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.

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Project Number: 21-054

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

3/09/22
Date

ATTACHMENTS

Attachment 1 – Site Map

Attachment 2 – Figures & Tables from the San Diego County Hydrology Manual 2003

Attachment 3 – Watershed Information
- **Watershed Map**
- **Soils Index Map**
- **Soil Report**
- **Rainfall Isopluvial Maps**

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ATTACHMENT 1
SITE MAP

MANNING HOMES SITE MAP

SCALE: 1:50

0 50 100 150 200

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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"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	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.

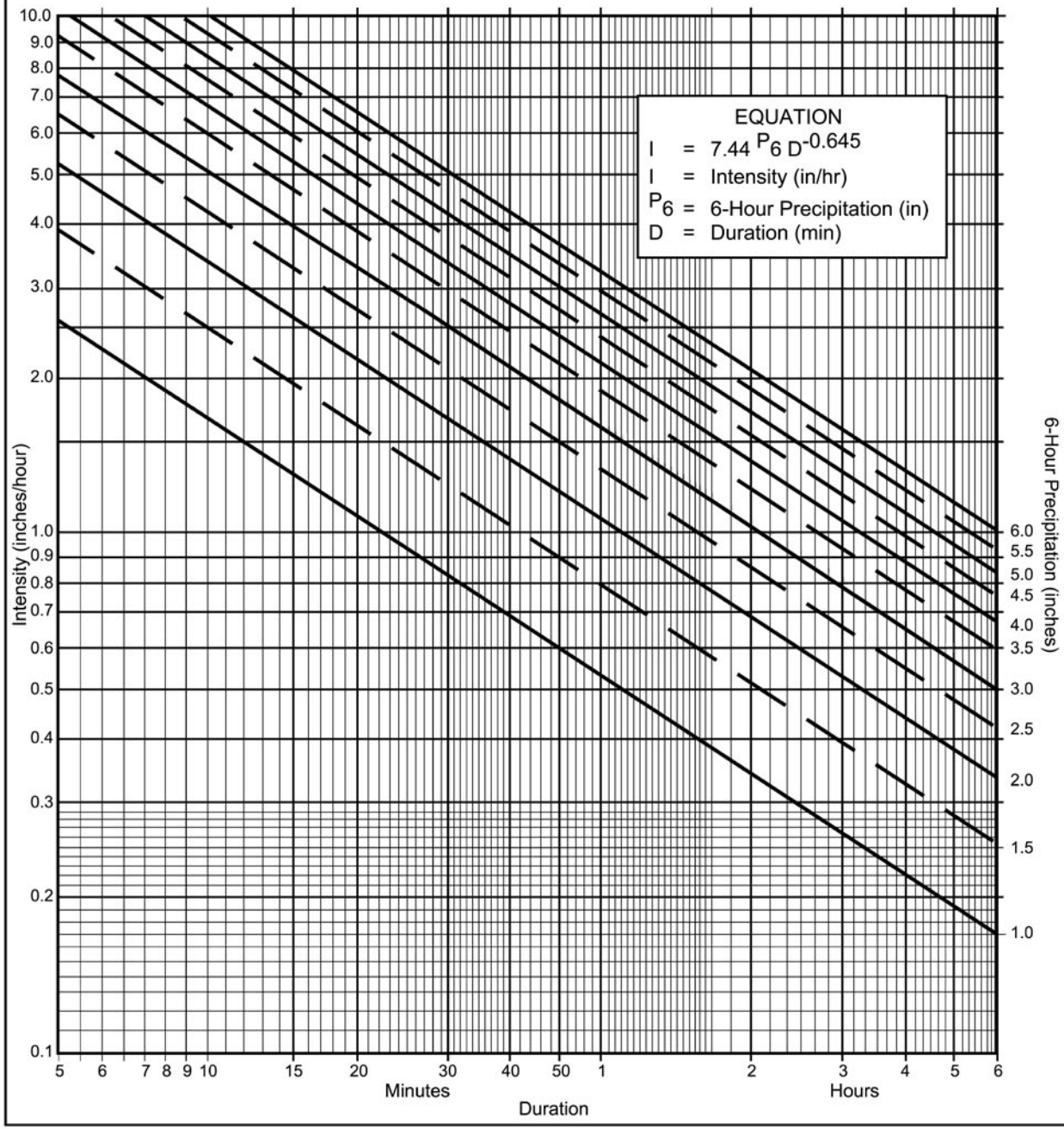
Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved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

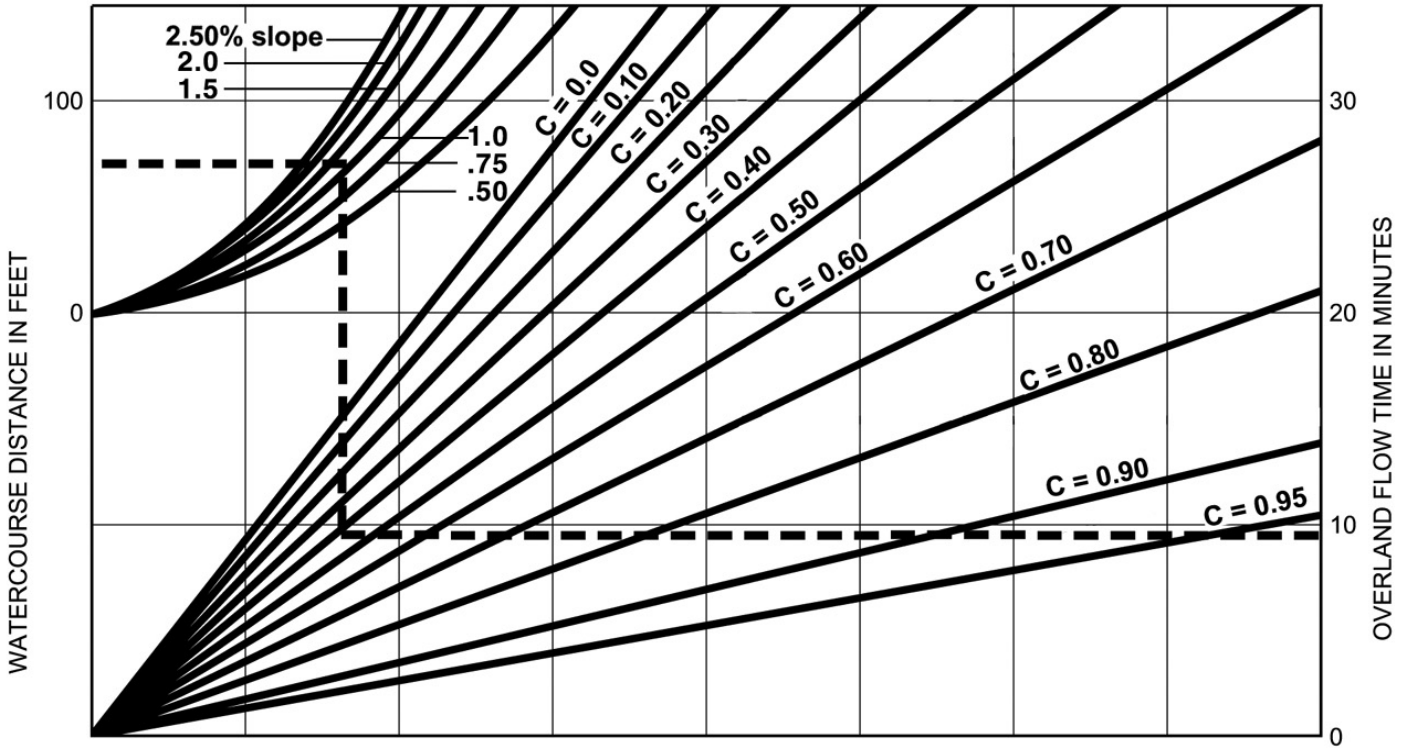
(e) I = _____ in./hr.

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
Duration	I	I	I	I	I	I	I	I	I	I	I
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

FIGURE 3-1



EXAMPLE:

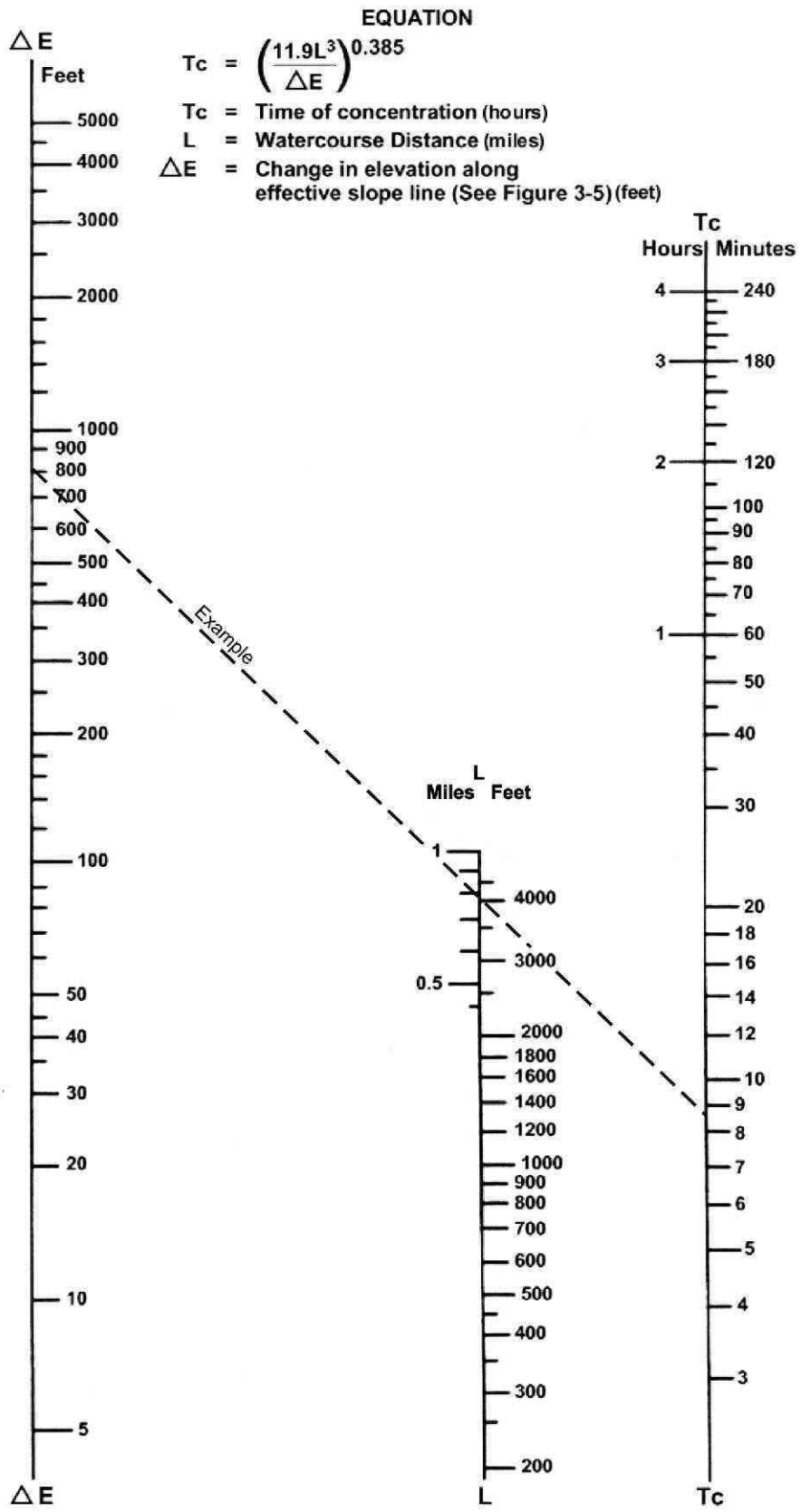
Given: Watercourse Distance (D) = 70 Feet
Slope (s) = 1.3%
Runoff Coefficient (C) = 0.41
Overland Flow Time (T) = 9.5 Minutes

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

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

FIGURE 3-3

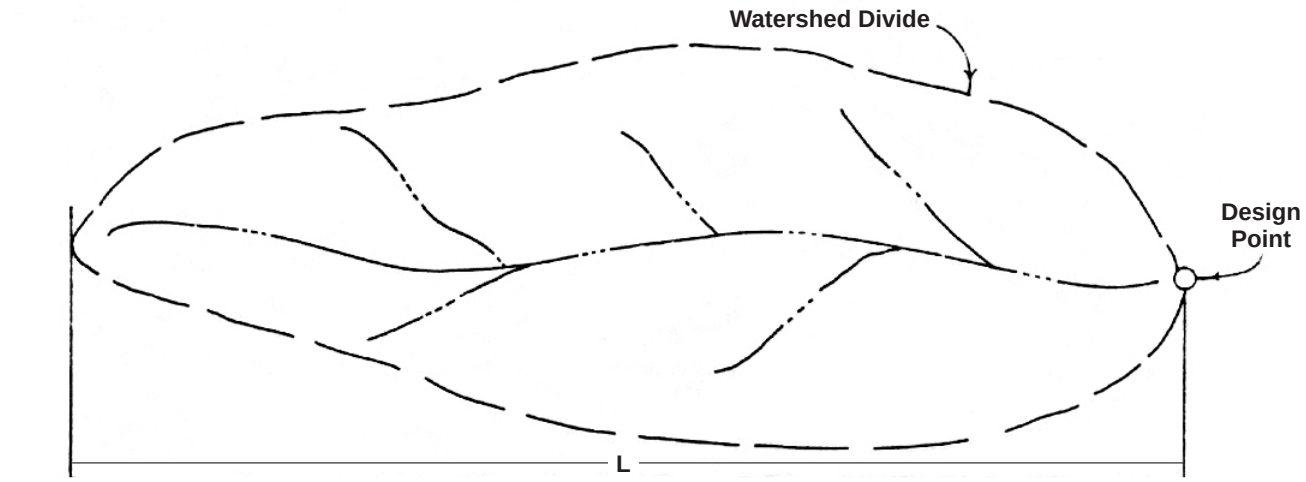
Rational Formula - Overland Time of Flow Nomograph

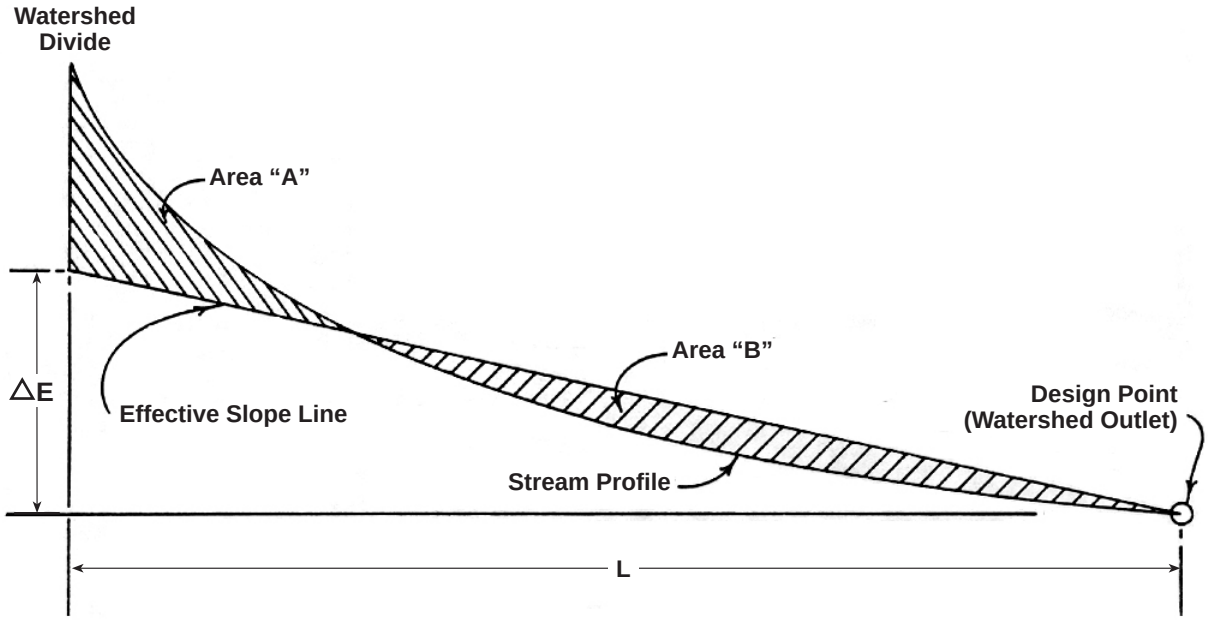


SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE 3-4

Nomograph for Determination of
Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds



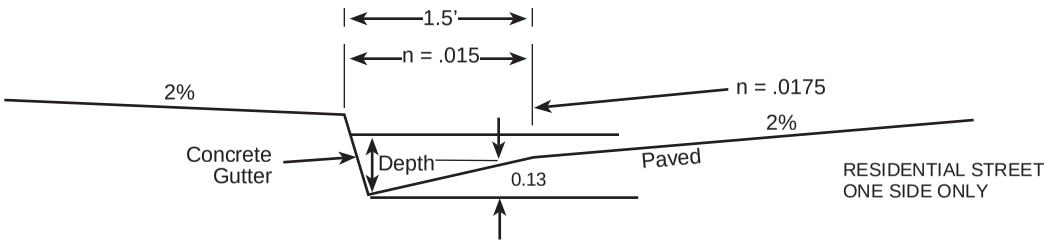


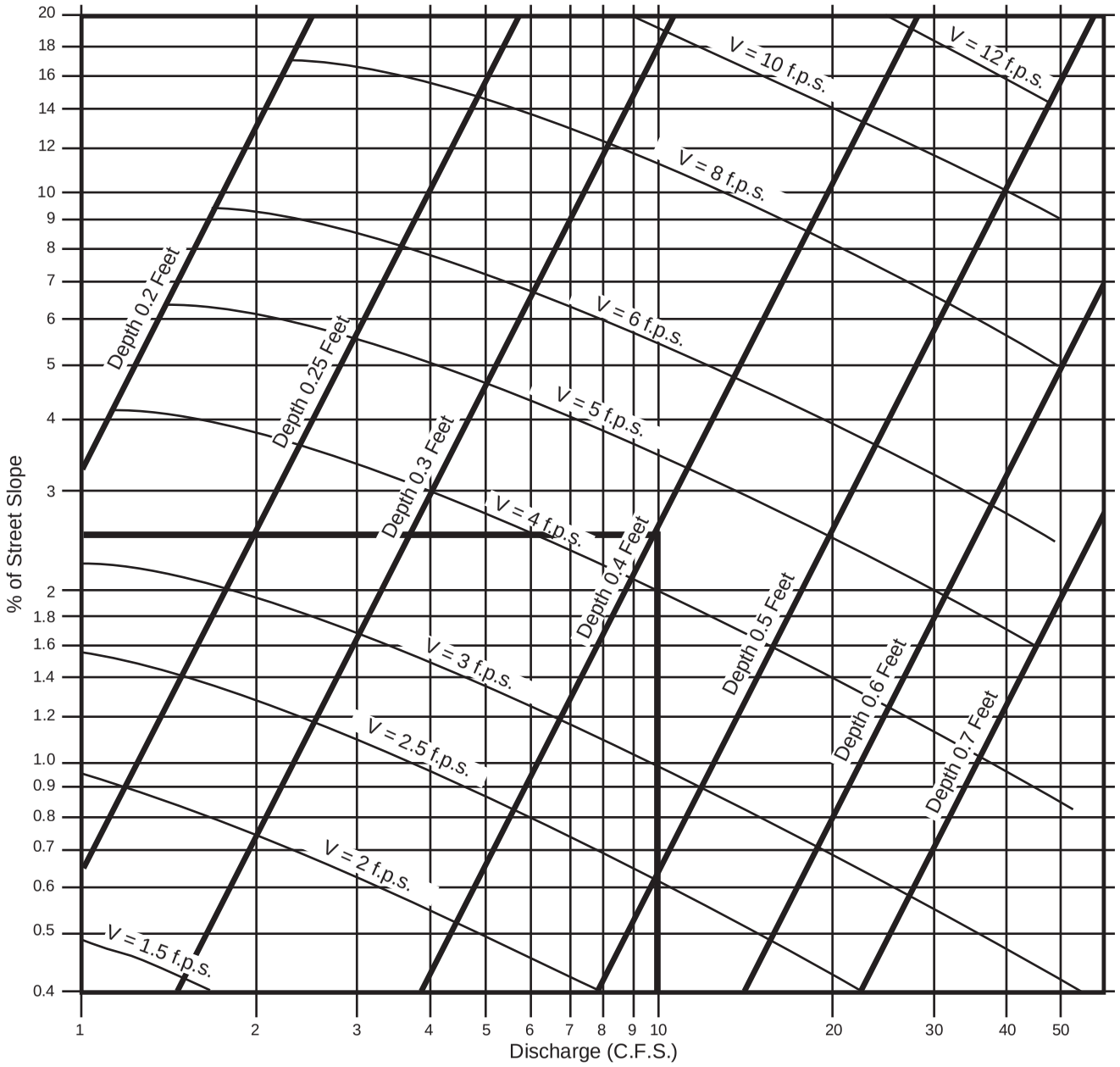
Area "A" = Area "B"

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

FIGURE 3-5

Computation of Effective Slope for Natural Watersheds





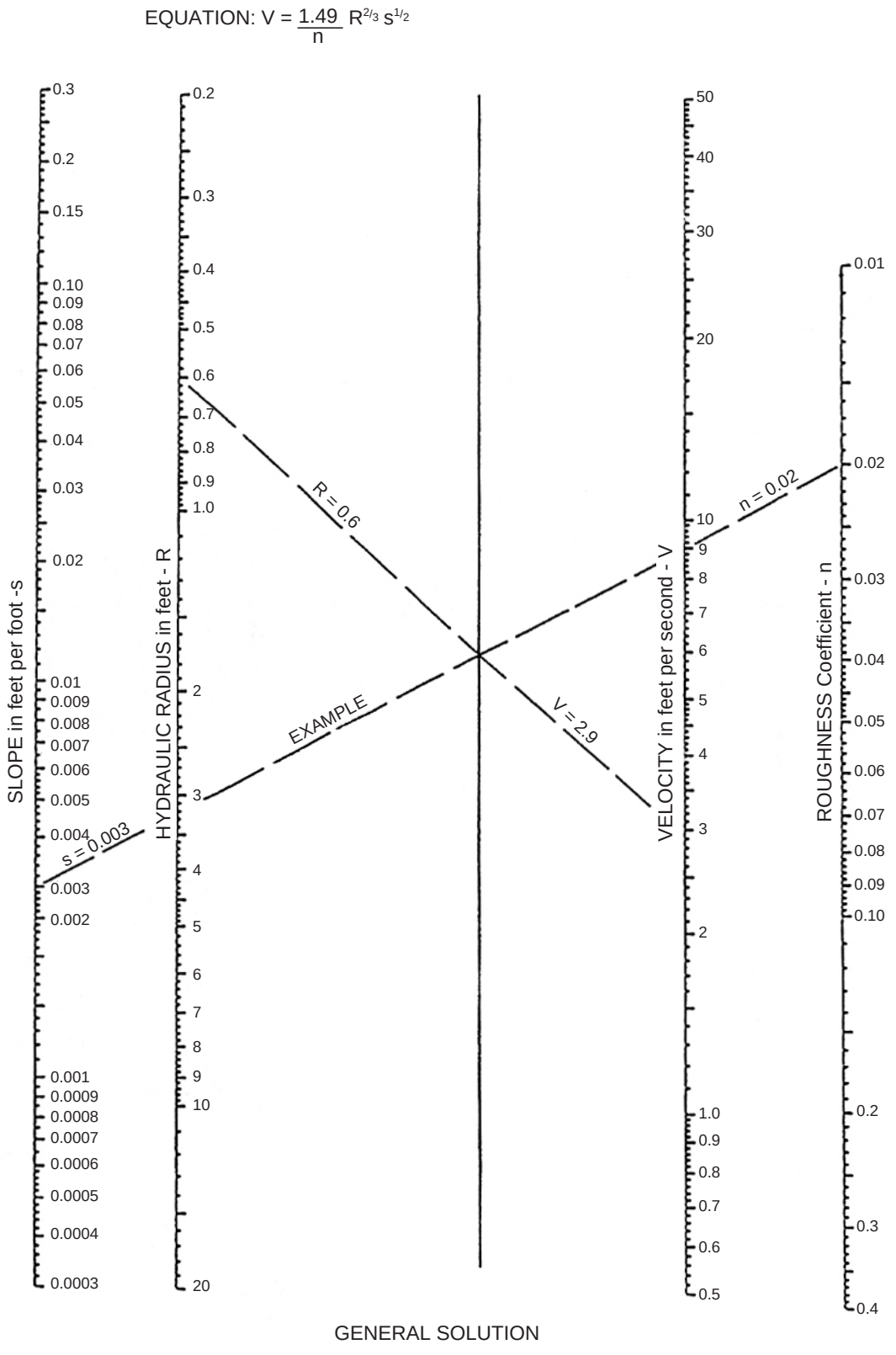
EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

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

F I G U R E

Gutter and Roadway Discharge - Velocity Chart

3-6



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

FIGURE 3-7

Manning's Equation Nomograph

Table A-1 Average Manning Roughness Coefficients for Pavement and Gutters[1]

Concrete Gutter[2]	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 Conduits[3]

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>=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.

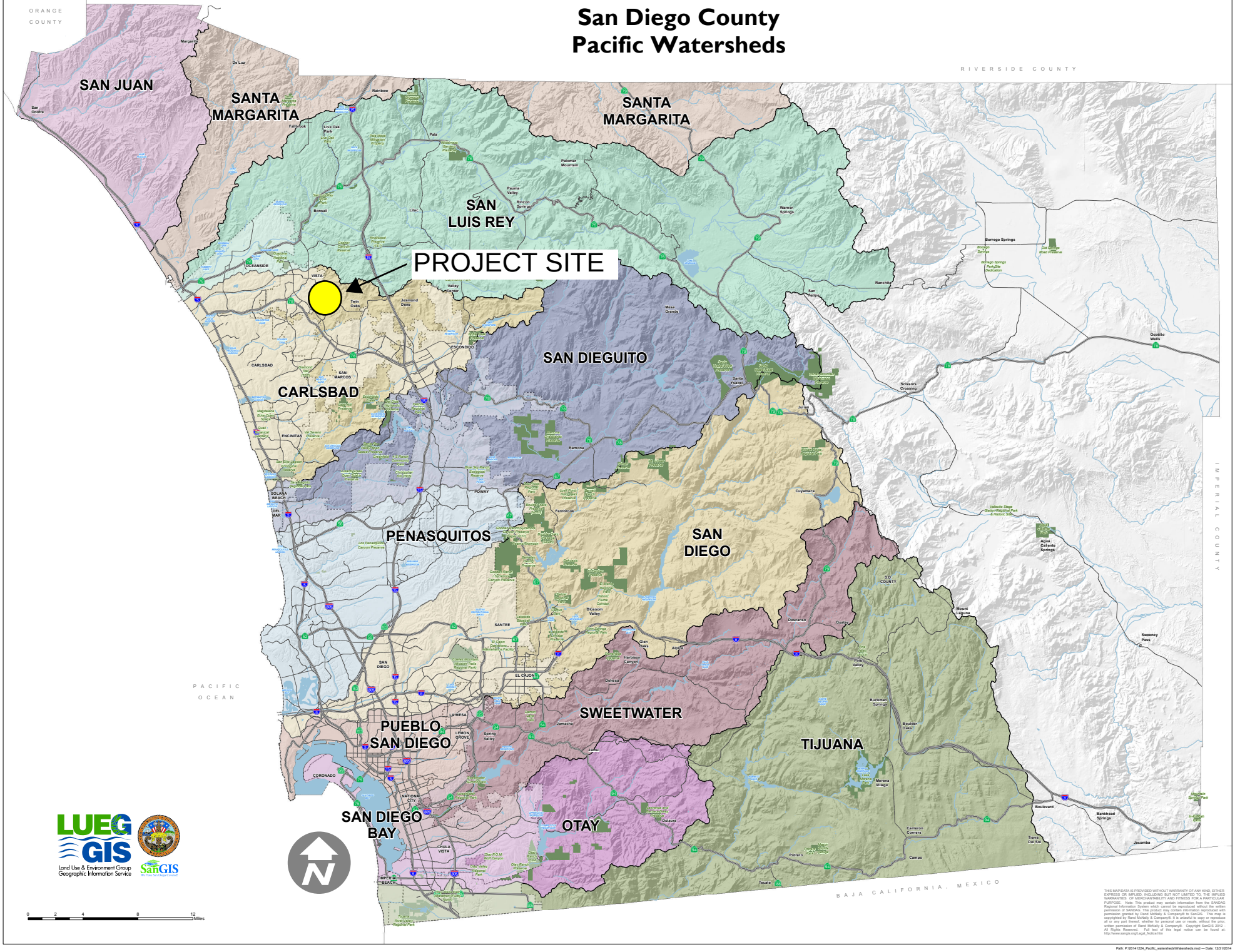
Table A-5 Average Manning Roughness Coefficients for Natural Channels

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



Path: P:\20141224_Pacific_watersheds\Watersheds.mxd — Date: 12/31/2014

SOIL INDEX MAP

County of San Diego Hydrology Manual

Soil Hydrologic Groups

Orange County

Riverside County

Imperial County

Mexico

Pacific Ocean

PROJECT SITE

OCEANSIDE
VISTA
CARLSBAD
ESCONDIDO
ENCINITAS
SOLANA BEACH
DEL MAR
POWAY
S.D. COUNTY
SANTEE
SAN DIEGO
EL CAJON
LA MESA
LEMON GROVE
CORONADO
CHULA VISTA
IMPERIAL BEACH

117°30' 117°15' 117°00' 116°45' 116°30' 116°15'
33°30' 33°15' 33°00' 32°45' 32°30'

Legend

Soil Groups

- Group A
- Group B
- Group C
- Group D
- Undetermined
- Data Unavailable

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Geographic Information Services

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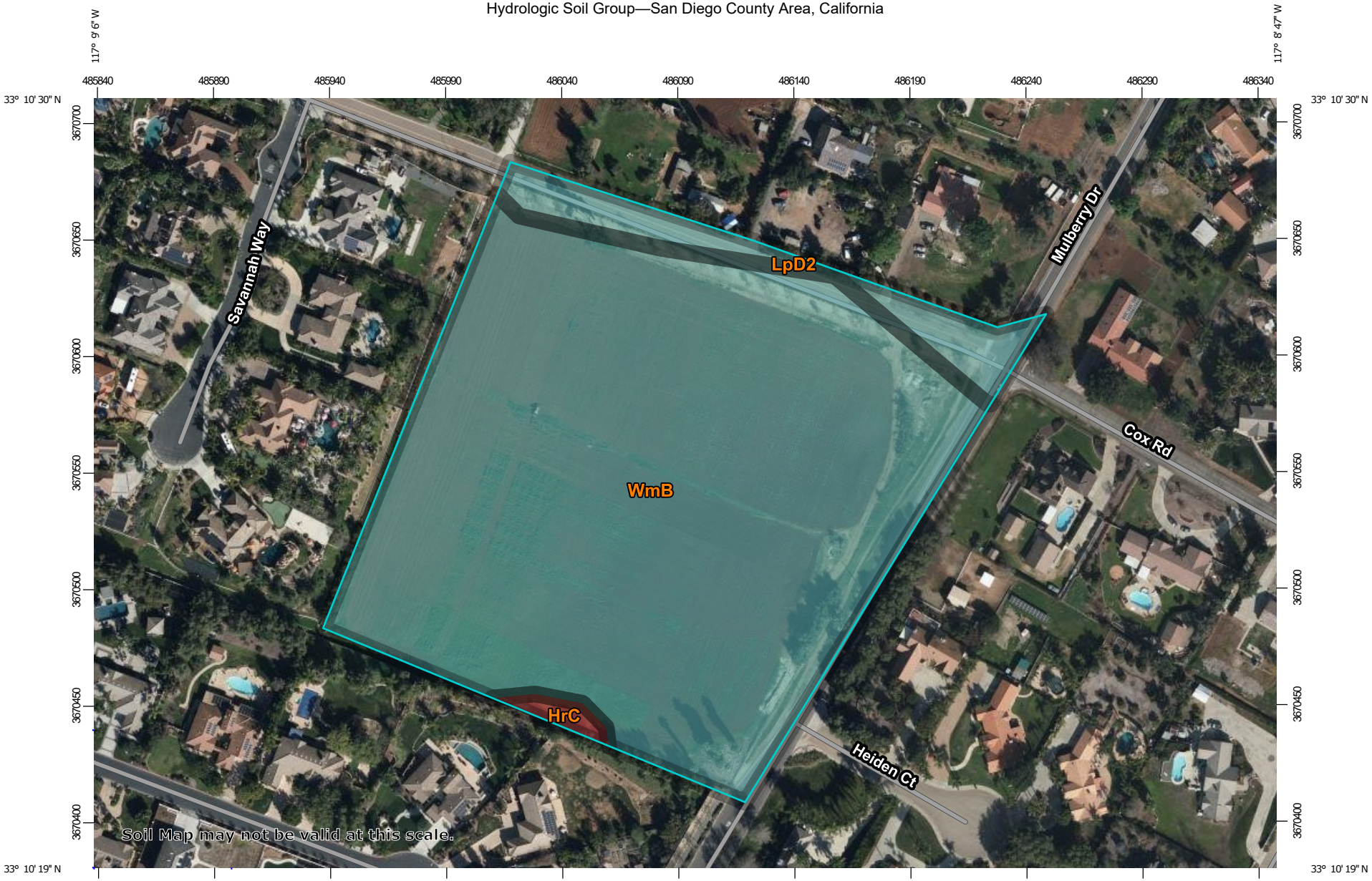
N
W E
S

3 0 3 Miles

SOIL REPORT



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

N

Meters
0 30 60 120 180

Feet
0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: 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

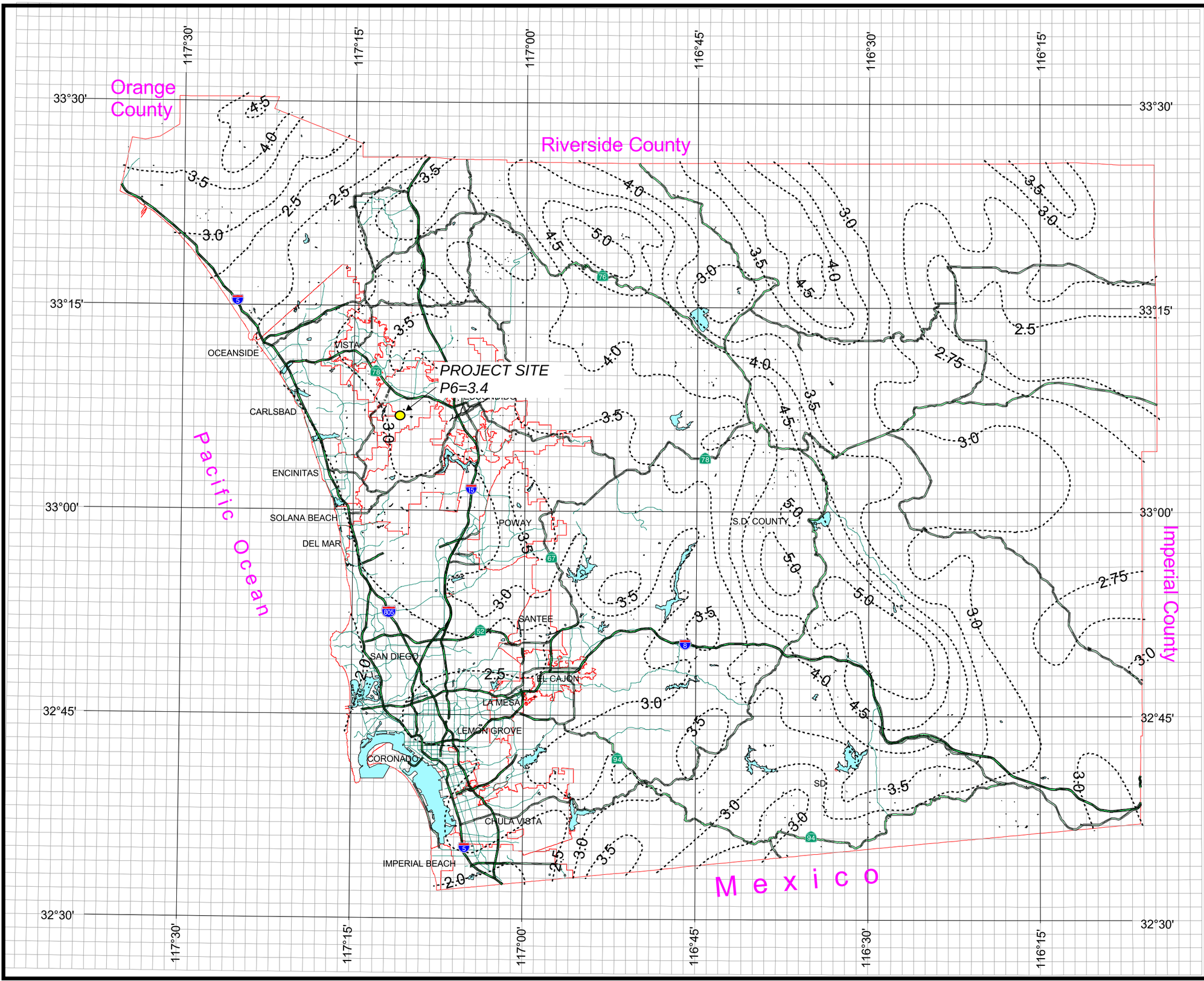
RAINFALL ISOPLUVIAL MAPS

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)



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3 0 3 Miles

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

Orange County

Riverside County

Imperial County

Pacific Ocean

Mexico

PROJECT SITE
P24=6.8

OCEANSIDE
VISTA
CARLSBAD
ENCINITAS
SOLANA BEACH
DEL MAR
POWAY
S.D. COUNTY
SANTEE
SAN DIEGO
EL CAJON
LA MESA
LEMON GROVE
CORONADO
CHULA VISTA
IMPERIAL BEACH
SD

117°30' 117°15' 117°00' 116°45' 116°30' 116°15'
33°30' 33°15' 33°00' 32°45' 32°30'

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Department of Public Works
Geographic Information Services

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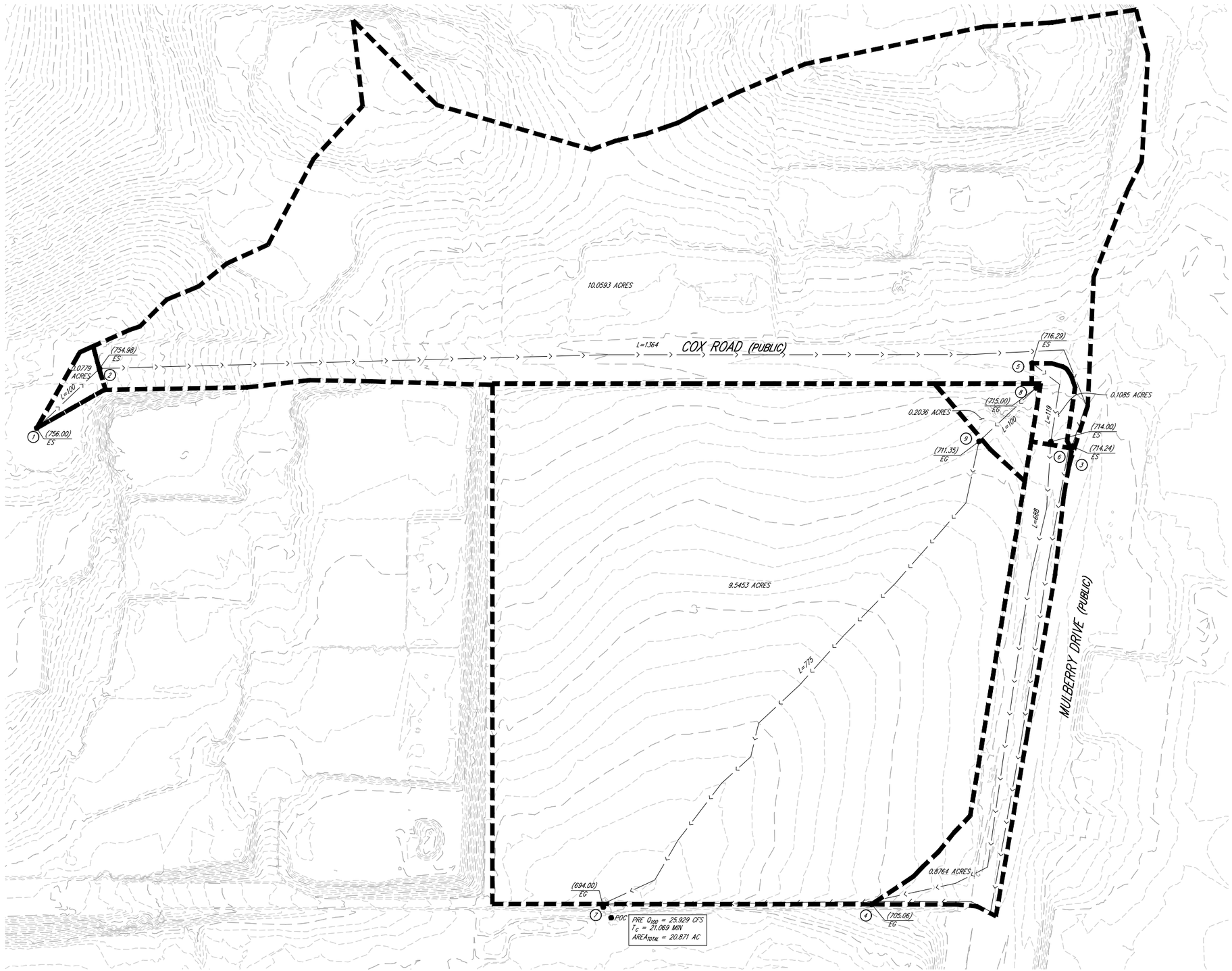
N W E S

3 0 3 Miles

ATTACHMENT 4
PRE-DEVELOPMENT CONDITION EXHIBIT



LEGEND

- (7) 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

SCALE : 1:60

0 60 120 180 240

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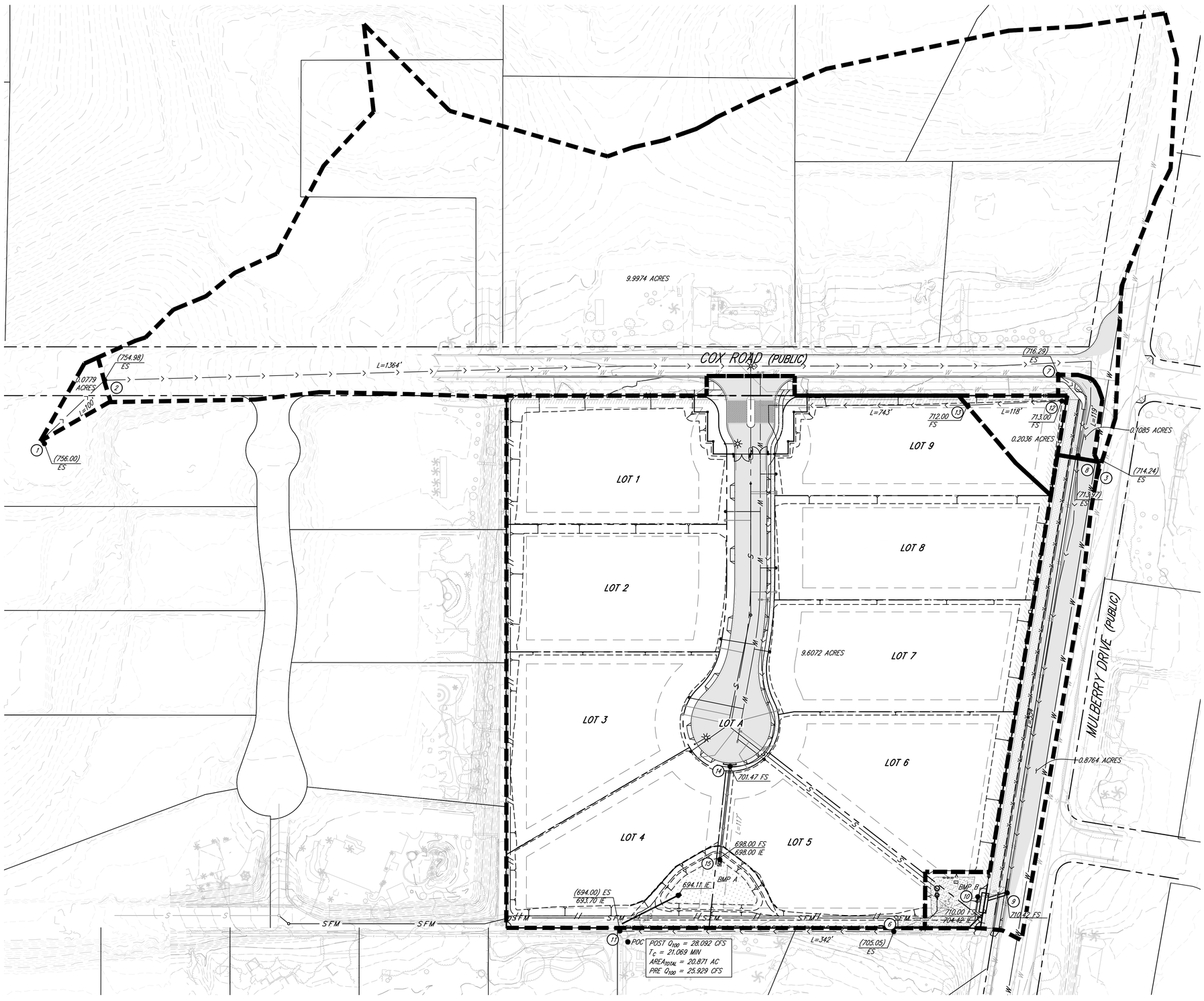
ATTACHMENT 5
POST-DEVELOPMENT CONDITION EXHIBIT

5a. Hydrology Map of Post-Development Condition Exhibit



LEGEND

- 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

SCALE: 1:60

0 60 120 180 240

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

9.9974 ACRES

COX ROAD (PUBLIC)

(754.98) ES

2.0779 ACRES

L=1364'

(716.29) ES

L=100'

(756.00) ES

0.1085 ACRES

(714.24) ES

(713.42) ES

LOT 1

LOT 9

LOT 8

LOT 2

ONSITE IS MITIGATED (SEE POST DEVELOPMENT MAP FOR SUB BASIN)

LOT 7

LOT 3

LOT A

LOT 6

MULBERRY DRIVE (PUBLIC)

0.8764 ACRES

LOT 4

LOT 5

(694.00) ES
693.70 IE

694.11 IE

BMP A

BMP B

710.00 IE

704.42 IE

710.42 FS

SFM

SFM

SFM

POC

POST Q_{100} = 25.352 CFS
T_C = 21.069 MIN
$AREA_{TOTAL}$ = 20.871 AC
PRE Q_{100} = 25.929 CFS

L=342'

(705.05) ES

LEGEND

- 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

SCALE: 1:60

0 60 120 180 240

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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 $\mathbf{Q_{100}}$. 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 ***********
```

```
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              0.50
    2              0.00              0.00
    3              1.50              0.13
    4             20.25              0.38
Manning's 'N' friction factor =   0.013
------------------------------------------------------------------
Sub-Channel flow  =      7.509(CFS)
  '     '    flow top width =     15.554(Ft.)
  '     '    velocity=    4.439(Ft/s)
  '     '    area =      1.692(Sq.Ft)
  '     '    Froude number =     2.372

Upstream point elevation =   754.950(Ft.)
Downstream point elevation =   714.240(Ft.)
Flow length =  1364.000(Ft.)
Travel time  =    5.12 min.
Time of concentration =   16.98 min.
Depth of flow =   0.312(Ft.)
Average velocity =   4.439(Ft/s)
Total irregular channel flow =     7.508(CFS)
Irregular channel normal depth above invert elev. =   0.312(Ft.)
Average velocity of channel(s) =   4.439(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      4.072(In/Hr) for a   100.0 year storm
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
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      4.072(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      3.645
Subarea runoff =     14.721(CFS) for     10.059(Ac.)
Total runoff =     14.842(CFS)  Total area =      10.137(Ac.)
Depth of flow =   0.376(Ft.), Average velocity =   5.249(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        3.000 to Point/Station        4.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =     15.081(CFS)
Depth of flow =   0.420(Ft.), Average velocity =   4.053(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              0.50
    2              0.00              0.00
    3              1.50              0.13
    4             20.25              0.38
Manning's 'N' friction factor =   0.013
------------------------------------------------------------------
Sub-Channel flow  =     15.082(CFS)
  '     '    flow top width =     20.250(Ft.)
  '     '    velocity=    4.053(Ft/s)
  '     '    area =      3.721(Sq.Ft)
  '     '    Froude number =     1.666

Upstream point elevation =   714.240(Ft.)
Downstream point elevation =   705.060(Ft.)
Flow length =   742.000(Ft.)
Travel time  =    3.05 min.
```

```
Time of concentration =   20.03 min.
Depth of flow =   0.420(Ft.)
Average velocity =   4.053(Ft/s)
Total irregular channel flow =    15.081(CFS)
Irregular channel normal depth above invert elev. =   0.420(Ft.)
Average velocity of channel(s) =   4.053(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      3.660(In/Hr) for a   100.0 year storm
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
[MEDIUM DENSITY RESIDENTIAL                  ]
(14.5 DU/A or Less      )
Impervious value, Ai = 0.500
Sub-Area C Value = 0.600
Rainfall intensity =      3.660(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.379  CA =      4.170
Subarea runoff =      0.423(CFS) for      0.876(Ac.)
Total runoff =     15.264(CFS)  Total area =      11.013(Ac.)
Depth of flow =   0.421(Ft.), Average velocity =   4.072(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        4.000 to Point/Station        4.000
**** CONFLUENCE OF MINOR STREAMS ****
------------------------------------------------------------------------------
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     11.013(Ac.)
Runoff from this stream =     15.264(CFS)
Time of concentration =   20.03 min.
Rainfall intensity =     3.660(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        5.000 to Point/Station        6.000
**** 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  =  119.000(Ft.)
Highest elevation =  716.290(Ft.)
Lowest elevation =  714.000(Ft.)
Elevation difference =    2.290(Ft.) Slope =  1.924 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 85.00 (Ft)
for the top area slope value of   1.92 %, in a development type of
 Permanent Open Space
In Accordance With Figure 3-3
Initial Area Time of Concentration =  10.67 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3000)*(  85.000^.5)/(   1.924^(1/3)]=  10.67
Rainfall intensity (I) =      5.493(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.300
Subarea runoff =      0.180(CFS)
Total initial stream area =       0.109(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        6.000 to Point/Station        4.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
------------------------------------------------------------------------------
```

```
Depth of flow =   0.124(Ft.), Average velocity =   1.935(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              0.50
    2              0.00              0.00
    3              1.50              0.13
    4             18.50              0.39
Manning's 'N' friction factor =   0.013
------------------------------------------------------------------
Sub-Channel flow  =      0.180(CFS)
  '     '    flow top width =      1.493(Ft.)
  '     '    velocity=    1.935(Ft/s)
  '     '    area =      0.093(Sq.Ft)
  '     '    Froude number =     1.367

Upstream point elevation =   714.000(Ft.)
Downstream point elevation =   705.060(Ft.)
Flow length =   688.000(Ft.)
Travel time  =    5.93 min.
Time of concentration =   16.60 min.
Depth of flow =   0.124(Ft.)
Average velocity =   1.935(Ft/s)
Total irregular channel flow =     0.180(CFS)
Irregular channel normal depth above invert elev. =   0.124(Ft.)
Average velocity of channel(s) =   1.935(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        4.000 to Point/Station        4.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.109(Ac.)
Runoff from this stream =      0.180(CFS)
Time of concentration =   16.60 min.
Rainfall intensity =     4.131(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       15.264     20.03             3.660
2        0.180     16.60             4.131
Qmax(1) =
       1.000 *    1.000 *    15.264) +
       0.886 *    1.000 *     0.180) + =      15.424
Qmax(2) =
       1.000 *    0.829 *    15.264) +
       1.000 *    1.000 *     0.180) + =      12.833

Total of 2 streams to confluence:
Flow rates before confluence point:
      15.264       0.180
Maximum flow rates at confluence using above data:
       15.424       12.833
Area of streams before confluence:
       11.013        0.109
Results of confluence:
Total flow rate =     15.424(CFS)
Time of concentration =    20.026 min.
Effective stream area after confluence =     11.122(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        4.000 to Point/Station        7.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
```

```
_____________________________________________________________________
Depth of flow =   1.111(Ft.), Average velocity =  10.004(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              2.00
    2              2.50              0.00
    3              5.00              2.00
Manning's 'N' friction factor =   0.015
------------------------------------------------------------------
Sub-Channel flow  =     15.424(CFS)
  '     '    flow top width =      2.777(Ft.)
  '     '    velocity=   10.004(Ft/s)
  '     '    area =      1.542(Sq.Ft)
  '     '    Froude number =     2.366

Upstream point elevation =   705.060(Ft.)
Downstream point elevation =   694.000(Ft.)
Flow length =   356.000(Ft.)
Travel time  =    0.59 min.
Time of concentration =   20.62 min.
Depth of flow =   1.111(Ft.)
Average velocity =  10.004(Ft/s)
Total irregular channel flow =    15.424(CFS)
Irregular channel normal depth above invert elev. =   1.111(Ft.)
Average velocity of channel(s) =  10.004(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        7.000 to Point/Station        7.000
**** CONFLUENCE OF MINOR STREAMS ****
_____________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     11.122(Ac.)
Runoff from this stream =     15.424(CFS)
Time of concentration =   20.62 min.
Rainfall intensity =     3.592(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        8.000 to Point/Station        9.000
**** 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 =  715.000(Ft.)
Lowest elevation =  711.350(Ft.)
Elevation difference =    3.650(Ft.) Slope =  3.650 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   3.65 %, in a development type of
 Permanent Open Space
In Accordance With Figure 3-3
Initial Area Time of Concentration =   9.35 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3000)*( 100.000^.5)/(   3.650^(1/3)]=   9.35
Rainfall intensity (I) =      5.981(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.300
Subarea runoff =      0.366(CFS)
Total initial stream area =        0.204(Ac.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        9.000 to Point/Station        7.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      6.195(CFS)
Depth of flow =   0.224(Ft.), Average velocity =   1.720(Ft/s)
    ******* Irregular Channel Data ***********
----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              1.00
    2             77.00              0.00
    3            144.00              1.00
Manning's 'N' friction factor =   0.030
----------------------------------------------------------------
Sub-Channel flow  =      6.195(CFS)
  '     '    flow top width =     32.206(Ft.)
  '     '    velocity=    1.720(Ft/s)
  '     '    area =      3.602(Sq.Ft)
  '     '    Froude number =     0.906

Upstream point elevation =   711.350(Ft.)
Downstream point elevation =   694.000(Ft.)
Flow length =   775.000(Ft.)
Travel time  =    7.51 min.
Time of concentration =   16.86 min.
Depth of flow =   0.224(Ft.)
Average velocity =   1.720(Ft/s)
Total irregular channel flow =     6.195(CFS)
Irregular channel normal depth above invert elev. =   0.224(Ft.)
Average velocity of channel(s) =   1.720(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      4.090(In/Hr) for a   100.0 year storm
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
Rainfall intensity =      4.090(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.300  CA =      2.925
Subarea runoff =     11.595(CFS) for      9.545(Ac.)
Total runoff =     11.961(CFS)  Total area =       9.749(Ac.)
Depth of flow =   0.286(Ft.), Average velocity =   2.028(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        7.000 to Point/Station        7.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      9.749(Ac.)
Runoff from this stream =     11.961(CFS)
Time of concentration =   16.86 min.
Rainfall intensity =     4.090(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       15.424     20.62             3.592
2       11.961     16.86             4.090
Qmax(1) =
       1.000 *    1.000 *    15.424) +
```

```
            0.878 *    1.000 *    11.961) + =      25.929
      Qmax(2) =
            1.000 *    0.818 *    15.424) +
            1.000 *    1.000 *    11.961) + =      24.574

      Total of 2 streams to confluence:
      Flow rates before confluence point:
           15.424      11.961
      Maximum flow rates at confluence using above data:
            25.929       24.574
      Area of streams before confluence:
            11.122        9.749
      Results of confluence:
      Total flow rate =     25.929(CFS)
      Time of concentration =    20.620 min.
      Effective stream area after confluence =     20.871(Ac.)
      End of computations, total study area =          20.871 (Ac.)
```

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 ***********
```

```
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              0.50
    2              0.00              0.00
    3              1.50              0.13
    4             20.25              0.38
Manning's 'N' friction factor =   0.013
------------------------------------------------------------------
Sub-Channel flow  =      7.427(CFS)
  '     '    flow top width =     15.479(Ft.)
  '     '    velocity=    4.431(Ft/s)
  '     '    area =      1.676(Sq.Ft)
  '     '    Froude number =     2.373

Upstream point elevation =   754.980(Ft.)
Downstream point elevation =   714.170(Ft.)
Flow length =  1364.000(Ft.)
Travel time  =    5.13 min.
Time of concentration =   17.10 min.
Depth of flow =   0.311(Ft.)
Average velocity =   4.431(Ft/s)
Total irregular channel flow =     7.427(CFS)
Irregular channel normal depth above invert elev. =   0.311(Ft.)
Average velocity of channel(s) =   4.431(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      4.053(In/Hr) for a   100.0 year storm
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
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      4.053(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      3.622
Subarea runoff =     14.562(CFS) for      9.997(Ac.)
Total runoff =     14.682(CFS)  Total area =      10.075(Ac.)
Depth of flow =   0.375(Ft.), Average velocity =   5.233(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        3.000 to Point/Station        4.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =     14.903(CFS)
Depth of flow =   0.471(Ft.), Average velocity =   3.165(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              0.50
    2              0.00              0.00
    3              1.50              0.13
    4             20.25              0.38
Manning's 'N' friction factor =   0.013
------------------------------------------------------------------
Sub-Channel flow  =     14.903(CFS)
  '     '    flow top width =     20.250(Ft.)
  '     '    velocity=    3.165(Ft/s)
  '     '    area =      4.709(Sq.Ft)
  '     '    Froude number =     1.157

Upstream point elevation =   714.170(Ft.)
Downstream point elevation =   710.840(Ft.)
Flow length =   602.000(Ft.)
Travel time  =    3.17 min.
```

```
Time of concentration =   20.27 min.
Depth of flow =   0.471(Ft.)
Average velocity =   3.165(Ft/s)
Total irregular channel flow =    14.903(CFS)
Irregular channel normal depth above invert elev. =   0.471(Ft.)
Average velocity of channel(s) =   3.165(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      3.632(In/Hr) for a   100.0 year storm
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
[MEDIUM DENSITY RESIDENTIAL                  ]
(14.5 DU/A or Less      )
Impervious value, Ai = 0.500
Sub-Area C Value = 0.600
Rainfall intensity =      3.632(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.379  CA =      4.148
Subarea runoff =      0.384(CFS) for      0.876(Ac.)
Total runoff =     15.065(CFS)  Total area =      10.951(Ac.)
Depth of flow =   0.472(Ft.), Average velocity =   3.179(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        4.000 to Point/Station        5.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
________________________________________________________________________
Upstream point/station elevation =   710.260(Ft.)
Downstream point/station elevation =   707.650(Ft.)
Pipe length  =    43.00(Ft.) Slope =   0.0607  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    15.065(CFS)
Given pipe size =     18.00(In.)
Calculated individual pipe flow  =    15.065(CFS)
Normal flow depth in pipe =    9.87(In.)
Flow top width inside pipe =   17.92(In.)
Critical Depth =   16.88(In.)
Pipe flow velocity =     15.20(Ft/s)
Travel time through pipe =    0.05 min.
Time of concentration (TC) =    20.32 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        5.000 to Point/Station        6.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
________________________________________________________________________
Depth of flow =   1.149(Ft.), Average velocity =   9.134(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              2.00
    2              2.50              0.00
    3              5.00              2.00
Manning's 'N' friction factor =   0.015
------------------------------------------------------------------
Sub-Channel flow  =     15.065(CFS)
  '     '    flow top width =      2.872(Ft.)
  '     '    velocity=    9.134(Ft/s)
  '     '    area =      1.649(Sq.Ft)
  '     '    Froude number =     2.124

Upstream point elevation =   707.650(Ft.)
Downstream point elevation =   705.050(Ft.)
Flow length =   105.000(Ft.)
Travel time  =    0.19 min.
Time of concentration =   20.51 min.
Depth of flow =   1.149(Ft.)
Average velocity =   9.134(Ft/s)
```

```
Total irregular channel flow =    15.065(CFS)
Irregular channel normal depth above invert elev. =   1.149(Ft.)
Average velocity of channel(s) =   9.134(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        6.000 to Point/Station        6.000
**** CONFLUENCE OF MINOR STREAMS ****
------------------------------------------------------------------------
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     10.951(Ac.)
Runoff from this stream =     15.065(CFS)
Time of concentration =   20.51 min.
Rainfall intensity =     3.605(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        7.000 to Point/Station        8.000
**** 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
[MEDIUM DENSITY RESIDENTIAL                 ]
(14.5 DU/A or Less      )
Impervious value, Ai = 0.500
Sub-Area C Value = 0.600
Initial subarea total flow distance  =  119.000(Ft.)
Highest elevation =  716.290(Ft.)
Lowest elevation =  713.970(Ft.)
Elevation difference =    2.320(Ft.) Slope =  1.950 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 80.00 (Ft)
for the top area slope value of   1.95 %, in a development type of
 14.5 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.44 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.6000)*(  80.000^.5)/(   1.950^(1/3)]=   6.44
Rainfall intensity (I) =      7.606(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.600
Subarea runoff =      0.497(CFS)
Total initial stream area =        0.109(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        8.000 to Point/Station        9.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
------------------------------------------------------------------------
Depth of flow =   0.203(Ft.), Average velocity =   1.224(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              0.50
    2              0.00              0.00
    3              1.50              0.13
    4             18.50              0.39
Manning's 'N' friction factor =   0.015
------------------------------------------------------------------
Sub-Channel flow  =      0.497(CFS)
  '     '    flow top width =      6.499(Ft.)
  '     '    velocity=    1.224(Ft/s)
  '     '    area =      0.407(Sq.Ft)
  '     '    Froude number =     0.862

Upstream point elevation =   713.970(Ft.)
Downstream point elevation =   710.420(Ft.)
```

```
Flow length =   554.000(Ft.)
Travel time  =    7.55 min.
Time of concentration =   13.99 min.
Depth of flow =   0.203(Ft.)
Average velocity =   1.224(Ft/s)
Total irregular channel flow =     0.497(CFS)
Irregular channel normal depth above invert elev. =   0.203(Ft.)
Average velocity of channel(s) =   1.224(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        9.000 to Point/Station       10.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
________________________________________________________________________
Upstream point/station elevation =   710.420(Ft.)
Downstream point/station elevation =   704.420(Ft.)
Pipe length  =    37.00(Ft.) Slope =   0.1622  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     0.497(CFS)
Given pipe size =     36.00(In.)
Calculated individual pipe flow  =     0.497(CFS)
Normal flow depth in pipe =    1.15(In.)
Flow top width inside pipe =   12.68(In.)
Critical depth could not be calculated.
Pipe flow velocity =      7.30(Ft/s)
Travel time through pipe =    0.08 min.
Time of concentration (TC) =    14.07 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       10.000 to Point/Station        6.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
________________________________________________________________________
Upstream point/station elevation =   710.000(Ft.)
Downstream point/station elevation =   705.050(Ft.)
Pipe length  =    73.00(Ft.) Slope =   0.0678  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     0.497(CFS)
Given pipe size =     12.00(In.)
Calculated individual pipe flow  =     0.497(CFS)
Normal flow depth in pipe =    1.89(In.)
Flow top width inside pipe =    8.74(In.)
Critical Depth =    3.51(In.)
Pipe flow velocity =      6.29(Ft/s)
Travel time through pipe =    0.19 min.
Time of concentration (TC) =    14.27 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        6.000 to Point/Station        6.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.109(Ac.)
Runoff from this stream =      0.497(CFS)
Time of concentration =   14.27 min.
Rainfall intensity =     4.555(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (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
```

```
Total of 2 streams to confluence:
Flow rates before confluence point:
      15.065       0.497
Maximum flow rates at confluence using above data:
       15.459       10.979
Area of streams before confluence:
       10.951        0.109
Results of confluence:
Total flow rate =     15.459(CFS)
Time of concentration =    20.508 min.
Effective stream area after confluence =     11.060(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        6.000 to Point/Station       11.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
________________________________________________________________________
Depth of flow =   1.103(Ft.), Average velocity =  10.158(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              2.00
    2              2.50              0.00
    3              5.00              2.00
Manning's 'N' friction factor =   0.015
------------------------------------------------------------------
Sub-Channel flow  =     15.459(CFS)
  '      '    flow top width =      2.759(Ft.)
  '      '    velocity=   10.158(Ft/s)
  '      '    area =      1.522(Sq.Ft)
  '      '    Froude number =     2.410

Upstream point elevation =   705.050(Ft.)
Downstream point elevation =   694.000(Ft.)
Flow length =   342.000(Ft.)
Travel time  =    0.56 min.
Time of concentration =   21.07 min.
Depth of flow =   1.103(Ft.)
Average velocity =  10.158(Ft/s)
Total irregular channel flow =    15.459(CFS)
Irregular channel normal depth above invert elev. =   1.103(Ft.)
Average velocity of channel(s) =  10.158(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       11.000 to Point/Station       11.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     11.060(Ac.)
Runoff from this stream =     15.459(CFS)
Time of concentration =   21.07 min.
Rainfall intensity =     3.542(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       12.000 to Point/Station       13.000
**** 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
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
```

```
Initial subarea total flow distance  =  118.000(Ft.)
Highest elevation =  713.000(Ft.)
Lowest elevation =  712.000(Ft.)
Elevation difference =    1.000(Ft.) Slope =  0.847 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 70.00 (Ft)
for the top area slope value of   0.85 %, in a development type of
 1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =  11.78 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(  70.000^.5)/(   0.847^(1/3)]=  11.78
Rainfall intensity (I) =      5.155(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff =      0.379(CFS)
Total initial stream area =        0.204(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       13.000 to Point/Station       14.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
________________________________________________________________________
Estimated mean flow rate at midpoint of channel =      7.779(CFS)
Depth of flow =   0.375(Ft.), Average velocity =   3.151(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              0.50
    2              0.00              0.00
    3              1.50              0.13
    4             18.50              0.39
Manning's 'N' friction factor =   0.015
------------------------------------------------------------------
Sub-Channel flow  =      7.779(CFS)
  '     '    flow top width =     17.486(Ft.)
  '     '    velocity=    3.152(Ft/s)
  '     '    area =      2.468(Sq.Ft)
  '     '    Froude number =     1.478

Upstream point elevation =   712.000(Ft.)
Downstream point elevation =   701.470(Ft.)
Flow length =   743.000(Ft.)
Travel time  =    3.93 min.
Time of concentration =   15.71 min.
Depth of flow =   0.375(Ft.)
Average velocity =   3.151(Ft/s)
Total irregular channel flow =     7.779(CFS)
Irregular channel normal depth above invert elev. =   0.375(Ft.)
Average velocity of channel(s) =   3.151(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      4.281(In/Hr) for a   100.0 year storm
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
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      4.281(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      3.532
Subarea runoff =     14.742(CFS) for      9.607(Ac.)
Total runoff =     15.121(CFS)  Total area =       9.811(Ac.)
Depth of flow =   0.446(Ft.), Average velocity =   4.016(Ft/s)


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```
Process from Point/Station       14.000 to Point/Station       15.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
------------------------------------------------------------------------
Upstream point/station elevation =   701.470(Ft.)
Downstream point/station elevation =   698.000(Ft.)
Pipe length  =   117.00(Ft.) Slope =   0.0297  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    15.121(CFS)
Given pipe size =     24.00(In.)
Calculated individual pipe flow  =    15.121(CFS)
Normal flow depth in pipe =   10.38(In.)
Flow top width inside pipe =   23.78(In.)
Critical Depth =   16.82(In.)
Pipe flow velocity =     11.62(Ft/s)
Travel time through pipe =    0.17 min.
Time of concentration (TC) =    15.88 min.


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


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       11.000 to Point/Station       11.000
**** CONFLUENCE OF MINOR STREAMS ****
------------------------------------------------------------------------
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      9.811(Ac.)
Runoff from this stream =     15.121(CFS)
Time of concentration =   15.94 min.
Rainfall intensity =     4.240(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       15.459     21.07             3.542
2       15.121     15.94             4.240
Qmax(1) =
       1.000 *    1.000 *    15.459) +
       0.835 *    1.000 *    15.121) + =      28.092
Qmax(2) =
       1.000 *    0.757 *    15.459) +
       1.000 *    1.000 *    15.121) + =      26.820

Total of 2 streams to confluence:
Flow rates before confluence point:
      15.459      15.121
Maximum flow rates at confluence using above data:
       28.092       26.820
Area of streams before confluence:
       11.060        9.811
Results of confluence:
Total flow rate =     28.092(CFS)
```

```
      Time of concentration =    21.069 min.
      Effective stream area after confluence =     20.871(Ac.)
      End of computations, total study area =          20.871 (Ac.)
```

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.)^.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 ***********
```

```
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              0.50
    2              0.00              0.00
    3              1.50              0.13
    4             20.25              0.38
Manning's 'N' friction factor =   0.013
------------------------------------------------------------------
Sub-Channel flow  =      7.427(CFS)
  '     '    flow top width =     15.479(Ft.)
  '     '    velocity=    4.431(Ft/s)
  '     '    area =      1.676(Sq.Ft)
  '     '    Froude number =     2.373

Upstream point elevation =   754.980(Ft.)
Downstream point elevation =   714.170(Ft.)
Flow length =  1364.000(Ft.)
Travel time  =    5.13 min.
Time of concentration =   17.10 min.
Depth of flow =   0.311(Ft.)
Average velocity =   4.431(Ft/s)
Total irregular channel flow =     7.427(CFS)
Irregular channel normal depth above invert elev. =   0.311(Ft.)
Average velocity of channel(s) =   4.431(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      4.053(In/Hr) for a   100.0 year storm
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
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      4.053(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      3.622
Subarea runoff =     14.562(CFS) for      9.997(Ac.)
Total runoff =     14.682(CFS)  Total area =      10.075(Ac.)
Depth of flow =   0.375(Ft.), Average velocity =   5.233(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        3.000 to Point/Station        4.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =     14.903(CFS)
Depth of flow =   0.471(Ft.), Average velocity =   3.165(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              0.50
    2              0.00              0.00
    3              1.50              0.13
    4             20.25              0.38
Manning's 'N' friction factor =   0.013
------------------------------------------------------------------
Sub-Channel flow  =     14.903(CFS)
  '     '    flow top width =     20.250(Ft.)
  '     '    velocity=    3.165(Ft/s)
  '     '    area =      4.709(Sq.Ft)
  '     '    Froude number =     1.157

Upstream point elevation =   714.170(Ft.)
Downstream point elevation =   710.840(Ft.)
Flow length =   602.000(Ft.)
Travel time  =    3.17 min.
```

```
Time of concentration =   20.27 min.
Depth of flow =   0.471(Ft.)
Average velocity =   3.165(Ft/s)
Total irregular channel flow =    14.903(CFS)
Irregular channel normal depth above invert elev. =   0.471(Ft.)
Average velocity of channel(s) =   3.165(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      3.632(In/Hr) for a   100.0 year storm
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
[MEDIUM DENSITY RESIDENTIAL                  ]
(14.5 DU/A or Less      )
Impervious value, Ai = 0.500
Sub-Area C Value = 0.600
Rainfall intensity =      3.632(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.379  CA =      4.148
Subarea runoff =      0.384(CFS) for      0.876(Ac.)
Total runoff =     15.065(CFS)  Total area =      10.951(Ac.)
Depth of flow =   0.472(Ft.), Average velocity =   3.179(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        4.000 to Point/Station        5.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
________________________________________________________________________
Upstream point/station elevation =   710.260(Ft.)
Downstream point/station elevation =   707.650(Ft.)
Pipe length  =    43.00(Ft.) Slope =   0.0607  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    15.065(CFS)
Given pipe size =     18.00(In.)
Calculated individual pipe flow  =    15.065(CFS)
Normal flow depth in pipe =    9.87(In.)
Flow top width inside pipe =   17.92(In.)
Critical Depth =   16.88(In.)
Pipe flow velocity =     15.20(Ft/s)
Travel time through pipe =    0.05 min.
Time of concentration (TC) =    20.32 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        5.000 to Point/Station        6.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
________________________________________________________________________
Depth of flow =   1.149(Ft.), Average velocity =   9.134(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              2.00
    2              2.50              0.00
    3              5.00              2.00
Manning's 'N' friction factor =   0.015
------------------------------------------------------------------
Sub-Channel flow  =     15.065(CFS)
  '     '    flow top width =      2.872(Ft.)
  '     '    velocity=    9.134(Ft/s)
  '     '    area =      1.649(Sq.Ft)
  '     '    Froude number =     2.124

Upstream point elevation =   707.650(Ft.)
Downstream point elevation =   705.050(Ft.)
Flow length =   105.000(Ft.)
Travel time  =    0.19 min.
Time of concentration =   20.51 min.
Depth of flow =   1.149(Ft.)
Average velocity =   9.134(Ft/s)
```

```
Total irregular channel flow =    15.065(CFS)
Irregular channel normal depth above invert elev. =   1.149(Ft.)
Average velocity of channel(s) =   9.134(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        6.000 to Point/Station        6.000
**** CONFLUENCE OF MINOR STREAMS ****
------------------------------------------------------------------------
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     10.951(Ac.)
Runoff from this stream =     15.065(CFS)
Time of concentration =   20.51 min.
Rainfall intensity =     3.605(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        7.000 to Point/Station        8.000
**** 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
[MEDIUM DENSITY RESIDENTIAL                 ]
(14.5 DU/A or Less      )
Impervious value, Ai = 0.500
Sub-Area C Value = 0.600
Initial subarea total flow distance  =  119.000(Ft.)
Highest elevation =  716.290(Ft.)
Lowest elevation =  713.970(Ft.)
Elevation difference =    2.320(Ft.) Slope =  1.950 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 80.00 (Ft)
for the top area slope value of   1.95 %, in a development type of
 14.5 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.44 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.6000)*(  80.000^.5)/(   1.950^(1/3)]=   6.44
Rainfall intensity (I) =      7.606(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.600
Subarea runoff =      0.497(CFS)
Total initial stream area =        0.109(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        8.000 to Point/Station        9.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
------------------------------------------------------------------------
Depth of flow =   0.203(Ft.), Average velocity =   1.224(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              0.50
    2              0.00              0.00
    3              1.50              0.13
    4             18.50              0.39
Manning's 'N' friction factor =   0.015
------------------------------------------------------------------
Sub-Channel flow  =      0.497(CFS)
  '     '    flow top width =      6.499(Ft.)
  '     '    velocity=    1.224(Ft/s)
  '     '    area =      0.407(Sq.Ft)
  '     '    Froude number =     0.862

Upstream point elevation =   713.970(Ft.)
Downstream point elevation =   710.420(Ft.)
```

```
Flow length =   554.000(Ft.)
Travel time  =    7.55 min.
Time of concentration =   13.99 min.
Depth of flow =   0.203(Ft.)
Average velocity =   1.224(Ft/s)
Total irregular channel flow =     0.497(CFS)
Irregular channel normal depth above invert elev. =   0.203(Ft.)
Average velocity of channel(s) =   1.224(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        9.000 to Point/Station       10.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
________________________________________________________________________
Upstream point/station elevation =   710.420(Ft.)
Downstream point/station elevation =   704.420(Ft.)
Pipe length  =    37.00(Ft.) Slope =   0.1622  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     0.497(CFS)
Given pipe size =     36.00(In.)
Calculated individual pipe flow  =     0.497(CFS)
Normal flow depth in pipe =    1.15(In.)
Flow top width inside pipe =   12.68(In.)
Critical depth could not be calculated.
Pipe flow velocity =      7.30(Ft/s)
Travel time through pipe =    0.08 min.
Time of concentration (TC) =    14.07 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       10.000 to Point/Station        6.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
________________________________________________________________________
Upstream point/station elevation =   710.000(Ft.)
Downstream point/station elevation =   705.050(Ft.)
Pipe length  =    73.00(Ft.) Slope =   0.0678  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     0.497(CFS)
Given pipe size =     12.00(In.)
Calculated individual pipe flow  =     0.497(CFS)
Normal flow depth in pipe =    1.89(In.)
Flow top width inside pipe =    8.74(In.)
Critical Depth =    3.51(In.)
Pipe flow velocity =      6.29(Ft/s)
Travel time through pipe =    0.19 min.
Time of concentration (TC) =    14.27 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        6.000 to Point/Station        6.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.109(Ac.)
Runoff from this stream =      0.497(CFS)
Time of concentration =   14.27 min.
Rainfall intensity =     4.555(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (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
```

```
Total of 2 streams to confluence:
Flow rates before confluence point:
      15.065       0.497
Maximum flow rates at confluence using above data:
       15.459       10.979
Area of streams before confluence:
       10.951        0.109
Results of confluence:
Total flow rate =     15.459(CFS)
Time of concentration =    20.508 min.
Effective stream area after confluence =     11.060(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        6.000 to Point/Station       11.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
________________________________________________________________________
Depth of flow =   1.103(Ft.), Average velocity =  10.158(Ft/s)
    ******* Irregular Channel Data ***********
------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
    1              0.00              2.00
    2              2.50              0.00
    3              5.00              2.00
Manning's 'N' friction factor =   0.015
------------------------------------------------------------------
Sub-Channel flow  =     15.459(CFS)
  '     '    flow top width =      2.759(Ft.)
  '     '    velocity=   10.158(Ft/s)
  '     '    area =      1.522(Sq.Ft)
  '     '    Froude number =     2.410

Upstream point elevation =   705.050(Ft.)
Downstream point elevation =   694.000(Ft.)
Flow length =   342.000(Ft.)
Travel time  =    0.56 min.
Time of concentration =   21.07 min.
Depth of flow =   1.103(Ft.)
Average velocity =  10.158(Ft/s)
Total irregular channel flow =    15.459(CFS)
Irregular channel normal depth above invert elev. =   1.103(Ft.)
Average velocity of channel(s) =  10.158(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       11.000 to Point/Station       11.000
**** CONFLUENCE OF MINOR STREAMS ****
________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     11.060(Ac.)
Runoff from this stream =     15.459(CFS)
Time of concentration =   21.07 min.
Rainfall intensity =     3.542(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       12.000 to Point/Station       15.000
**** USER DEFINED FLOW INFORMATION AT A POINT ****
________________________________________________________________________
User specified 'C' value of 0.284 given for subarea
Rainfall intensity (I) =      4.251(In/Hr) for a   100.0 year storm
User specified values are as follows:
TC =  15.88 min.  Rain intensity =       4.25(In/Hr)
Total area =        9.811(Ac.)  Total runoff =    11.830(CFS)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
Process from Point/Station       15.000 to Point/Station       11.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****
------------------------------------------------------------------------
Upstream point/station elevation =   694.110(Ft.)
Downstream point/station elevation =   693.700(Ft.)
Pipe length  =    79.00(Ft.) Slope =   0.0052  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    11.830(CFS)
Given pipe size =     12.00(In.)
NOTE: Normal flow is pressure flow in user selected pipe size.
The approximate hydraulic grade line above the pipe invert is
    13.581(Ft.)  at the headworks or inlet of the pipe(s)
 Pipe friction loss =      8.707(Ft.)
 Minor friction loss =      5.284(Ft.)  K-factor =   1.50
Pipe flow velocity =     15.06(Ft/s)
Travel time through pipe =    0.09 min.
Time of concentration (TC) =    15.97 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       11.000 to Point/Station       11.000
**** CONFLUENCE OF MINOR STREAMS ****
------------------------------------------------------------------------
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      9.811(Ac.)
Runoff from this stream =     11.830(CFS)
Time of concentration =   15.97 min.
Rainfall intensity =     4.236(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)

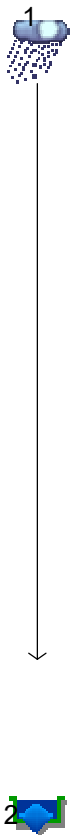

1       15.459     21.07             3.542
2       11.830     15.97             4.236
Qmax(1) =
       1.000 *    1.000 *    15.459) +
       0.836 *    1.000 *    11.830) + =      25.352
Qmax(2) =
       1.000 *    0.758 *    15.459) +
       1.000 *    1.000 *    11.830) + =      23.546

Total of 2 streams to confluence:
Flow rates before confluence point:
      15.459      11.830
Maximum flow rates at confluence using above data:
       25.352       23.546
Area of streams before confluence:
       11.060        9.811
Results of confluence:
Total flow rate =     25.352(CFS)
Time of concentration =    21.069 min.
Effective stream area after confluence =     20.871(Ac.)
End of computations, total study area =          20.871 (Ac.)
```

ATTACHMENT 7
HYDROGRAPH

7a. Hydrograph Report

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	Manual	21054node15hydrograph
2	Reservoir	BMP-A

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	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

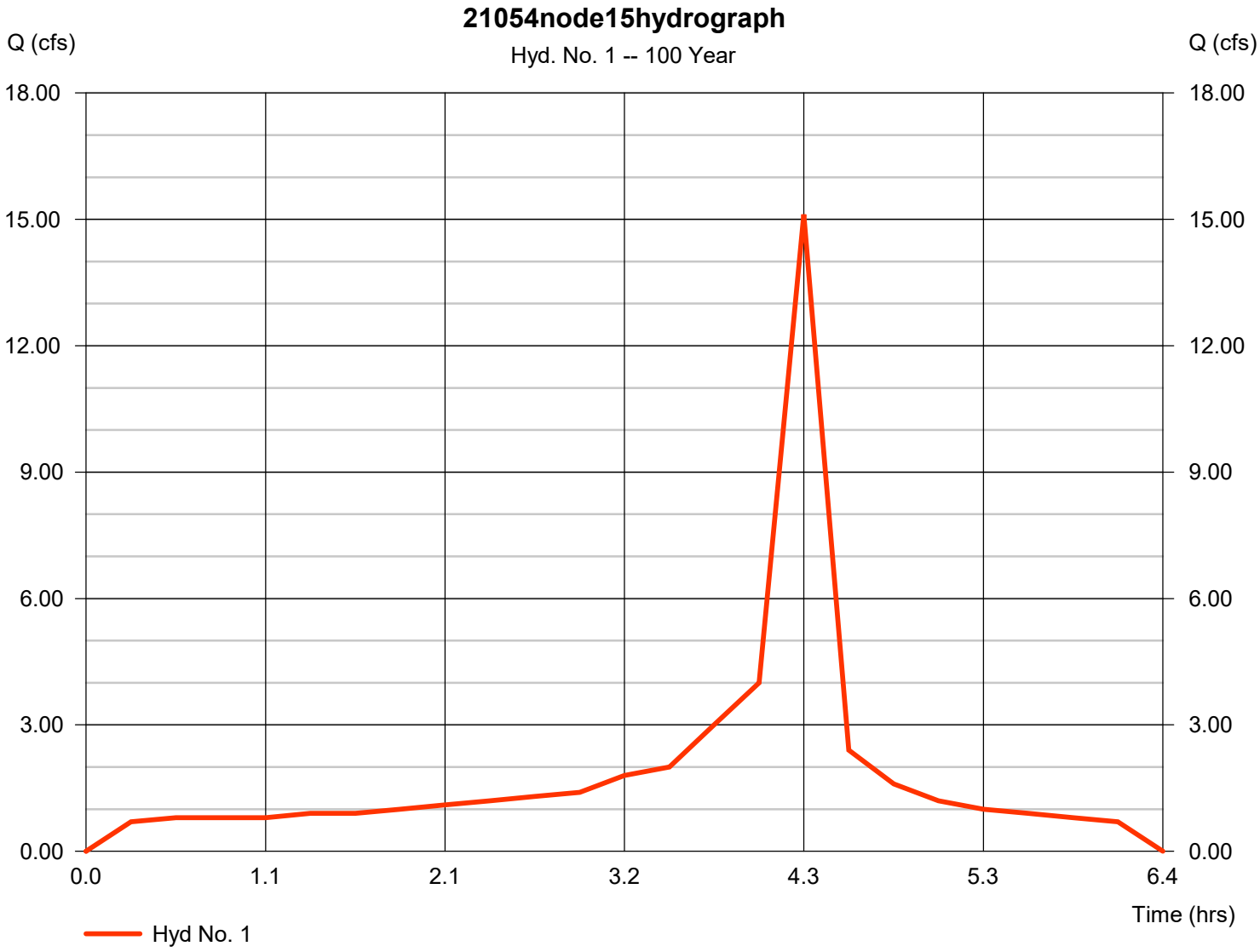
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Manual	15.12	16	256	43,603	------	------	------	21054node15hydrograph
2	Reservoir	11.83	16	256	43,559	1	699.57	5,547	BMP-A

Hydrograph Report

Hyd. No. 1

21054node15hydrograph

Hydrograph type	= Manual	Peak discharge	= 15.12 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.27 hrs
Time interval	= 16 min	Hyd. volume	= 43,603 cuft



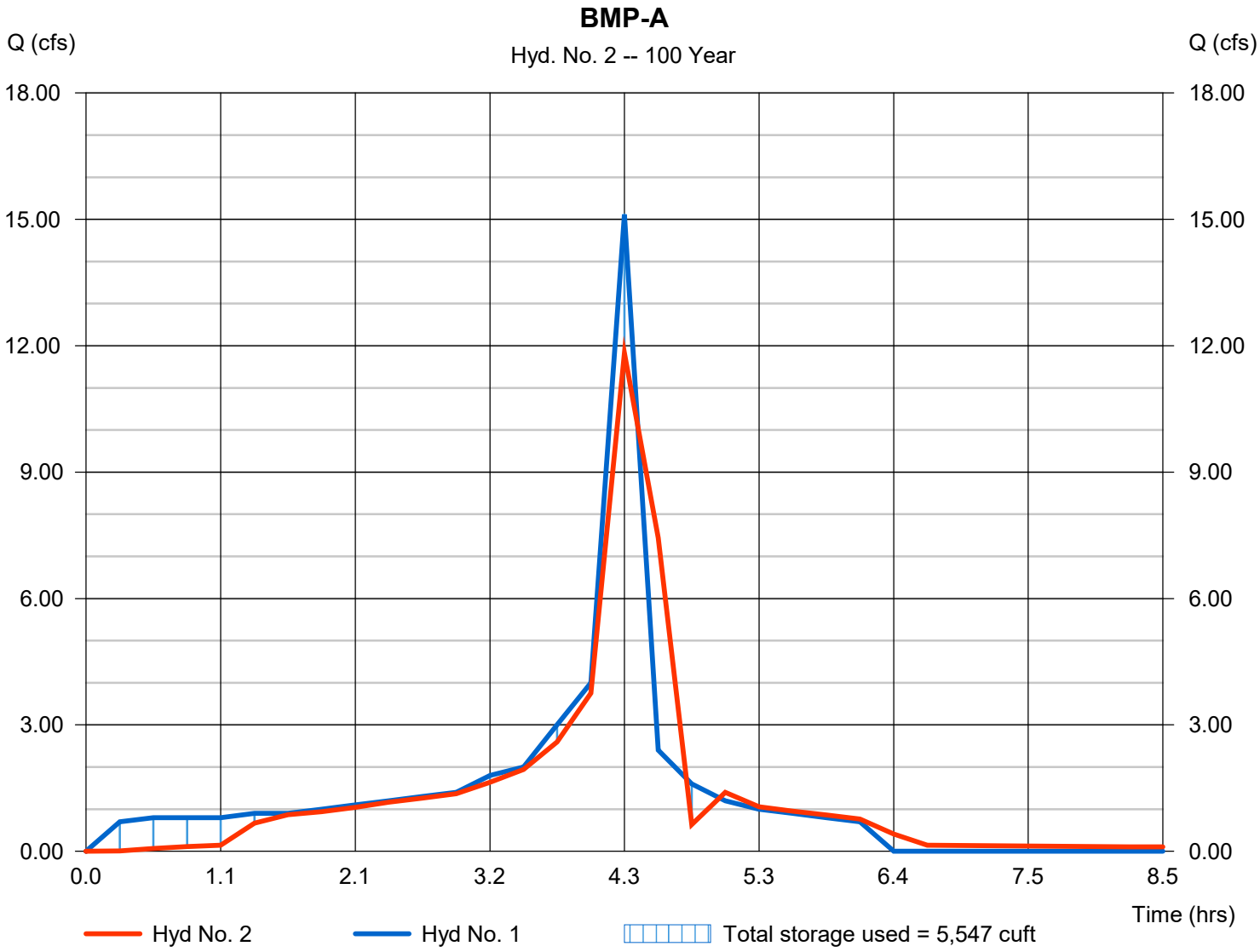
Hydrograph Report

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

RATIONAL METHOD HYDROGRAPH PROGRAM

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

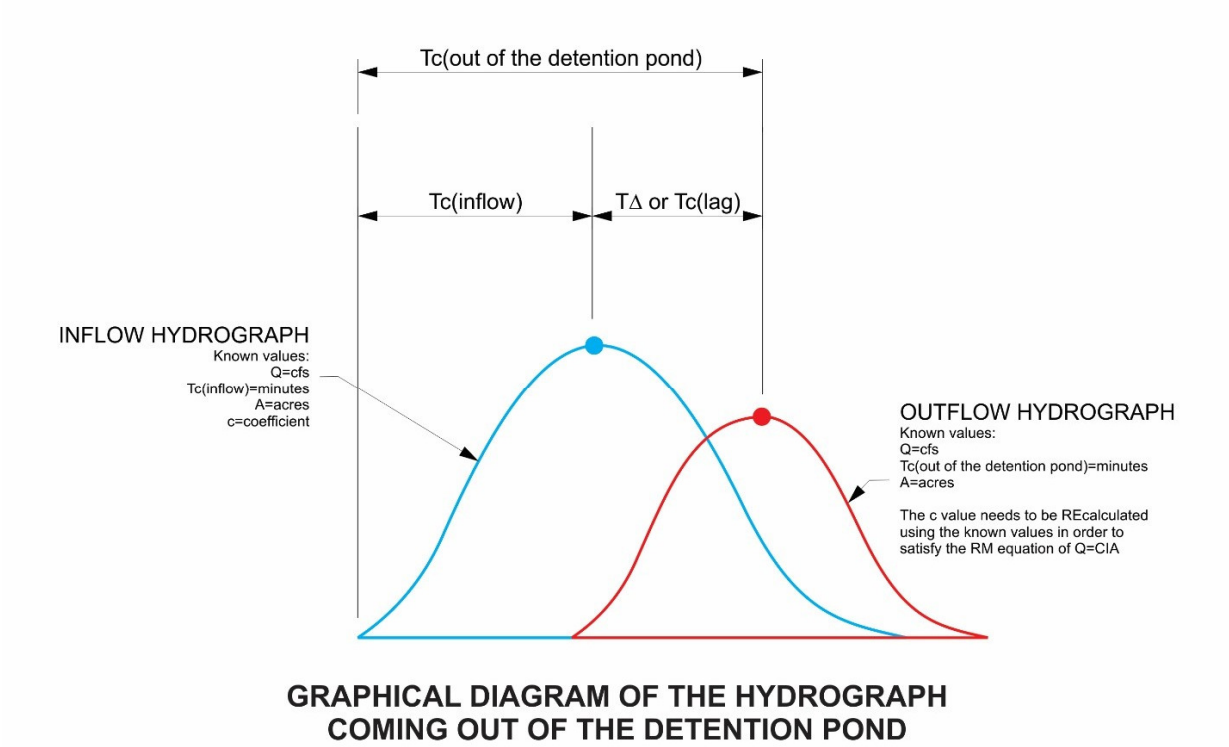
The purpose of the detention structure is to alter the peak flow and or time to peak of a given storm so it will not have a negative impact on the downstream facilities. There are different methods on how to use the resulting values of the outflow hydrograph.

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(outflow). In this interpretation, we will get a Tc that will not match the value of the $Tc_{(\text{out of the detention structure})}$ 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 $Tc_{(\text{out of the detention structure})}$. 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 TΔ 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 = cfs
- $Tc_{(\text{out of the detention structure})}$ = minutes
- A = 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 $Tc_{(\text{out of the detention structure})}$ 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:

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

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

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

(minutes) $Tc_{(\text{out of the detention structure})} = Tc_{(\text{inflow})} + T\Delta$ (minutes)
P_6 = 6 hour precipitation (inches), known value.
I = intensity (inches/hour), calculated based on the value of $Tc_{(\text{out of the detention structure})}$
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, Tc 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 $Tc_{(\text{out of the detention structure})}$, 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, Tc 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.