

MACRO STORM WATER DRAINAGE STUDY

Colbern Road Investments

Site Acreage: 6.09 Acres

900 NE Colbern Road

Lee's Summit, MO

PREPARED BY:



Revision

Date	Comment	By

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3. GENERAL INFORMATION

This storm study has been prepared to provide a temporary storm water solution until the ultimate storm water solution will be provided with the development of the site adjacent to the existing pond located on Future Lot 4. The proposed project will consist of the construction of a building and parking lot improvements and specifically a new C-Store on Lot 2. The development is located at 900 NE Colbern Road and consists of 6.09 acres+/- . The existing site drains generally from southwest to northeast. An enclosed storm sewer system is located on the property which collects runoff from the north parking lot and conveys it to the south. The final detention basin for the site will be a redevelopment of the pond side located within Tract A of the development and constructed with Lot 4 in a future phases. There existing pond does not appear to be a functioning as a detention basin onsite. Detention will be constructed to attenuate runoff from Lots 1 thru 3. Runoff from the site is tributary to Lake Jacomo. See Exhibit A for an aerial image of the proposed project site along with an aerial image of the surrounding area. The site is located in Section 29, Township 48N, Range 31W, Lee's Summit, Jackson County, Missouri.

3.1 FEMA FLOODPLAIN DETERMINATION

The property is located in an Area of Minimal Flood Hazard, Zone X, according to FEMA Firm Map Number 29095C0430G, 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 23, September 1, 2021. The existing site contains two major soil types:

10128 Sharpsburg-Urban Land Copmlex, 2 to 5 percent slopes Soil Group D

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

4. METHODOLOGY

The study utilized a field topo to create the 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 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 has been calculated using the following formulas:

- Sheet Flow (Max. 100 LF): APWA 5602.5 Time Inlet, $T_1 = 1.8 * (1.1-C) * L^{1/2} / S^{1/3}$
- Shallow Concentrated Flow: SCS TR-55 Appendix F:

Unpaved	$V=16.1345(S)^{0.5}$
Paved	$V=20.3282(S)^{0.5}$
- Shallow Concentrated Travel Time (min): SCS TR-55 Eq-3-1, $T_t = L / V \times 60$
- Channel Flow Improved: Manning's Equation (Full Flow)
- Channel Flow Unimproved: APWA 5602.7.A. Travel Time, Table 5602-6

<u>Avg. Channel Slope (%)</u>	<u>Velocity (fps)</u>
< 2	7
2 to 5	10
>5	15

5. EXISTING CONDITIONS ANALYSIS

The site has previously been utilized as a meat processing site but has been vacant for many years and is vegetated with grass. The City is requiring that attenuation measures be utilized to meet current storm water regulations for the proposed project, however this storm study is requesting a Temporary Basin be utilized until the development of specifically Future Lot 4 is determined. At that time the existing pond will be modified into a retention basin to serve the overall development. The proposed temporary detention system will be designed to accommodate storm water runoff for Lots 1 thru 3 and will meet the 10 and 100 year controls for storm water management. The site contains one sub-basin which encompasses all of the development area and infrastructure improvements. The sub-basin will be referred to as Sub-basin A for the purposes of this report. Sub-basin A contains 6.09 acres and drains to Point of Interest A located in the northeast portion of the site. The Drainage Area Map is located in Exhibit D.

The following tables summarize the results of the Existing Conditions analysis. Composite curve number calculations by sub-basin may be found in Exhibit E. Time of concentration calculations by sub-basin may be found in Exhibit F. A complete breakdown of TR-55 unit hydrographs may be found in Exhibit G.

Table 5-1 Existing Conditions Sub-basin Data

Sub-basin	Area (ac.)	Composite CN	Tc (min.)
A	6.09	80	10

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

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	10.90	21.35	41.82

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

Per City direction all onsite area is to be multiplied by the above factors to determine allowable peak release rates. Any offsite area contributing shall utilize its percentage of existing peak discharge which will be added to allowable onsite to determine the total allowable peak discharge at the point of interest.

Allowable Release Example Calculations: Sub-basin A (2-Yr): $(6.09 \times 0.5) = 3.04$ cfs

Table 5-3 Existing Conditions Sub-basin/Point of Interest Allowable Peak Discharge Release Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	3.04	12.18	18.27

6. PROPOSED CONDITIONS ANALYSIS

The developer plans to expand the development to up to four (4) potential building sites. Sub-basin A will encompass the proposed improvements. Runoff will be conveyed to the proposed detention basin at POI A via the existing enclosed storm sewer system and a set of swales. Sub-basin A was analyzed in the proposed conditions analysis to determine if any negative impacts are anticipated downstream due to the new development.. The Drainage Area Map is located in Exhibit F.

The following tables summarize the results of the Proposed Conditions analysis.

Table 6-1 Proposed Conditions Sub-basin Data

Sub-basin	Area (ac.)	Composite CN	Tc (min.)
A	6.09	92	5

Table 6-2 Proposed Conditions Sub-basin/Point of Interest Peak Discharge Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	29.98	44.06	68.29

As shown above in Table 6-2 Sub-basin A will require detention to attenuate peak discharge rates below Allowable Release Rates as shown in Table 5-3 for Sub-basin A. The developer has plans for future development on the site which would require the relocation of the Temporary Detention Basin and modifications to the existing pond to create a Retention Facility for the entire development. The future developments will require a revised storm study as this study is focused on Lots 1 thru 3.

The proposed Temporary Detention system has been designed to attenuate the 10 and 100 year storm rates as the future Retention Facility will facilitate the entire site.

6.1 DETENTION

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

Designation: Detention Basin A

Type: Earthen Basin

Side Slopes: 3:1 Max.

Bottom Slope: 2% Min., Turf Lined

Basin Bottom Elevation: 968.50 @ Influent Pipe

Basin Top Berm Elevation: 975.50

Basin Volume: 59,235 cf @ 974.50

Control Structure: 15" Storm Pipe with 5" Orifice

Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=974.50, Crest Length=55'

Consecutive 100-YR Q=46.94 cfs, Emergency Spillway HGL=973.48, Freeboard=1.00'

Combination Emergency Spillway:

Earthen Broad Crested Weir: Q=39.30 cfs

Control Structure Overflow: Q=7.64 cfs

Total Discharge: Q=46.94 cfs

The Detention Basin Plan is located in Exhibit I. See Table 6-5 for a summary of detention basin data.

Table 6-5 Future Conditions 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)
Basin A						
2-Year	29.98	717	11.01	724	971.90	15,956
10-Year	44.06	717	11.50	725	972.99	27,349
100-Year	68.29	717	11.99	727	974.42	49,316

As shown in the table above all anticipated future peak flowrates have been attenuated.

Table 6-6 below provides a comparison of runoff data between Proposed and Existing Conditions in addition to Proposed Conditions and Allowable Release Rates at each Point of Interest.

Table 6-6 Point of Interest Discharge Comparison

		Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
Point A	Proposed	11.01	11.50	11.99
	Existing	10.90	21.35	41.82
	Difference	0.11	-9.85	-29.83
	Allowable	3.04	12.18	18.27
	Difference	7.97	-0.68	-6.28

Peak discharge rates at Point A will be reduced below allowable for 10 and 100 year design storms analyzed.

7. 40 HOUR EXTENDED DETENTION/INFILTRATION BMP

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

8. CONCLUSIONS & RECOMMENDATIONS

This macro storm water drainage study reveals that the proposed development will not generate any negative downstream hydraulic impacts. A new Temporary earthen detention basin is being proposed to provide detention for the proposed development along with a potential future addition. In conclusion, the Temporary basin will be replaced with modifications to the existing pond facility and peak discharge rates at POI A are below both existing and allowable release rates for the 10 and 100 year events. The study is in conformance with all applicable City of Lee's Summit standards and criteria with exception of the 2 year event therefore Engineering Solutions recommends approval of this macro storm water drainage study.

The requested waiver of the 2 year event will allow the developer time to work with all the necessary jurisdictions to obtain approval for the modifications to the existing pond facility. The proposed Temporary Basin will provide Flood Controls for the 10 and 100 year event and has reduced the 2 year event to near existing conditions.

Engineering Solutions would like to request a temporary waiver for the 2 year event to allow the permanent facility to serve as the ultimate storm water controls.

Exhibit A

Aerial Image & Aerial Image of Surrounding Area

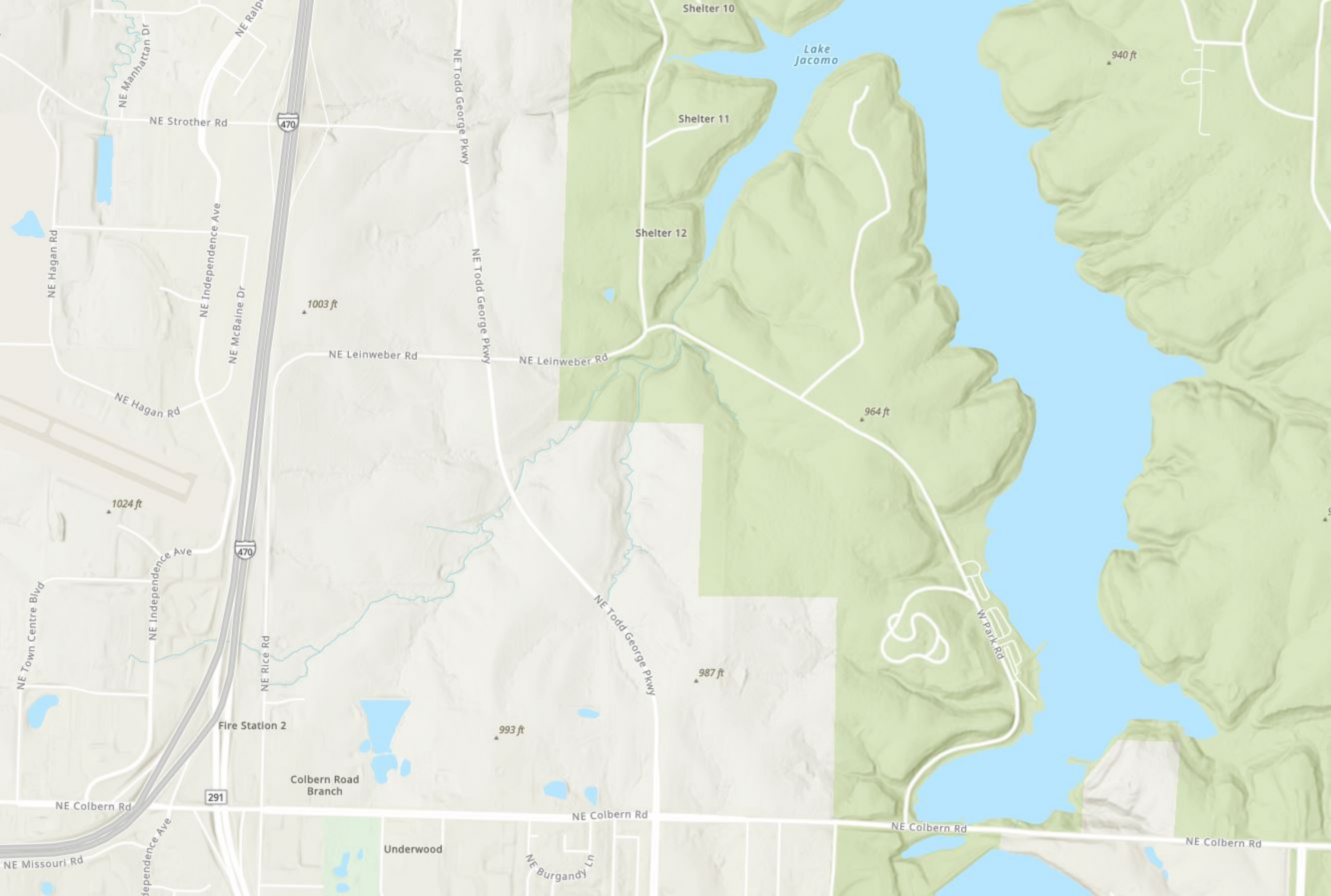


Exhibit B

FEMA FIRMette

National Flood Hazard Layer FIRMette



94°21'48"W 38°56'57"N



0 250 500 1,000 1,500 2,000 Feet 1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

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 Water Surface Elevation
		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
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



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 **9/12/2022 at 4:53 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

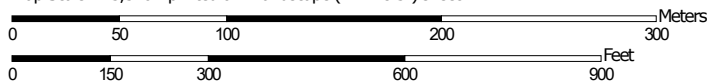
NRCS Soil Classification Report

Hydrologic Soil Group—Jackson County, Missouri



Soil Map may not be valid at this scale.

Map Scale: 1:3,520 if printed on A landscape (11" x 8.5") sheet.



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



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

9/12/2022
Page 1 of 4

MAP LEGEND**Area of Interest (AOI)**
 Area of Interest (AOI)
Soils**Soil Rating Polygons**

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

Soil Rating Lines

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

Soil Rating Points

-  A
-  A/D
-  B
-  B/D

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

Water Features
 Streams and Canals
Transportation

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

Background
 Aerial Photography
MAP INFORMATION

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

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 23, Sep 1, 2021

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

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

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10000	Arisburg silt loam, 1 to 5 percent slopes	C	1.5	2.3%
10117	Sampsel silty clay loam, 5 to 9 percent slopes	C/D	24.5	37.5%
10120	Sharpsburg silt loam, 2 to 5 percent slopes	C	0.9	1.4%
10122	Sharpsburg silt loam, 5 to 9 percent slopes, eroded	C	2.1	3.2%
10128	Sharpsburg-Urban land complex, 2 to 5 percent slopes	D	32.0	49.0%
10180	Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes	C	1.9	2.9%
30080	Greenton silty clay loam, 5 to 9 percent slopes	C/D	2.4	3.7%
Totals for Area of Interest			65.4	100.0%

Description

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

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

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

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

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

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

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

Rating Options

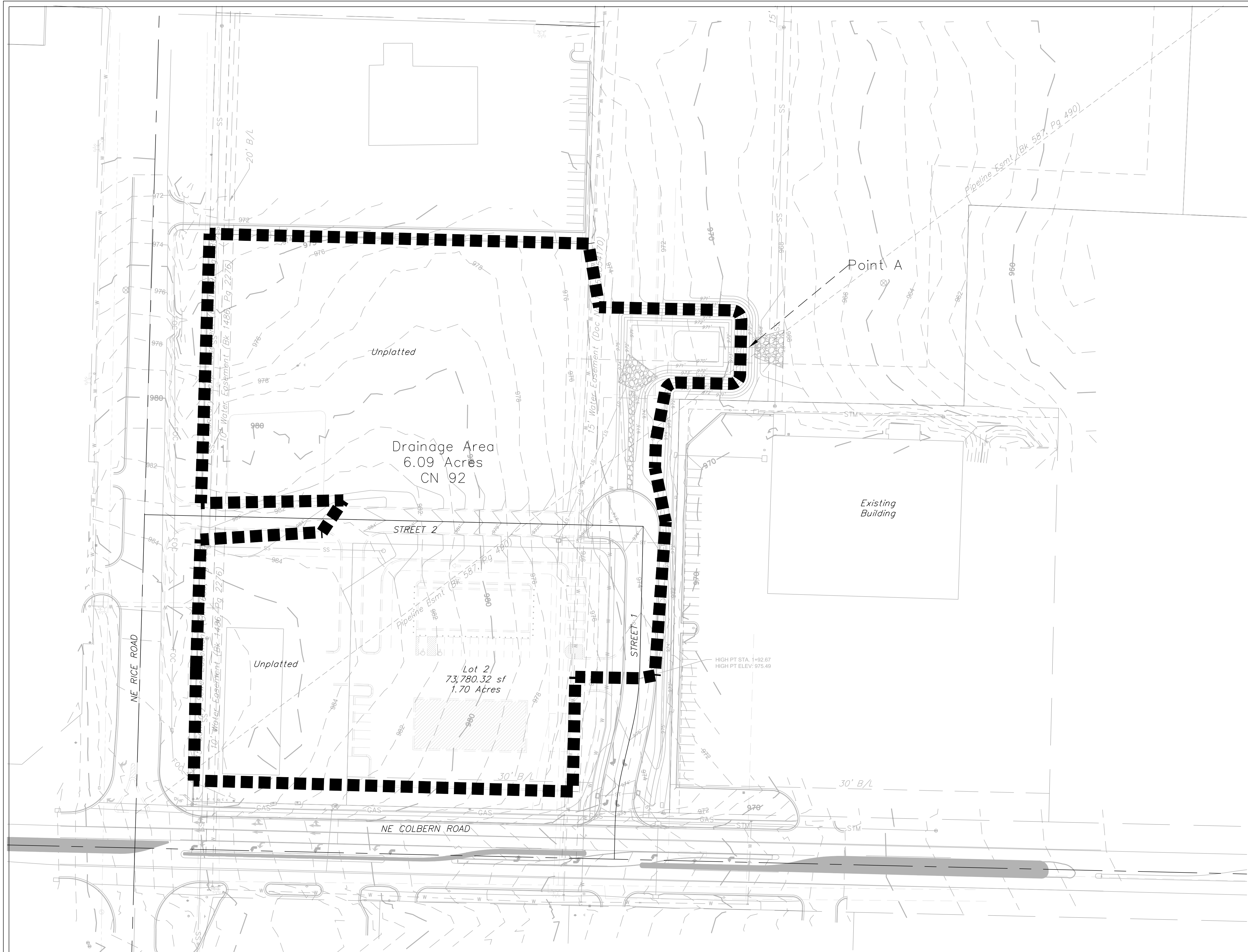
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Exhibit D

Drainage Map





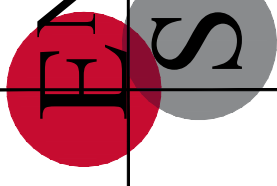
North



0 50' 100' 200'

DRAINAGE AREA MAP

SCALE: 1" = 100'



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Oklahoma
Engineering 6254

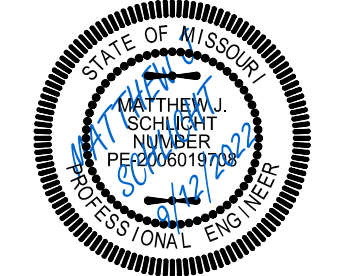
Nebraska
Engineering CA2821

Project: COLBERN ROAD INVESTMENTS L&MO

Issue Date: September 12, 2022

Drainage Area Map
Construction Plans for:
Colbern Road Investments
Lee's Summit, Jackson County, Missouri

Colbern Road Investments
Lee's Summit, Jackson County, Missouri



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

REVISIONS

Figure 1

Exhibit E

Complete Hydraflow Report Combination Emergency Spillway Analysis

Hydraflow Table of Contents

COLBERN ROAD.gpw

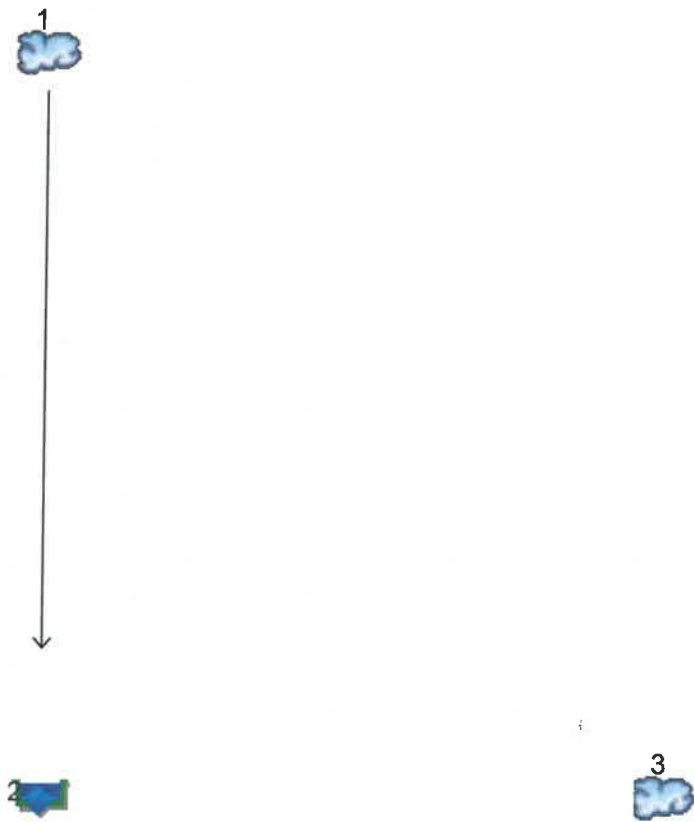
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Monday, 09 / 12 / 2022

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Watershed Model Schematic

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021



Legend

Hyd.	Origin	Description
1	SCS Runoff	SITE RUNOFF
2	Reservoir	TEMP BASIN
3	SCS Runoff	Existing

[illegible]

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

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	29.98	1	717	64,703	----	----	----	SITE RUNOFF
2	Reservoir	11.01	1	724	64,701	1	971.90	15,956	TEMP BASIN
3	SCS Runoff	10.90	1	720	25,204	----	----	----	Existing
COLBERN ROAD.gpw					Return Period: 2 Year			Monday, 09 / 12 / 2022	

Hydrograph Report

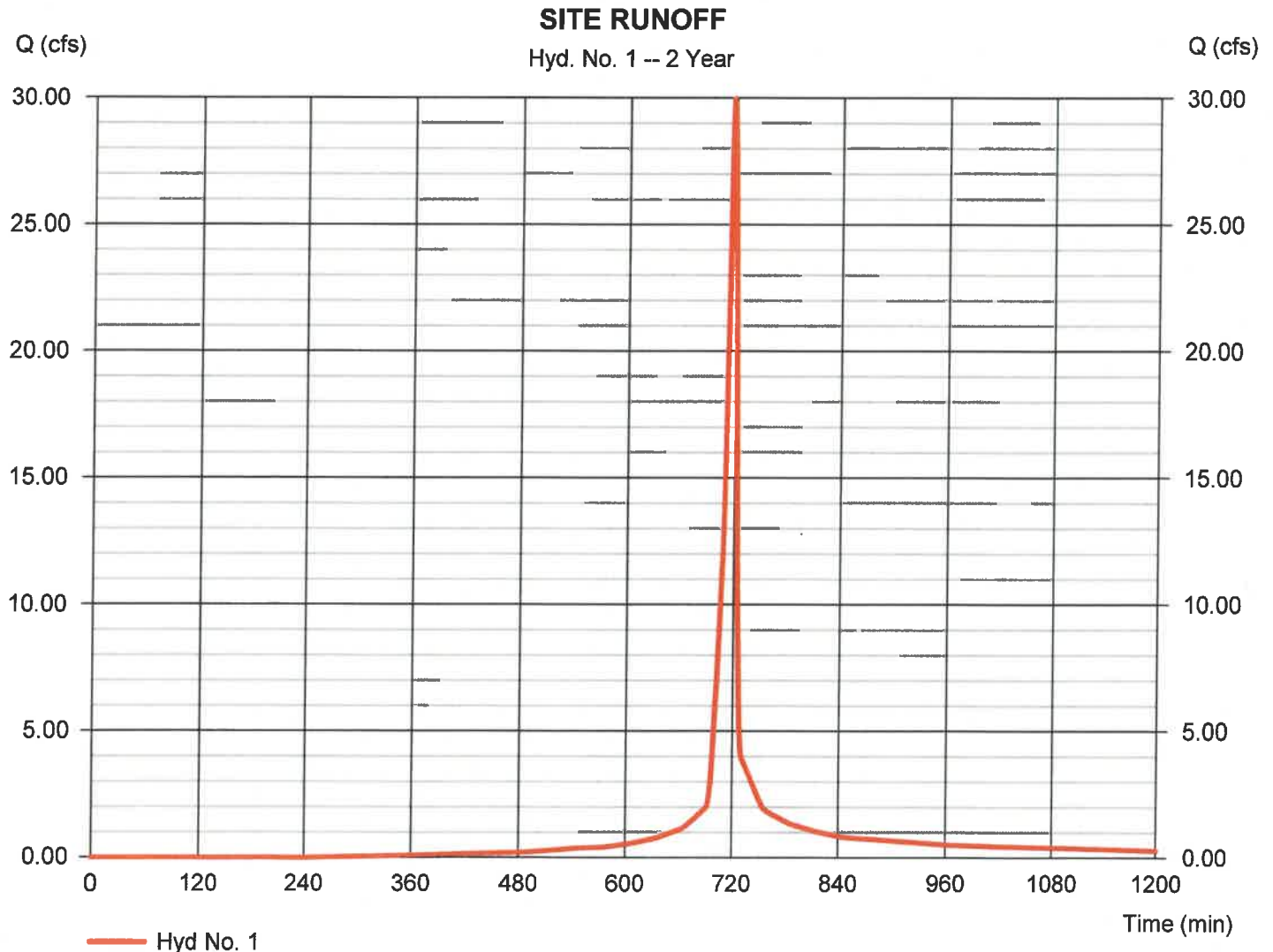
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

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Hyd. No. 1

SITE RUNOFF

Hydrograph type	= SCS Runoff	Peak discharge	= 29.98 cfs
Storm frequency	= 2 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 64,703 cuft
Drainage area	= 6.090 ac	Curve number	= 92
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.71 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

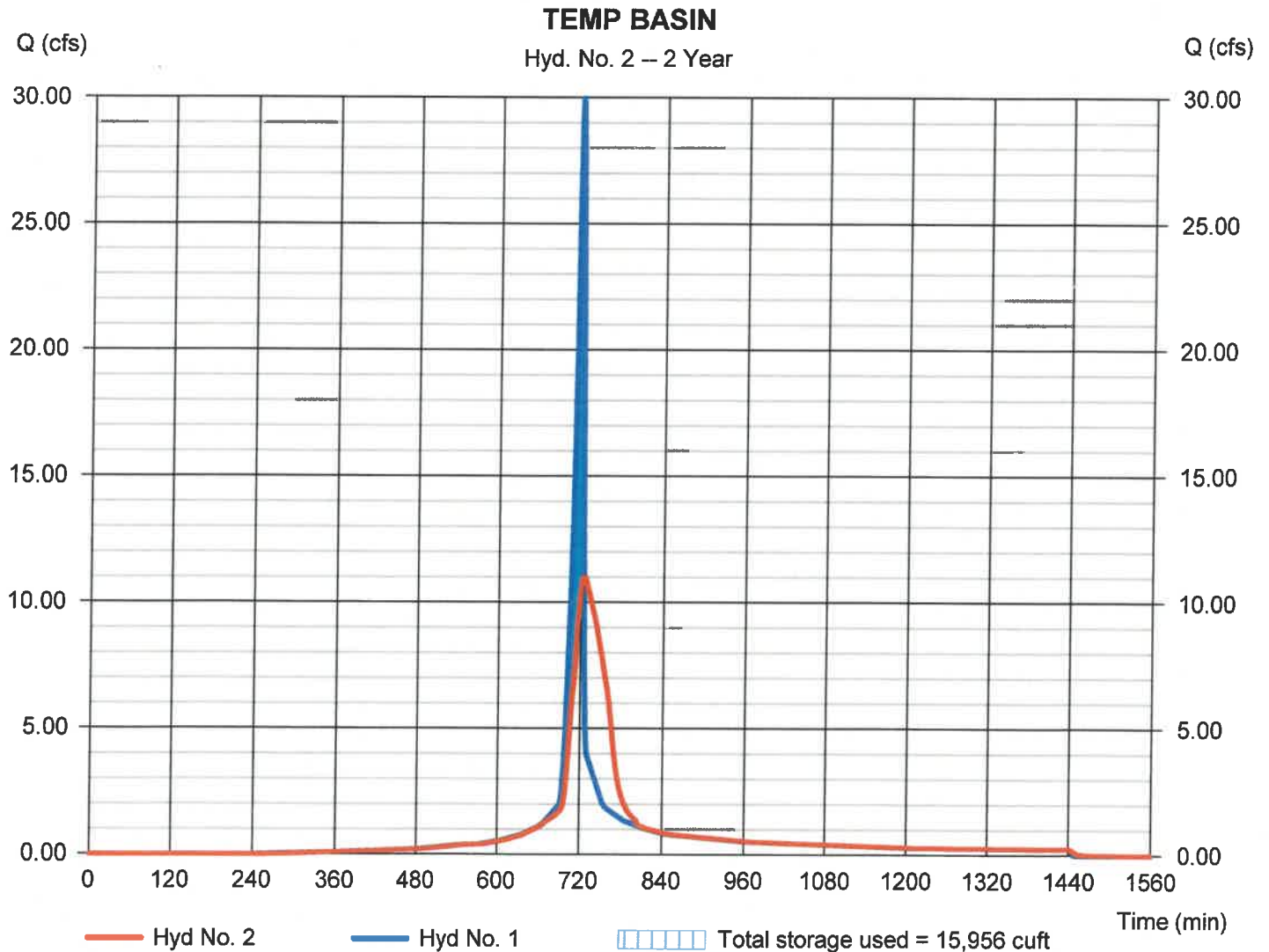
Monday, 09 / 12 / 2022

Hyd. No. 2

TEMP BASIN

Hydrograph type	= Reservoir	Peak discharge	= 11.01 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 64,701 cuft
Inflow hyd. No.	= 1 - SITE RUNOFF	Max. Elevation	= 971.90 ft
Reservoir name	= TEMP BASIN	Max. Storage	= 15,956 cuft

Storage Indication method used.



Pond Report

6

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Monday, 09 / 12 / 2022

Pond No. 1 - TEMP BASIN

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 968.50 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	968.50	00	0	0
0.50	969.00	1,803	300	300
1.50	970.00	5,198	3,354	3,654
2.50	971.00	6,332	5,755	9,409
3.50	972.00	8,259	7,273	16,683
4.50	973.00	13,467	10,756	27,439
5.50	974.00	15,832	14,632	42,071
6.50	975.00	18,535	17,164	59,235

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 15.00	5.00	0.00	0.00
Span (in)	= 15.00	5.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 968.50	968.50	0.00	0.00
Length (ft)	= 967.50	1.00	0.00	0.00
Slope (%)	= 2.27	1.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 55.00	0.00	0.00	0.00
Crest El. (ft)	= 975.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
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	968.50	0.00	0.00	---	---	0.00	---	---	---	---	---	0.000
0.05	30	968.55	0.01 ic	0.01 oc	---	---	0.00	---	---	---	---	---	0.018
0.10	60	968.60	0.05 ic	0.02 oc	---	---	0.00	---	---	---	---	---	0.065
0.15	90	968.65	0.11 ic	0.03 oc	---	---	0.00	---	---	---	---	---	0.138
0.20	120	968.70	0.19 ic	0.04 oc	---	---	0.00	---	---	---	---	---	0.234
0.25	150	968.75	0.30 ic	0.05 oc	---	---	0.00	---	---	---	---	---	0.353
0.30	180	968.80	0.42 ic	0.07 oc	---	---	0.00	---	---	---	---	---	0.490
0.35	210	968.85	0.57 ic	0.08 oc	---	---	0.00	---	---	---	---	---	0.645
0.40	240	968.90	0.73 ic	0.09 oc	---	---	0.00	---	---	---	---	---	0.816
0.45	270	968.95	0.91 ic	0.18 oc	---	---	0.00	---	---	---	---	---	1.090
0.50	300	969.00	1.10 ic	0.26 oc	---	---	1.00	---	---	---	---	---	1.368
0.60	636	969.10	1.54 ic	0.38 oc	---	---	0.00	---	---	---	---	---	1.918
0.70	971	969.20	2.02 ic	0.46 ic	---	---	0.00	---	---	---	---	---	2.476
0.80	1,307	969.30	2.53 ic	0.50 ic	---	---	0.00	---	---	---	---	---	3.032
0.90	1,642	969.40	3.05 ic	0.55 ic	---	---	0.00	---	---	---	---	---	3.601
1.00	1,977	969.50	3.58 ic	0.58 ic	---	---	0.00	---	---	---	---	---	4.168
1.10	2,313	969.60	4.08 ic	0.62 ic	---	---	0.00	---	---	---	---	---	4.705
1.20	2,648	969.70	4.52 ic	0.65 ic	---	---	0.00	---	---	---	---	---	5.169
1.30	2,984	969.80	4.85 ic	0.69 ic	---	---	0.00	---	---	---	---	---	5.539
1.40	3,319	969.90	5.20 ic	0.72 ic	---	---	0.00	---	---	---	---	---	5.917
1.50	3,654	970.00	5.53 ic	0.75 ic	---	---	0.00	---	---	---	---	---	6.273
1.60	4,230	970.10	5.83 ic	0.77 ic	---	---	0.00	---	---	---	---	---	6.608
1.70	4,805	970.20	6.13 ic	0.80 ic	---	---	0.00	---	---	---	---	---	6.927
1.80	5,381	970.30	6.40 ic	0.83 ic	---	---	0.00	---	---	---	---	---	7.232
1.90	5,956	970.40	6.67 ic	0.85 ic	---	---	0.00	---	---	---	---	---	7.525
2.00	6,532	970.50	6.93 ic	0.88 ic	---	---	0.00	---	---	---	---	---	7.806
2.10	7,107	970.60	7.18 ic	0.90 ic	---	---	0.00	---	---	---	---	---	8.078
2.20	7,683	970.70	7.41 ic	0.93 ic	---	---	0.00	---	---	---	---	---	8.341
2.30	8,258	970.80	7.65 ic	0.95 ic	---	---	0.00	---	---	---	---	---	8.595
2.40	8,834	970.90	7.87 ic	0.97 ic	---	---	0.00	---	---	---	---	---	8.843
2.50	9,409	971.00	8.09 ic	0.99 ic	---	---	0.00	---	---	---	---	---	9.084
2.60	10,137	971.10	8.30 ic	1.02 ic	---	---	0.00	---	---	---	---	---	9.318
2.70	10,864	971.20	8.51 ic	1.04 ic	---	---	0.00	---	---	---	---	---	9.547

Continues on next page...

TEMP BASIN

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
2.80	11,591	971.30	8.71 ic	1.06 ic	---	---	0.00	---	---	---	---	---	9.770
2.90	12,319	971.40	8.91 ic	1.08 ic	---	---	0.00	---	---	---	---	---	9.988
3.00	13,046	971.50	9.10 ic	1.10 ic	---	---	0.00	---	---	---	---	---	10.20
3.10	13,773	971.60	9.29 ic	1.12 ic	---	---	0.00	---	---	---	---	---	10.41
3.20	14,501	971.70	9.48 ic	1.14 ic	---	---	0.00	---	---	---	---	---	10.62
3.30	15,228	971.80	9.66 ic	1.15 ic	---	---	0.00	---	---	---	---	---	10.82
3.40	15,955	971.90	9.84 ic	1.17 ic	---	---	0.00	---	---	---	---	---	11.01
3.50	16,683	972.00	9.94 oc	1.19 ic	---	---	0.00	---	---	---	---	---	11.13
3.60	17,758	972.10	9.96 oc	1.21 ic	---	---	0.00	---	---	---	---	---	11.17
3.70	18,834	972.20	9.98 oc	1.23 ic	---	---	0.00	---	---	---	---	---	11.20
3.80	19,910	972.30	10.00 oc	1.24 ic	---	---	0.00	---	---	---	---	---	11.24
3.90	20,985	972.40	10.02 oc	1.26 ic	---	---	0.00	---	---	---	---	---	11.28
4.00	22,061	972.50	10.04 oc	1.28 ic	---	---	0.00	---	---	---	---	---	11.32
4.10	23,137	972.60	10.06 oc	1.29 ic	---	---	0.00	---	---	---	---	---	11.35
4.20	24,212	972.70	10.08 oc	1.31 ic	---	---	0.00	---	---	---	---	---	11.39
4.30	25,288	972.80	10.10 oc	1.33 ic	---	---	0.00	---	---	---	---	---	11.43
4.40	26,364	972.90	10.12 oc	1.34 ic	---	---	0.00	---	---	---	---	---	11.46
4.50	27,439	973.00	10.14 oc	1.36 ic	---	---	0.00	---	---	---	---	---	11.50
4.60	28,902	973.10	10.16 oc	1.38 ic	---	---	0.00	---	---	---	---	---	11.54
4.70	30,366	973.20	10.18 oc	1.39 ic	---	---	0.00	---	---	---	---	---	11.57
4.80	31,829	973.30	10.20 oc	1.41 ic	---	---	0.00	---	---	---	---	---	11.61
4.90	33,292	973.40	10.22 oc	1.42 ic	---	---	0.00	---	---	---	---	---	11.64
5.00	34,755	973.50	10.24 oc	1.44 ic	---	---	0.00	---	---	---	---	---	11.68
5.10	36,218	973.60	10.26 oc	1.45 ic	---	---	0.00	---	---	---	---	---	11.71
5.20	37,682	973.70	10.28 oc	1.47 ic	---	---	0.00	---	---	---	---	---	11.75
5.30	39,145	973.80	10.30 oc	1.48 ic	---	---	0.00	---	---	---	---	---	11.78
5.40	40,608	973.90	10.32 oc	1.50 ic	---	---	0.00	---	---	---	---	---	11.81
5.50	42,071	974.00	10.34 oc	1.51 ic	---	---	0.00	---	---	---	---	---	11.85
5.60	43,788	974.10	10.36 oc	1.52 ic	---	---	0.00	---	---	---	---	---	11.88
5.70	45,504	974.20	10.38 oc	1.54 ic	---	---	0.00	---	---	---	---	---	11.92
5.80	47,221	974.30	10.40 oc	1.55 ic	---	---	0.00	---	---	---	---	---	11.95
5.90	48,937	974.40	10.42 oc	1.57 ic	---	---	0.00	---	---	---	---	---	11.98
6.00	50,653	974.50	10.44 oc	1.58 ic	---	---	0.00	---	---	---	---	---	12.02
6.10	52,370	974.60	10.46 oc	1.59 ic	---	---	0.00	---	---	---	---	---	12.05
6.20	54,086	974.70	10.48 oc	1.61 ic	---	---	0.00	---	---	---	---	---	12.08
6.30	55,803	974.80	10.50 oc	1.62 ic	---	---	0.00	---	---	---	---	---	12.12
6.40	57,519	974.90	10.51 oc	1.63 ic	---	---	0.00	---	---	---	---	---	12.15
6.50	59,235	975.00	10.53 oc	1.65 ic	---	---	0.00	---	---	---	---	---	12.18

...End

Hydrograph Report

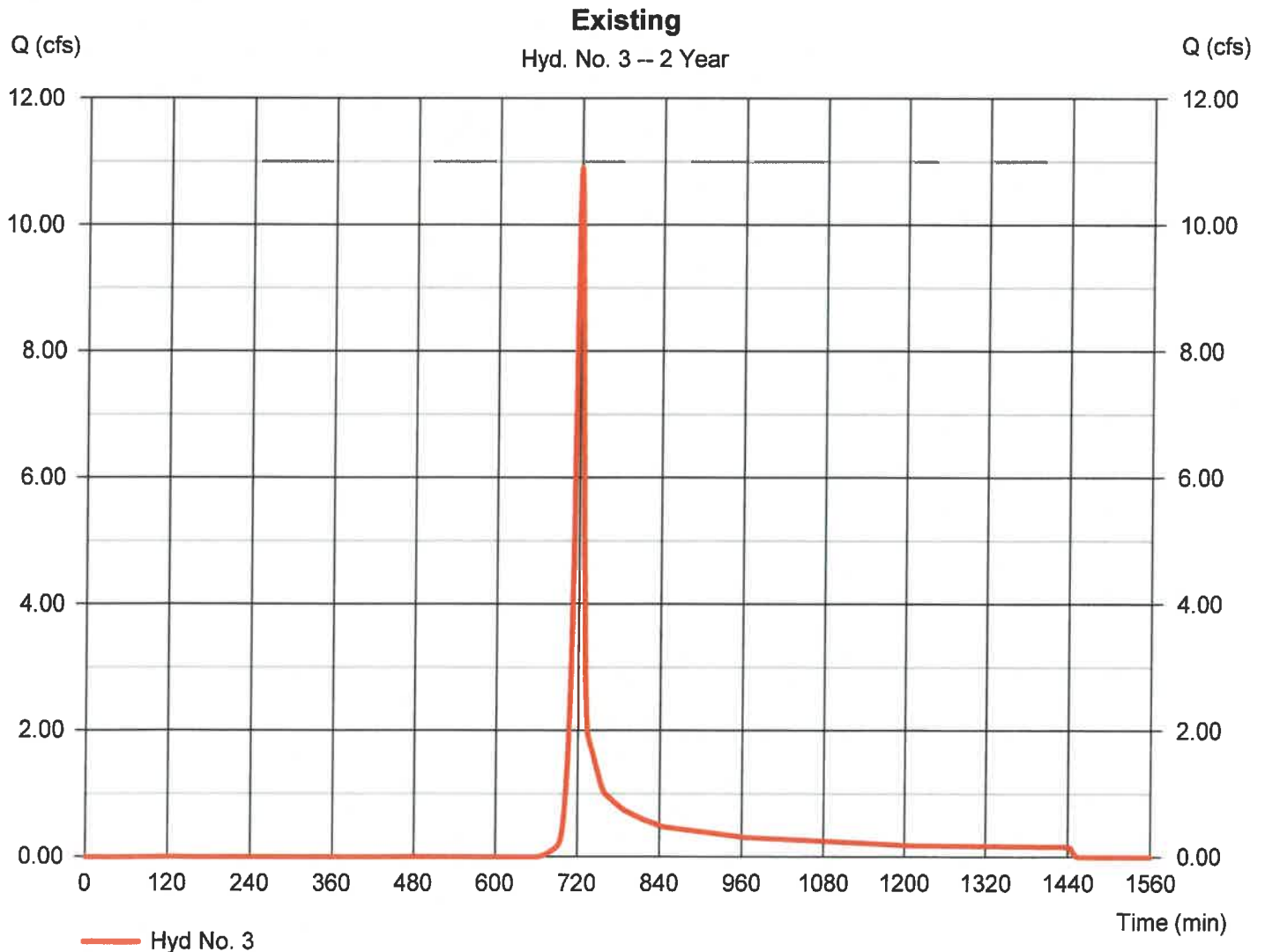
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Monday, 09 / 12 / 2022

Hyd. No. 3

Existing

Hydrograph type	= SCS Runoff	Peak discharge	= 10.90 cfs
Storm frequency	= 2 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 25,204 cuft
Drainage area	= 6.090 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 3.71 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

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	44.06	1	717	97,682	-----	-----	-----	SITE RUNOFF
2	Reservoir	11.50	1	725	97,681	1	972.99	27,349	TEMP BASIN
3	SCS Runoff	21.35	1	720	48,321	-----	-----	-----	Existing
COLBERN ROAD.gpw					Return Period: 10 Year			Monday, 09 / 12 / 2022	

Hydrograph Report

10

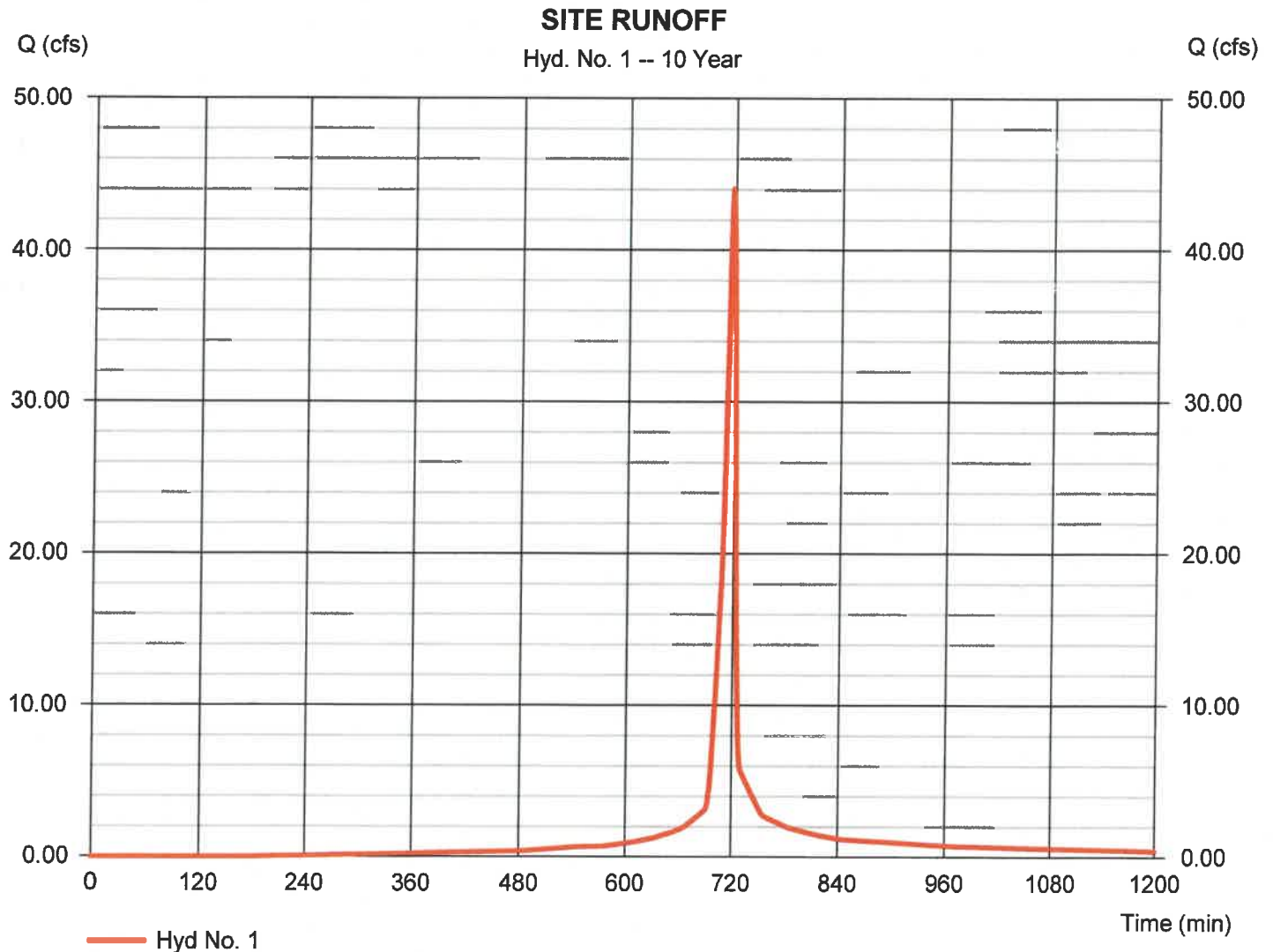
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Monday, 09 / 12 / 2022

Hyd. No. 1

SITE RUNOFF

Hydrograph type	= SCS Runoff	Peak discharge	= 44.06 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 97,682 cuft
Drainage area	= 6.090 ac	Curve number	= 92
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

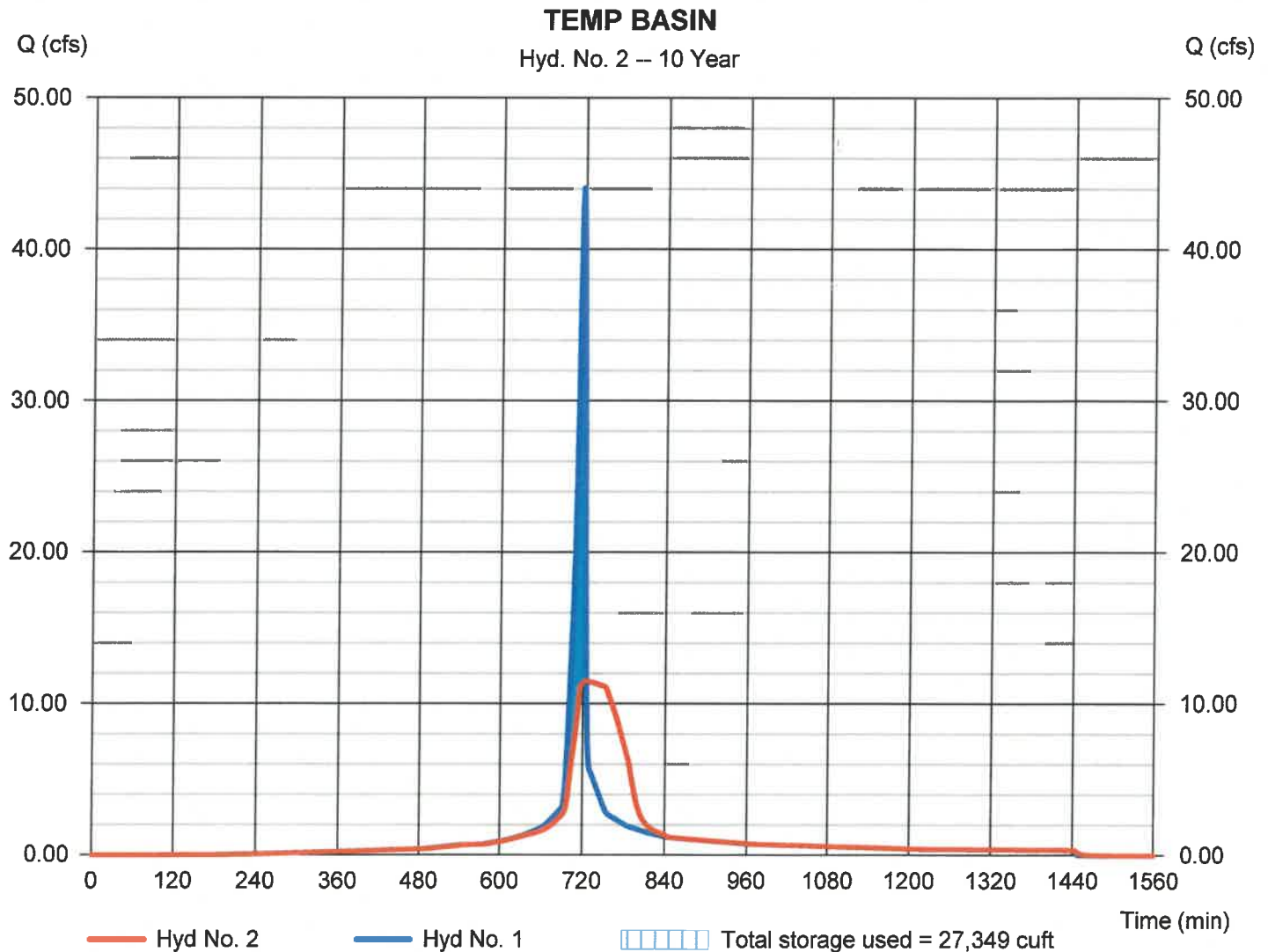
Monday, 09 / 12 / 2022

Hyd. No. 2

TEMP BASIN

Hydrograph type	= Reservoir	Peak discharge	= 11.50 cfs
Storm frequency	= 10 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 97,681 cuft
Inflow hyd. No.	= 1 - SITE RUNOFF	Max. Elevation	= 972.99 ft
Reservoir name	= TEMP BASIN	Max. Storage	= 27,349 cuft

Storage Indication method used.



Hydrograph Report

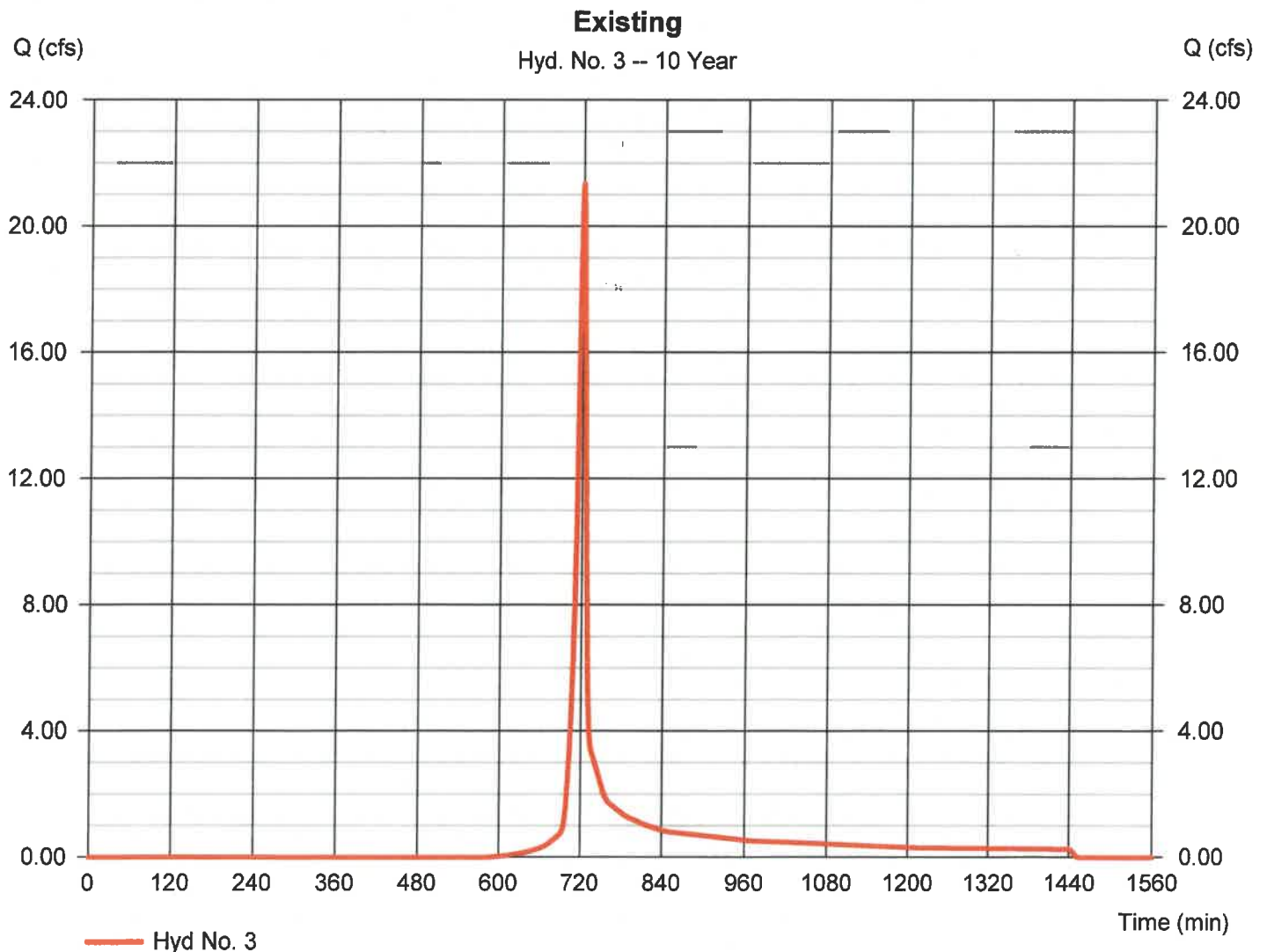
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Monday, 09 / 12 / 2022

Hyd. No. 3

Existing

Hydrograph type	= SCS Runoff	Peak discharge	= 21.35 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 48,321 cuft
Drainage area	= 6.090 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

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	68.29	1	717	156,061	-----	-----	-----	SITE RUNOFF
2	Reservoir	11.99	1	727	156,059	1	974.42	49,316	TEMP BASIN
3	SCS Runoff	41.82	1	719	94,902	-----	-----	-----	Existing
COLBERN ROAD.gpw					Return Period: 100 Year			Monday, 09 / 12 / 2022	

Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

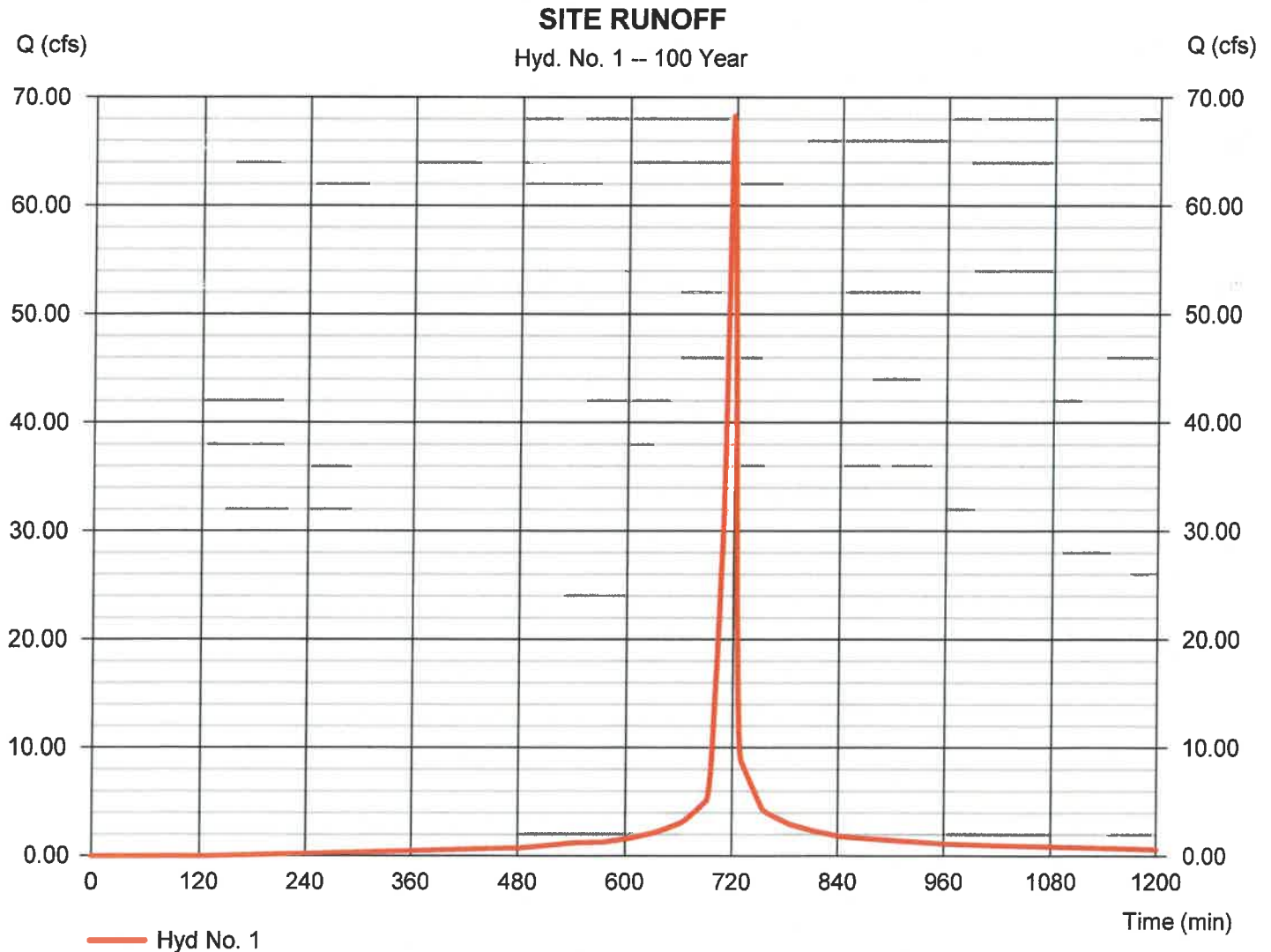
Monday, 09 / 12 / 2022

Hyd. No. 1

SITE RUNOFF

Hydrograph type = SCS Runoff
 Storm frequency = 100 yrs
 Time interval = 1 min
 Drainage area = 6.090 ac
 Basin Slope = 0.0 %
 Tc method = User
 Total precip. = 7.80 in
 Storm duration = 24 hrs

Peak discharge = 68.29 cfs
 Time to peak = 717 min
 Hyd. volume = 156,061 cuft
 Curve number = 92
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 5.00 min
 Distribution = Type II
 Shape factor = 484



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

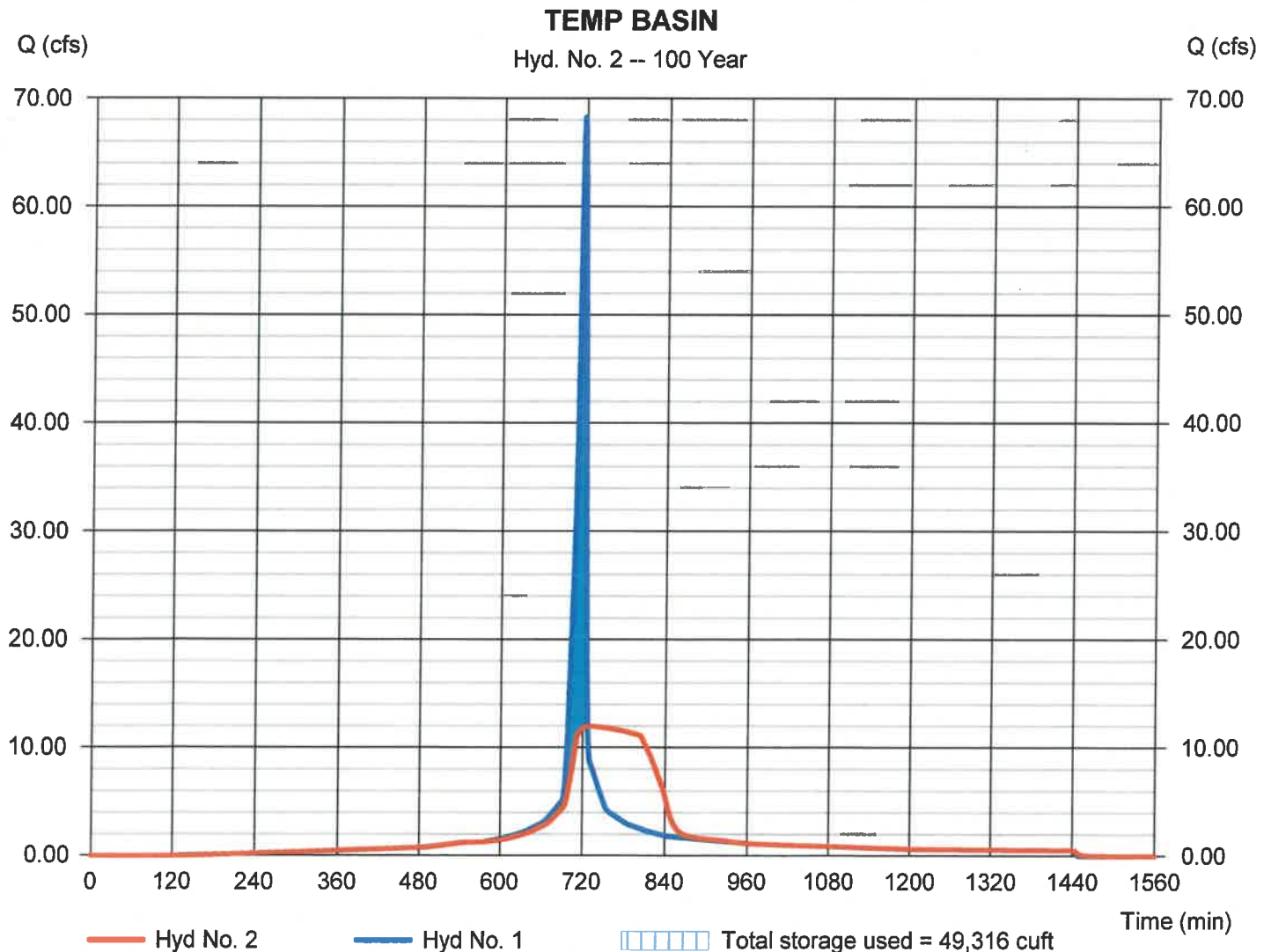
Monday, 09 / 12 / 2022

Hyd. No. 2

TEMP BASIN

Hydrograph type	= Reservoir	Peak discharge	= 11.99 cfs
Storm frequency	= 100 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 156,059 cuft
Inflow hyd. No.	= 1 - SITE RUNOFF	Max. Elevation	= 974.42 ft
Reservoir name	= TEMP BASIN	Max. Storage	= 49,316 cuft

Storage Indication method used.



Hydrograph Report

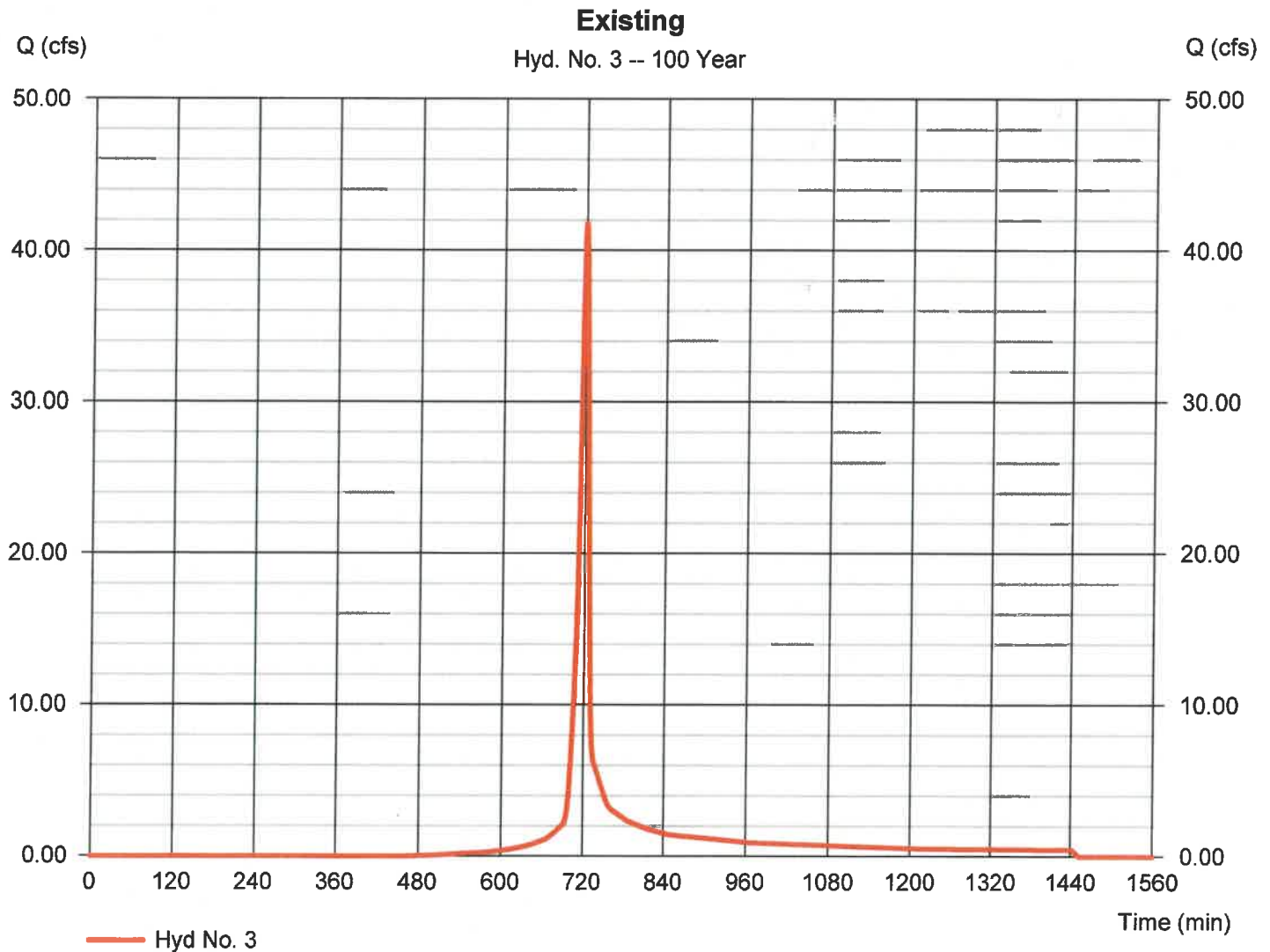
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Monday, 09 / 12 / 2022

Hyd. No. 3

Existing

Hydrograph type	= SCS Runoff	Peak discharge	= 41.82 cfs
Storm frequency	= 100 yrs	Time to peak	= 719 min
Time interval	= 1 min	Hyd. volume	= 94,902 cuft
Drainage area	= 6.090 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 7.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Monday, 09 / 12 / 2022

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	-----
2	79.5706	15.0000	0.8977	-----
3	0.0000	0.0000	0.0000	-----
5	100.0945	17.1000	0.8850	-----
10	90.6951	15.4000	0.8336	-----
25	112.5419	15.8000	0.8190	-----
50	135.5891	16.1000	0.8156	-----
100	160.7297	16.8000	0.8186	-----

File name: APWA 2011 K.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.41	4.42	3.76	3.27	2.90	2.61	2.37	2.18	2.02	1.88	1.76	1.65
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	6.47	5.40	4.65	4.09	3.66	3.31	3.03	2.79	2.59	2.42	2.27	2.14
10	7.34	6.12	5.27	4.64	4.16	3.77	3.46	3.19	2.97	2.78	2.62	2.47
25	9.37	7.86	6.80	6.01	5.40	4.91	4.51	4.18	3.89	3.65	3.44	3.25
50	11.27	9.48	8.22	7.28	6.55	5.96	5.48	5.08	4.74	4.44	4.19	3.96
100	12.90	10.89	9.47	8.40	7.57	6.90	6.35	5.89	5.50	5.16	4.86	4.60

Tc = time in minutes. Values may exceed 60.

Precip. file name: C:\API\Hydraflow\Town Centre LSMO.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	3.71	0.00	3.30	5.20	6.00	6.80	7.80
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