PRELIMINARY DETENTION CALCULATIONS

ZINFANDEL SUBDIVISION
1583 EL CENTRO AVENUE
NAPA, CALIFORNIA 94558

Trinity Project, LLC

Project #4117017.0

September 15, 2023

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INTRODUCTION

In order to satisfy the City of Napa Drainage Design Standard Section 2.10.02, which states that projects must provide detention of stormwater such that peak flows do not exceed predeveloped runoff rates, the TR-55 method was used to demonstrate the peak runoff rates of the site in both the pre- and post-developed conditions. The calculations were then used to determine the on-site storage volumes necessary to limit post-development rates below the pre-developed conditions. Because the project site is located within the Salvador Basin and proposes more than 4 residential units, it is required to detain up to the 100-year design storm. Based on these calculations, as summarized in the Conclusion in Appendix C, the site has adequate storage capacity in the bioretention/detention facilities to detain the post-development peak flows as required.

The method used for this calculation is hydrograph analysis. The unit hydrograph rainfall distribution for the City of Napa falls under Type IA-distribution. The SCS hydrograph analysis is based on the National Resources Conservation Service Technical Release 55 for Urban Hydrology for Small Watersheds (TR-55) method (refer to Appendix B for Hydrograph Calculation Parameters).

There are two watersheds considered in this calculation. The larger Watershed #1 consists of the northern portion of the site between El Centro Avenue and Salvador Creek, while the smaller Watershed #2 consists of the remaining portion of the site south of Salvador Creek.

EXISTING CONDITIONS

The entire site, including Watersheds #1 & #2, currently drains to Salvador Creek at the eastern limit of the project. An exhibit showing the existing watersheds and time of concentration flow summary can be found in Appendix A.

PROPOSED CONDITIONS

Combination bioretention/detention facilities will be provided to detain runoff and mitigate peak flows. Portions of the developed site are not feasible to be captured and detained, including the new frontage along El Centro Avenue and the terraces along Salvador Creek. Therefore, both Watersheds #1 & #2 have portions that will be detained and portions that will not be detained. Total post-development flow was calculated by summing the detained and undetained portions for comparison with pre-development conditions using the terminus at Salvador Creek.

Refer to Appendix A for Watershed Exhibits for the proposed detained and undetained watersheds with areas. The proposed runoff for the 100-year storm is shown in the Conclusion (refer to Appendix C for Detention Calculation using Hydraflow Hydrographs Extension).

CONCLUSION

These calculations identify and describe the impacts of the proposed Zinfandel Subdivision on the hydrologic characteristics of the site and quantify the necessary storage requirement for the detention facility. The storm drain system of Zinfandel Subdivision is designed such that the proposed post-developed flow discharge from the development will not exceed pre-developed levels in accordance with the City of Napa Drainage Standards.

Summary of hydrologic analysis:

FOR DETENTION BASIN #1

100-year Pre & Post Developed Flow Discharge

Pre-developed peak run-off = **8.663 cfs**

Post-developed (Undetained) peak run-off = 2.698 cfs
Post-developed (Detained) peak run-off = 5.912 cfs
Post-developed flow discharge = 8.61 cfs

Results
100-year: **8.61 cfs** (Post-developed) **≤ 8.663 cfs** (Pre-developed) **√**

Detention Volume Requirement

Detention volume required = 16,710 ft^3 or 0.3836 ac-ft
Detention volume provided * = 21,069 ft^3 or 0.4837 ac-ft

Results
Detention: **16,710 ft^3** (required) **≤ 21,069 ft^3** (provided) **√**

Orifice Requirement

The routing and detention are accomplished by a broad crested orifice in the metering structure within the bioretention and detention basin.

The required orifice dimensions are: 18 inches long & 9.2 inches high.

FOR DETENTION BASIN #2

100-year Pre & Post Developed Flow Discharge

Pre-developed peak run-off = **1.035 cfs**

Post-developed (Undetained) peak run-off = 0.411 cfs
Post-developed (Detained) peak run-off = 0.563 cfs
Post-developed flow discharge = 0.974 cfs

Results
100-year: **0.974 cfs** (Post-developed) **≤ 1.035 cfs** (Pre-developed) **√**

Detention Volume Requirement

Detention volume required = 1,740 ft^3 or 0.0399 ac-ft
Detention volume provided * = 2,024 ft^3 or 0.0465 ac-ft

Results
Detention: **1,740 ft^3** (required) **≤ 2,024 ft^3** (provided) **√**

Orifice Requirement

The routing and detention are accomplished by a broad crested orifice in the metering structure within the bioretention and detention basin.

The required orifice dimensions are: 8 inches long & 2 inches high.

Appendix A

Watershed Exhibits

EXISTING WATERSHED EXHIBIT FOR PRELIMINARY DETENTION SYSTEM CALCULATION

SCALE: 1" = 100'

EXISTING WATERSHED 1
= 9.14 ACRES

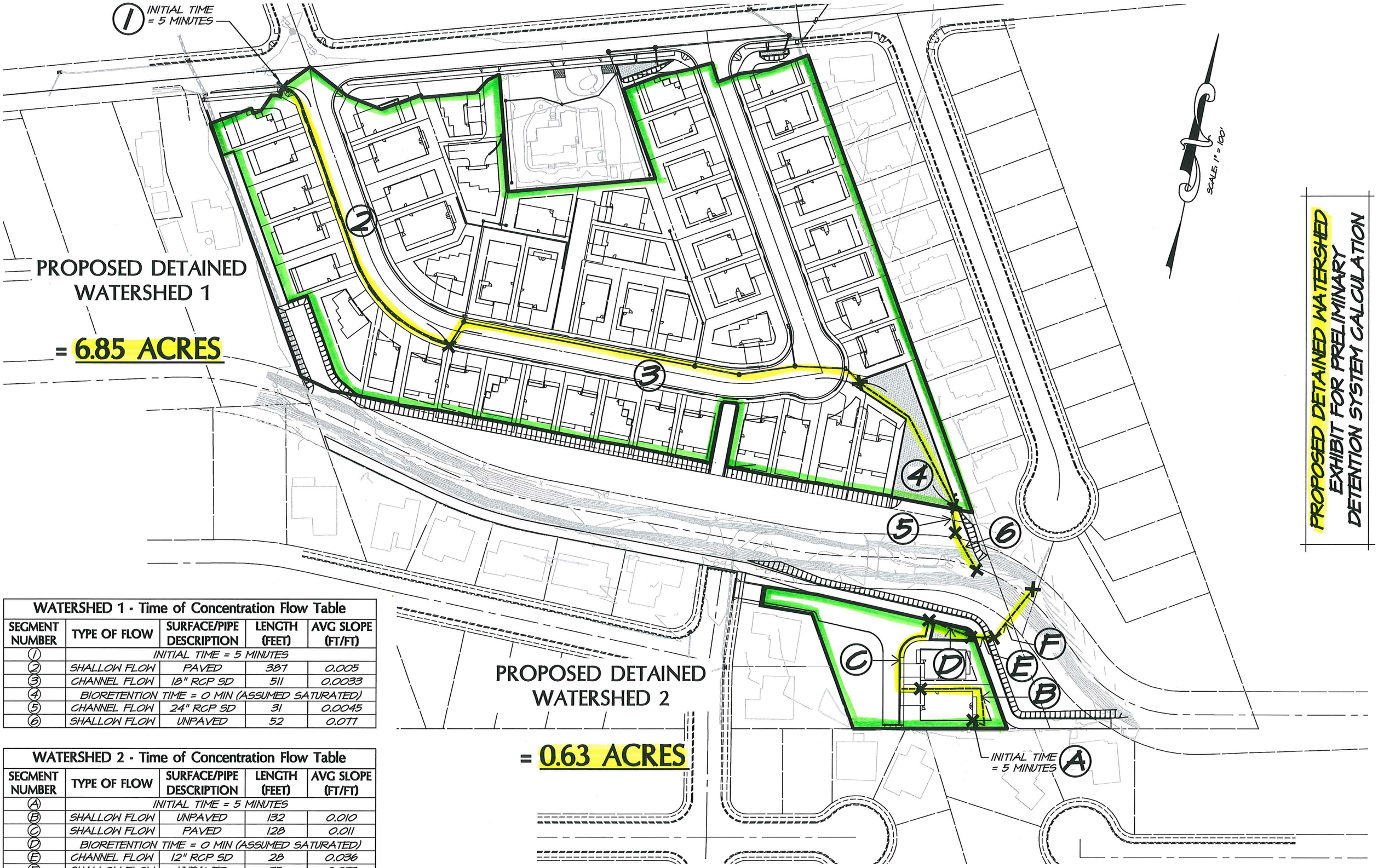
Open Space = 8.44 Acres
Impervious Areas = 0.70 Acres

EXISTING WATERSHED 2
= 0.95 ACRES

Open Space = 0.95 Acres
Impervious Areas = None

WATERSHED 1 - Time of Concentration Flow Table				
SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (FT/FT)
①	SHEET FLOW	VINEYARD	300	0.014
②	SHALLOW FLOW	UNPAVED	860	0.009

WATERSHED 2 - Time of Concentration Flow Table				
SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (FT/FT)
①	SHEET FLOW	SHORT GRASS	275	0.04



WATERSHED 1 - Time of Concentration Flow Table

SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (FT/FT)
1	INITIAL TIME = 5 MINUTES			
2	SHALLOW FLOW	PAVED	387	0.005
3	CHANNEL FLOW	18" RCP SD	511	0.0033
4	BIORETENTION TIME = 0 MIN (ASSUMED SATURATED)			
5	CHANNEL FLOW	24" RCP SD	31	0.0045
6	SHALLOW FLOW	UNPAVED	52	0.077

WATERSHED 2 - Time of Concentration Flow Table

SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (FT/FT)
A	INITIAL TIME = 5 MINUTES			
B	SHALLOW FLOW	UNPAVED	132	0.010
C	SHALLOW FLOW	PAVED	128	0.011
D	BIORETENTION TIME = 0 MIN (ASSUMED SATURATED)			
E	CHANNEL FLOW	12" RCP SD	28	0.036
F	SHALLOW FLOW	UNPAVED	75	0.077

PROPOSED UNDETAINED WATERSHED
EXHIBIT FOR PRELIMINARY
DETENTION SYSTEM CALCULATION

SCALE 1" = 100'

PROPOSED UNDETAINED
WATERSHED 1

= 2.30 ACRES

PROPOSED UNDETAINED
WATERSHED 2

= 0.32 ACRES

WATERSHED 1 - Time of Concentration Flow Table				
SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (FT/FT)
①	SHEET FLOW	SHORT GRASS	300	0.03
②	SHALLOW FLOW	UNPAVED	840	0.005

WATERSHED 2 - Time of Concentration Flow Table				
SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (FT/FT)
Ⓐ	SHEET FLOW	SHORT GRASS	300	0.03
Ⓑ	SHALLOW FLOW	UNPAVED	80	0.0125

Appendix B

Hydrograph Calculation Parameters

RUNOFF CURVE NUMBERS

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

USED TO CALCULATE EXISTING CN

PROPOSED CN

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

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

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

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

TABLE 2-2a (TR 55)

CURVE NUMBER CALCULATIONS

Worksheet: Runoff Curve Number (EXISTING)

Project	Zinfandel Subdivision	By	Ray	Date	8/30/2019
Location	Napa, California	Checked		Date	
Subshed name	Existing Watershed 1	Check one:	☑ Present	☐ Developed	

RUNOFF CURVE NUMBER

Soil name and hydrologic group (SCS book)	**Cover description** (cover type, treatment and hydrogic condition; percent impervious)	**CN (1)** (Table 2-2)	**Area** ☑ acres ☐ mi2 ☐ %	**Product of CN x Area**
145-D	Open Space (Grass Cover, Fair condition)	84	8.44	708.96
145-D	Impervious Areas (Paved Areas & Roofs)	98	0.70	68.60
(1) Use only one CN source per line		**TOTAL:**	9.14	777.56

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{777.56}{9.14} = 85.07$; **USE CN** **85**

Worksheet: Runoff Curve Number

Project	Zinfandel Subdivision	By	Ray	Date	8/30/2019
Location	Napa, California	Checked		Date	
Subshed name	Existing Watershed 2	Check one:	☑ Present	☐ Developed	

RUNOFF CURVE NUMBER

Soil name and hydrologic group (SCS book)	**Cover description** (cover type, treatment and hydrogic condition; percent impervious)	**CN (1)** (Table 2-2)	**Area** ☑ acres ☐ mi2 ☐ %	**Product of CN x Area**
116-D	Open Space (Grass Cover, Fair condition)	84	0.95	79.80
116-D	Impervious Areas (Paved Areas & Roofs)	98	0.00	0.00
		TOTAL:	0.95	79.80

(1) Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{79.80}{0.95} = 84.00$; **USE CN** **84**

2 OF 2

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods: [3]	
Light underbrush	0.40
Dense underbrush	0.80

[1] The n values are a composite of information compiled by Engman (1986).
[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3] When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

TABLE 3-1
ROUGHNESS COEFFICIENTS FOR SHEET FLOW

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bankfull elevation.

FREQUENCY	RAINFALL DEPTH/STORM DURATION, INCHES									
	5 M	15 M	1 HR	2 HR	3 HR	6 HR	12 HR	24 HR	2 D	4 D
2-YR	0.15	0.27	0.57	0.82	1.02	1.50	1.98	2.45	3.12	4.03
5-YR	0.20	0.38	0.80	1.16	1.42	2.12	2.79	3.44	4.51	5.77
10-YR	0.25	0.46	0.97	1.39	1.70	2.53	3.33	4.12	5.42	6.94
25-YR	0.30	0.56	1.16	1.66	2.04	3.03	4.00	4.95	6.63	8.38
50-YR	0.32	0.62	1.30	1.87	2.29	3.40	4.48	5.56	7.49	9.44
100-YR	0.36	0.69	1.44	2.07	2.54	3.76	4.96	6.14	8.33	10.45
500-YR	0.45	0.85	1.78	2.55	3.14	4.67	6.15	7.60	10.50	13.01

CHART IS FROM CITY OF NAPA 2006 STORM DRAINAGE MASTER PLAN TABLE 3-2

CITY OF NAPA

PUBLIC WORKS DEPARTMENT

RAINFALL DEPTH - DURATION

DRAWN BY:	BRL	CHECKED BY:	TCW
DATE:	05/2018	APPROVED BY:	JRL
SCALE:	NONE	DRAWING NO.	TABLE-2.2
FIELD NOTES:			

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122° 19' 2" W

122° 18' 43" W

38° 20' 10" N

38° 20' 0" N

Map Scale: 1:2,120 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 30 60 120 180

Feet
0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84

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: Napa County, California
Survey Area Data: Version 10, Sep 25, 2017

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

Date(s) aerial images were photographed: Apr 17, 2015—Oct 18, 2016

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
116	Clear Lake clay, drained, 0 to 2 percent slopes, MLRA 14	D	1.2	11.9%
145	Haire loam, 0 to 2 percent slopes	D	9.2	88.1%
Totals for Area of Interest			**10.5**	**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:

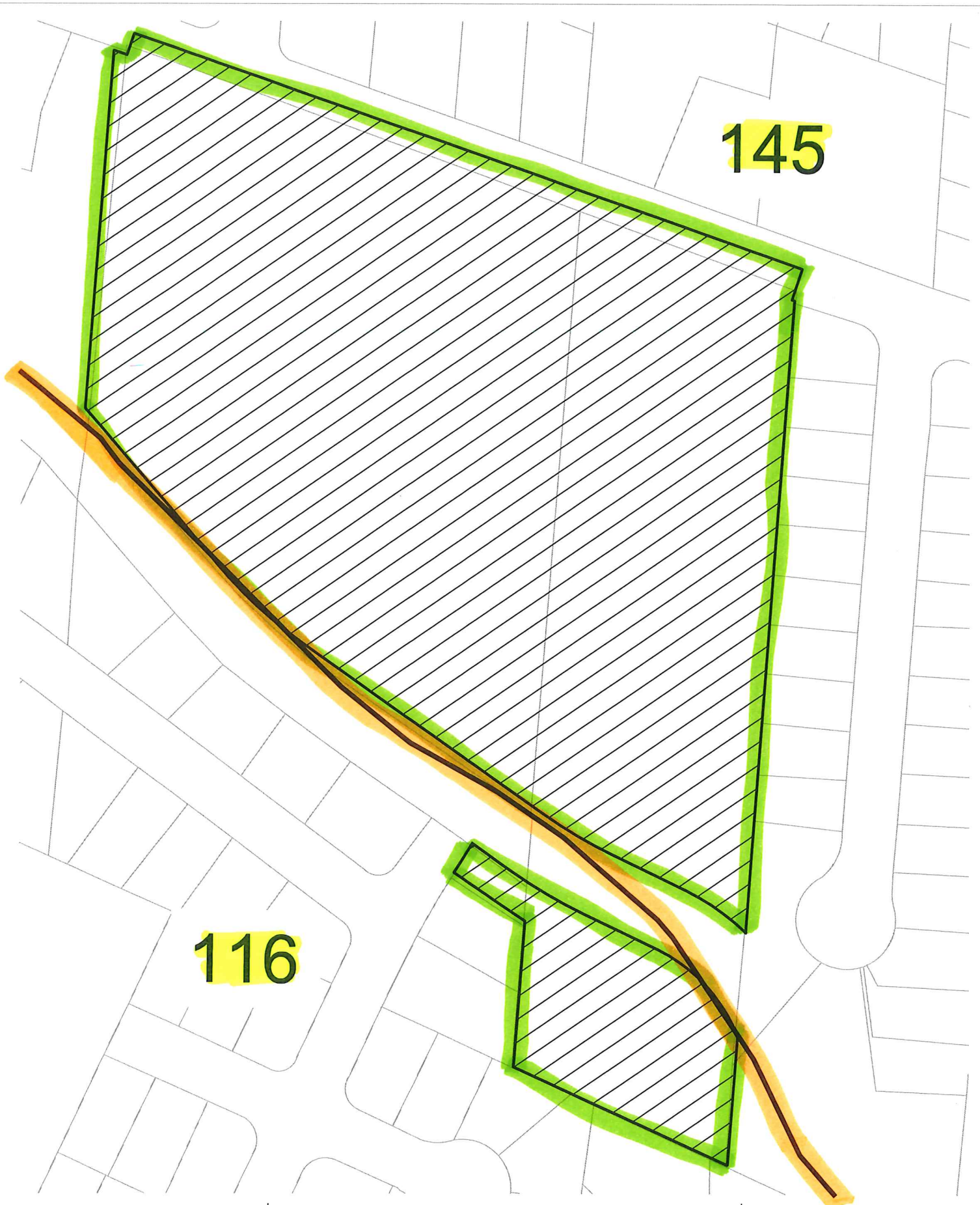
Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

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.



SCS SOIL CLASSIFICATION EXHIBIT
FOR PRELIMINARY
DETENTION SYSTEM CALCULATION

12. Pipe sizes.

As noted in Table 2.1, several options are available for use in estimating discharge for storm events. Table 2.2 provides the Design Depth Frequency (DDF) for selected storms and Table 2.3 shows Rainfall Intensity Duration.

TABLE 2.2 – RAINFALL DEPTH (DURATION)

	RAINFALL DEPTH/STORM DURATION (INCHES)									
DDF	**5M**	**15M**	**1HR**	**2HR**	**3HR**	**6HR**	**12 HR**	**24 HR**	**2D**	**4D**
2-YR	0.15	0.27	0.57	0.82	1.02	1.50	1.98	2.45	3.12	4.03
5-YR	0.20	0.38	0.80	1.16	1.42	2.12	2.79	3.44	4.51	5.77
10-YR	0.25	0.46	0.97	1.39	1.70	2.53	3.33	4.12	5.42	6.94
25-YR	0.30	0.56	1.16	1.66	2.04	3.03	4.00	4.95	6.63	8.38
50-YR	0.32	0.62	1.30	1.87	2.29	3.40	4.48	5.56	7.49	9.44
100-YR	0.36	0.69	1.44	2.07	2.54	3.76	4.96	6.14	8.33	10.45
500-YR	0.45	0.85	1.78	2.55	3.14	4.67	6.15	7.60	10.50	13.01

Source: City of Napa 2006 Storm Drainage Master Plan Table 3-1

TABLE 2.3 – RAINFALL INTENSITY (DURATION)

	RAINFALL DEPTH/STORM DURATION (INCHES PER HOUR)									
DDF	**5M**	**15M**	**1HR**	**2HR**	**3HR**	**6HR**	**12 HR**	**24 HR**	**2D**	**4D**
2-YR	1.80	1.08	0.80	0.41	0.34	0.25	0.16	0.10	0.06	0.04
5-YR	2.40	1.52	0.08	0.58	0.47	0.35	0.23	0.14	0.09	0.06
10-YR	3.00	1.84	0.97	0.70	0.57	0.42	0.28	0.17	0.11	0.07
25-YR	3.60	2.24	1.16	0.83	0.68	0.50	0.33	0.20	0.14	0.08
50-YR	3.84	2.48	1.30	0.94	0.76	0.57	0.37	0.23	0.16	0.10
100-YR	4.32	2.76	1.44	1.04	0.84	0.63	0.41	0.26	0.17	0.11
500-YR	5.40	3.40	1.78	1.28	1.04	0.78	0.51	0.32	0.22	0.14

Source: City of Napa 2006 Storm Drainage Master Plan Table 3-2

A. Rational Method

The 10-and 100-year peak runoff shall be determined for each analysis point using the Rational Method. The Rational Method provides reasonable estimates of peak runoff for small watersheds. The method relates a peak discharge for the project site, a runoff coefficient (C), and rainfall intensity (i). Runoff coefficients were found to vary between 0.35 and 0.90 for land use and storm frequency.

The Rational Method equation has the form: Q = CiA

Where:

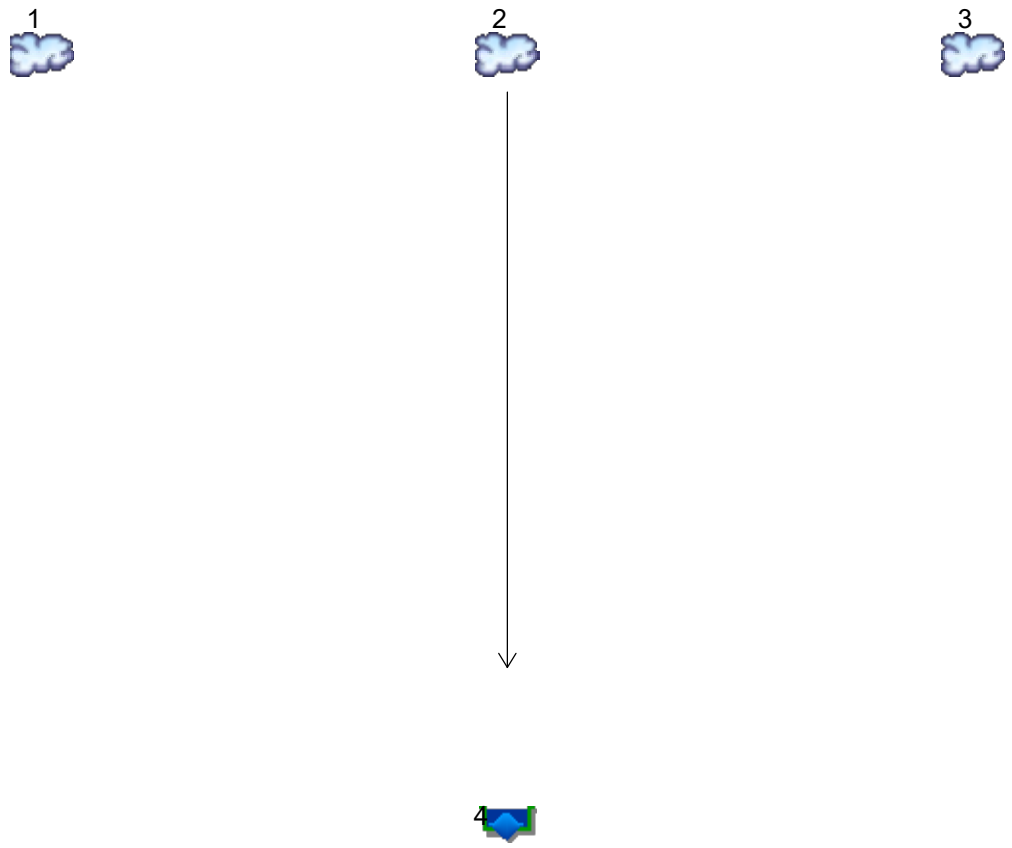
Q = rate of runoff, acre-inches per hour or cubic feet per second

C = runoff coefficient, which is the ratio of peak runoff to average rainfall intensity

Appendix C

Detention Calculations using Hydraflow

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	Existing 100-yr Watershed 1
2	SCS Runoff	Proposed Pre-Routed 100-yr Watershed 1
3	SCS Runoff	Proposed Undetained 100-yr Watershed 1
4	Reservoir	DETAINED ROUTED (100)

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	------	-------	-------	-------	-------	-------	-------	-------	8.663	Existing 100-yr Watershed 1
2	SCS Runoff	------	-------	-------	-------	-------	-------	-------	-------	9.121	Proposed Pre-Routed 100-yr Watersh
3	SCS Runoff	------	-------	-------	-------	-------	-------	-------	-------	2.698	Proposed Undetained 100-yr Watersh
4	Reservoir	2	-------	-------	-------	-------	-------	-------	-------	5.912	DETAINED ROUTED (100)

Hydrograph Summary Report

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

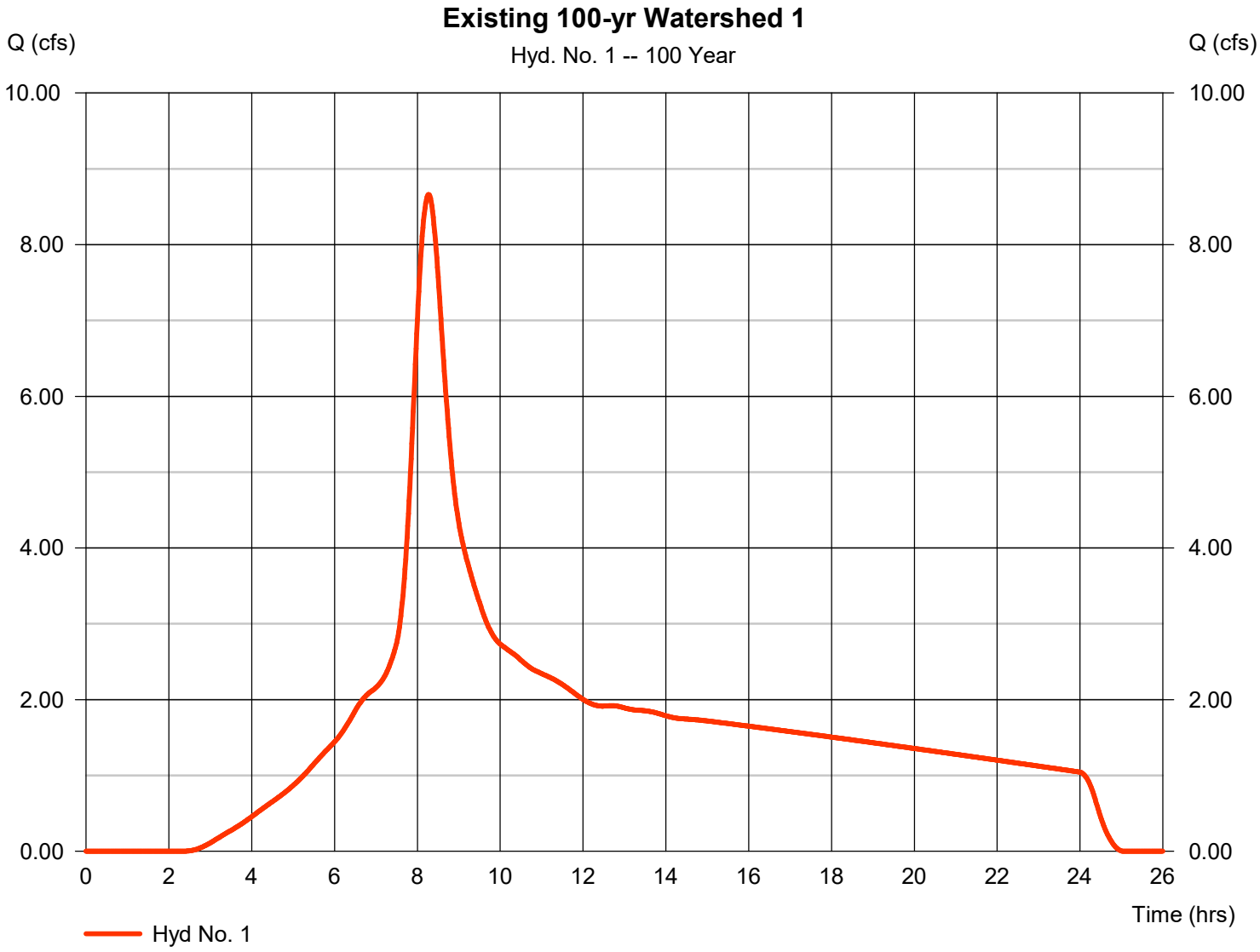
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	8.663	1	496	147,137	------	------	------	Existing 100-yr Watershed 1
2	SCS Runoff	9.121	1	477	127,455	------	------	------	Proposed Pre-Routed 100-yr Watersh
3	SCS Runoff	2.698	1	492	43,474	------	------	------	Proposed Undetained 100-yr Watersh
4	Reservoir	5.912	1	493	119,651	2	68.94	16,710	DETAINED ROUTED (100)

Hydrograph Report

Hyd. No. 1

Existing 100-yr Watershed 1

Hydrograph type	= SCS Runoff	Peak discharge	= 8.663 cfs
Storm frequency	= 100 yrs	Time to peak	= 8.27 hrs
Time interval	= 1 min	Hyd. volume	= 147,137 cuft
Drainage area	= 9.140 ac	Curve number	= 85
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 40.50 min
Total precip.	= 6.14 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

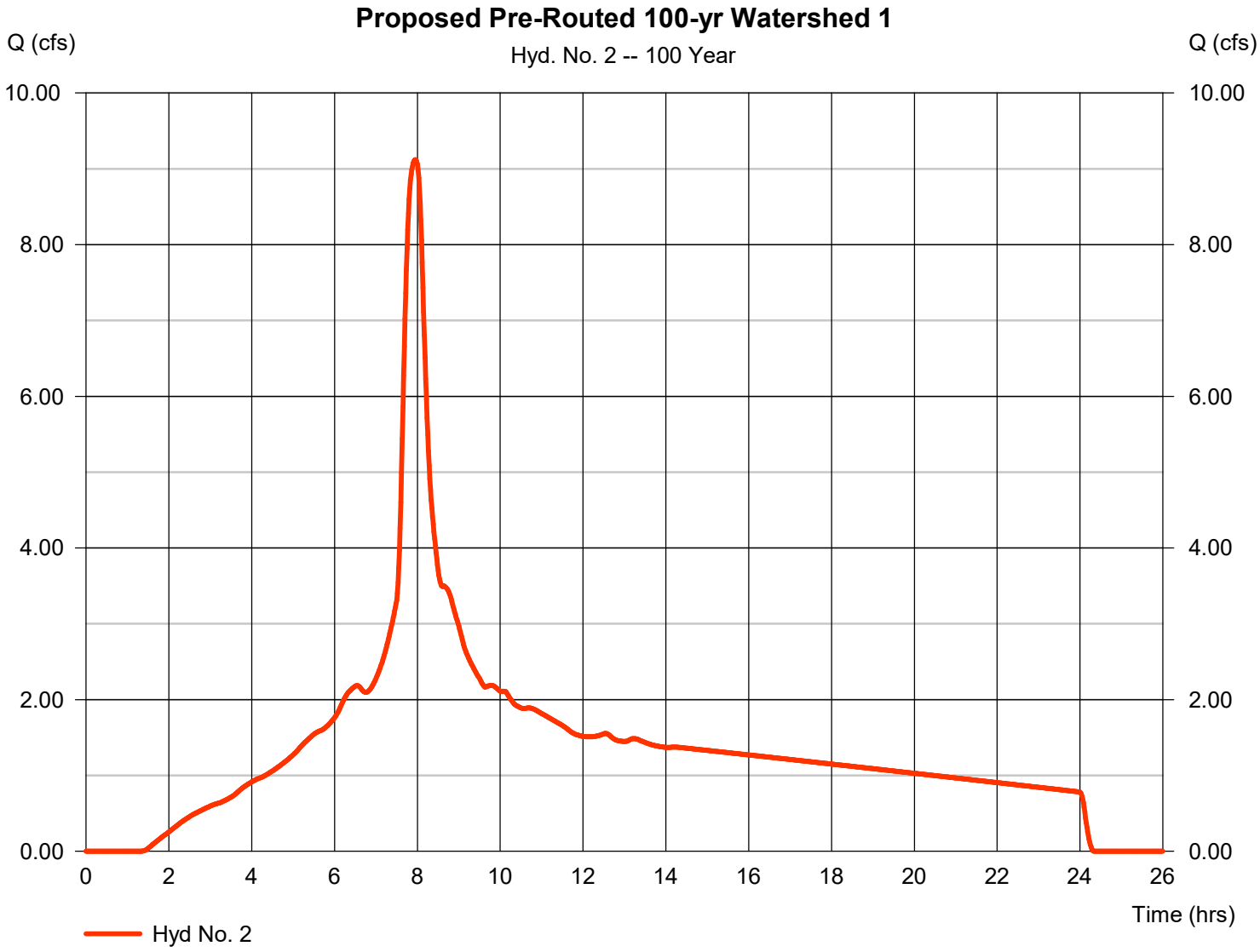


Hydrograph Report

Hyd. No. 2

Proposed Pre-Routed 100-yr Watershed 1

Hydrograph type	= SCS Runoff	Peak discharge	= 9.121 cfs
Storm frequency	= 100 yrs	Time to peak	= 7.95 hrs
Time interval	= 1 min	Hyd. volume	= 127,455 cuft
Drainage area	= 6.850 ac	Curve number	= 92
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 12.30 min
Total precip.	= 6.14 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

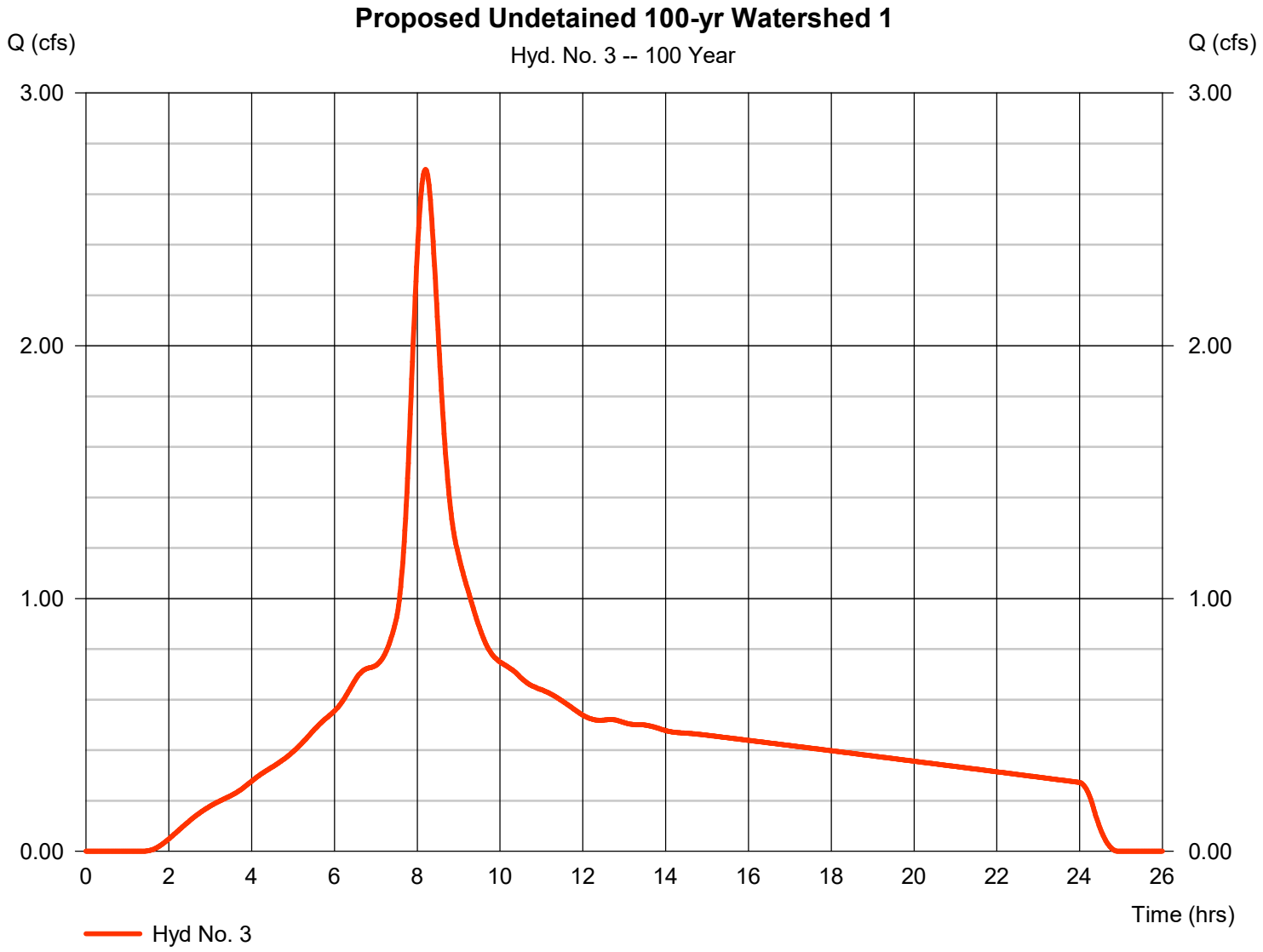


Hydrograph Report

Hyd. No. 3

Proposed Undetained 100-yr Watershed 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.698 cfs
Storm frequency	=	100 yrs	Time to peak	=	8.20 hrs
Time interval	=	1 min	Hyd. volume	=	43,474 cuft
Drainage area	=	2.300 ac	Curve number	=	92
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	35.20 min
Total precip.	=	6.14 in	Distribution	=	Type IA
Storm duration	=	24 hrs	Shape factor	=	484



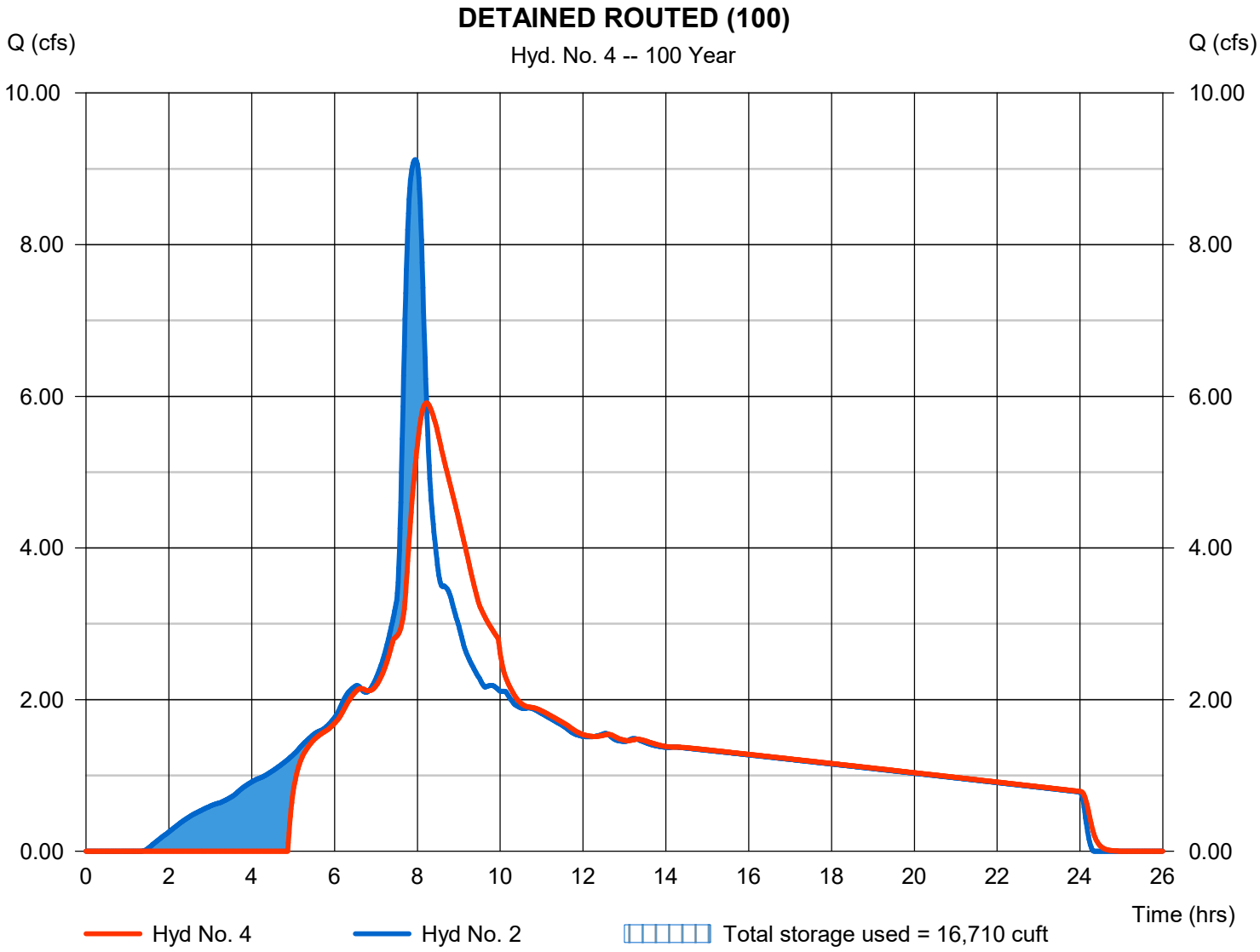
Hydrograph Report

Hyd. No. 4

DETAINED ROUTED (100)

Hydrograph type	=	Reservoir	Peak discharge	=	5.912 cfs
Storm frequency	=	100 yrs	Time to peak	=	8.22 hrs
Time interval	=	1 min	Hyd. volume	=	119,651 cuft
Inflow hyd. No.	=	2 - Proposed Pre-Routed 100-yr Watershed 1	Max. Elevation	=	68.94 ft
Reservoir name	=	DETENTION BASIN 1	Max. Storage	=	16,710 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - DETENTION BASIN 1

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 66.80 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	66.80	7,804	0	0
1.00	67.80	7,804	7,803	7,803
2.70	69.60	7,804	13,265	21,069

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 9.20	0.00	0.00	0.00
Span (in)	= 18.00	0.00	0.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 67.30	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

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

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 67.80

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	66.80	0.00	---	---	---	---	---	---	---	---	---	0.000
1.00	7,803	67.80	0.00	---	---	---	---	---	---	---	---	---	0.000
2.70	21,069	69.60	7.43 ic	---	---	---	---	---	---	---	---	---	7.429

Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	5.1978	2.3000	0.5349	--------
3	0.0000	0.0000	0.0000	--------
5	0.0000	0.0000	0.0000	--------
10	12.1604	5.1000	0.6055	--------
25	16.1806	5.9000	0.6293	--------
50	0.0000	0.0000	0.0000	--------
100	22.1077	7.4000	0.6487	--------

File name: NAPA.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	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	1.79	1.36	1.13	0.99	0.89	0.81	0.75	0.70	0.66	0.63	0.60	0.57
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	3.00	2.35	1.98	1.73	1.55	1.41	1.30	1.21	1.14	1.07	1.02	0.97
25	3.60	2.84	2.39	2.09	1.87	1.70	1.57	1.46	1.36	1.29	1.22	1.16
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	4.32	3.47	2.94	2.58	2.32	2.11	1.94	1.81	1.70	1.60	1.51	1.44

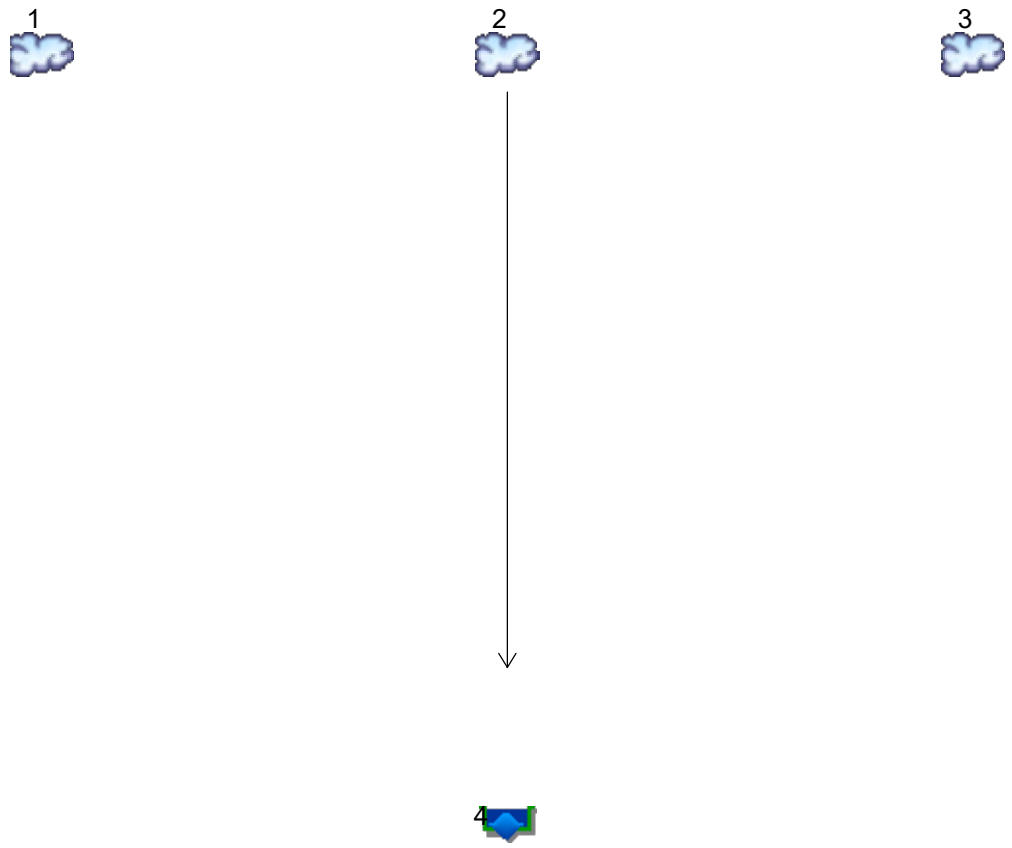
Tc = time in minutes. Values may exceed 60.

Precip. file name: NAPA.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	0.00	2.45	0.00	3.44	4.12	4.95	5.56	6.14
SCS 6-Hr	0.00	1.50	0.00	2.12	2.53	3.03	3.40	3.76
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Hydraflow Table of Contents

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	Existing 100-yr Watershed 2
2	SCS Runoff	Proposed Pre-Routed 100-yr Watershed 2
3	SCS Runoff	Proposed Undetained 100-yr Watershed 2
4	Reservoir	DETAINED ROUTED (100)

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	-------	-------	-------	-------	-------	-------	-------	1.035	Existing 100-yr Watershed 2
2	SCS Runoff	------	-------	-------	-------	-------	-------	-------	-------	0.837	Proposed Pre-Routed 100-yr Watersh
3	SCS Runoff	------	-------	-------	-------	-------	-------	-------	-------	0.411	Proposed Undetained 100-yr Watersh
4	Reservoir	2	-------	-------	-------	-------	-------	-------	-------	0.563	DETAINED ROUTED (100)

Hydrograph Summary Report

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

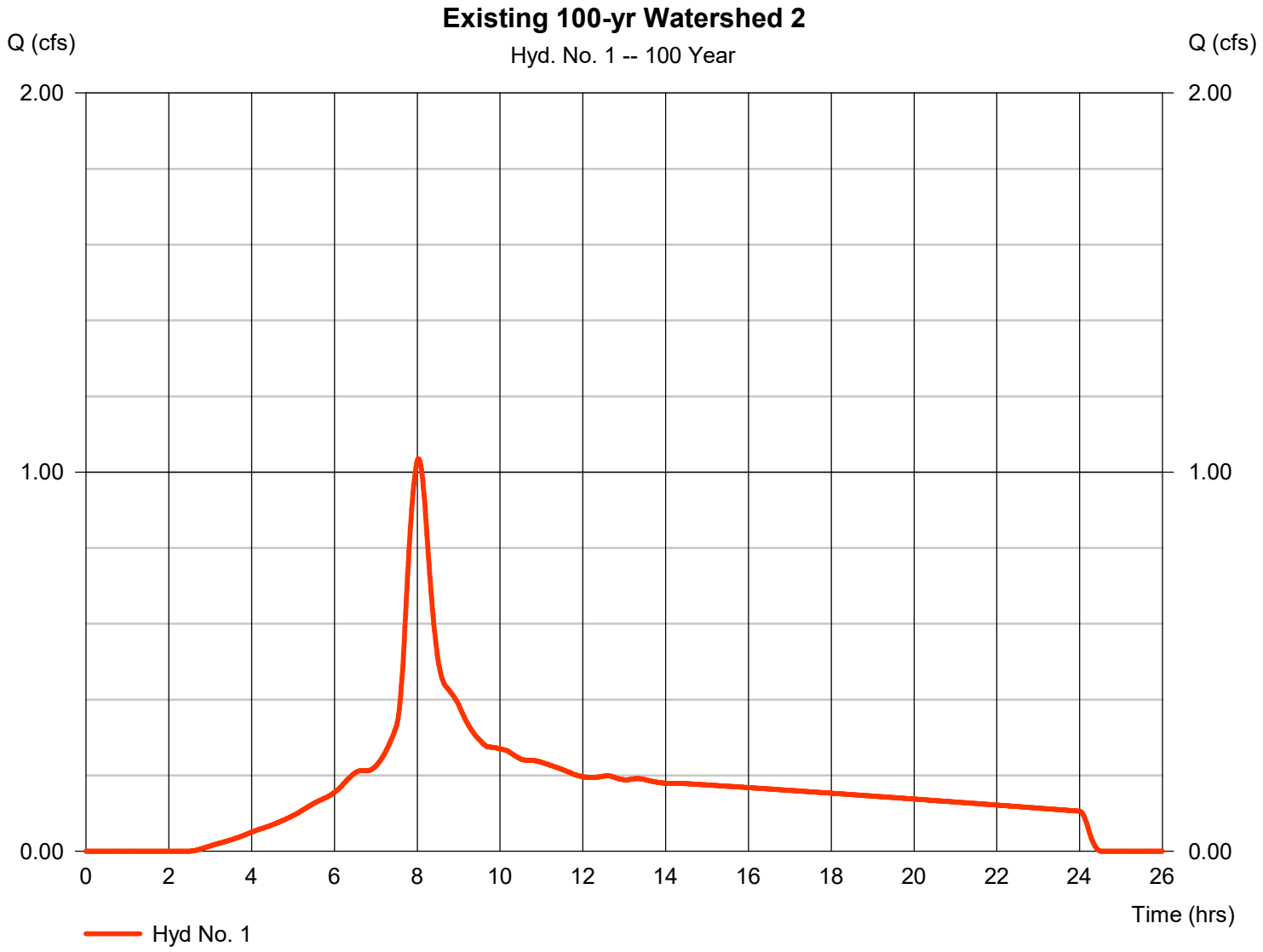
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	1.035	1	482	14,924	------	------	------	Existing 100-yr Watershed 2
2	SCS Runoff	0.837	1	473	11,611	------	------	------	Proposed Pre-Routed 100-yr Watersh
3	SCS Runoff	0.411	1	485	6,049	------	------	------	Proposed Undetained 100-yr Watersh
4	Reservoir	0.563	1	488	10,670	2	68.91	1,740	DETAINED ROUTED (100)

Hydrograph Report

Hyd. No. 1

Existing 100-yr Watershed 2

Hydrograph type	= SCS Runoff	Peak discharge	= 1.035 cfs
Storm frequency	= 100 yrs	Time to peak	= 8.03 hrs
Time interval	= 1 min	Hyd. volume	= 14,924 cuft
Drainage area	= 0.950 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 19.10 min
Total precip.	= 6.14 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

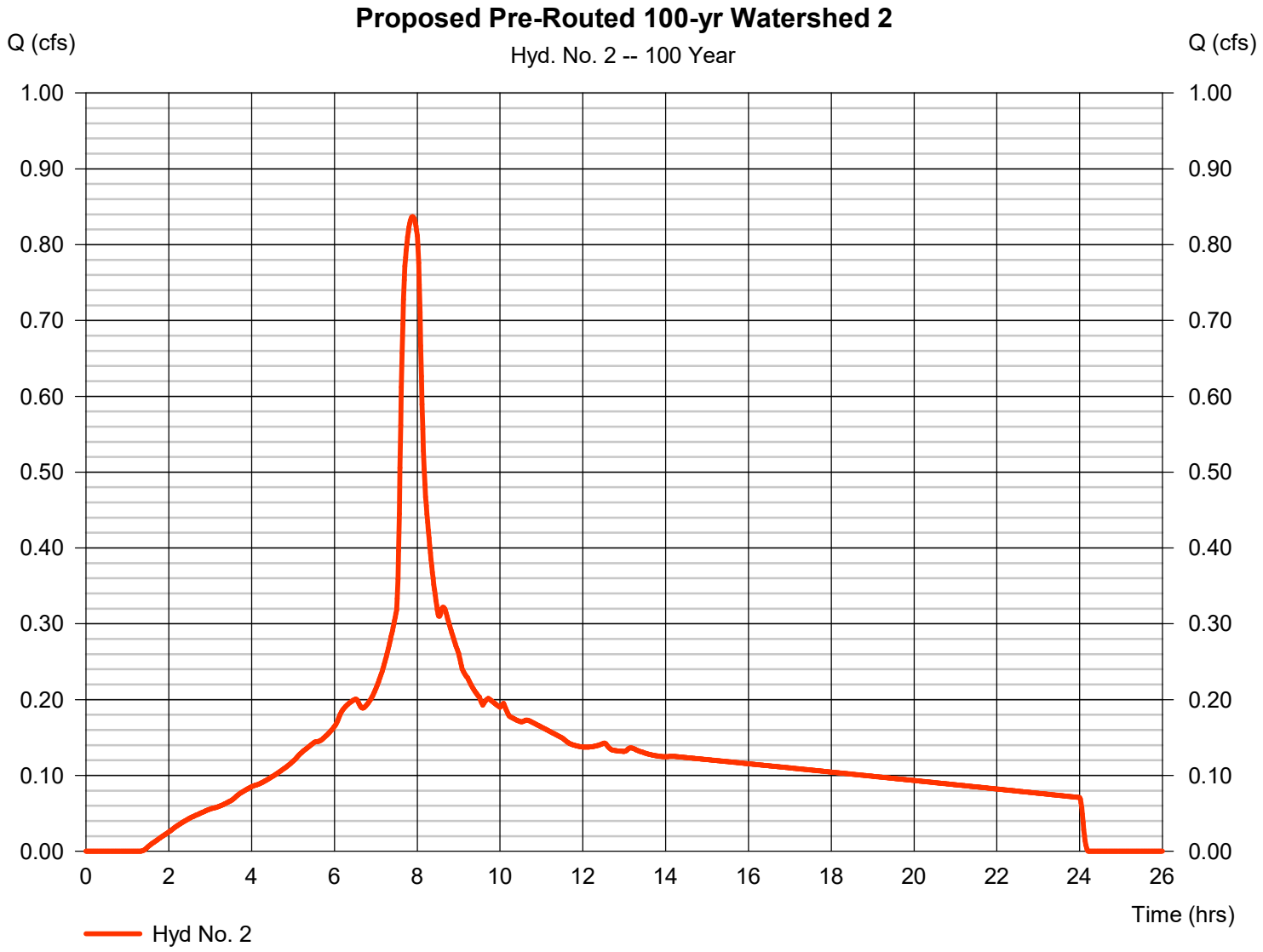


Hydrograph Report

Hyd. No. 2

Proposed Pre-Routed 100-yr Watershed 2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.837 cfs
Storm frequency	= 100 yrs	Time to peak	= 7.88 hrs
Time interval	= 1 min	Hyd. volume	= 11,611 cuft
Drainage area	= 0.630 ac	Curve number	= 92
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 7.30 min
Total precip.	= 6.14 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484

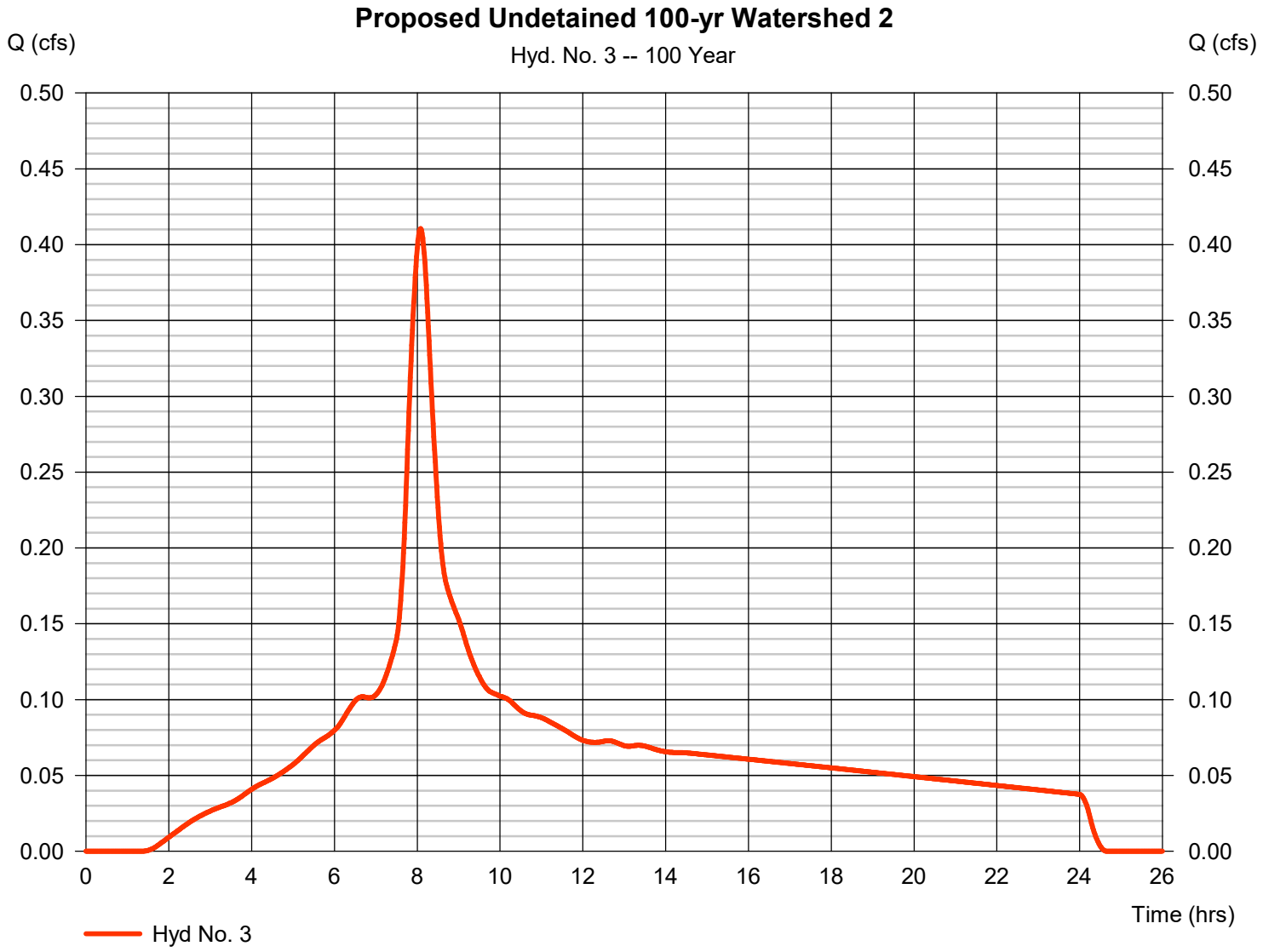


Hydrograph Report

Hyd. No. 3

Proposed Undetained 100-yr Watershed 2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.411 cfs
Storm frequency	= 100 yrs	Time to peak	= 8.08 hrs
Time interval	= 1 min	Hyd. volume	= 6,049 cuft
Drainage area	= 0.320 ac	Curve number	= 92
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 23.70 min
Total precip.	= 6.14 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= 484



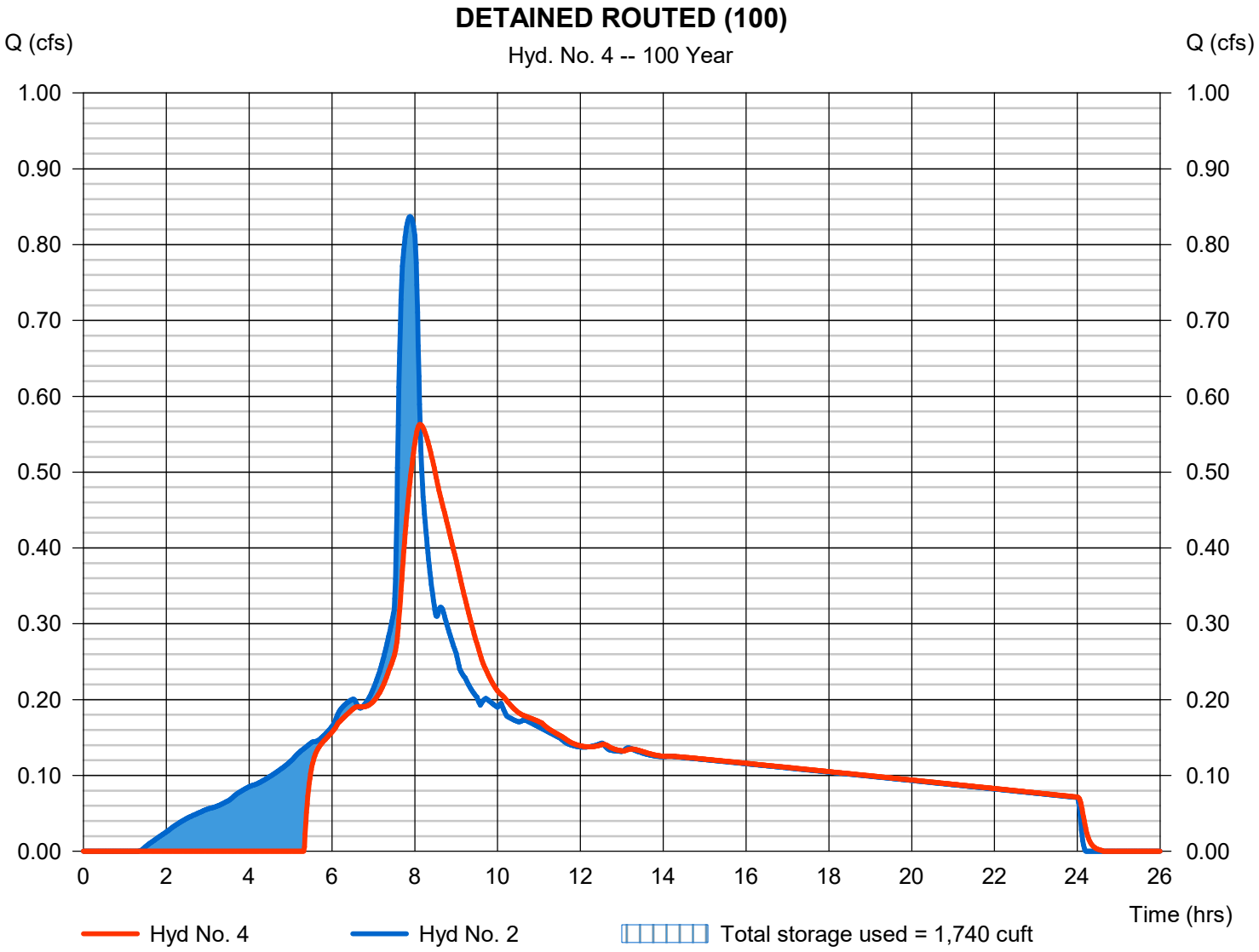
Hydrograph Report

Hyd. No. 4

DETAINED ROUTED (100)

Hydrograph type	=	Reservoir	Peak discharge	=	0.563 cfs
Storm frequency	=	100 yrs	Time to peak	=	8.13 hrs
Time interval	=	1 min	Hyd. volume	=	10,670 cuft
Inflow hyd. No.	=	2 - Proposed Pre-Routed 100-yr Watershed 2	Max. Elevation	=	68.91 ft
Reservoir name	=	DETENTION BASIN 2	Max. Storage	=	1,740 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - DETENTION BASIN 2

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 66.50 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	66.50	723	0	0
0.50	67.00	723	361	361
1.50	68.00	723	723	1,084
2.00	68.50	723	361	1,446
2.50	69.00	723	361	1,807
2.80	69.30	723	217	2,024

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 2.00	0.00	0.00	0.00
Span (in)	= 8.00	0.00	0.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 67.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

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

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 67.80

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	66.50	0.00	---	---	---	---	---	---	---	---	---	0.000
0.50	361	67.00	0.00	---	---	---	---	---	---	---	---	---	0.000
1.50	1,084	68.00	0.24 ic	---	---	---	---	---	---	---	---	---	0.239
2.00	1,446	68.50	0.45 ic	---	---	---	---	---	---	---	---	---	0.448
2.50	1,807	69.00	0.59 ic	---	---	---	---	---	---	---	---	---	0.586
2.80	2,024	69.30	0.66 ic	---	---	---	---	---	---	---	---	---	0.655

Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	5.1978	2.3000	0.5349	--------
3	0.0000	0.0000	0.0000	--------
5	0.0000	0.0000	0.0000	--------
10	12.1604	5.1000	0.6055	--------
25	16.1806	5.9000	0.6293	--------
50	0.0000	0.0000	0.0000	--------
100	22.1077	7.4000	0.6487	--------

File name: NAPA.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	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	1.79	1.36	1.13	0.99	0.89	0.81	0.75	0.70	0.66	0.63	0.60	0.57
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	3.00	2.35	1.98	1.73	1.55	1.41	1.30	1.21	1.14	1.07	1.02	0.97
25	3.60	2.84	2.39	2.09	1.87	1.70	1.57	1.46	1.36	1.29	1.22	1.16
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	4.32	3.47	2.94	2.58	2.32	2.11	1.94	1.81	1.70	1.60	1.51	1.44

Tc = time in minutes. Values may exceed 60.

Precip. file name: NAPA.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	0.00	2.45	0.00	3.44	4.12	4.95	5.56	6.14
SCS 6-Hr	0.00	1.50	0.00	2.12	2.53	3.03	3.40	3.76
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Hydraflow Table of Contents

DB2-100yrDetention Minus BRF Tc.gpw

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

Thursday, 07 / 6 / 2023