MICRO STORM WATER DRAINAGE STUDY

PRO DEO

SITE ACREAGE: 0.90 ACRES

Lee's Summit, MO

PREPARED BY:

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NUMBER
PROFESSIONAL ENGINEER

12/2023

Matthew J. Schlicht, PE

Revision

Date	Comment	By

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3. GENERAL INFORMATION

A new youth facility called Pro Deo is being proposed on Lots 9 and 10 of Southview Heights. The property is located at the NW corner of the intersection of SE Douglas Street and SE Blue Parkway. The property contains 0.90 acres. The proposed improvements will consist of a new building, parking lot, drive aisle and associated utility infrastructure. The site generally drains from west to the southeast via sheet and shallow concentrated flow. No storm sewer, BMPs detention facilities nor water bodies currently exist on site. See Exhibit A for an aerial image of the proposed project site along with an aerial image of 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 29095C0438G, dated January 20, 2017.

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

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 25, August 22, 2023. The existing site contains one major soil type:

10082 Arisburg-Urban Land Complex, 1 to 5 Percent Slopes
Hydrologic Soils Group (HSG): Type C

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

4. METHODOLOGY

This Micro Storm Drainage Study has been prepared to evaluate potential hydrologic impacts from the proposed development and recommend improvements to eliminate potential negative downstream impacts. 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 the Soil Conservation Service, SCS TR-55 method to calculate storm runoff volumes, peak rates of discharge, pre and post developed hydrographs and required storage volumes for detention facilities. TR-55 was first introduced in 1975 by the SCS particularly for small urbanizing watersheds. The analysis contains results for the 2, 10 and 100-year design storms.

Hydraflow Hydrographs Extension for AutoCAD Civil 3D was utilized to model the various SCS TR-55 stormwater rainfall runoff events. The following SCS TR-55 Unit Hydrograph variables were utilized;

- AMC II Soil Moisture Conditions
- 24-Hour SCS Type II Rainfall Distribution (Shape Factor 484)
- SCS Runoff Curve Numbers per SCS TR-55 (Tables 2-2a to 2-2c)
- Time of Concentration per APWA 5600

Per APWA 5608.4 and City of Lee's Summit criteria, post development peak discharge rates from the site shall not exceed those indicated below:

- 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

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 facility shall release the water quality event over a period of 40-72 hours. Design principles taken from the MARC BMP Manual will be utilized to assist in the design of the detention basin control structure for extended release events.

5. EXISTING CONDITIONS ANALYSIS

The existing site is grass covered and generally drains from the West to the Southeast via sheet and shallow concentrated flow. The site contains two drainage sub-basins labeled E and S for the purposes of this report. Sub-basin E contains 0.57 acres and is located in the northeast corner of the site. Sub-area E drains southeasterly via sheet and shallow concentrated flow where it is intercepted by a grate inlet at the intersection of Douglas and Blue Parkway. Sub-basin S contains 0.33 acres and is located generally in the southwest corner of the property. Sub-basin S drains to the south via sheet flow where it is collected by a roadside ditch south of Blue Parkway. See Exhibit D - Existing Drainage Area Map for details of each sub-basin. Table 5-1 below details the hydrologic properties for each sub-basin along with peak discharge rates for the 2, 10 and 100-year storms.

Table 5-1 Existing Conditions Sub-area Data and Peak Discharge Rates

Sub-Basin	Area (ac.)	Composite CN	Tc (min.)	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
E	0.57	74	10.4	1.06	2.20	4.03
S	0.33	74	10.4	0.62	1.27	2.33

Exhibit E contains a complete Hydraflow Hydrograph Report with pre and post development hydrographs for each sub-basin along with proposed detention basin data and routed hydrographs.

5.1 ALLOWABLE RELEASE RATES

Per APWA 5608.4 and City of Lee's Summit criteria, post development peak discharge rates from the site shall not exceed those indicated below:

- 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

Allowable peak discharge release rates were calculated at each Point of Interest, POI.

Allowable Peak Discharge Release Rate Example Calculation:
Sub-basin E (2-Yr): 0.57 x 0.5 = 0.29 cfs

Table 5-2 Existing Conditions Sub-basin/Point of Interest Allowable Peak Discharge Release Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
E	0.29	1.14	1.71
S	0.17	0.66	0.99

6. PROPOSED CONDITIONS ANALYSIS

The proposed improvements will consist of a new building, parking lot, drive aisle and associated utility infrastructure. The proposed site will consist of three drainage sub-basins referred to as E, E1 and S for the purposes of this report. Sub-basin E1 contains 0.69 acres. Sub-basin E1 contains nearly all of the proposed site improvements. Sub-basin E1 will drain via sheet and shallow concentrated flow to an inlet located in the parking lot where flow will be routed to the proposed earthen detention basin. The building will have a roof drain system installed and routed to the proposed detention basin. Sub-basin E contains 0.11 acres of unimproved land located along the north and east boundaries of the property. Sub-basin E will be combined with detained Sub-basin E1 to determine if proposed peak discharge rates are at or below allowable for Sub-basin E. Sub-basin S contains 0.10 acres with no proposed improvements. Sub-basin S will free release via sheet flow to the south where it will be collected by a roadside ditch along Blue Parkway at POI S.

Exhibit F contains the Proposed Drainage Area Map. Table 6-1 below details the hydrologic properties for each sub-basin along with peak discharge rates for the 2, 10 and 100-year storms.

Table 6-1 Proposed Conditions Sub-basin Data and Peak Discharge Rates

Sub-Basin	Area (ac.)	Composite CN	Tc (min.)	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
E	0.11	74	5.9	0.25	0.52	0.93
E1	0.69	87	8.1	2.48	4.15	6.60
S	0.10	74	7.4	0.21	0.42	0.77

As shown above in Table 6-1 Sub-basin Combined E + E1 will require detention to attenuate proposed peak discharge rates below Allowable Release Rates as shown in Table 5-2 for Sub-basin E.

DETENTION

A new single stage earthen detention basin is being proposed in Sub-basin E1 to attenuate proposed peak discharge rates. Following are a list of design parameters for the detention system.

Designation: Detention Basin E1
Type: Earthen Basin
Side Slopes: 3:1 Max.
Bottom Slope: 2% Min., Turf Lined
Basin Bottom Elevation: 1024.60 @ Influent Pipe
Basin Top Berm Elevation: 1031.40
Basin Volume: 10,635 cf @ 1031.00
Control Structure: 6'x5' deep precast concrete box, with interior 6" Baffle wall
Weir Wall Orifices: (8) 1" Diameter on 4" Centers (Extended Detention) FL=1024.20
(1) 3" Dia. Orifice, FL=1027.75
Weir Crest EL=1030.25, Crest Length 5'-0"
Control Structure Top Elevation: 1031.25
Control Structure Emergency Overflow Weir Openings: All Sides, FL=1030.25, 6" Openings
Control Structure Influent Pipe: 15" HDPE, FL (In) = 1024.60, FL (Out) = 1024.40, L=18.51', S=1.08%
Control Structure Effluent Pipe: 15" HDPE, FL (In) = 1024.00, FL (Out) = 1022.45, L=40.95', S=3.79%
Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=1030.25, Crest Length=42'
Control Structure Overflow: Crest Elevation, Crest Length=10.5'
Consecutive 100-YR Q=6.60 cfs Emergency Spillway HGL=1030.38, Water Depth=0.13', Freeboard=1.02'
The emergency overflow shall consist of both the control structure overflow weir and the earthen broad crested weir.

The Detention Basin Plan may be found in Exhibit G. Water quality volume calculations may be found in Exhibit H. Emergency spillway calculations may be found in Exhibit I. See Table 6-2 below for a summary of detention basin data.

Table 6-2 Proposed Detention Basin Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
2-Year	2.48	718	0.30	739	1027.55	2,429
10-Year	4.15	718	0.66	730	1028.56	4,155
100-Year	6.60	718	1.00	730	1029.73	6,836

As shown in the table above all proposed peak flowrates have been attenuated. See Table 6-3 below for a summary of proposed peak discharge rates for combined Sub-basins E and E1. Hydrographs of each sub-basin have been combined to determine subsequent peak discharge rates for the entire area.

Table 6-3 Proposed Conditions Post Detention Peak Discharge Rates

Sub-Basin	**Q2 (cfs)**	**Q10 (cfs)**	**Q100 (cfs)**
Combined E & E1	0.47	0.97	1.71

Table 6-4 below provides a comparison of peak discharge rates for Existing, Proposed and Allowable Conditions for Sub-basins E and S.

Table 6-4 Peak Discharge Comparison

POI	**Condition**	**Q2 (cfs)**	**Q10 (cfs)**	**Q100 (cfs)**
E	Proposed	0.47	0.97	1.71
	Existing	1.06	2.20	4.03
	Difference	-0.59	-1.23	-2.32
	Allowable	0.29	1.14	1.71
	Difference	0.18	-0.17	0.00
S	Proposed	0.21	0.42	0.77
	Existing	0.62	1.27	2.33
	Difference	-0.41	-0.85	-1.56
	Allowable	0.17	0.66	0.99
	Difference	0.04	-0.24	-0.22

As shown in Table 6-4 above peak discharge rates for Sub-basins E and S will be reduced well below existing discharge rates for all regulatory design storms. In addition runoff from the water quality storm event will be detained and released over a minimum 40 hour time period. Proposed peak discharge rates for the more minor 2-year storm at each POI do not quite meet allowable release rates therefore a formal waiver will be requested.

7. CONCLUSION & RECOMMENDATIONS

This micro storm water drainage study shows that the development of Pro Deo will not generate any negative downstream hydraulic impacts. A new earthen detention basin located in the southeast corner of the property will provide attenuation for the proposed improvements.

In conclusion, proposed peak discharge rates are all well below existing discharge rates. The water quality storm will be detained and released over a 40 hour time period. The proposed peak discharge rates meet allowable release rates except for the more minor 2-year storm. A waiver will be requested for this exception to

the standard requirements. Except for the proposed waiver this study is in conformance with all applicable City of Lee's Summit standards and criteria therefore Engineering Solutions recommends approval of this micro storm water drainage study.

8. EXHIBITS:

- **Exhibit A – Aerial Images**
- **Exhibit B – FEMA FIRMette**
- **Exhibit C – NRCS Soils Report**
- **Exhibit D – Pre-Development Drainage Area Map**
- **Exhibit E – Hydraflow Hydrograph Calculations (Pre, Post & Detention)**
- **Exhibit F – Post-Development Drainage Area Map**
- **Exhibit G – Detention Basin Plan (Outlet Control Structure)**
- **Exhibit H – Water Quality Volume Calculations**
- **Exhibit I – Emergency Spillway Calculations**

Exhibit A

Aerial Images


SE 9 St
PRO DEO
SE Douglas St
SE Blue Pkwy
Rte 291

501 SW Mission Road

PRO DEO

1111 SE Broadway

1231 Century

SW 4th St
SW Walnut St
SW Jefferson St
SW Market St
SW Main St
SE Main St
SE 5th St
SE Green St
SE 6th St
SE Florence Ave
SE Miller St
SE 7th St
SE Douglas St
SE Browning St
SE Hamblen Rd
SE 7th Terrace
SE Blue Pkwy
SE Oldham Pkwy
SW Lakeview Blvd
SW Stratford Rd
Oldham Pkwy
50

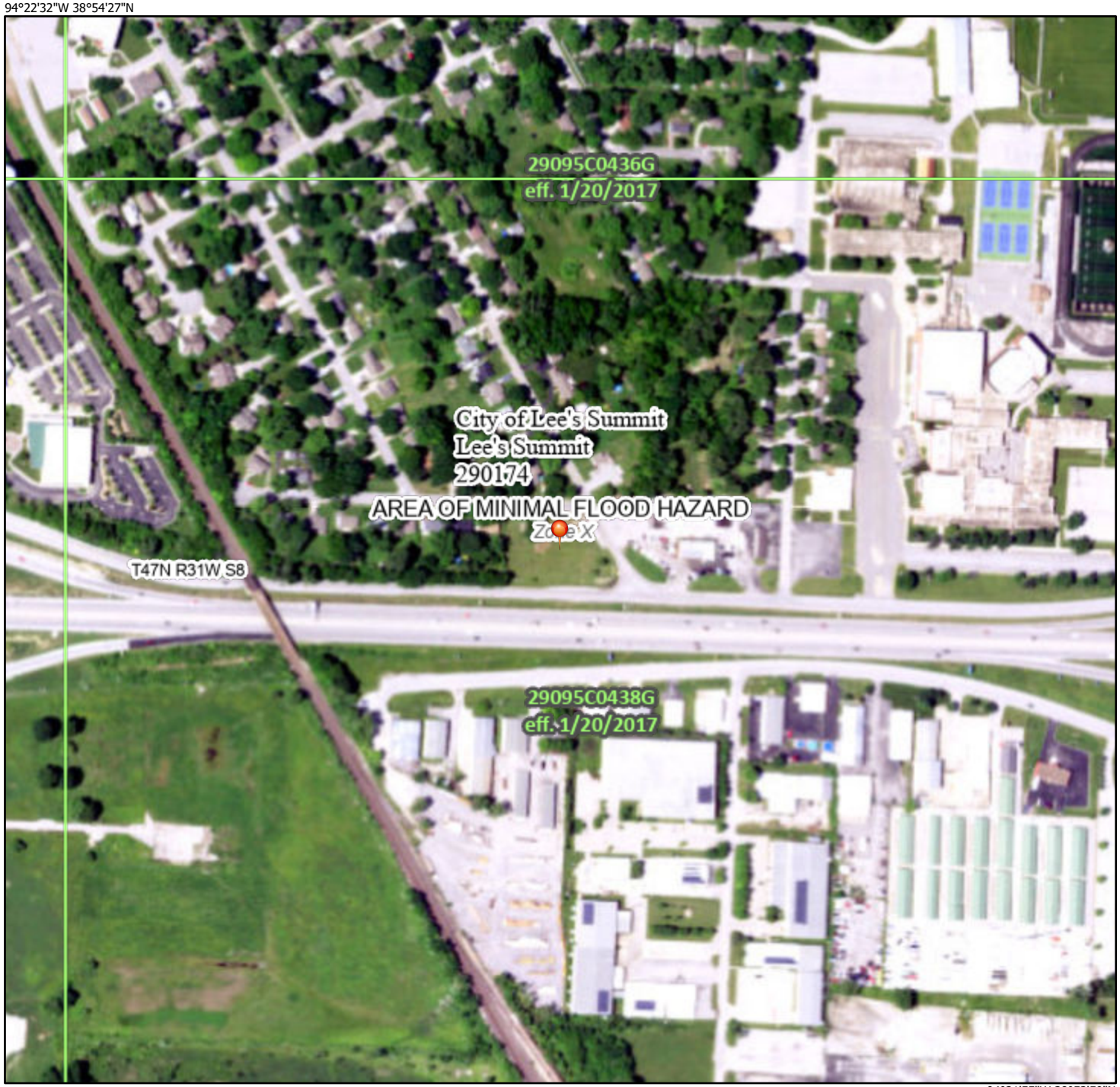
Exhibit B

FEMA FIRMette

National Flood Hazard Layer FIRMette

FEMA

94°22'32"W 38°54'27"N



94°21'55"W 38°53'59"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap Imagery Source: USGS National Map 2023

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
- 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 12/5/2023 at 4:25 PM 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

PRO DEO

December 5, 2023

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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

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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: 1:473 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 5 10 20 30

Feet
0 20 40 80 120

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 25, Aug 22, 2023

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

Date(s) aerial images were photographed: Aug 30, 2022—Sep 8, 2022

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
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	1.0	100.0%
Totals for Area of Interest		**1.0**	**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

10082—Arisburg-Urban land complex, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2w7ld
Elevation: 750 to 1,130 feet
Mean annual precipitation: 39 to 45 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

Arisburg and similar soils: 61 percent
Urban land: 30 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arisburg

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

Ap - 0 to 6 inches: silt loam
A - 6 to 13 inches: silt loam
Bt - 13 to 19 inches: silty clay loam
Btg - 19 to 56 inches: silty clay loam
BCg - 56 to 79 inches: silty clay loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 11.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: R107XB007MO - Loess Upland Prairie
Hydric soil rating: No

Description of Urban Land

Interpretive groups

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

Minor Components

Sampsel

Percent of map unit: 3 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Hydric soil rating: Yes

Greenton

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Sharpsburg

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

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Exhibit D

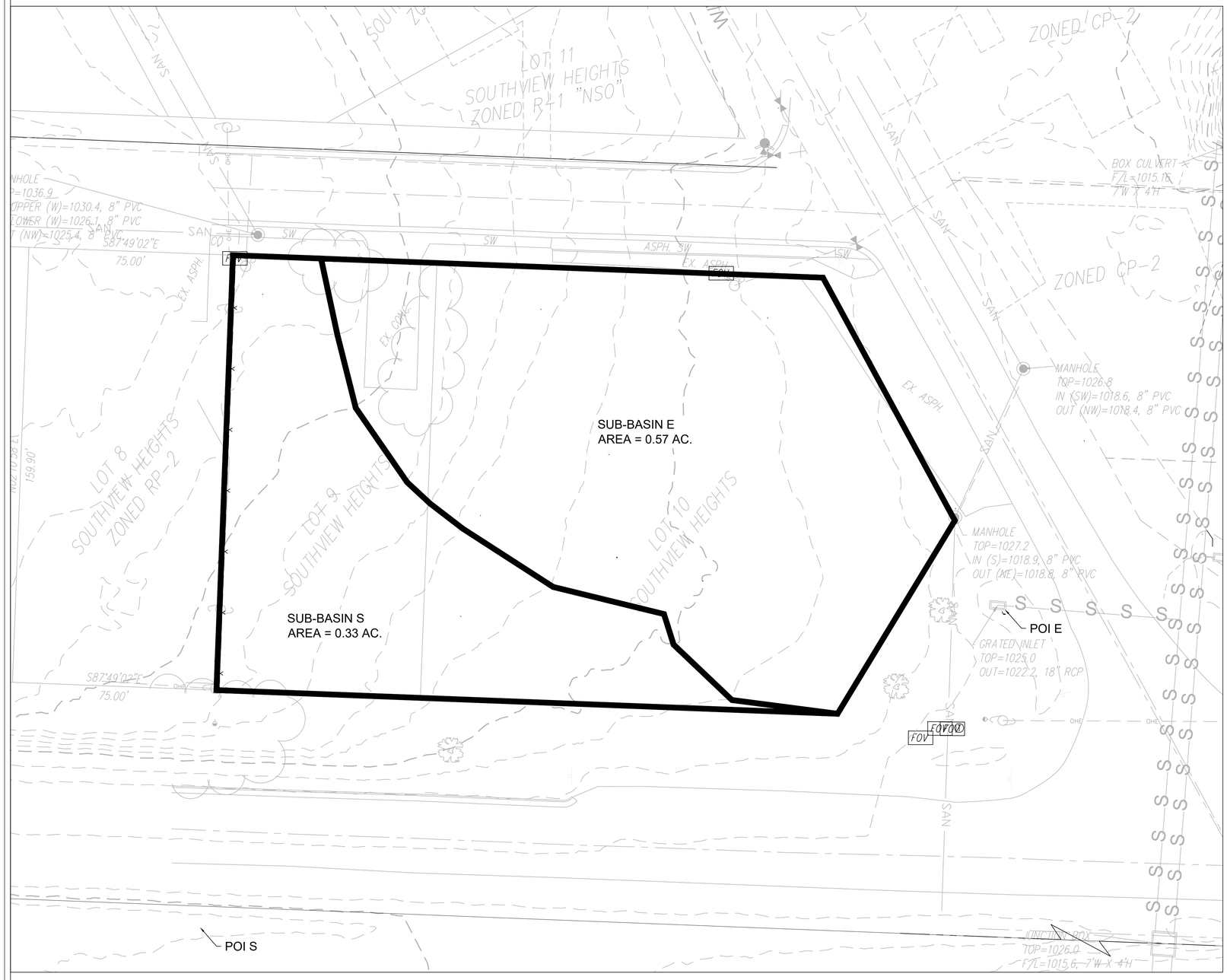
Existing Drainage Area Map

North

0 10' 20' 40'

EXISTING DRAINAGE MAP

SCALE: 1" = 20'



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Nebraska
Engineering CA2821

902 SE Douglas St
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: Pro Dev Youth Ctnr
Issue Date: December 6, 2023

Existing Drainage Map
Preliminary Plans for:
Lot 9 & 10, Southview Heights
Lee's Summit, Jackson County, Missouri

STATE OF MISSOURI
MATTHEW J. SCHLICHT
NUMBER PE-2006019708
PROFESSIONAL ENGINEER

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226

REVISIONS

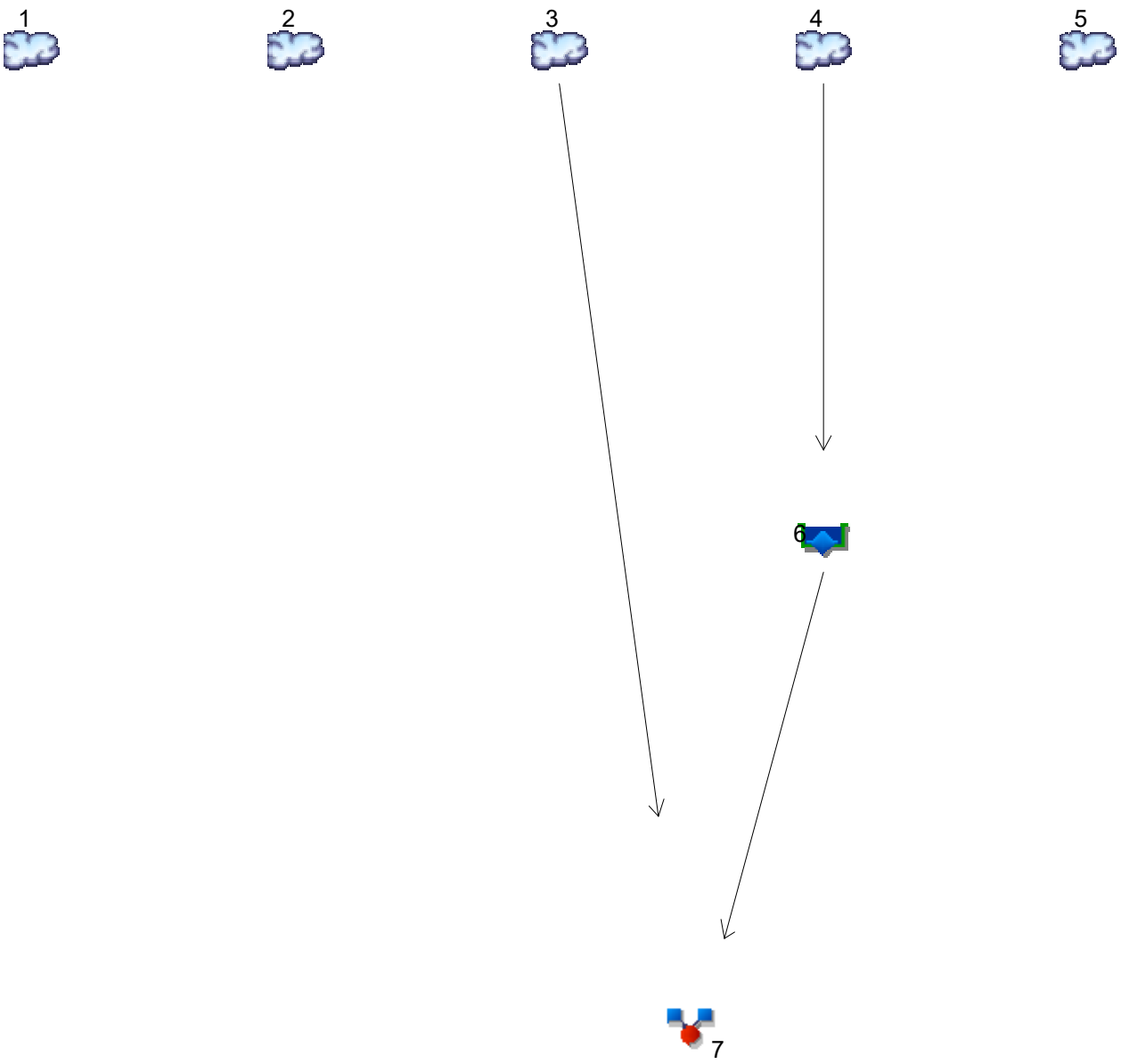
EXHIBIT

Exhibit E

Hydraflow Hydrograph Calculations

Hydraflow Table of Contents

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	EX. E
2	SCS Runoff	EX. S
3	SCS Runoff	PROP. E
4	SCS Runoff	PROP. E1
5	SCS Runoff	PROP. S
6	Reservoir	ROUTED PROP. E1
7	Combine	POI E

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	------	-------	1.064	-------	-------	2.199	-------	-------	4.026	EX. E
2	SCS Runoff	------	-------	0.616	-------	-------	1.273	-------	-------	2.331	EX. S
3	SCS Runoff	------	-------	0.253	-------	-------	0.516	-------	-------	0.931	PROP. E
4	SCS Runoff	------	-------	2.478	-------	-------	4.152	-------	-------	6.601	PROP. E1
5	SCS Runoff	------	-------	0.207	-------	-------	0.422	-------	-------	0.769	PROP. S
6	Reservoir	4	-------	0.297	-------	-------	0.656	-------	-------	1.002	ROUTED PROP. E1
7	Combine	3, 6	-------	0.473	-------	-------	0.969	-------	-------	1.713	POI E

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

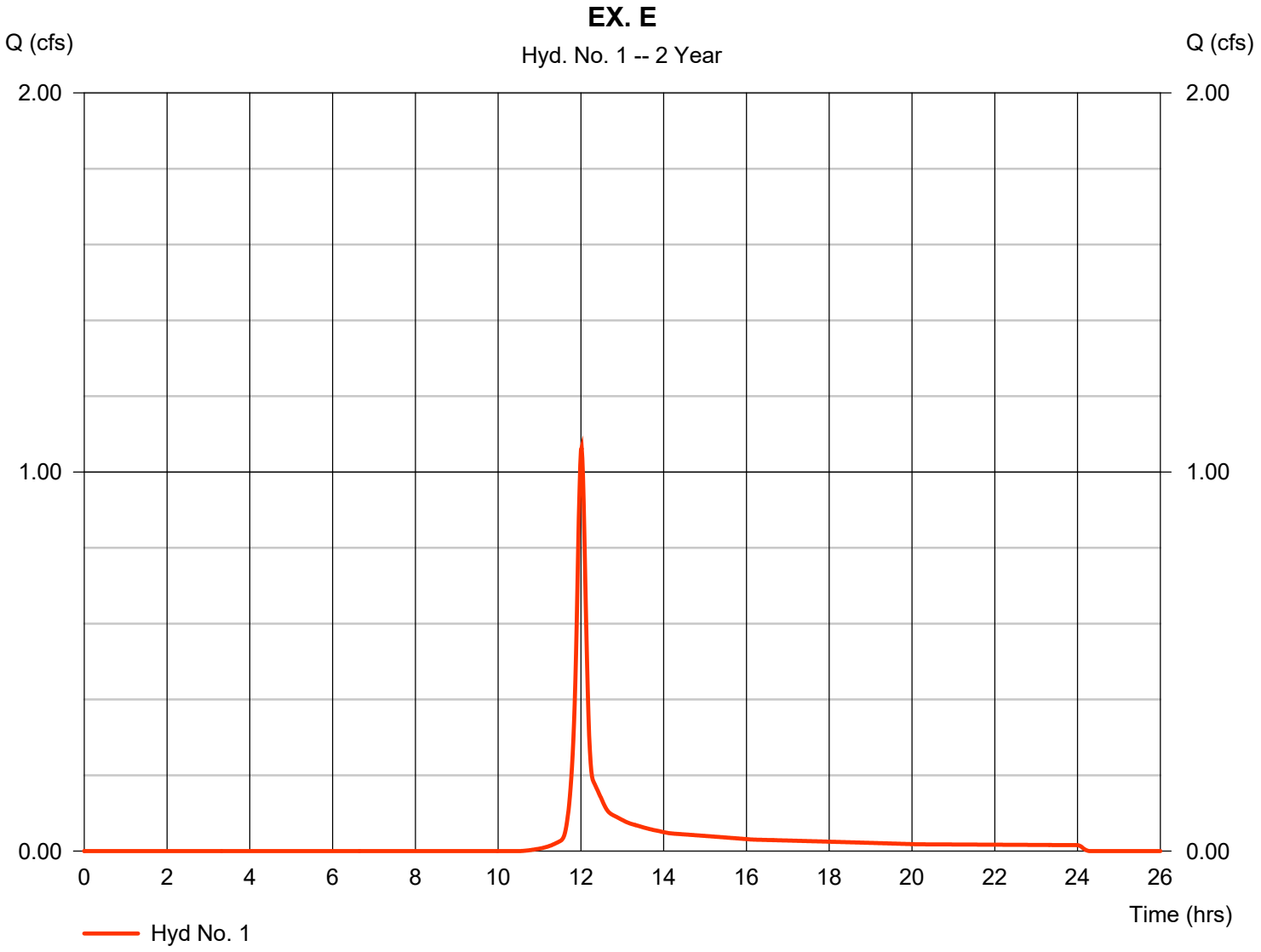
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	1.064	1	721	2,611	------	------	------	EX. E
2	SCS Runoff	0.616	1	721	1,512	------	------	------	EX. S
3	SCS Runoff	0.253	1	718	511	------	------	------	PROP. E
4	SCS Runoff	2.478	1	718	5,330	------	------	------	PROP. E1
5	SCS Runoff	0.207	1	719	439	------	------	------	PROP. S
6	Reservoir	0.297	1	739	5,317	4	1027.55	2,429	ROUTED PROP. E1
7	Combine	0.473	1	719	5,827	3, 6	------	------	POI E

Hydrograph Report

Hyd. No. 1

EX. E

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.064 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.02 hrs
Time interval	=	1 min	Hyd. volume	=	2,611 cuft
Drainage area	=	0.570 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.40 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

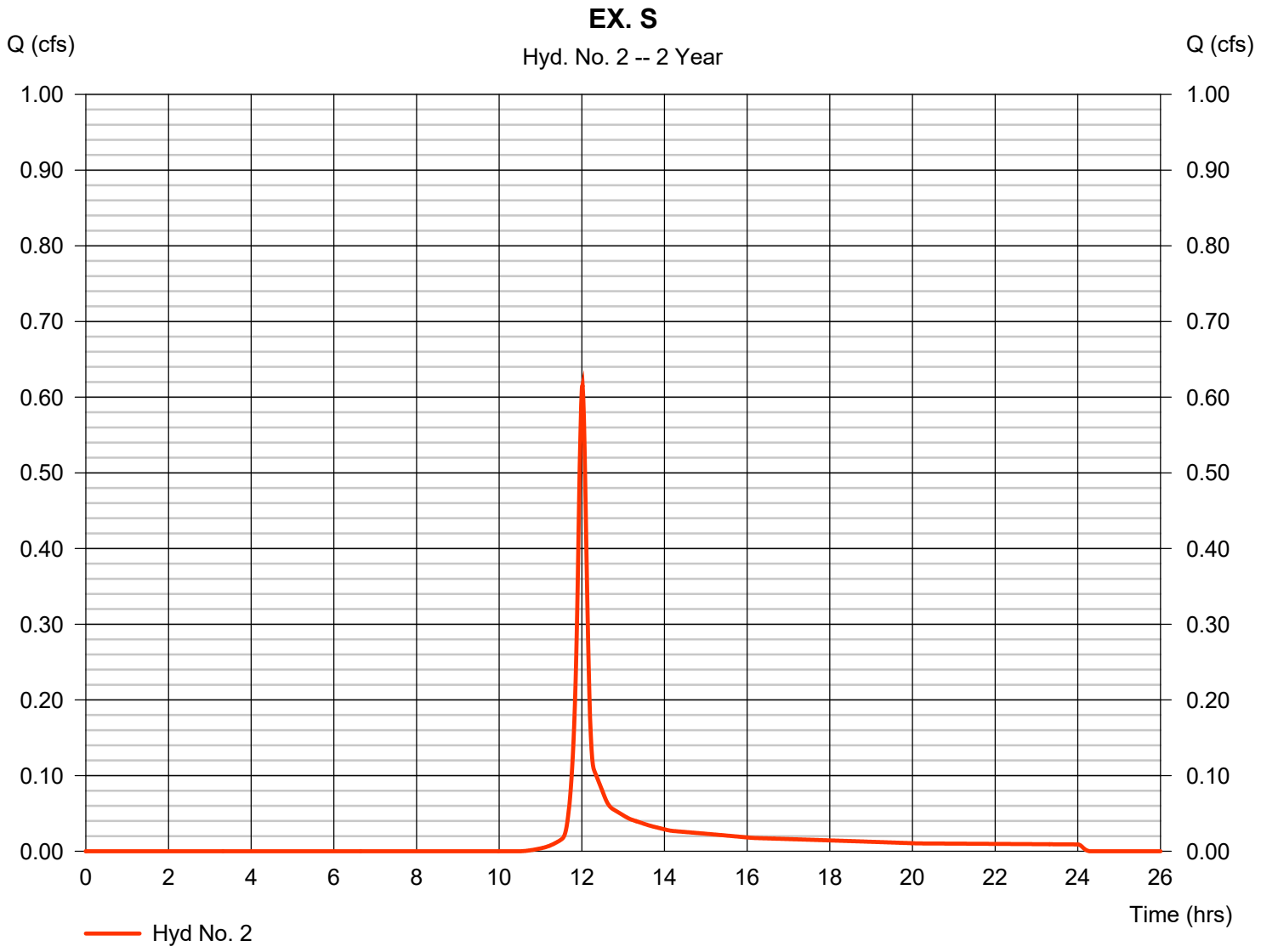


Hydrograph Report

Hyd. No. 2

EX. S

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.616 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.02 hrs
Time interval	=	1 min	Hyd. volume	=	1,512 cuft
Drainage area	=	0.330 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.40 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

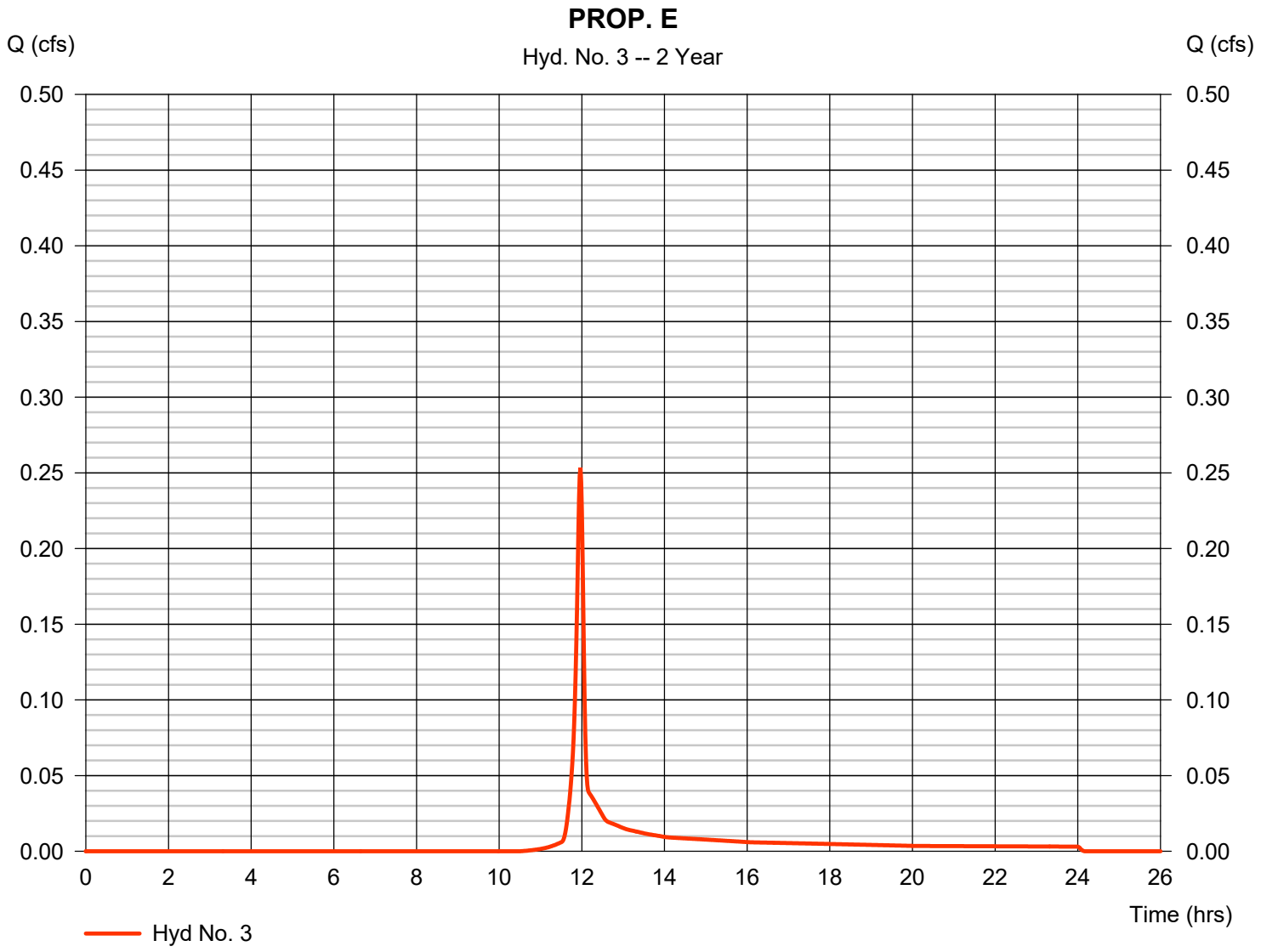


Hydrograph Report

Hyd. No. 3

PROP. E

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.253 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	511 cuft
Drainage area	=	0.110 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.90 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

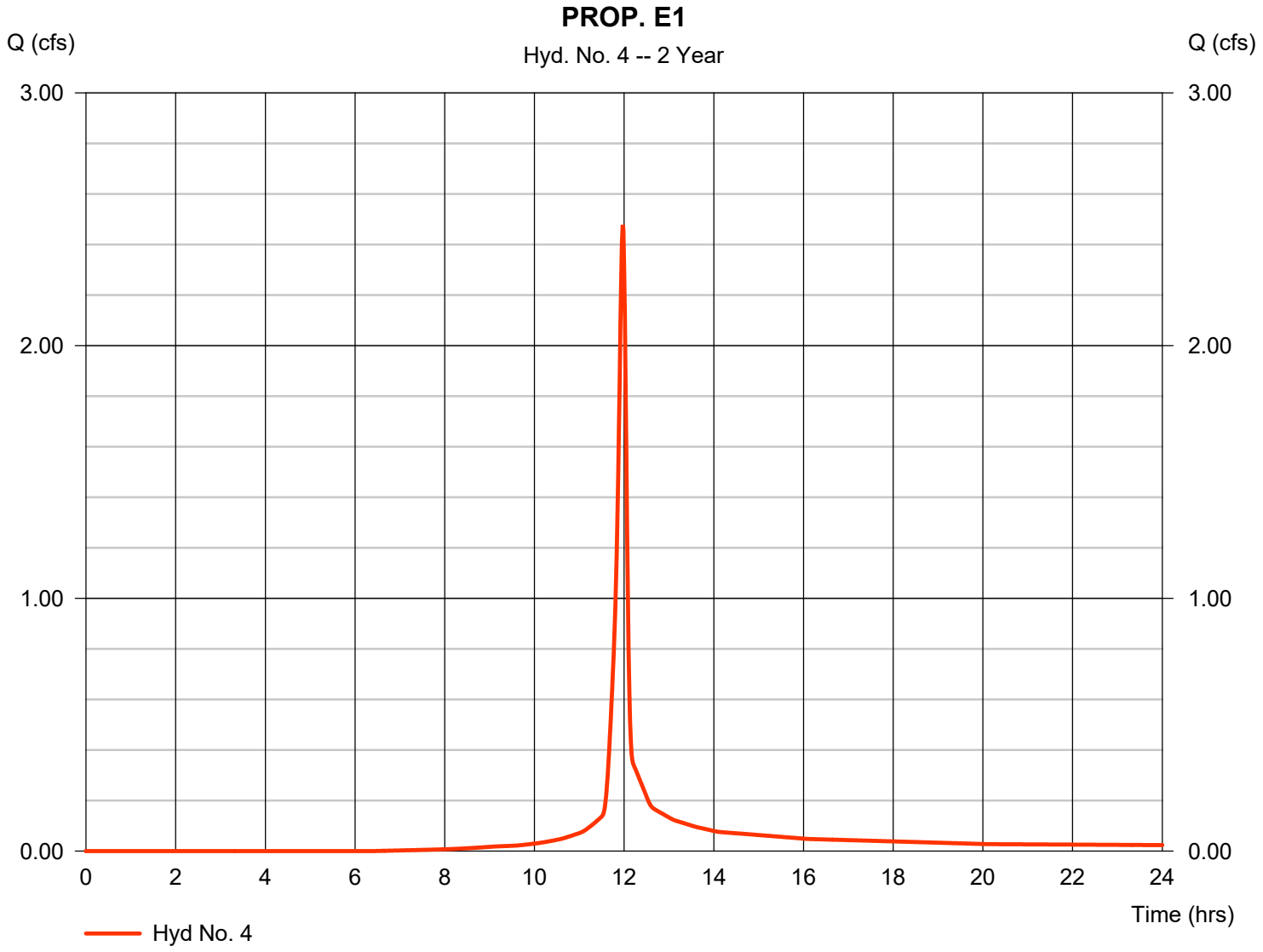


Hydrograph Report

Hyd. No. 4

PROP. E1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.478 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	5,330 cuft
Drainage area	=	0.690 ac	Curve number	=	87
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	8.10 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

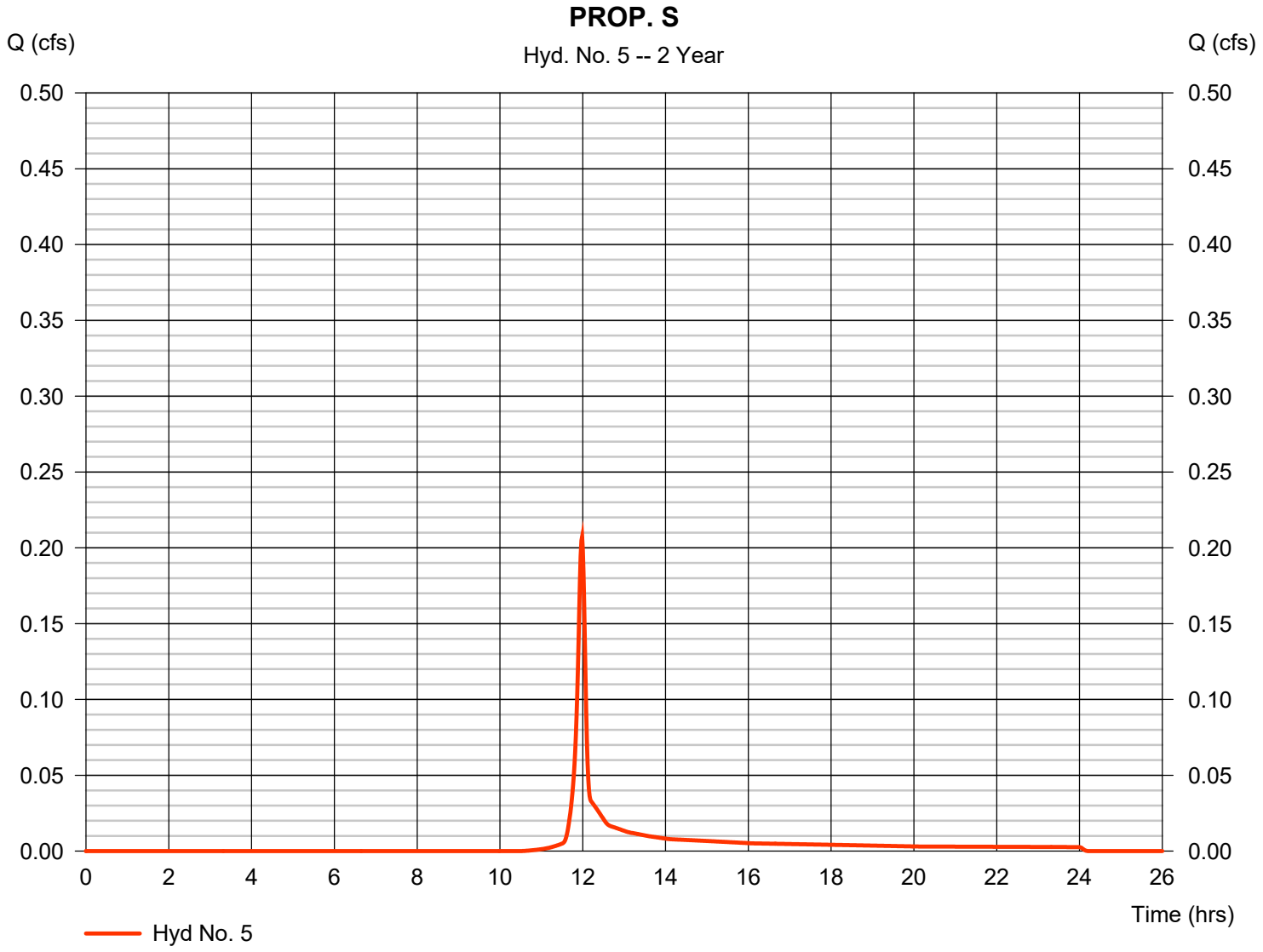


Hydrograph Report

Hyd. No. 5

PROP. S

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.207 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.98 hrs
Time interval	=	1 min	Hyd. volume	=	439 cuft
Drainage area	=	0.100 ac	Curve number	=	74
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



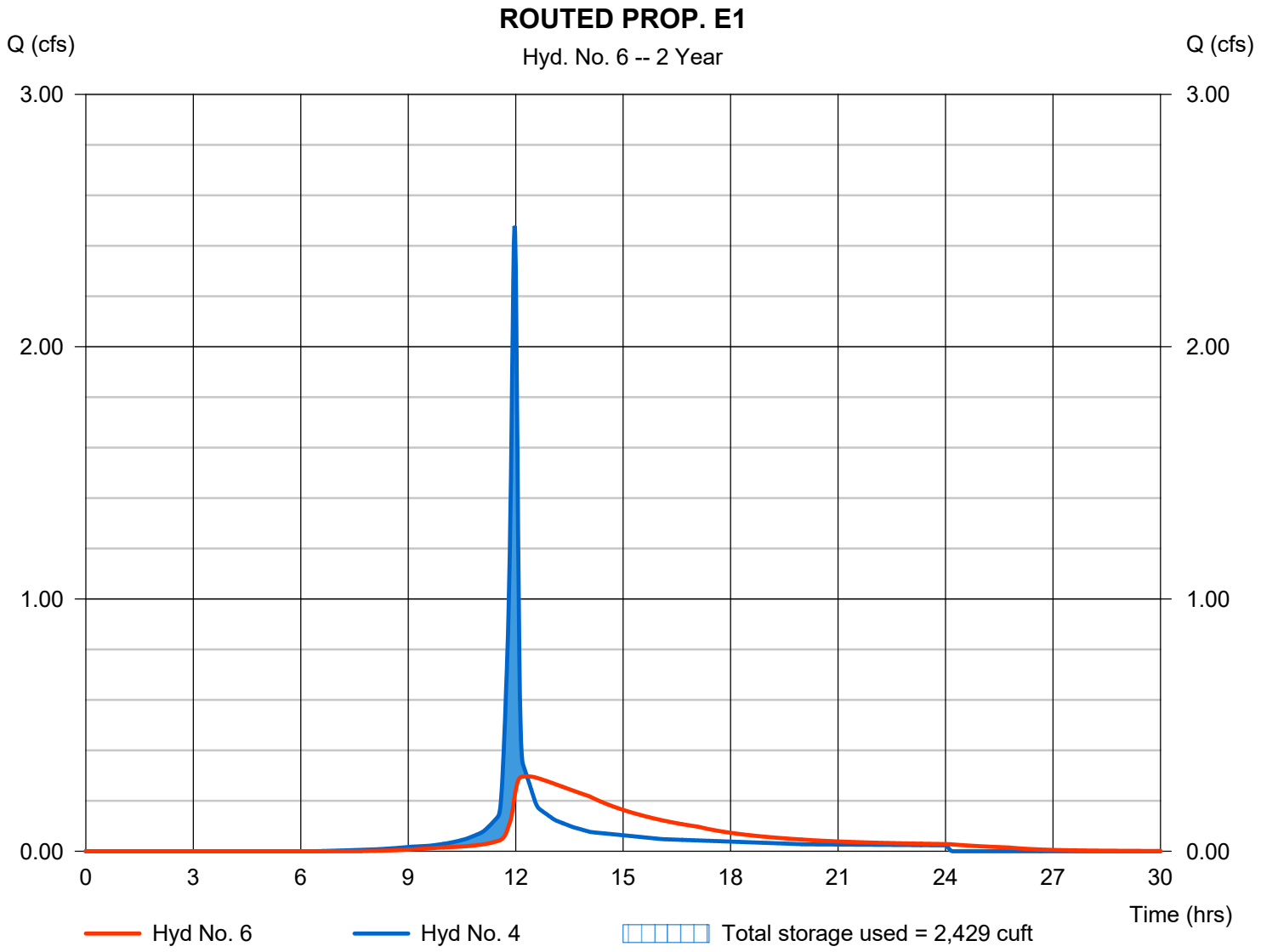
Hydrograph Report

Hyd. No. 6

ROUTED PROP. E1

Hydrograph type	=	Reservoir	Peak discharge	=	0.297 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.32 hrs
Time interval	=	1 min	Hyd. volume	=	5,317 cuft
Inflow hyd. No.	=	4 - PROP. E1	Max. Elevation	=	1027.55 ft
Reservoir name	=	Basin E1	Max. Storage	=	2,429 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Basin E1

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 1024.60 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1024.60	00	0	0
0.40	1025.00	407	81	81
1.40	1026.00	760	584	665
2.40	1027.00	1,188	974	1,639
3.40	1028.00	1,682	1,435	3,074
4.40	1029.00	2,211	1,947	5,020
5.40	1030.00	2,768	2,490	7,510
6.40	1031.00	3,482	3,125	10,635

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 15.00	3.00	0.00	1.00
Span (in)	= 15.00	3.00	0.00	1.00
No. Barrels	= 1	1	0	8
Invert El. (ft)	= 1024.00	1027.75	0.00	1024.20
Length (ft)	= 40.95	0.00	0.00	2.39
Slope (%)	= 3.79	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)	= 42.00	0.00	0.00	0.00
Crest El. (ft)	= 1030.25	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 Contour)

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

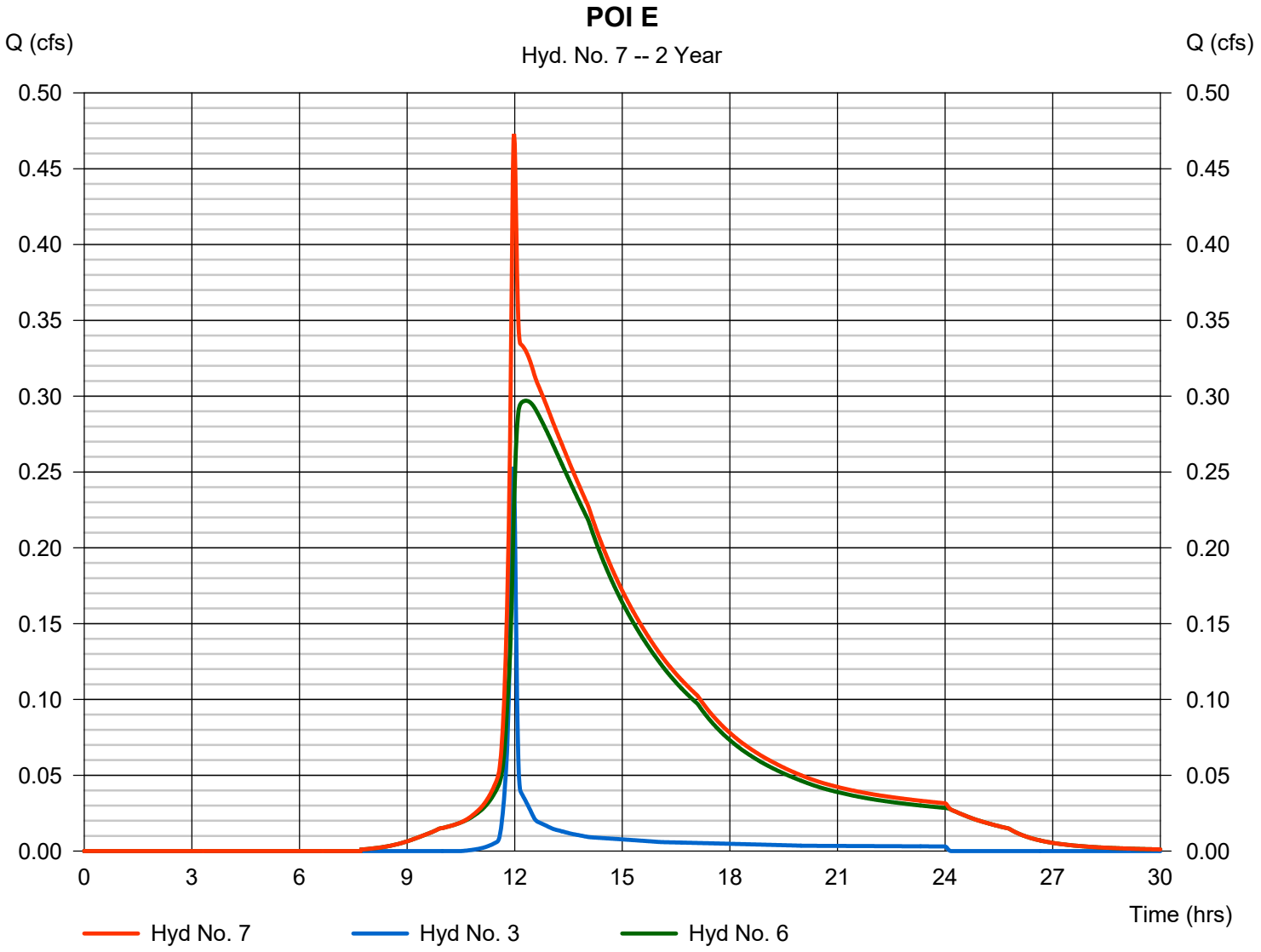
Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	1024.60	0.00	0.00	---	0.00	0.00	---	---	---	---	---	0.000
0.40	81	1025.00	1.55 ic	0.00	---	0.01	0.00	---	---	---	---	---	0.015
1.40	665	1026.00	1.55 ic	0.00	---	0.10	0.00	---	---	---	---	---	0.097
2.40	1,639	1027.00	1.55 ic	0.00	---	0.22	0.00	---	---	---	---	---	0.218
3.40	3,074	1028.00	1.55 ic	0.08 ic	---	0.37	0.00	---	---	---	---	---	0.451
4.40	5,020	1029.00	1.55 ic	0.25 ic	---	0.54	0.00	---	---	---	---	---	0.791
5.40	7,510	1030.00	1.55 ic	0.34 ic	---	0.74	0.00	---	---	---	---	---	1.080
6.40	10,635	1031.00	1.55 ic	0.42 ic	---	0.95	70.93	---	---	---	---	---	72.29

Hydrograph Report

Hyd. No. 7

POI E

Hydrograph type	=	Combine	Peak discharge	=	0.473 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.98 hrs
Time interval	=	1 min	Hyd. volume	=	5,827 cuft
Inflow hyds.	=	3, 6	Contrib. drain. area	=	0.110 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

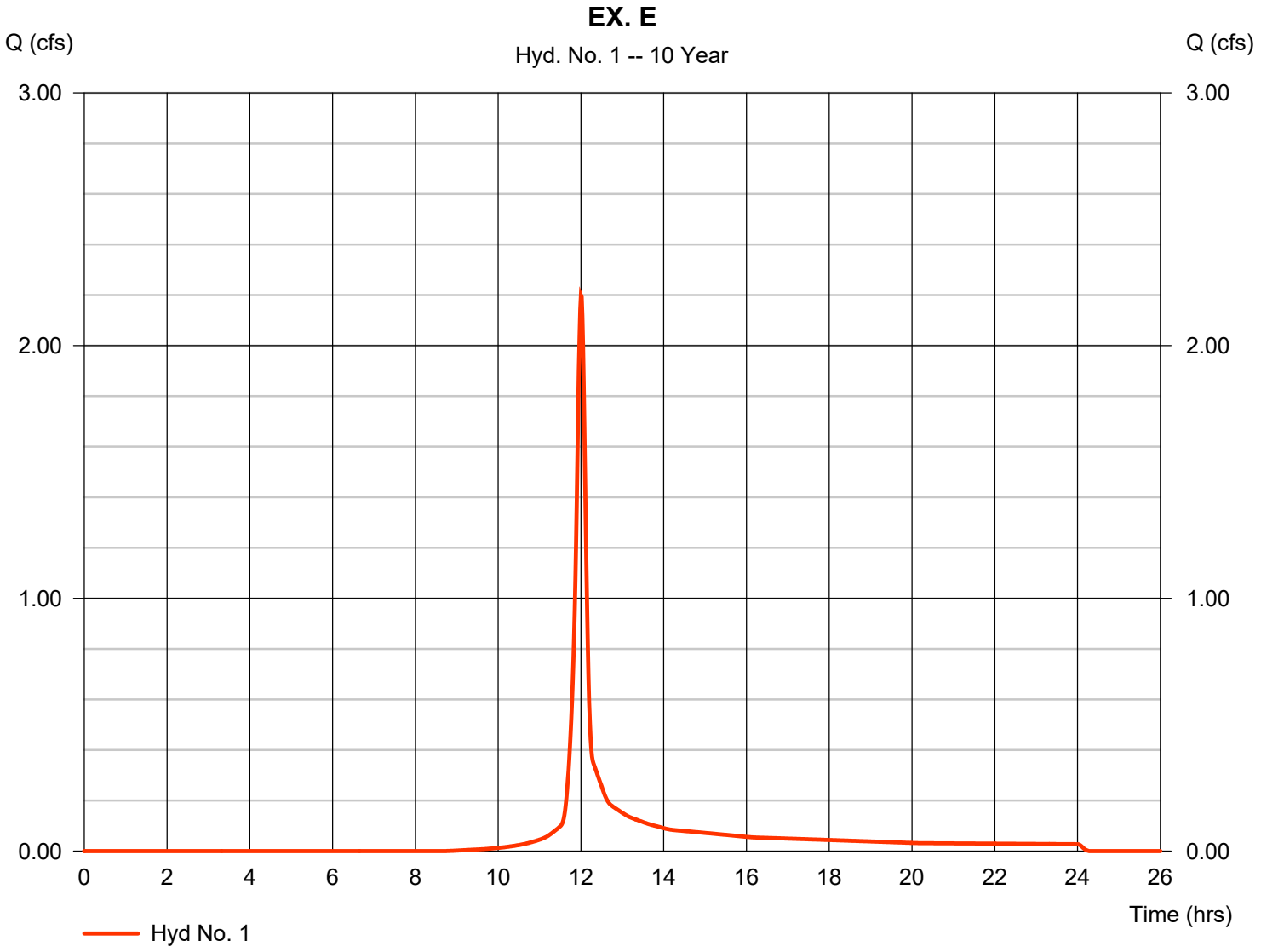
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	2.199	1	720	5,317	------	------	------	EX. E
2	SCS Runoff	1.273	1	720	3,078	------	------	------	EX. S
3	SCS Runoff	0.516	1	718	1,040	------	------	------	PROP. E
4	SCS Runoff	4.152	1	718	9,173	------	------	------	PROP. E1
5	SCS Runoff	0.422	1	718	894	------	------	------	PROP. S
6	Reservoir	0.656	1	730	9,159	4	1028.56	4,155	ROUTED PROP. E1
7	Combine	0.969	1	720	10,199	3, 6	------	------	POI E

Hydrograph Report

Hyd. No. 1

EX. E

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.199 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.00 hrs
Time interval	=	1 min	Hyd. volume	=	5,317 cuft
Drainage area	=	0.570 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.40 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

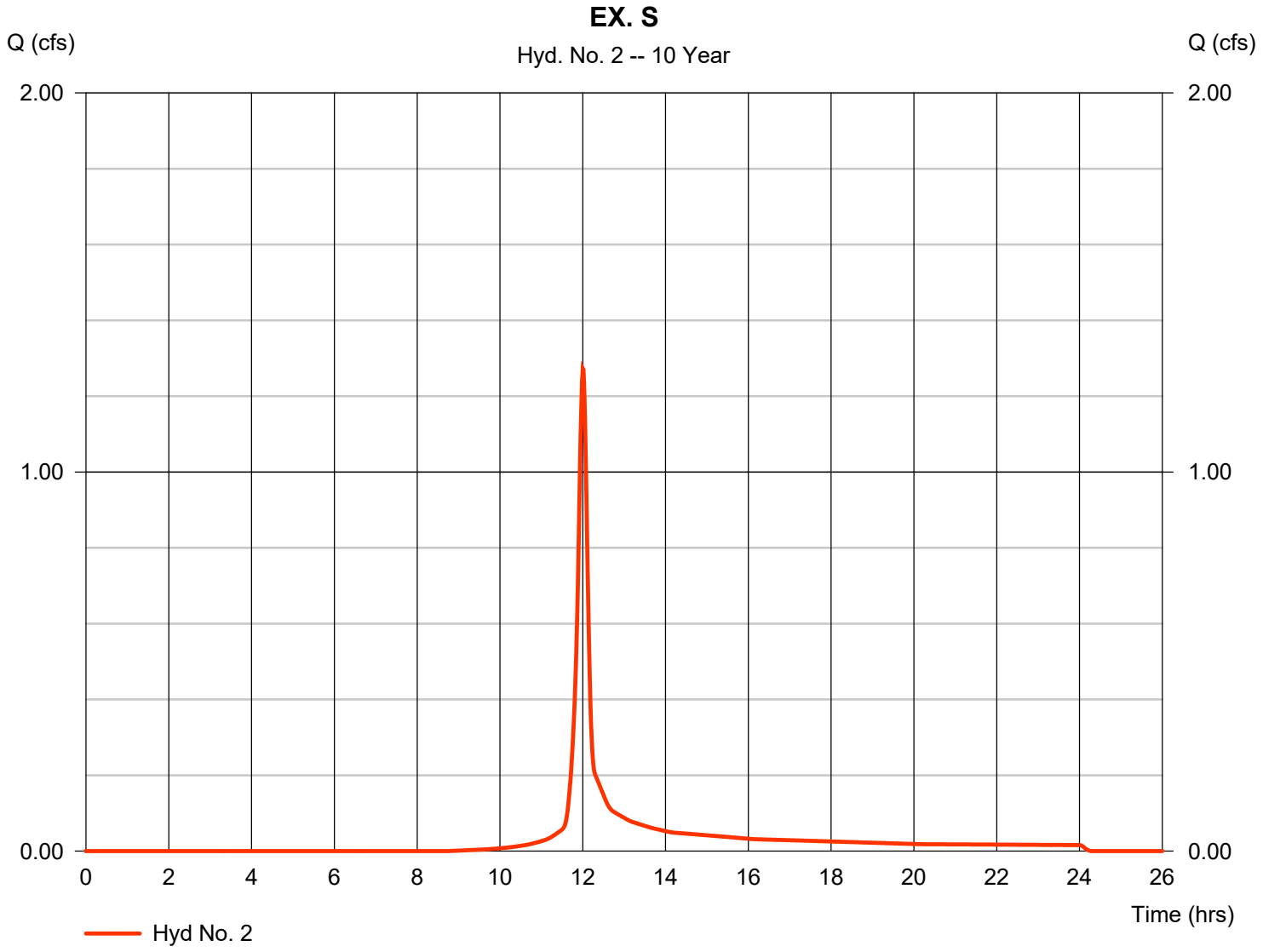


Hydrograph Report

Hyd. No. 2

EX. S

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.273 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.00 hrs
Time interval	=	1 min	Hyd. volume	=	3,078 cuft
Drainage area	=	0.330 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.40 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

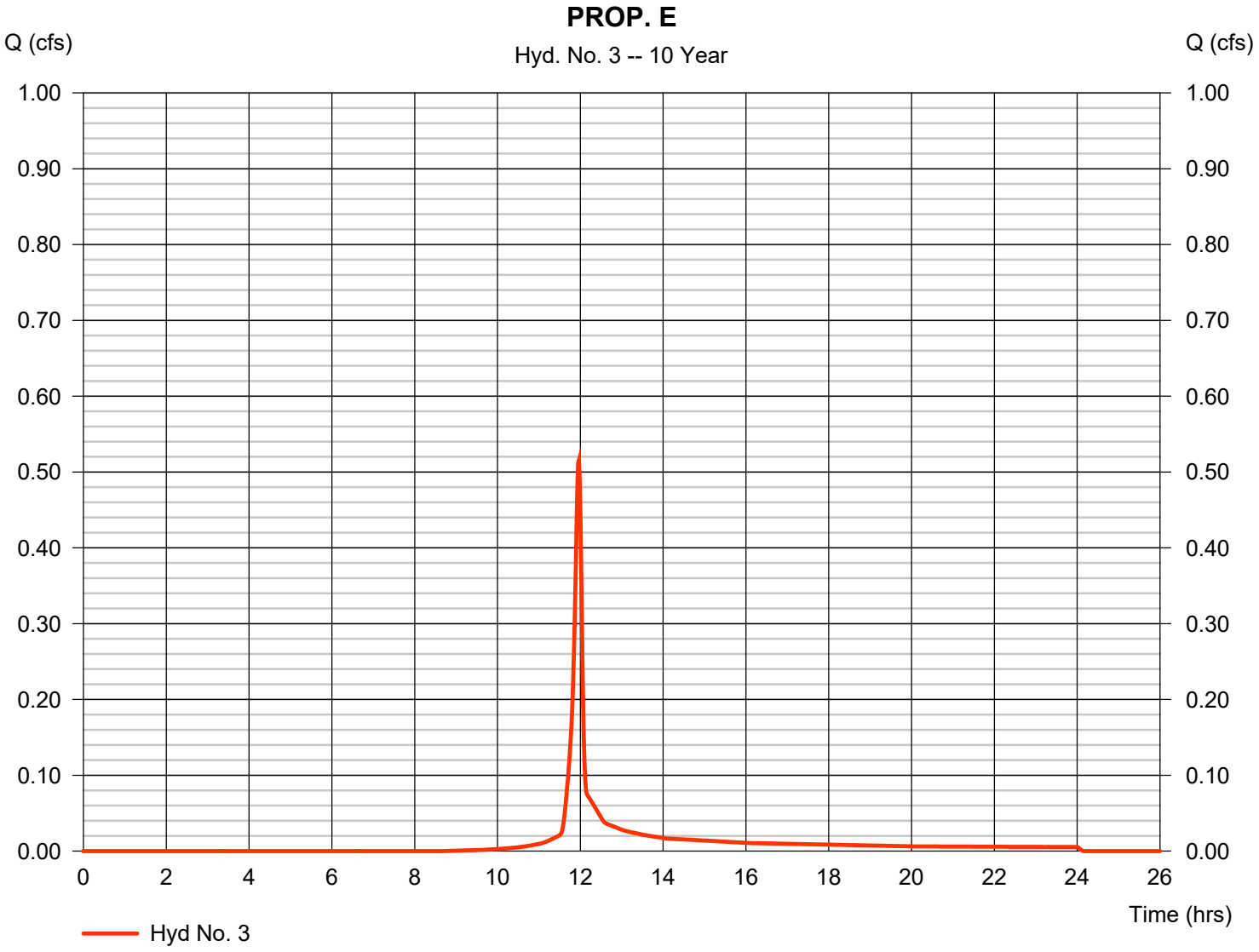


Hydrograph Report

Hyd. No. 3

PROP. E

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.516 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	1,040 cuft
Drainage area	=	0.110 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.90 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

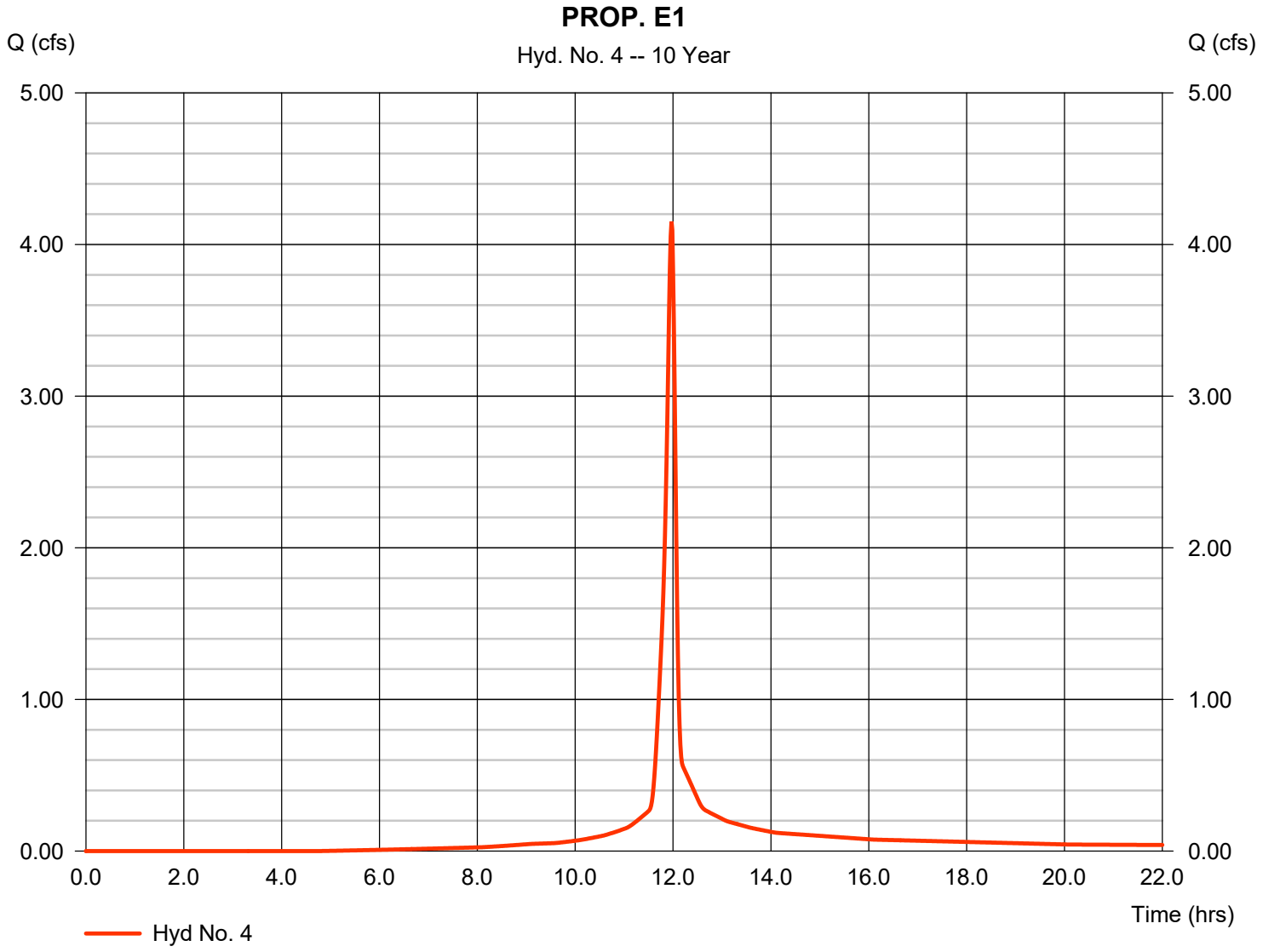


Hydrograph Report

Hyd. No. 4

PROP. E1

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.152 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	9,173 cuft
Drainage area	=	0.690 ac	Curve number	=	87
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	8.10 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

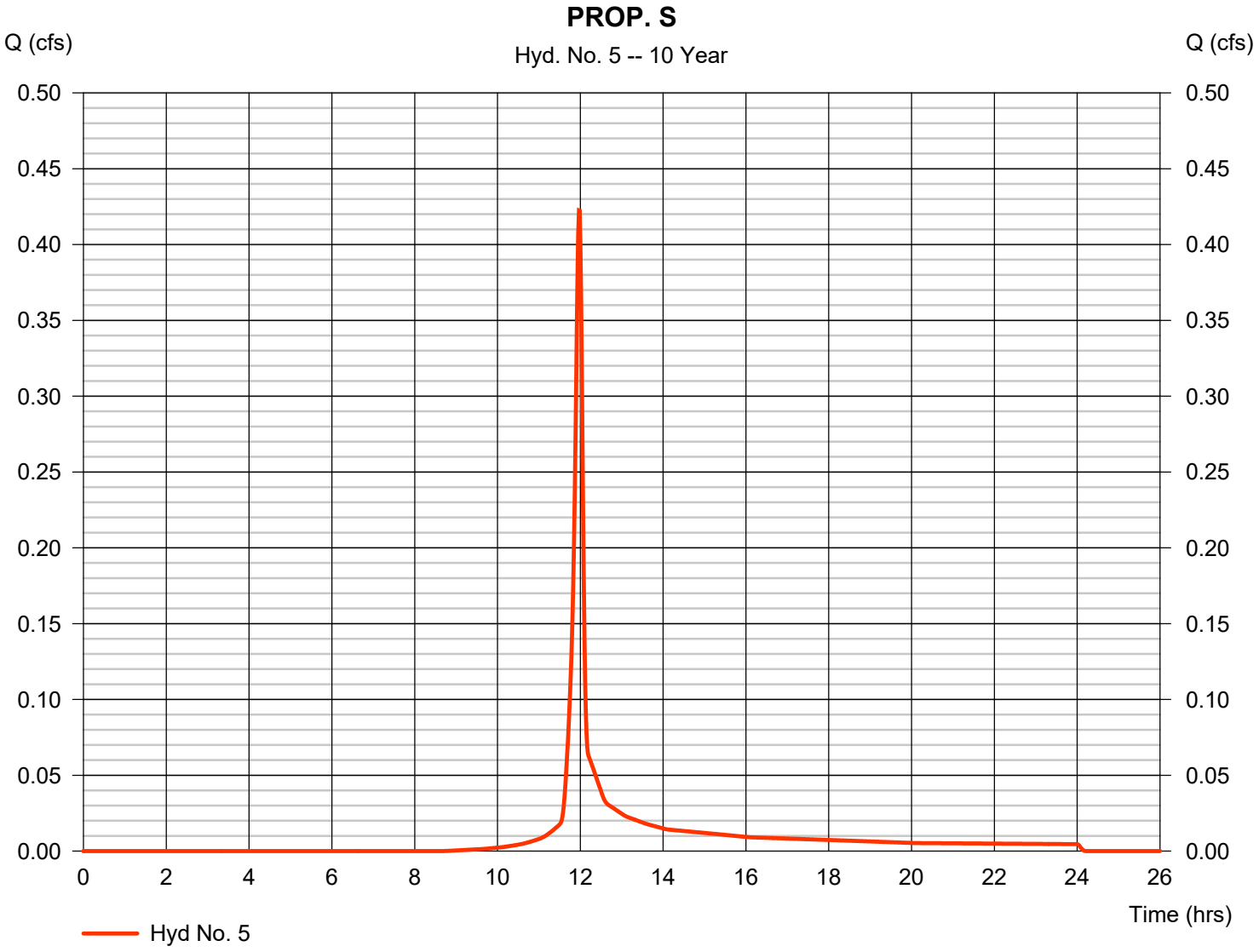


Hydrograph Report

Hyd. No. 5

PROP. S

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.422 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	894 cuft
Drainage area	=	0.100 ac	Curve number	=	74
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



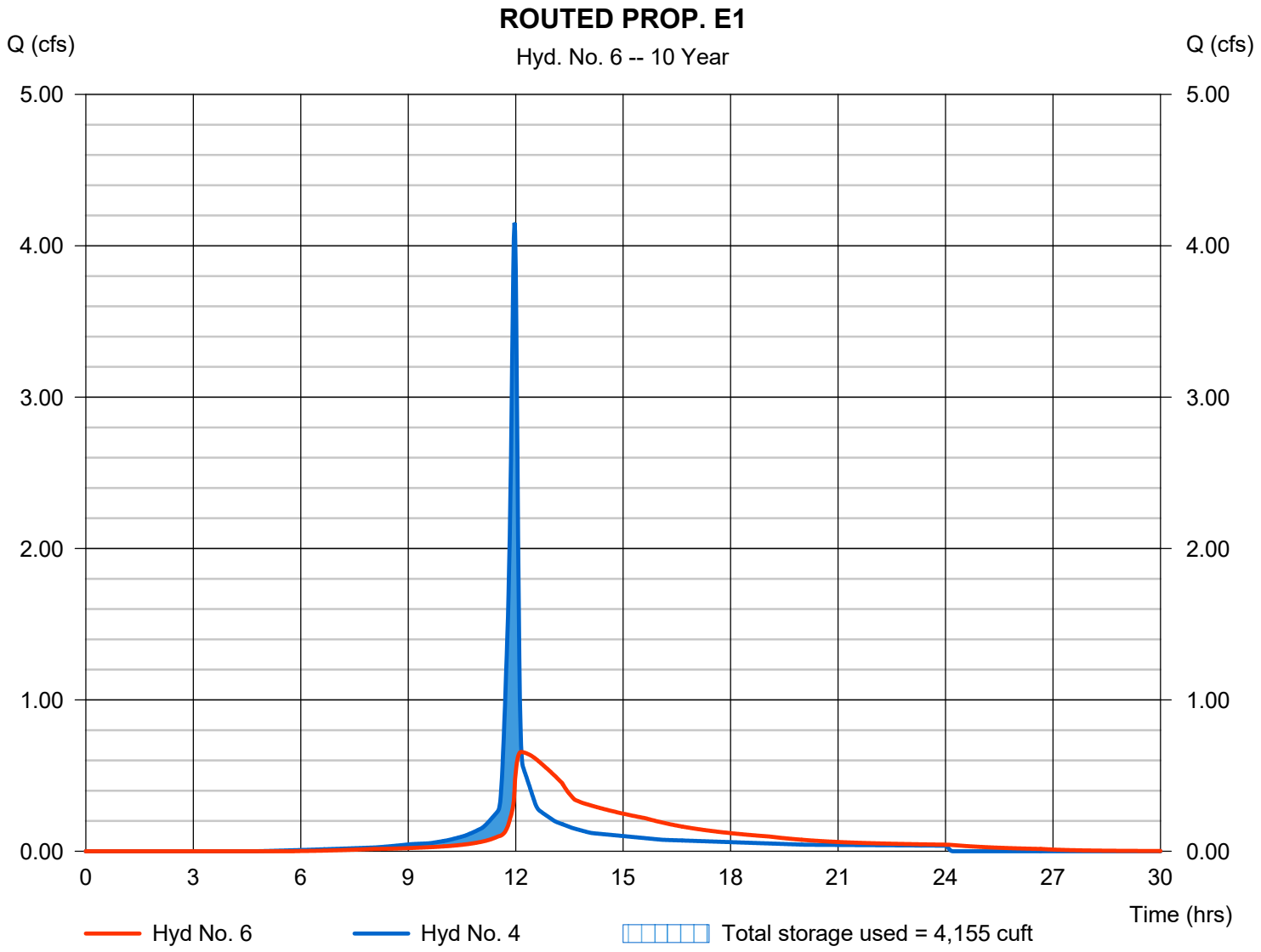
Hydrograph Report

Hyd. No. 6

ROUTED PROP. E1

Hydrograph type	= Reservoir	Peak discharge	= 0.656 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.17 hrs
Time interval	= 1 min	Hyd. volume	= 9,159 cuft
Inflow hyd. No.	= 4 - PROP. E1	Max. Elevation	= 1028.56 ft
Reservoir name	= Basin E1	Max. Storage	= 4,155 cuft

Storage Indication method used.

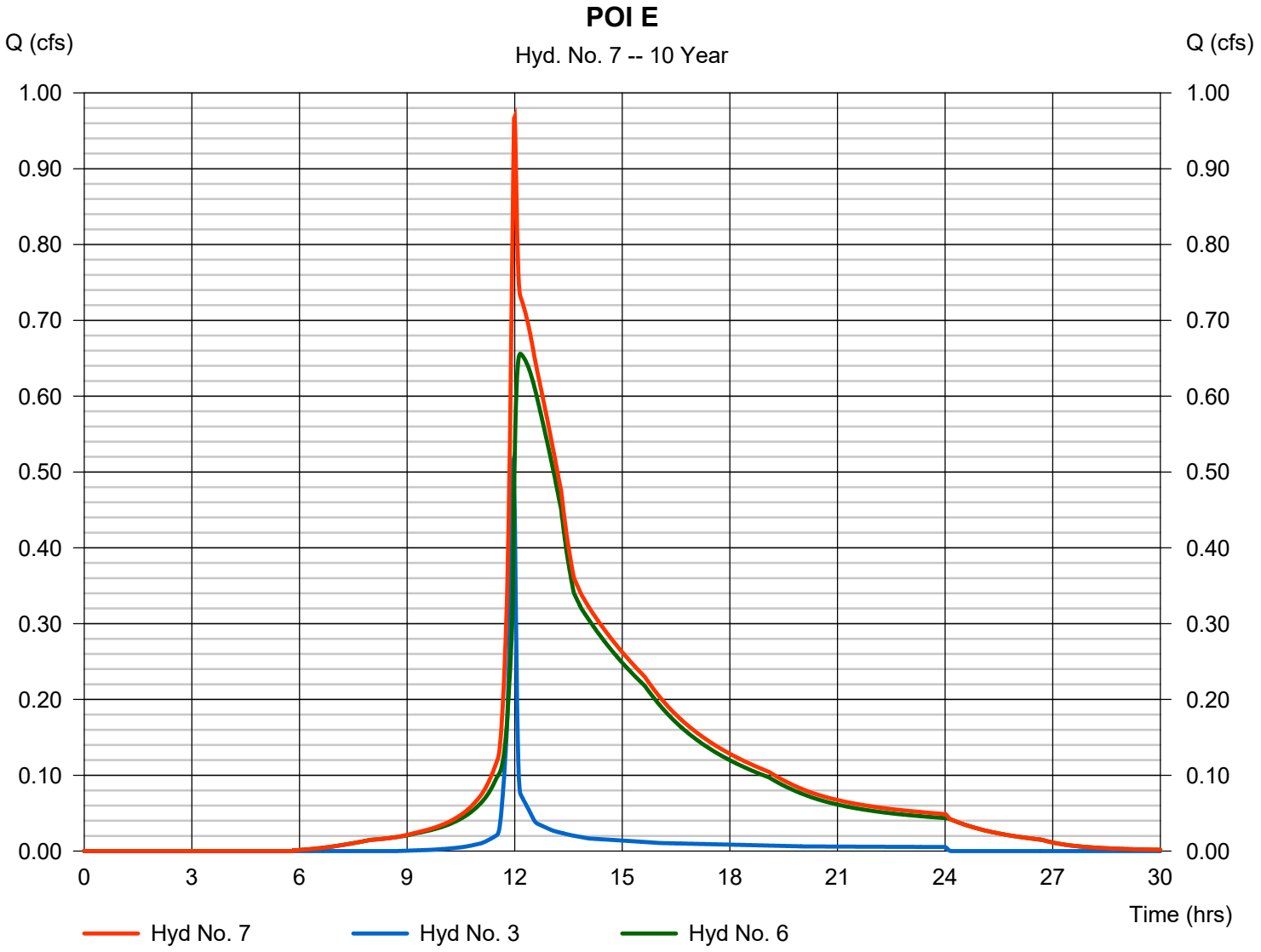


Hydrograph Report

Hyd. No. 7

POI E

Hydrograph type	=	Combine	Peak discharge	=	0.969 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.00 hrs
Time interval	=	1 min	Hyd. volume	=	10,199 cuft
Inflow hyds.	=	3, 6	Contrib. drain. area	=	0.110 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

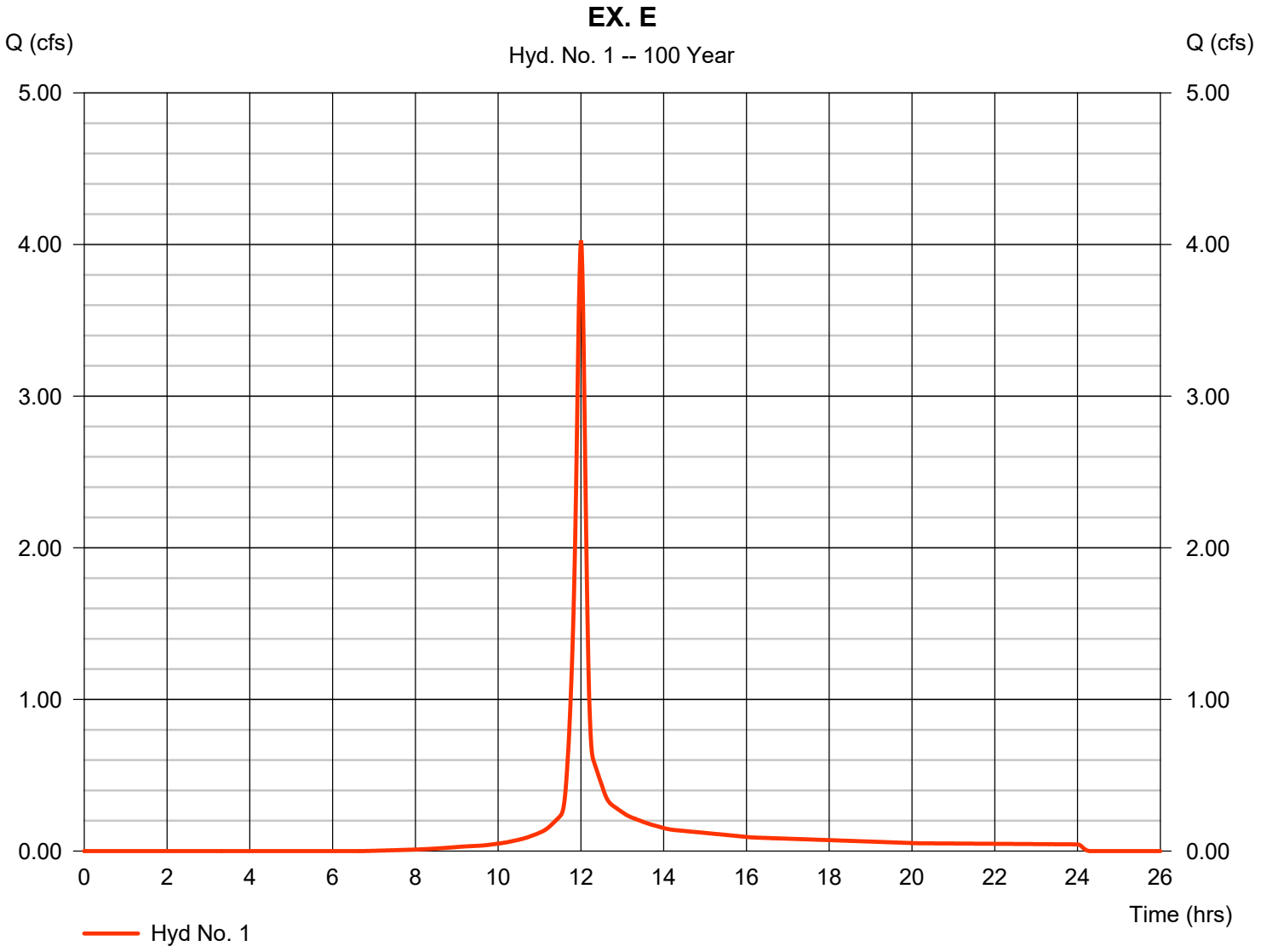
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	4.026	1	720	9,811	------	------	------	EX. E
2	SCS Runoff	2.331	1	720	5,680	------	------	------	EX. S
3	SCS Runoff	0.931	1	717	1,918	------	------	------	PROP. E
4	SCS Runoff	6.601	1	718	15,038	------	------	------	PROP. E1
5	SCS Runoff	0.769	1	718	1,649	------	------	------	PROP. S
6	Reservoir	1.002	1	730	15,025	4	1029.73	6,836	ROUTED PROP. E1
7	Combine	1.713	1	718	16,943	3, 6	------	------	POI E

Hydrograph Report

Hyd. No. 1

EX. E

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.026 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.00 hrs
Time interval	=	1 min	Hyd. volume	=	9,811 cuft
Drainage area	=	0.570 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.40 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

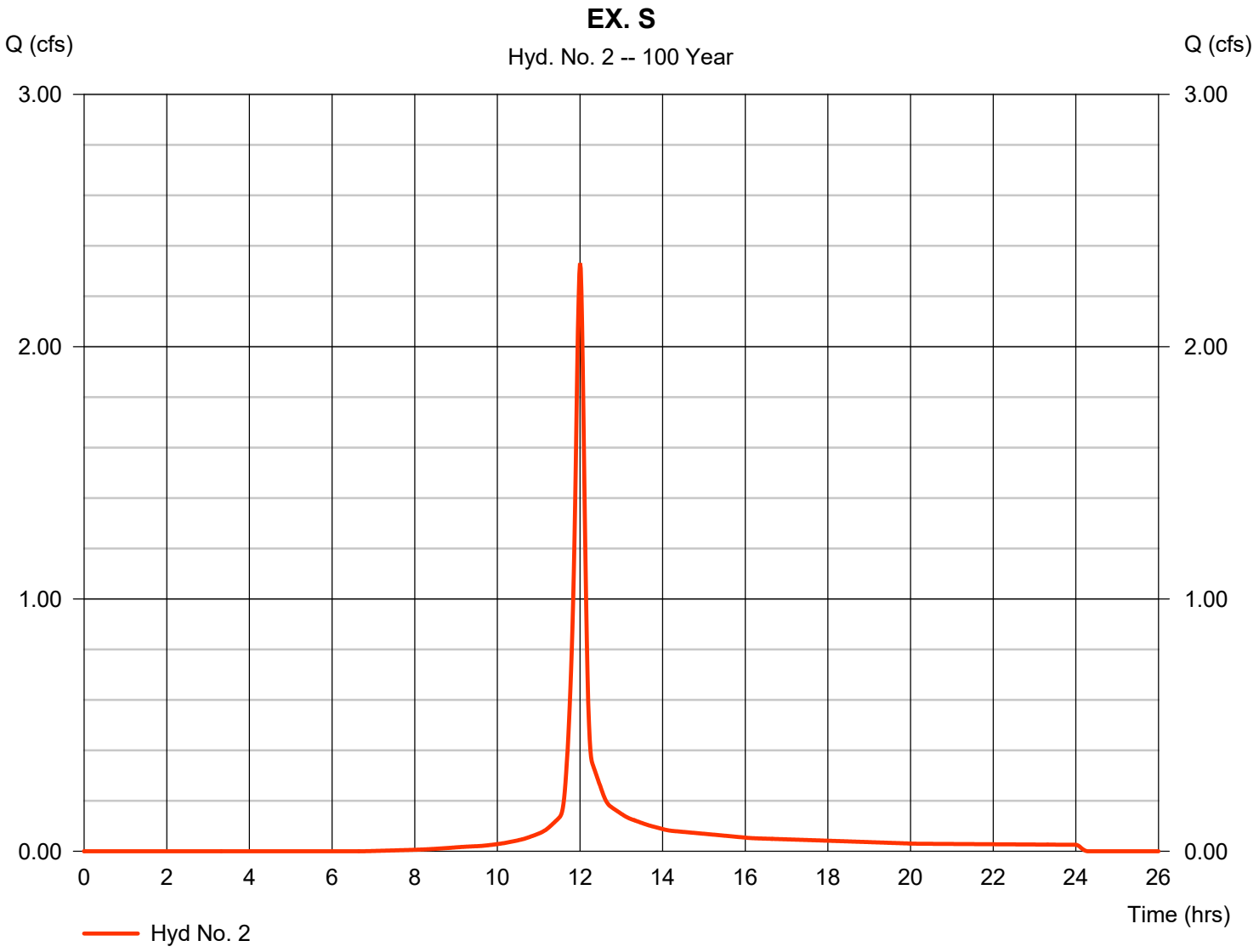


Hydrograph Report

Hyd. No. 2

EX. S

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.331 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.00 hrs
Time interval	=	1 min	Hyd. volume	=	5,680 cuft
Drainage area	=	0.330 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	10.40 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

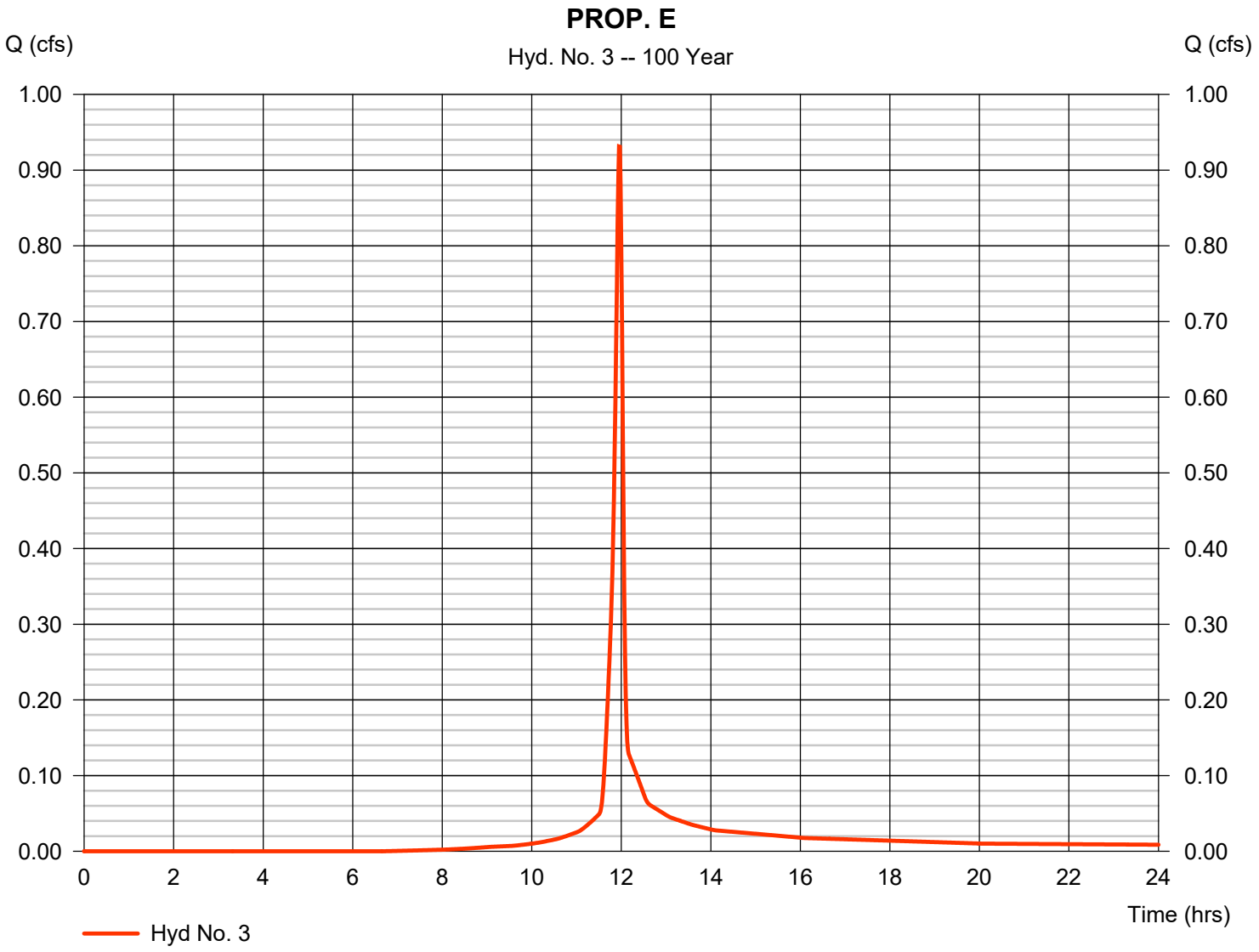


Hydrograph Report

Hyd. No. 3

PROP. E

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.931 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.95 hrs
Time interval	=	1 min	Hyd. volume	=	1,918 cuft
Drainage area	=	0.110 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.90 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

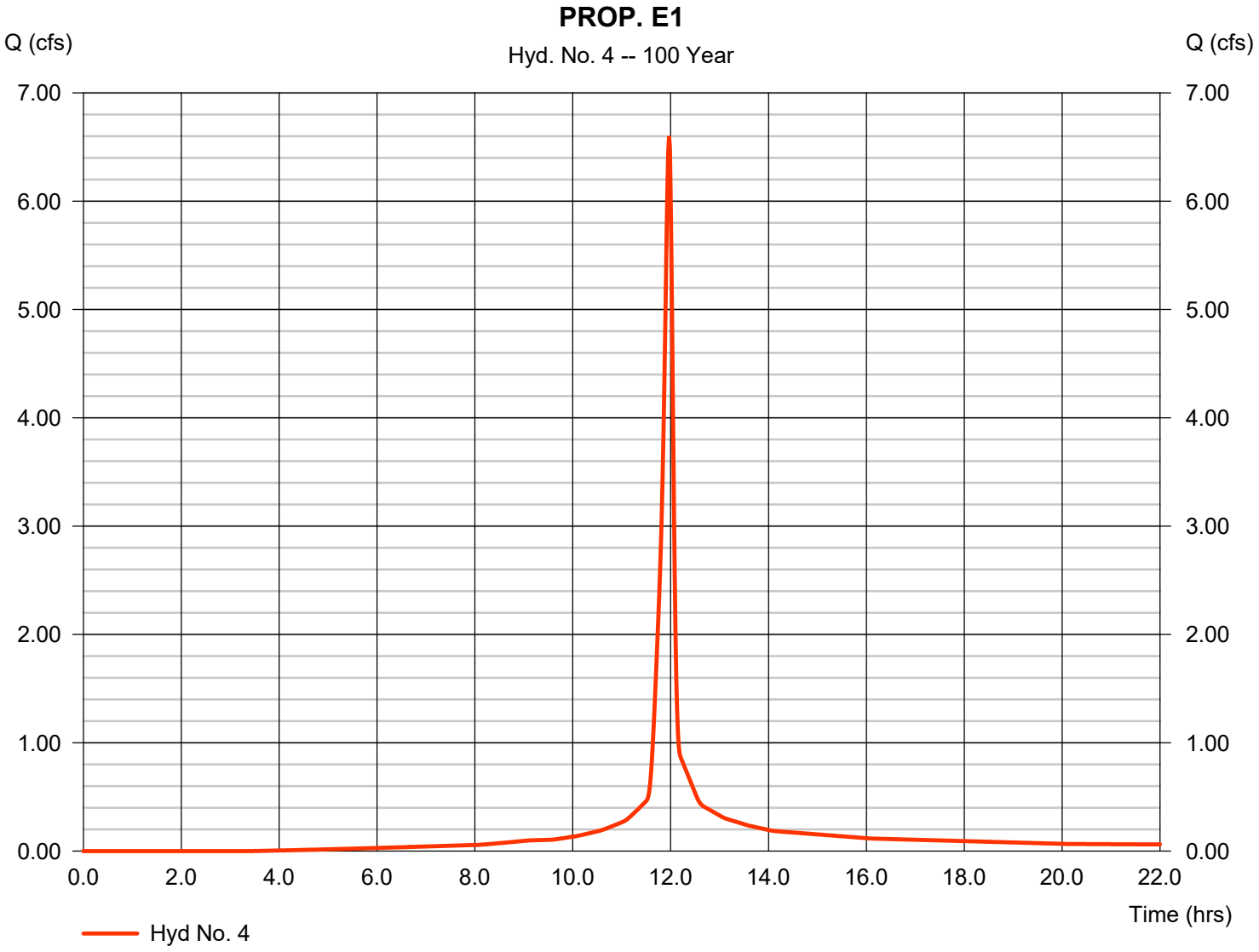


Hydrograph Report

Hyd. No. 4

PROP. E1

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.601 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	15,038 cuft
Drainage area	=	0.690 ac	Curve number	=	87
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	8.10 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

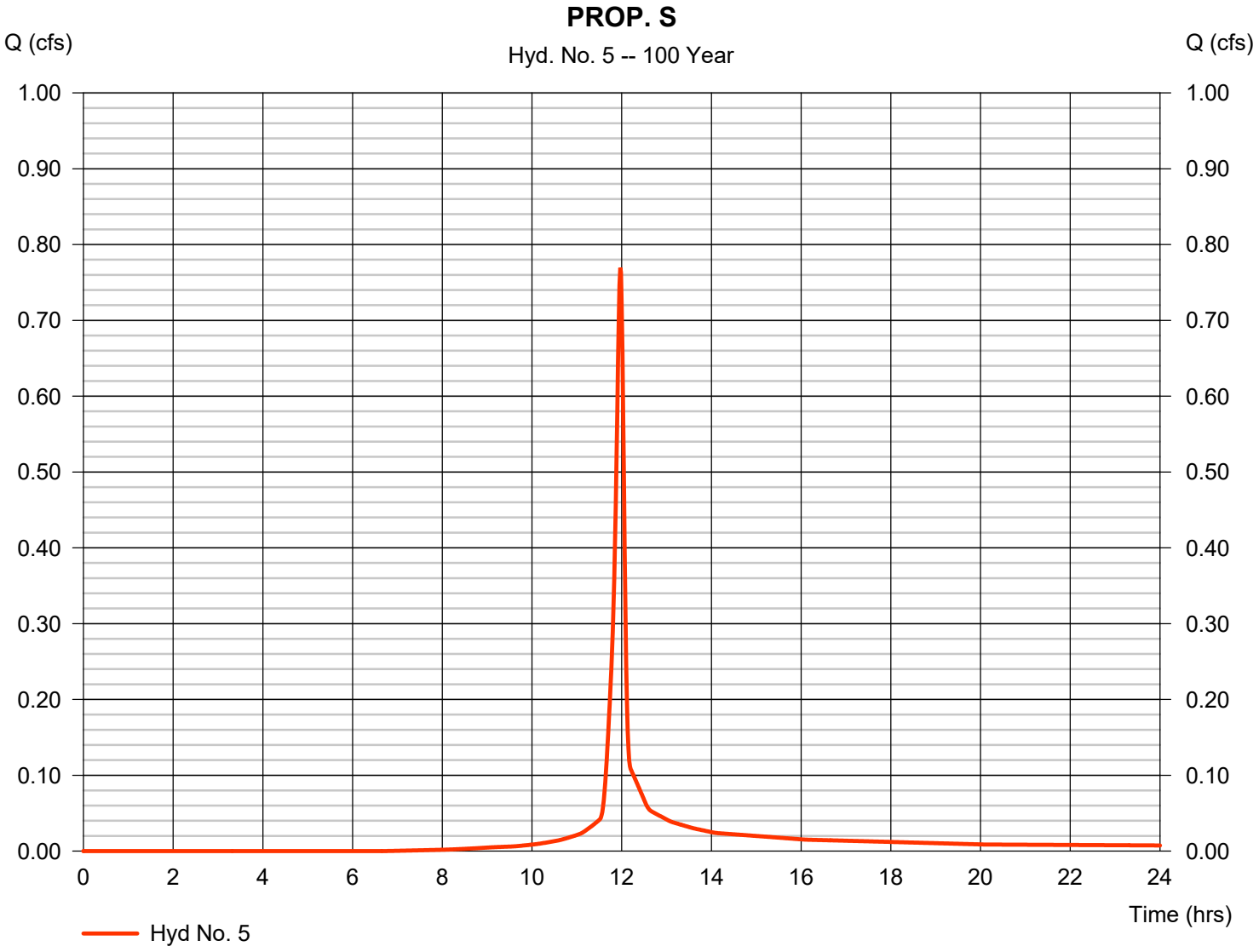


Hydrograph Report

Hyd. No. 5

PROP. S

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.769 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	1,649 cuft
Drainage area	=	0.100 ac	Curve number	=	74
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



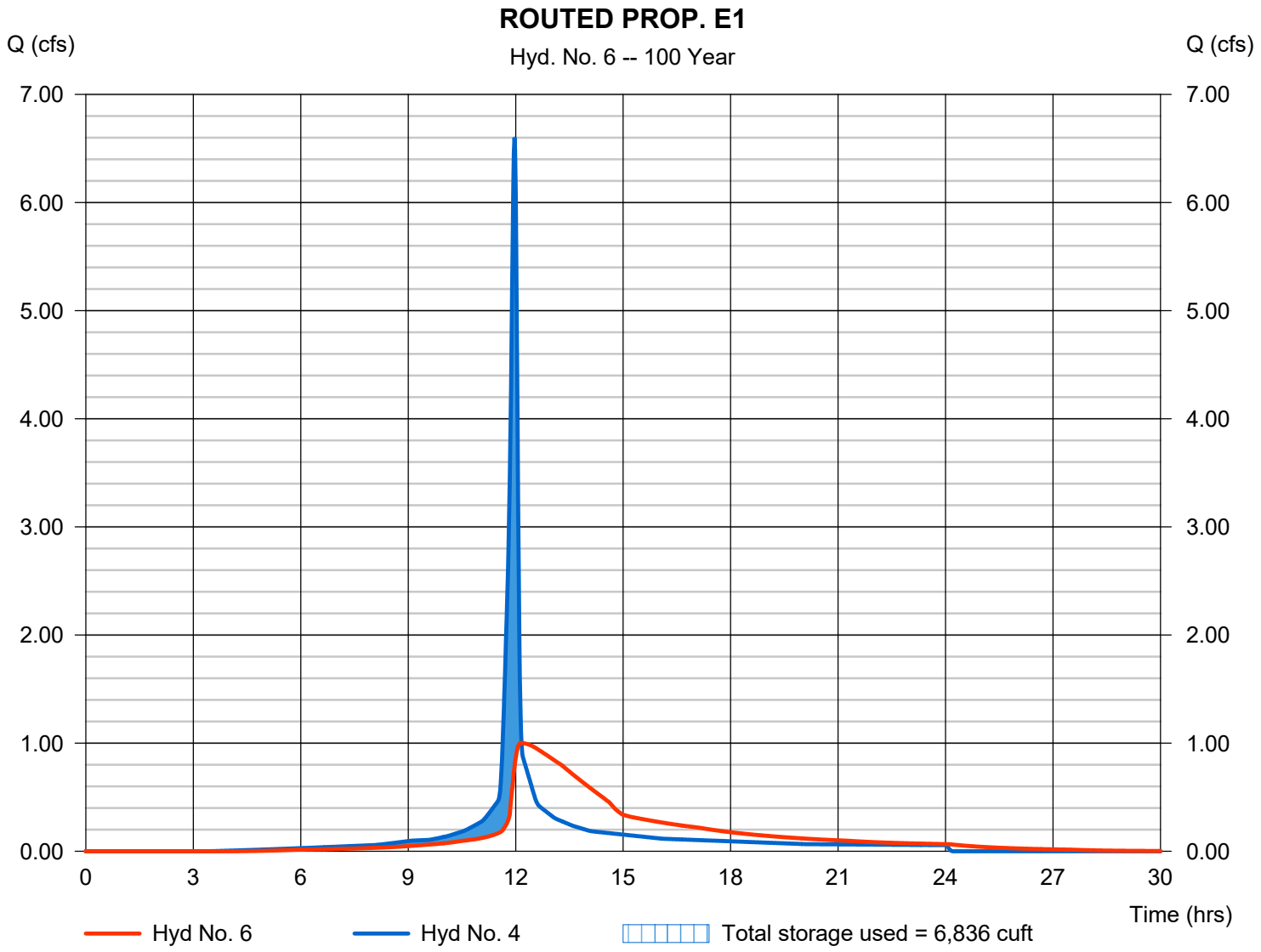
Hydrograph Report

Hyd. No. 6

ROUTED PROP. E1

Hydrograph type	=	Reservoir	Peak discharge	=	1.002 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.17 hrs
Time interval	=	1 min	Hyd. volume	=	15,025 cuft
Inflow hyd. No.	=	4 - PROP. E1	Max. Elevation	=	1029.73 ft
Reservoir name	=	Basin E1	Max. Storage	=	6,836 cuft

Storage Indication method used.

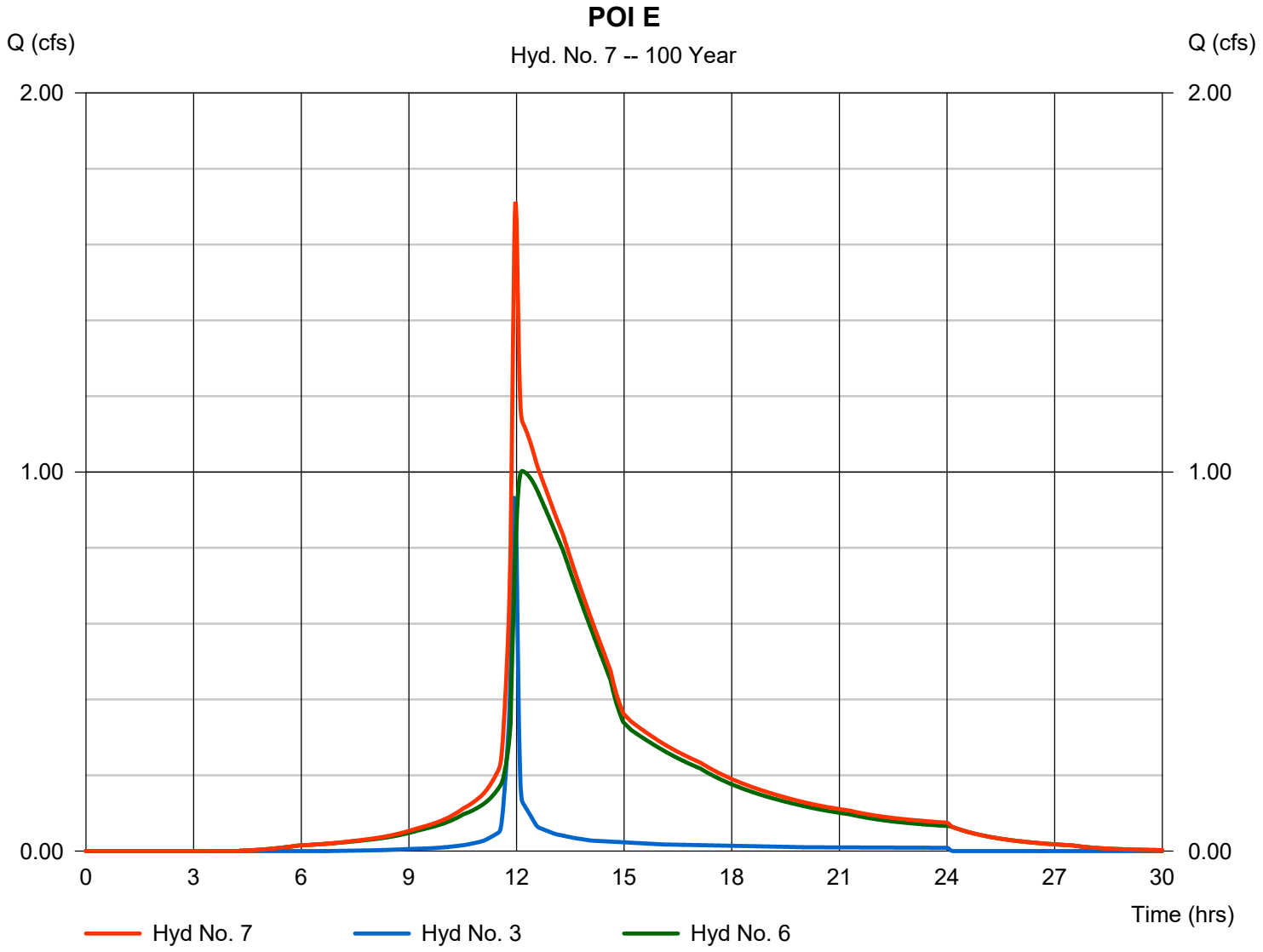


Hydrograph Report

Hyd. No. 7

POI E

Hydrograph type	= Combine	Peak discharge	= 1.713 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.97 hrs
Time interval	= 1 min	Hyd. volume	= 16,943 cuft
Inflow hyds.	= 3, 6	Contrib. drain. area	= 0.110 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	3.50	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	3.25	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 F

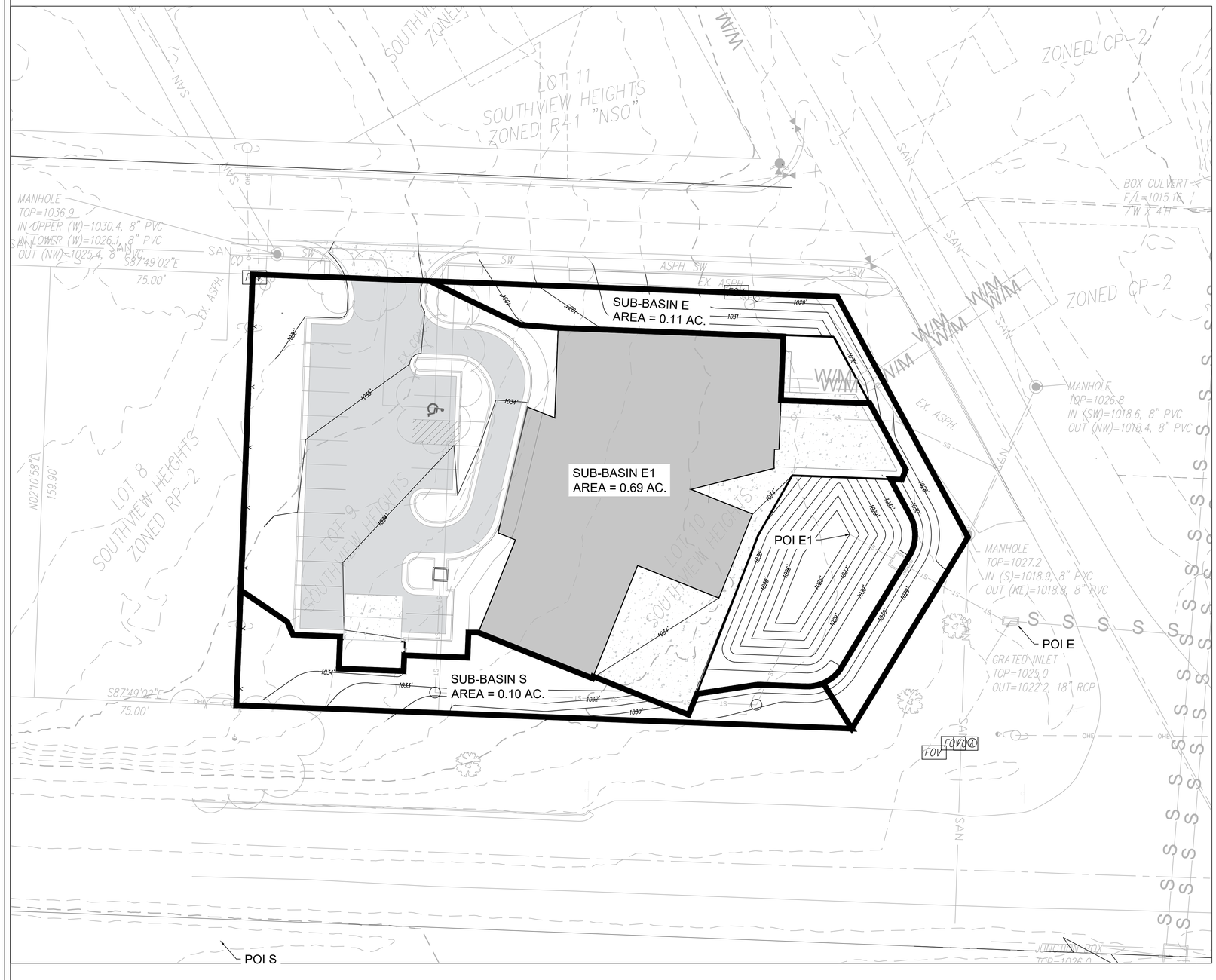
Post-Development Drainage Area Map

North

0 10' 20' 40'

PROPOSED DRAINAGE MAP

SCALE: 1" = 20'



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Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

902 SE Douglas St
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: Pro Dev Youth Cntr
Issue Date: December 6, 2023

Proposed Drainage Map
Preliminary Plans for:
Lot 9 & 10, Southview Heights
Lee's Summit, Jackson County, Missouri

STATE OF MISSOURI
MATTHEW J. SCHLICHT
NUMBER PE-2006019708
PROFESSIONAL ENGINEER

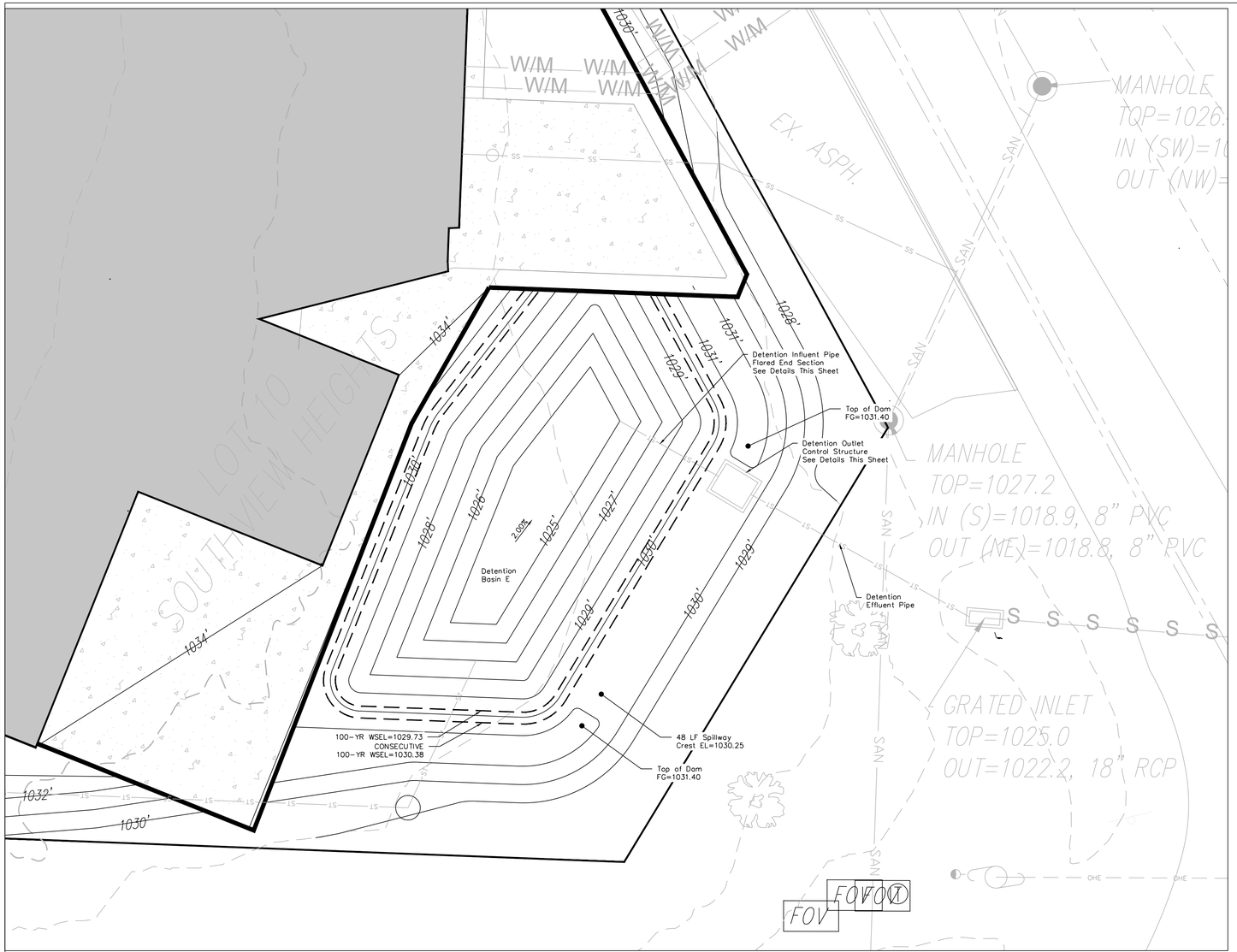
Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226

REVISIONS

EXHIBIT

Exhibit G

Detention Basin Plan



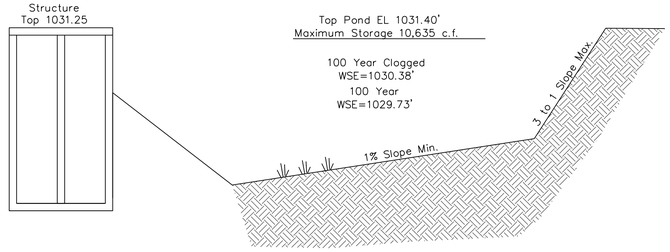
North

0 5' 10' 20'

DETENTION BASIN PLAN

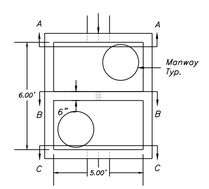
SCALE: 1" = 10'

NOTES:
1. THE BASIN SHALL BE CONSTRUCTED WITH EROSION AND SEDIMENT CONTROL MEASURES.
2. AN AS-BUILT DETENTION BASIN PLAN SHALL BE SUBMITTED AND ACCEPTED PRIOR TO ISSUANCE OF A CERTIFICATE OF SUBSTANTIAL COMPLETION, WITH AS-BUILT VERSUS PROPOSED STORAGE.

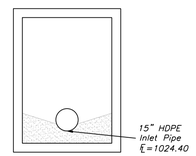


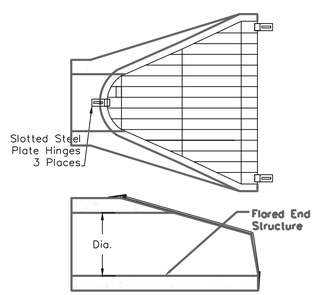
SECTION VIEW – BASIN E1

N.T.S.

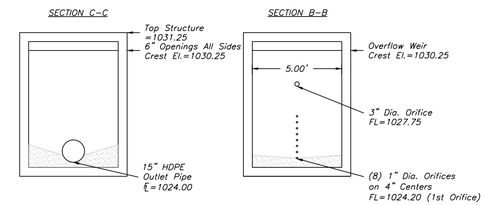


SECTION A-A





Galvanized
Trash Guard
For Influent Flared Ends
(Both Basins)



CONTROL STRUCTURE – BASIN E1

1/4" = 1'-0"

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LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: Pre Dev Youth Cntr
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Detention Basin Plan
Preliminary Plans for:
Lot 9 & 10, Southview Heights
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STATE OF MISSOURI
MATTHEW J. SCHLICHT
NUMBER
PE-2006019708
PROFESSIONAL ENGINEER

Matthew J. Schlicht
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OK PE 25226

REVISIONS

EXHIBIT

Exhibit H

Water Quality Volume Calculations

Calculate Water Quality for Storm Study

Project: PRO DEO

Date: 12-08-23

To Calculate: WQv = P * Rv * A

P (in) =	1.37
P (ft) =	0.11
Impervious Area (sq. ft.) =	13,825.94
Total Area (sq. ft.) =	30,056.40
Impervious Area (ac) =	0.46
Total Area (acre) =	0.69
Rv = (0.05 * 0.009(I)) =	0.51
Percent Impervious (I) =	51.00
WQ_v (cu. ft.) =	1,747
WQ_v (ac. ft.) =	0.040

Enter data in these Fields

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

CCN = 87

Pond Volume

Elevation	Area (Sq. Ft.)	Volume (Cu. Ft.)
1,024.00	-	-
1,025.00	407.00	203.50
1,026.00	760.00	787.00
1,027.00	1,188.00	1,761.00
1,028.00	1,682.00	3,196.00
1,029.00	2,211.00	5,142.50
1,030.00	2,768.00	7,632.00
1,031.00	3,482.00	10,757.00

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) =	0.69
Step 2) Calculate WQ_v using Sec. 6 (ac-ft) =	WQ_v (ac. ft.)=	0.040
Step 3) Add 20 Percent to Step 2.	V_{design} (ac-ft) =	0.048

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 =	1026.00	Storage 1 =	787.00
Elevation X =		Storage X =	1,746.60
Elevation 2 =	1027.00	Storage 2 =	1,761.00

Elevation X = 1026.99

Lowest Elevation of Pond =	1024.60
Elevation X =	1026.99
Z_{WQ} (ft) =	2.39

IIc. Water Quality Outlet, Perforated Riser

Step 1) Depth at outlet above lowest perforation:	Z_{WQ} (ft) =	2.39
Step 2) Recommended maximum outlet area per row:	A_0 (in^2) =	0.080
Step 3) Circular perforation diameter per row assuming a single column:	D_1 (in) =	0.120
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

Exhibit I

Emergency Spillway Calculations

Weir Report

Emergency Spillway - Broad Crested Earthen Weir

Rectangular Weir

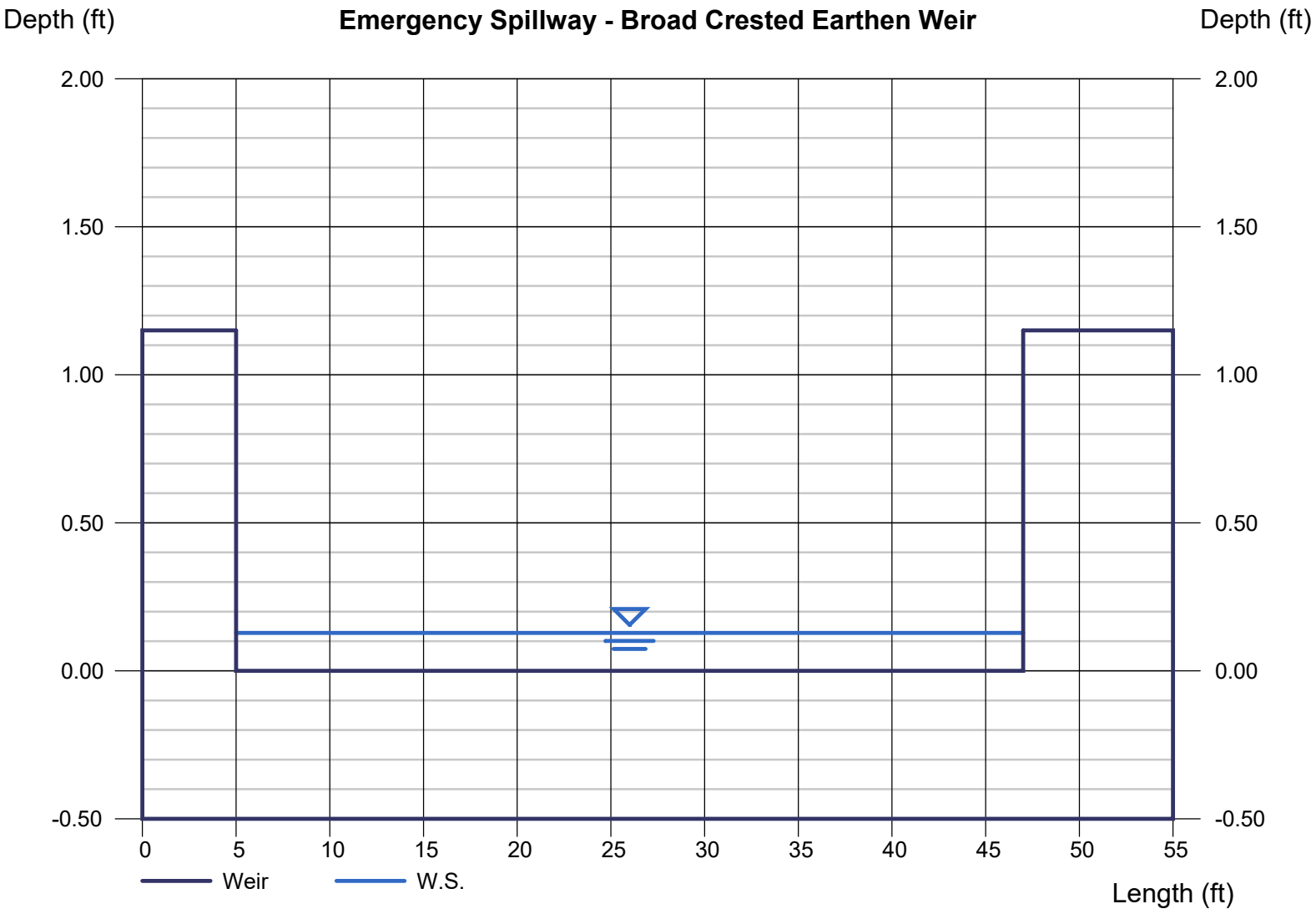
Crest	= Broad
Bottom Length (ft)	= 42.00
Total Depth (ft)	= 1.15

Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Known Q
Known Q (cfs)	= 5.00

Highlighted

Depth (ft)	= 0.13
Q (cfs)	= 5.000
Area (sqft)	= 5.37
Velocity (ft/s)	= 0.93
Top Width (ft)	= 42.00



Weir Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 7 2023

Emergency Spillway - Control Structure Rectangular Weir

Rectangular Weir

Crest	= Sharp
Bottom Length (ft)	= 10.50
Total Depth (ft)	= 0.50

Calculations

Weir Coeff. Cw	= 3.33
Compute by:	Known Q
Known Q (cfs)	= 1.60

Highlighted

Depth (ft)	= 0.13
Q (cfs)	= 1.600
Area (sqft)	= 1.34
Velocity (ft/s)	= 1.19
Top Width (ft)	= 10.50