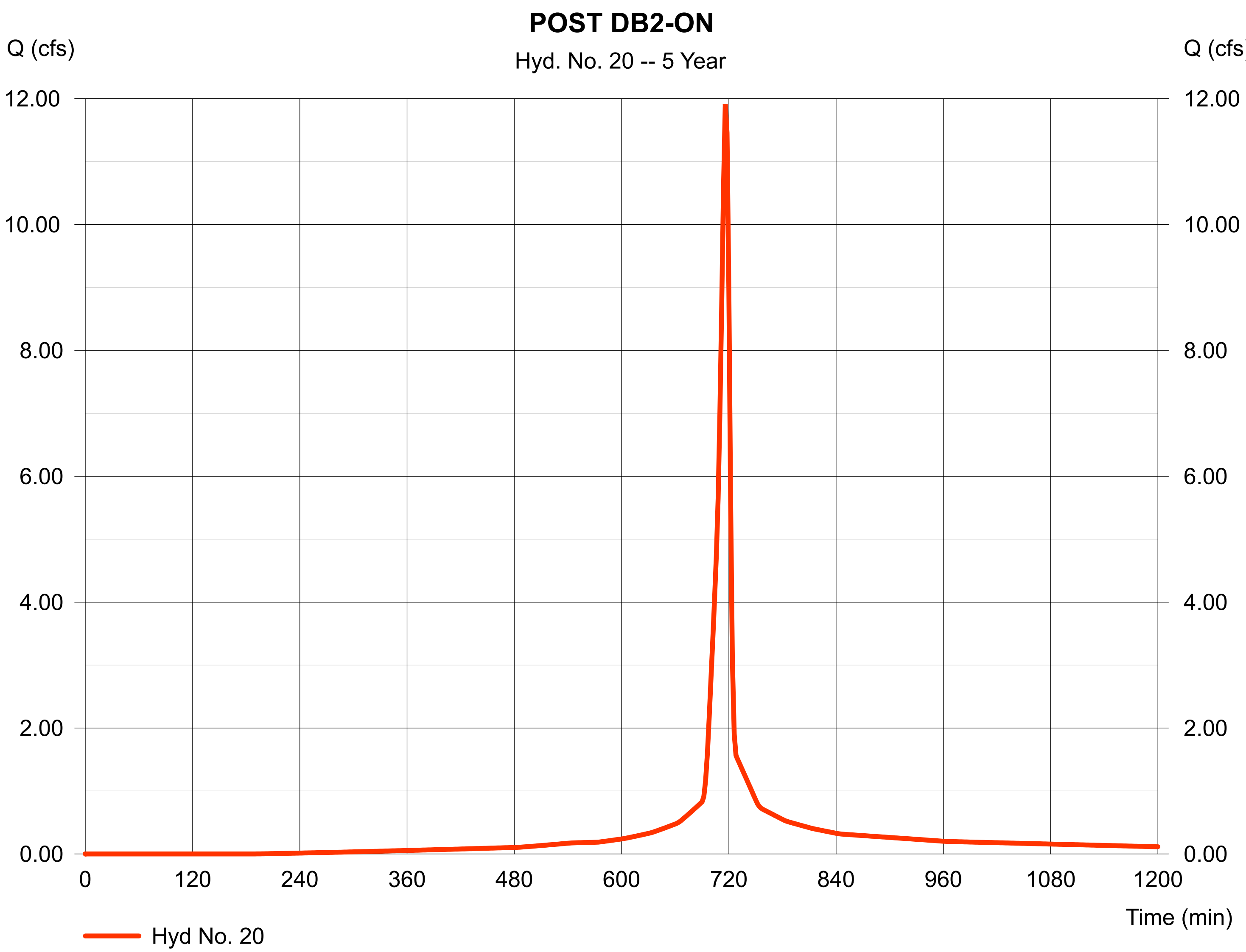
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 20

POST DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 11.91 cfs
Storm frequency	= 5 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 25,974 cuft
Drainage area	= 1.960 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.090 x 61) + (0.280 x 85) + (13.450 x 98) + (1.000 x 55)] / 1.960



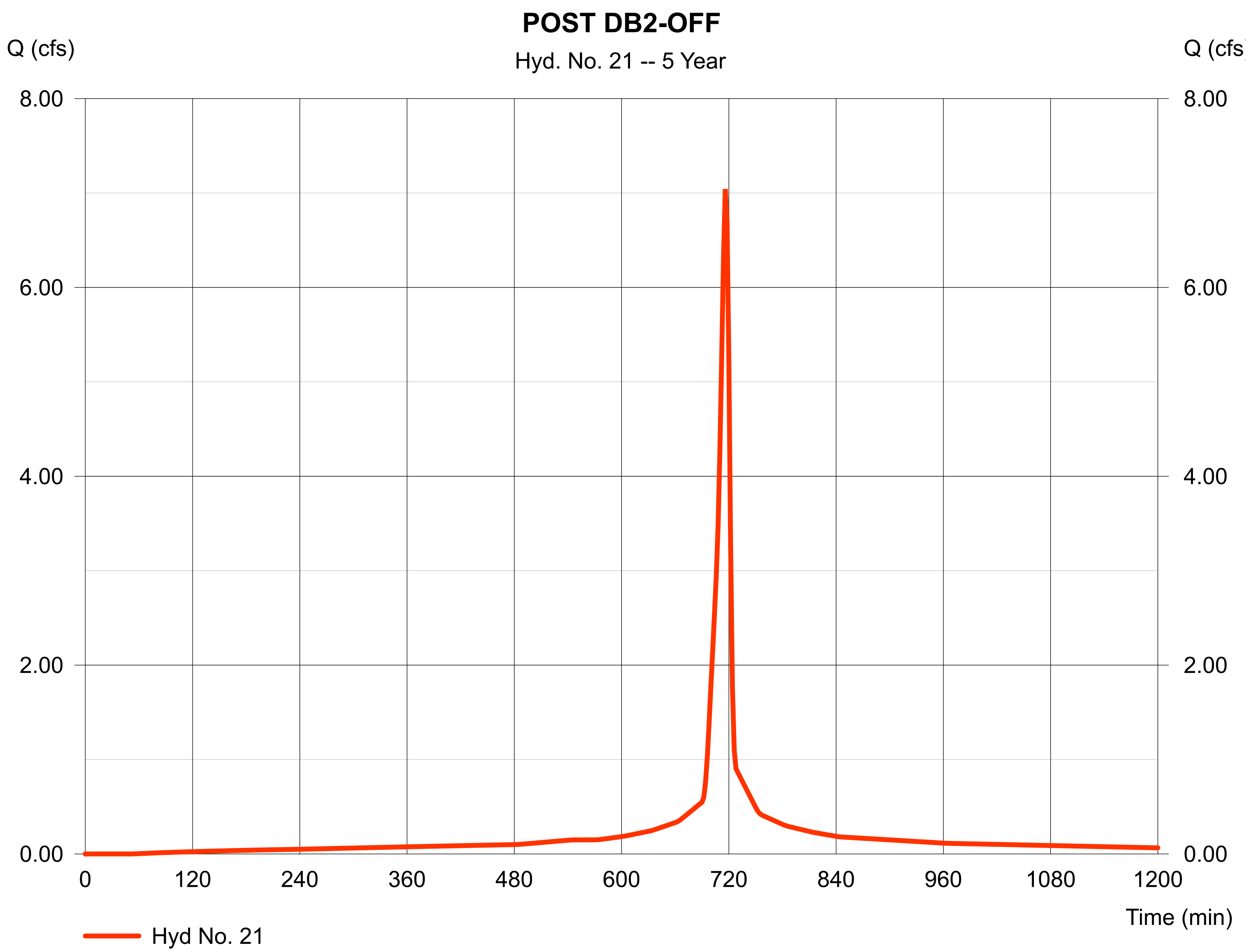
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 21

POST DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 7.042 cfs
Storm frequency	= 5 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 16,773 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

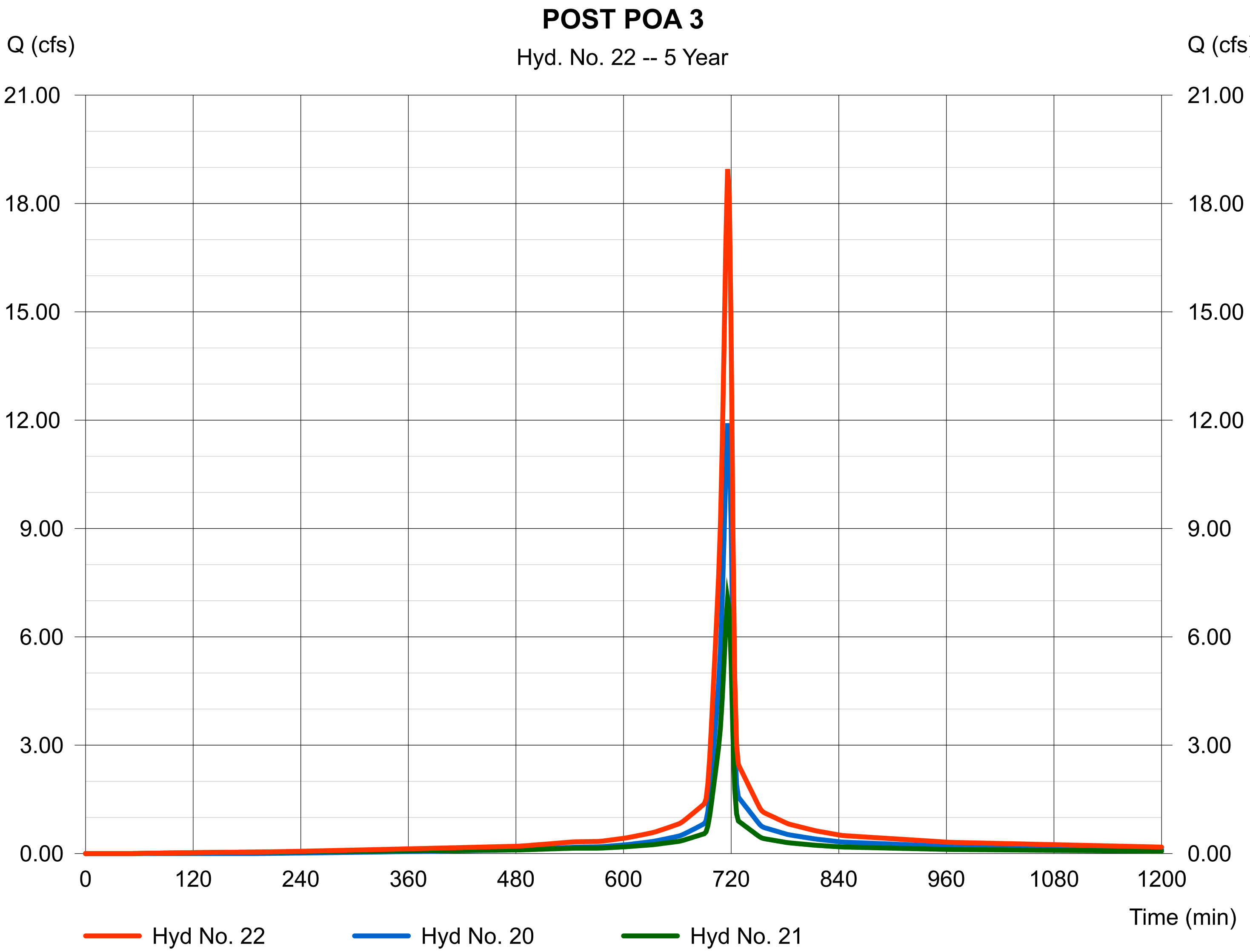


Hydrograph Report

Hyd. No. 22

POST POA 3

Hydrograph type	= Combine	Peak discharge	= 18.96 cfs
Storm frequency	= 5 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 42,747 cuft
Inflow hyds.	= 20, 21	Contrib. drain. area	= 3.040 ac



Hydrograph Report

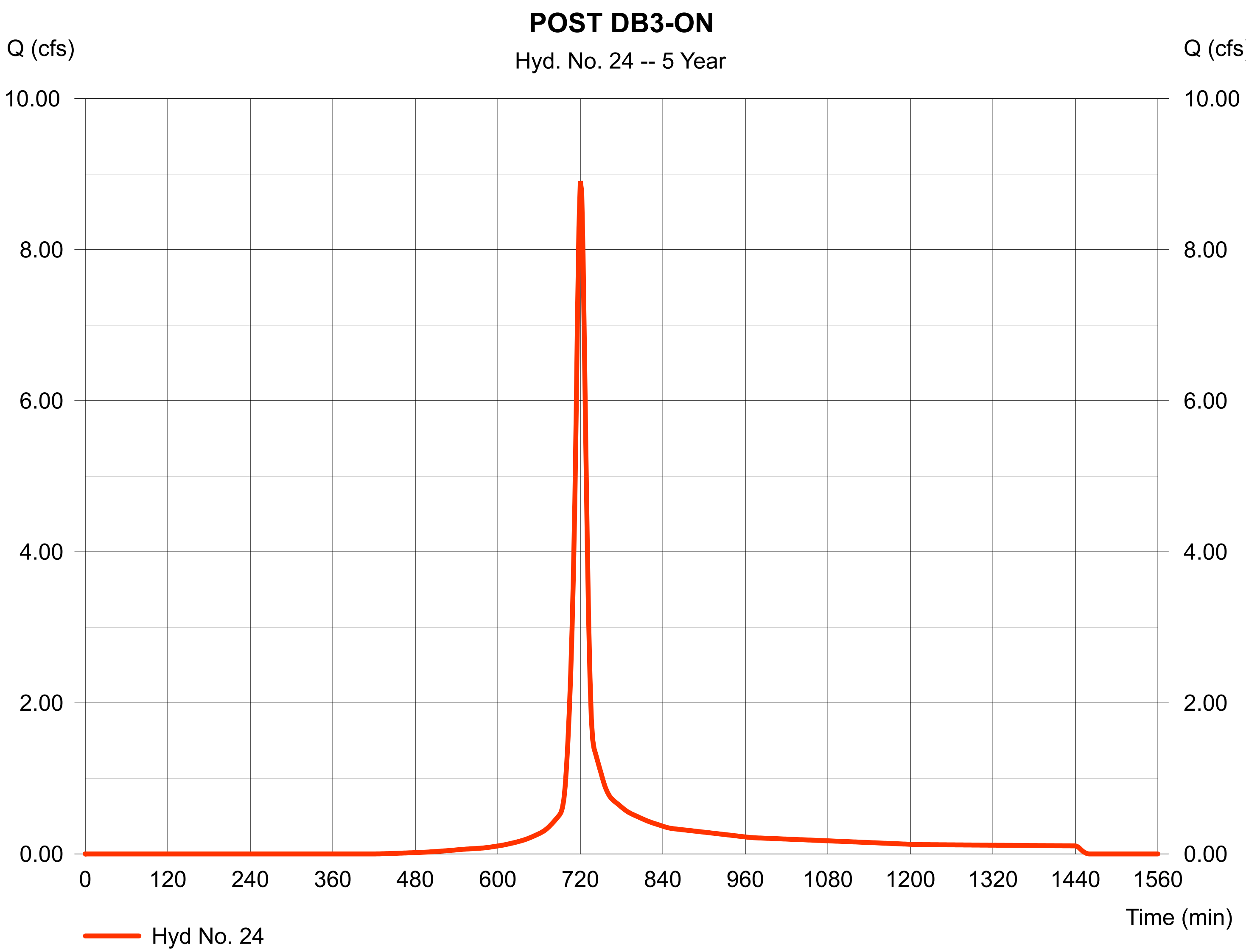
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 24

POST DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 8.908 cfs
Storm frequency	= 5 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 23,136 cuft
Drainage area	= 2.200 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (2.810 x 61) + (10.490 x 98)] / 2.200



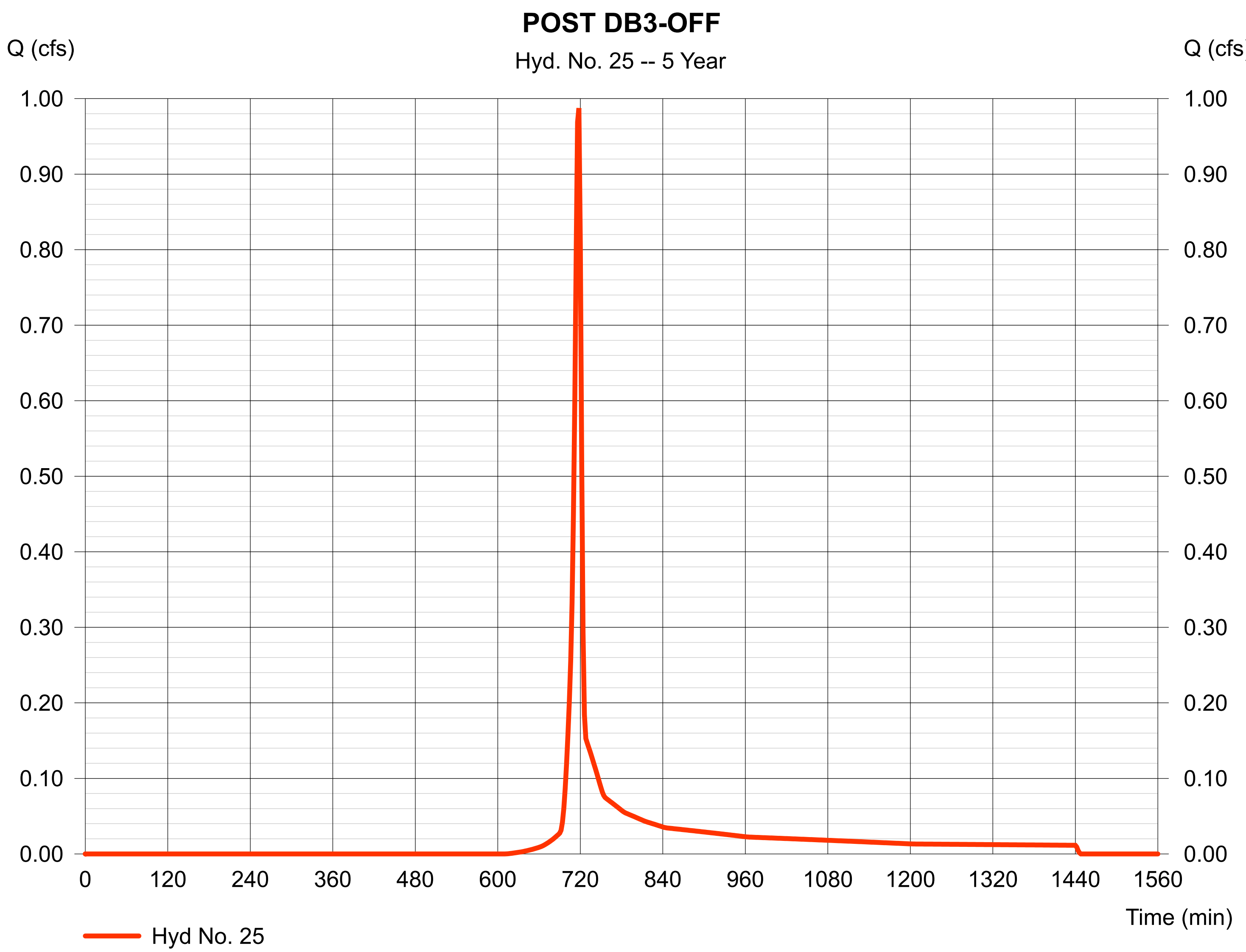
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 25

POST DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 0.987 cfs
Storm frequency	= 5 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 1,975 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



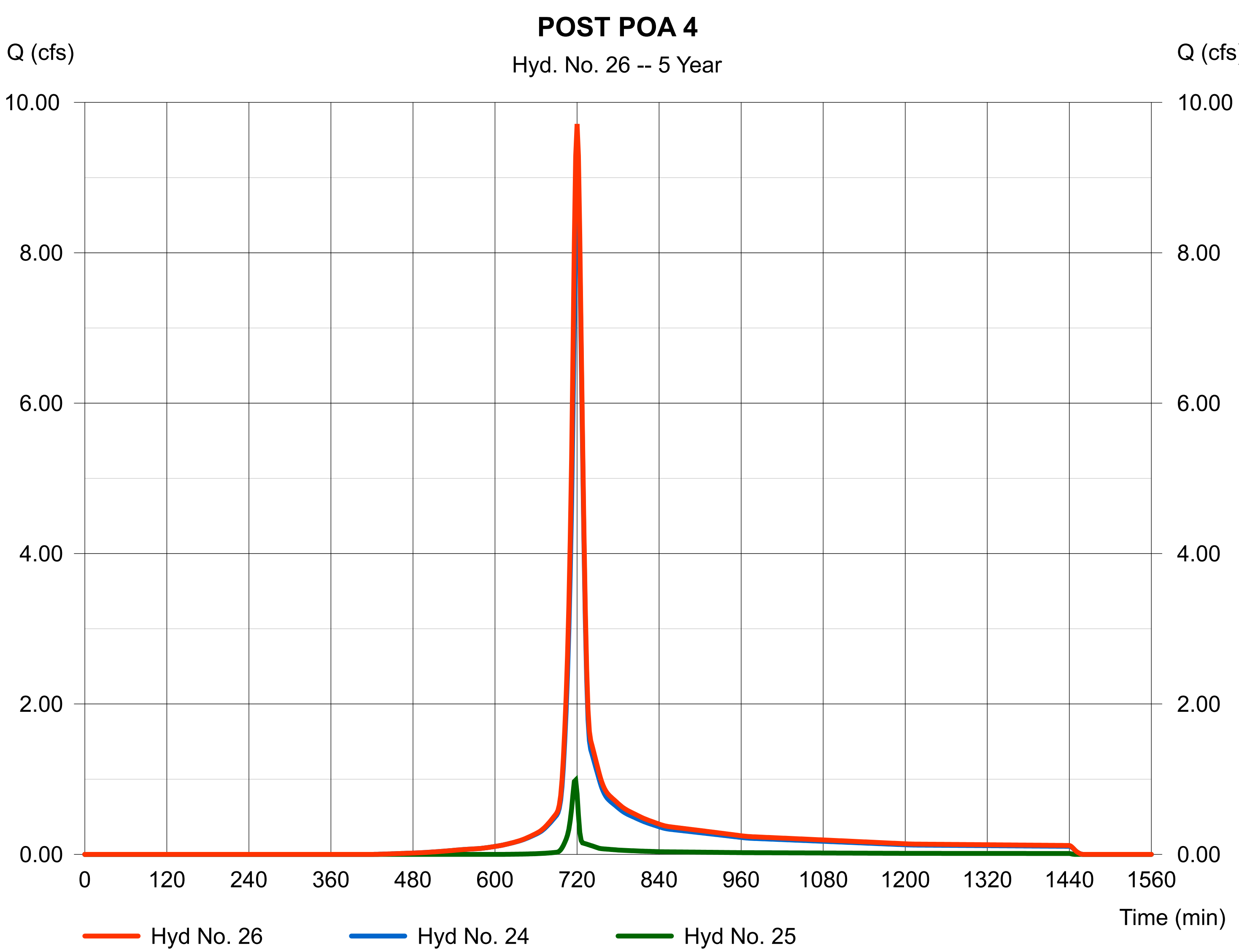
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 26

POST POA 4

Hydrograph type	= Combine	Peak discharge	= 9.713 cfs
Storm frequency	= 5 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 25,111 cuft
Inflow hyds.	= 24, 25	Contrib. drain. area	= 2.520 ac



Hydrograph Report

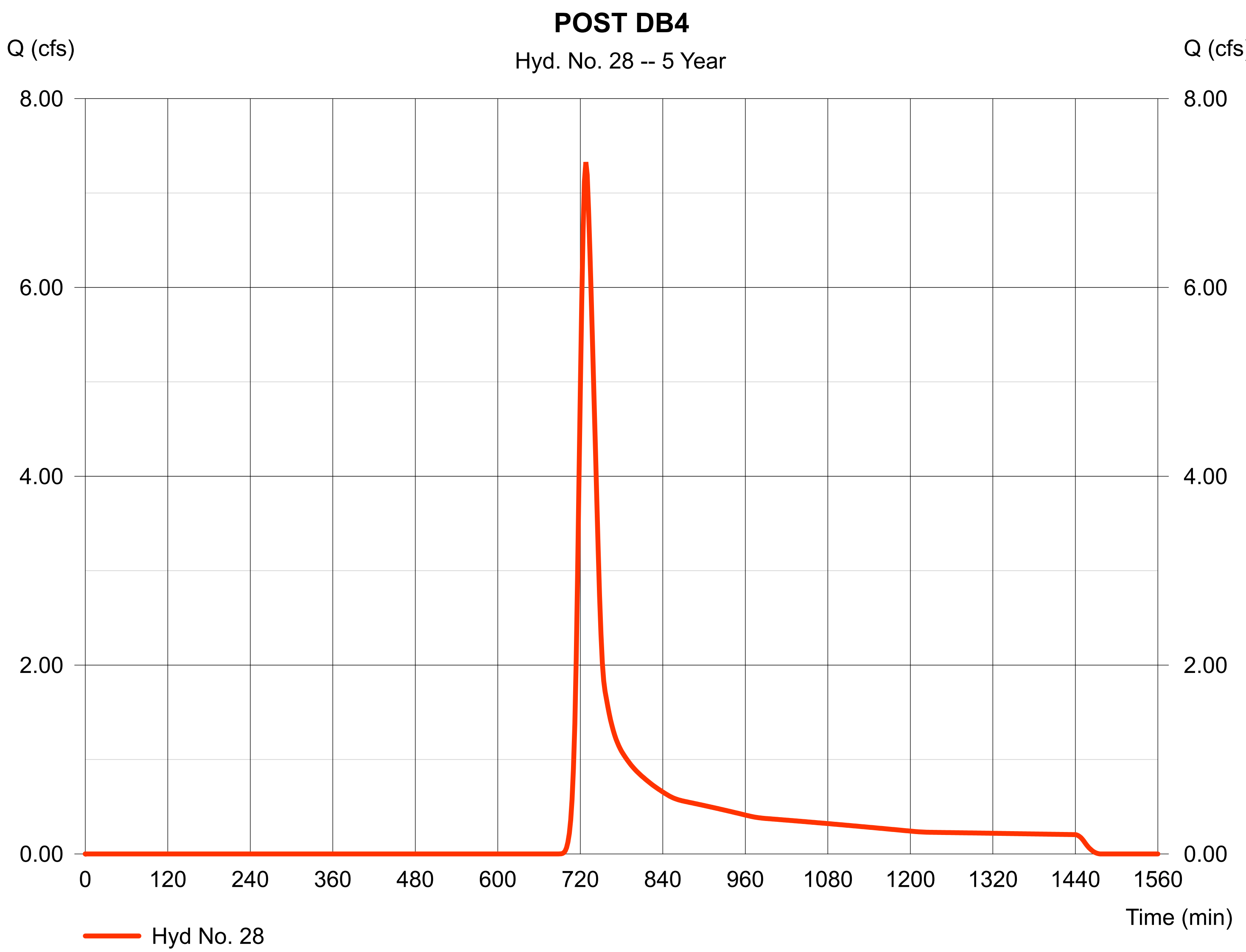
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 28

POST DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 7.327 cfs
Storm frequency	= 5 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 28,833 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.94 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.520 x 98) + (4.480 x 61)] / 6.580



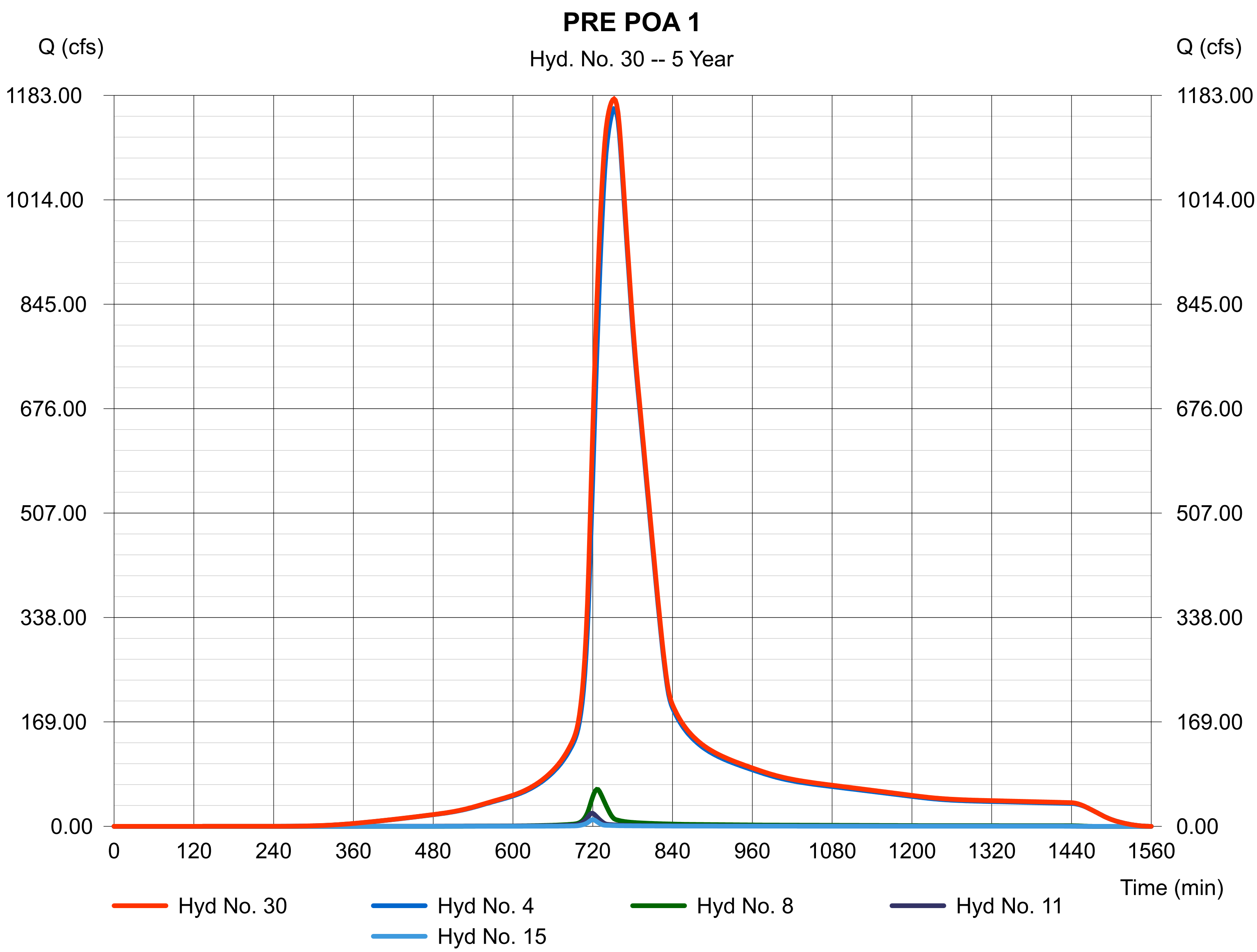
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 30

PRE POA 1

Hydrograph type	= Combine	Peak discharge	= 1177.37 cfs
Storm frequency	= 5 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 9,267,672 cuft
Inflow hyds.	= 4, 8, 11, 15	Contrib. drain. area	= 22.020 ac



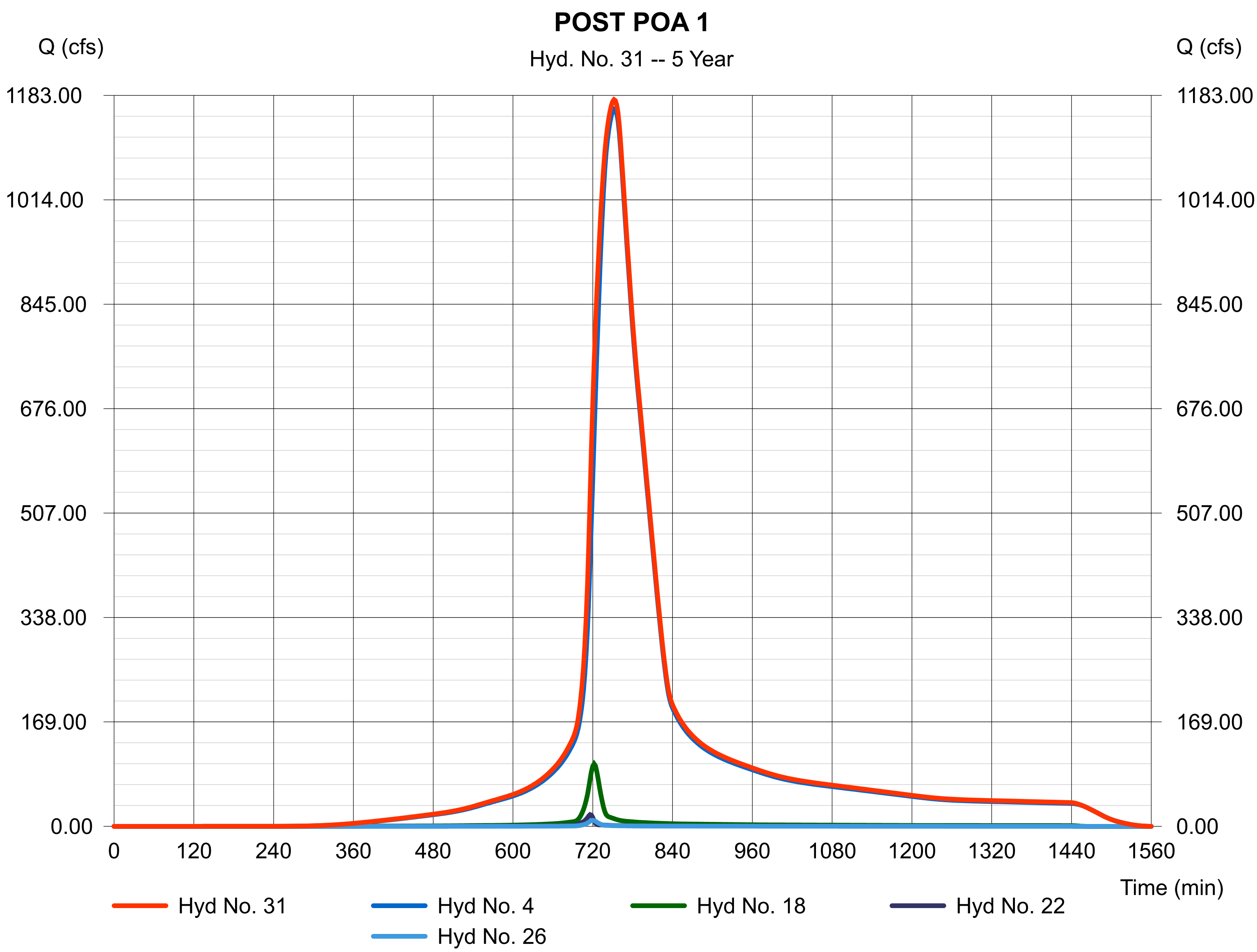
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 31

POST POA 1

Hydrograph type	= Combine	Peak discharge	= 1176.11 cfs
Storm frequency	= 5 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 9,325,387 cuft
Inflow hyds.	= 4, 18, 22, 26	Contrib. drain. area	= 24.120 ac



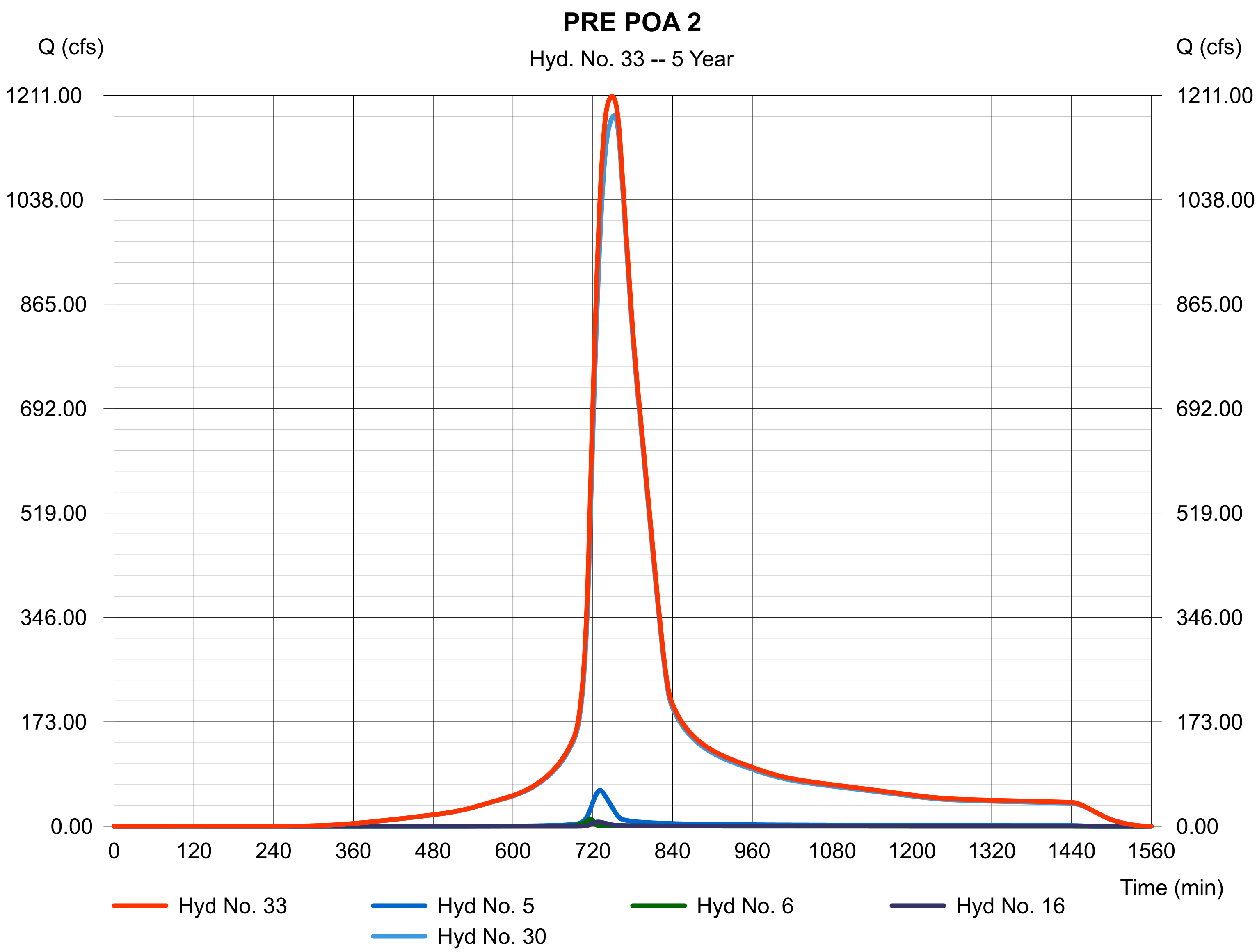
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 33

PRE POA 2

Hydrograph type	= Combine	Peak discharge	= 1209.04 cfs
Storm frequency	= 5 yrs	Time to peak	= 748 min
Time interval	= 2 min	Hyd. volume	= 9,566,881 cuft
Inflow hyds.	= 5, 6, 16, 30	Contrib. drain. area	= 37.480 ac



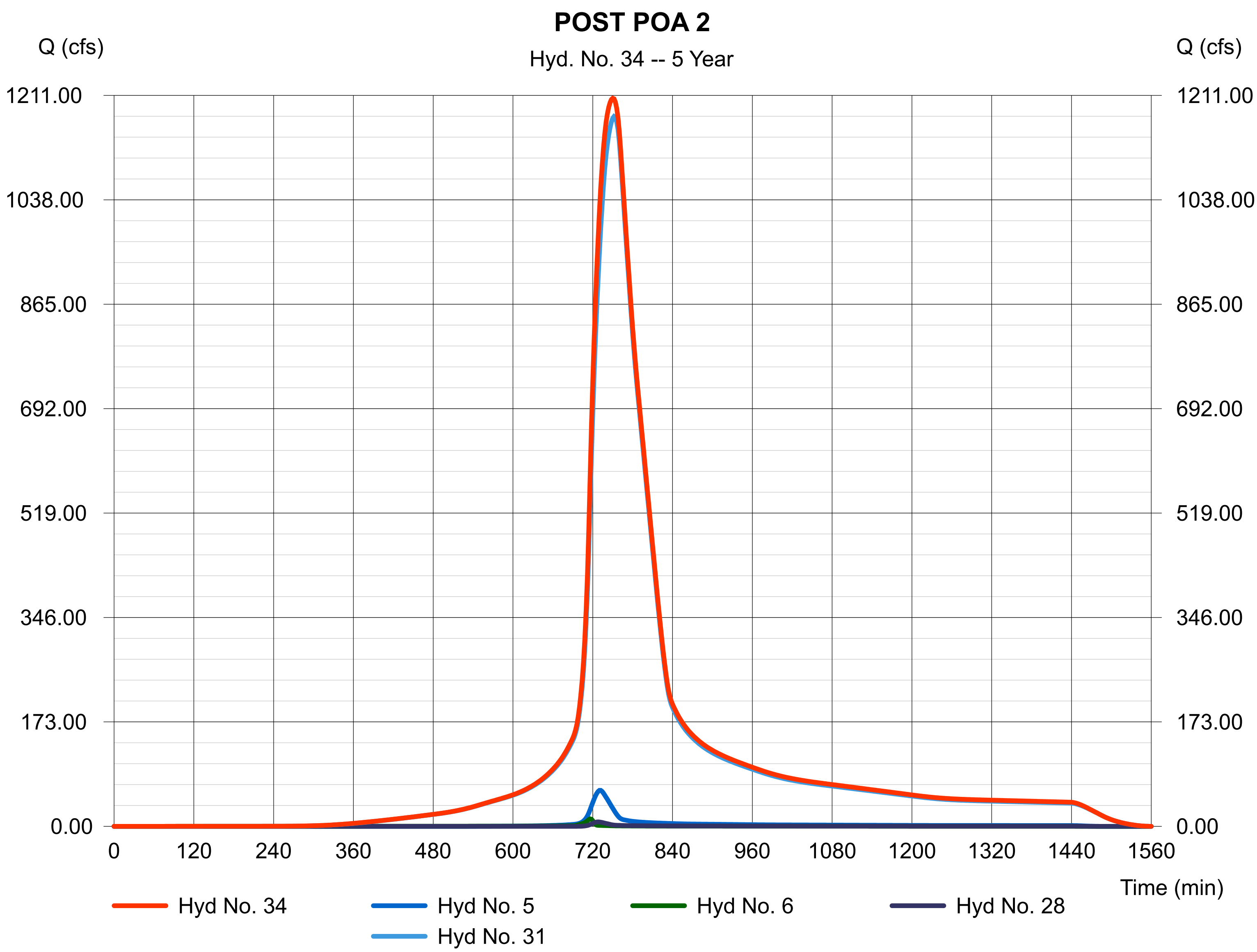
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 34

POST POA 2

Hydrograph type	= Combine	Peak discharge	= 1206.39 cfs
Storm frequency	= 5 yrs	Time to peak	= 750 min
Time interval	= 2 min	Hyd. volume	= 9,624,595 cuft
Inflow hyds.	= 5, 6, 28, 31	Contrib. drain. area	= 37.480 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	1032.80	2	758	8,009,941	------	------	------	MACRO BASIN 1
2	SCS Runoff	431.84	2	738	2,280,666	------	------	------	MACRO BASIN 2
3	SCS Runoff	101.62	2	732	439,468	------	------	------	MACRO BASIN 3
4	Combine	1382.41	2	752	10,730,056	1, 2, 3	------	------	OFF POA 1
5	SCS Runoff	75.48	2	730	302,885	------	------	------	MACRO BASIN 4
6	SCS Runoff	14.27	2	716	34,156	------	------	------	OFF BASIN 5
8	SCS Runoff	74.43	2	726	256,966	------	------	------	PRE DB1
9	SCS Runoff	19.30	2	722	56,239	------	------	------	PRE DB2-ON
10	SCS Runoff	8.110	2	716	19,415	------	------	------	PRE DB2-OFF
11	Combine	24.87	2	718	75,654	9, 10	------	------	PRE POA 3
13	SCS Runoff	12.24	2	720	31,864	------	------	------	PRE DB3-ON
14	SCS Runoff	1.272	2	718	2,552	------	------	------	PRE DB3-OFF
15	Combine	13.27	2	720	34,415	13, 14	------	------	PRE POA 4
16	SCS Runoff	10.49	2	728	39,264	------	------	------	PRE DB4
18	SCS Runoff	120.37	2	722	346,536	------	------	------	POST DB1
19	Reservoir	24.14	2	740	342,256	18	963.62	180,974	FALSE PHASE 1 VAULT
20	SCS Runoff	13.92	2	716	30,670	------	------	------	POST DB2-ON
21	SCS Runoff	8.110	2	716	19,415	------	------	------	POST DB2-OFF
22	Combine	22.03	2	716	50,085	20, 21	------	------	POST POA 3
24	SCS Runoff	10.89	2	720	28,405	------	------	------	POST DB3-ON
25	SCS Runoff	1.272	2	718	2,552	------	------	------	POST DB3-OFF
26	Combine	11.92	2	720	30,957	24, 25	------	------	POST POA 4
28	SCS Runoff	10.49	2	728	39,264	------	------	------	POST DB4
30	Combine	1401.65	2	752	11,097,096	4, 8, 11, 15,	------	------	PRE POA 1
31	Combine	1399.71	2	752	11,157,645	4, 18, 22, 26,	------	------	POST POA 1
33	Combine	1443.02	2	748	11,473,404	5, 6, 16, 30,	------	------	PRE POA 2
34	Combine	1438.22	2	750	11,533,948	5, 6, 28, 31,	------	------	POST POA 2

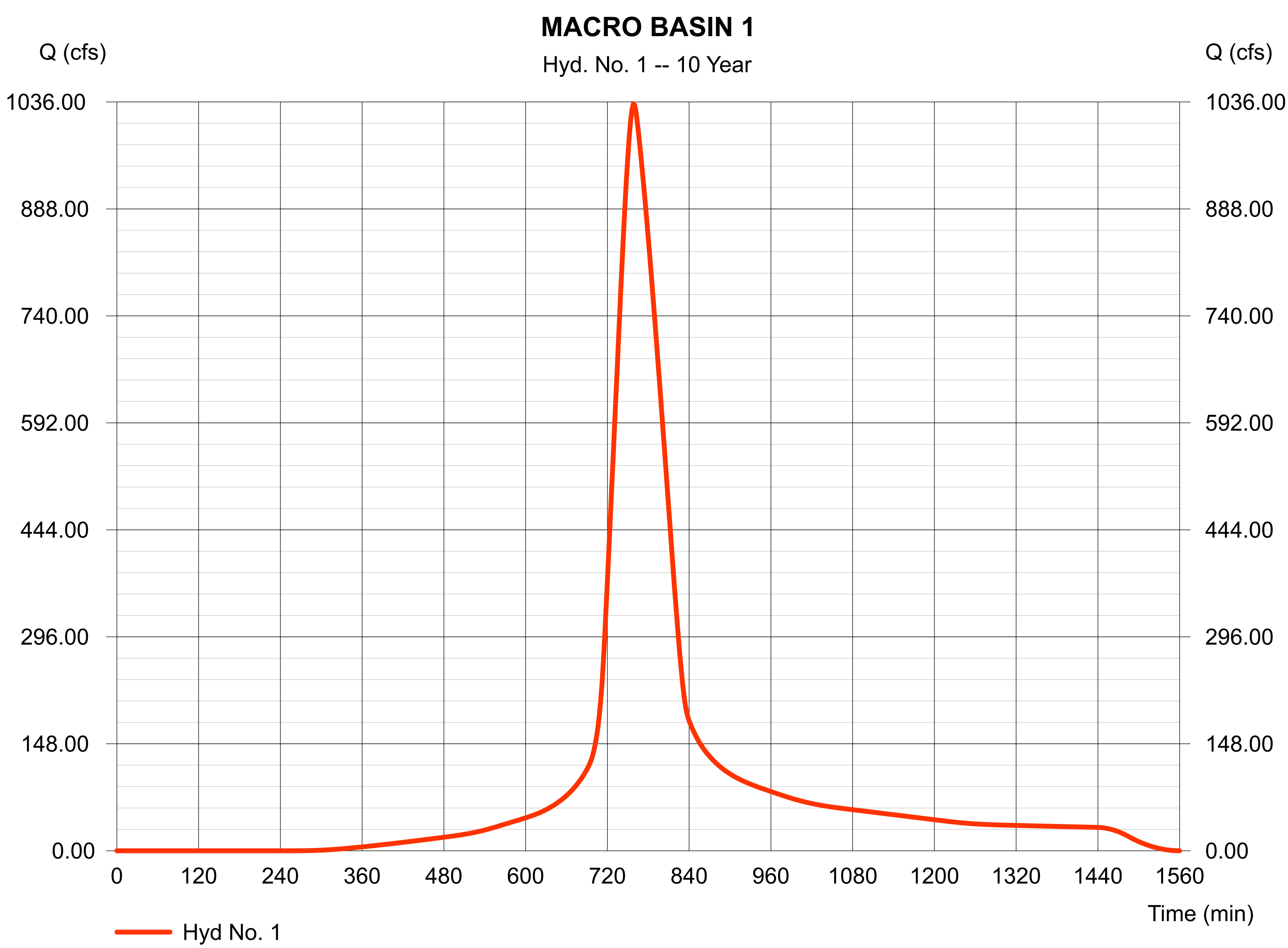
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 1

MACRO BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 1032.80 cfs
Storm frequency	= 10 yrs	Time to peak	= 758 min
Time interval	= 2 min	Hyd. volume	= 8,009,941 cuft
Drainage area	= 532.700 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 76.90 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



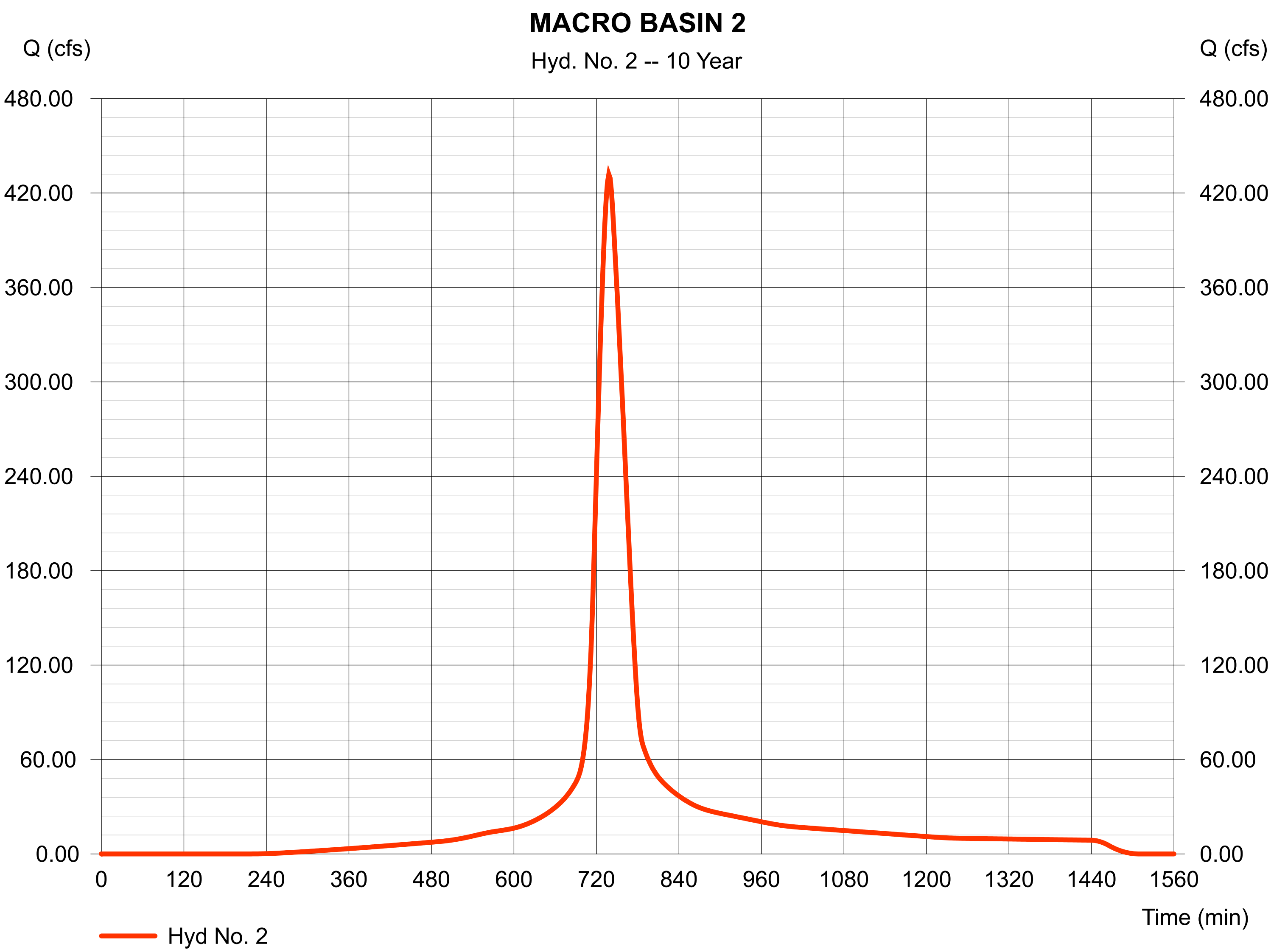
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 2

MACRO BASIN 2

Hydrograph type	= SCS Runoff	Peak discharge	= 431.84 cfs
Storm frequency	= 10 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 2,280,666 cuft
Drainage area	= 142.100 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 42.00 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



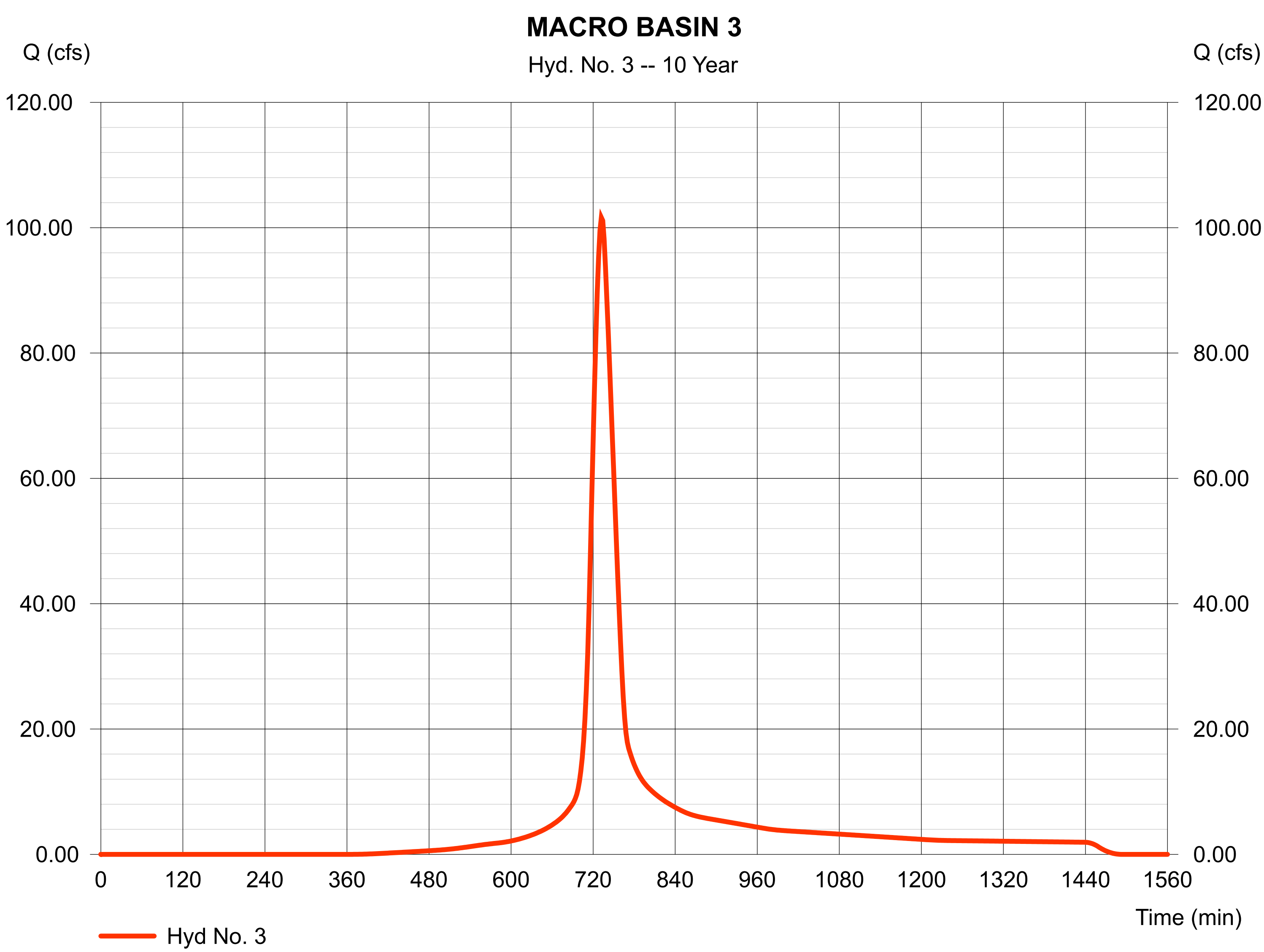
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 3

MACRO BASIN 3

Hydrograph type	= SCS Runoff	Peak discharge	= 101.62 cfs
Storm frequency	= 10 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 439,468 cuft
Drainage area	= 33.700 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 31.50 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



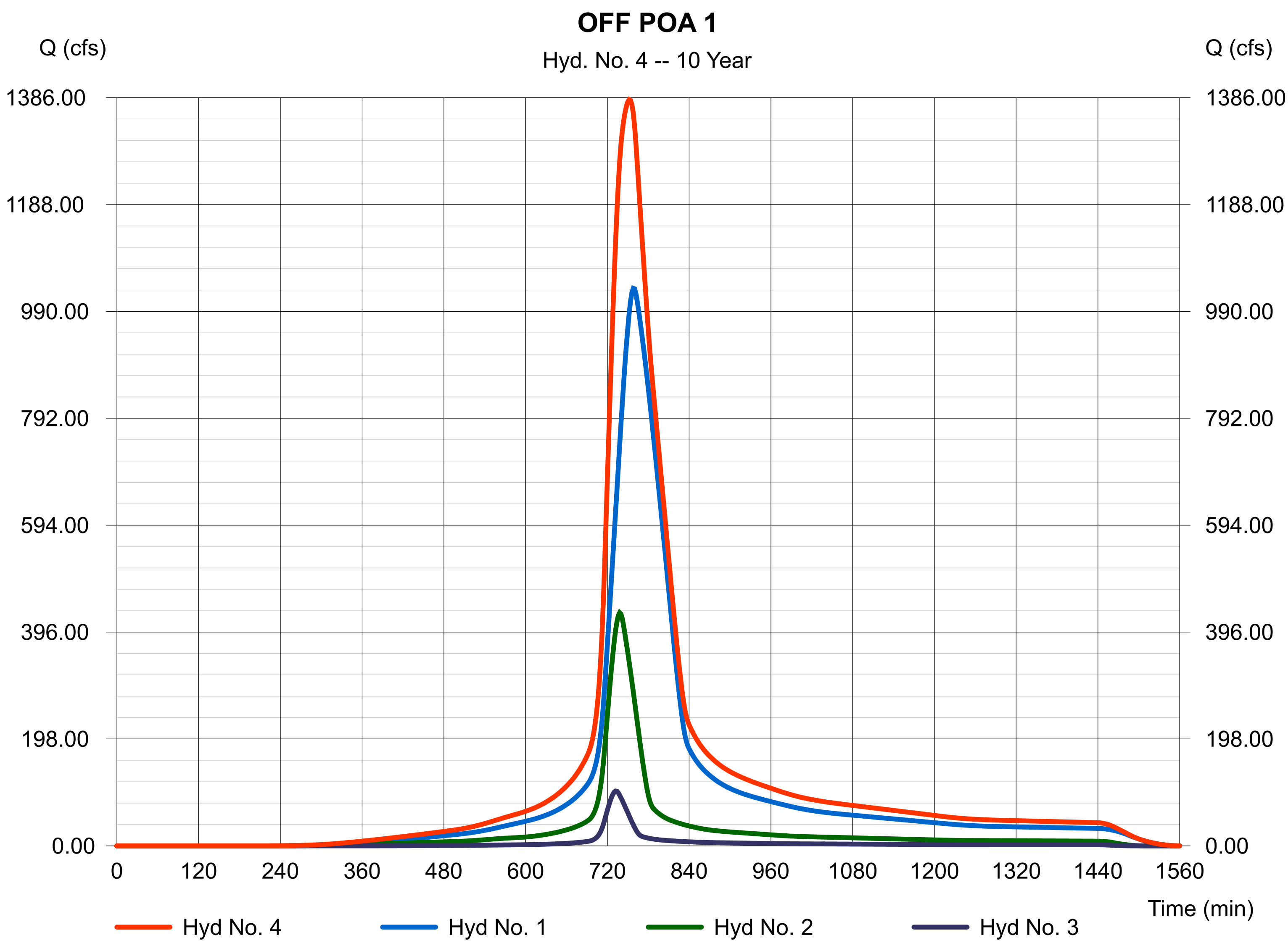
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 4

OFF POA 1

Hydrograph type	= Combine	Peak discharge	= 1382.41 cfs
Storm frequency	= 10 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 10,730,056 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 708.500 ac



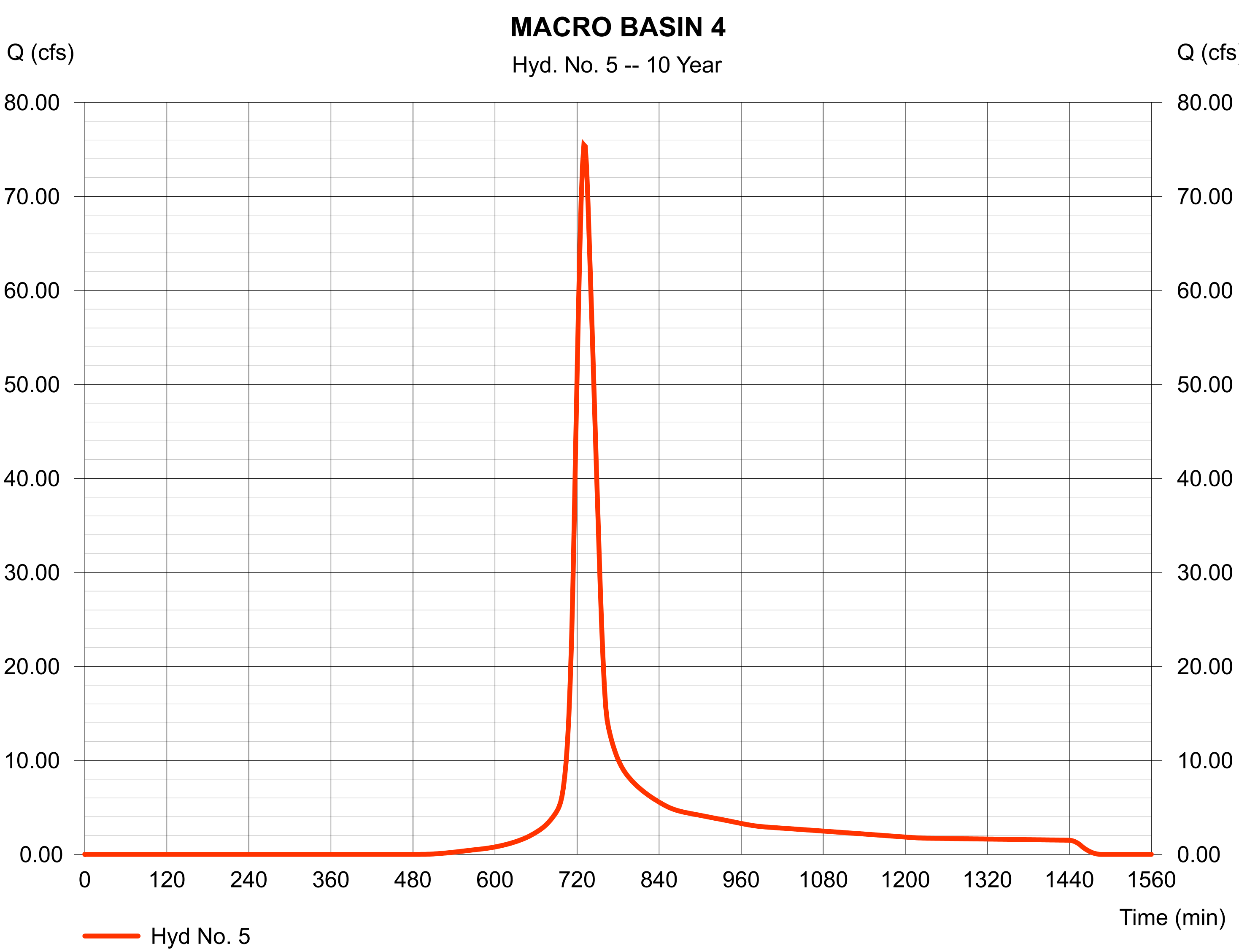
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 5

MACRO BASIN 4

Hydrograph type	= SCS Runoff	Peak discharge	= 75.48 cfs
Storm frequency	= 10 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 302,885 cuft
Drainage area	= 29.000 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 27.10 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



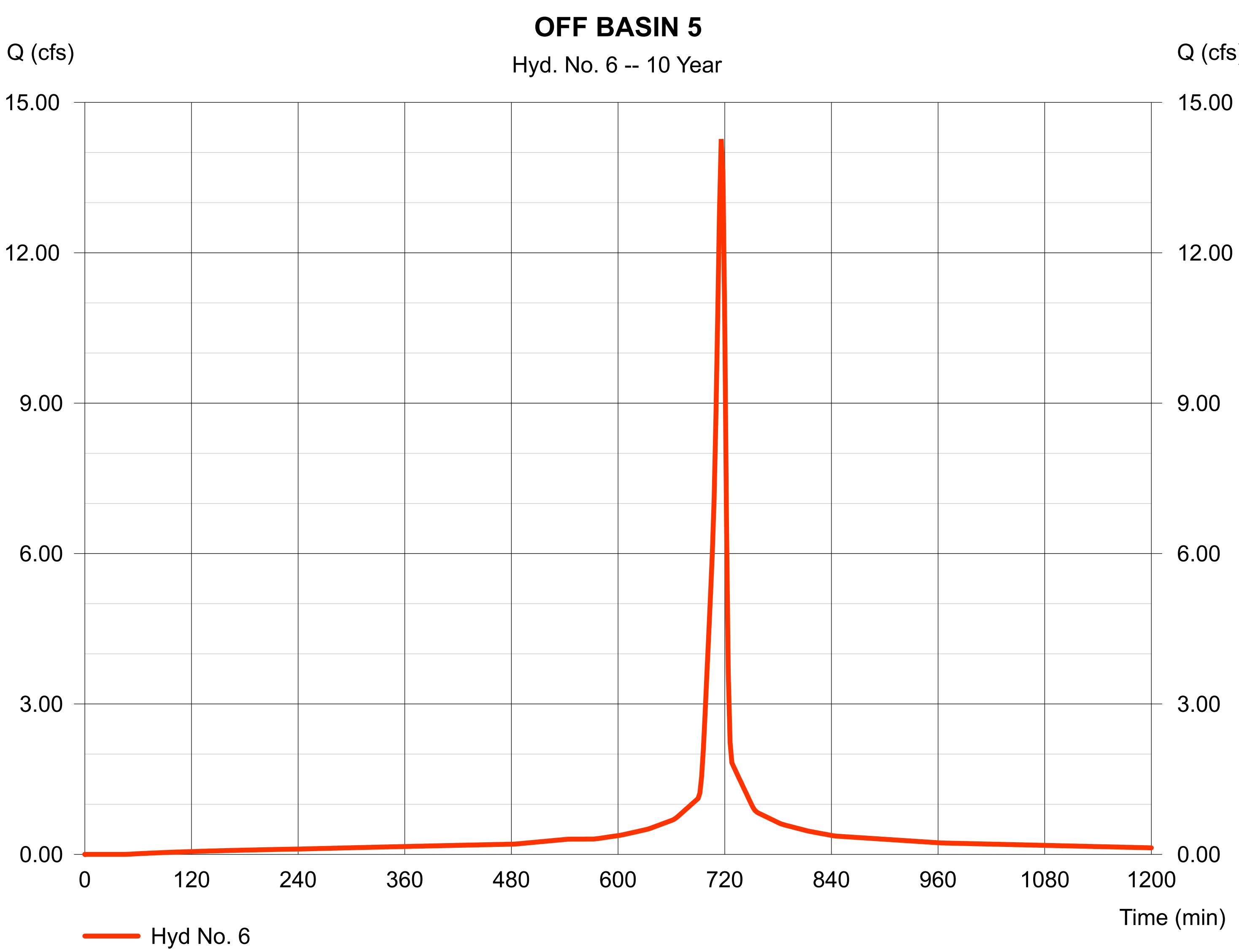
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 6

OFF BASIN 5

Hydrograph type	= SCS Runoff	Peak discharge	= 14.27 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 34,156 cuft
Drainage area	= 1.900 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

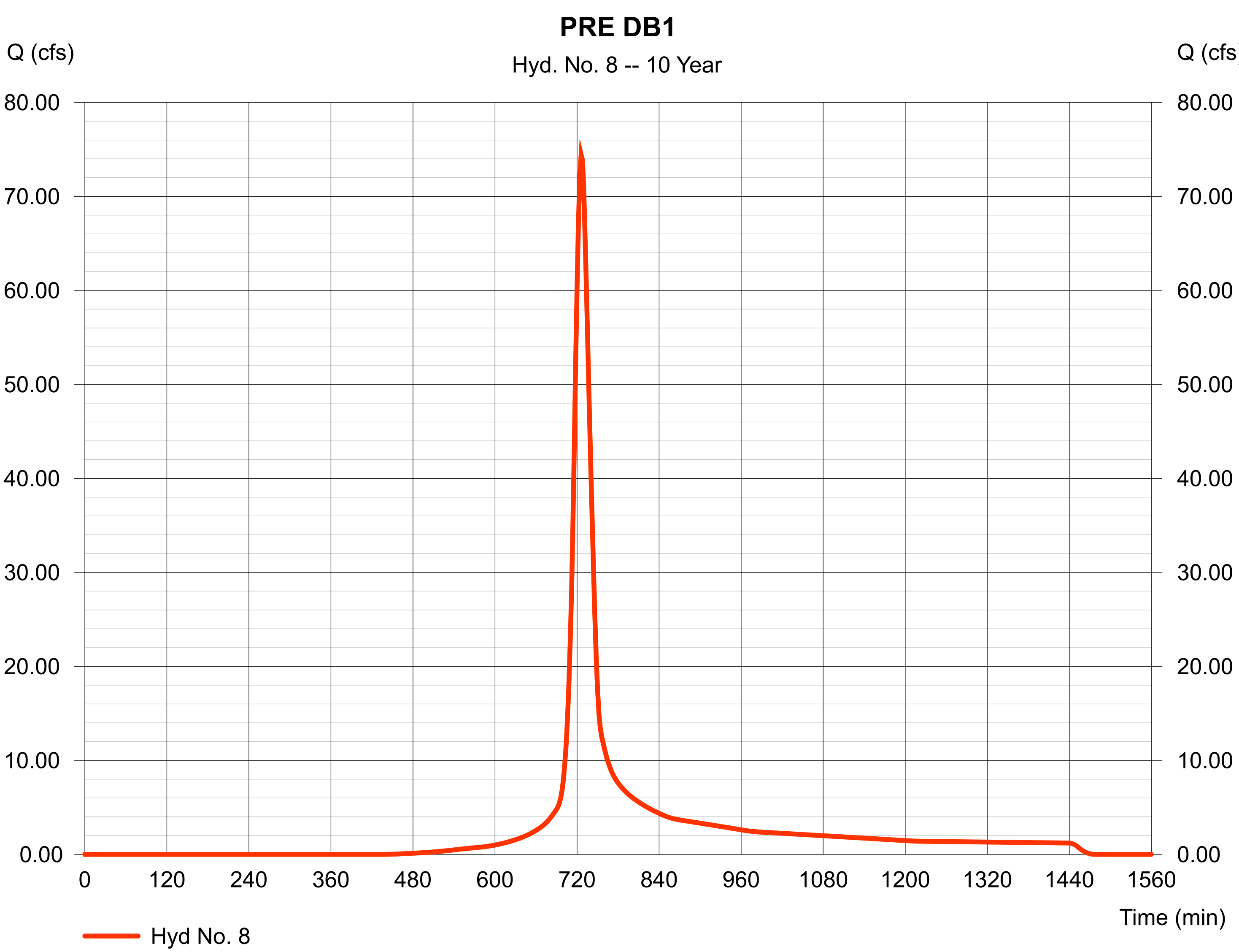
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 8

PRE DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 74.43 cfs
Storm frequency	= 10 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 256,966 cuft
Drainage area	= 22.020 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 20.73 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 22.020



Hydrograph Report

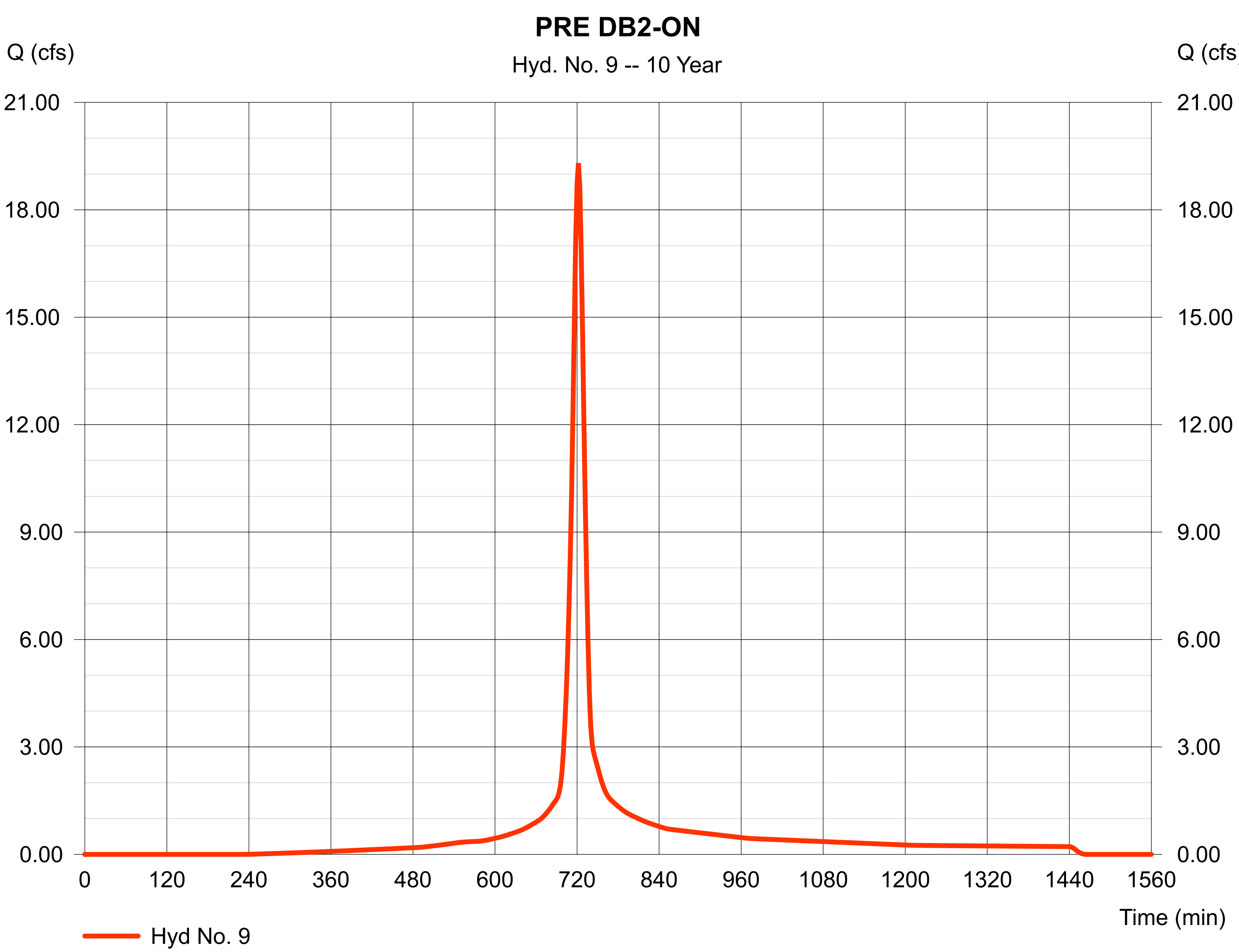
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 9

PRE DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 19.30 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 56,239 cuft
Drainage area	= 3.720 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.33 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 3.720



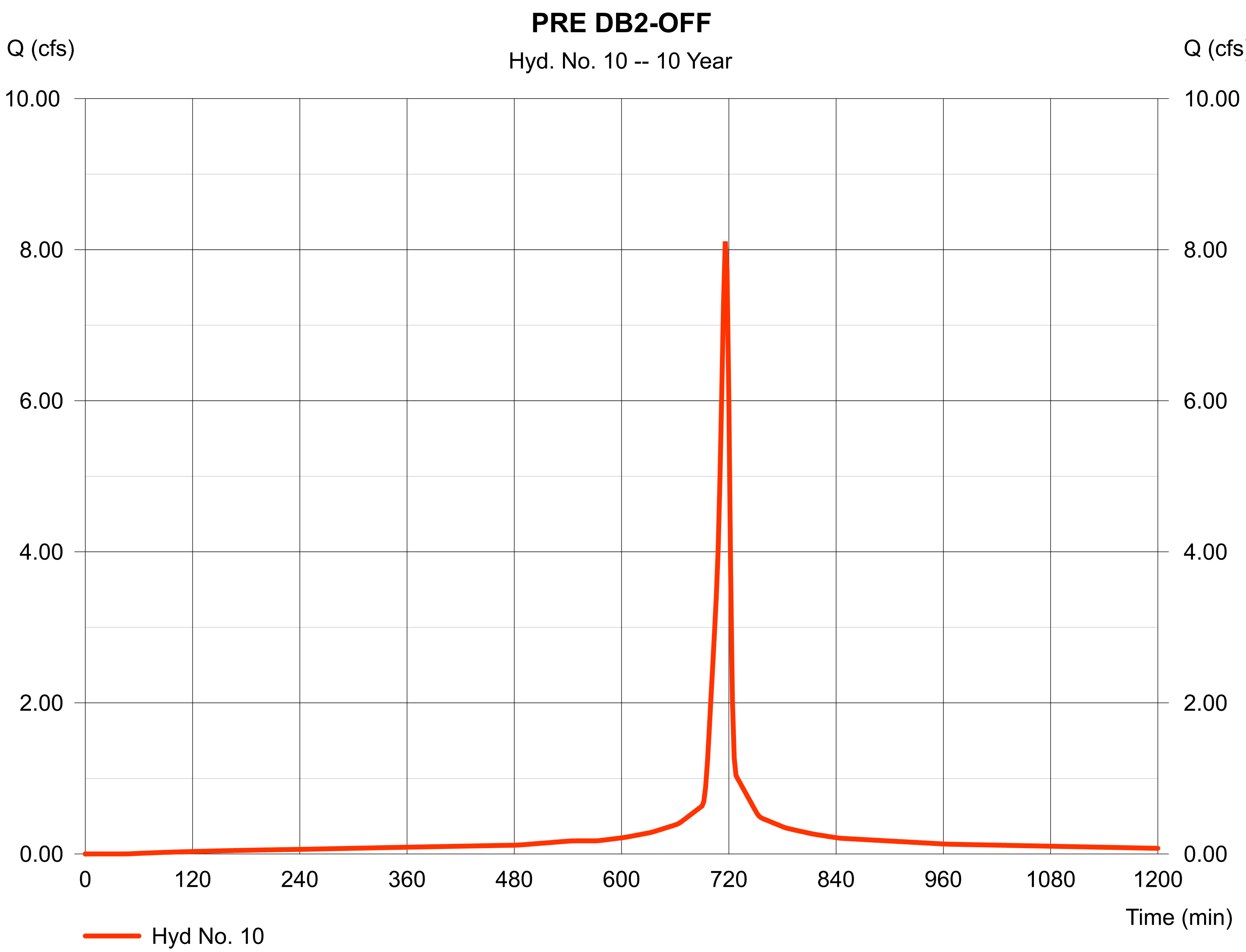
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 10

PRE DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 8.110 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 19,415 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



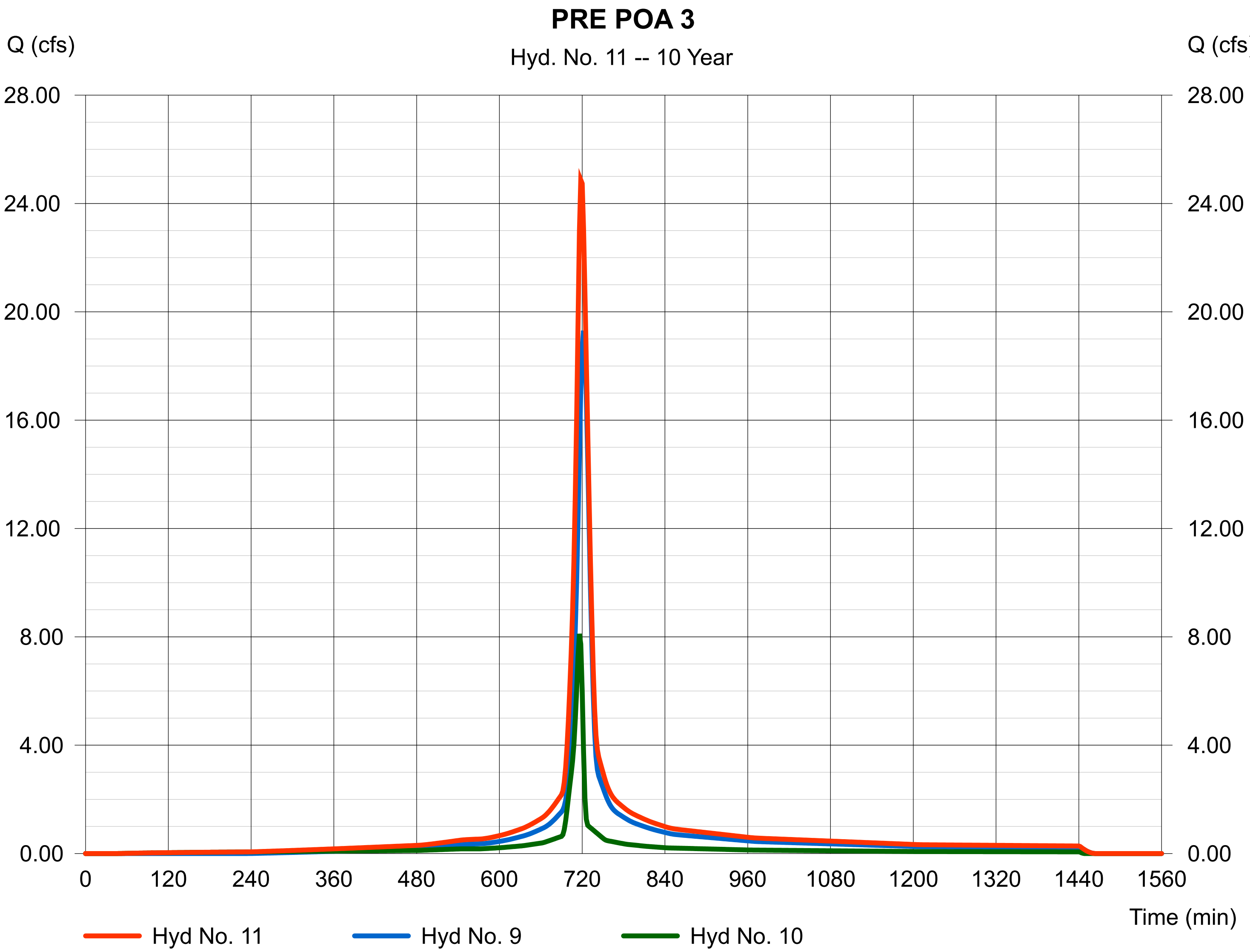
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 11

PRE POA 3

Hydrograph type	= Combine	Peak discharge	= 24.87 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 75,654 cuft
Inflow hyds.	= 9, 10	Contrib. drain. area	= 4.800 ac



Hydrograph Report

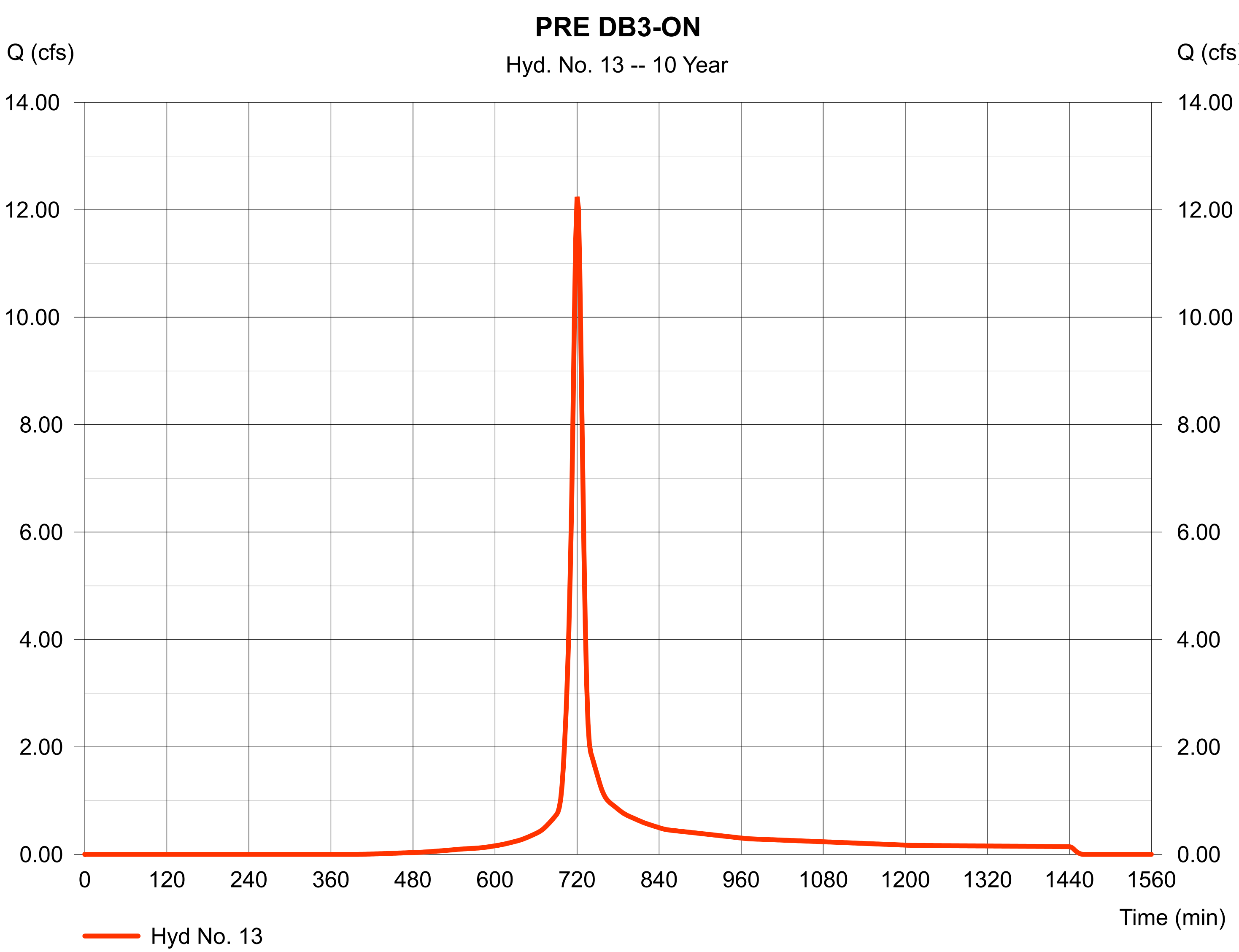
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 13

PRE DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 12.24 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 31,864 cuft
Drainage area	= 2.540 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 55) + (0.570 x 61) + (2.130 x 98)] / 2.540



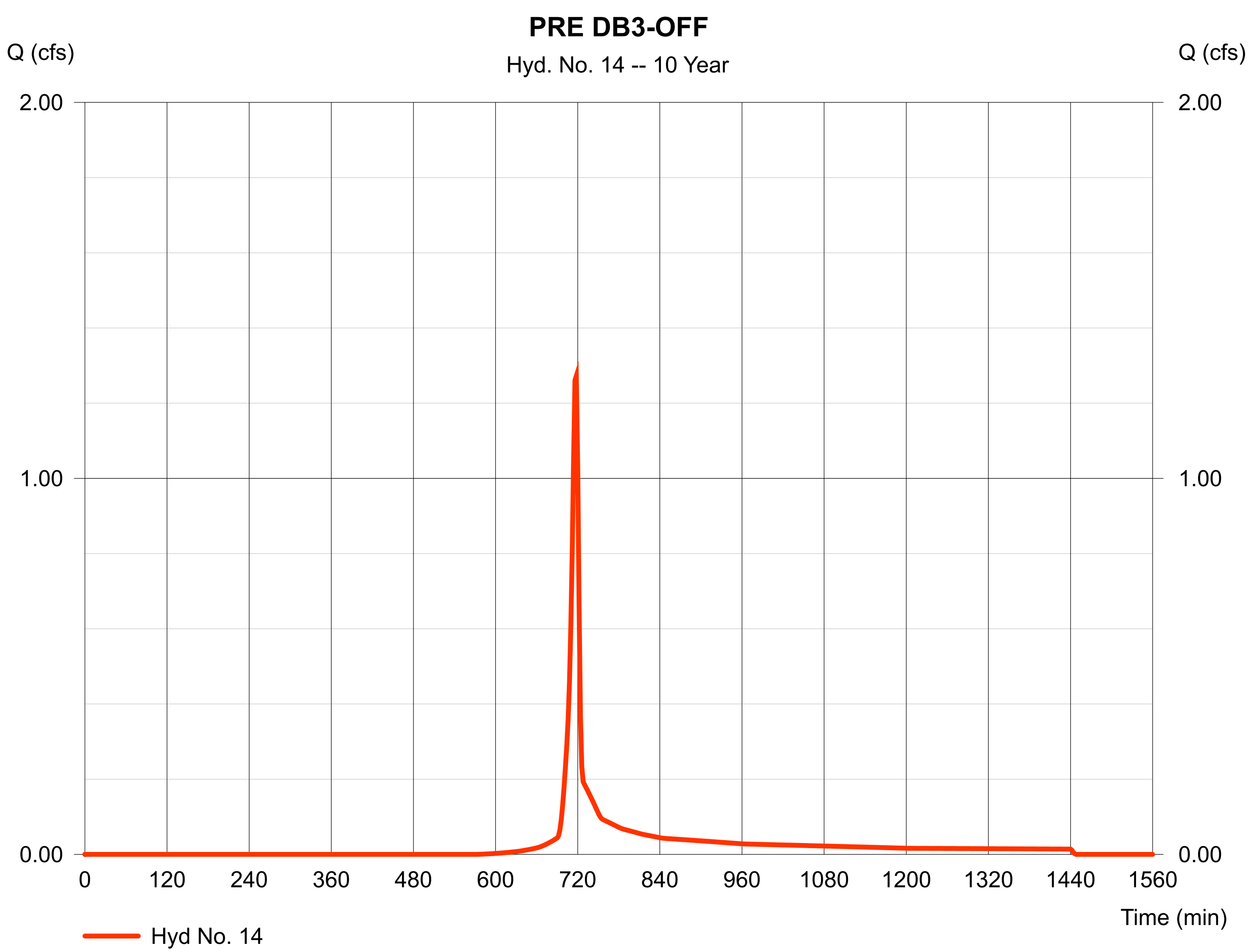
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 14

PRE DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 1.272 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 2,552 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



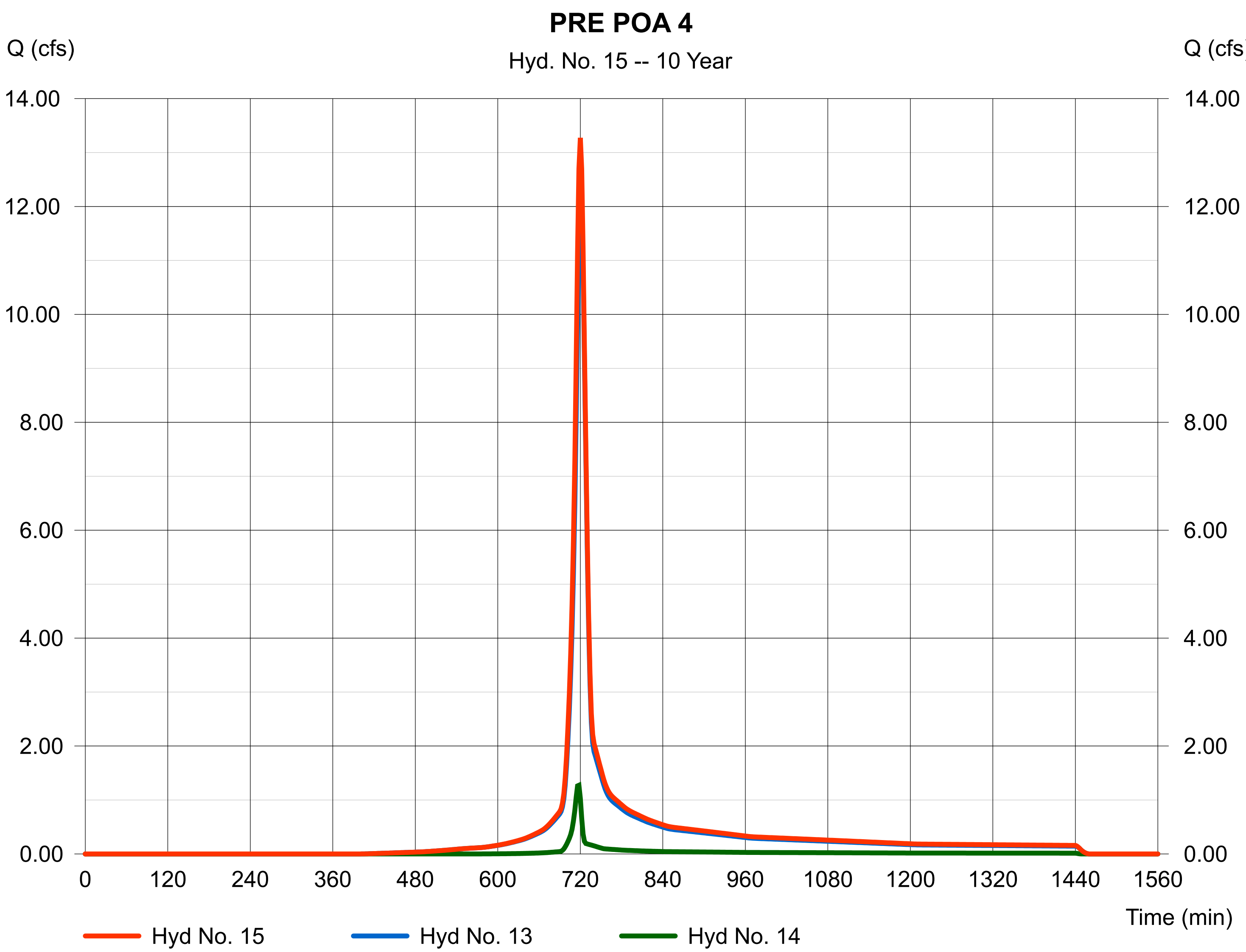
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 15

PRE POA 4

Hydrograph type	= Combine	Peak discharge	= 13.27 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 34,415 cuft
Inflow hyds.	= 13, 14	Contrib. drain. area	= 2.860 ac



Hydrograph Report

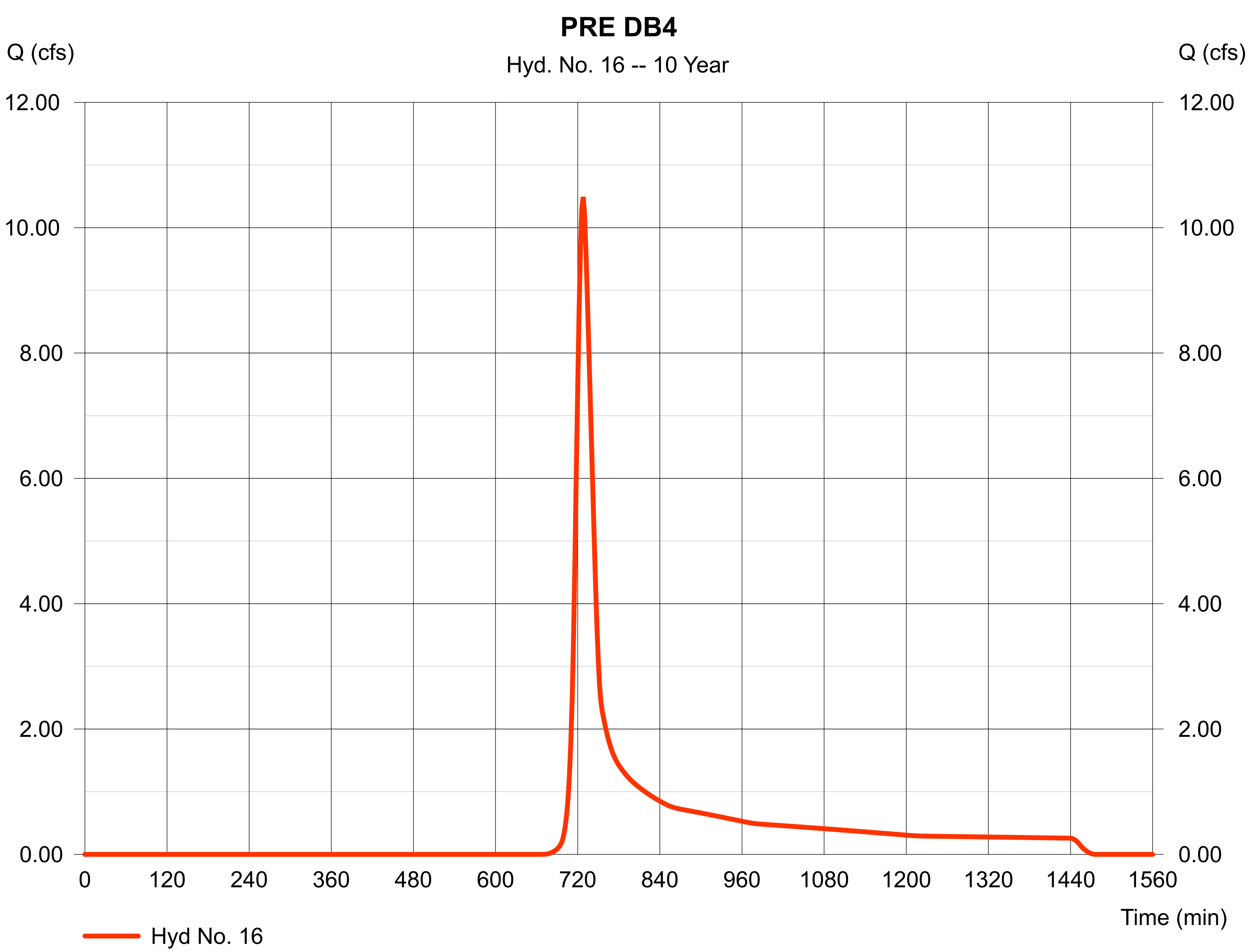
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 16

PRE DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 10.49 cfs
Storm frequency	= 10 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 39,264 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.12 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.160 x 61) + (1.840 x 55)] / 6.580



Hydrograph Report

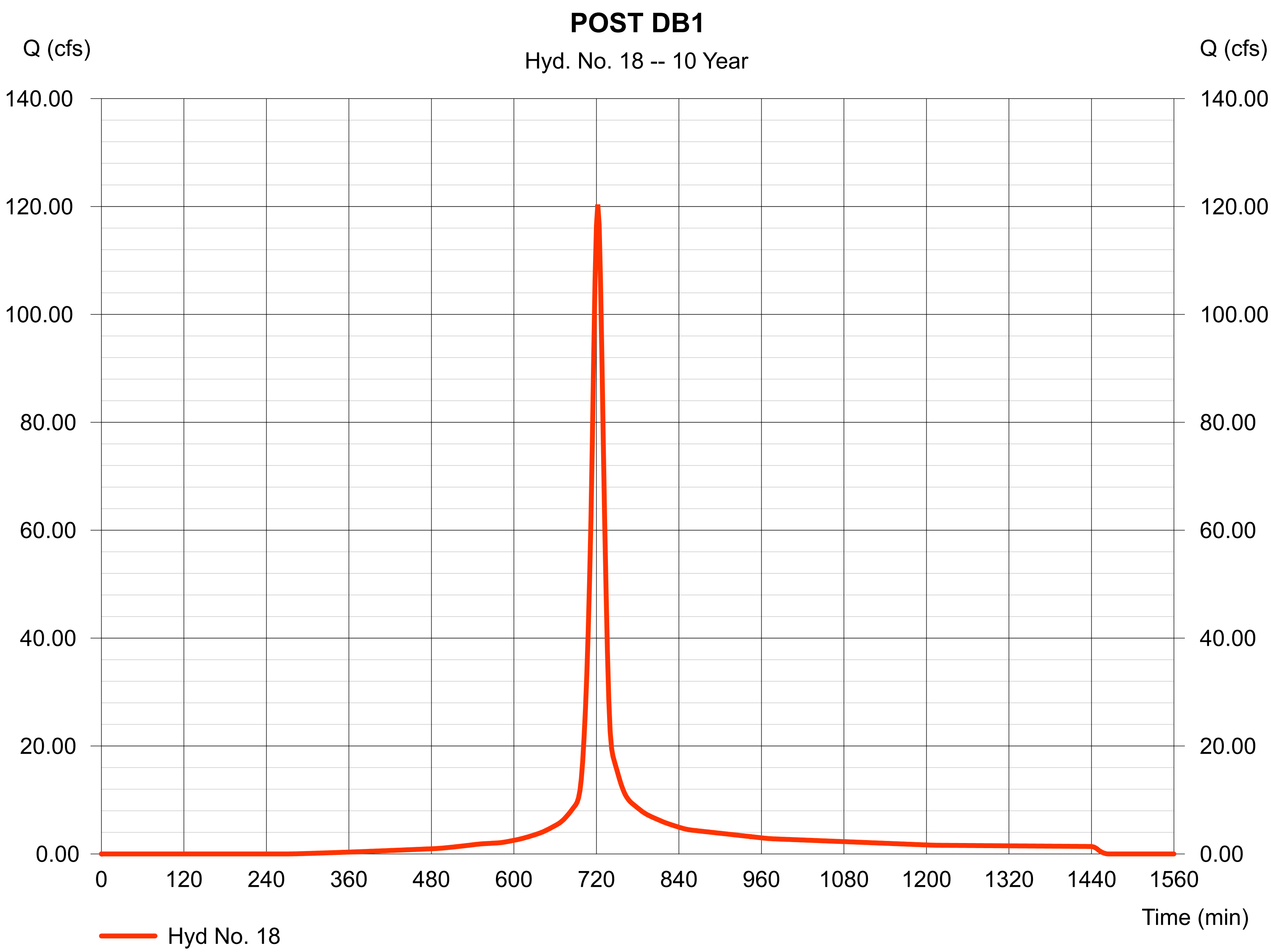
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 18

POST DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 120.37 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 346,536 cuft
Drainage area	= 24.120 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.62 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 98) + (0.310 x 55) + (0.510 x 61)] / 24.120



Hydrograph Report

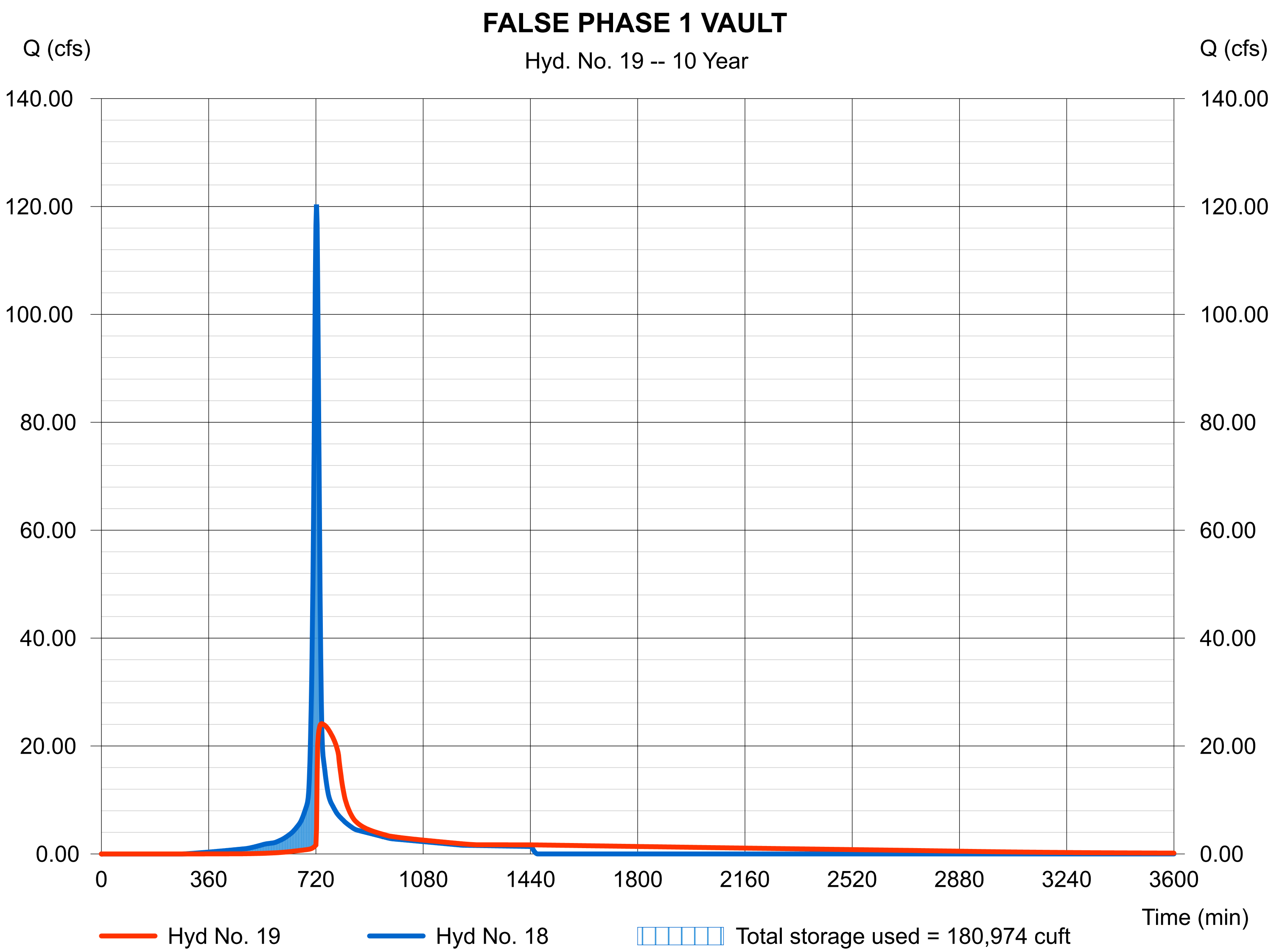
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 19

FALSE PHASE 1 VAULT

Hydrograph type	= Reservoir	Peak discharge	= 24.14 cfs
Storm frequency	= 10 yrs	Time to peak	= 740 min
Time interval	= 2 min	Hyd. volume	= 342,256 cuft
Inflow hyd. No.	= 18 - POST DB1	Max. Elevation	= 963.62 ft
Reservoir name	= FALSE POND	Max. Storage	= 180,974 cuft

Storage Indication method used.



Hydrograph Report

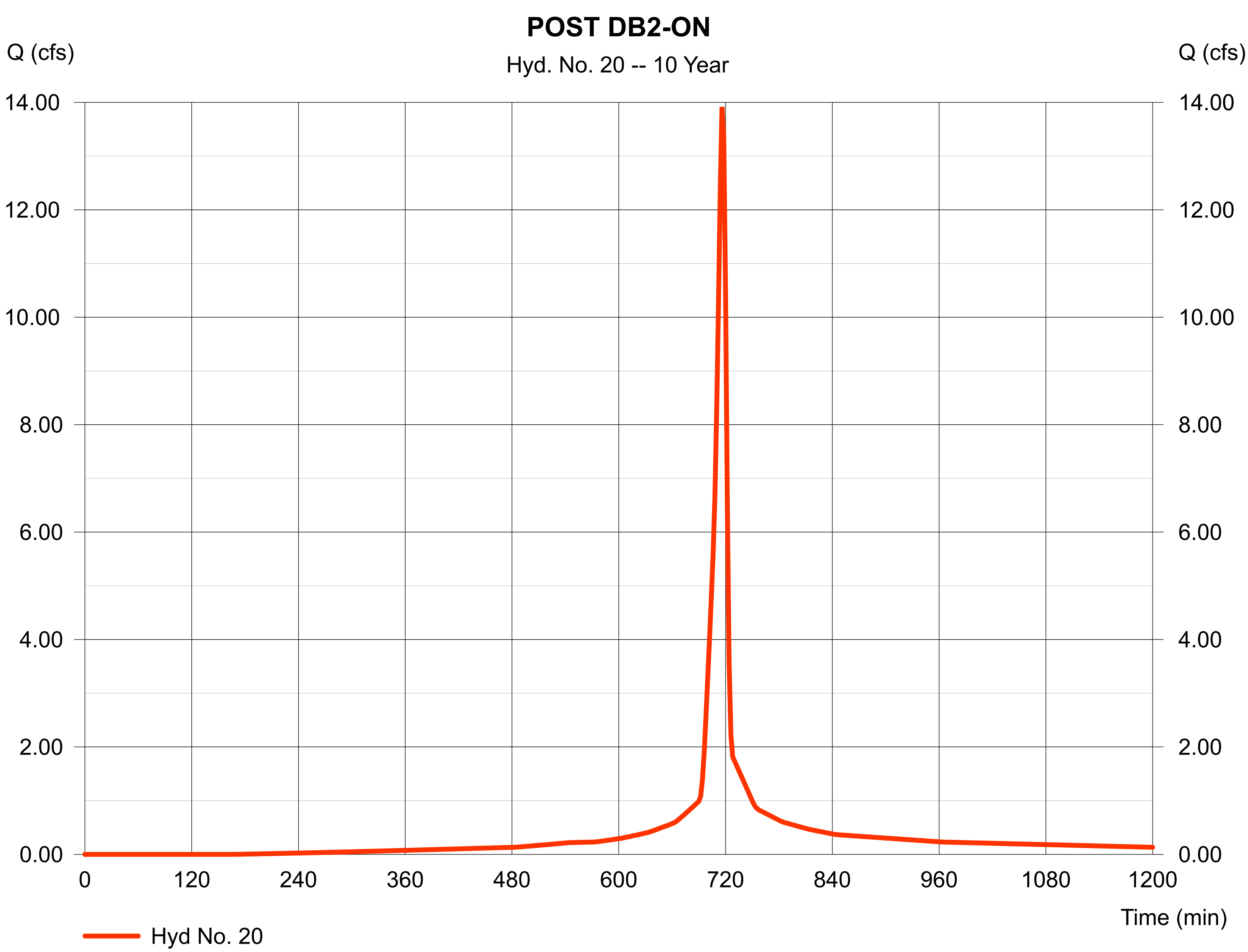
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 20

POST DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 13.92 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 30,670 cuft
Drainage area	= 1.960 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.090 x 61) + (0.280 x 85) + (13.450 x 98) + (1.000 x 55)] / 1.960



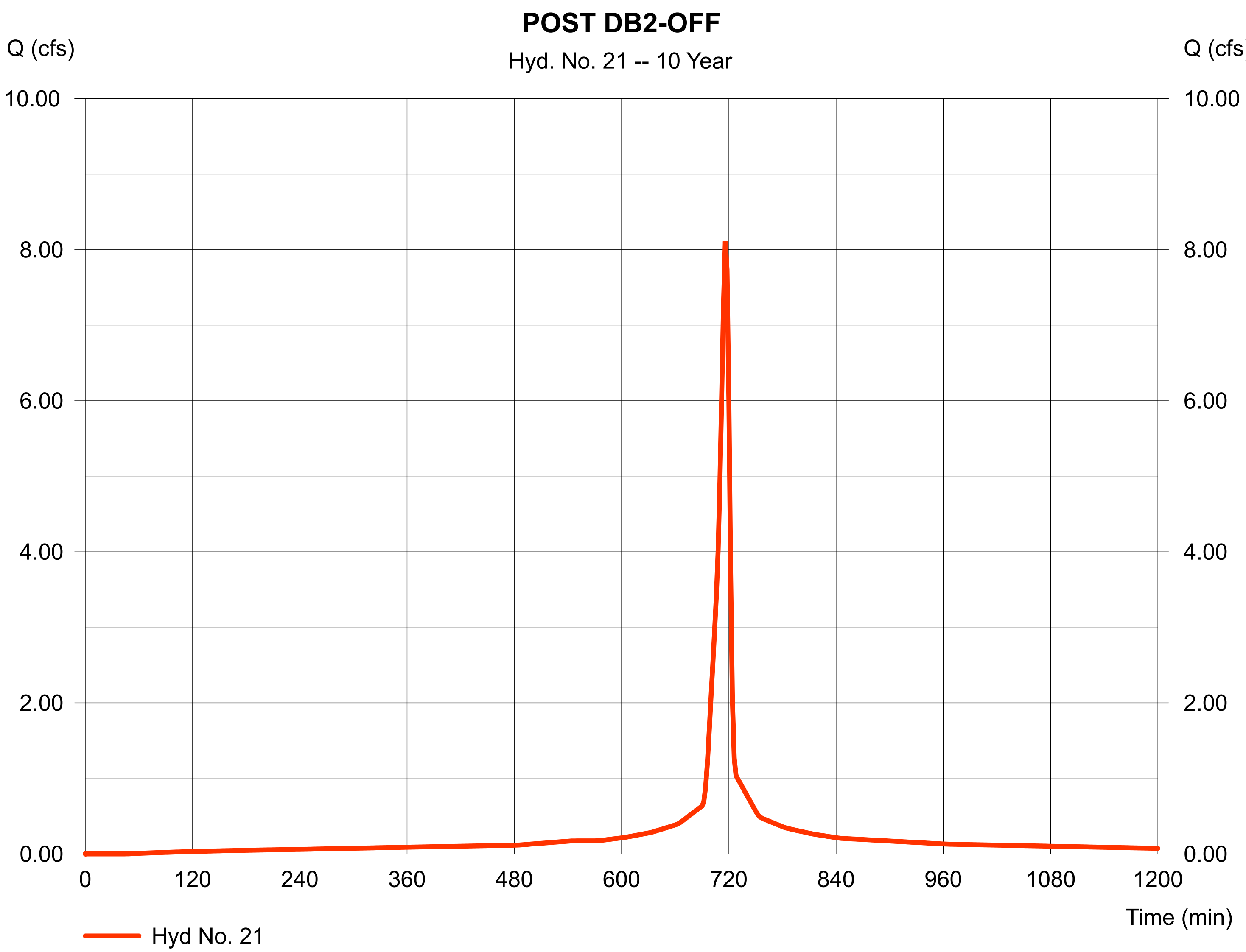
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 21

POST DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 8.110 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 19,415 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



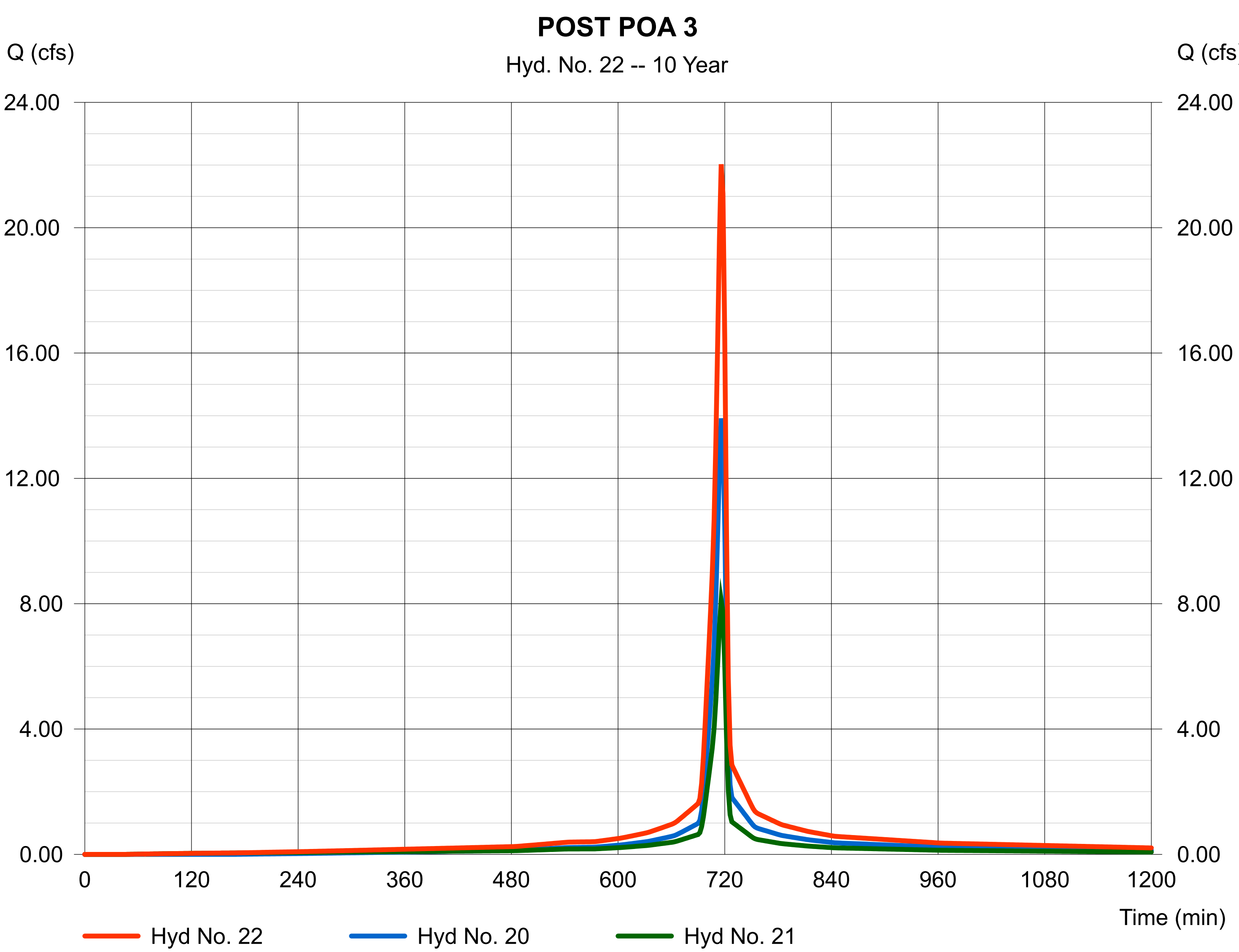
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 22

POST POA 3

Hydrograph type	= Combine	Peak discharge	= 22.03 cfs
Storm frequency	= 10 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 50,085 cuft
Inflow hyds.	= 20, 21	Contrib. drain. area	= 3.040 ac



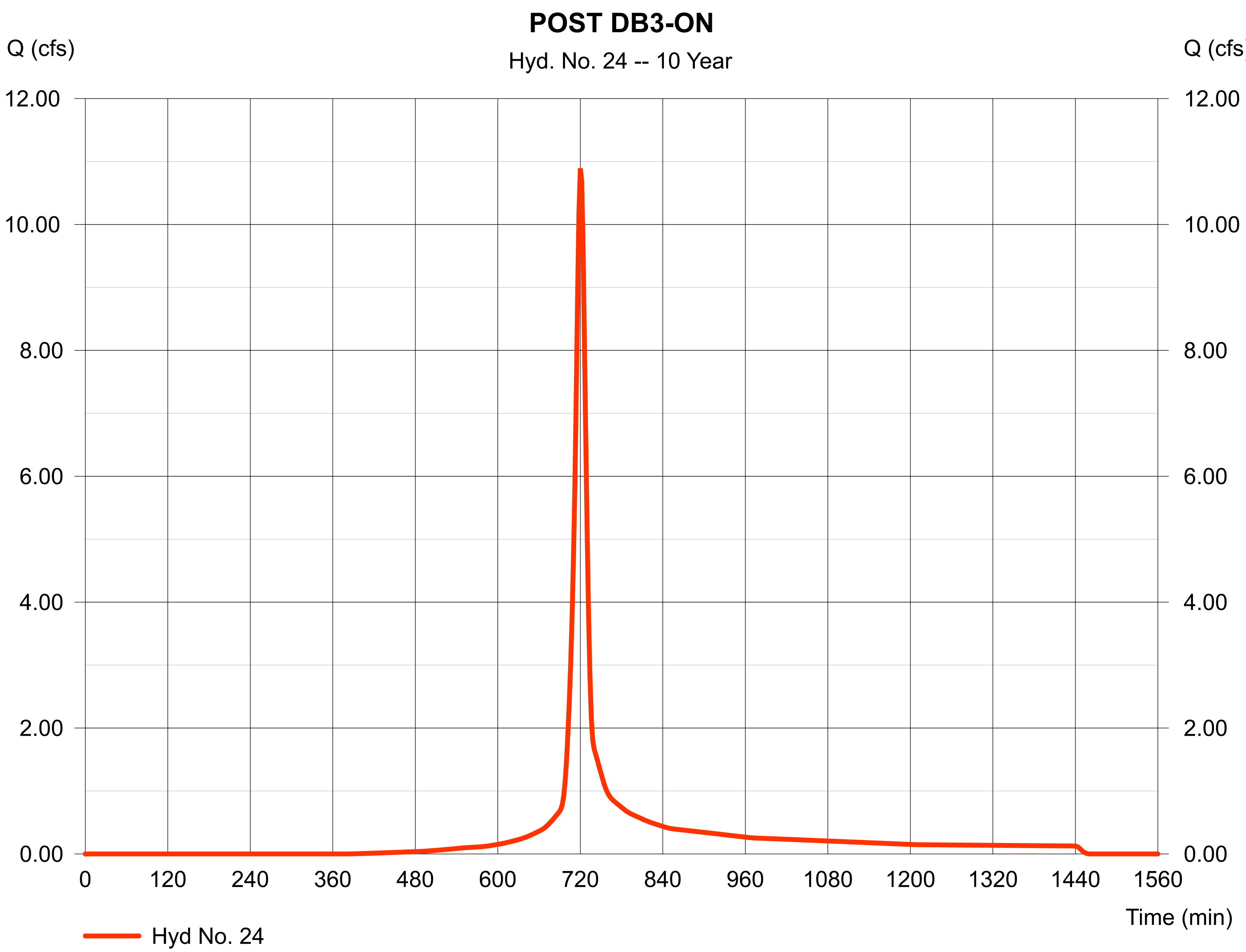
Hydrograph Report

Hyd. No. 24

POST DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 10.89 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 28,405 cuft
Drainage area	= 2.200 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (2.810 x 61) + (10.490 x 98)] / 2.200



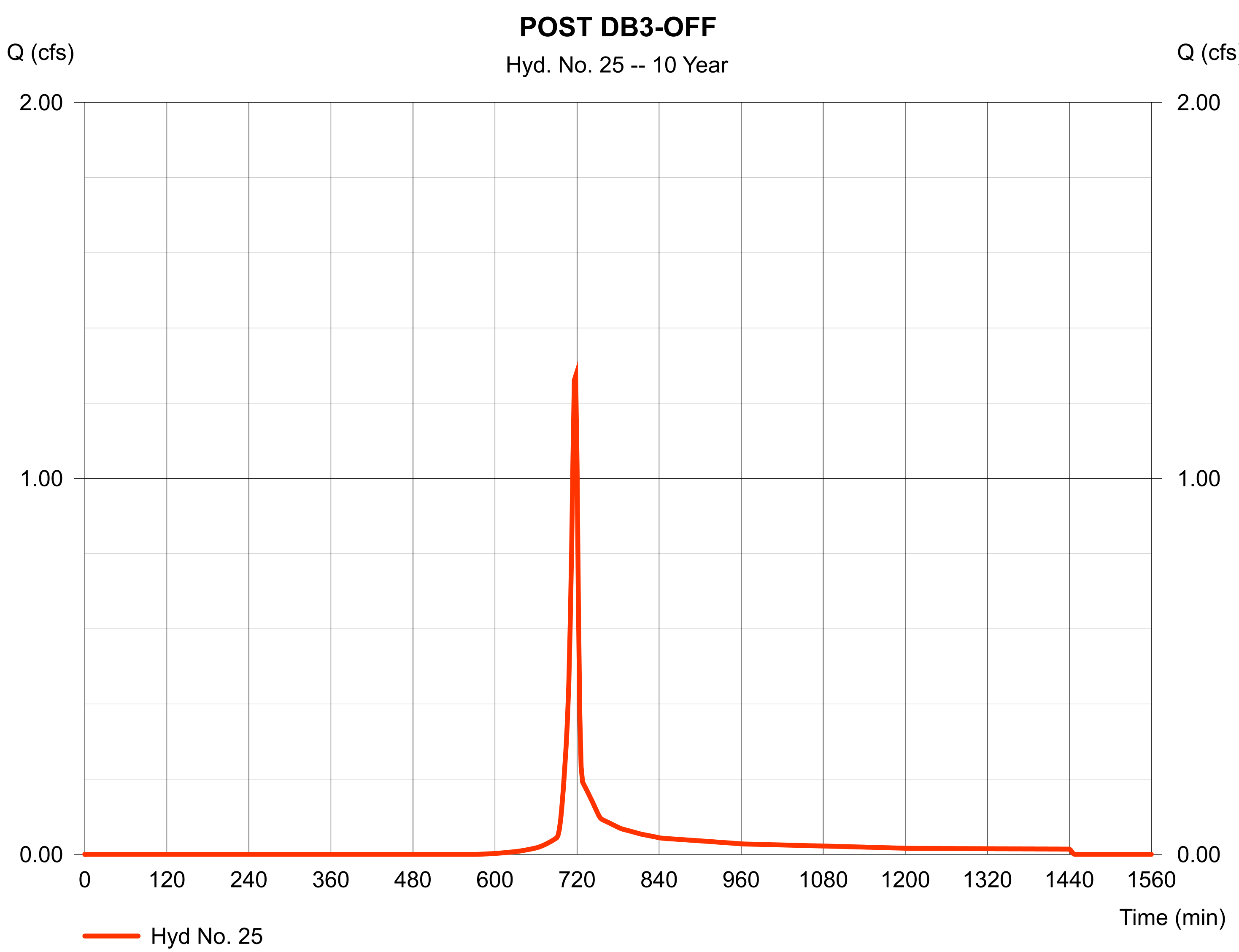
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 25

POST DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 1.272 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 2,552 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



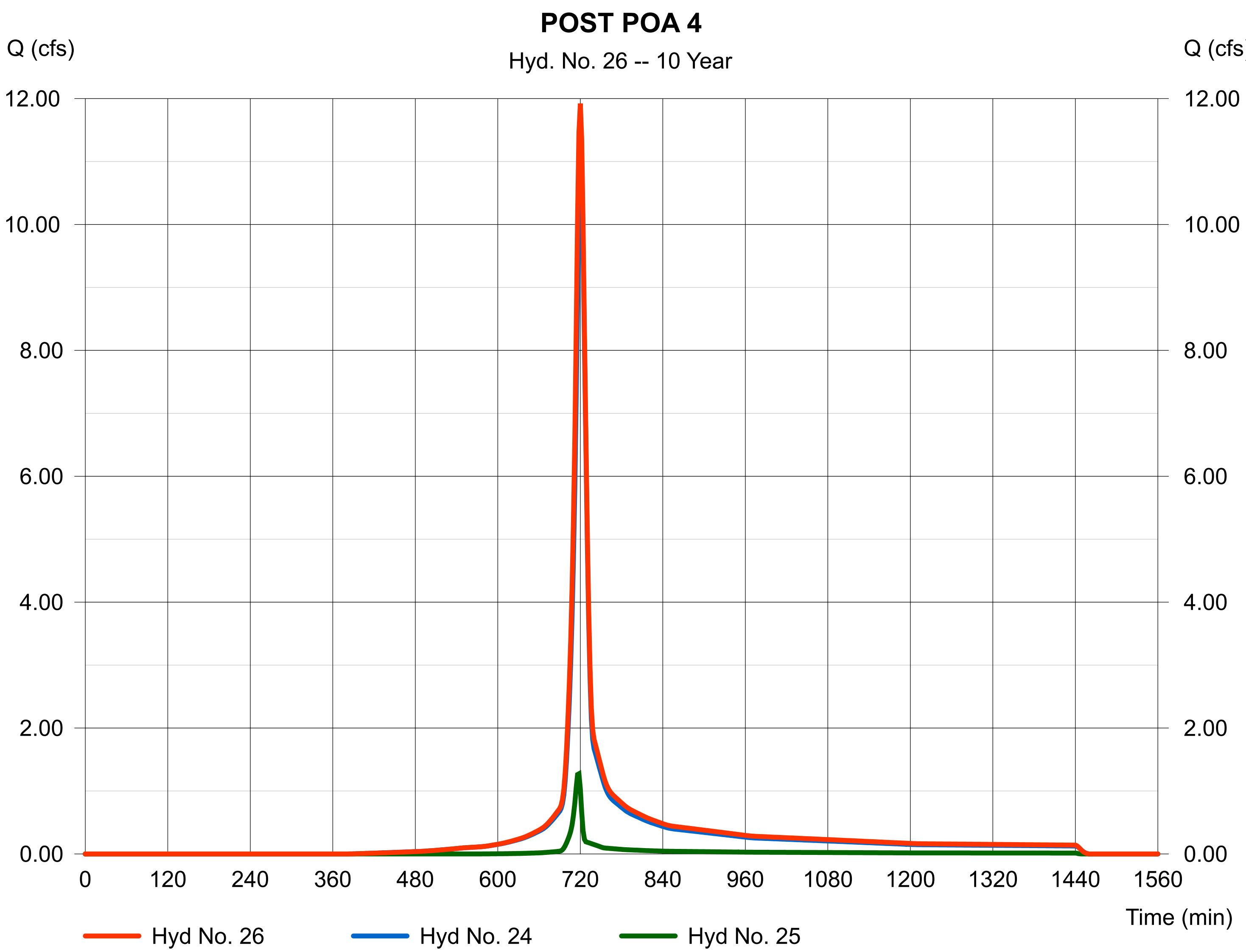
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 26

POST POA 4

Hydrograph type	= Combine	Peak discharge	= 11.92 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 30,957 cuft
Inflow hyds.	= 24, 25	Contrib. drain. area	= 2.520 ac



Hydrograph Report

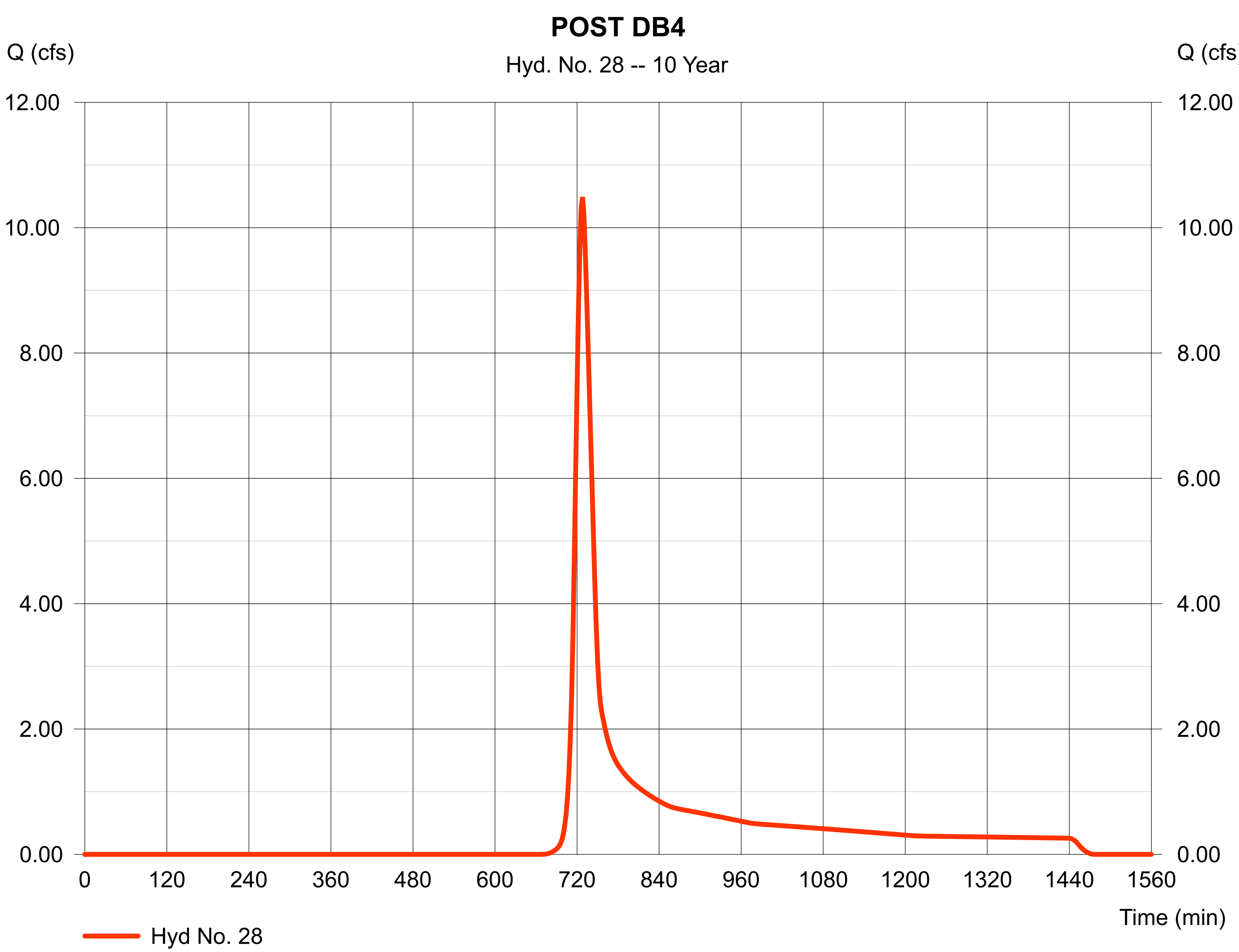
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 28

POST DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 10.49 cfs
Storm frequency	= 10 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 39,264 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.94 min
Total precip.	= 5.52 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.520 x 98) + (4.480 x 61)] / 6.580



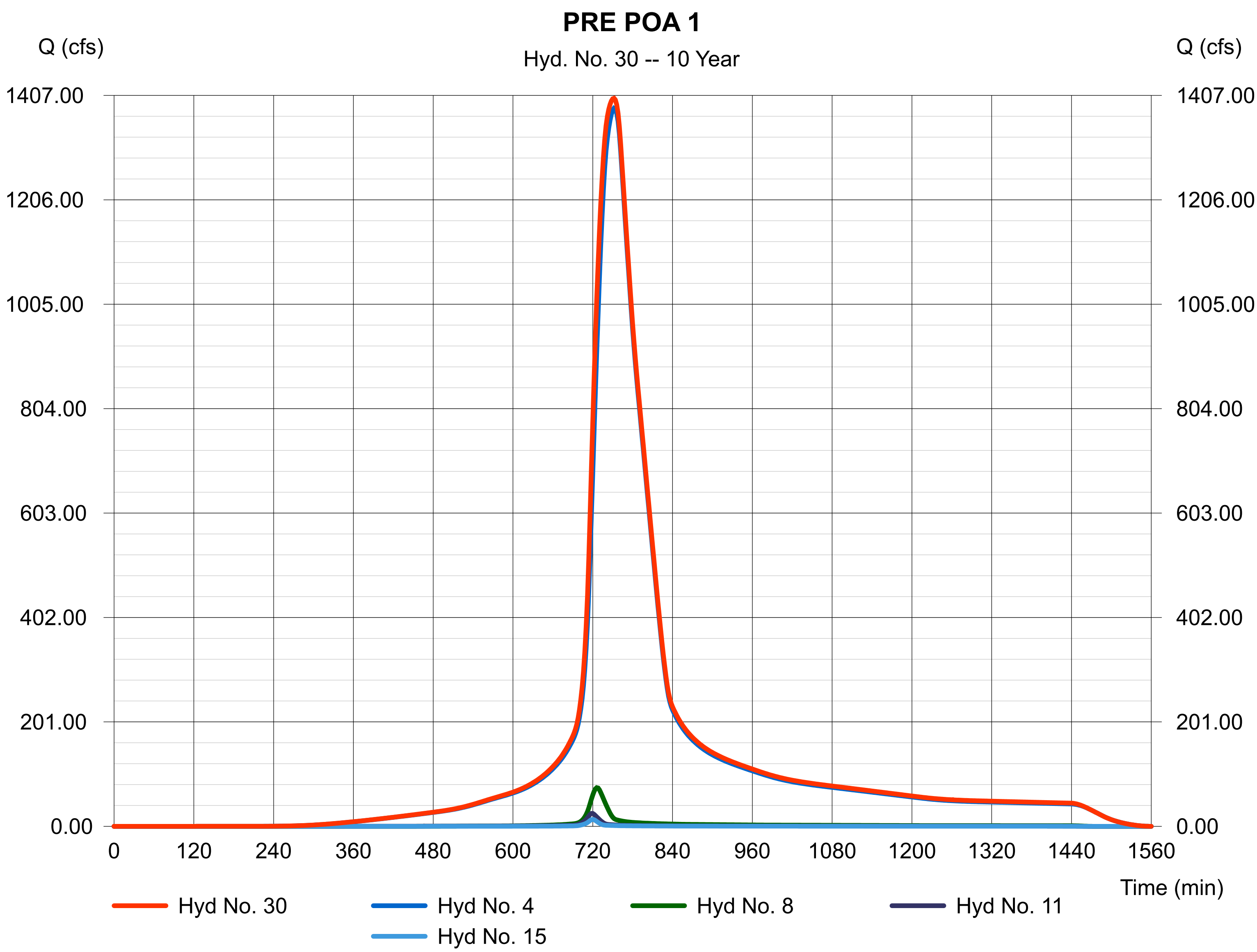
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 30

PRE POA 1

Hydrograph type	= Combine	Peak discharge	= 1401.65 cfs
Storm frequency	= 10 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 11,097,096 cuft
Inflow hyds.	= 4, 8, 11, 15	Contrib. drain. area	= 22.020 ac



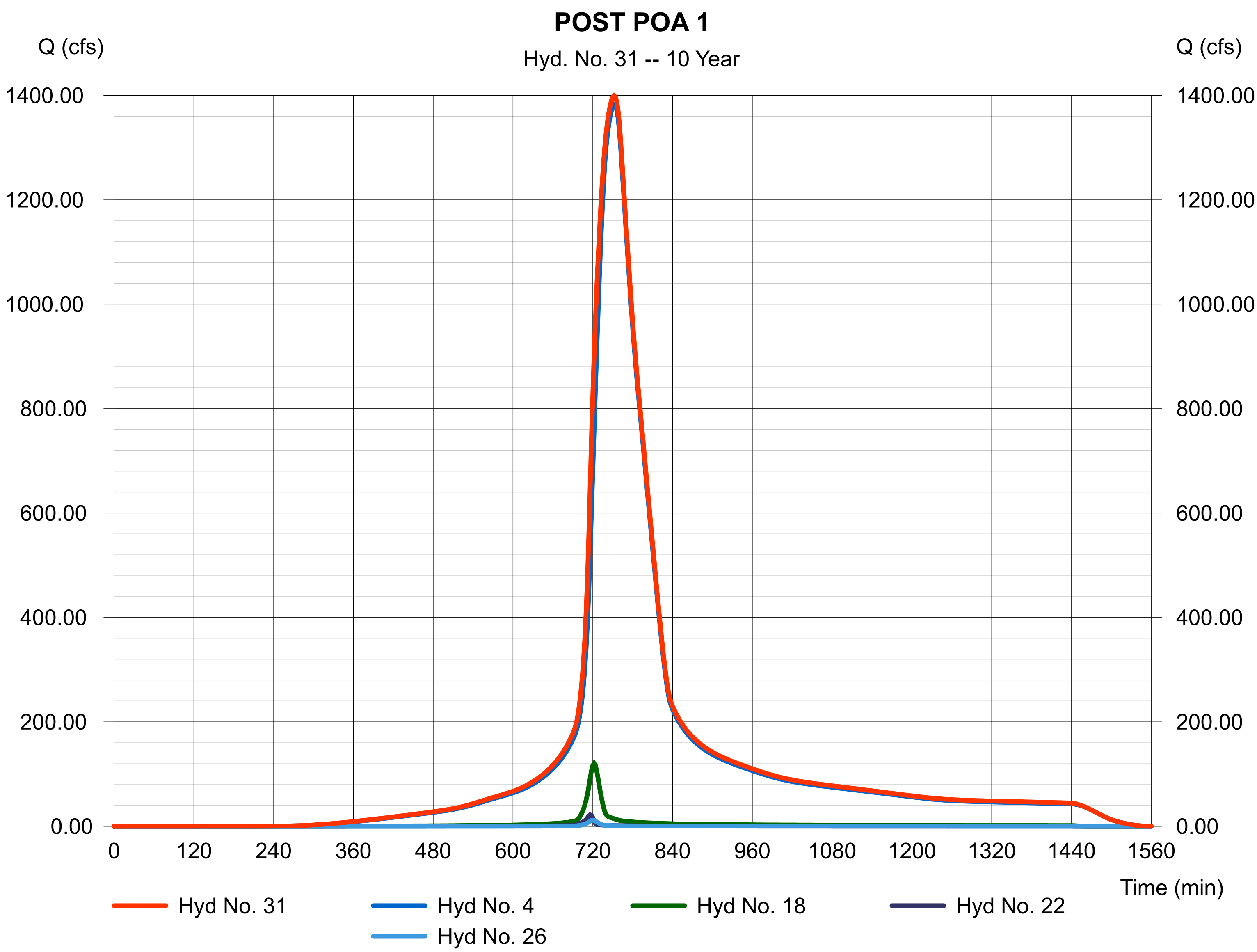
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 31

POST POA 1

Hydrograph type	= Combine	Peak discharge	= 1399.71 cfs
Storm frequency	= 10 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 11,157,645 cuft
Inflow hyds.	= 4, 18, 22, 26	Contrib. drain. area	= 24.120 ac



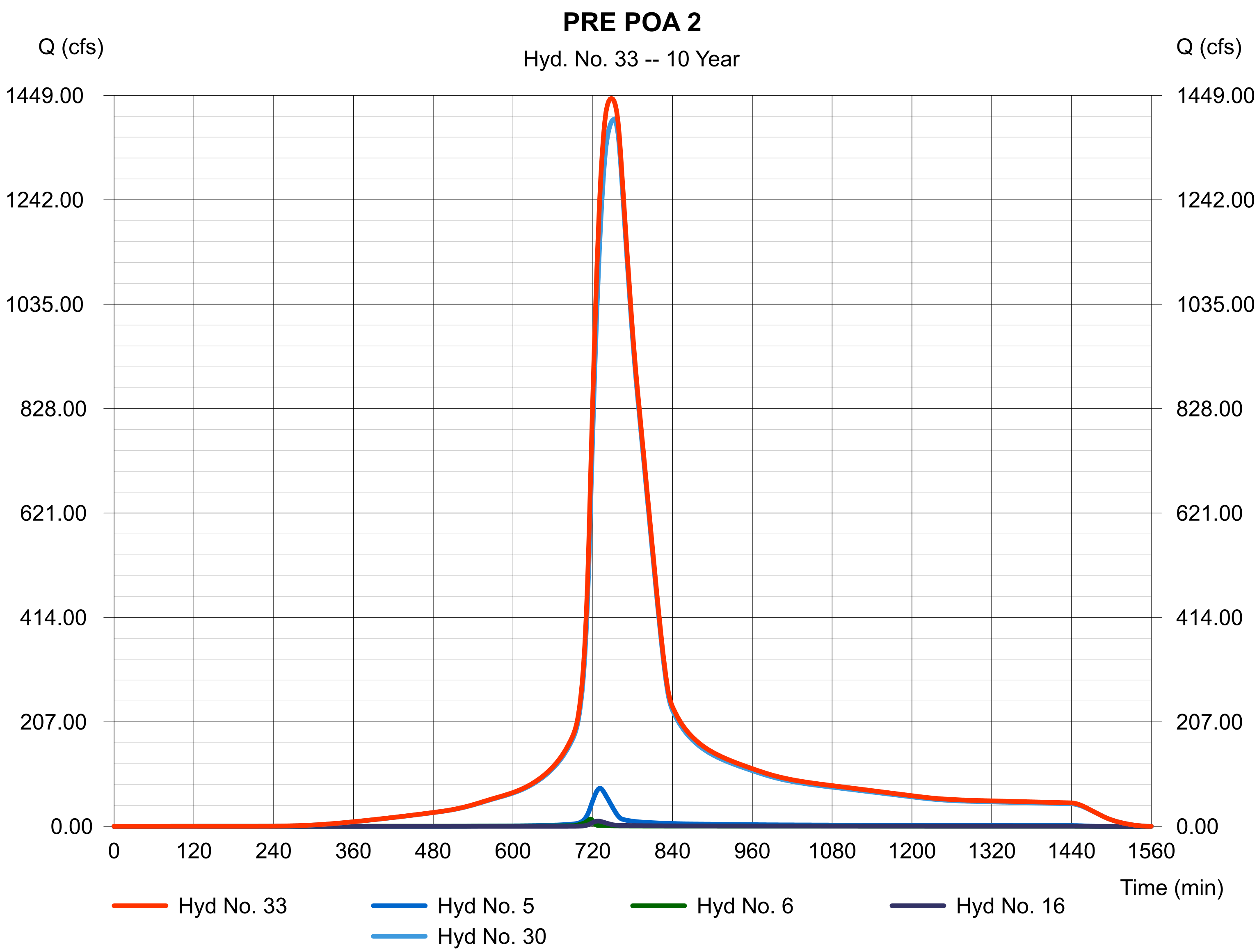
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 33

PRE POA 2

Hydrograph type	= Combine	Peak discharge	= 1443.02 cfs
Storm frequency	= 10 yrs	Time to peak	= 748 min
Time interval	= 2 min	Hyd. volume	= 11,473,404 cuft
Inflow hyds.	= 5, 6, 16, 30	Contrib. drain. area	= 37.480 ac



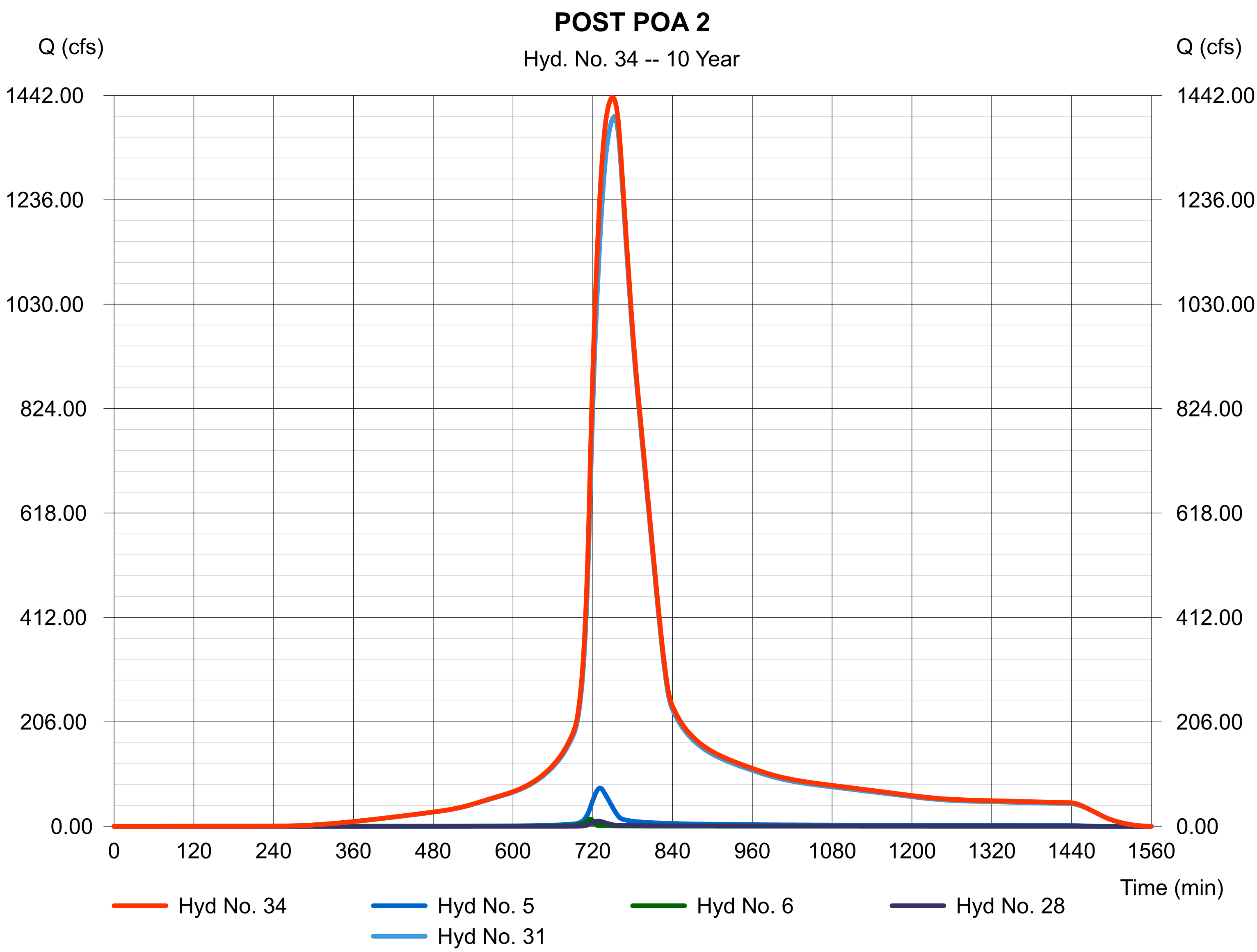
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 34

POST POA 2

Hydrograph type	= Combine	Peak discharge	= 1438.22 cfs
Storm frequency	= 10 yrs	Time to peak	= 750 min
Time interval	= 2 min	Hyd. volume	= 11,533,948 cuft
Inflow hyds.	= 5, 6, 28, 31	Contrib. drain. area	= 37.480 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	1254.15	2	758	9,787,592	------	------	------	MACRO BASIN 1
2	SCS Runoff	519.66	2	738	2,767,547	------	------	------	MACRO BASIN 2
3	SCS Runoff	126.45	2	732	548,813	------	------	------	MACRO BASIN 3
4	Combine	1676.73	2	752	13,103,967	1, 2, 3	------	------	OFF POA 1
5	SCS Runoff	97.30	2	730	388,949	------	------	------	MACRO BASIN 4
6	SCS Runoff	16.77	2	716	40,356	------	------	------	OFF BASIN 5
8	SCS Runoff	94.32	2	726	325,926	------	------	------	PRE DB1
9	SCS Runoff	23.26	2	722	68,481	------	------	------	PRE DB2-ON
10	SCS Runoff	9.531	2	716	22,939	------	------	------	PRE DB2-OFF
11	Combine	29.81	2	718	91,421	9, 10	------	------	PRE POA 3
13	SCS Runoff	15.32	2	720	40,097	------	------	------	PRE DB3-ON
14	SCS Runoff	1.668	2	716	3,368	------	------	------	PRE DB3-OFF
15	Combine	16.66	2	720	43,464	13, 14	------	------	PRE POA 4
16	SCS Runoff	15.08	2	728	54,513	------	------	------	PRE DB4
18	SCS Runoff	146.14	2	722	424,938	------	------	------	POST DB1
19	Reservoir	27.29	2	740	420,623	18	964.45	222,286	FALSE PHASE 1 VAULT
20	SCS Runoff	16.57	2	716	36,965	------	------	------	POST DB2-ON
21	SCS Runoff	9.531	2	716	22,939	------	------	------	POST DB2-OFF
22	Combine	26.10	2	716	59,905	20, 21	------	------	POST POA 3
24	SCS Runoff	13.56	2	720	35,607	------	------	------	POST DB3-ON
25	SCS Runoff	1.668	2	716	3,368	------	------	------	POST DB3-OFF
26	Combine	14.90	2	720	38,975	24, 25	------	------	POST POA 4
28	SCS Runoff	15.08	2	728	54,513	------	------	------	POST DB4
30	Combine	1700.33	2	752	13,564,773	4, 8, 11, 15,	------	------	PRE POA 1
31	Combine	1697.47	2	752	13,627,783	4, 18, 22, 26,	------	------	POST POA 1
33	Combine	1755.07	2	748	14,048,604	5, 6, 16, 30,	------	------	PRE POA 2
34	Combine	1747.24	2	750	14,111,601	5, 6, 28, 31,	------	------	POST POA 2

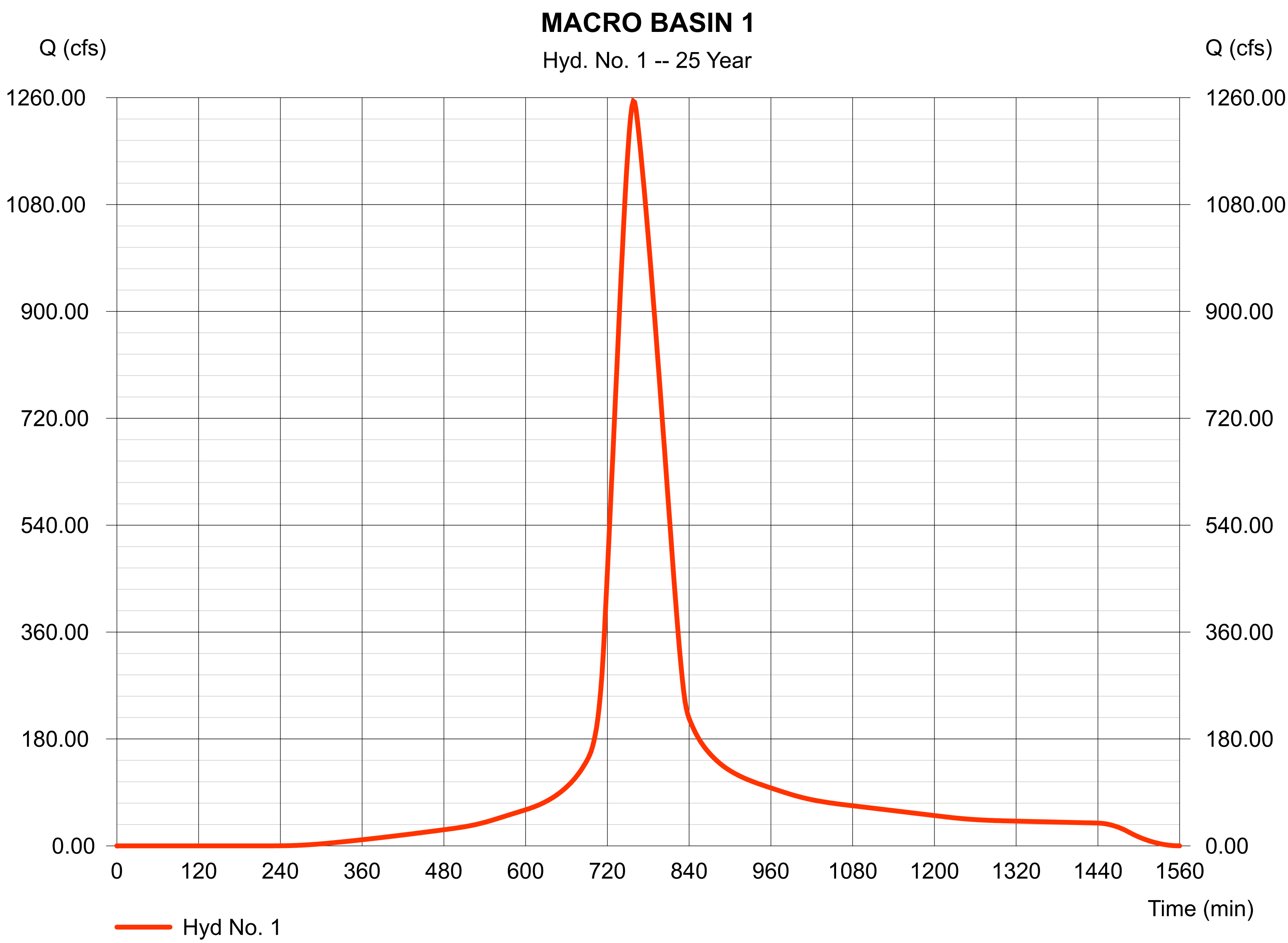
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 1

MACRO BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 1254.15 cfs
Storm frequency	= 25 yrs	Time to peak	= 758 min
Time interval	= 2 min	Hyd. volume	= 9,787,592 cuft
Drainage area	= 532.700 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 76.90 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



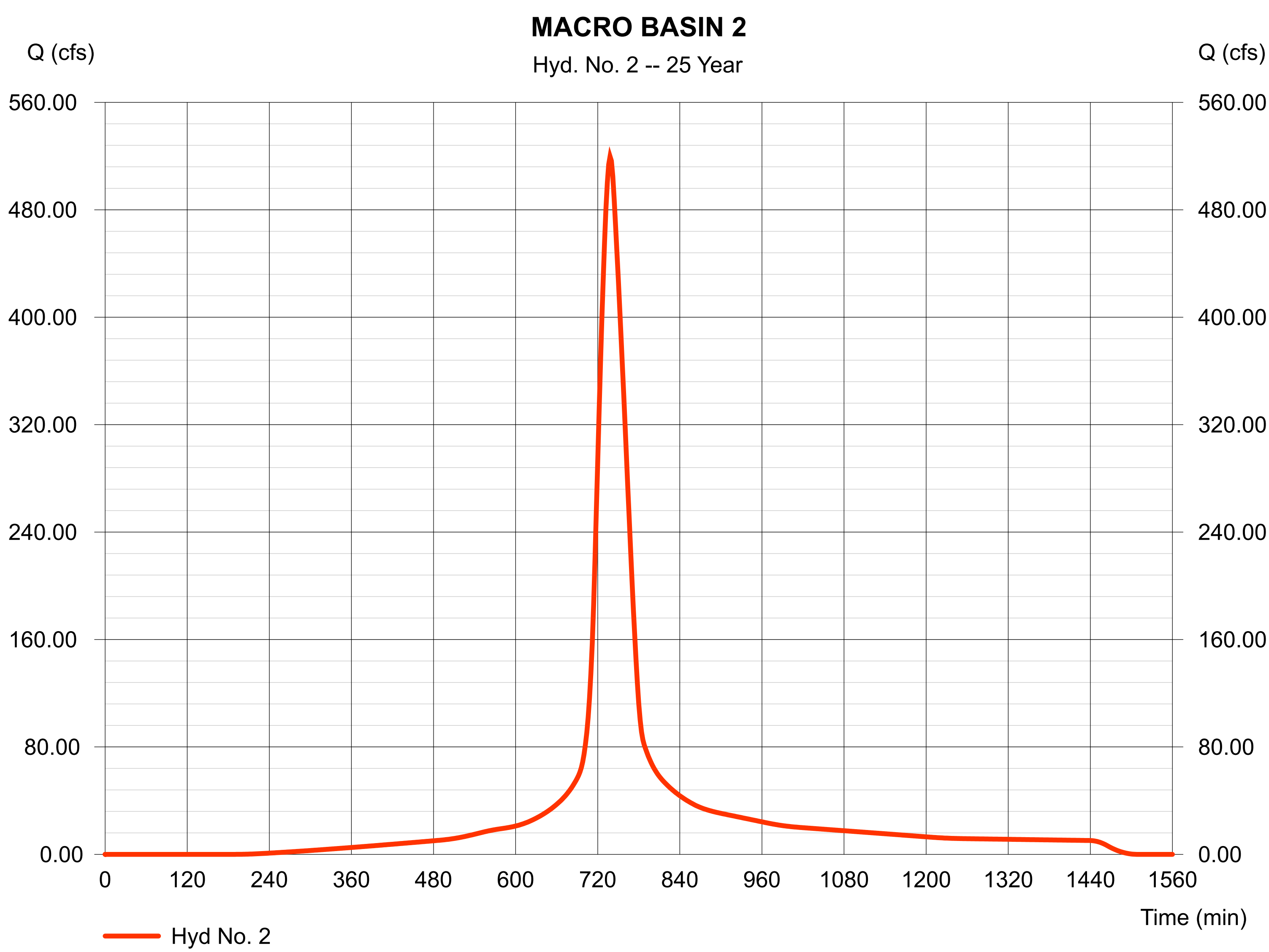
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 2

MACRO BASIN 2

Hydrograph type	= SCS Runoff	Peak discharge	= 519.66 cfs
Storm frequency	= 25 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 2,767,547 cuft
Drainage area	= 142.100 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 42.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



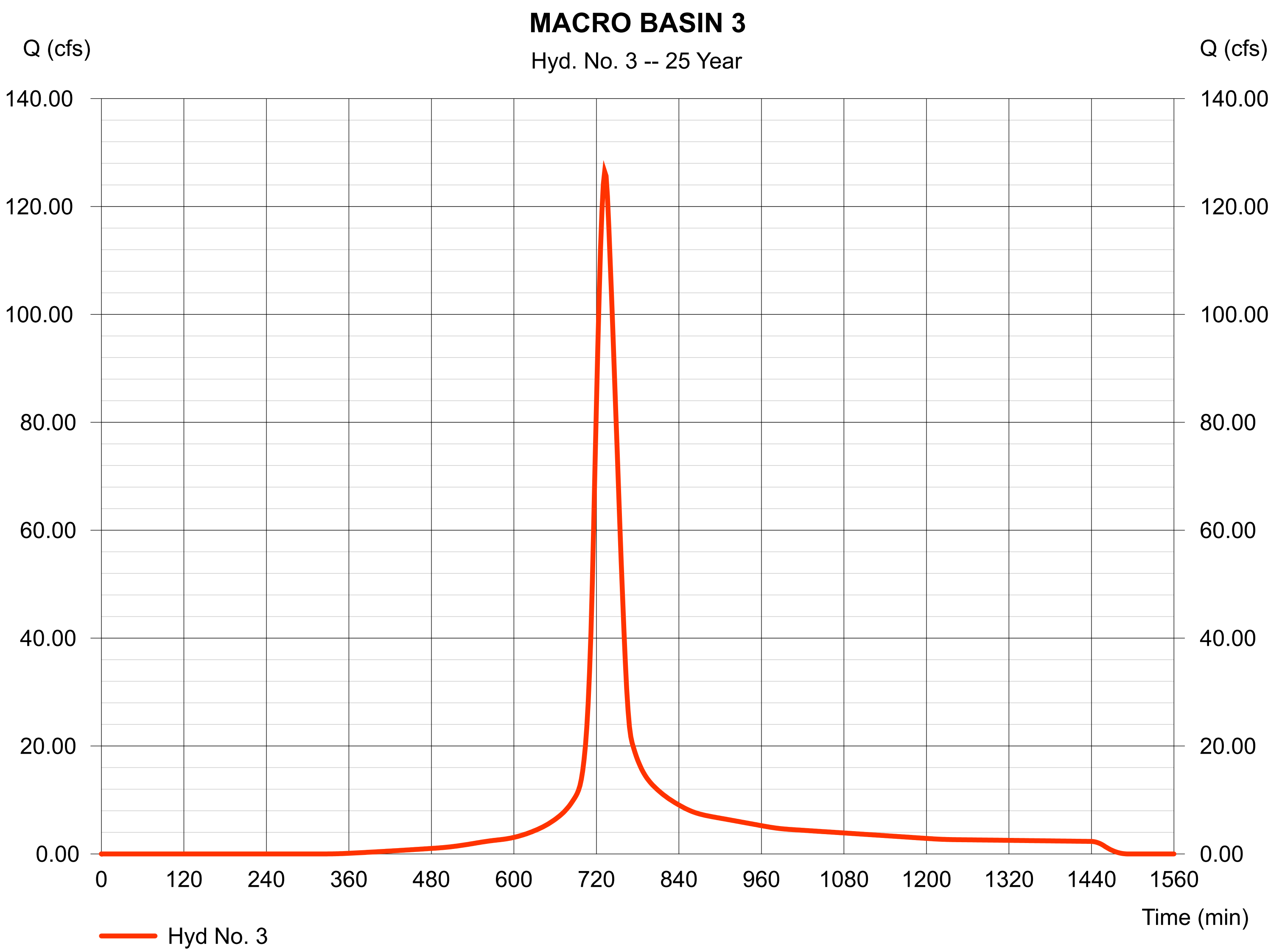
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 3

MACRO BASIN 3

Hydrograph type	= SCS Runoff	Peak discharge	= 126.45 cfs
Storm frequency	= 25 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 548,813 cuft
Drainage area	= 33.700 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 31.50 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



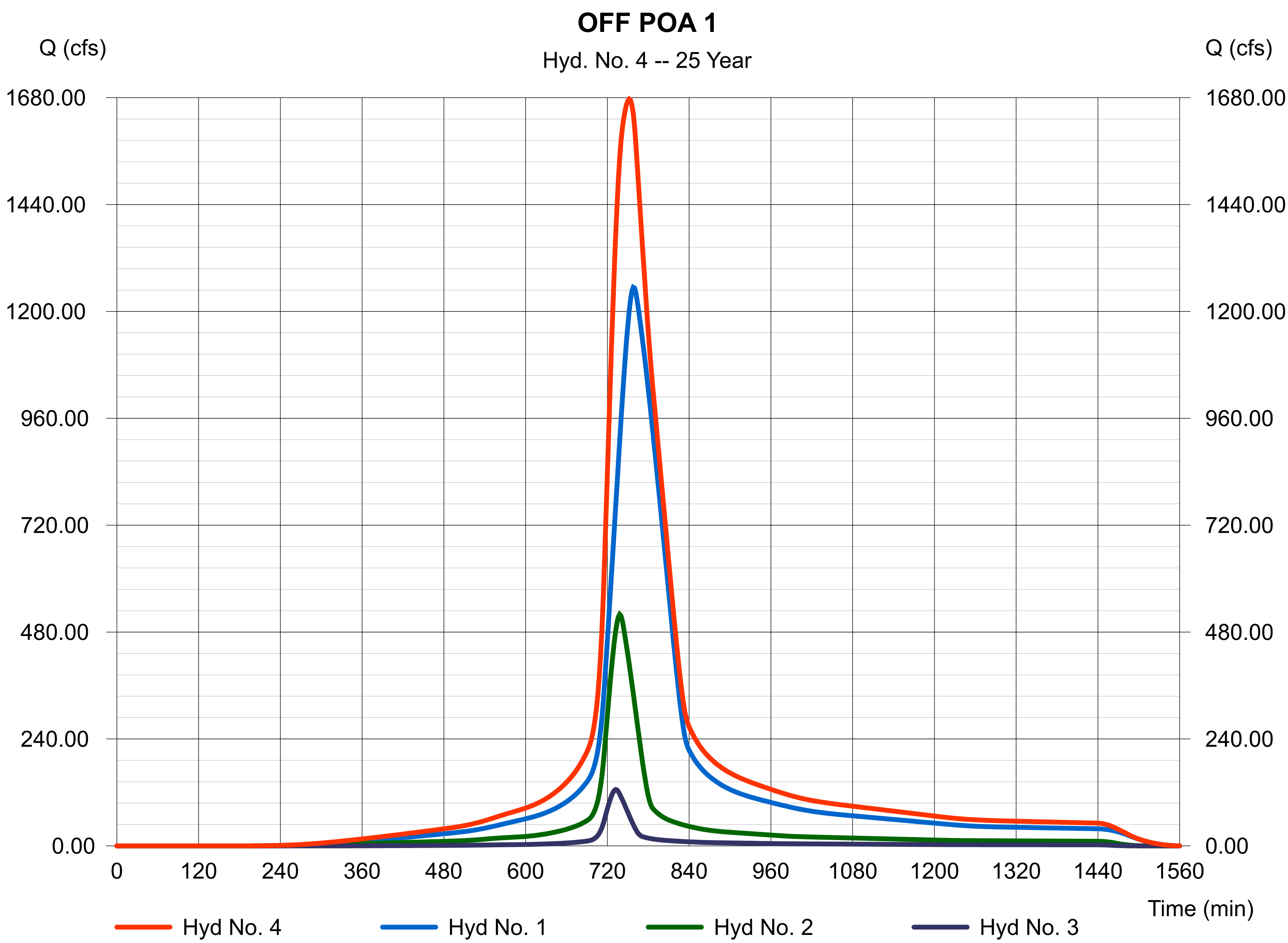
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 4

OFF POA 1

Hydrograph type	= Combine	Peak discharge	= 1676.73 cfs
Storm frequency	= 25 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 13,103,967 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 708.500 ac



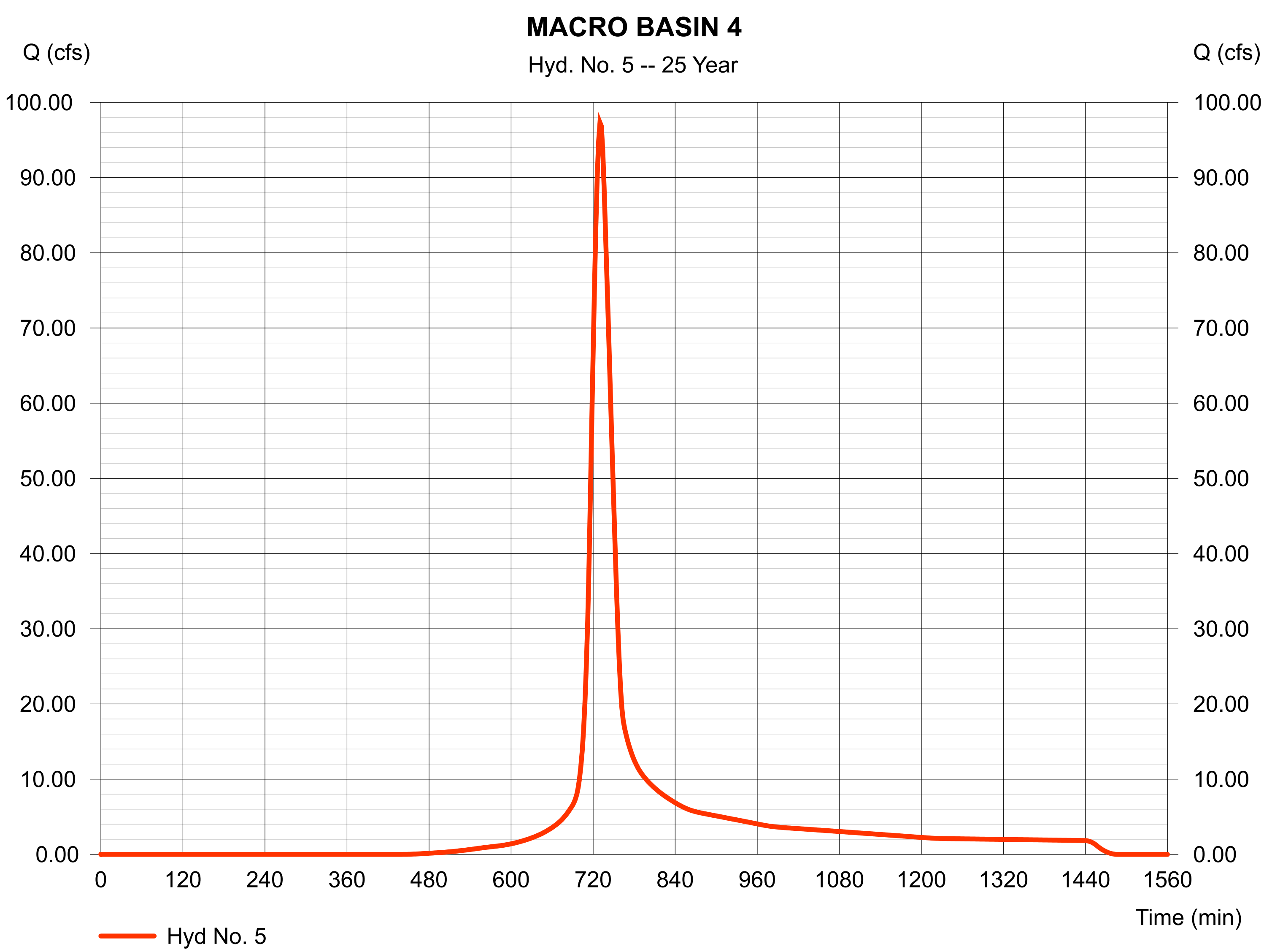
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 5

MACRO BASIN 4

Hydrograph type	= SCS Runoff	Peak discharge	= 97.30 cfs
Storm frequency	= 25 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 388,949 cuft
Drainage area	= 29.000 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 27.10 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



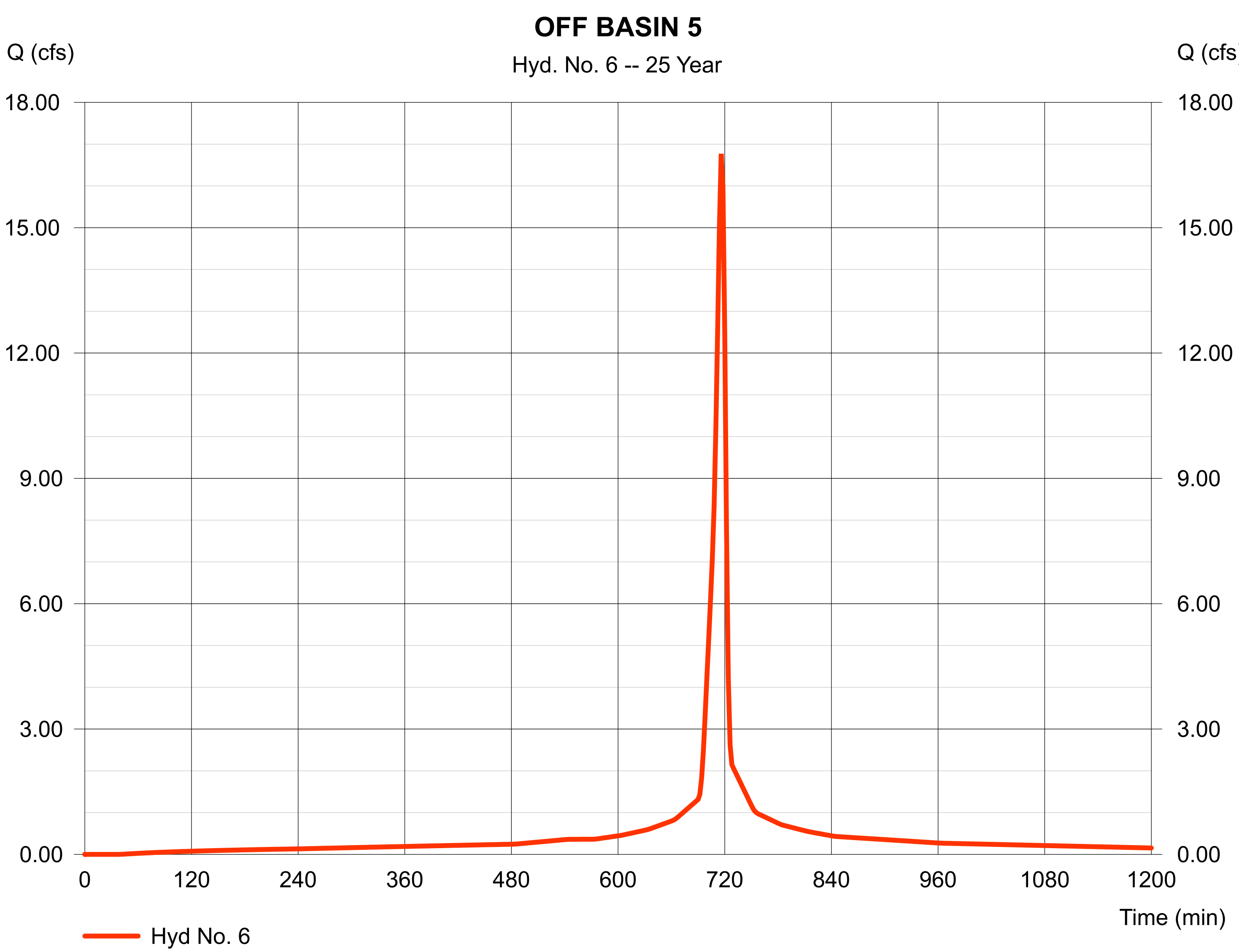
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 6

OFF BASIN 5

Hydrograph type	= SCS Runoff	Peak discharge	= 16.77 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 40,356 cuft
Drainage area	= 1.900 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

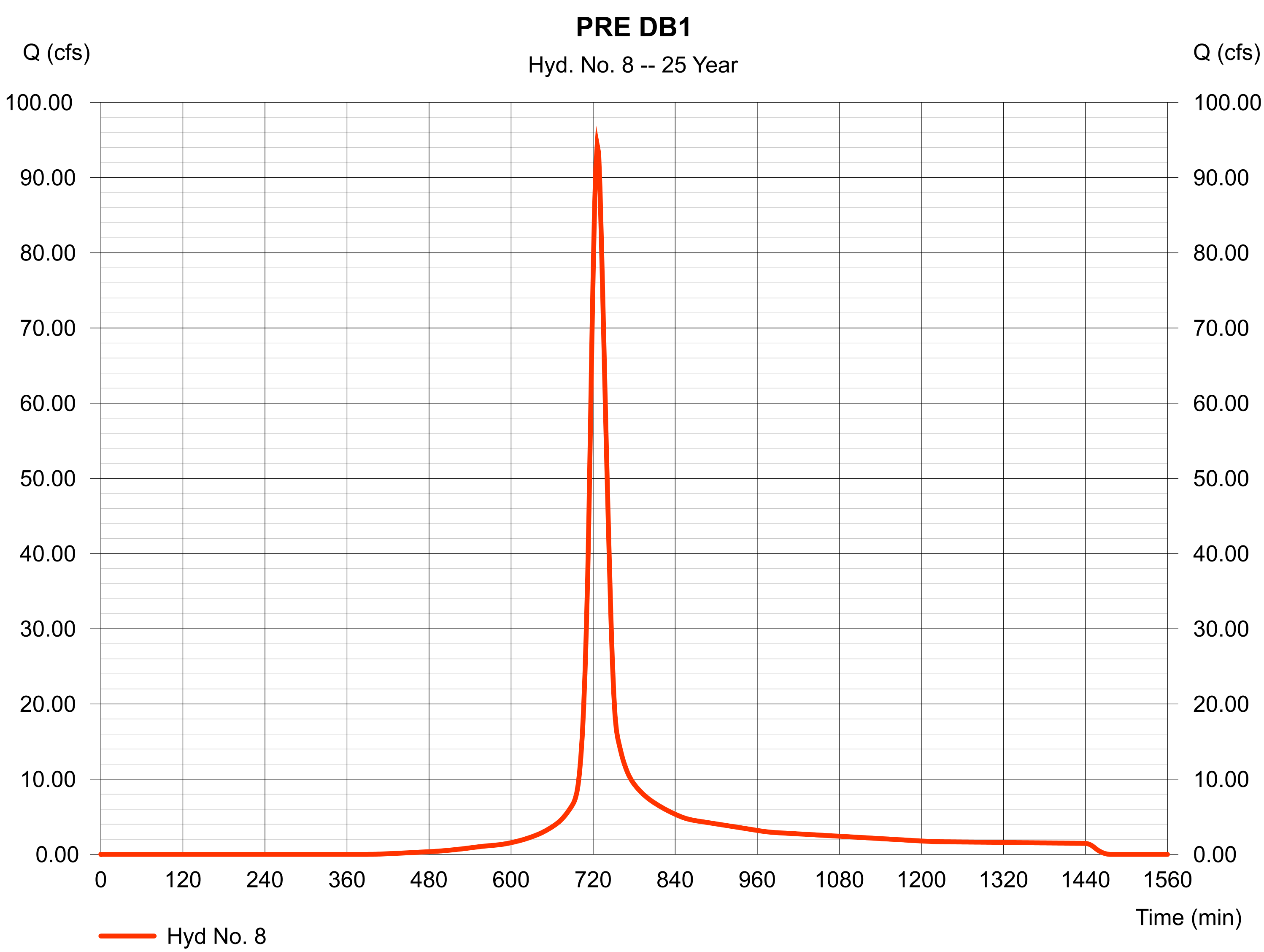
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 8

PRE DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 94.32 cfs
Storm frequency	= 25 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 325,926 cuft
Drainage area	= 22.020 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 20.73 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 22.020



Hydrograph Report

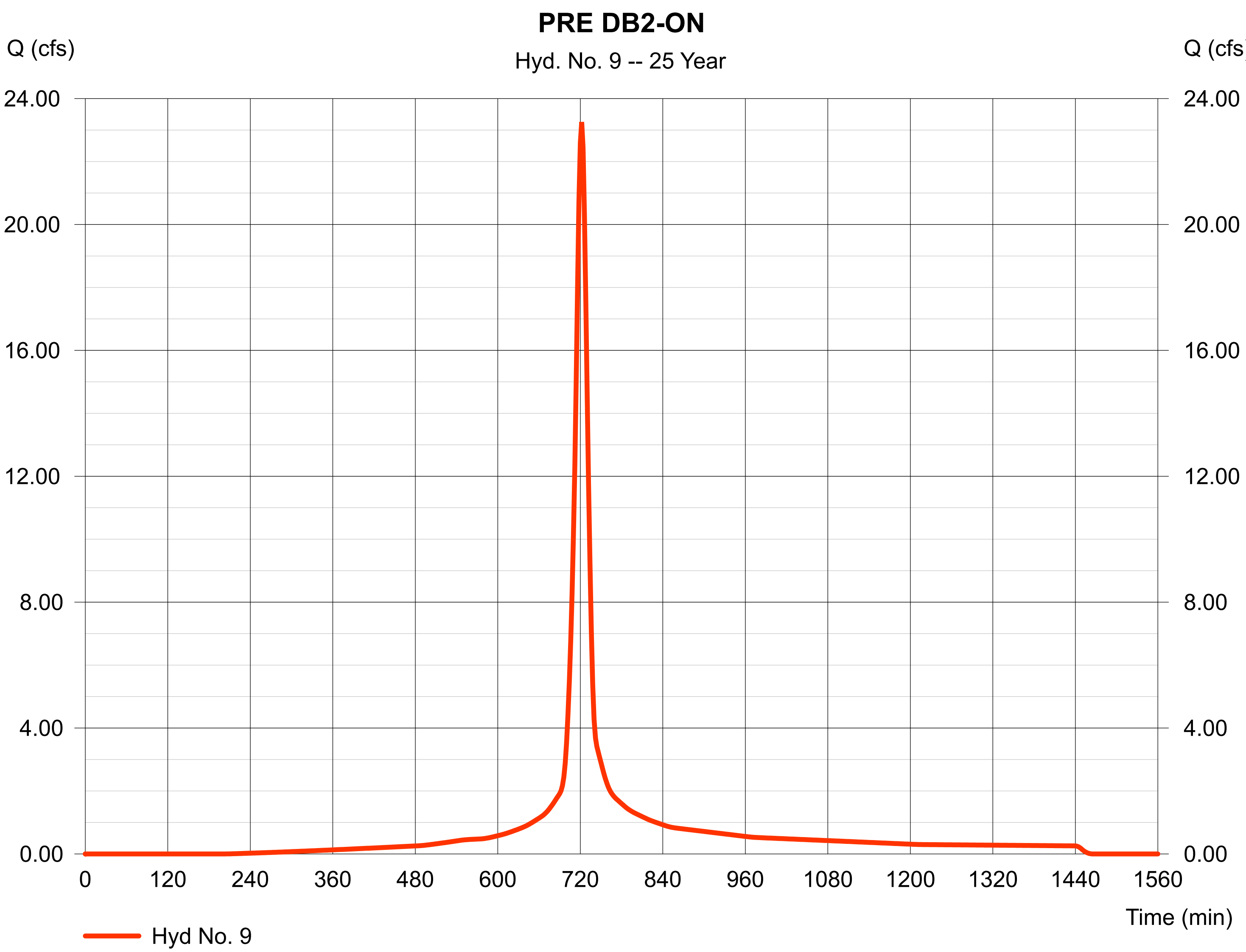
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 9

PRE DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 23.26 cfs
Storm frequency	= 25 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 68,481 cuft
Drainage area	= 3.720 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.33 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 3.720



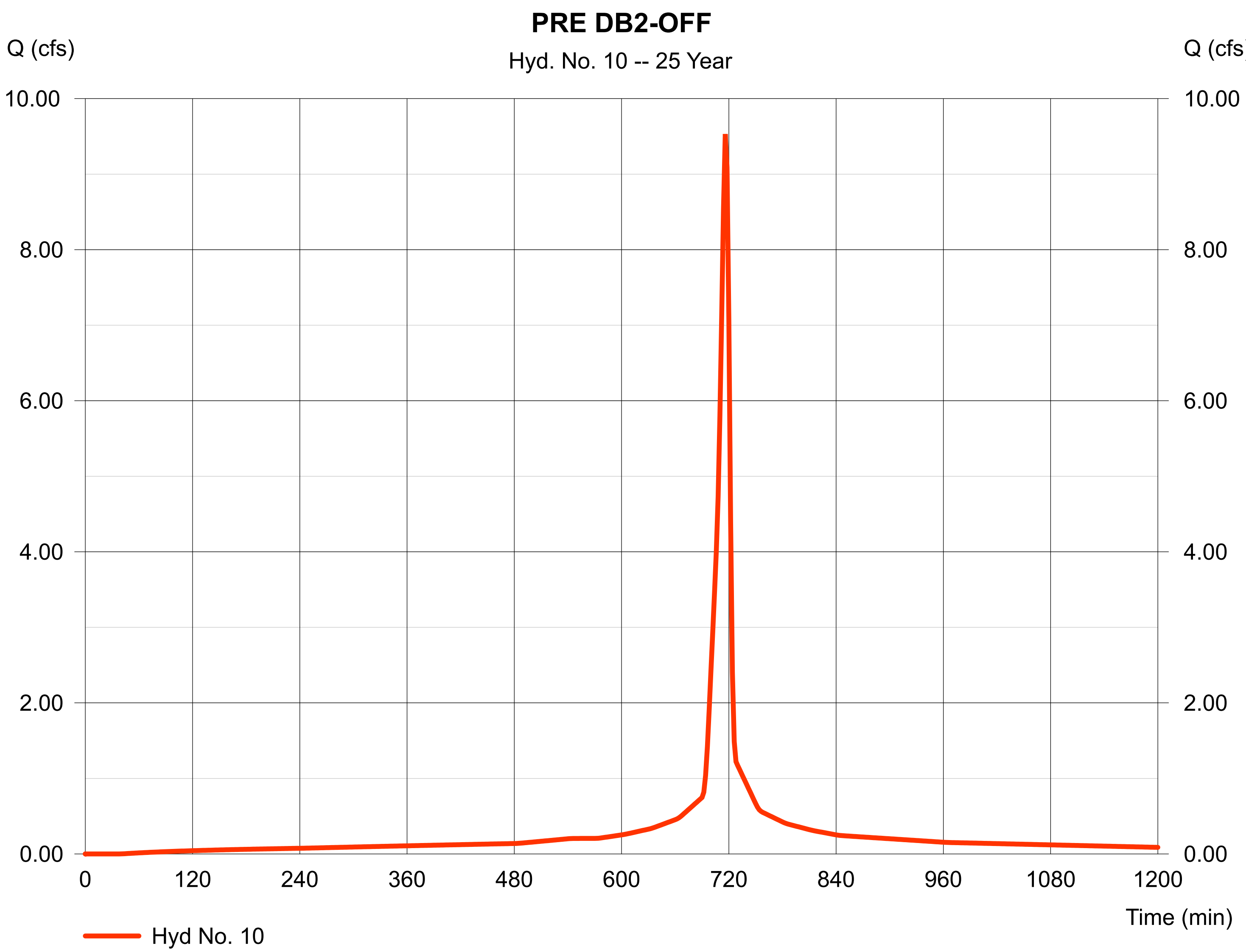
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 10

PRE DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 9.531 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 22,939 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



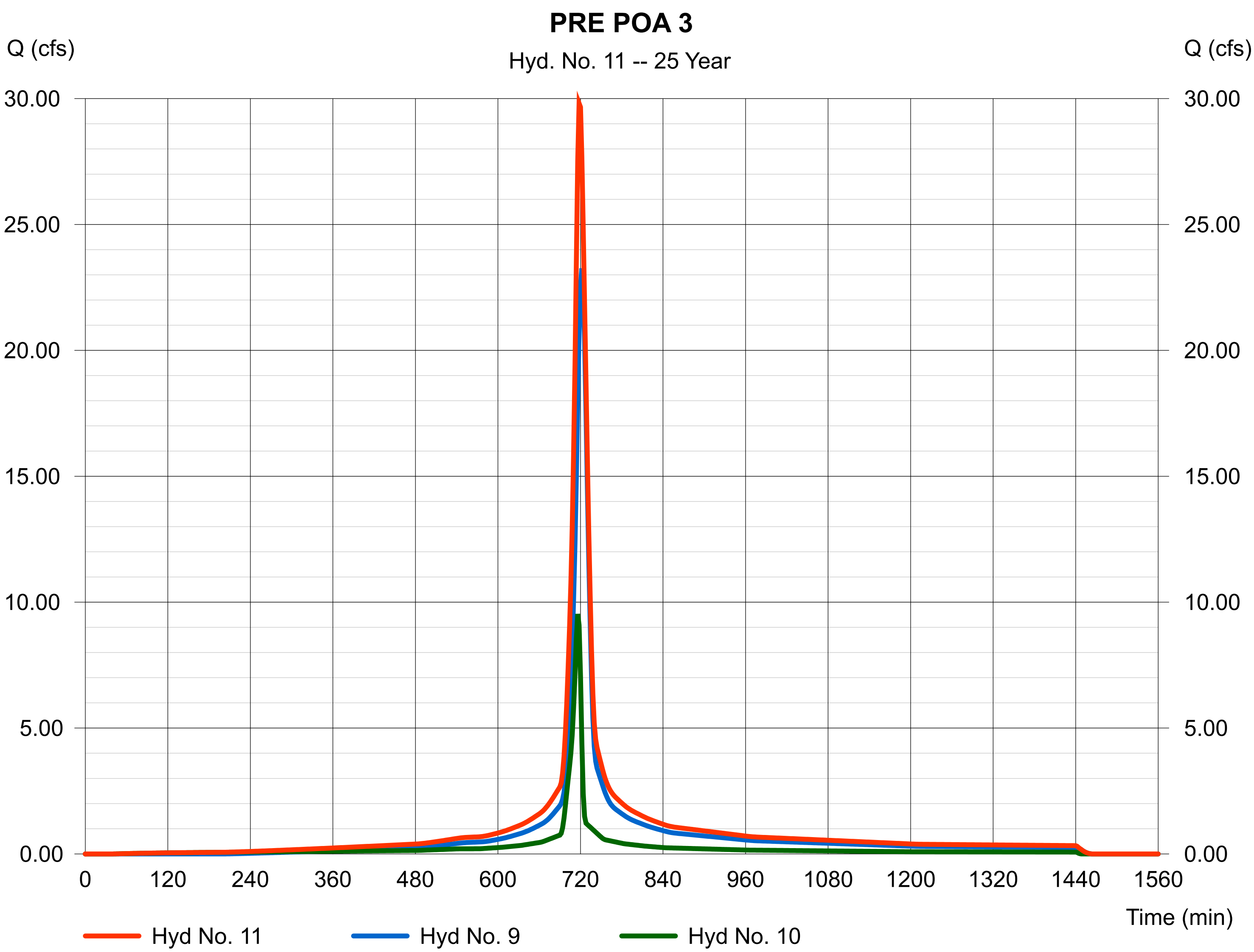
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 11

PRE POA 3

Hydrograph type	= Combine	Peak discharge	= 29.81 cfs
Storm frequency	= 25 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 91,421 cuft
Inflow hyds.	= 9, 10	Contrib. drain. area	= 4.800 ac



Hydrograph Report

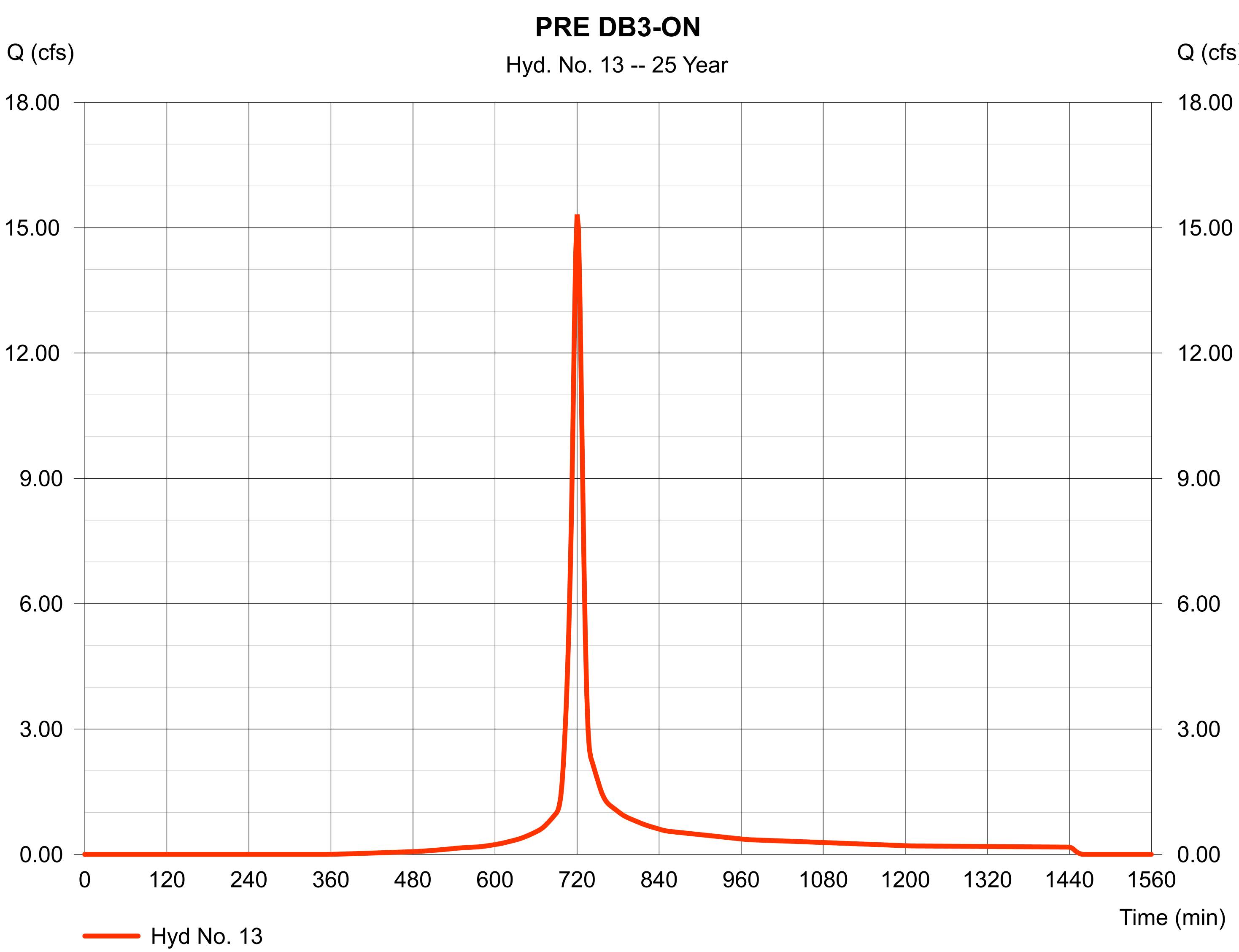
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 13

PRE DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 15.32 cfs
Storm frequency	= 25 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 40,097 cuft
Drainage area	= 2.540 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 55) + (0.570 x 61) + (2.130 x 98)] / 2.540



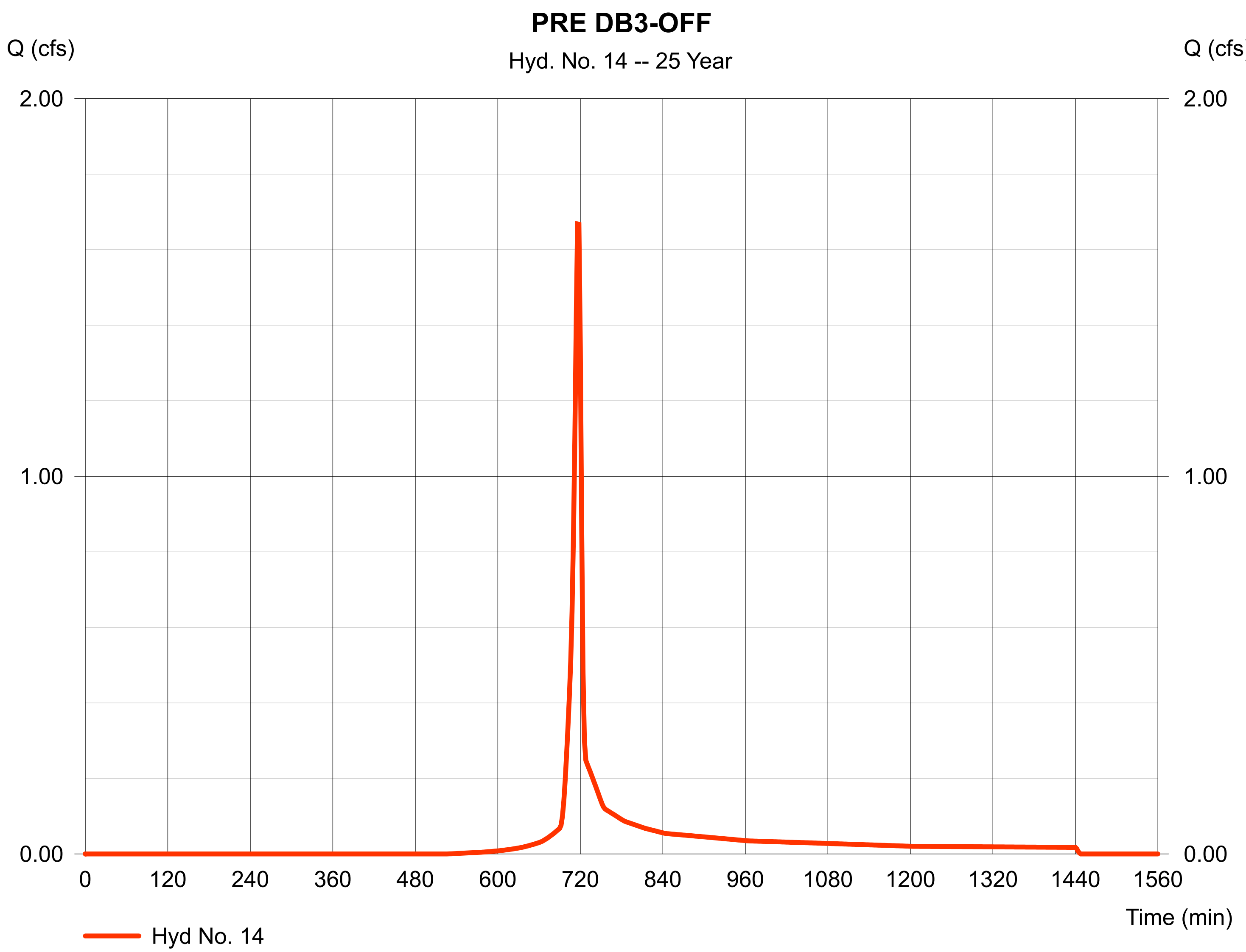
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 14

PRE DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 1.668 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 3,368 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



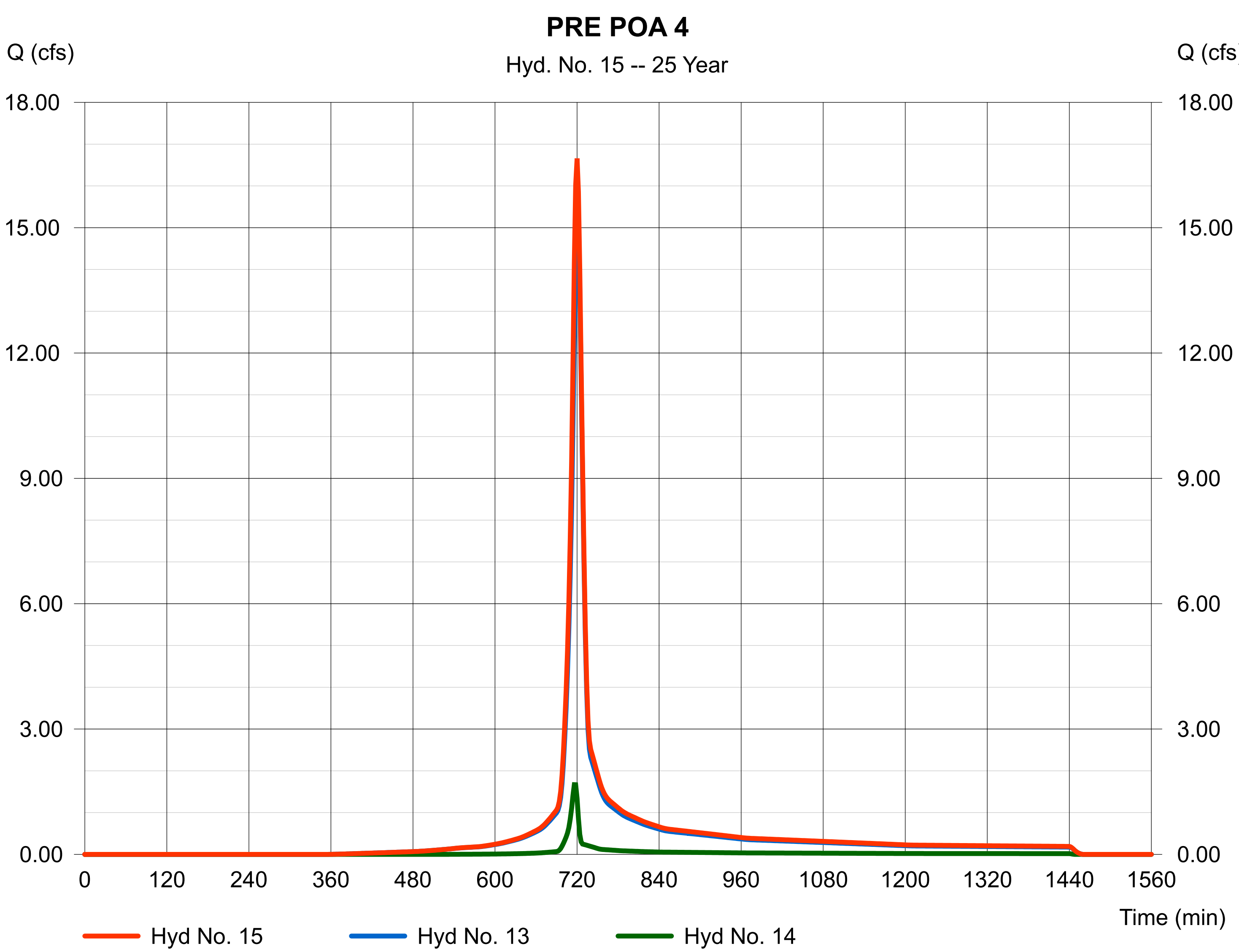
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 15

PRE POA 4

Hydrograph type	= Combine	Peak discharge	= 16.66 cfs
Storm frequency	= 25 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 43,464 cuft
Inflow hyds.	= 13, 14	Contrib. drain. area	= 2.860 ac



Hydrograph Report

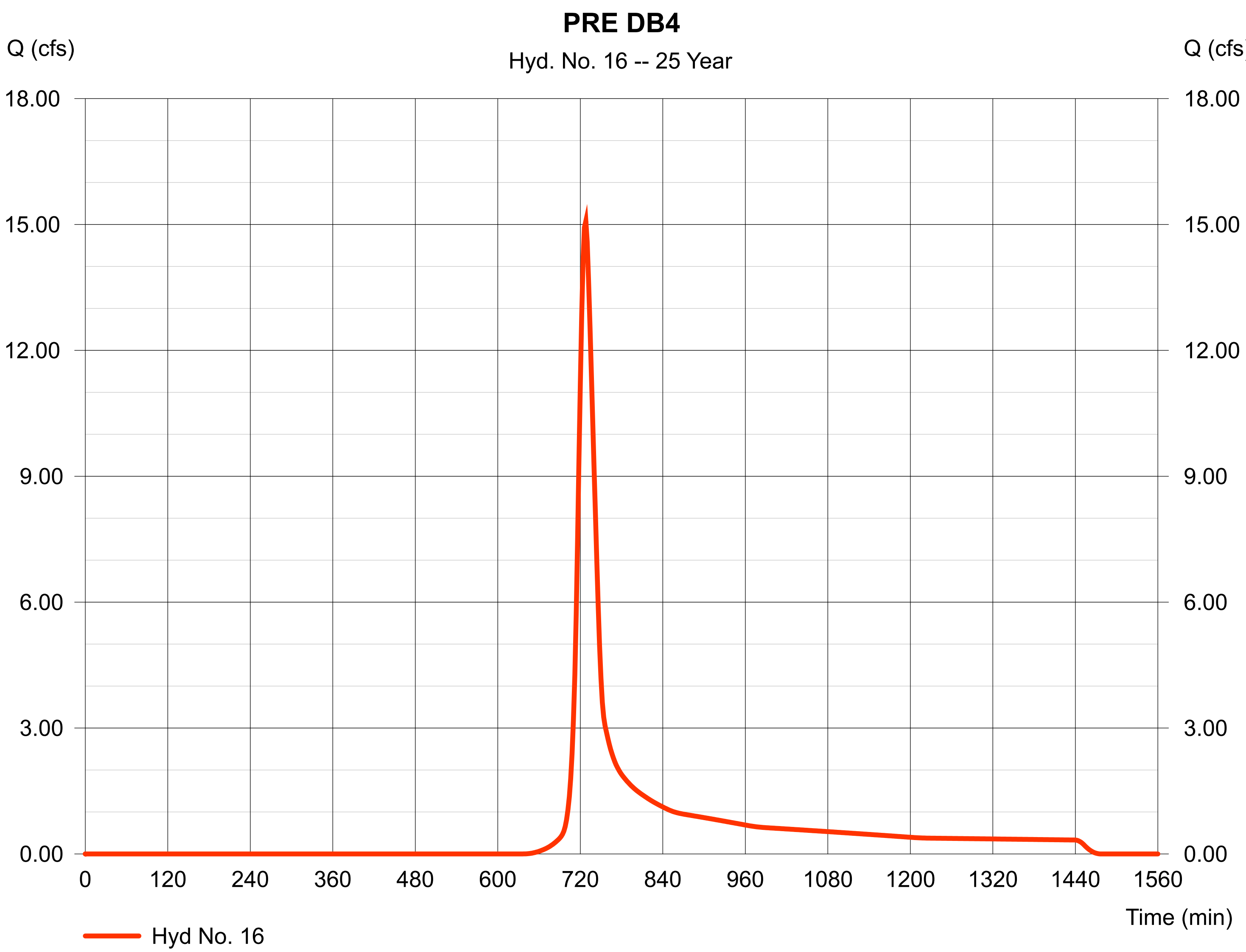
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 16

PRE DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 15.08 cfs
Storm frequency	= 25 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 54,513 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.12 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.160 x 61) + (1.840 x 55)] / 6.580



Hydrograph Report

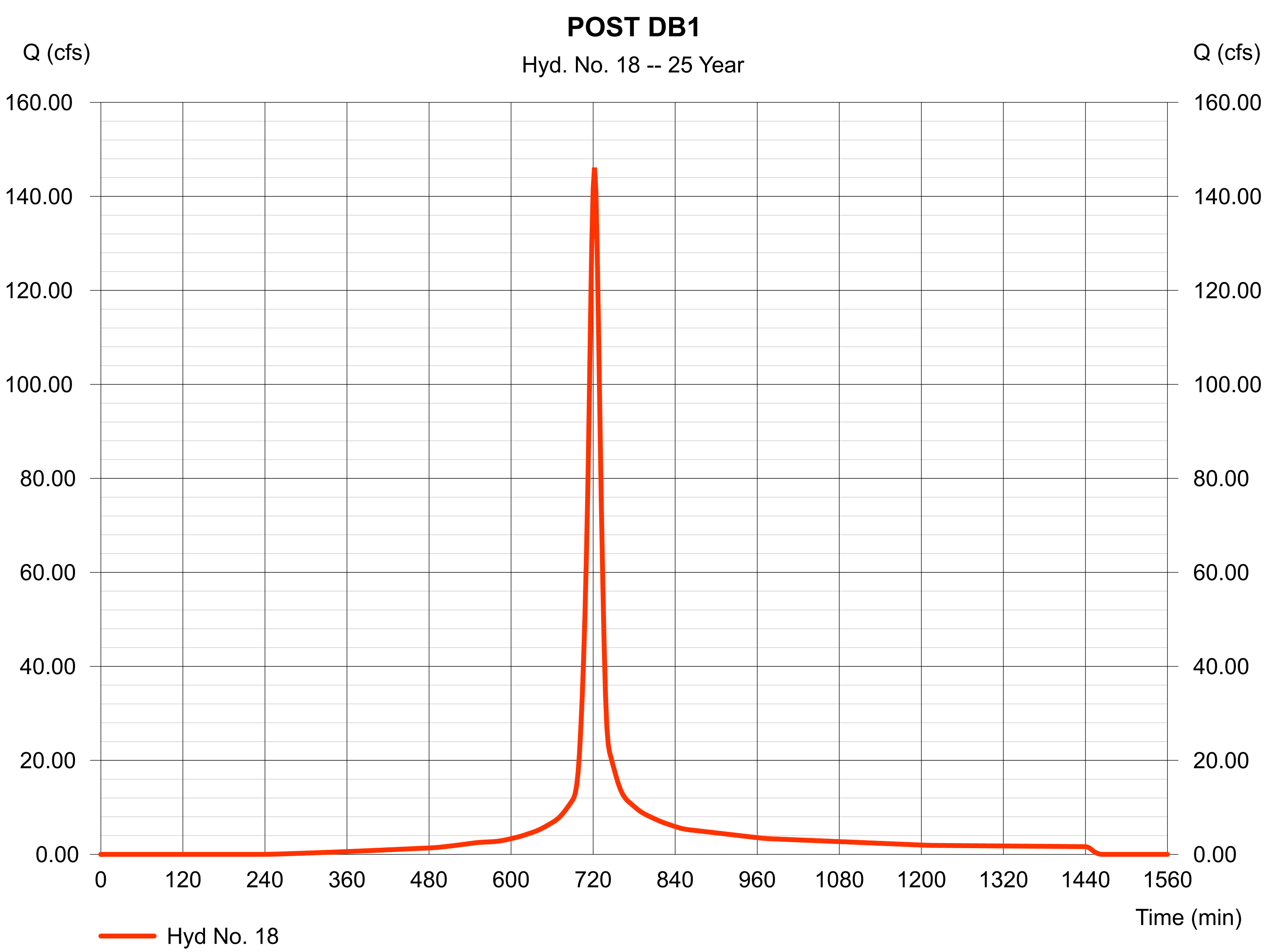
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 18

POST DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 146.14 cfs
Storm frequency	= 25 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 424,938 cuft
Drainage area	= 24.120 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.62 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 98) + (0.310 x 55) + (0.510 x 61)] / 24.120



Hydrograph Report

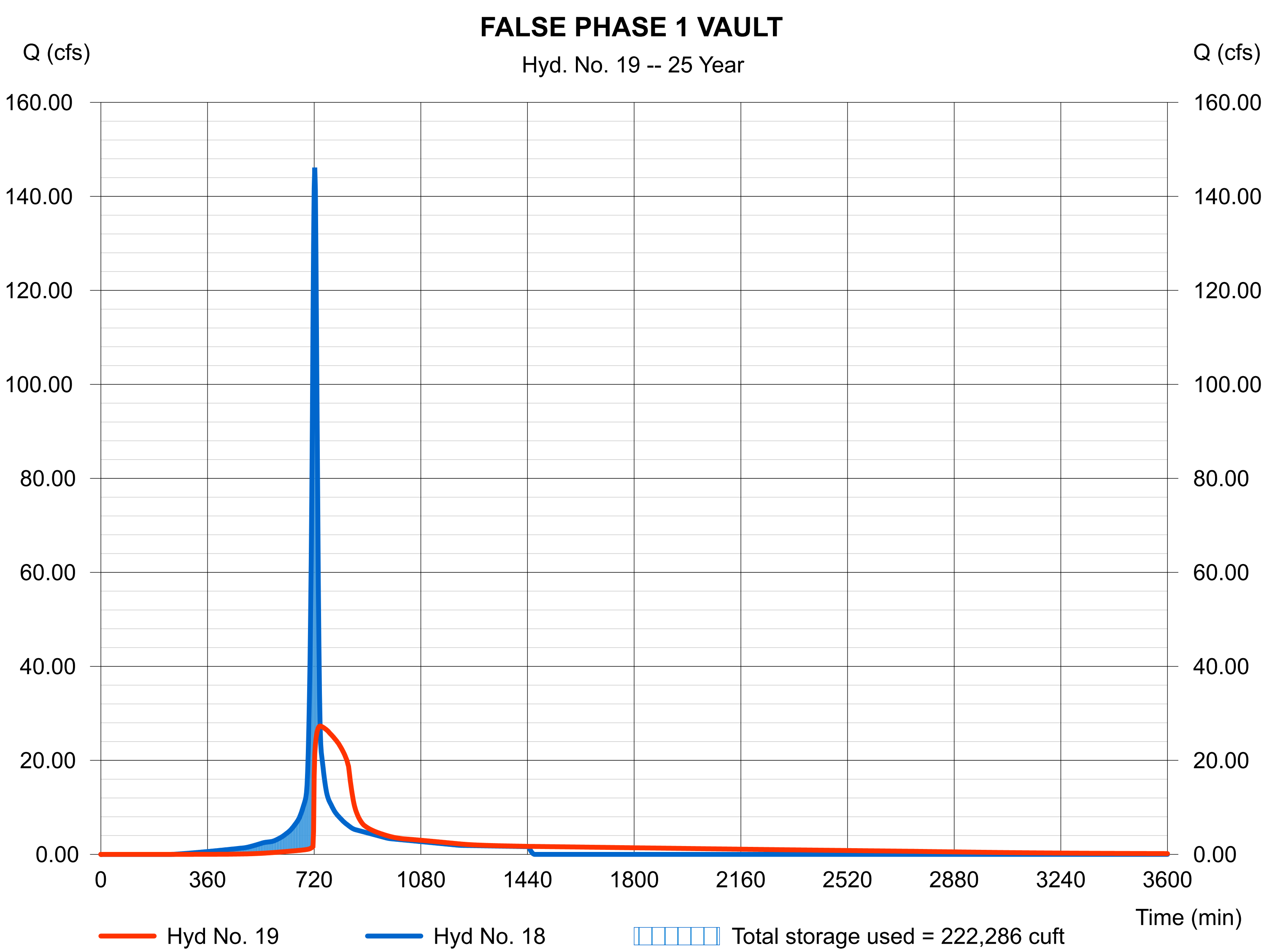
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 19

FALSE PHASE 1 VAULT

Hydrograph type	= Reservoir	Peak discharge	= 27.29 cfs
Storm frequency	= 25 yrs	Time to peak	= 740 min
Time interval	= 2 min	Hyd. volume	= 420,623 cuft
Inflow hyd. No.	= 18 - POST DB1	Max. Elevation	= 964.45 ft
Reservoir name	= FALSE POND	Max. Storage	= 222,286 cuft

Storage Indication method used.



Hydrograph Report

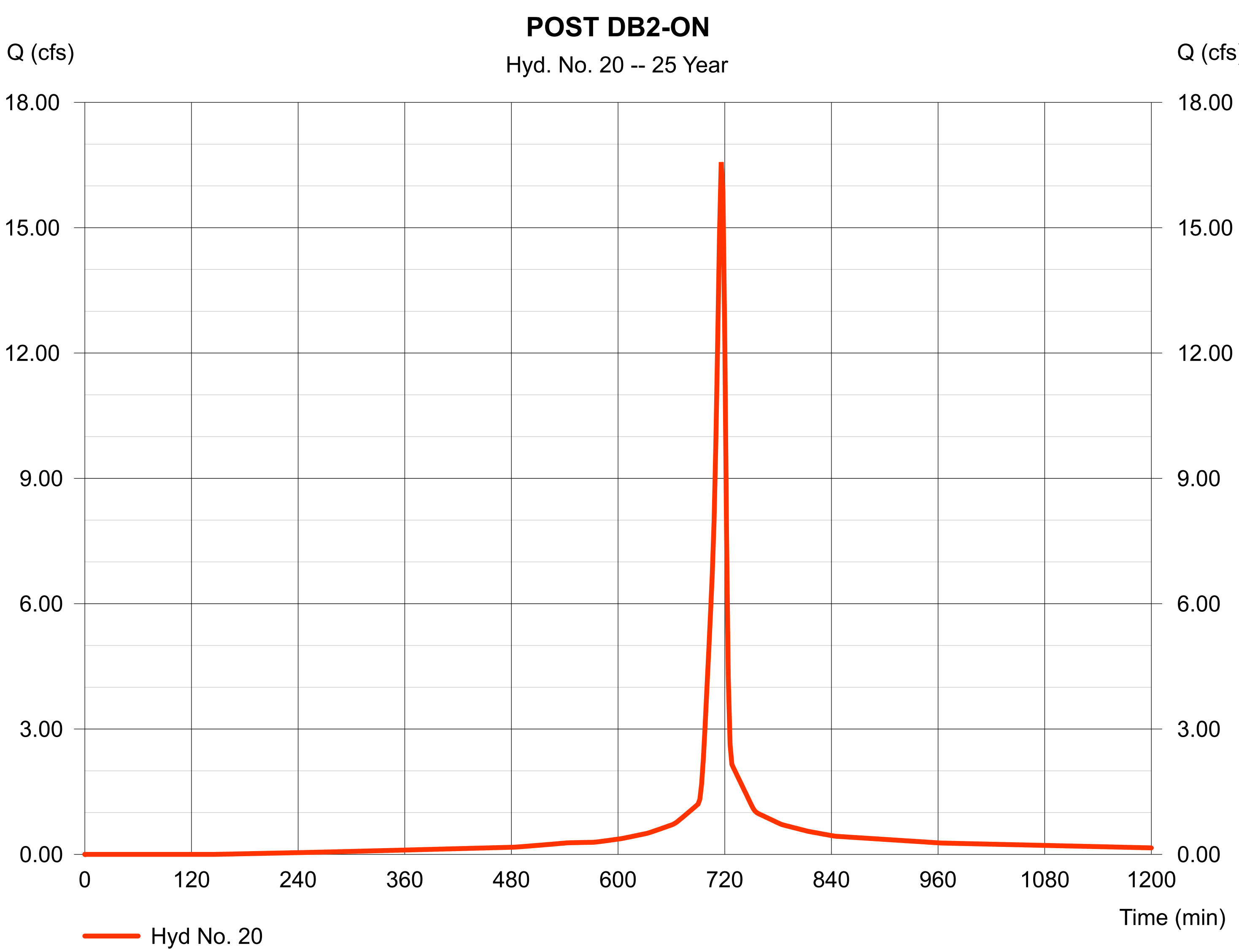
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 20

POST DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 16.57 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 36,965 cuft
Drainage area	= 1.960 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.090 x 61) + (0.280 x 85) + (13.450 x 98) + (1.000 x 55)] / 1.960



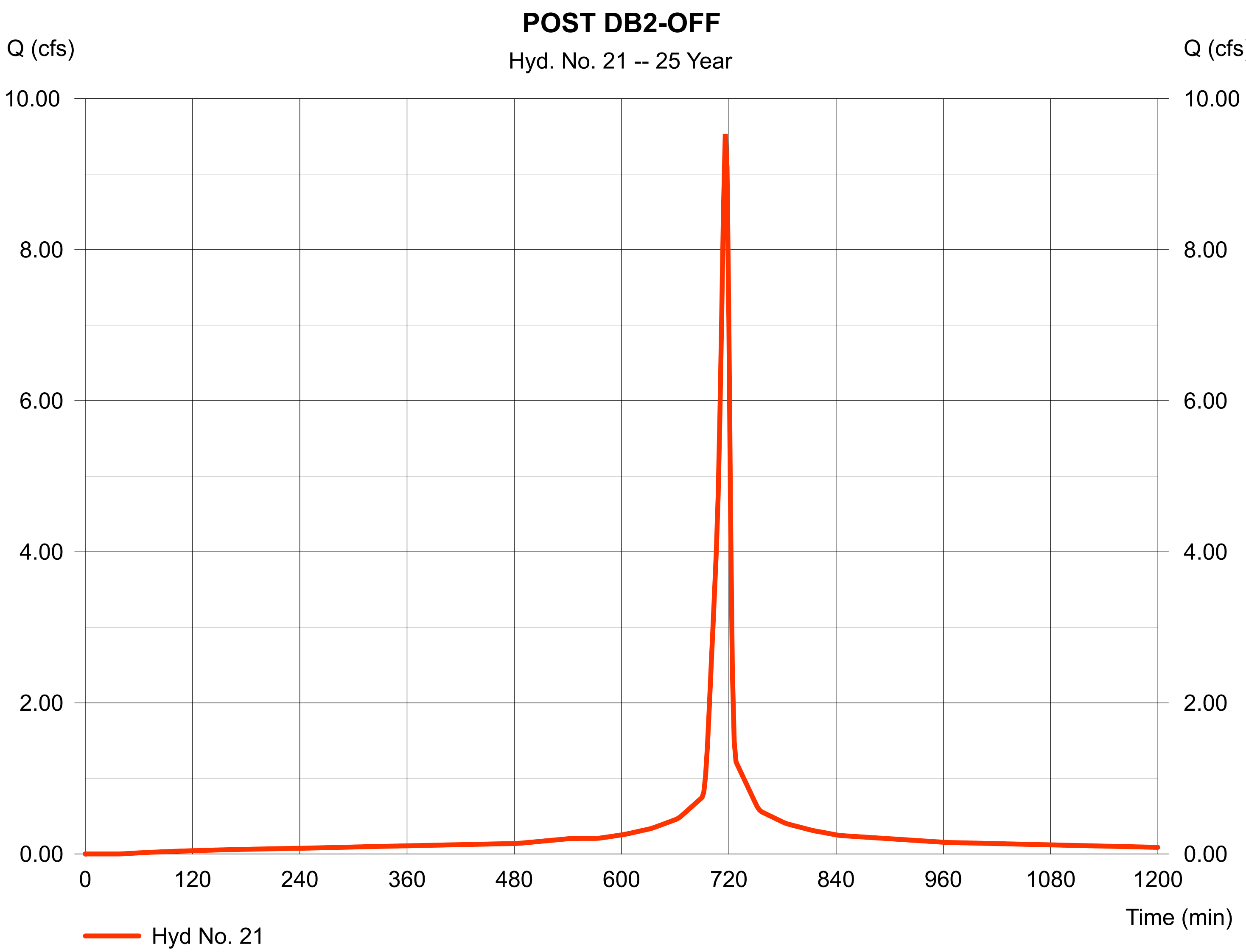
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 21

POST DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 9.531 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 22,939 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



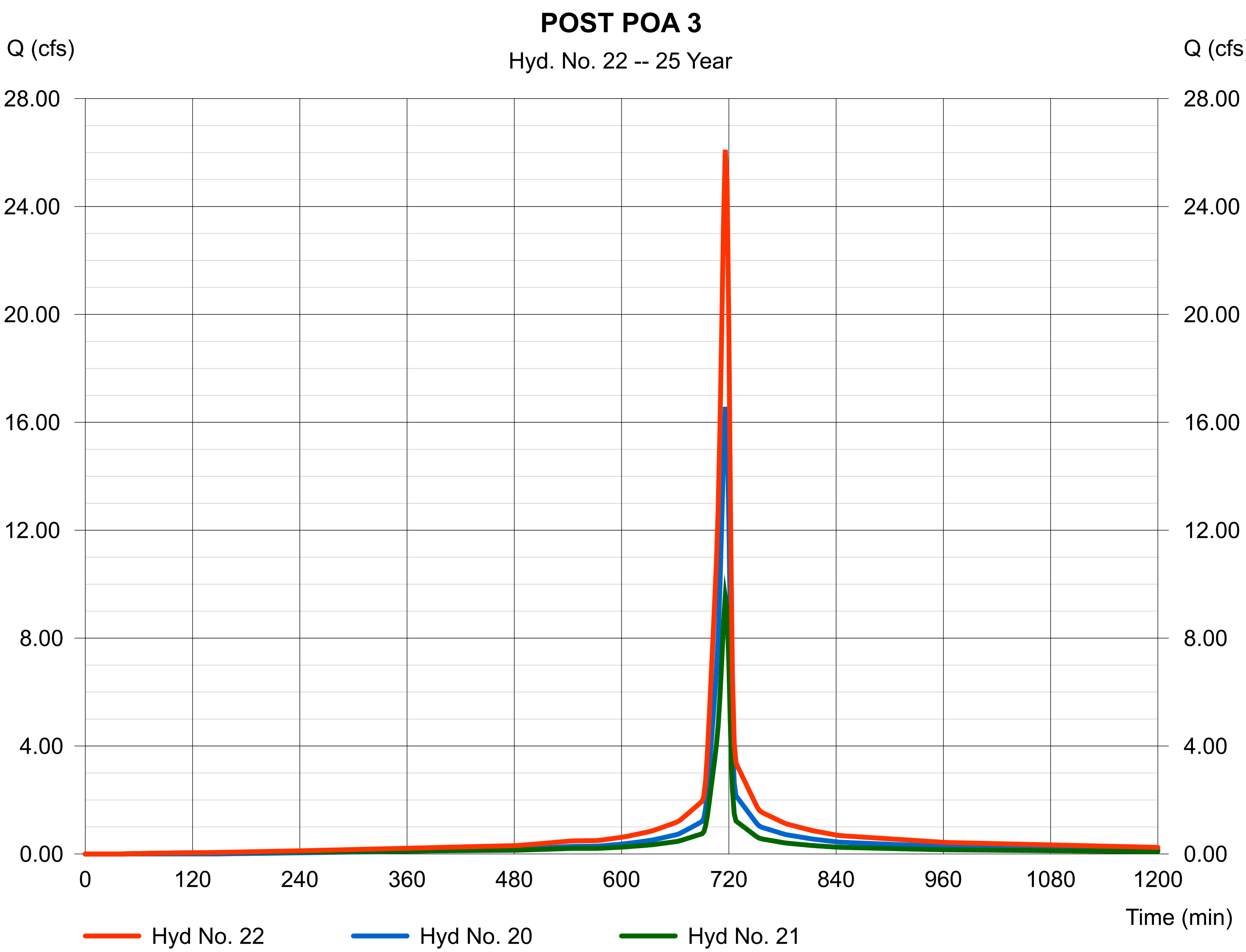
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 22

POST POA 3

Hydrograph type	= Combine	Peak discharge	= 26.10 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 59,905 cuft
Inflow hyds.	= 20, 21	Contrib. drain. area	= 3.040 ac



Hydrograph Report

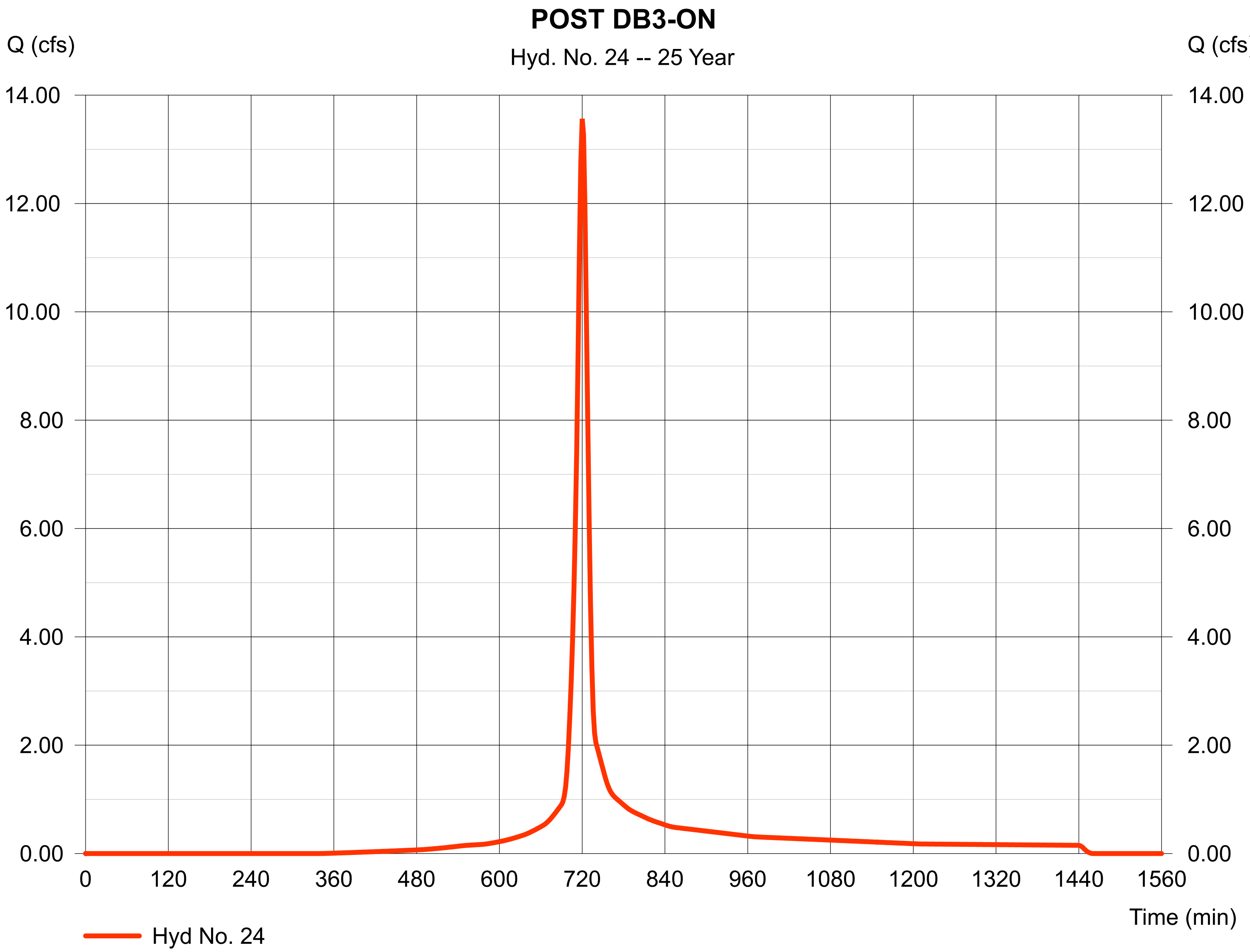
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 24

POST DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 13.56 cfs
Storm frequency	= 25 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 35,607 cuft
Drainage area	= 2.200 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (2.810 x 61) + (10.490 x 98)] / 2.200



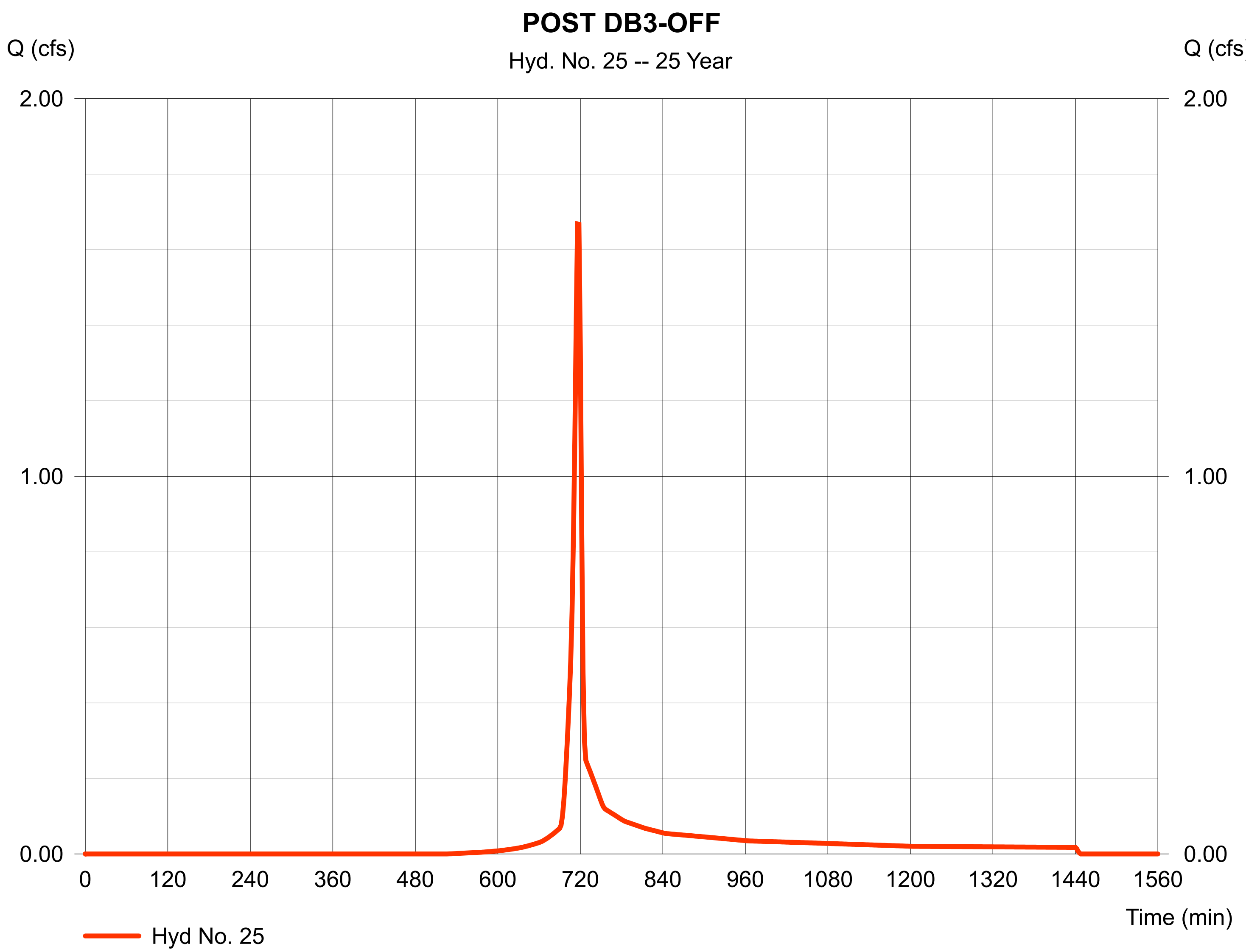
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 25

POST DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 1.668 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 3,368 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



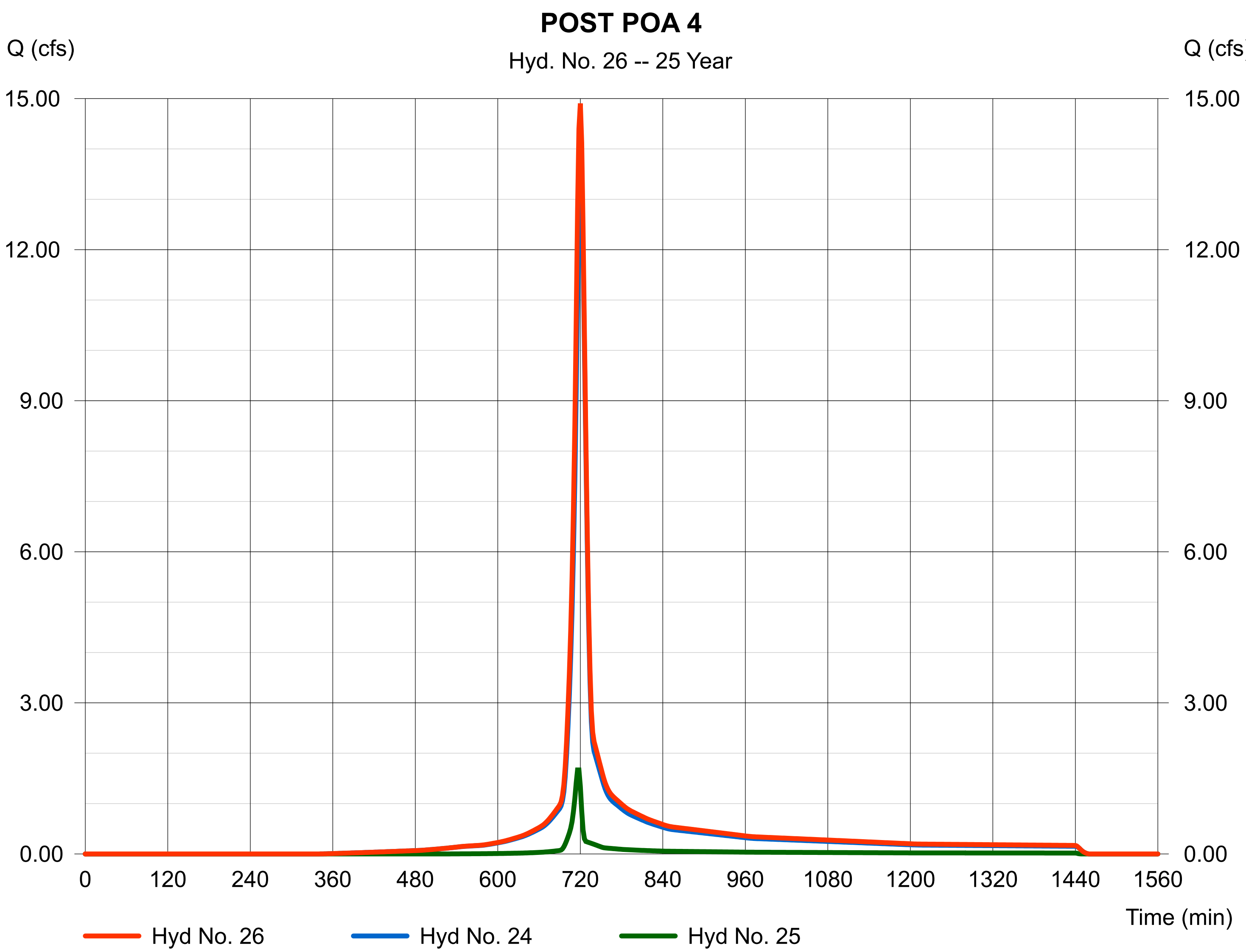
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 26

POST POA 4

Hydrograph type	= Combine	Peak discharge	= 14.90 cfs
Storm frequency	= 25 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 38,975 cuft
Inflow hyds.	= 24, 25	Contrib. drain. area	= 2.520 ac



Hydrograph Report

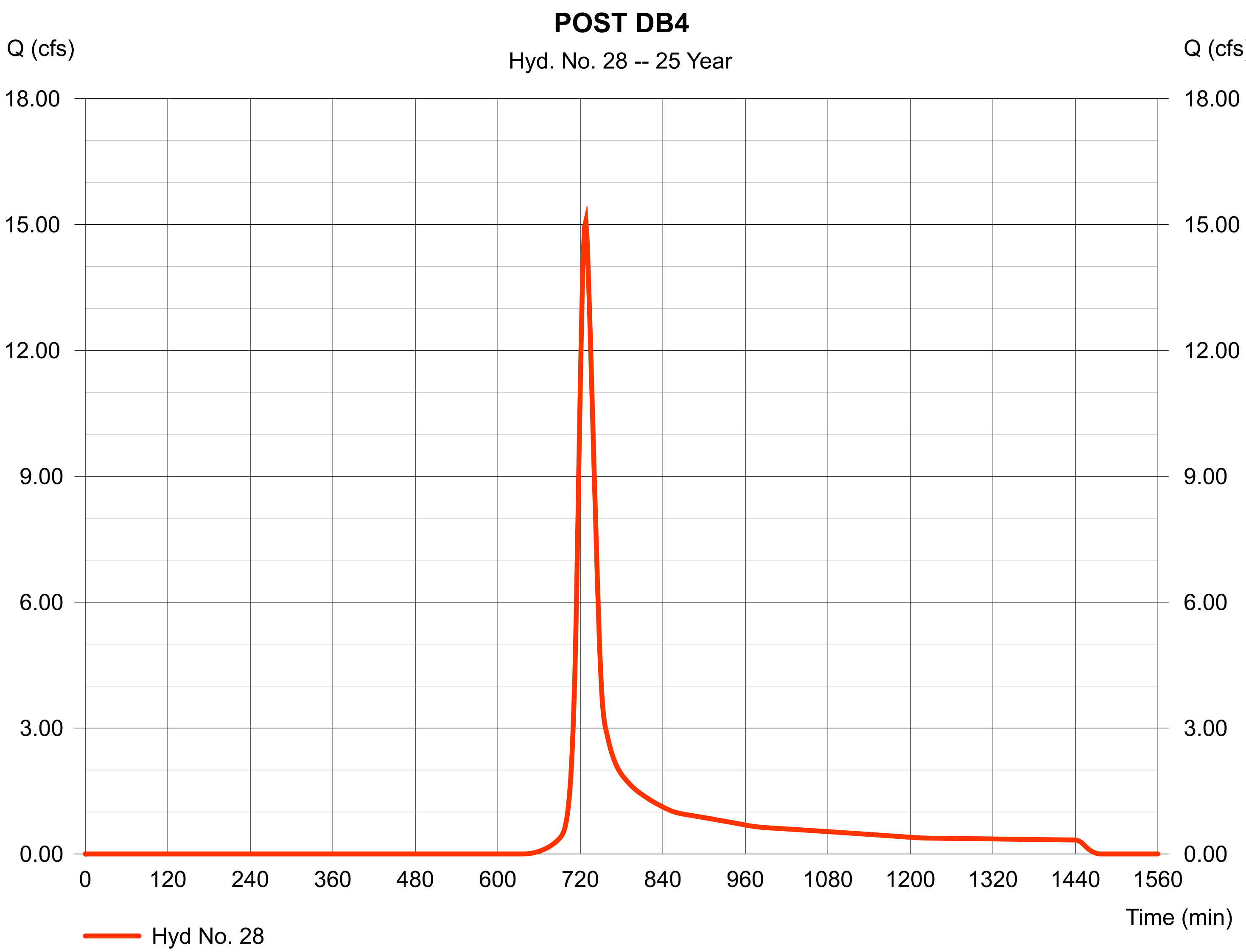
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 28

POST DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 15.08 cfs
Storm frequency	= 25 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 54,513 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.94 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.520 x 98) + (4.480 x 61)] / 6.580



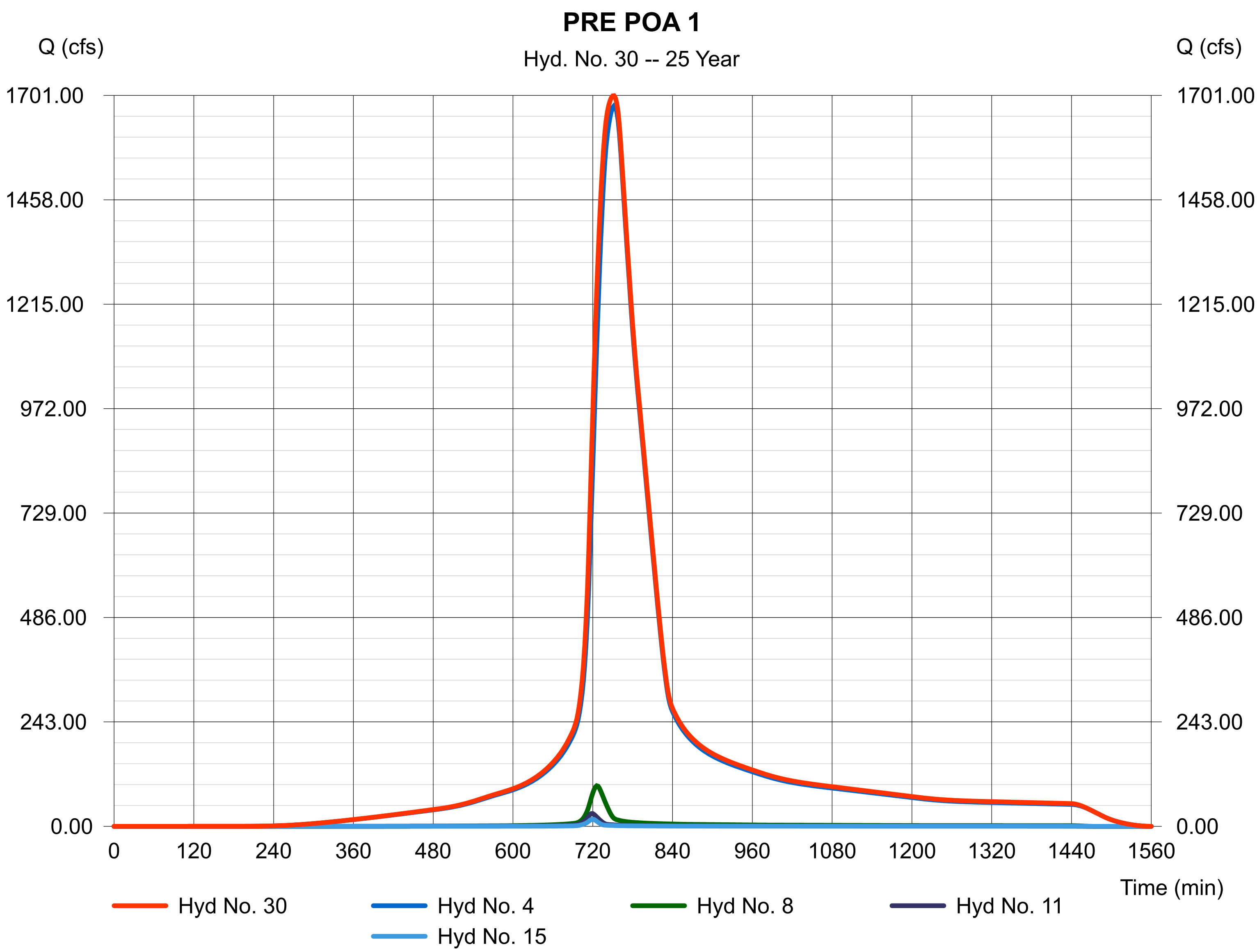
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 30

PRE POA 1

Hydrograph type	= Combine	Peak discharge	= 1700.33 cfs
Storm frequency	= 25 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 13,564,773 cuft
Inflow hyds.	= 4, 8, 11, 15	Contrib. drain. area	= 22.020 ac



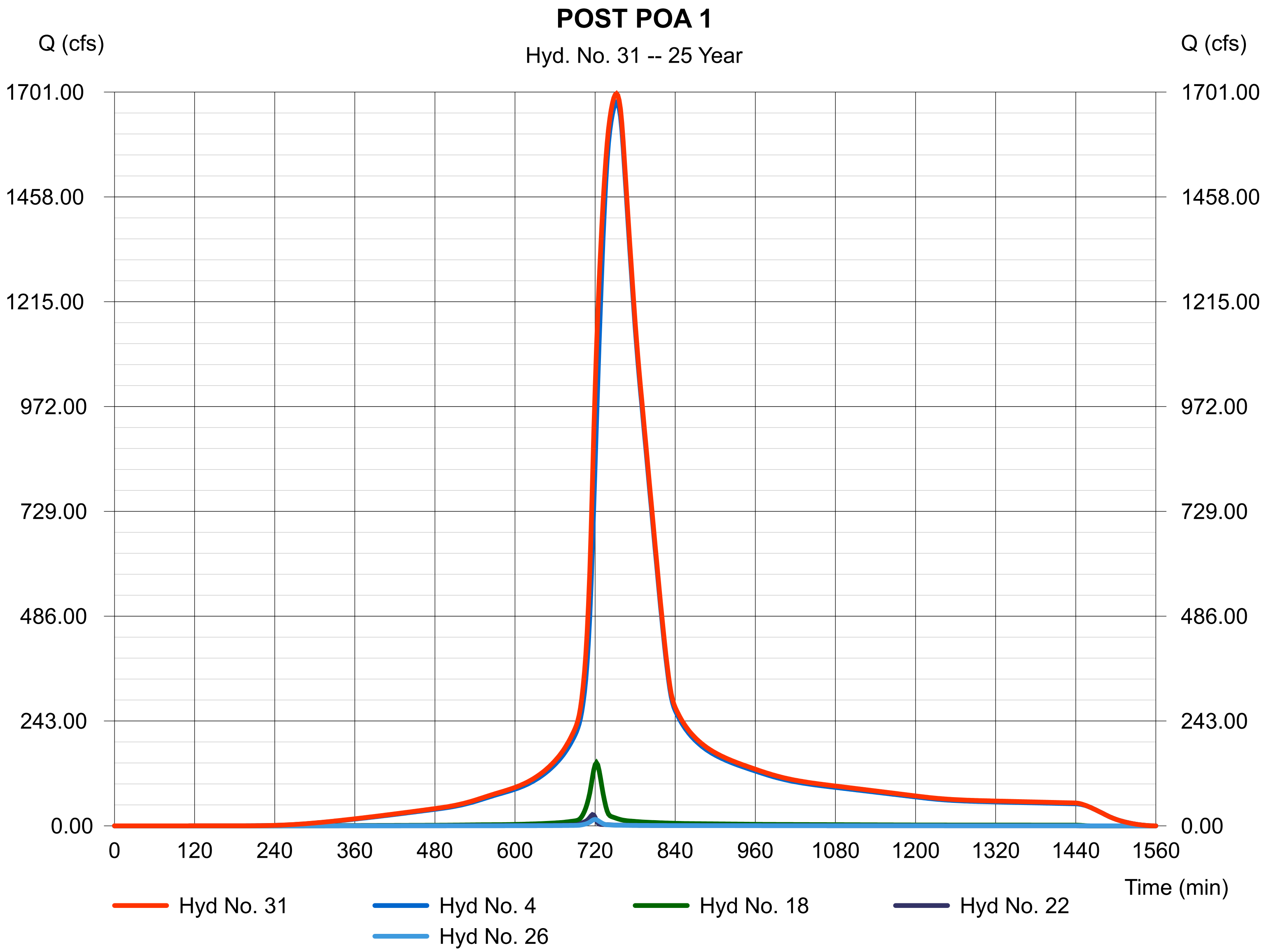
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 31

POST POA 1

Hydrograph type	= Combine	Peak discharge	= 1697.47 cfs
Storm frequency	= 25 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 13,627,783 cuft
Inflow hyds.	= 4, 18, 22, 26	Contrib. drain. area	= 24.120 ac



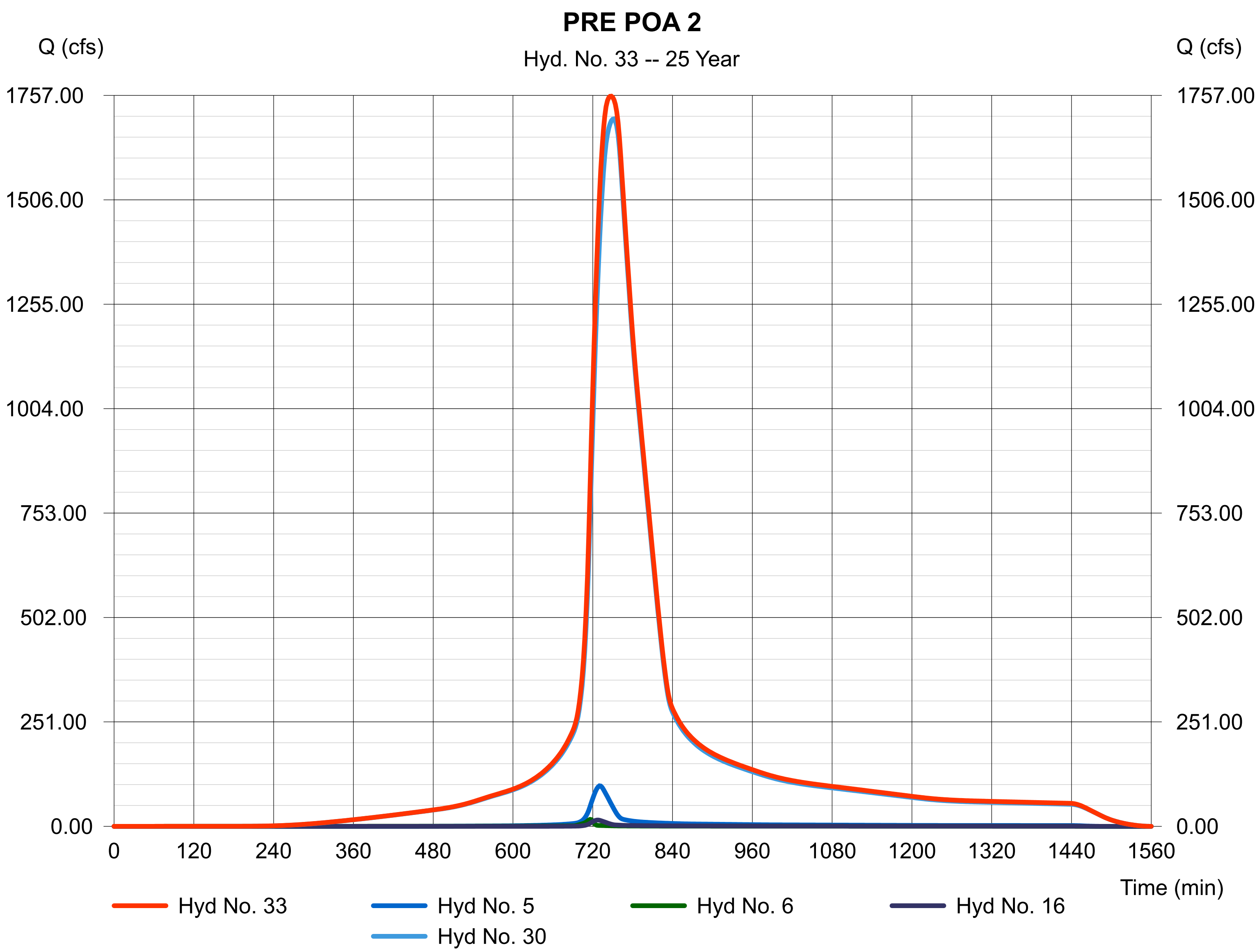
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 33

PRE POA 2

Hydrograph type	= Combine	Peak discharge	= 1755.07 cfs
Storm frequency	= 25 yrs	Time to peak	= 748 min
Time interval	= 2 min	Hyd. volume	= 14,048,604 cuft
Inflow hyds.	= 5, 6, 16, 30	Contrib. drain. area	= 37.480 ac



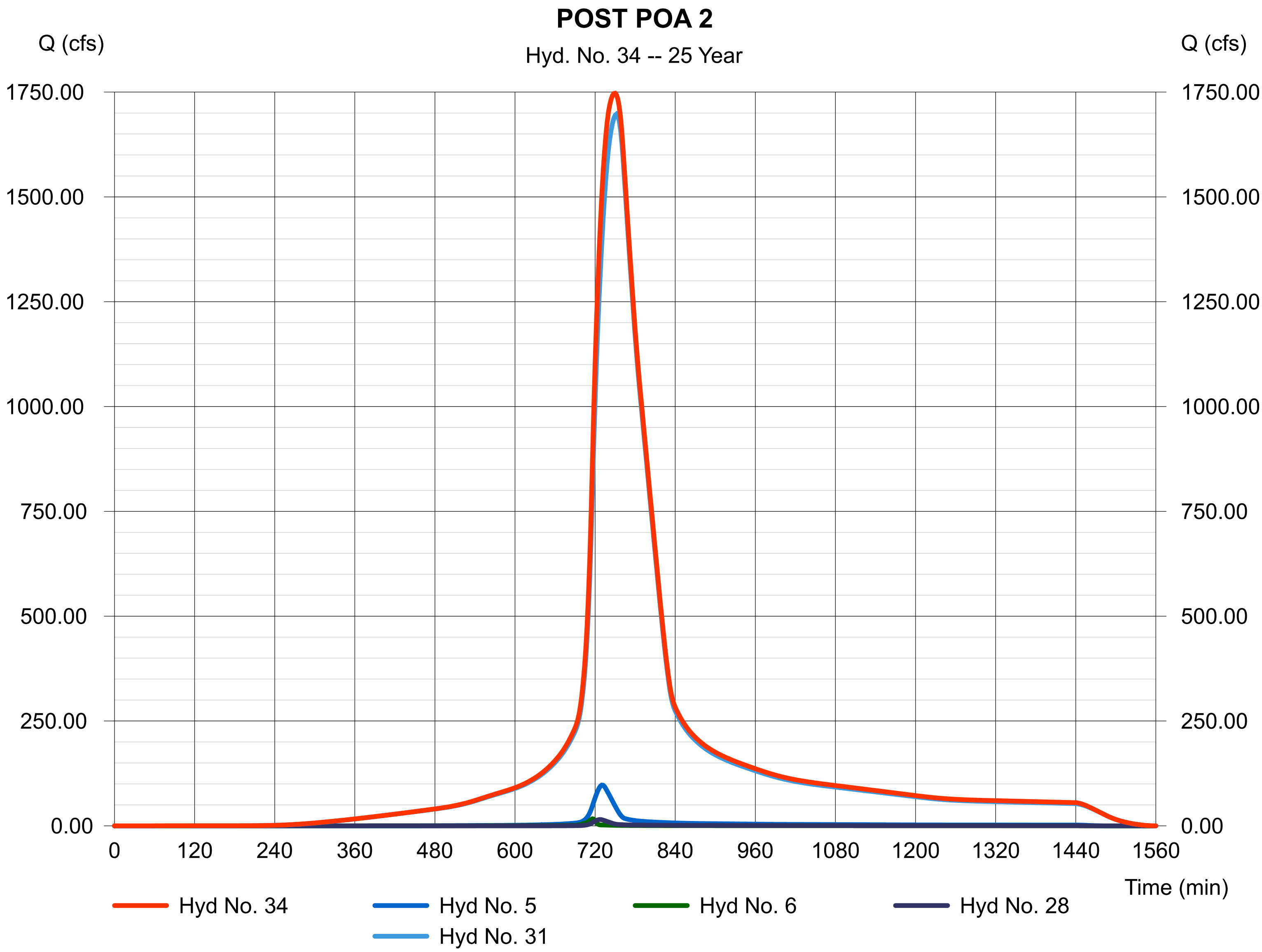
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 34

POST POA 2

Hydrograph type	= Combine	Peak discharge	= 1747.24 cfs
Storm frequency	= 25 yrs	Time to peak	= 750 min
Time interval	= 2 min	Hyd. volume	= 14,111,601 cuft
Inflow hyds.	= 5, 6, 28, 31	Contrib. drain. area	= 37.480 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	1419.74	2	758	11,131,280	------	------	------	MACRO BASIN 1
2	SCS Runoff	585.24	2	738	3,134,742	------	------	------	MACRO BASIN 2
3	SCS Runoff	145.16	2	732	632,167	------	------	------	MACRO BASIN 3
4	Combine	1896.91	2	752	14,898,198	1, 2, 3	------	------	OFF POA 1
5	SCS Runoff	113.97	2	730	455,411	------	------	------	MACRO BASIN 4
6	SCS Runoff	18.64	2	716	45,008	------	------	------	OFF BASIN 5
8	SCS Runoff	109.40	2	726	378,865	------	------	------	PRE DB1
9	SCS Runoff	26.21	2	722	77,724	------	------	------	PRE DB2-ON
10	SCS Runoff	10.60	2	716	25,583	------	------	------	PRE DB2-OFF
11	Combine	33.51	2	718	103,308	9, 10	------	------	PRE POA 3
13	SCS Runoff	17.64	2	720	46,394	------	------	------	PRE DB3-ON
14	SCS Runoff	1.982	2	716	4,006	------	------	------	PRE DB3-OFF
15	Combine	19.22	2	720	50,401	13, 14	------	------	PRE POA 4
16	SCS Runoff	18.74	2	728	66,763	------	------	------	PRE DB4
18	SCS Runoff	165.39	2	722	484,273	------	------	------	POST DB1
19	Reservoir	29.39	2	740	479,948	18	965.09	254,416	FALSE PHASE 1 VAULT
20	SCS Runoff	18.55	2	716	41,704	------	------	------	POST DB2-ON
21	SCS Runoff	10.60	2	716	25,583	------	------	------	POST DB2-OFF
22	Combine	29.15	2	716	67,287	20, 21	------	------	POST POA 3
24	SCS Runoff	15.58	2	720	41,107	------	------	------	POST DB3-ON
25	SCS Runoff	1.982	2	716	4,006	------	------	------	POST DB3-OFF
26	Combine	17.15	2	720	45,113	24, 25	------	------	POST POA 4
28	SCS Runoff	18.74	2	728	66,763	------	------	------	POST DB4
30	Combine	1923.93	2	750	15,430,765	4, 8, 11, 15,	------	------	PRE POA 1
31	Combine	1920.21	2	752	15,494,862	4, 18, 22, 26,	------	------	POST POA 1
33	Combine	1989.38	2	746	15,997,950	5, 6, 16, 30,	------	------	PRE POA 2
34	Combine	1978.64	2	748	16,062,049	5, 6, 28, 31,	------	------	POST POA 2

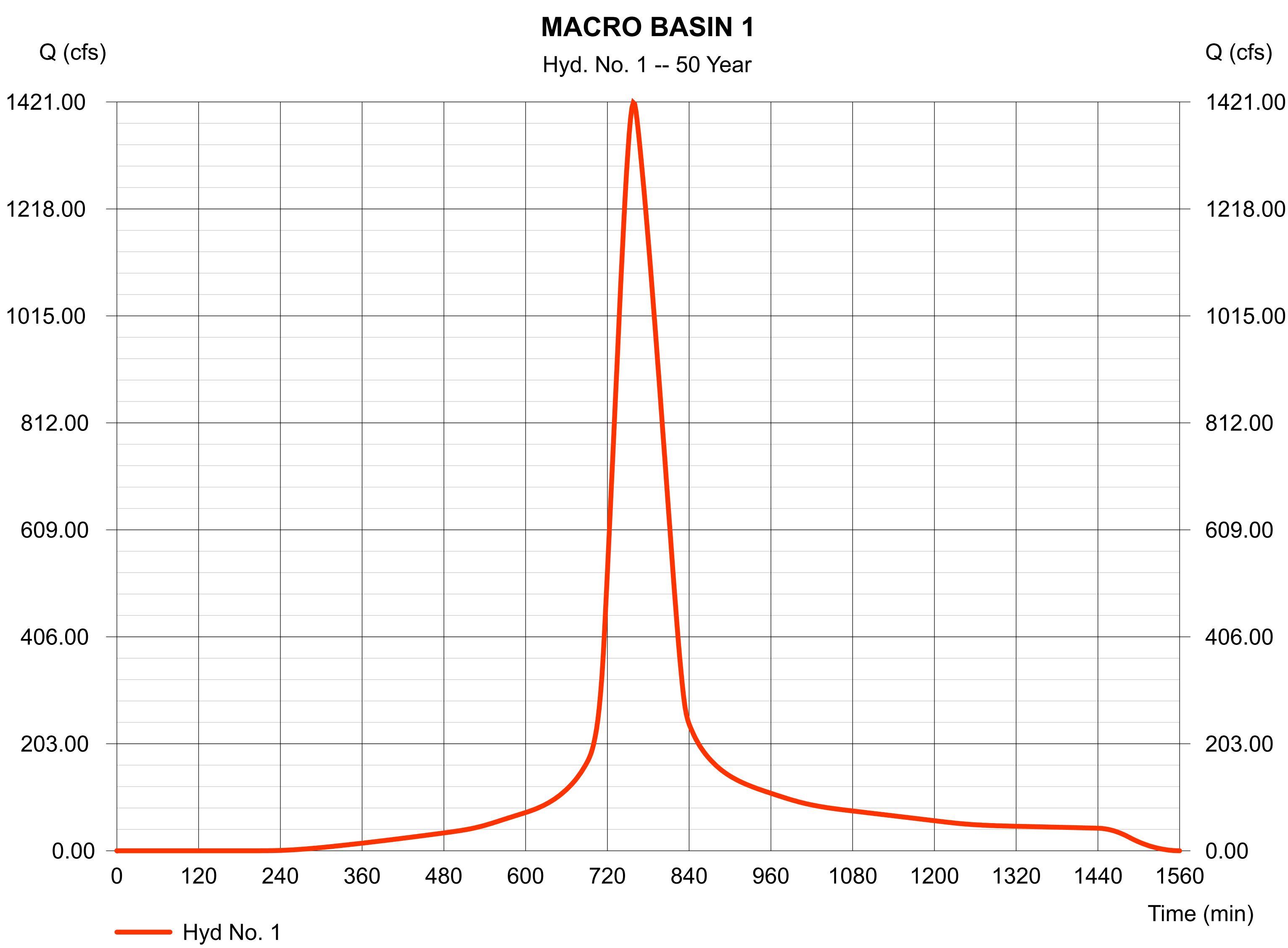
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 1

MACRO BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 1419.74 cfs
Storm frequency	= 50 yrs	Time to peak	= 758 min
Time interval	= 2 min	Hyd. volume	= 11,131,280 cuft
Drainage area	= 532.700 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 76.90 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



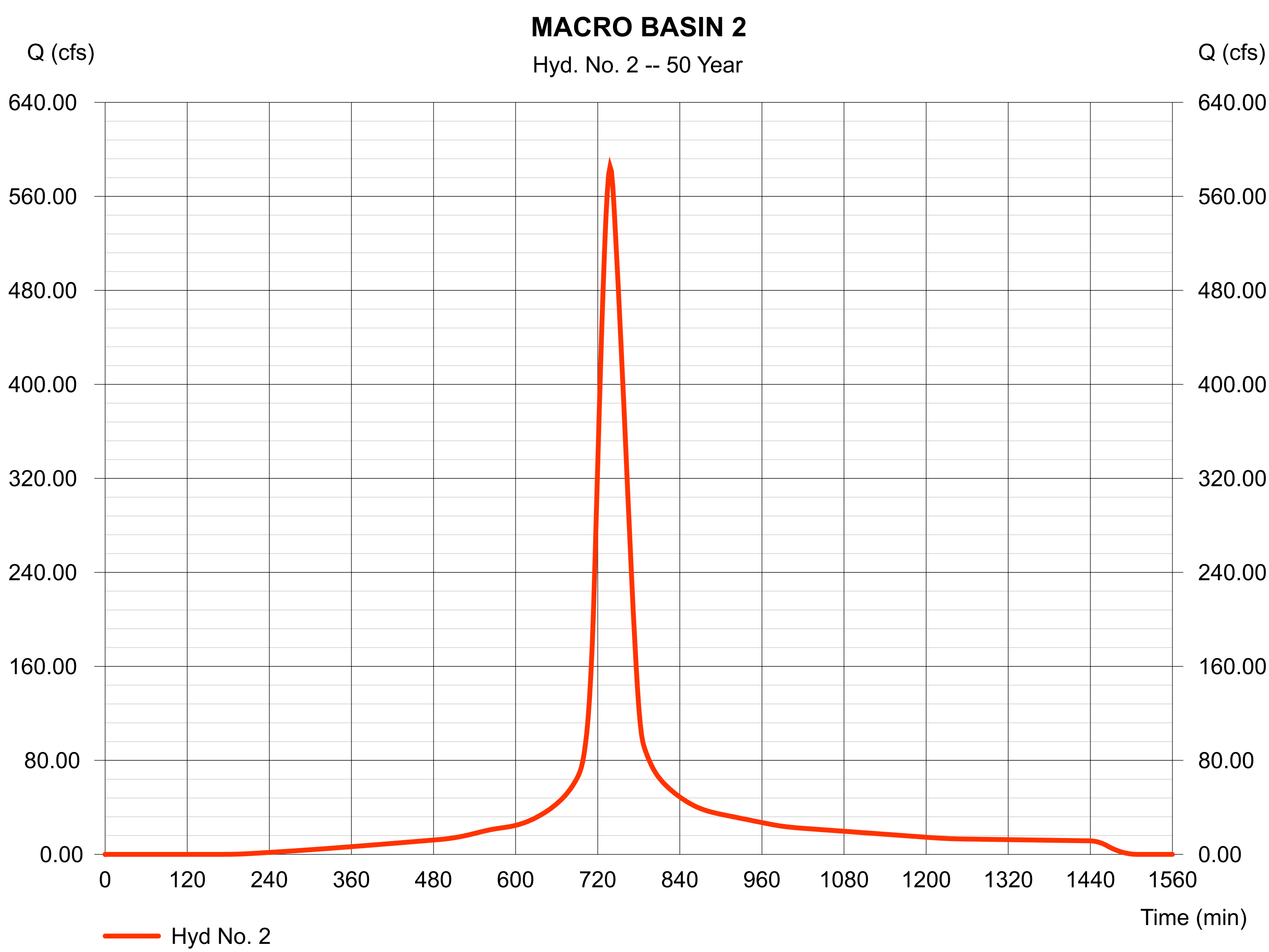
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 2

MACRO BASIN 2

Hydrograph type	= SCS Runoff	Peak discharge	= 585.24 cfs
Storm frequency	= 50 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 3,134,742 cuft
Drainage area	= 142.100 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 42.00 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



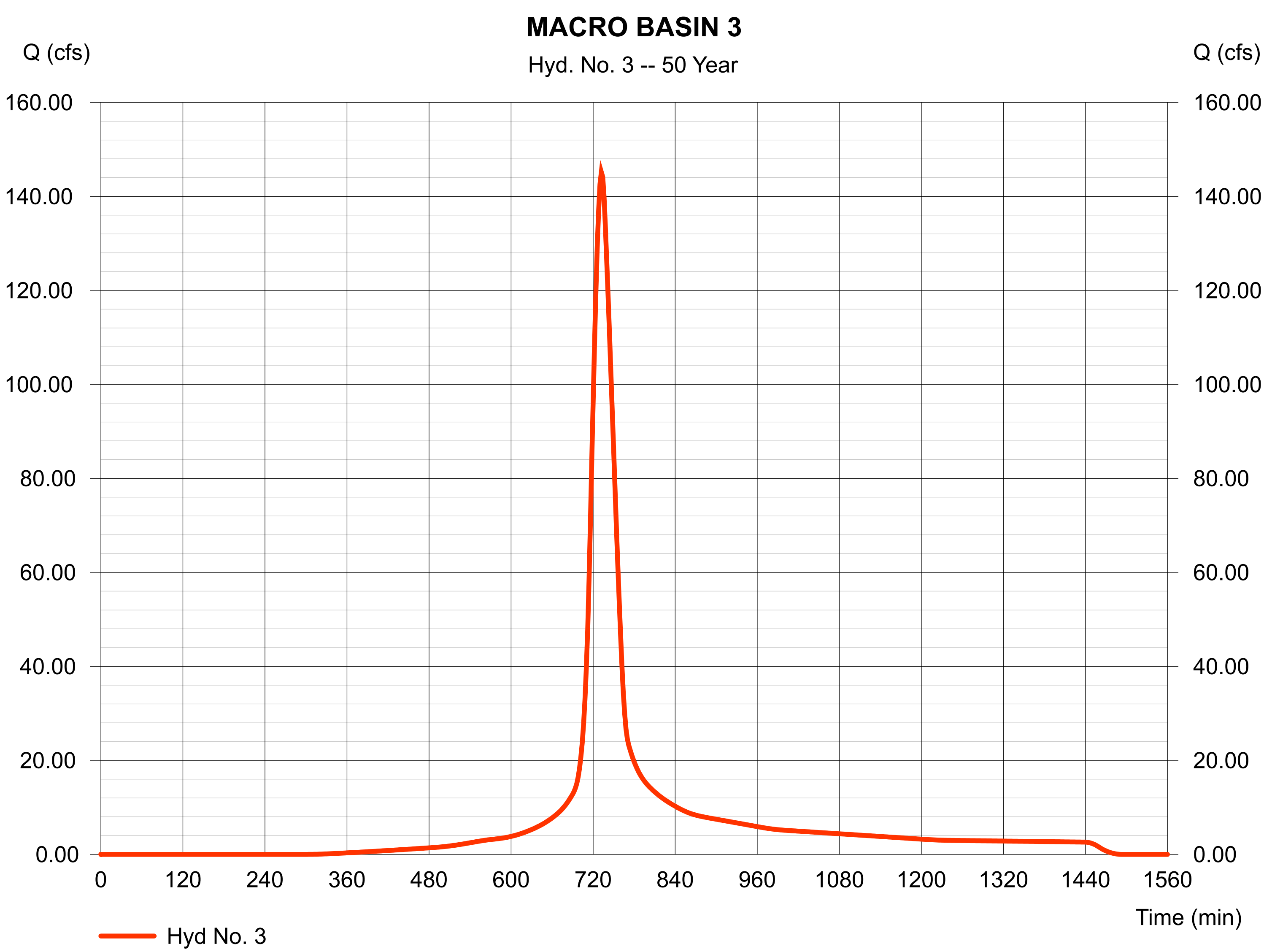
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 3

MACRO BASIN 3

Hydrograph type	= SCS Runoff	Peak discharge	= 145.16 cfs
Storm frequency	= 50 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 632,167 cuft
Drainage area	= 33.700 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 31.50 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



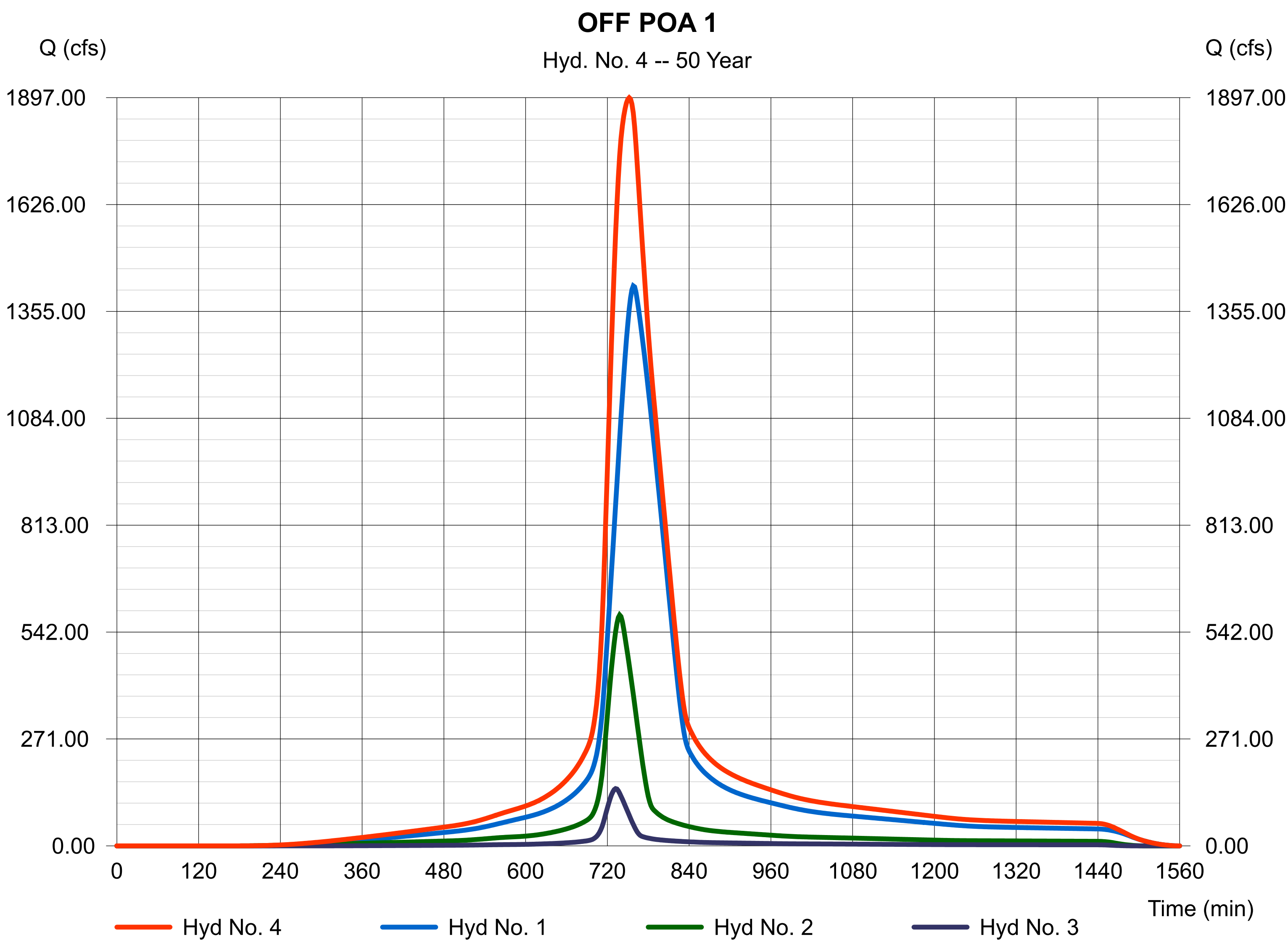
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 4

OFF POA 1

Hydrograph type	= Combine	Peak discharge	= 1896.91 cfs
Storm frequency	= 50 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 14,898,198 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 708.500 ac



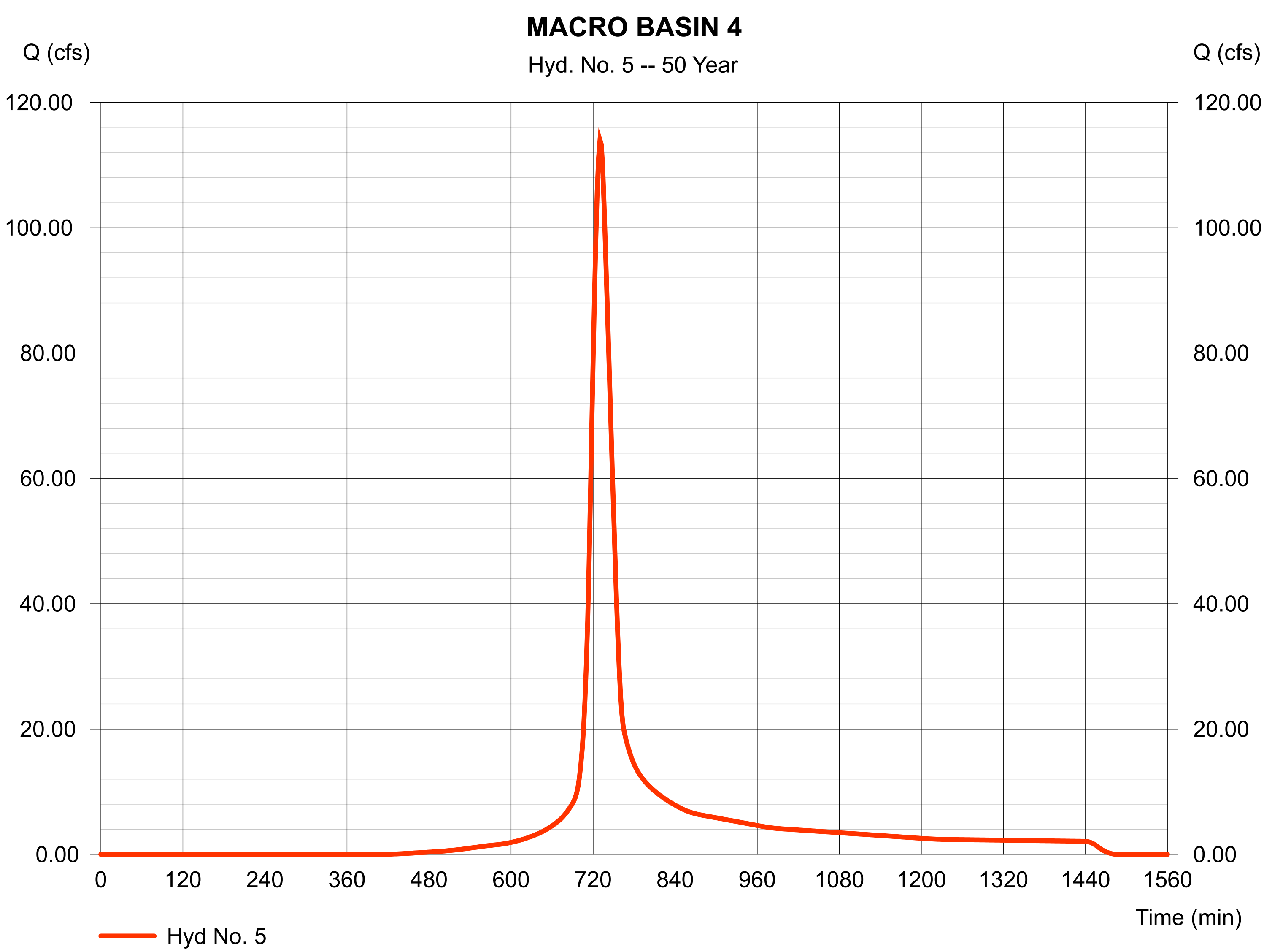
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 5

MACRO BASIN 4

Hydrograph type	= SCS Runoff	Peak discharge	= 113.97 cfs
Storm frequency	= 50 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 455,411 cuft
Drainage area	= 29.000 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 27.10 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



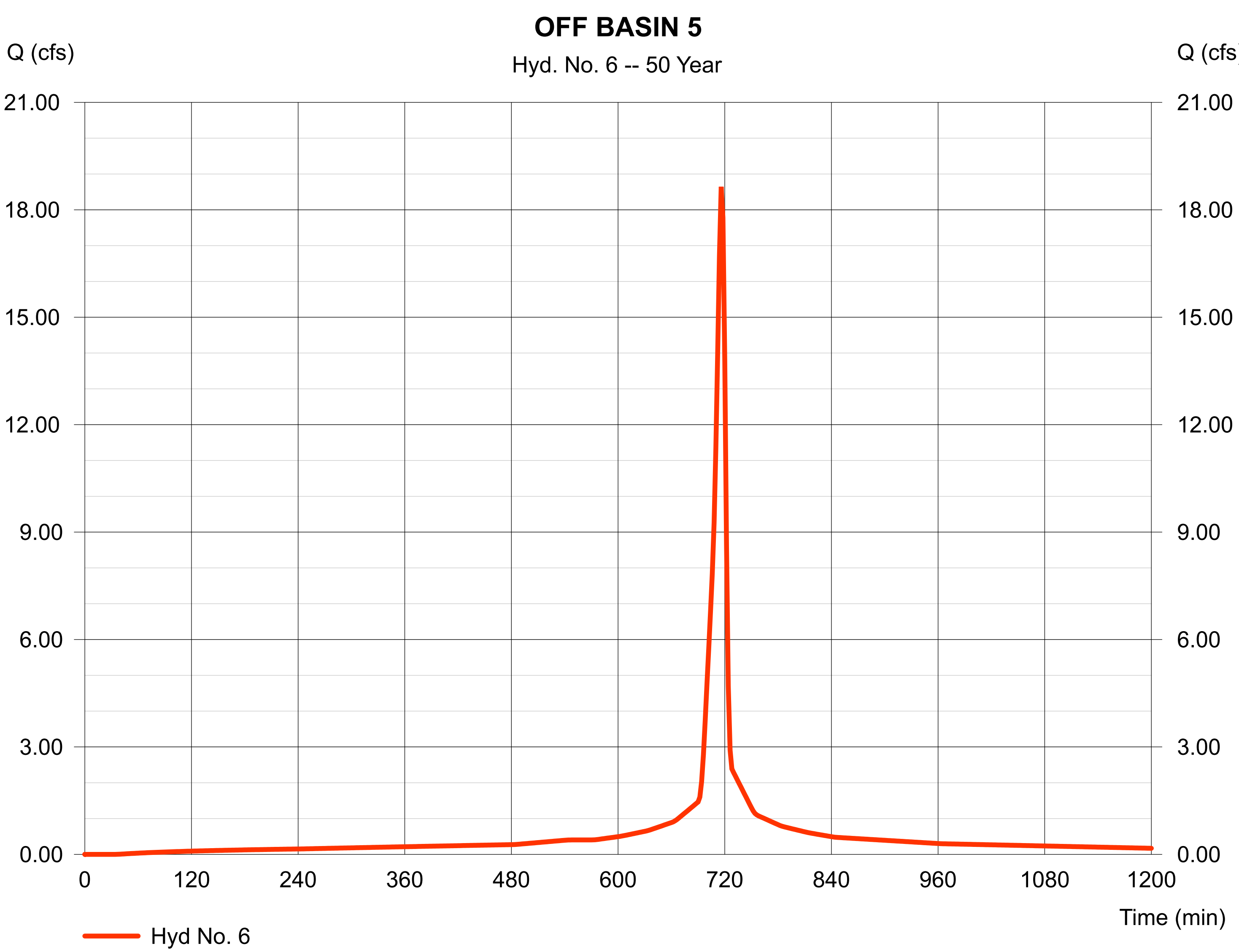
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 6

OFF BASIN 5

Hydrograph type	= SCS Runoff	Peak discharge	= 18.64 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 45,008 cuft
Drainage area	= 1.900 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

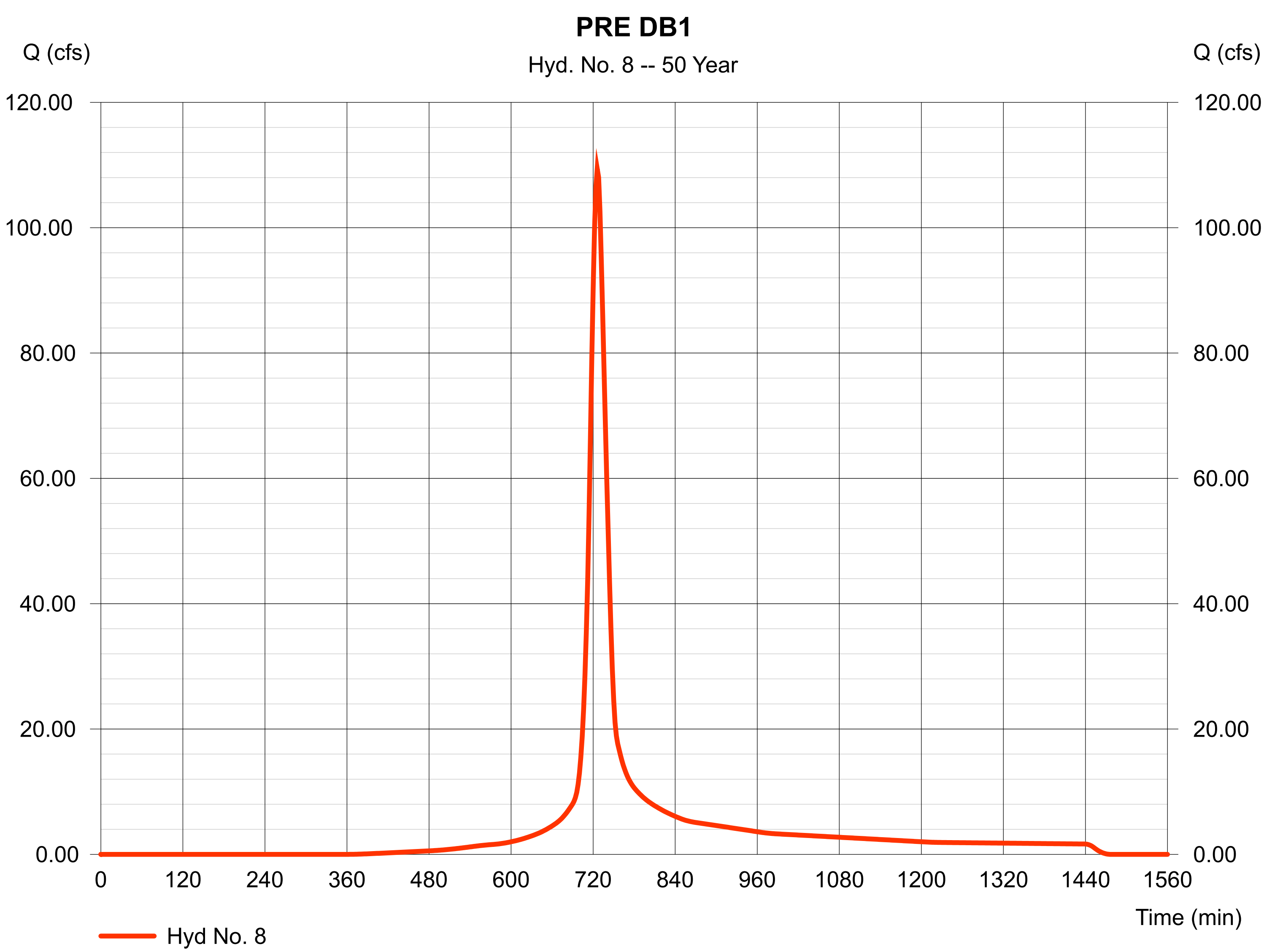
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 8

PRE DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 109.40 cfs
Storm frequency	= 50 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 378,865 cuft
Drainage area	= 22.020 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 20.73 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 22.020



Hydrograph Report

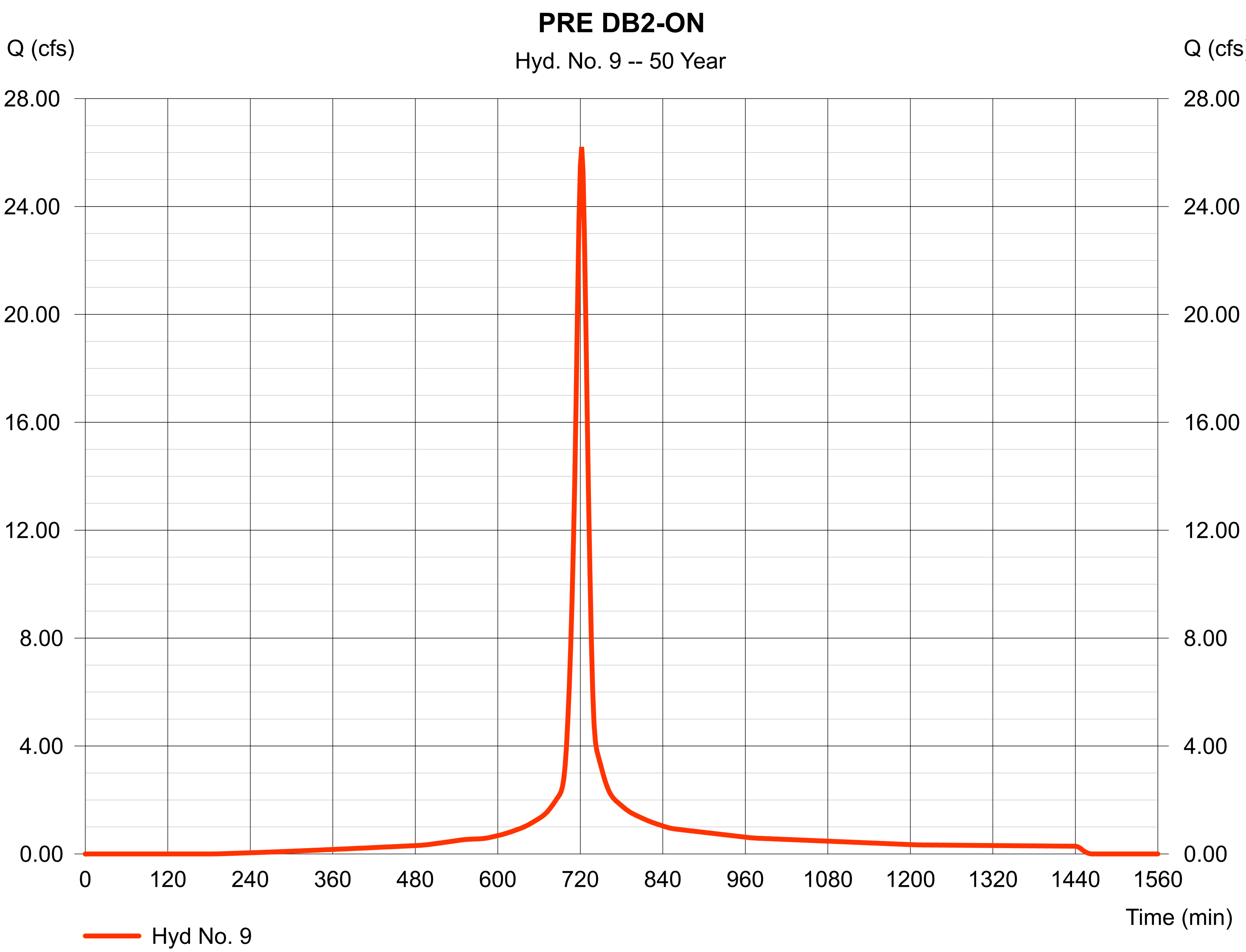
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 9

PRE DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 26.21 cfs
Storm frequency	= 50 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 77,724 cuft
Drainage area	= 3.720 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.33 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 3.720



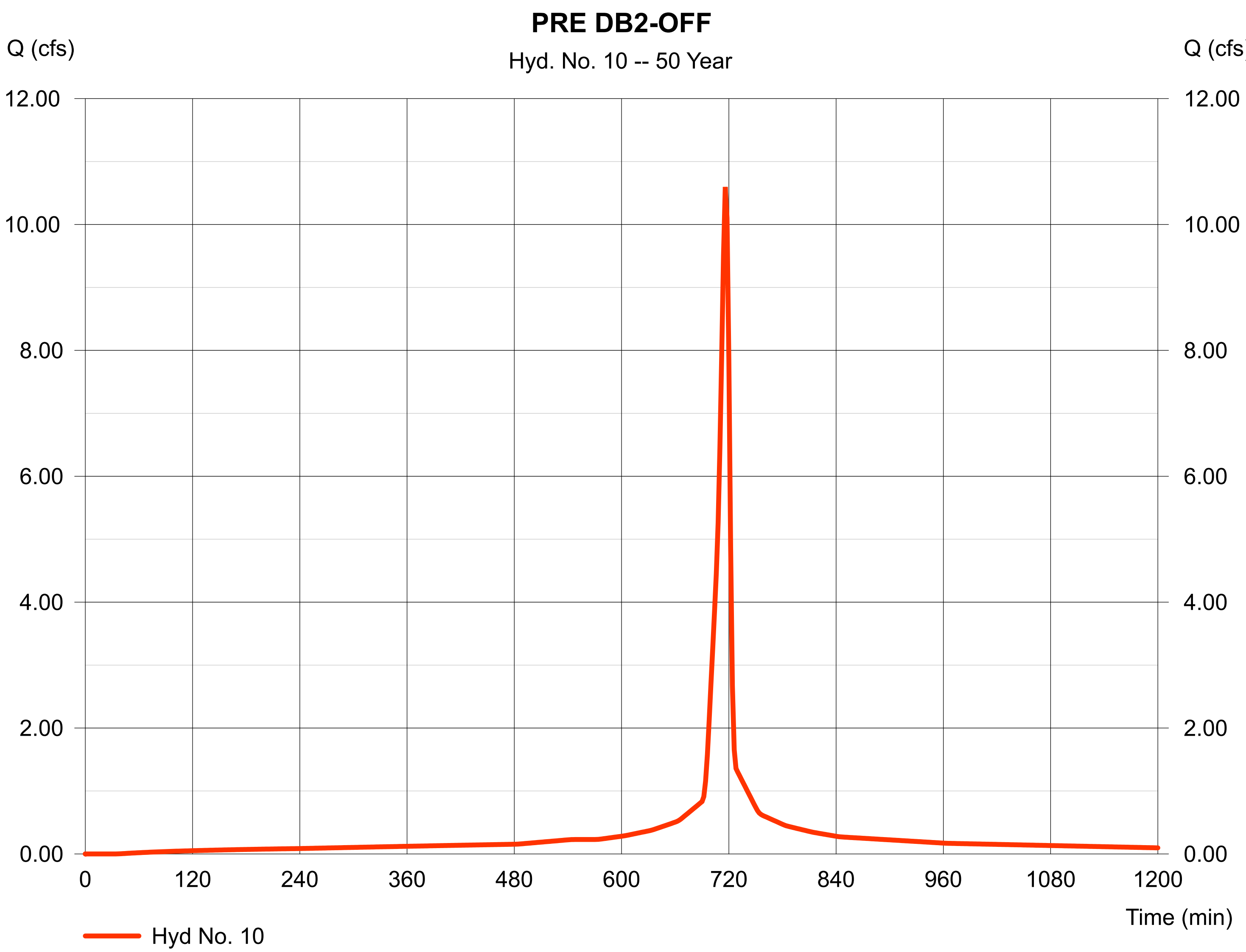
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 10

PRE DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 10.60 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 25,583 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



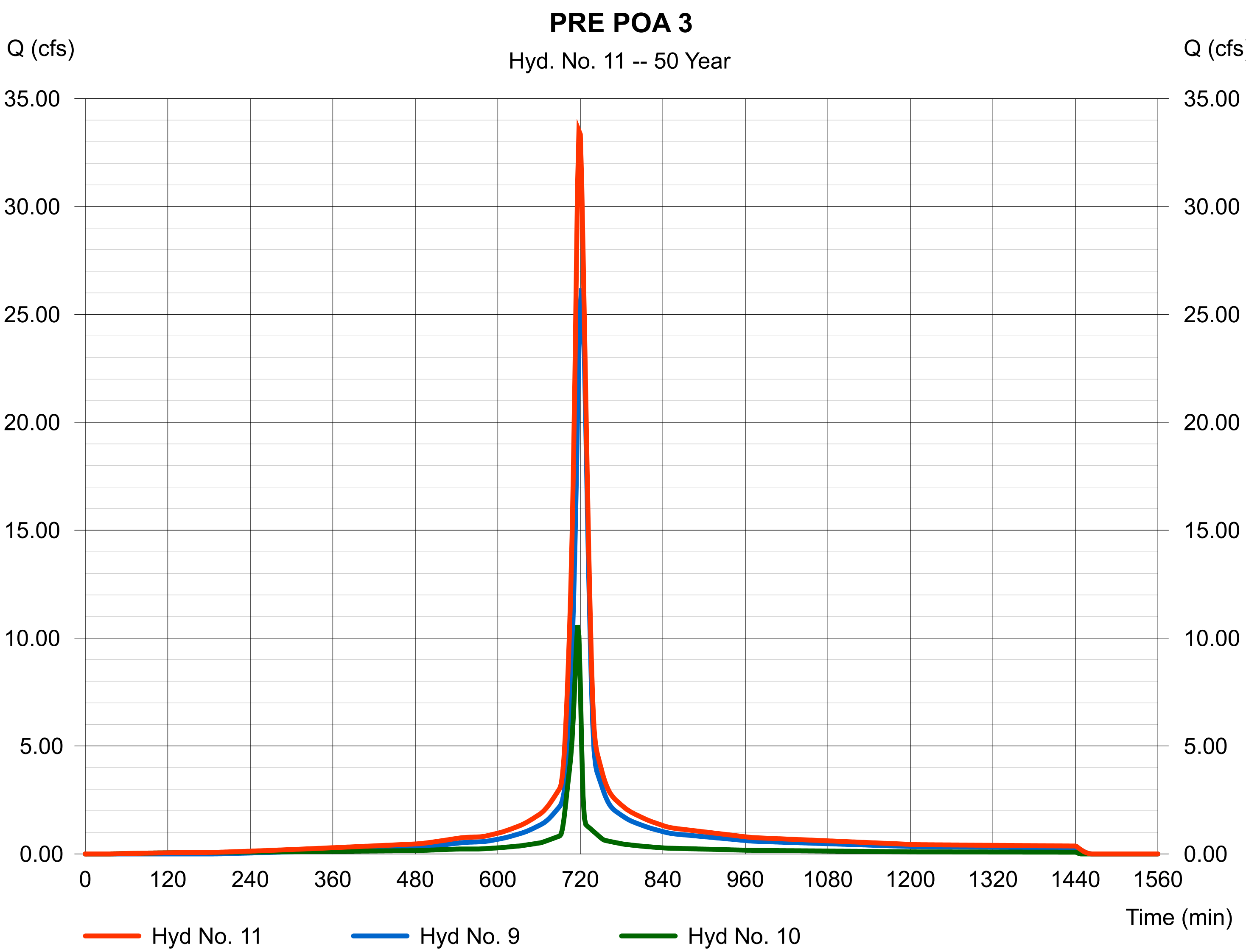
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 11

PRE POA 3

Hydrograph type	= Combine	Peak discharge	= 33.51 cfs
Storm frequency	= 50 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 103,308 cuft
Inflow hyds.	= 9, 10	Contrib. drain. area	= 4.800 ac



Hydrograph Report

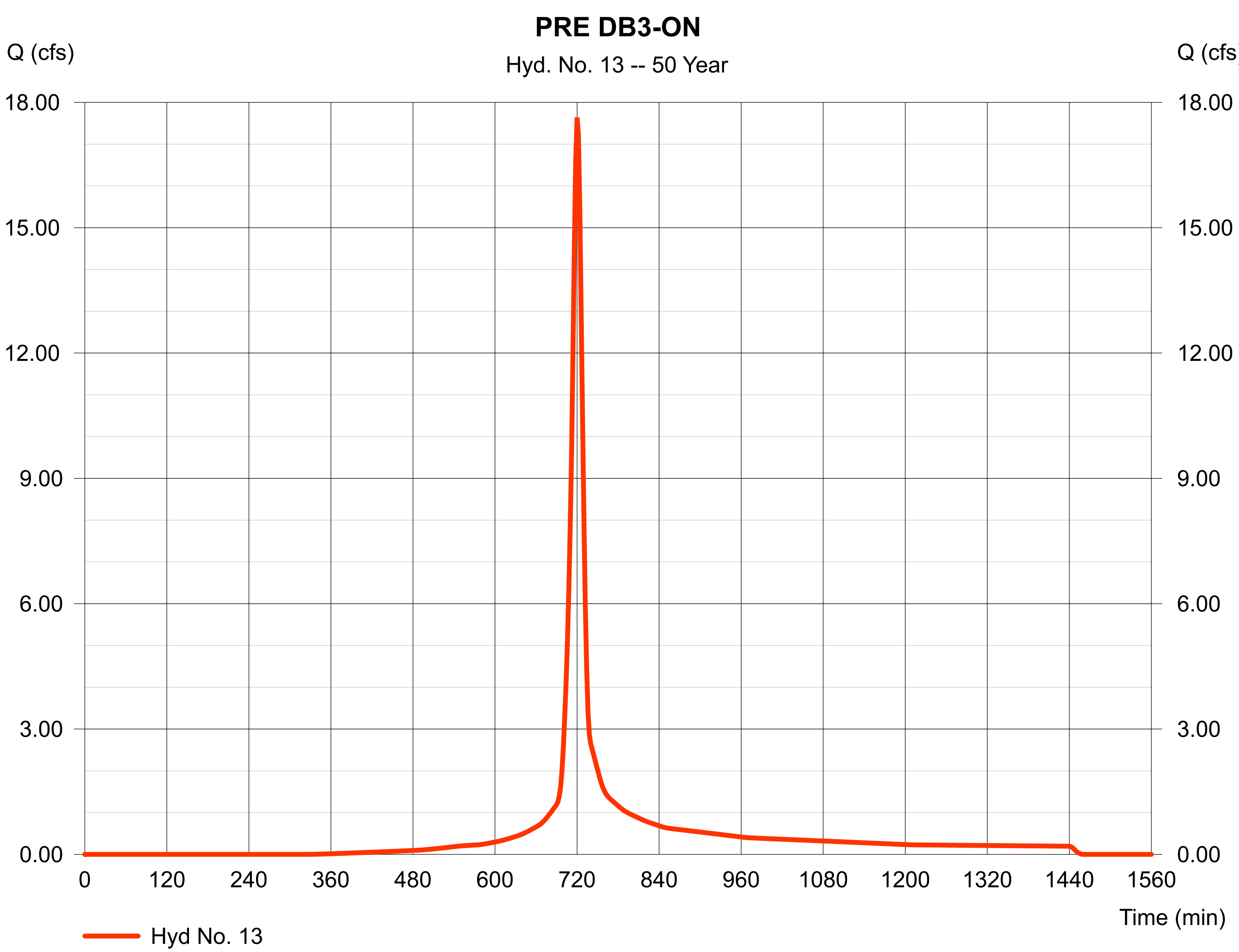
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 13

PRE DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 17.64 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 46,394 cuft
Drainage area	= 2.540 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 55) + (0.570 x 61) + (2.130 x 98)] / 2.540



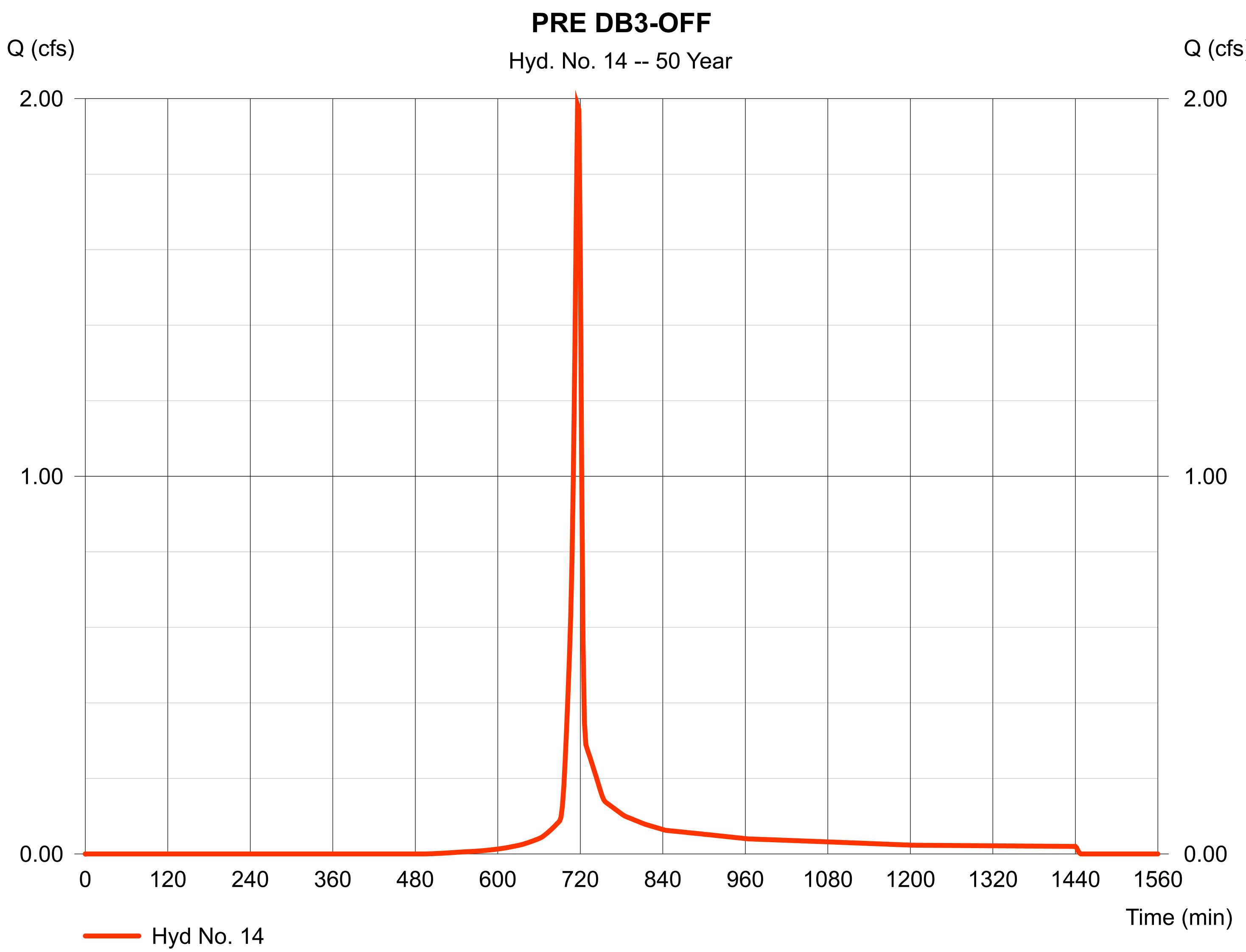
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 14

PRE DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 1.982 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 4,006 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



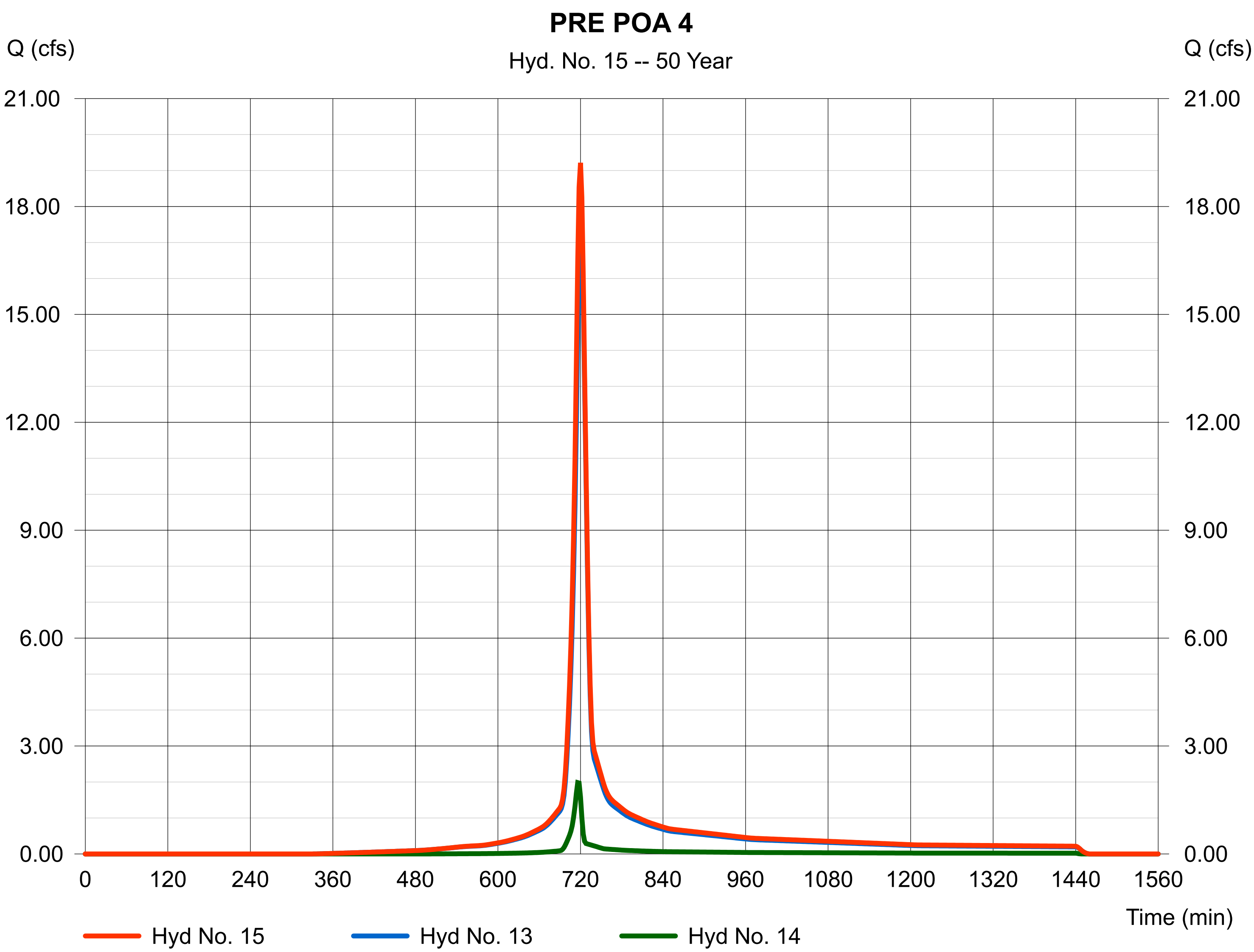
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 15

PRE POA 4

Hydrograph type	= Combine	Peak discharge	= 19.22 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 50,401 cuft
Inflow hyds.	= 13, 14	Contrib. drain. area	= 2.860 ac



Hydrograph Report

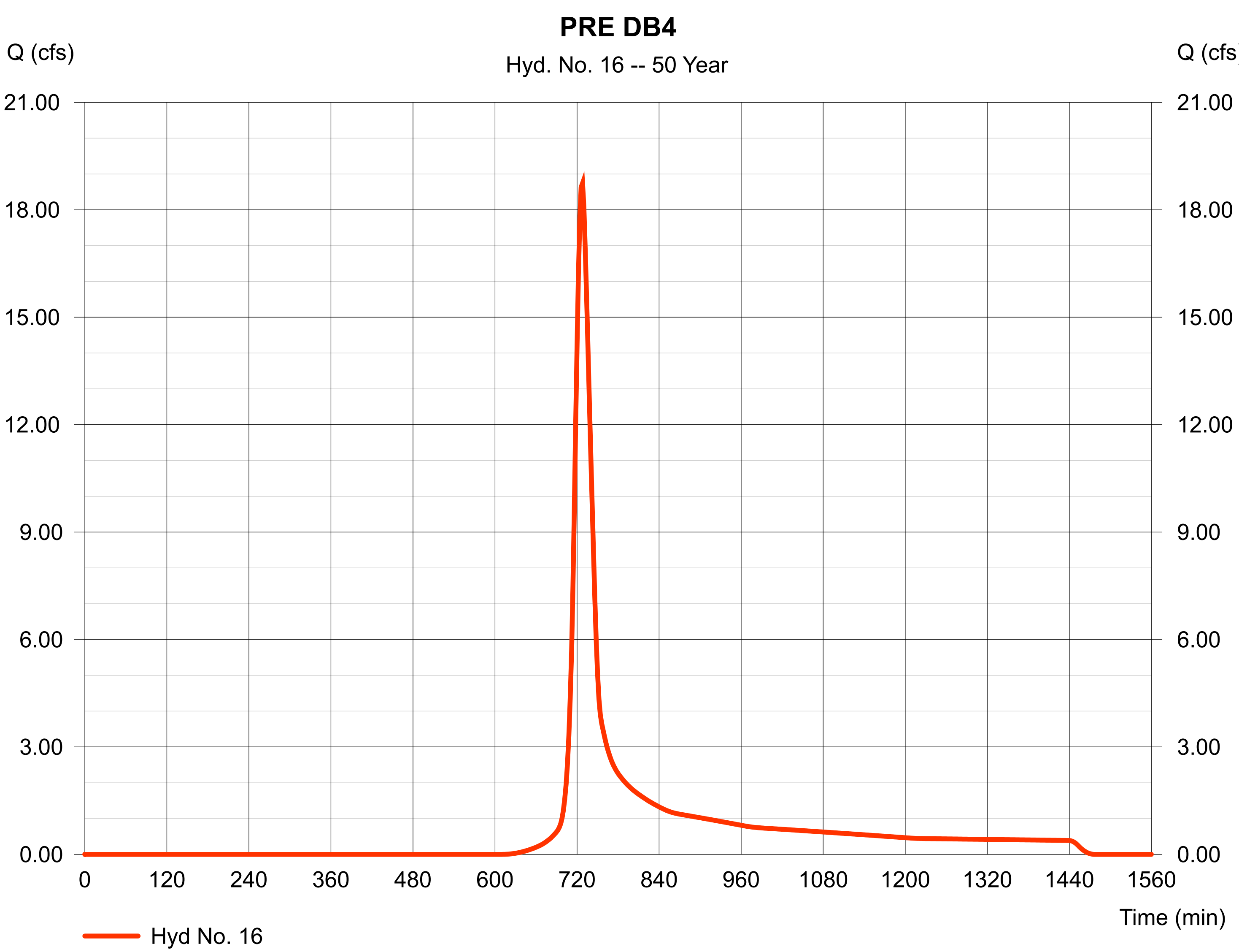
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 16

PRE DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 18.74 cfs
Storm frequency	= 50 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 66,763 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.12 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.160 x 61) + (1.840 x 55)] / 6.580



Hydrograph Report

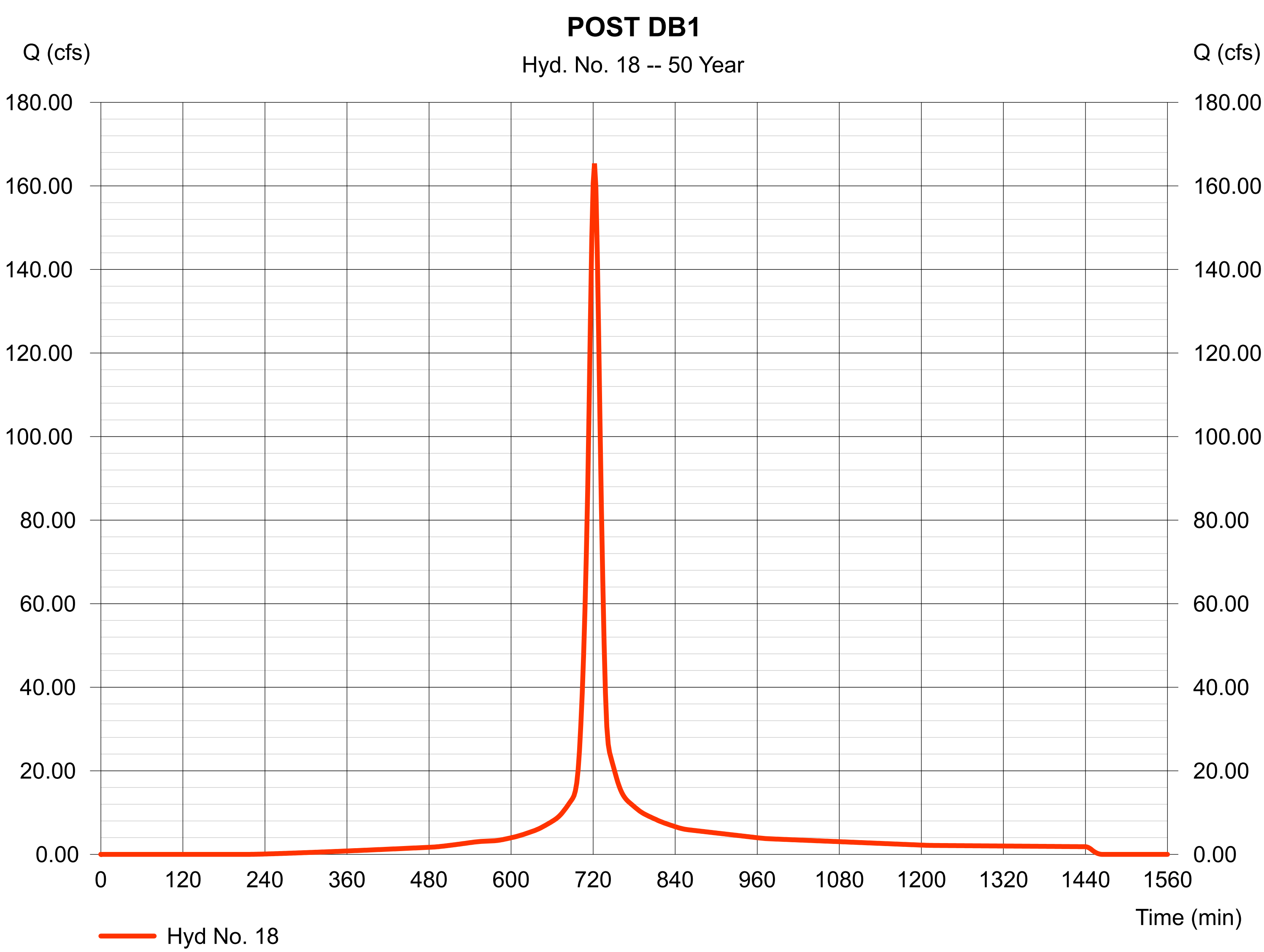
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 18

POST DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 165.39 cfs
Storm frequency	= 50 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 484,273 cuft
Drainage area	= 24.120 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.62 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 98) + (0.310 x 55) + (0.510 x 61)] / 24.120



Hydrograph Report

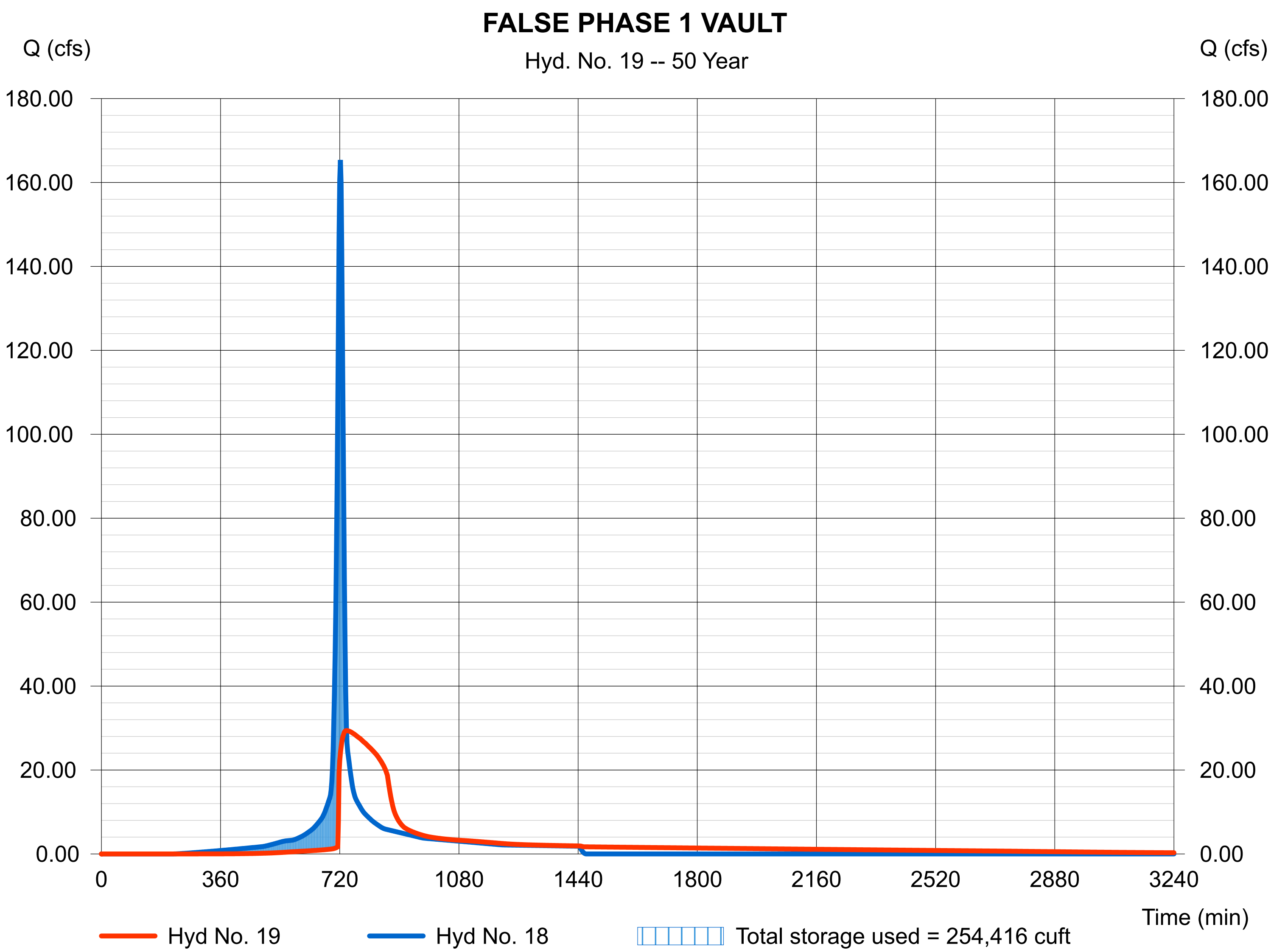
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 19

FALSE PHASE 1 VAULT

Hydrograph type	= Reservoir	Peak discharge	= 29.39 cfs
Storm frequency	= 50 yrs	Time to peak	= 740 min
Time interval	= 2 min	Hyd. volume	= 479,948 cuft
Inflow hyd. No.	= 18 - POST DB1	Max. Elevation	= 965.09 ft
Reservoir name	= FALSE POND	Max. Storage	= 254,416 cuft

Storage Indication method used.



Hydrograph Report

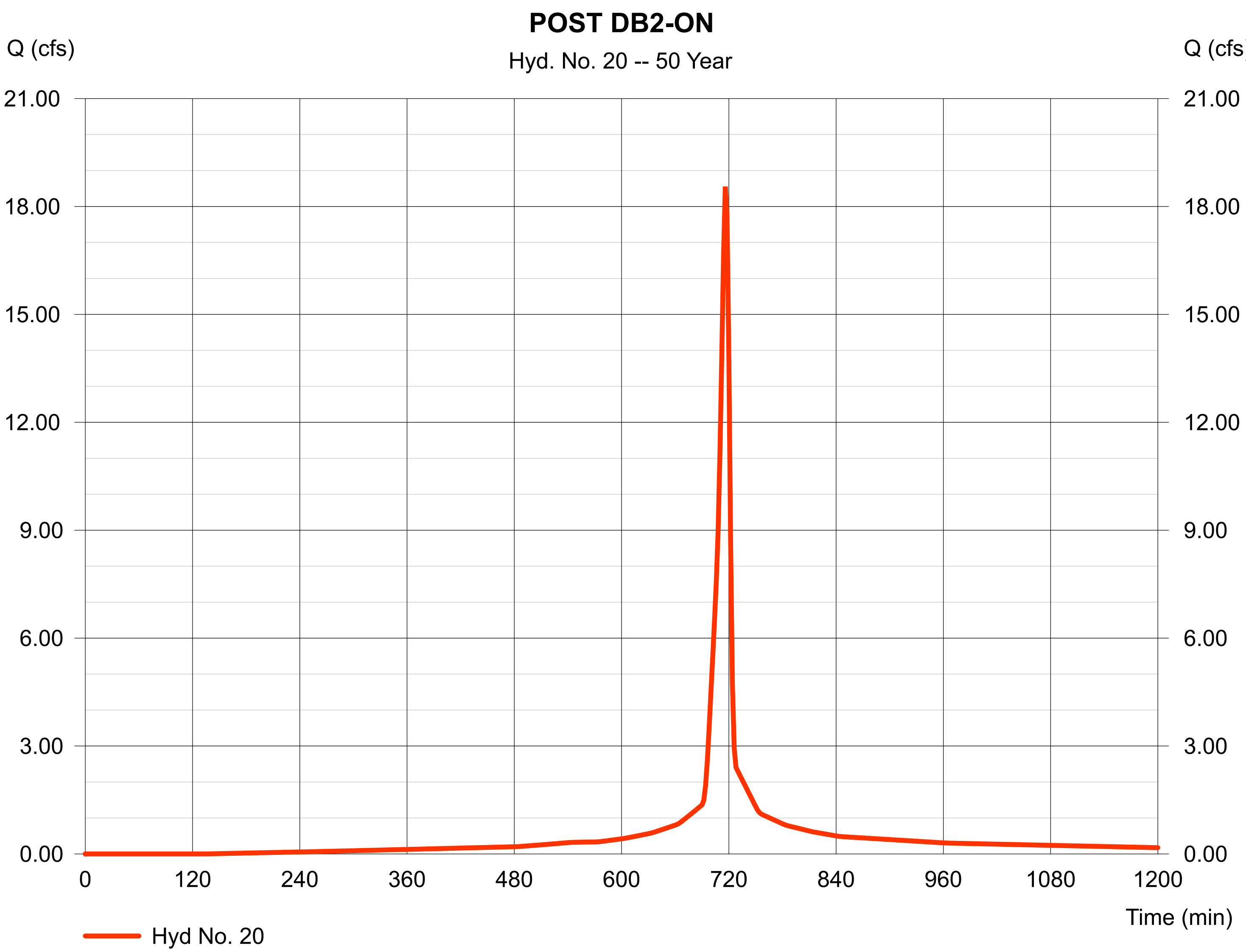
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 20

POST DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 18.55 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 41,704 cuft
Drainage area	= 1.960 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.090 x 61) + (0.280 x 85) + (13.450 x 98) + (1.000 x 55)] / 1.960



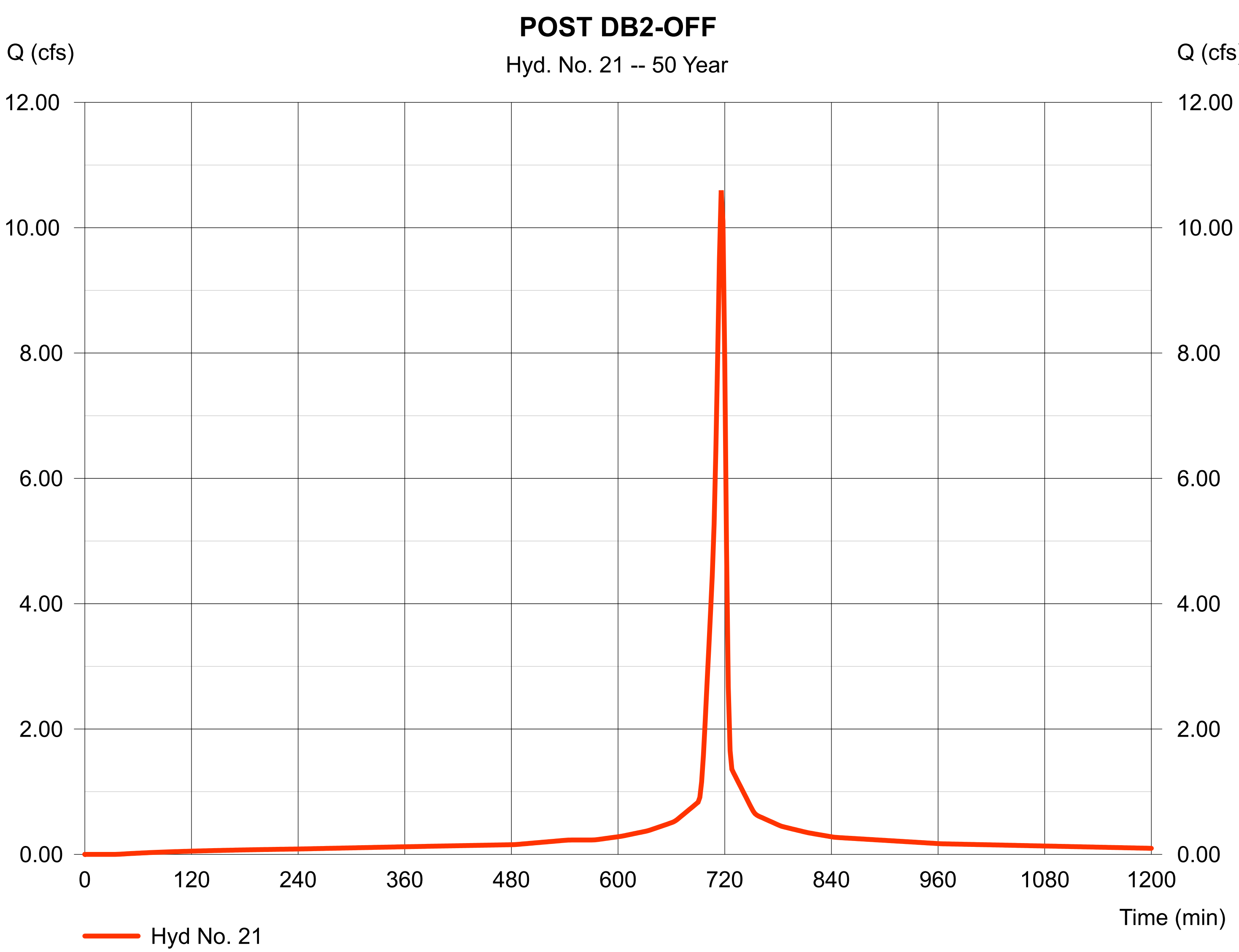
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 21

POST DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 10.60 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 25,583 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



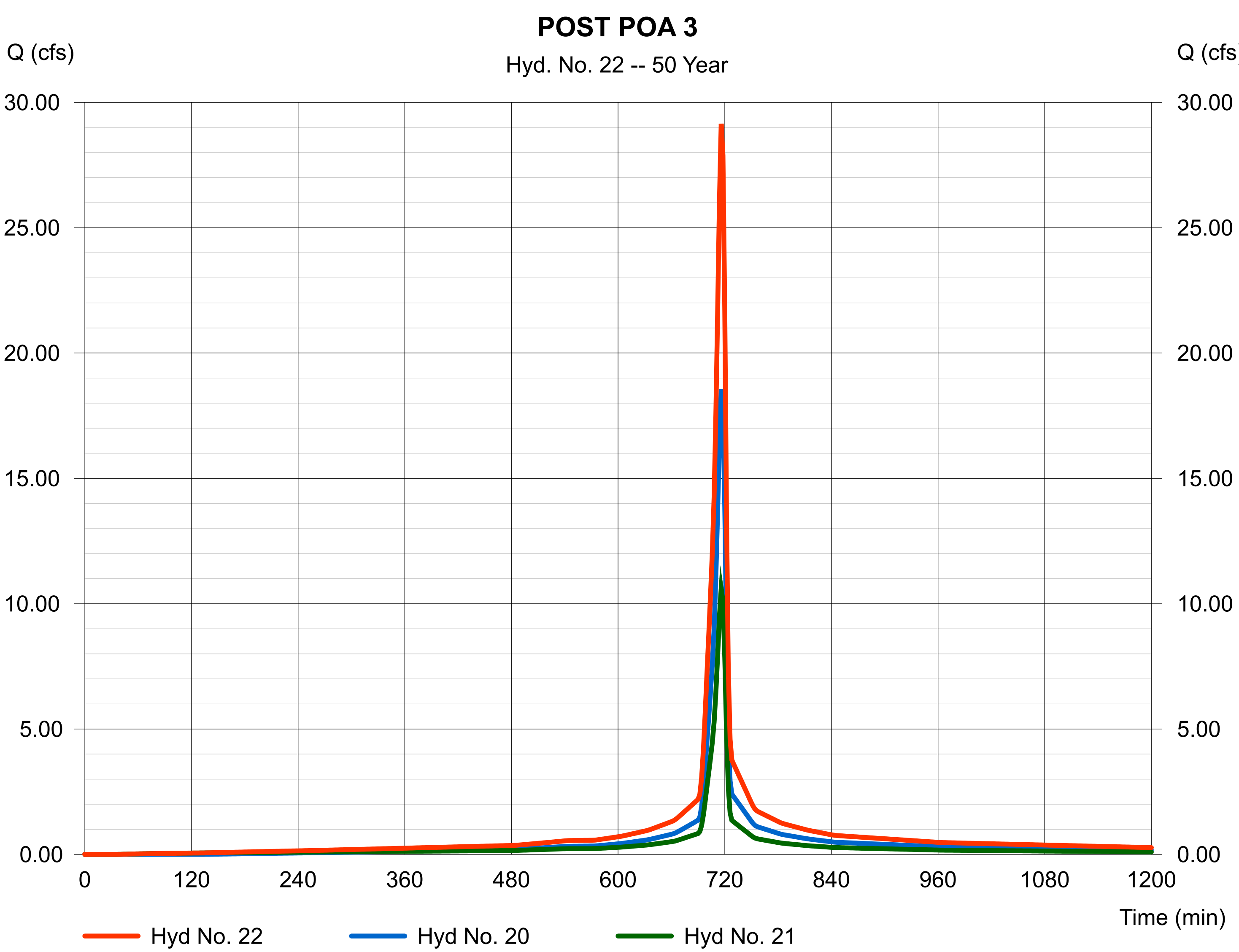
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 22

POST POA 3

Hydrograph type	= Combine	Peak discharge	= 29.15 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 67,287 cuft
Inflow hyds.	= 20, 21	Contrib. drain. area	= 3.040 ac



Hydrograph Report

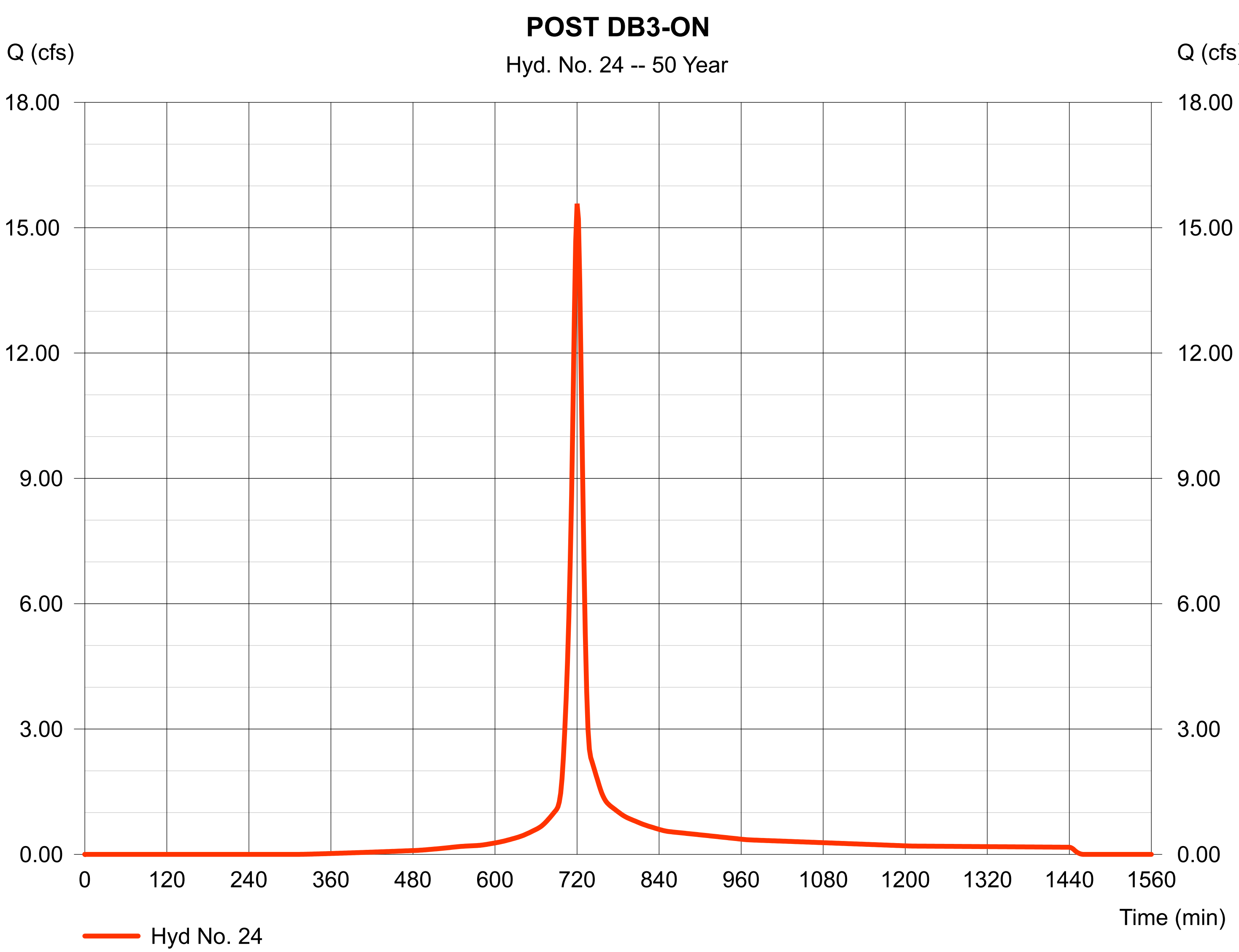
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 24

POST DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 15.58 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 41,107 cuft
Drainage area	= 2.200 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (2.810 x 61) + (10.490 x 98)] / 2.200



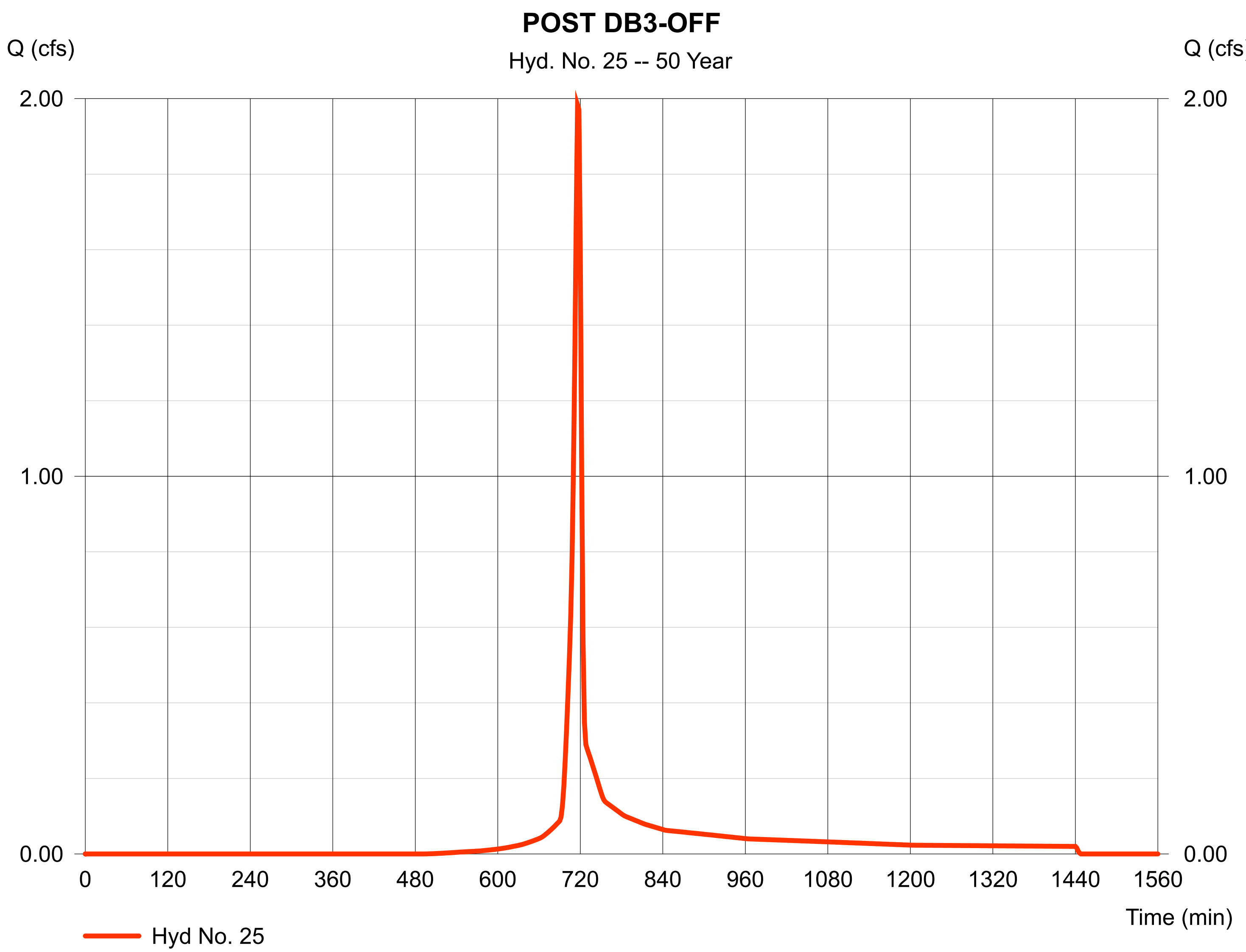
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 25

POST DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 1.982 cfs
Storm frequency	= 50 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 4,006 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



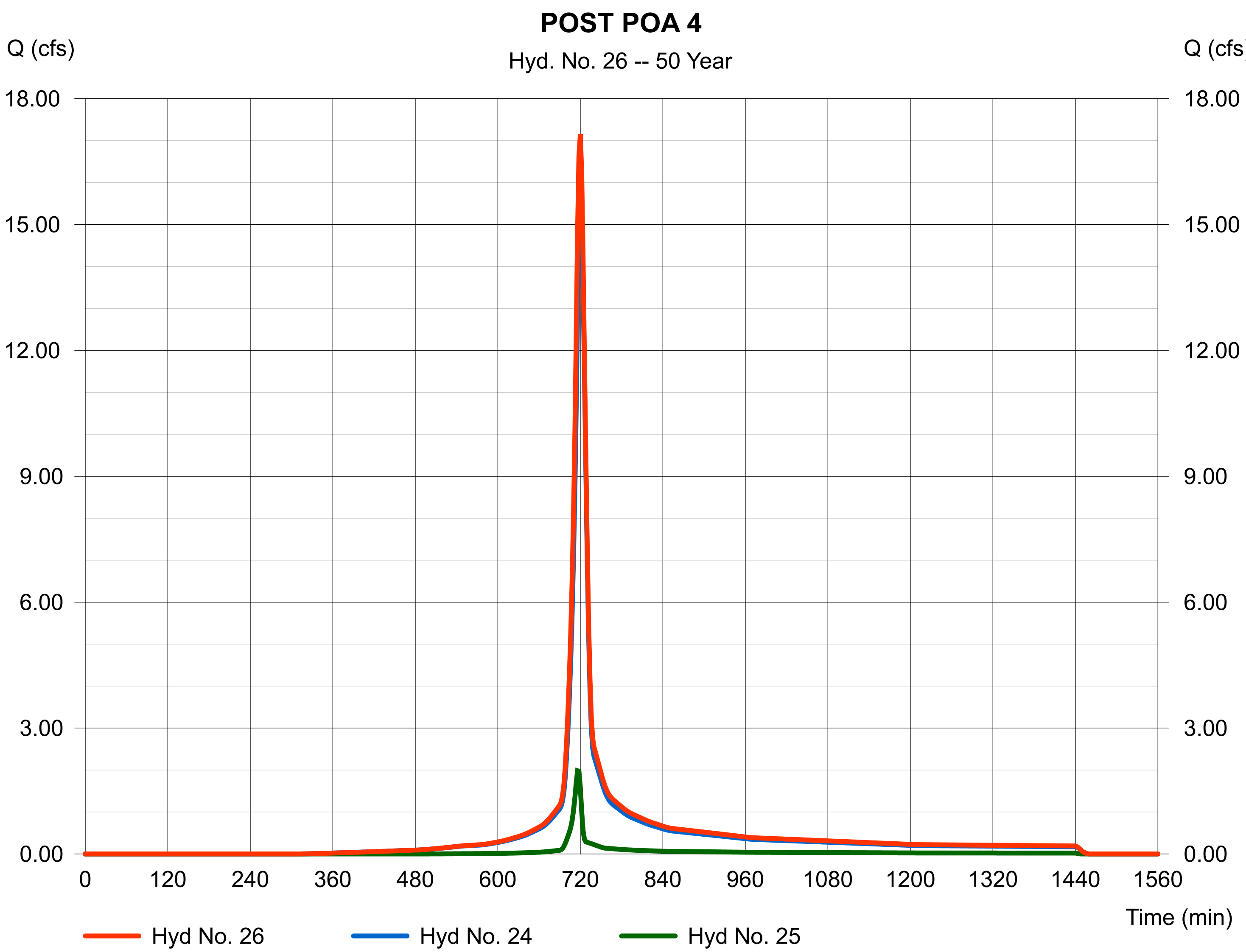
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 26

POST POA 4

Hydrograph type	= Combine	Peak discharge	= 17.15 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 45,113 cuft
Inflow hyds.	= 24, 25	Contrib. drain. area	= 2.520 ac



Hydrograph Report

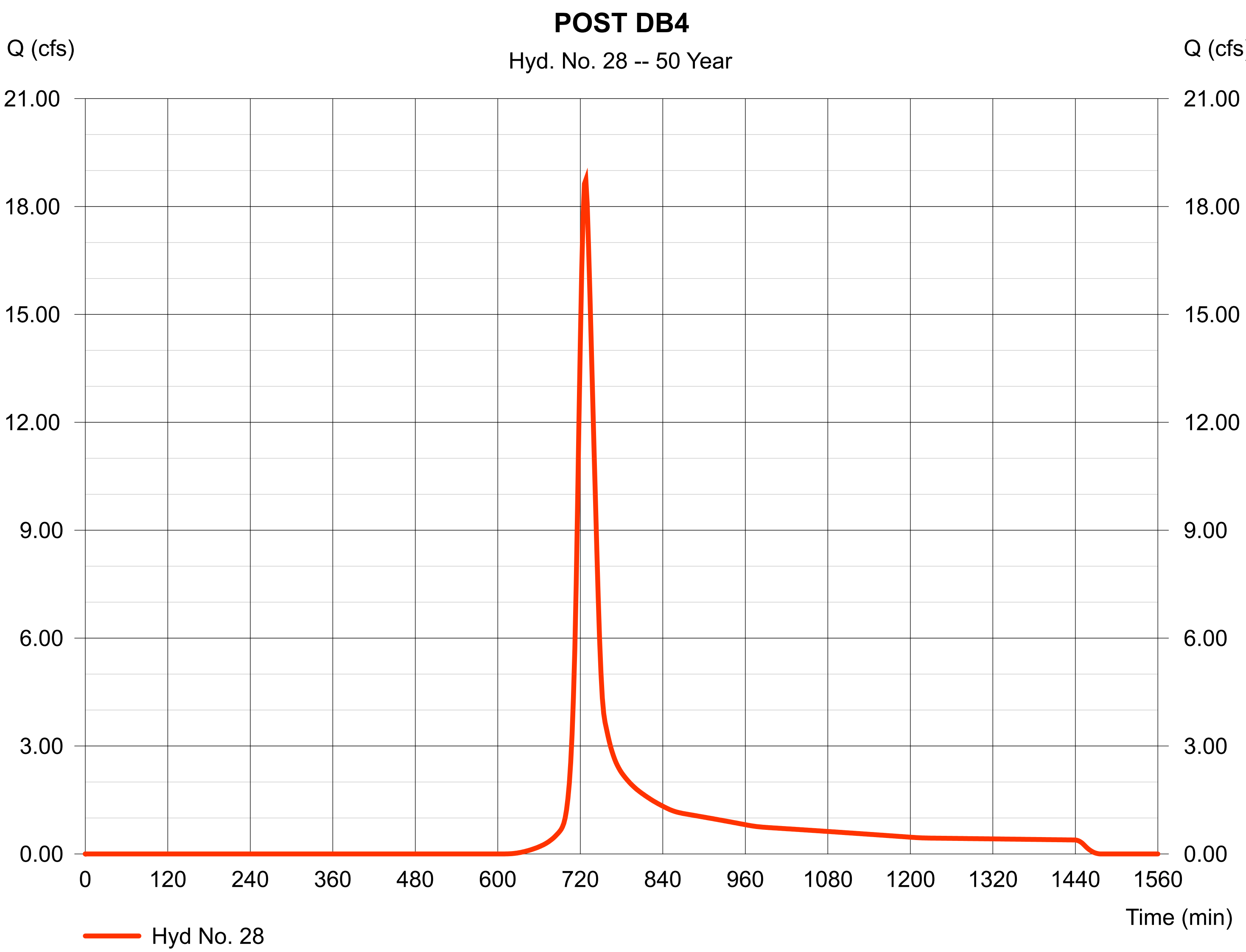
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 28

POST DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 18.74 cfs
Storm frequency	= 50 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 66,763 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.94 min
Total precip.	= 7.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.520 x 98) + (4.480 x 61)] / 6.580



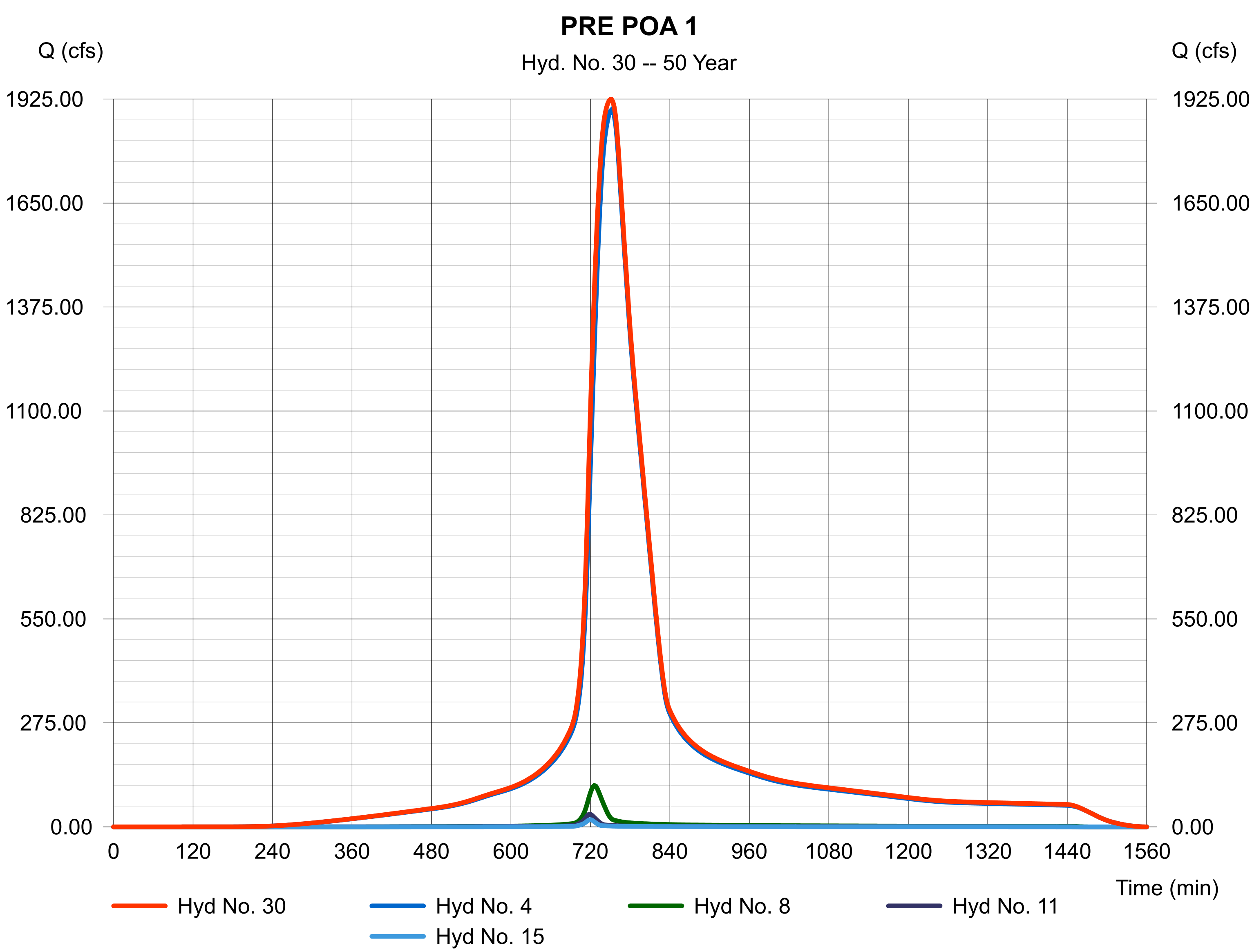
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 30

PRE POA 1

Hydrograph type	= Combine	Peak discharge	= 1923.93 cfs
Storm frequency	= 50 yrs	Time to peak	= 750 min
Time interval	= 2 min	Hyd. volume	= 15,430,765 cuft
Inflow hyds.	= 4, 8, 11, 15	Contrib. drain. area	= 22.020 ac



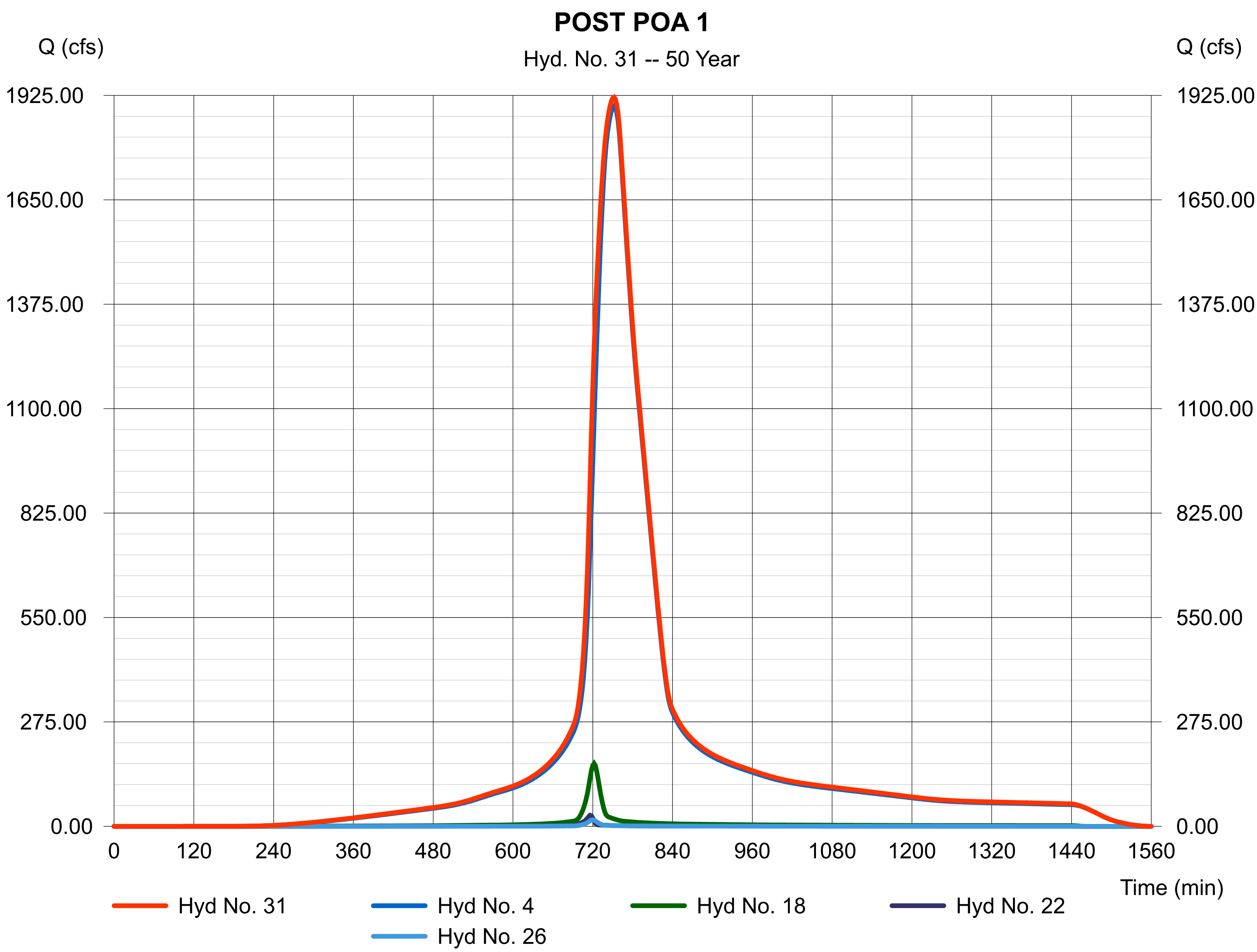
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 31

POST POA 1

Hydrograph type	= Combine	Peak discharge	= 1920.21 cfs
Storm frequency	= 50 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 15,494,862 cuft
Inflow hyds.	= 4, 18, 22, 26	Contrib. drain. area	= 24.120 ac



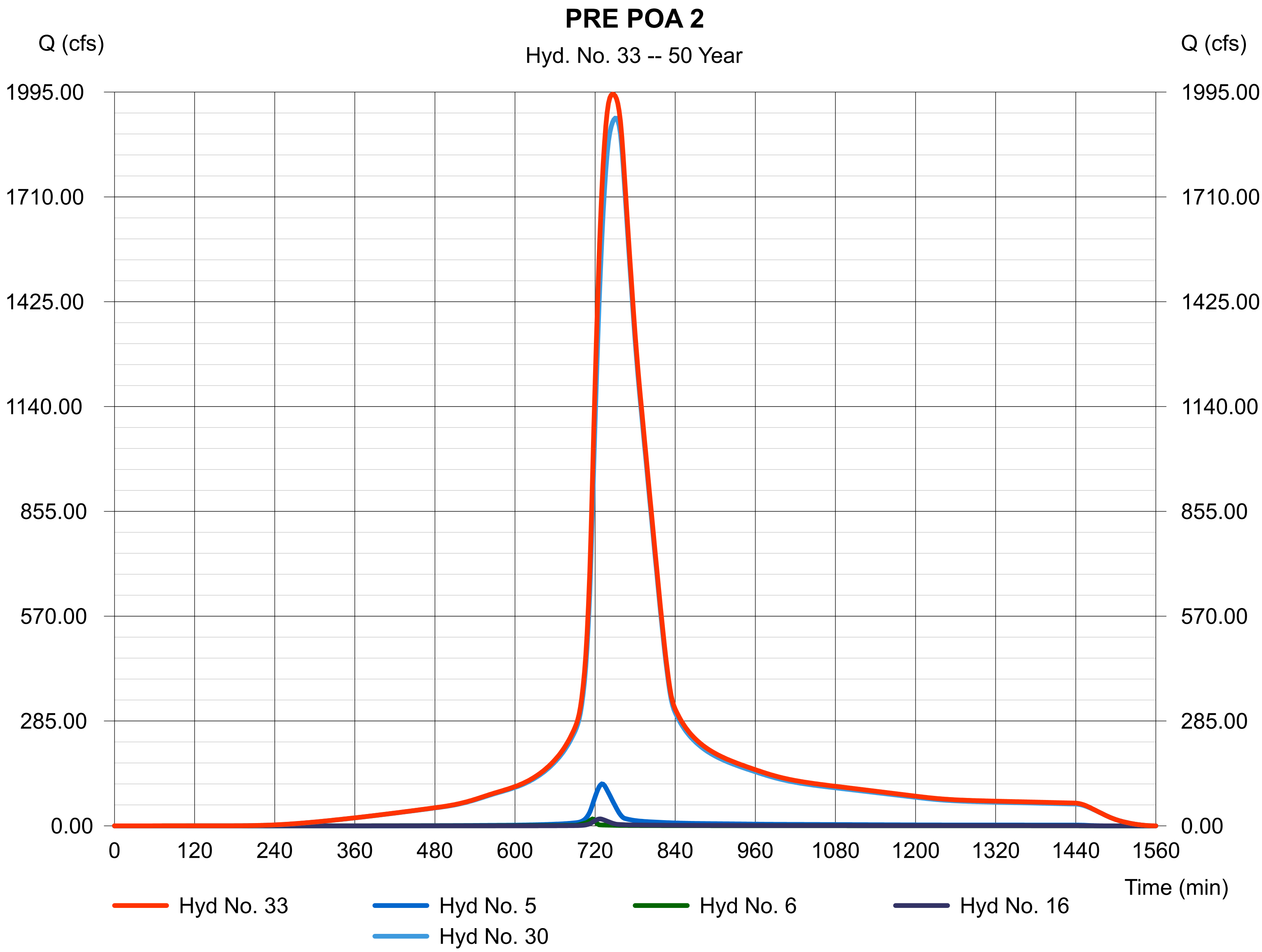
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 33

PRE POA 2

Hydrograph type	= Combine	Peak discharge	= 1989.38 cfs
Storm frequency	= 50 yrs	Time to peak	= 746 min
Time interval	= 2 min	Hyd. volume	= 15,997,950 cuft
Inflow hyds.	= 5, 6, 16, 30	Contrib. drain. area	= 37.480 ac



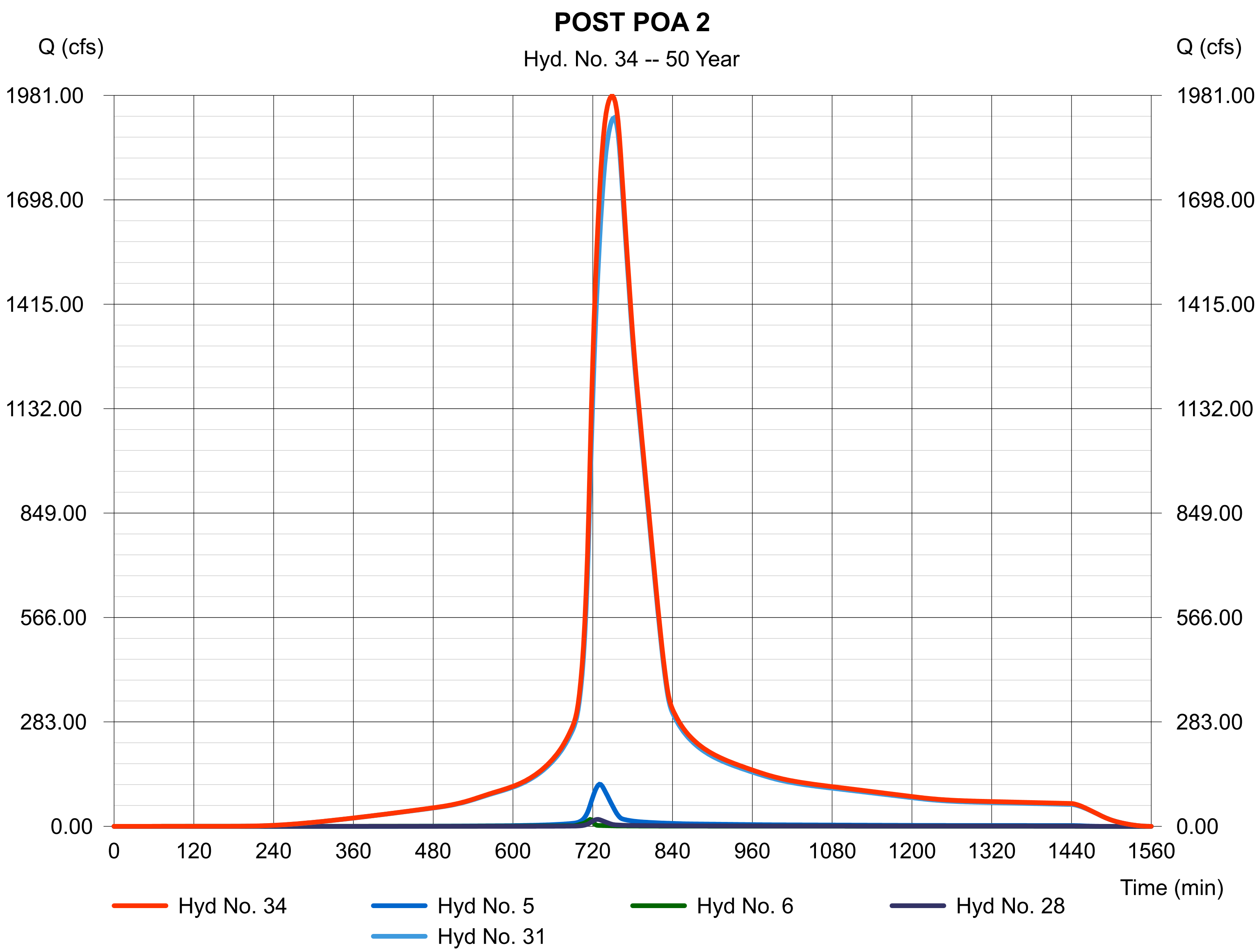
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 34

POST POA 2

Hydrograph type	= Combine	Peak discharge	= 1978.64 cfs
Storm frequency	= 50 yrs	Time to peak	= 748 min
Time interval	= 2 min	Hyd. volume	= 16,062,049 cuft
Inflow hyds.	= 5, 6, 28, 31	Contrib. drain. area	= 37.480 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

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	1584.89	2	758	12,481,507	------	------	------	MACRO BASIN 1
2	SCS Runoff	650.60	2	738	3,503,213	------	------	------	MACRO BASIN 2
3	SCS Runoff	163.89	2	732	716,387	------	------	------	MACRO BASIN 3
4	Combine	2116.51	2	752	16,701,121	1, 2, 3	------	------	OFF POA 1
5	SCS Runoff	130.83	2	730	523,143	------	------	------	MACRO BASIN 4
6	SCS Runoff	20.52	2	716	49,660	------	------	------	OFF BASIN 5
8	SCS Runoff	124.58	2	726	432,601	------	------	------	PRE DB1
9	SCS Runoff	29.15	2	722	87,005	------	------	------	PRE DB2-ON
10	SCS Runoff	11.66	2	716	28,228	------	------	------	PRE DB2-OFF
11	Combine	37.19	2	718	115,233	9, 10	------	------	PRE POA 3
13	SCS Runoff	19.96	2	720	52,772	------	------	------	PRE DB3-ON
14	SCS Runoff	2.303	2	716	4,663	------	------	------	PRE DB3-OFF
15	Combine	21.78	2	720	57,434	13, 14	------	------	PRE POA 4
16	SCS Runoff	22.55	2	728	79,584	------	------	------	PRE DB4
18	SCS Runoff	184.59	2	722	543,943	------	------	------	POST DB1
19	Reservoir	31.42	2	742	539,611	18	965.74	286,954	FALSE PHASE 1 VAULT
20	SCS Runoff	20.53	2	716	46,453	------	------	------	POST DB2-ON
21	SCS Runoff	11.66	2	716	28,228	------	------	------	POST DB2-OFF
22	Combine	32.19	2	716	74,680	20, 21	------	------	POST POA 3
24	SCS Runoff	17.59	2	720	46,670	------	------	------	POST DB3-ON
25	SCS Runoff	2.303	2	716	4,663	------	------	------	POST DB3-OFF
26	Combine	19.41	2	720	51,332	24, 25	------	------	POST POA 4
28	SCS Runoff	22.55	2	728	79,584	------	------	------	POST DB4
30	Combine	2147.35	2	750	17,306,372	4, 8, 11, 15,	------	------	PRE POA 1
31	Combine	2142.36	2	752	17,371,092	4, 18, 22, 26,	------	------	POST POA 1
33	Combine	2223.56	2	746	17,958,768	5, 6, 16, 30,	------	------	PRE POA 2
34	Combine	2210.22	2	748	18,023,470	5, 6, 28, 31,	------	------	POST POA 2

2019-08-01 - High Street_PHASE 1.gpw	Return Period: 100 Year	Monday, 08 / 19 / 2019

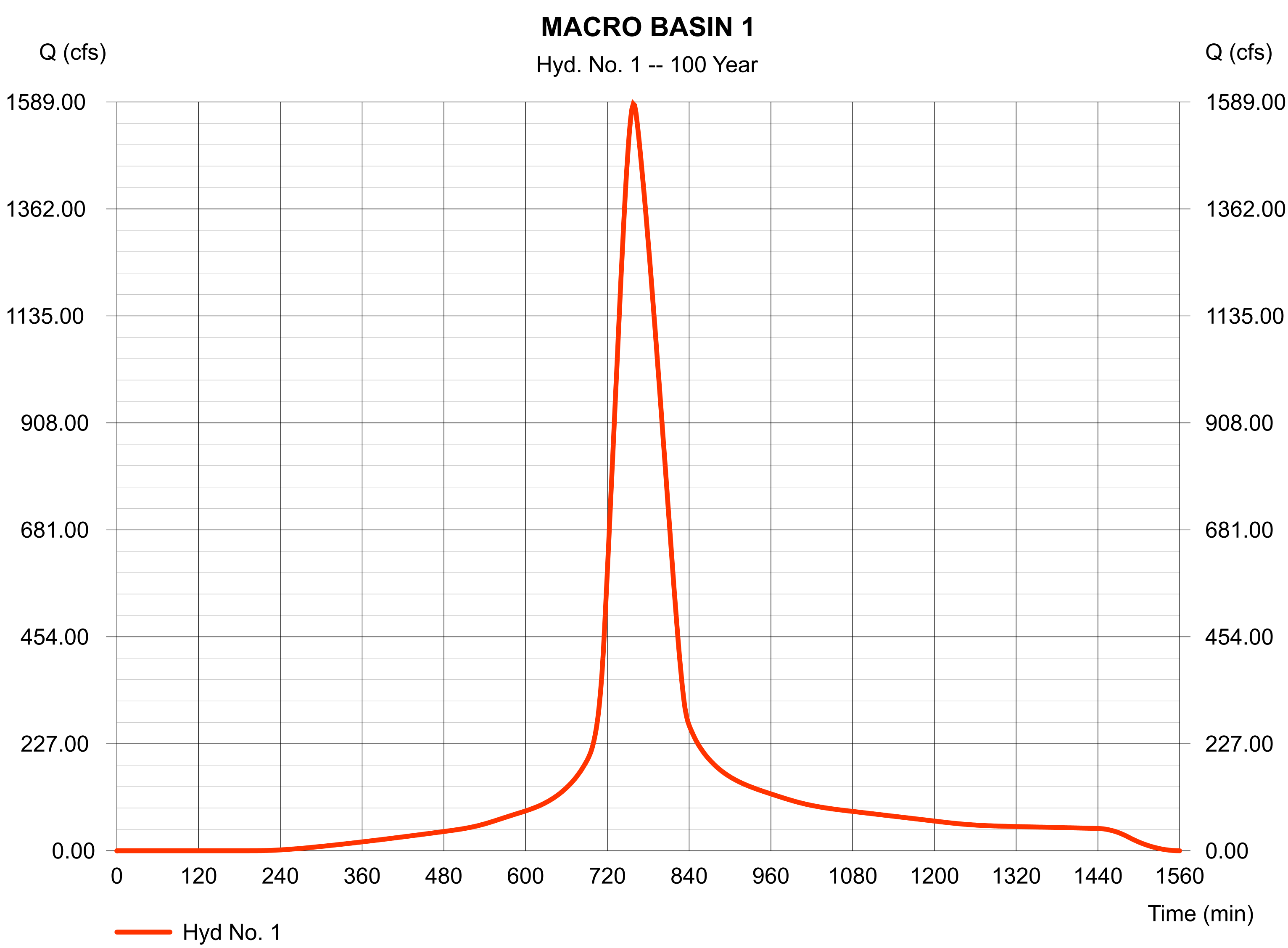
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 1

MACRO BASIN 1

Hydrograph type	= SCS Runoff	Peak discharge	= 1584.89 cfs
Storm frequency	= 100 yrs	Time to peak	= 758 min
Time interval	= 2 min	Hyd. volume	= 12,481,507 cuft
Drainage area	= 532.700 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 76.90 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



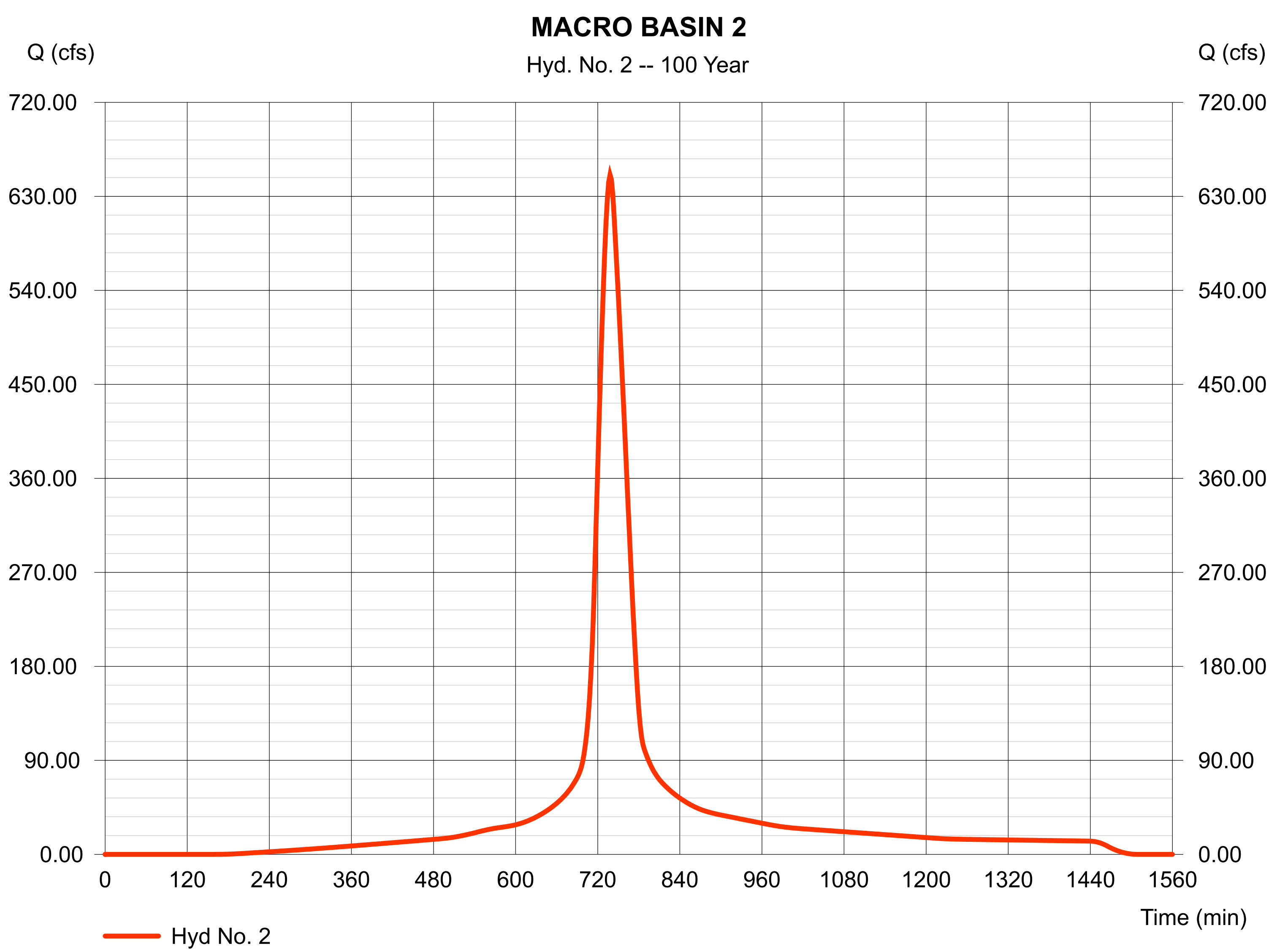
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 2

MACRO BASIN 2

Hydrograph type	= SCS Runoff	Peak discharge	= 650.60 cfs
Storm frequency	= 100 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 3,503,213 cuft
Drainage area	= 142.100 ac	Curve number	= 90
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 42.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



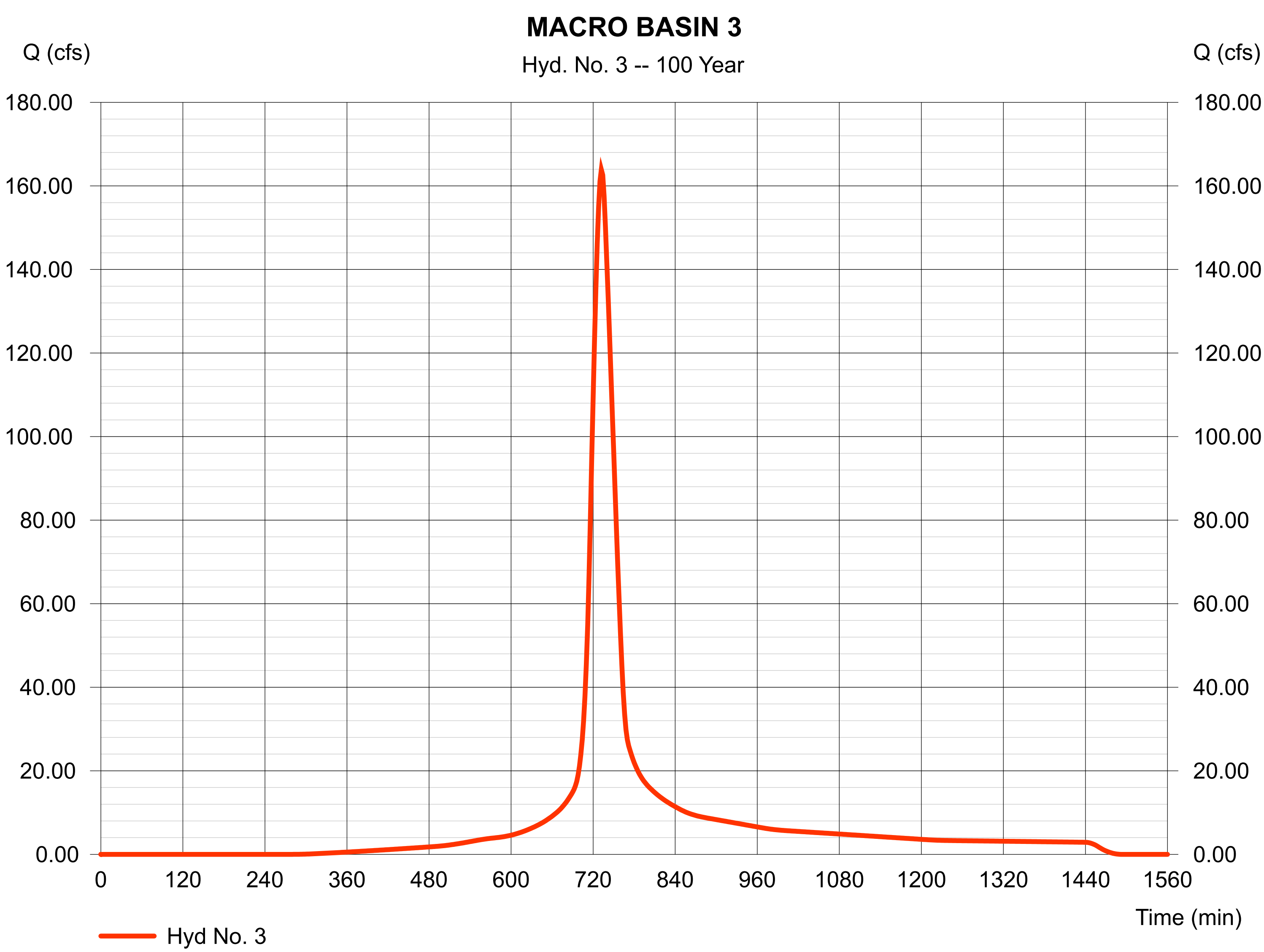
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 3

MACRO BASIN 3

Hydrograph type	= SCS Runoff	Peak discharge	= 163.89 cfs
Storm frequency	= 100 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 716,387 cuft
Drainage area	= 33.700 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 31.50 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



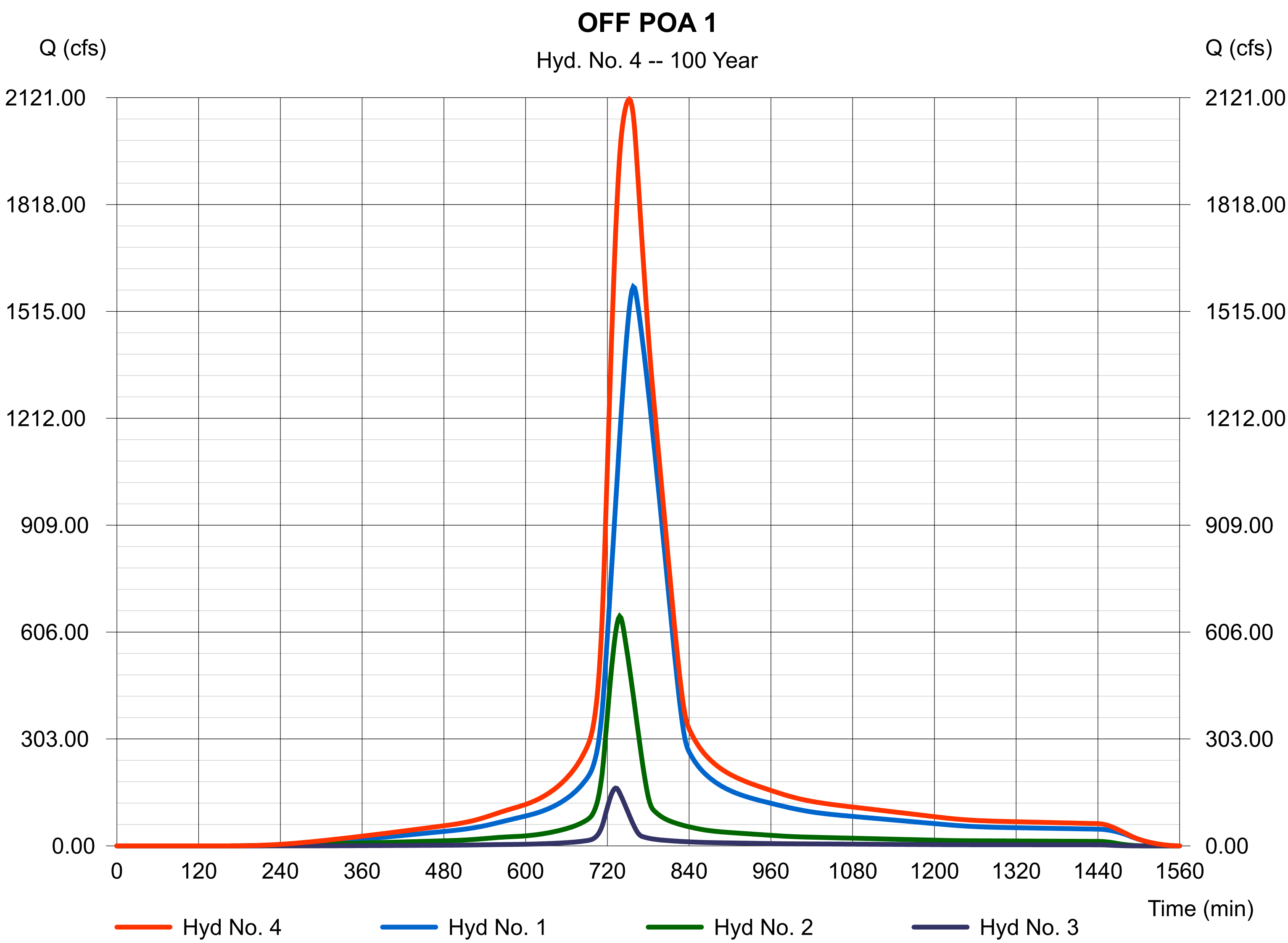
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 4

OFF POA 1

Hydrograph type	= Combine	Peak discharge	= 2116.51 cfs
Storm frequency	= 100 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 16,701,121 cuft
Inflow hyds.	= 1, 2, 3	Contrib. drain. area	= 708.500 ac



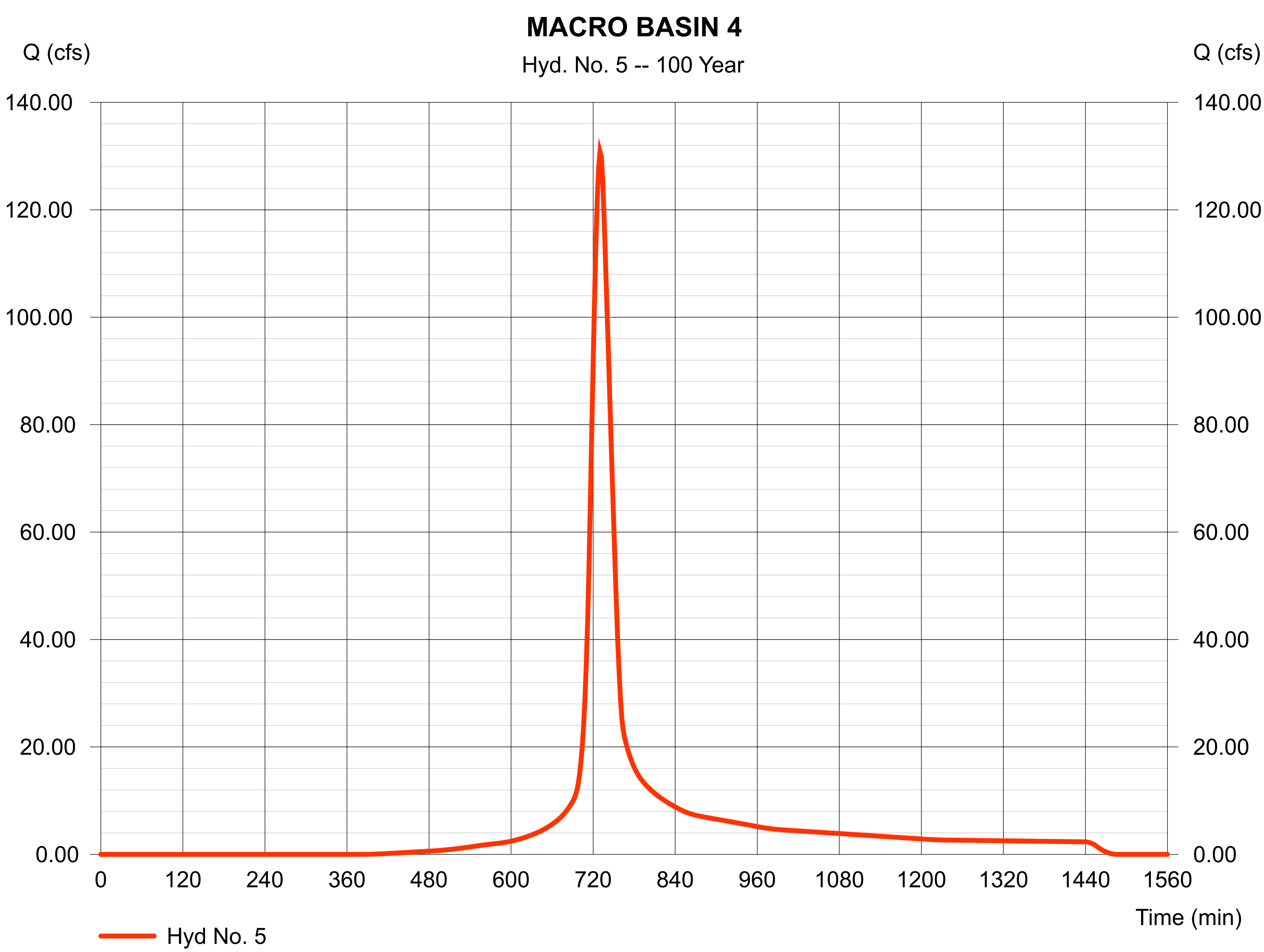
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 5

MACRO BASIN 4

Hydrograph type	= SCS Runoff	Peak discharge	= 130.83 cfs
Storm frequency	= 100 yrs	Time to peak	= 730 min
Time interval	= 2 min	Hyd. volume	= 523,143 cuft
Drainage area	= 29.000 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 27.10 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



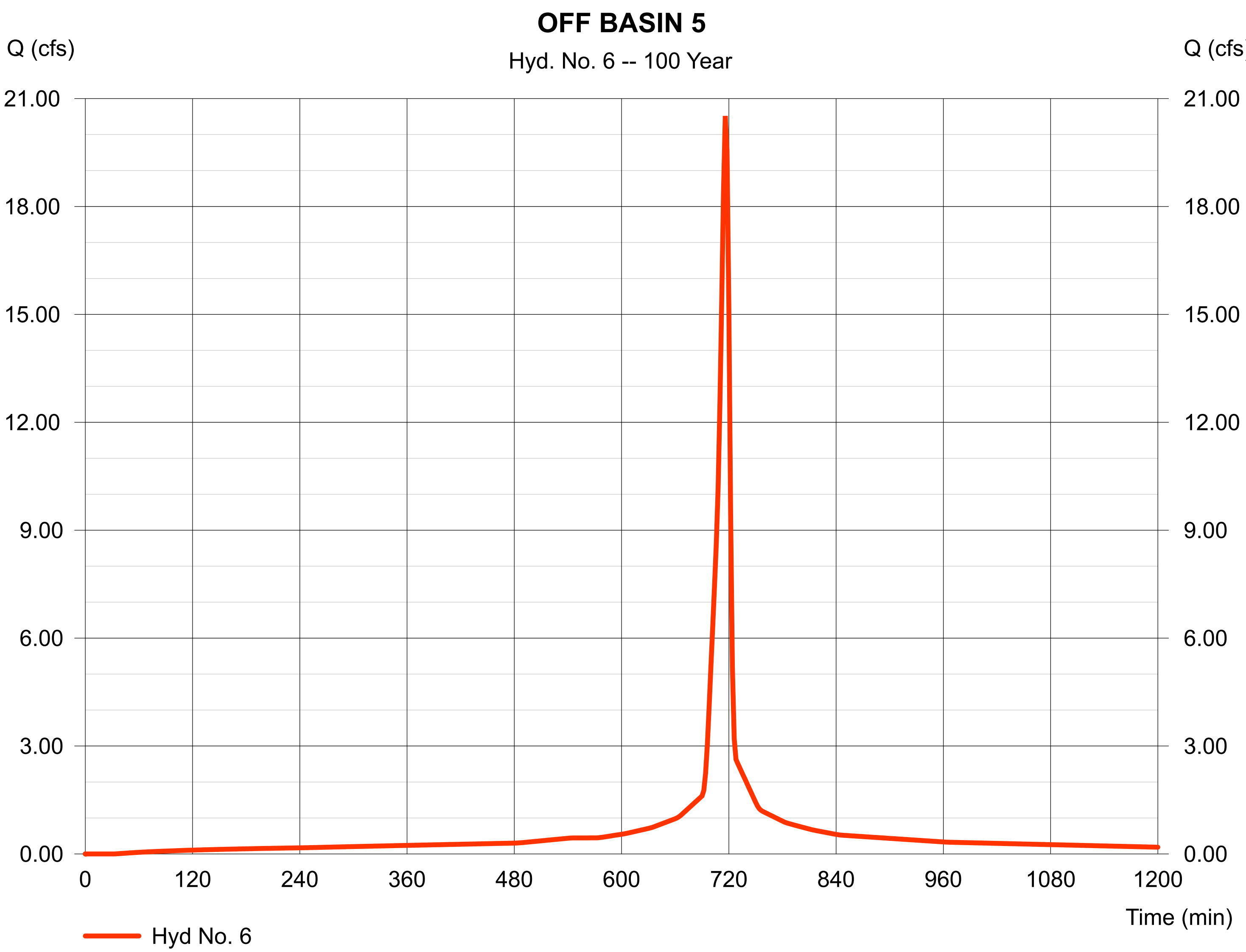
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 6

OFF BASIN 5

Hydrograph type	= SCS Runoff	Peak discharge	= 20.52 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 49,660 cuft
Drainage area	= 1.900 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

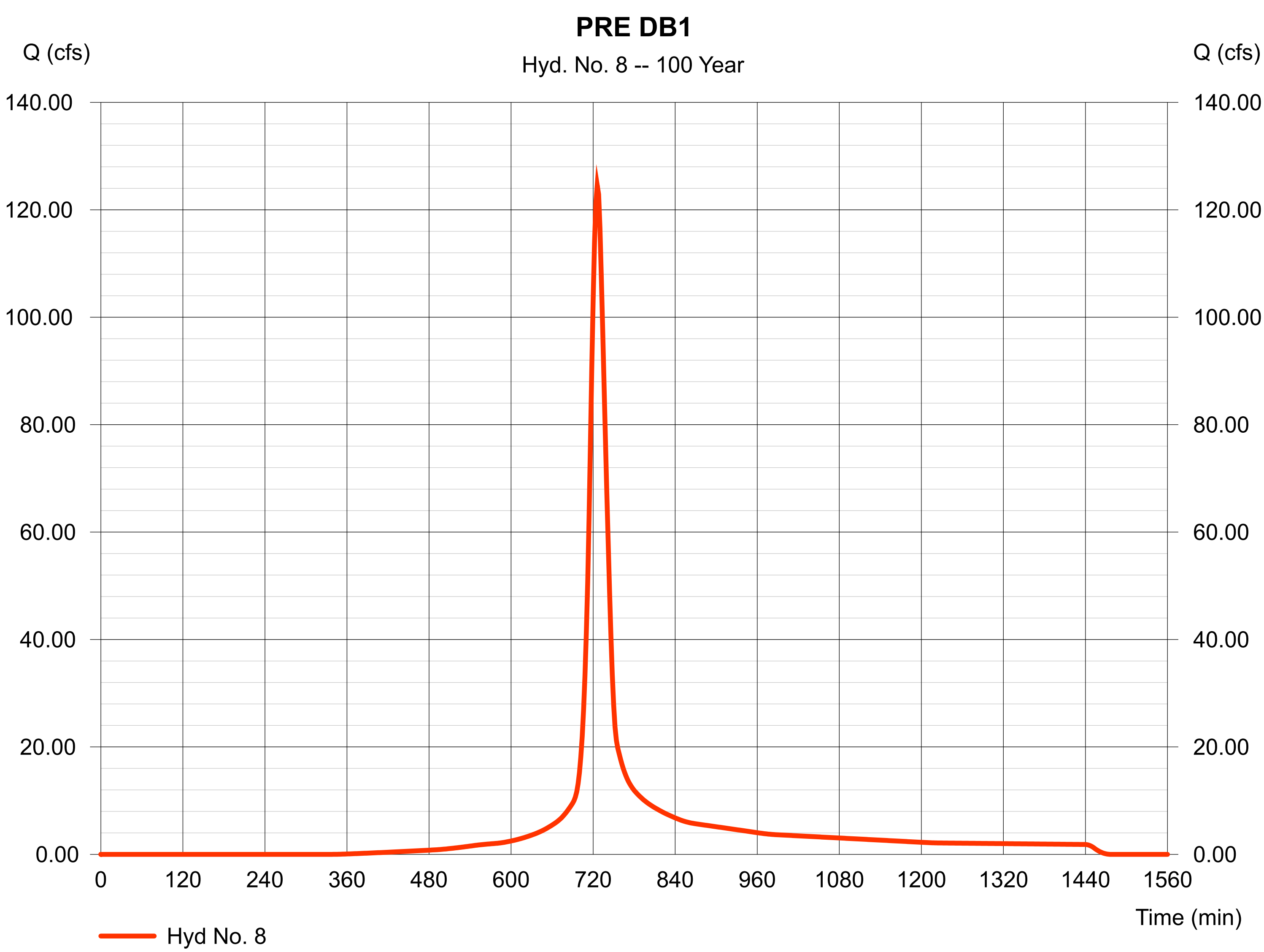
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 8

PRE DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 124.58 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 432,601 cuft
Drainage area	= 22.020 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 20.73 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 22.020



Hydrograph Report

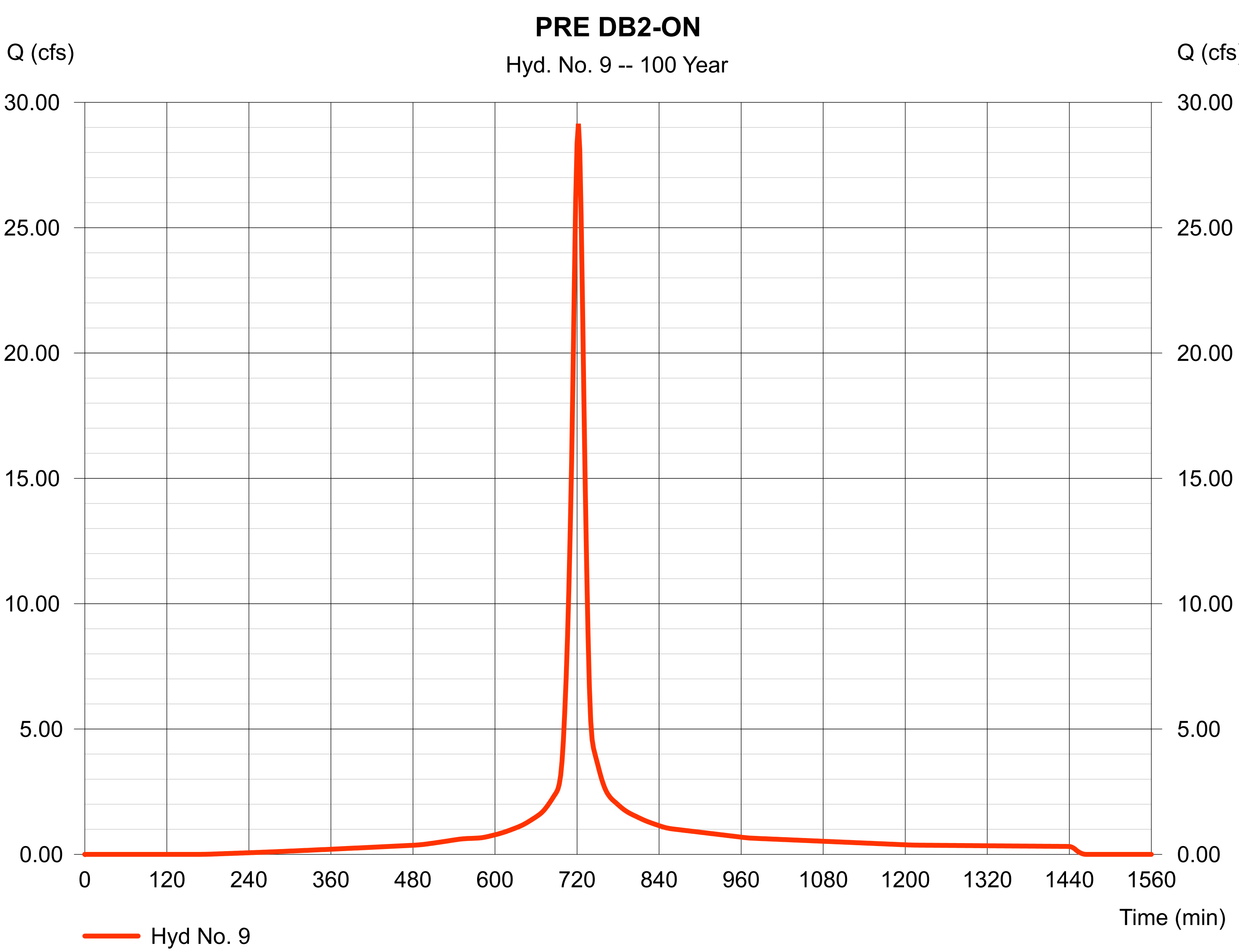
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 9

PRE DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 29.15 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 87,005 cuft
Drainage area	= 3.720 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.33 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (0.070 x 61) + (1.100 x 98)] / 3.720



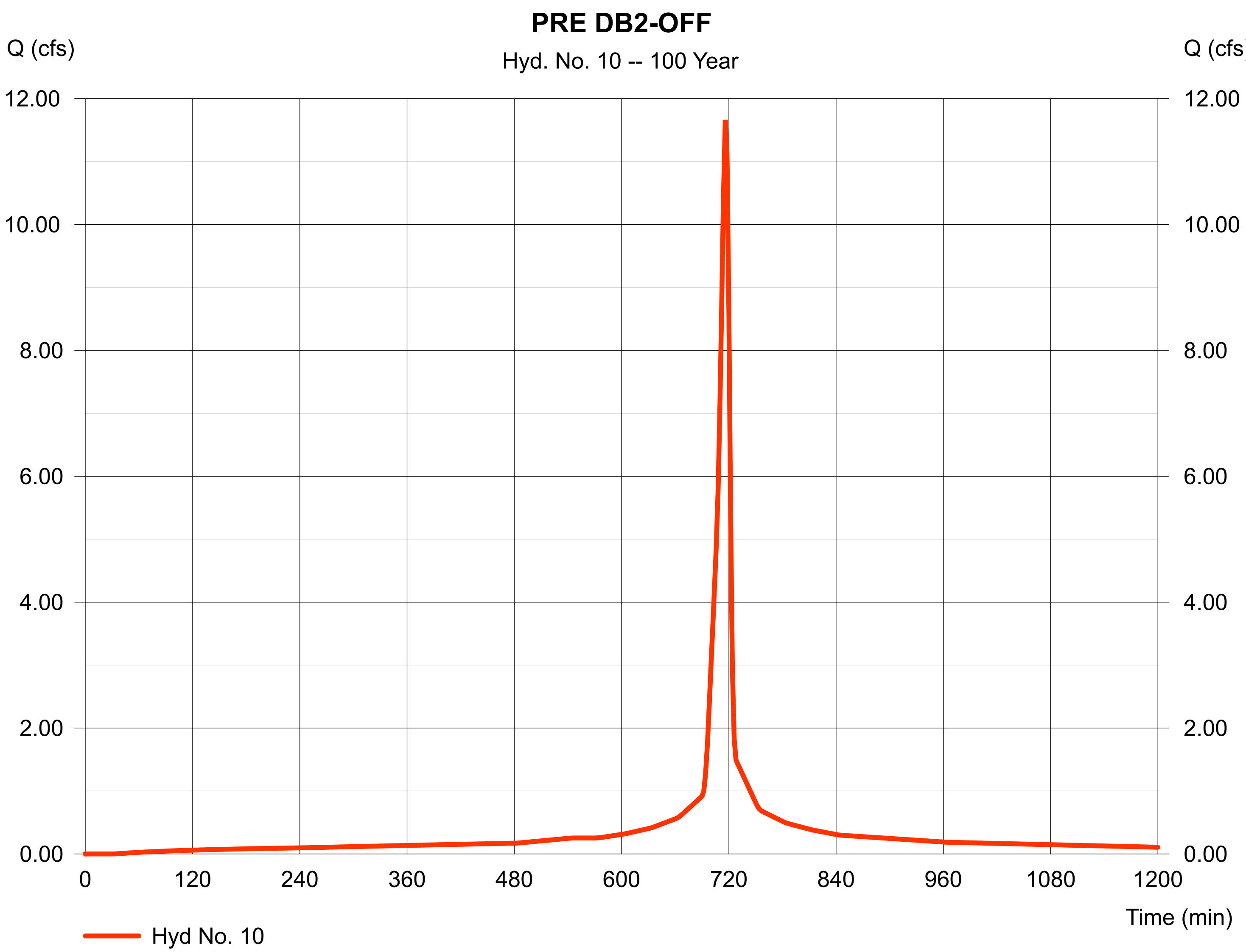
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 10

PRE DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 11.66 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 28,228 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



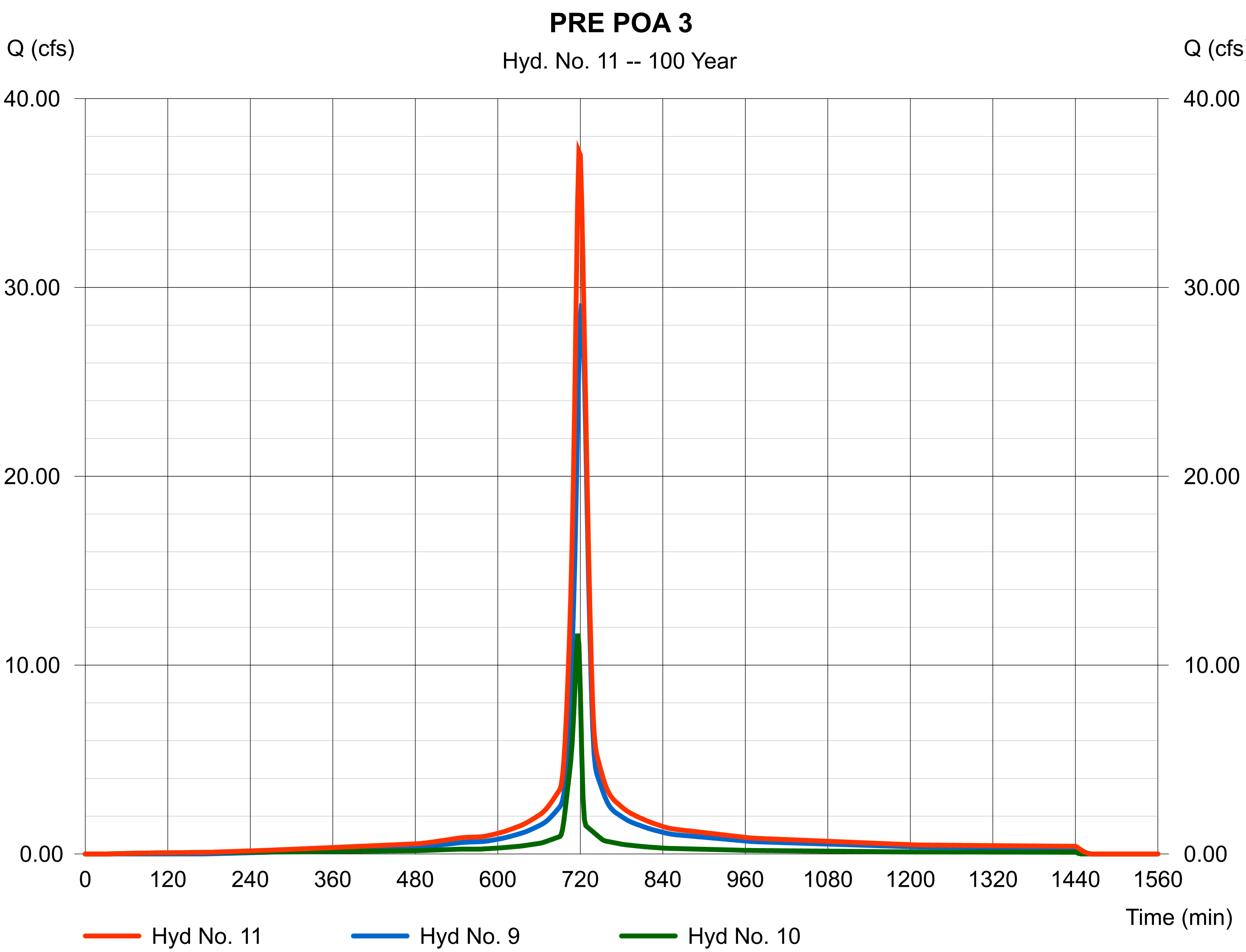
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 11

PRE POA 3

Hydrograph type	= Combine	Peak discharge	= 37.19 cfs
Storm frequency	= 100 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 115,233 cuft
Inflow hyds.	= 9, 10	Contrib. drain. area	= 4.800 ac



Hydrograph Report

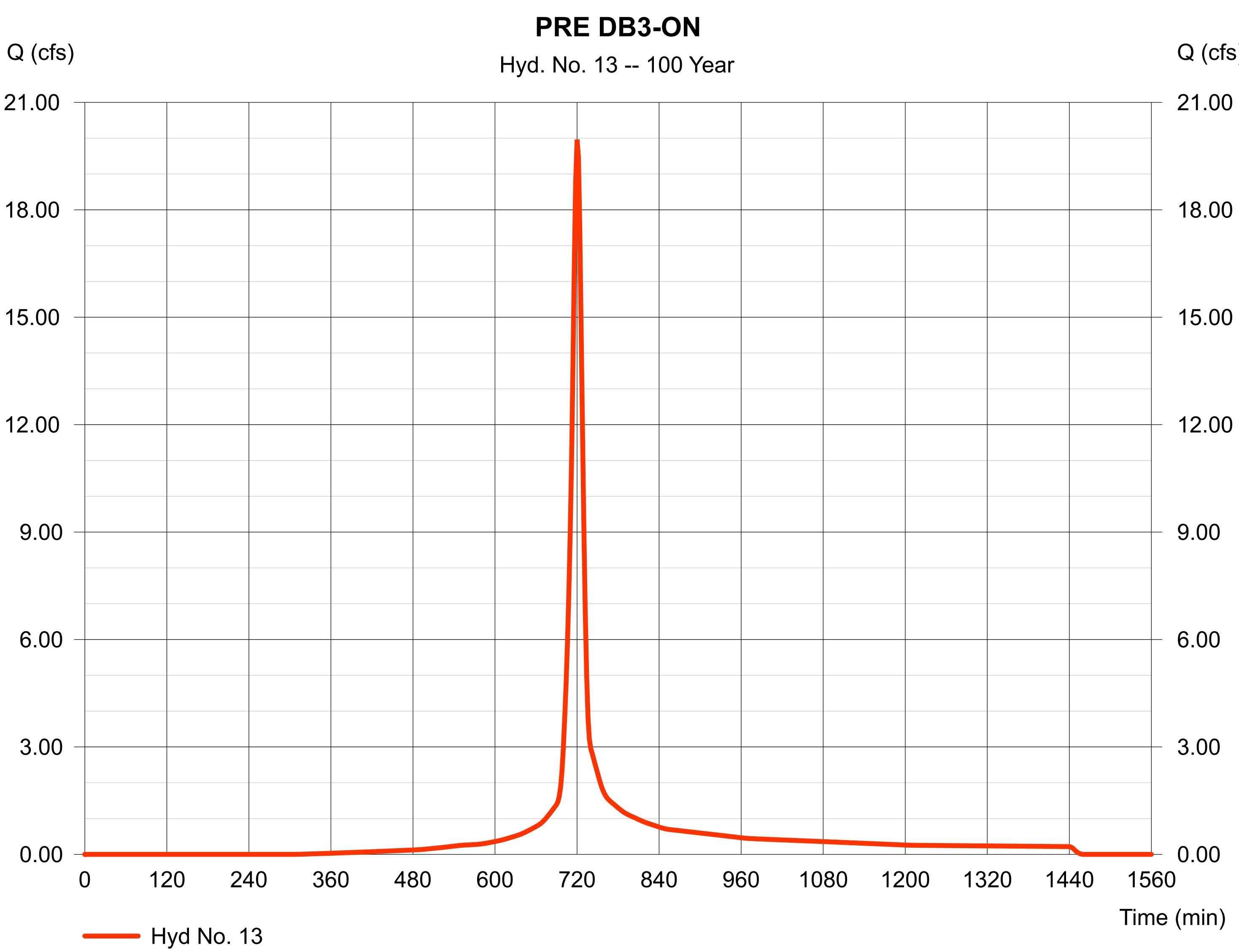
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 13

PRE DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 19.96 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 52,772 cuft
Drainage area	= 2.540 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 55) + (0.570 x 61) + (2.130 x 98)] / 2.540



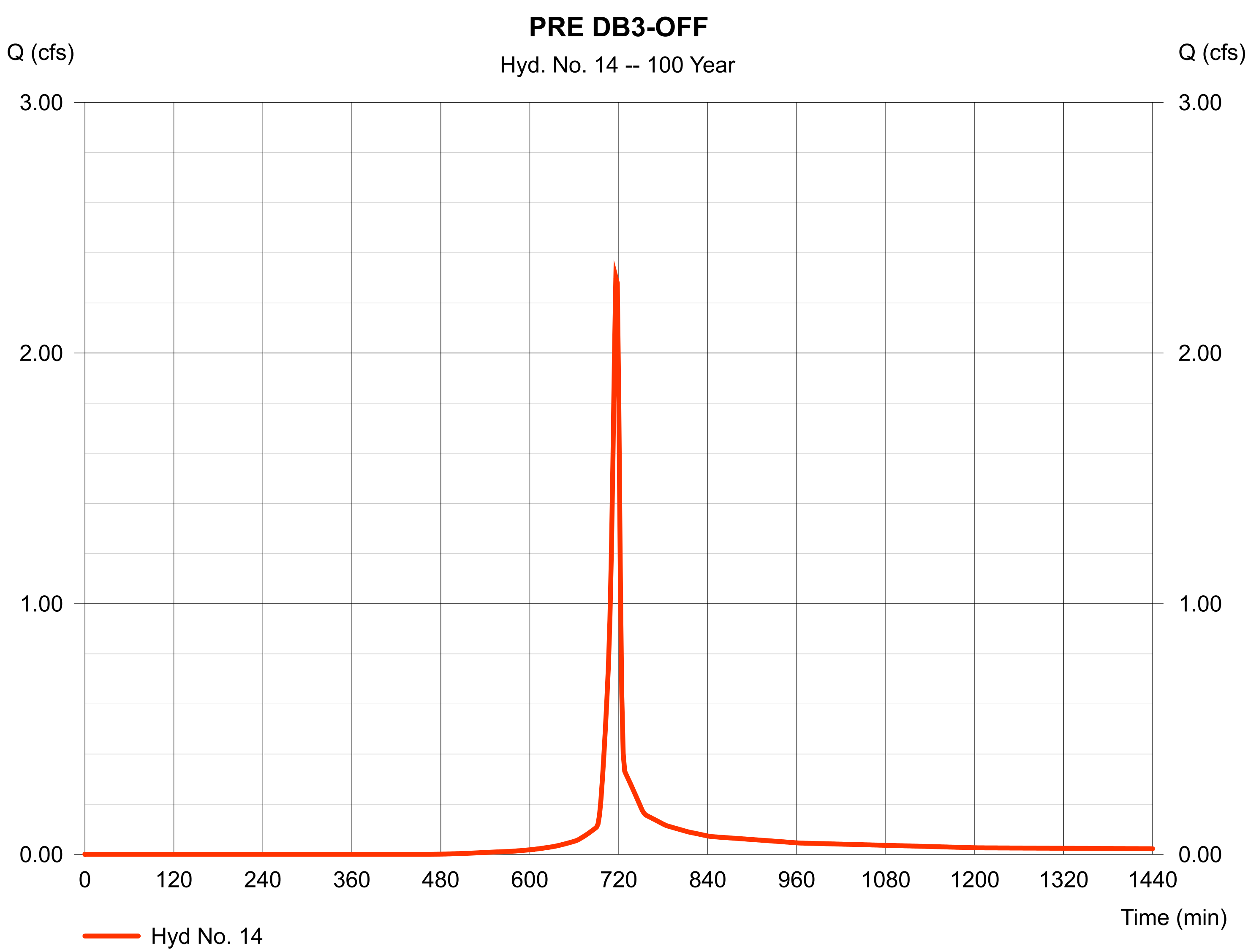
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 14

PRE DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 2.303 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 4,663 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



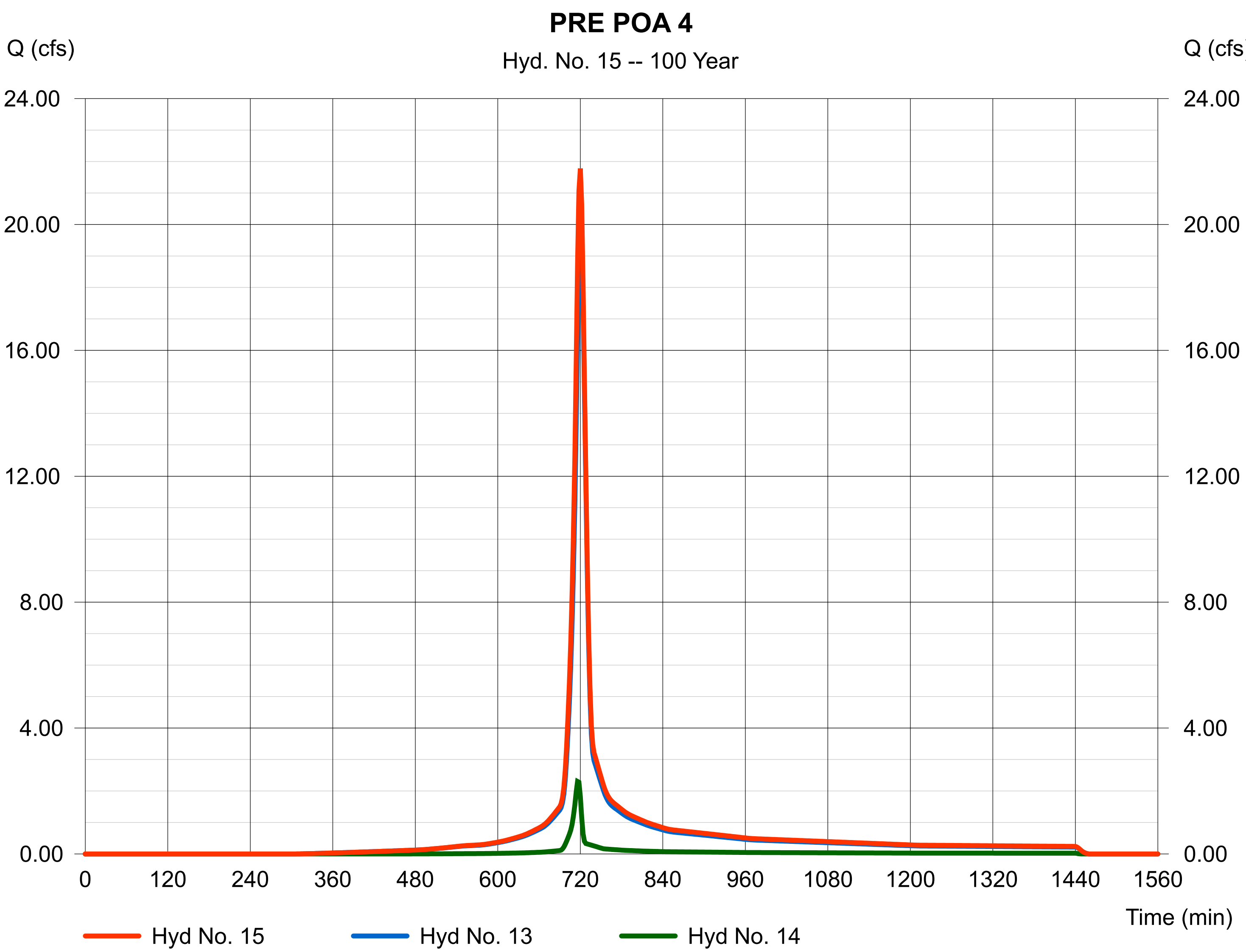
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 15

PRE POA 4

Hydrograph type	= Combine	Peak discharge	= 21.78 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 57,434 cuft
Inflow hyds.	= 13, 14	Contrib. drain. area	= 2.860 ac



Hydrograph Report

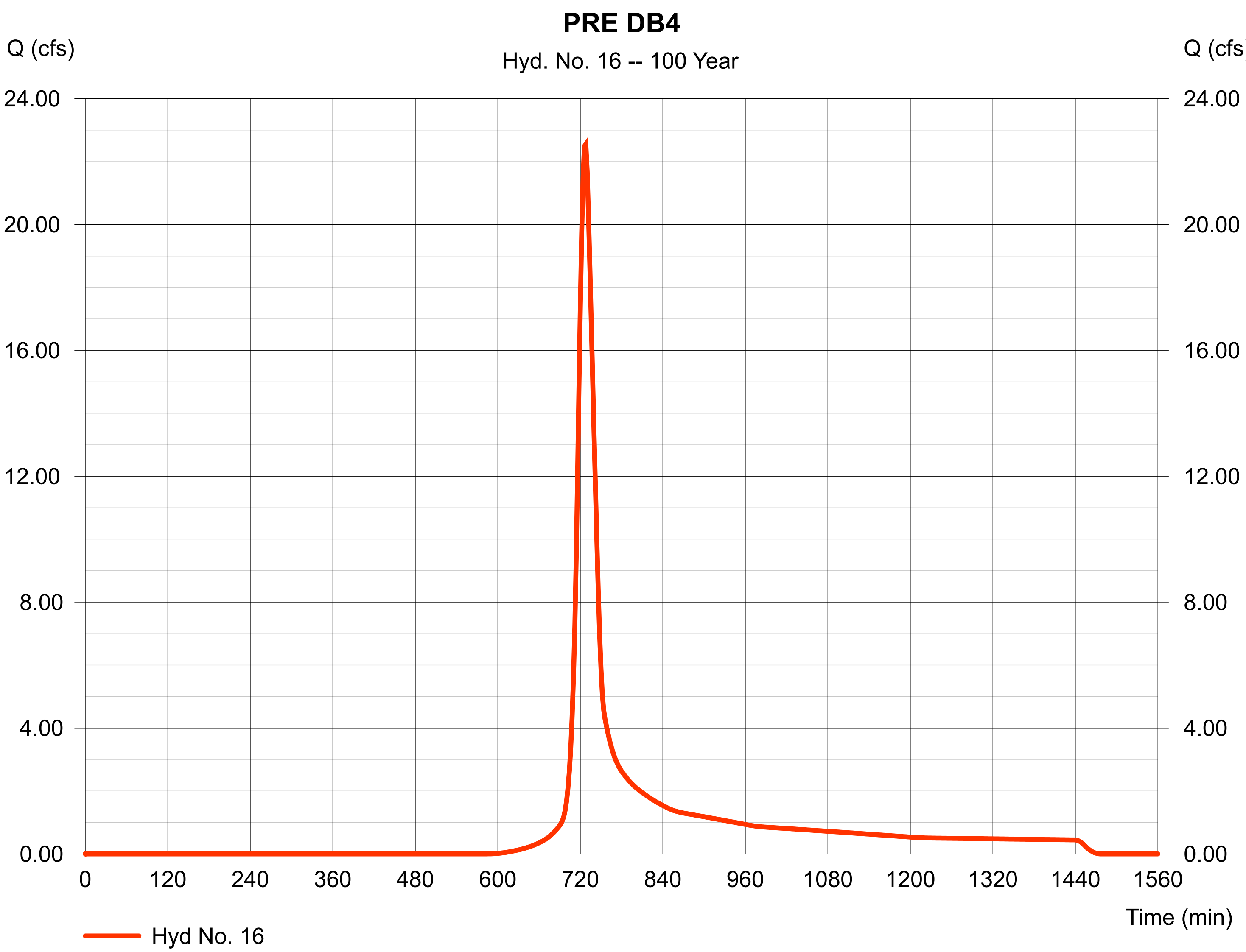
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 16

PRE DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 22.55 cfs
Storm frequency	= 100 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 79,584 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.12 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.160 x 61) + (1.840 x 55)] / 6.580



Hydrograph Report

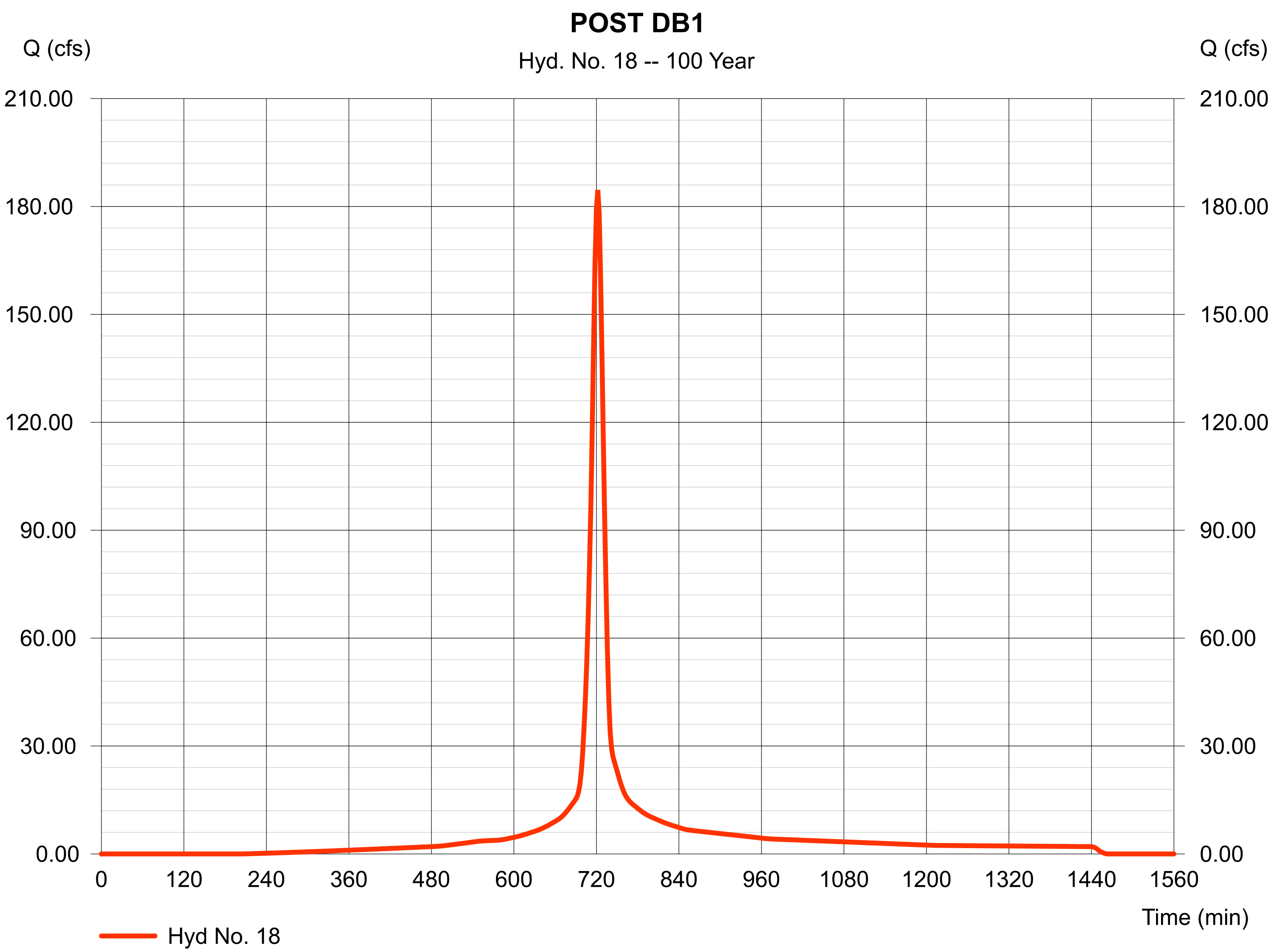
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 18

POST DB1

Hydrograph type	= SCS Runoff	Peak discharge	= 184.59 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 543,943 cuft
Drainage area	= 24.120 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.62 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.160 x 98) + (0.310 x 55) + (0.510 x 61)] / 24.120



Hydrograph Report

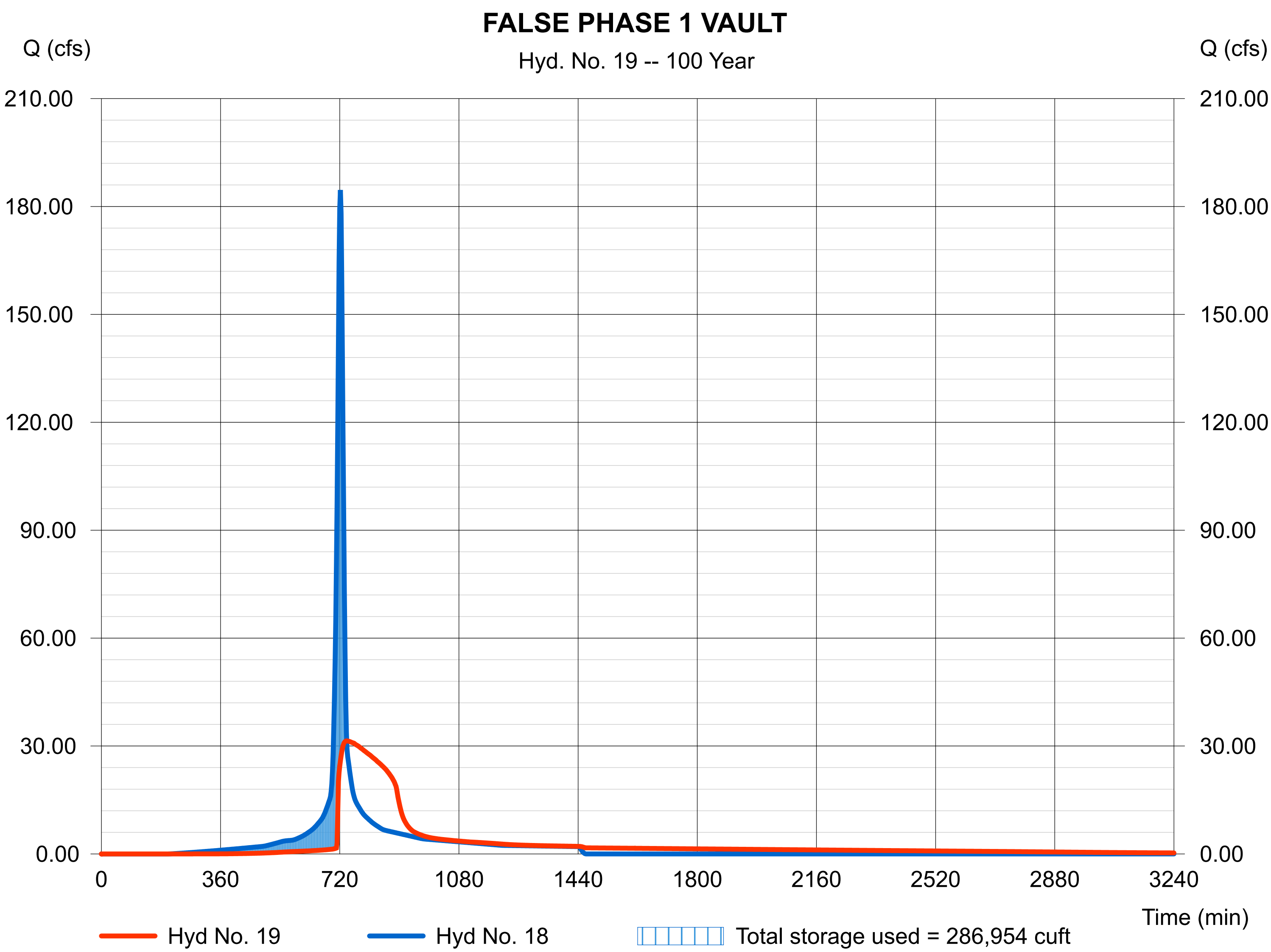
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 | Monday, 08 / 19 / 2019

Hyd. No. 19

FALSE PHASE 1 VAULT

Hydrograph type	= Reservoir	Peak discharge	= 31.42 cfs
Storm frequency	= 100 yrs	Time to peak	= 742 min
Time interval	= 2 min	Hyd. volume	= 539,611 cuft
Inflow hyd. No.	= 18 - POST DB1	Max. Elevation	= 965.74 ft
Reservoir name	= FALSE POND	Max. Storage	= 286,954 cuft

Storage Indication method used.



Hydrograph Report

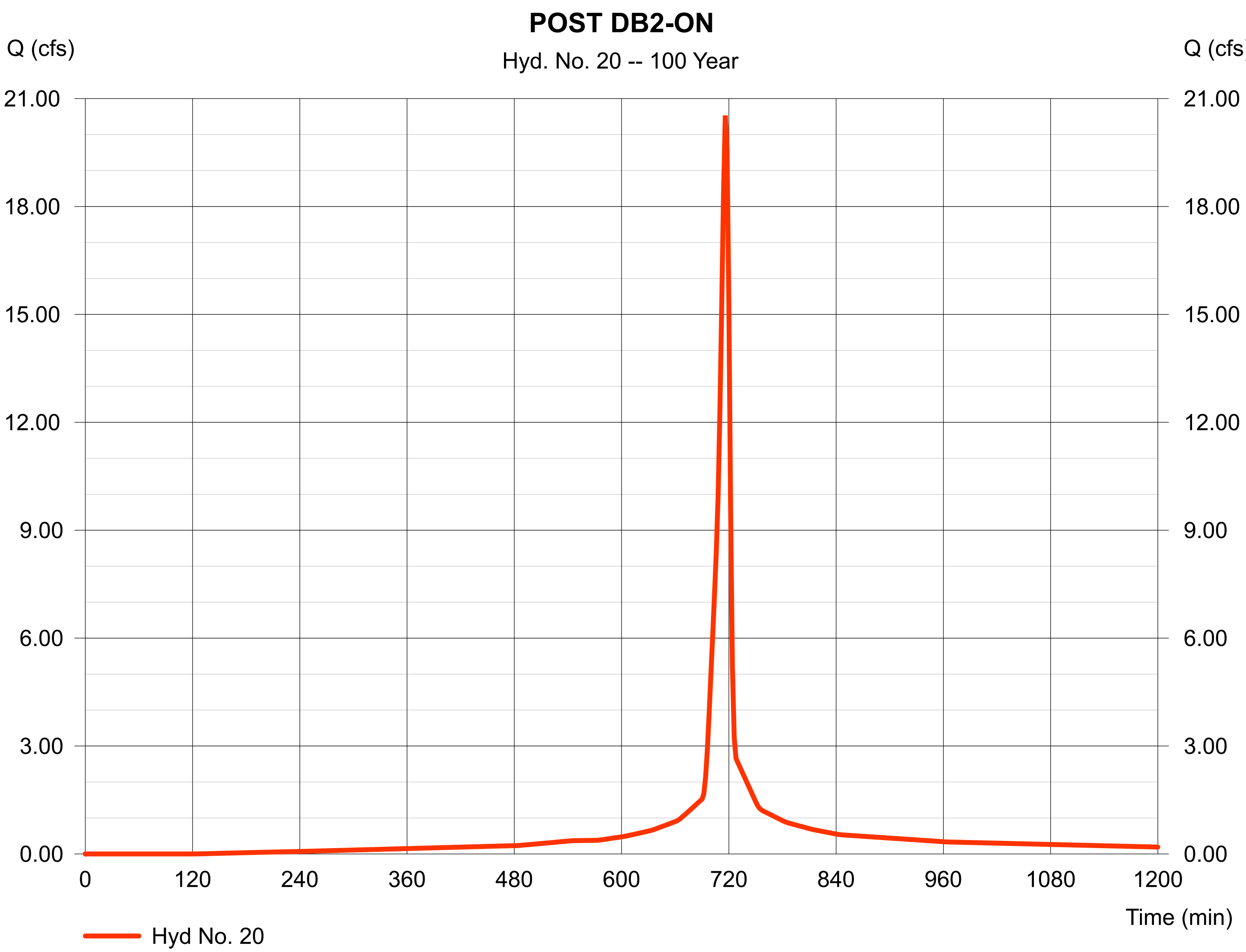
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 20

POST DB2-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 20.53 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 46,453 cuft
Drainage area	= 1.960 ac	Curve number	= 92*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.090 x 61) + (0.280 x 85) + (13.450 x 98) + (1.000 x 55)] / 1.960



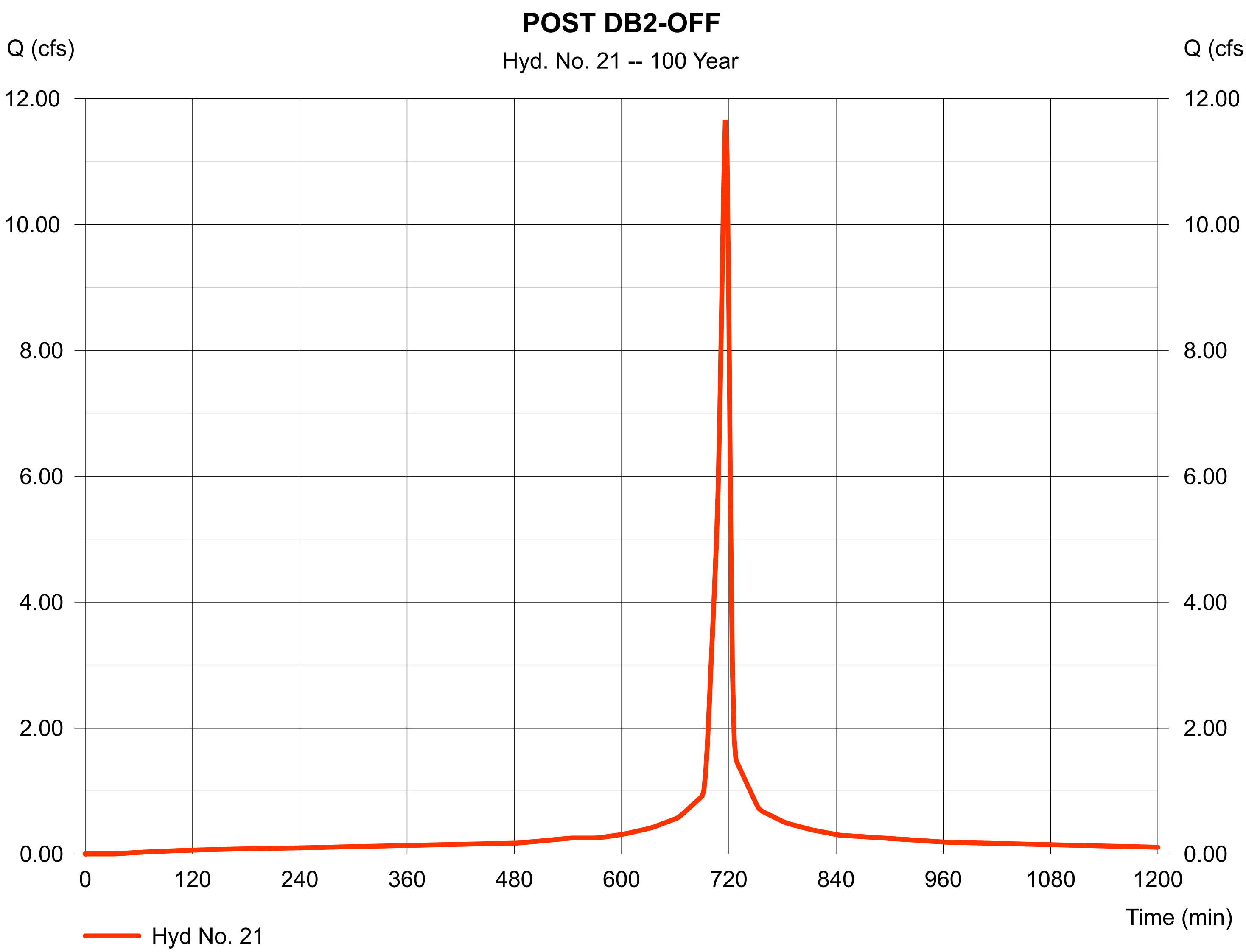
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 21

POST DB2-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 11.66 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 28,228 cuft
Drainage area	= 1.080 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



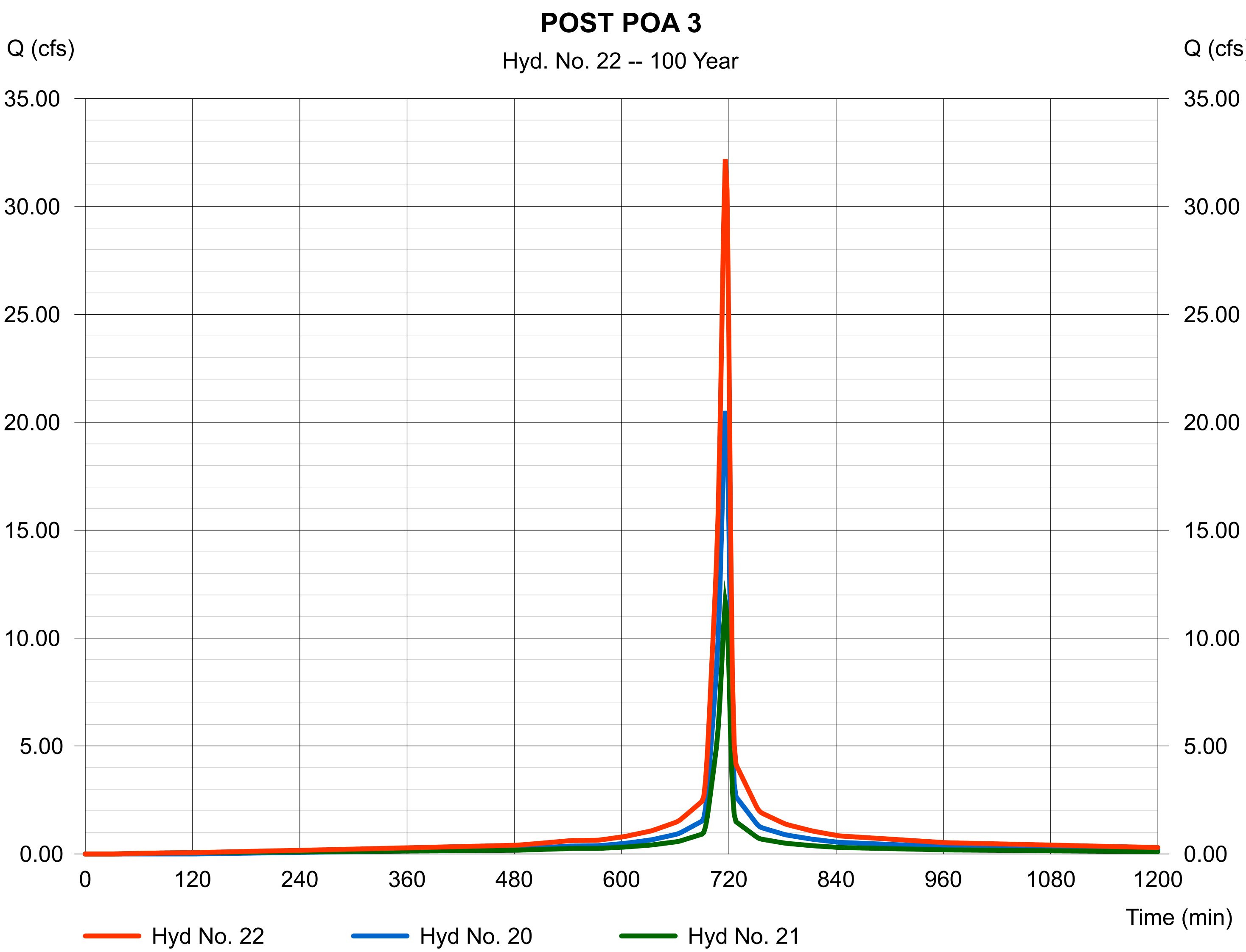
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 22

POST POA 3

Hydrograph type	= Combine	Peak discharge	= 32.19 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 74,680 cuft
Inflow hyds.	= 20, 21	Contrib. drain. area	= 3.040 ac



Hydrograph Report

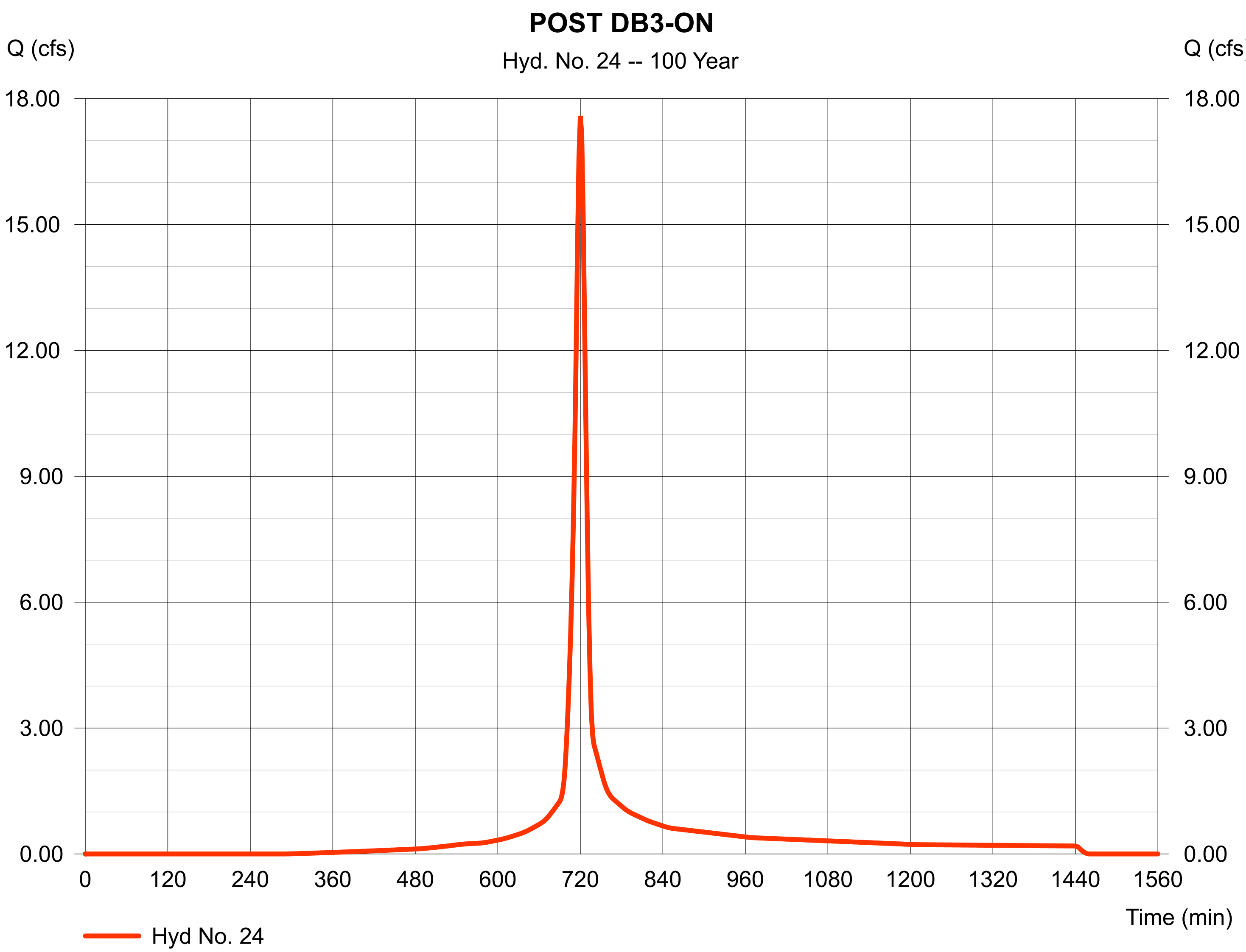
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 — Monday, 08 / 19 / 2019

Hyd. No. 24

POST DB3-ON

Hydrograph type	= SCS Runoff	Peak discharge	= 17.59 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 46,670 cuft
Drainage area	= 2.200 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 11.27 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (2.810 x 61) + (10.490 x 98)] / 2.200



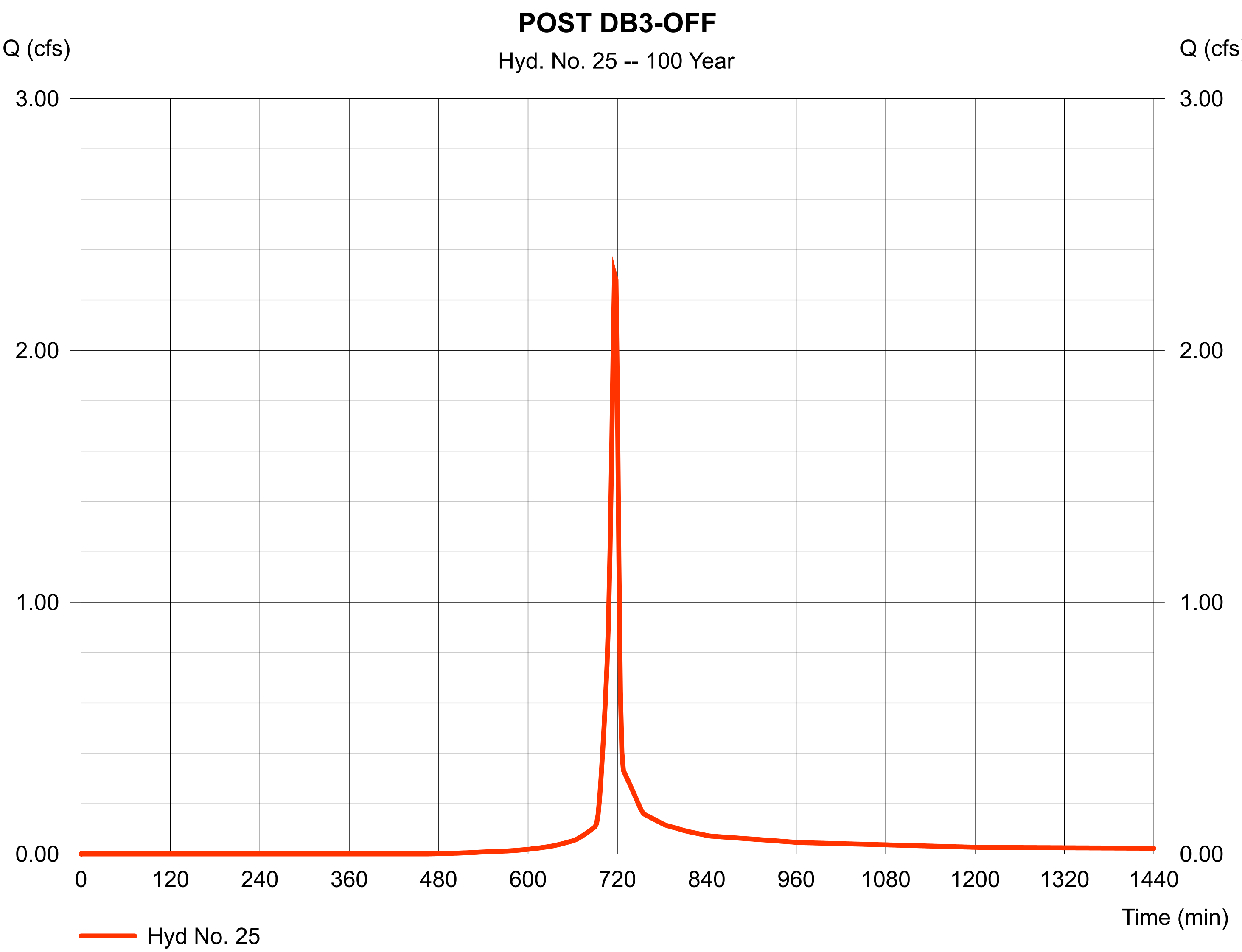
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 25

POST DB3-OFF

Hydrograph type	= SCS Runoff	Peak discharge	= 2.303 cfs
Storm frequency	= 100 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 4,663 cuft
Drainage area	= 0.320 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



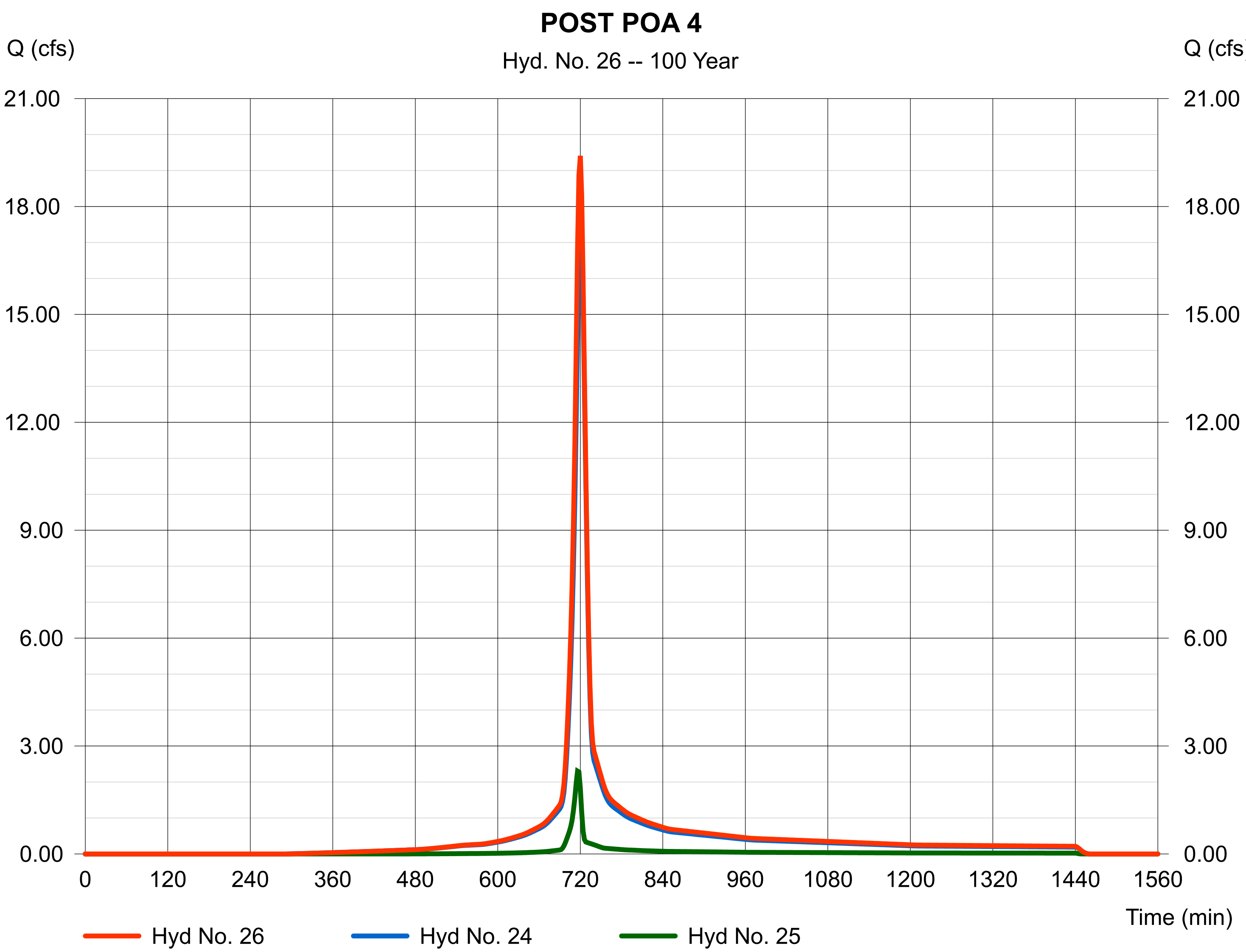
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 26

POST POA 4

Hydrograph type	= Combine	Peak discharge	= 19.41 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 51,332 cuft
Inflow hyds.	= 24, 25	Contrib. drain. area	= 2.520 ac



Hydrograph Report

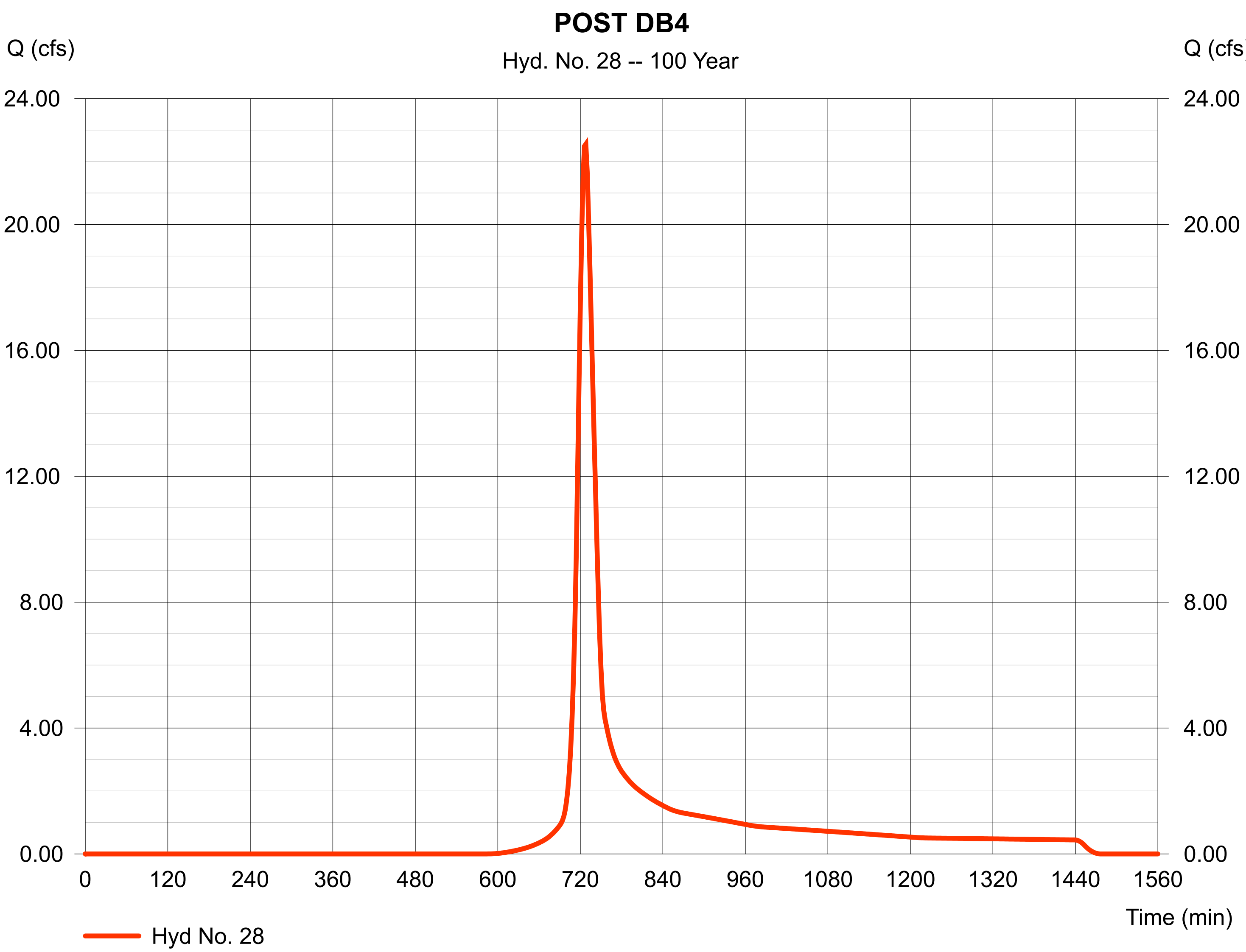
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 28

POST DB4

Hydrograph type	= SCS Runoff	Peak discharge	= 22.55 cfs
Storm frequency	= 100 yrs	Time to peak	= 728 min
Time interval	= 2 min	Hyd. volume	= 79,584 cuft
Drainage area	= 6.580 ac	Curve number	= 60*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.94 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.520 x 98) + (4.480 x 61)] / 6.580



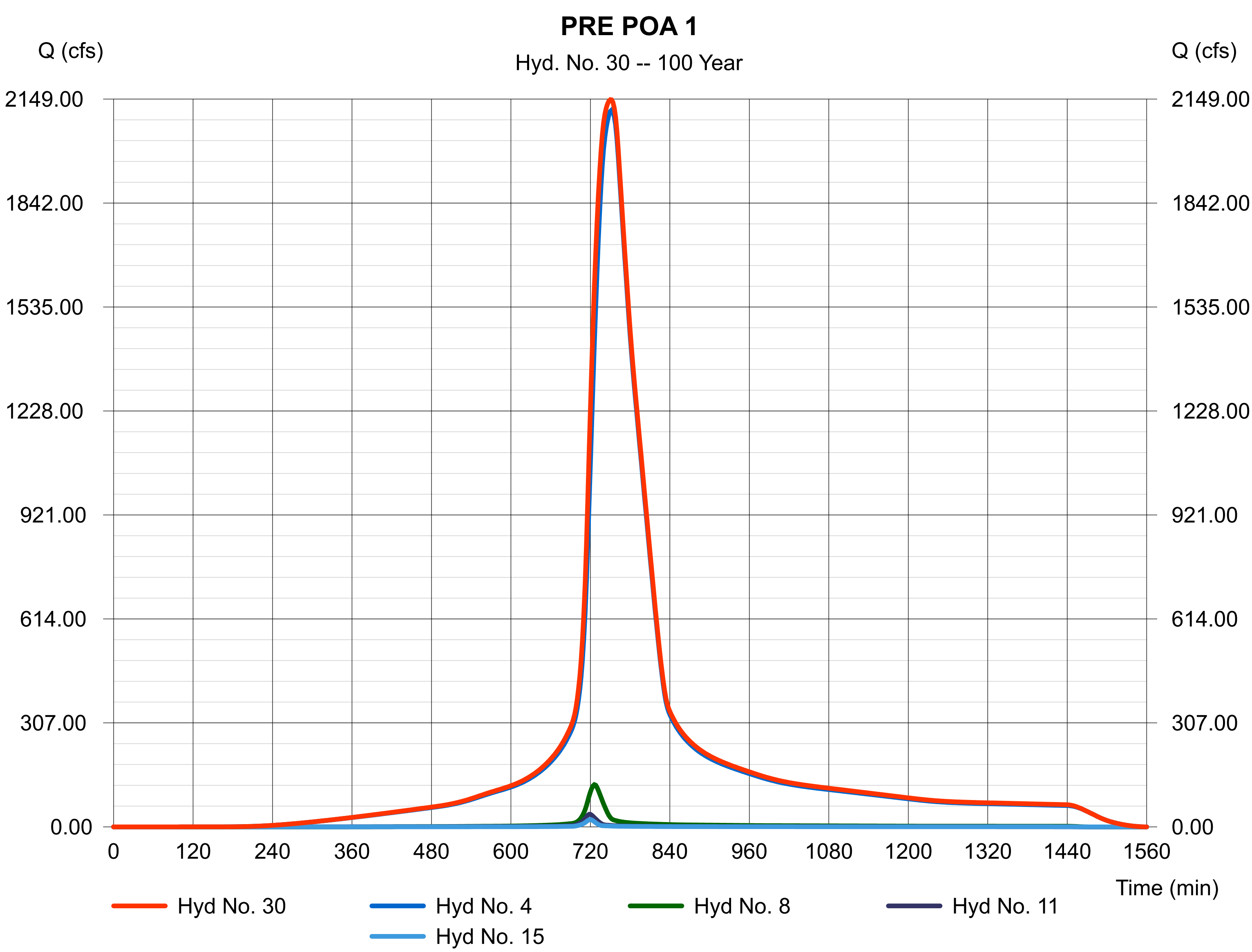
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 30

PRE POA 1

Hydrograph type	= Combine	Peak discharge	= 2147.35 cfs
Storm frequency	= 100 yrs	Time to peak	= 750 min
Time interval	= 2 min	Hyd. volume	= 17,306,372 cuft
Inflow hyds.	= 4, 8, 11, 15	Contrib. drain. area	= 22.020 ac



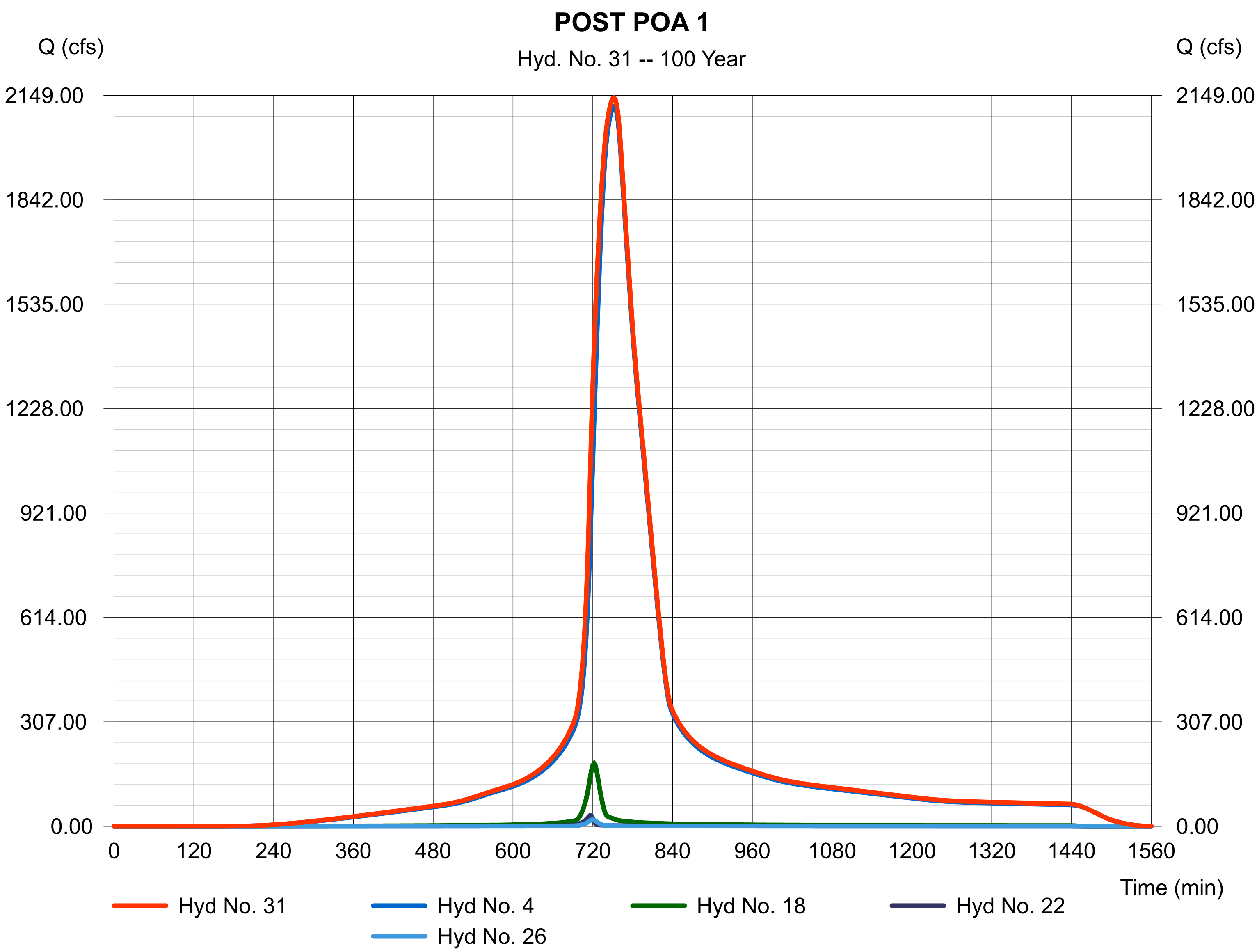
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 31

POST POA 1

Hydrograph type	= Combine	Peak discharge	= 2142.36 cfs
Storm frequency	= 100 yrs	Time to peak	= 752 min
Time interval	= 2 min	Hyd. volume	= 17,371,092 cuft
Inflow hyds.	= 4, 18, 22, 26	Contrib. drain. area	= 24.120 ac



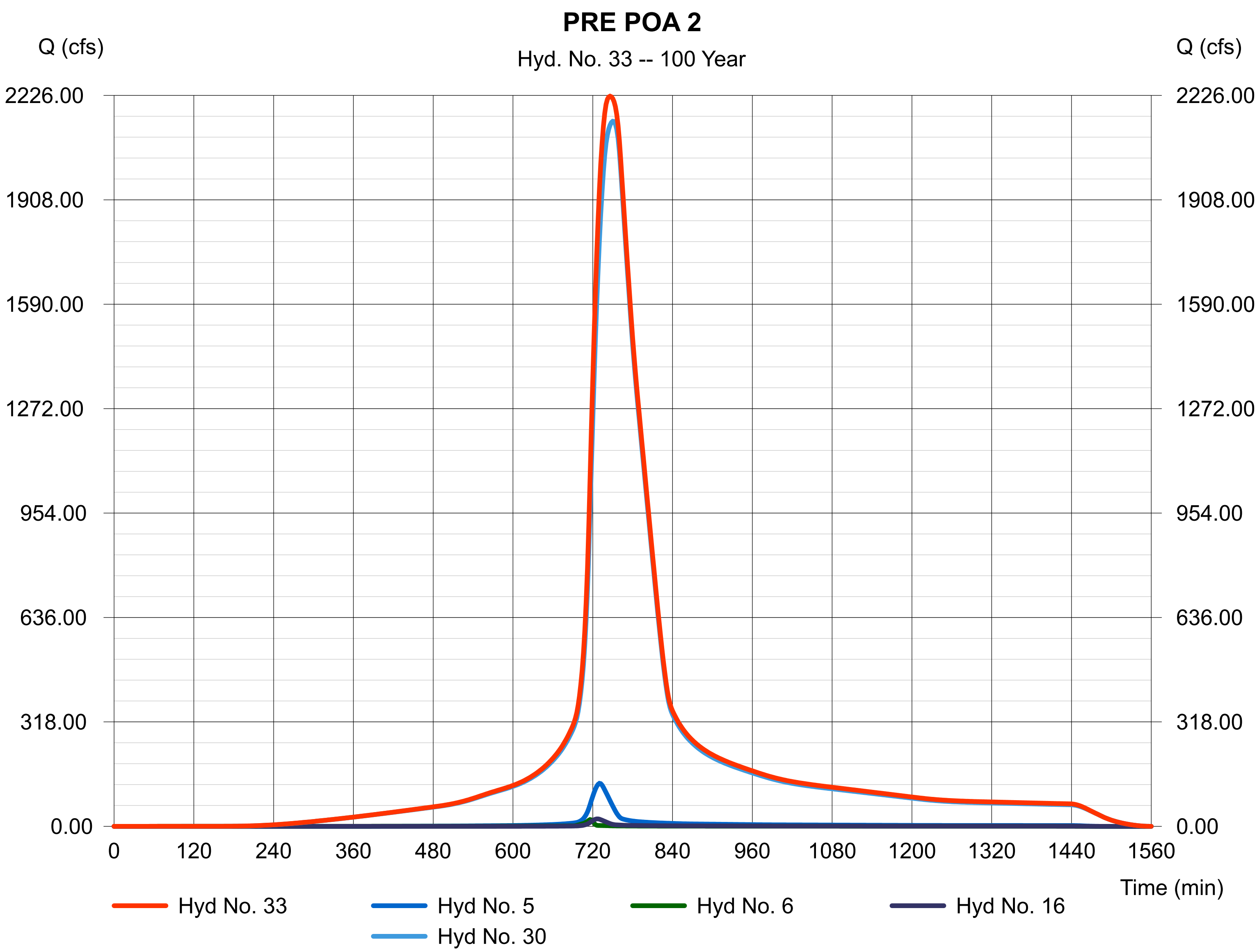
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 33

PRE POA 2

Hydrograph type	= Combine	Peak discharge	= 2223.56 cfs
Storm frequency	= 100 yrs	Time to peak	= 746 min
Time interval	= 2 min	Hyd. volume	= 17,958,768 cuft
Inflow hyds.	= 5, 6, 16, 30	Contrib. drain. area	= 37.480 ac



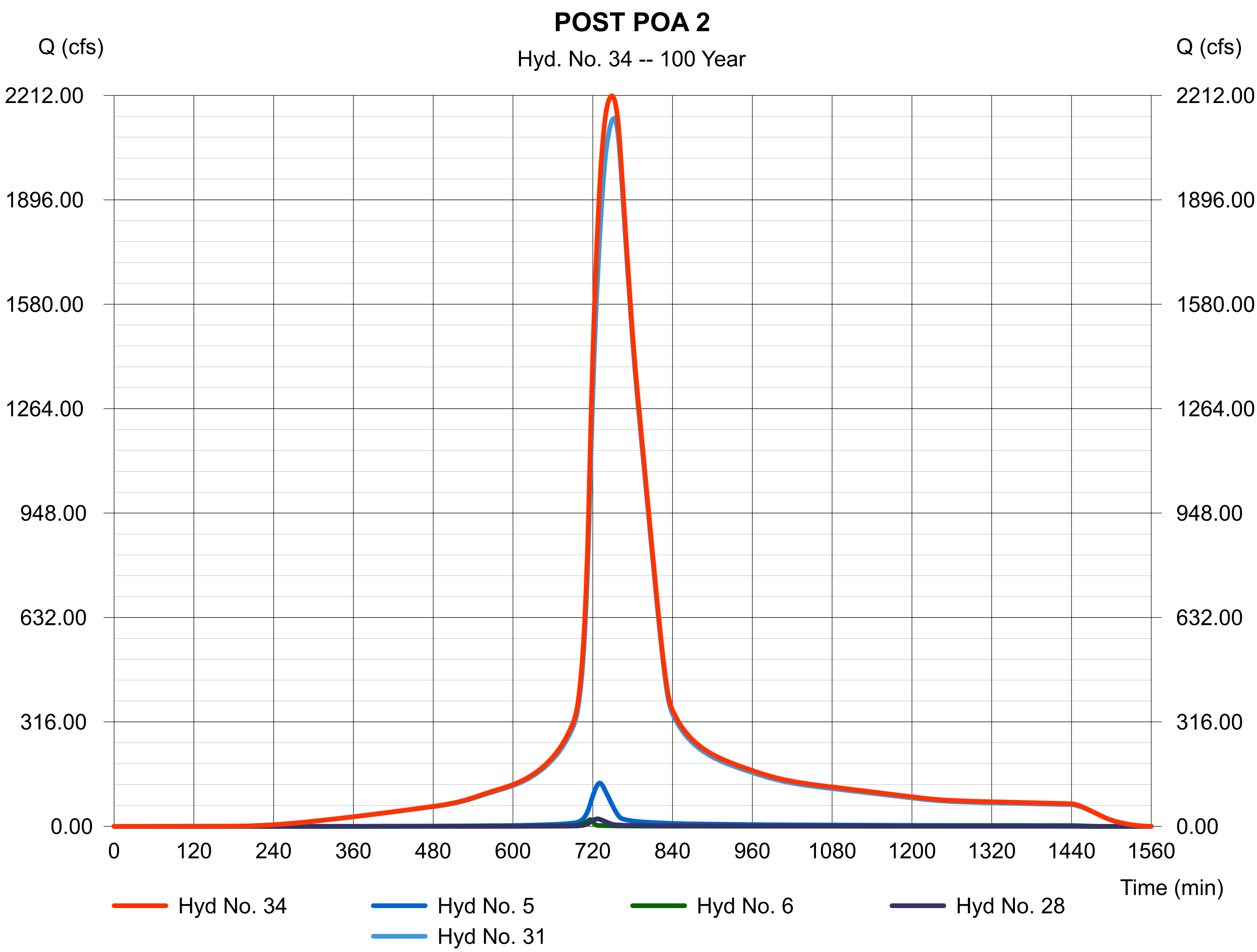
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 08 / 19 / 2019

Hyd. No. 34

POST POA 2

Hydrograph type	= Combine	Peak discharge	= 2210.22 cfs
Storm frequency	= 100 yrs	Time to peak	= 748 min
Time interval	= 2 min	Hyd. volume	= 18,023,470 cuft
Inflow hyds.	= 5, 6, 28, 31	Contrib. drain. area	= 37.480 ac



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