MACRO STORM WATER DRAINAGE STUDY

Oldham Village

SW Quadrant SW Oldham Parkway & MO 291 South

Site Acreage: 49.68 Acres (Future Buildout)

Lee's Summit, MO

PREPARED BY:

ENGINEERING SOLUTIONS
ENGINEERING & SURVEYING
50 S.E. 30th Street Lee's Summit, MO 64082
816.623.9888 • engineeringsolutionskc.com

Prepared On: May 22, 2024

STATE OF MISSOURI
MATTHEW J. SCHLICHT
NUMBER
PROFESSIONAL ENGINEER

Matthew J. Schlicht, PE
5/22/2024

Revision

Date	Comment	By

TABLE OF CONTENTS

3. GENERAL INFORMATION

The macro storm study has been prepared to evaluate potential negative downstream hydraulic impacts and propose potential mitigation measures associated with the redevelopment of the proposed Planned Mixed Use Development, Oldham Village. The proposed redevelopment will consist of three multi-family communities in addition to multiple commercial establishments. The site is located at the southwest corner of SW Oldham Parkway and MO 291 Highway. The proposed master development contains 45.41 acres with future potential up to 49.68 acres. The existing site is developed and contains primarily hard surface. An existing earthen detention basin is located on the southwest corner of the site. The detention basin drains into the upper most reach of Cedar Creek. The site consists of land located in Section 7, Township 47 North, and Range 31 West. See Exhibit A for an aerial view of the site along with a historical aerial of the site and surrounding area. A proposed site plan is also included in Exhibit A.

3.1 FEMA FLOODPLAIN DETERMINATION

The property is located in an Area of Minimal Flood Hazard, Zone X, according to FEMA Firm Map Number 29095C0419G, effective January 20, 2017.

See Exhibit B for a FEMA 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 24, August 31, 2022. The existing site contains three major soil types:

10082	Arisburg-Urban Land Complex, 1 to 5 Percent Slopes Hydrologic Soils Group (HSG): Type C
10181	Udarents-Urban Land-Sampsel Complex, 5 to 9 Percent Slopes (HSG): Type C
99033	Udarents-Urban Land 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 redevelopment and recommend improvements to eliminate any potential negative impacts. The study utilized existing contours to create the Existing 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, existing and proposed 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 consists of one (1) drainage basin. The basin includes a substantial amount of offsite area to the north, south and east. The basin drains to Point of Interest A located approximately 260 feet west of the sites western property boundary. POI A is the termination point for the FEMA FIS on Cedar Creek. The tributary area to the

POI is 147.45+/- acres. The basin consists of 49.68 acres of proposed master development which includes potential future parcels and 97.77 acres of right-of-way and offsite area. The drainage basin has been essentially built out in the past and therefore currently has both open and enclosed storm sewer systems active throughout the basin. The basin generally drains to Cedar Creek located along the west central portion of the property. The basin is fairly symmetric with nearly equal portions draining from the north, east and south. The existing onsite detention basin area (Tract B) adjacent to Cedar Creek will continue to serve as detention for the proposed redevelopment.

An Existing Drainage Map may be found in Exhibit D. 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 E. 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	147.45	88	28.8

Table 5.2 Existing Conditions Runoff Data: Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	303.47	508.68	809.50

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

The allowable offsite contribution was determined by the area ratio method. The allowable offsite peak discharge is the product of the ratio of offsite area to onsite area multiplied by a given storms existing peak discharge rate. The allowable peak discharge rate is the sum of the offsite allowable plus the onsite allowable per APWA Section 5608.4. See allowable 100-year peak discharge rate calculation below.

Example (100-YR): [(97.77 / 147.45 x 809.50) + (49.68 x 3.0)] = 685.80 cfs

Table 5.3 Existing Conditions APWA Allowable Peak Discharge Release Rates

POI	Onsite Area (ac.)	Offsite Area (ac.)	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	49.68	97.77	226.06	436.65	685.80

There are a few very minor subareas that are peripheral (free release) areas on the site consisting primarily of turf with no hard infrastructure improvements. These areas are not being negatively impacted by the proposed improvements. Subarea A will be the focus of this report.

6. PROPOSED CONDITIONS ANALYSIS

The proposed conditions analysis will include potential future Oldham Village lots located along MO 291 Highway south of SW Oldham Parkway. The proposed onsite area including potential future lots is 49.68 acres. Tributary runoff will be conveyed via both open and enclosed storm sewer systems to POI "A". A new retention system shall be constructed to attenuate post development runoff from Subarea A1 which includes a large

percentage of right-of-way and offsite area. Detained peak discharge rates from Subarea A1 will be combined with peak discharge rates from Subarea A to determine the overall peak discharge rates at POI "A". The proposed peak discharge rates will be compared to allowable discharge rates to determine if they meet or exceed the City's Comprehensive Control Storm Water Management criteria. The Proposed Drainage Map may be found in Exhibit F.

Proposed Flow Rates

Existing Subarea A has been divided into two subareas to account for proposed retention. Subarea A1 is located generally in the north and accounts for all proposed and potential future improvements for Oldham Marketplace. Subarea 1 will drain via open and enclosed storm sewer systems to a new earthen retention basin located adjacent to Cedar Creek on a parcel of property labeled Tract B. The remainder of the property which will not be detained is generally located in the southern portion of the basin and will be referred to as Subarea B. The composite curve numbers utilized for Subareas A and B consist of the following classifications and land usage specific curve numbers; right-of-way and single family residential 82, multi-family residential 88 and commercial 94.

Table 6.1 Proposed Conditions Subarea Data

Subarea	Area (ac.)	Composite CN	Tc (min)
A1	128.42	88	28.8
A	19.02	82	15.7

Table 6.2 Proposed Conditions Runoff Data: Subarea Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A1	264.31	443.03	705.02
A	43.70	79.44	133.37
Combined (A1 + A)	294.69	498.80	799.42

As shown in Table 6.2 above Subarea A1 will require detention to attenuate storm runoff peak discharge rates at or below regulatory levels at POI A.

6.1. DETENTION

A new single stage earthen retention basin A is being proposed in Subarea A1 to attenuate proposed peak discharge rates. Following are a list of design parameters for the retention system.

Designation: Retention Basin A
Type: Earthen Basin
Side Slopes: 3:1 Max. (Above Normal Pool)
Side Slopes: 2:1 Max. (Below Normal Pool)
Bottom Slope: N/A
Basin Bottom Elevation: 970.00
Basin Top Berm Elevation: 1001.20
Basin Volume: 1,079,459 cf @ 1000.00 to normal pool 992.00
Control Structure: (3) 8'x6' Precast Concrete Box with Interior 6" Baffle/Weir Wall
Baffle Wall Orifices: (1) 6.75"x6.75" Rectangular Orifice (WQv Orifice)
Weir Wall Crest Elevation: 993.33
Control Structure Top Elevation: 998.00
Control Structure Overflow Weir Openings: N/A – NO Field Inlet Openings

Control Structure Influent Pipe: 60" HDPE, FL (In) = 992.00, FL (Out) = 991.90, L=11.5', S= 0.87%
Control Structure Effluent Pipe: 60" HDPE, FL (In) = 991.70, FL (Out) = 991.50, L=40.0', S=0.50%
Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=999.10, Crest Length=240'
Consecutive 100-YR Q=705.02 cfs, Emergency Spillway HGL=1000.18, Freeboard=1.02'
Normal Pool Elevation: 992.00
Pond Bottom: 970.00 – 22' of water volume includes required siltation allowance

The Detention Basin Plan for the Development may be found in Exhibit G. Basin A1 emergency spillway calculations may be found in Exhibit H. See Table 6.3 for a summary of detention basin data.

Table 6.3 Proposed Conditions Detention Basin A1 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	264.31	731	124.48	750	995.40	414,283
10-Year	443.03	731	245.50	747	997.18	657,596
100-Year	705.02	731	467.58	744	998.60	864,603

As shown in the table above all proposed peak discharge rates from Subarea A1 have been attenuated. See Table 6.4 below for a summary of proposed peak discharge rates at POI "A" which consists of combined subareas post detained A1 and A.

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

Point of Interest	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	131.07	257.60	490.05

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

Table 6.5 below provides a comparison of runoff data between Proposed, Existing and Allowable Conditions for the Proposed Development.

Table 6.5 Point of Interest Discharge Comparison

POI	Condition	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	Proposed	131.07	257.60	490.05
	Existing	303.47	508.68	809.50
	Difference	-172.40	-251.08	-319.45
	Allowable	226.06	436.65	685.80
	Difference	-94.99	-179.05	-195.75

All proposed peak discharge rates as shown in Table 6.5 will be significantly below allowable.

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 facility will release the water quality event over a period of 40-72 hours. See Exhibit I for 40 hour extended detention calculations for the basin.

8. CONCLUSIONS & RECOMMENDATIONS

Runoff from the Development will be reduced below both existing and allowable for the Subarea. A retention basin is being proposed in Subarea A1 to attenuate peak discharge rates. Retention Basin A1 will attenuate all proposed peak discharge rates below both Existing and Allowable. It is the opinion of the Engineer that the proposed storm water management improvements outlined in the report will mitigate any negative hydraulic impacts onsite and downstream and therefore recommends approval of said improvements and the storm study.

9. EXHIBITS

- **Exhibit A**
  - **Aerial View of Site**
  - **Historical Aerial View of Site & Surrounding Area**
  - **Overall Site Plan**
- **Exhibit B**
  - **FEMA FIRMette**
- **Exhibit C**
  - **NRCS Soils Report**
- **Exhibit D**
  - **Existing Drainage Area Map**
- **Exhibit E**
  - **Hydraflow Hydrograph Report**
- **Exhibit F**
  - **Proposed Drainage Area Map**
- **Exhibit G**
  - **Detention Plan**
- **Exhibit H**
  - **Emergency Spillway Calculations**
- **Exhibit I**
  - **40 Hour Extended Detention Calculations**

Exhibit A

Aerial View of Site

&

Aerial View of Surrounding Area

&

Overall Site Plan

5/2023

SW Oldham Pkwy

SW Allendale Blvd

SW Stratford Rd

Oldham Pkwy

Oldham Pkwy

SE Blue Pkwy

50

50

50

50

SW Jefferson St

291

SW Persels Rd

SW Persels Rd

Image © 2023 Airbus

SE Bailey Rd

SE Brownlee St

1158 ft

8/2007

SW Oldham Pkwy

SE Blue Pkwy

SW Allendale Blvd

SW Stratford Rd

Oldham Pkwy

Oldham Pkwy

SW Walnut St

SW Jefferson St

SW Persels Rd

SW Persels Rd

Image USDA/FPAC/GEO

SE Bailey Rd

SE Browning St

1158 ft

50

50

50

291

OLDHAM VILLAGE PHASE 2

Preliminary Development Plan

Section 7, Township 47 North, Range 31 West

LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

PROPERTY DESCRIPTION

Llot 1, Adesa Lots 1, 2 and 3 (ex pt taken for row)

and

Lots 1 and 2, Leland's Commercial Park, a subdivision in Lee's Summit, Jackson County, Missouri.

and

Tract 1, Metro Estates, a subdivision in Lee's Summit, Jackson County, Missouri, according to the recorded plat thereof.

and

Part of Lots 11 and 12, Clearview Acres, a subdivision in Lee's Summit, Jackson County, Missouri

Site Impervious Area

Total Area	*45.41 acres (1,978,094.49 sq. ft.)*	
Right of Way	*3.83 acres (166,754.98 sf)*	

Proposed Site

Lot	Area (Ac)	Building Area / Residential Units	FAR / Density	Use
11	2.43	11,370 sf	%	
12	1.21	3,762 sf		Commercial Drive Thru
13	0.97	3,762 sf		Commercial Drive Thru
14	1.16	5,172 sf	%	Commercial Drive Thru
16	1.53	4,533 sf	%	
17	1.24	5,025		

Street	*148,600*	*sq. ft.*
Parking Lot	*668,031*	*sq. ft.*
Buildings	*242,620*	*sq. ft.*

Impervious Area *1,059,251 sq. ft (54% of Site)*

Common Areas

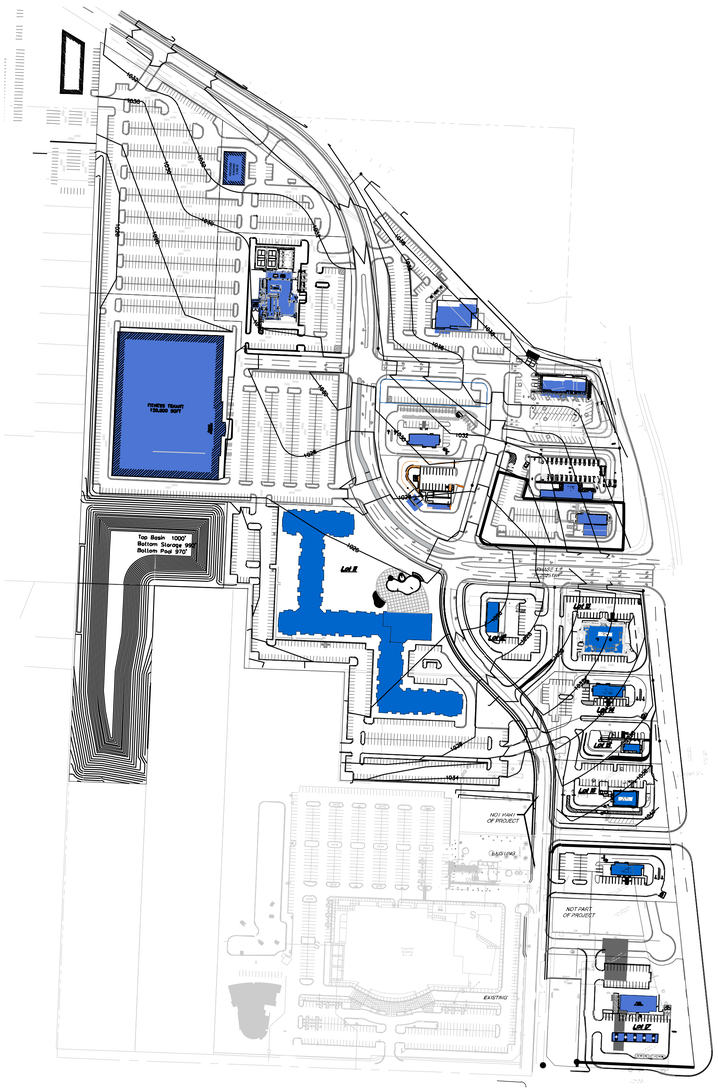
Tract A 5.10 acres (sf) Retention Area

Parking:

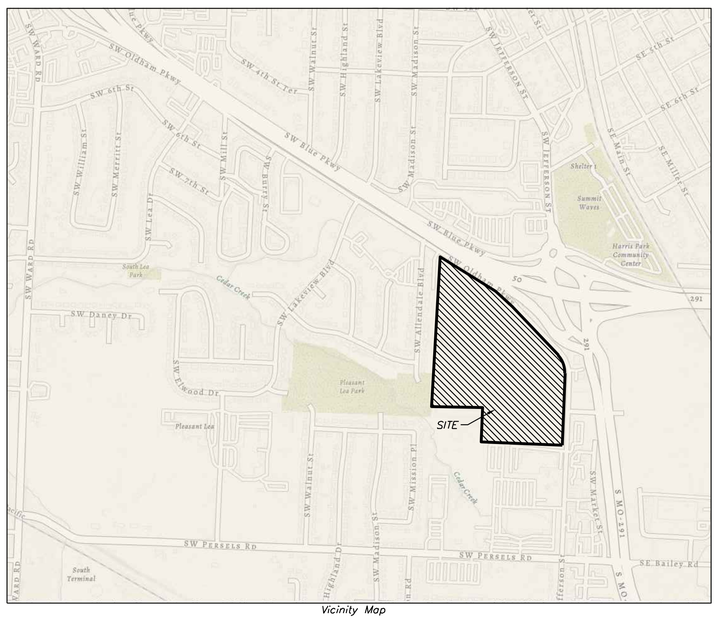
Proposed Site

Lot	Building Area / Residential Units	Parking Provided	Parking Ratio
11	11,370 sf	38	3.34 Spaces / 1,000 sf
12	3,762 sf	53	14.09 Spaces / 1,000 sf
13	3,762 sf	51	13.56 Spaces / 1,000 sf
14	5,172 sf	32	6.19 Spaces / 1,000 sf
16	4,533 sf	33	7.28 Spaces / 1,000 sf
17	5,025 sf	4	0.80 Spaces / 1,000 sf

Current Zoning: PMIX - Planned Mixed Use
Proposed Zoning: PMIX - Planned Mixed Use



North



Vicinity Map

North

0 100' 200' 400'

Preliminary Development Plan

SCALE: 1" = 200'

INDEX OF SHEETS:

Site Improvement Notes

Sanitary Sewer Improvements
–The site will utilize the existing sanitary sewer on the east side of SE M 291 HWY.

Water Main Improvements
–The existing 16" water main located on the east side of SE M 291 HWY.

Storm Sewer
–Enclosed pipe systems and inlets will collected and convey the onsite storm water runoff and direct it toward the existing public storm sewer system.

Storm Water Detention
–The site will utilize onsite storm detention

Common Area
–HOA will be responsible for all maintenance

LEGEND:

Existing Underground Power	UGP
Existing Conc. Curb & Gutter	
Existing Wood Fence	X
Existing Gas Main	GAS
Existing Water Main	X-W/M
Existing Storm Sewer	X-STM
Existing Sanitary Sewer	X-SAN
Existing Underground Telephone	UGT
Existing Overhead Power	OHE
Proposed Storm Sewer	ST
Proposed Sanitary Sewer	SS
Proposed Underground Power	UGT
Proposed Gas Service	GAS
Proposed 8" D.I.P. Water	W
Proposed Electrical Service	UGP

ALL PAVING ON THE PARKING LOT WILL COMPLY WITH THE UNIFIED DEVELOPMENT ORDINANCE ARTICLE 8 IN TERMS OF PAVING THICKNESS AND BASE

OIL - GAS WELLS
ACCORDING TO EDWARD ALTON MAY JR'S ENVIRONMENTAL IMPACT STUDY OF ABANDONED OIL AND GAS WELLS IN LEE'S SUMMIT, MISSOURI IN 1995, THERE ARE NOT OIL AND GAS WELLS WITHIN 185 FEET OF THE PROPERTY AS SURVEYED HEREON.

SURVEY AND PLAT NOTES:
THE SUBJECT PROPERTY SURVEYED LIES WITHIN A FLOOD ZONE DESIGNATED ZONE (X), AREAS LOCATED OUTSIDE THE 100 YEAR FLOOD PLAIN, PER F.E.M.A. MAP, COMMUNITY PANEL NO. 29095C0419G EFFECTIVE DATE: JANUARY 20, 2017.

UTILITY COMPANIES:

THE FOLLOWING LIST OF UTILITY COMPANIES IS PROVIDED FOR INFORMATION ONLY. WE DO NOT OFFER ANY GUARANTEE OR WARRANTY THAT THIS LIST IS COMPLETE OR ACCURATE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING ALL UTILITY COMPANIES THAT MAY BE AFFECTED BY THE PROPOSED CONSTRUCTION AND VERIFYING THE ACTUAL LOCATION OF EACH UTILITY LINE. THE CONTRACTOR SHALL NOTIFY ENGINEERING SOLUTIONS AT 816.623.9888 OF ANY CONFLICT WITH PROPOSED IMPROVEMENTS.

EVERGY ~ 298-1196
MISSOURI GAS ENERGY ~ 756-5261
SOUTHWESTERN BELL TELEPHONE ~ 761-5011
COMCAST CABLE ~ 795-1100
WILLIAMS PIPELINE ~ 422-6300
CITY OF LEE'S SUMMIT PUBLIC WORKS ~ 969-1800
CITY OF LEE'S SUMMIT PUBLIC WORKS INSPECTIONS ~ 969-1800
CITY OF LEE'S SUMMIT WATER UTILITIES ~ 969-1900
MISSOURI ONE CALL (DIG RITE) ~ 1-800-344-7483

GENERAL NOTES:

1 ~ ALL CONSTRUCTION SHALL CONFORM TO THE CITY OF LEE'S SUMMIT DESIGN AND CONSTRUCTION MANUAL AS ADOPTED BY ORDINANCE 5813.
2 ~ ALL REQUIRED EASEMENTS WITHIN THE BOUNDARY OF THIS PROJECT SHALL BE PROVIDED BY SEPARATE DOCUMENT
3 ~ ANY REQUIRED EASEMENT LOCATED OUTSIDE OF THE BOUNDARY OF THIS PROJECT SHALL BE PROVIDED FOR BY SEPARATE INSTRUMENT PRIOR TO ISSUANCE OF CONSTRUCTION PERMITS.
4 ~ THE CONTRACTOR SHALL CONTACT THE CITY'S DEVELOPMENT SERVICES ENGINEERING INSPECTORS 48 HOURS PRIOR TO ANY LAND DISTURBANCE WORK AT (816) 969-1200.
5 ~ THE CONTRACTOR SHALL NOTIFY ENGINEERING SOLUTIONS AT 816.623.9888 OF ANY CONFLICT WITH THE IMPROVEMENTS PROPOSED BY THESE PLANS AND SITE CONDITIONS.
6 ~ THE CONTRACTOR SHALL NOTIFY THE CITY ENGINEER AND OBTAIN THE APPROPRIATE BLASTING PERMITS FOR A REQUIRED BLASTING. IF BLASTING IS ALLOWED, ALL BLASTING SHALL CONFORM TO STATE REGULATIONS AND LOCAL ORDINANCES.

ENGINEERING SOLUTIONS
ENGINEERING & SURVEYING
50 SE 30TH STREET
LEE'S SUMMIT, MO 64082
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Professional Registration
Missouri
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Surveying 2005008319-D
Kansas
Engineering E-1886
Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2621

Oldham Village
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: OLDHAM VILLAGE
Issue Date: April 12, 2024

PRELIMINARY DEVELOPMENT PLAN
Phase 2 Preliminary Development Plans for:
Oldham Village
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

STATE OF MISSOURI
MATTHEW J. SCHICHT
NUMBER PE-2006019708
PROFESSIONAL ENGINEER
10-30-2024

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

REVISIONS

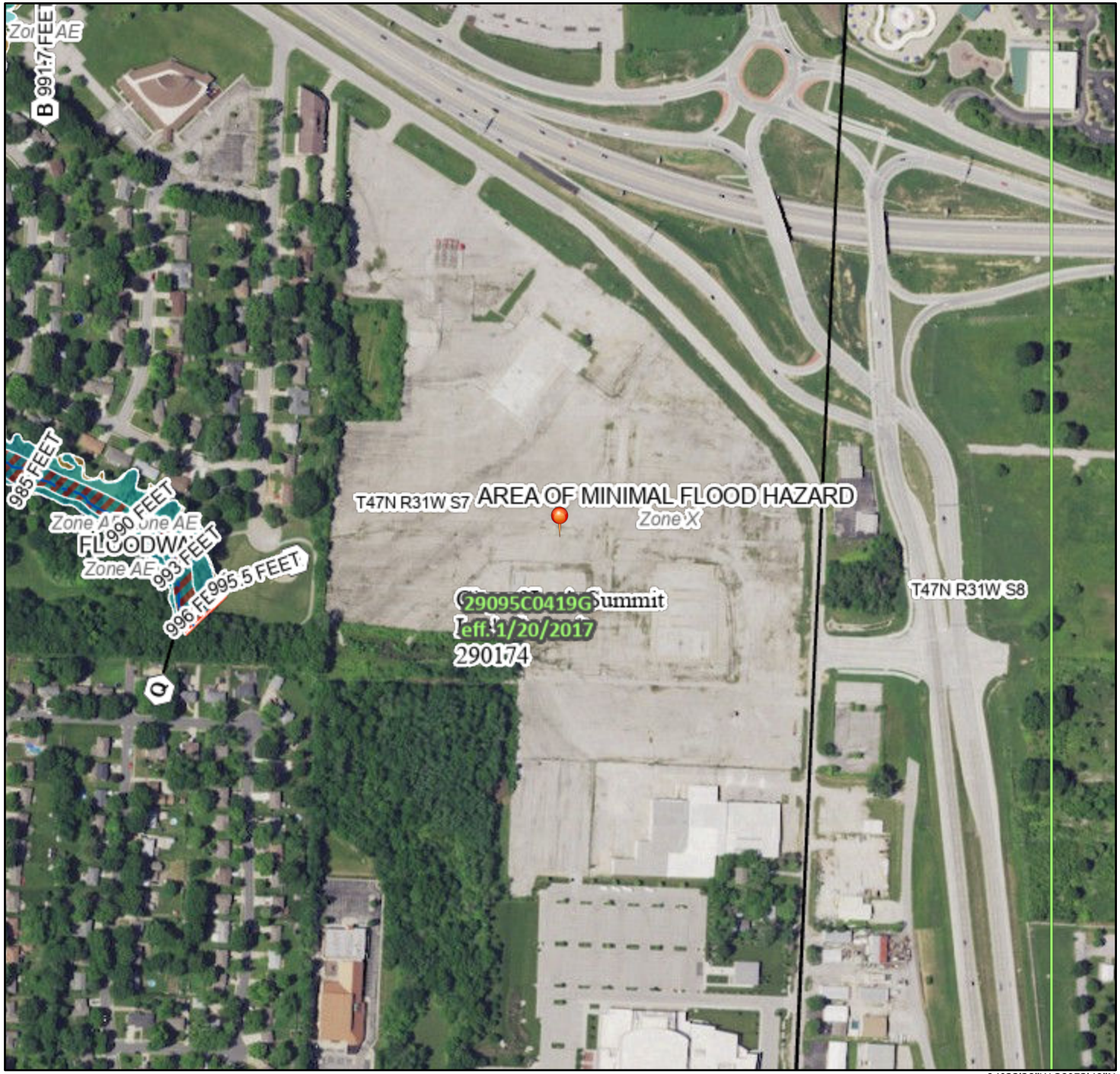
C.100

Exhibit B

FEMA FIRMette

National Flood Hazard Layer FIRMette

94°23'5"W 38°54'17"N



94°22'28"W 38°53'49"N

Feet 1:6,000

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

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 Cross Sections with 1% Annual Chance
- 17.5 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 6/9/2023 at 12:56 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

Oldham Marketplace

June 9, 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: 1:3,200 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 45 90 180 270

Feet
0 150 300 600 900

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 24, Aug 31, 2022

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	2.1	5.8%
10181	Udarents-Urban land-Sampsel complex, 5 to 9 percent slopes	10.2	28.2%
99033	Udarents-Urban land complex, 2 to 9 percent slopes	23.8	65.9%
Totals for Area of Interest		**36.1**	**100.0%**

Map Unit Descriptions

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

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

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

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

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

10181—Udarents-Urban land-Sampsel complex, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 1n85g
Elevation: 600 to 900 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: 46 percent
Urban land: 39 percent
Sampsel and similar soils: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udarents

Setting

Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
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
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
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: R107XB002MO - Deep Loess Upland Prairie
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Across-slope shape: Convex

Interpretive groups

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

Description of Sampsel

Setting

Landform: Hillslopes

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Convex
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
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
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: 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: R109XY010MO - Interbedded Sedimentary Upland Savanna
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

99033—Udarents-Urban land complex, 2 to 9 percent slopes

Map Unit Setting

National map unit symbol: 1n85n
Elevation: 710 to 1,470 feet
Mean annual precipitation: 31 to 47 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 170 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Udarents and similar soils: 50 percent
Urban land: 45 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udarents

Setting

Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, 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: 2 to 9 percent
Depth to restrictive feature: More than 80 inches
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
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform position (two-dimensional): Backslope
Across-slope shape: Convex

Interpretive groups

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

Minor Components

Knox

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R107XB003MO - Deep Loess Exposed Backslope Savanna, F107XB004MO - Deep Loess Protected Backslope Woodland
Hydric soil rating: No

Sibley

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

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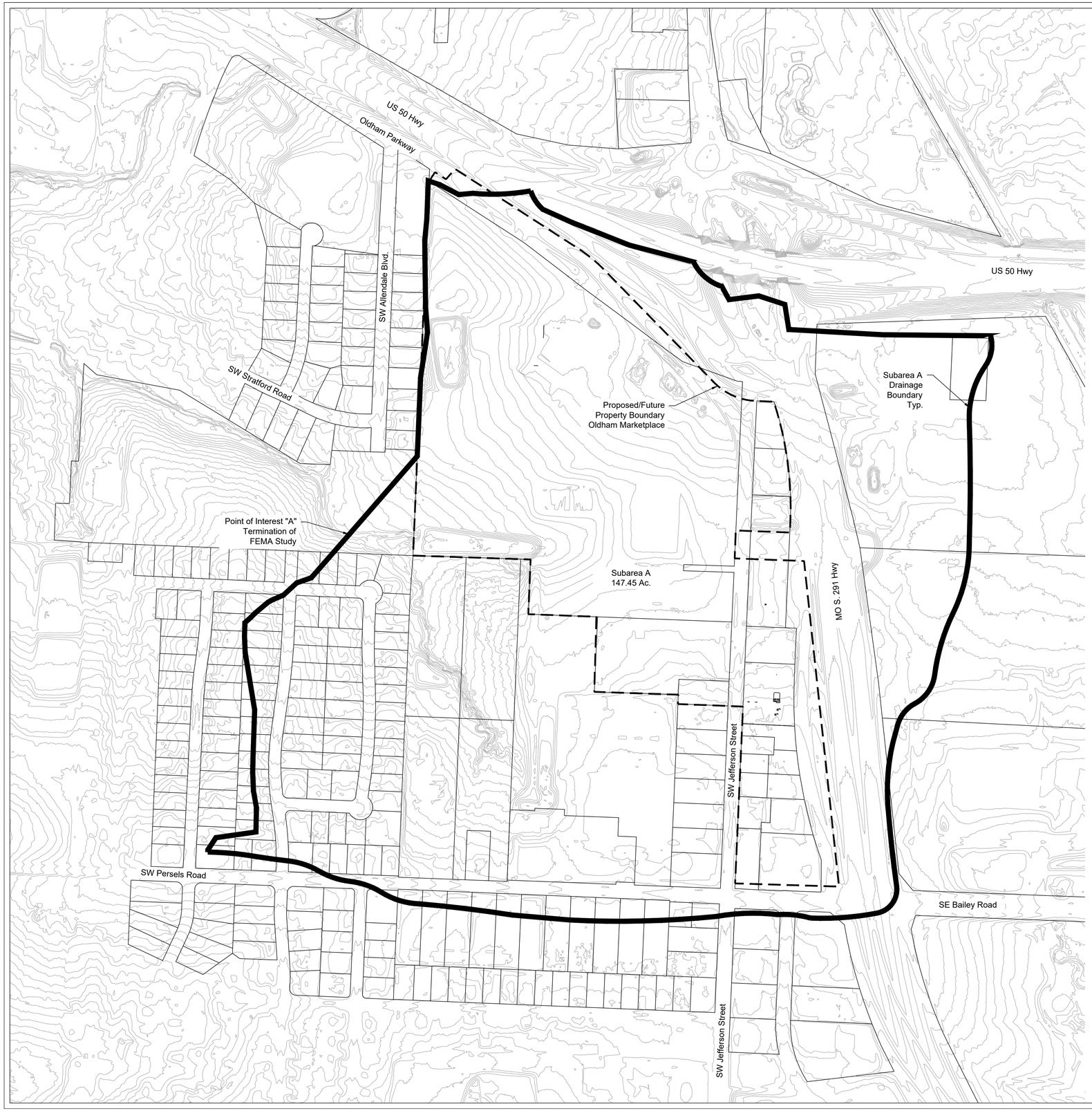
Exhibit D

Existing Drainage Area Map



North

0 100' 200' 400'

EXISTING DRAINAGE MAP

SCALE: 1" = 200'

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Nebraska
Engineering CA2821

Oldham Marketplace
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: Oldham Marketplace
Issue Date: October 20, 2022

EXISTING DRAINAGE MAP
Conceptual Drainage Plan for:
Oldham Marketplace
Lee's Summit, Jackson County, Missouri

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

REVISIONS

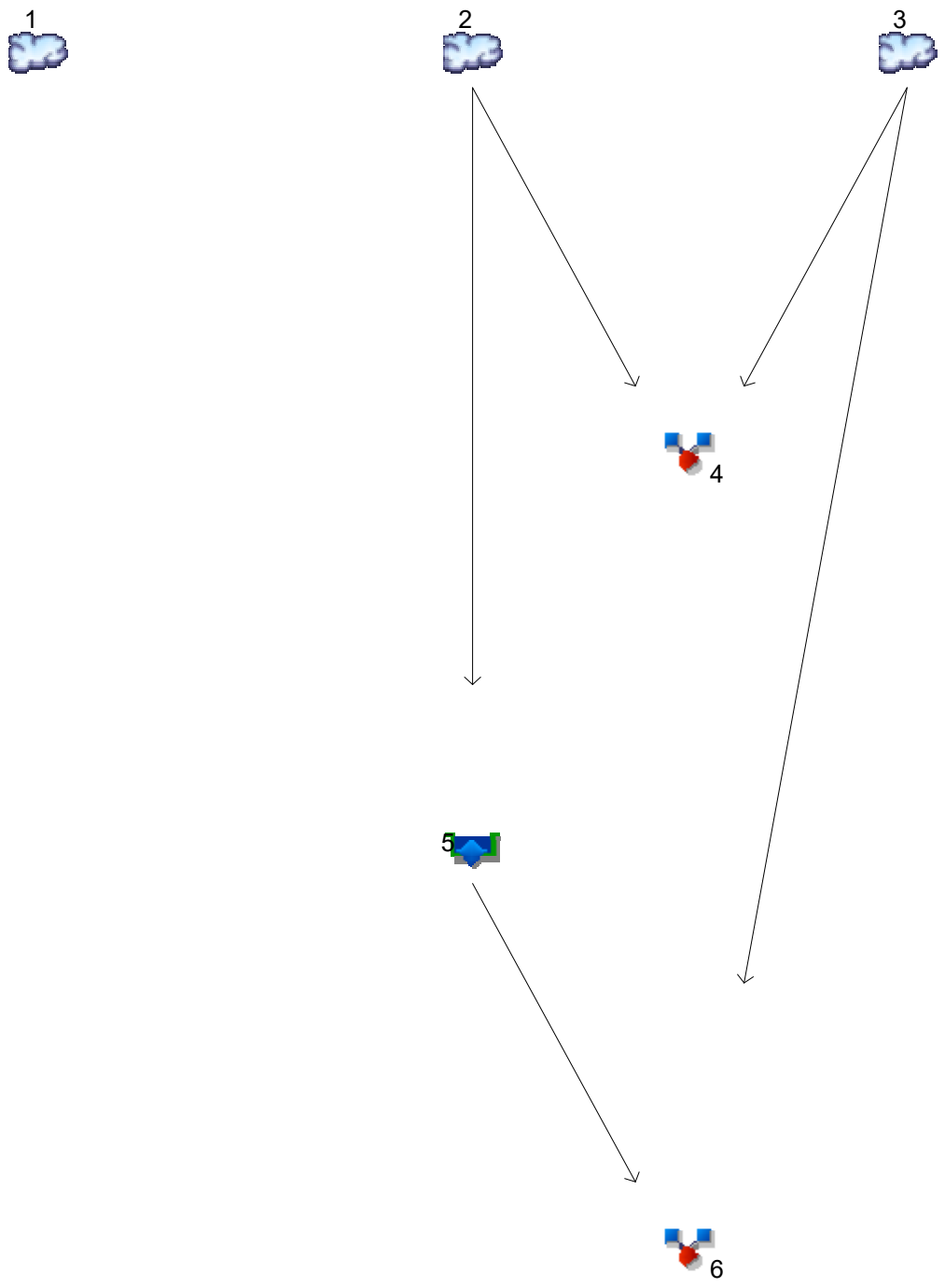
EXHIBIT

Exhibit E

Hydraflow Hydrograph Report

Hydraflow Table of Contents

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	EX POI A
2	SCS Runoff	PROP POI A1
3	SCS Runoff	PROP SUBAREA A
4	Combine	COMBINED (A1+A)
5	Reservoir	DETAINED SUBAREA A1
6	Combine	PROP POI A

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	------	-------	303.47	-------	-------	508.68	-------	-------	809.50	EX POI A
2	SCS Runoff	------	-------	264.31	-------	-------	443.03	-------	-------	705.02	PROP POI A1
3	SCS Runoff	------	-------	43.70	-------	-------	79.44	-------	-------	133.37	PROP SUBAREA A
4	Combine	2, 3	-------	294.69	-------	-------	498.80	-------	-------	799.42	COMBINED (A1+A)
5	Reservoir	2	-------	124.48	-------	-------	245.50	-------	-------	467.58	DETAINED SUBAREA A1
6	Combine	3, 5	-------	131.07	-------	-------	257.60	-------	-------	490.05	PROP POI A

Hydrograph Summary Report

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

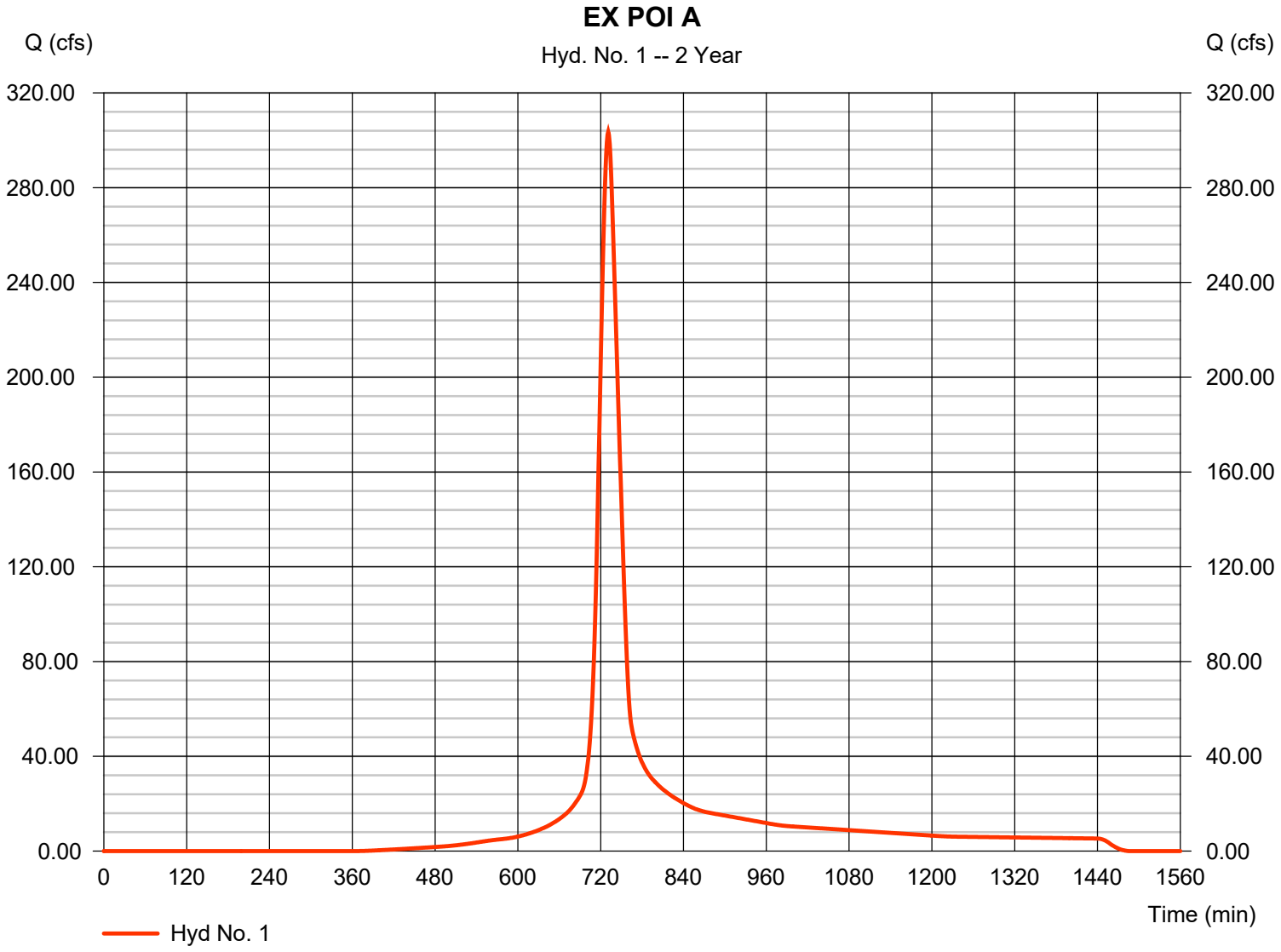
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	303.47	1	731	1,214,296	------	------	------	EX POI A
2	SCS Runoff	264.31	1	731	1,057,578	------	------	------	PROP POI A1
3	SCS Runoff	43.70	1	723	124,615	------	------	------	PROP SUBAREA A
4	Combine	294.69	1	730	1,182,192	2, 3	------	------	COMBINED (A1+A)
5	Reservoir	124.48	1	750	999,862	2	995.40	414,283	DETAINED SUBAREA A1
6	Combine	131.07	1	749	1,124,477	3, 5	------	------	PROP POI A

Hydrograph Report

Hyd. No. 1

EX POI A

Hydrograph type	=	SCS Runoff	Peak discharge	=	303.47 cfs
Storm frequency	=	2 yrs	Time to peak	=	731 min
Time interval	=	1 min	Hyd. volume	=	1,214,296 cuft
Drainage area	=	147.450 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	28.80 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

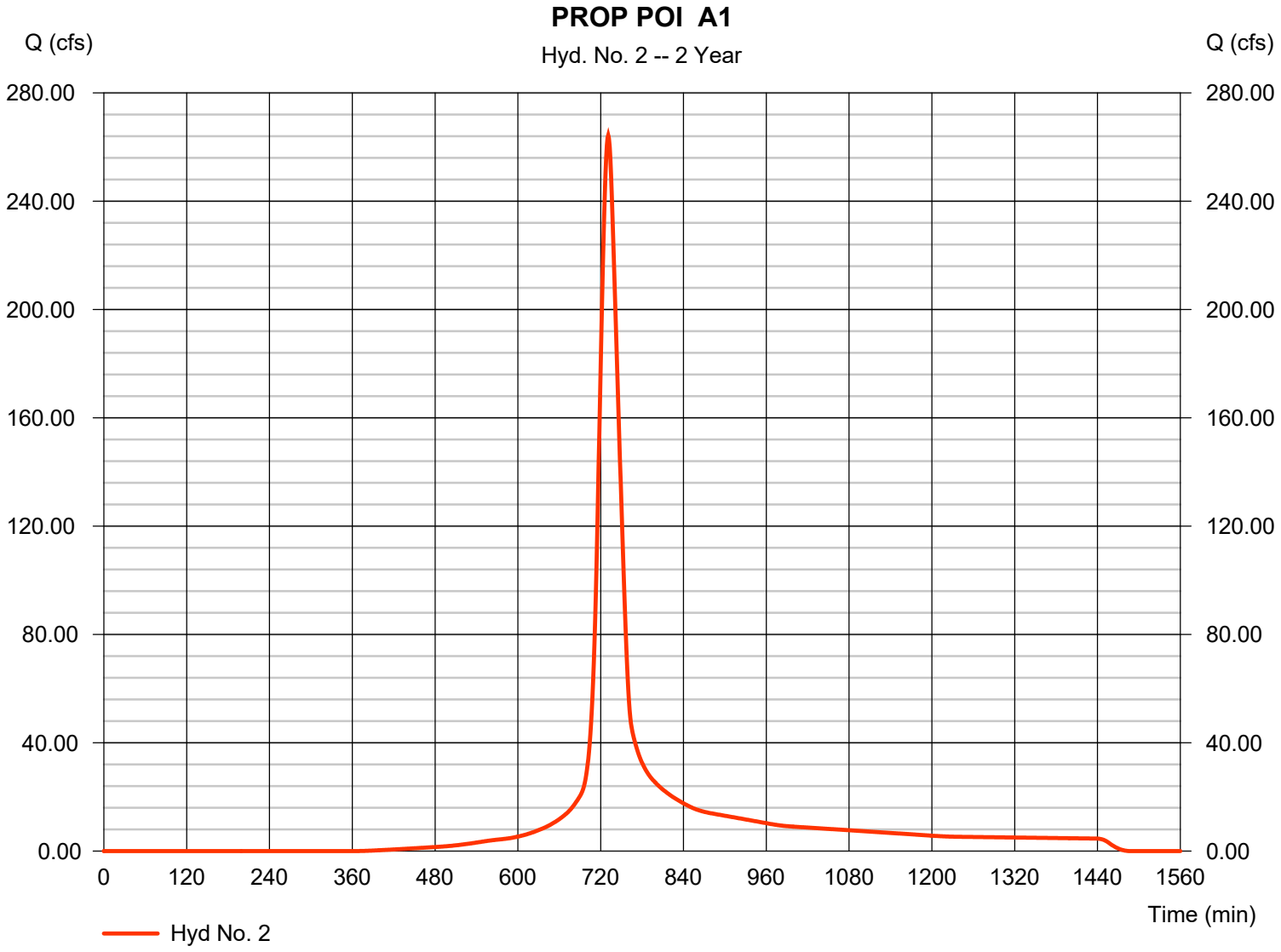


Hydrograph Report

Hyd. No. 2

PROP POI A1

Hydrograph type	=	SCS Runoff	Peak discharge	=	264.31 cfs
Storm frequency	=	2 yrs	Time to peak	=	731 min
Time interval	=	1 min	Hyd. volume	=	1,057,578 cuft
Drainage area	=	128.420 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	28.80 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

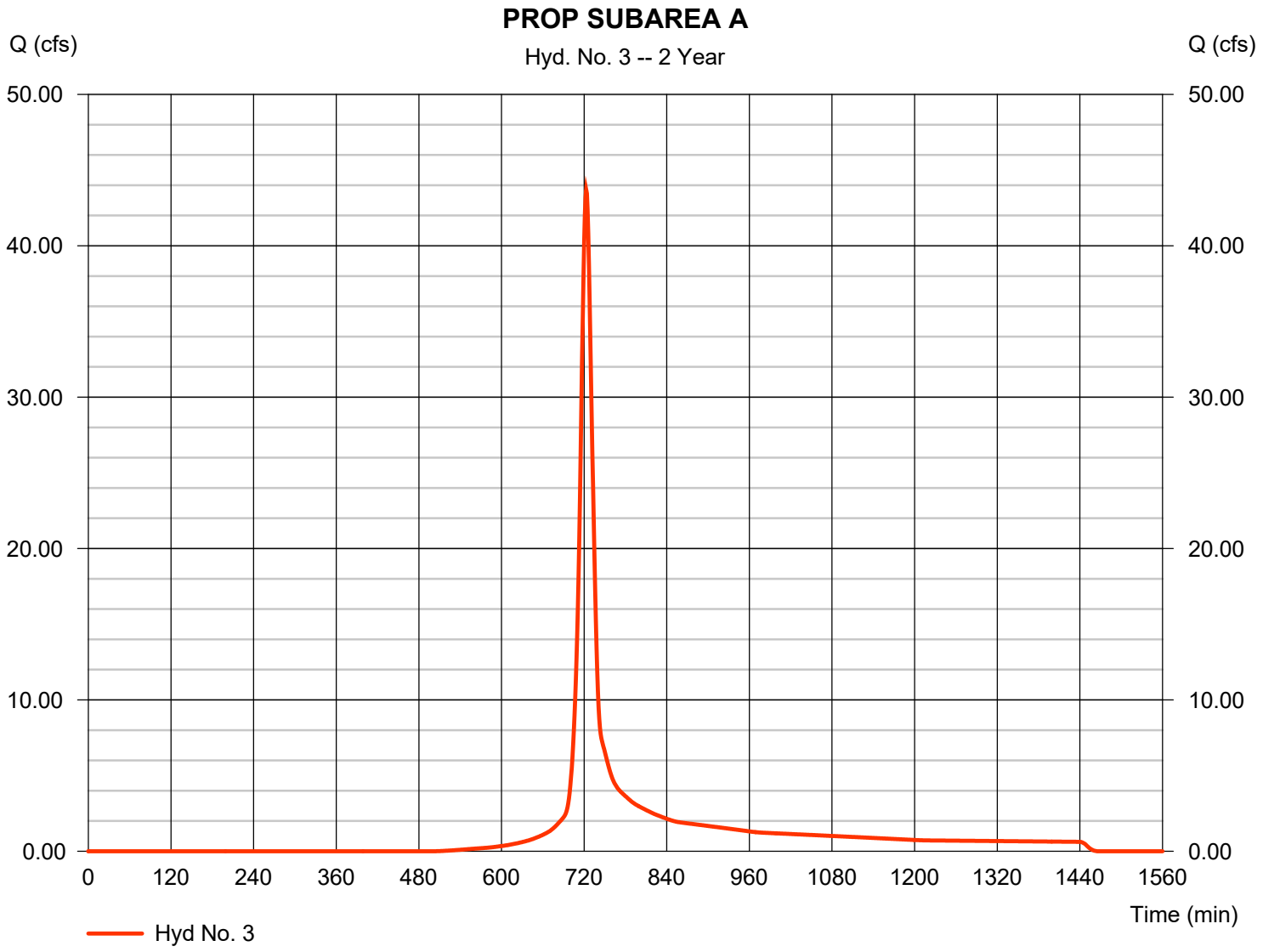


Hydrograph Report

Hyd. No. 3

PROP SUBAREA A

Hydrograph type	= SCS Runoff	Peak discharge	= 43.70 cfs
Storm frequency	= 2 yrs	Time to peak	= 723 min
Time interval	= 1 min	Hyd. volume	= 124,615 cuft
Drainage area	= 19.020 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.70 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

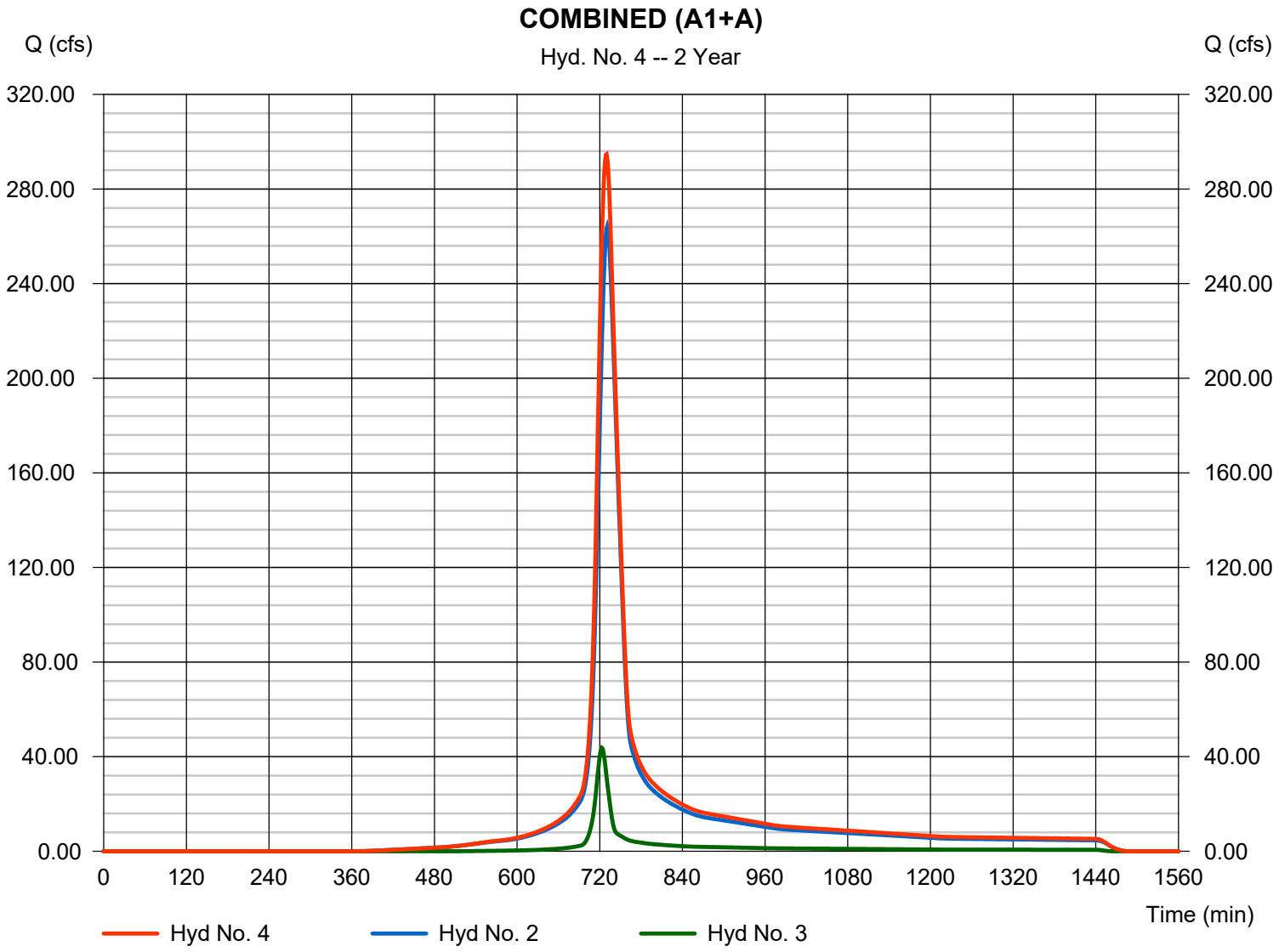


Hydrograph Report

Hyd. No. 4

COMBINED (A1+A)

Hydrograph type	=	Combine	Peak discharge	=	294.69 cfs
Storm frequency	=	2 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	1,182,192 cuft
Inflow hyds.	=	2, 3	Contrib. drain. area	=	147.440 ac



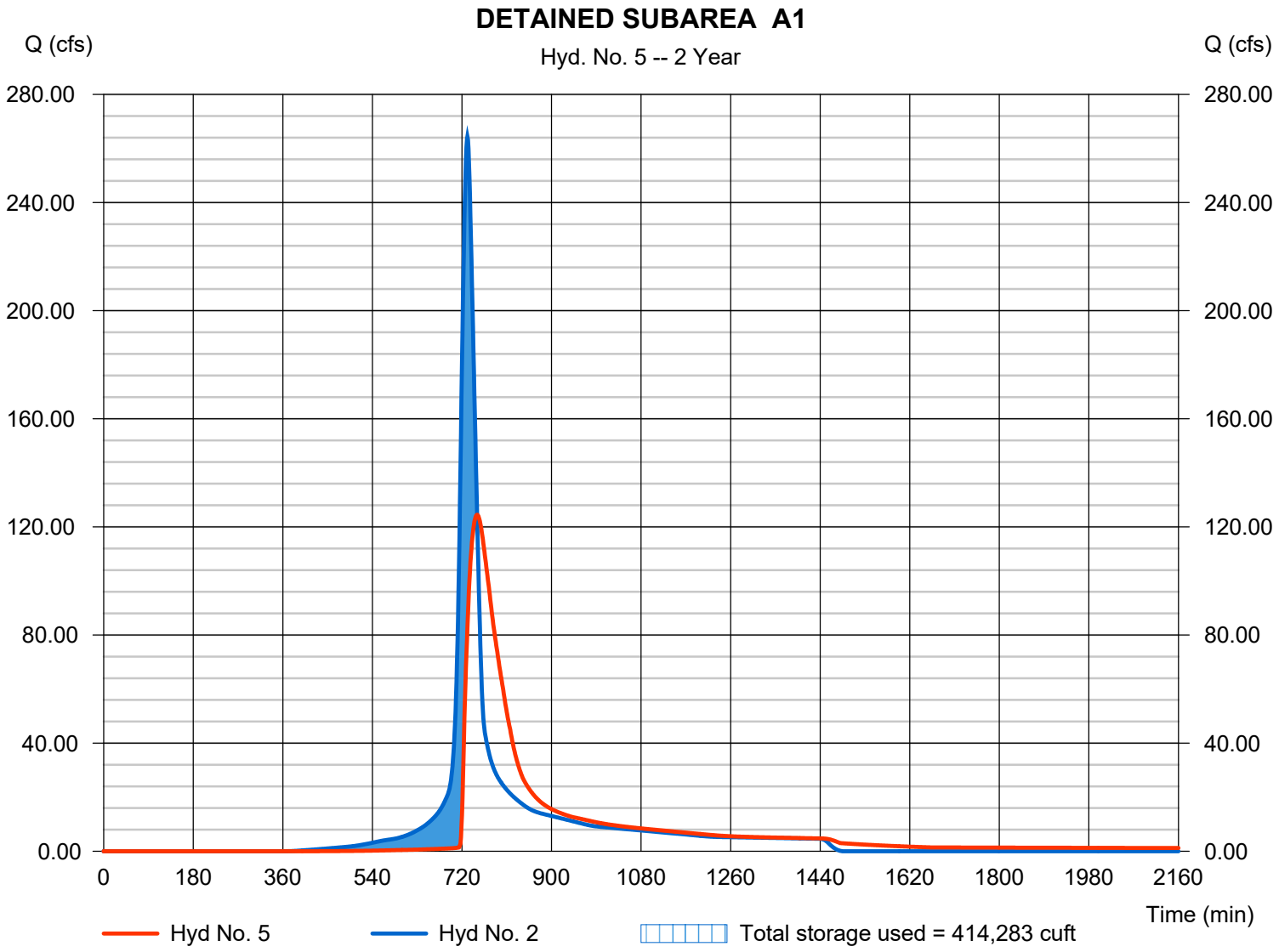
Hydrograph Report

Hyd. No. 5

DETAINED SUBAREA A1

Hydrograph type	= Reservoir	Peak discharge	= 124.48 cfs
Storm frequency	= 2 yrs	Time to peak	= 750 min
Time interval	= 1 min	Hyd. volume	= 999,862 cuft
Inflow hyd. No.	= 2 - PROP POI A1	Max. Elevation	= 995.40 ft
Reservoir name	= Retention Basin A	Max. Storage	= 414,283 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Retention Basin A

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 992.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	992.00	111,143	0	0
2.00	994.00	122,794	233,937	233,937
4.00	996.00	134,735	257,529	491,466
6.00	998.00	146,934	281,669	773,135
8.00	1000.00	159,390	306,324	1,079,459

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 60.00	6.75	0.00	0.00
Span (in)	= 60.00	6.75	0.00	0.00
No. Barrels	= 3	1	0	0
Invert El. (ft)	= 991.70	991.80	0.00	0.00
Length (ft)	= 40.00	0.00	0.00	0.00
Slope (%)	= 0.50	0.00	0.00	n/a
N-Value	= .010	.013	.013	n/a
Orifice Coeff.	= 0.60	0.67	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 24.00	0.00	0.00	0.00
Crest El. (ft)	= 993.33	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
Multi-Stage	= Yes	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

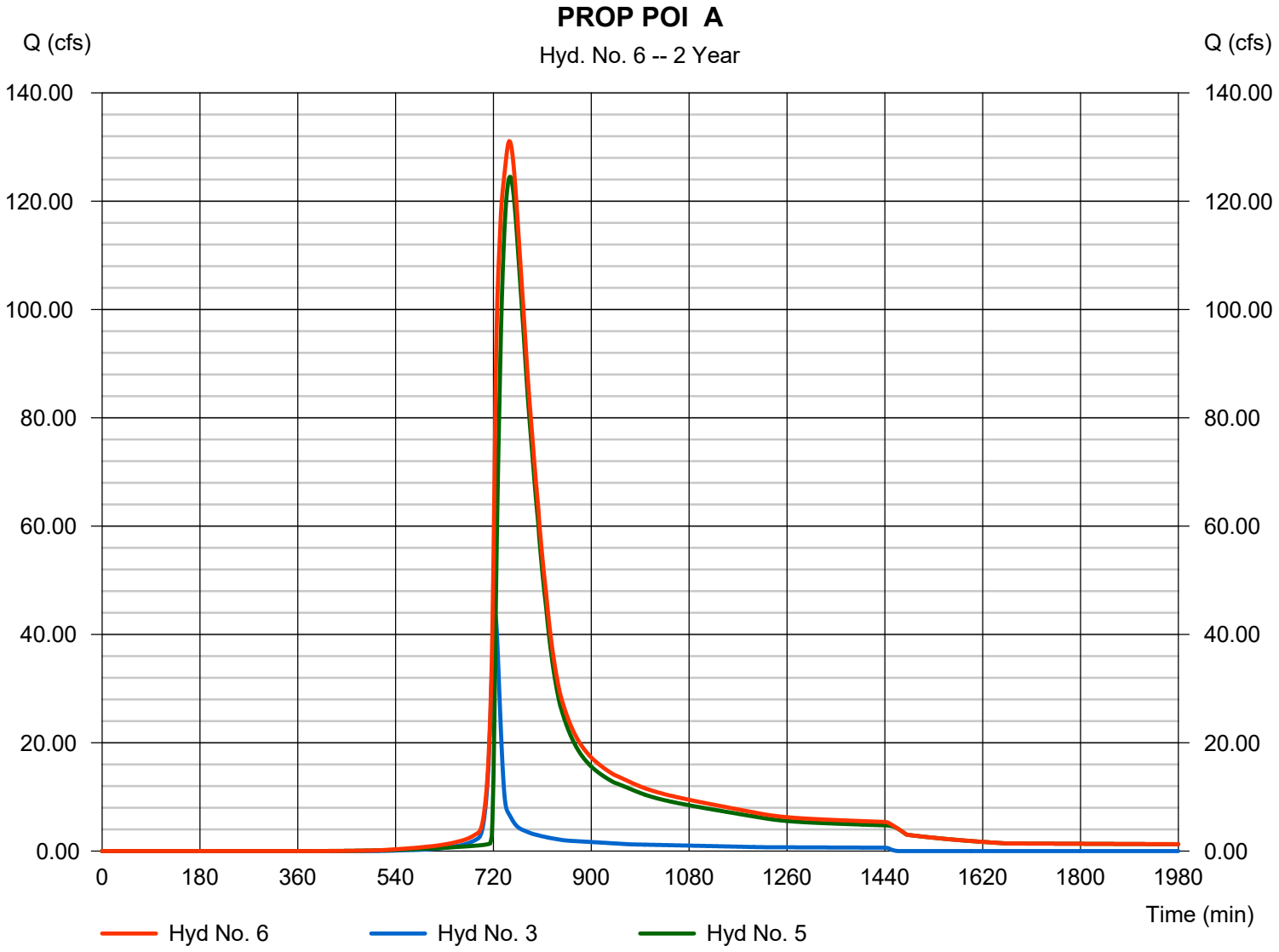
Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	992.00	0.00	0.00	---	---	0.00	---	---	---	---	---	0.000
2.00	233,937	994.00	46.30 oc	1.13 ic	---	---	43.83	---	---	---	---	---	44.96
4.00	491,466	996.00	149.01 oc	0.59 ic	---	---	148.40 s	---	---	---	---	---	148.99
6.00	773,135	998.00	382.99 oc	0.90 ic	---	---	382.05 s	---	---	---	---	---	382.95
8.00	1,079,459	1000.00	637.56 oc	1.05 ic	---	---	636.49 s	---	---	---	---	---	637.54

Hydrograph Report

Hyd. No. 6

PROP POI A

Hydrograph type	=	Combine	Peak discharge	=	131.07 cfs
Storm frequency	=	2 yrs	Time to peak	=	749 min
Time interval	=	1 min	Hyd. volume	=	1,124,477 cuft
Inflow hyds.	=	3, 5	Contrib. drain. area	=	19.020 ac



Hydrograph Summary Report

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

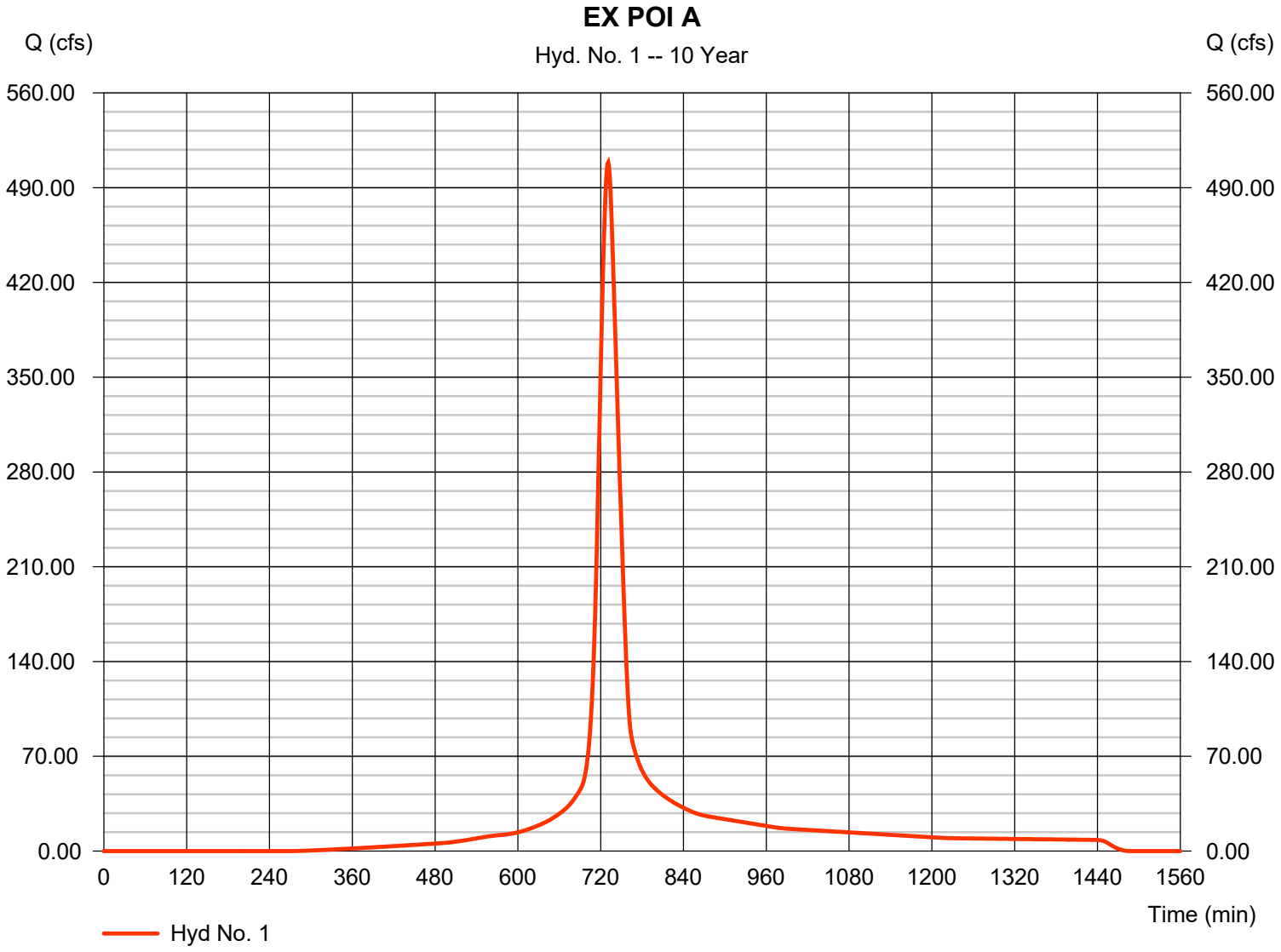
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	508.68	1	731	2,065,624	------	------	------	EX POI A
2	SCS Runoff	443.03	1	731	1,799,034	------	------	------	PROP POI A1
3	SCS Runoff	79.44	1	723	227,792	------	------	------	PROP SUBAREA A
4	Combine	498.80	1	729	2,026,826	2, 3	------	------	COMBINED (A1+A)
5	Reservoir	245.50	1	747	1,740,406	2	997.18	657,596	DETAINED SUBAREA A1
6	Combine	257.60	1	747	1,968,198	3, 5	------	------	PROP POI A

Hydrograph Report

Hyd. No. 1

EX POI A

Hydrograph type	=	SCS Runoff	Peak discharge	=	508.68 cfs
Storm frequency	=	10 yrs	Time to peak	=	731 min
Time interval	=	1 min	Hyd. volume	=	2,065,624 cuft
Drainage area	=	147.450 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	28.80 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

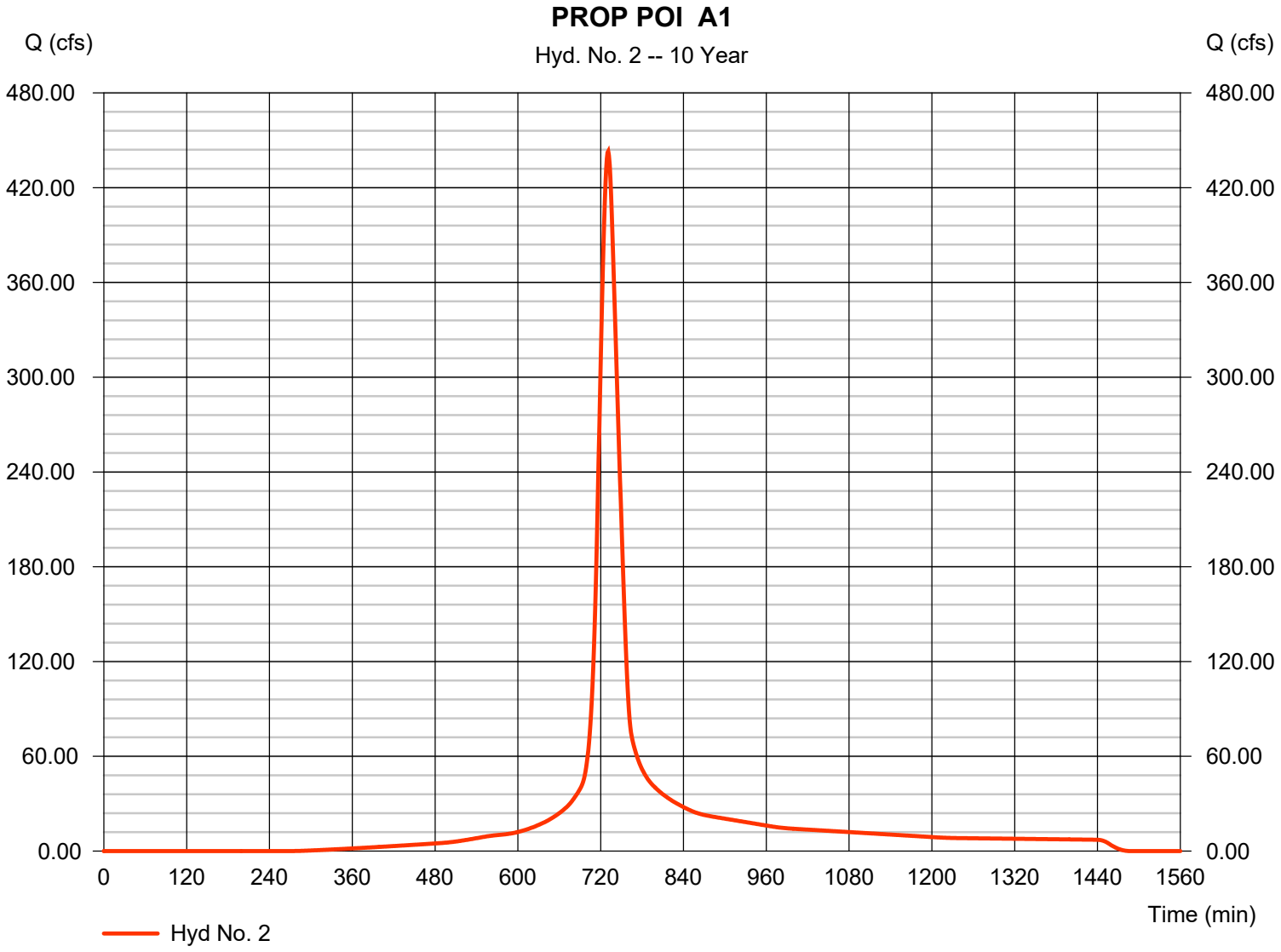


Hydrograph Report

Hyd. No. 2

PROP POI A1

Hydrograph type	=	SCS Runoff	Peak discharge	=	443.03 cfs
Storm frequency	=	10 yrs	Time to peak	=	731 min
Time interval	=	1 min	Hyd. volume	=	1,799,034 cuft
Drainage area	=	128.420 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	28.80 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

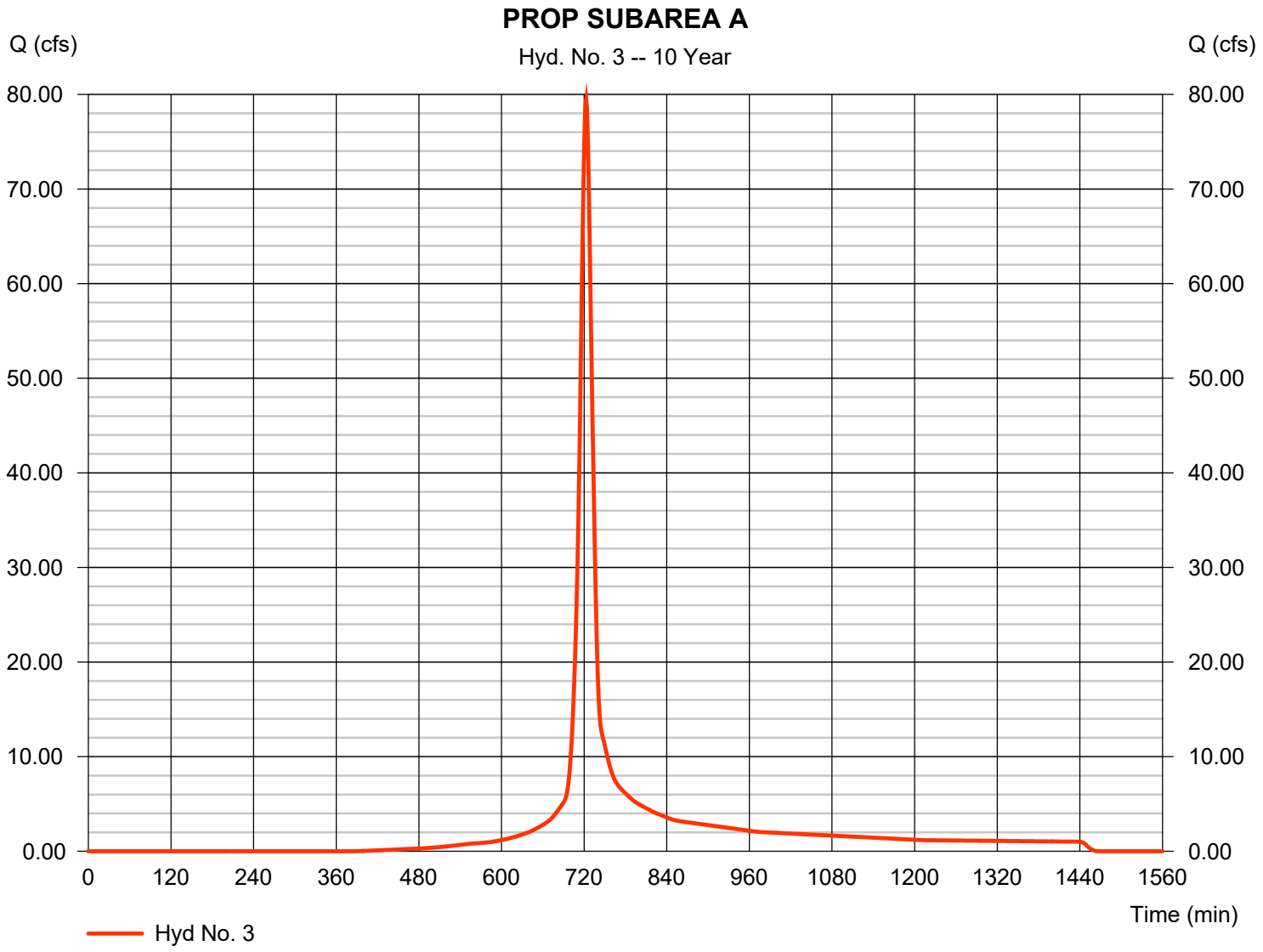


Hydrograph Report

Hyd. No. 3

PROP SUBAREA A

Hydrograph type	=	SCS Runoff	Peak discharge	=	79.44 cfs
Storm frequency	=	10 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	227,792 cuft
Drainage area	=	19.020 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.70 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

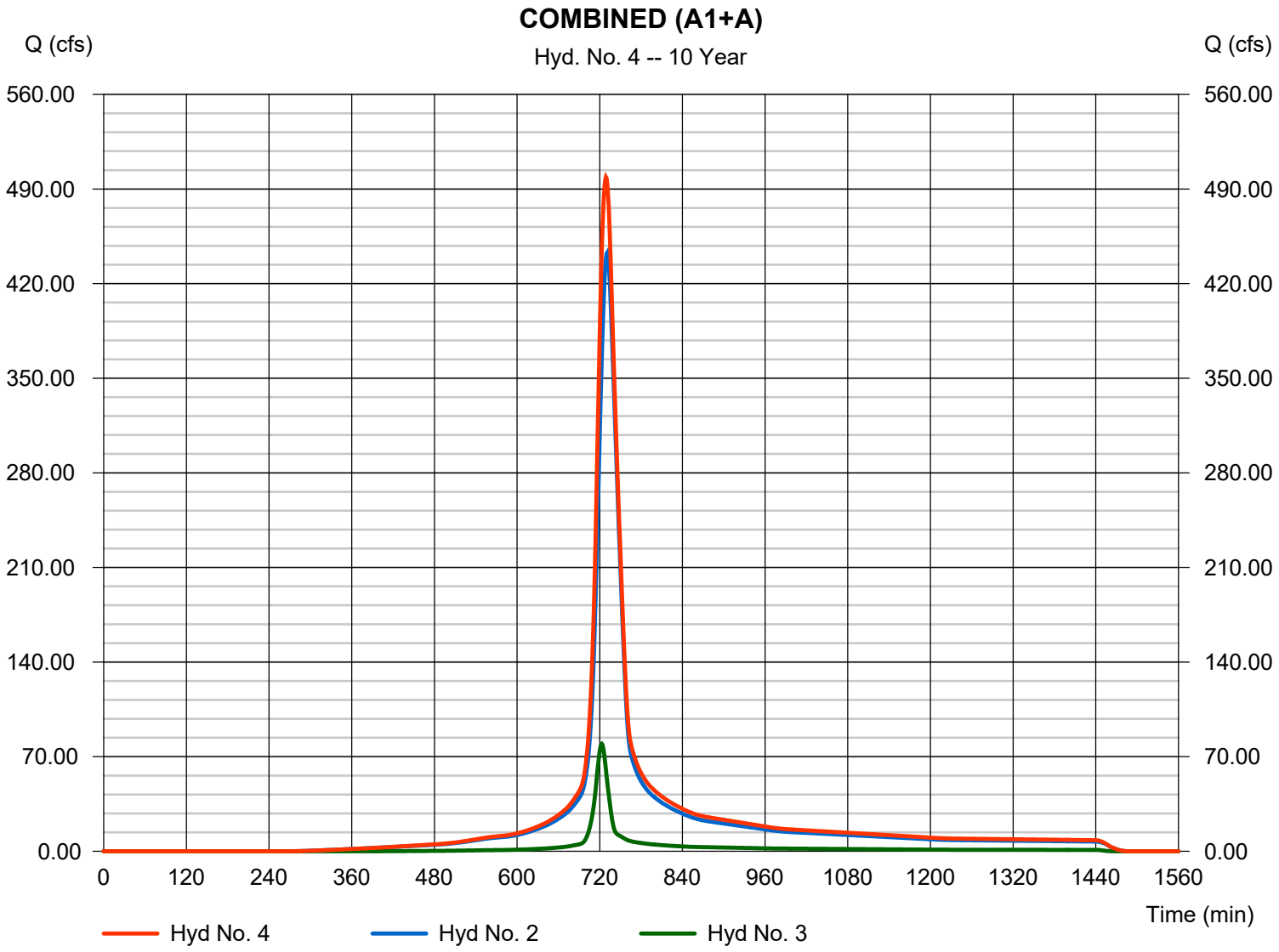


Hydrograph Report

Hyd. No. 4

COMBINED (A1+A)

Hydrograph type	=	Combine	Peak discharge	=	498.80 cfs
Storm frequency	=	10 yrs	Time to peak	=	729 min
Time interval	=	1 min	Hyd. volume	=	2,026,826 cuft
Inflow hyds.	=	2, 3	Contrib. drain. area	=	147.440 ac



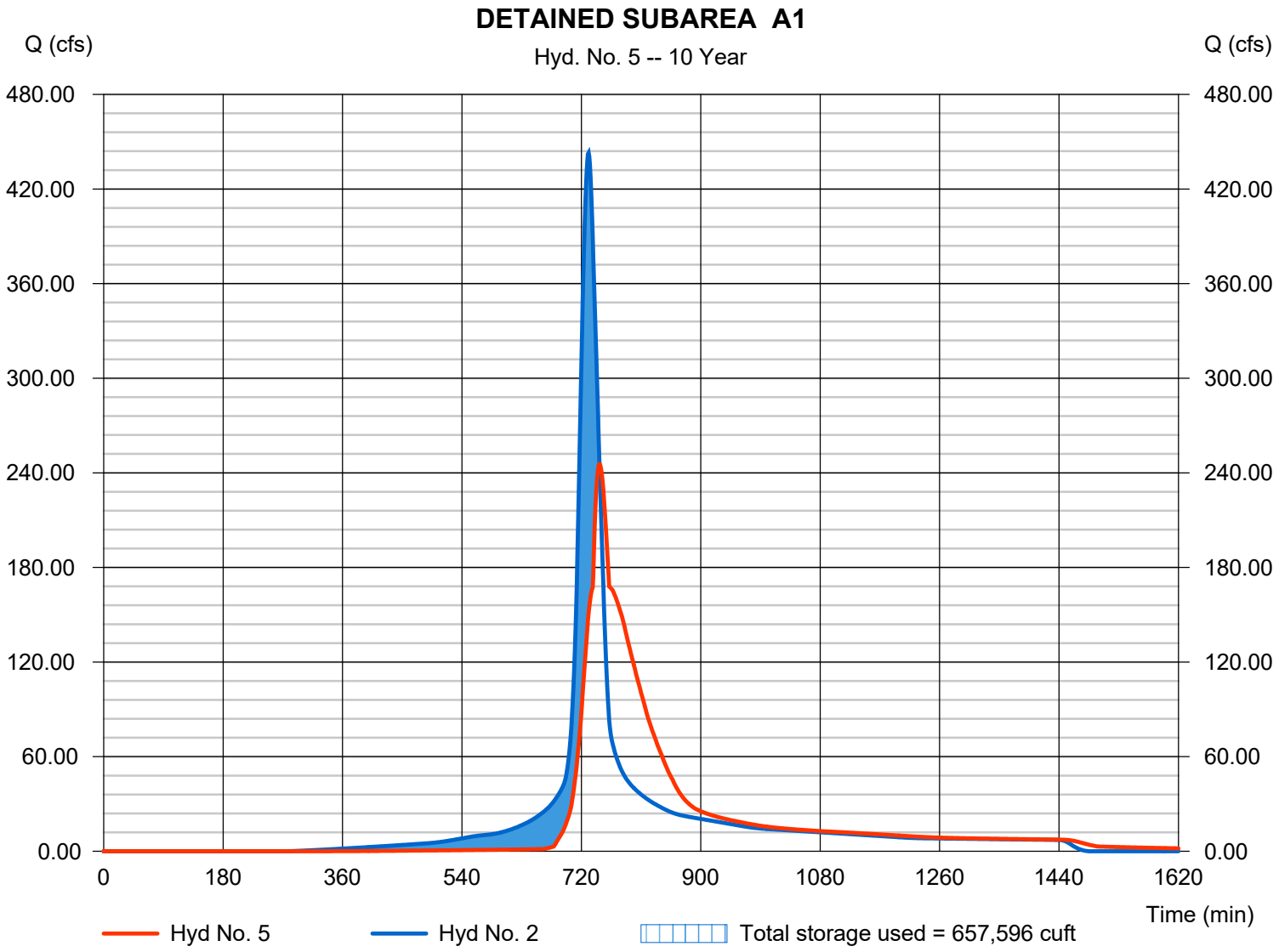
Hydrograph Report

Hyd. No. 5

DETAINED SUBAREA A1

Hydrograph type	=	Reservoir	Peak discharge	=	245.50 cfs
Storm frequency	=	10 yrs	Time to peak	=	747 min
Time interval	=	1 min	Hyd. volume	=	1,740,406 cuft
Inflow hyd. No.	=	2 - PROP POI A1	Max. Elevation	=	997.18 ft
Reservoir name	=	Retention Basin A	Max. Storage	=	657,596 cuft

Storage Indication method used.

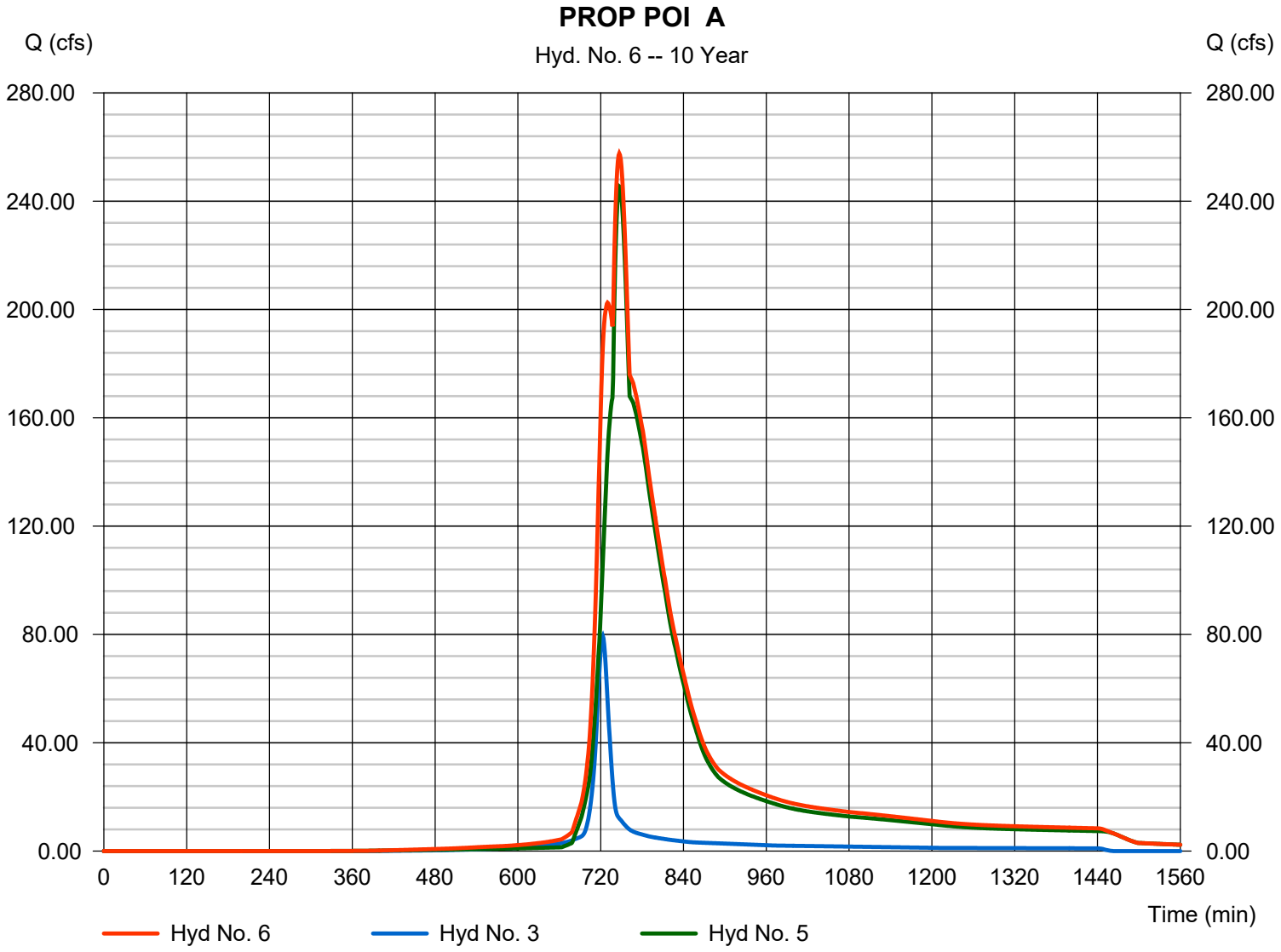


Hydrograph Report

Hyd. No. 6

PROP POI A

Hydrograph type	= Combine	Peak discharge	= 257.60 cfs
Storm frequency	= 10 yrs	Time to peak	= 747 min
Time interval	= 1 min	Hyd. volume	= 1,968,198 cuft
Inflow hyds.	= 3, 5	Contrib. drain. area	= 19.020 ac



Hydrograph Summary Report

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

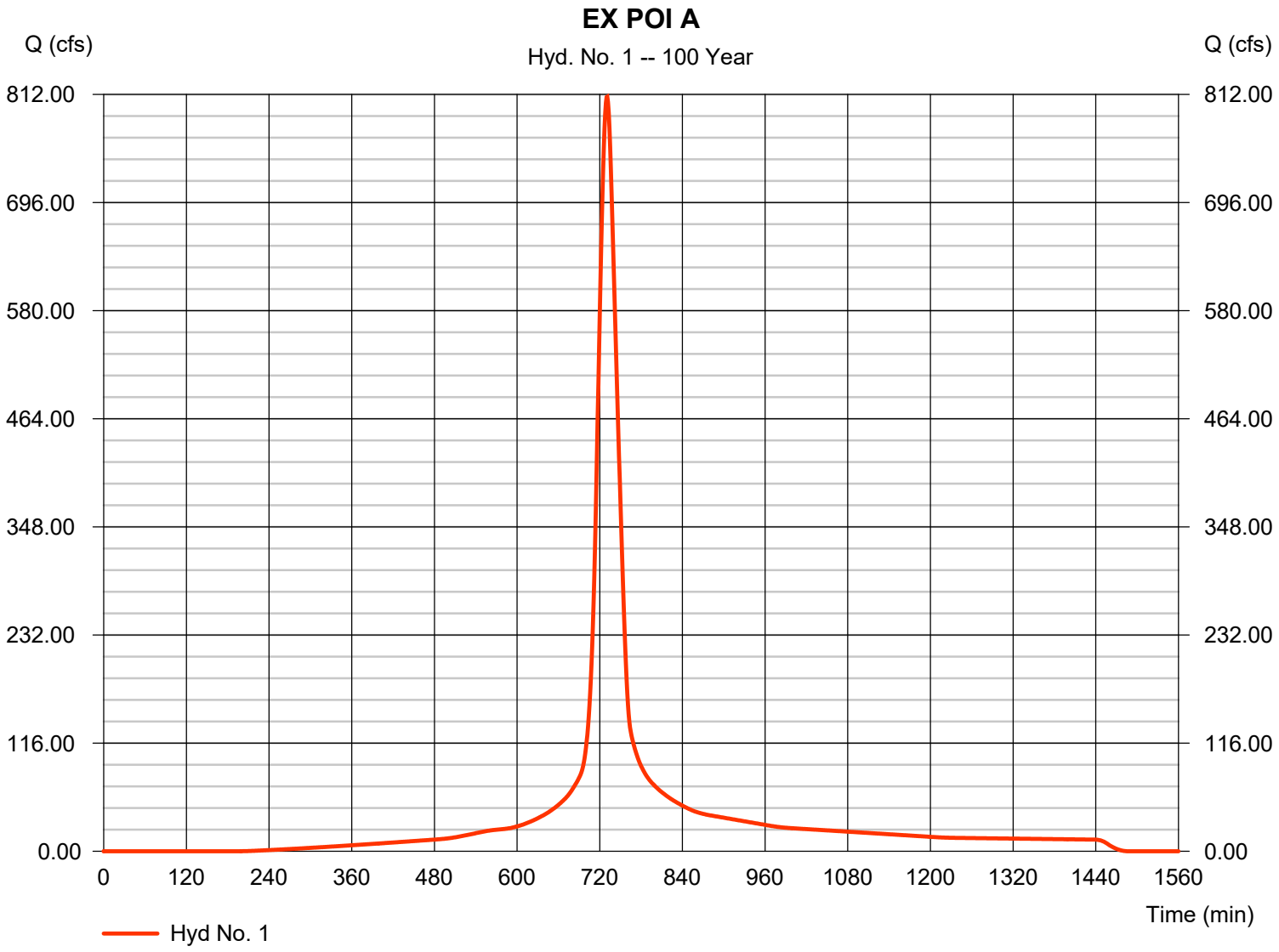
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	809.50	1	731	3,358,744	------	------	------	EX POI A
2	SCS Runoff	705.02	1	731	2,925,259	------	------	------	PROP POI A1
3	SCS Runoff	133.37	1	723	389,754	------	------	------	PROP SUBAREA A
4	Combine	799.42	1	729	3,315,014	2, 3	------	------	COMBINED (A1+A)
5	Reservoir	467.58	1	744	2,865,763	2	998.60	864,603	DETAINED SUBAREA A1
6	Combine	490.05	1	742	3,255,519	3, 5	------	------	PROP POI A

Hydrograph Report

Hyd. No. 1

EX POI A

Hydrograph type	=	SCS Runoff	Peak discharge	=	809.50 cfs
Storm frequency	=	100 yrs	Time to peak	=	731 min
Time interval	=	1 min	Hyd. volume	=	3,358,744 cuft
Drainage area	=	147.450 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	28.80 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

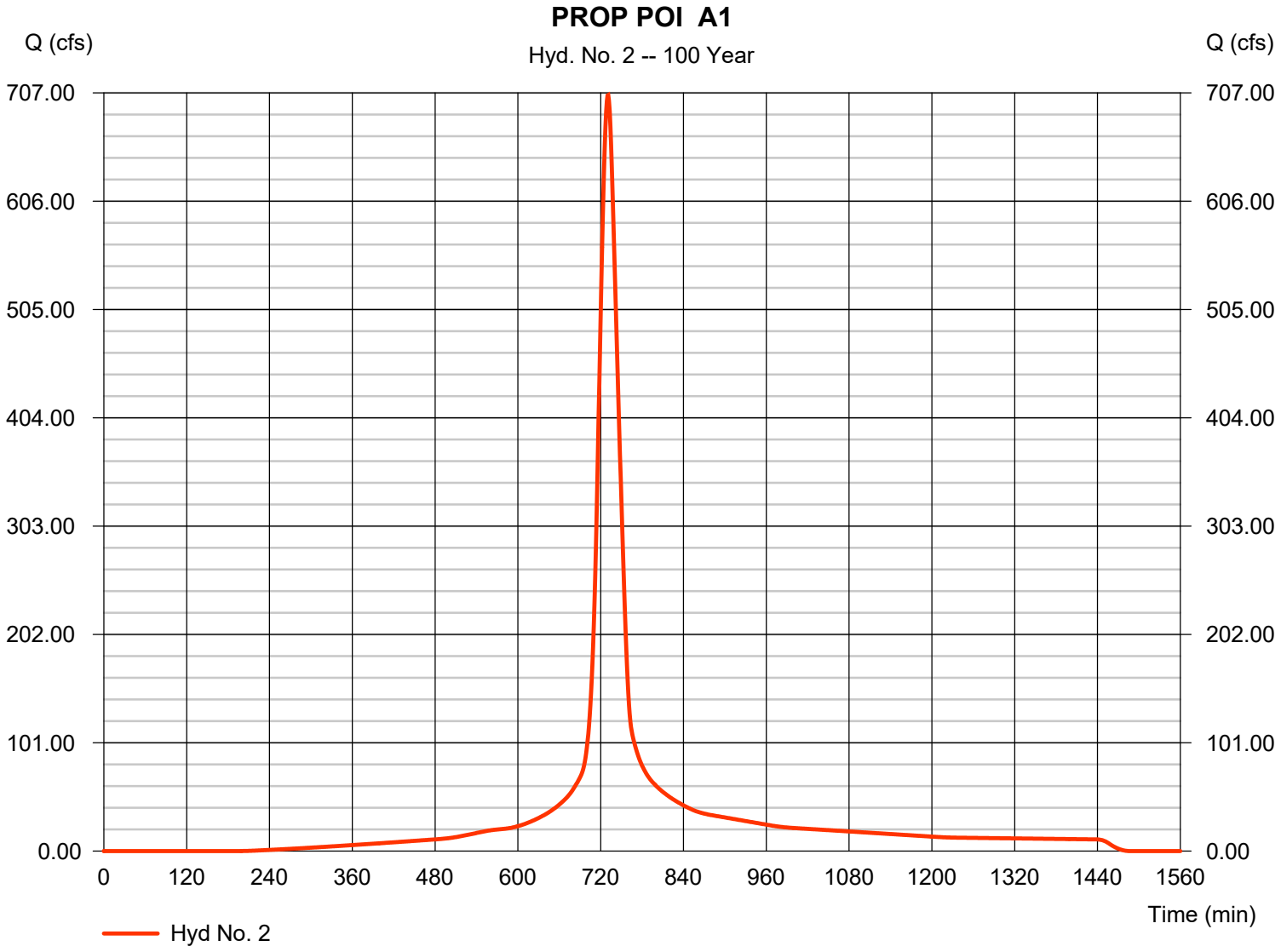


Hydrograph Report

Hyd. No. 2

PROP POI A1

Hydrograph type	=	SCS Runoff	Peak discharge	=	705.02 cfs
Storm frequency	=	100 yrs	Time to peak	=	731 min
Time interval	=	1 min	Hyd. volume	=	2,925,259 cuft
Drainage area	=	128.420 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	28.80 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

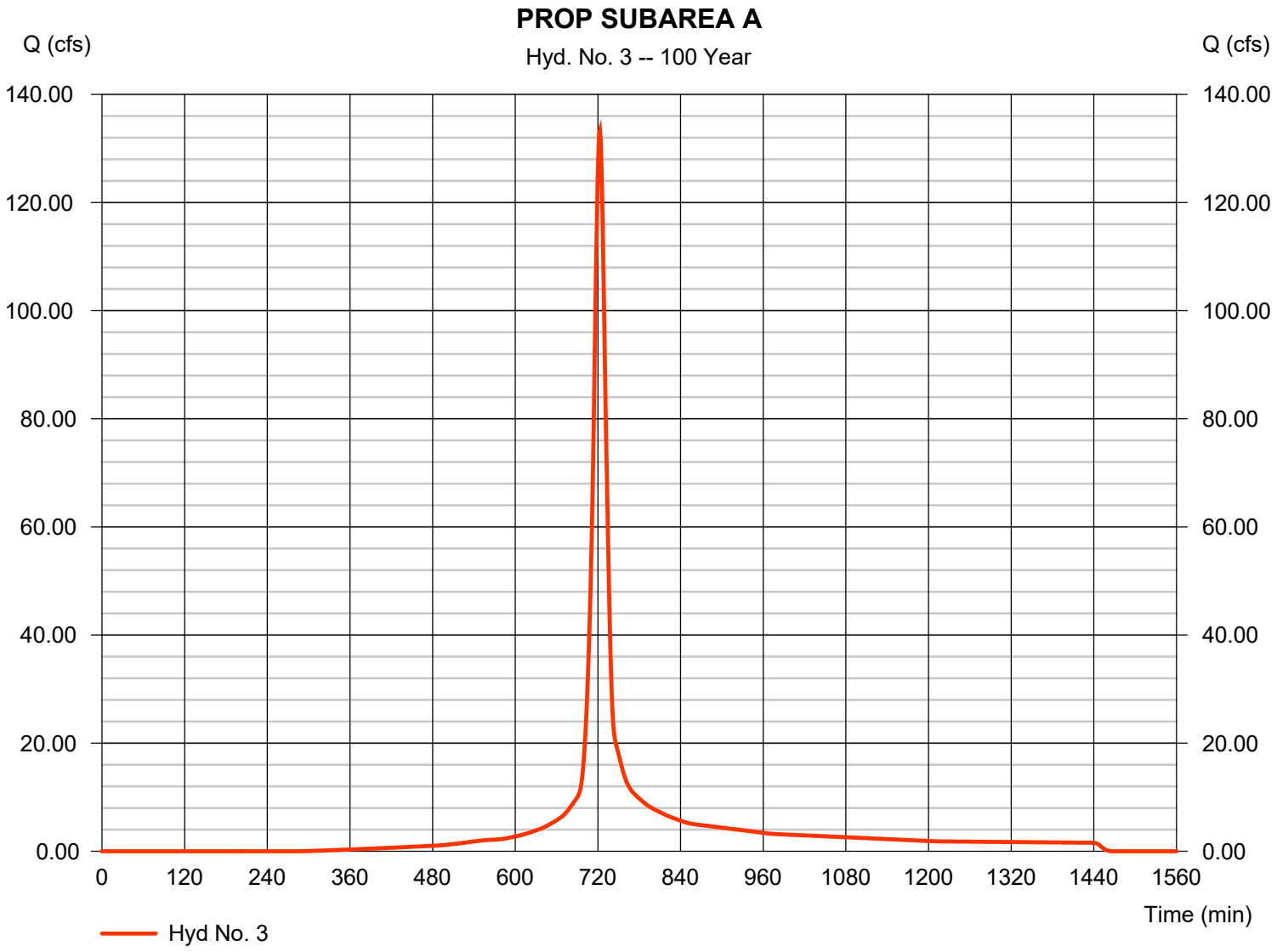


Hydrograph Report

Hyd. No. 3

PROP SUBAREA A

Hydrograph type	=	SCS Runoff	Peak discharge	=	133.37 cfs
Storm frequency	=	100 yrs	Time to peak	=	723 min
Time interval	=	1 min	Hyd. volume	=	389,754 cuft
Drainage area	=	19.020 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.70 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

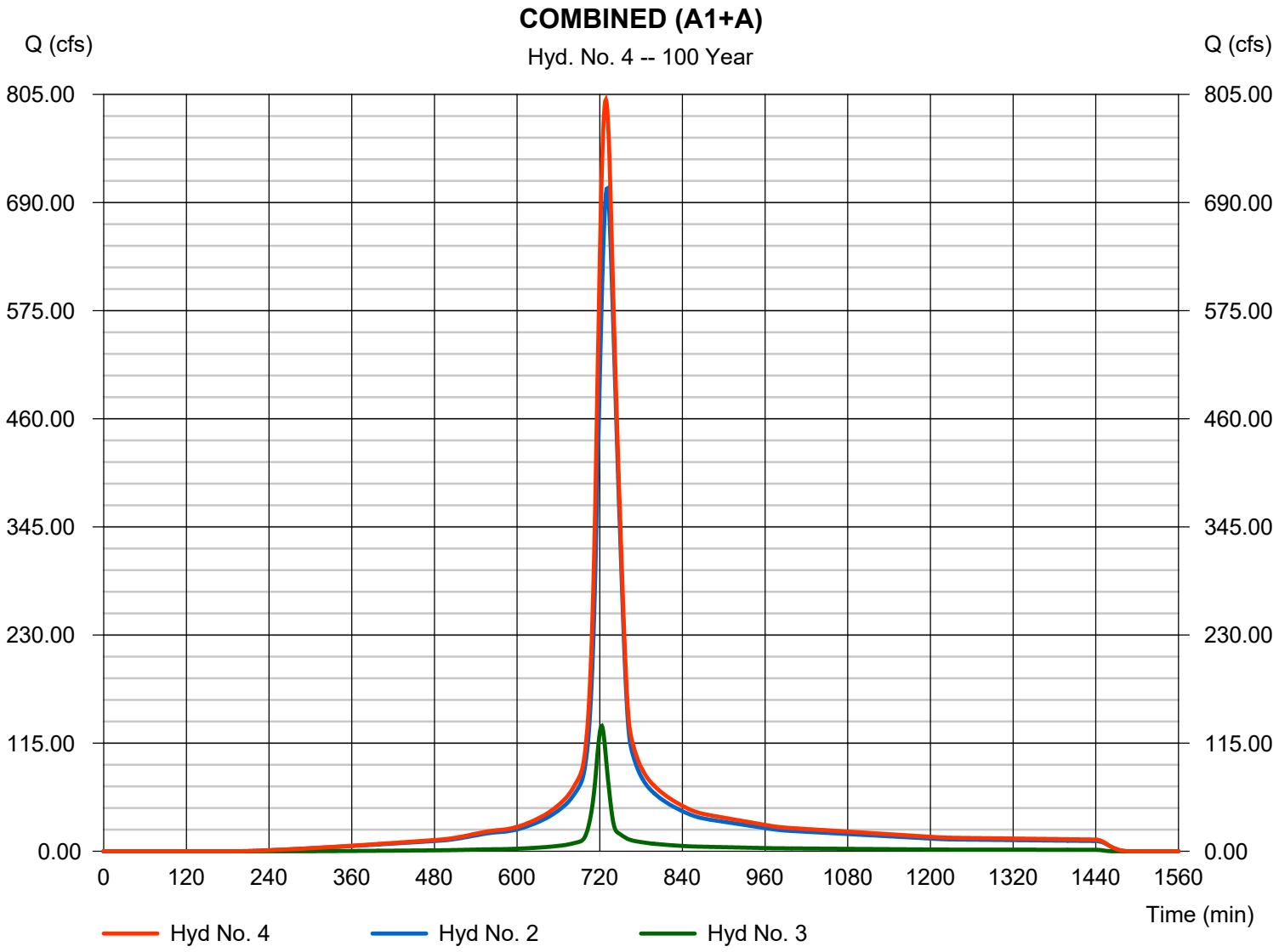


Hydrograph Report

Hyd. No. 4

COMBINED (A1+A)

Hydrograph type	=	Combine	Peak discharge	=	799.42 cfs
Storm frequency	=	100 yrs	Time to peak	=	729 min
Time interval	=	1 min	Hyd. volume	=	3,315,014 cuft
Inflow hyds.	=	2, 3	Contrib. drain. area	=	147.440 ac



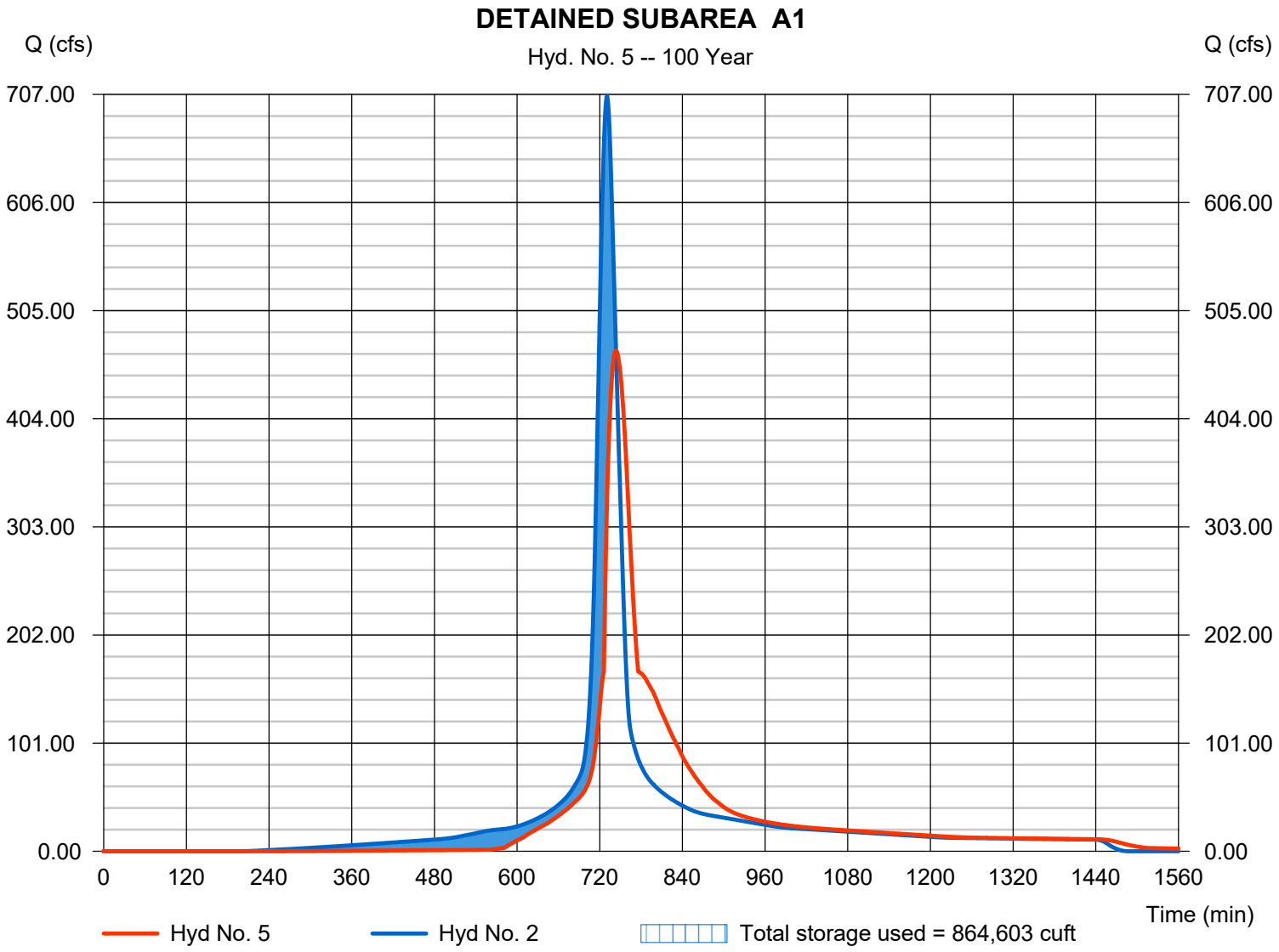
Hydrograph Report

Hyd. No. 5

DETAINED SUBAREA A1

Hydrograph type	= Reservoir	Peak discharge	= 467.58 cfs
Storm frequency	= 100 yrs	Time to peak	= 744 min
Time interval	= 1 min	Hyd. volume	= 2,865,763 cuft
Inflow hyd. No.	= 2 - PROP POI A1	Max. Elevation	= 998.60 ft
Reservoir name	= Retention Basin A	Max. Storage	= 864,603 cuft

Storage Indication method used.

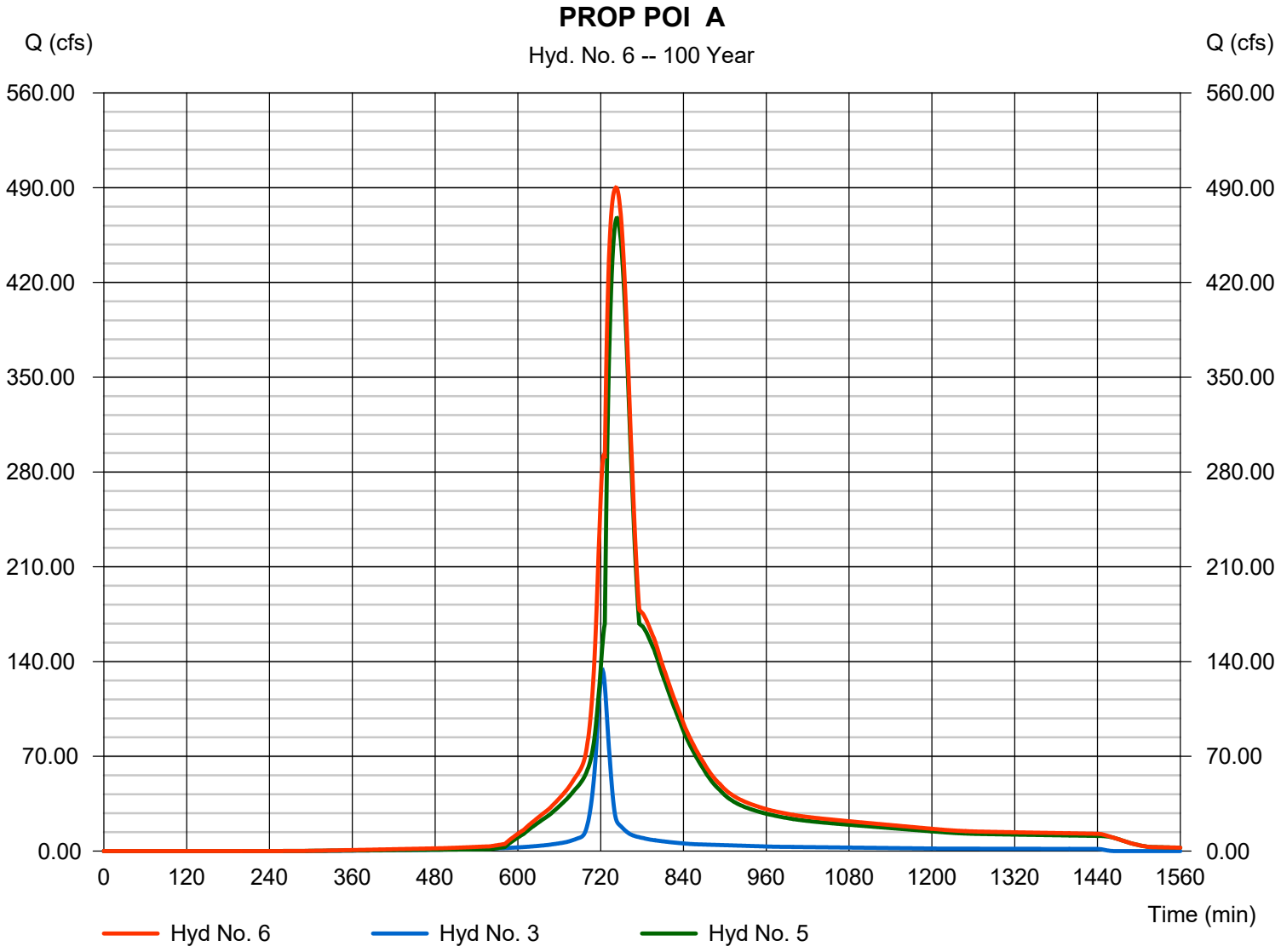


Hydrograph Report

Hyd. No. 6

PROP POI A

Hydrograph type	=	Combine	Peak discharge	=	490.05 cfs
Storm frequency	=	100 yrs	Time to peak	=	742 min
Time interval	=	1 min	Hyd. volume	=	3,255,519 cuft
Inflow hyds.	=	3, 5	Contrib. drain. area	=	19.020 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 F

Proposed Drainage Area Map

North

0 100' 200' 400'

PROPOSED DRAINAGE MAP

SCALE: 1" = 200'

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

Professional Registration
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Engineering 2005002186-D
Surveying 2005008319-D
Kansas
Engineering E-1695
Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

Oldham Marketplace
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: Oldham Marketplace
Issue Date: October 20, 2022

PROPOSED DRAINAGE MAP
Conceptual Drainage Plan for:
Oldham Marketplace
Lee's Summit, Jackson County, Missouri

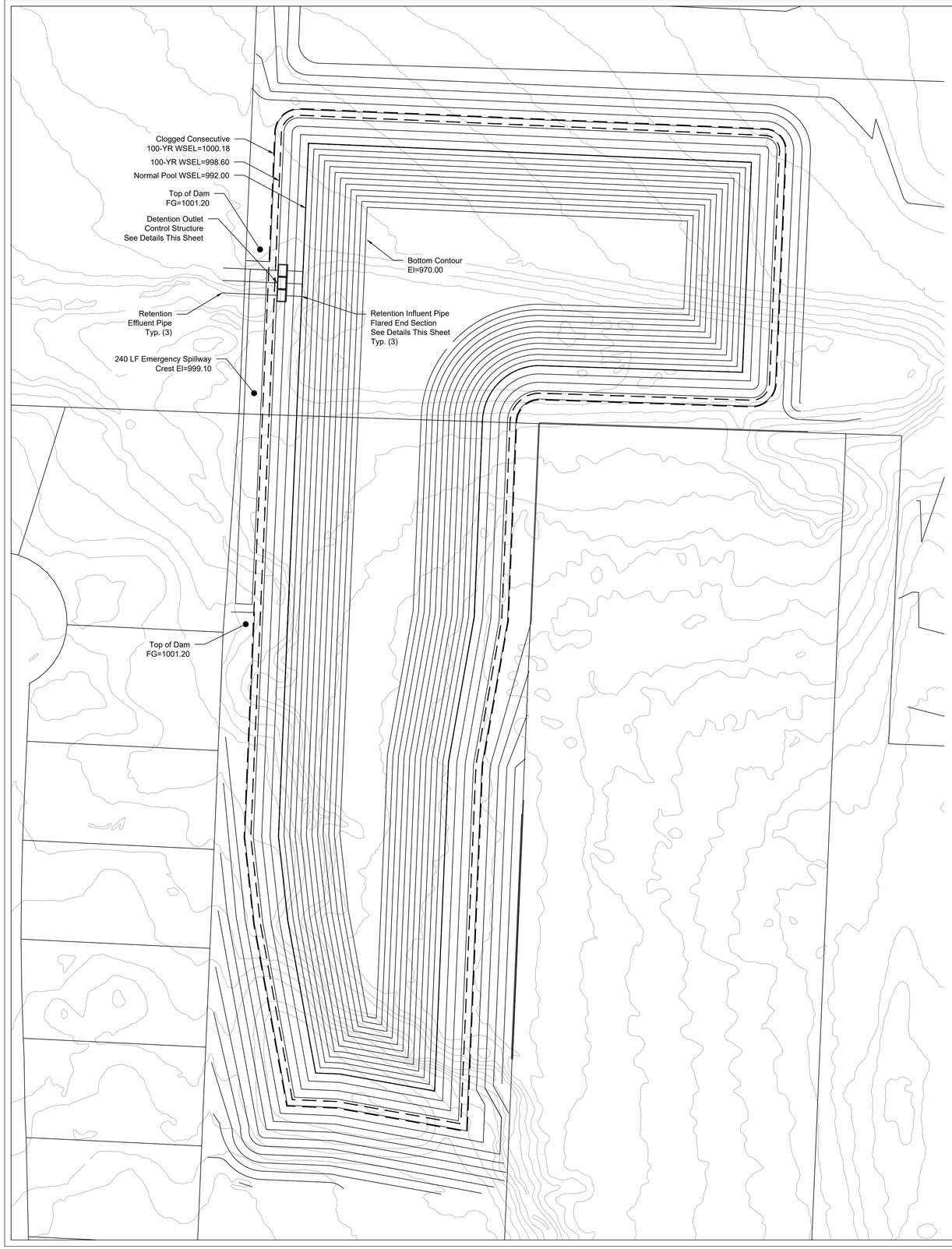
Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

EXHIBIT

Exhibit G

Retention Plan



NOTES:

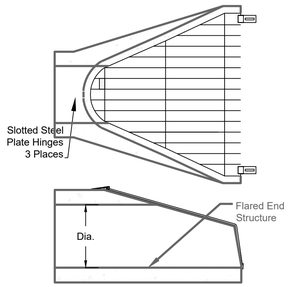
1. THE BASIN SHALL BE CONSTRUCTED WITH THE EROSION AND SEDIMENT CONTROL MEASURES.
2. AN AS-BUILT DETENTION BASIN PLAN SHALL BE SUBMITTED AND ACCEPTED PRIOR TO ISSUANCE OF A CERTIFICATE OF SUBSTANTIAL COMPLETION, WITH AS-BUILT VERSUS PROPOSED STORAGE.

North

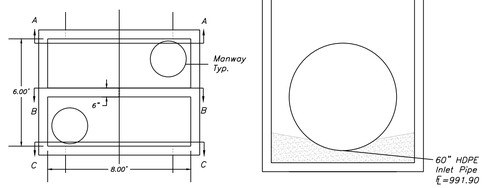
0 20' 40' 80'

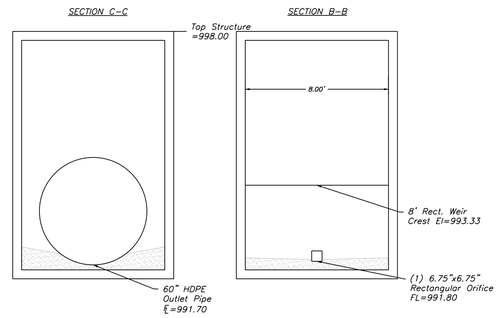
RETENTION BASIN PLAN

SCALE: 1" = 40'



Galvanized
Trash Guard
For Influent Flared Ends
(Both Basins)

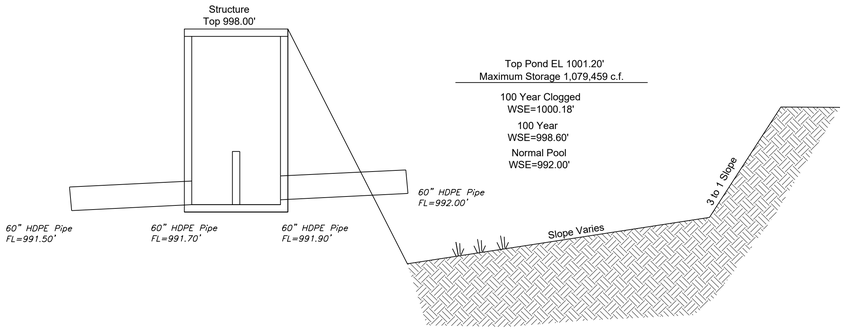




CONTROL STRUCTURE - BASIN A1

$\frac{3}{4}$" = 1'-0"

Control Structure Notes:
1. Control Structure depicted is the center box of (3) 8'x6' precast boxes.
2. The adjacent boxes shall not contain the 6.75" Rectangular Orifice.
3. Both adjacent structures shall have 10" diameter leveler pipes installed to center box upstream of the weir wall at elevation 991.90.



SECTION VIEW - BASIN A1

N.T.S.

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Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

Oldham Marketplace
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: Oldham Marketplace
Issue Date: October 20, 2022

PROPOSED DRAINAGE MAP
Conceptual Drainage Plan for:
Oldham Marketplace
Lee's Summit, Jackson County, Missouri

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

REVISIONS

EXHIBIT

Exhibit H

Emergency Spillway Calculations

Weir Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Jul 13 2023

Emergency Spillway Detention Basin A

Rectangular Weir

Crest	= Broad
Bottom Length (ft)	= 300.00
Total Depth (ft)	= 2.00

Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Known Q
Known Q (cfs)	= 667.95

Highlighted

Depth (ft)	= 0.90
Q (cfs)	= 667.95
Area (sqft)	= 270.52
Velocity (ft/s)	= 2.47
Top Width (ft)	= 300.00

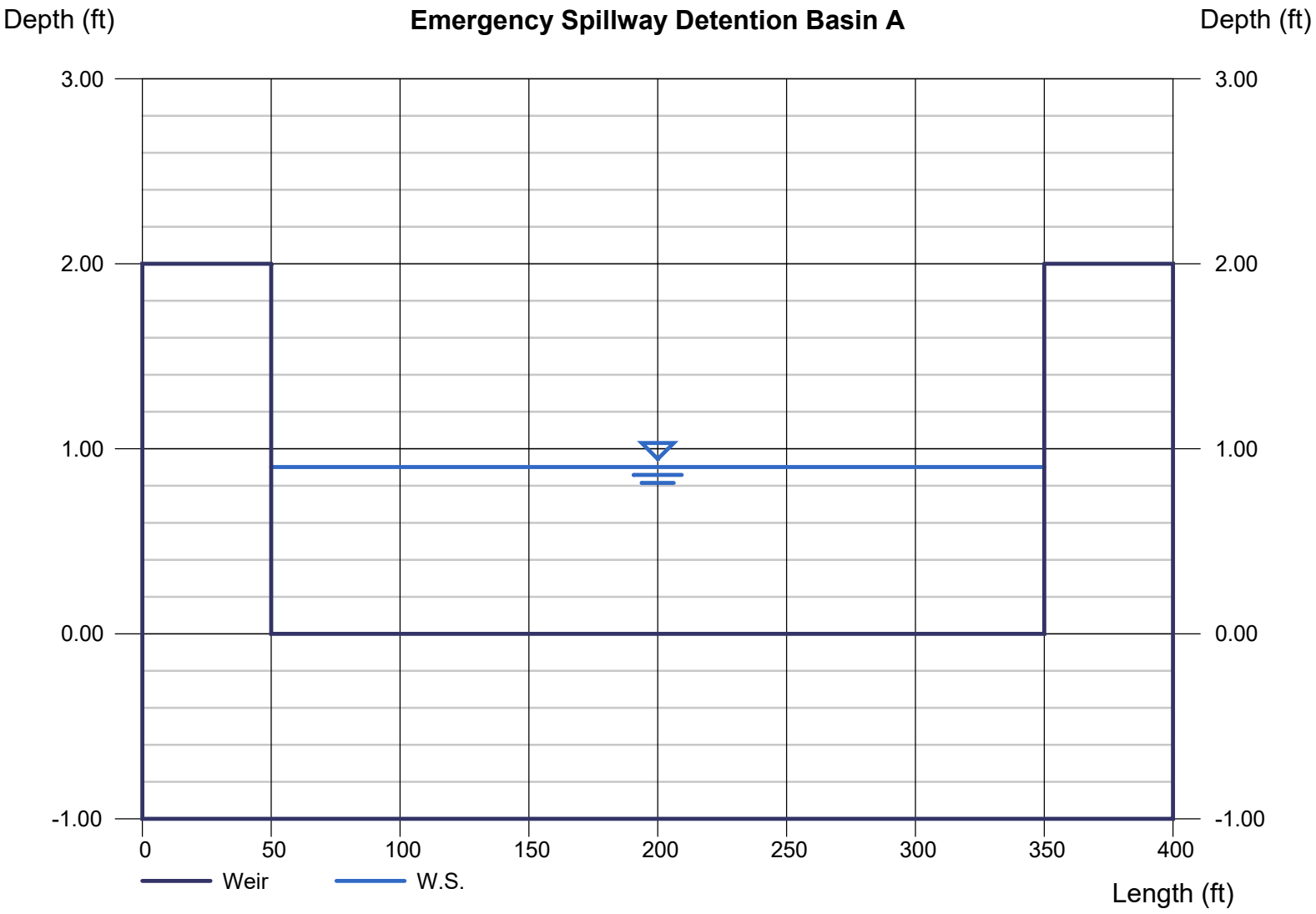

Exhibit I

40 Hour Extended Detention Calculations

Calculate Water Quality for Storm Study

Project: Oldham Village (South Basin) Date: 5-20-24

To Calculate: WQv = P * Rv * A

P (in) =	1.37
P (ft) =	0.11
Impervious Area (sq. ft.) =	1,341,652.77
Total Area (sq. ft.) =	2,164,060.80
Impervious Area (ac) =	30.80
Total Area (acre) =	49.68
Rv = (0.05 * 0.009(I)) =	0.62
Percent Impervious (I) =	63.33
WQ_v (cu. ft.) =	153,172
WQ_v (ac. ft.) =	3.516

Enter data in these Fields

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

Pond Volume

Elevation	Area (Sq. Ft.)	Volume (Cu. Ft.)
992	111,143	0
994	122,794	233,937
996	134,735	491,466
998	146,934	773,135
1,000	159,390	1,079,459

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) =	49.68
Step 2) Calculate WQ_v using Sec. 6 (ac-ft) =	WQ_v (ac. ft.)=	3.516
Step 3) Add 20 Percent to Step 2.	V_{design} (ac-ft) =	4.220

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 = 1

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

IIb. Water Quality Outlet, Single Orifice

Step 1) Depth of water quality volume at outlet	Z_{WQ} (ft) =	1.31	See Below to Calc. Z_{WQ}
Step 2) Average Head of water volume over invert of Orifice	H_{WQ} (ft) =	0.65	
Step 3) Average Water quality outflow rate	Q_{WQ} (cfs) =	1.064	
Step 4) Set value of orifice discharge coefficient a) 0.66 when thickness of riser/weir plate ≤ orifice dia. b) 0.80 when thickness of riser/weir plate > orifice dia.	C0 (unitless) =	0.66	
Step 5) Water quality outlet orifice dia.	D_0 (in) =	6.75	6.747475706

(if orifice dia. < 4 inches, use outlet type 2 or 3)

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

Elevation 1 =	992.00	Storage 1 =	-
Elevation X =		Storage X =	153,172.03
Elevation 2 =	994.00	Storage 2 =	233,937.00
		Elevation X =	993.31

Lowest Elevation of Pond =	992.00
Elevation X =	993.31
Z_{WQ} (ft) =	1.31

Recommended Method: Single Orifice