



ATTACHMENT D

MITIGATED NEGATIVE DECLARATION

APPENDIX H

HYDROLOGY REPORT

**PRELIMINARY HYDROLOGY STUDY
FOR
MANNING HOMES**

ENGINEER OF WORK

EXCEL ENGINEERING
440 State Place
Escondido, CA 92029
(760) 745-8118
Project No. 21-054



PREPARED
November 9, 2021

REVISED
August 12, 2024

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1.0 Project Description

1.1 Project Purpose

The objective of this study is to determine the amount of 100-year runoff that the existing site is generating right now and compare it to the 100 year runoff that the proposed project will be generating. We will also calculate adequacy of the proposed storm drain facilities and mitigation measures.

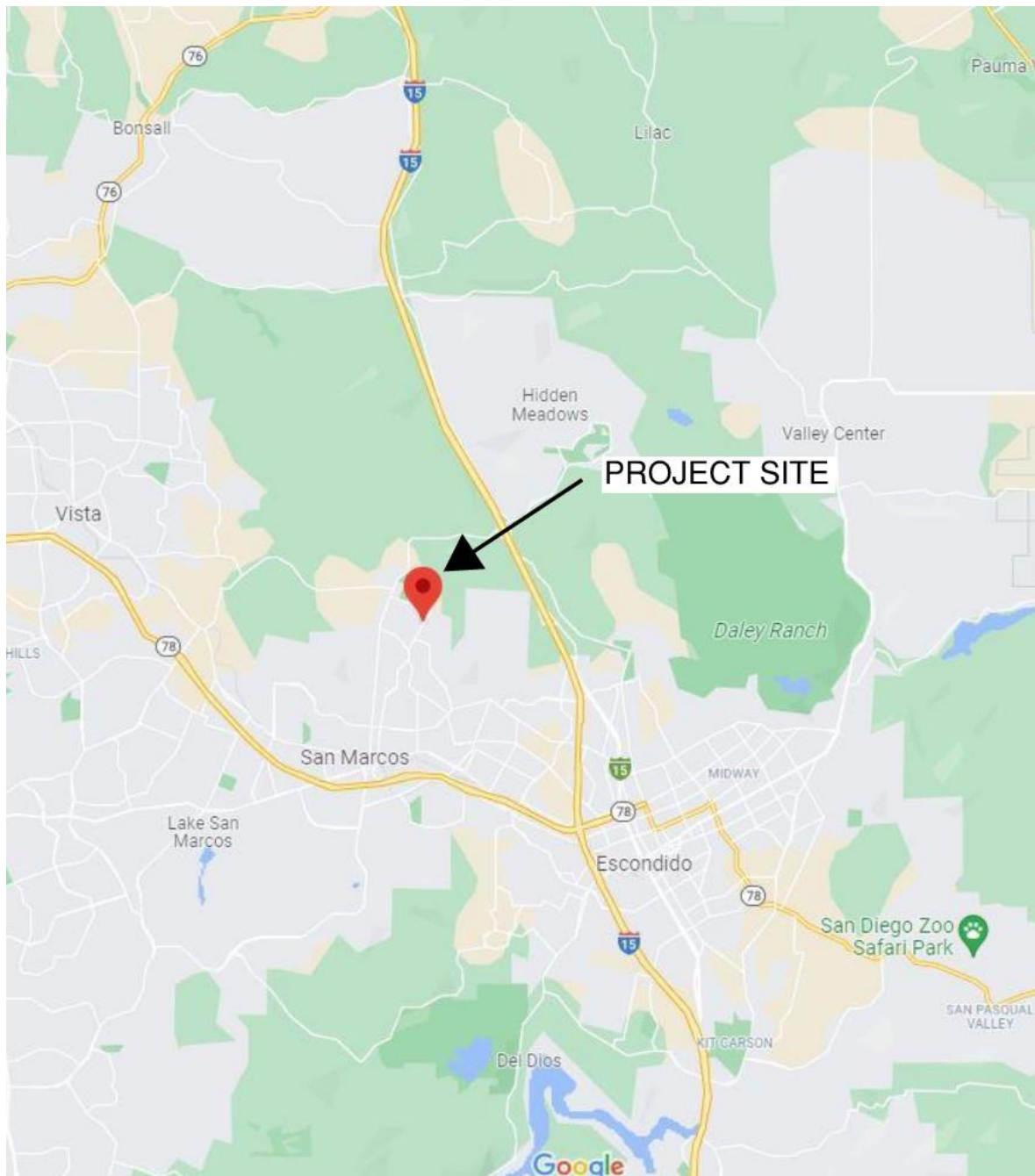
1.2 Project Proposed Facilities

The 10.74-acre residential project site is located south of Cox Road in San Marcos, California. The site is a farmland currently. The project site is face to Cox Road to the north and bordered by Mulberry Drive to the west. The present site configuration, consist of a relatively level building pad bordered by fill slopes descending to the west, north and northeast. The fill slopes have a gradient of about 2:1 (horizontal:vertical).

The project is proposing to build an approximately 10.05 acre of residential houses. As part of this project, associated improvements will include biofiltration basins located at the south edge and southeast corner of the project site. All necessary utilities (storm, sewer, water, etc.) will be installed as part of the project.

2.0 Vicinity Map

The project is located on the south side of Cox Road just southwest of the intersection of Cox Road and Mulberry Drive in San Marcos, California.



3.0 Site Map

Please see Attachment 1 – Site Map

4.0 Description of Watershed

4.1 Existing Conditions Topography and Drainage Patterns

The project onsite is an existing farmland. The project fronts onto Cox Road and Mulberry Drive. The property drains primarily by overland flow to an existing storm drain system located at the south edge of the project site. The site is relatively level with a small 2:1 cut slope. According to the Web Soil Survey, the soil type in this project is Type C. The same runoff factors will be used for the overall project calculations.

The **pre-development onsite** area is approximately 10.734 acre. The impervious square footage of the site was estimated based on aerial photography and detailed aerial topographic mapping to be approximately 0% of the site. From table 3-1 “RUNOFF COEFFICIENTS FOR URBAN AREAS”, runoff coefficients for 0% impervious will be used in the pre-development runoff calculations.

The **pre-development offsite** is approximately 10.137 acres total. Storm water drains from the west to the east side of the offsite then bypass from the north to the south of the project site and meets the onsite discharge at the southeast edge of the project site. The impervious square footage of the site was estimated based on aerial photography and detailed aerial topographic mapping to be approximately 10% for the north part of the site and 50% for the eastern street part of the site. From table 3-1 “RUNOFF COEFFICIENTS FOR URBAN AREAS”, runoff coefficients for 10% and 50% impervious will be used in the pre-development runoff calculations.

A pre-developed drainage map can be found as Attachment 4 in this report.

4.2 Post Conditions Topography and Drainage Patterns

This project proposed to install residential houses. The project is proposed to build two biofiltration basins for storm water quality, which located at the south edge and southeast corner of the project site, respectively, to incorporate the collection of storm water from the building and street and direct the storm water through storm water drainage pipes to POC, which is located at the south edge of the study site.

The average impervious square footage of the **post-development onsite** was estimated based on aerial photography and detailed aerial topographic mapping to be approximately 10% of the site. From table 3-1 “RUNOFF COEFFICIENTS FOR URBAN AREAS”, runoff coefficient for 10% impervious will be used in the post-development runoff calculations.

As calculated below and summarized further in section 6, the pre-development discharges a peak 100-year flow of 25.929 CFS. The project proposed post-development discharge a peak 100-year flow of 28.092 CFS, which need storage detention in post development. After mitigation, the peak 100-year flow of the post-development is 25.352 CFS. The most southerly biofiltration basin (BMP-A) perform peak flow detention purposes in addition to stormwater treatment.

A post-developed drainage map can be found as Attachment 5 in this report.

4.3 Hydrologic Unit Contribution

The project site is located in Twin Oaks Hydrologic Sub Area of the San Marcos Hydrologic Area of the Carlsbad Hydrologic Unit (904.53).

5.0 Methodology

This report is prepared in accordance with the 2003 San Diego County Hydrology Manual. Based on the overall tributary study area, calculations are based on the Rational Method.

5.1 Hydrology Software

We are using **the CivilCadd/CivilDesign®** software to analyze the runoff. The module we are using is the one for the *San Diego County Flood Control Division 2003 Hydrology Manual*. Please see the detailed hydrology calculations in Attachment 6.

5.2 Routing Software

Hydraflow Hydrographs Extension for Autodesk Civil 3D, Version 2021 is used for hydrologic routing of the entire project site. The hydrograph developed from the rational method is then manually entered into this software and routed into each detention pipe. The hydrograph report can be found in Attachment 7 in this report.

5.3 Soil Type Determination

The soil type for the proposed project was determined by mapping the project limits on the EPA Web Soil Survey website. The Web soil Survey indicate that the site is composed of soil type C. The soil report and soil index map can be found in Attachment 3 of this report.

5.4 Isopluvial Value Determination

The isopluvial values for the 100-year 6 hour and 24 hour storm events were determined by plotting the projects location on the respective exhibits from Appendix B of the Hydrology Manual. The rainfall isopluvial maps can be found in Attachment 3 of this report.

6.0 Calculations

The existing 100-year peak flowrates of the site is 25.929 CFS, the intent of the post-development calculation done as part of this report is to verify the 100-year flowrates expected from the post-developed conditions are lower than the pre-developed conditions. These numbers will be used to size the proposed storm drainage pipes and to doublecheck if the existing storm drain outlet facilities are adequate.

6.1 Calculate Runoff Coefficient

The runoff coefficients for each of the drainage areas are taken from Table 3-1 of the Hydrology Manual. Based on the EPA Web Soil Survey, this project site is in type C soil. The runoff coefficients C are based on the %IMPER. for this project. Table 3-1 is included in the CIVILD software, and the values chosen based on the program input parameters. The output file was checked to ensure that the correct C values are used.

In order to not have a negative impact on the post development downstream facilities, detention structure is needed in this project. The method we are using here on how to use the resulting values of the outflow hydrograph is to recalculate the runoff coefficient c value based on the fix values of the outflow hydrograph to achieve a c_{out} . The detailed description and calculation of the c_{out} value can be found in Attachment 7 in this report.

6.2 Manning Roughness Coefficient

Manning Roughness Coefficients are taken from San Diego County Drainage Design Manual. Values are taken from Table A-1, Average Manning Roughness Coefficients for Pavement and Gutters, Table A-2, Average Manning Roughness Coefficients for Closed Conduits, and Table A-5, Average Manning roughness Coefficient for Natural Channels. Values of 0.015 for Concrete Gutter, 0.013 for Smooth Asphalt Pavement, 0.013 for PVC Pipe, and 0.03 for Fairly Regular Section Some Grass and Weeds, Little or No Brush are used in the hydrology calculations. Table of Manning's n value can be found in Attachment 2 in this report.

6.3 Rational Method Calculation Summary

The peak runoff values for the 100-year storm are calculated according to the Hydrology Manual Rational Method. The calculations are performed using the CIVILD software. A summary of the initial calculations is summarized in the table below:

Summary of Q100 Runoff

	Area (AC)	Tc (MIN)	Q (CFS)
Existing Condition	20.871	20.620	25.929
Unmitigated Developed Condition	20.871	21.069	28.092
Mitigated Developed Condition	20.871	21.069	25.352

Table 1. Q100 Analysis Results

Structure that used for detention is the biofiltration basin located at the south edge of the project site (BMP-A).

CIVILD data and output files can be found in Attachment 6 of this report.

By observation of the results in the summary table, the mitigated developed condition of the site will have an overall decrease in the 100 year peak flow discharge from the site.

7.0 Summary

This project will not negatively impact the existing downstream storm drain facilities. Based on the results of this report, the project does not increase the 100-year peak flow rate of the Mitigated Post Development stormwater discharge (25.352 CFS) from the site as flows are lower than those of the Pre Development condition (25.929 CFS).

8.0 References

County of San Diego, Department of Public Works, Flood Control Section, June 2003 San Diego County Hydrology Manual.

County of San Diego, Department of Public Works, Flood Control Section, September 2014 San Diego County Hydraulic Design Manual.

9.0 DECLARATION OF RESPONSIBLE CHARGE

I hereby declare that I am the engineer of work for this project. That I have exercised responsible charge over the design of the project as defined in section 6703 of the business and professions codes, and that the design is consistent with current design.


I understand that the check of the project drawings and specifications by the City of San Marcos is confined to a review only and does not relieve me, as engineer of work, of my responsibilities for project design.

ENGINEER OF WORK

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Tel – (760)745-8118
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Project Number: 21-054




Robert D. Dentino, RCE 45629
Registration Expire: December 31, 2022

3/09/22
Date

ATTACHMENTS

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ATTACHMENT 1
SITE MAP



MANNING HOMES SITE MAP

ATTACHMENT 2
FIGURES & TABLES FROM THE SAN DIEGO COUNTY HYDROLOGY
MANUAL 2003

**Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS**

Land Use		Runoff Coefficient "C"				
		% IMPER.	Soil Type			
NRCS Elements	County Elements		A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).

DU/A = dwelling units per acre

NRCS = National Resources Conservation Service

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

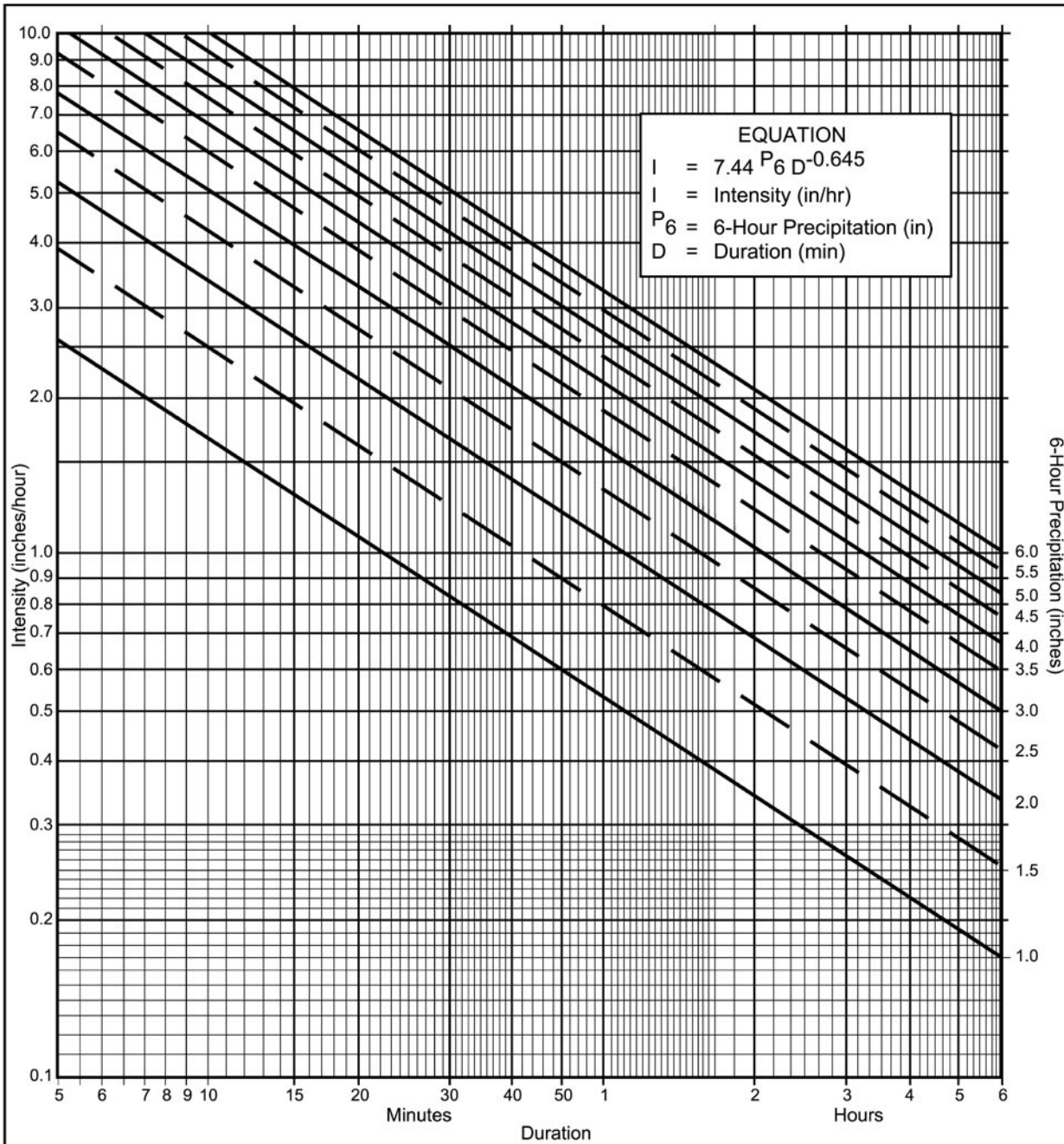
Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the “Regulating Agency” when submitted with a detailed study.

Table 3-2

**MAXIMUM OVERLAND FLOW LENGTH (L_M)
 & INITIAL TIME OF CONCENTRATION (T_i)**

Element*	DU/ Acre	.5%		1%		2%		3%		5%		10%	
		L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description



Directions for Application:

- (1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).
- (2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicable to Desert).
- (3) Plot 6 hr precipitation on the right side of the chart.
- (4) Draw a line through the point parallel to the plotted lines.
- (5) This line is the intensity-duration curve for the location being analyzed.

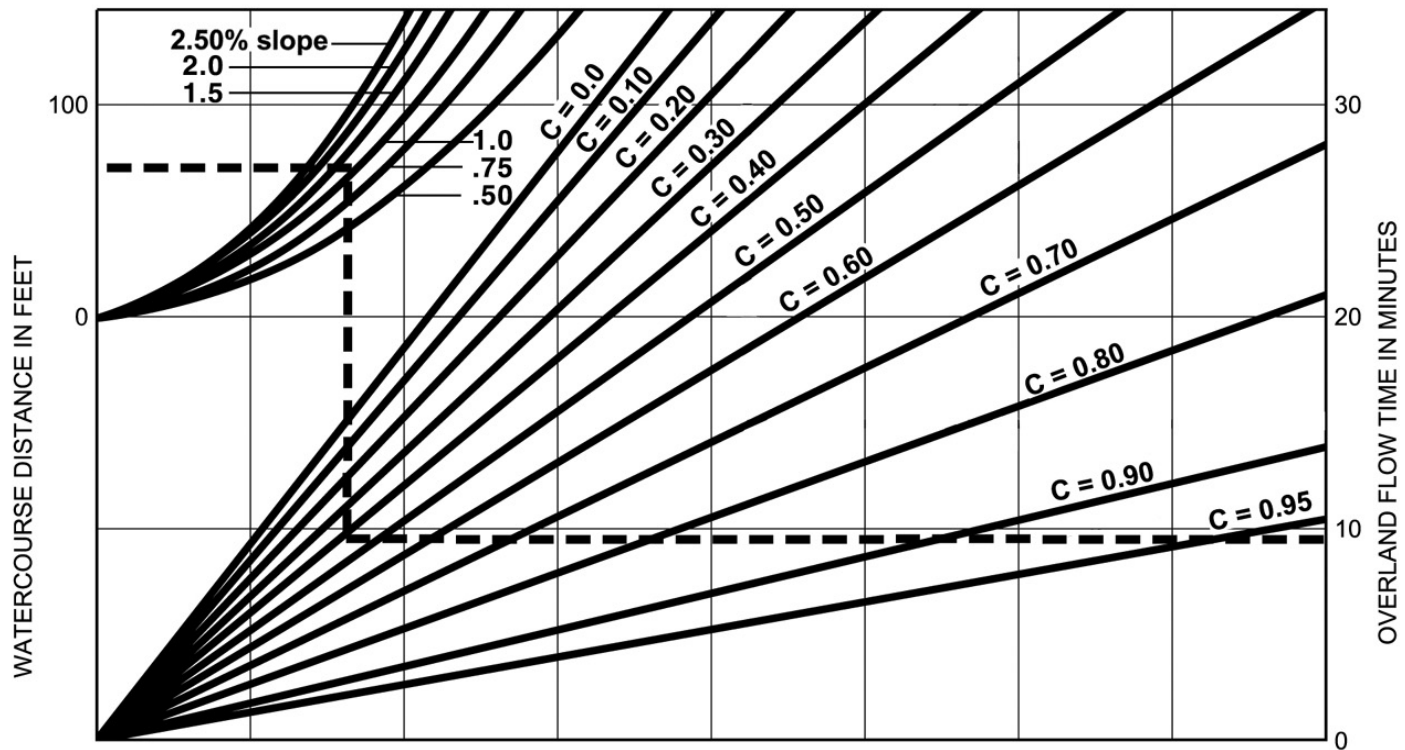
Application Form:

- (a) Selected frequency _____ year
- (b) $P_6 =$ _____ in., $P_{24} =$ _____, $\frac{P_6}{P_{24}} =$ _____ %⁽²⁾
- (c) Adjusted $P_6^{(2)} =$ _____ in.
- (d) $t_x =$ _____ min.
- (e) $I =$ _____ in./hr.

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

Intensity-Duration Design Chart - Template



EXAMPLE:

Given: Watercourse Distance (D) = 70 Feet
 Slope (s) = 1.3%
 Runoff Coefficient (C) = 0.41
 Overland Flow Time (T) = 9.5 Minutes

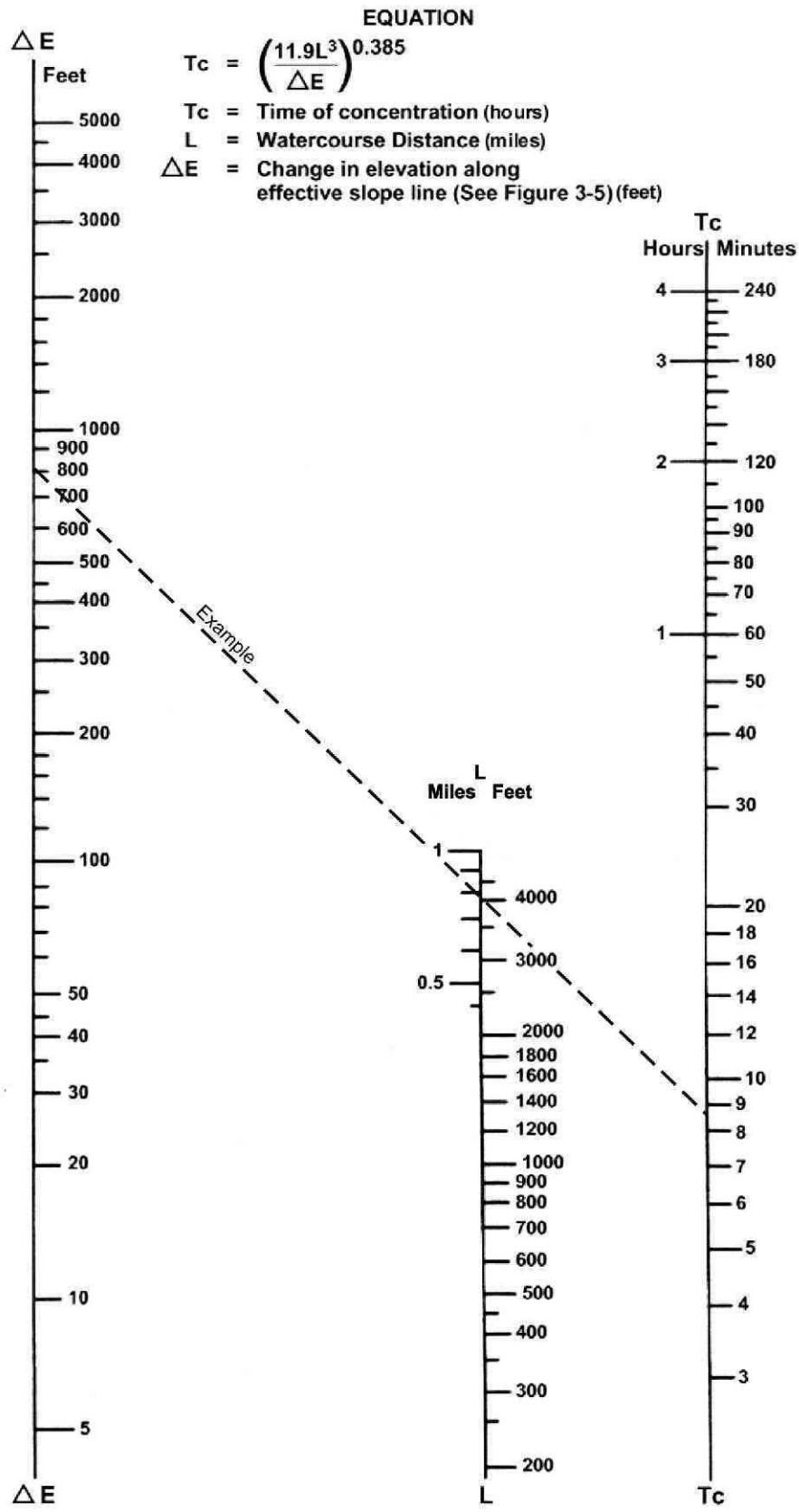
$$T = \frac{1.8 (1.1-C) \sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

F I G U R E

Rational Formula - Overland Time of Flow Nomograph

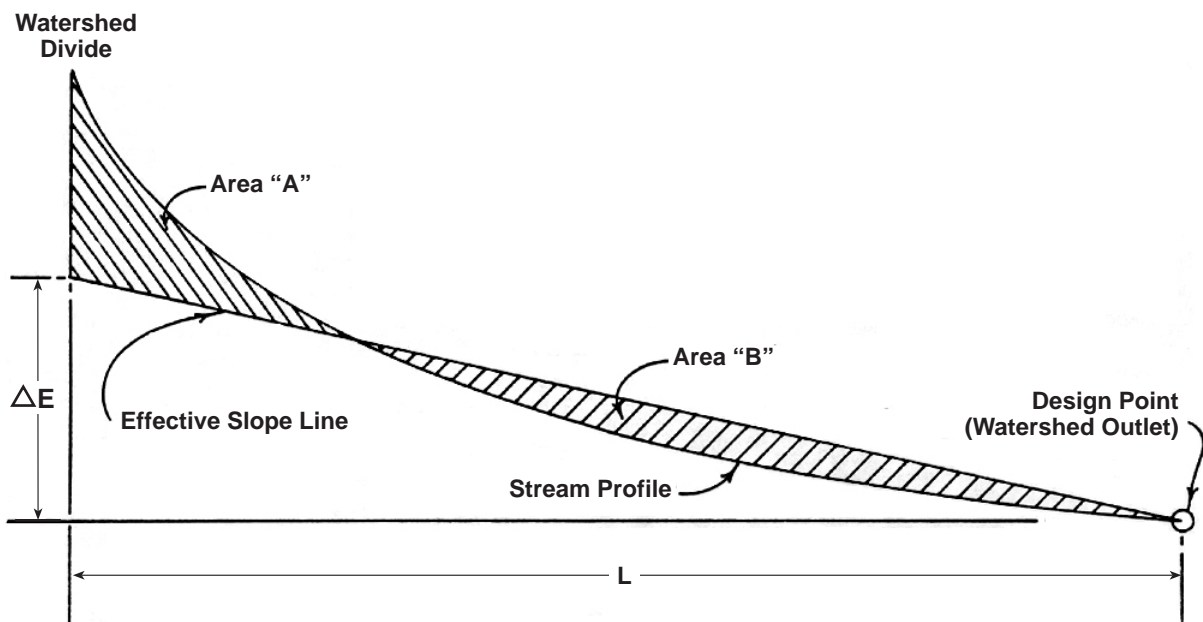
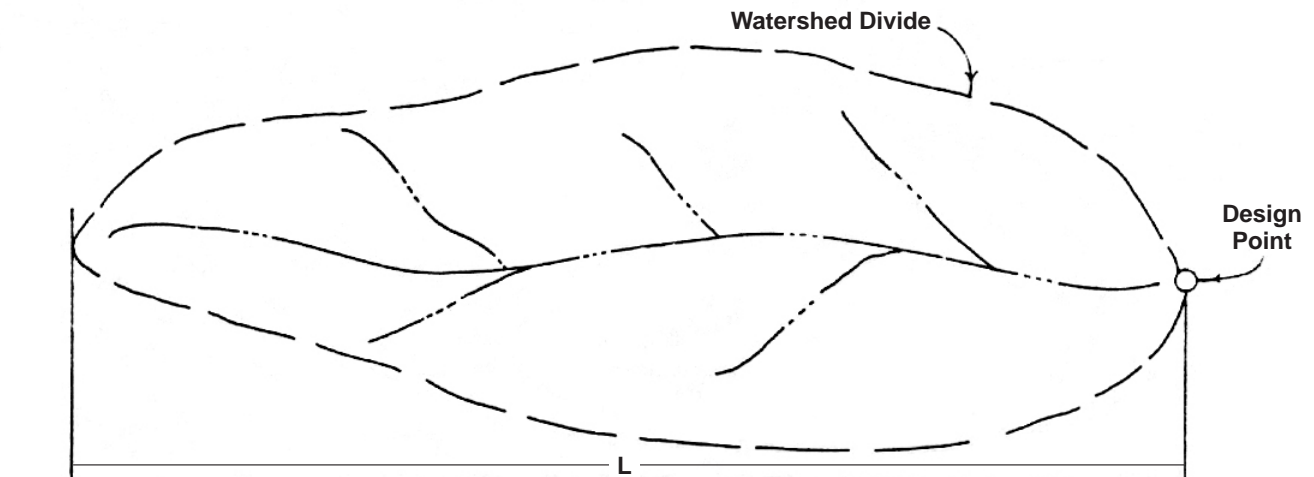
3-3



SOURCE: California Division of Highways (1941) and Kirpich (1940)

**Nomograph for Determination of
Time of Concentration (T_c) or Travel Time (T_t) for Natural Watersheds**

**FIGURE
3-4**



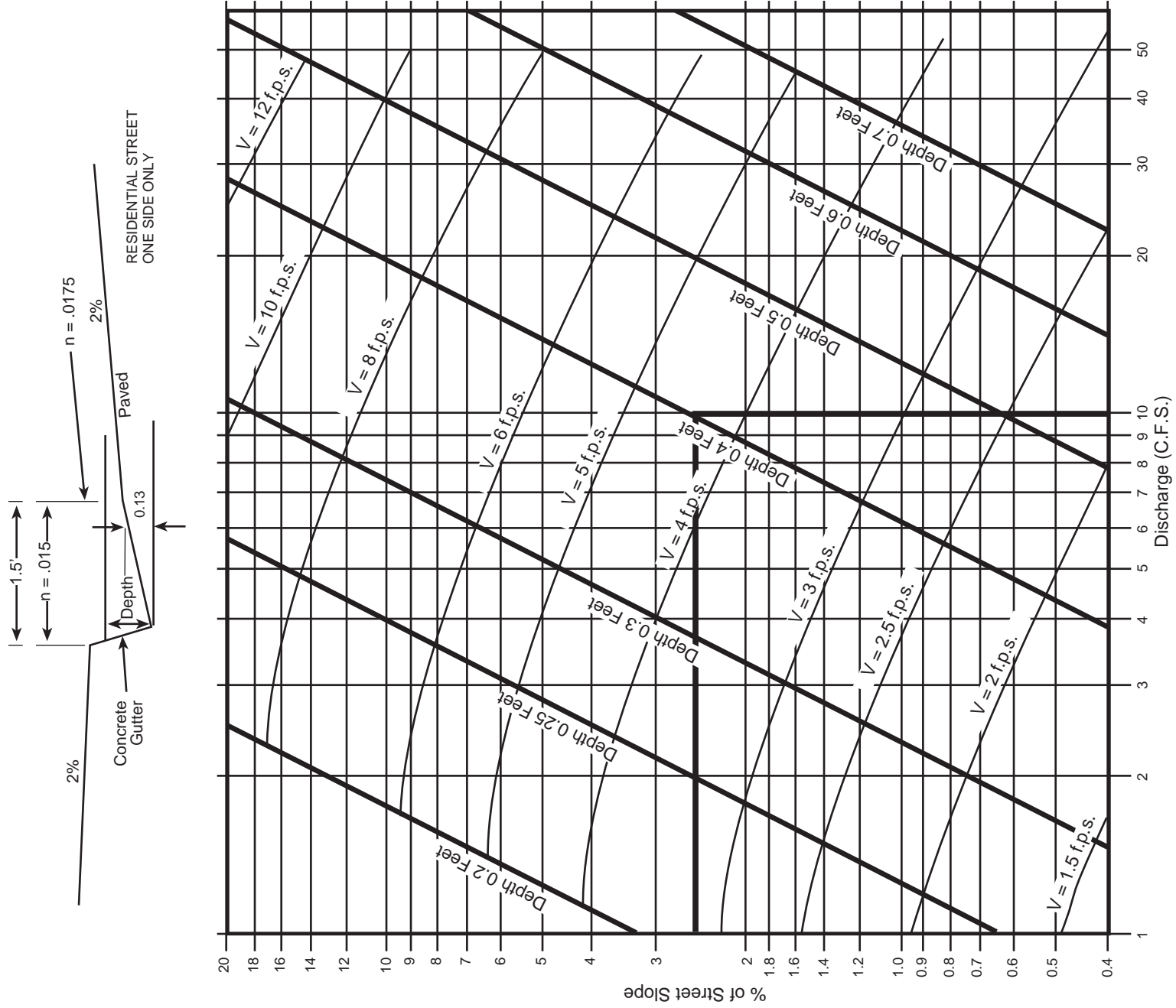
Area "A" = Area "B"

SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE

3-5

Computation of Effective Slope for Natural Watersheds



EXAMPLE:
 Given: $Q = 10$ $S = 2.5\%$
 Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

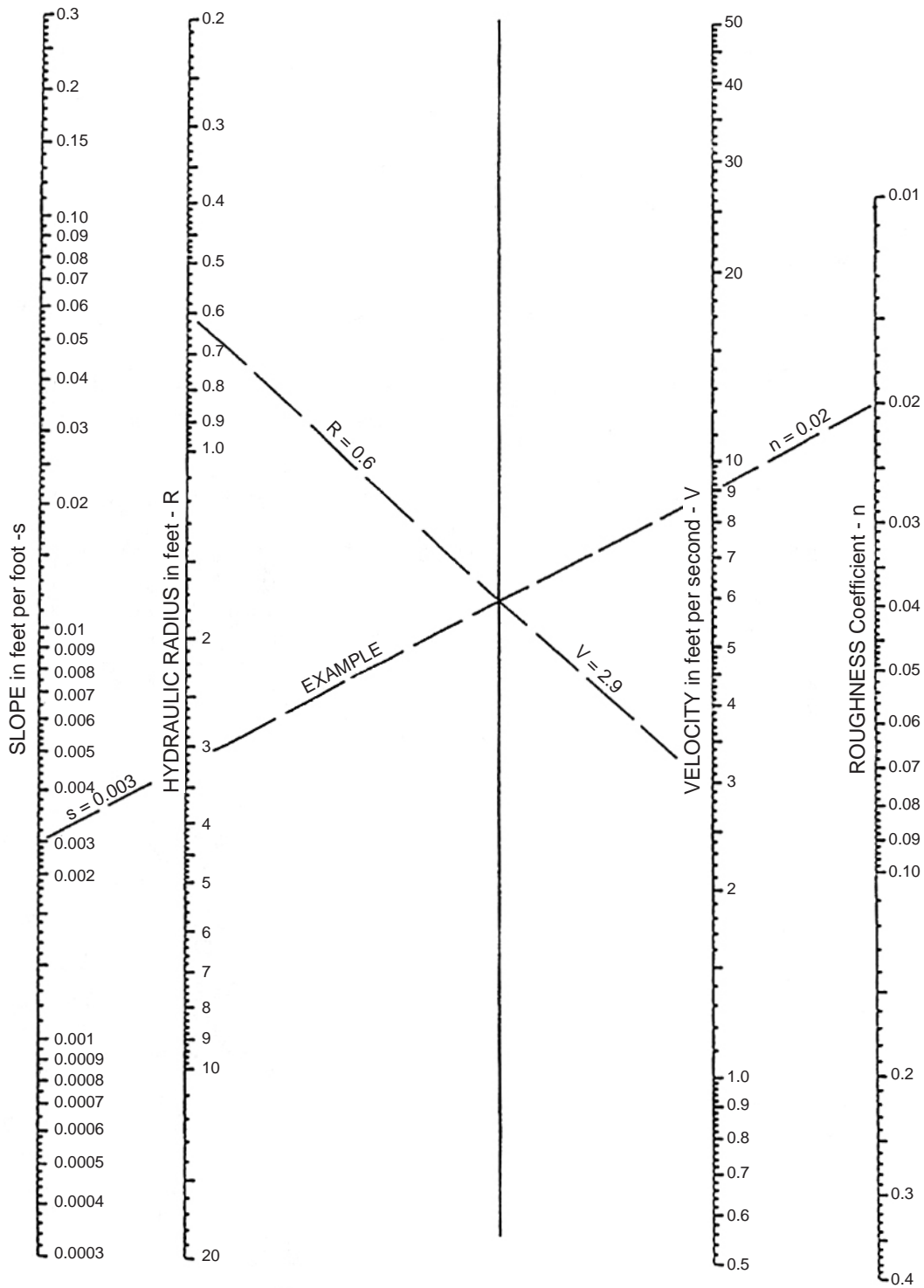
SOURCE: San Diego County Department of Special District Services Design Manual

FIGURE

Gutter and Roadway Discharge - Velocity Chart

3-6

EQUATION: $V = \frac{1.49}{n} R^{2/3} s^{1/2}$



SOURCE: USDOT, FHWA, HDS-3 (1961)

Manning's Equation Nomograph

FIGURE

3-7

Table A-1 Average Manning Roughness Coefficients for Pavement and Gutters¹

Concrete Gutter²	0.015
Concrete Pavement	
Float Finish	0.014
Broom Finish.....	0.016
Concrete Gutter with Asphalt Pavement	
Smooth Finish.....	0.013
Rough Texture	0.015
Asphalt Pavement	
Smooth Finish.....	0.013
Rough Texture	0.016

Based on FHWA HEC-22.

¹ Based on materials and workmanship required by standard specifications.

² Increase roughness coefficient in gutters with mild slopes where sediment might accumulate by 0.020.

Table A-2 Average Manning Roughness Coefficients for Closed Conduits³

Reinforced Concrete Pipe (RCP)	0.013
Corrugated Metal Pipe and Pipe Arch	
2-3/8 x 1/2 inch Corrugations	
Unlined	0.024
Half Lined	
Full Flow	0.018
$d/D \geq 0.60$	0.016
$d/D < 0.60$	0.013
Fully Lined	0.013
3 x 1 inch Corrugations	0.027
6 x 2 inch Corrugations	0.032
Spiral Rib Pipe	0.013
Helically Wound Pipe	
18-inch	0.015
24-inch	0.017
30-inch	0.019
36-inch	0.021
42-inch	0.022
48-inch	0.023
Plastic Pipe (HPDE and PVC)	
Smooth	0.013
Corrugated	0.024
Vitrified Clay Pipe	0.014
Cast-Iron Pipe (Uncoated)	0.013
Steel Pipe	0.011
Brick	0.017
Cast-In-Place Concrete Pipe	
Rough Wood Forms	0.017
Smooth Wood or Steel Forms	0.014

³ Based on materials and workmanship required by standard specifications.

Table A-5 Average Manning Roughness Coefficients for Natural Channels

Minor Streams (Surface Width at Flood Stage < 100 ft)	
Fairly Regular Section	
(A) Some Grass and Weeds, Little or No Brush	0.030
(B) Dense Growth of Weeds, Depth of Flow Materially Greater Than Weed Height	0.040
(C) Some Weeds, Light Brush on Banks	0.040
(D) Some Weeds, Heavy Brush on Banks	0.060
(E) For Trees within Channel with Branches Submerged at High Stage, Increase All Above Values By	0.015
Irregular Section, with Pools, Slight Channel Meander	
Channels (A) to (E) Above, Increase All Values By	0.015
Mountain Streams; No Vegetation in Channel, Banks Usually Steep, Trees and Brush along Banks Submerged at High Stage	
(A) Bottom, Gravel, Cobbles and Few Boulders	0.050
(B) Bottom, Cobbles with Large Boulders	0.060
Flood Plains (Adjacent To Natural Streams)	
Pasture, No Brush	
(A) Short Grass	0.030
(B) High Grass	0.040
Cultivated Areas	
(A) No Crop	0.040
(B) Mature Row Crops	0.040
(C) Mature Field Crops	0.050
Heavy Weeds, Scattered Brush	0.050
Light Brush and Trees	0.060
Medium To Dense Brush	0.090
Dense Willows	0.170
Cleared Land with Tree Stumps, 100-150 Per Acre	0.060
Heavy Stand of Timber, Little Undergrowth	
(A) Flood Depth below Branches	0.110
(B) Flood Depth Reaches Branches	0.140

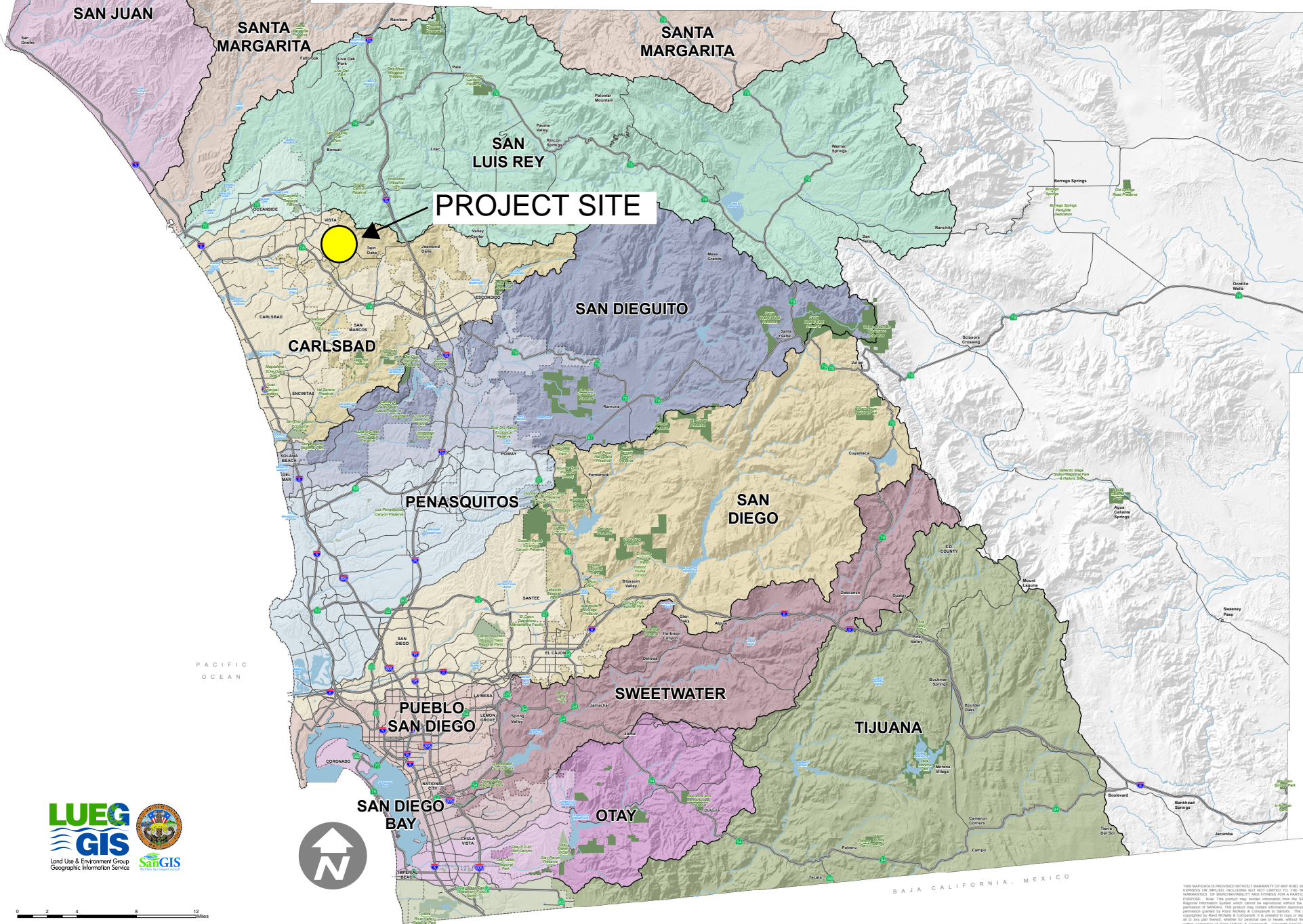
ATTACHMENT 3
WATERSHED INFORMATION
WATERSHED MAP

San Diego County Pacific Watersheds

ORANGE COUNTY

RIVERSIDE COUNTY

IMPERIAL COUNTY



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
SOIL INDEX MAP

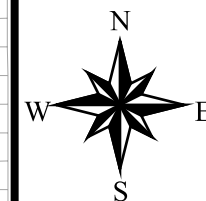
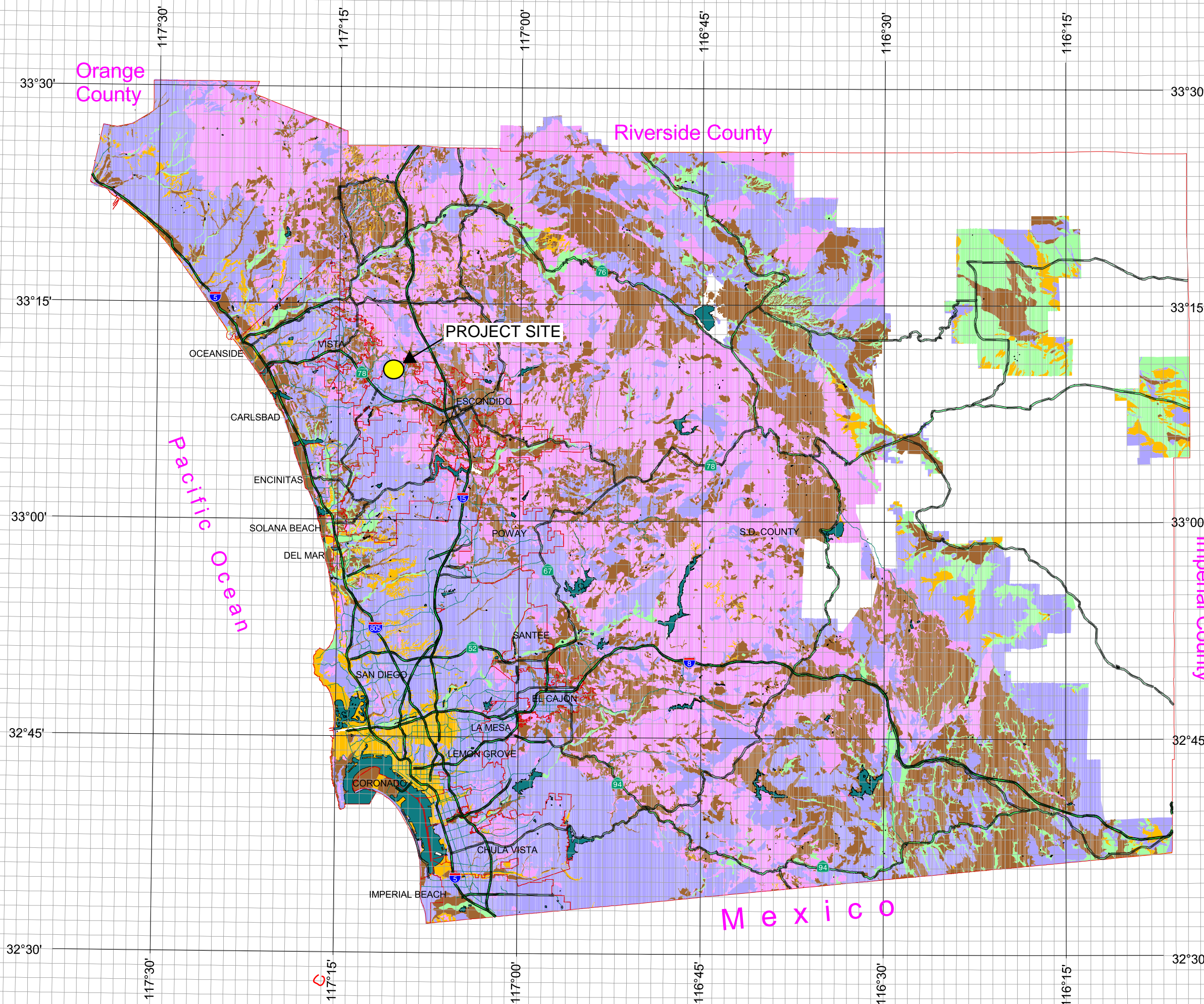
County of San Diego Hydrology Manual



Soil Hydrologic Groups

Legend

Soil Groups	
	Group A
	Group B
	Group C
	Group D
	Undetermined
	Data Unavailable



3 0 3 Miles

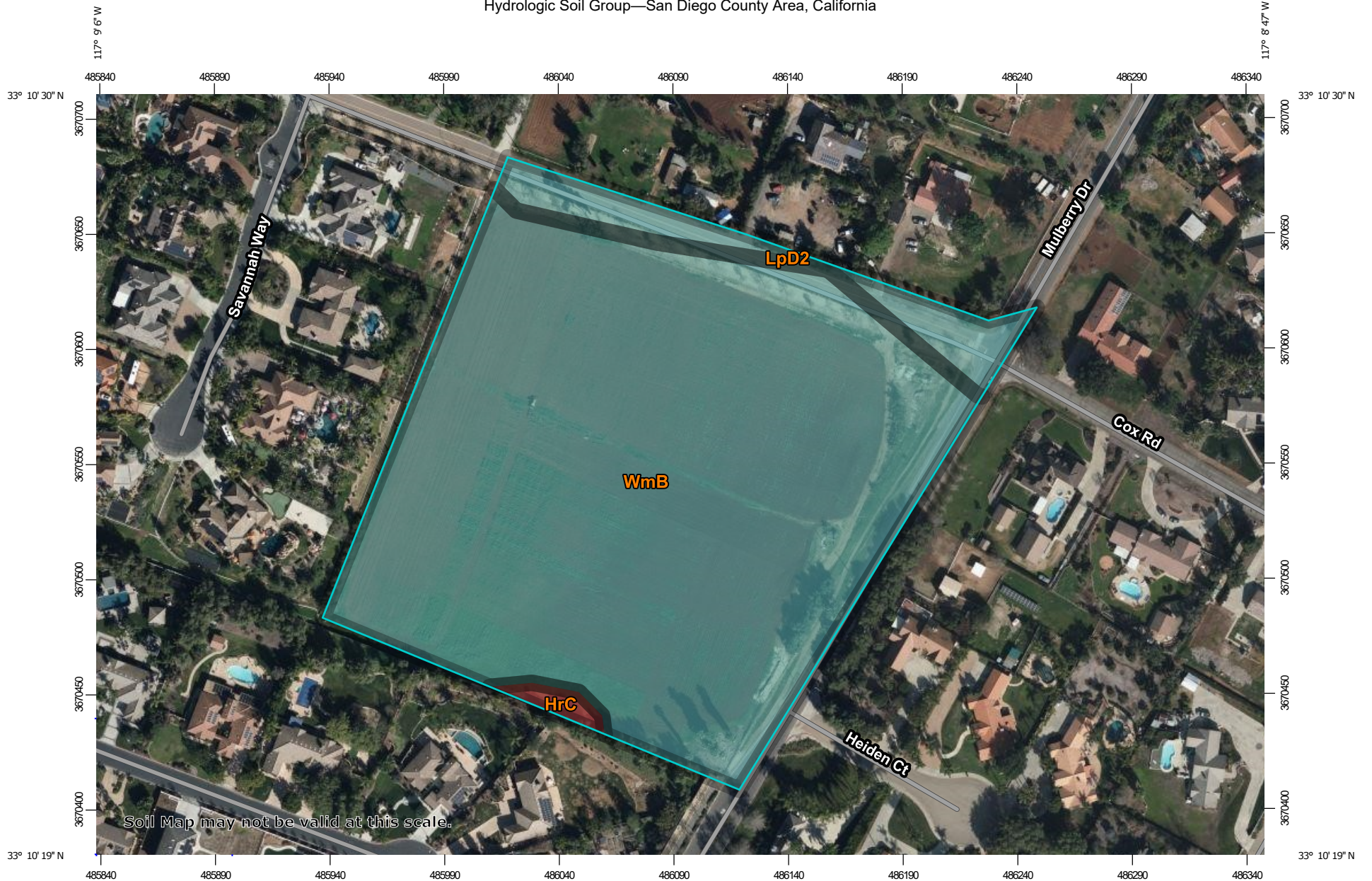
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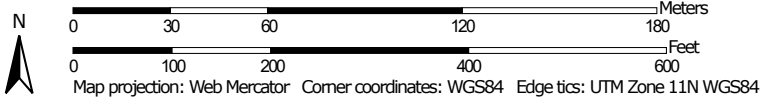
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SOIL REPORT

Hydrologic Soil Group—San Diego County Area, California



Map Scale: 1:2,330 if printed on A landscape (11" x 8.5") sheet.



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: San Diego County Area, California
 Survey Area Data: Version 16, Sep 13, 2021

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

Date(s) aerial images were photographed: Jan 24, 2020—Feb 12, 2020

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
HrC	Huerhuero loam, 2 to 9 percent slopes	D	0.1	0.9%
LpD2	Las Posas fine sandy loam, 9 to 15 percent slopes, eroded	C	0.9	7.6%
WmB	Wyman loam, 2 to 5 percent slopes	C	11.0	91.5%
Totals for Area of Interest			12.0	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

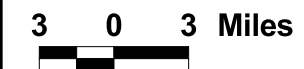
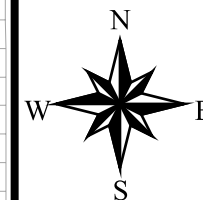
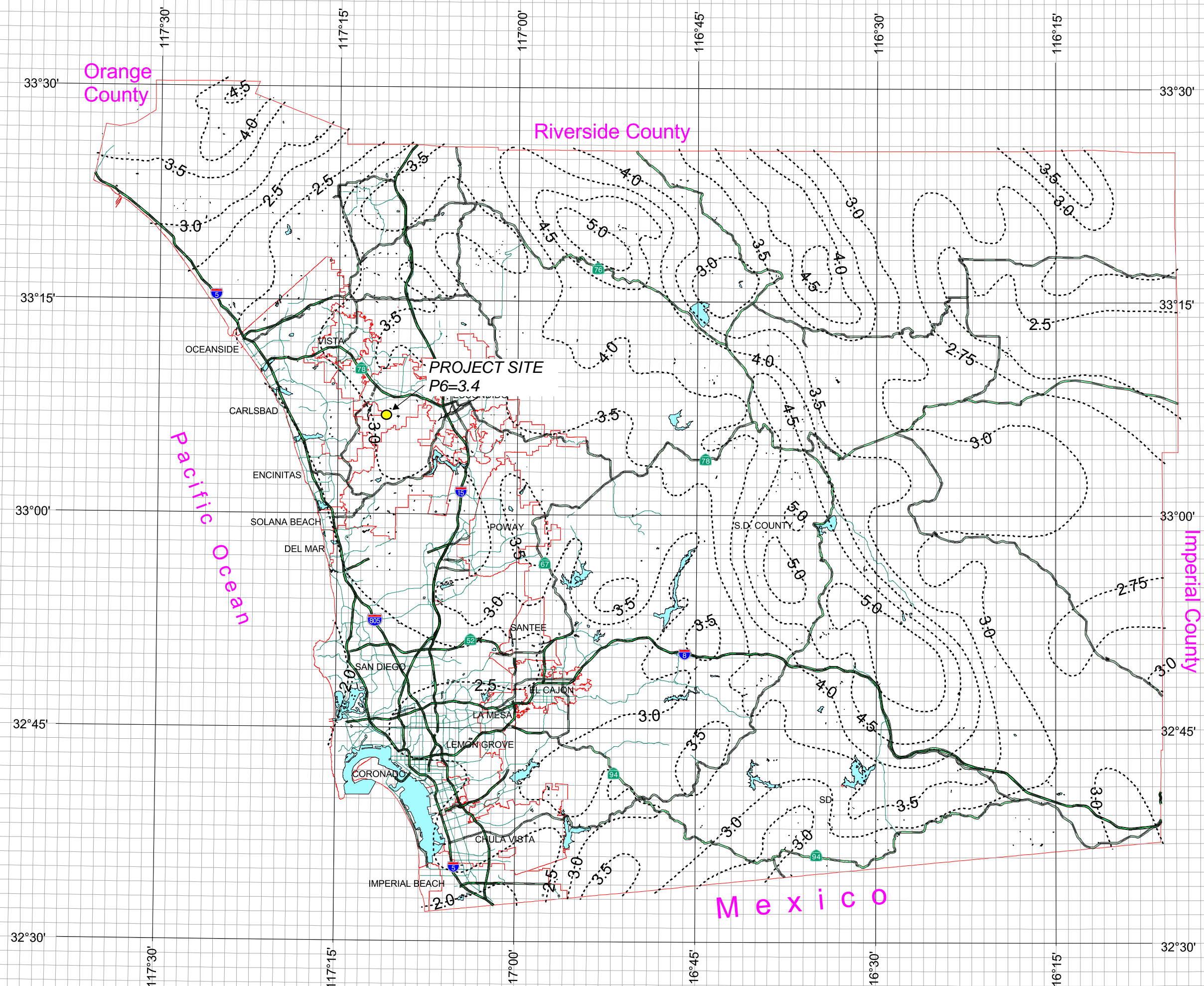
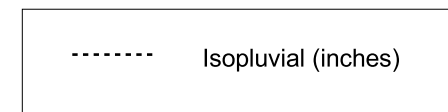
RAINFALL ISOPLUVIAL MAPS

County of San Diego Hydrology Manual



Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours



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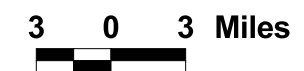
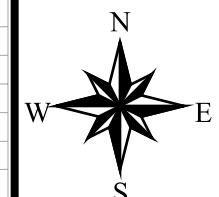
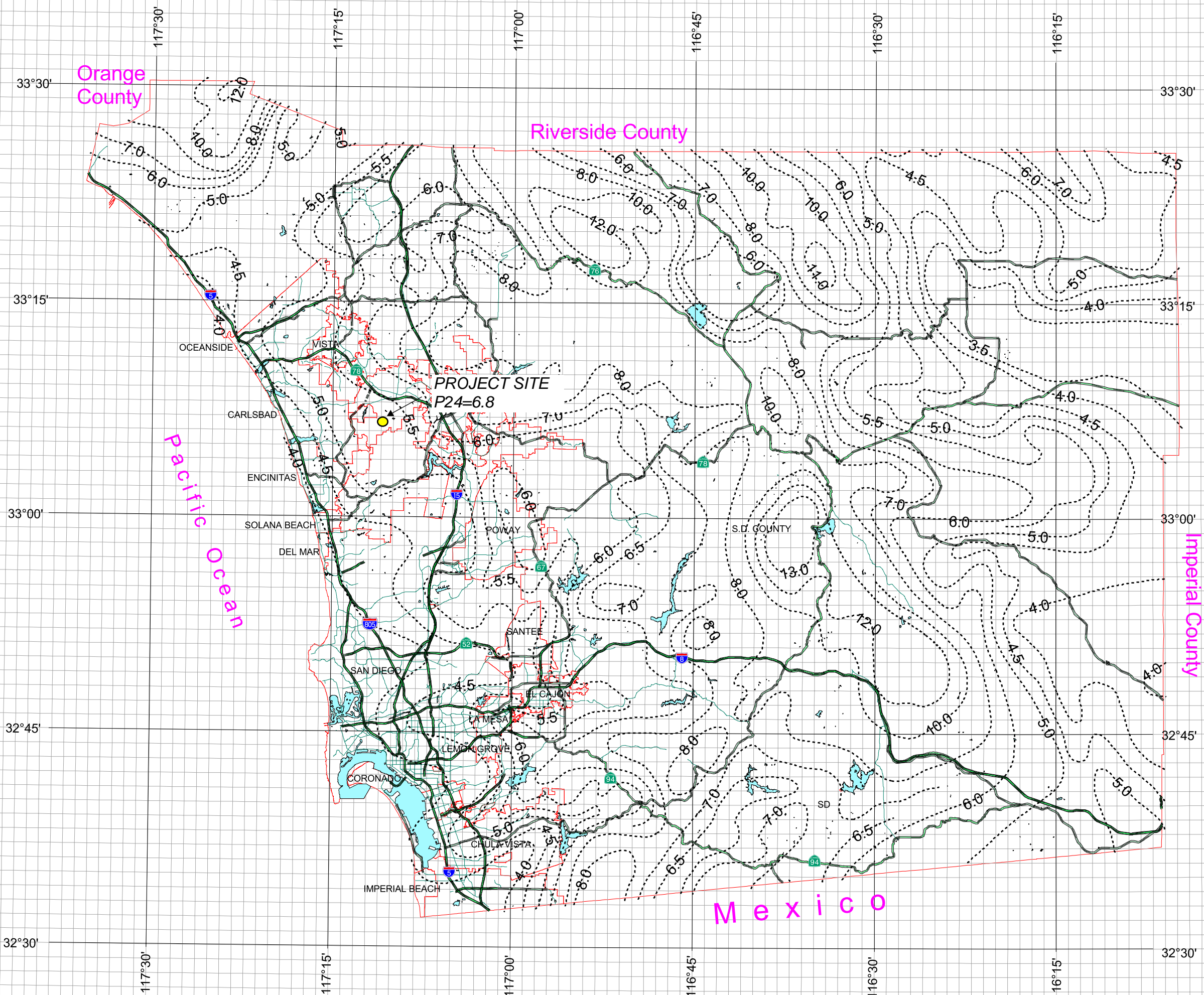
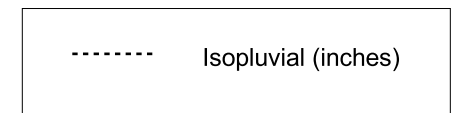
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County of San Diego Hydrology Manual



Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

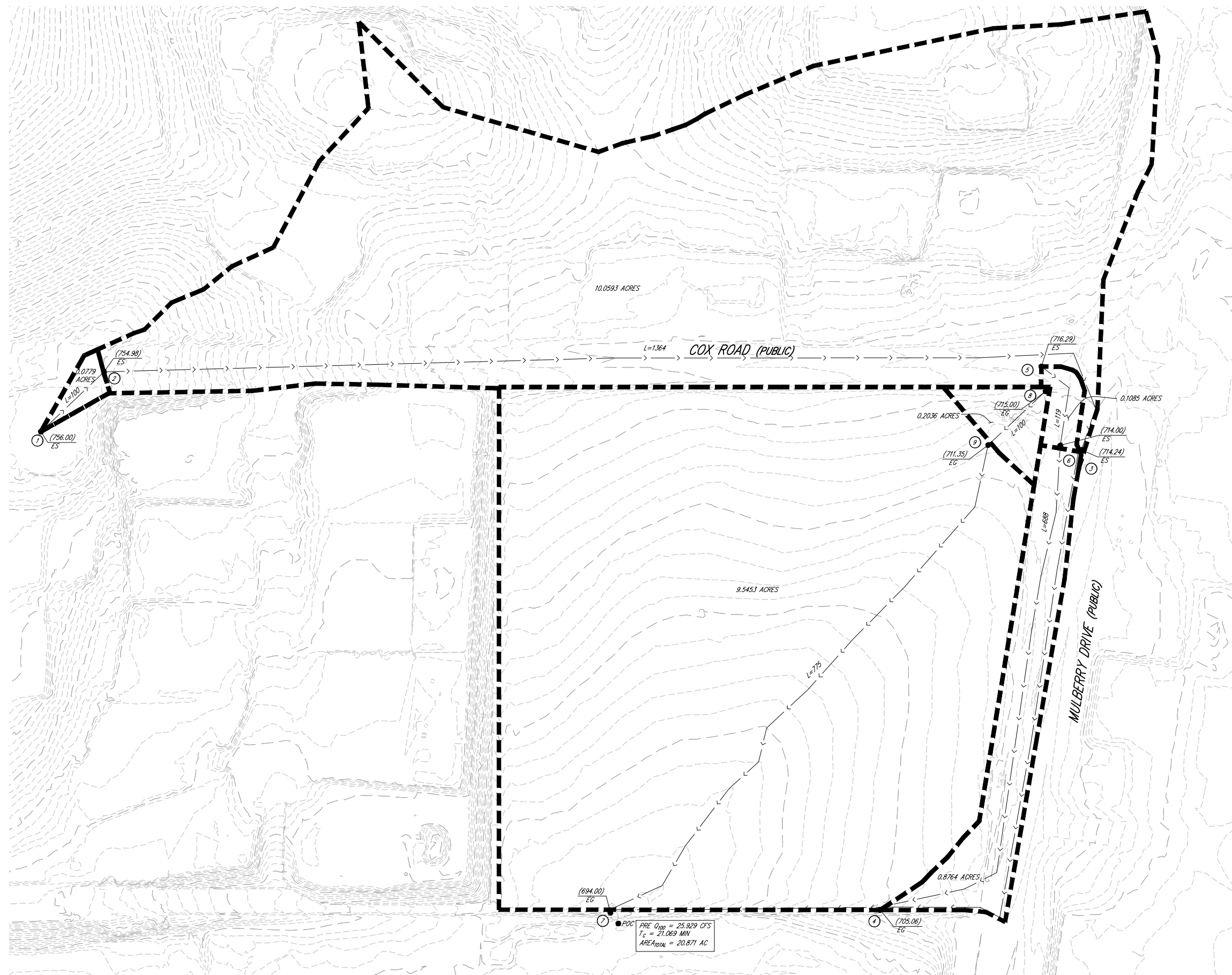


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ATTACHMENT 4
PRE-DEVELOPMENT CONDITION EXHIBIT



10.0593 ACRES

L=1364 COX ROAD (PUBLIC)

1 (756.00) ES
L=100
2 (754.95) ES
0.0779 ACRES

5 (716.29) ES
6 (715.00) EG
L=100
7 (711.35) EG
L=119
8 (714.00) ES
9 (714.24) ES
0.2036 ACRES
0.1085 ACRES

9.5453 ACRES

MULBERRY DRIVE (PUBLIC)

7 (694.00) EG
POC

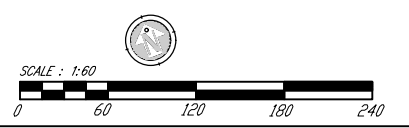
PRE Q₁₀₀ = 25,929 CFS
T_c = 21.069 MIN
AREA₁₀₀ = 20.871 AC

4 (705.06) EG
0.8764 ACRES

- LEGEND**
- ① NODE NUMBER
 - SURFACE FLOW
 - HYDROLOGY BASIN BOUNDARY
 - ELEVATION

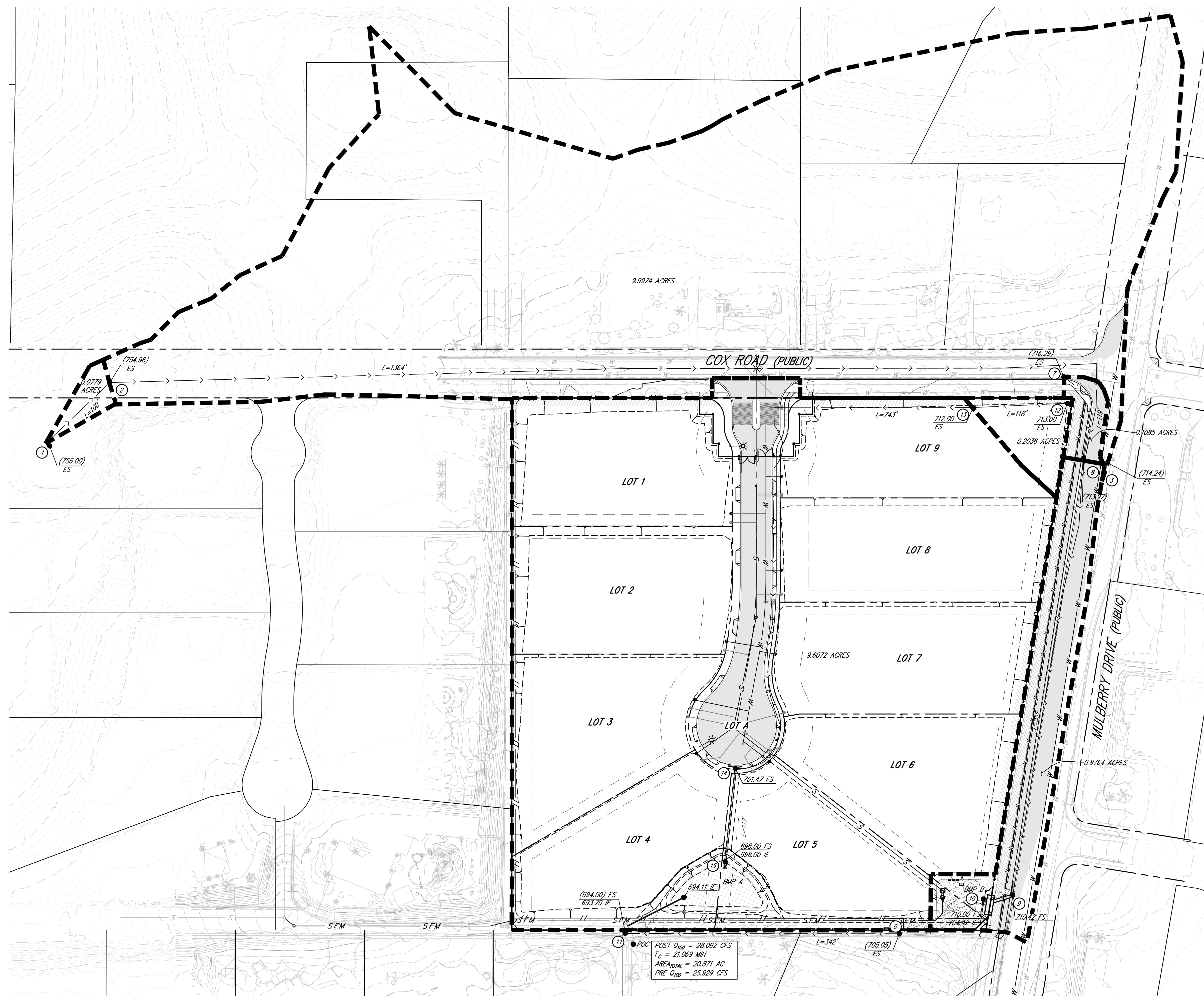
HYDROLOGIC SOIL GROUP
THE HYDROLOGIC SOIL GROUP FOR THIS SITE IS TYPE C
NOTE:
APPROXIMATE DEPTH TO GROUNDWATER IS GREATER THAN 20'

MANNING HOMES
PRE DEVELOPMENT HYDROLOGY EXHIBIT



ATTACHMENT 5
POST-DEVELOPMENT CONDITION EXHIBIT

5a. Hydrology Map of Post-Development Condition Exhibit



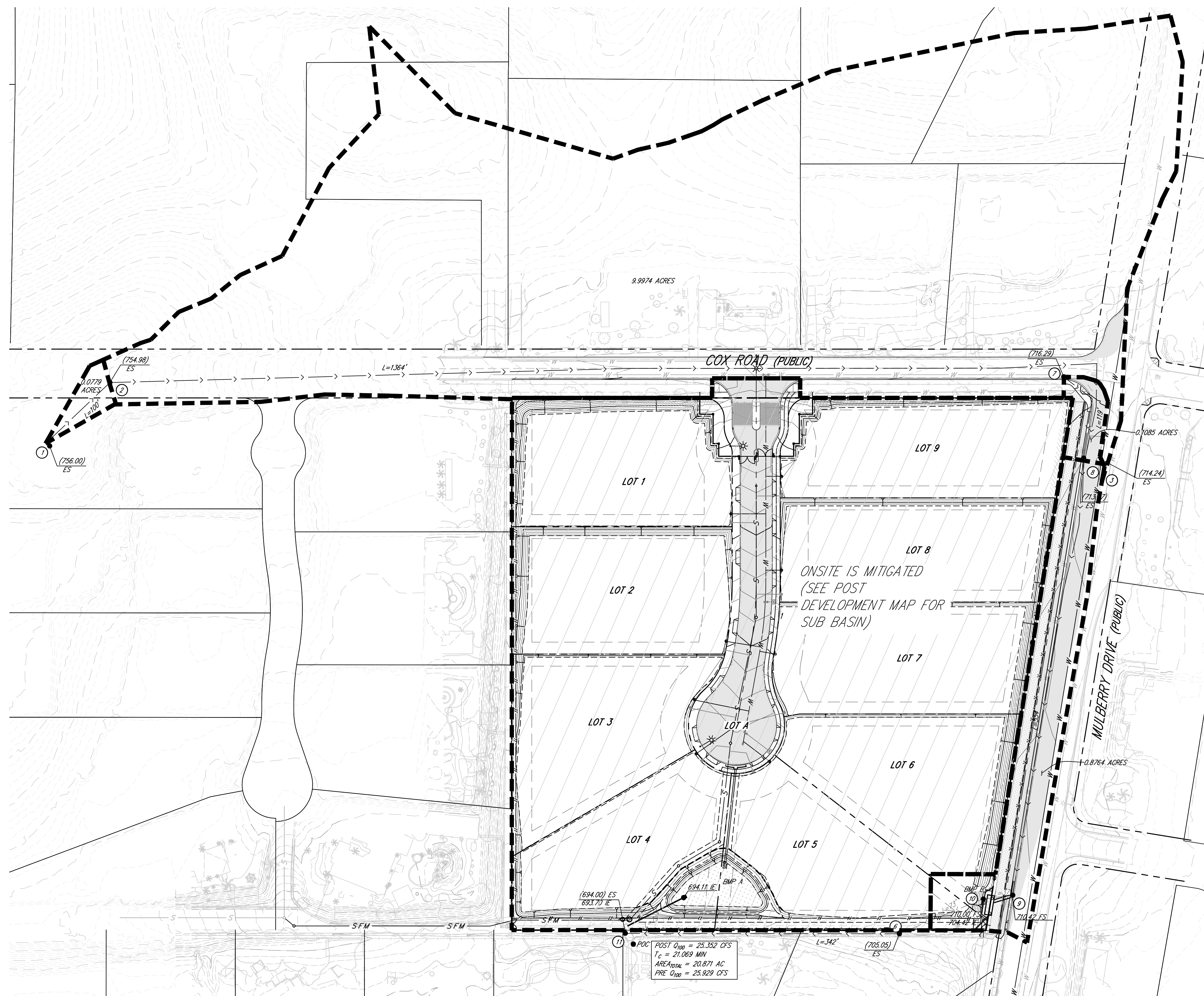
- LEGEND**
- ① NODE NUMBER
 - SURFACE FLOW
 - PIPE FLOW
 - HYDROLOGY BASIN BOUNDARY
 - ELEVATION

HYDROLOGIC SOIL GROUP
 THE HYDROLOGIC SOIL GROUP FOR THIS SITE IS TYPE C

NOTE:
 APPROXIMATE DEPTH TO GROUNDWATER IS GREATER THAN 20'

**MANNING HOMES
 POST DEVELOPMENT HYDROLOGY EXHIBIT**

5b. Hydrology Map of Post-Development Mitigation Condition Exhibit

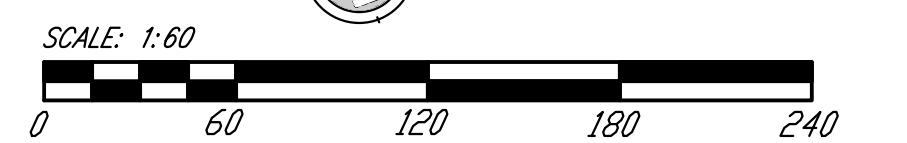


- LEGEND**
- ① NODE NUMBER
 - SURFACE FLOW
 - PIPE FLOW
 - HYDROLOGY BASIN BOUNDARY
 - ELEVATION

HYDROLOGIC SOIL GROUP
 THE HYDROLOGIC SOIL GROUP FOR THIS SITE IS TYPE C

NOTE:
 APPROXIMATE DEPTH TO GROUNDWATER IS GREATER THAN 20'

**MANNING HOMES
 POST DEVELOPMENT HYDROLOGY EXHIBIT**



ATTACHMENT 6

MODIFIED RATIONAL METHOD RUNOFF CALCULATIONS

Steps Taken To Analyze This Condition

The Rational Method Runoff Calculations are followed here. The software that we are using is the “Rational Hydrology Method, San Diego County (2003 Manual)” module of the CIVILCADD/CIVILDESIGN Engineering Software, Version 9.1.

Please see the subsequent pages for the calculations. These calculations are for the **Q₁₀₀**. The results are outlined/summarized in Section 6.

6a. CivilD Pre-Development Calculations

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2014 Version 9.0

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 11/02/21

21054 PRE DEV HYD

***** Hydrology Study Control Information *****

Program License Serial Number 6332

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.400
24 hour precipitation(inches) = 6.800
P6/P24 = 50.0%
San Diego hydrology manual 'C' values used

Process from Point/Station 1.000 to Point/Station 2.000
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[UNDISTURBED NATURAL TERRAIN]
(Permanent Open Space)
Impervious value, Ai = 0.000
Sub-Area C Value = 0.300
Initial subarea total flow distance = 100.000(Ft.)
Highest elevation = 756.000(Ft.)
Lowest elevation = 754.950(Ft.)
Elevation difference = 1.050(Ft.) Slope = 1.050 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 70.00 (Ft)
for the top area slope value of 1.05 %, in a development type of
Permanent Open Space
In Accordance With Figure 3-3
Initial Area Time of Concentration = 11.85 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^{.5}/(% slope^(1/3))]
TC = [1.8*(1.1-0.3000)*(70.000^{.5})/(1.050^(1/3))] = 11.85
Rainfall intensity (I) = 5.134(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.300
Subarea runoff = 0.120(CFS)
Total initial stream area = 0.078(Ac.)

Process from Point/Station 2.000 to Point/Station 3.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Estimated mean flow rate at midpoint of channel = 7.508(CFS)
Depth of flow = 0.312(Ft.), Average velocity = 4.439(Ft/s)
***** Irregular Channel Data *****

```

70 -----
71 Information entered for subchannel number 1 :
72 Point number      'X' coordinate      'Y' coordinate
73      1              0.00              0.50
74      2              0.00              0.00
75      3              1.50              0.13
76      4              20.25             0.38
77 Manning's 'N' friction factor = 0.013
78 -----
79 Sub-Channel flow = 7.509(CFS)
80 ' ' flow top width = 15.554(Ft.)
81 ' ' velocity= 4.439(Ft/s)
82 ' ' area = 1.692(Sq.Ft)
83 ' ' Froude number = 2.372
84
85 Upstream point elevation = 754.950(Ft.)
86 Downstream point elevation = 714.240(Ft.)
87 Flow length = 1364.000(Ft.)
88 Travel time = 5.12 min.
89 Time of concentration = 16.98 min.
90 Depth of flow = 0.312(Ft.)
91 Average velocity = 4.439(Ft/s)
92 Total irregular channel flow = 7.508(CFS)
93 Irregular channel normal depth above invert elev. = 0.312(Ft.)
94 Average velocity of channel(s) = 4.439(Ft/s)
95 Adding area flow to channel
96 Rainfall intensity (I) = 4.072(In/Hr) for a 100.0 year storm
97 Decimal fraction soil group A = 0.000
98 Decimal fraction soil group B = 0.000
99 Decimal fraction soil group C = 1.000
100 Decimal fraction soil group D = 0.000
101 [LOW DENSITY RESIDENTIAL ]
102 (1.0 DU/A or Less )
103 Impervious value, Ai = 0.100
104 Sub-Area C Value = 0.360
105 Rainfall intensity = 4.072(In/Hr) for a 100.0 year storm
106 Effective runoff coefficient used for total area
107 (Q=KCIA) is C = 0.360 CA = 3.645
108 Subarea runoff = 14.721(CFS) for 10.059(Ac.)
109 Total runoff = 14.842(CFS) Total area = 10.137(Ac.)
110 Depth of flow = 0.376(Ft.), Average velocity = 5.249(Ft/s)
111
112
113 +-----+
114 Process from Point/Station 3.000 to Point/Station 4.000
115 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
116
117 -----
118 Estimated mean flow rate at midpoint of channel = 15.081(CFS)
119 Depth of flow = 0.420(Ft.), Average velocity = 4.053(Ft/s)
120 ***** Irregular Channel Data *****
121 -----
122 Information entered for subchannel number 1 :
123 Point number      'X' coordinate      'Y' coordinate
124      1              0.00              0.50
125      2              0.00              0.00
126      3              1.50              0.13
127      4              20.25             0.38
128 Manning's 'N' friction factor = 0.013
129 -----
130 Sub-Channel flow = 15.082(CFS)
131 ' ' flow top width = 20.250(Ft.)
132 ' ' velocity= 4.053(Ft/s)
133 ' ' area = 3.721(Sq.Ft)
134 ' ' Froude number = 1.666
135
136 Upstream point elevation = 714.240(Ft.)
137 Downstream point elevation = 705.060(Ft.)
138 Flow length = 742.000(Ft.)
139 Travel time = 3.05 min.

```


139 Time of concentration = 20.03 min.
 140 Depth of flow = 0.420(Ft.)
 141 Average velocity = 4.053(Ft/s)
 142 Total irregular channel flow = 15.081(CFS)
 143 Irregular channel normal depth above invert elev. = 0.420(Ft.)
 144 Average velocity of channel(s) = 4.053(Ft/s)
 145 Adding area flow to channel
 146 Rainfall intensity (I) = 3.660(In/Hr) for a 100.0 year storm
 147 Decimal fraction soil group A = 0.000
 148 Decimal fraction soil group B = 0.000
 149 Decimal fraction soil group C = 1.000
 150 Decimal fraction soil group D = 0.000
 151 [MEDIUM DENSITY RESIDENTIAL]
 152 (14.5 DU/A or Less)
 153 Impervious value, Ai = 0.500
 154 Sub-Area C Value = 0.600
 155 Rainfall intensity = 3.660(In/Hr) for a 100.0 year storm
 156 Effective runoff coefficient used for total area
 157 (Q=KCIA) is C = 0.379 CA = 4.170
 158 Subarea runoff = 0.423(CFS) for 0.876(Ac.)
 159 Total runoff = 15.264(CFS) Total area = 11.013(Ac.)
 160 Depth of flow = 0.421(Ft.), Average velocity = 4.072(Ft/s)

161
 162
 163 +-----+
 164 Process from Point/Station 4.000 to Point/Station 4.000
 165 **** CONFLUENCE OF MINOR STREAMS ****
 166

167 Along Main Stream number: 1 in normal stream number 1
 168 Stream flow area = 11.013(Ac.)
 169 Runoff from this stream = 15.264(CFS)
 170 Time of concentration = 20.03 min.
 171 Rainfall intensity = 3.660(In/Hr)

172
 173
 174 +-----+
 175 Process from Point/Station 5.000 to Point/Station 6.000
 176 **** INITIAL AREA EVALUATION ****
 177

178 Decimal fraction soil group A = 0.000
 179 Decimal fraction soil group B = 0.000
 180 Decimal fraction soil group C = 1.000
 181 Decimal fraction soil group D = 0.000
 182 [UNDISTURBED NATURAL TERRAIN]
 183 (Permanent Open Space)
 184 Impervious value, Ai = 0.000
 185 Sub-Area C Value = 0.300
 186 Initial subarea total flow distance = 119.000(Ft.)
 187 Highest elevation = 716.290(Ft.)
 188 Lowest elevation = 714.000(Ft.)
 189 Elevation difference = 2.290(Ft.) Slope = 1.924 %
 190 INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
 191 The maximum overland flow distance is 85.00 (Ft)
 192 for the top area slope value of 1.92 %, in a development type of
 193 Permanent Open Space
 194 In Accordance With Figure 3-3
 195 Initial Area Time of Concentration = 10.67 minutes
 196 $TC = [1.8 * (1.1 - C) * distance(Ft.)^{.5}] / (% slope^{(1/3)})$
 197 $TC = [1.8 * (1.1 - 0.3000) * (85.000^{.5})] / (1.924^{(1/3)}) = 10.67$
 198 Rainfall intensity (I) = 5.493(In/Hr) for a 100.0 year storm
 199 Effective runoff coefficient used for area (Q=KCIA) is C = 0.300
 200 Subarea runoff = 0.180(CFS)
 201 Total initial stream area = 0.109(Ac.)
 202
 203

204 +-----+
 205 Process from Point/Station 6.000 to Point/Station 4.000
 206 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
 207

208 Depth of flow = 0.124(Ft.), Average velocity = 1.935(Ft/s)
209 ***** Irregular Channel Data *****

210 -----
211 Information entered for subchannel number 1 :
212 Point number 'X' coordinate 'Y' coordinate
213 1 0.00 0.50
214 2 0.00 0.00
215 3 1.50 0.13
216 4 18.50 0.39

217 Manning's 'N' friction factor = 0.013
218 -----

219 Sub-Channel flow = 0.180(CFS)
220 ' ' flow top width = 1.493(Ft.)
221 ' ' velocity= 1.935(Ft/s)
222 ' ' area = 0.093(Sq.Ft)
223 ' ' Froude number = 1.367
224

225 Upstream point elevation = 714.000(Ft.)
226 Downstream point elevation = 705.060(Ft.)
227 Flow length = 688.000(Ft.)
228 Travel time = 5.93 min.
229 Time of concentration = 16.60 min.
230 Depth of flow = 0.124(Ft.)
231 Average velocity = 1.935(Ft/s)
232 Total irregular channel flow = 0.180(CFS)
233 Irregular channel normal depth above invert elev. = 0.124(Ft.)
234 Average velocity of channel(s) = 1.935(Ft/s)
235
236

237 +-----+
238 Process from Point/Station 4.000 to Point/Station 4.000
239 **** CONFLUENCE OF MINOR STREAMS ****
240

241 Along Main Stream number: 1 in normal stream number 2
242 Stream flow area = 0.109(Ac.)
243 Runoff from this stream = 0.180(CFS)
244 Time of concentration = 16.60 min.
245 Rainfall intensity = 4.131(In/Hr)
246 Summary of stream data:
247

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	15.264	20.03	3.660
2	0.180	16.60	4.131

254 Qmax(1) =
255 1.000 * 1.000 * 15.264) +
256 0.886 * 1.000 * 0.180) + = 15.424
257 Qmax(2) =
258 1.000 * 0.829 * 15.264) +
259 1.000 * 1.000 * 0.180) + = 12.833
260

261 Total of 2 streams to confluence:
262 Flow rates before confluence point:
263 15.264 0.180
264 Maximum flow rates at confluence using above data:
265 15.424 12.833
266 Area of streams before confluence:
267 11.013 0.109

268 Results of confluence:
269 Total flow rate = 15.424(CFS)
270 Time of concentration = 20.026 min.
271 Effective stream area after confluence = 11.122(Ac.)
272
273

274 +-----+
275 Process from Point/Station 4.000 to Point/Station 7.000
276 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

```

277
278 Depth of flow = 1.111(Ft.), Average velocity = 10.004(Ft/s)
279 ***** Irregular Channel Data *****
280 -----
281 Information entered for subchannel number 1 :
282 Point number      'X' coordinate      'Y' coordinate
283     1              0.00              2.00
284     2              2.50              0.00
285     3              5.00              2.00
286 Manning's 'N' friction factor = 0.015
287 -----
288 Sub-Channel flow = 15.424(CFS)
289     '   '   flow top width = 2.777(Ft.)
290     '   '   velocity= 10.004(Ft/s)
291     '   '   area = 1.542(Sq.Ft)
292     '   '   Froude number = 2.366
293
294 Upstream point elevation = 705.060(Ft.)
295 Downstream point elevation = 694.000(Ft.)
296 Flow length = 356.000(Ft.)
297 Travel time = 0.59 min.
298 Time of concentration = 20.62 min.
299 Depth of flow = 1.111(Ft.)
300 Average velocity = 10.004(Ft/s)
301 Total irregular channel flow = 15.424(CFS)
302 Irregular channel normal depth above invert elev. = 1.111(Ft.)
303 Average velocity of channel(s) = 10.004(Ft/s)
304
305
306 *****
307 Process from Point/Station 7.000 to Point/Station 7.000
308 **** CONFLUENCE OF MINOR STREAMS ****
309 -----
310 Along Main Stream number: 1 in normal stream number 1
311 Stream flow area = 11.122(Ac.)
312 Runoff from this stream = 15.424(CFS)
313 Time of concentration = 20.62 min.
314 Rainfall intensity = 3.592(In/Hr)
315
316
317 *****
318 Process from Point/Station 8.000 to Point/Station 9.000
319 **** INITIAL AREA EVALUATION ****
320 -----
321 Decimal fraction soil group A = 0.000
322 Decimal fraction soil group B = 0.000
323 Decimal fraction soil group C = 1.000
324 Decimal fraction soil group D = 0.000
325 [UNDISTURBED NATURAL TERRAIN ]
326 (Permanent Open Space )
327 Impervious value, Ai = 0.000
328 Sub-Area C Value = 0.300
329 Initial subarea total flow distance = 100.000(Ft.)
330 Highest elevation = 715.000(Ft.)
331 Lowest elevation = 711.350(Ft.)
332 Elevation difference = 3.650(Ft.) Slope = 3.650 %
333 INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
334 The maximum overland flow distance is 100.00 (Ft)
335 for the top area slope value of 3.65 %, in a development type of
336 Permanent Open Space
337 In Accordance With Figure 3-3
338 Initial Area Time of Concentration = 9.35 minutes
339 TC = [1.8*(1.1-C)*distance(Ft.)^.5]/(% slope^(1/3))
340 TC = [1.8*(1.1-0.3000)*( 100.000^.5)]/( 3.650^(1/3))= 9.35
341 Rainfall intensity (I) = 5.981(In/Hr) for a 100.0 year storm
342 Effective runoff coefficient used for area (Q=KCIA) is C = 0.300
343 Subarea runoff = 0.366(CFS)
344 Total initial stream area = 0.204(Ac.)
345

```


346
 347 *****
 348 Process from Point/Station 9.000 to Point/Station 7.000
 349 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

350
 351 Estimated mean flow rate at midpoint of channel = 6.195(CFS)
 352 Depth of flow = 0.224(Ft.), Average velocity = 1.720(Ft/s)
 353 ***** Irregular Channel Data *****

354 -----
 355 Information entered for subchannel number 1 :
 356 Point number 'X' coordinate 'Y' coordinate
 357 1 0.00 1.00
 358 2 77.00 0.00
 359 3 144.00 1.00
 360 Manning's 'N' friction factor = 0.030

361 -----
 362 Sub-Channel flow = 6.195(CFS)
 363 ' ' flow top width = 32.206(Ft.)
 364 ' ' velocity = 1.720(Ft/s)
 365 ' ' area = 3.602(Sq.Ft)
 366 ' ' Froude number = 0.906

367
 368 Upstream point elevation = 711.350(Ft.)
 369 Downstream point elevation = 694.000(Ft.)
 370 Flow length = 775.000(Ft.)
 371 Travel time = 7.51 min.
 372 Time of concentration = 16.86 min.
 373 Depth of flow = 0.224(Ft.)
 374 Average velocity = 1.720(Ft/s)
 375 Total irregular channel flow = 6.195(CFS)
 376 Irregular channel normal depth above invert elev. = 0.224(Ft.)
 377 Average velocity of channel(s) = 1.720(Ft/s)

378 Adding area flow to channel
 379 Rainfall intensity (I) = 4.090(In/Hr) for a 100.0 year storm
 380 Decimal fraction soil group A = 0.000
 381 Decimal fraction soil group B = 0.000
 382 Decimal fraction soil group C = 1.000
 383 Decimal fraction soil group D = 0.000
 384 [UNDISTURBED NATURAL TERRAIN]
 385 (Permanent Open Space)
 386 Impervious value, Ai = 0.000
 387 Sub-Area C Value = 0.300
 388 Rainfall intensity = 4.090(In/Hr) for a 100.0 year storm
 389 Effective runoff coefficient used for total area
 390 (Q=KCIA) is C = 0.300 CA = 2.925
 391 Subarea runoff = 11.595(CFS) for 9.545(Ac.)
 392 Total runoff = 11.961(CFS) Total area = 9.749(Ac.)
 393 Depth of flow = 0.286(Ft.), Average velocity = 2.028(Ft/s)

394
 395
 396 *****
 397 Process from Point/Station 7.000 to Point/Station 7.000
 398 **** CONFLUENCE OF MINOR STREAMS ****

399
 400 Along Main Stream number: 1 in normal stream number 2
 401 Stream flow area = 9.749(Ac.)
 402 Runoff from this stream = 11.961(CFS)
 403 Time of concentration = 16.86 min.
 404 Rainfall intensity = 4.090(In/Hr)
 405 Summary of stream data:

406
 407

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	15.424	20.62	3.592
2	11.961	16.86	4.090

409
 410
 411
 412
 413 Qmax(1) =
 414 1.000 * 1.000 * 15.424) +

415 0.878 * 1.000 * 11.961) + = 25.929
416 Qmax(2) =
417 1.000 * 0.818 * 15.424) +
418 1.000 * 1.000 * 11.961) + = 24.574

419
420 Total of 2 streams to confluence:

421 Flow rates before confluence point:

422 15.424 11.961

423 Maximum flow rates at confluence using above data:

424 25.929 24.574

425 Area of streams before confluence:

426 11.122 9.749

427 Results of confluence:

428 Total flow rate = 25.929(CFS)

429 Time of concentration = 20.620 min.

430 Effective stream area after confluence = 20.871(Ac.)

431 End of computations, total study area = 20.871 (Ac.)

432

433

434

6b. CivilD Post-Development Calculations

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2014 Version 9.0

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 11/02/21

21054 POST DEV HYD

***** Hydrology Study Control Information *****

Program License Serial Number 6332

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.400
24 hour precipitation(inches) = 6.800
P6/P24 = 50.0%
San Diego hydrology manual 'C' values used

Process from Point/Station 1.000 to Point/Station 2.000
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[UNDISTURBED NATURAL TERRAIN]
(Permanent Open Space)
Impervious value, Ai = 0.000
Sub-Area C Value = 0.300
Initial subarea total flow distance = 100.000(Ft.)
Highest elevation = 756.000(Ft.)
Lowest elevation = 754.980(Ft.)
Elevation difference = 1.020(Ft.) Slope = 1.020 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 70.00 (Ft)
for the top area slope value of 1.02 %, in a development type of
Permanent Open Space
In Accordance With Figure 3-3
Initial Area Time of Concentration = 11.97 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^{.5}/(% slope^(1/3))]
TC = [1.8*(1.1-0.3000)*(70.000^{.5})/(1.020^(1/3))] = 11.97
Rainfall intensity (I) = 5.102(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.300
Subarea runoff = 0.119(CFS)
Total initial stream area = 0.078(Ac.)

Process from Point/Station 2.000 to Point/Station 3.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Estimated mean flow rate at midpoint of channel = 7.427(CFS)
Depth of flow = 0.311(Ft.), Average velocity = 4.431(Ft/s)
***** Irregular Channel Data *****

```

70 -----
71 Information entered for subchannel number 1 :
72 Point number      'X' coordinate      'Y' coordinate
73     1              0.00              0.50
74     2              0.00              0.00
75     3              1.50              0.13
76     4              20.25             0.38
77 Manning's 'N' friction factor = 0.013
78 -----
79 Sub-Channel flow = 7.427(CFS)
80 ' ' flow top width = 15.479(Ft.)
81 ' ' velocity= 4.431(Ft/s)
82 ' ' area = 1.676(Sq.Ft)
83 ' ' Froude number = 2.373
84
85 Upstream point elevation = 754.980(Ft.)
86 Downstream point elevation = 714.170(Ft.)
87 Flow length = 1364.000(Ft.)
88 Travel time = 5.13 min.
89 Time of concentration = 17.10 min.
90 Depth of flow = 0.311(Ft.)
91 Average velocity = 4.431(Ft/s)
92 Total irregular channel flow = 7.427(CFS)
93 Irregular channel normal depth above invert elev. = 0.311(Ft.)
94 Average velocity of channel(s) = 4.431(Ft/s)
95 Adding area flow to channel
96 Rainfall intensity (I) = 4.053(In/Hr) for a 100.0 year storm
97 Decimal fraction soil group A = 0.000
98 Decimal fraction soil group B = 0.000
99 Decimal fraction soil group C = 1.000
100 Decimal fraction soil group D = 0.000
101 [LOW DENSITY RESIDENTIAL ]
102 (1.0 DU/A or Less )
103 Impervious value, Ai = 0.100
104 Sub-Area C Value = 0.360
105 Rainfall intensity = 4.053(In/Hr) for a 100.0 year storm
106 Effective runoff coefficient used for total area
107 (Q=KCIA) is C = 0.360 CA = 3.622
108 Subarea runoff = 14.562(CFS) for 9.997(Ac.)
109 Total runoff = 14.682(CFS) Total area = 10.075(Ac.)
110 Depth of flow = 0.375(Ft.), Average velocity = 5.233(Ft/s)
111
112
113 +-----+
114 Process from Point/Station 3.000 to Point/Station 4.000
115 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
116
117 -----
118 Estimated mean flow rate at midpoint of channel = 14.903(CFS)
119 Depth of flow = 0.471(Ft.), Average velocity = 3.165(Ft/s)
120 ***** Irregular Channel Data *****
121 -----
122 Information entered for subchannel number 1 :
123 Point number      'X' coordinate      'Y' coordinate
124     1              0.00              0.50
125     2              0.00              0.00
126     3              1.50              0.13
127     4              20.25             0.38
128 Manning's 'N' friction factor = 0.013
129 -----
130 Sub-Channel flow = 14.903(CFS)
131 ' ' flow top width = 20.250(Ft.)
132 ' ' velocity= 3.165(Ft/s)
133 ' ' area = 4.709(Sq.Ft)
134 ' ' Froude number = 1.157
135
136 Upstream point elevation = 714.170(Ft.)
137 Downstream point elevation = 710.840(Ft.)
138 Flow length = 602.000(Ft.)
139 Travel time = 3.17 min.

```

139 Time of concentration = 20.27 min.
 140 Depth of flow = 0.471(Ft.)
 141 **Average** velocity = 3.165(Ft/s)
 142 Total irregular channel flow = 14.903(CFS)
 143 Irregular channel normal depth above invert elev. = 0.471(Ft.)
 144 **Average** velocity of channel(s) = 3.165(Ft/s)
 145 Adding area flow to channel
 146 Rainfall intensity (I) = 3.632(In/Hr) for a 100.0 year storm
 147 Decimal fraction soil group A = 0.000
 148 Decimal fraction soil group B = 0.000
 149 Decimal fraction soil group C = 1.000
 150 Decimal fraction soil group D = 0.000
 151 [MEDIUM DENSITY RESIDENTIAL]
 152 (14.5 DU/A or Less)
 153 Impervious value, Ai = 0.500
 154 Sub-Area C Value = 0.600
 155 Rainfall intensity = 3.632(In/Hr) for a 100.0 year storm
 156 Effective runoff coefficient used for total area
 157 (Q=KCIA) is C = 0.379 CA = 4.148
 158 Subarea runoff = 0.384(CFS) for 0.876(Ac.)
 159 Total runoff = 15.065(CFS) Total area = 10.951(Ac.)
 160 Depth of flow = 0.472(Ft.), **Average** velocity = 3.179(Ft/s)

161
 162
 163 ++++++
 164 Process from Point/Station 4.000 to Point/Station 5.000
 165 **** PIPEFLOW TRAVEL TIME (User specified size) ****
 166

167 Upstream point/station elevation = 710.260(Ft.)
 168 Downstream point/station elevation = 707.650(Ft.)
 169 Pipe **length** = 43.00(Ft.) Slope = 0.0607 Manning's N = 0.013
 170 No. of pipes = 1 Required pipe flow = 15.065(CFS)
 171 Given pipe size = 18.00(In.)
 172 Calculated individual pipe flow = 15.065(CFS)
 173 Normal flow depth in pipe = 9.87(In.)
 174 Flow top width inside pipe = 17.92(In.)
 175 Critical Depth = 16.88(In.)
 176 Pipe flow velocity = 15.20(Ft/s)
 177 Travel time through pipe = 0.05 min.
 178 Time of concentration (TC) = 20.32 min.
 179
 180

181 ++++++
 182 Process from Point/Station 5.000 to Point/Station 6.000
 183 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
 184

185 Depth of flow = 1.149(Ft.), **Average** velocity = 9.134(Ft/s)
 186 ***** Irregular Channel Data *****
 187

188 -----
 188 Information entered for subchannel number 1 :
 189 Point number 'X' coordinate 'Y' coordinate
 190 1 0.00 2.00
 191 2 2.50 0.00
 192 3 5.00 2.00
 193 Manning's 'N' friction factor = 0.015
 194 -----

195 Sub-Channel flow = 15.065(CFS)
 196 ' ' flow top width = 2.872(Ft.)
 197 ' ' velocity = 9.134(Ft/s)
 198 ' ' area = 1.649(Sq.Ft)
 199 ' ' Froude number = 2.124
 200

201 Upstream point elevation = 707.650(Ft.)
 202 Downstream point elevation = 705.050(Ft.)
 203 Flow **length** = 105.000(Ft.)
 204 Travel time = 0.19 min.
 205 Time of concentration = 20.51 min.
 206 Depth of flow = 1.149(Ft.)
 207 **Average** velocity = 9.134(Ft/s)

```

208 Total irregular channel flow = 15.065(CFS)
209 Irregular channel normal depth above invert elev. = 1.149(Ft.)
210 Average velocity of channel(s) = 9.134(Ft/s)
211
212
213 +-----+
214 Process from Point/Station 6.000 to Point/Station 6.000
215 **** CONFLUENCE OF MINOR STREAMS ****
216
217 -----
218 Along Main Stream number: 1 in normal stream number 1
219 Stream flow area = 10.951(Ac.)
220 Runoff from this stream = 15.065(CFS)
221 Time of concentration = 20.51 min.
222 Rainfall intensity = 3.605(In/Hr)
223
224 +-----+
225 Process from Point/Station 7.000 to Point/Station 8.000
226 **** INITIAL AREA EVALUATION ****
227
228 -----
229 Decimal fraction soil group A = 0.000
230 Decimal fraction soil group B = 0.000
231 Decimal fraction soil group C = 1.000
232 Decimal fraction soil group D = 0.000
233 [MEDIUM DENSITY RESIDENTIAL ]
234 (14.5 DU/A or Less )
235 Impervious value, Ai = 0.500
236 Sub-Area C Value = 0.600
237 Initial subarea total flow distance = 119.000(Ft.)
238 Highest elevation = 716.290(Ft.)
239 Lowest elevation = 713.970(Ft.)
240 Elevation difference = 2.320(Ft.) Slope = 1.950 %
241 INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
242 The maximum overland flow distance is 80.00 (Ft)
243 for the top area slope value of 1.95 %, in a development type of
244 14.5 DU/A or Less
245 In Accordance With Figure 3-3
246 Initial Area Time of Concentration = 6.44 minutes
247 TC = [1.8*(1.1-C)*distance(Ft.)^0.5]/(% slope^(1/3))
248 TC = [1.8*(1.1-0.6000)*( 80.000^0.5)]/( 1.950^(1/3))= 6.44
249 Rainfall intensity (I) = 7.606(In/Hr) for a 100.0 year storm
250 Effective runoff coefficient used for area (Q=KCIA) is C = 0.600
251 Subarea runoff = 0.497(CFS)
252 Total initial stream area = 0.109(Ac.)
253
254 +-----+
255 Process from Point/Station 8.000 to Point/Station 9.000
256 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
257
258 -----
259 Depth of flow = 0.203(Ft.), Average velocity = 1.224(Ft/s)
260 ***** Irregular Channel Data *****
261 -----
262 Information entered for subchannel number 1 :
263 Point number 'X' coordinate 'Y' coordinate
264 1 0.00 0.50
265 2 0.00 0.00
266 3 1.50 0.13
267 4 18.50 0.39
268 Manning's 'N' friction factor = 0.015
269 -----
270 Sub-Channel flow = 0.497(CFS)
271 ' ' flow top width = 6.499(Ft.)
272 ' ' velocity= 1.224(Ft/s)
273 ' ' area = 0.407(Sq.Ft)
274 ' ' Froude number = 0.862
275
276 Upstream point elevation = 713.970(Ft.)
277 Downstream point elevation = 710.420(Ft.)

```

277 Flow length = 554.000(Ft.)
 278 Travel time = 7.55 min.
 279 Time of concentration = 13.99 min.
 280 Depth of flow = 0.203(Ft.)
 281 Average velocity = 1.224(Ft/s)
 282 Total irregular channel flow = 0.497(CFS)
 283 Irregular channel normal depth above invert elev. = 0.203(Ft.)
 284 Average velocity of channel(s) = 1.224(Ft/s)

 287 Process from Point/Station 9.000 to Point/Station 10.000
 288 **** PIPEFLOW TRAVEL TIME (User specified size) ****
 289

291 Upstream point/station elevation = 710.420(Ft.)
 292 Downstream point/station elevation = 704.420(Ft.)
 293 Pipe length = 37.00(Ft.) Slope = 0.1622 Manning's N = 0.013
 294 No. of pipes = 1 Required pipe flow = 0.497(CFS)
 295 Given pipe size = 36.00(In.)
 296 Calculated individual pipe flow = 0.497(CFS)
 297 Normal flow depth in pipe = 1.15(In.)
 298 Flow top width inside pipe = 12.68(In.)
 299 Critical depth could not be calculated.
 300 Pipe flow velocity = 7.30(Ft/s)
 301 Travel time through pipe = 0.08 min.
 302 Time of concentration (TC) = 14.07 min.
 303
 304

 306 Process from Point/Station 10.000 to Point/Station 6.000
 307 **** PIPEFLOW TRAVEL TIME (User specified size) ****
 308

309 Upstream point/station elevation = 710.000(Ft.)
 310 Downstream point/station elevation = 705.050(Ft.)
 311 Pipe length = 73.00(Ft.) Slope = 0.0678 Manning's N = 0.013
 312 No. of pipes = 1 Required pipe flow = 0.497(CFS)
 313 Given pipe size = 12.00(In.)
 314 Calculated individual pipe flow = 0.497(CFS)
 315 Normal flow depth in pipe = 1.89(In.)
 316 Flow top width inside pipe = 8.74(In.)
 317 Critical Depth = 3.51(In.)
 318 Pipe flow velocity = 6.29(Ft/s)
 319 Travel time through pipe = 0.19 min.
 320 Time of concentration (TC) = 14.27 min.
 321
 322

 324 Process from Point/Station 6.000 to Point/Station 6.000
 325 **** CONFLUENCE OF MINOR STREAMS ****
 326

327 Along Main Stream number: 1 in normal stream number 2
 328 Stream flow area = 0.109(Ac.)
 329 Runoff from this stream = 0.497(CFS)
 330 Time of concentration = 14.27 min.
 331 Rainfall intensity = 4.555(In/Hr)
 332 Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	15.065	20.51	3.605
2	0.497	14.27	4.555
Qmax(1) =			
	1.000 *	1.000 *	15.065) +
	0.791 *	1.000 *	0.497) + = 15.459
Qmax(2) =			
	1.000 *	0.696 *	15.065) +
	1.000 *	1.000 *	0.497) + = 10.979


```

346
347 Total of 2 streams to confluence:
348 Flow rates before confluence point:
349     15.065     0.497
350 Maximum flow rates at confluence using above data:
351     15.459     10.979
352 Area of streams before confluence:
353     10.951     0.109
354 Results of confluence:
355 Total flow rate = 15.459(CFS)
356 Time of concentration = 20.508 min.
357 Effective stream area after confluence = 11.060(Ac.)
358
359
360 +-----+
361 Process from Point/Station 6.000 to Point/Station 11.000
362 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
363
364 -----
365 Depth of flow = 1.103(Ft.), Average velocity = 10.158(Ft/s)
366 ***** Irregular Channel Data *****
367 -----
368 Information entered for subchannel number 1 :
369 Point number 'X' coordinate 'Y' coordinate
370     1         0.00         2.00
371     2         2.50         0.00
372     3         5.00         2.00
373 Manning's 'N' friction factor = 0.015
374 -----
375 Sub-Channel flow = 15.459(CFS)
376 ' ' flow top width = 2.759(Ft.)
377 ' ' velocity= 10.158(Ft/s)
378 ' ' area = 1.522(Sq.Ft)
379 ' ' Froude number = 2.410
380
381 Upstream point elevation = 705.050(Ft.)
382 Downstream point elevation = 694.000(Ft.)
383 Flow length = 342.000(Ft.)
384 Travel time = 0.56 min.
385 Time of concentration = 21.07 min.
386 Depth of flow = 1.103(Ft.)
387 Average velocity = 10.158(Ft/s)
388 Total irregular channel flow = 15.459(CFS)
389 Irregular channel normal depth above invert elev. = 1.103(Ft.)
390 Average velocity of channel(s) = 10.158(Ft/s)
391
392 +-----+
393 Process from Point/Station 11.000 to Point/Station 11.000
394 **** CONFLUENCE OF MINOR STREAMS ****
395
396 -----
397 Along Main Stream number: 1 in normal stream number 1
398 Stream flow area = 11.060(Ac.)
399 Runoff from this stream = 15.459(CFS)
400 Time of concentration = 21.07 min.
401 Rainfall intensity = 3.542(In/Hr)
402
403 +-----+
404 Process from Point/Station 12.000 to Point/Station 13.000
405 **** INITIAL AREA EVALUATION ****
406
407 -----
408 Decimal fraction soil group A = 0.000
409 Decimal fraction soil group B = 0.000
410 Decimal fraction soil group C = 1.000
411 Decimal fraction soil group D = 0.000
412 [LOW DENSITY RESIDENTIAL ]
413 (1.0 DU/A or Less )
414 Impervious value, Ai = 0.100
415 Sub-Area C Value = 0.360

```

```

415 Initial subarea total flow distance = 118.000(Ft.)
416 Highest elevation = 713.000(Ft.)
417 Lowest elevation = 712.000(Ft.)
418 Elevation difference = 1.000(Ft.) Slope = 0.847 %
419 INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
420 The maximum overland flow distance is 70.00 (Ft)
421 for the top area slope value of 0.85 %, in a development type of
422 1.0 DU/A or Less
423 In Accordance With Figure 3-3
424 Initial Area Time of Concentration = 11.78 minutes
425  $TC = [1.8*(1.1-C)*distance(Ft.)^{.5}/(%\ slope^{(1/3)})]$ 
426  $TC = [1.8*(1.1-0.3600)*(70.000^{.5})/((0.847^{(1/3)})]= 11.78$ 
427 Rainfall intensity (I) = 5.155(In/Hr) for a 100.0 year storm
428 Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
429 Subarea runoff = 0.379(CFS)
430 Total initial stream area = 0.204(Ac.)
431
432
433 ++++++
434 Process from Point/Station 13.000 to Point/Station 14.000
435 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
436
437 -----
438 Estimated mean flow rate at midpoint of channel = 7.779(CFS)
439 Depth of flow = 0.375(Ft.), Average velocity = 3.151(Ft/s)
440 ***** Irregular Channel Data *****
441 -----
442 Information entered for subchannel number 1 :
443 Point number 'X' coordinate 'Y' coordinate
444 1 0.00 0.50
445 2 0.00 0.00
446 3 1.50 0.13
447 4 18.50 0.39
448 Manning's 'N' friction factor = 0.015
449 -----
450 Sub-Channel flow = 7.779(CFS)
451 ' ' flow top width = 17.486(Ft.)
452 ' ' velocity = 3.152(Ft/s)
453 ' ' area = 2.468(Sq.Ft)
454 ' ' Froude number = 1.478
455
456 Upstream point elevation = 712.000(Ft.)
457 Downstream point elevation = 701.470(Ft.)
458 Flow length = 743.000(Ft.)
459 Travel time = 3.93 min.
460 Time of concentration = 15.71 min.
461 Depth of flow = 0.375(Ft.)
462 Average velocity = 3.151(Ft/s)
463 Total irregular channel flow = 7.779(CFS)
464 Irregular channel normal depth above invert elev. = 0.375(Ft.)
465 Average velocity of channel(s) = 3.151(Ft/s)
466 Adding area flow to channel
467 Rainfall intensity (I) = 4.281(In/Hr) for a 100.0 year storm
468 Decimal fraction soil group A = 0.000
469 Decimal fraction soil group B = 0.000
470 Decimal fraction soil group C = 1.000
471 Decimal fraction soil group D = 0.000
472 [LOW DENSITY RESIDENTIAL ]
473 (1.0 DU/A or Less )
474 Impervious value, Ai = 0.100
475 Sub-Area C Value = 0.360
476 Rainfall intensity = 4.281(In/Hr) for a 100.0 year storm
477 Effective runoff coefficient used for total area
478 (Q=KCIA) is C = 0.360 CA = 3.532
479 Subarea runoff = 14.742(CFS) for 9.607(Ac.)
480 Total runoff = 15.121(CFS) Total area = 9.811(Ac.)
481 Depth of flow = 0.446(Ft.), Average velocity = 4.016(Ft/s)
482
483 ++++++

```

484 Process from Point/Station 14.000 to Point/Station 15.000
 485 **** PIPEFLOW TRAVEL TIME (User specified size) ****
 486
 487 Upstream point/station elevation = 701.470(Ft.)
 488 Downstream point/station elevation = 698.000(Ft.)
 489 Pipe length = 117.00(Ft.) Slope = 0.0297 Manning's N = 0.013
 490 No. of pipes = 1 Required pipe flow = 15.121(CFS)
 491 Given pipe size = 24.00(In.)
 492 Calculated individual pipe flow = 15.121(CFS)
 493 Normal flow depth in pipe = 10.38(In.)
 494 Flow top width inside pipe = 23.78(In.)
 495 Critical Depth = 16.82(In.)
 496 Pipe flow velocity = 11.62(Ft/s)
 497 Travel time through pipe = 0.17 min.
 498 Time of concentration (TC) = 15.88 min.
 499
 500

501 +-----+
 502 Process from Point/Station 15.000 to Point/Station 11.000
 503 **** PIPEFLOW TRAVEL TIME (User specified size) ****
 504
 505 Upstream point/station elevation = 694.110(Ft.)
 506 Downstream point/station elevation = 693.700(Ft.)
 507 Pipe length = 79.00(Ft.) Slope = 0.0052 Manning's N = 0.013
 508 No. of pipes = 1 Required pipe flow = 15.121(CFS)
 509 Given pipe size = 12.00(In.)
 510 NOTE: Normal flow is pressure flow in user selected pipe size.
 511 The approximate hydraulic grade line above the pipe invert is
 512 22.448(Ft.) at the headworks or inlet of the pipe(s)
 513 Pipe friction loss = 14.225(Ft.)
 514 Minor friction loss = 8.633(Ft.) K-factor = 1.50
 515 Pipe flow velocity = 19.25(Ft/s)
 516 Travel time through pipe = 0.07 min.
 517 Time of concentration (TC) = 15.94 min.
 518
 519

520 +-----+
 521 Process from Point/Station 11.000 to Point/Station 11.000
 522 **** CONFLUENCE OF MINOR STREAMS ****
 523

524 Along Main Stream number: 1 in normal stream number 2
 525 Stream flow area = 9.811(Ac.)
 526 Runoff from this stream = 15.121(CFS)
 527 Time of concentration = 15.94 min.
 528 Rainfall intensity = 4.240(In/Hr)
 529 Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	15.459	21.07	3.542
2	15.121	15.94	4.240

537 Qmax(1) =
 538 1.000 * 1.000 * 15.459) +
 539 0.835 * 1.000 * 15.121) + = 28.092
 540 Qmax(2) =
 541 1.000 * 0.757 * 15.459) +
 542 1.000 * 1.000 * 15.121) + = 26.820
 543

544 Total of 2 streams to confluence:
 545 Flow rates before confluence point:
 546 15.459 15.121
 547 Maximum flow rates at confluence using above data:
 548 28.092 26.820
 549 Area of streams before confluence:
 550 11.060 9.811
 551 Results of confluence:
 552 Total flow rate = 28.092(CFS)

553 Time of concentration = 21.069 min.
554 Effective stream area after confluence = 20.871(Ac.)
555 End of computations, total study area = 20.871 (Ac.)
556
557
558

6c. CivilD Mitigated Post-Development Calculations

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2014 Version 9.0

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 11/05/21

21054 POST DEV HYD
MITIGATION

***** Hydrology Study Control Information *****

Program License Serial Number 6332

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.400
24 hour precipitation(inches) = 6.800
P6/P24 = 50.0%
San Diego hydrology manual 'C' values used

Process from Point/Station 1.000 to Point/Station 2.000
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[UNDISTURBED NATURAL TERRAIN]
(Permanent Open Space)
Impervious value, Ai = 0.000
Sub-Area C Value = 0.300
Initial subarea total flow distance = 100.000(Ft.)
Highest elevation = 756.000(Ft.)
Lowest elevation = 754.980(Ft.)
Elevation difference = 1.020(Ft.) Slope = 1.020 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 70.00 (Ft)
for the top area slope value of 1.02 %, in a development type of
Permanent Open Space
In Accordance With Figure 3-3
Initial Area Time of Concentration = 11.97 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^0.5]/(% slope^(1/3))
TC = [1.8*(1.1-0.3000)*(70.000^0.5)]/(1.020^(1/3))= 11.97
Rainfall intensity (I) = 5.102(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.300
Subarea runoff = 0.119(CFS)
Total initial stream area = 0.078(Ac.)

Process from Point/Station 2.000 to Point/Station 3.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Estimated mean flow rate at midpoint of channel = 7.427(CFS)
Depth of flow = 0.311(Ft.), Average velocity = 4.431(Ft/s)
***** Irregular Channel Data *****

```

70 -----
71 Information entered for subchannel number 1 :
72 Point number      'X' coordinate      'Y' coordinate
73     1              0.00              0.50
74     2              0.00              0.00
75     3              1.50              0.13
76     4              20.25             0.38
77 Manning's 'N' friction factor = 0.013
78 -----
79 Sub-Channel flow = 7.427(CFS)
80 '   '   flow top width = 15.479(Ft.)
81 '   '   velocity= 4.431(Ft/s)
82 '   '   area = 1.676(Sq.Ft)
83 '   '   Froude number = 2.373
84
85 Upstream point elevation = 754.980(Ft.)
86 Downstream point elevation = 714.170(Ft.)
87 Flow length = 1364.000(Ft.)
88 Travel time = 5.13 min.
89 Time of concentration = 17.10 min.
90 Depth of flow = 0.311(Ft.)
91 Average velocity = 4.431(Ft/s)
92 Total irregular channel flow = 7.427(CFS)
93 Irregular channel normal depth above invert elev. = 0.311(Ft.)
94 Average velocity of channel(s) = 4.431(Ft/s)
95 Adding area flow to channel
96 Rainfall intensity (I) = 4.053(In/Hr) for a 100.0 year storm
97 Decimal fraction soil group A = 0.000
98 Decimal fraction soil group B = 0.000
99 Decimal fraction soil group C = 1.000
100 Decimal fraction soil group D = 0.000
101 [LOW DENSITY RESIDENTIAL ]
102 (1.0 DU/A or Less )
103 Impervious value, Ai = 0.100
104 Sub-Area C Value = 0.360
105 Rainfall intensity = 4.053(In/Hr) for a 100.0 year storm
106 Effective runoff coefficient used for total area
107 (Q=KCIA) is C = 0.360 CA = 3.622
108 Subarea runoff = 14.562(CFS) for 9.997(Ac.)
109 Total runoff = 14.682(CFS) Total area = 10.075(Ac.)
110 Depth of flow = 0.375(Ft.), Average velocity = 5.233(Ft/s)
111
112
113 +-----+
114 Process from Point/Station 3.000 to Point/Station 4.000
115 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
116
117 -----
118 Estimated mean flow rate at midpoint of channel = 14.903(CFS)
119 Depth of flow = 0.471(Ft.), Average velocity = 3.165(Ft/s)
120 ***** Irregular Channel Data *****
121 -----
122 Information entered for subchannel number 1 :
123 Point number      'X' coordinate      'Y' coordinate
124     1              0.00              0.50
125     2              0.00              0.00
126     3              1.50              0.13
127     4              20.25             0.38
128 Manning's 'N' friction factor = 0.013
129 -----
130 Sub-Channel flow = 14.903(CFS)
131 '   '   flow top width = 20.250(Ft.)
132 '   '   velocity= 3.165(Ft/s)
133 '   '   area = 4.709(Sq.Ft)
134 '   '   Froude number = 1.157
135
136 Upstream point elevation = 714.170(Ft.)
137 Downstream point elevation = 710.840(Ft.)
138 Flow length = 602.000(Ft.)
139 Travel time = 3.17 min.

```

139 Time of concentration = 20.27 min.
 140 Depth of flow = 0.471(Ft.)
 141 **Average** velocity = 3.165(Ft/s)
 142 Total irregular channel flow = 14.903(CFS)
 143 Irregular channel normal depth above invert elev. = 0.471(Ft.)
 144 **Average** velocity of channel(s) = 3.165(Ft/s)
 145 Adding area flow to channel
 146 Rainfall intensity (I) = 3.632(In/Hr) for a 100.0 year storm
 147 Decimal fraction soil group A = 0.000
 148 Decimal fraction soil group B = 0.000
 149 Decimal fraction soil group C = 1.000
 150 Decimal fraction soil group D = 0.000
 151 [MEDIUM DENSITY RESIDENTIAL]
 152 (14.5 DU/A or Less)
 153 Impervious value, Ai = 0.500
 154 Sub-Area C Value = 0.600
 155 Rainfall intensity = 3.632(In/Hr) for a 100.0 year storm
 156 Effective runoff coefficient used for total area
 157 (Q=KCIA) is C = 0.379 CA = 4.148
 158 Subarea runoff = 0.384(CFS) for 0.876(Ac.)
 159 Total runoff = 15.065(CFS) Total area = 10.951(Ac.)
 160 Depth of flow = 0.472(Ft.), **Average** velocity = 3.179(Ft/s)

161
 162
 163 ++++++
 164 Process from Point/Station 4.000 to Point/Station 5.000
 165 **** PIPEFLOW TRAVEL TIME (User specified size) ****
 166

167 Upstream point/station elevation = 710.260(Ft.)
 168 Downstream point/station elevation = 707.650(Ft.)
 169 Pipe **length** = 43.00(Ft.) Slope = 0.0607 Manning's N = 0.013
 170 No. of pipes = 1 Required pipe flow = 15.065(CFS)
 171 Given pipe size = 18.00(In.)
 172 Calculated individual pipe flow = 15.065(CFS)
 173 Normal flow depth in pipe = 9.87(In.)
 174 Flow top width inside pipe = 17.92(In.)
 175 Critical Depth = 16.88(In.)
 176 Pipe flow velocity = 15.20(Ft/s)
 177 Travel time through pipe = 0.05 min.
 178 Time of concentration (TC) = 20.32 min.
 179
 180

181 ++++++
 182 Process from Point/Station 5.000 to Point/Station 6.000
 183 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
 184

185 Depth of flow = 1.149(Ft.), **Average** velocity = 9.134(Ft/s)
 186 ***** Irregular Channel Data *****
 187

188 -----
 188 Information entered for subchannel number 1 :
 189 Point number 'X' coordinate 'Y' coordinate
 190 1 0.00 2.00
 191 2 2.50 0.00
 192 3 5.00 2.00
 193 Manning's 'N' friction factor = 0.015
 194 -----

195 Sub-Channel flow = 15.065(CFS)
 196 ' ' flow top width = 2.872(Ft.)
 197 ' ' velocity = 9.134(Ft/s)
 198 ' ' area = 1.649(Sq.Ft)
 199 ' ' Froude number = 2.124
 200

201 Upstream point elevation = 707.650(Ft.)
 202 Downstream point elevation = 705.050(Ft.)
 203 Flow **length** = 105.000(Ft.)
 204 Travel time = 0.19 min.
 205 Time of concentration = 20.51 min.
 206 Depth of flow = 1.149(Ft.)
 207 **Average** velocity = 9.134(Ft/s)


```

208 Total irregular channel flow = 15.065(CFS)
209 Irregular channel normal depth above invert elev. = 1.149(Ft.)
210 Average velocity of channel(s) = 9.134(Ft/s)
211
212
213 +-----+
214 Process from Point/Station 6.000 to Point/Station 6.000
215 **** CONFLUENCE OF MINOR STREAMS ****
216
217 -----
218 Along Main Stream number: 1 in normal stream number 1
219 Stream flow area = 10.951(Ac.)
220 Runoff from this stream = 15.065(CFS)
221 Time of concentration = 20.51 min.
222 Rainfall intensity = 3.605(In/Hr)
223
224 +-----+
225 Process from Point/Station 7.000 to Point/Station 8.000
226 **** INITIAL AREA EVALUATION ****
227
228 -----
229 Decimal fraction soil group A = 0.000
230 Decimal fraction soil group B = 0.000
231 Decimal fraction soil group C = 1.000
232 Decimal fraction soil group D = 0.000
233 [MEDIUM DENSITY RESIDENTIAL ]
234 (14.5 DU/A or Less )
235 Impervious value, Ai = 0.500
236 Sub-Area C Value = 0.600
237 Initial subarea total flow distance = 119.000(Ft.)
238 Highest elevation = 716.290(Ft.)
239 Lowest elevation = 713.970(Ft.)
240 Elevation difference = 2.320(Ft.) Slope = 1.950 %
241 INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
242 The maximum overland flow distance is 80.00 (Ft)
243 for the top area slope value of 1.95 %, in a development type of
244 14.5 DU/A or Less
245 In Accordance With Figure 3-3
246 Initial Area Time of Concentration = 6.44 minutes
247 TC = [1.8*(1.1-C)*distance(Ft.)^0.5]/(% slope^(1/3))
248 TC = [1.8*(1.1-0.6000)*( 80.000^0.5)]/( 1.950^(1/3))= 6.44
249 Rainfall intensity (I) = 7.606(In/Hr) for a 100.0 year storm
250 Effective runoff coefficient used for area (Q=KCIA) is C = 0.600
251 Subarea runoff = 0.497(CFS)
252 Total initial stream area = 0.109(Ac.)
253
254 +-----+
255 Process from Point/Station 8.000 to Point/Station 9.000
256 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
257
258 -----
259 Depth of flow = 0.203(Ft.), Average velocity = 1.224(Ft/s)
260 ***** Irregular Channel Data *****
261 -----
262 Information entered for subchannel number 1 :
263 Point number 'X' coordinate 'Y' coordinate
264 1 0.00 0.50
265 2 0.00 0.00
266 3 1.50 0.13
267 4 18.50 0.39
268 Manning's 'N' friction factor = 0.015
269 -----
270 Sub-Channel flow = 0.497(CFS)
271 ' ' flow top width = 6.499(Ft.)
272 ' ' velocity= 1.224(Ft/s)
273 ' ' area = 0.407(Sq.Ft)
274 ' ' Froude number = 0.862
275
276 Upstream point elevation = 713.970(Ft.)
277 Downstream point elevation = 710.420(Ft.)

```

277 Flow length = 554.000(Ft.)
 278 Travel time = 7.55 min.
 279 Time of concentration = 13.99 min.
 280 Depth of flow = 0.203(Ft.)
 281 Average velocity = 1.224(Ft/s)
 282 Total irregular channel flow = 0.497(CFS)
 283 Irregular channel normal depth above invert elev. = 0.203(Ft.)
 284 Average velocity of channel(s) = 1.224(Ft/s)

287 *****
 288 Process from Point/Station 9.000 to Point/Station 10.000
 289 **** PIPEFLOW TRAVEL TIME (User specified size) ****

291 Upstream point/station elevation = 710.420(Ft.)
 292 Downstream point/station elevation = 704.420(Ft.)
 293 Pipe length = 37.00(Ft.) Slope = 0.1622 Manning's N = 0.013
 294 No. of pipes = 1 Required pipe flow = 0.497(CFS)
 295 Given pipe size = 36.00(In.)
 296 Calculated individual pipe flow = 0.497(CFS)
 297 Normal flow depth in pipe = 1.15(In.)
 298 Flow top width inside pipe = 12.68(In.)
 299 Critical depth could not be calculated.
 300 Pipe flow velocity = 7.30(Ft/s)
 301 Travel time through pipe = 0.08 min.
 302 Time of concentration (TC) = 14.07 min.

305 *****
 306 Process from Point/Station 10.000 to Point/Station 6.000
 307 **** PIPEFLOW TRAVEL TIME (User specified size) ****

309 Upstream point/station elevation = 710.000(Ft.)
 310 Downstream point/station elevation = 705.050(Ft.)
 311 Pipe length = 73.00(Ft.) Slope = 0.0678 Manning's N = 0.013
 312 No. of pipes = 1 Required pipe flow = 0.497(CFS)
 313 Given pipe size = 12.00(In.)
 314 Calculated individual pipe flow = 0.497(CFS)
 315 Normal flow depth in pipe = 1.89(In.)
 316 Flow top width inside pipe = 8.74(In.)
 317 Critical Depth = 3.51(In.)
 318 Pipe flow velocity = 6.29(Ft/s)
 319 Travel time through pipe = 0.19 min.
 320 Time of concentration (TC) = 14.27 min.

323 *****
 324 Process from Point/Station 6.000 to Point/Station 6.000
 325 **** CONFLUENCE OF MINOR STREAMS ****

327 Along Main Stream number: 1 in normal stream number 2
 328 Stream flow area = 0.109(Ac.)
 329 Runoff from this stream = 0.497(CFS)
 330 Time of concentration = 14.27 min.
 331 Rainfall intensity = 4.555(In/Hr)
 332 Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	15.065	20.51	3.605
2	0.497	14.27	4.555
Qmax(1) =			
	1.000 *	1.000 *	15.065) +
	0.791 *	1.000 *	0.497) + = 15.459
Qmax(2) =			
	1.000 *	0.696 *	15.065) +
	1.000 *	1.000 *	0.497) + = 10.979

```

346
347 Total of 2 streams to confluence:
348 Flow rates before confluence point:
349     15.065     0.497
350 Maximum flow rates at confluence using above data:
351     15.459     10.979
352 Area of streams before confluence:
353     10.951     0.109
354 Results of confluence:
355 Total flow rate = 15.459(CFS)
356 Time of concentration = 20.508 min.
357 Effective stream area after confluence = 11.060(Ac.)
358
359
360 +-----+
361 Process from Point/Station 6.000 to Point/Station 11.000
362 **** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
363
364 -----
365 Depth of flow = 1.103(Ft.), Average velocity = 10.158(Ft/s)
366 ***** Irregular Channel Data *****
367 -----
368 Information entered for subchannel number 1 :
369 Point number 'X' coordinate 'Y' coordinate
370     1         0.00         2.00
371     2         2.50         0.00
372     3         5.00         2.00
373 Manning's 'N' friction factor = 0.015
374 -----
375 Sub-Channel flow = 15.459(CFS)
376 ' ' flow top width = 2.759(Ft.)
377 ' ' velocity= 10.158(Ft/s)
378 ' ' area = 1.522(Sq.Ft)
379 ' ' Froude number = 2.410
380
381 Upstream point elevation = 705.050(Ft.)
382 Downstream point elevation = 694.000(Ft.)
383 Flow length = 342.000(Ft.)
384 Travel time = 0.56 min.
385 Time of concentration = 21.07 min.
386 Depth of flow = 1.103(Ft.)
387 Average velocity = 10.158(Ft/s)
388 Total irregular channel flow = 15.459(CFS)
389 Irregular channel normal depth above invert elev. = 1.103(Ft.)
390 Average velocity of channel(s) = 10.158(Ft/s)
391
392 +-----+
393 Process from Point/Station 11.000 to Point/Station 11.000
394 **** CONFLUENCE OF MINOR STREAMS ****
395
396 -----
397 Along Main Stream number: 1 in normal stream number 1
398 Stream flow area = 11.060(Ac.)
399 Runoff from this stream = 15.459(CFS)
400 Time of concentration = 21.07 min.
401 Rainfall intensity = 3.542(In/Hr)
402
403 +-----+
404 Process from Point/Station 12.000 to Point/Station 15.000
405 **** USER DEFINED FLOW INFORMATION AT A POINT ****
406
407 -----
408 User specified 'C' value of 0.284 given for subarea
409 Rainfall intensity (I) = 4.251(In/Hr) for a 100.0 year storm
410 User specified values are as follows:
411 TC = 15.88 min. Rain intensity = 4.25(In/Hr)
412 Total area = 9.811(Ac.) Total runoff = 11.830(CFS)
413
414 +-----+

```

415 Process from Point/Station 15.000 to Point/Station 11.000
416 **** PIPEFLOW TRAVEL TIME (User specified size) ****
417

418 Upstream point/station elevation = 694.110(Ft.)
419 Downstream point/station elevation = 693.700(Ft.)
420 Pipe length = 79.00(Ft.) Slope = 0.0052 Manning's N = 0.013
421 No. of pipes = 1 Required pipe flow = 11.830(CFS)
422 Given pipe size = 12.00(In.)
423 NOTE: Normal flow is pressure flow in user selected pipe size.
424 The approximate hydraulic grade line above the pipe invert is
425 13.581(Ft.) at the headworks or inlet of the pipe(s)
426 Pipe friction loss = 8.707(Ft.)
427 Minor friction loss = 5.284(Ft.) K-factor = 1.50
428 Pipe flow velocity = 15.06(Ft/s)
429 Travel time through pipe = 0.09 min.
430 Time of concentration (TC) = 15.97 min.
431
432

433 ++++++
434 Process from Point/Station 11.000 to Point/Station 11.000
435 **** CONFLUENCE OF MINOR STREAMS ****
436

437 Along Main Stream number: 1 in normal stream number 2
438 Stream flow area = 9.811(Ac.)
439 Runoff from this stream = 11.830(CFS)
440 Time of concentration = 15.97 min.
441 Rainfall intensity = 4.236(In/Hr)
442 Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	15.459	21.07	3.542
2	11.830	15.97	4.236

443
444
445
446
447
448
449
450 Qmax(1) =
451 1.000 * 1.000 * 15.459) +
452 0.836 * 1.000 * 11.830) + = 25.352
453 Qmax(2) =
454 1.000 * 0.758 * 15.459) +
455 1.000 * 1.000 * 11.830) + = 23.546
456

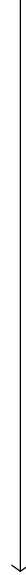
457 Total of 2 streams to confluence:
458 Flow rates before confluence point:
459 15.459 11.830
460 Maximum flow rates at confluence using above data:
461 25.352 23.546
462 Area of streams before confluence:
463 11.060 9.811
464 Results of confluence:
465 Total flow rate = 25.352(CFS)
466 Time of concentration = 21.069 min.
467 Effective stream area after confluence = 20.871(Ac.)
468 End of computations, total study area = 20.871 (Ac.)
469
470
471

ATTACHMENT 7
HYDROGRAPH

7a. Hydrograph Report

Watershed Model Schematic

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



Legend

<u>Hyd.</u>	<u>Origin</u>	<u>Description</u>
1	Manual	21054node15hydrograph
2	Reservoir	BMP-A

Hydrograph Return Period Recap

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

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	Manual	----	----	----	----	----	----	----	----	15.12	21054node15hydrograph
2	Reservoir	1	----	----	----	----	----	----	----	11.83	BMP-A

Hydrograph Summary Report

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

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Manual	15.12	16	256	43,603	-----	-----	-----	21054node15hydrograph
2	Reservoir	11.83	16	256	43,559	1	699.57	5,547	BMP-A
BMP-A DETENTION.gpw					Return Period: 100 Year			Monday, 11 / 8 / 2021	

Hydrograph Report

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

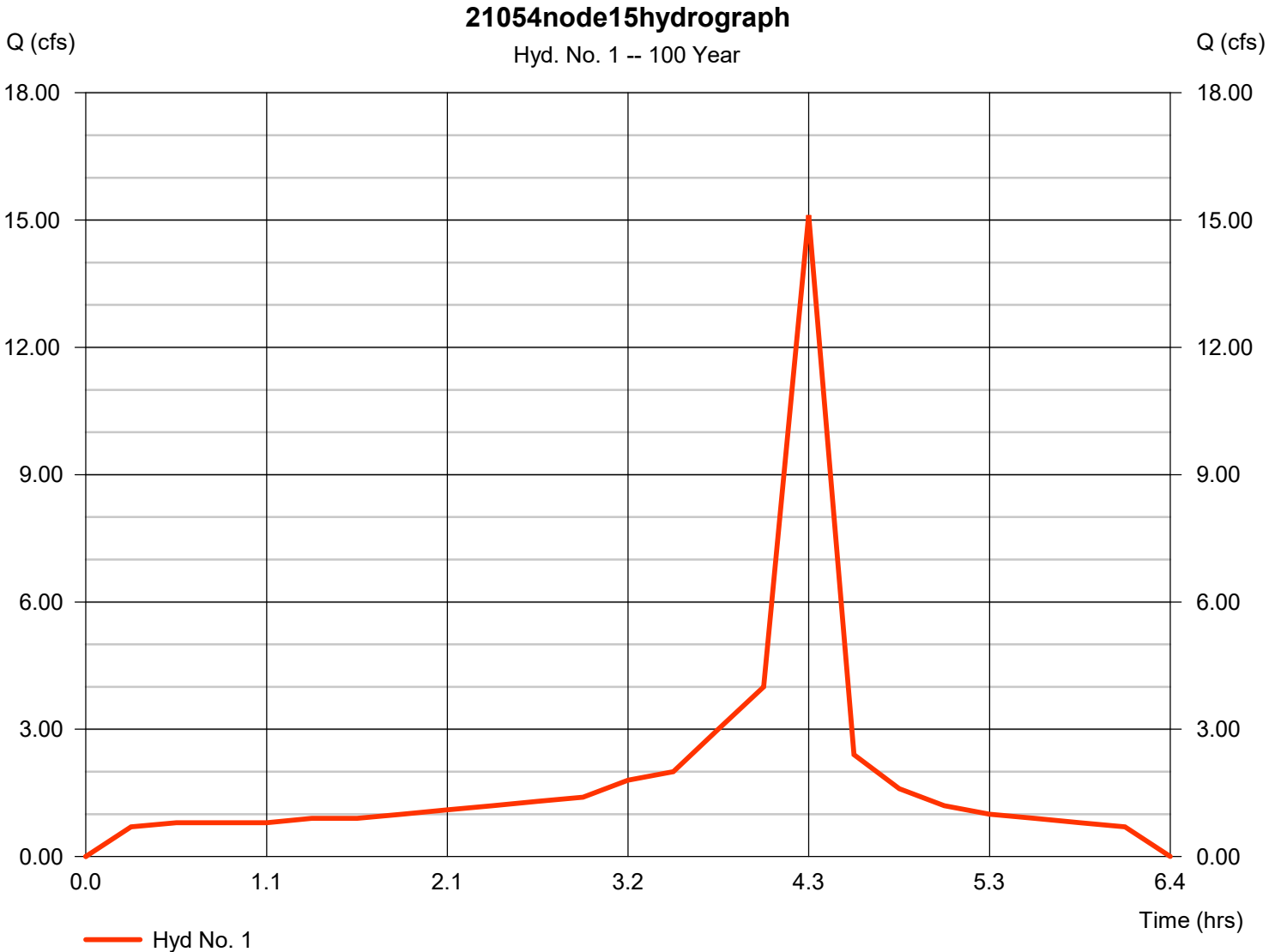
Monday, 11 / 8 / 2021

Hyd. No. 1

21054node15hydrograph

Hydrograph type = Manual
Storm frequency = 100 yrs
Time interval = 16 min

Peak discharge = 15.12 cfs
Time to peak = 4.27 hrs
Hyd. volume = 43,603 cuft



Hydrograph Report

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

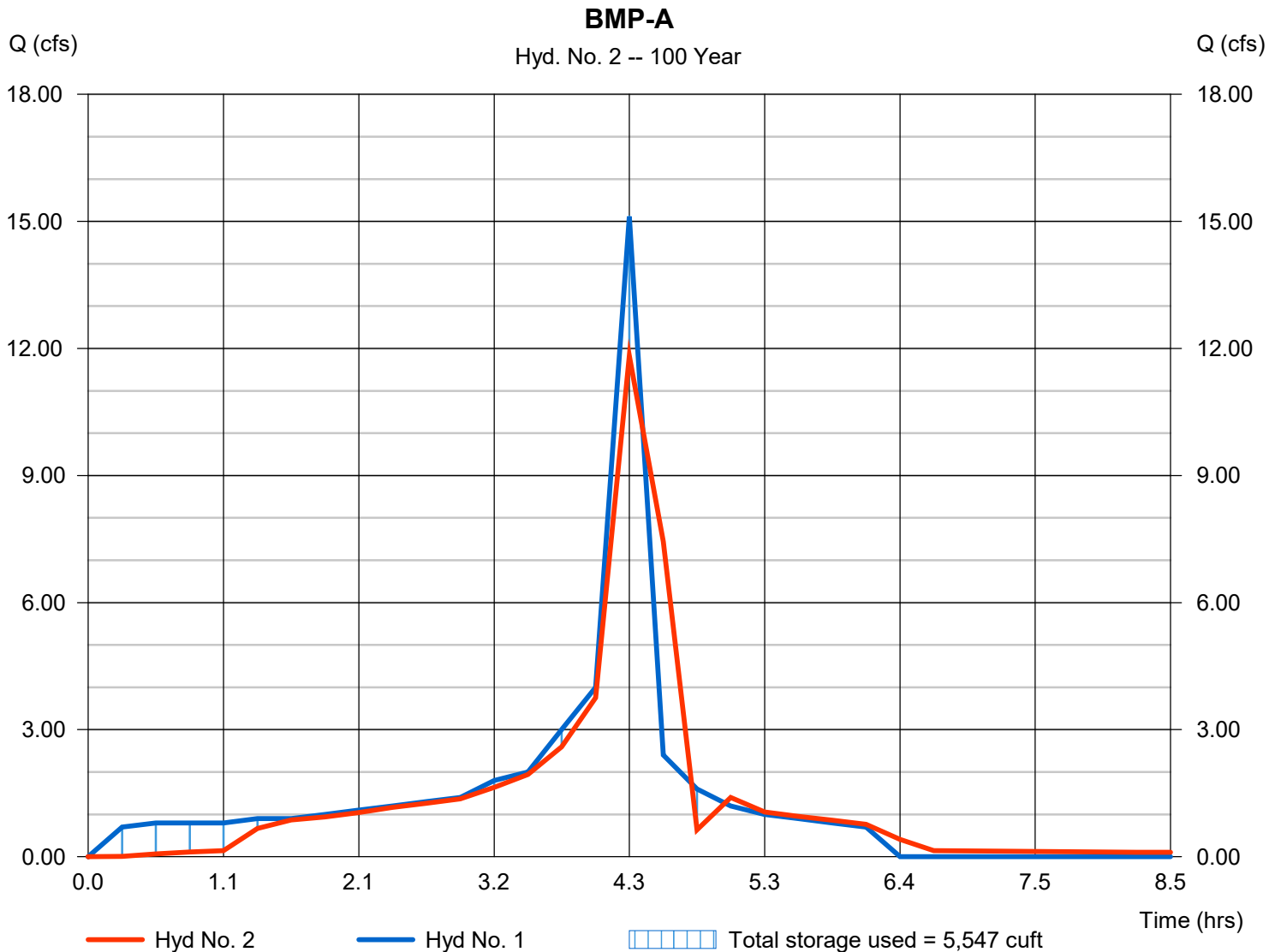
Monday, 11 / 8 / 2021

Hyd. No. 2

BMP-A

Hydrograph type	= Reservoir	Peak discharge	= 11.83 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.27 hrs
Time interval	= 16 min	Hyd. volume	= 43,559 cuft
Inflow hyd. No.	= 1 - 21054node15hydrograph	Max. Elevation	= 699.57 ft
Reservoir name	= BMP-A	Max. Storage	= 5,547 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - BMP-A

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 698.50 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	698.50	4,677	0	0
0.50	699.00	5,109	2,445	2,445
1.50	700.00	5,714	5,408	7,853
2.50	701.00	6,350	6,028	13,882

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	3.00	Inactive	0.00
Span (in)	= 18.00	3.00	4.00	6.00
No. Barrels	= 1	1	3	0
Invert El. (ft)	= 694.11	698.50	698.70	0.00
Length (ft)	= 18.00	0.00	0.00	0.00
Slope (%)	= 0.50	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	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 8.00	0.00	0.00	0.00
Crest El. (ft)	= 699.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	698.50	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.05	245	698.55	16.23 ic	0.01 ic	0.00	---	0.00	---	---	---	---	---	0.006
0.10	489	698.60	16.23 ic	0.02 ic	0.00	---	0.00	---	---	---	---	---	0.020
0.15	734	698.65	16.23 ic	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.041
0.20	978	698.70	16.23 ic	0.06 ic	0.00	---	0.00	---	---	---	---	---	0.064
0.25	1,223	698.75	16.23 ic	0.08 ic	0.00	---	0.00	---	---	---	---	---	0.084
0.30	1,467	698.80	16.23 ic	0.10 ic	0.00	---	0.00	---	---	---	---	---	0.099
0.35	1,712	698.85	16.23 ic	0.11 ic	0.00	---	0.00	---	---	---	---	---	0.112
0.40	1,956	698.90	16.23 ic	0.12 ic	0.00	---	0.00	---	---	---	---	---	0.124
0.45	2,201	698.95	16.23 ic	0.13 ic	0.00	---	0.00	---	---	---	---	---	0.135
0.50	2,445	699.00	16.23 ic	0.14 ic	0.00	---	0.00	---	---	---	---	---	0.145
0.60	2,986	699.10	16.23 ic	0.16 ic	0.00	---	0.84	---	---	---	---	---	1.005
0.70	3,527	699.20	16.23 ic	0.18 ic	0.00	---	2.38	---	---	---	---	---	2.561
0.80	4,068	699.30	16.23 ic	0.19 ic	0.00	---	4.38	---	---	---	---	---	4.570
0.90	4,608	699.40	16.23 ic	0.21 ic	0.00	---	6.74	---	---	---	---	---	6.945
1.00	5,149	699.50	16.23 ic	0.22 ic	0.00	---	9.42	---	---	---	---	---	9.636
1.10	5,690	699.60	16.23 ic	0.23 ic	0.00	---	12.38	---	---	---	---	---	12.61
1.20	6,231	699.70	16.23 ic	0.25 ic	0.00	---	15.60	---	---	---	---	---	15.84
1.30	6,772	699.80	17.83 ic	0.17 ic	0.00	---	17.66 s	---	---	---	---	---	17.83
1.40	7,312	699.90	18.36 ic	0.15 ic	0.00	---	18.22 s	---	---	---	---	---	18.36
1.50	7,853	700.00	18.75 ic	0.13 ic	0.00	---	18.62 s	---	---	---	---	---	18.75
1.60	8,456	700.10	19.06 ic	0.11 ic	0.00	---	18.95 s	---	---	---	---	---	19.06
1.70	9,059	700.20	19.33 ic	0.10 ic	0.00	---	19.23 s	---	---	---	---	---	19.33
1.80	9,662	700.30	19.58 ic	0.09 ic	0.00	---	19.49 s	---	---	---	---	---	19.58
1.90	10,265	700.40	19.81 ic	0.08 ic	0.00	---	19.72 s	---	---	---	---	---	19.80
2.00	10,867	700.50	20.03 ic	0.07 ic	0.00	---	19.95 s	---	---	---	---	---	20.03
2.10	11,470	700.60	20.23 ic	0.07 ic	0.00	---	20.16 s	---	---	---	---	---	20.23
2.20	12,073	700.70	20.43 ic	0.06 ic	0.00	---	20.36 s	---	---	---	---	---	20.43
2.30	12,676	700.80	20.63 ic	0.06 ic	0.00	---	20.56 s	---	---	---	---	---	20.62
2.40	13,279	700.90	20.81 ic	0.06 ic	0.00	---	20.75 s	---	---	---	---	---	20.81
2.50	13,882	701.00	21.00 ic	0.05 ic	0.00	---	20.93 s	---	---	---	---	---	20.98

RUN DATE 11/5/2021
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 16 MIN.
6 HOUR RAINFALL 3.4 INCHES
BASIN AREA 9.8108 ACRES
RUNOFF COEFFICIENT 0.36
PEAK DISCHARGE 15.121 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 16	DISCHARGE (CFS) = 0.7
TIME (MIN) = 32	DISCHARGE (CFS) = 0.8
TIME (MIN) = 48	DISCHARGE (CFS) = 0.8
TIME (MIN) = 64	DISCHARGE (CFS) = 0.8
TIME (MIN) = 80	DISCHARGE (CFS) = 0.9
TIME (MIN) = 96	DISCHARGE (CFS) = 0.9
TIME (MIN) = 112	DISCHARGE (CFS) = 1
TIME (MIN) = 128	DISCHARGE (CFS) = 1.1
TIME (MIN) = 144	DISCHARGE (CFS) = 1.2
TIME (MIN) = 160	DISCHARGE (CFS) = 1.3
TIME (MIN) = 176	DISCHARGE (CFS) = 1.4
TIME (MIN) = 192	DISCHARGE (CFS) = 1.8
TIME (MIN) = 208	DISCHARGE (CFS) = 2
TIME (MIN) = 224	DISCHARGE (CFS) = 3
TIME (MIN) = 240	DISCHARGE (CFS) = 4
TIME (MIN) = 256	DISCHARGE (CFS) = 15.121
TIME (MIN) = 272	DISCHARGE (CFS) = 2.4
TIME (MIN) = 288	DISCHARGE (CFS) = 1.6
TIME (MIN) = 304	DISCHARGE (CFS) = 1.2
TIME (MIN) = 320	DISCHARGE (CFS) = 1
TIME (MIN) = 336	DISCHARGE (CFS) = 0.9
TIME (MIN) = 352	DISCHARGE (CFS) = 0.8
TIME (MIN) = 368	DISCHARGE (CFS) = 0.7
TIME (MIN) = 384	DISCHARGE (CFS) = 0

7b. Runoff Coefficient C After Detention Structure

CALCULATION AFTER THE DETENTION STRUCTURE

The purpose of the detention structure is to alter the peak flow and or time to peak of a given storm so it will not have a negative impact on the downstream facilities. There are different methods on how to use the resulting values of the outflow hydrograph.

For the purposes of this example there will be an association of the following values:

Q_{in} = Is equal to the inflow value that will enter the basin before storage

Q_{out} = Is equal to the outflow value that will exit the basin after storage

Tc_{in} = Is equal to the Time of Concentration flowing into the basin before detention

Tc_{out} = Is equal to the Time of Concentration exiting the basin after detention

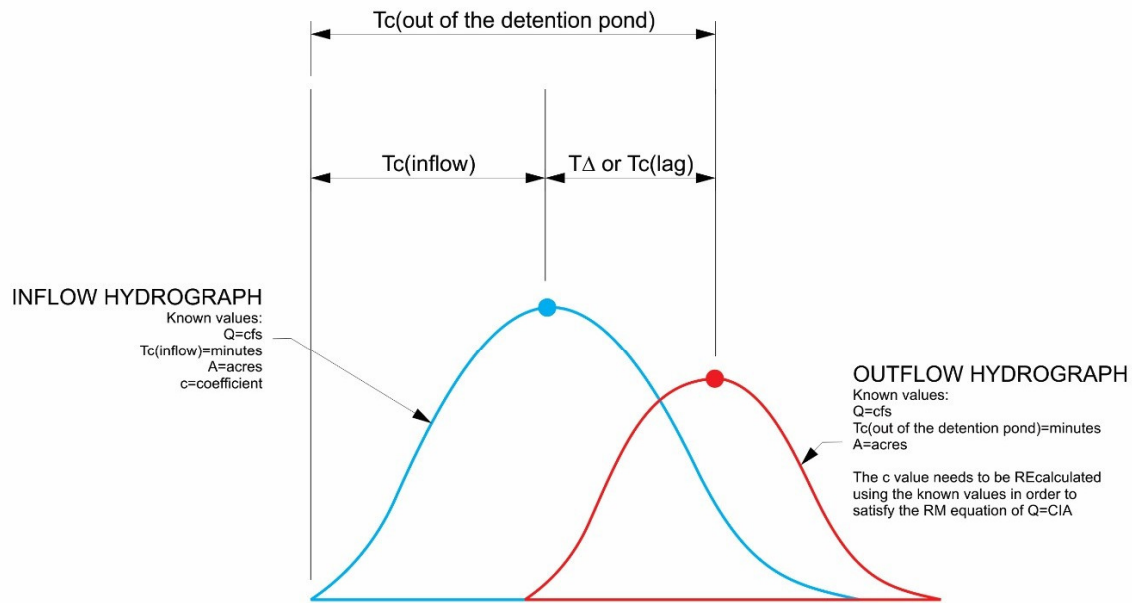
A = Area of the tributary area being examined; (This value does not change)

c_{inflow} = The runoff coefficient going into the basin for detention

c_{out} = The runoff coefficient recalculated taking into account water stored in pond for detention

One method is to keep the value of c_{inflow} and solve for the I =intensity & Tc_{out} (outflow). In this interpretation, we will get a Tc that will not match the value of the Tc_{out} (out of the detention structure) of the outflow hydrograph that was calculated using the detention pond. The Tc Using this method shows a disruption on the oneness & continuity of the outflow hydrograph & the formula $Q=cIA$.

The second method; that is the method we are using is to recalculate the c =coefficient based on the fix values of the outflow hydrograph to achieve a c_{out} . This value uses the c_{inflow} from the flow into the detention basin and then is recalculated by the output of the hydrograph software using $Q=cIA$; translated as $c=Q/IA$. This method preserves the formula $Q=cIA$ & does not alter the Tc_{out} (out of the detention structure). This method shows that in order to maintain mathematical integrity of the rational equation ($Q=CIA$), the detention structure alters the runoff coefficient which is the only unknown in the equation. It is noted that the designer feels it is important to hold the value of Tc and the Q values that are calculated from the hydrograph.



GRAPHICAL DIAGRAM OF THE HYDROGRAPH COMING OUT OF THE DETENTION POND

The routing of the runoff through the detention structure gives us the $Q_{(\text{out of the detention structure})}$ and $T\Delta$ time lag between $Q_{(\text{inflow})}$ & $Q_{(\text{out of the detention structure})}$.

The known fix values coming out of the detention structure are:

- $Q = \text{cfs}$
- $T_{c(\text{out of the detention structure})} = \text{minutes}$
- $A = \text{acres}$
- *Please note that c =coefficient is not given directly from the resulting hydrograph coming out of the detention pond.*

In order to satisfy the rational equation of $Q=CIA$ (see Section 3 of the 2003 San Diego County Hydrology Manual) coming out of the detention structure, we will calculate the only unknown value of the equation which is the outlet runoff coefficient, $C_{(\text{outlet})}$. By using the $T_{c(\text{out of the detention structure})}$ we can solve for the intensity, I . With the intensity (I) value calculated, we can solve for the outlet runoff coefficient, $C_{(\text{outlet})}$.

The following equations are used in

this stage: $Q = CIA$

$$I = 7.44P_6D^{-0.645}$$

Where:

$Q_{(\text{out of the detention structure})} = \text{runoff (cfs), known value}$

$T_{c(\text{inflow})} = \text{detention structure inflow time of concentration (D)}$
(minutes)

$T\Delta = \text{time lag between } Q_{(\text{inflow})} \text{ \& } Q_{(\text{out of the detention structure})}$

(minutes) $T_{C(\text{out of the detention structure})} = T_{C(\text{inflow})} + T\Delta$ (minutes)

$P_6 = 6$ hour precipitation (inches), known value.

$I =$ intensity (inches/hour), calculated based on the value of $T_{C(\text{out of the detention structure})}$

$A =$ tributary area of the detention structure (acres),

known value $C_{(\text{outflow})} =$ runoff coefficient (unitless),

value to be solved

STORAGE PIPE			
LINE	ITEM	STORAGE PIPE	REMARKS
1	P6 inch	3.4	KNOWN VALUE
2	TC (inflow) mins	15.88	KNOWN VALUE
3	TC (lag) mins	0	FROM THE OUTFLOW HYDROGRAPH
4	TC (ouflow) mins	15.88	LINE 2+3
5	I inches/hour	4.251	FROM THE INTENSITY FORMULA
6	Q(outflow)	11.83	KNOWN VALUE
7	A (inflow=outflow)	9.811	KNOWN VALUE
8	c(inflow)	0.36	KNOWN VALUE FROM THE CONTRIBUTING BASIN(S)
9	c(outflow)	0.284	CALCULATED FROM $C=Q/IA$

The preceding highlighted data are then used to continue the calculations downstream of the detention structure.

In summary these are the steps of the calculations presented here:

1. Hydrologic methods of calculation as laid out in the 2003 San Diego Hydrology Manual was used upstream of the detention structure. These includes the methods of determining c , T_c and confluence of a junction. The c values used in the proposed conditions range from “undisturbed natural terrain” to “low & high density residential” whichever is appropriate for the contributing basin.
2. At the outflow of the detention structure, the c value was recalculated using the resulting values of the outflow hydrograph. This method preserves the values of $T_{C(\text{out of the detention structure})}$, A & $Q_{(\text{outflow})}$. Methods and software satisfy the formula $Q=cIA$ & the 2003 San Diego Hydrology Manual. This step shows that in order to maintain mathematical integrity of the rational equation ($Q=CIA$), the detention structure alters the runoff coefficient which is the only unknown in the equation.
3. The values determined in step 2 were used in the continuation of the calculations using the Hydrologic methods of calculation as laid out in the 2003 San Diego Hydrology Manual downstream of the detention structure. These includes the methods of determining c , T_c and confluence of a junction. The c values used in the proposed conditions range from “undisturbed natural terrain” to “low & high density residential” whichever is appropriate for the contributing basin.