

PDS LD
Accepted
11/2/2020

HYDROLOGY STUDY

(Standard Development Project)

FOR THE:

GRADING VIOLATION GRADING PLAN

RECORD ID: PDS2018-LDGRMN-20215

APN 178-100-07-00

2755 North Deer Springs Place,
San Marcos, CA 92029

PREPARED FOR:

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PREPARED BY:

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Project No: 18-013

DATE PREPARED:

December 10, 2018

REVISION DATE(S):

August 6, 2020

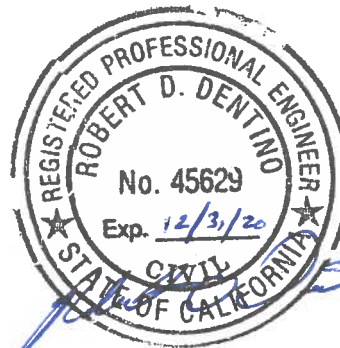


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1.0 PROJECT DESCRIPTION

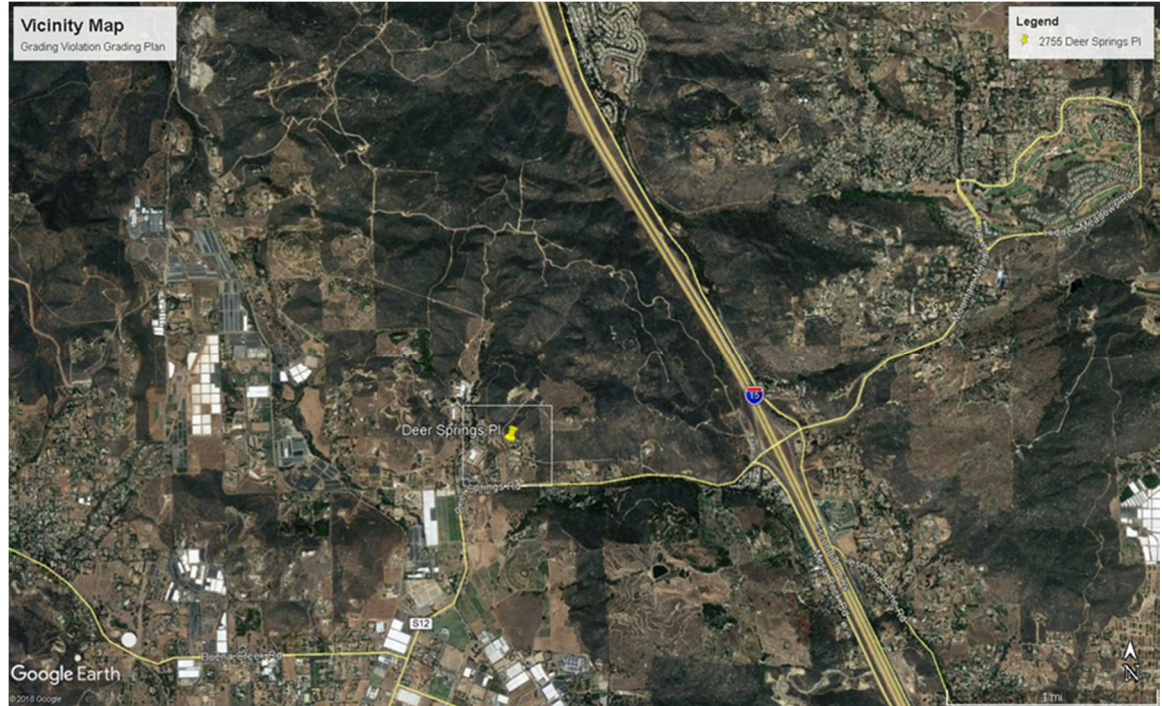
1.1 Project Purpose

The purpose of this project is to develop a set of grading plans for an area of the property that was graded outside of the area approved under the most current grading plan. A site visit inspection on 10/20/15 revealed an area with cuts and fills greater than 8 ft in height and greater than 1,000 cubic yards without required grading permits. This resulted on the issuance of an administrative grading warning, case number PDS2015-ENFGCO-000164. Whereas the grading has already been performed many years ago, and no further development is proposed on the site, it is anticipated that minimal improvements to the site will be required for the site to be in conformance with the grading ordinance.

1.2 Project Proposed Drainage Facilities

The proposed drainage improvements for the site include redefining the grades along the top of the fill slope to prevent runoff from flowing down the face of the slopes, and installing a down drain near the original subcatchment divide location to prevent the diversion of runoff from the northern drainage basin to the southern basin.

2.0 VICINTIY MAP



3.0 DESCRIPITON OF WATERSHED

3.1 Pre-Graded Topography

The entire property is tributary to an un-named tributary to the San Marcos Creek. The pre-graded topography of the site was obtained from the 2ft County provided GIS shape files for the area. The graded area of the site is located at the divide of two smaller localized drainage basins. One basin drains to the north and one to the south. The basin to the north drains to a natural vegetated channel and the basin to the south drains to the road improvements to Deer Springs Place. The graded area is bounded to the south by Deer Springs Place, to the west by a previously graded lot and access drive (graded only no improvements), to the north by natural topography, and the east by existing agricultural property, and to the south easy by a natural topography.

Please see Attachment 1 for the Pre-Graded Topographic Map.

3.2 Post-Graded Topography

The post development topography was obtained by a field survey of the site. The field survey points were then combined with the pre-graded County topography as described under the previous section of this report. The site grading was performed to develop a level pad storage area for several construction containers and semi-truck trailers. The pad area grading extends across the boundary between the north and the south drainage basins and is graded such that the entire pad area drains to the southern drainage basin (Deer Springs Place).

Please see Attachment 1 for the Post-Development Topographic Map

3.3 Hydrologic Unit Contribution

The project is located in the Twin Oaks Hydrologic Sub Area of the San Marcos Hydrologic Area of the Carlsbad Hydrologic Unit (904.53). The project discharges to an un-named tributary which discharges to the San Marcos Creek which discharges to the Batiquitos Lagoon which discharges to the Pacific Ocean.

4.0 METHODOLOGY

4.1 Design Standards

The 2003 San Diego County Hydrology Manual (Hydrology Manual) and 2014 The 2014 San Diego County Hydraulic Design Manual (Hydraulic Manual) are used as guidance to design the drainage facilities within this project.

5.0 CALCULATIONS

5.1 Calculate Runoff Coefficient

Per Web Soil Survey from the USDA, the project site was found to lay within Hydraulic Soil Group “D”.

Per the Hydrology Manual section 3.1.2, the runoff coefficient can be calculated for an area based on soil type and impervious percentage using the formula:

$$C = 0.90 * (\%Impervious) + C_p * (1 - \%Impervious)$$

From Table 3-1 of the Hydrology Manual, the value of C_p for soils type D is 0.35.

Since both the pre and post development percentage imperviousness is zero, the resultant C value for both conditions is taken as $C = C_p = 0.35$.

Please see Attachment 2 for the Web Soils Survey Exhibits

5.2 Determine P6 and P24

The project was mapped based on the latitude and longitude of the site on isopluvial maps of the 100 year 6 hour and 24 hour rainfall events respectively. The estimate P6 and P24 values for the site are 3.5 and 7.0 inches respectively. Since $P6/P24 = 0.5$ is within the range given for these values (0.45-0.65), the adjusted value for P6 is taken as P6.

Please see Attachment 3 for the isopluvial map exhibits.

5.3 Calculate Storm Flows using the Rational Method

Since the respective drainage basin are relatively small and simple in nature, the San Diego County Rational Method is used to determine the peak flow discharge from each basin. The two drainage basins (north and south) are analyzed by taking the respective take-off values from the AutoCAD drawings (area, flow length, basin high and low points) and entering those into a spread sheet program designed to calculate the discharge based on the equations given in the Hydrology Manual.

Once entered into the spread sheet, the combined pre and combined post graded areas are compared to confirm that similar study areas are being used. Then the flow path and elevation difference is used to calculate the estimated time of concentration (tc) for the basin. When the calculated tc is less than 5 minutes then the minimum tc of 5 minutes is used (as per the Hydrology Manual). Then using the rational method formula of $Q=CiA$, the peak flow rate (cfs) is calculated for each basin for both pre and post graded conditions. The following chart summarizes those findings:

SUMMARY OF THE PEAK 100-YEAR STORM RUNOFF			
Basin	Pre-Graded Flow Rate	Post Graded Flow Rate	Increase in Flow Rate
A	1.94	1.63	No increase
B	0.55	0.49	No increase

By observation the graded condition of each basin does not increase the peak flow rate of the basin discharge.

Please see Attachment 4 for the Rational Method Calculations

6.0 CONCLUSION

This study and the resulting data indicate that the project will not increase the 100-year peak flow runoff at either of the projects discharge points in accordance with the County of San Diego development standards. It can therefore be concluded that the project does not have a negative peak flow impact on existing downstream storm drain facilities or adjacent and downstream properties.

7.0 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

8.0 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 County of San Diego is confined to a review only and does not relieve me, as engineer of work, of my responsibilities for project design.

ENGINEER OF WORK

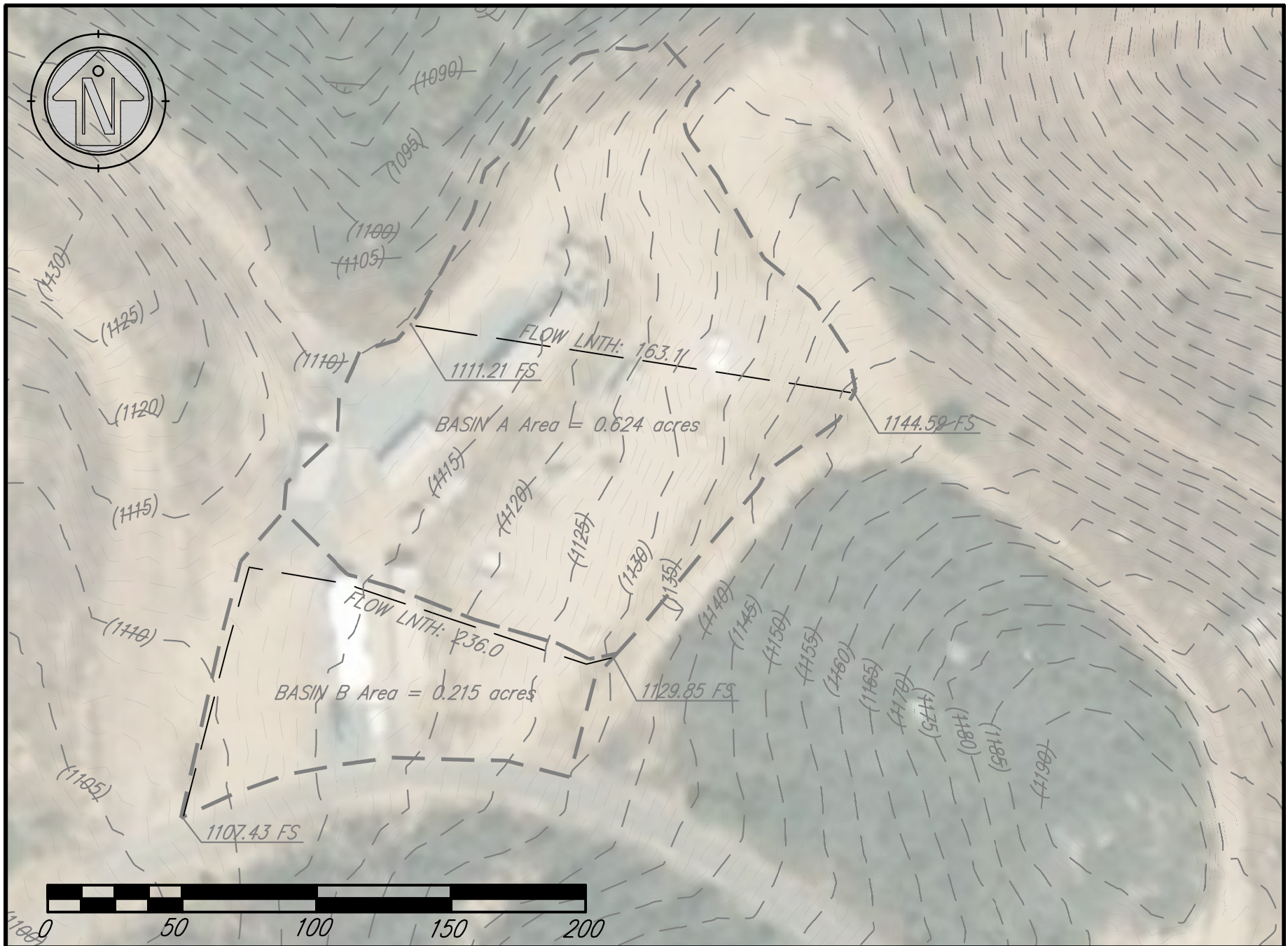
Excel Engineering
440 State Place
Escondido, CA 92029
Tel – (760)745-8118
Fax – (760)745-1890

Project Number: 18-013

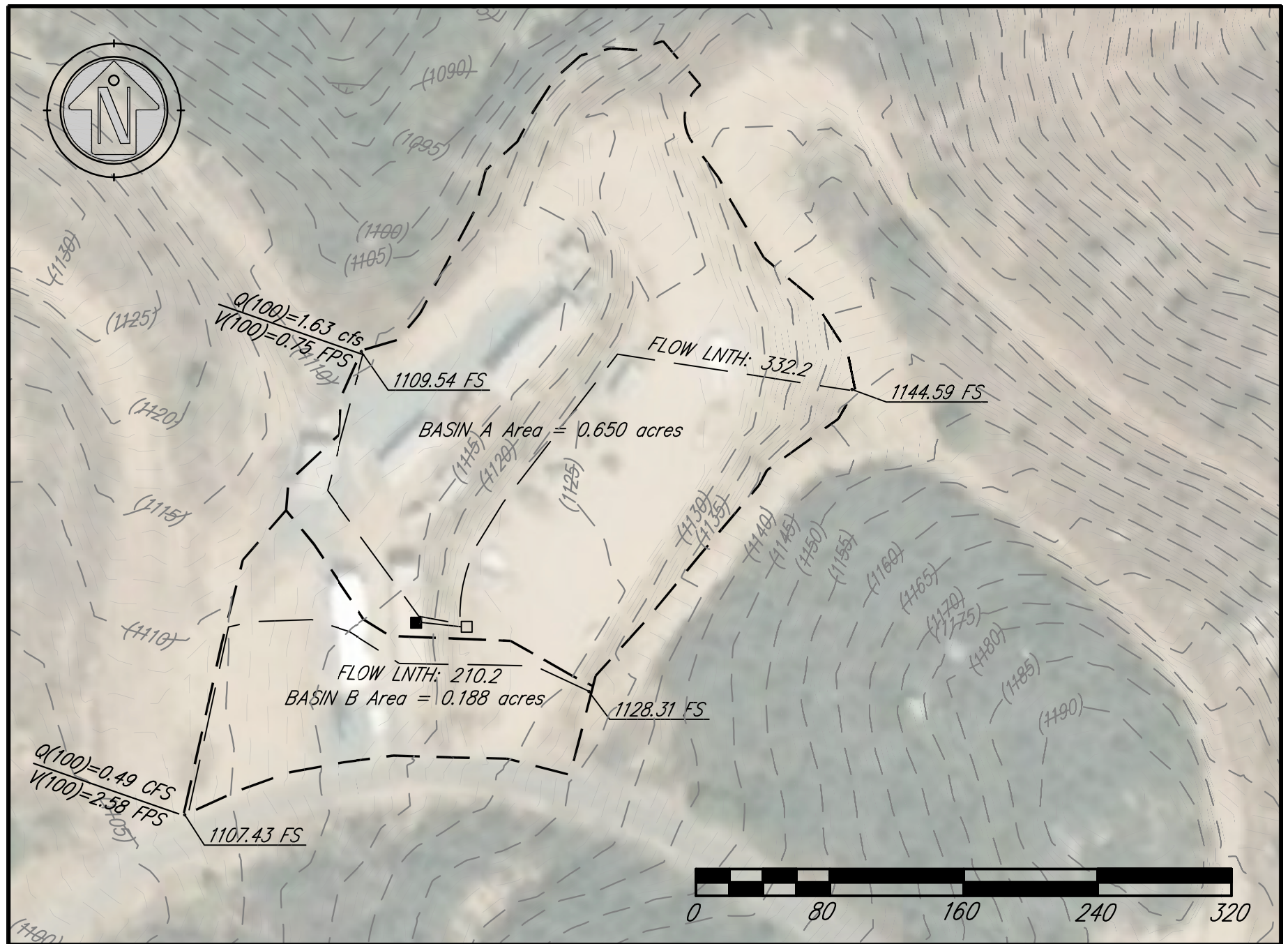
Robert D. Dentino, RCE 45629
Registration Expire: December 31, 2020

Date

ATTACHMENT 1



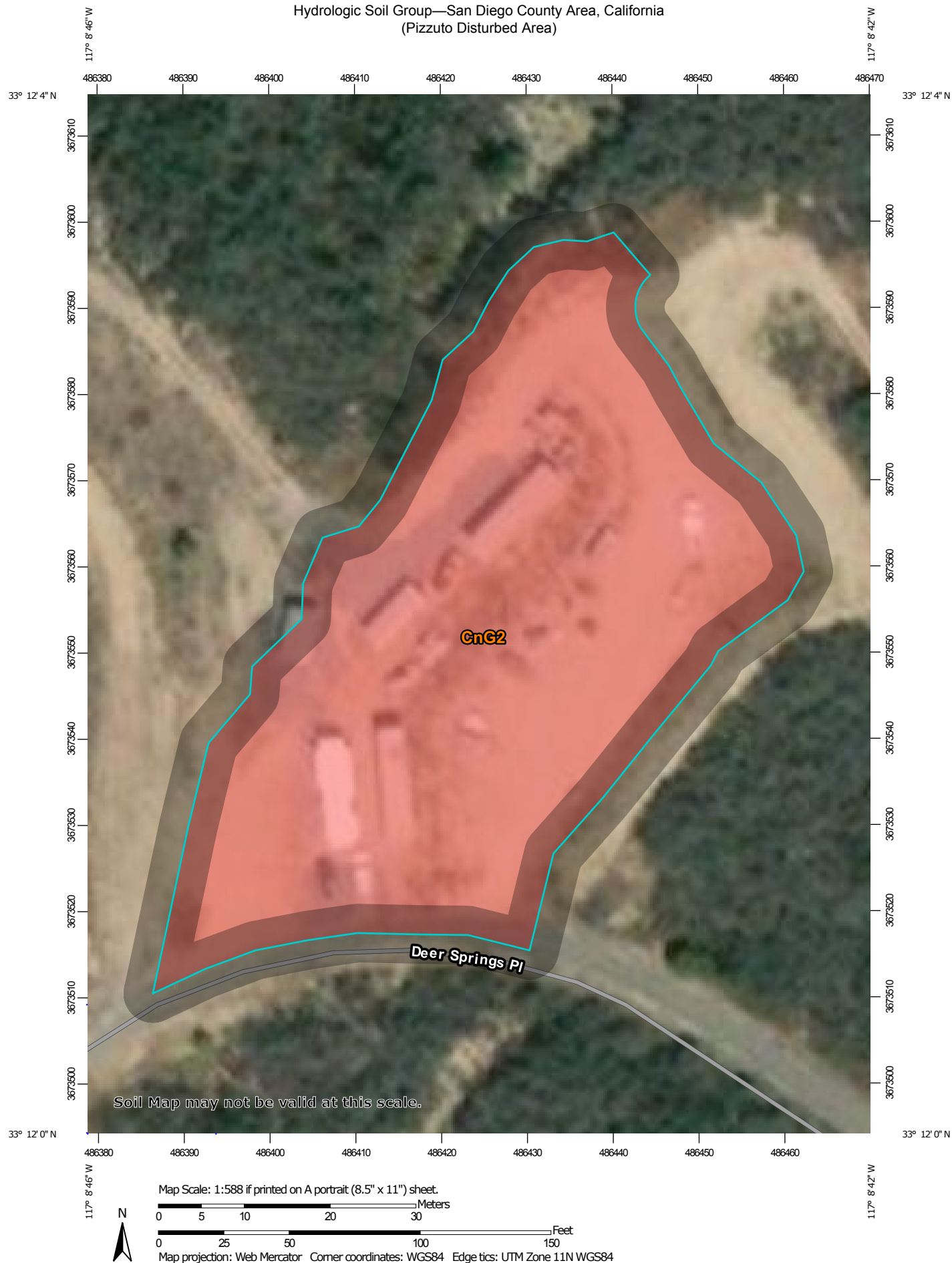
PRE-GRADED TOPOGRAPHY



POST-GRADED TOPOGRAPHY

ATTACHMENT 2

Hydrologic Soil Group—San Diego County Area, California (Pizzuto Disturbed Area)



Hydrologic Soil Group—San Diego County Area, California
(Pizzuto Disturbed Area)

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 13, Sep 12, 2018

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

Date(s) aerial images were photographed: Dec 31, 2009—Oct 22, 2017

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
CnG2	Cieneba-Fallbrook rocky sandy loams, 30 to 65 percent slopes, eroded	D	0.8	100.0%
Totals for Area of Interest			0.8	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

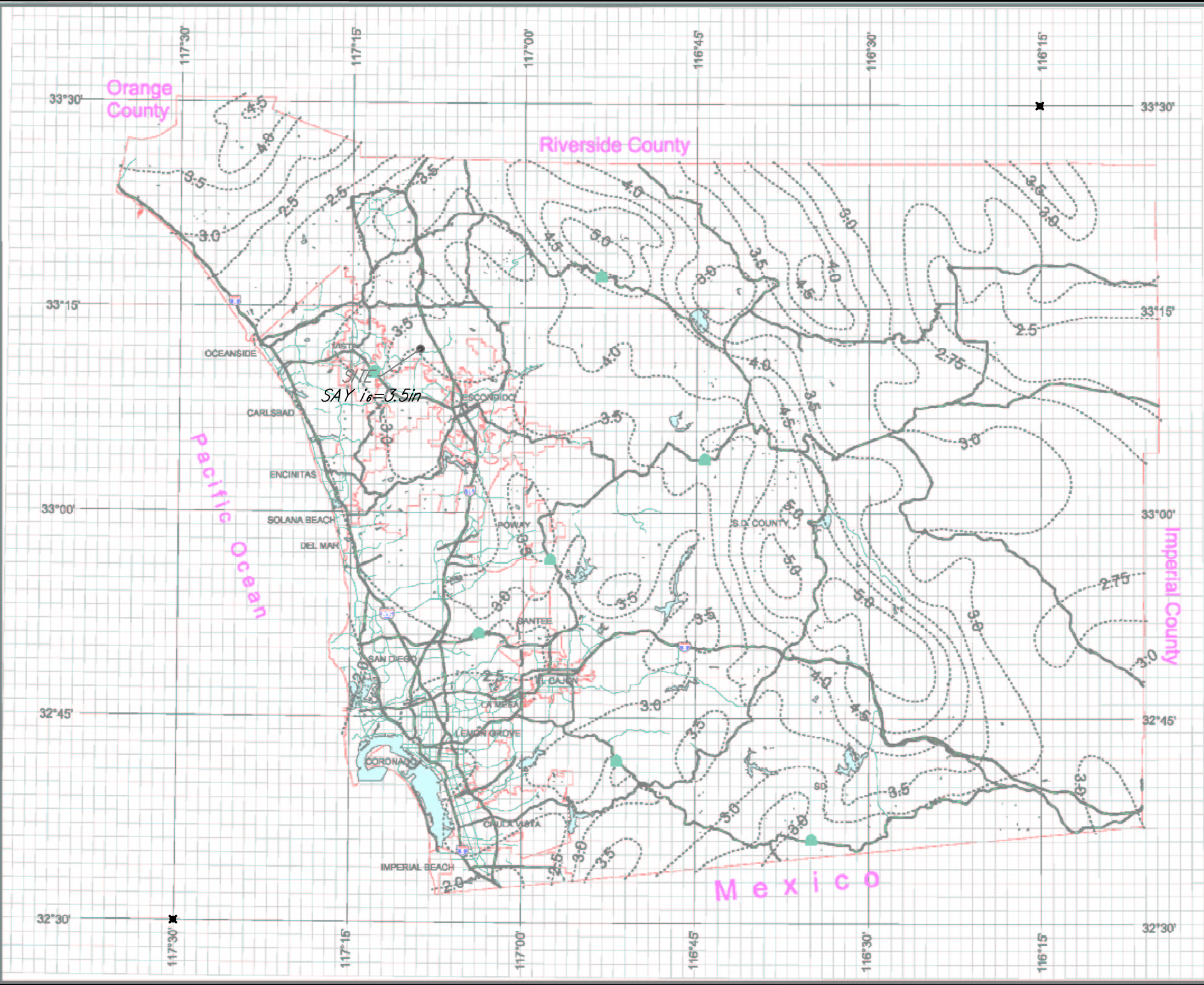
ATTACHMENT 3

County of San Diego Hydrology Manual



Rainfall Isopleths

100 Year Rainfall Event - 6 Hours



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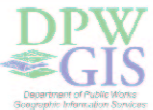
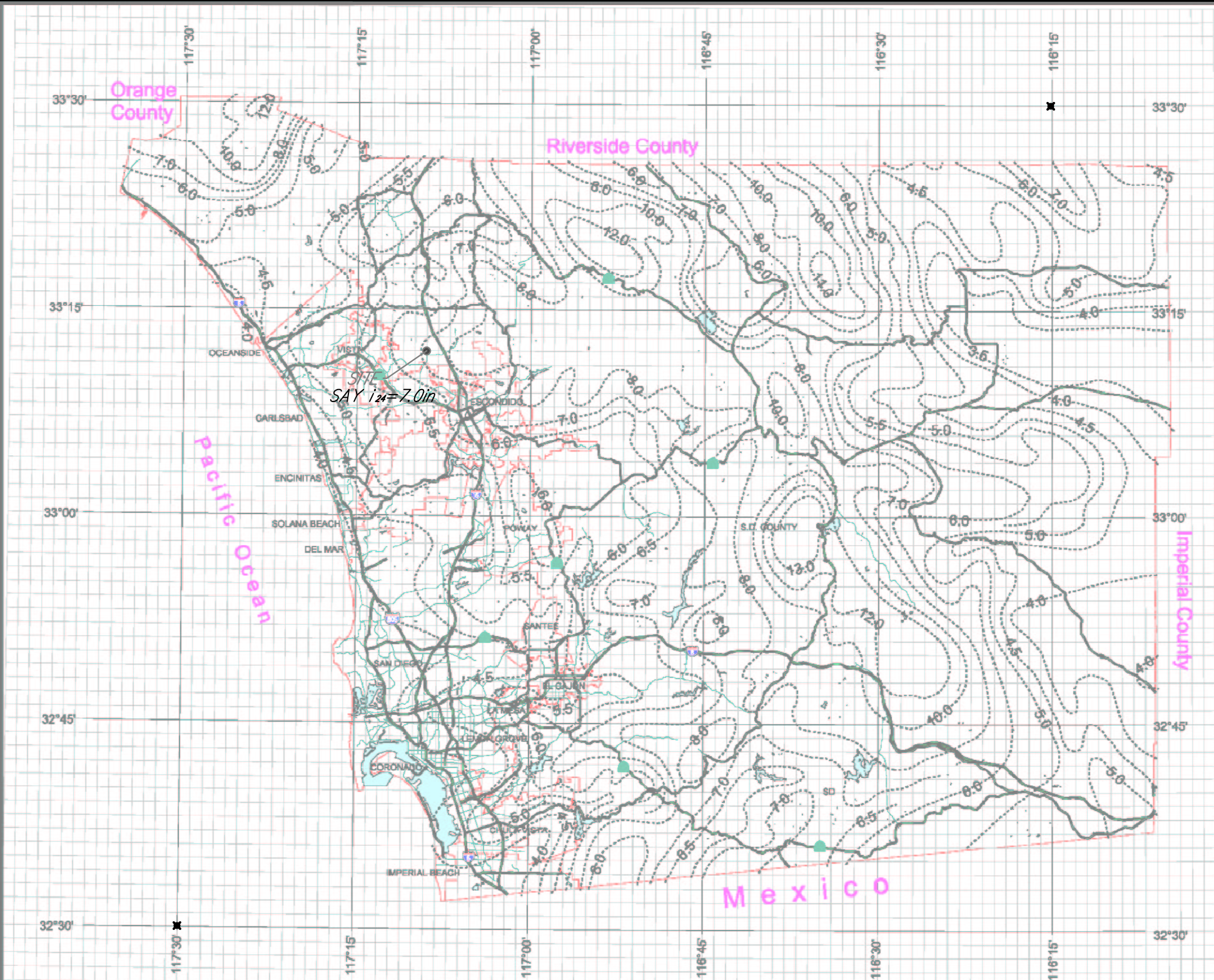
County of San Diego Hydrology Manual



Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

----- Isopluvial (inches)



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ATTACHMENT 4

Rational Method Calculations.xlsx

V:\18\18013\engineering\GPIP\Storm\HYD\Rational Method Calculations.xlsx

Pre-Development

Basin	Area (AC)	Runoff Factor ©	High Pt (ft)	Low Pt (ft)	Flow Path (ft)	P6 (in)	P24 (in)	P6/P24 (%)	Adj P6 (in)	ti (min)	tt (min)	tc (min)	tc (use) (min)	I (in/hr)	Q peak (cfs)
A	0.624	0.35	1144.59	1111.21	163.1	3.5	7.0	0.5	3.5	4.94	0.35	5.29	5.29	8.892	1.94
B	0.215	0.35	1129.85	1107.43	236	3.5	7.0	0.5	3.5	6.37	0.85	7.22	7.22	7.276	0.55

0.839

Post-Development

Basin	Area (AC)	Runoff Factor ©	High Pt (ft)	Low Pt (ft)	Flow Path (ft)	P6 (in)	P24 (in)	P6/P24 (%)	Adj P6 (in)	ti (min)	tt (min)	tc (min)	tc (use) (min)	I (in/hr)	Q peak (cfs)
A	0.65	0.35	1144.59	1109.54	332	3.5	7.0	0.5	3.5	6.15	1.23	7.38	7.38	7.174	1.63
B	0.188	0.35	1128.31	1107.43	210	3.5	7.0	0.5	3.5	6.28	0.71	6.99	6.99	7.429	0.49

0.838

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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: 04/03/19

***** 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) = 3.500
24 hour precipitation(inches) = 7.000
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 = 0.000
Decimal fraction soil group D = 1.000
[UNDISTURBED NATURAL TERRAIN]
(Permanent Open Space)
Impervious value, $A_i = 0.000$
Sub-Area C Value = 0.350
Initial subarea total flow distance = 163.100(Ft.)
Highest elevation = 1144.590(Ft.)
Lowest elevation = 1111.210(Ft.)
Elevation difference = 33.380(Ft.) slope = 20.466 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 20.47 %, in a development type of
Permanent Open Space
In Accordance With Figure 3-3
Initial Area Time of Concentration = 4.94 minutes
 $TC = [1.8 * (1.1 - C) * \text{distance}(\text{Ft.})^{1.5}] / (\% \text{ slope}^{1/3})$
 $TC = [1.8 * (1.1 - 0.3500) * (100.000^{1.5})] / (20.466^{1/3}) = 4.94$
The initial area total distance of 163.10 (Ft.) entered leaves a
remaining distance of 63.10 (Ft.)
Using Figure 3-4, the travel time for this distance is 0.35 minutes
for a distance of 63.10 (Ft.) and a slope of 20.47 %
with an elevation difference of 12.91(Ft.) from the end of the top area
 $Tt = [11.9 * \text{length}(\text{Mi})^3] / (\text{elevation change}(\text{Ft.}))^{1.385} * 60(\text{min/hr})$
 $= 0.350 \text{ Minutes}$
 $Tt = [(11.9 * 0.0120^3) / (12.91)]^{1.385} = 0.35$
Total initial area $T_i = 4.94$ minutes from Figure 3-3 formula plus
0.35 minutes from the Figure 3-4 formula = 5.29 minutes
Rainfall intensity (I) = 8.897(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.350
Subarea runoff = 1.943(CFS)
Total initial stream area = 0.624(Ac.)

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+++++
 Process from Point/Station 1.000 to Point/Station 2.000
 **** 6 HOUR HYDROGRAPH ****

+++++
 Hydrograph Data - Section 6, San Diego County Hydrology manual, June 2003

Time of Concentration = 5.29
 Basin Area = 0.62 Acres
 6 Hour Rainfall = 3.500 Inches
 Runoff Coefficient = 0.350
 Peak Discharge = 1.94 CFS

Time (Min)	Discharge (CFS)
0	0.000
5	0.046
10	0.046
15	0.047
20	0.047
25	0.048
30	0.049
35	0.050
40	0.050
45	0.051
50	0.052
55	0.053
60	0.054
65	0.055
70	0.056
75	0.057
80	0.058
85	0.059
90	0.060
95	0.062
100	0.063
105	0.065
110	0.066
115	0.068
120	0.069
125	0.072
130	0.073
135	0.076
140	0.077
145	0.081
150	0.082
155	0.086
160	0.089
165	0.093
170	0.096
175	0.102
180	0.105
185	0.113
190	0.117
195	0.127
200	0.133
205	0.148
210	0.157
215	0.180
220	0.195
225	0.238
230	0.272
235	0.399
240	0.562
245	1.943
250	0.320
255	0.214
260	0.167

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265	0.140
270	0.122
275	0.109
280	0.099
285	0.091
290	0.084
295	0.079
300	0.074
305	0.070
310	0.067
315	0.064
320	0.061
325	0.058
330	0.056
335	0.054
340	0.052
345	0.051
350	0.049
355	0.048
360	0.046
365	0.045
+++++	

End of computations, total study area = 0.624 (Ac.)

basinbpre.out

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: 04/03/19

***** 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) = 3.500
24 hour precipitation(inches) = 7.000
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 = 0.000
Decimal fraction soil group D = 1.000
[UNDISTURBED NATURAL TERRAIN]
(Permanent Open Space)
Impervious value, Ai = 0.000
Sub-Area C Value = 0.350
Initial subarea total flow distance = 236.000(Ft.)
Highest elevation = 1129.850(Ft.)
Lowest elevation = 1107.430(Ft.)
Elevation difference = 22.420(Ft.) slope = 9.500 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 9.50 %, in a development type of
Permanent Open Space
In Accordance With Figure 3-3
Initial Area Time of Concentration = 6.37 minutes
 $TC = [1.8 * (1.1 - C) * distance(Ft.)^{.5}] / (% slope^{(1/3)})]$
 $TC = [1.8 * (1.1 - 0.3500) * (100.000^{.5})] / (9.500^{(1/3)}) = 6.37$
The initial area total distance of 236.00 (Ft.) entered leaves a
remaining distance of 136.00 (Ft.)
Using Figure 3-4, the travel time for this distance is 0.85 minutes
for a distance of 136.00 (Ft.) and a slope of 9.50 %
with an elevation difference of 12.92(Ft.) from the end of the top area
 $Tt = [11.9 * length(Mi)^3] / (elevation change(Ft.))^{.385} * 60(min/hr)$
 $= 0.849 Minutes$
 $Tt = [(11.9 * 0.0258^3) / (12.92)]^{.385} = 0.85$
Total initial area Ti = 6.37 minutes from Figure 3-3 formula plus
0.85 minutes from the Figure 3-4 formula = 7.22 minutes
Rainfall intensity (I) = 7.274(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.350
Subarea runoff = 0.547(CFS)
Total initial stream area = 0.215(Ac.)

basinbpre.out

+++++
 Process from Point/Station 1.000 to Point/Station 2.000
 **** 6 HOUR HYDROGRAPH ****

+++++
 Hydrograph Data - Section 6, San Diego County Hydrology manual, June 2003

Time of Concentration = 7.22
 Basin Area = 0.22 Acres
 6 Hour Rainfall = 3.500 Inches
 Runoff Coefficient = 0.350
 Peak Discharge = 0.55 CFS

Time (Min)	Discharge (CFS)
0	0.000
7	0.016
14	0.016
21	0.016
28	0.017
35	0.017
42	0.017
49	0.018
56	0.018
63	0.019
70	0.019
77	0.020
84	0.020
91	0.021
98	0.021
105	0.022
112	0.023
119	0.024
126	0.025
133	0.026
140	0.027
147	0.028
154	0.029
161	0.031
168	0.033
175	0.035
182	0.037
189	0.041
196	0.044
203	0.050
210	0.054
217	0.066
224	0.075
231	0.111
238	0.156
245	0.547
252	0.089
259	0.059
266	0.046
273	0.039
280	0.034
287	0.030
294	0.027
301	0.025
308	0.023
315	0.022
322	0.021
329	0.019
336	0.019
343	0.018
350	0.017
357	0.016
364	0.016

basinbpre.out

+++++

End of computations, total study area = 0.215 (Ac.)

basinapost.out

San Diego County Rational Hydrology Program

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Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 04/03/19

***** 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) = 3.500
24 hour precipitation(inches) = 7.000
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 = 0.000
Decimal fraction soil group D = 1.000
[UNDISTURBED NATURAL TERRAIN]
(Permanent Open Space)
Impervious value, Ai = 0.000
Sub-Area C Value = 0.350
Initial subarea total flow distance = 332.000(Ft.)
Highest elevation = 1144.590(Ft.)
Lowest elevation = 1109.540(Ft.)
Elevation difference = 35.050(Ft.) slope = 10.557 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 10.56 %, in a development type of
Permanent Open Space
In Accordance With Figure 3-3
Initial Area Time of Concentration = 6.15 minutes
 $TC = [1.8 * (1.1 - C) * \text{distance}(\text{Ft.})^{.5}] / (\% \text{ slope}^{(1/3)})$
 $TC = [1.8 * (1.1 - 0.3500) * (100.000^{.5})] / (10.560^{(1/3)}) = 6.15$
The initial area total distance of 332.00 (Ft.) entered leaves a
remaining distance of 232.00 (Ft.)
Using Figure 3-4, the travel time for this distance is 1.23 minutes
for a distance of 232.00 (Ft.) and a slope of 10.56 %
with an elevation difference of 24.50(Ft.) from the end of the top area
 $Tt = [11.9 * \text{length}(\text{Mi})^3] / (\text{elevation change}(\text{Ft.}))^{.385} * 60(\text{min/hr})$
 $= 1.230 \text{ Minutes}$
 $Tt = [(11.9 * 0.0439^3) / (24.50)]^{.385} = 1.23$
Total initial area Ti = 6.15 minutes from Figure 3-3 formula plus
1.23 minutes from the Figure 3-4 formula = 7.38 minutes
Rainfall intensity (I) = 7.172(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.350
Subarea runoff = 1.632(CFS)
Total initial stream area = 0.650(Ac.)

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+++++
 Process from Point/Station 1.000 to Point/Station 2.000
 **** 6 HOUR HYDROGRAPH ****

+++++
 Hydrograph Data - Section 6, San Diego County Hydrology manual, June 2003

Time of Concentration = 7.38
 Basin Area = 0.65 Acres
 6 Hour Rainfall = 3.500 Inches
 Runoff Coefficient = 0.350
 Peak Discharge = 1.63 CFS

Time (Min)	Discharge (CFS)
0	0.000
7	0.048
14	0.048
21	0.050
28	0.050
35	0.052
42	0.053
49	0.054
56	0.055
63	0.057
70	0.058
77	0.060
84	0.061
91	0.063
98	0.065
105	0.068
112	0.069
119	0.072
126	0.074
133	0.078
140	0.080
147	0.085
154	0.088
161	0.095
168	0.098
175	0.107
182	0.112
189	0.124
196	0.132
203	0.151
210	0.164
217	0.200
224	0.228
231	0.334
238	0.471
245	1.632
252	0.268
259	0.179
266	0.140
273	0.118
280	0.102
287	0.091
294	0.083
301	0.076
308	0.071
315	0.066
322	0.062
329	0.059
336	0.056
343	0.053
350	0.051
357	0.049
364	0.047

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+++++

End of computations, total study area = 0.650 (Ac.)

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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: 04/03/19

***** 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) = 3.500
24 hour precipitation(inches) = 7.000
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 = 0.000
Decimal fraction soil group D = 1.000
[UNDISTURBED NATURAL TERRAIN]
(Permanent Open Space)
Impervious value, Ai = 0.000
Sub-Area C Value = 0.350
Initial subarea total flow distance = 210.000(Ft.)
Highest elevation = 1128.310(Ft.)
Lowest elevation = 1107.430(Ft.)
Elevation difference = 20.880(Ft.) slope = 9.943 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 9.94 %, in a development type of
Permanent Open Space
In Accordance With Figure 3-3
Initial Area Time of Concentration = 6.28 minutes
 $TC = [1.8 * (1.1 - C) * distance(Ft.)^{1.5}] / (% slope^{1/3})$
 $TC = [1.8 * (1.1 - 0.3500) * (100.000^{1.5})] / (9.940^{1/3}) = 6.28$
The initial area total distance of 210.00 (Ft.) entered leaves a
remaining distance of 110.00 (Ft.)
Using Figure 3-4, the travel time for this distance is 0.71 minutes
for a distance of 110.00 (Ft.) and a slope of 9.94 %
with an elevation difference of 10.93(Ft.) from the end of the top area
 $Tt = [11.9 * length(Mi)^3] / (elevation change(Ft.))^{1.385} * 60(min/hr)$
 $= 0.709 Minutes$
 $Tt = [(11.9 * 0.0208^3) / (10.93)]^{1.385} = 0.71$
Total initial area Ti = 6.28 minutes from Figure 3-3 formula plus
0.71 minutes from the Figure 3-4 formula = 6.99 minutes
Rainfall intensity (I) = 7.431(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.350
Subarea runoff = 0.489(CFS)
Total initial stream area = 0.188(Ac.)

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+++++
 Process from Point/Station 1.000 to Point/Station 2.000
 **** 6 HOUR HYDROGRAPH ****

+++++
 Hydrograph Data - Section 6, San Diego County Hydrology manual, June 2003

Time of Concentration = 6.99
 Basin Area = 0.19 Acres
 6 Hour Rainfall = 3.500 Inches
 Runoff Coefficient = 0.350
 Peak Discharge = 0.49 CFS

Time (Min)	Discharge (CFS)
0	0.000
6	0.014
12	0.014
18	0.014
24	0.014
30	0.015
36	0.015
42	0.015
48	0.015
54	0.016
60	0.016
66	0.017
72	0.017
78	0.017
84	0.018
90	0.018
96	0.018
102	0.019
108	0.020
114	0.020
120	0.021
126	0.022
132	0.022
138	0.023
144	0.024
150	0.025
156	0.026
162	0.027
168	0.028
174	0.030
180	0.031
186	0.034
192	0.036
198	0.040
204	0.042
210	0.048
216	0.052
222	0.064
228	0.073
234	0.107
240	0.151
246	0.489
252	0.086
258	0.057
264	0.045
270	0.038
276	0.033
282	0.029
288	0.026
294	0.024
300	0.023
306	0.021
312	0.020

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318	0.019
324	0.018
330	0.017
336	0.016
342	0.016
348	0.015
354	0.015
360	0.014
366	0.014
+++++	

End of computations, total study area = 0.188 (Ac.)

ATTACHMENT 5

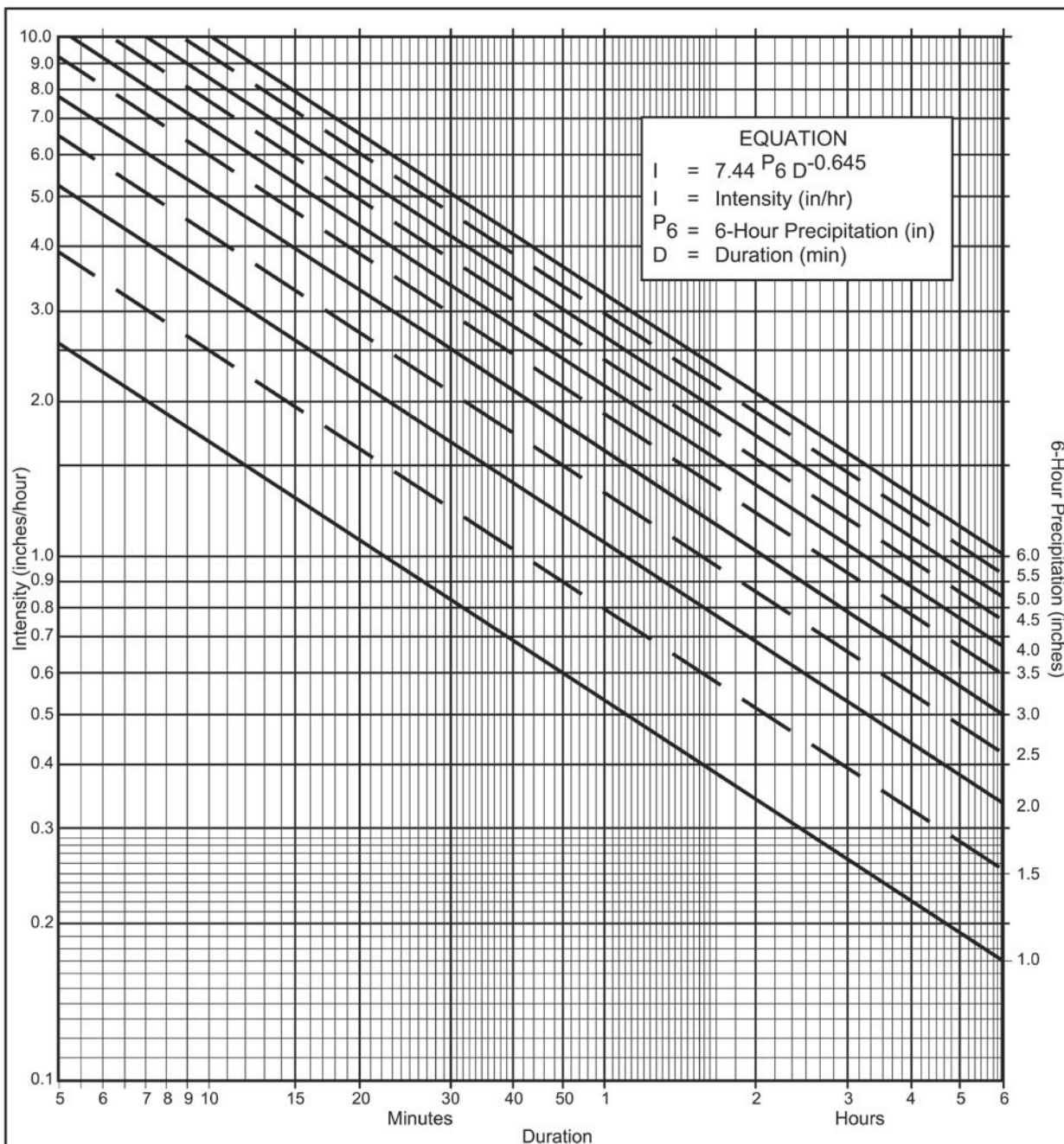
**Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS**

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

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, C_p , 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



Directions for Application:

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

Application Form:

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

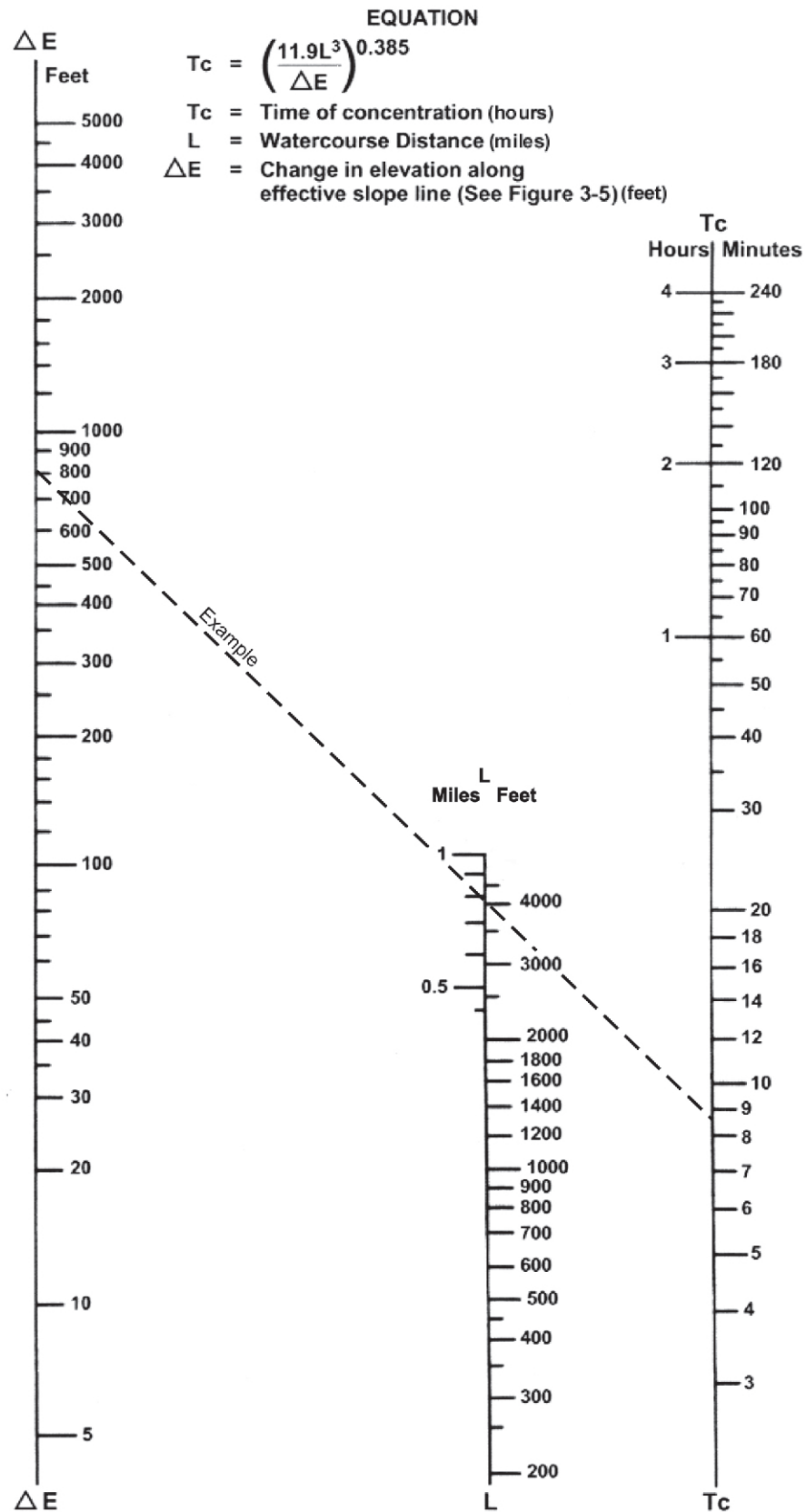
Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
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



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

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

FIGURE

3-4

