MACRO STORM WATER DRAINAGE STUDY

WOODLAND OAKS

SW Corner Colbern & Blackwell

Site Acreage: 20.81 Acres

Lee's Summit, MO

PREPARED BY:

ENGINEERING SOLUTIONS
ENGINEERING & SURVEYING
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Submittal Date: March 3, 2020

Matthew J. Schlicht, PE

Revision

Date	Comment	By
3-24-20	Revised Per City Comments	AEP
4-6-20	Revised Per City Comments Dated 3-31-20	AEP
5-26-20	Revised Per City Comments Dated 4-15-20	AEP

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3. GENERAL INFORMATION

This storm study has been prepared to evaluate potential impacts of the proposed single family residential subdivision, Woodland Oaks. The proposed development shall consist of 42 single family residential lots. The site is located at the southwest corner of Colbern Road and Blackwell Road. The site contains 20.81 acres. The existing site consists mainly of grass meadow with some wooded areas. There are currently no water bodies nor storm sewer systems on site. The property is bound by Colbern Road to the north, Blackwell Road to the east, Woodland Shores single family residential subdivision to the south and a large acre single family tract to the west. Woodland Oaks is tributary to Lake Jacomo which is located to the northwest just across Colbern Road. The site is a tract of land located in SE ¼ of Section 27, Township 48 North, and Range 31 West. See Exhibit A for an aerial view of the site along with the surrounding area.

3.1 FEMA FLOODPLAIN DETERMINATION

The property is located in an Area of Minimal Flood Hazard, Zone X, according to FEMA Firm Map Number 29095C0430G, effective January 20, 2017.

See Exhibit B for a FIRMette which includes the proposed project area.

3.2 NRCS SOIL CLASSIFICATION

Soil classifications published by the United States Department of Agriculture/National Resources Conservation Service (USDA/NRCS) website for Jackson County, Missouri, Version 20, September 16, 2019. The existing site contains six major soil types:

10117	Sampsel Silty Clay Loam, 5 to 9 Percent Slopes Hydrologic Soils Group (HSG): Type C/D
10122	Sharpsburg Silt Loam, 5 to 9 Percent Slopes (HSG): Type C
10128	Sharpsburg-Urban Land Complex, 2 to 5 Percent Slopes (HSG): Type D
10141	Snead-Rock Outcrop Complex, 14 to 30 Percent Slopes (HSG): Type D
10179	Udarents-Urban Land Osaka-Complex, 5 to 9 Percent Slopes (HSG): Type D
60025	Urban Land Harvester-Complex, 2 to 9 Percent Slopes (HSG): Type C

See Exhibit C for a detailed soils report of the proposed project site.

4. METHODOLOGY

This Macro Storm Drainage Study has been prepared to evaluate potential hydrologic impacts from the proposed development and recommend improvements to eliminate potential negative impacts. The study utilized existing city contours to create the Pre-Development Drainage Area Map. The study conforms to the requirements of the City of Lee's Summit, Missouri "Design and Construction Manual" and all applicable codes and criteria referred to therein.

Using the above criteria, the proposed site was evaluated using SCS Methods to calculate storm runoff volumes, peak rates of discharge, pre and post developed hydrographs and required storage volumes for detention facilities. The analysis contains results for the 2, 10 and 100-year design storms.

5. EXISTING CONDITIONS ANALYSIS

The site has five (5) drainage subareas all consisting of meadow/wooded land that drain offsite along with two (2) offsite drainage subareas that drain through the site from Woodland Shores. Following are brief descriptions of each drainage subarea.

- Subarea A, 1.36 acres, consists primarily of Colbern Road right-of-way. The subarea drains to the Northwest along Colbern Road where it is collected by a curb inlet on Colbern. Subarea A will be evaluated at the curb inlet on Colbern, Point of Interest A

-Subarea B, 0.75 acres, is located along the north edge of the property and consists primarily of Colbern Road right-of-way. The subarea drains via sheet and gutter flow to a sump curb inlet for further conveyance north to Lake Jacomo.

-Subarea C, 1.10 acres, is located along the eastern edge of the property and consists primarily of Colbern and Blackwell Road right-of-way's. Runoff drains to the northeast where it is collected by an enclosed storm sewer system located at the intersection of Colbern and Blackwell Roads. Subarea C will be evaluated at the offsite curb inlet located on Colbern Road, Point of Interest C.

-Subarea D, 9.34 acres, is generally located on the west side of the property and drains to the west via sheet and shallow concentrated flow. Runoff is collected by two ponds on the neighbor's property. Excess flow from the downstream pond is conveyed to the north via a culvert under Colbern Road for eventual conveyance to Lake Jacomo. Subarea D will be evaluated at the west property line, Point of Interest D.

-Subarea E, 8.26 acres, is generally located on the east side of the property and drains to the north via sheet and shallow concentrated flow. Runoff is collected and conveyed by a culvert connected to an enclosed storm sewer system running along Colbern Road. Subarea E will be evaluated at the culvert entrance, Point of Interest, E.

-Offsite Undetained, 3.90 acres, is located adjacent to the southwest corner of the property and drains through the southwest corner of the property, Subarea D, via sheet and shallow concentrated flow. The subarea was evaluated at the south property line.

-Offsite Detained, 14.21 acres, is located adjacent to Subarea D just east of the Offsite Undetained Subarea. Runoff from this subarea is detained in an earthen reservoir where it is attenuated then released via a culvert to the southwest corner of Woodland Oaks. Both offsite subareas will be conveyed via a bypass channel around the proposed southwest detention basin, Basin D1. Woodland Shores 3rd Plat Offsite Detained Subarea data has been modeled in Hydraflow to determine peak discharge rates. Offsite Detained and Offsite Undetained Subarea data has been combined in Hydraflow as Offsite Bypass, to size the bypass channel. Storm sewer data from Woodland Shores 3rd Plat may be found in Exhibit D along with capacity calculations for the proposed bypass channel. Woodland Shores 3rd Plat detention system structures and piping have been field verified and shot. Elevations and data are in-line with recorded as-built information. Attenuation from offsite detention was not accounted for in the sizing of the bypass channel.

An Existing Drainage Map may be found in Exhibit E. Hydraflow Hydrograph software was utilized to calculate SCS Method peak discharge rates. A complete breakdown of Existing and Proposed hydrographs may be found in Exhibit F. The following tables summarize the results of the Existing Conditions analysis.

Table 5.1 Existing Conditions Subarea

Subarea	Area (ac.)	Curve Number	Tc (min)
A	1.36	82	9.5

B	0.75	82	7.5
C	1.10	82	6.0
D	9.34	74	11.6
E	8.26	74	11.6
Offsite Undetained	3.90	82	8.6
Offsite Detained	14.21	82	14.5

Table 5.2 Existing Conditions Runoff Data: Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	3.89	7.01	11.71
B	2.24	4.02	6.70
C	3.63	6.49	10.80
D	17.43	36.03	65.98
E	15.42	31.86	58.35
Ex B Combined	17.43	35.62	64.55
Offsite Bypass*	11.15	20.11	33.57

Ex B Combined = (B + E)

*The Offsite Bypass Subarea shows results for the Woodland Shores hydrograph detailed in the Hydraflow Report in Exhibit F representing the combination of Offsite Undetained and Offsite Detained Subareas. Attenuation of offsite runoff was not accounted for in an effort to be conservative in the sizing of the bypass channel. The "Ex B Combined" hydrograph will be used in Section 6.0 for comparative analysis.

Per APWA Section 5608.4 and City of Lee's Summit criteria, the performance criteria for detention is to provide detention to limit peak flow rates at downstream points of interest to maximum release rates:

- 50% storm peak rate less than or equal to 0.5 cfs per site acre
- 10% storm peak rate less than or equal to 2.0 cfs per site acre
- 1% storm peak rate less than or equal to 3.0 cfs per site acre

Due to the nature of the drainage areas onsite and the surrounding infrastructure the onsite subarea limits were tied to the property boundaries.

Table 5.3 Existing Conditions APWA Allowable Peak Discharge Release Rates

Subarea	Onsite Area (ac.)	Offsite Area (ac.)	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	1.36	N/A	0.68	2.72	4.08
B	0.75	N/A	0.38	1.50	2.25
C	1.10	N/A	0.55	2.20	3.30
D	9.34	N/A	4.67	18.68	28.02
E	8.26	N/A	4.13	16.52	24.78

Subareas A, B and C are peripheral (free release) areas on the site consisting mainly of existing right-of-way. These areas are not being negatively impacted by the proposed improvements. Subareas D and E contain the majority of the area onsite along with the actual hard infrastructure improvements. Subareas D and E will be the focus of this report.

6. PROPOSED CONDITIONS ANALYSIS

The difference between Existing and Proposed Conditions is a direct result of the new single family residential development. Subareas A and C have been reduced significantly due to redirection of their tributary areas with proposed grading. Subarea B has increased slightly due to the creation of a detention basin to detain runoff from Subarea E. The additional land area will be turf lined and consist of the backside of the earthen dam. New detention systems shall be used to attenuate post development runoff from Subareas D1 and E. Subarea D shall continue to drain to the westerly neighbor via sheet and shallow concentrated flow. A Proposed Drainage Map may be found in Exhibit G.

Proposed Flow Rates

The proposed flow rates were calculated with the use of composite curve numbers as applicable. Subareas D, D1 and E utilize composite curve numbers due to the amount of turf area associated with proposed detention in each area. The curve numbers were determined based on APWA Table 5602-3 for residential lots. A curve of 82 was used for single family areas and a curve number of 74 was used for turf areas.

Table 6.1 Proposed Conditions Subarea Data

Subarea	Area (ac.)	Composite CN	Tc (min)
A	1.03	82	6.8
B	0.89	82	7.4
C	0.55	82	8.7
D	1.34	79	9.7
D1	6.00	82	9.6
E	11.00	81	11.8

Table 6.2 Proposed Conditions Runoff Data: Sub-Area Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	3.07	5.52	9.20
B	2.65	4.77	7.95
C	1.57	2.84	4.73
D	3.37	6.36	10.96
D1	17.16	30.94	51.64
E	27.74	50.20	83.98

As shown in Table 6.2 above Subareas D and E will require detention to attenuate storm runoff at or below regulatory levels. Subarea B has increased slightly due to the geometry of the detention basin configuration however Subareas E and B are tributary to the same enclosed storm sewer system crossing Colbern. Peak discharge rates from these combined subareas will be below Allowable Release Rates as detailed in Table 5.3. Existing Subarea D has been divided into subareas D and D1. Subarea D will continue to free release to the west while subarea D1 will be captured and routed through the new southwest detention basin for attenuation.

6.1. DETENTION

A new single stage earthen detention basin E is being proposed in Sub-basin E to attenuate proposed peak discharge rates. Following are a list of design parameters for the detention system.

Designation: Detention Basin E
Type: Earthen Basin
Side Slopes: 3:1 Max.
Bottom Slope: 2% Min., Turf Lined
Basin Bottom Elevation: 934.6 @ Influent Pipe
Basin Top Berm Elevation: 944.00
Basin Volume: 200,503 cf @ 944.00
Control Structure: 5'x5' Precast Concrete Box with Interior 6" Baffle/Weir Wall
Baffle Wall Orifices: (8) 1" Diameter on 4" Centers, FL=934.00 (Bottom Orifice)
(1) 15" Diameter, FL=937.50
Baffle Wall Crest Elevation: 942
Control Structure Top Elevation: 944.00
Control Structure Overflow Weir Openings: N/A – NO Field Inlet Openings
Control Structure Influent Pipe: 30" HDPE, FL (In) = 934.60, FL (Out) = 934.20, L=51', S= 0.78%
Control Structure Effluent Pipe: 36" RCP, FL (In) = 932.78, FL (Out) = 924.42, L=47', S=17.64%
Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=942.00, Crest Length=160'
Consecutive 100-YR Q=83.98 cfs, Emergency Spillway HGL=942.34', Freeboard=1.66'

The Detention Basin Plan for the Development may be found in Exhibit H. Basin E emergency spillway calculations may be found in Exhibit I. See Table 6.3 for a summary of detention basin data.

Table 6.3 Proposed Conditions Detention Basin E Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
Basin E						
2-Year	27.74	721	3.03	754	938.30	35,284
10-Year	50.20	721	7.99	738	939.66	63,060
100-Year	83.98	721	11.86	741	941.49	111,524

As shown in the table above all proposed peak discharge rates have been attenuated below both Existing and Allowable. See Table 6.4 below for a summary of proposed peak discharge rates at point of interest B which consists of combined subareas B and post detained E.

Table 6.4 Proposed Conditions Post Detention Point of Interest Peak Discharge Rates

Point of Interest	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
B	3.26	8.99	16.53

As shown in the above table all peak discharge rates attributable to Proposed Subareas B & E have been attenuated below both Existing and Allowable Peak Discharge rates as outlined in Tables 5.2 and 5.3, respectively.

A new single stage earthen detention basin D1 is being proposed in Sub-basin D1 to attenuate proposed peak discharge rates. As discussed previously the goal shall be to attenuate post development peak discharge rates at or below pre development rates. Following are a list of design parameters for the proposed detention system.

Designation: Detention Basin D1
Type: Earthen Basin
Side Slopes: 3:1 Max.
Bottom Slope: 2% Min., Turf Lined
Basin Bottom Elevation: 908.40 @ Influent Pipe
Basin Top Berm Elevation: 918.00
Basin Volume: 114,055 cf @ 918.00
Control Structure: 5'x4' Precast Concrete Box with Interior 6" Baffle/Weir Wall
Baffle Wall Orifices: (6) 1" Diameter on 4" Centers, FL=908.20 (Bottom Orifice)
(1) 12" Diameter, FL=913.00
Baffle Wall Crest Elevation: N/A
Control Structure Top Elevation: 916.10
Control Structure Overflow Weir Openings: None
Control Structure Influent Pipe: 24" HDPE, FL (In) = 908.40, FL (Out) = 908.30, L=25.47', S= 0.39%
Control Structure Effluent Pipe: 24" HDPE, FL (In) = 908.10, FL (Out) = 908.00, L=25.47', S= 0.39%
Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=916.10, Crest Length=128'
Consecutive 100-YR Q=51.64 cfs, Emergency Spillway HGL=916.39, Freeboard=1.61'

Basin D1 emergency spillway calculations may also be found in Exhibit I. See Table 6.5 for a summary of detention basin data.

Table 6.5 Proposed Conditions Detention Basin D1 Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
Basin D1						
2-Year	17.16	719	0.47	926	912.31	24,502
10-Year	30.94	719	1.35	811	913.89	43,577
100-Year	51.64	719	5.29	747	915.40	66,564

As shown in the table above all proposed peak flowrates have been attenuated below both Existing and Allowable. See Table 6.6 below for a summary of proposed peak discharge rates at point of interest D which consists of combined subareas D and routed Subarea D1.

Table 6.6 Proposed Conditions Post Detention Point of Interest Peak Discharge Rates

Point of Interest	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
D	3.62	6.83	13.59

As shown in the above table all peak discharge rates attributable to Proposed Subareas D and D1 have been attenuated below both Existing and Allowable Peak Discharge Rates as outlined in Table 5.2.

Table 6.7 below provides a comparison of runoff data between Proposed, Existing and Allowable Conditions for the Proposed Development.

Table 6.7 Point of Interest Discharge Comparison

		Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
Point A	Proposed	3.07	5.52	9.20
	Existing	3.89	7.01	11.71
	Difference	-0.82	-1.49	-2.51
	Allowable	0.68	2.72	4.08

	Difference	2.39	2.80	5.12
Combined Point B	Proposed	3.26	8.99	16.53
	Existing	17.43	35.62	64.55
	Difference	-14.17	-26.63	-48.02
	Allowable	4.51	18.02	27.03
	Difference	-1.25	-9.03	-10.50
Point C	Proposed	1.57	2.84	4.73
	Existing	3.63	6.49	10.80
	Difference	-2.06	-3.65	-6.07
	Allowable	0.55	2.20	3.30
	Difference	1.02	0.64	1.00
Combined Point D	Proposed	3.62	6.83	13.59
	Existing	17.43	36.03	65.98
	Difference	-13.81	-29.20	-52.39
	Allowable	4.67	18.68	28.02
	Difference	-1.05	-11.85	-14.43

Point A is a peripheral (free release) area made up primarily of right-of-way. No additional improvements are being proposed in this area. All proposed peak discharge rates will be below existing. Allowable release rates will not be met however the minimal area and associated runoff will not create adverse impacts to existing storm water infrastructure.

Combined Point B is a combination of Subarea B and post detained Subarea E. The runoff from this area utilizes the same storm sewer infrastructure to cross Colbern Road for further conveyance downstream to Lake Jacomo. This Subarea reduces peak discharge rates below both Existing and Allowable for all regulatory design storms.

Point C is a peripheral (free release) area made up primarily of right-of-way. No additional improvements are being proposed in this area. All proposed peak discharge rates will be below existing. Allowable release rates will not be met however the minimal area and associated runoff will not create adverse impacts to existing storm water infrastructure.

Combined Point D is a combination of Subarea D and D1. All subarea runoff will continue to be conveyed to a series of ponds located on the west neighbor. The proposed detention basin D1 will attenuate peak discharge rates below Existing and Allowable for all regulatory design storms.

7. 40 HOUR EXTENDED DETENTION

In addition to mitigation of peak flow rates, APWA Section 5608.4 also requires 40 hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). The proposed detention facilities will release the water quality event over a period of 40-72 hours. See Exhibit J for 40 hour extended detention calculations for each basin.

8. CONCLUSIONS & RECOMMENDATIONS

Runoff from the Development will be reduced below existing for all Subareas. A detention basin is being proposed in Subarea D1 to attenuate peak discharge rates. Detention Basin D1 will attenuate all proposed peak discharge rates below both Existing and Allowable. A detention basin will also be provided in Subarea E to attenuate peak discharge rates. Detention Basin E will attenuate all proposed peak discharge rates below both Existing and Allowable. No negative impacts are anticipated downstream of the Development. Subareas A, B, and C are peripheral areas of the Development and contain mainly established right-of-way. No improvements

are being proposed in these areas. Peak discharge rates from Subareas A, B and C will be reduced below Existing for all regulatory design storms. Allowable release rates which are peak discharge rate goals will not be met for the 2-yr storm for each subarea in addition to the 10-yr and 100-yr storms for Subareas A and C. See proposed Waivers for Allowable Peak Discharge Rates below. The study is in conformance with all applicable codes and regulations.

Waiver Requests:
Subarea A: Allowable (2-Yr), (10-Yr) & (100-Yr), Peripheral Area, Mainly Right-of-Way
Subarea B: Allowable (2-Yr), Peripheral Area, Mainly Right-of-Way
Subarea C: Allowable (2-Yr), (10-Yr) & (100-Yr), Peripheral Area, Mainly Right-of-Way

9. EXHIBITS

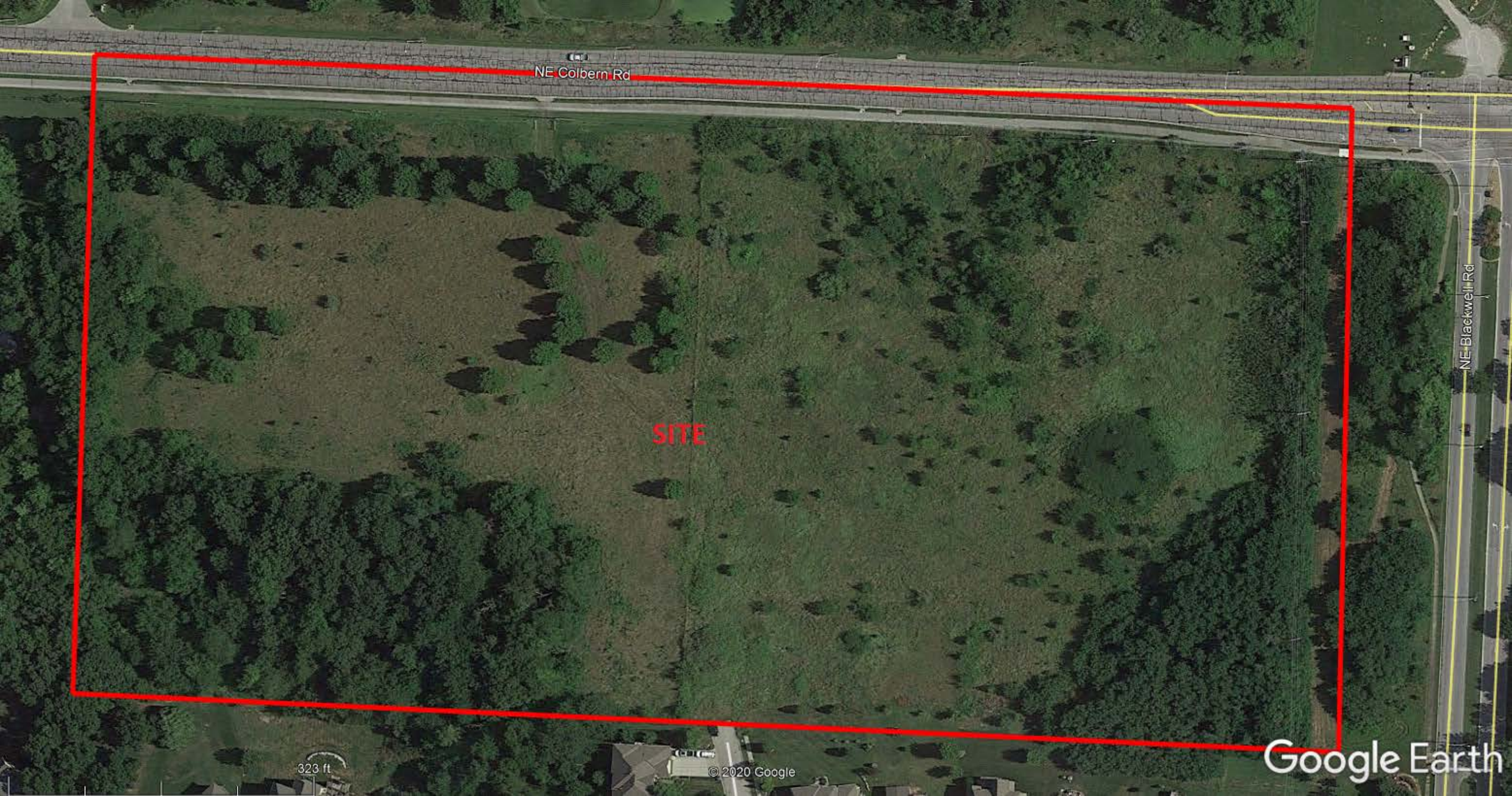
- **Exhibit A**
  - **Aerial View of Site**
  - **Aerial View of Site & Surrounding Area**
- **Exhibit B**
  - **FEMA FIRMette**
- **Exhibit C**
  - **NRCS Soils Report**
- **Exhibit D**
  - **Woodland Shores 3rd Plat – Storm Sewer Data**
  - **Proposed Bypass Channel Capacity Calculations**
- **Exhibit E**
  - **Existing Drainage Area Map**
- **Exhibit F**
  - **Hydraflow Hydrograph Report**
- **Exhibit G**
  - **Proposed Drainage Area Map**
- **Exhibit H**
  - **Detention Plan**
- **Exhibit I**
  - **Emergency Spillway Calculations**
- **Exhibit J**
  - **40 Hour Extended Detention Calculations**

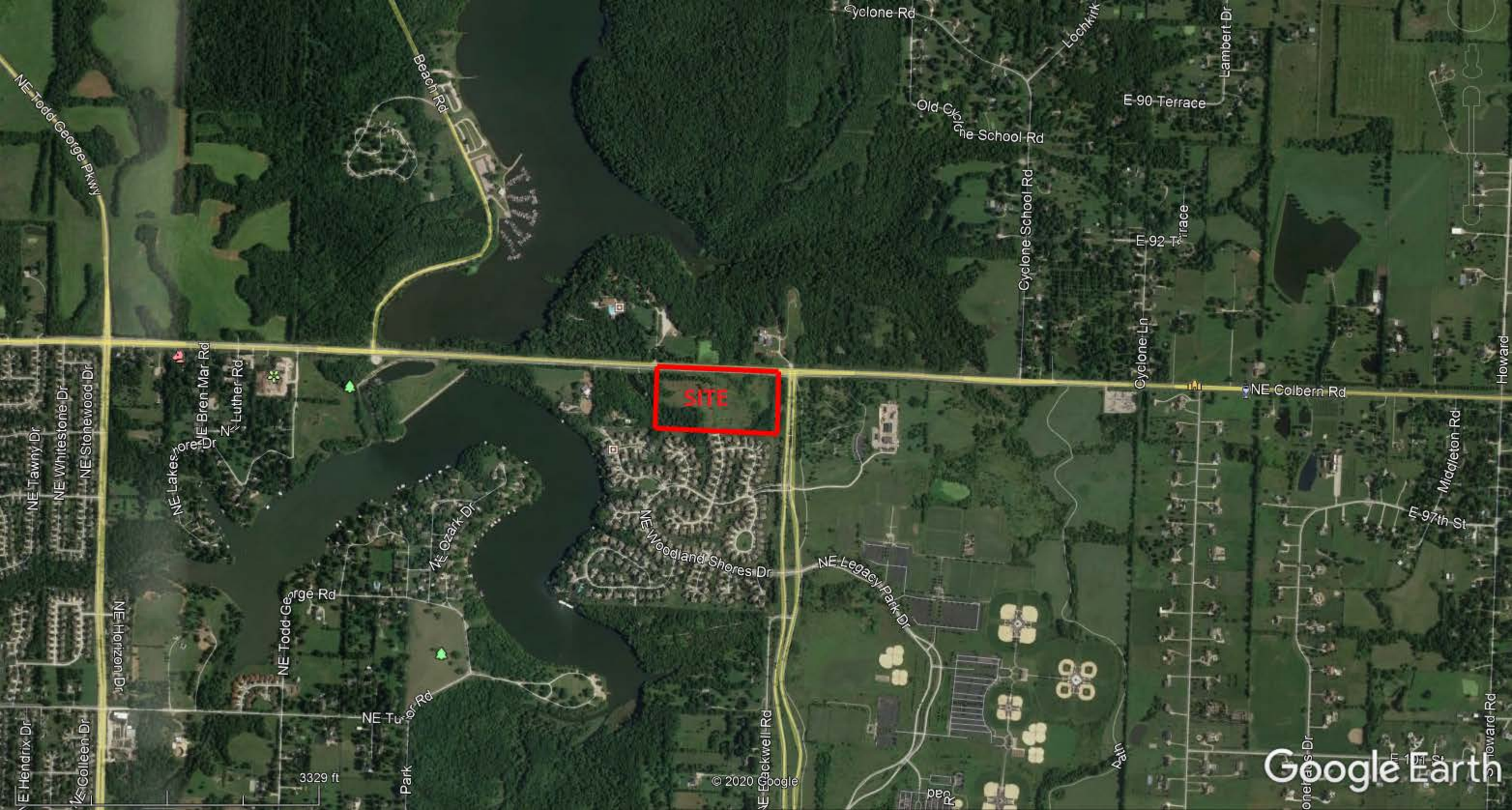
Exhibit A

Aerial View of Site

&

Aerial View of Surrounding Area


NE Colbern Rd
SITE
NE Blackwell Rd
323 ft
© 2020 Google
Google Earth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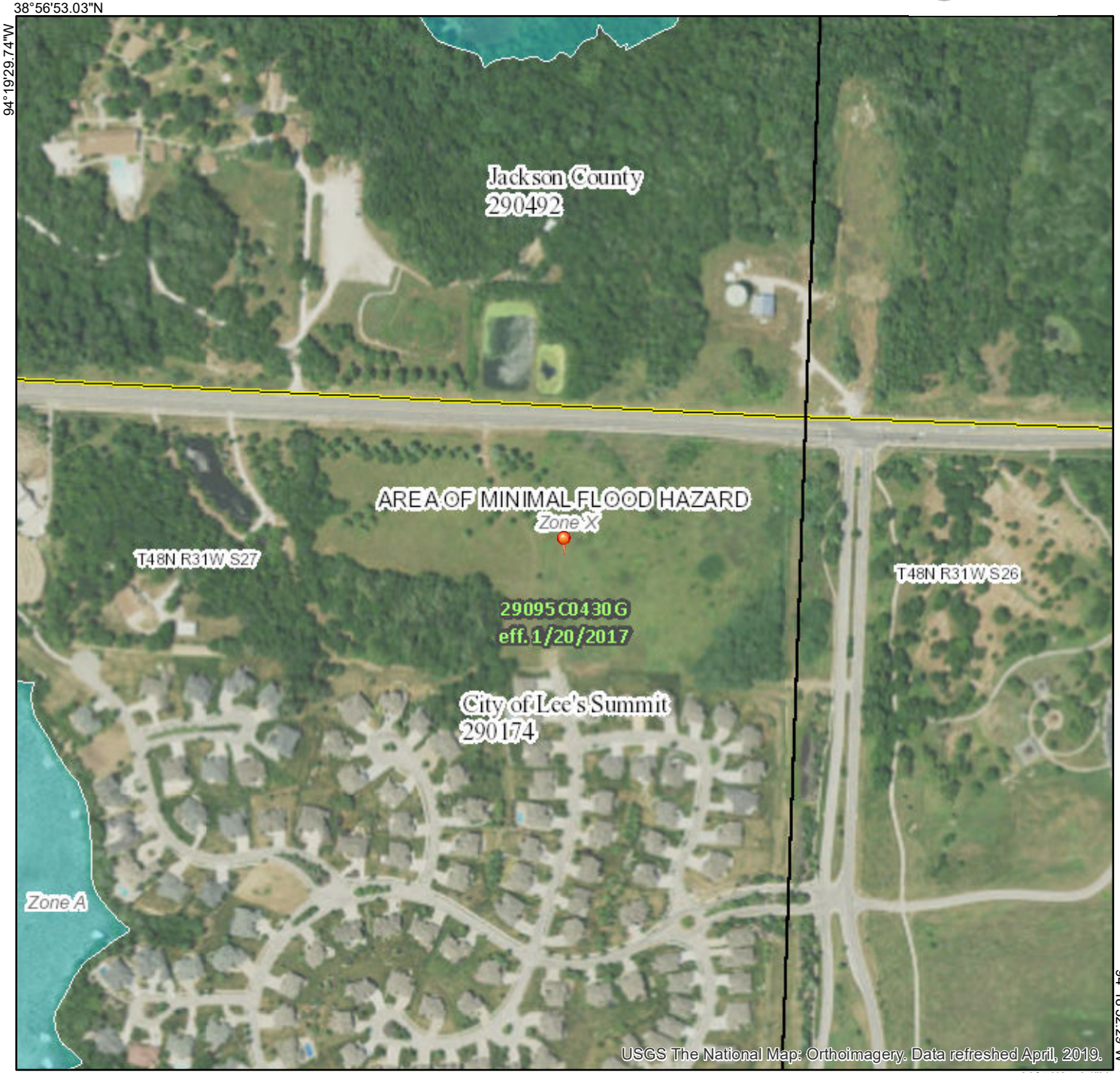
Cyclone Rd
Old Cyclone School Rd
Cyclone School Rd
E 90 Terrace
E 92 Terrace
Cyclone Ln
Lambert Dr
Howard
Middleton Rd
E 97th St
Howard Rd
Beach Rd
NE Todd George Pkwy
NE Bren Mar Rd
NE Luther Rd
NE Lakeshore Dr
NE Tawny Dr
NE Whitestone Dr
NE Stonewood Dr
NE Ozark Dr
NE Woodland Shores Dr
NE Legacy Park Dr
NE Todd George Rd
NE Tudor Rd
NE Horizon Dr
NE Hendrix Dr
Colleen Dr
NE Blackwell Rd
Park
Path
3329 ft
© 2020 Google
Google Earth

Exhibit B

FEMA FIRMette

National Flood Hazard Layer FIRMette

FEMA



Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN — Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 — Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- 513 — Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/2/2020 at 11:29:55 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Exhibit C

NRCS Soils Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for Jackson County, Missouri

March 2, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:2,270 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 30 60 120 180

Feet
0 100 200 400 600

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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: Jackson County, Missouri
Survey Area Data: Version 20, Sep 16, 2019

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

Date(s) aerial images were photographed: Sep 6, 2019—Nov 16, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10117	Sampsel silty clay loam, 5 to 9 percent slopes	3.9	18.6%
10122	Sharpsburg silt loam, 5 to 9 percent slopes, eroded	0.0	0.1%
10128	Sharpsburg-Urban land complex, 2 to 5 percent slopes	7.7	37.1%
10141	Snead-Rock outcrop complex, 14 to 30 percent slopes	5.2	24.9%
10179	Udarents-Urban land-Oska complex, 5 to 9 percent slopes	3.5	16.7%
60025	Urban land-Harvester complex, 2 to 9 percent slopes	0.5	2.6%
Totals for Area of Interest		**20.7**	**100.0%**

Map Unit Descriptions

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

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

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

components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

Jackson County, Missouri

10117—Sampsel silty clay loam, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2qkzz
Elevation: 600 to 900 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Sampsel and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sampsel

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Convex, concave
Parent material: Residuum weathered from shale

Typical profile

Ap - 0 to 13 inches: silty clay loam
Bt - 13 to 80 inches: silty clay

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Ecological site: Interbedded Sedimentary Upland Savanna (R109XY010MO)
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

10122—Sharpsburg silt loam, 5 to 9 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2yy7x
Elevation: 1,000 to 1,300 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Sharpsburg, eroded, and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sharpsburg, Eroded

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loess

Typical profile

Ap - 0 to 6 inches: silt loam
A - 6 to 8 inches: silty clay loam
Bt1 - 8 to 18 inches: silty clay loam
Bt2 - 18 to 46 inches: silty clay loam
BC - 46 to 58 inches: silty clay loam
C - 58 to 79 inches: silty clay loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 45 to 50 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C

Ecological site: Loess Upland Prairie (R107BY007MO)
Hydric soil rating: No

Minor Components

Higginsville, eroded
Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: Loess Upland Prairie (R109XY002MO)
Hydric soil rating: No

10128—Sharpsburg-Urban land complex, 2 to 5 percent slopes

Map Unit Setting
National map unit symbol: 2ql09
Elevation: 1,000 to 1,300 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Sharpsburg and similar soils: 60 percent
Urban land: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sharpsburg

Setting
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess

Typical profile
A - 0 to 17 inches: silt loam
Bt - 17 to 55 inches: silty clay loam
C - 55 to 60 inches: silty clay loam

Properties and qualities
Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 24 to 35 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very high (about 12.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: D
Ecological site: Loess Upland Prairie (R109XY002MO)
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

10141—Snead-Rock outcrop complex, 14 to 30 percent slopes

Map Unit Setting
National map unit symbol: 2ql0p
Elevation: 600 to 1,100 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition
Snead and similar soils: 70 percent
Rock outcrop: 15 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Snead

Setting
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope

Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from calcareous shale

Typical profile

Ap - 0 to 3 inches: silty clay loam
Bw - 3 to 24 inches: silty clay
Cr - 24 to 80 inches: bedrock

Properties and qualities

Slope: 14 to 30 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: Interbedded Sedimentary Backslope Savanna (R109XY012MO)
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: No

Description of Rock Outcrop

Typical profile

R - 0 to 80 inches: bedrock

Properties and qualities

Slope: 14 to 30 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Sampsel

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Convex
Across-slope shape: Concave

Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

10179—Udarents-Urban land-Oska complex, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 1n85j
Elevation: 700 to 1,200 feet
Mean annual precipitation: 33 to 43 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 175 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Udarents and similar soils: 41 percent
Urban land: 39 percent
Oska and similar soils: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udarents

Setting

Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Mine spoil or earthy fill

Typical profile

C1 - 0 to 5 inches: silt loam
C2 - 5 to 80 inches: silty clay loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C

Ecological site: Deep Loess Upland Prairie (R107BY002MO)
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Across-slope shape: Convex

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Description of Oska

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum

Typical profile

A - 0 to 7 inches: silty clay loam
Bt - 7 to 34 inches: silty clay loam
R - 34 to 80 inches: bedrock

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Ecological site: Limestone Upland Prairie (R112XY020MO)
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

60025—Urban land-Harvester complex, 2 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2qp0t
Mean annual precipitation: 37 to 47 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 184 to 228 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 50 percent
Harvester and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Description of Harvester

Setting

Landform: Hillslopes, interfluves
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Loess

Typical profile

C1 - 0 to 7 inches: silt loam
C2 - 7 to 31 inches: silty clay loam
C3 - 31 to 80 inches: clay loam

Properties and qualities

Slope: 2 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 30 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: Deep Loess Upland Woodland (F115BY001MO)
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

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United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Exhibit D

Woodland Shores 3rd Plat – Storm Sewer Data

&

Proposed Bypass Channel Capacity Calculations

17566

DRAWING FILE NAME:	PLOT SCALE:	DATE ISSUED:
13502-P3STDRNG.DWG	1:100	02/28/06

FILES ATTACHED:	DESIGNED BY:	DRAWN BY:	CHECKED BY:
5	RBH	RBH	JOB

ATTACHED FILE NAMES:
XRF13502.DWG, XRF13502ST.DWG, XRF13502SS.DWG
XRF13502WA.DWG, & XRF-CONTOURS.DWG

NO.	DATE	BY	REVISION
1	05/11/06	RBH	PER CITY COMMENTS DATED 04/24/06
2	06/12/06	RBH	REVISED INLETS 3-13B & 3-13C DRAINAGE AREAS

STATE OF MISSOURI
JOHN OSCAR BEALE
NUMBER A-18221
PROFESSIONAL ENGINEER
06/22/06

E. T. ARCHER CORPORATION D.B.A.
Archer
TOTAL PROJECT MANAGEMENT
CORPORATE OFFICE:
3741 NE TROON DRIVE
LEE'S SUMMIT, MO 64064
PHONE: 816-554-3019 • Fax: 816-554-3061

OTHER OFFICE LOCATIONS
- 8340 MISSION ROAD, SUITE 240, PRAIRIE VILLAGE, KS 66206 913-652-6757 FAX 816-347-1399
- 187 E. DAVID, P.O. BOX 989, FORSYTH, MO 65653 417-546-3218 FAX 417-546-5324
- 800 STARKS BUILDING, LOUISVILLE, KY 40202 502-581-9484 FAX 502-581-9485
- 1000 CITY PARKWAY, OSAGE BEACH, MO 65065 573-348-3222 FAX 573-348-3499
- 355 CARPENTER DRIVE, HOLLISTER, MO 65672 417-334-7817 FAX 417-334-8912
- 255 SO. UNION, SPRINGFIELD, MO 65802 417-865-4083 FAX 417-865-4085
- 2480 EXECUTIVE DRIVE, SUITE 116, ST. CHARLES, MO 63303 636-477-8389 FAX 636-477-7569

WOODLAND SHORES - PHASE 3
G & R DEVELOPMENT
LEE'S SUMMIT, MISSOURI

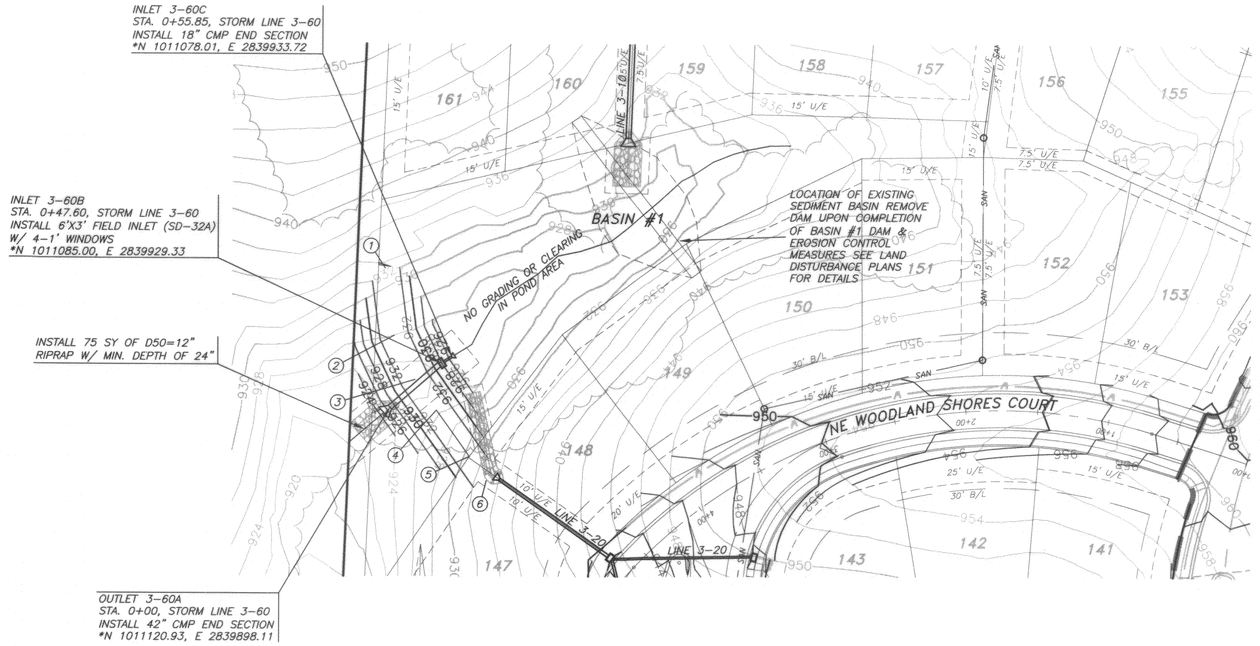
PROJECT NO. 23113502

STORM DRAINAGE MAP

DRAWING NO. 15

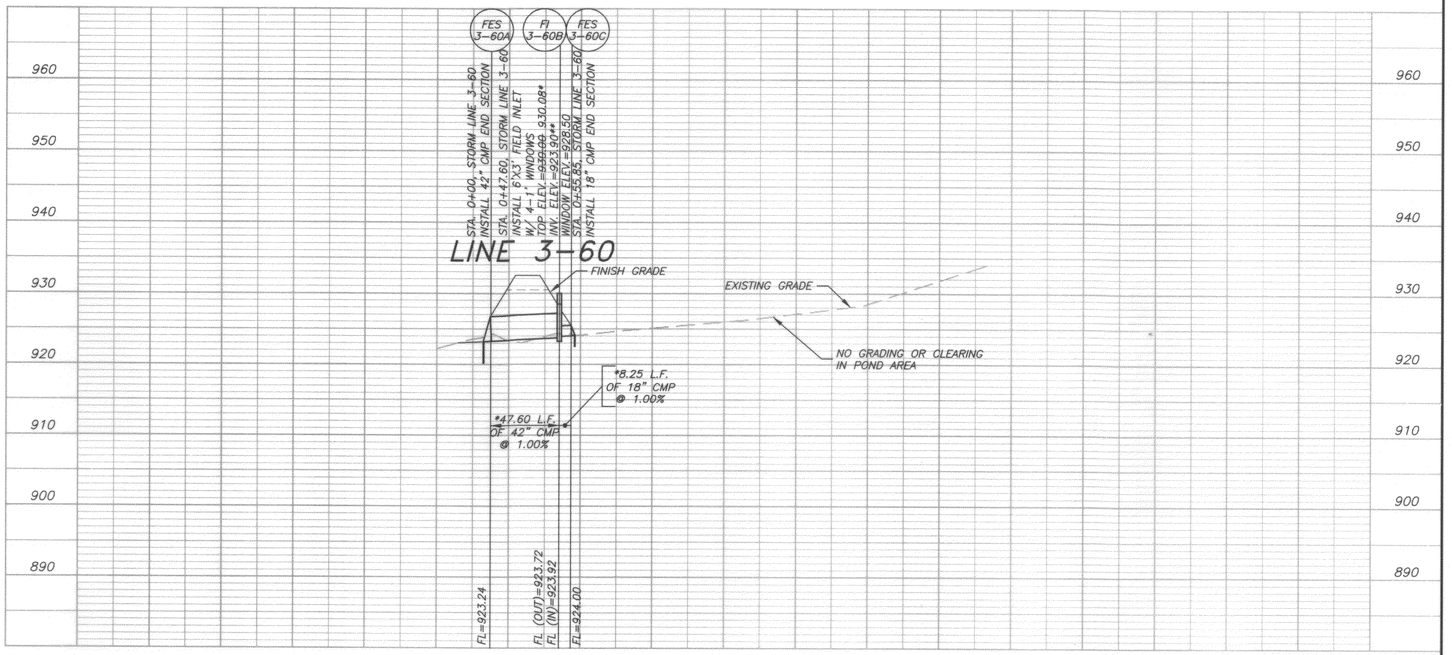
17571

DETENTION BASIN #1 INFORMATION	
	PROPOSED
DAM TOP ELEVATION	932.50
EMERGENCY SPILLWAY ELEVATION (L=40 FT)	930.50
BARREL PIPE FLOWLINE IN	923.72
BARREL PIPE DIAMETER (IN)	42
BARREL PIPE LENGTH (FT)	47.60
BARREL PIPE SLOPE (%)	1.00%
BARREL PIPE FLOWLINE OUT	923.24
TOP OF OUTLET STRUCTURE	930.00
TOTAL DRAINAGE AREA (AC)	14.21
Q 2-YEAR (CFS) PER TR-55 METHOD (EXISTING)	29.2
Q 2-YEAR (CFS) PER TR-55 METHOD (PROPOSED INFLOW)	34.2
Q 2-YEAR (CFS) PER TR-55 METHOD (PROPOSED OUTFLOW)	22.2
2-YEAR VOLUME AT ELEV. 928.30 (AC-FT)	0.36
2-YR. DEWATERING TIME (HRS)	11.83
Q 10-YEAR (CFS) PER TR-55 METHOD (EXISTING)	61.6
Q 10-YEAR (CFS) PER TR-55 METHOD (PROPOSED INFLOW)	62.9
Q 10-YEAR (CFS) PER TR-55 METHOD (PROPOSED OUTFLOW)	54.8
10-YEAR VOLUME AT ELEV. 929.24 (AC-FT)	0.58
10-YR. DEWATERING TIME (HRS)	11.90
Q 100-YEAR (CFS) PER TR-55 METHOD (EXISTING)	108.7
Q 100-YEAR (CFS) PER TR-55 METHOD (PROPOSED INFLOW)	101.9
Q 100-YEAR (CFS) PER TR-55 METHOD (PROPOSED OUTFLOW)	95.4
100-YEAR VOLUME AT ELEV. 929.80 (AC-FT)	0.74
100-YEAR DEWATERING TIME (HRS)	11.92



STAGE, STORAGE DISCHARGE TABLE		
STAGE (FT)	STORAGE (AC-FT)	DISCHARGE (CFS)
924	0.00	0.00
926	0.07	9.83
928	0.30	15.85
930	0.80	109.70
932	1.65	399.25
932.5	1.93	610.39

PROJECT COORDINATE LIST			
ID NO.	NORTHING	EASTING	DESCRIPTION
(1)	1011124.51	2839995.58	C/L TOP OF DAM
(2)	1011118.21	2839948.75	C/L TOP OF DAM
(3)	1011103.74	2839917.75	C/L TOP OF DAM
(4)	1011088.58	2839896.20	C/L DAM / EMERGENCY SPILLWAY
(5)	1011065.56	2839863.49	C/L DAM / EMERGENCY SPILLWAY
(5)	1011053.60	2839846.49	C/L TOP OF DAM



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13502-P3ST06.DWG	1:50	02/28/06
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6	RBH	RBH	JOB

ATTACHED FILE NAMES:
XRF13502.DWG, XRF13502SS.DWG, XRF13502ST.DWG, XRF13502STPRO.DWG, XRF13502WA.DWG
XRF-CONTOURS.DWG

NO.	DATE	BY	REVISION
1	05/11/06	RBH	PER CITY COMMENTS DATED 04/24/06
2	06/12/06	RBH	REVISED SEDIMENT BASIN NOTE AND CLEANED UP CONTOUR LABELS ON DETENTION BASIN DAM

STATE OF MISSOURI JOHN OSCAR BEALE NUMBER E-18221 PROFESSIONAL ENGINEER
03/21/07

E. T. ARCHER CORPORATION D.B.A.
Archer
TOTAL PROJECT MANAGEMENT
CORPORATE OFFICE:
3741 NE TROON DRIVE
LEE'S SUMMIT, MO 64064
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- 1000 CITY PARKWAY, OSAGE BEACH, MO 65065 573-348-3222 FAX 573-348-3499
- 355 CARPENTER DRIVE, HOLLISTER, MO 65672 417-334-7817 FAX 417-334-8912
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- 2480 EXECUTIVE DRIVE, SUITE 116, ST. CHARLES, MO 63303 636-477-8389 FAX 636-477-7569

WOODLAND SHORES - PHASE 3
G & R DEVELOPMENT
LEE'S SUMMIT, MISSOURI

PROJECT NO. 23113502

STORM SEWER PLAN AND PROFILE
DETENTION BASIN #1
AND LINE 3-60

DRAWING NO. 20

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Apr 7 2020

BYPASS CHANNEL - WOODLAND SHORES

Trapezoidal

Bottom Width (ft)	= 10.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 915.51
Slope (%)	= 2.00
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cfs)	= 128.96

Highlighted

Depth (ft)	= 1.32
Q (cfs)	= 128.96
Area (sqft)	= 18.43
Velocity (ft/s)	= 7.00
Wetted Perim (ft)	= 18.35
Crit Depth, Yc (ft)	= 1.49
Top Width (ft)	= 17.92
EGL (ft)	= 2.08

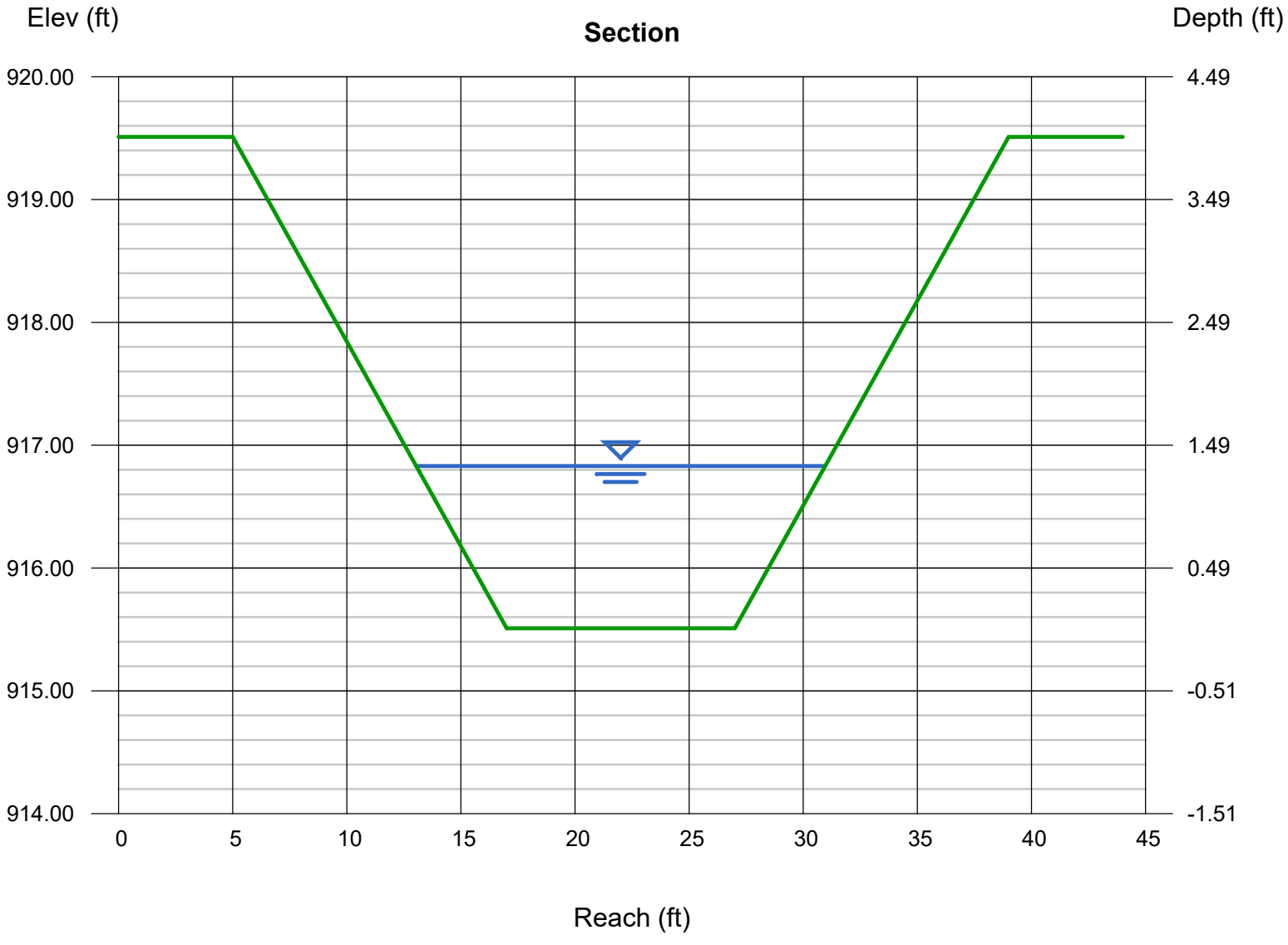


Exhibit E

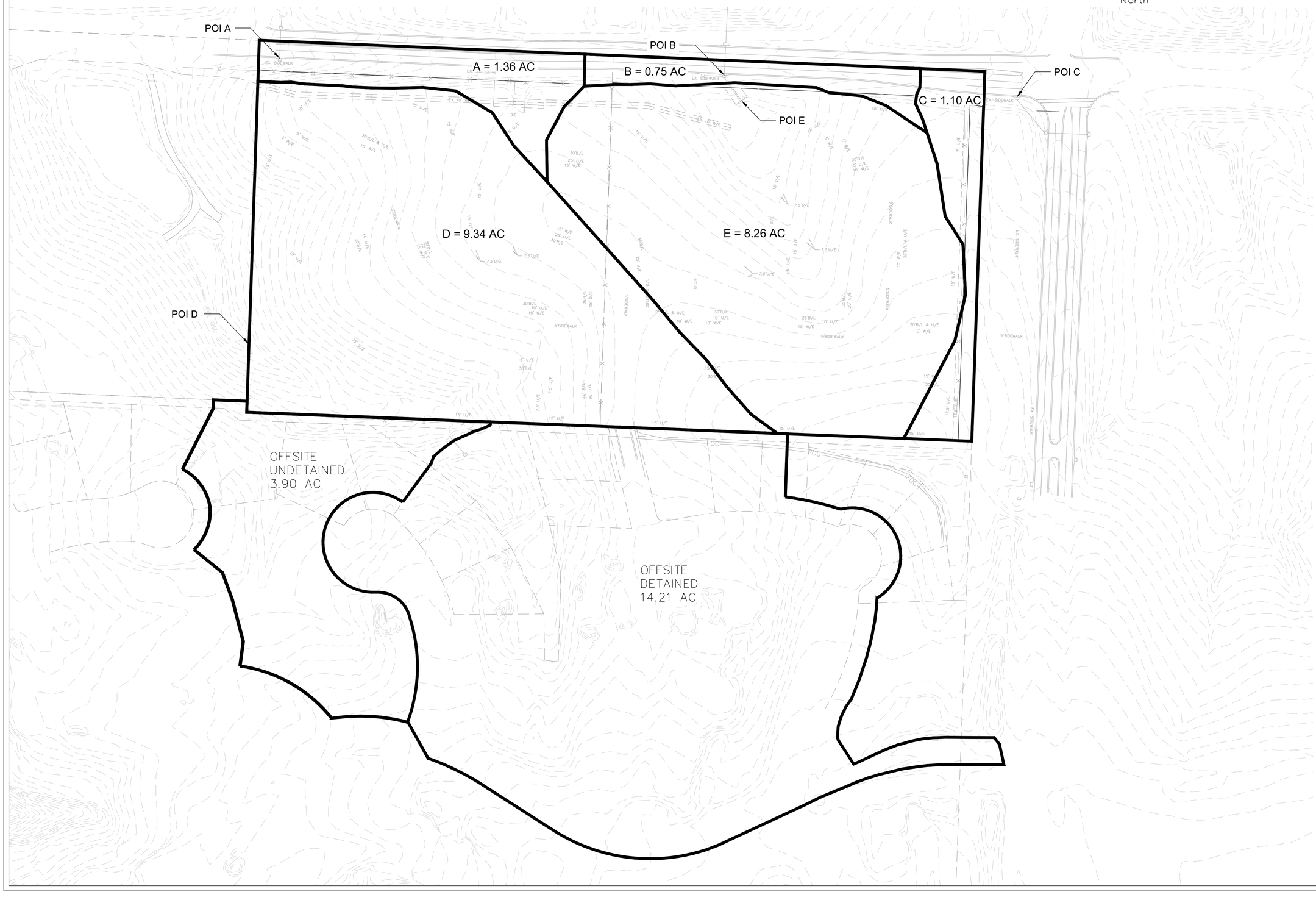
Existing Drainage Area Map

North

0 40' 80' 160'

EX DRAINAGE MAP

SCALE: 1" = 80'



ENGINEERING SOLUTIONS
ENGINEERING & SURVEYING
50 SE 30TH STREET
LEE'S SUMMIT, MO 64082
P:(816) 623-9888 F:(816)623-9849

Professional Registration
Missouri
Engineering 2005002186-D
Surveying 2005005319-D
Kansas
Engineering E-1695
Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

Part of the Southeast $\frac{1}{4}$
Section 27, Township 48 North, Range 31 West
Lee's Summit, Jackson County, Missouri

Project: WOODLAND OAKS LSMO
Issue Date: February 25, 2020

Ex. Drainage Map
Preliminary Development Plans for:
Lots 1 thru 42
WOODLAND OAKS
Lee's Summit, Jackson County, Missouri

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

City Comments 3-24-20

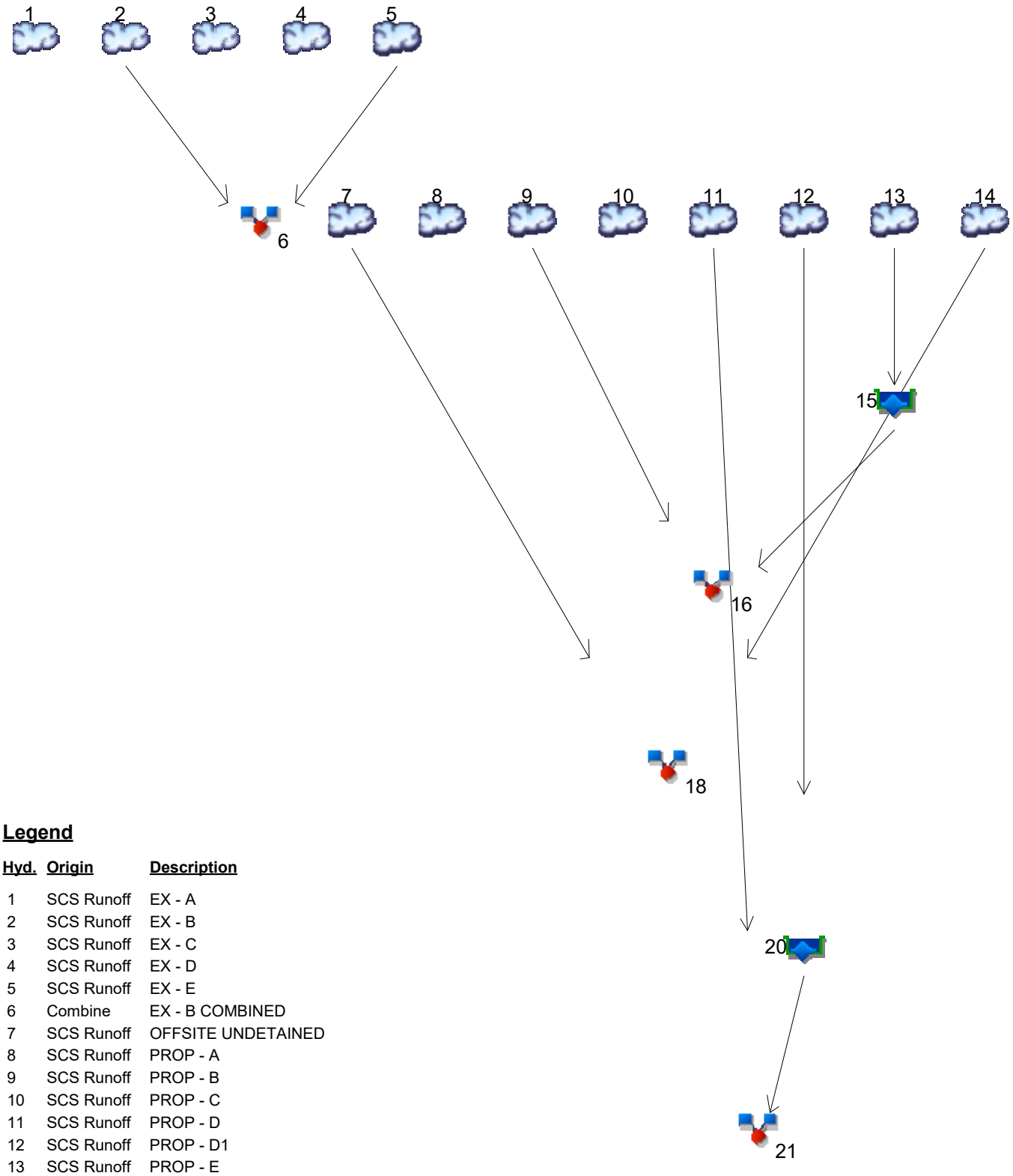
EXHIBIT

Exhibit F

Hydraflow Hydrograph Report

Hydraflow Table of Contents

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	EX - A
2	SCS Runoff	EX - B
3	SCS Runoff	EX - C
4	SCS Runoff	EX - D
5	SCS Runoff	EX - E
6	Combine	EX - B COMBINED
7	SCS Runoff	OFFSITE UNDETAINED
8	SCS Runoff	PROP - A
9	SCS Runoff	PROP - B
10	SCS Runoff	PROP - C
11	SCS Runoff	PROP - D
12	SCS Runoff	PROP - D1
13	SCS Runoff	PROP - E
14	SCS Runoff	OFFSITE DETAINED
15	Reservoir	BASIN E
16	Combine	COMBINED PROP B
18	Combine	OFFSITE BYPASS
20	Reservoir	BASIN D1
21	Combine	POI D

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)							Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	-------	3.889	-------	-------	7.013	-------	-------	11.71	EX - A
2	SCS Runoff	------	-------	2.235	-------	-------	4.019	-------	-------	6.695	EX - B
3	SCS Runoff	------	-------	3.629	-------	-------	6.486	-------	-------	10.80	EX - C
4	SCS Runoff	------	-------	17.43	-------	-------	36.03	-------	-------	65.98	EX - D
5	SCS Runoff	------	-------	15.42	-------	-------	31.86	-------	-------	58.35	EX - E
6	Combine	2, 5	-------	17.43	-------	-------	35.62	-------	-------	64.55	EX - B COMBINED
7	SCS Runoff	------	-------	11.15	-------	-------	20.11	-------	-------	33.57	OFFSITE UNDETAINED
8	SCS Runoff	------	-------	3.069	-------	-------	5.519	-------	-------	9.195	PROP - A
9	SCS Runoff	------	-------	2.652	-------	-------	4.769	-------	-------	7.945	PROP - B
10	SCS Runoff	------	-------	1.573	-------	-------	2.836	-------	-------	4.734	PROP - C
11	SCS Runoff	------	-------	3.367	-------	-------	6.362	-------	-------	10.96	PROP - D
12	SCS Runoff	------	-------	17.16	-------	-------	30.94	-------	-------	51.64	PROP - D1
13	SCS Runoff	------	-------	27.74	-------	-------	50.20	-------	-------	83.98	PROP - E
14	SCS Runoff	------	-------	32.65	-------	-------	59.35	-------	-------	99.64	OFFSITE DETAINED
15	Reservoir	13	-------	3.031	-------	-------	7.991	-------	-------	11.86	BASIN E
16	Combine	9, 15	-------	3.264	-------	-------	8.990	-------	-------	16.53	COMBINED PROP B
18	Combine	7, 14,	-------	42.20	-------	-------	76.67	-------	-------	128.96	OFFSITE BYPASS
20	Reservoir	12	-------	0.465	-------	-------	1.352	-------	-------	5.294	BASIN D1
21	Combine	11, 20	-------	3.621	-------	-------	6.826	-------	-------	13.59	POI D

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

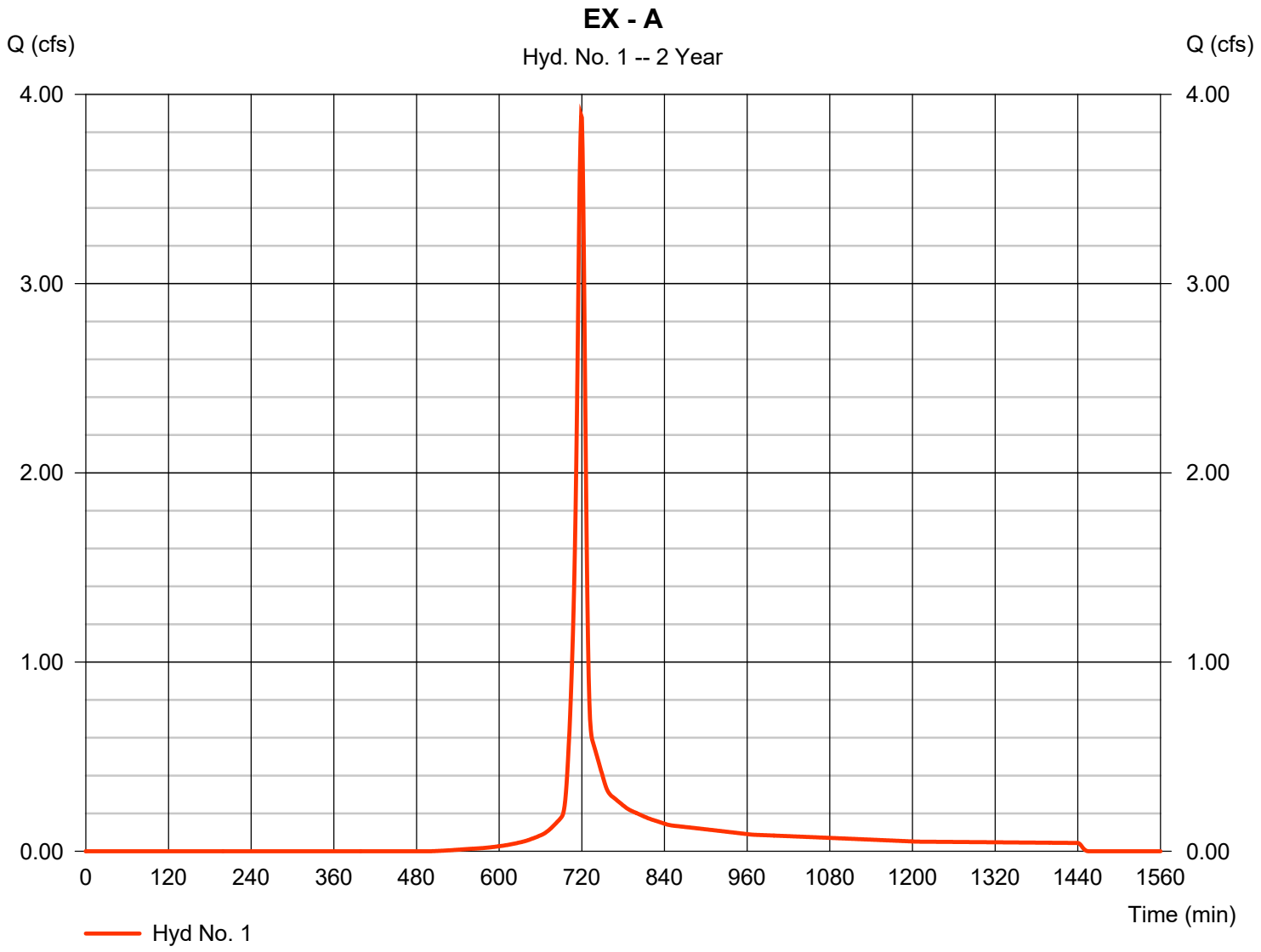
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	3.889	1	719	8,800	------	------	------	EX - A
2	SCS Runoff	2.235	1	718	4,732	------	------	------	EX - B
3	SCS Runoff	3.629	1	718	7,340	------	------	------	EX - C
4	SCS Runoff	17.43	1	721	42,789	------	------	------	EX - D
5	SCS Runoff	15.42	1	721	37,841	------	------	------	EX - E
6	Combine	17.43	1	720	42,573	2, 5	------	------	EX - B COMBINED
7	SCS Runoff	11.15	1	719	25,236	------	------	------	OFFSITE UNDETAINED
8	SCS Runoff	3.069	1	718	6,498	------	------	------	PROP - A
9	SCS Runoff	2.652	1	718	5,615	------	------	------	PROP - B
10	SCS Runoff	1.573	1	719	3,559	------	------	------	PROP - C
11	SCS Runoff	3.367	1	720	7,617	------	------	------	PROP - D
12	SCS Runoff	17.16	1	719	38,825	------	------	------	PROP - D1
13	SCS Runoff	27.74	1	721	70,067	------	------	------	PROP - E
14	SCS Runoff	32.65	1	723	93,101	------	------	------	OFFSITE DETAINED
15	Reservoir	3.031	1	754	65,279	13	938.30	35,284	BASIN E
16	Combine	3.264	1	749	70,894	9, 15	------	------	COMBINED PROP B
18	Combine	42.20	1	722	118,337	7, 14,	------	------	OFFSITE BYPASS
20	Reservoir	0.465	1	926	36,251	12	912.31	24,502	BASIN D1
21	Combine	3.621	1	720	43,868	11, 20	------	------	POI D

Hydrograph Report

Hyd. No. 1

EX - A

Hydrograph type	= SCS Runoff	Peak discharge	= 3.889 cfs
Storm frequency	= 2 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 8,800 cuft
Drainage area	= 1.360 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 9.50 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

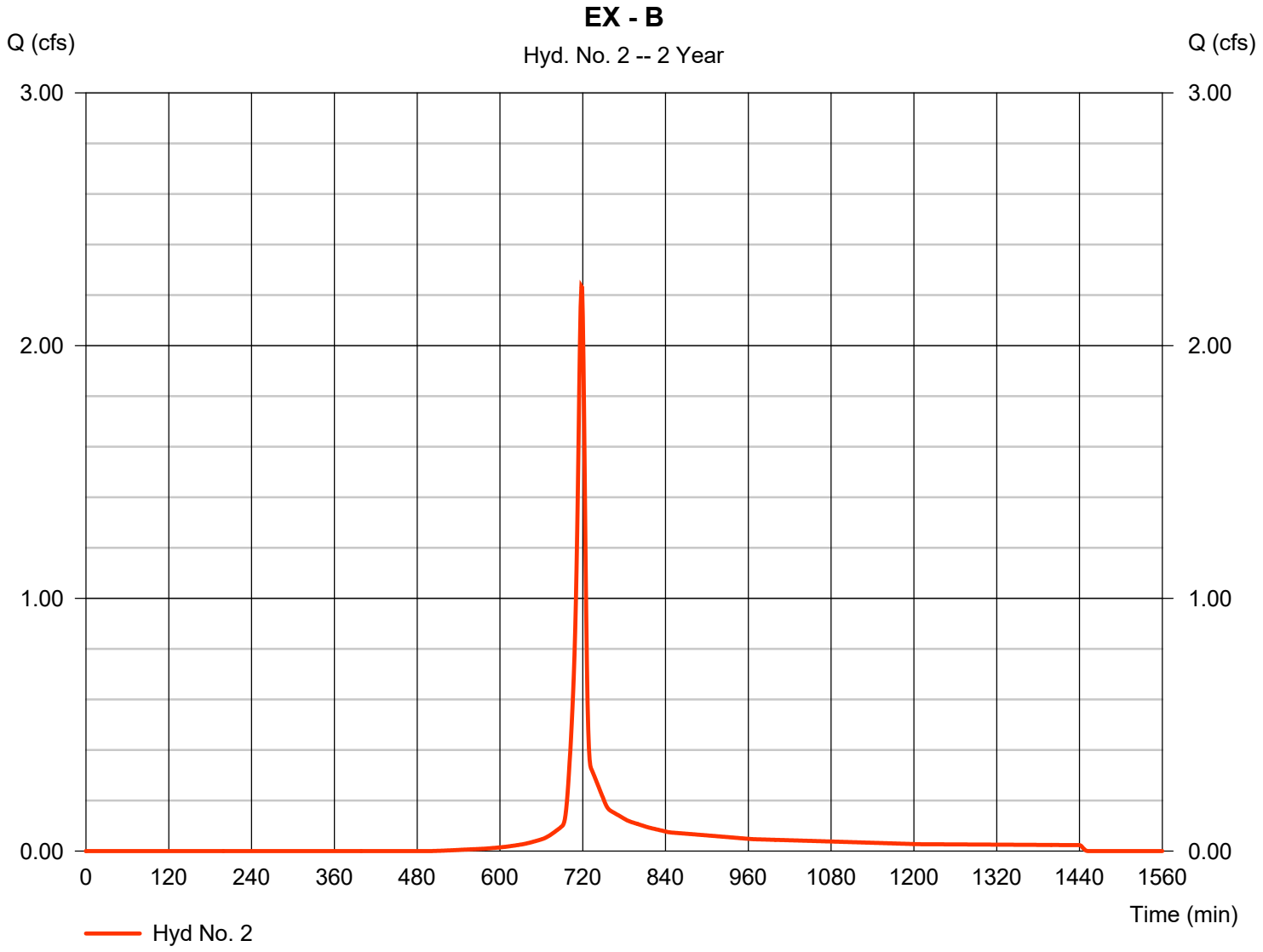


Hydrograph Report

Hyd. No. 2

EX - B

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.235 cfs
Storm frequency	=	2 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	4,732 cuft
Drainage area	=	0.750 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	7.50 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

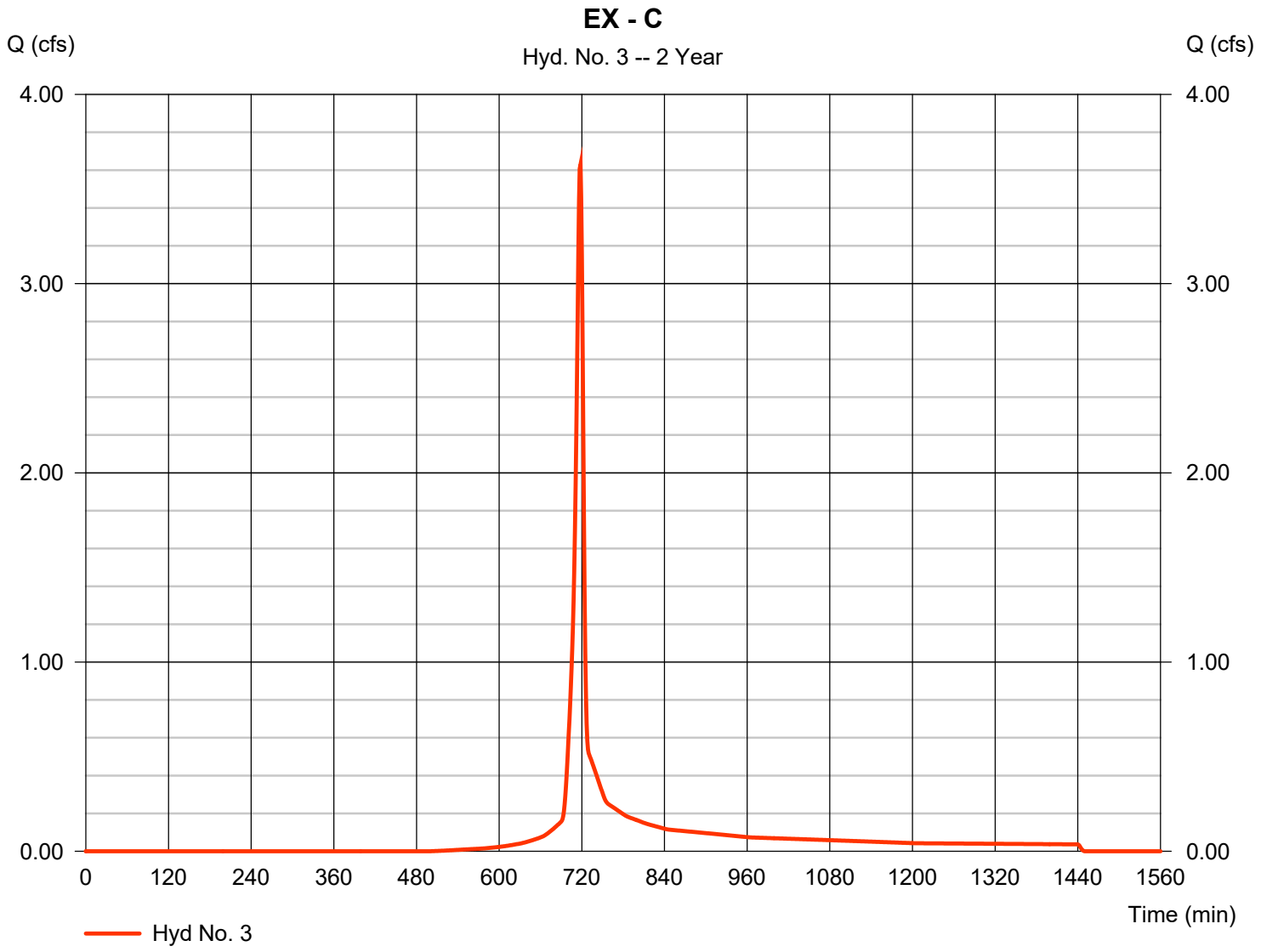


Hydrograph Report

Hyd. No. 3

EX - C

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.629 cfs
Storm frequency	=	2 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	7,340 cuft
Drainage area	=	1.100 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	6.00 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

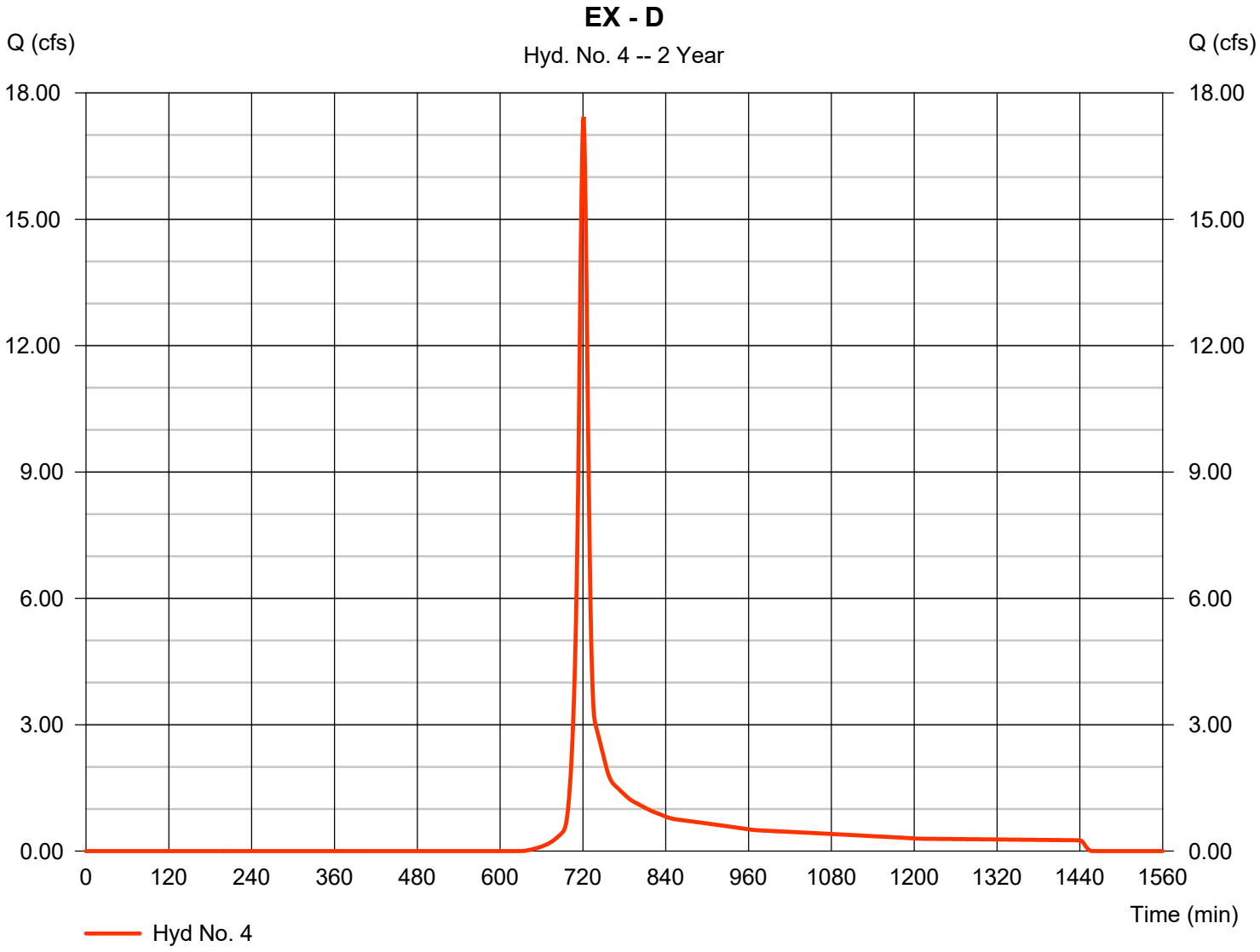


Hydrograph Report

Hyd. No. 4

EX - D

Hydrograph type	= SCS Runoff	Peak discharge	= 17.43 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 42,789 cuft
Drainage area	= 9.340 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.60 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

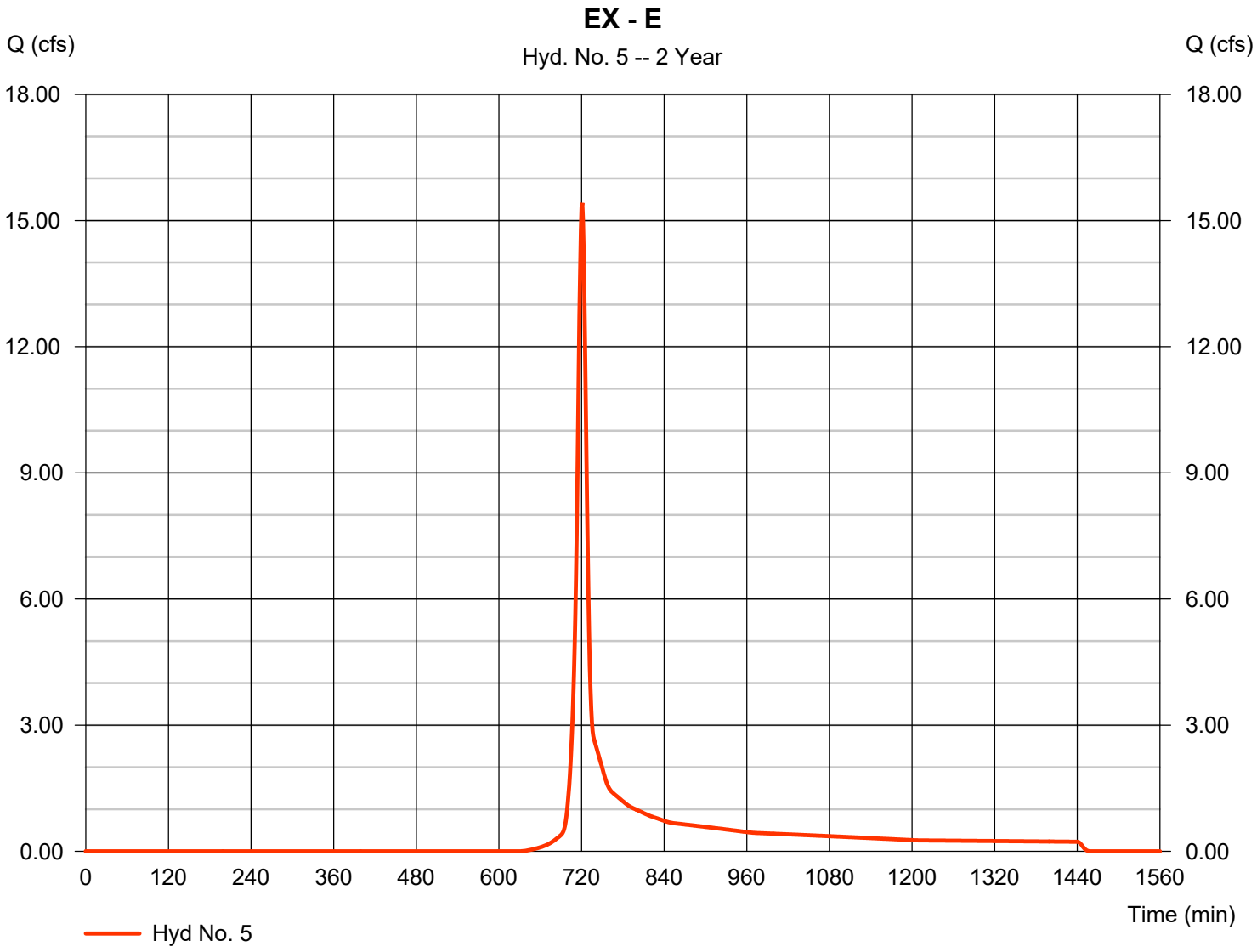


Hydrograph Report

Hyd. No. 5

EX - E

Hydrograph type	= SCS Runoff	Peak discharge	= 15.42 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 37,841 cuft
Drainage area	= 8.260 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.60 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

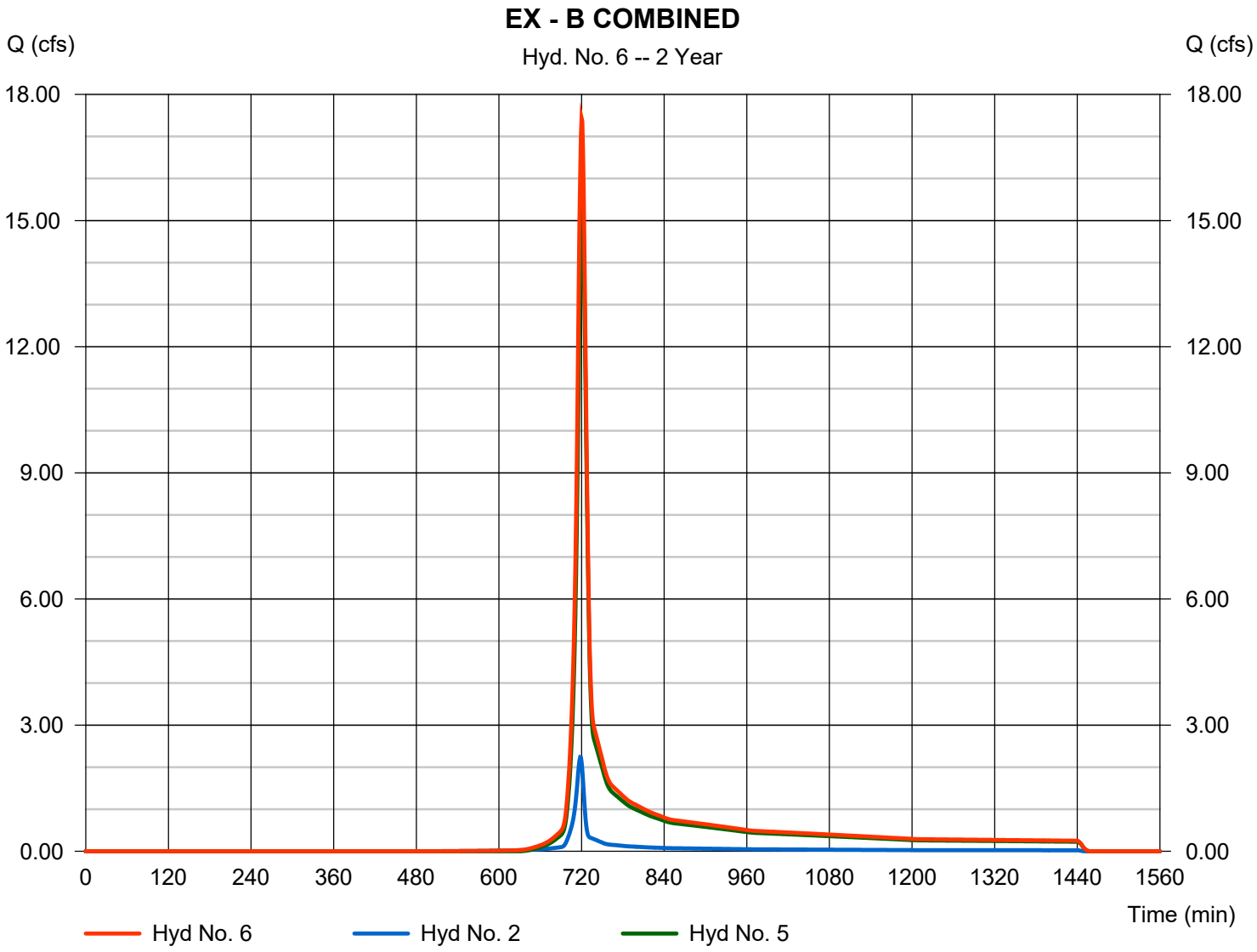


Hydrograph Report

Hyd. No. 6

EX - B COMBINED

Hydrograph type	= Combine	Peak discharge	= 17.43 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 42,573 cuft
Inflow hyds.	= 2, 5	Contrib. drain. area	= 9.010 ac

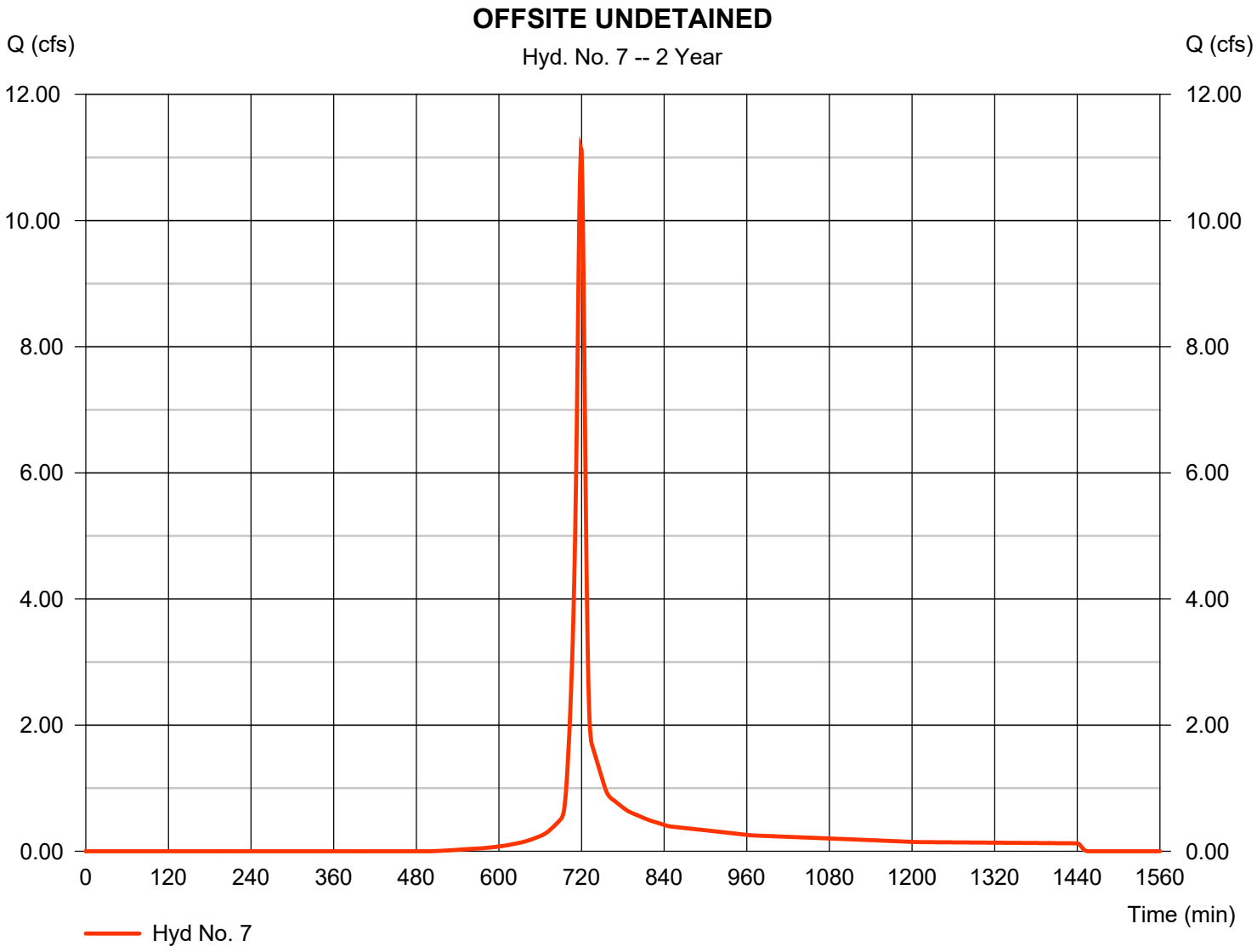


Hydrograph Report

Hyd. No. 7

OFFSITE UNDETAINED

Hydrograph type	=	SCS Runoff	Peak discharge	=	11.15 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	25,236 cuft
Drainage area	=	3.900 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	8.60 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

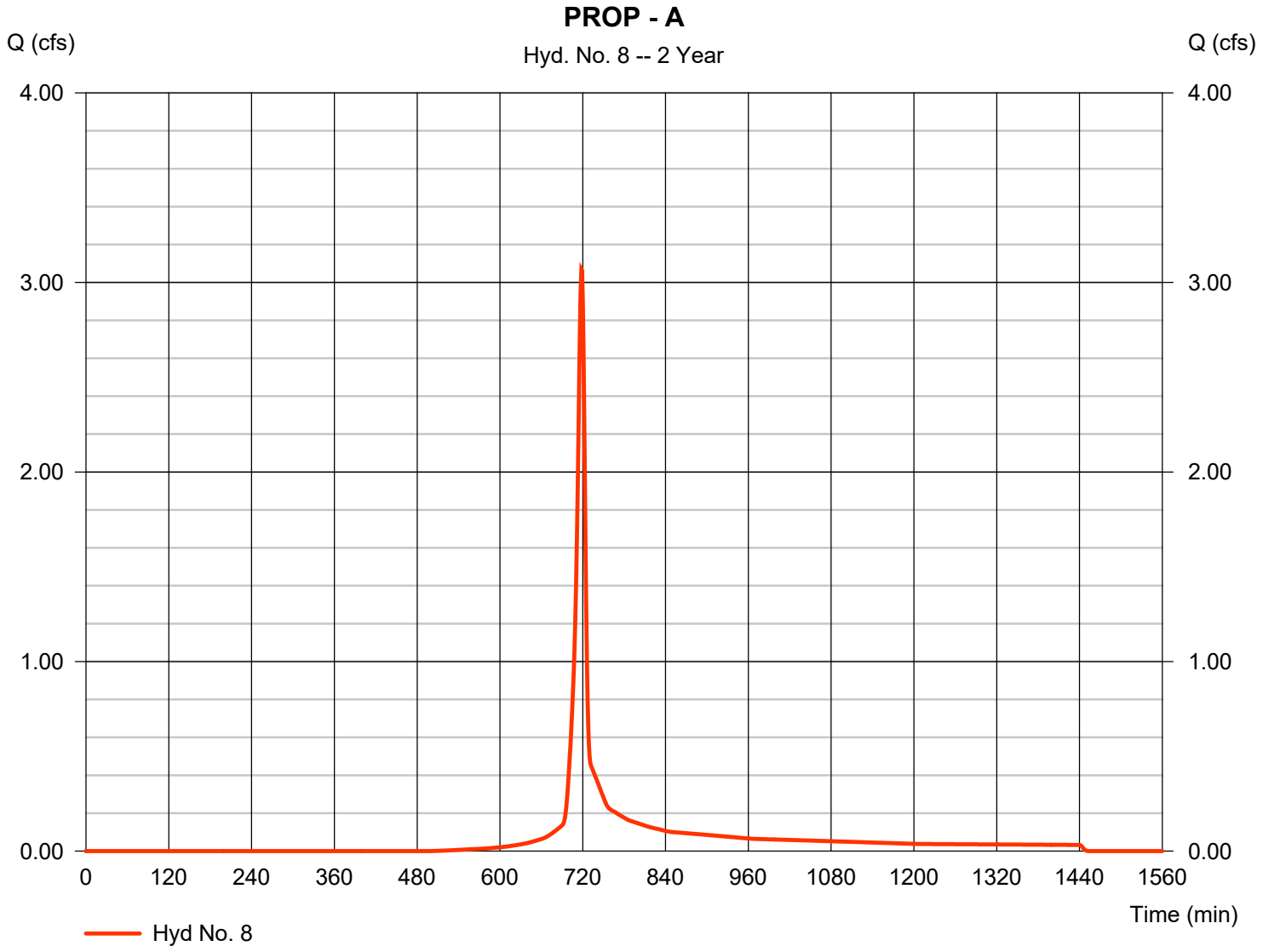


Hydrograph Report

Hyd. No. 8

PROP - A

Hydrograph type	= SCS Runoff	Peak discharge	= 3.069 cfs
Storm frequency	= 2 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 6,498 cuft
Drainage area	= 1.030 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.80 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

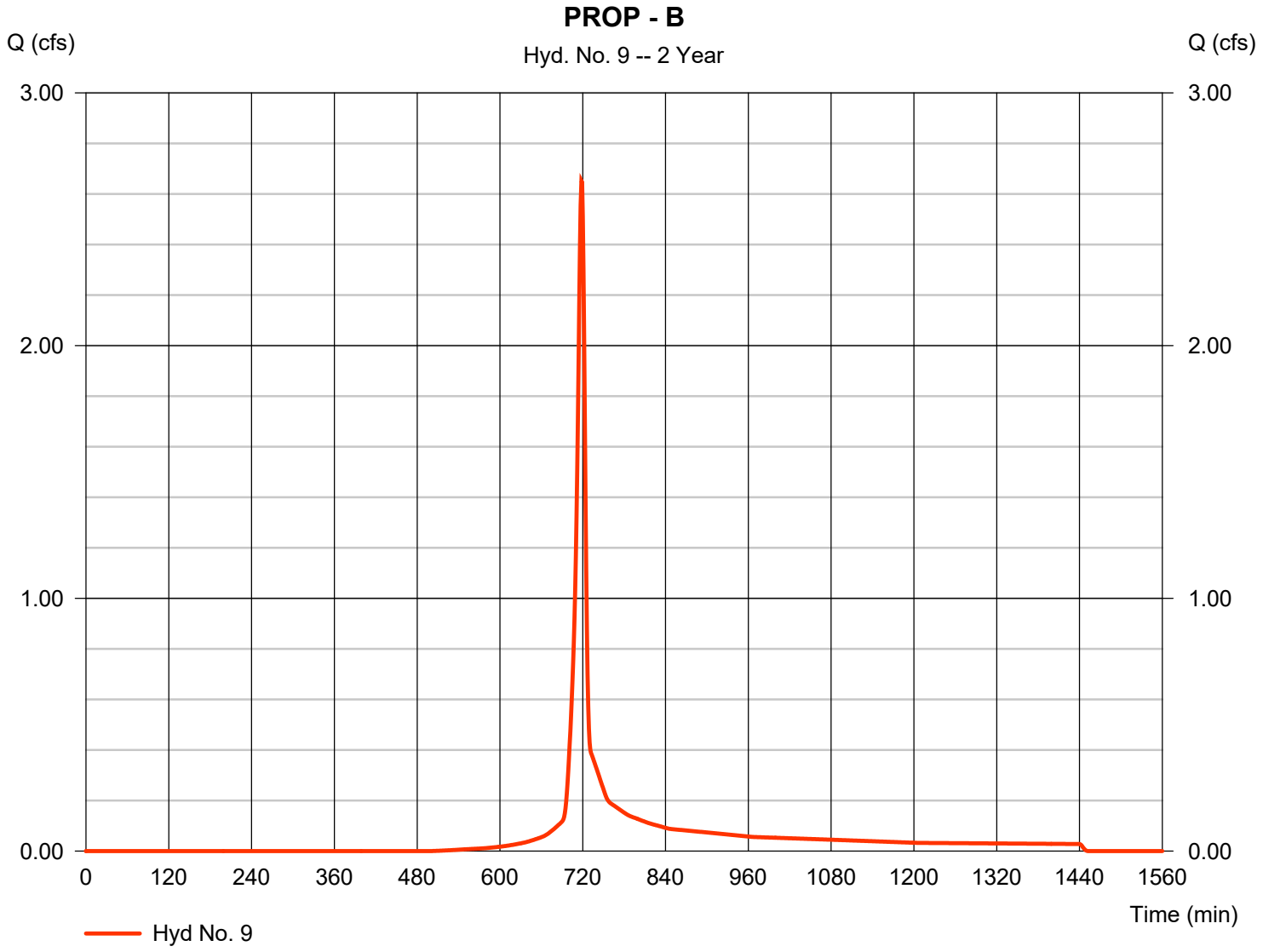


Hydrograph Report

Hyd. No. 9

PROP - B

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.652 cfs
Storm frequency	=	2 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	5,615 cuft
Drainage area	=	0.890 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	7.40 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

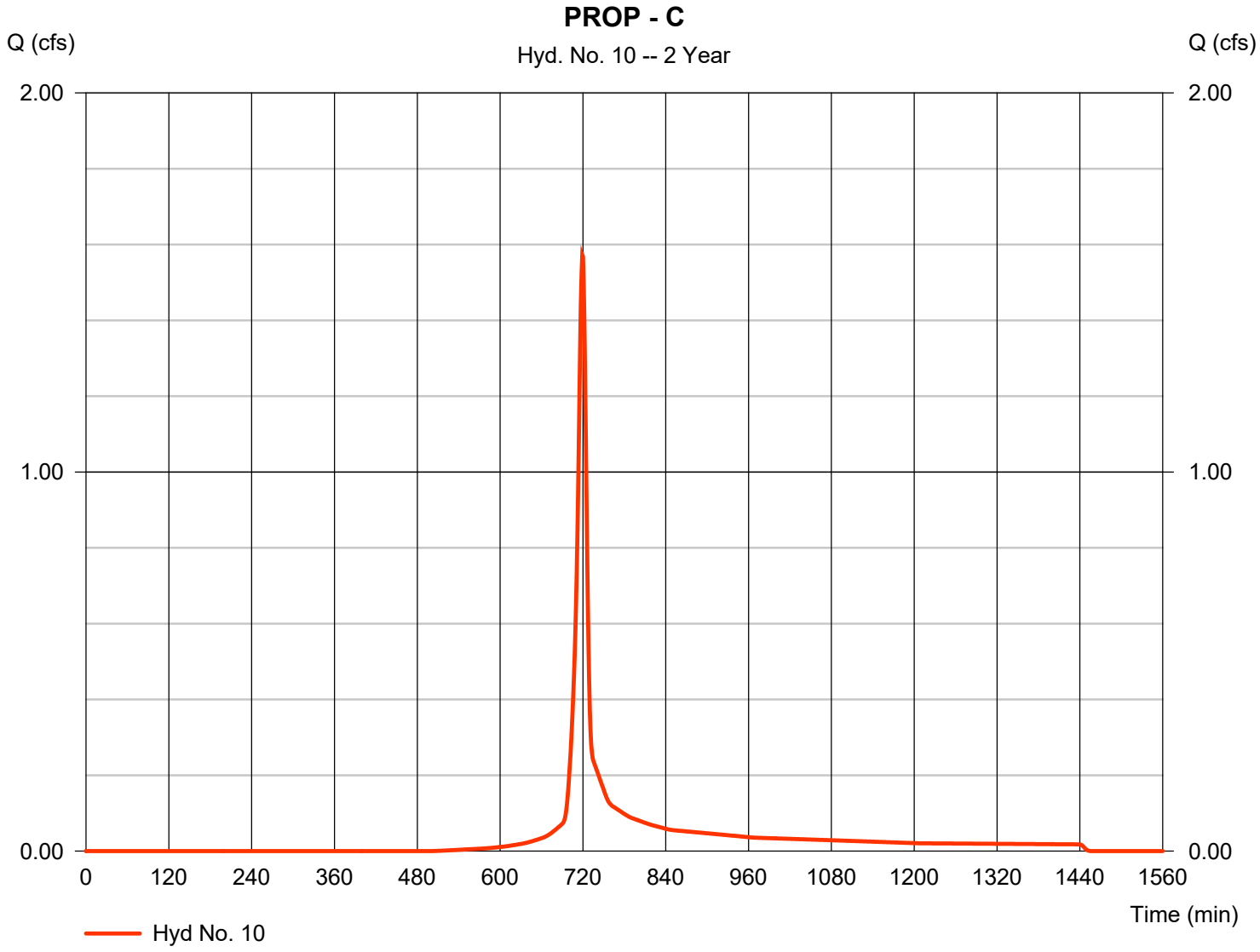


Hydrograph Report

Hyd. No. 10

PROP - C

Hydrograph type	= SCS Runoff	Peak discharge	= 1.573 cfs
Storm frequency	= 2 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 3,559 cuft
Drainage area	= 0.550 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 8.70 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

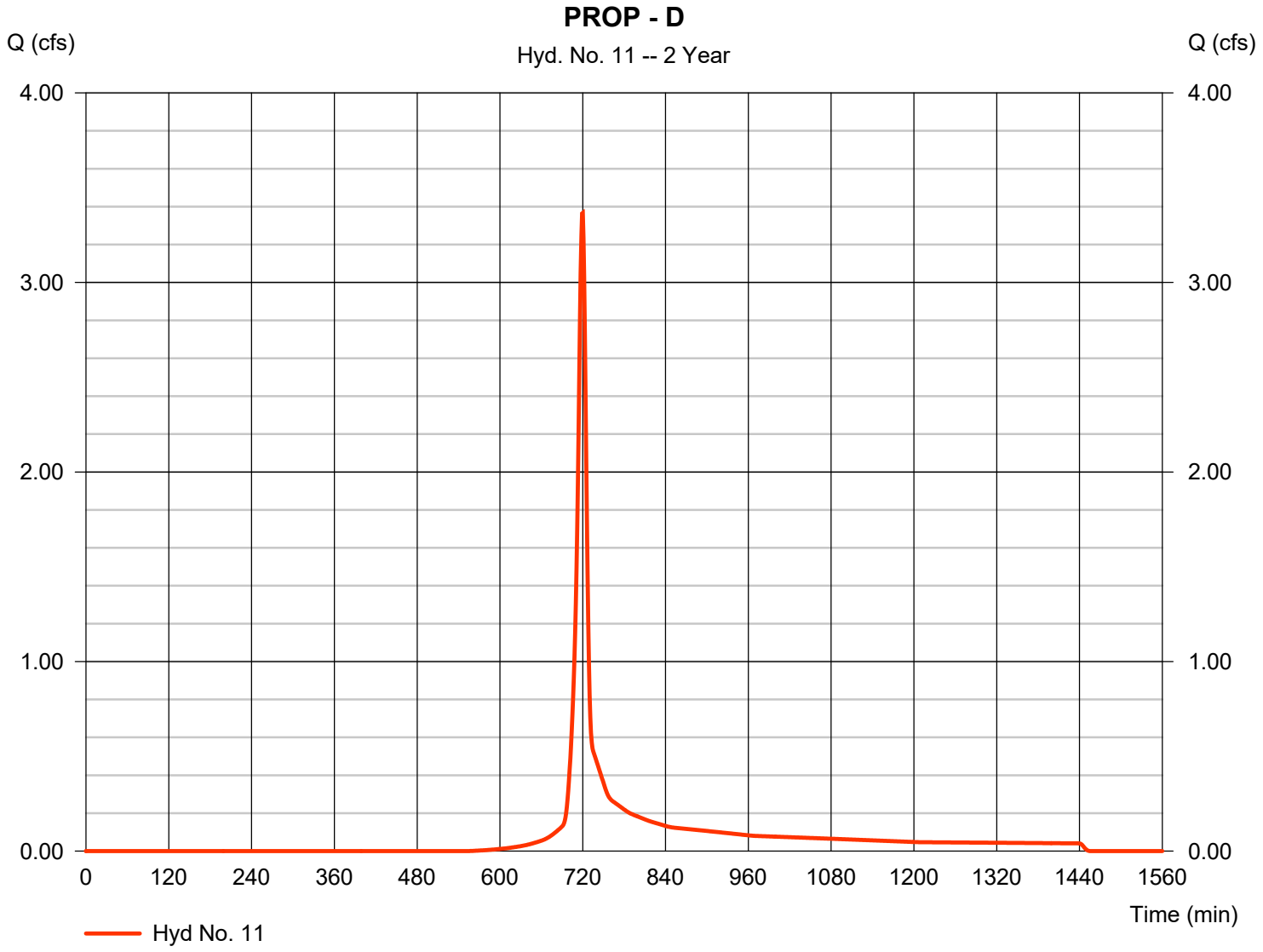


Hydrograph Report

Hyd. No. 11

PROP - D

Hydrograph type	= SCS Runoff	Peak discharge	= 3.367 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 7,617 cuft
Drainage area	= 1.340 ac	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 9.70 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

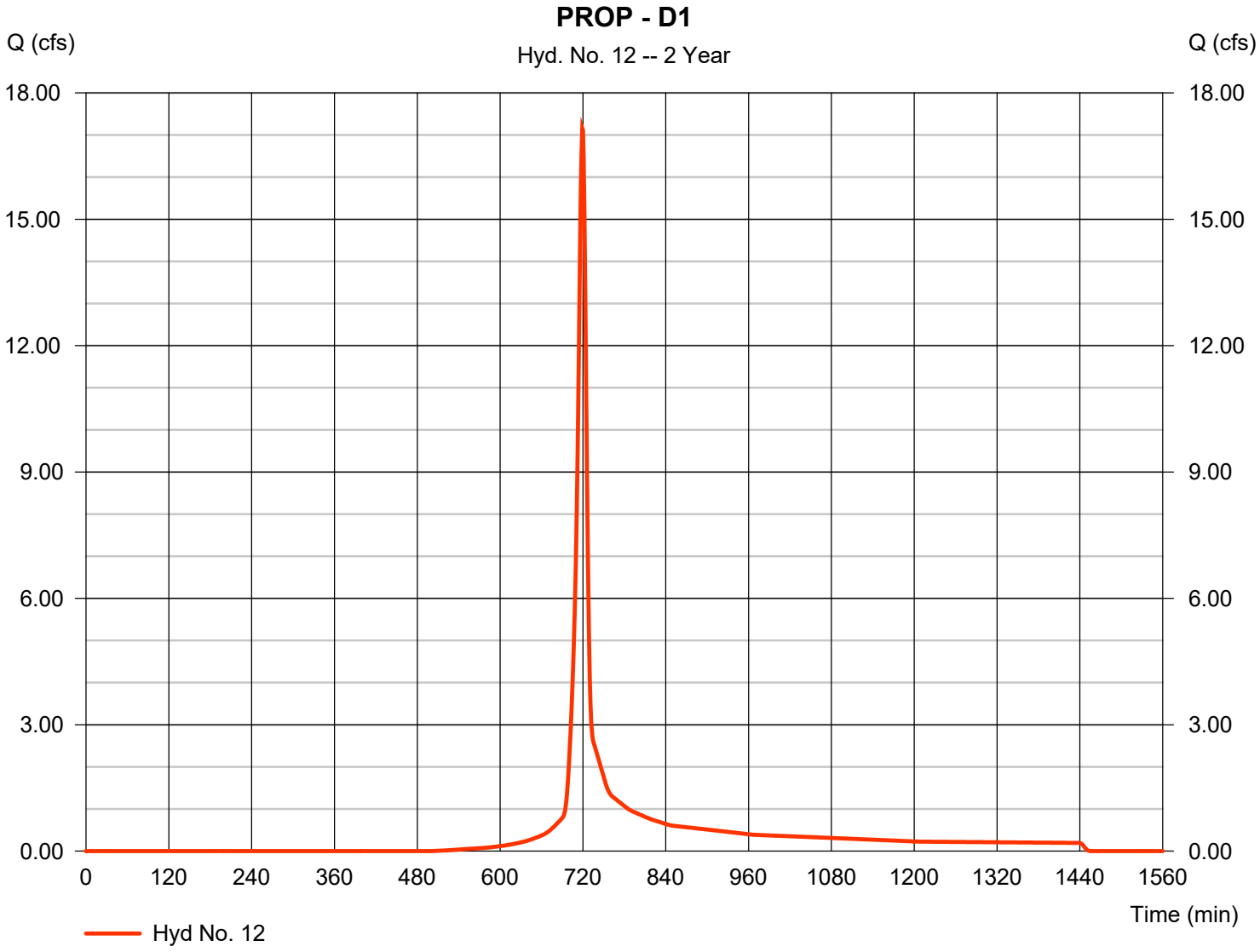


Hydrograph Report

Hyd. No. 12

PROP - D1

Hydrograph type	=	SCS Runoff	Peak discharge	=	17.16 cfs
Storm frequency	=	2 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	38,825 cuft
Drainage area	=	6.000 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	9.60 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

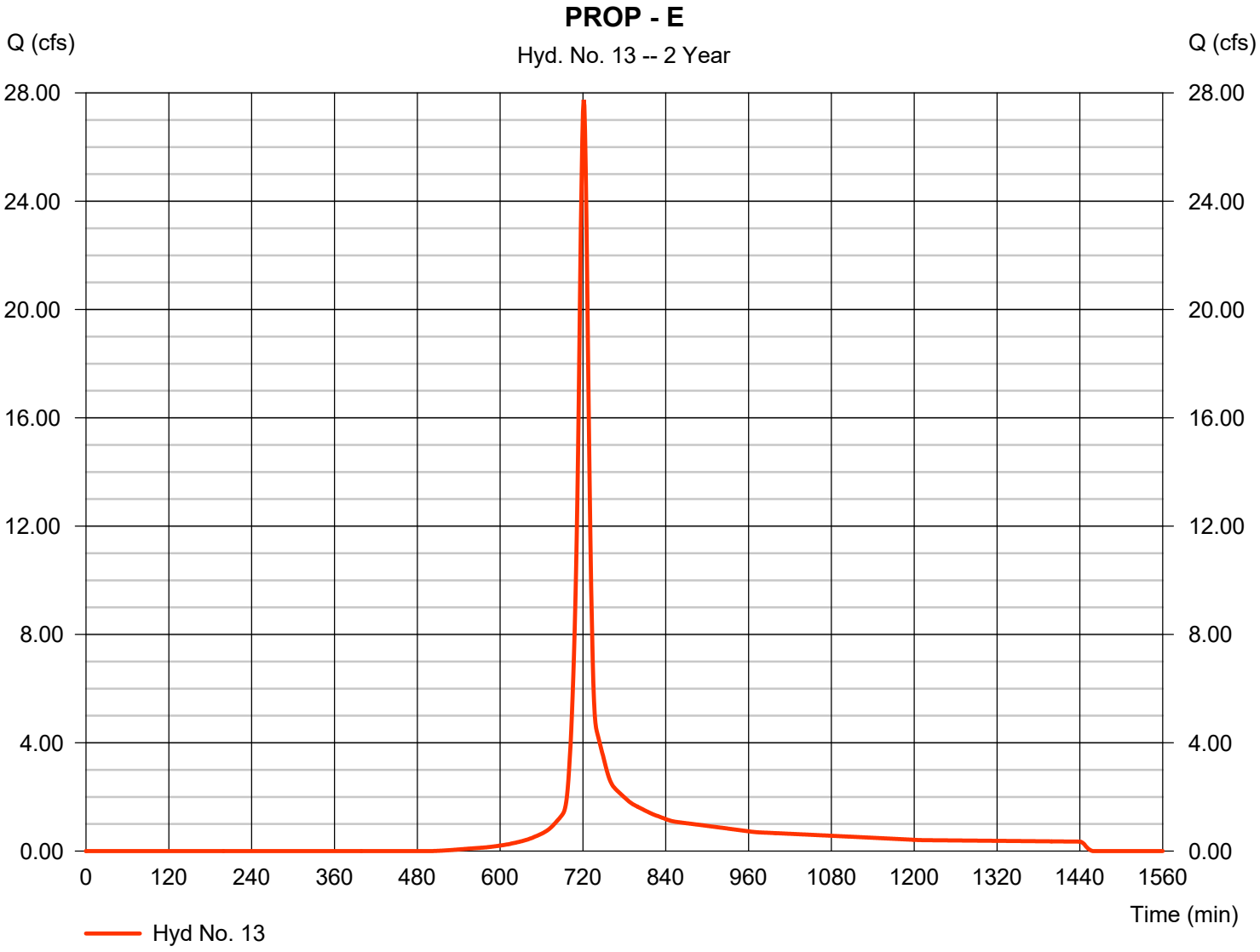


Hydrograph Report

Hyd. No. 13

PROP - E

Hydrograph type	= SCS Runoff	Peak discharge	= 27.74 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 70,067 cuft
Drainage area	= 11.000 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 11.80 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

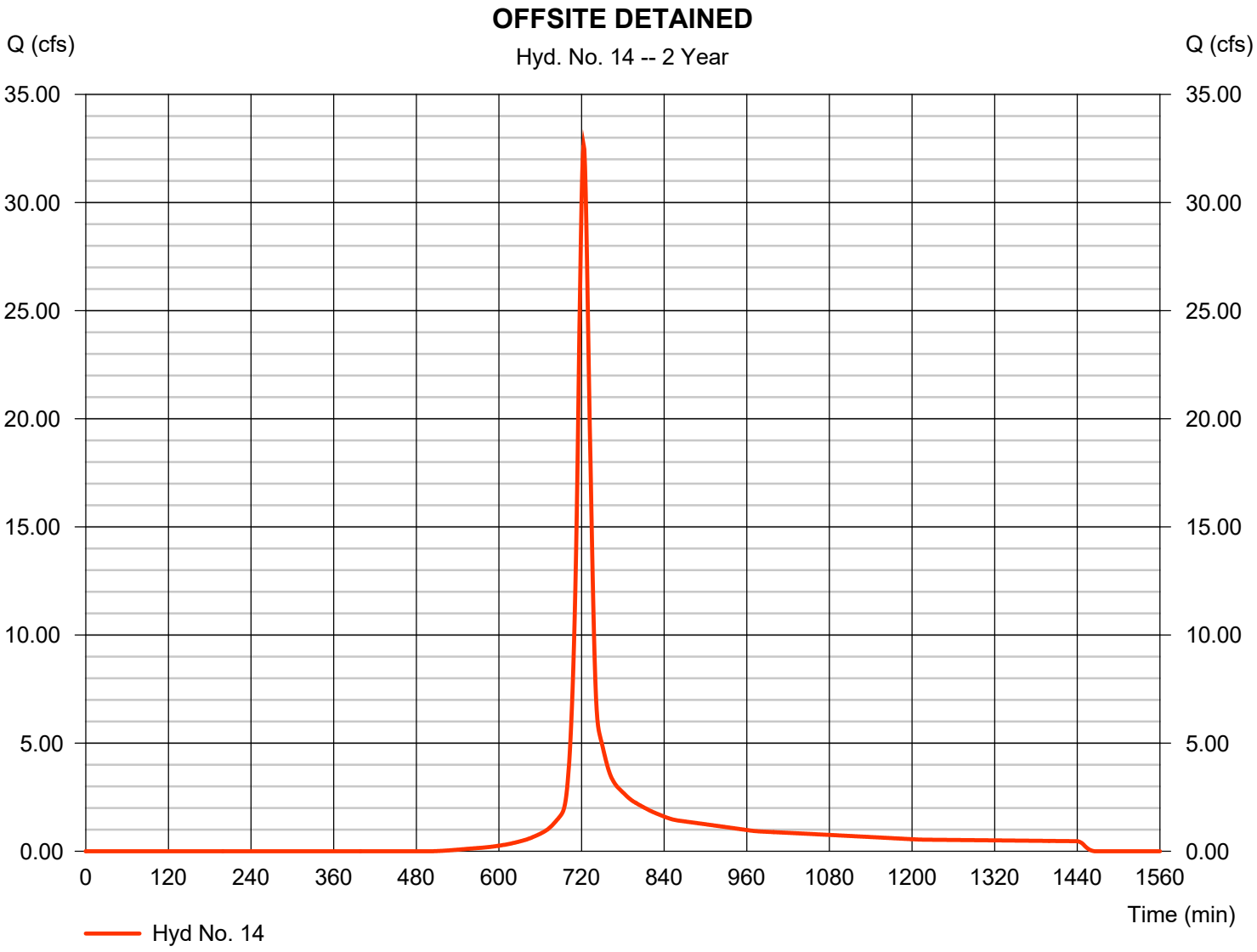


Hydrograph Report

Hyd. No. 14

OFFSITE DETAINED

Hydrograph type	=	SCS Runoff	Peak discharge	=	32.65 cfs
Storm frequency	=	2 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	93,101 cuft
Drainage area	=	14.210 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.50 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



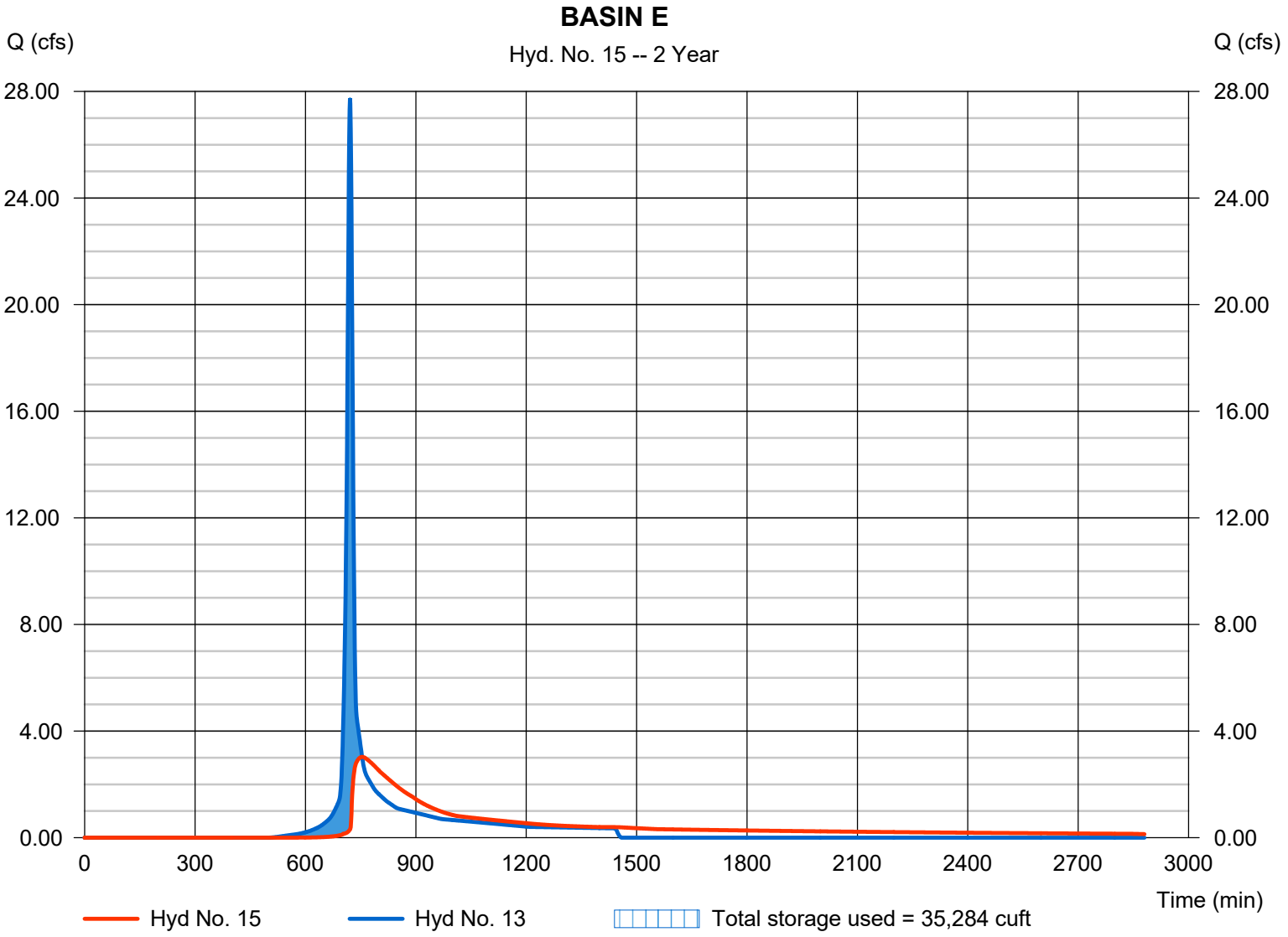
Hydrograph Report

Hyd. No. 15

BASIN E

Hydrograph type	=	Reservoir	Peak discharge	=	3.031 cfs
Storm frequency	=	2 yrs	Time to peak	=	754 min
Time interval	=	1 min	Hyd. volume	=	65,279 cuft
Inflow hyd. No.	=	13 - PROP - E	Max. Elevation	=	938.30 ft
Reservoir name	=	Basin E	Max. Storage	=	35,284 cuft

Storage Indication method used.



Pond Report

Pond No. 2 - Basin E

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 932.78 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	932.78	02	0	0
1.22	934.00	02	3	3
3.22	936.00	7,456	5,058	5,061
5.22	938.00	17,199	23,984	29,044
7.22	940.00	24,091	41,093	70,137
9.22	942.00	31,725	55,636	125,773
11.22	944.00	43,313	74,731	200,503

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	0.00	15.00	1.00
Span (in)	= 36.00	0.00	15.00	1.00
No. Barrels	= 1	0	1	8
Invert El. (ft)	= 932.78	0.00	937.50	934.00
Length (ft)	= 47.00	0.00	0.00	2.75
Slope (%)	= 17.64	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	Yes	Yes

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 160.00	0.00	0.00	0.00
Crest El. (ft)	= 942.00	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 0.000 (by Wet area)			
TW Elev. (ft)	= 0.00			

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

Stage / Storage / Discharge Table

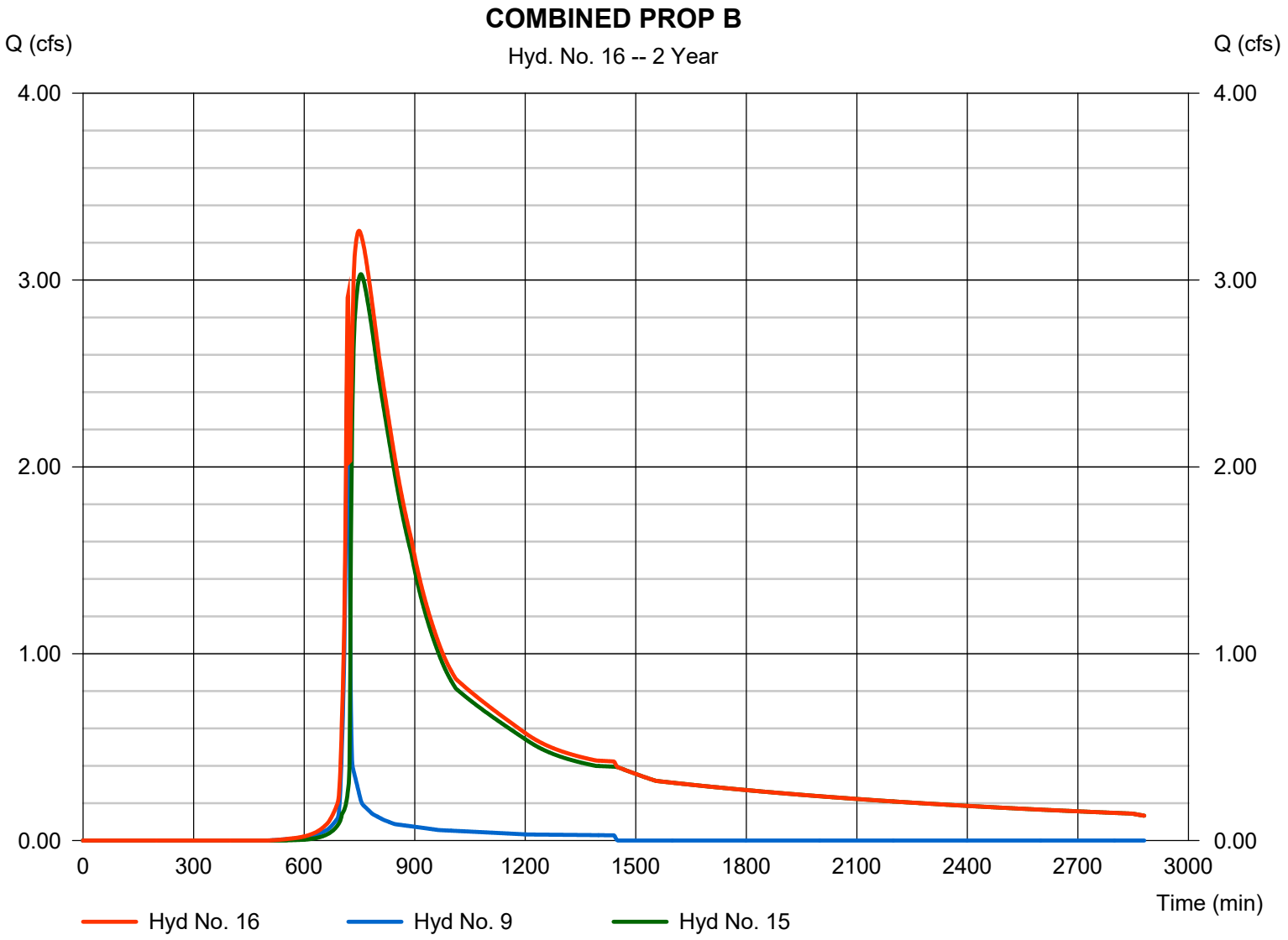
Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	932.78	0.00	---	0.00	0.00	0.00	---	---	---	---	---	0.000
1.22	3	934.00	0.00	---	0.00	0.00	0.00	---	---	---	---	---	0.000
3.22	5,061	936.00	0.15 ic	---	0.00	0.14	0.00	---	---	---	---	---	0.144
5.22	29,044	938.00	1.53 ic	---	1.13 ic	0.41	0.00	---	---	---	---	---	1.534
7.22	70,137	940.00	9.01 ic	---	8.09 ic	0.75	0.00	---	---	---	---	---	8.838
9.22	125,773	942.00	13.02 ic	---	11.63 ic	1.12	0.00	---	---	---	---	---	12.75
11.22	200,503	944.00	15.87 ic	---	14.32 ic	1.53	1176.63	---	---	---	---	---	1192.48

Hydrograph Report

Hyd. No. 16

COMBINED PROP B

Hydrograph type	=	Combine	Peak discharge	=	3.264 cfs
Storm frequency	=	2 yrs	Time to peak	=	749 min
Time interval	=	1 min	Hyd. volume	=	70,894 cuft
Inflow hyds.	=	9, 15	Contrib. drain. area	=	0.890 ac

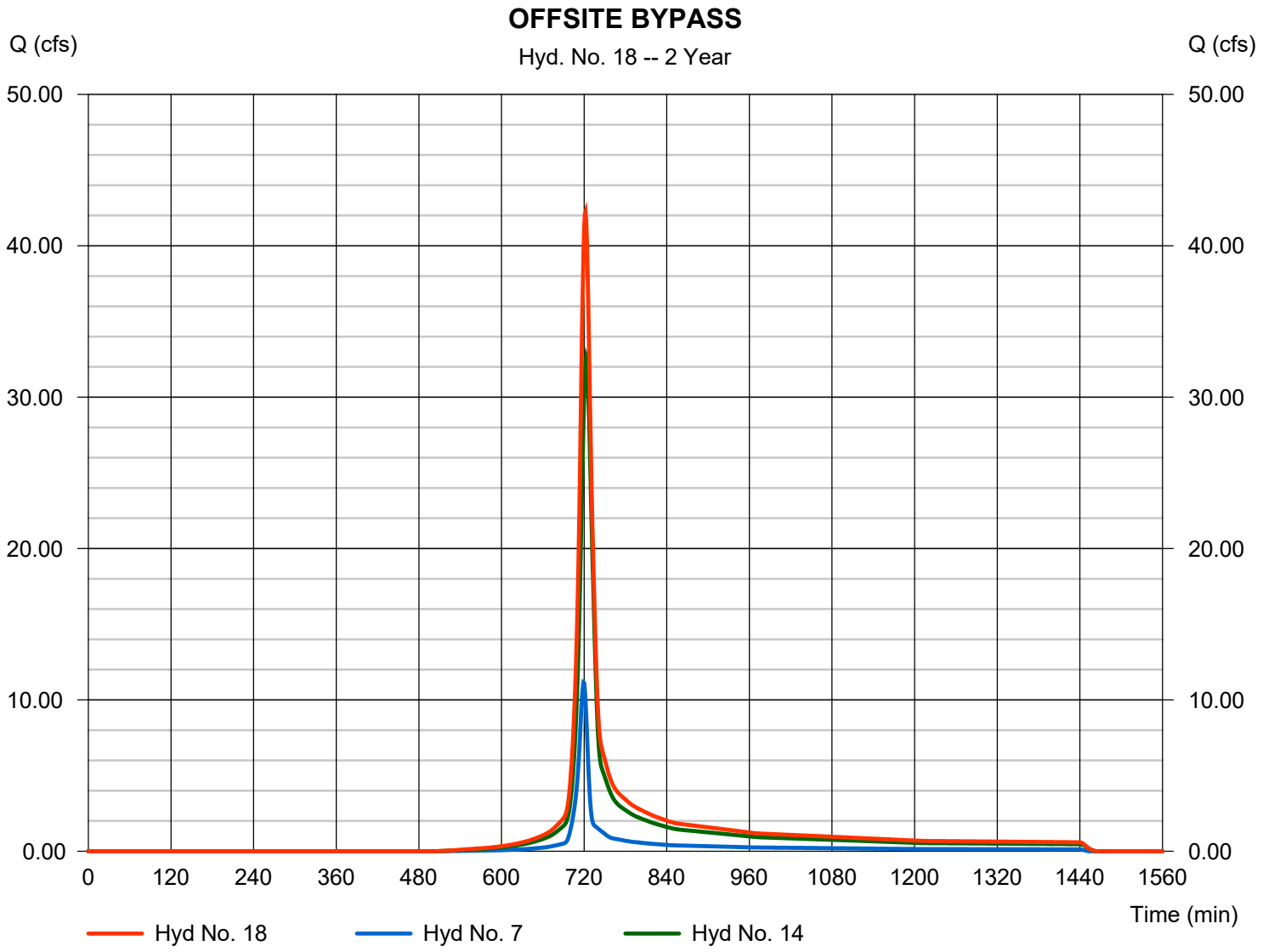


Hydrograph Report

Hyd. No. 18

OFFSITE BYPASS

Hydrograph type	= Combine	Peak discharge	= 42.20 cfs
Storm frequency	= 2 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 118,337 cuft
Inflow hyds.	= 7, 14	Contrib. drain. area	= 18.110 ac



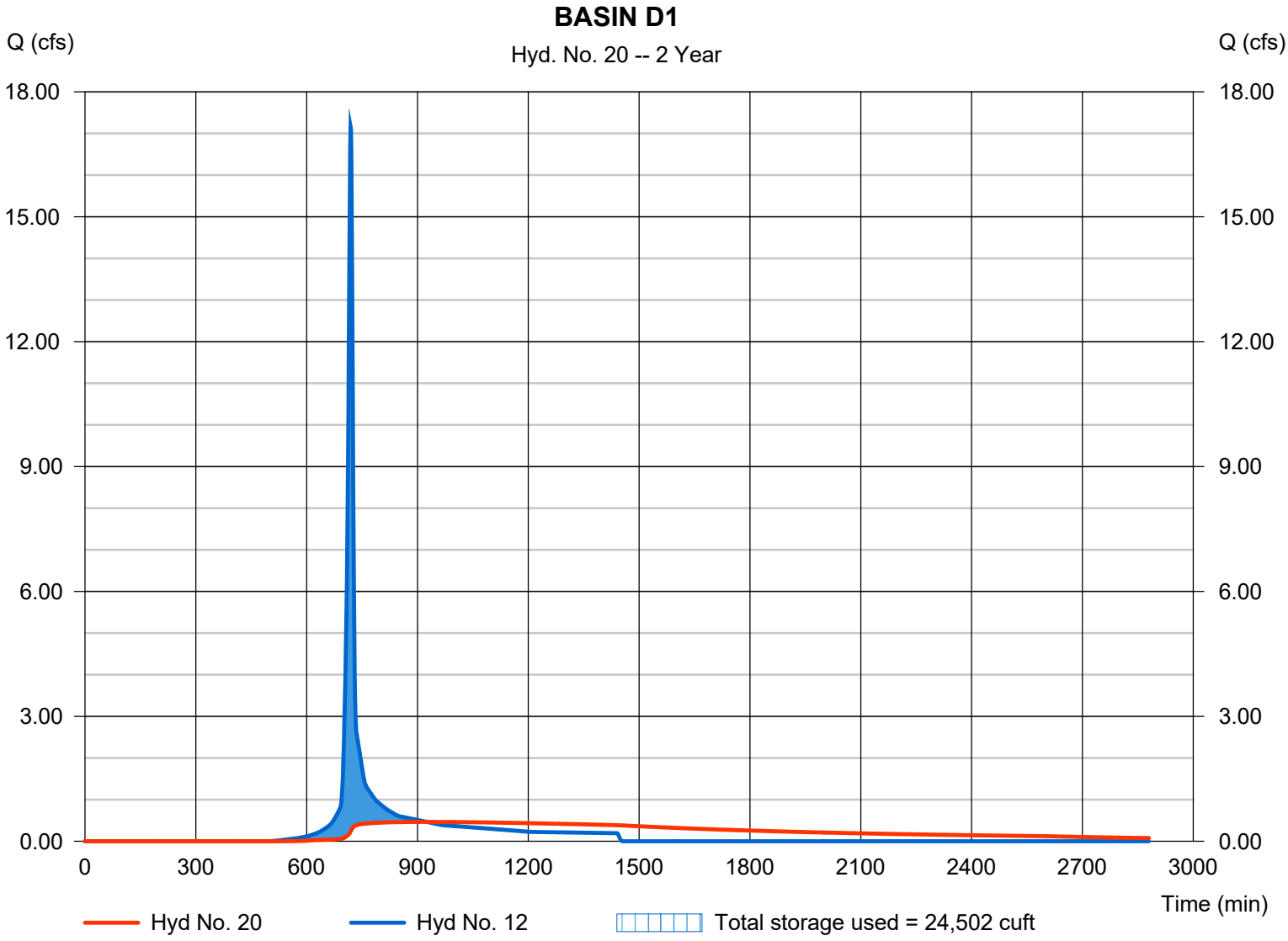
Hydrograph Report

Hyd. No. 20

BASIN D1

Hydrograph type	= Reservoir	Peak discharge	= 0.465 cfs
Storm frequency	= 2 yrs	Time to peak	= 926 min
Time interval	= 1 min	Hyd. volume	= 36,251 cuft
Inflow hyd. No.	= 12 - PROP - D1	Max. Elevation	= 912.31 ft
Reservoir name	= Basin D1	Max. Storage	= 24,502 cuft

Storage Indication method used.



Pond Report

Pond No. 3 - Basin D1

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 908.40 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	908.40	00	0	0
0.60	909.00	1,413	424	424
1.60	910.00	6,105	3,759	4,183
3.60	912.00	10,444	16,549	20,732
5.60	914.00	13,719	24,163	44,895
7.60	916.00	17,234	30,953	75,848
9.60	918.00	20,973	38,207	114,055

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	12.00	0.00	1.00
Span (in)	= 24.00	12.00	0.00	1.00
No. Barrels	= 1	1	0	6
Invert El. (ft)	= 908.10	913.50	0.00	908.20
Length (ft)	= 25.47	0.00	0.00	1.75
Slope (%)	= 0.39	0.00	0.00	n/a
N-Value	= .010	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	Yes

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 128.00	0.00	0.00	0.00
Crest El. (ft)	= 916.00	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

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

TW Elev. (ft) = 0.00

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

Stage / Storage / Discharge Table

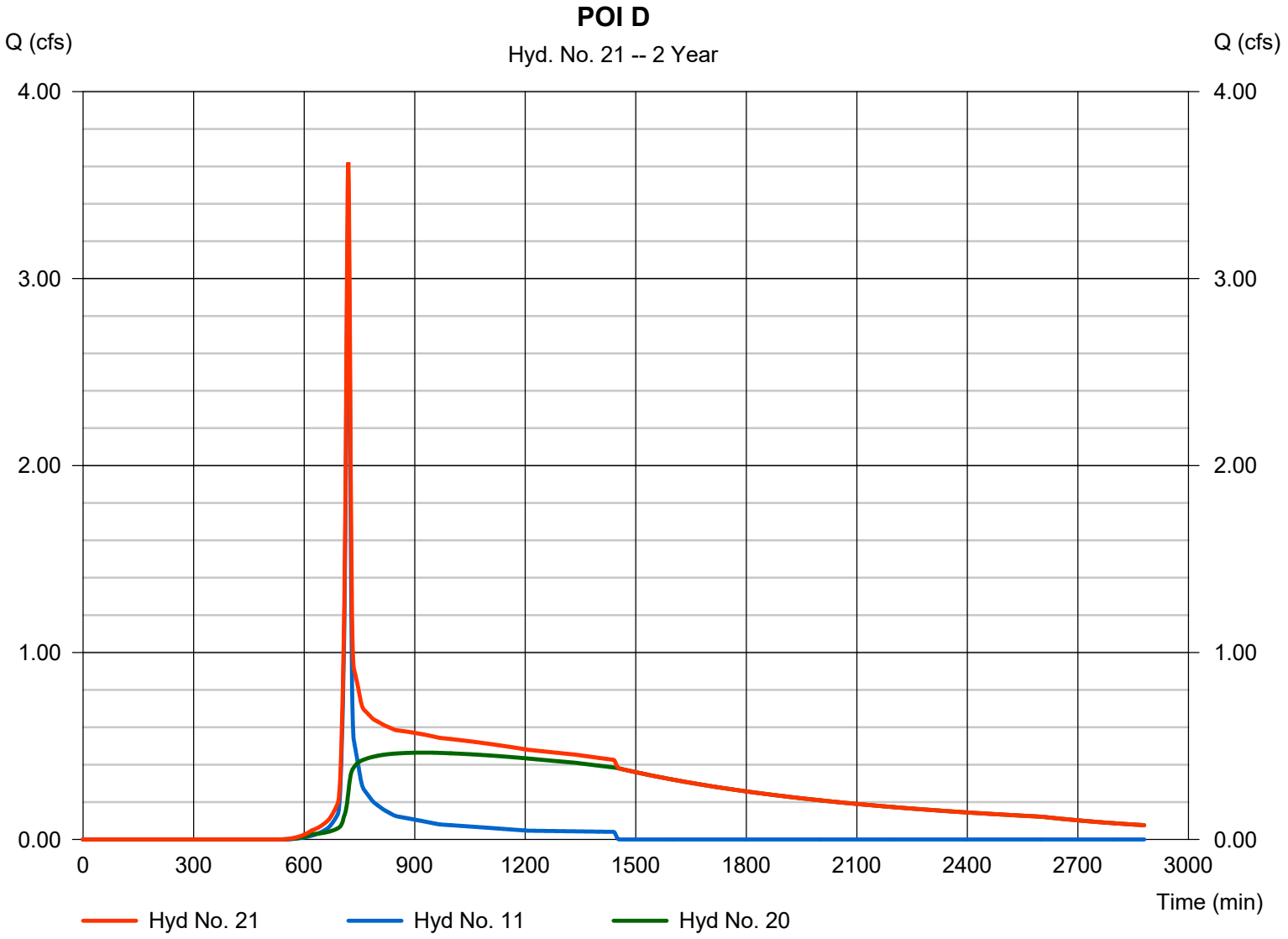
Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	908.40	0.00	0.00	---	0.00	0.00	---	---	---	---	---	0.000
0.60	424	909.00	0.52 oc	0.00	---	0.03	0.00	---	---	---	---	---	0.028
1.60	4,183	910.00	0.52 oc	0.00	---	0.12	0.00	---	---	---	---	---	0.121
3.60	20,732	912.00	0.52 oc	0.00	---	0.41	0.00	---	---	---	---	---	0.410
5.60	44,895	914.00	1.72 oc	0.95 ic	---	0.72	0.00	---	---	---	---	---	1.668
7.60	75,848	916.00	6.21 oc	5.35 ic	---	0.86	0.00	---	---	---	---	---	6.207
9.60	114,055	918.00	8.87 oc	7.56 ic	---	1.31	941.30	---	---	---	---	---	950.17

Hydrograph Report

Hyd. No. 21

POI D

Hydrograph type	=	Combine	Peak discharge	=	3.621 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	43,868 cuft
Inflow hyds.	=	11, 20	Contrib. drain. area	=	1.340 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

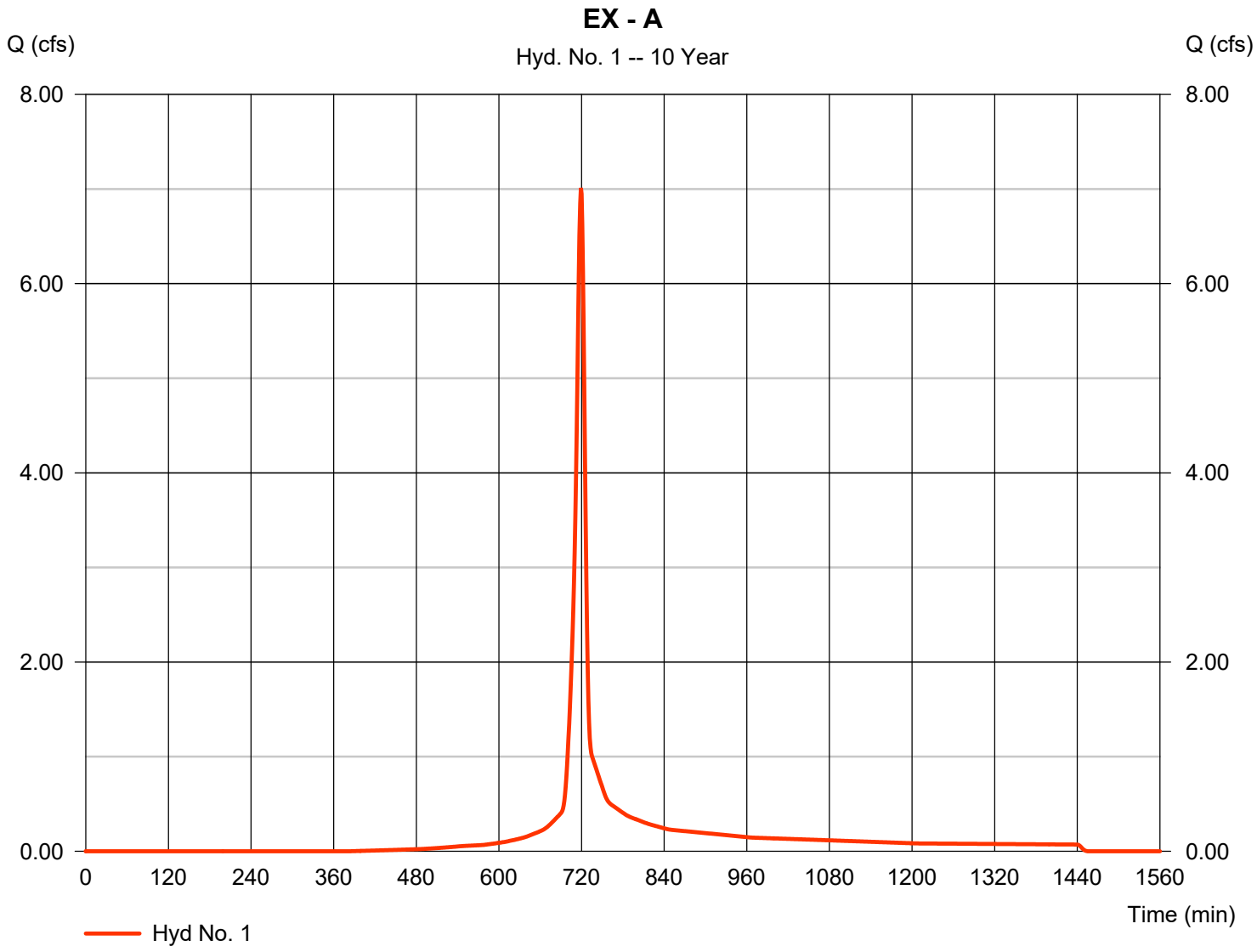
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	7.013	1	719	16,087	------	------	------	EX - A
2	SCS Runoff	4.019	1	718	8,650	------	------	------	EX - B
3	SCS Runoff	6.486	1	717	13,418	------	------	------	EX - C
4	SCS Runoff	36.03	1	720	87,130	------	------	------	EX - D
5	SCS Runoff	31.86	1	720	77,055	------	------	------	EX - E
6	Combine	35.62	1	720	85,704	2, 5	------	------	EX - B COMBINED
7	SCS Runoff	20.11	1	719	46,131	------	------	------	OFFSITE UNDETAINED
8	SCS Runoff	5.519	1	718	11,879	------	------	------	PROP - A
9	SCS Runoff	4.769	1	718	10,264	------	------	------	PROP - B
10	SCS Runoff	2.836	1	719	6,506	------	------	------	PROP - C
11	SCS Runoff	6.362	1	719	14,469	------	------	------	PROP - D
12	SCS Runoff	30.94	1	719	70,972	------	------	------	PROP - D1
13	SCS Runoff	50.20	1	721	128,081	------	------	------	PROP - E
14	SCS Runoff	59.35	1	723	170,185	------	------	------	OFFSITE DETAINED
15	Reservoir	7.991	1	738	122,897	13	939.66	63,060	BASIN E
16	Combine	8.990	1	722	133,162	9, 15	------	------	COMBINED PROP B
18	Combine	76.67	1	721	216,317	7, 14,	------	------	OFFSITE BYPASS
20	Reservoir	1.352	1	811	65,140	12	913.89	43,577	BASIN D1
21	Combine	6.826	1	719	79,609	11, 20	------	------	POI D

Hydrograph Report

Hyd. No. 1

EX - A

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.013 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	16,087 cuft
Drainage area	=	1.360 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	9.50 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

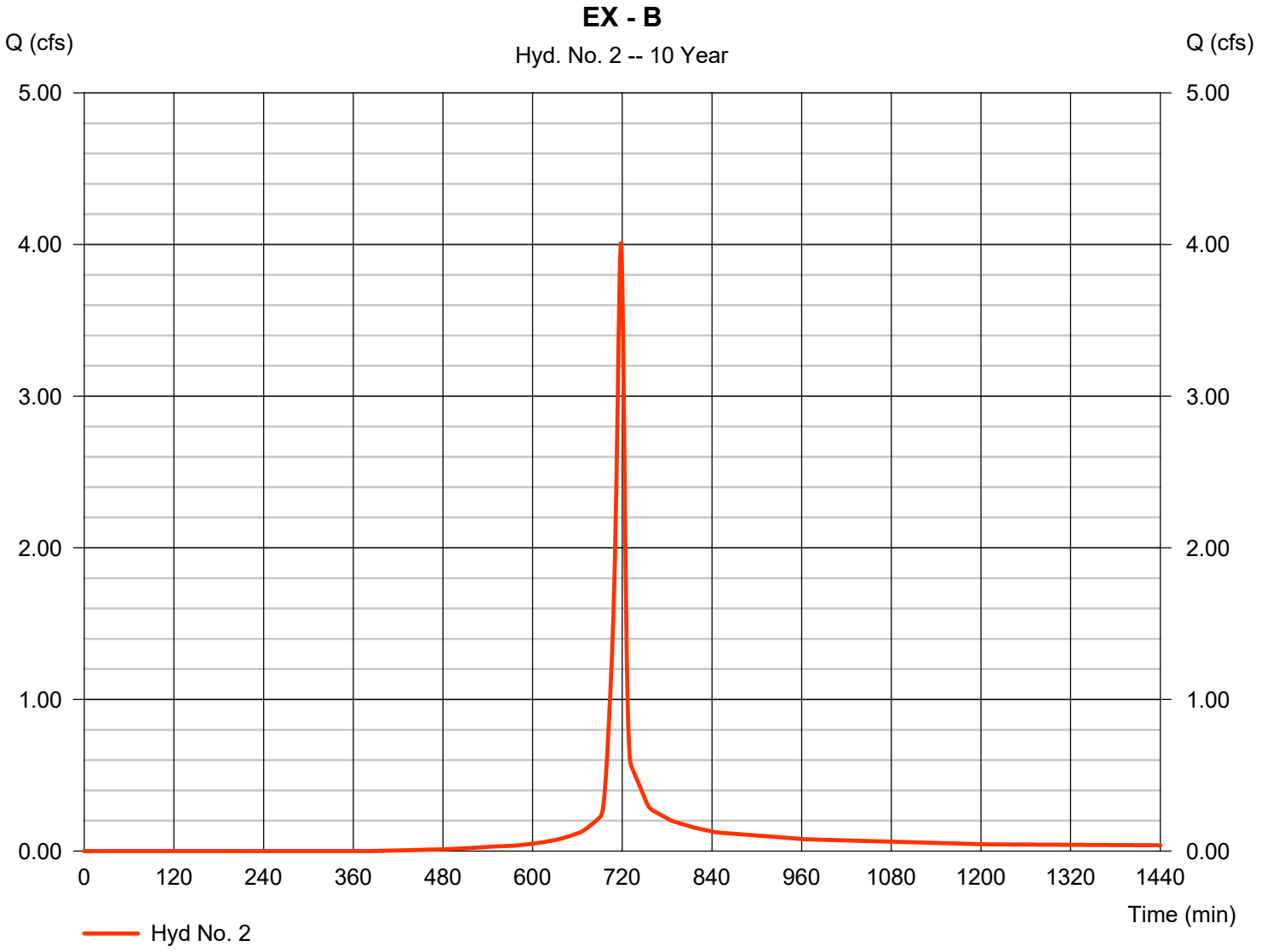


Hydrograph Report

Hyd. No. 2

EX - B

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.019 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	8,650 cuft
Drainage area	=	0.750 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	7.50 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

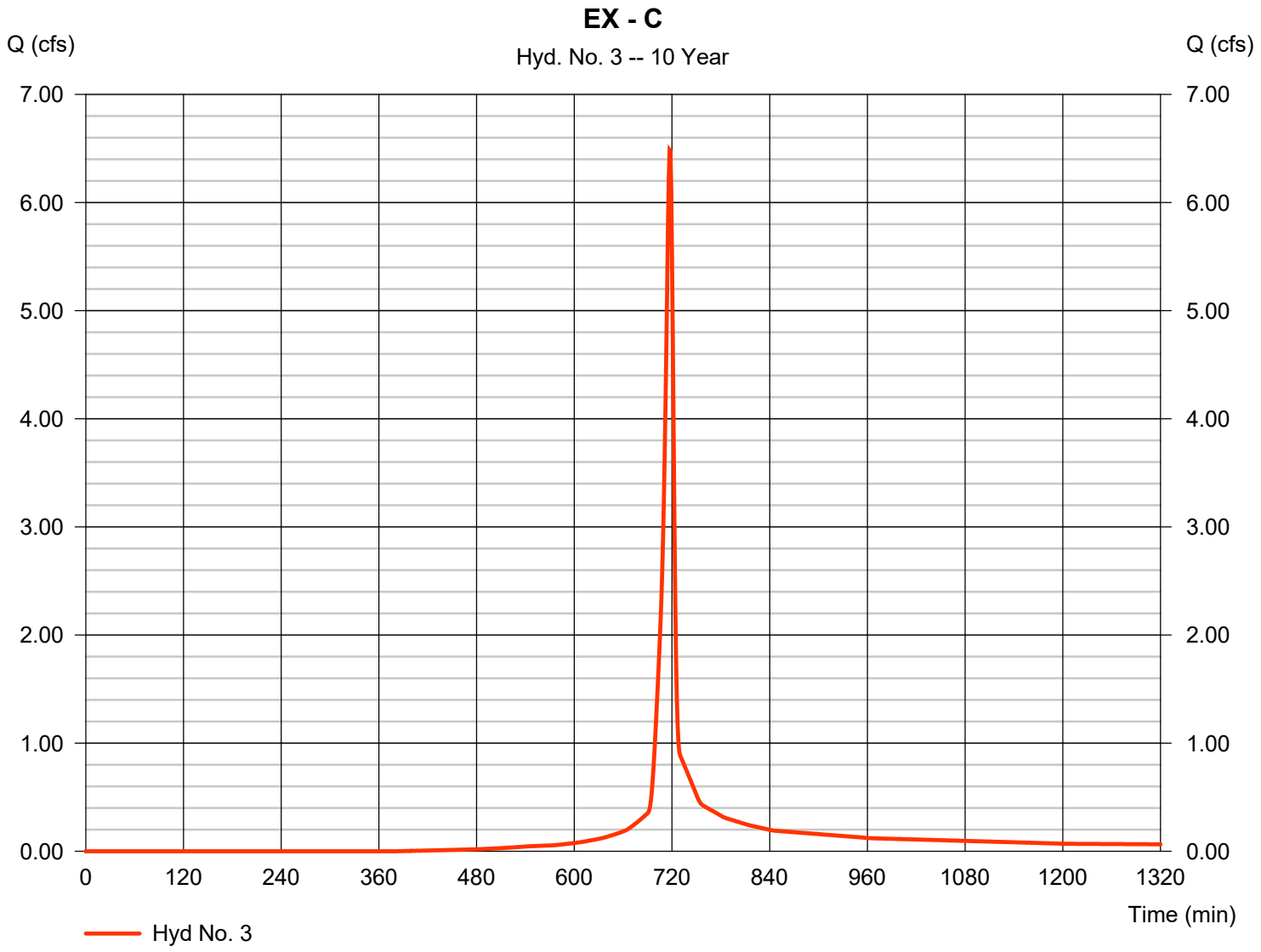


Hydrograph Report

Hyd. No. 3

EX - C

Hydrograph type	= SCS Runoff	Peak discharge	= 6.486 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 13,418 cuft
Drainage area	= 1.100 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

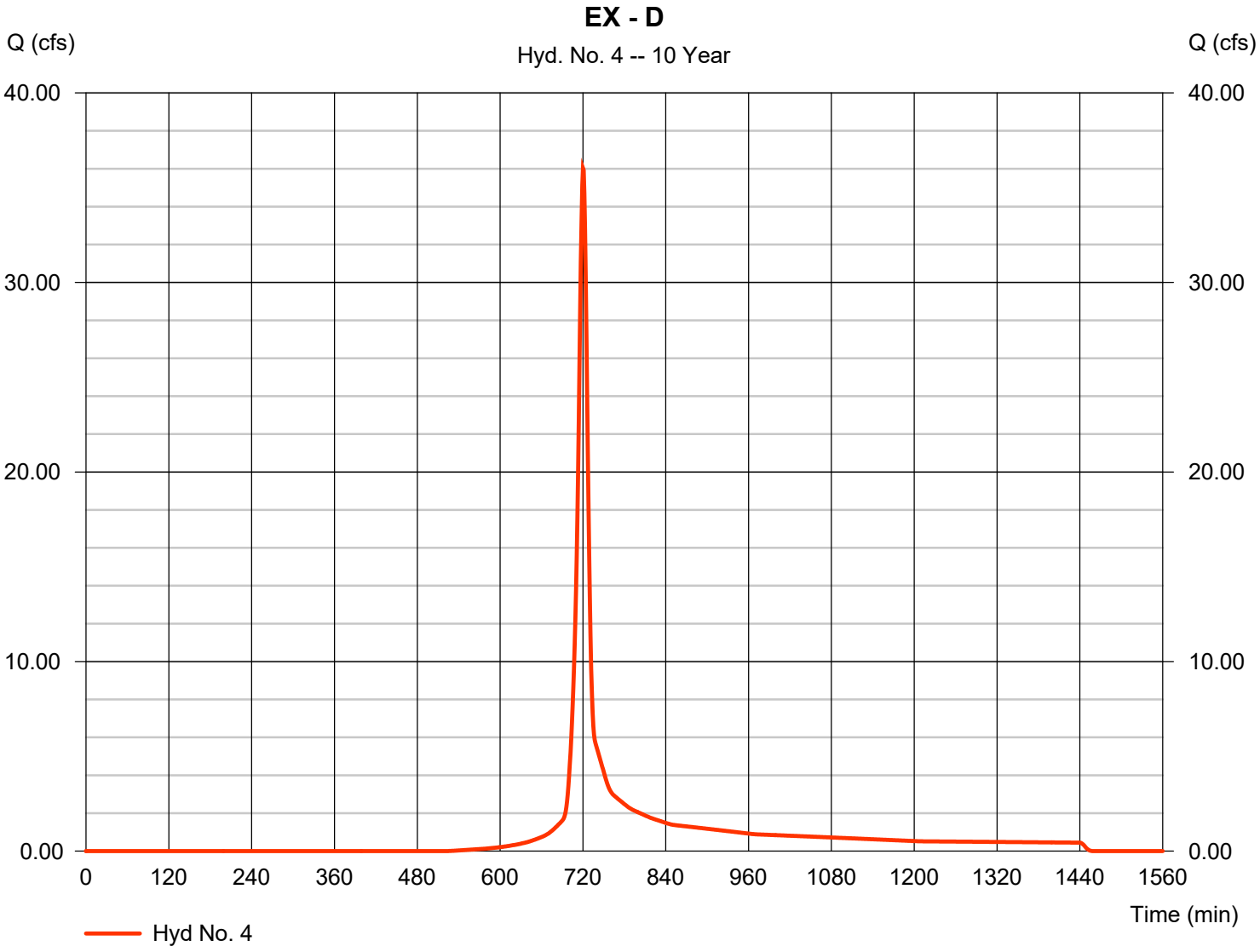


Hydrograph Report

Hyd. No. 4

EX - D

Hydrograph type	=	SCS Runoff	Peak discharge	=	36.03 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	87,130 cuft
Drainage area	=	9.340 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.60 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

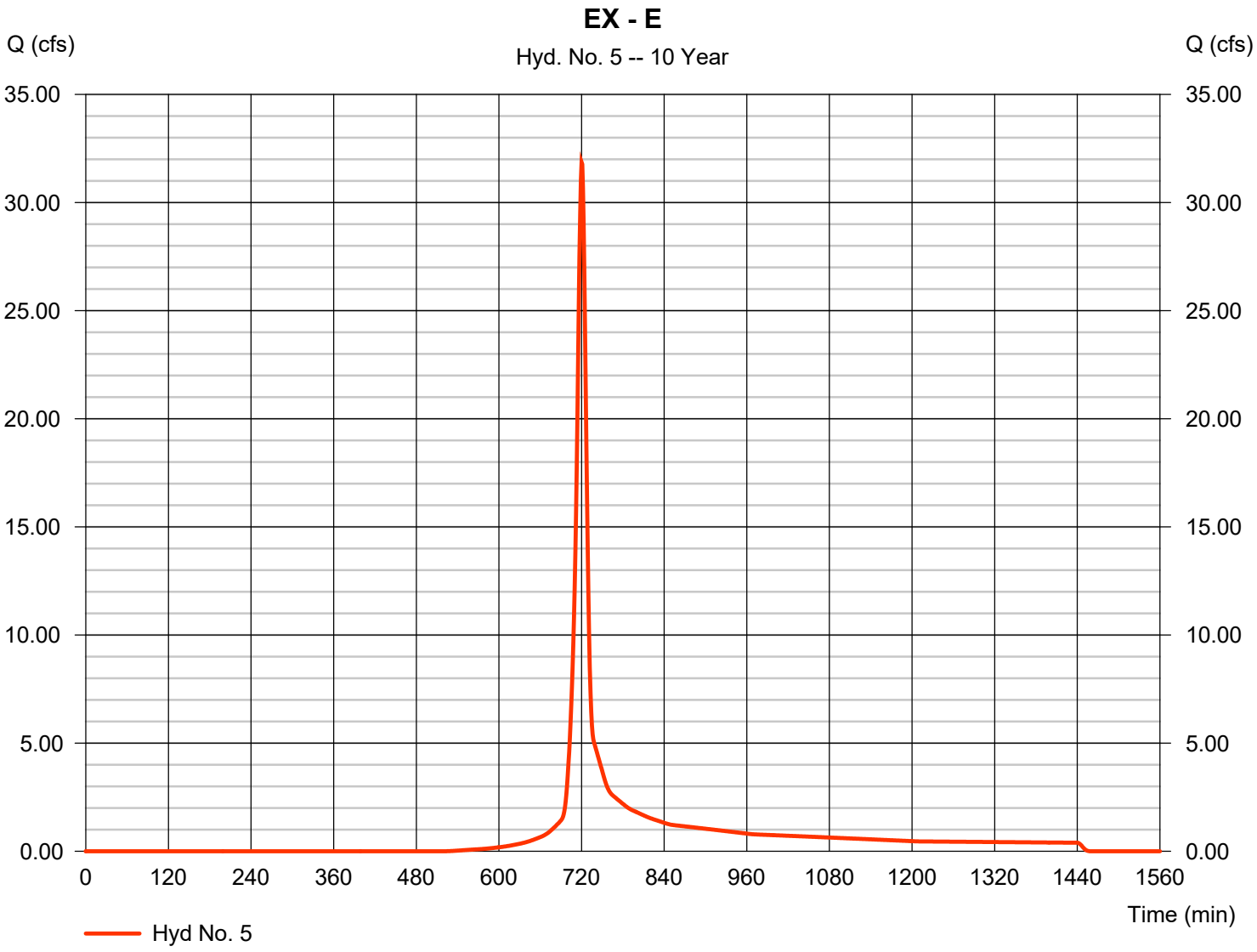


Hydrograph Report

Hyd. No. 5

EX - E

Hydrograph type	=	SCS Runoff	Peak discharge	=	31.86 cfs
Storm frequency	=	10 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	77,055 cuft
Drainage area	=	8.260 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.60 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

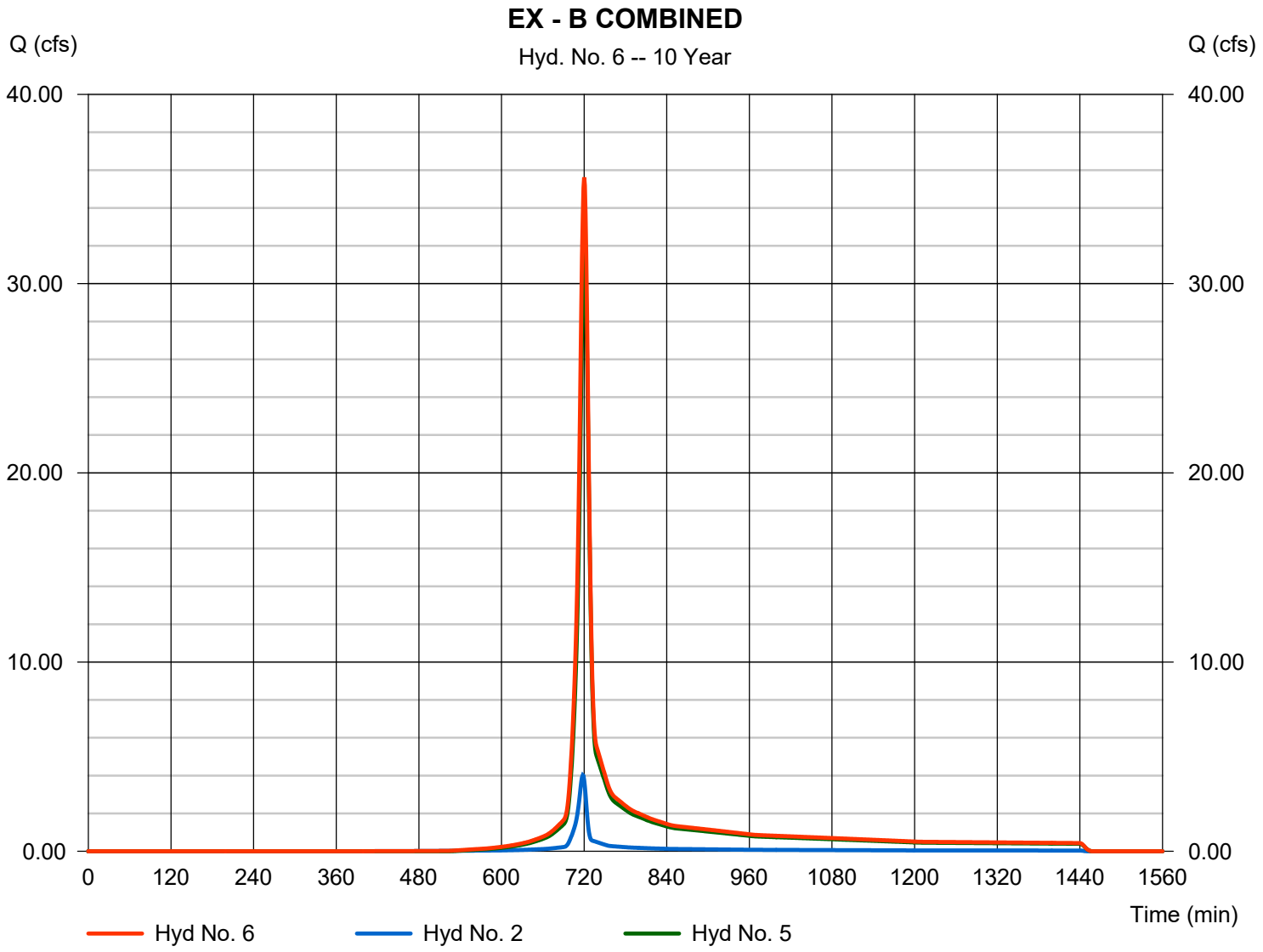


Hydrograph Report

Hyd. No. 6

EX - B COMBINED

Hydrograph type	= Combine	Peak discharge	= 35.62 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 85,704 cuft
Inflow hyds.	= 2, 5	Contrib. drain. area	= 9.010 ac

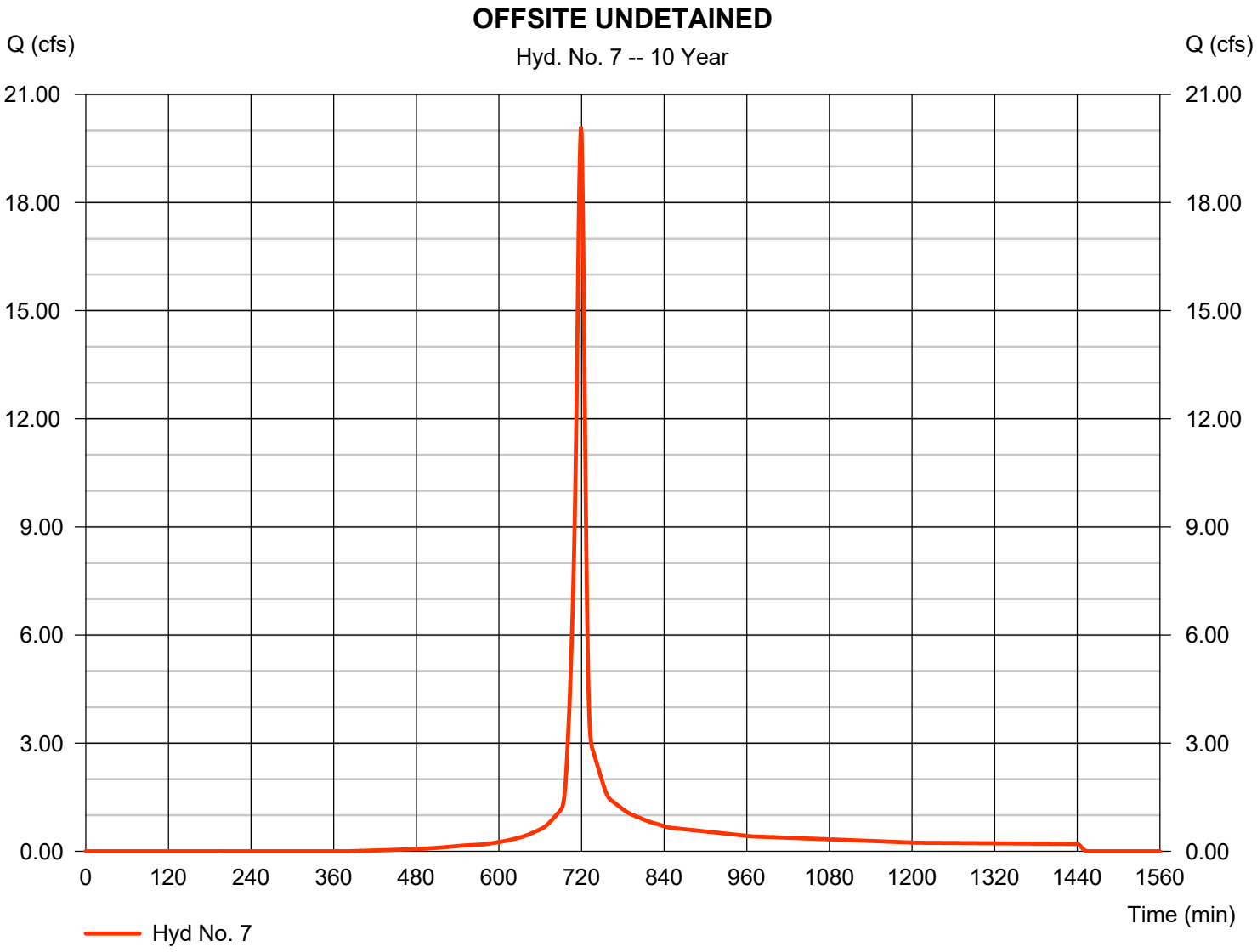


Hydrograph Report

Hyd. No. 7

OFFSITE UNDETAINED

Hydrograph type	=	SCS Runoff	Peak discharge	=	20.11 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	46,131 cuft
Drainage area	=	3.900 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	8.60 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

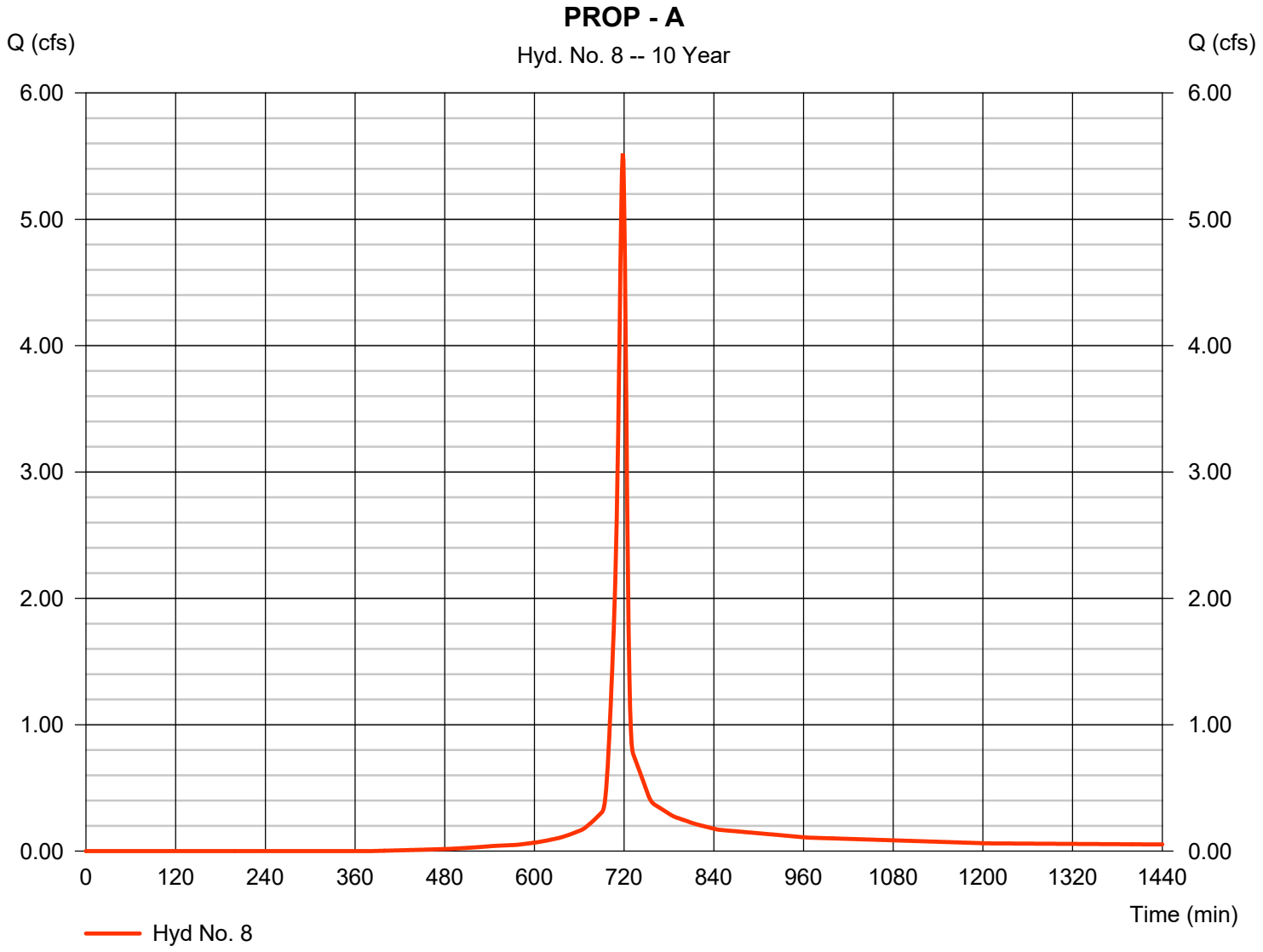


Hydrograph Report

Hyd. No. 8

PROP - A

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.519 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	11,879 cuft
Drainage area	=	1.030 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	6.80 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

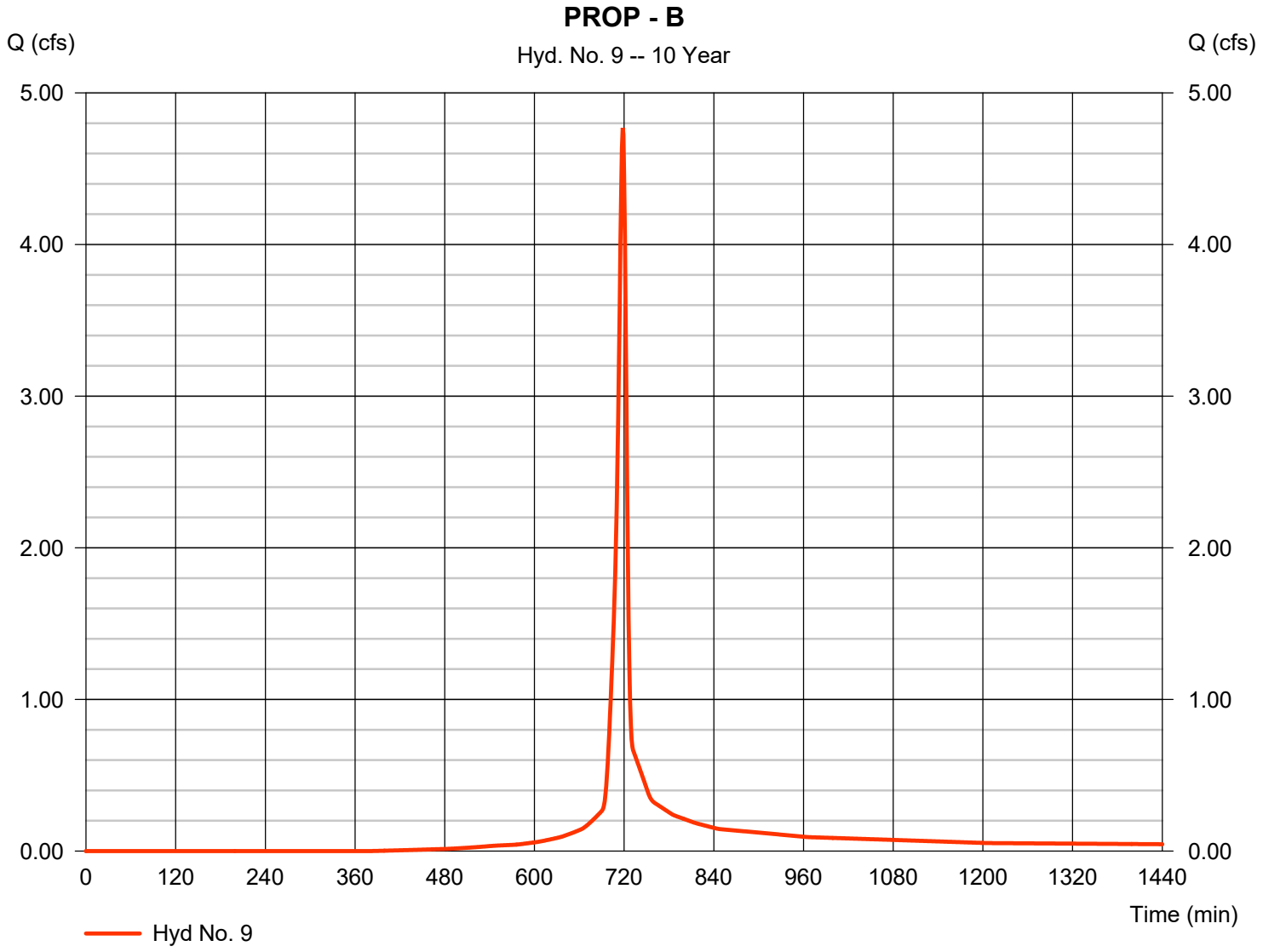


Hydrograph Report

Hyd. No. 9

PROP - B

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.769 cfs
Storm frequency	=	10 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	10,264 cuft
Drainage area	=	0.890 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	7.40 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

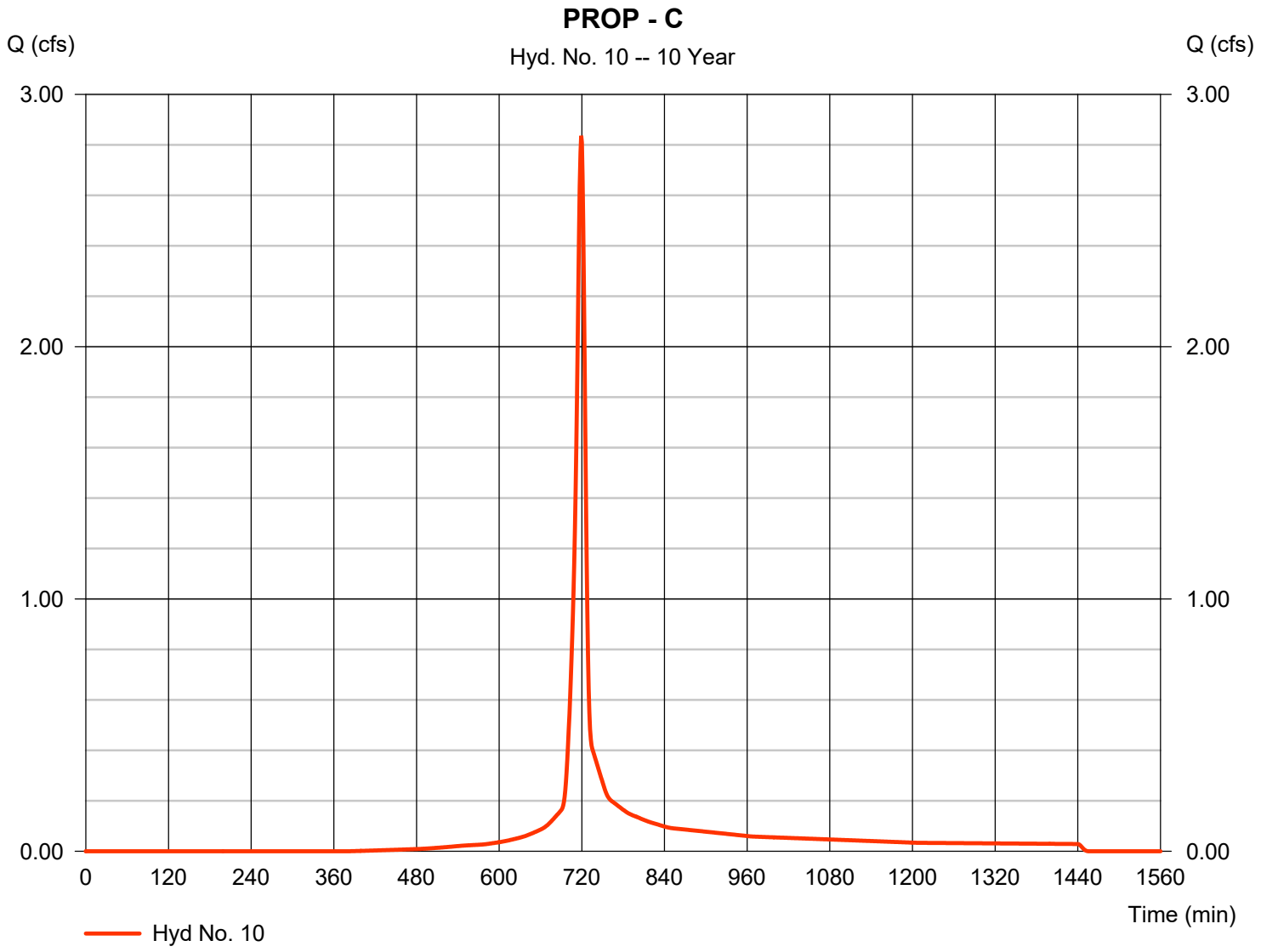


Hydrograph Report

Hyd. No. 10

PROP - C

Hydrograph type	= SCS Runoff	Peak discharge	= 2.836 cfs
Storm frequency	= 10 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 6,506 cuft
Drainage area	= 0.550 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 8.70 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

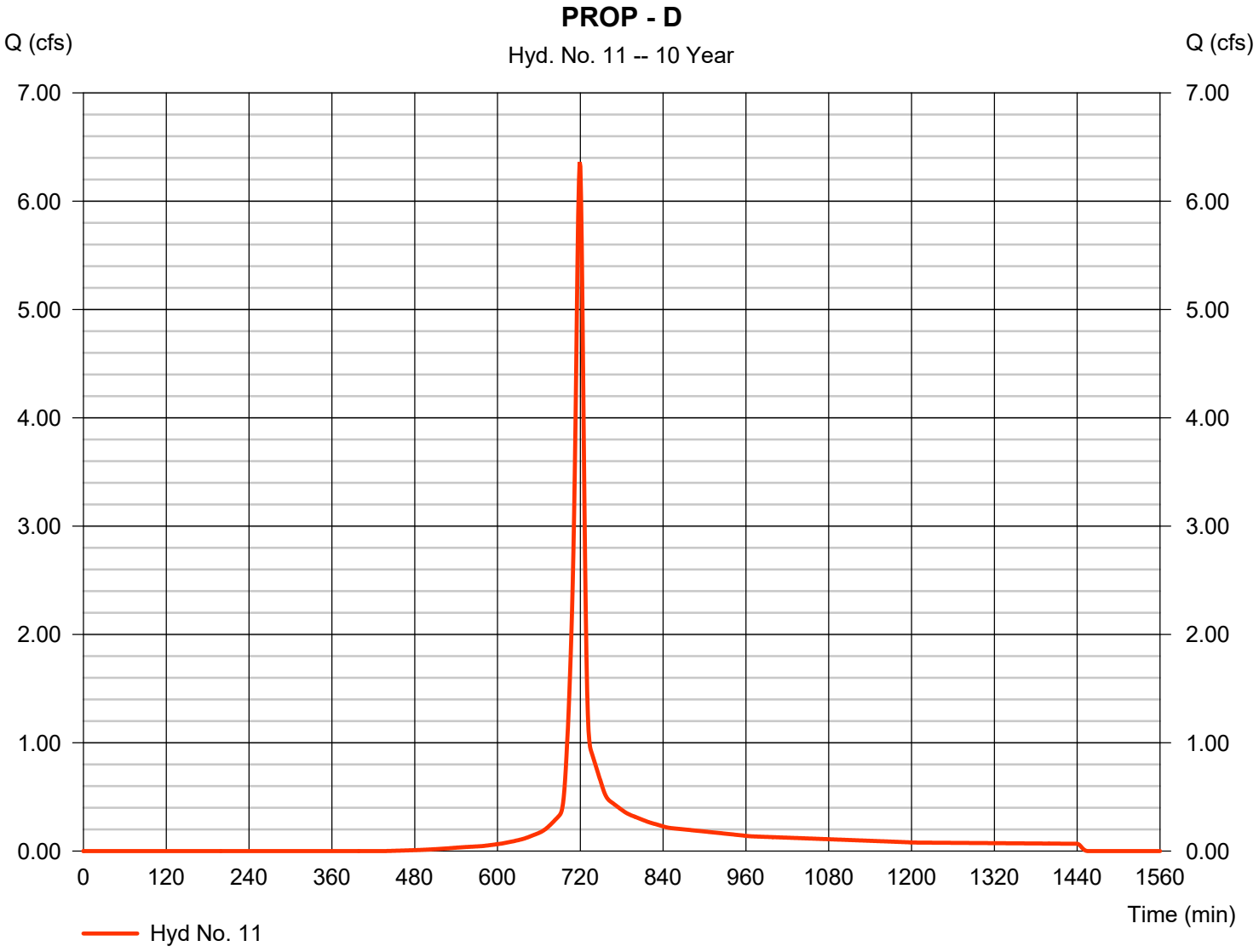


Hydrograph Report

Hyd. No. 11

PROP - D

Hydrograph type	= SCS Runoff	Peak discharge	= 6.362 cfs
Storm frequency	= 10 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 14,469 cuft
Drainage area	= 1.340 ac	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 9.70 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

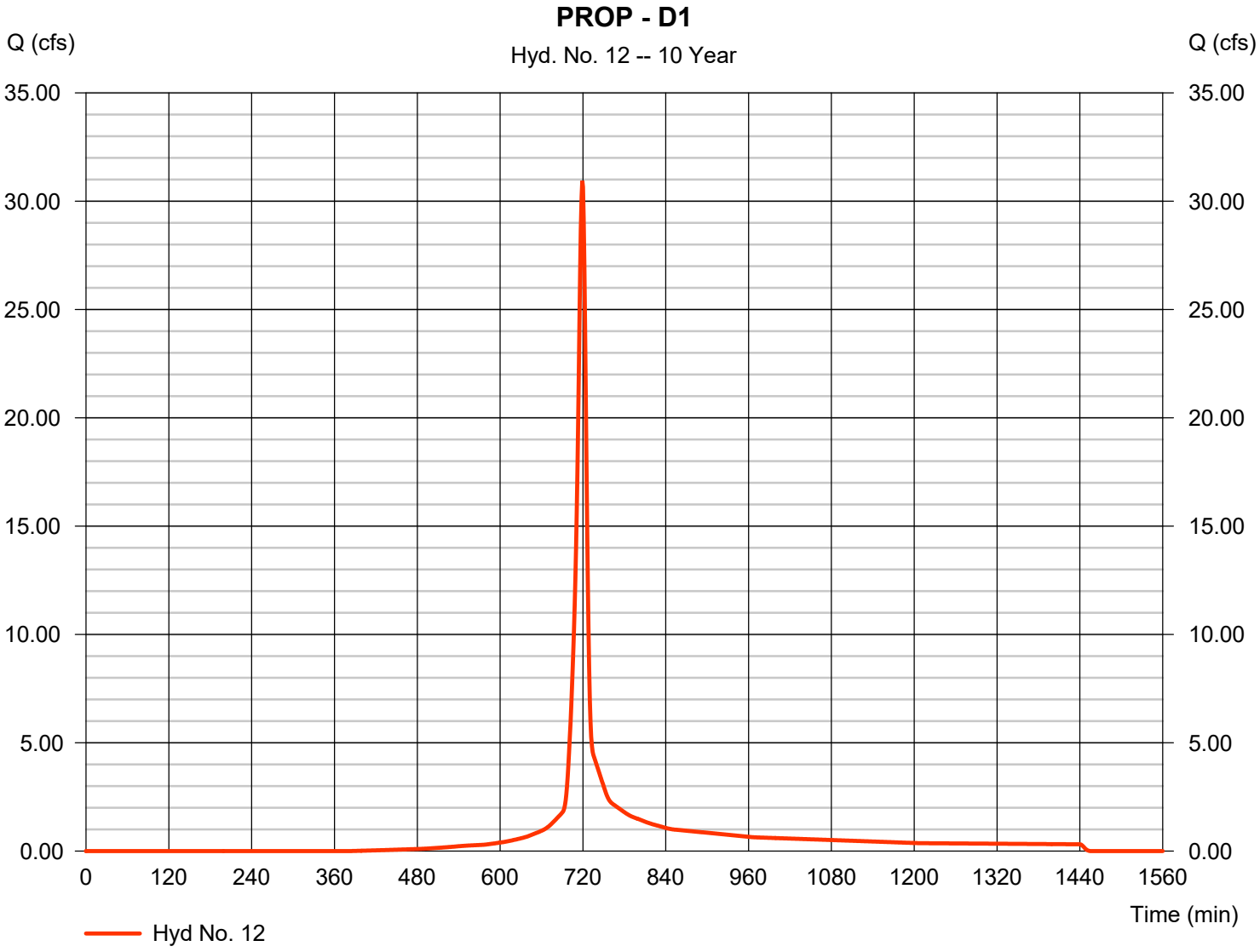


Hydrograph Report

Hyd. No. 12

PROP - D1

Hydrograph type	=	SCS Runoff	Peak discharge	=	30.94 cfs
Storm frequency	=	10 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	70,972 cuft
Drainage area	=	6.000 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	9.60 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

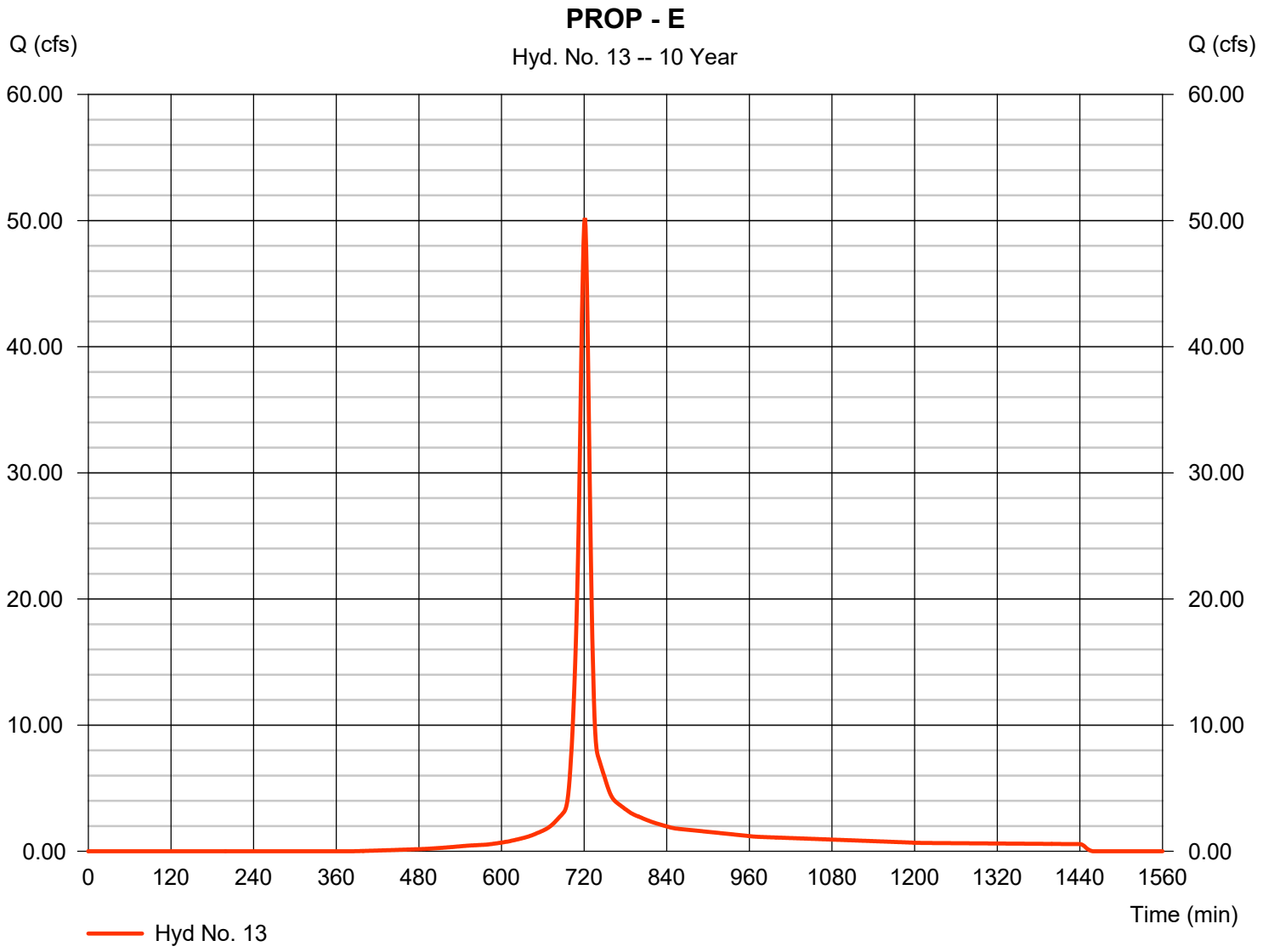


Hydrograph Report

Hyd. No. 13

PROP - E

Hydrograph type	=	SCS Runoff	Peak discharge	=	50.20 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	128,081 cuft
Drainage area	=	11.000 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.80 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

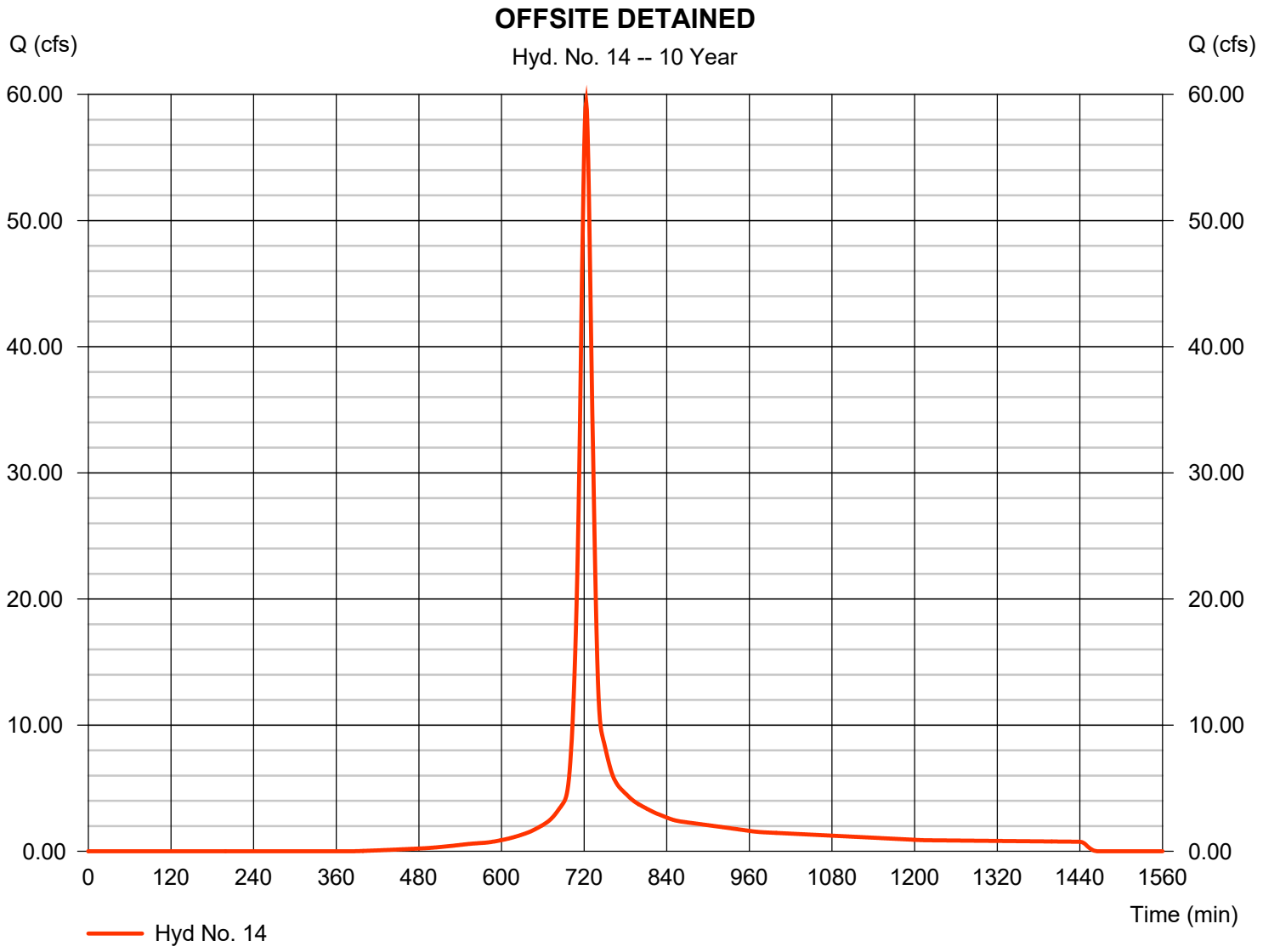


Hydrograph Report

Hyd. No. 14

OFFSITE DETAINED

Hydrograph type	=	SCS Runoff	Peak discharge	=	59.35 cfs
Storm frequency	=	10 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	170,185 cuft
Drainage area	=	14.210 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.50 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



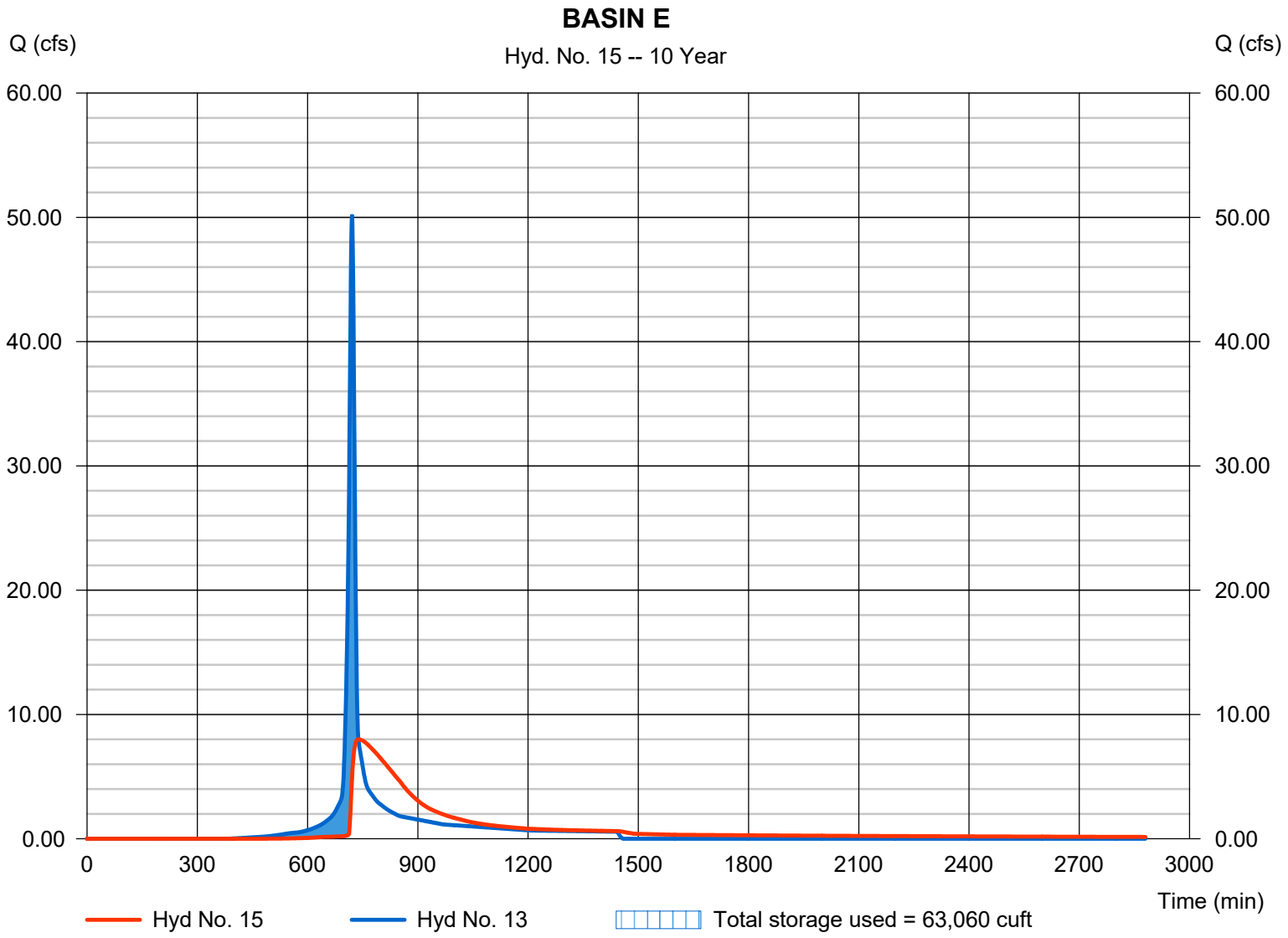
Hydrograph Report

Hyd. No. 15

BASIN E

Hydrograph type	= Reservoir	Peak discharge	= 7.991 cfs
Storm frequency	= 10 yrs	Time to peak	= 738 min
Time interval	= 1 min	Hyd. volume	= 122,897 cuft
Inflow hyd. No.	= 13 - PROP - E	Max. Elevation	= 939.66 ft
Reservoir name	= Basin E	Max. Storage	= 63,060 cuft

Storage Indication method used.

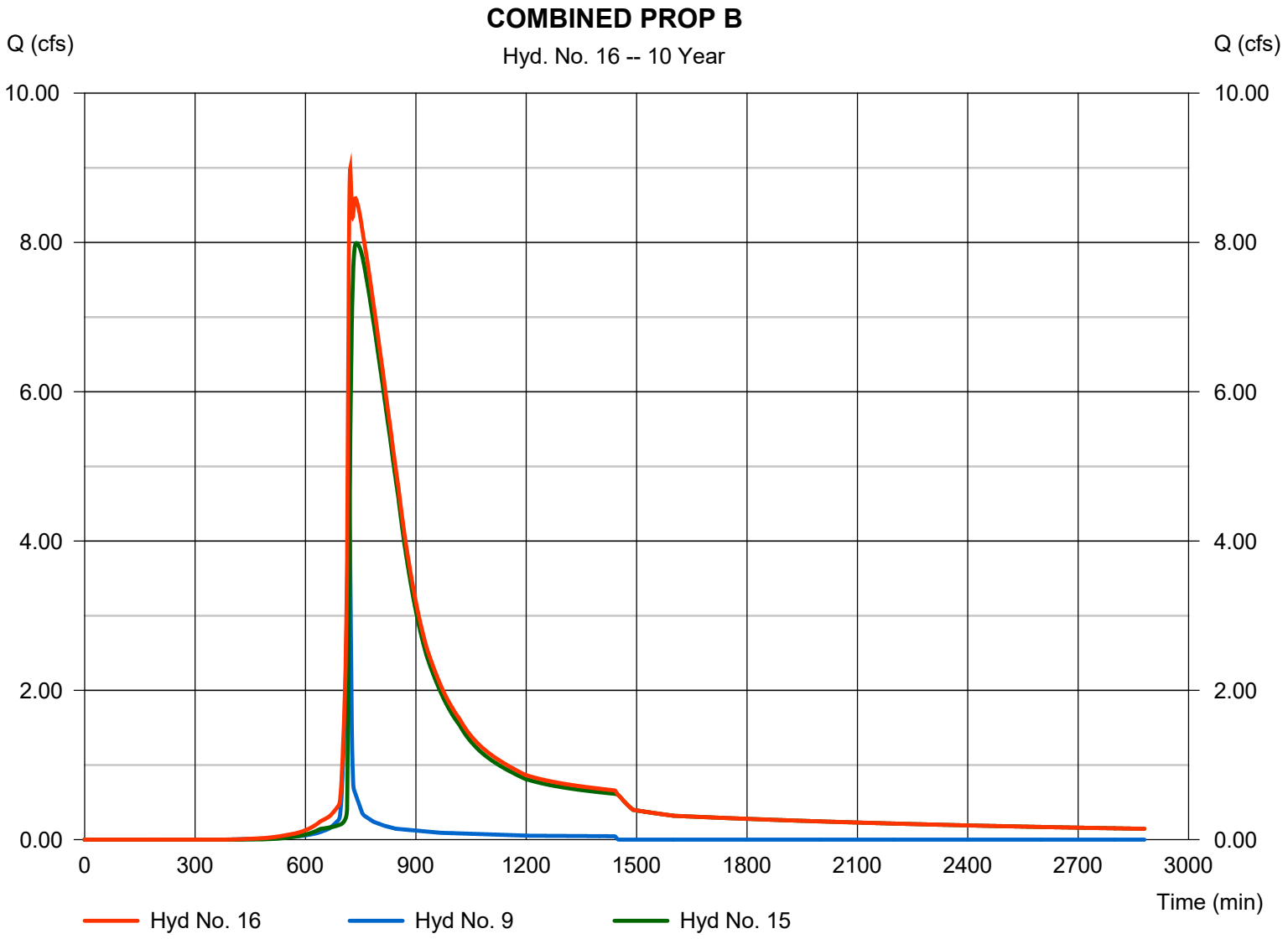


Hydrograph Report

Hyd. No. 16

COMBINED PROP B

Hydrograph type	=	Combine	Peak discharge	=	8.990 cfs
Storm frequency	=	10 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	133,162 cuft
Inflow hyds.	=	9, 15	Contrib. drain. area	=	0.890 ac

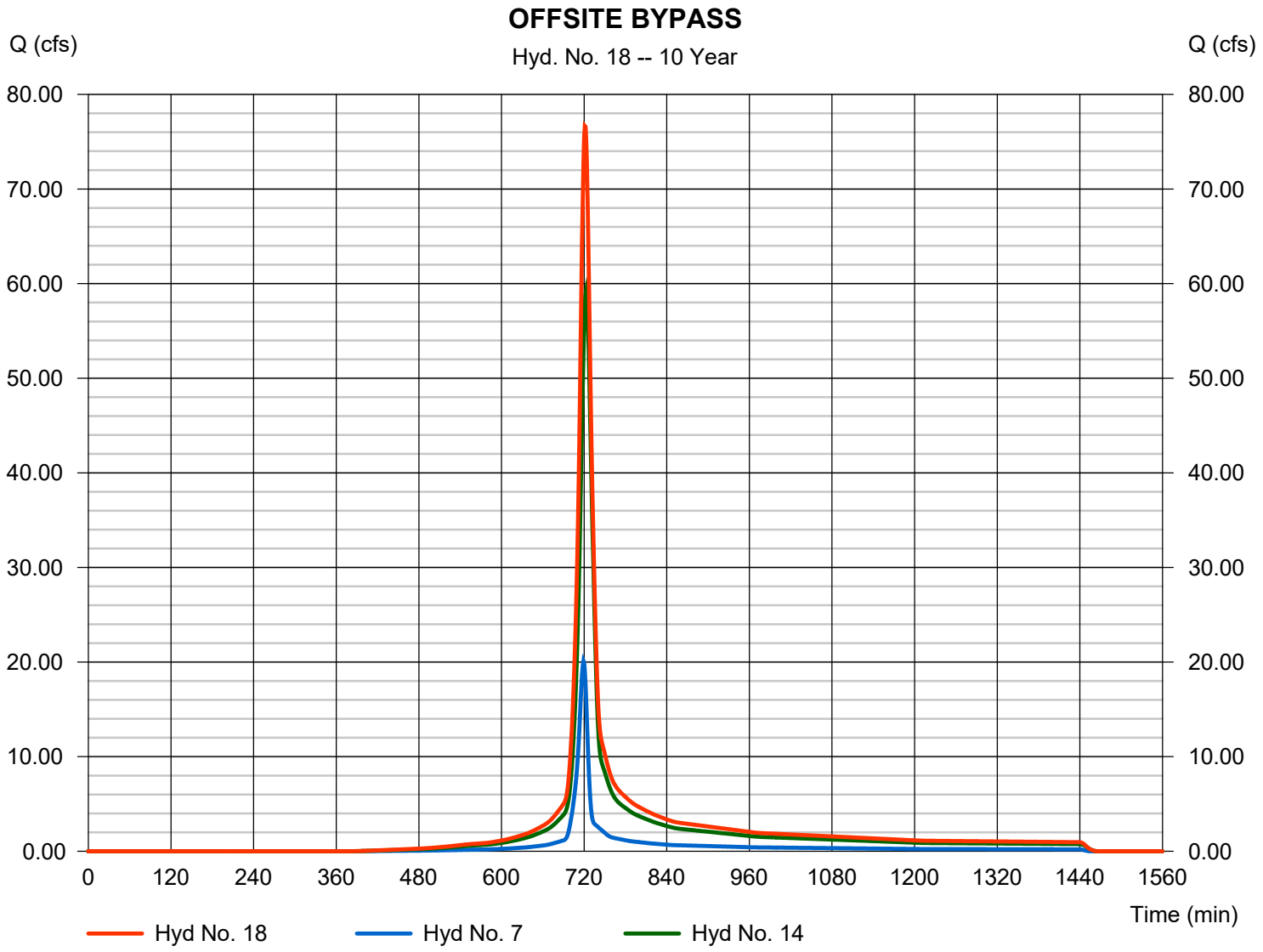


Hydrograph Report

Hyd. No. 18

OFFSITE BYPASS

Hydrograph type	=	Combine	Peak discharge	=	76.67 cfs
Storm frequency	=	10 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	216,317 cuft
Inflow hyds.	=	7, 14	Contrib. drain. area	=	18.110 ac



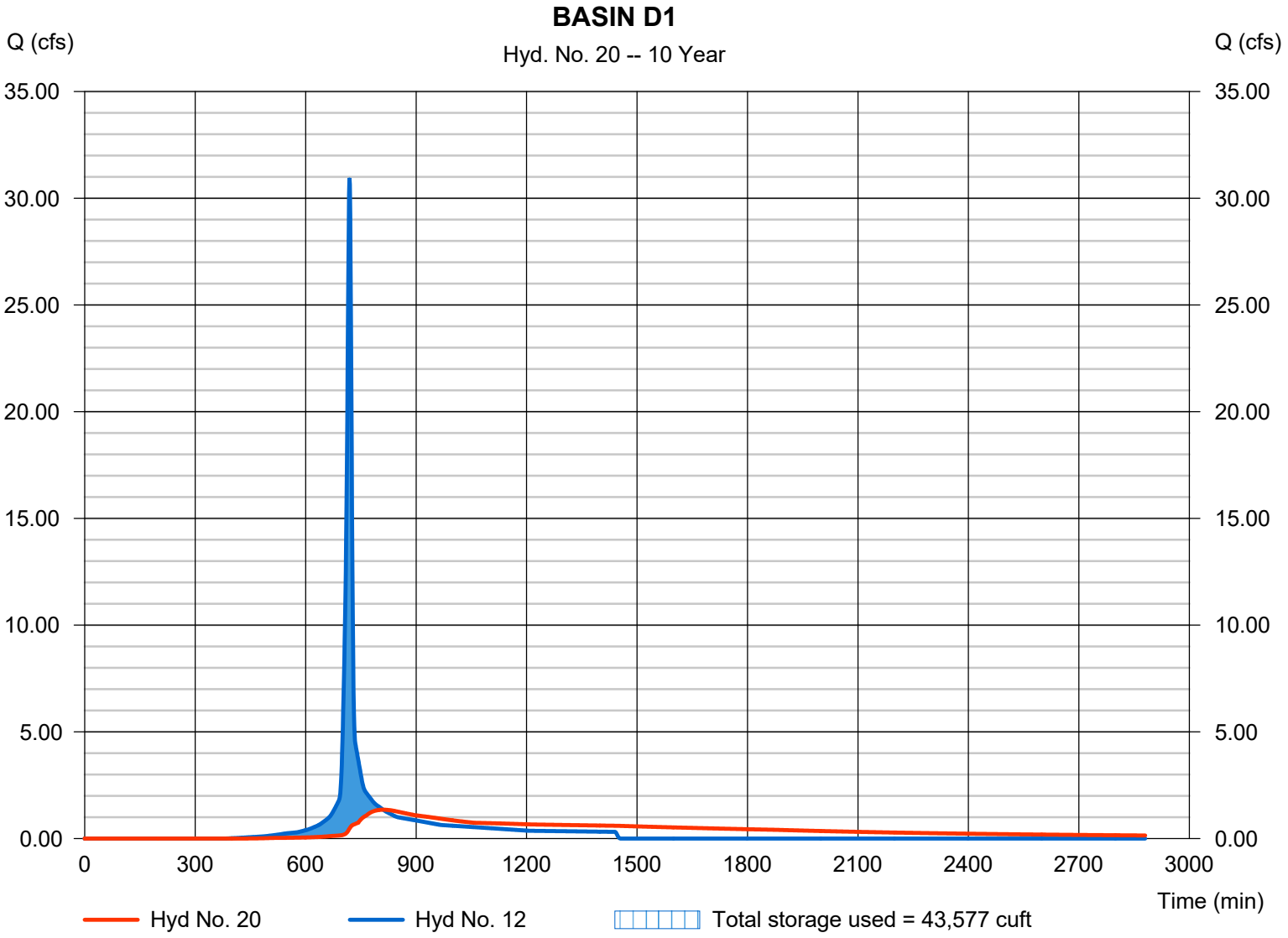
Hydrograph Report

Hyd. No. 20

BASIN D1

Hydrograph type	=	Reservoir	Peak discharge	=	1.352 cfs
Storm frequency	=	10 yrs	Time to peak	=	811 min
Time interval	=	1 min	Hyd. volume	=	65,140 cuft
Inflow hyd. No.	=	12 - PROP - D1	Max. Elevation	=	913.89 ft
Reservoir name	=	Basin D1	Max. Storage	=	43,577 cuft

Storage Indication method used.

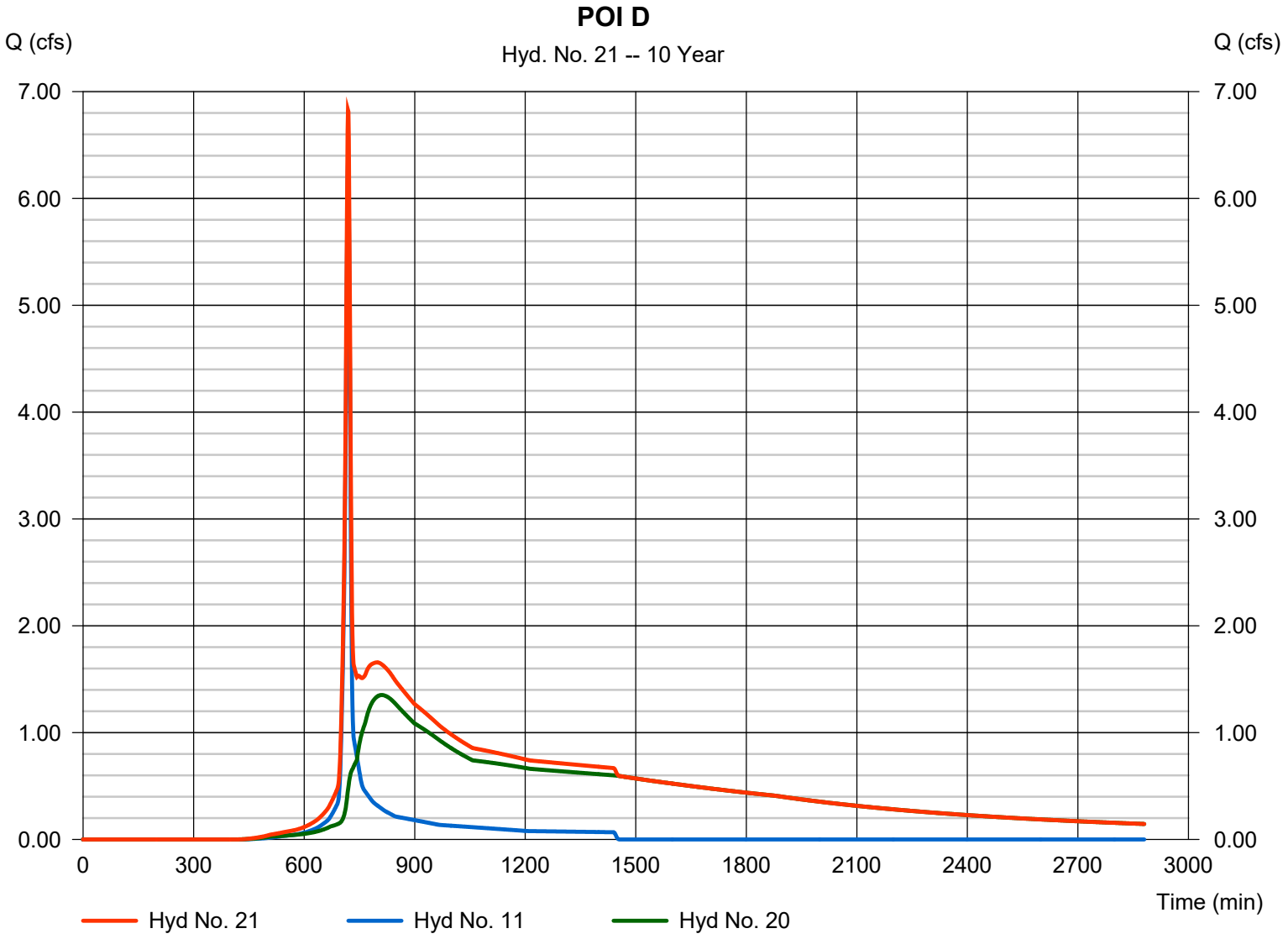


Hydrograph Report

Hyd. No. 21

POI D

Hydrograph type	= Combine	Peak discharge	= 6.826 cfs
Storm frequency	= 10 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 79,609 cuft
Inflow hyds.	= 11, 20	Contrib. drain. area	= 1.340 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

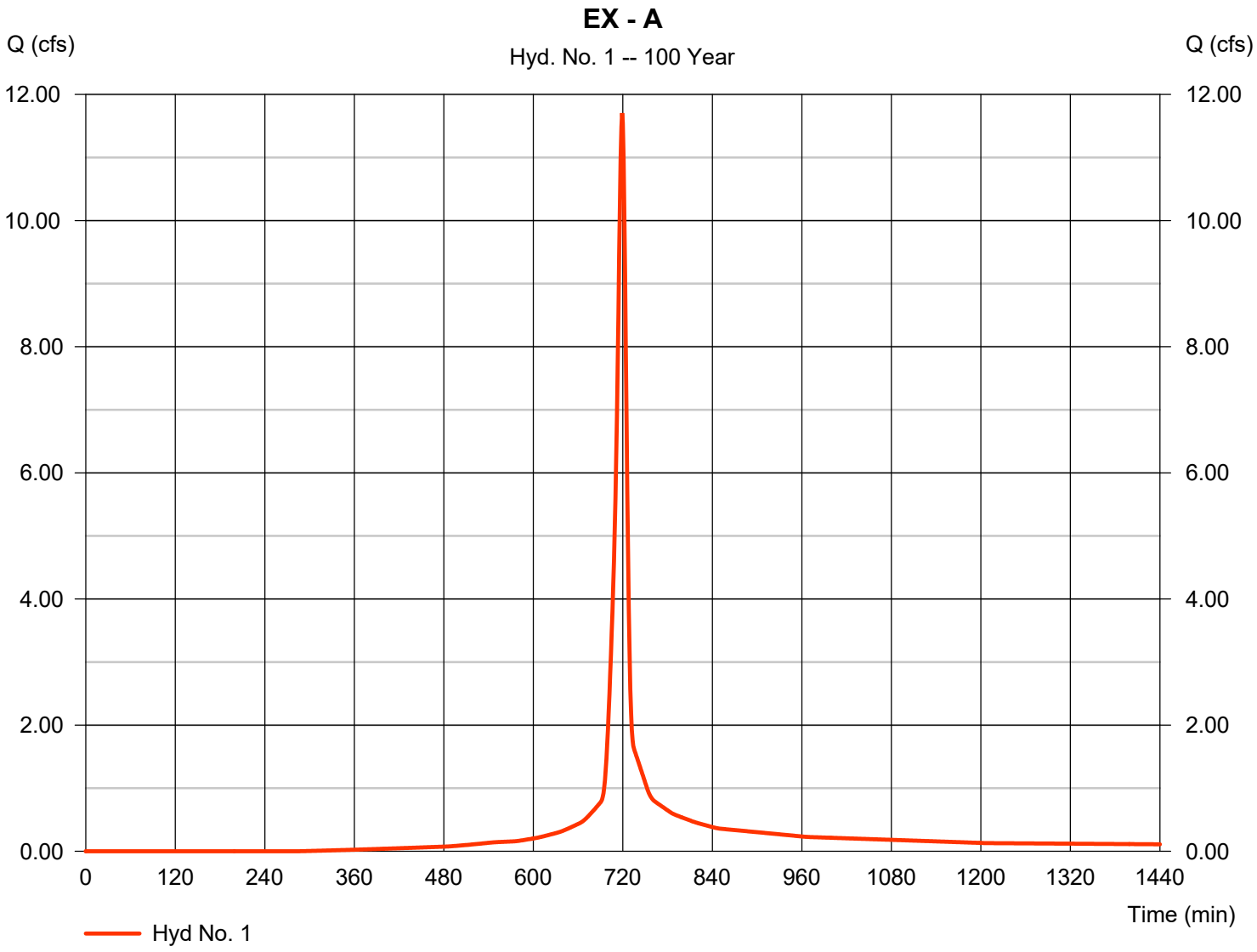
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	11.71	1	719	27,525	------	------	------	EX - A
2	SCS Runoff	6.695	1	718	14,800	------	------	------	EX - B
3	SCS Runoff	10.80	1	717	22,958	------	------	------	EX - C
4	SCS Runoff	65.98	1	720	160,755	------	------	------	EX - D
5	SCS Runoff	58.35	1	720	142,167	------	------	------	EX - E
6	Combine	64.55	1	720	156,966	2, 5	------	------	EX - B COMBINED
7	SCS Runoff	33.57	1	719	78,931	------	------	------	OFFSITE UNDETAINED
8	SCS Runoff	9.195	1	718	20,325	------	------	------	PROP - A
9	SCS Runoff	7.945	1	718	17,562	------	------	------	PROP - B
10	SCS Runoff	4.734	1	719	11,131	------	------	------	PROP - C
11	SCS Runoff	10.96	1	719	25,436	------	------	------	PROP - D
12	SCS Runoff	51.64	1	719	121,433	------	------	------	PROP - D1
13	SCS Runoff	83.98	1	721	219,148	------	------	------	PROP - E
14	SCS Runoff	99.64	1	723	291,188	------	------	------	OFFSITE DETAINED
15	Reservoir	11.86	1	741	213,662	13	941.49	111,524	BASIN E
16	Combine	16.53	1	719	231,224	9, 15	------	------	COMBINED PROP B
18	Combine	128.96	1	721	370,120	7, 14,	------	------	OFFSITE BYPASS
20	Reservoir	5.294	1	747	114,581	12	915.40	66,564	BASIN D1
21	Combine	13.59	1	721	140,017	11, 20	------	------	POI D

Hydrograph Report

Hyd. No. 1

EX - A

Hydrograph type	=	SCS Runoff	Peak discharge	=	11.71 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	27,525 cuft
Drainage area	=	1.360 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	9.50 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

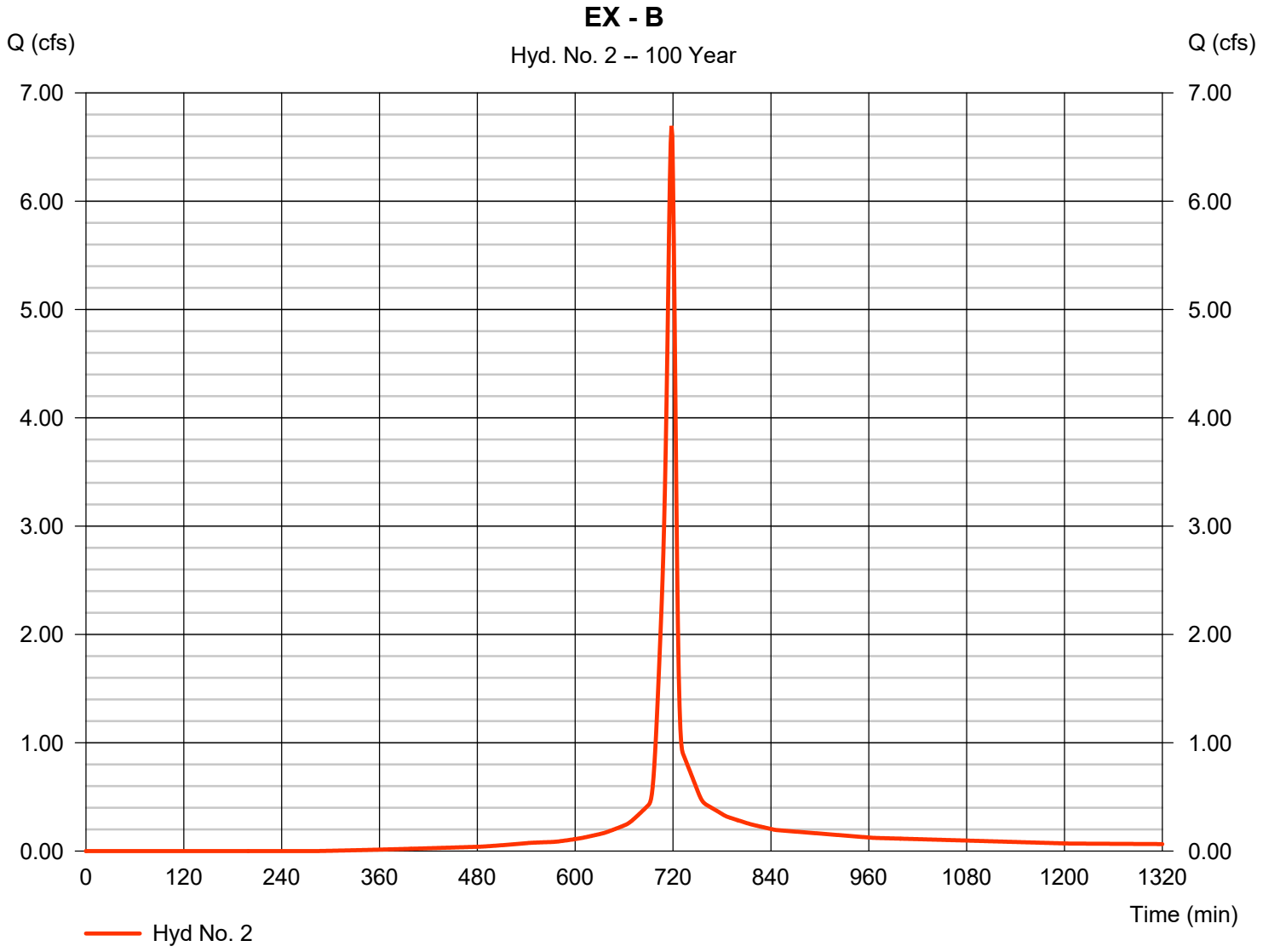


Hydrograph Report

Hyd. No. 2

EX - B

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.695 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	14,800 cuft
Drainage area	=	0.750 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	7.50 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

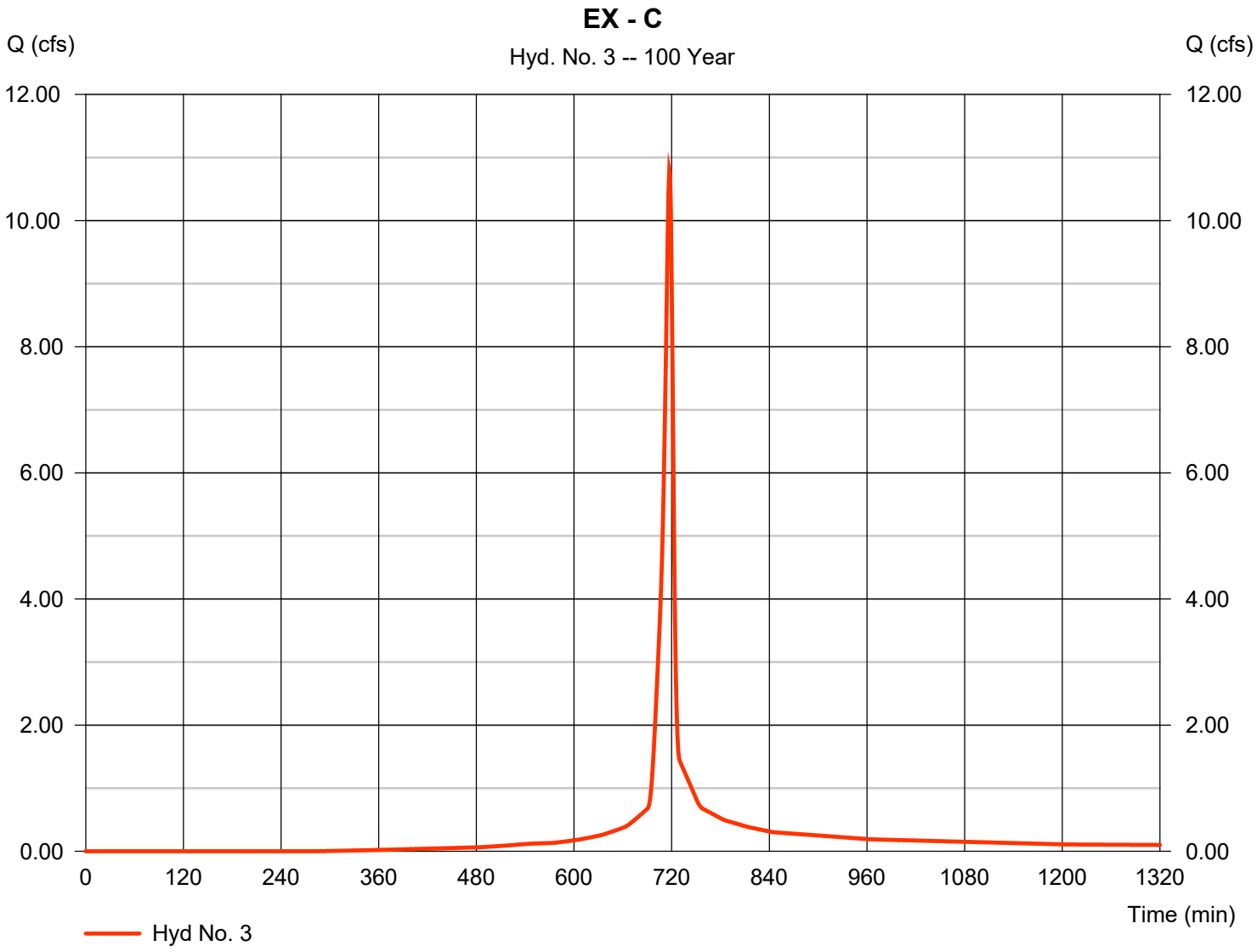


Hydrograph Report

Hyd. No. 3

EX - C

Hydrograph type	=	SCS Runoff	Peak discharge	=	10.80 cfs
Storm frequency	=	100 yrs	Time to peak	=	717 min
Time interval	=	1 min	Hyd. volume	=	22,958 cuft
Drainage area	=	1.100 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	6.00 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

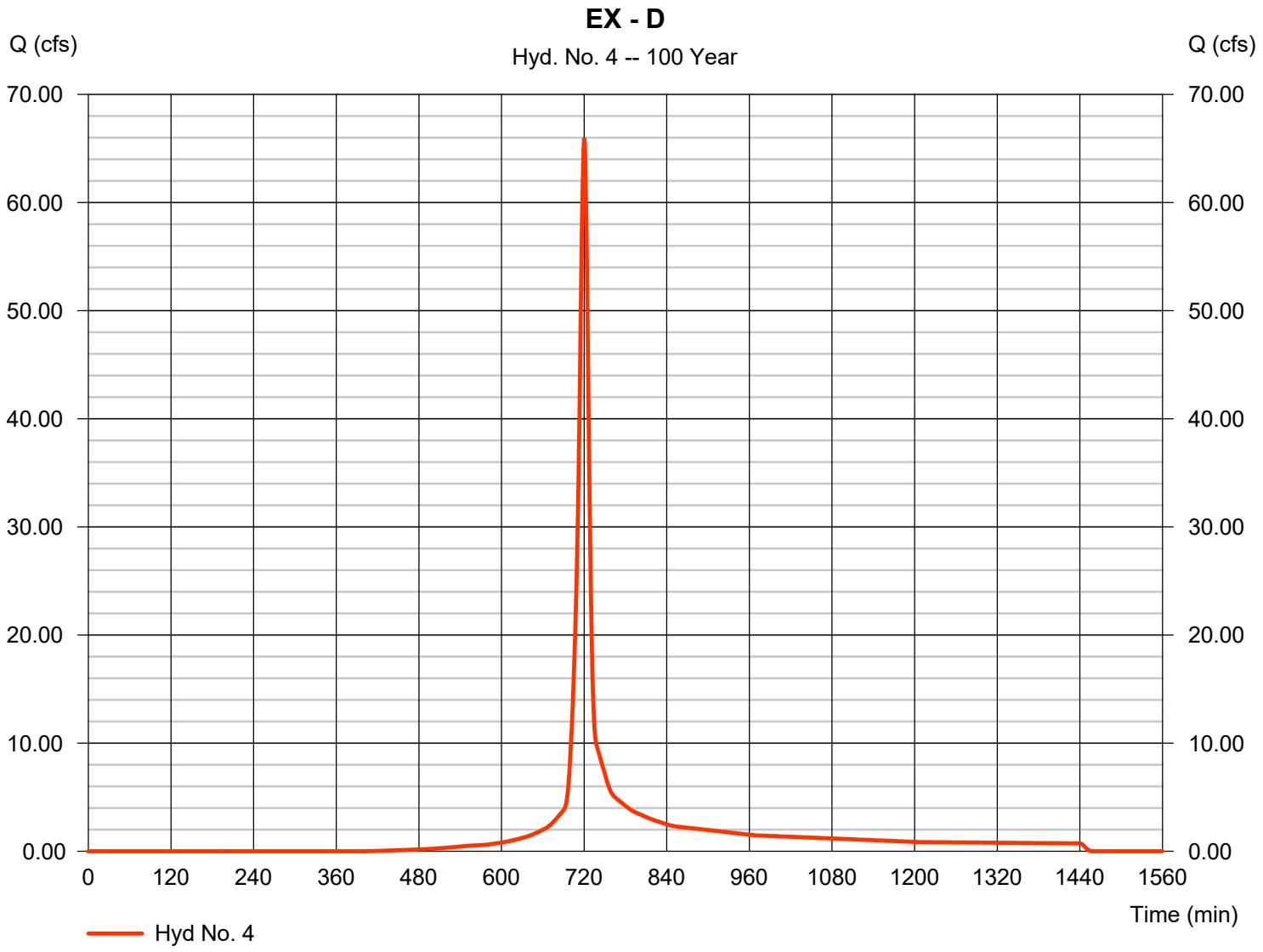


Hydrograph Report

Hyd. No. 4

EX - D

Hydrograph type	=	SCS Runoff	Peak discharge	=	65.98 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	160,755 cuft
Drainage area	=	9.340 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.60 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

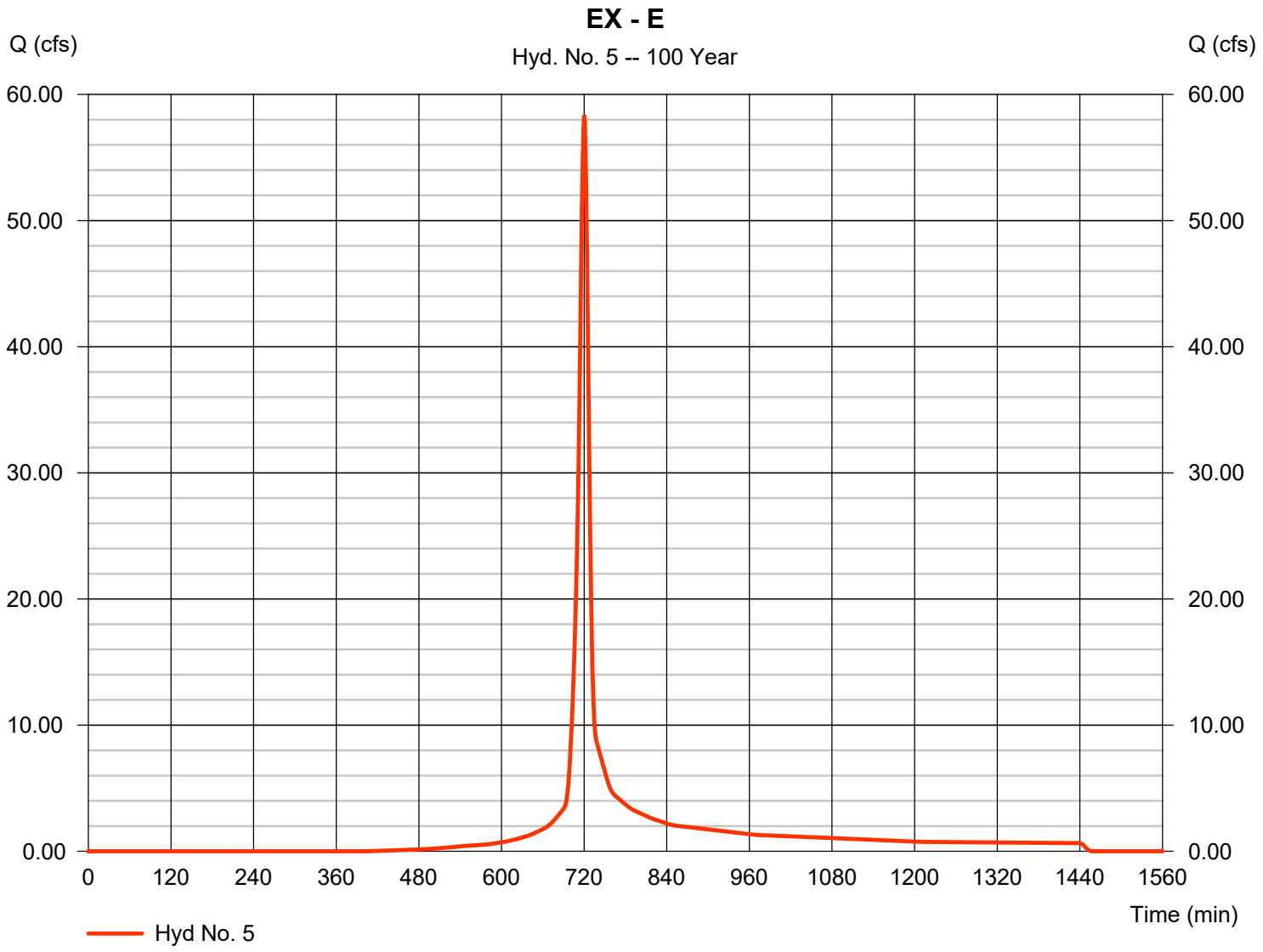


Hydrograph Report

Hyd. No. 5

EX - E

Hydrograph type	=	SCS Runoff	Peak discharge	=	58.35 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	1 min	Hyd. volume	=	142,167 cuft
Drainage area	=	8.260 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.60 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

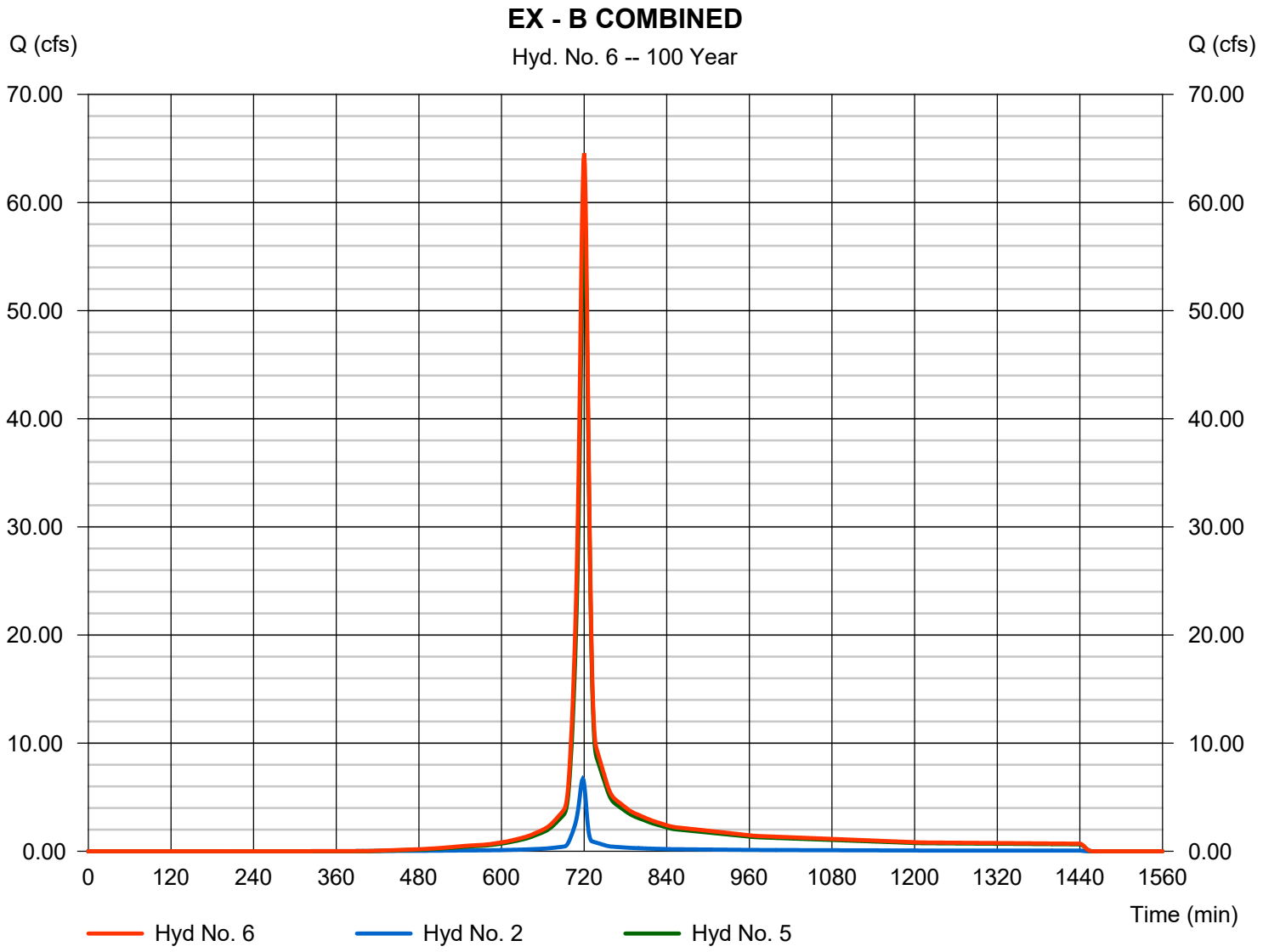


Hydrograph Report

Hyd. No. 6

EX - B COMBINED

Hydrograph type	= Combine	Peak discharge	= 64.55 cfs
Storm frequency	= 100 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 156,966 cuft
Inflow hyds.	= 2, 5	Contrib. drain. area	= 9.010 ac

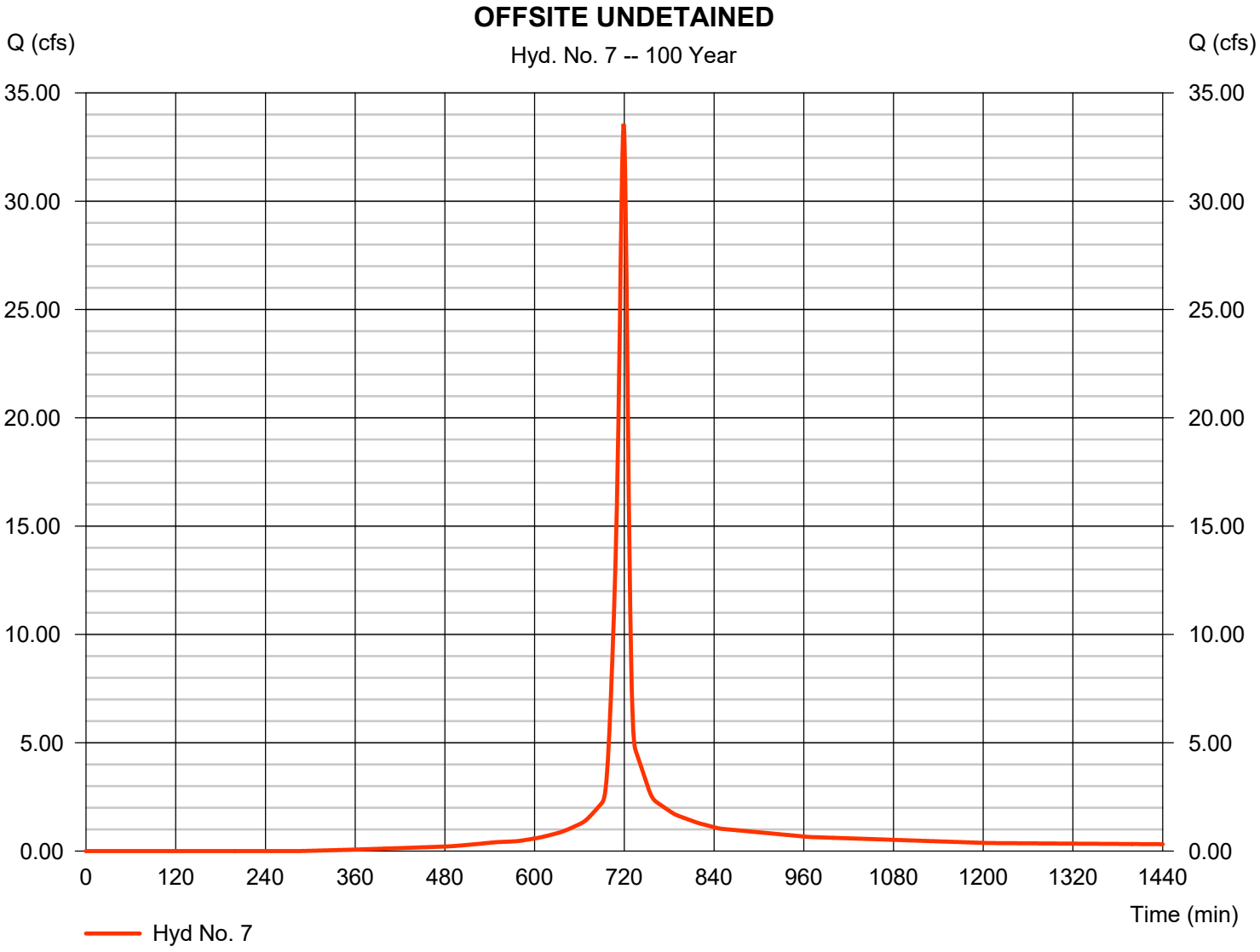


Hydrograph Report

Hyd. No. 7

OFFSITE UNDETAINED

Hydrograph type	=	SCS Runoff	Peak discharge	=	33.57 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	78,931 cuft
Drainage area	=	3.900 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	8.60 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

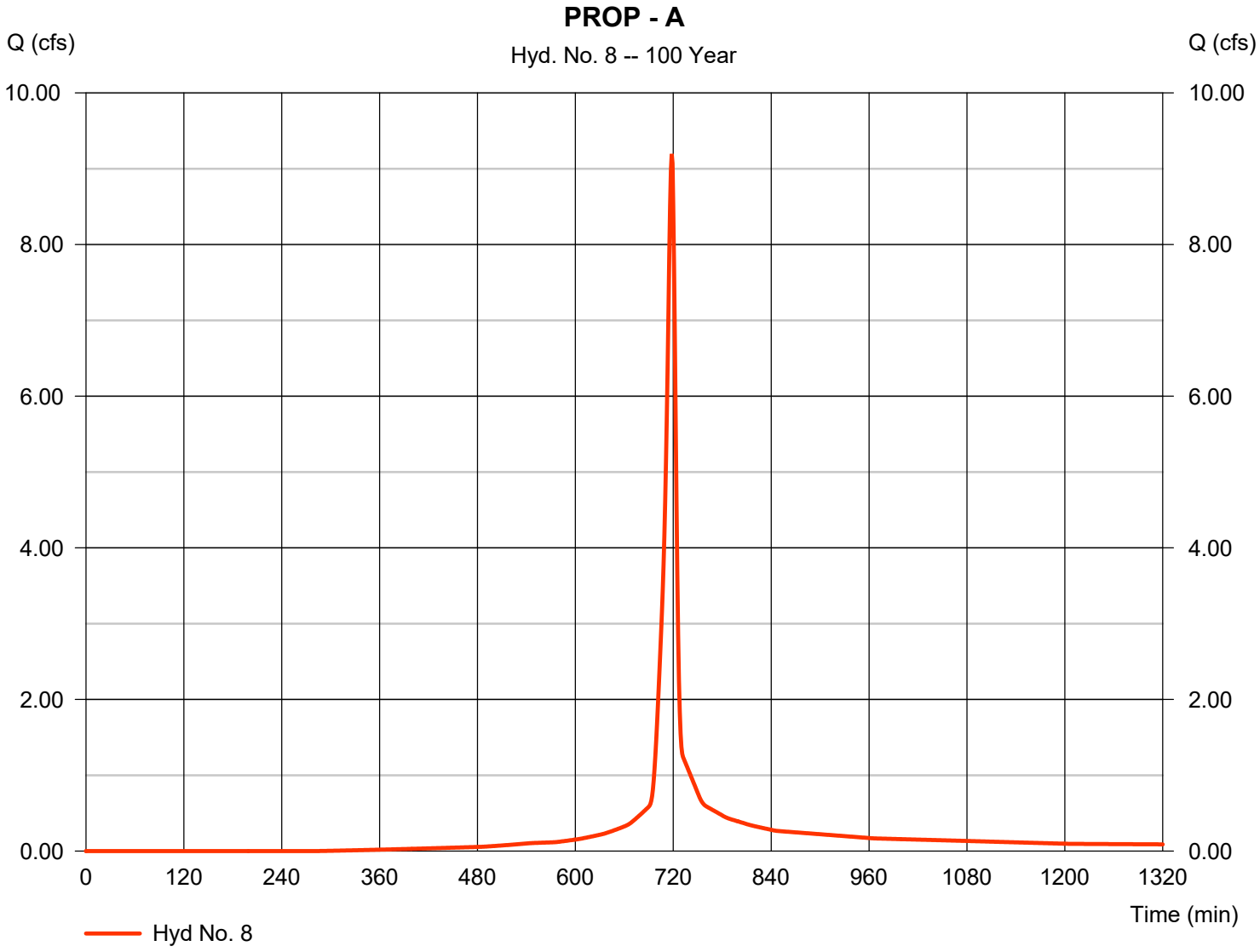


Hydrograph Report

Hyd. No. 8

PROP - A

Hydrograph type	=	SCS Runoff	Peak discharge	=	9.195 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	20,325 cuft
Drainage area	=	1.030 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	6.80 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

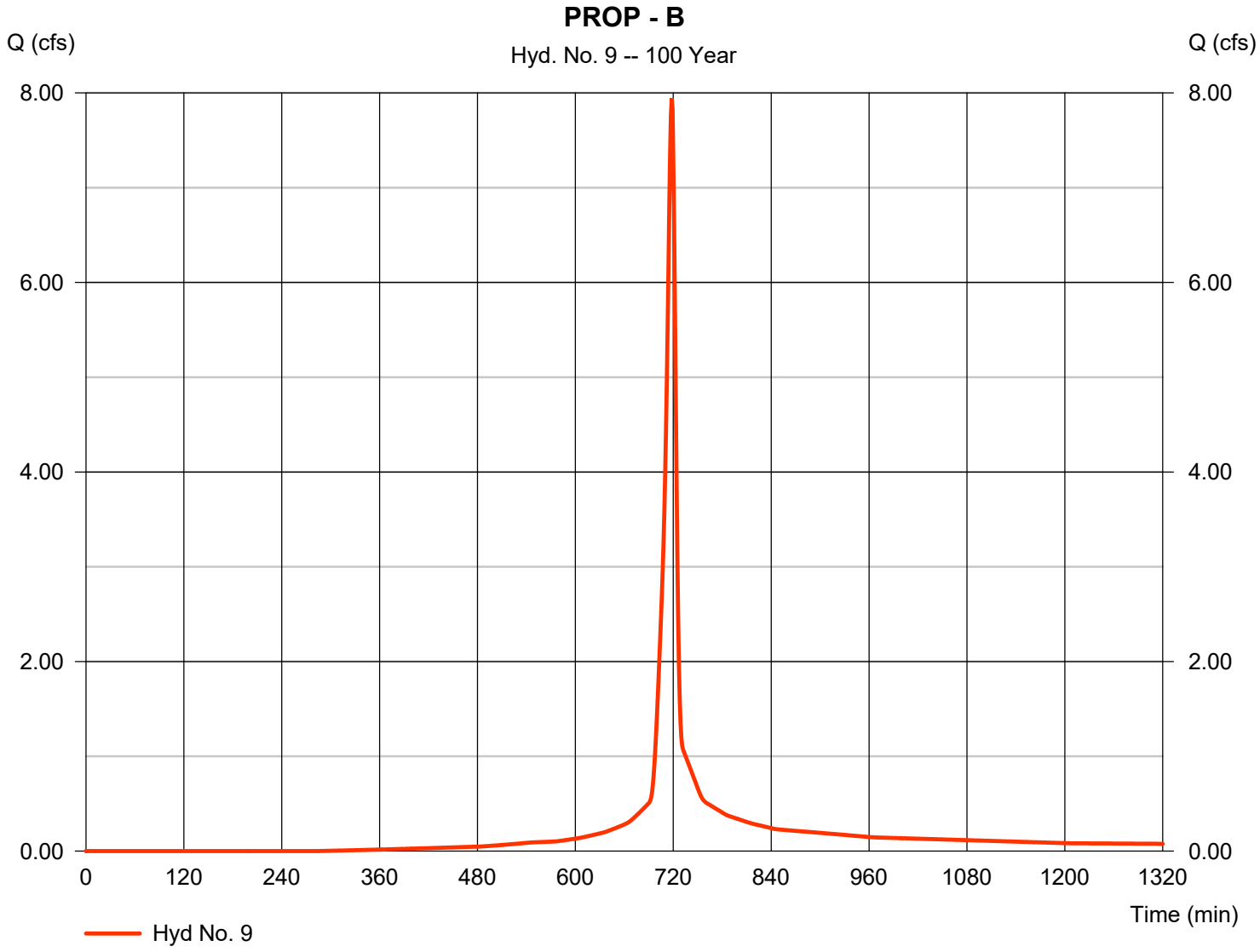


Hydrograph Report

Hyd. No. 9

PROP - B

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.945 cfs
Storm frequency	=	100 yrs	Time to peak	=	718 min
Time interval	=	1 min	Hyd. volume	=	17,562 cuft
Drainage area	=	0.890 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	7.40 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

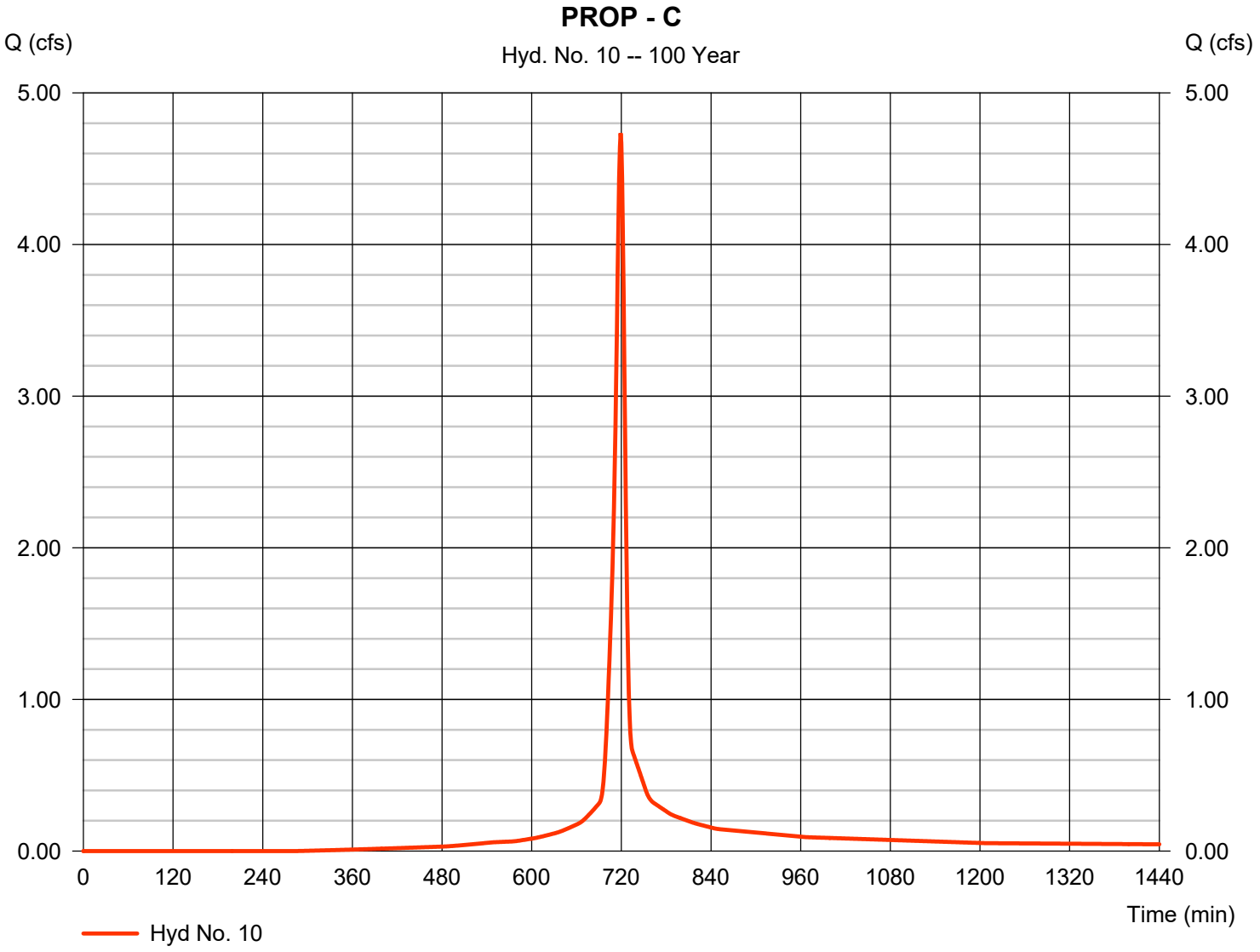


Hydrograph Report

Hyd. No. 10

PROP - C

Hydrograph type	= SCS Runoff	Peak discharge	= 4.734 cfs
Storm frequency	= 100 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 11,131 cuft
Drainage area	= 0.550 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 8.70 min
Total precip.	= 7.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

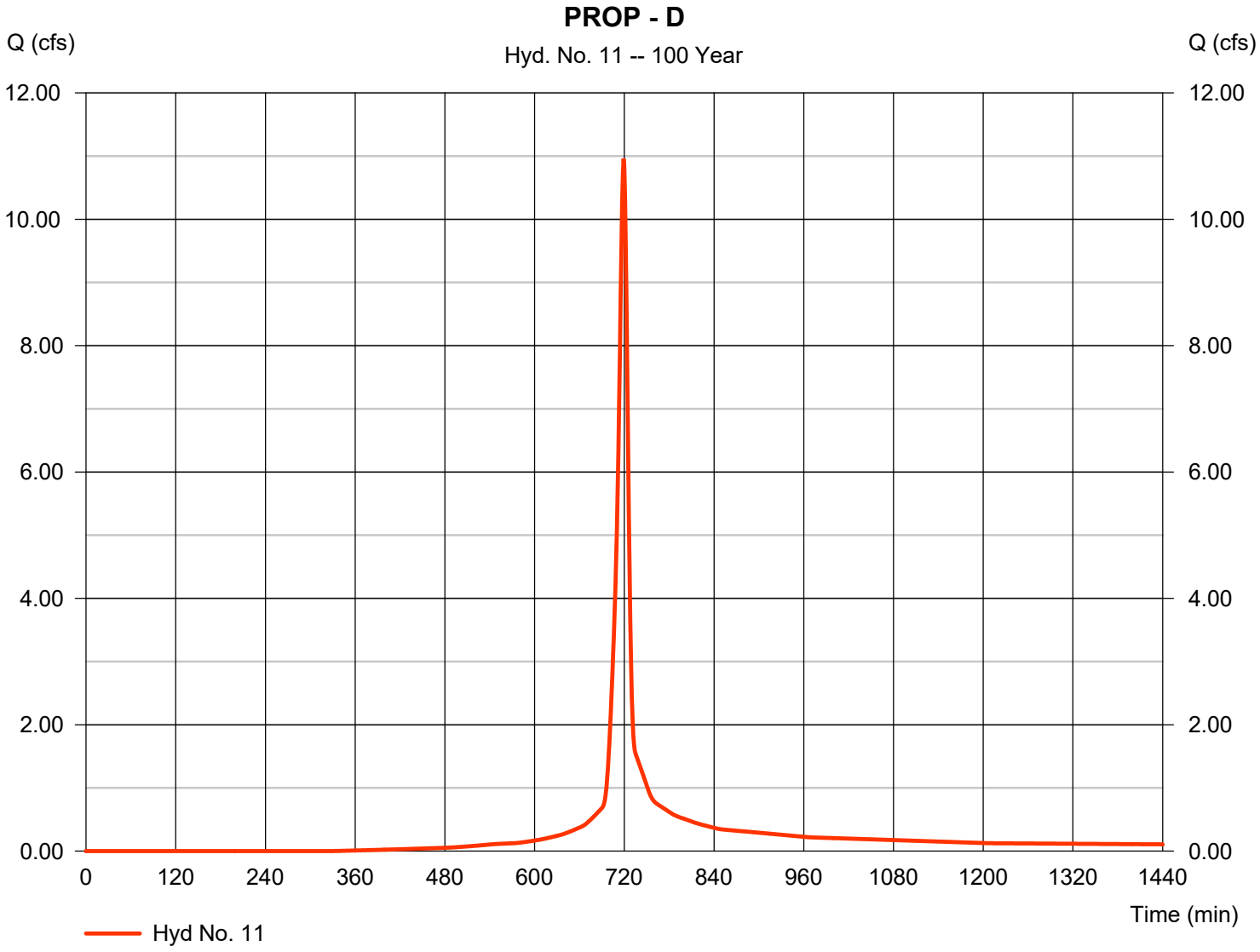


Hydrograph Report

Hyd. No. 11

PROP - D

Hydrograph type	=	SCS Runoff	Peak discharge	=	10.96 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	25,436 cuft
Drainage area	=	1.340 ac	Curve number	=	79
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	9.70 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

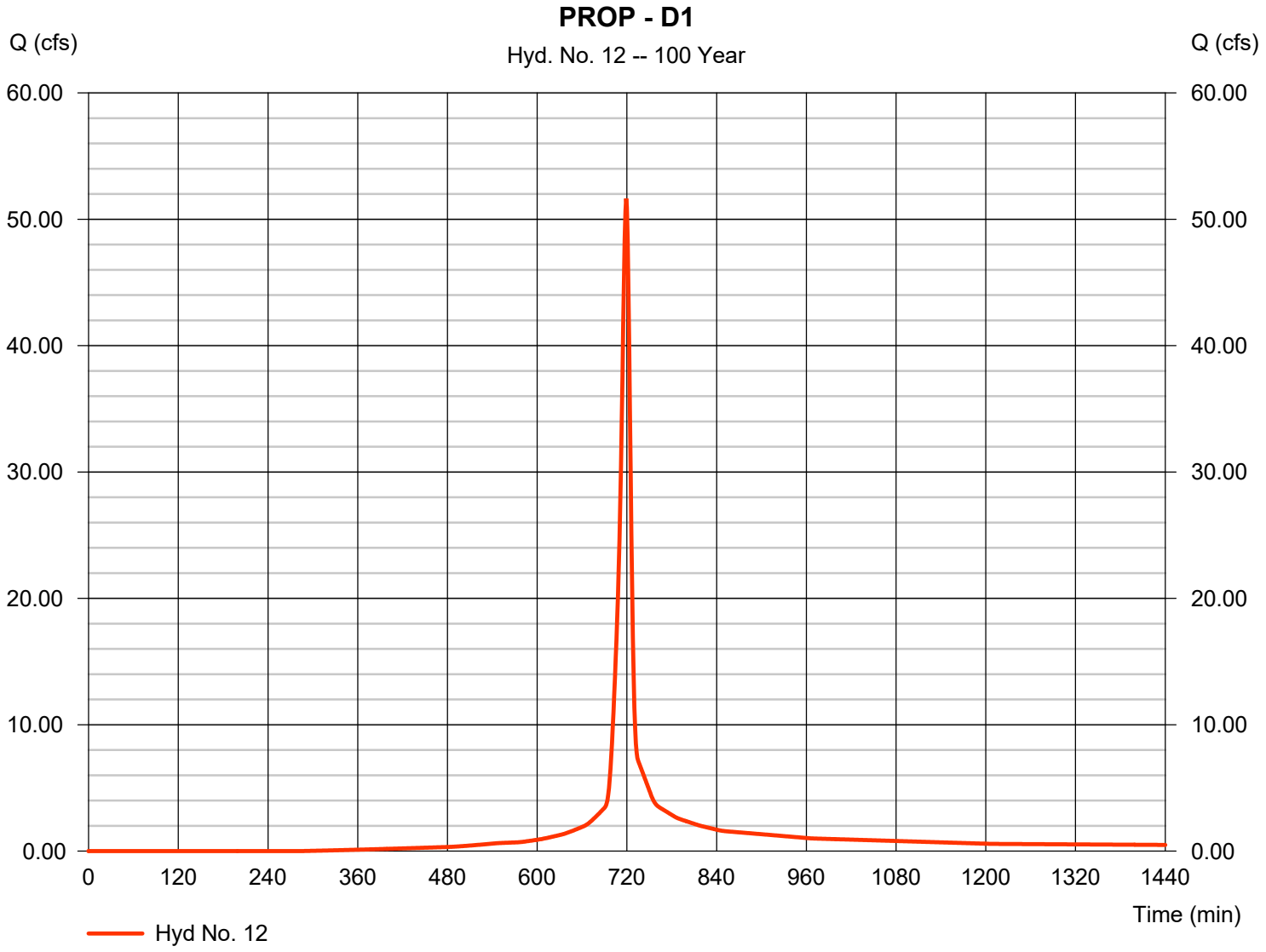


Hydrograph Report

Hyd. No. 12

PROP - D1

Hydrograph type	=	SCS Runoff	Peak discharge	=	51.64 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	121,433 cuft
Drainage area	=	6.000 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	9.60 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

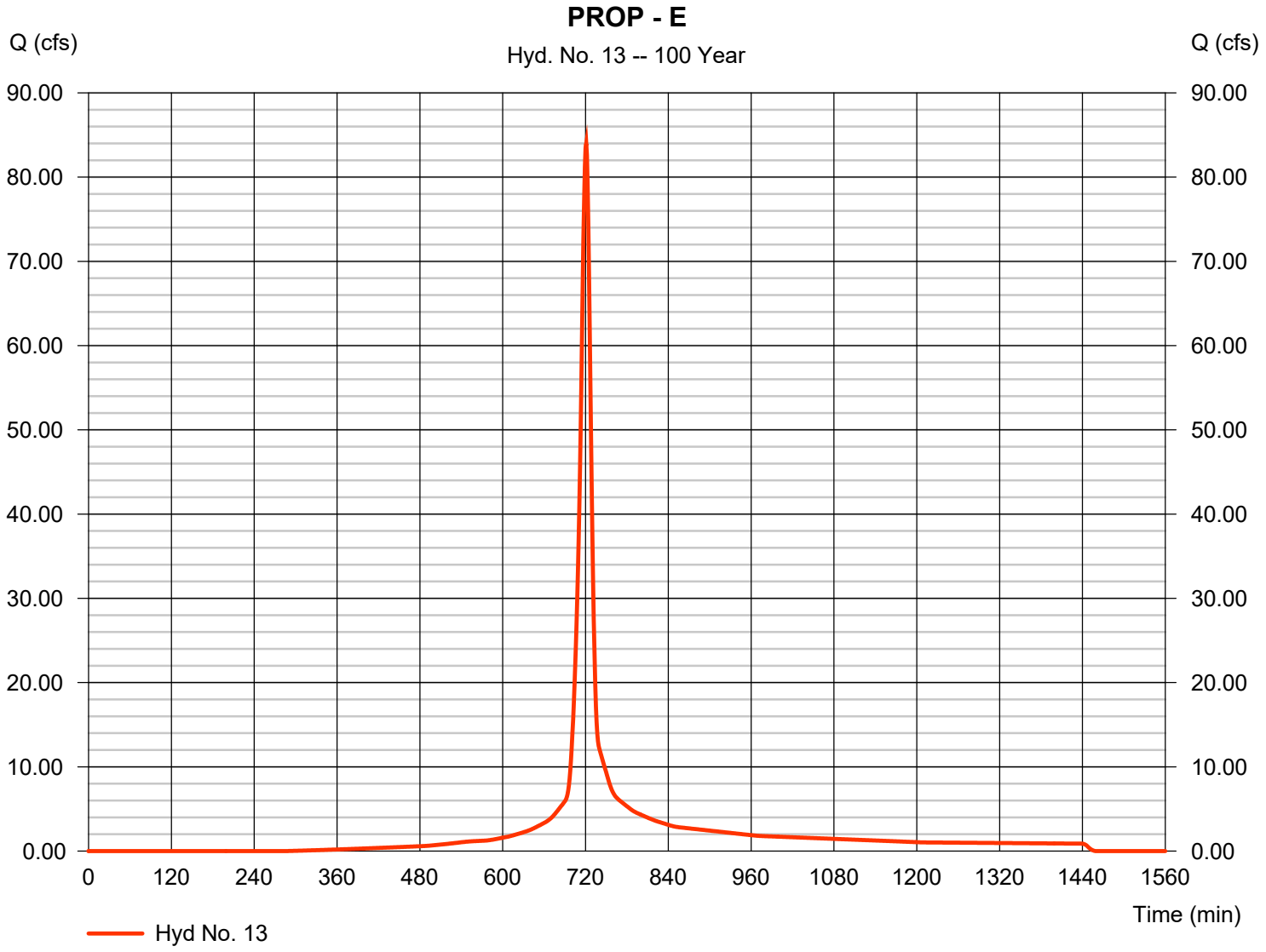


Hydrograph Report

Hyd. No. 13

PROP - E

Hydrograph type	=	SCS Runoff	Peak discharge	=	83.98 cfs
Storm frequency	=	100 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	219,148 cuft
Drainage area	=	11.000 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	11.80 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

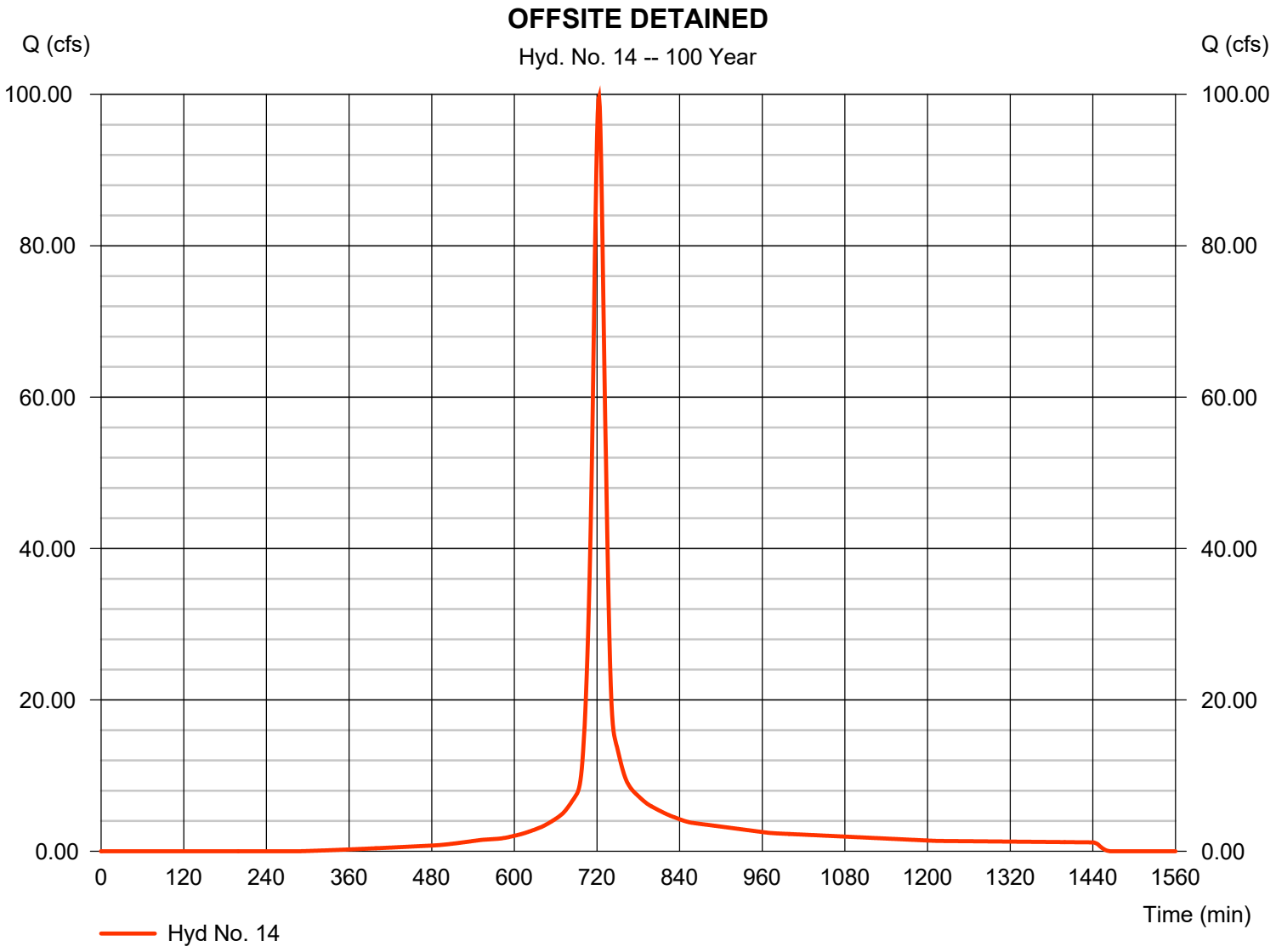


Hydrograph Report

Hyd. No. 14

OFFSITE DETAINED

Hydrograph type	=	SCS Runoff	Peak discharge	=	99.64 cfs
Storm frequency	=	100 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	291,188 cuft
Drainage area	=	14.210 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.50 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



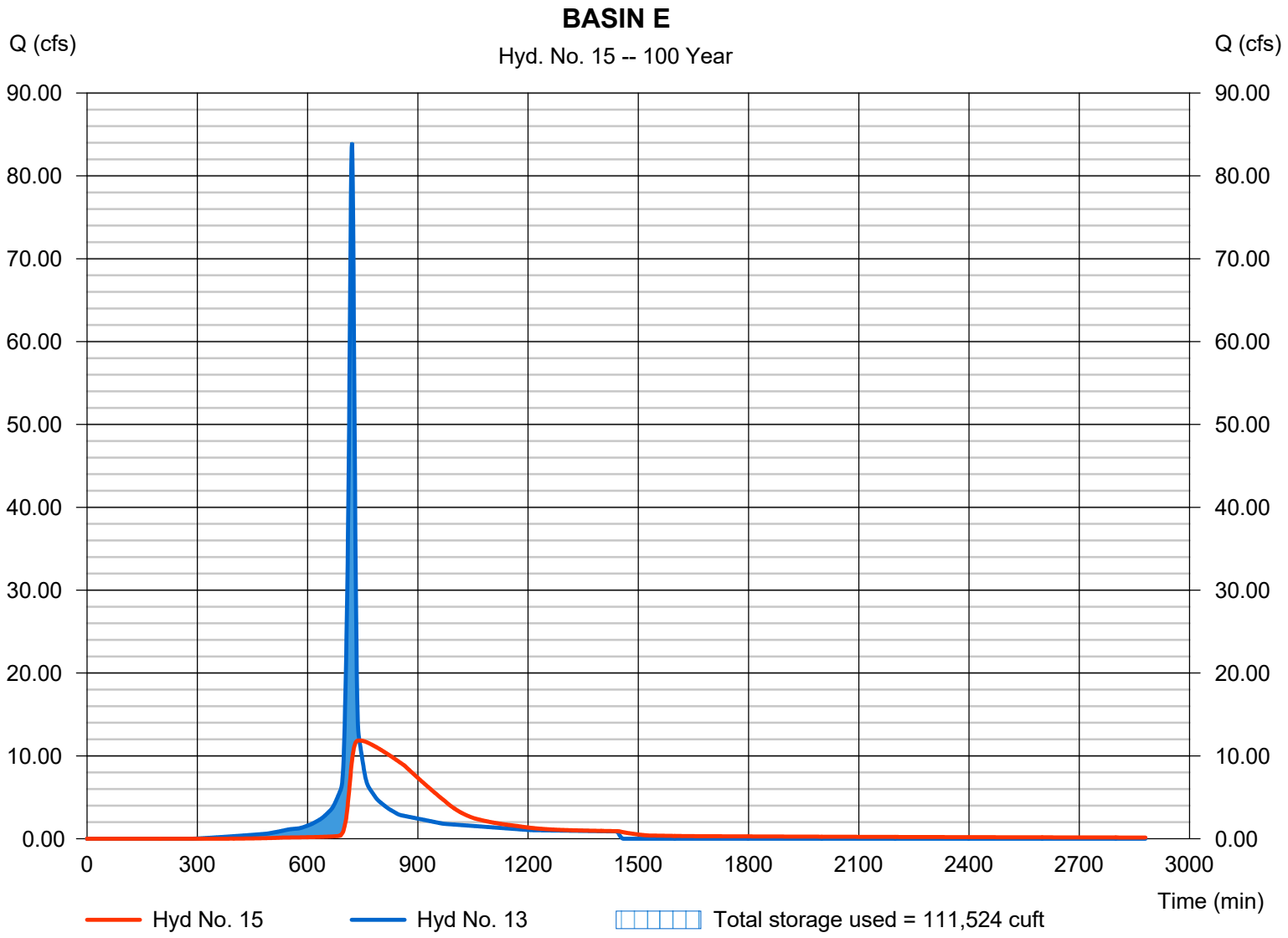
Hydrograph Report

Hyd. No. 15

BASIN E

Hydrograph type	= Reservoir	Peak discharge	= 11.86 cfs
Storm frequency	= 100 yrs	Time to peak	= 741 min
Time interval	= 1 min	Hyd. volume	= 213,662 cuft
Inflow hyd. No.	= 13 - PROP - E	Max. Elevation	= 941.49 ft
Reservoir name	= Basin E	Max. Storage	= 111,524 cuft

Storage Indication method used.

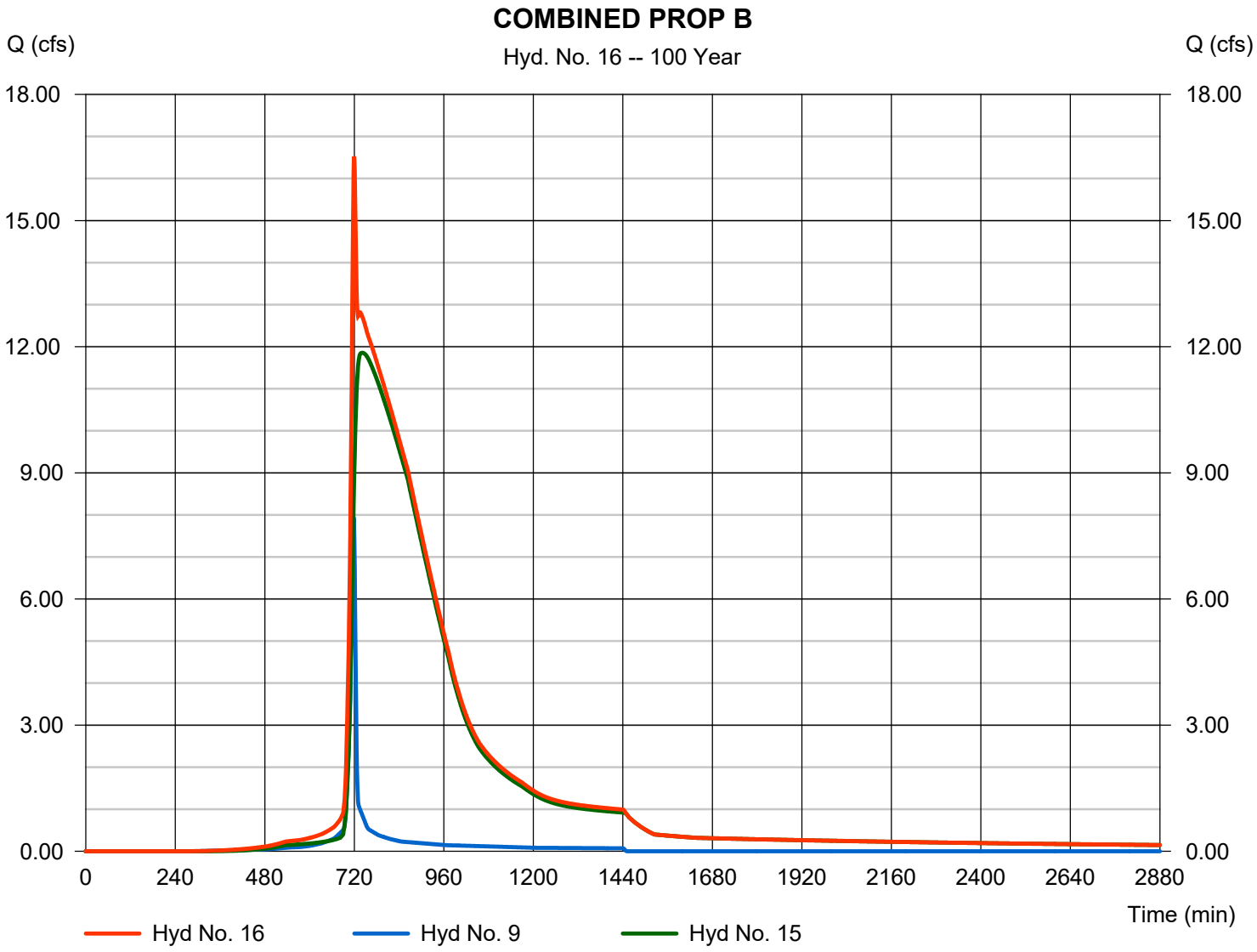


Hydrograph Report

Hyd. No. 16

COMBINED PROP B

Hydrograph type	=	Combine	Peak discharge	=	16.53 cfs
Storm frequency	=	100 yrs	Time to peak	=	719 min
Time interval	=	1 min	Hyd. volume	=	231,224 cuft
Inflow hyds.	=	9, 15	Contrib. drain. area	=	0.890 ac

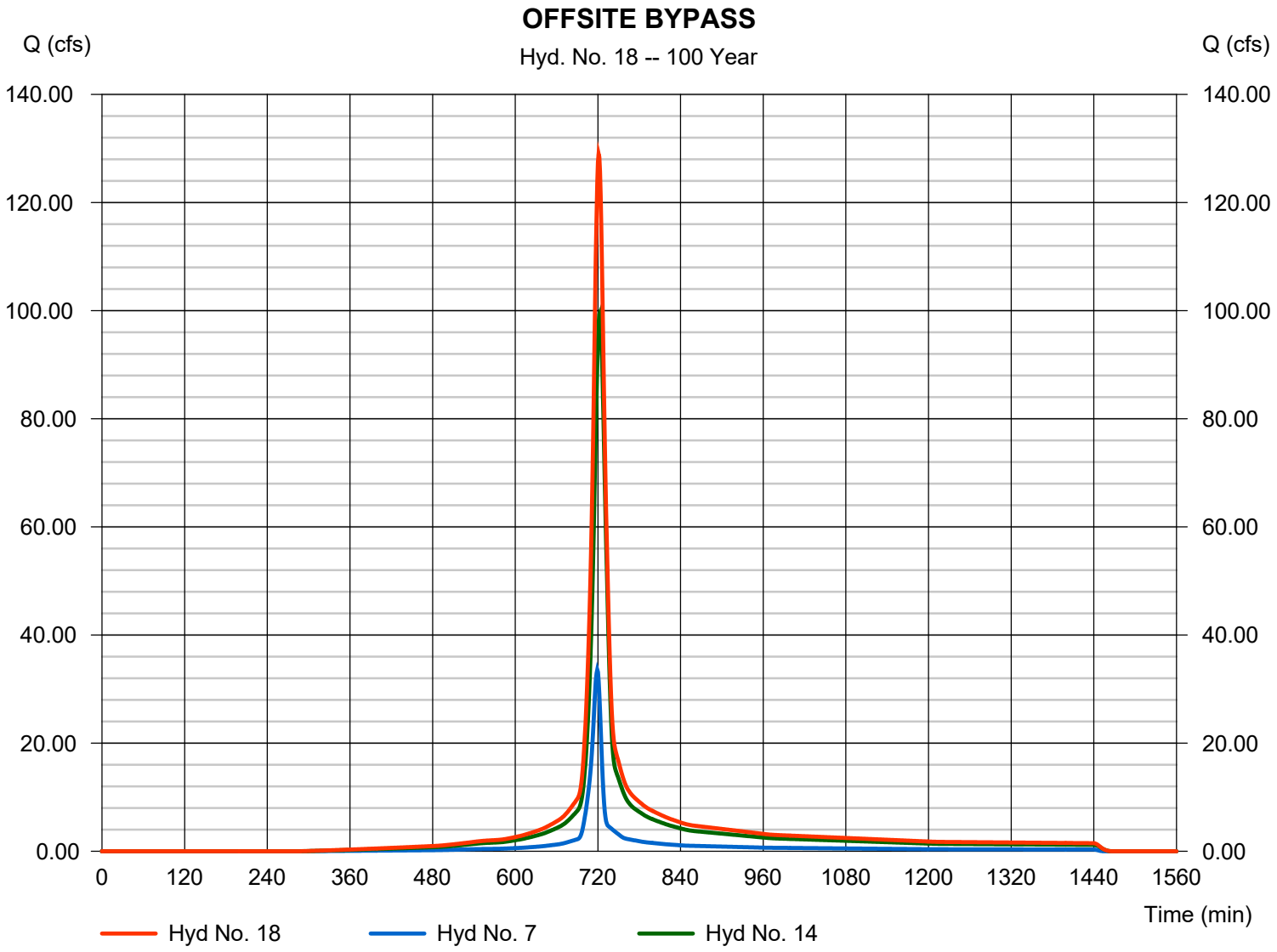


Hydrograph Report

Hyd. No. 18

OFFSITE BYPASS

Hydrograph type	=	Combine	Peak discharge	=	128.96 cfs
Storm frequency	=	100 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	370,120 cuft
Inflow hyds.	=	7, 14	Contrib. drain. area	=	18.110 ac



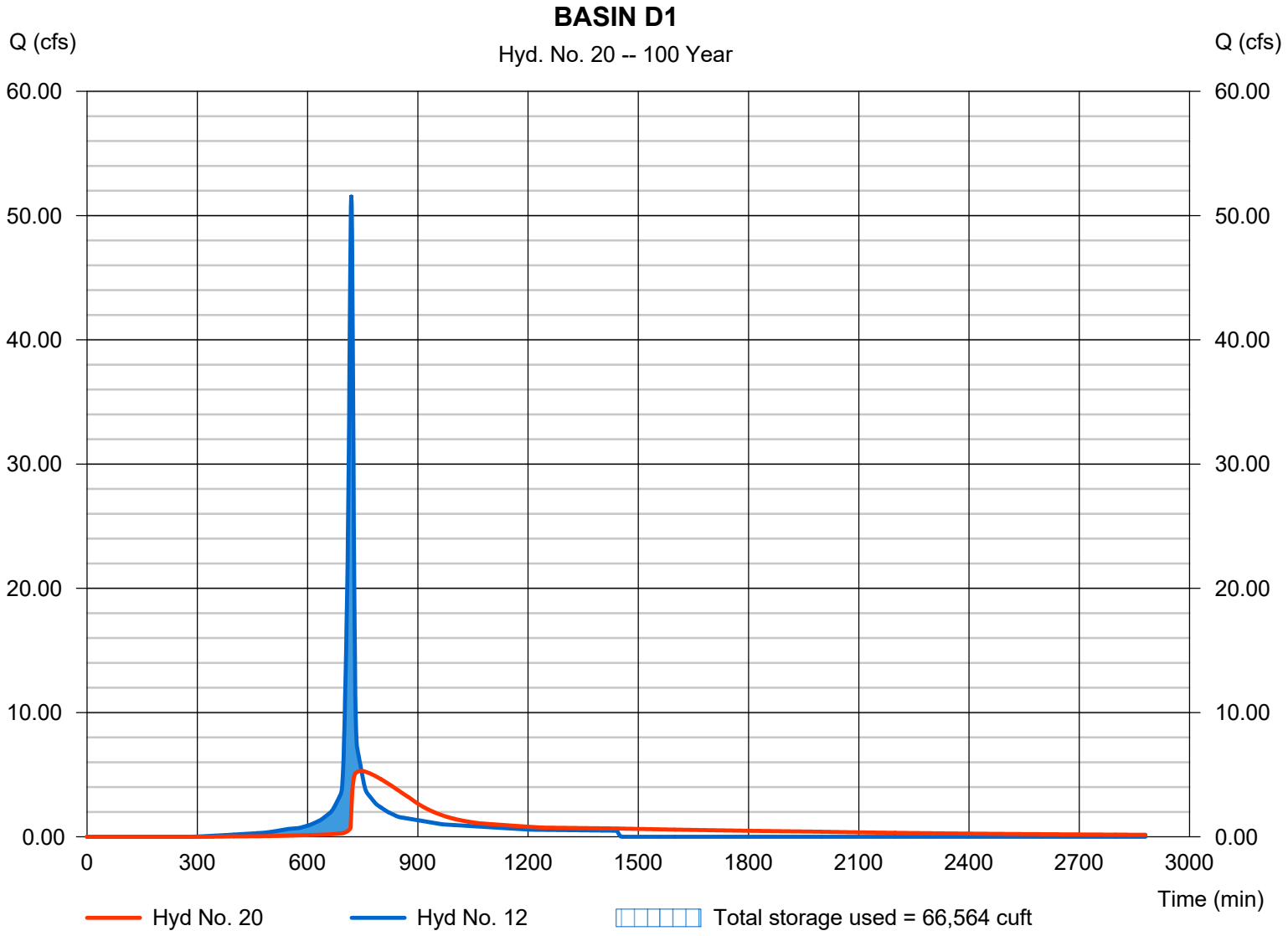
Hydrograph Report

Hyd. No. 20

BASIN D1

Hydrograph type	=	Reservoir	Peak discharge	=	5.294 cfs
Storm frequency	=	100 yrs	Time to peak	=	747 min
Time interval	=	1 min	Hyd. volume	=	114,581 cuft
Inflow hyd. No.	=	12 - PROP - D1	Max. Elevation	=	915.40 ft
Reservoir name	=	Basin D1	Max. Storage	=	66,564 cuft

Storage Indication method used.

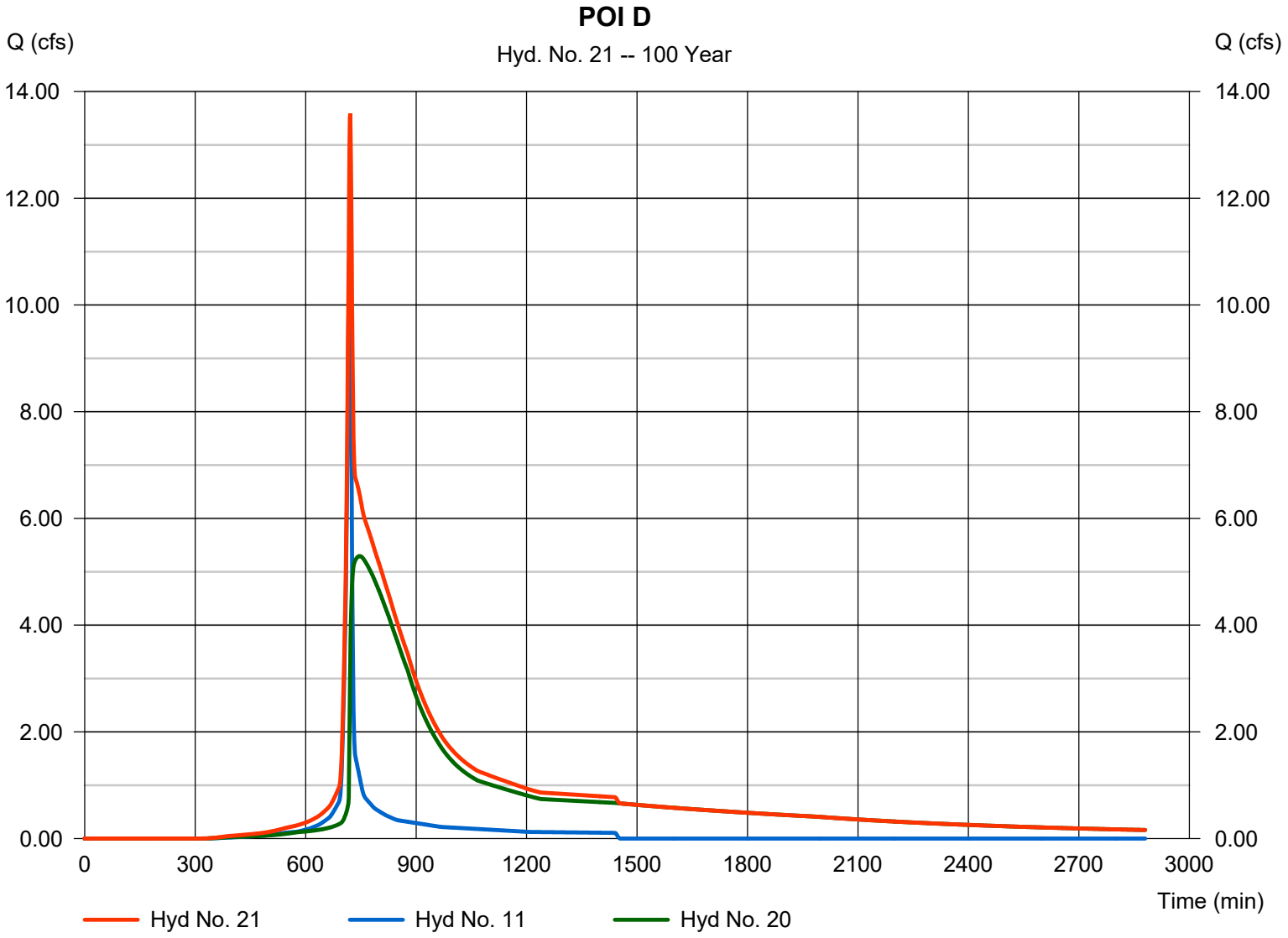


Hydrograph Report

Hyd. No. 21

POI D

Hydrograph type	=	Combine	Peak discharge	=	13.59 cfs
Storm frequency	=	100 yrs	Time to peak	=	721 min
Time interval	=	1 min	Hyd. volume	=	140,017 cuft
Inflow hyds.	=	11, 20	Contrib. drain. area	=	1.340 ac



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	64.1474	17.7000	0.8922	--------
2	95.7859	19.2000	0.9317	--------
3	0.0000	0.0000	0.0000	--------
5	118.7799	19.1000	0.9266	--------
10	125.1300	18.2000	0.9051	--------
25	158.9867	18.7000	0.9180	--------
50	171.2459	18.3000	0.9078	--------
100	187.3624	18.1000	0.9031	--------

File name: KCMO.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	3.96	3.31	2.86	2.52	2.25	2.04	1.87	1.72	1.60	1.49	1.40	1.32
2	4.92	4.13	3.56	3.14	2.81	2.54	2.32	2.14	1.98	1.85	1.73	1.63
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.23	5.23	4.51	3.98	3.56	3.22	2.94	2.71	2.52	2.35	2.20	2.07
10	7.27	6.09	5.26	4.63	4.14	3.75	3.43	3.16	2.93	2.74	2.57	2.42
25	8.70	7.30	6.30	5.54	4.96	4.49	4.10	3.78	3.51	3.27	3.07	2.89
50	9.83	8.24	7.11	6.26	5.60	5.07	4.64	4.27	3.97	3.70	3.47	3.27
100	11.00	9.21	7.95	7.00	6.26	5.67	5.19	4.78	4.44	4.14	3.89	3.66

Tc = time in minutes. Values may exceed 60.

Precip. file name: Z:\acad\KCMO.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	1.37	3.50	0.00	3.30	5.20	6.00	6.80	7.70
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	0.00	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	2.49	3.10	0.00	4.01	4.64	5.52	6.21	6.90
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

Exhibit G

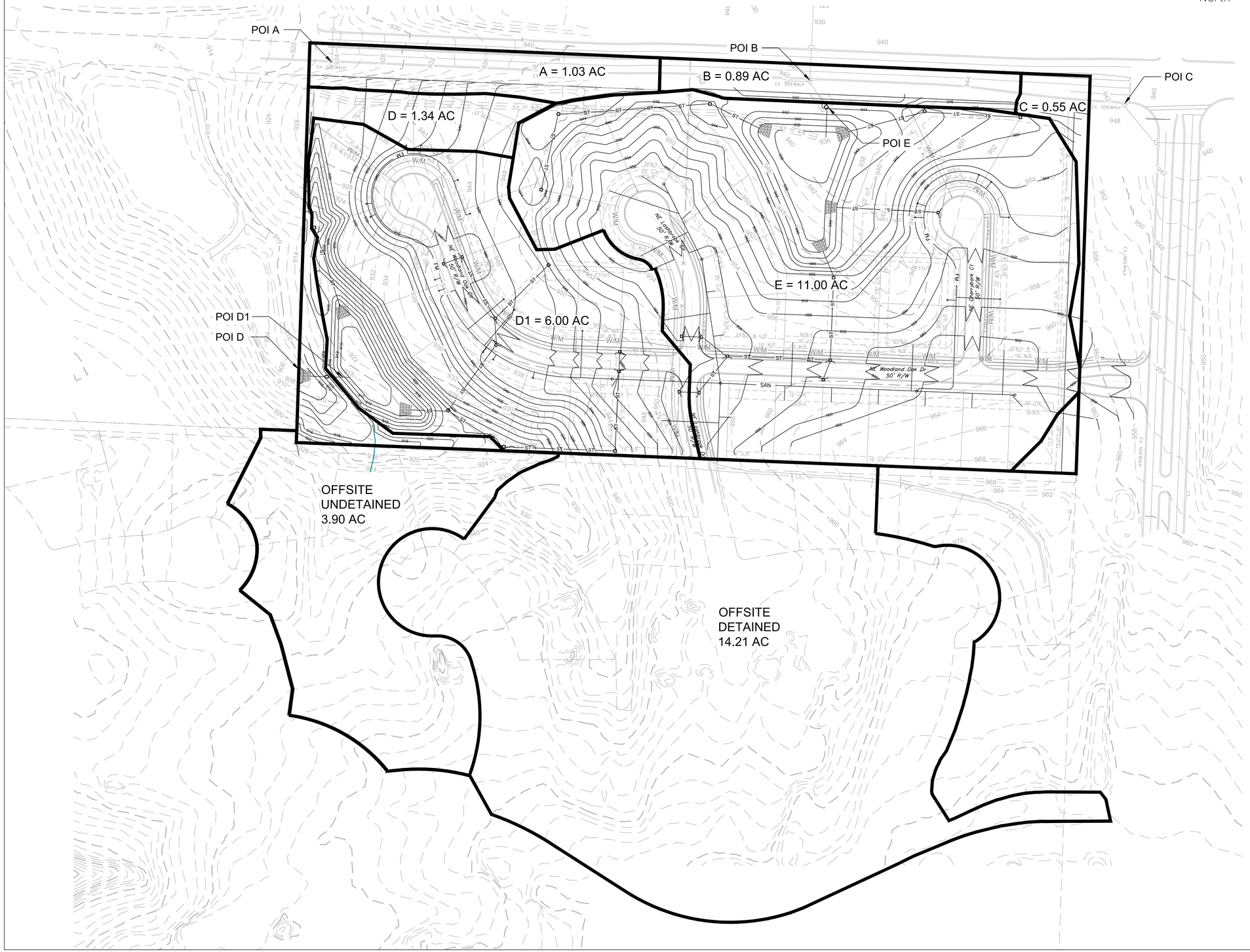
Proposed Drainage Area Map

PROP. DRAINAGE MAP

SCALE: 1" = 80'

North

0 40' 80' 160'



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Kansas
Engineering E-1695
Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

Part of the Southeast $\frac{1}{4}$
Section 27, Township 48 North, Range 31 West
Lee's Summit, Jackson County, Missouri

Project: WOODLAND OAKS LSMO
Issue Date: February 25, 2020

Prop. Drainage Map
Preliminary Development Plans for:
Lots 1 thru 42
WOODLAND OAKS
Lee's Summit, Jackson County, Missouri

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

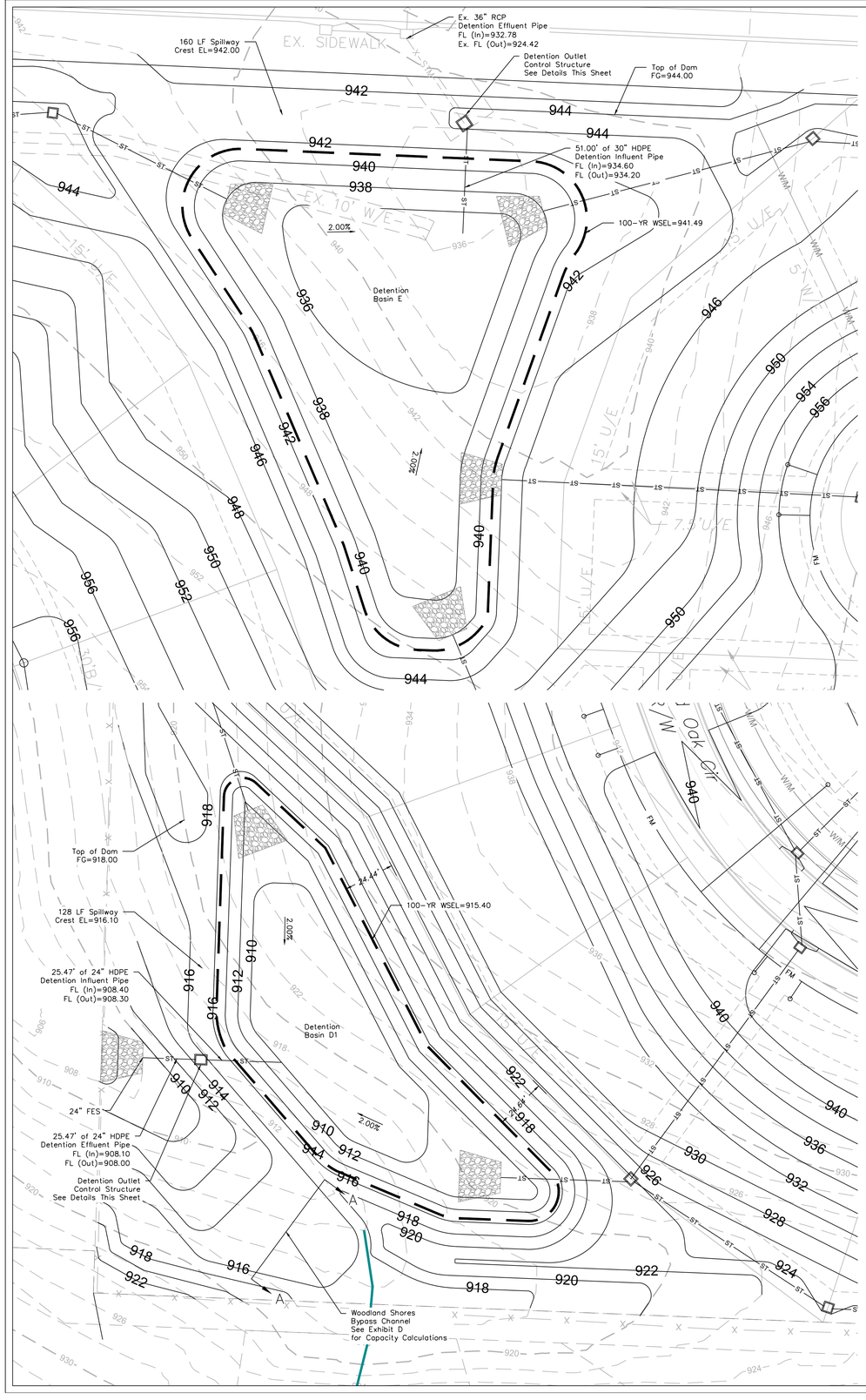
City Comments 3-24-20

City Comments 3-31-20

EXHIBIT

Exhibit H

Detention Plan

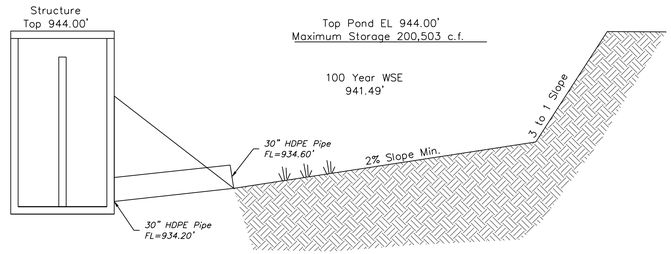


North

0 15' 30' 60'

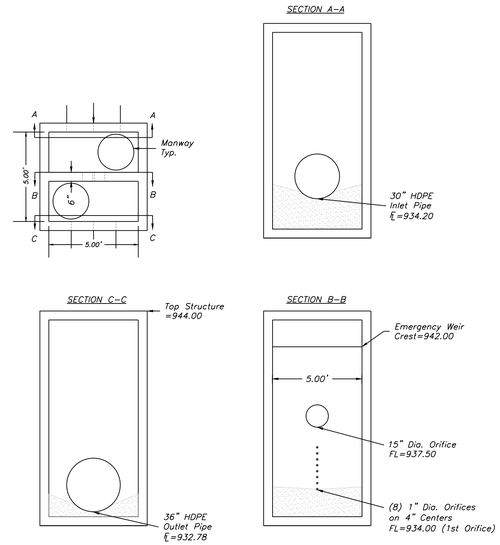
DETENTION BASIN PLAN

SCALE: 1" = 30'



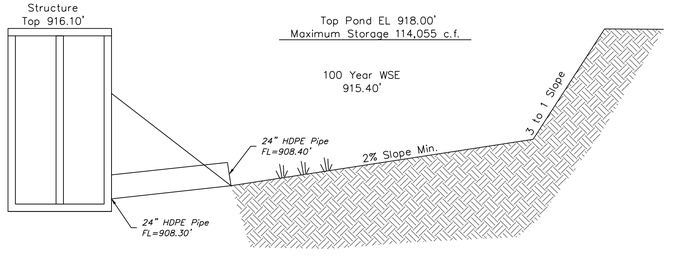
SECTION VIEW – BASIN E

N.T.S.



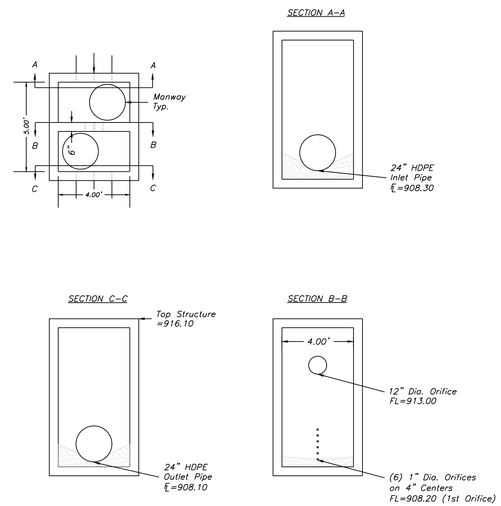
CONTROL STRUCTURE – BASIN E

1" = 1'-0"



SECTION VIEW – BASIN D1

N.T.S.



CONTROL STRUCTURE – BASIN D1

1" = 1'-0"

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Part of the Southeast 1/4
Section 27, Township 48 North, Range 31 West
Lee's Summit, Jackson County, Missouri

Project: WOODLAND OAKS LSMO
Issue Date: February 25, 2020

Detention Basin Plan

Preliminary Development Plans for:
Lots 1 thru 42
WOODLAND OAKS
Lee's Summit, Jackson County, Missouri

STATE OF MISSOURI
MATTHEW J. SCHLICHT
NUMBER PE-2005019708
PROFESSIONAL ENGINEER

Matthew J. Schlicht
MO PE 2005019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

City Comments 3-24-20

City Comments 3-31-20

EXHIBIT

Exhibit I

Emergency Spillway Calculations

Weir Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Apr 7 2020

EMERGENCY SPILLWAY - BASIN D1

Rectangular Weir

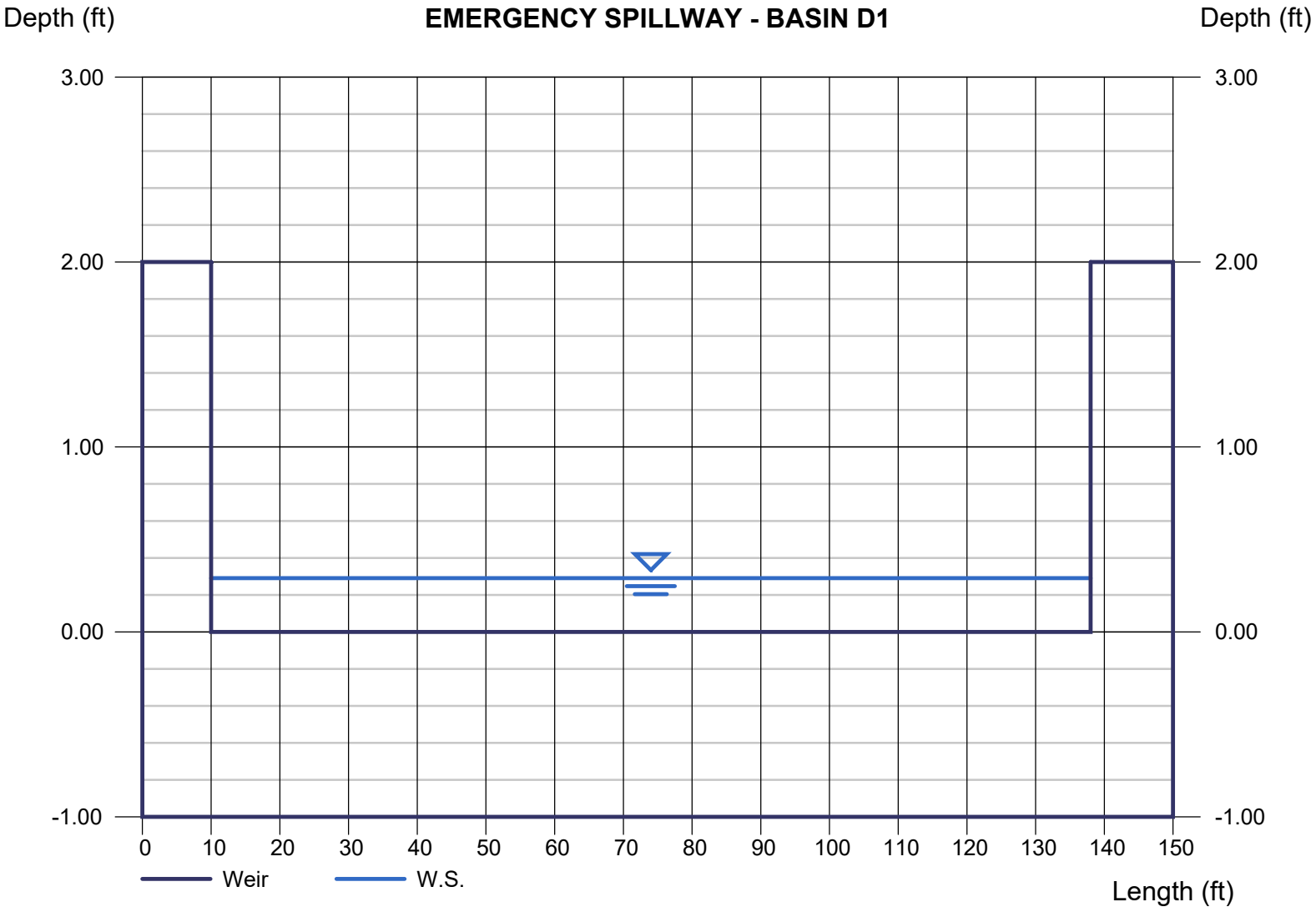
Crest	= Broad
Bottom Length (ft)	= 128.00
Total Depth (ft)	= 2.00

Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Known Q
Known Q (cfs)	= 51.64

Highlighted

Depth (ft)	= 0.29
Q (cfs)	= 52.24
Area (sqft)	= 37.22
Velocity (ft/s)	= 1.40
Top Width (ft)	= 128.00



Weir Report

BASIN E - EMERGENCY SPILLWAY

Rectangular Weir

Crest	= Broad
Bottom Length (ft)	= 160.00
Total Depth (ft)	= 2.00

Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Known Q
Known Q (cfs)	= 83.98

Highlighted

Depth (ft)	= 0.34
Q (cfs)	= 83.98
Area (sqft)	= 55.03
Velocity (ft/s)	= 1.53
Top Width (ft)	= 160.00

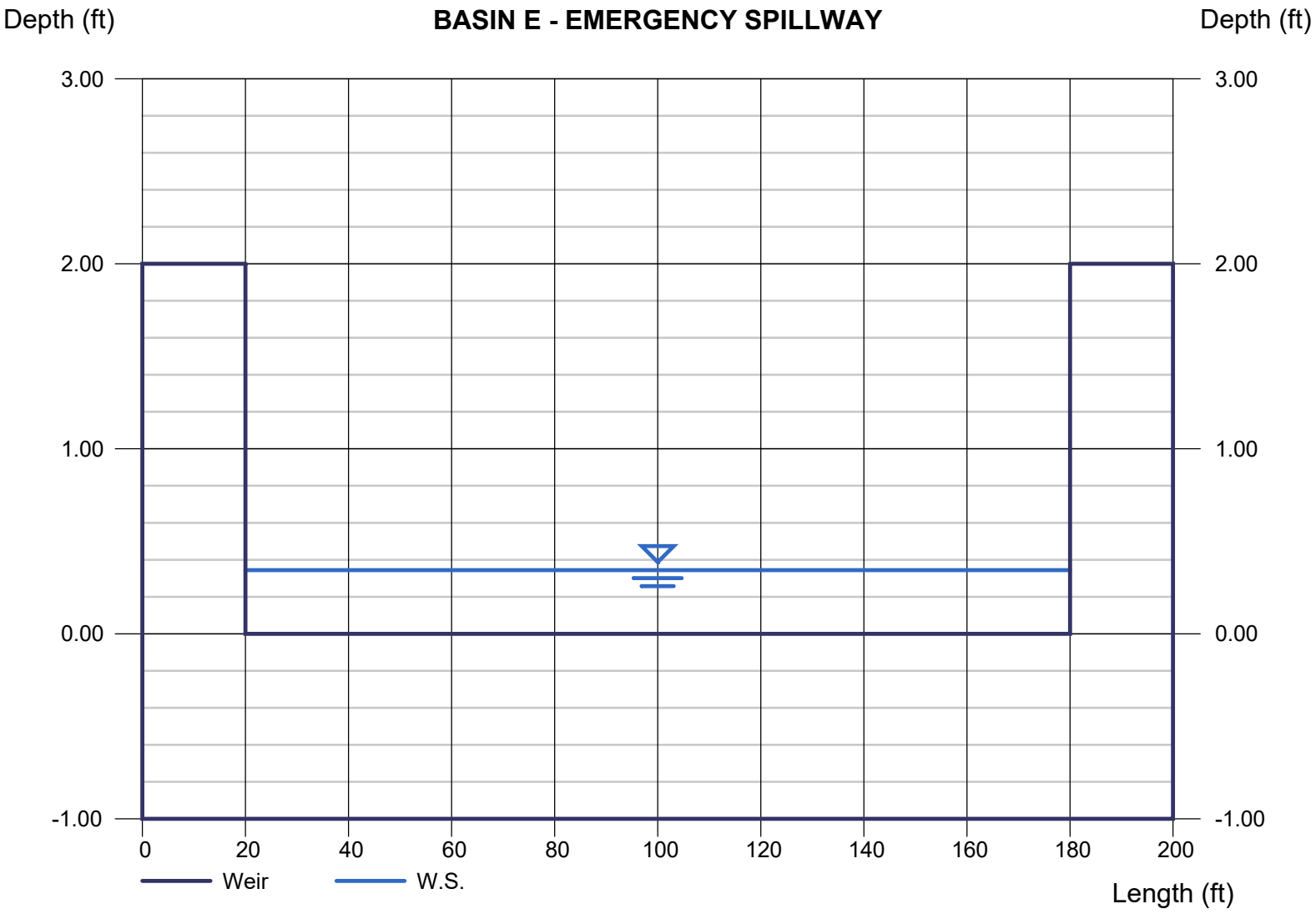


Exhibit J

40 Hour Extended Detention Calculations

Calculate Water Quality for Storm Study

Project: Woodland Oaks D1 Date: 4-16-20

To Calculate: WQv = P * Rv * A

P (in) =	1.37
P (ft) =	0.11
Impervious Area (sq. ft.) =	64,033.20
Total Area (sq. ft.) =	256,132.80
Impervious Area (ac) =	1.47
Total Area (acre) =	5.88
Rv = (0.05 * 0.009(I)) =	0.28
Percent Impervious (I) =	25.00
WQ_v (cu. ft.) =	8,042
WQ_v (ac. ft.) =	0.185

Enter data in these Fields

Unit Conversions
1 Acre = 43,560 Sq. Ft.

CCN = 80

Pond Volume

Elevation	Area (Sq. Ft.)	Volume (Cu. Ft.)
908.40	-	-
909.00	1,413.00	706.50
910.00	6,105.00	4,465.50
911.00	8,274.50	11,655.25
912.00	10,444.00	21,014.50
913.00	12,081.50	32,277.25
914.00	13,719.00	45,177.50
915.00	13,839.00	58,956.50
916.00	17,234.00	74,493.00
917.00	17,346.00	91,783.00
918.00	20,973.00	110,942.50

40 HOUR DETENTION CALC.

To Calculate: 40 Hour Detention (EDDB)

I. Basin Water Quality Storage Volume

Step 1) Tributary area To EDDB, A_t (ac) =	A_T (ac) =	5.88
Step 2) Calculate WQ_v using Sec. 6 (ac-ft) =	WQ_v (ac. ft.)=	0.185
Step 3) Add 20 Percent to Step 2.	V_{design} (ac-ft) =	0.222

II.a. Water Quality Outlet Type

Step 1) Set water quality outlet type
Type 1 = single orifice
Type 2 = perforated riser or plate
Type 3 = v-notch weir

Outlet Type = 2

Step 2) Proceed to Step IIb, IIc, or IId based on selection

To Calculate Z_{WQ} (ft) interpolate from Storm Study (Sheet 13)

Elevation 1 =	910.00	Storage 1 =	4,465.50
Elevation X =		Storage X =	8,041.50
Elevation 2 =	911.00	Storage 2 =	11,655.25

Elevation X = 910.50

Lowest Elevation of Pond =	908.35
Elevation X =	910.50
Z_{WQ} (ft) =	2.15

IIc. Water Quality Outlet, Perforated Riser

Step 1) Depth at outlet above lowest perforation:	Z_{WQ} (ft) =	2.15
Step 2) Recommended maximum outlet area per row:	A_0 (in^2) =	0.427
Step 3) Circular perforation diameter per row assuming a single column:	D_1 (in) =	0.290
1	n_c (unitless) =	1
Step 5) Design circular perforation diameter (should be between 1 and 2 inches):	D_{perf} (in) =	1.000
Step 6) Horizontal perforation column spacing when n_c > 1, center to center:	S_c (in) =	4
Note: If D_{perf} ≥ 1.0 inch, S_c = 4		
Step 7) Number of rows (4" vertical spacing between perforations, center to center):	n_r (unitless) =	6

Calculates the diameter of each hole given the depth of water and the area per row. Assuming 4" spacing. If less than 1" use 1" as D_{perf}.

Recommended Method: Perforated Riser

Calculate Water Quality for Storm Study

Project: Woodland Oaks E Date: 4-6-20

To Calculate: WQv = P * Rv * A

P (in) =	1.37
P (ft) =	0.11
Impervious Area (sq. ft.) =	134,164.80
Total Area (sq. ft.) =	479,160.00
Impervious Area (ac) =	3.08
Total Area (acre) =	11.00
Rv = (0.05 * 0.009(I)) =	0.30
Percent Impervious (I) =	28.00
WQ_v (cu. ft.) =	16,521
WQ_v (ac. ft.) =	0.379

Enter data in these Fields

Unit Conversions
1 Acre = 43,560 Sq. Ft.

CCN = 81

Pond Volume

Elevation	Area (Sq. Ft.)	Volume (Cu. Ft.)
934.00	2.00	-
935.00	3,729.00	1,865.50
936.00	7,456.00	7,458.00
937.00	12,327.50	17,349.75
938.00	17,199.00	32,113.00
939.00	20,645.00	51,035.00
940.00	24,091.00	73,403.00
941.00	27,908.00	99,402.50
942.00	31,725.00	129,219.00
943.00	37,519.00	163,841.00
944.00	43,313.00	204,257.00

40 HOUR DETENTION CALC.

To Calculate: 40 Hour Detention (EDDB)

I. Basin Water Quality Storage Volume

Step 1) Tributary area To EDDB, A_t (ac) =	A_T (ac) =	11.00
Step 2) Calculate WQ_v using Sec. 6 (ac-ft) =	WQ_v (ac. ft.)=	0.379
Step 3) Add 20 Percent to Step 2.	V_{design} (ac-ft) =	0.455

II.a. Water Quality Outlet Type

Step 1) Set water quality outlet type
Type 1 = single orifice
Type 2 = perforated riser or plate
Type 3 = v-notch weir

Outlet Type = 2

Step 2) Proceed to Step IIb, IIc, or IId based on selection

To Calculate Z_{WQ} (ft) interpolate from Storm Study (Sheet 13)

Elevation 1 =	936.00	Storage 1 =	7,458.00
Elevation X =		Storage X =	16,520.64
Elevation 2 =	937.00	Storage 2 =	17,349.75

Elevation X = 936.92

Lowest Elevation of Pond = 934.00
Elevation X = 936.92

Z_{WQ} (ft) = 2.92

IIc. Water Quality Outlet, Perforated Riser

Step 1) Depth at outlet above lowest perforation:	Z_{WQ} (ft) =	2.92
Step 2) Recommended maximum outlet area per row:	A_0 (in^2) =	0.582
Step 3) Circular perforation diameter per row assuming a single column:	D_1 (in) =	0.291
1	n_c (unitless) =	1
Step 5) Design circular perforation diameter (should be between 1 and 2 inches):	D_{perf} (in) =	1.000
Step 6) Horizontal perforation column spacing when n_c > 1, center to center:	S_c (in) =	4
Step 7) Number of rows (4" vertical spacing between perforations, center to center):	n_r (unitless) =	8

Calculates the diameter of each hole given the depth of water and the area per row. Assuming 4" spacing. If less than 1" use 1" as D_{perf}.

Note: If $D_{perf} \geq 1.0$ inch, $S_c = 4$

Recommended Method: Perforated Riser