

EXHIBIT E



HYDROLOGY REPORT

For

Acierno Track I – Vineyard Blocks G, H, and I
7070 Silverado Trail
Napa, CA 94558

Prepared for:
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Project No. 4122064.0
December 4, 2023
Revised February 23, 2024





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2. AUTODESK STORM & SANITARY ANALYSIS OUTPUT FILES
3. CROSS-SLOPE DIVERSION SWALE ANALYSIS



I. Executive Summary

Hydrology

The Acierno Track I - Block G, H and I project is located at 7070 Silverado Trail, in Napa, CA (APN 032-070-024) and has a parcel area of 40.33 ± acres. The parcel is zoned as Agricultural Watershed (AW) by Napa County. A drainage analysis utilizing the SCS TR-55 method was performed for the proposed project. The parcel is located in Zone "X", which is entirely outside of the 100-year floodway and flood plain as well as the 500-year flood plain. For additional information refer to the FEMA FIRMette Map included in Attachment 1.

The project site hydrology study was calculated using the following Napa County Standards:

- Design Method: SCS TR-55
- Design Return: 2-,10-,50-, and 100-year/24-hour
- Per Conservation Regulation CON-50c: 2-,10-,50-, and 100-yr/24-hr post-development peak stormwater rates shall be less than pre-development peak stormwater rates.

Pre-Development Peak Flow Rates:

- Existing Watershed: $Q_{2\text{-yr}} = 16.7$ cfs
- Existing Watershed: $Q_{10\text{-yr}} = 32.5$ cfs
- Existing Watershed: $Q_{50\text{-yr}} = 49.5$ cfs
- Existing Watershed: $Q_{100\text{-yr}} = 56.7$ cfs

Post-Development Watershed peak flow rates:

- Proposed Watershed: $Q_{2\text{-yr}} = 16.7$ cfs
- Proposed Watershed: $Q_{10\text{-yr}} = 32.5$ cfs
- Proposed Watershed: $Q_{50\text{-yr}} = 49.5$ cfs
- Proposed Watershed: $Q_{100\text{-yr}} = 56.7$ cfs

Post-development peak stormwater runoff rates are estimated to be equal to pre-development stormwater runoff rates. See Attachment 2 Hydrology Calculations for detailed watershed calculations.

II. Purpose

This report addresses Napa County drainage requirements for the proposed project as part of the Vineyard Erosion Control Plan application, and includes pre- and post-development hydrologic analysis.

III. Existing Conditions

The subject parcel is currently developed with existing vineyards, a residence, a driveway, and other minor residential improvements. The site is bounded by rural residential homes to the west, vineyards to the north and east, and Silverado Trail to the West. The predominant soil type in the project area is Rock outcrop, which does not have a defining Hydrologic Soil Group. However, a Hydrologic Soil Group (HSG) of D is used for the purposes of this drainage analysis. Other soil types consist of Bale Clay Loam (HSG B), Boomer-Felta complex (HSG B), and hambright rock outcrop (HSG



D). Refer to Attachment 1 for the Soils Map. The parcel and project area have westerly facing slopes with various drainage courses that convey storm water along the southern and westerly sides of the parcel, then through a culvert under Silverado Trail, and ultimately to the Napa River.

The subject parcel has been modeled as one subbasin for the existing site conditions. This area starts at the northeasterly portion of the parcel and drains southerly towards Silverado Trail. The drainage area concentrates at the roadside swale along the southern property line. Runoff from this area will enter this roadside swale before draining to an existing culvert which drains alongside Silverado Trail.

IV. Proposed Conditions

The project is proposing to permit and plant approximately $0.73 \pm$ acres of new vineyard located on a $40.33 \pm$ acre parcel. The proposed drainage subbasin for the project is designated as one drainage area and is shown on the attached Drainage Exhibit in Attachment 1.

IV. A. Subbasin A

Subbasin A consists of the entire parcel. Subbasin A includes a residence, a driveway, vegetation, vineyard, and woods and grass combination. This subbasin drains west via sheet, shallow concentrated, and channelized flow to existing drainage features on Silverado Trail to the Napa River. See the Proposed Drainage Exhibit in Attachment 1.

IV. B. Stormwater Detention

Since there is no calculated increase between the post-development and pre-development peak stormwater runoff rates, there are no retention or detention facilities proposed for the project.

V. Pre & Post-Development Hydrologic Analysis

This hydrologic analysis compares the pre- and post-development peak stormwater runoff rates from the project area for the 2-year, 10-year, 50-year, and 100-year, 24-hour design storms. The peak stormwater runoff rates were estimated using Autodesk Storm and Sanitary Analysis (SSA) 2020.

The following precipitation data for the project site was collected from the NOAA Atlas 14, Volume 6 – California (refer to NOAA Precipitation Frequency table in Attachment 1):

Table 1 - NOAA Precipitation Data

Storm Frequency	Precipitation Depth (Inches, in 24-hour period)
2-yr	3.50
10-yr	5.52
50-yr	6.97
100-yr	7.70

V.A. Existing Conditions

The method used for studying the site stormwater runoff is a hydrograph analysis. The unit hydrograph rainfall distribution for Napa County 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. The purpose of the hydrograph analysis is to identify and mitigate the estimated increase between the pre- to post-development peak stormwater runoff rates. One (1) subbasin was used to model the existing runoff from the project site. The existing watershed characteristics and estimated runoff for the 2-year, 10-year, 50-year, and 100-year, 24-hour storm events are summarized as follows (for supporting documentation, refer to AutoDesk Storm and Sanitary Analysis Output Files).

Table 2 – Existing Watersheds Stormwater Runoff Summary

Proposed Curve Number	CN	83	
Proposed Time of Concentration	T _C	18.34	[min]
Proposed Peak Flow (2-yr)	Q _{2YEAR-EXIST}	16.7	[cfs]
Proposed Peak Flow (10-yr)	Q _{10YEAR-EXIST}	32.6	[cfs]
Proposed Peak Flow (50-yr)	Q _{50YEAR-EXIST}	49.5	[cfs]
Proposed Peak Flow (100-yr)	Q _{100YEAR-EXIST}	56.7	[cfs]

V.B. Proposed Conditions

The post-development peak stormwater runoff rates were designed to be less than the pre-development peak stormwater runoff rates for 2-year, 10-year, 50-year, and 100-year, 24-hour storm events per Napa County requirements.

For post-development conditions, the parcel was kept as one subbasin to analyze the post-construction runoff flows. The proposed runoff for the 2-year, 10-year, 50-year, and 100-year, 24-hour storm events are shown in Table 3 (for supporting documentation, refer to AutoDesk Storm and Sanitary Analysis Output Files in Attachment 2).

Table 3 – Proposed Watersheds Stormwater Runoff Summary

Proposed Curve Number	CN	83	
Proposed Time of Concentration	T _C	18.34	[min]
Proposed Peak Flow (2-yr)	Q _{2YEAR-EXIST}	16.7	[cfs]
Proposed Peak Flow (10-yr)	Q _{10YEAR-EXIST}	32.6	[cfs]
Proposed Peak Flow (50-yr)	Q _{50YEAR-EXIST}	49.5	[cfs]
Proposed Peak Flow (100-yr)	Q _{100YEAR-EXIST}	56.7	[cfs]

Upon successful completion of the project, the post-development peak flow rates are estimated to be less than or equal to the pre-development peak flow rates for the 2, 10, 50, and 100-year; 24-hour storm events.



VI. STORMDRAIN HYDRAULICS STUDY

The existing drainage features will remain the same as peak flow runoff for the 2-yr, 10-yr, 50-yr, and 100-yr remained the same with the proposed new vineyard. The Autodesk Storm and Sanitary Analysis 2020 program was used to determine the capacity of proposed storm drain pipes.

As requested by Napa County, further analysis of the proposed cross-slope diversion swales has been performed to evaluate the impacts to the time of travel from installing new diversions throughout the vineyard blocks. An exhibit showing the paths for the time of travel analyzed as well as calculations for the time of travel within the sub-area of the project subbasin (an area encompassing Vineyard Blocks A through I) are included in Attachment 3. Based on these calculations, the time of travel (and Time of Concentration) for this sub-area increased when the proposed cross-slope diversion swales were included. An increase in the Time of Concentration decreases the peak stormwater runoff. Therefore, the inclusion of cross-slope diversion swales would not increase peak stormwater runoff.

VII. CONCLUSION

The post-development peak stormwater runoff rates for the proposed project and associated improvements are calculated to be equal to the pre-development peak stormwater runoff rates. Therefore, the proposed project meets Napa County General Plan requirements for post-development runoff requirements.



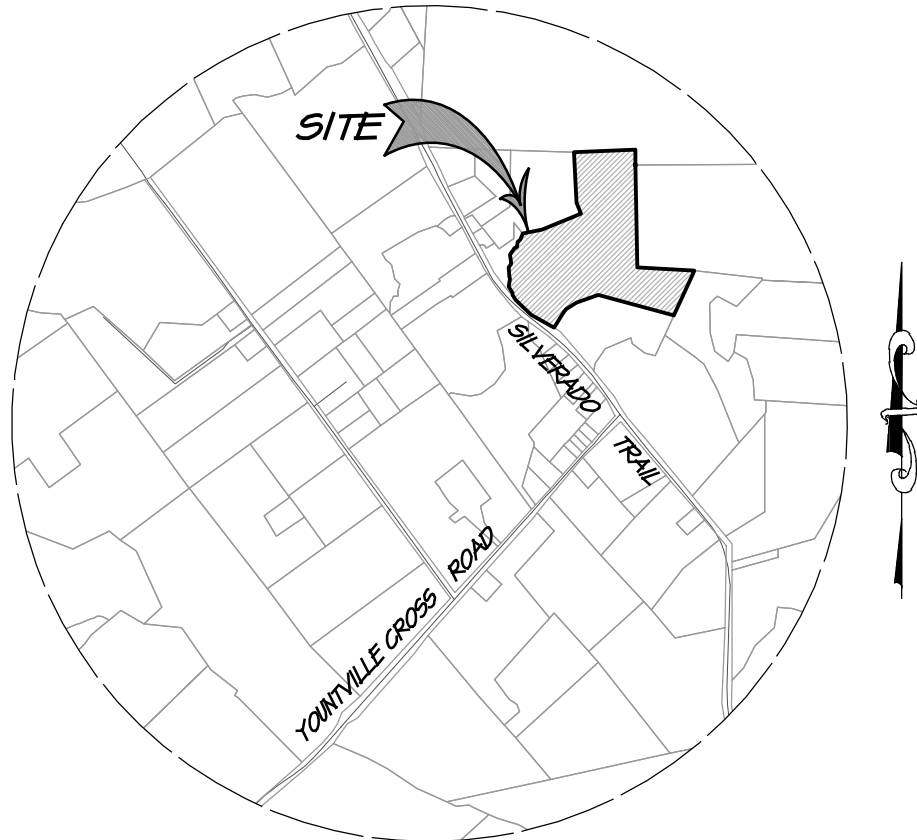
ATTACHMENT 1

Vicinity Map, Soil Map, FIRMette, NOAA Atlas 14 Rainfall Chart, Curve
Number, Drainage Area Exhibits

ACIERNO - SILVERADO TRAIL VECP VICINITY MAP

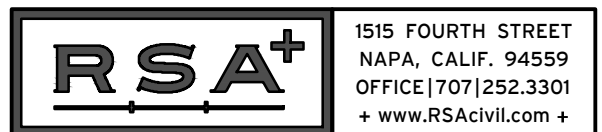
NAPA COUNTY

CALIFORNIA



VICINITY MAP

SCALE: 1" = 2000'



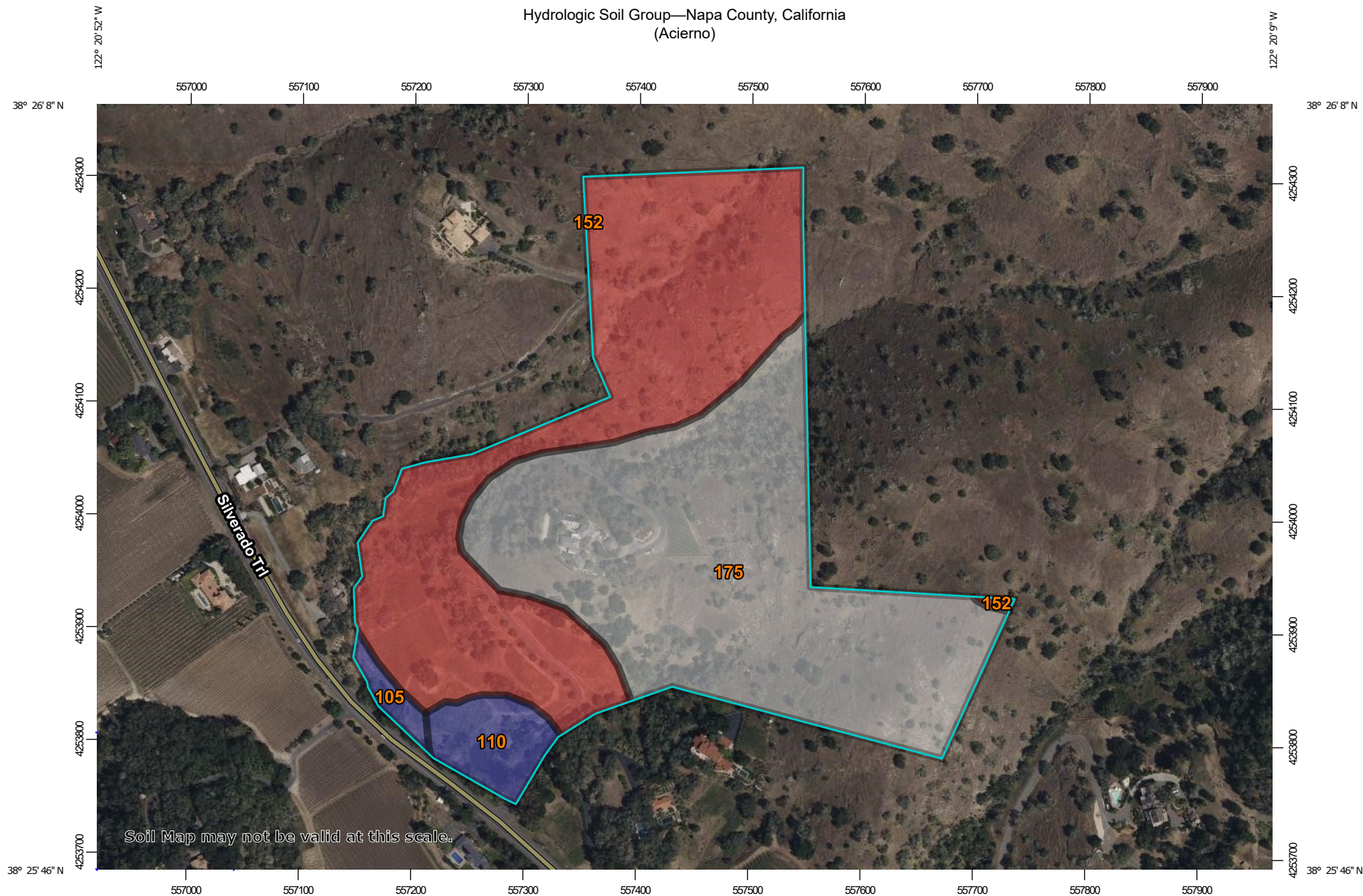
RSA+ | CONSULTING CIVIL ENGINEERS + SURVEYORS + est. 1980

OCT. 19, 2022

4122064.0

Exh-Vic Map.dwg

Hydrologic Soil Group—Napa County, California (Acierno)



Soil Map may not be valid at this scale.

Map Scale: 1:4,780 if printed on A landscape (11" x 8.5") sheet.

0 50 100 200 300 Meters

0 200 400 800 1200 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

10/7/2022
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: Napa County, California
Survey Area Data: Version 15, Sep 1, 2022

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

Date(s) aerial images were photographed: Mar 26, 2022—Apr 25, 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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
105	Bale clay loam, 2 to 5 percent slopes	B	0.5	1.3%
110	Boomer-Forward-Felta complex, 30 to 50 percent slopes	B	1.9	4.5%
152	Hambright rock-Outcrop complex, 30 to 75 percent slopes	D	17.9	43.5%
175	Rock outcrop		20.8	50.6%
Totals for Area of Interest			41.2	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

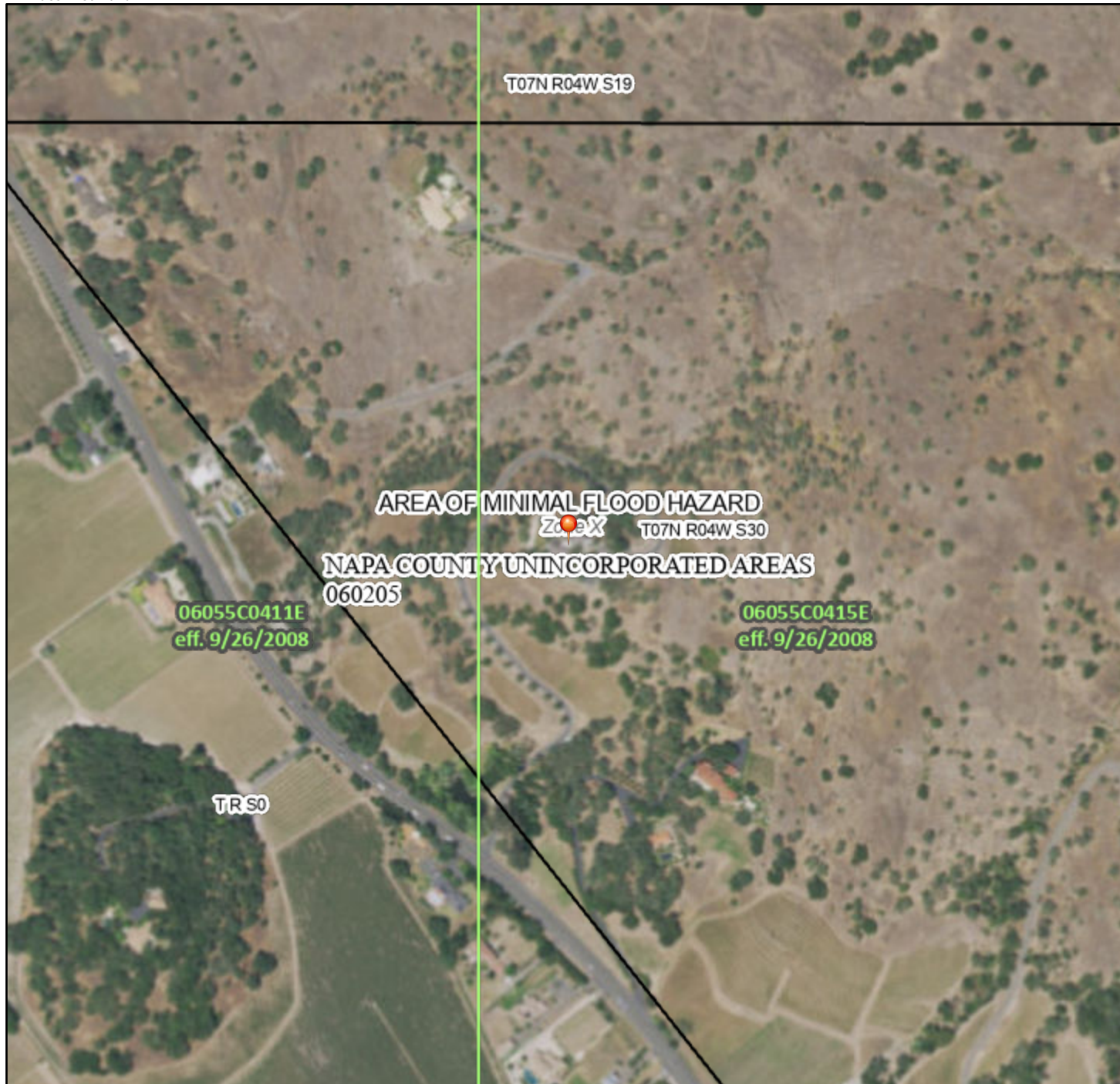
Component Percent Cutoff: None Specified

Tie-break Rule: Higher

National Flood Hazard Layer FIRMette



122°20'53"W 38°26'10"N



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

1:6,000

122°20'16"W 38°25'42"N

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 **11/29/2022 at 3:17 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.



NOAA Atlas 14, Volume 6, Version 2
Location name: Napa, California, USA*
Latitude: 38.4323°, Longitude: -122.3429°
Elevation: 369.41 ft**
* source: ESRI Maps
** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.138 (0.123-0.157)	0.169 (0.150-0.192)	0.210 (0.186-0.239)	0.244 (0.214-0.280)	0.290 (0.245-0.347)	0.327 (0.269-0.400)	0.364 (0.292-0.459)	0.404 (0.314-0.525)	0.458 (0.340-0.625)	0.502 (0.358-0.711)
10-min	0.198 (0.176-0.225)	0.242 (0.215-0.275)	0.301 (0.267-0.343)	0.349 (0.306-0.402)	0.416 (0.351-0.497)	0.468 (0.386-0.573)	0.522 (0.419-0.658)	0.579 (0.449-0.753)	0.657 (0.487-0.896)	0.719 (0.513-1.02)
15-min	0.239 (0.213-0.272)	0.293 (0.260-0.333)	0.364 (0.322-0.415)	0.422 (0.371-0.486)	0.503 (0.425-0.601)	0.566 (0.467-0.693)	0.631 (0.506-0.795)	0.700 (0.544-0.910)	0.795 (0.589-1.08)	0.870 (0.620-1.23)
30-min	0.343 (0.305-0.389)	0.419 (0.373-0.476)	0.521 (0.461-0.594)	0.604 (0.530-0.695)	0.720 (0.608-0.861)	0.810 (0.668-0.993)	0.904 (0.725-1.14)	1.00 (0.778-1.30)	1.14 (0.843-1.55)	1.25 (0.887-1.77)
60-min	0.496 (0.441-0.563)	0.606 (0.539-0.689)	0.753 (0.667-0.859)	0.874 (0.767-1.01)	1.04 (0.879-1.25)	1.17 (0.966-1.44)	1.31 (1.05-1.65)	1.45 (1.13-1.88)	1.65 (1.22-2.24)	1.80 (1.28-2.55)
2-hr	0.749 (0.667-0.850)	0.915 (0.814-1.04)	1.13 (1.00-1.29)	1.31 (1.15-1.51)	1.55 (1.31-1.85)	1.73 (1.43-2.12)	1.92 (1.54-2.41)	2.11 (1.64-2.74)	2.36 (1.75-3.22)	2.56 (1.82-3.63)
3-hr	0.959 (0.853-1.09)	1.17 (1.04-1.33)	1.45 (1.28-1.65)	1.67 (1.47-1.92)	1.97 (1.66-2.36)	2.20 (1.81-2.69)	2.43 (1.95-3.06)	2.66 (2.07-3.46)	2.97 (2.20-4.05)	3.21 (2.29-4.55)
6-hr	1.43 (1.27-1.63)	1.76 (1.56-2.00)	2.17 (1.93-2.48)	2.51 (2.20-2.89)	2.95 (2.49-3.53)	3.28 (2.71-4.02)	3.61 (2.90-4.55)	3.95 (3.07-5.13)	4.39 (3.25-5.98)	4.72 (3.37-6.69)
12-hr	1.99 (1.77-2.26)	2.49 (2.21-2.82)	3.12 (2.76-3.55)	3.62 (3.18-4.16)	4.28 (3.61-5.12)	4.77 (3.94-5.85)	5.26 (4.22-6.63)	5.75 (4.47-7.48)	6.39 (4.74-8.71)	6.87 (4.90-9.74)
24-hr	2.75 (2.47-3.11)	3.50 (3.15-3.98)	4.46 (4.00-5.08)	5.22 (4.65-5.98)	6.22 (5.39-7.33)	6.97 (5.93-8.35)	7.70 (6.43-9.41)	8.44 (6.88-10.6)	9.40 (7.40-12.2)	10.1 (7.74-13.5)
2-day	3.58 (3.22-4.06)	4.60 (4.13-5.22)	5.89 (5.28-6.70)	6.91 (6.16-7.92)	8.26 (7.16-9.73)	9.27 (7.89-11.1)	10.3 (8.57-12.5)	11.3 (9.18-14.1)	12.6 (9.90-16.3)	13.5 (10.4-18.1)
3-day	4.19 (3.77-4.76)	5.39 (4.84-6.12)	6.92 (6.20-7.87)	8.13 (7.24-9.31)	9.72 (8.43-11.5)	10.9 (9.30-13.1)	12.1 (10.1-14.8)	13.3 (10.8-16.6)	14.8 (11.7-19.2)	16.0 (12.3-21.4)
4-day	4.65 (4.18-5.28)	5.99 (5.38-6.80)	7.69 (6.90-8.75)	9.04 (8.05-10.4)	10.8 (9.37-12.7)	12.1 (10.3-14.5)	13.4 (11.2-16.4)	14.7 (12.0-18.4)	16.5 (13.0-21.3)	17.7 (13.6-23.7)
7-day	5.74 (5.16-6.51)	7.40 (6.65-8.40)	9.50 (8.51-10.8)	11.1 (9.93-12.8)	13.3 (11.5-15.7)	14.9 (12.7-17.8)	16.4 (13.7-20.1)	18.0 (14.7-22.5)	20.0 (15.7-25.9)	21.5 (16.4-28.6)
10-day	6.46 (5.81-7.33)	8.34 (7.49-9.47)	10.7 (9.59-12.2)	12.5 (11.2-14.4)	14.9 (12.9-17.6)	16.7 (14.2-20.0)	18.4 (15.3-22.4)	20.0 (16.3-25.1)	22.2 (17.5-28.7)	23.8 (18.2-31.7)
20-day	8.44 (7.59-9.57)	10.9 (9.81-12.4)	14.0 (12.5-15.9)	16.3 (14.5-18.7)	19.3 (16.8-22.8)	21.5 (18.3-25.8)	23.6 (19.7-28.8)	25.6 (20.9-32.1)	28.2 (22.2-36.5)	30.0 (23.0-40.0)
30-day	10.2 (9.15-11.5)	13.1 (11.8-14.9)	16.7 (15.0-19.1)	19.5 (17.4-22.3)	23.0 (19.9-27.1)	25.5 (21.7-30.5)	27.9 (23.3-34.1)	30.2 (24.6-37.7)	33.0 (26.0-42.8)	35.1 (26.8-46.7)
45-day	12.4 (11.2-14.1)	15.9 (14.3-18.1)	20.1 (18.1-22.9)	23.4 (20.8-26.8)	27.4 (23.7-32.2)	30.3 (25.8-36.2)	33.0 (27.5-40.3)	35.5 (29.0-44.5)	38.7 (30.5-50.2)	41.0 (31.3-54.6)
60-day	14.8 (13.4-16.8)	18.9 (16.9-21.4)	23.7 (21.2-27.0)	27.3 (24.3-31.3)	31.9 (27.6-37.5)	35.1 (29.9-42.0)	38.1 (31.8-46.6)	40.9 (33.4-51.2)	44.4 (35.0-57.6)	46.9 (35.9-62.5)

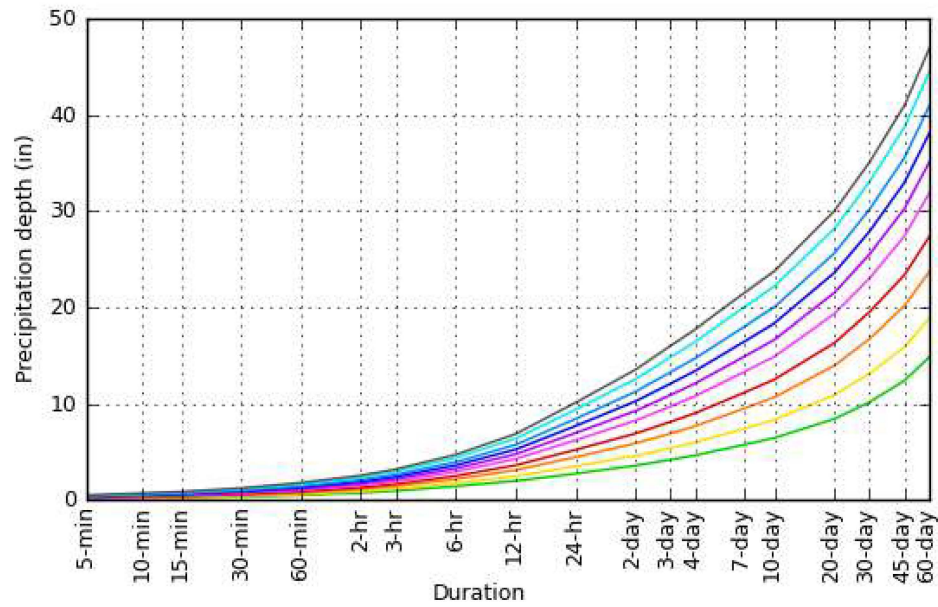
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

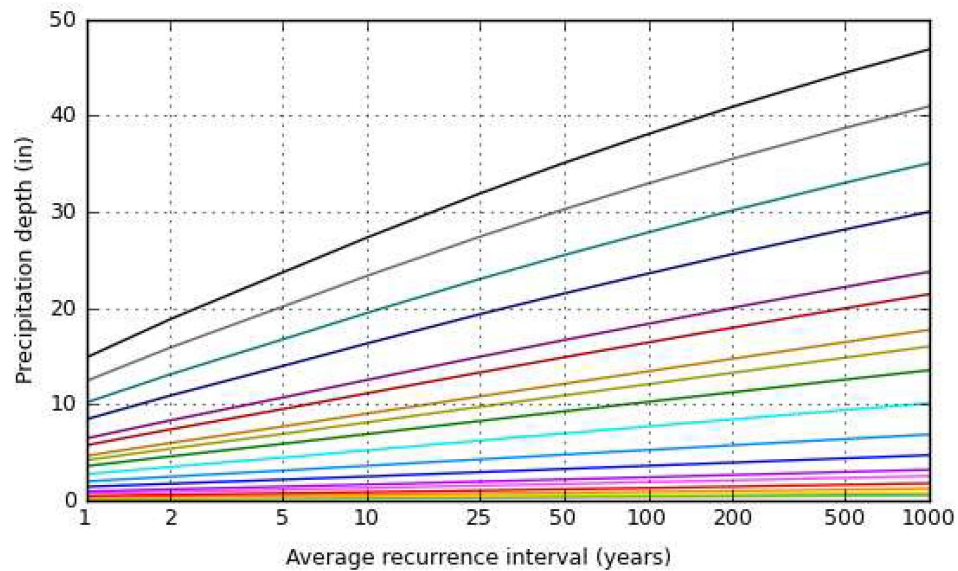
PF graphical

PDS-based depth-duration-frequency (DDF) curves

Latitude: 38.4323°, Longitude: -122.3429°



Average recurrence interval (years)
1
2
5
10
25
50
100
200
500
1000

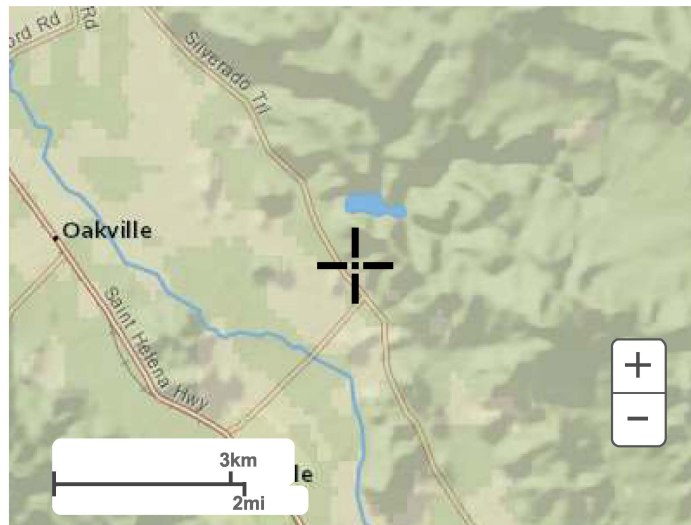


Duration	
5-min	2-day
10-min	3-day
15-min	4-day
30-min	7-day
60-min	10-day
2-hr	20-day
3-hr	30-day
6-hr	45-day
12-hr	60-day
24-hr	

[Back to Top](#)

Maps & aeriels

Small scale terrain



Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

[US Department of Commerce](#)
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[National Weather Service](#)
[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)

Table 2-2a Runoff curve numbers for urban areas ^{1/}

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area ^{2/}	A	B	C	D
<i>Fully developed urban areas (vegetation established)</i>					
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
<i>Developing urban areas</i>					
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).					

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 2-2b Runoff curve numbers for cultivated agricultural lands ^{1/}

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment ^{2/}	Hydrologic condition ^{3/}	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded or broadcast legumes or rotation meadow	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

¹ Average runoff condition, and $I_a=0.2S$ ² Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.³ Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good $\geq 20\%$), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands ^{1/}

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. ^{2/}	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. ^{3/}	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 ^{4/}	48	65	73
Woods—grass combination (orchard or tree farm). ^{5/}	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. ^{6/}	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 ^{4/}	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

¹ Average runoff condition, and $I_a = 0.2S$.² *Poor*: <50% ground cover or heavily grazed with no mulch.*Fair*: 50 to 75% ground cover and not heavily grazed.*Good*: > 75% ground cover and lightly or only occasionally grazed.³ *Poor*: <50% ground cover.*Fair*: 50 to 75% ground cover.*Good*: >75% ground cover.⁴ Actual curve number is less than 30; use CN = 30 for runoff computations.⁵ CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.⁶ *Poor*: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.*Fair*: Woods are grazed but not burned, and some forest litter covers the soil.*Good*: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands ^{1/}

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition ^{2/}	A ^{3/}	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

¹ Average runoff condition, and $I_a = 0.2S$. For range in humid regions, use table 2-2c.² Poor: <30% ground cover (litter, grass, and brush overstory).

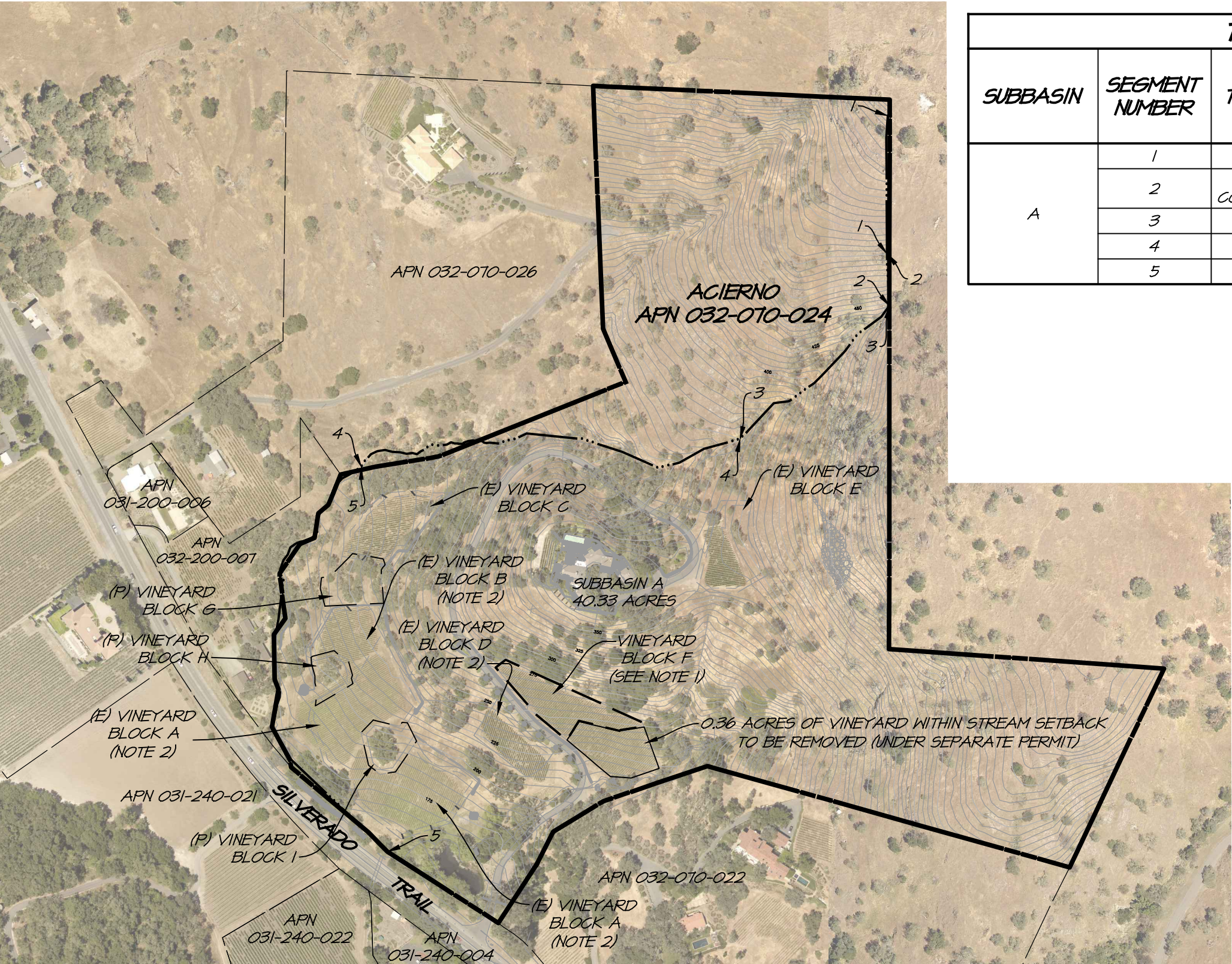
Fair: 30 to 70% ground cover.

Good: > 70% ground cover.

³ Curve numbers for group A have been developed only for desert shrub.

Land Use	Cover	Hydrologic <u>1</u> / Condition	Hydrologic Soil Groups			
	Treatment or Practice		A	B	C	D
Orchards, deciduous		(See accompanying land-use description)				
Orchards, Evergreen		Poor	55	72	81	86
		Fair	42	64	76	82
		Good	33	58	72	79
Vineyards		(See accompanying land-use description)				
NON-CULTIVATED AGRICULTURAL LAND (Grassland, Woodland, Brushland)						
Annual grass		Poor	65	78	86	89
		Fair (< 75%)	49	69	79	84
		Good (75% +)	38	61	75	81
Broadleaf chaparral		Poor	53	70	80	85
		Fair	40	63	75	81
		Good	31	57	71	78
Meadow		Poor	63	77	84	90
		Fair	58	70	78	84
		Good	30	58	72	78
Narrowleaf chaparral		Poor	70	82	88	90
		Fair	55	72	81	86
Open brush		Poor	61	76	84	88
		Fair	46	66	77	83
		Good	41	63	75	81

ACIERNO TRACK I - BLOCKS G, H AND I
DRAINAGE EXHIBIT
NAPA CALIFORNIA



TIME OF CONCENTRATION					
SUBBASIN	SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (%)
A	1	SHEET FLOW	UNPAVED	300	41.60
	2	SHALLOW CONCENTRATED FLOW	UNPAVED	113	26.55
	3	CHANNEL FLOW	UNPAVED	436	23.00
	4	CHANNEL FLOW	UNPAVED	847	14.63
	5	CHANNEL FLOW	UNPAVED	1006	5.37

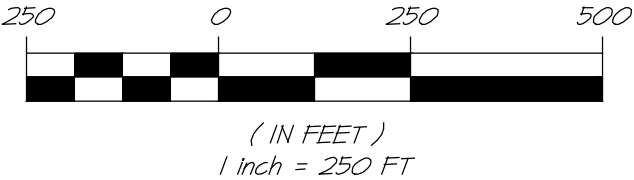
LEGEND

- APPROXIMATE PROPERTY LINE
- ADJOINING PROPERTY LINE
- PATH OF TIME OF CONCENTRATION (T.O.C.)

NOTE

- EXISTING VINEYARD PLANTED CIRCA 2007 AND 2011 (BY PREVIOUS OWNER) TO BE REMOVED & RESTORED UNDER SEPARATE PERMIT.
- VINEYARD BLOCKS A THROUGH E TO BE REPLANTED UNDER PERMIT #P22-00412
- PER PRE-APPLICATION MEETING WITH NAPA COUNTY ON 10-13-2022 TREES REMOVED BY PG&E ARE NOT COUNTED AGAINST PROJECT IN REGARDS TO THE VEGETATION RETENTION REQUIREMENTS OF REQUIRED TO BE REPLANTED AS PART OF THESE PLANS.

GRAPHIC SCALE



RSA+

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NAPA, CALIF. 94559
OFFICE | 707 | 252.3301
+ www.RSAcivil.com +

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R:\2022\4122064.0_Acierno_Silverado_Trail_Property\DESIGN\EXHIBITS\Exh-Drainage Block G_H and I.dwg 11/15/2023



ATTACHMENT 2

Pre-development and Post- Development AutoDesk Storm & Sanitary Analysis Output Files

Project Description

File Name Acierno.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method SCS TR-55
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Kinematic Wave
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods ... YES

Analysis Options

Start Analysis On Aug 25, 2023 00:00:00
End Analysis On Aug 26, 2023 00:00:00
Start Reporting On Aug 25, 2023 00:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:00:30 days hh:mm:ss
Routing Time Step 30 seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	TS-002	Cumulative	inches	California	Napa (Napa Metro)	2	3.50	SCS Type IA 24-hr

Subbasin Summary

SN	Subbasin ID	Area	Peak Rate Factor	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
		(ac)			(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1	A	40.33	0.00	83	3.50	1.83	73.84	16.7	0 00:18:20

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	Out-01	Outfall	0.00					0.00	0.00					

Subbasin Hydrology

Subbasin : A

Input Data

Area (ac) 40.33
Peak Rate Factor 0.00
Weighted Curve Number 82.64
Rain Gage ID Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.79	B	69.00
Vineyard - Annual Grass CC	0.45	B	61.00
Paved parking & roofs	0.07	B	98.00
50 - 75% grass cover, Fair	25.33	D	84.00
Woods & grass combination, Fair	8.79	D	82.00
Vineyard - Annual Grass CC	2.88	D	81.00
Paved parking & roofs	0.94	D	98.00
Woods & grass combination, Fair	1.08	B	65.00
Composite Area & Weighted CN	40.33		82.64

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

T_c = Time of Concentration (hr)
n = Manning's roughness
L_f = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (S_f^{0.5}) (unpaved surface)
V = 20.3282 * (S_f^{0.5}) (paved surface)
V = 15.0 * (S_f^{0.5}) (grassed waterway surface)
V = 10.0 * (S_f^{0.5}) (nearly bare & untilled surface)
V = 9.0 * (S_f^{0.5}) (cultivated straight rows surface)
V = 7.0 * (S_f^{0.5}) (short grass pasture surface)
V = 5.0 * (S_f^{0.5}) (woodland surface)
V = 2.5 * (S_f^{0.5}) (forest w/heavy litter surface)
T_c = (L_f / V) / (3600 sec/hr)

Where:

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (S_f^{0.5})) / n
R = A_q / W_p
T_c = (L_f / V) / (3600 sec/hr)

Where :

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
R = Hydraulic Radius (ft)
A_q = Flow Area (ft²)
W_p = Wetted Perimeter (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)
n = Manning's roughness

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.35	0.00	0.00
Flow Length (ft) :	300	0.00	0.00
Slope (%) :	41.60	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.50	0.00	0.00
Velocity (ft/sec) :	0.38	0.00	0.00
Computed Flow Time (min) :	13.20	0.00	0.00
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	113	0.00	0.00
Slope (%) :	26.55	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	3.61	0.00	0.00
Computed Flow Time (min) :	0.52	0.00	0.00
	Subarea A	Subarea B	Subarea C
Channel Flow Computations			
Manning's Roughness :	0.05	0.05	0.05
Flow Length (ft) :	436	847	1006
Channel Slope (%) :	23	14.65	5.37
Cross Section Area (ft ²) :	6.9	6.9	6.9
Wetted Perimeter (ft) :	8.03	8.03	8.03
Velocity (ft/sec) :	12.92	10.31	6.24
Computed Flow Time (min) :	0.56	1.37	2.69
Total TOC (min)	18.34		

Subbasin Runoff Results

Total Rainfall (in)	3.50
Total Runoff (in)	1.83
Peak Runoff (cfs)	16.72
Weighted Curve Number	82.64
Time of Concentration (days hh:mm:ss)	0 00:18:20

Project Description

File Name Acierno.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method SCS TR-55
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Kinematic Wave
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods ... YES

Analysis Options

Start Analysis On Aug 25, 2023 00:00:00
End Analysis On Aug 26, 2023 00:00:00
Start Reporting On Aug 25, 2023 00:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:00:30 days hh:mm:ss
Routing Time Step 30 seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	TS-010	Cumulative	inches	California	Napa (Napa Metro)	10	5.22	SCS Type IA 24-hr

Subbasin Summary

SN	Subbasin ID	Area	Peak Rate Factor	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
		(ac)			(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1	A	40.33	0.00	83	5.22	3.34	134.66	32.6	0 00:18:20

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	Out-01	Outfall	0.00					0.00	0.00					

Subbasin Hydrology

Subbasin : A

Input Data

Area (ac) 40.33
Peak Rate Factor 0.00
Weighted Curve Number 82.64
Rain Gage ID Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.79	B	69.00
Vineyard - Annual Grass CC	0.45	B	61.00
Paved parking & roofs	0.07	B	98.00
50 - 75% grass cover, Fair	25.33	D	84.00
Woods & grass combination, Fair	8.79	D	82.00
Vineyard - Annual Grass CC	2.88	D	81.00
Paved parking & roofs	0.94	D	98.00
Woods & grass combination, Fair	1.08	B	65.00
Composite Area & Weighted CN	40.33		82.64

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

T_c = Time of Concentration (hr)
n = Manning's roughness
L_f = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (S_f^{0.5}) (unpaved surface)
V = 20.3282 * (S_f^{0.5}) (paved surface)
V = 15.0 * (S_f^{0.5}) (grassed waterway surface)
V = 10.0 * (S_f^{0.5}) (nearly bare & untilled surface)
V = 9.0 * (S_f^{0.5}) (cultivated straight rows surface)
V = 7.0 * (S_f^{0.5}) (short grass pasture surface)
V = 5.0 * (S_f^{0.5}) (woodland surface)
V = 2.5 * (S_f^{0.5}) (forest w/heavy litter surface)
T_c = (L_f / V) / (3600 sec/hr)

Where:

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (S_f^{0.5})) / n
R = A_q / W_p
T_c = (L_f / V) / (3600 sec/hr)

Where :

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
R = Hydraulic Radius (ft)
A_q = Flow Area (ft²)
W_p = Wetted Perimeter (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)
n = Manning's roughness

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.35	0.00	0.00
Flow Length (ft) :	300	0.00	0.00
Slope (%) :	41.60	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.50	0.00	0.00
Velocity (ft/sec) :	0.38	0.00	0.00
Computed Flow Time (min) :	13.20	0.00	0.00
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	113	0.00	0.00
Slope (%) :	26.55	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	3.61	0.00	0.00
Computed Flow Time (min) :	0.52	0.00	0.00
	Subarea A	Subarea B	Subarea C
Channel Flow Computations			
Manning's Roughness :	0.05	0.05	0.05
Flow Length (ft) :	436	847	1006
Channel Slope (%) :	23	14.65	5.37
Cross Section Area (ft ²) :	6.9	6.9	6.9
Wetted Perimeter (ft) :	8.03	8.03	8.03
Velocity (ft/sec) :	12.92	10.31	6.24
Computed Flow Time (min) :	0.56	1.37	2.69
Total TOC (min)	18.34		

Subbasin Runoff Results

Total Rainfall (in)	5.22
Total Runoff (in)	3.34
Peak Runoff (cfs)	32.56
Weighted Curve Number	82.64
Time of Concentration (days hh:mm:ss)	0 00:18:20

Project Description

File Name Acierno.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method SCS TR-55
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Kinematic Wave
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods ... YES

Analysis Options

Start Analysis On Aug 25, 2023 00:00:00
End Analysis On Aug 26, 2023 00:00:00
Start Reporting On Aug 25, 2023 00:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:00:30 days hh:mm:ss
Routing Time Step 30 seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	TS-050	Cumulative	inches	California	Napa (Napa Metro)	50	6.97	SCS Type IA 24-hr

Subbasin Summary

SN	Subbasin ID	Area	Peak Rate Factor	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
		(ac)			(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1	A	40.33	0.00	83	6.97	4.96	200.00	49.5	0 00:18:20

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	Out-01	Outfall	0.00					0.00	0.00					

Subbasin Hydrology

Subbasin : A

Input Data

Area (ac) 40.33
Peak Rate Factor 0.00
Weighted Curve Number 82.64
Rain Gage ID Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.79	B	69.00
Vineyard - Annual Grass CC	0.45	B	61.00
Paved parking & roofs	0.07	B	98.00
50 - 75% grass cover, Fair	25.33	D	84.00
Woods & grass combination, Fair	8.79	D	82.00
Vineyard - Annual Grass CC	2.88	D	81.00
Paved parking & roofs	0.94	D	98.00
Woods & grass combination, Fair	1.08	B	65.00
Composite Area & Weighted CN	40.33		82.64

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

T_c = Time of Concentration (hr)
n = Manning's roughness
L_f = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (S_f^{0.5}) (unpaved surface)
V = 20.3282 * (S_f^{0.5}) (paved surface)
V = 15.0 * (S_f^{0.5}) (grassed waterway surface)
V = 10.0 * (S_f^{0.5}) (nearly bare & untilled surface)
V = 9.0 * (S_f^{0.5}) (cultivated straight rows surface)
V = 7.0 * (S_f^{0.5}) (short grass pasture surface)
V = 5.0 * (S_f^{0.5}) (woodland surface)
V = 2.5 * (S_f^{0.5}) (forest w/heavy litter surface)
T_c = (L_f / V) / (3600 sec/hr)

Where:

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (S_f^{0.5})) / n
R = A_q / W_p
T_c = (L_f / V) / (3600 sec/hr)

Where :

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
R = Hydraulic Radius (ft)
A_q = Flow Area (ft²)
W_p = Wetted Perimeter (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)
n = Manning's roughness

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.35	0.00	0.00
Flow Length (ft) :	300	0.00	0.00
Slope (%) :	41.60	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.50	0.00	0.00
Velocity (ft/sec) :	0.38	0.00	0.00
Computed Flow Time (min) :	13.20	0.00	0.00
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	113	0.00	0.00
Slope (%) :	26.55	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	3.61	0.00	0.00
Computed Flow Time (min) :	0.52	0.00	0.00
	Subarea A	Subarea B	Subarea C
Channel Flow Computations			
Manning's Roughness :	0.05	0.05	0.05
Flow Length (ft) :	436	847	1006
Channel Slope (%) :	23	14.65	5.37
Cross Section Area (ft ²) :	6.9	6.9	6.9
Wetted Perimeter (ft) :	8.03	8.03	8.03
Velocity (ft/sec) :	12.92	10.31	6.24
Computed Flow Time (min) :	0.56	1.37	2.69
Total TOC (min)	18.34		

Subbasin Runoff Results

Total Rainfall (in)	6.97
Total Runoff (in)	4.96
Peak Runoff (cfs)	49.52
Weighted Curve Number	82.64
Time of Concentration (days hh:mm:ss)	0 00:18:20

Project Description

File Name Acierno.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method SCS TR-55
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Kinematic Wave
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods ... YES

Analysis Options

Start Analysis On Aug 25, 2023 00:00:00
End Analysis On Aug 26, 2023 00:00:00
Start Reporting On Aug 25, 2023 00:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:00:30 days hh:mm:ss
Routing Time Step 30 seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	TS-100	Cumulative	inches	California	Napa (Napa Metro)	100	7.70	SCS Type IA 24-hr

Subbasin Summary

SN Subbasin ID	Area	Peak Rate Factor	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
	(ac)			(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1 A	40.33	0.00	83	7.70	5.65	227.86	56.7	0 00:18:20

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	Out-01	Outfall	0.00					0.00	0.00					

Subbasin Hydrology

Subbasin : A

Input Data

Area (ac) 40.33
Peak Rate Factor 0.00
Weighted Curve Number 82.64
Rain Gage ID Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.79	B	69.00
Vineyard - Annual Grass CC	0.45	B	61.00
Paved parking & roofs	0.07	B	98.00
50 - 75% grass cover, Fair	25.33	D	84.00
Woods & grass combination, Fair	8.79	D	82.00
Vineyard - Annual Grass CC	2.88	D	81.00
Paved parking & roofs	0.94	D	98.00
Woods & grass combination, Fair	1.08	B	65.00
Composite Area & Weighted CN	40.33		82.64

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

T_c = Time of Concentration (hr)
n = Manning's roughness
L_f = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (S_f^{0.5}) (unpaved surface)
V = 20.3282 * (S_f^{0.5}) (paved surface)
V = 15.0 * (S_f^{0.5}) (grassed waterway surface)
V = 10.0 * (S_f^{0.5}) (nearly bare & untilled surface)
V = 9.0 * (S_f^{0.5}) (cultivated straight rows surface)
V = 7.0 * (S_f^{0.5}) (short grass pasture surface)
V = 5.0 * (S_f^{0.5}) (woodland surface)
V = 2.5 * (S_f^{0.5}) (forest w/heavy litter surface)
T_c = (L_f / V) / (3600 sec/hr)

Where:

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (S_f^{0.5})) / n
R = A_q / W_p
T_c = (L_f / V) / (3600 sec/hr)

Where :

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
R = Hydraulic Radius (ft)
A_q = Flow Area (ft²)
W_p = Wetted Perimeter (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)
n = Manning's roughness

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.35	0.00	0.00
Flow Length (ft) :	300	0.00	0.00
Slope (%) :	41.60	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.50	0.00	0.00
Velocity (ft/sec) :	0.38	0.00	0.00
Computed Flow Time (min) :	13.20	0.00	0.00
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	113	0.00	0.00
Slope (%) :	26.55	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	3.61	0.00	0.00
Computed Flow Time (min) :	0.52	0.00	0.00
	Subarea A	Subarea B	Subarea C
Channel Flow Computations			
Manning's Roughness :	0.05	0.05	0.05
Flow Length (ft) :	436	847	1006
Channel Slope (%) :	23	14.65	5.37
Cross Section Area (ft ²) :	6.9	6.9	6.9
Wetted Perimeter (ft) :	8.03	8.03	8.03
Velocity (ft/sec) :	12.92	10.31	6.24
Computed Flow Time (min) :	0.56	1.37	2.69
Total TOC (min)	18.34		

Subbasin Runoff Results

Total Rainfall (in)	7.70
Total Runoff (in)	5.65
Peak Runoff (cfs)	56.67
Weighted Curve Number	82.64
Time of Concentration (days hh:mm:ss)	0 00:18:20

Project Description

File Name Acierno_POST.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method SCS TR-55
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Kinematic Wave
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods ... YES

Analysis Options

Start Analysis On Aug 25, 2023 00:00:00
End Analysis On Aug 26, 2023 00:00:00
Start Reporting On Aug 25, 2023 00:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:00:30 days hh:mm:ss
Routing Time Step 30 seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	TS-002	Cumulative	inches	California	Napa (Napa Metro)	2	3.50	SCS Type IA 24-hr

Subbasin Summary

SN Subbasin ID	Area	Peak Rate Factor	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
	(ac)			(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1 A	40.33	0.00	83	3.50	1.83	73.76	16.7	0 00:18:20

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	Out-01	Outfall	0.00					0.00	0.00					

Subbasin Hydrology

Subbasin : A

Input Data

Area (ac) 40.33
Peak Rate Factor 0.00
Weighted Curve Number 82.62
Rain Gage ID Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.79	B	69.00
Vineyard - Annual Grass CC	0.45	B	61.00
Paved parking & roofs	0.07	B	98.00
50 - 75% grass cover, Fair	25.33	D	84.00
Woods & grass combination, Fair	8.06	D	82.00
Vineyard - Annual Grass CC	3.61	D	81.00
Paved parking & roofs	0.94	D	98.00
Woods & grass combination, Fair	1.08	B	65.00
Composite Area & Weighted CN	40.33		82.62

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

T_c = Time of Concentration (hr)
n = Manning's roughness
L_f = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (S_f^{0.5}) (unpaved surface)
V = 20.3282 * (S_f^{0.5}) (paved surface)
V = 15.0 * (S_f^{0.5}) (grassed waterway surface)
V = 10.0 * (S_f^{0.5}) (nearly bare & untilled surface)
V = 9.0 * (S_f^{0.5}) (cultivated straight rows surface)
V = 7.0 * (S_f^{0.5}) (short grass pasture surface)
V = 5.0 * (S_f^{0.5}) (woodland surface)
V = 2.5 * (S_f^{0.5}) (forest w/heavy litter surface)
T_c = (L_f / V) / (3600 sec/hr)

Where:

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (S_f^{0.5})) / n
R = A_q / W_p
T_c = (L_f / V) / (3600 sec/hr)

Where :

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
R = Hydraulic Radius (ft)
A_q = Flow Area (ft²)
W_p = Wetted Perimeter (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)
n = Manning's roughness

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.35	0.00	0.00
Flow Length (ft) :	300	0.00	0.00
Slope (%) :	41.60	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.50	0.00	0.00
Velocity (ft/sec) :	0.38	0.00	0.00
Computed Flow Time (min) :	13.20	0.00	0.00
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	113	0.00	0.00
Slope (%) :	26.55	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	3.61	0.00	0.00
Computed Flow Time (min) :	0.52	0.00	0.00
	Subarea A	Subarea B	Subarea C
Channel Flow Computations			
Manning's Roughness :	0.05	0.05	0.05
Flow Length (ft) :	436	847	1006
Channel Slope (%) :	23	14.65	5.37
Cross Section Area (ft ²) :	6.9	6.9	6.9
Wetted Perimeter (ft) :	8.03	8.03	8.03
Velocity (ft/sec) :	12.92	10.31	6.24
Computed Flow Time (min) :	0.56	1.37	2.69
Total TOC (min)	18.34		

Subbasin Runoff Results

Total Rainfall (in)	3.50
Total Runoff (in)	1.83
Peak Runoff (cfs)	16.70
Weighted Curve Number	82.62
Time of Concentration (days hh:mm:ss)	0 00:18:20

Project Description

File Name Acierno_POST.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method SCS TR-55
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Kinematic Wave
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods ... YES

Analysis Options

Start Analysis On Aug 25, 2023 00:00:00
End Analysis On Aug 26, 2023 00:00:00
Start Reporting On Aug 25, 2023 00:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:00:30 days hh:mm:ss
Routing Time Step 30 seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	TS-010	Cumulative	inches	California	Napa (Napa Metro)	10	5.22	SCS Type IA 24-hr

Subbasin Summary

SN Subbasin ID	Area	Peak Rate Factor	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
	(ac)			(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1 A	40.33	0.00	83	5.22	3.34	134.58	32.5	0 00:18:20

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	Out-01	Outfall	0.00					0.00	0.00					

Subbasin Hydrology

Subbasin : A

Input Data

Area (ac) 40.33
Peak Rate Factor 0.00
Weighted Curve Number 82.62
Rain Gage ID Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.79	B	69.00
Vineyard - Annual Grass CC	0.45	B	61.00
Paved parking & roofs	0.07	B	98.00
50 - 75% grass cover, Fair	25.33	D	84.00
Woods & grass combination, Fair	8.06	D	82.00
Vineyard - Annual Grass CC	3.61	D	81.00
Paved parking & roofs	0.94	D	98.00
Woods & grass combination, Fair	1.08	B	65.00
Composite Area & Weighted CN	40.33		82.62

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

T_c = Time of Concentration (hr)
n = Manning's roughness
L_f = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (S_f^{0.5}) (unpaved surface)
V = 20.3282 * (S_f^{0.5}) (paved surface)
V = 15.0 * (S_f^{0.5}) (grassed waterway surface)
V = 10.0 * (S_f^{0.5}) (nearly bare & untilled surface)
V = 9.0 * (S_f^{0.5}) (cultivated straight rows surface)
V = 7.0 * (S_f^{0.5}) (short grass pasture surface)
V = 5.0 * (S_f^{0.5}) (woodland surface)
V = 2.5 * (S_f^{0.5}) (forest w/heavy litter surface)
T_c = (L_f / V) / (3600 sec/hr)

Where:

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (S_f^{0.5})) / n
R = A_q / W_p
T_c = (L_f / V) / (3600 sec/hr)

Where :

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
R = Hydraulic Radius (ft)
A_q = Flow Area (ft²)
W_p = Wetted Perimeter (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)
n = Manning's roughness

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.35	0.00	0.00
Flow Length (ft) :	300	0.00	0.00
Slope (%) :	41.60	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.50	0.00	0.00
Velocity (ft/sec) :	0.38	0.00	0.00
Computed Flow Time (min) :	13.20	0.00	0.00
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	113	0.00	0.00
Slope (%) :	26.55	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	3.61	0.00	0.00
Computed Flow Time (min) :	0.52	0.00	0.00
	Subarea A	Subarea B	Subarea C
Channel Flow Computations			
Manning's Roughness :	0.05	0.05	0.05
Flow Length (ft) :	436	847	1006
Channel Slope (%) :	23	14.65	5.37
Cross Section Area (ft ²) :	6.9	6.9	6.9
Wetted Perimeter (ft) :	8.03	8.03	8.03
Velocity (ft/sec) :	12.92	10.31	6.24
Computed Flow Time (min) :	0.56	1.37	2.69
Total TOC (min)	18.34		

Subbasin Runoff Results

Total Rainfall (in)	5.22
Total Runoff (in)	3.34
Peak Runoff (cfs)	32.54
Weighted Curve Number	82.62
Time of Concentration (days hh:mm:ss)	0 00:18:20

Project Description

File Name Acierno_POST.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method SCS TR-55
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Kinematic Wave
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods ... YES

Analysis Options

Start Analysis On Aug 25, 2023 00:00:00
End Analysis On Aug 26, 2023 00:00:00
Start Reporting On Aug 25, 2023 00:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:00:30 days hh:mm:ss
Routing Time Step 30 seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	TS-050	Cumulative	inches	California	Napa (Napa Metro)	50	6.97	SCS Type IA 24-hr

Subbasin Summary

SN	Subbasin ID	Area	Peak Rate Factor	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
		(ac)			(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1	A	40.33	0.00	83	6.97	4.96	199.92	49.5	0 00:18:20

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	Out-01	Outfall	0.00					0.00	0.00					

Subbasin Hydrology

Subbasin : A

Input Data

Area (ac) 40.33
Peak Rate Factor 0.00
Weighted Curve Number 82.62
Rain Gage ID Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.79	B	69.00
Vineyard - Annual Grass CC	0.45	B	61.00
Paved parking & roofs	0.07	B	98.00
50 - 75% grass cover, Fair	25.33	D	84.00
Woods & grass combination, Fair	8.06	D	82.00
Vineyard - Annual Grass CC	3.61	D	81.00
Paved parking & roofs	0.94	D	98.00
Woods & grass combination, Fair	1.08	B	65.00
Composite Area & Weighted CN	40.33		82.62

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

T_c = Time of Concentration (hr)
n = Manning's roughness
L_f = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (S_f^{0.5}) (unpaved surface)
V = 20.3282 * (S_f^{0.5}) (paved surface)
V = 15.0 * (S_f^{0.5}) (grassed waterway surface)
V = 10.0 * (S_f^{0.5}) (nearly bare & untilled surface)
V = 9.0 * (S_f^{0.5}) (cultivated straight rows surface)
V = 7.0 * (S_f^{0.5}) (short grass pasture surface)
V = 5.0 * (S_f^{0.5}) (woodland surface)
V = 2.5 * (S_f^{0.5}) (forest w/heavy litter surface)
T_c = (L_f / V) / (3600 sec/hr)

Where:

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (S_f^{0.5})) / n
R = A_q / W_p
T_c = (L_f / V) / (3600 sec/hr)

Where :

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
R = Hydraulic Radius (ft)
A_q = Flow Area (ft²)
W_p = Wetted Perimeter (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)
n = Manning's roughness

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.35	0.00	0.00
Flow Length (ft) :	300	0.00	0.00
Slope (%) :	41.60	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.50	0.00	0.00
Velocity (ft/sec) :	0.38	0.00	0.00
Computed Flow Time (min) :	13.20	0.00	0.00
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	113	0.00	0.00
Slope (%) :	26.55	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	3.61	0.00	0.00
Computed Flow Time (min) :	0.52	0.00	0.00
	Subarea A	Subarea B	Subarea C
Channel Flow Computations			
Manning's Roughness :	0.05	0.05	0.05
Flow Length (ft) :	436	847	1006
Channel Slope (%) :	23	14.65	5.37
Cross Section Area (ft ²) :	6.9	6.9	6.9
Wetted Perimeter (ft) :	8.03	8.03	8.03
Velocity (ft/sec) :	12.92	10.31	6.24
Computed Flow Time (min) :	0.56	1.37	2.69
Total TOC (min)	18.34		

Subbasin Runoff Results

Total Rainfall (in)	6.97
Total Runoff (in)	4.96
Peak Runoff (cfs)	49.50
Weighted Curve Number	82.62
Time of Concentration (days hh:mm:ss)	0 00:18:20

Project Description

File Name Acierno_POST.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method SCS TR-55
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Kinematic Wave
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods ... YES

Analysis Options

Start Analysis On Aug 25, 2023 00:00:00
End Analysis On Aug 26, 2023 00:00:00
Start Reporting On Aug 25, 2023 00:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:00:30 days hh:mm:ss
Routing Time Step 30 seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	TS-100	Cumulative	inches	California	Napa (Napa Metro)	100	7.70	SCS Type IA 24-hr

Subbasin Summary

SN Subbasin ID	Area	Peak Rate Factor	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
	(ac)			(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1 A	40.33	0.00	83	7.70	5.65	227.74	56.7	0 00:18:20

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)	(ft)	(days hh:mm)	(ac-in)	(min)
1	Out-01	Outfall	0.00					0.00	0.00					

Subbasin Hydrology

Subbasin : A

Input Data

Area (ac) 40.33
Peak Rate Factor 0.00
Weighted Curve Number 82.62
Rain Gage ID Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	0.79	B	69.00
Vineyard - Annual Grass CC	0.45	B	61.00
Paved parking & roofs	0.07	B	98.00
50 - 75% grass cover, Fair	25.33	D	84.00
Woods & grass combination, Fair	8.06	D	82.00
Vineyard - Annual Grass CC	3.61	D	81.00
Paved parking & roofs	0.94	D	98.00
Woods & grass combination, Fair	1.08	B	65.00
Composite Area & Weighted CN	40.33		82.62

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where :

T_c = Time of Concentration (hr)
n = Manning's roughness
L_f = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (S_f^{0.5}) (unpaved surface)
V = 20.3282 * (S_f^{0.5}) (paved surface)
V = 15.0 * (S_f^{0.5}) (grassed waterway surface)
V = 10.0 * (S_f^{0.5}) (nearly bare & untilled surface)
V = 9.0 * (S_f^{0.5}) (cultivated straight rows surface)
V = 7.0 * (S_f^{0.5}) (short grass pasture surface)
V = 5.0 * (S_f^{0.5}) (woodland surface)
V = 2.5 * (S_f^{0.5}) (forest w/heavy litter surface)
T_c = (L_f / V) / (3600 sec/hr)

Where:

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (S_f^{0.5})) / n
R = A_q / W_p
T_c = (L_f / V) / (3600 sec/hr)

Where :

T_c = Time of Concentration (hr)
L_f = Flow Length (ft)
R = Hydraulic Radius (ft)
A_q = Flow Area (ft²)
W_p = Wetted Perimeter (ft)
V = Velocity (ft/sec)
S_f = Slope (ft/ft)
n = Manning's roughness

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.35	0.00	0.00
Flow Length (ft) :	300	0.00	0.00
Slope (%) :	41.60	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.50	0.00	0.00
Velocity (ft/sec) :	0.38	0.00	0.00
Computed Flow Time (min) :	13.20	0.00	0.00
	Subarea A	Subarea B	Subarea C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	113	0.00	0.00
Slope (%) :	26.55	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	3.61	0.00	0.00
Computed Flow Time (min) :	0.52	0.00	0.00
	Subarea A	Subarea B	Subarea C
Channel Flow Computations			
Manning's Roughness :	0.05	0.05	0.05
Flow Length (ft) :	436	847	1006
Channel Slope (%) :	23	14.65	5.37
Cross Section Area (ft ²) :	6.9	6.9	6.9
Wetted Perimeter (ft) :	8.03	8.03	8.03
Velocity (ft/sec) :	12.92	10.31	6.24
Computed Flow Time (min) :	0.56	1.37	2.69
Total TOC (min)	18.34		

Subbasin Runoff Results

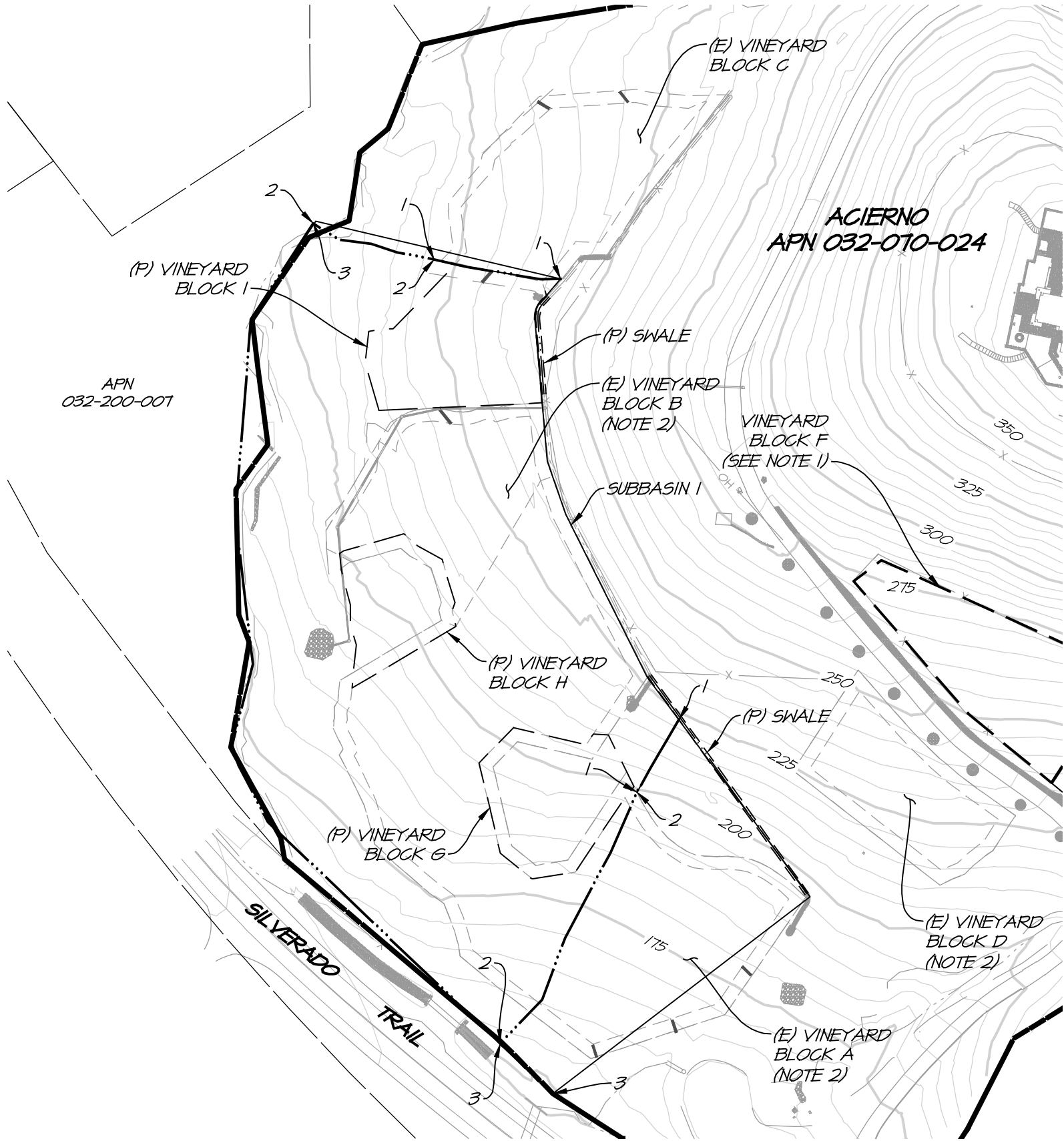
Total Rainfall (in)	7.70
Total Runoff (in)	5.65
Peak Runoff (cfs)	56.65
Weighted Curve Number	82.62
Time of Concentration (days hh:mm:ss)	0 00:18:20



ATTACHMENT 3

Cross-Slope Diversion Swale Analysis

ACIERNO TRACK I - BLOCKS G, H AND I
DIVERSION SWALE ANALYSIS - EXISTING
NAPA CALIFORNIA



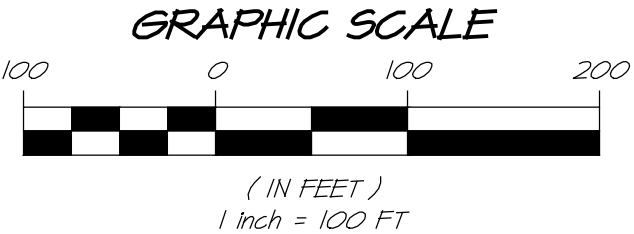
TIME OF CONCENTRATION					
SUBBASIN	SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (%)
1	1	SHEET FLOW	UNPAVED	65	35.50
	2	SHALLOW CONCENTRATED FLOW	GRASSY PASTURE	226	20.82
	3	CHANNEL FLOW	UNPAVED	56	4.78
2	1	SHEET FLOW	UNPAVED	100	19.42
	2	SHALLOW CONCENTRATED FLOW	GRASSY PASTURE	100	17.90
	3	CHANNEL FLOW	UNPAVED	598	6.78

LEGEND

- APPROXIMATE PROPERTY LINE
- ADJOINING PROPERTY LINE
- PATH OF TIME OF CONCENTRATION (T.O.C.)

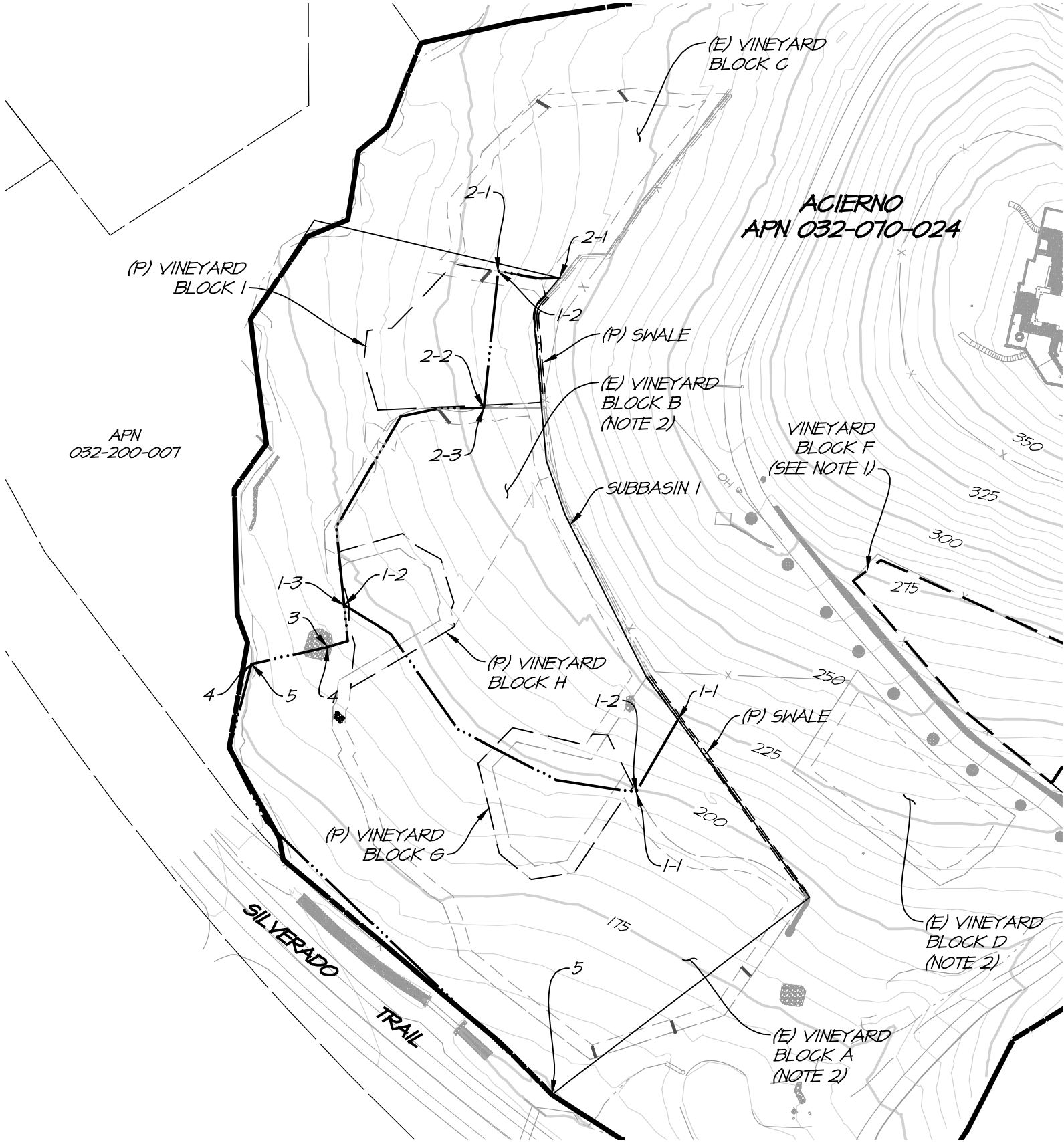
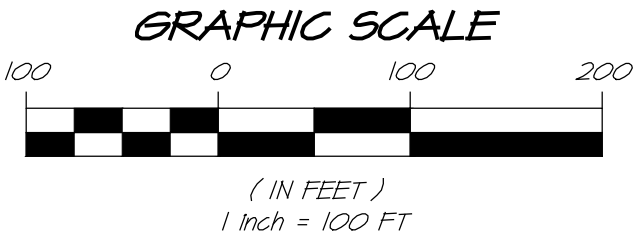
NOTES

- EXISTING VINEYARD PLANTED CIRCA 2007 AND 2011 (BY PREVIOUS OWNER) TO BE REMOVED & RESTORED UNDER SEPARATE PERMIT.
- VINEYARD BLOCKS A THROUGH E TO BE REPLANTED UNDER PERMIT #P22-00412
- PER PRE-APPLICATION MEETING WITH NAPA COUNTY ON 10-13-2022, TREES REMOVED BY PG&E ARE NOT COUNTED AGAINST PROJECT IN REGARDS TO THE VEGETATION RETENTION REQUIREMENTS OF REQUIRED TO BE REPLANTED AS PART OF THESE PLANS.



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ACIERNO TRACK I - BLOCKS G, H AND I
DIVERSION SWALE ANALYSIS - PROPOSED
NAPA CALIFORNIA



TIME OF CONCENTRATION					
SUBBASIN	SEGMENT NUMBER	TYPE OF FLOW	SURFACE/PIPE DESCRIPTION	LENGTH (FEET)	AVG SLOPE (%)
1	1	SHEET FLOW	UNPAVED	65	35.50
	2	CHANNEL FLOW	DIVERSION SWALE	283	1.42
	3	CHANNEL FLOW	12" PVC PIPE	44	18.06
	4	SHALLOW CONCENTRATED FLOW	GRASSY PASTURE	61	22.34
	5	CHANNEL FLOW	UNPAVED	439	5.49
2	1	SHEET FLOW	UNPAVED	48	18.38
	2	CHANNEL FLOW	DIVERSION SWALE	107	2.70
	3	CHANNEL FLOW	12" PVC PIPE	271	15.43
	4	SHALLOW CONCENTRATED FLOW	GRASSY PASTURE	61	22.34
	5	CHANNEL FLOW	UNPAVED	439	5.49

LEGEND

--- APPROXIMATE PROPERTY LINE

--- ADJOINING PROPERTY LINE

--- PATH OF TIME OF CONCENTRATION (T.O.C.)

NOTES

- EXISTING VINEYARD PLANTED CIRCA 2007 AND 2011 (BY PREVIOUS OWNER) TO BE REMOVED & RESTORED UNDER SEPARATE PERMIT.
- VINEYARD BLOCKS A THROUGH E TO BE REPLANTED UNDER PERMIT #P22-00412
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\\Client\RSA\2022\4122064.0_Acierno_Silverado_Trail_Property\DESIGN\EXHIBITS\Exh-Drainage Block G_H and I - Proposed Vineyard Drainage.dwg 02/20/2024

SCS TR-55 Time of Concentration Computations Report

=====

Sheet Flow Equation

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where:

T_c = Time of Concentration (hrs)

n = Manning's Roughness

L_f = Flow Length (ft)

P = 2 yr, 24 hr Rainfall (inches)

S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation

$$V = 16.1345 * (S_f^{0.5}) \text{ (unpaved surface)}$$

$$V = 20.3282 * (S_f^{0.5}) \text{ (paved surface)}$$

$$V = 15.0 * (S_f^{0.5}) \text{ (grassed waterway surface)}$$

$$V = 10.0 * (S_f^{0.5}) \text{ (nearly bare \& untilled surface)}$$

$$V = 9.0 * (S_f^{0.5}) \text{ (cultivated straight rows surface)}$$

$$V = 7.0 * (S_f^{0.5}) \text{ (short grass pasture surface)}$$

$$V = 5.0 * (S_f^{0.5}) \text{ (woodland surface)}$$

$$V = 2.5 * (S_f^{0.5}) \text{ (forest w/heavy litter surface)}$$

$$T_c = (L_f / V) / (3600 \text{ sec/hr})$$

Where:

T_c = Time of Concentration (hrs)

L_f = Flow Length (ft)

V = Velocity (ft/sec)

S_f = Slope (ft/ft)

Channel Flow Equation

$$V = (1.49 * (R^{(2/3)}) * (Sf^{0.5})) / n$$

$$R = Aq / Wp$$

$$Tc = (Lf / V) / (3600 \text{ sec/hr})$$

Where:

Tc = Time of Concentration (hrs)

Lf = Flow Length (ft)

R = Hydraulic Radius (ft)

Aq = Flow Area (ft²)

Wp = Wetted Perimeter (ft)

V = Velocity (ft/sec)

Sf = Slope (ft/ft)

n = Manning's Roughness

=====

Time_of_Travel_Existing_1

=====

Sheet Flow Computations

-	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.4	0.00	0.00
Flow Length (ft):	65	0.00	0.00
Slope (%):	35.50	0.00	0.00
2 yr, 24 hr Rainfall (in):	3.50	0.00	0.00
Velocity (ft/sec):	0.24	0.00	0.00
Computed Flow Time (minutes):	4.60	0.00	0.00

Shallow Concentrated Flow Computations

-	Subarea A	Subarea B	Subarea C
Flow Length (ft):	226	0.00	0.00

Slope (%):	20.82	0.00	0.00
Surface Type:	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec):	3.19	0.00	0.00
Computed Flow Time (minutes):	1.18	0.00	0.00

Channel Flow Computations

-	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.05	0.00	0.00
Flow Length (ft):	56	0.00	0.00
Channel Slope (%):	4.78	0.00	0.00
Cross Section Area (ft ²):	6.9	0.00	0.00
Wetted Perimeter (ft):	8.03	0.00	0.00
Velocity (ft/sec):	5.89	0.00	0.00
Computed Flow Time (minutes):	0.16	0.00	0.00

=====

Total TOC (minutes):	5.94
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SCS TR-55 Time of Concentration Computations Report

=====

Sheet Flow Equation

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where:

T_c = Time of Concentration (hrs)

n = Manning's Roughness

L_f = Flow Length (ft)

P = 2 yr, 24 hr Rainfall (inches)

S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation

$$V = 16.1345 * (S_f^{0.5}) \text{ (unpaved surface)}$$

$$V = 20.3282 * (S_f^{0.5}) \text{ (paved surface)}$$

$$V = 15.0 * (S_f^{0.5}) \text{ (grassed waterway surface)}$$

$$V = 10.0 * (S_f^{0.5}) \text{ (nearly bare \& untilled surface)}$$

$$V = 9.0 * (S_f^{0.5}) \text{ (cultivated straight rows surface)}$$

$$V = 7.0 * (S_f^{0.5}) \text{ (short grass pasture surface)}$$

$$V = 5.0 * (S_f^{0.5}) \text{ (woodland surface)}$$

$$V = 2.5 * (S_f^{0.5}) \text{ (forest w/heavy litter surface)}$$

$$T_c = (L_f / V) / (3600 \text{ sec/hr})$$

Where:

T_c = Time of Concentration (hrs)

L_f = Flow Length (ft)

V = Velocity (ft/sec)

S_f = Slope (ft/ft)

Channel Flow Equation

$$V = (1.49 * (R^{(2/3)}) * (Sf^{0.5})) / n$$

$$R = Aq / Wp$$

$$Tc = (Lf / V) / (3600 \text{ sec/hr})$$

Where:

Tc = Time of Concentration (hrs)

Lf = Flow Length (ft)

R = Hydraulic Radius (ft)

Aq = Flow Area (ft²)

Wp = Wetted Perimeter (ft)

V = Velocity (ft/sec)

Sf = Slope (ft/ft)

n = Manning's Roughness

=====

Time_of_Travel_Existing_2

=====

Sheet Flow Computations

-	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.4	0.00	0.00
Flow Length (ft):	100	0.00	0.00
Slope (%):	19.42	0.00	0.00
2 yr, 24 hr Rainfall (in):	3.50	0.00	0.00
Velocity (ft/sec):	0.20	0.00	0.00
Computed Flow Time (minutes):	8.27	0.00	0.00

Shallow Concentrated Flow Computations

-	Subarea A	Subarea B	Subarea C
Flow Length (ft):	100	0.00	0.00

Slope (%):	17.90	0.00	0.00
Surface Type:	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec):	2.96	0.00	0.00
Computed Flow Time (minutes):	0.56	0.00	0.00

Channel Flow Computations

-	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.05	0.00	0.00
Flow Length (ft):	598	0.00	0.00
Channel Slope (%):	6.78	0.00	0.00
Cross Section Area (ft ²):	6.9	0.00	0.00
Wetted Perimeter (ft):	8.03	0.00	0.00
Velocity (ft/sec):	7.01	0.00	0.00
Computed Flow Time (minutes):	1.42	0.00	0.00

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Total TOC (minutes):	10.26
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SCS TR-55 Time of Concentration Computations Report

=====

Sheet Flow Equation

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where:

T_c = Time of Concentration (hrs)

n = Manning's Roughness

L_f = Flow Length (ft)

P = 2 yr, 24 hr Rainfall (inches)

S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation

$$V = 16.1345 * (S_f^{0.5}) \text{ (unpaved surface)}$$

$$V = 20.3282 * (S_f^{0.5}) \text{ (paved surface)}$$

$$V = 15.0 * (S_f^{0.5}) \text{ (grassed waterway surface)}$$

$$V = 10.0 * (S_f^{0.5}) \text{ (nearly bare \& untilled surface)}$$

$$V = 9.0 * (S_f^{0.5}) \text{ (cultivated straight rows surface)}$$

$$V = 7.0 * (S_f^{0.5}) \text{ (short grass pasture surface)}$$

$$V = 5.0 * (S_f^{0.5}) \text{ (woodland surface)}$$

$$V = 2.5 * (S_f^{0.5}) \text{ (forest w/heavy litter surface)}$$

$$T_c = (L_f / V) / (3600 \text{ sec/hr})$$

Where:

T_c = Time of Concentration (hrs)

L_f = Flow Length (ft)

V = Velocity (ft/sec)

S_f = Slope (ft/ft)

Channel Flow Equation

$$V = (1.49 * (R^{(2/3)}) * (Sf^{0.5})) / n$$

$$R = Aq / Wp$$

$$Tc = (Lf / V) / (3600 \text{ sec/hr})$$

Where:

Tc = Time of Concentration (hrs)

Lf = Flow Length (ft)

R = Hydraulic Radius (ft)

Aq = Flow Area (ft²)

Wp = Wetted Perimeter (ft)

V = Velocity (ft/sec)

Sf = Slope (ft/ft)

n = Manning's Roughness

=====

Time_of_Travel_Proposed_1

=====

Sheet Flow Computations

-	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.4	0.00	0.00
Flow Length (ft):	65	0.00	0.00
Slope (%):	35.50	0.00	0.00
2 yr, 24 hr Rainfall (in):	3.50	0.00	0.00
Velocity (ft/sec):	0.24	0.00	0.00
Computed Flow Time (minutes):	4.60	0.00	0.00

Shallow Concentrated Flow Computations

-	Subarea A	Subarea B	Subarea C
Flow Length (ft):	61	0.00	0.00

Slope (%):	22.34	0.00	0.00
Surface Type:	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec):	3.31	0.00	0.00
Computed Flow Time (minutes):	0.31	0.00	0.00

Channel Flow Computations

-	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.27	0.012	0.05
Flow Length (ft):	283	44	439
Channel Slope (%):	1.42	18.06	5.49
Cross Section Area (ft ²):	0.5	0.74	6.9
Wetted Perimeter (ft):	2.24	0.9	8.03
Velocity (ft/sec):	0.24	46.31	6.31
Computed Flow Time (minutes):	19.49	0.02	1.16

=====

Total TOC (minutes):	25.58
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SCS TR-55 Time of Concentration Computations Report

=====

Sheet Flow Equation

$$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$$

Where:

T_c = Time of Concentration (hrs)

n = Manning's Roughness

L_f = Flow Length (ft)

P = 2 yr, 24 hr Rainfall (inches)

S_f = Slope (ft/ft)

Shallow Concentrated Flow Equation

$$V = 16.1345 * (S_f^{0.5}) \text{ (unpaved surface)}$$

$$V = 20.3282 * (S_f^{0.5}) \text{ (paved surface)}$$

$$V = 15.0 * (S_f^{0.5}) \text{ (grassed waterway surface)}$$

$$V = 10.0 * (S_f^{0.5}) \text{ (nearly bare \& untilled surface)}$$

$$V = 9.0 * (S_f^{0.5}) \text{ (cultivated straight rows surface)}$$

$$V = 7.0 * (S_f^{0.5}) \text{ (short grass pasture surface)}$$

$$V = 5.0 * (S_f^{0.5}) \text{ (woodland surface)}$$

$$V = 2.5 * (S_f^{0.5}) \text{ (forest w/heavy litter surface)}$$

$$T_c = (L_f / V) / (3600 \text{ sec/hr})$$

Where:

T_c = Time of Concentration (hrs)

L_f = Flow Length (ft)

V = Velocity (ft/sec)

S_f = Slope (ft/ft)

Channel Flow Equation

$$V = (1.49 * (R^{(2/3)}) * (Sf^{0.5})) / n$$

$$R = Aq / Wp$$

$$Tc = (Lf / V) / (3600 \text{ sec/hr})$$

Where:

Tc = Time of Concentration (hrs)

Lf = Flow Length (ft)

R = Hydraulic Radius (ft)

Aq = Flow Area (ft²)

Wp = Wetted Perimeter (ft)

V = Velocity (ft/sec)

Sf = Slope (ft/ft)

n = Manning's Roughness

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Time_of_Travel_Proposed_2

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Sheet Flow Computations

-	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.4	0.00	0.00
Flow Length (ft):	48	0.00	0.00
Slope (%):	18.38	0.00	0.00
2 yr, 24 hr Rainfall (in):	3.50	0.00	0.00
Velocity (ft/sec):	0.17	0.00	0.00
Computed Flow Time (minutes):	4.70	0.00	0.00

Shallow Concentrated Flow Computations

-	Subarea A	Subarea B	Subarea C
Flow Length (ft):	61	0.00	0.00

Slope (%):	22.34	0.00	0.00
Surface Type:	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec):	3.31	0.00	0.00
Computed Flow Time (minutes):	0.31	0.00	0.00

Channel Flow Computations

-	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.27	0.013	0.05
Flow Length (ft):	107	271	439
Channel Slope (%):	2.70	15.43	5.49
Cross Section Area (ft ²):	0.5	0.74	6.9
Wetted Perimeter (ft):	2.24	0.9	8.03
Velocity (ft/sec):	0.33	39.51	6.31
Computed Flow Time (minutes):	5.34	0.11	1.16

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Total TOC (minutes):	11.63
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