CEQA DRAINAGE STUDY FOR

VIDOVICH SUBDIVISION
TPM 21104 / PROJECT NO. 3200

COUNTY OF SAN DIEGO, CALIFORNIA

Prepared On:

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I. PROJECT DESCRIPTION

This drainage report has been prepared to document the design and calculations for the proposed drainage system associated with the Vidovich subdivision located in the Jamul Community of San Diego County. The project site is 5.43 acres in size and is bounded on the north, south, east and west by single-family residences. The site currently contains one single-family residence and separate garage structure located at the top of a small knoll. The onsite elevations range from 1213 at the center of the property, to 1123 at the southeast corner of the property.

The proposed design consists of subdividing the property in 4 parcels, each 1.0 acres in size or greater. Each parcel will have a graded pad of roughly 10,000 square feet in size, with a 20-foot wide graded driveway. Vehicular access to the site is provided via a paved, private driveway connecting to Heide Lane, and a new paved, private driveway located on Parcels 1, 2 & 3.

II. HYDROLOGY / HYDRAULICS METHODOLOGY

This drainage system has been designed in general conformance with the County of San Diego Hydrology Manual, 2003 Edition (H-Manual) and the San Diego County Drainage Design Manual (D-Manual). Drainage basins are less than one square mile, therefore, the Rational Method was utilized to calculate storm runoff values for the 2-year, 50-year and 100-year storms. Additionally:

- The runoff coefficients were calculated based on each drainage basin's percentage of impervious cover and the values from the "Runoff Coefficients for Urban Areas", Table 3-1 of the H-Manual (Soil Type 'B').

- Times of concentration for were calculated using the "Nomograph for Determination of Time of Concentration for Natural Watersheds", Figure 3-4 of the H-Manual.

- The intensities of rainfall were obtained from the "Intensity – Duration Design Chart", Figure 3-1 of the H-Manual, for each of the selected storm frequencies (2, 50 & 100-year).

III. EXISTING CONDITION DRAINAGE

As mentioned earlier, the project site currently contains a single-family residence and a separate garage structure located on a small knoll in the center of the property. The maximum knoll elevation is approximately 1213, and the low point of the property is in the southeast corner at elevation 1123. The property slopes away from the knoll in each direction, and there are no significant drainage courses on-site. Thus the runoff from the project is conveyed via surface flow to the north, south, east and west.

The property in the Existing Condition Drainage was divided into three drainage basins, one draining to the west, one to the east, and one to the south. As shown on Figure 2, Basin EX-1 collects runoff from the west side of the property and conveys it via surface flow to the northerly and westerly property lines. There are no existing runoff conveyance or collection facilities for this basin. This basin contains 1.70 acres and has a 'c' factor of 0.36, resulting in a 100-year storm runoff value of 3.73 cfs (see Appendix 1 for hydrological calculations and Table 1 for a hydrology summary).

Basin EX-2 collects runoff from the east side of the property and conveys it via surface flow to the easterly property line. There are no existing runoff conveyance or collection facilities for this basin. This basin contains 2.30 acres and has a 'c' factor of 0.33, resulting in a 100-year storm runoff value of 4.68 cfs.

Basin EX-3 comprises 1.43 acres and collects runoff from the south side of the property. This runoff travels to the south via surface flow towards the southerly property line. Like the other two Existing Condition drainage basins, this basin contains no existing runoff conveyance or collection facilities. A 'c' factor of 0.35 was calculated for this basin, resulting in a 100-year storm runoff value of 3.13 cfs.

The total Existing Condition 100-year storm runoff for the project was calculated to be 11.54 cfs, conveyed via surface flow to the westerly, easterly and southerly property line. The existing off-site drainage courses that ultimately carry the flows described above have been in existence for some time, and based on physical inspection, the existing drainage facilities appear to be adequate for the flows tributary to them. No erosion nor flooding issues were witnessed that would require remedial action.

IV. EXISTING PLUS PROPOSED CONDITION DRAINAGE

The Existing Plus Proposed Condition Drainage has also been divided into three drainage basins, one on the west, one on the east, and one on the south. Basin A1 collects runoff on the west side of the project and conveys it to the west via surface flow. This basin comprises 1.70 acres and has a 'c' factor of 0.40, resulting in a 100-year storm runoff value of 4.03 cfs. This basin contains a proposed paved private driveway providing access to Parcels 1, 2 & 3. As such, a bioretention basin is proposed to capture, detain, and treat the runoff from this basin. See the "Hydromodification Report for Vidovich Subdivision", prepared by Polaris Development Consultants, Inc., dated 7/27/11, for more information.

Basin B1 collects runoff from the east side of the property and conveys it via surface flow to the easterly property line. This basin contains 2.30 acres and has a 'c' factor of 0.32, resulting in a 100-year storm runoff value of 4.45 cfs. No new runoff conveyance or collection facilities are proposed for this basin.

Basin C1 comprises 1.43 acres and collects runoff from the south side of the property. This runoff travels to the south via surface flow towards the southerly property line. This basin

proposes no new runoff conveyance or collection facilities. A 'c' factor of 0.32 was calculated for this basin, resulting in a 100-year storm runoff value of 2.75 cfs.

The total Existing plus Proposed Condition 100-year storm runoff for the project was calculated to be 11.23 cfs.

V. CONCLUSIONS

FLOW COMPARISON AND DETENTION

The total flow exiting the project site in the Existing Condition Drainage was calculated to be 11.54 cfs for the 100-year storm. The same value for the Existing plus Proposed Condition Drainage was calculated to be 11.23 cfs. This equates to a decrease of 0.31 cfs for the 100-year storm event with the development of this project. Analyzed by individual basin, the westerly portion of the site will experience an increase of 0.30 cfs of 100-year storm runoff, while the easterly and southerly portions of the site will experience decreases of 0.23 cfs and 0.38 cfs, respectively. Thus the project will need to detain a portion of the runoff from the westerly basin only. See the "Hydromodification Report for Vidovich Subdivision", prepared by Polaris Development Consultants, Inc., dated 7/27/11, for a description and the design of the proposed bioretention basin for this project.

As shown by comparing Figures 2 and 3, the proposed project does not divert drainage from one basin to another. The basin acreages in the Existing and Existing Plus Proposed conditions are identical, although the basin boundaries do have slight variations.

EXIT VELOCITIES

An analysis of exit velocities for the project under the Existing and Existing Plus Proposed Conditions was not performed as there are no defined drainage courses on-site, and there are no significant changes in the slope of the property between the two conditions.

DOWNSTREAM DRAINAGE

As stated earlier, there does not appear to be any pre-existing flooding or erosion issues present in the downstream drainage courses that serve this project site. Since this project will not be increasing flows leaving the site, flooding and erosion issues should not be created with the development of this project. Thus, downstream mitigation measures are not necessary. And since the downstream flow characteristics will not be impacted by the proposed development, Waiver and Release Agreements from downstream property owners should not be required by the County Department of Public Works.

WATER QUALITY

This project proposes to incorporate a bioretention basin in Basin A1 located adjacent to the proposed private driveway. This facility will allow for runoff infiltration and will capture trash and pollutants before they have a chance to leave the site and pollute downstream drainage courses. Basins B1 and C1 contain no impervious surfaces, thus all runoff from these basins will have ample natural surfaces to provide infiltration and cleansing prior to leaving the site.

DRAINAGE FACILITY MAINTENANCE

Due to the bioretention basin proposed for this subdivision, a maintenance mechanism needs to be established with this project to address the long-term care and maintenance of this facility. As described in the County of San Diego Standard Urban Stormwater Mitigation Plan (SUSMP), this facility would be considered a Category 1 BMP. Thus each homeowner will be required to maintain the portion of the bioretention basin within their property, and provide the County with annual documentation verifying that the BMP's are maintained and functioning properly. The County will provide minimal oversight, and no initial funding is required by the landowner.

CEQA QUESTIONING

#1 *Would the project substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on-or off-site?*

No. As detailed earlier in this document, the proposed project will not substantially alter the existing drainage patterns in this area. Slight modifications will be made to some of the on-site drainage patterns, but these will have no effect on the overall drainage design of this area as a whole. Also, the project will landscape areas that are to be graded and some of the existing bare areas. This will help to reduce the sediment load in the existing and proposed drainage courses. Thus the proposed project will not result in substantial erosion or siltation on- or off-site.

#2 *Would the project substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?*

No. There does not appear to be any existing flooding issues on- or off-site, and since the proposed project does not alter existing drainage patterns nor increase flows, there should be no increase in flooding on- or off-site.

#3 *Would the project create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems?*

No. The proposed project will not create nor contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems. As previously mentioned, the project will incorporate a bioretention basin that will detain peak flows and restrict exiting flows to leave the site at their pre-development values. Since the existing drainage facilities in the vicinity of this project are adequate to handle the existing flows, they will also be adequate to handle the existing plus proposed flows.

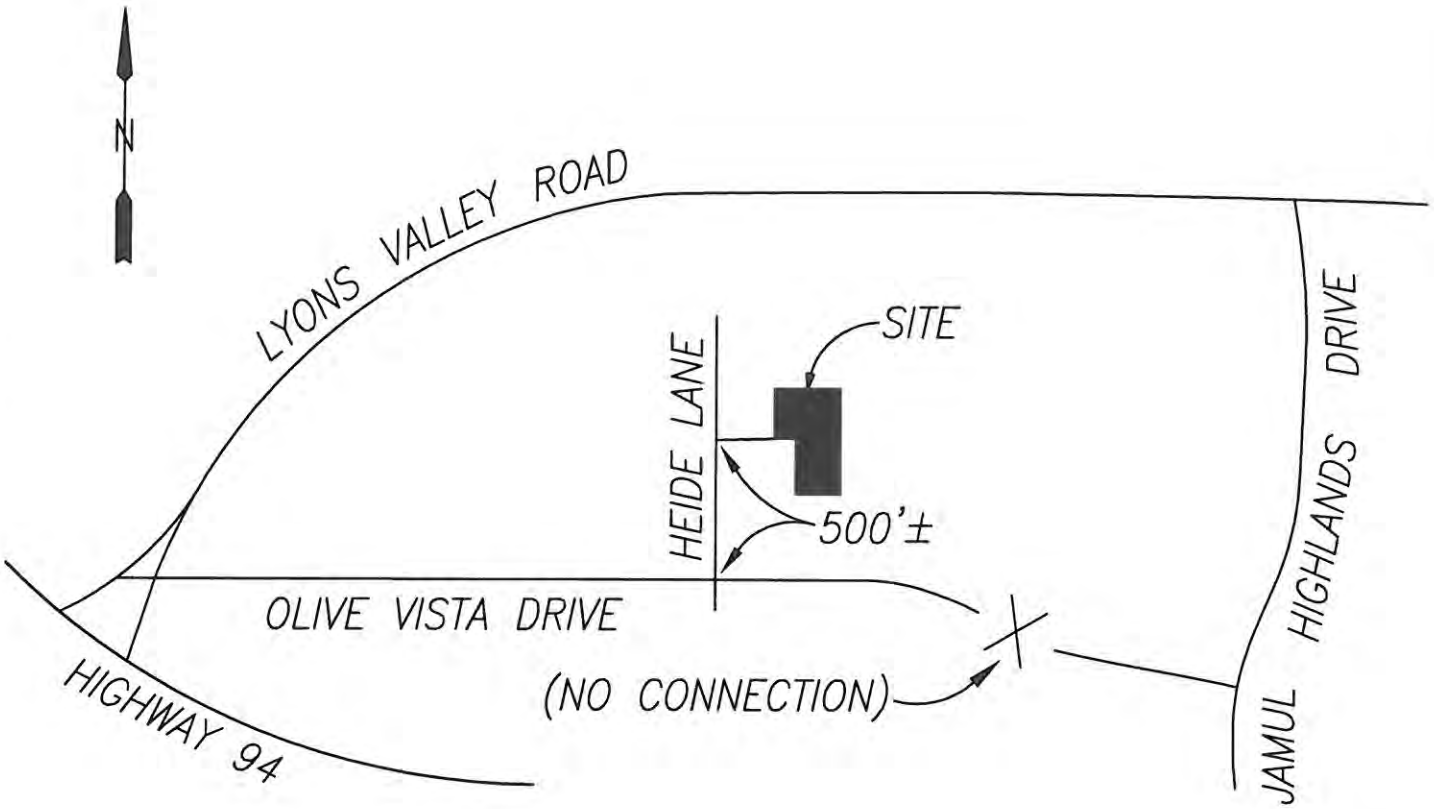
#4 *Would the project place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map, including County Floodplain Maps?*

No. The proposed project will not place housing within a 100-year flood hazard area. This was verified by checking the County of San Diego Floodplain Maps, which showed no floodplain in the vicinity of this project, and by viewing the FEMA Flood Insurance Rate Maps (FIRM), which determined the project to be outside of the 500-year floodplain.

#5 *Would the project place within a 100-year flood hazard area structures which would impede or redirect flood flows?*
No. The proposed project will not place within a 100-year flood hazard area structures which would impede or redirect flood flows. As stated in Question 4, the proposed project does not contain any areas within a 100-year flood hazard area. All portions of the proposed project are located outside of the 500-year floodplain.

#6 *Would the project expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam on-site or off-site?*
No. There are no dams or levees proposed for this project, nor are there any dams or levees located upstream of this project. Thus this project will not expose people or structures to a significant risk of loss, injury or death as a result of a dam or levee failure. In addition, this project should not create any significant flooding issues, as discussed in Question #2.

FIGURE 1



VICINITY MAP

NO SCALE

TABLE 1 HYDROLOGY SUMMARY

EXISTING CONDITION

BASIN NUMBER	AREA (acres)	C	L (ft.)	S (%) Heff	Tc (min.)	I_2 (in/hr)	I_{50} (in/hr)	I_{100} (in/hr)	Q_2 (cfs)	Q_{50} (cfs)	Q_{100} (cfs)	COMMENTS
EX-1	1.70	0.36	300	9.3	8.20	2.86	5.33	6.09	**1.75**	**3.26**	**3.73**	
EX-2	2.30	0.33	489	18.0	8.12	2.89	5.40	6.17	**2.19**	**4.10**	**4.68**	
EX-3	1.43	0.35	451	18.0	7.94	2.93	5.47	6.25	**1.47**	**2.74**	**3.13**	
TOTAL	**5.43**									**10.10**	**11.54**	

EXISTING PLUS PROPOSED CONDITION

BASIN NUMBER	AREA (acres)	C	L (ft.)	S (%) Heff	Tc (min.)	I_2 (in/hr)	I_{50} (in/hr)	I_{100} (in/hr)	Q_2 (cfs)	Q_{50} (cfs)	Q_{100} (cfs)	COMMENTS
A1	1.70	0.40	295	8.5	8.65	2.78	5.18	5.92	**1.89**	**3.52**	**4.03**	
B1	2.30	0.32	530	16.0	8.37	2.83	5.29	6.05	**2.08**	**3.89**	**4.45**	
C1	1.43	0.32	542	14.2	8.45	2.82	5.26	6.01	**1.29**	**2.41**	**2.75**	
TOTAL	**5.43**									**9.82**	**11.23**	
TOTAL EXISTING PLUS PROPOSED CONDITION FLOW										**9.82**	**11.23**	
TOTAL EXISTING CONDITION FLOW										**10.10**	**11.54**	
								DIFFERENCE		**-0.28**	**-0.31**	

FIGURE 2
EXISTING HYDROLOGY MAP

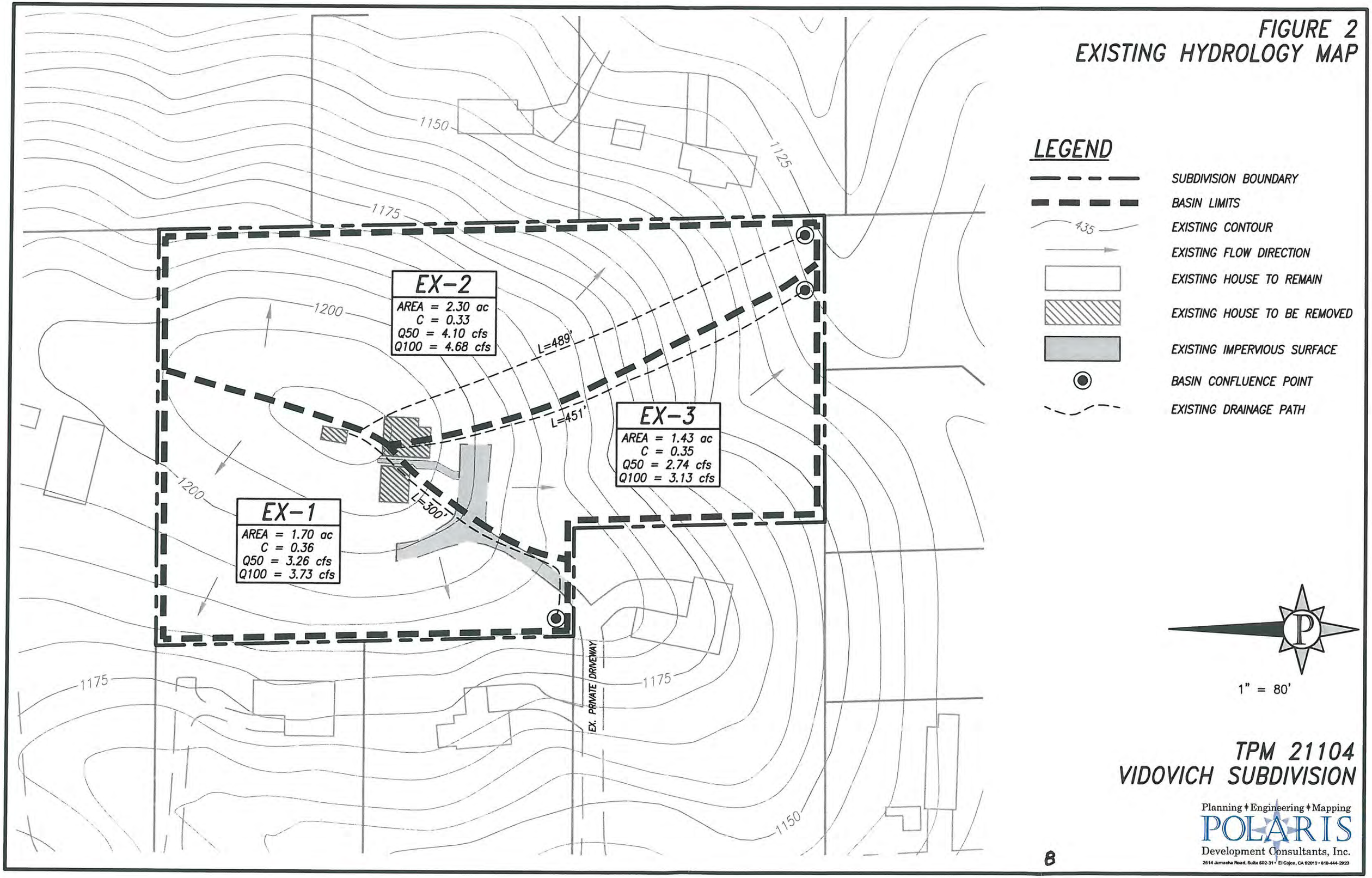


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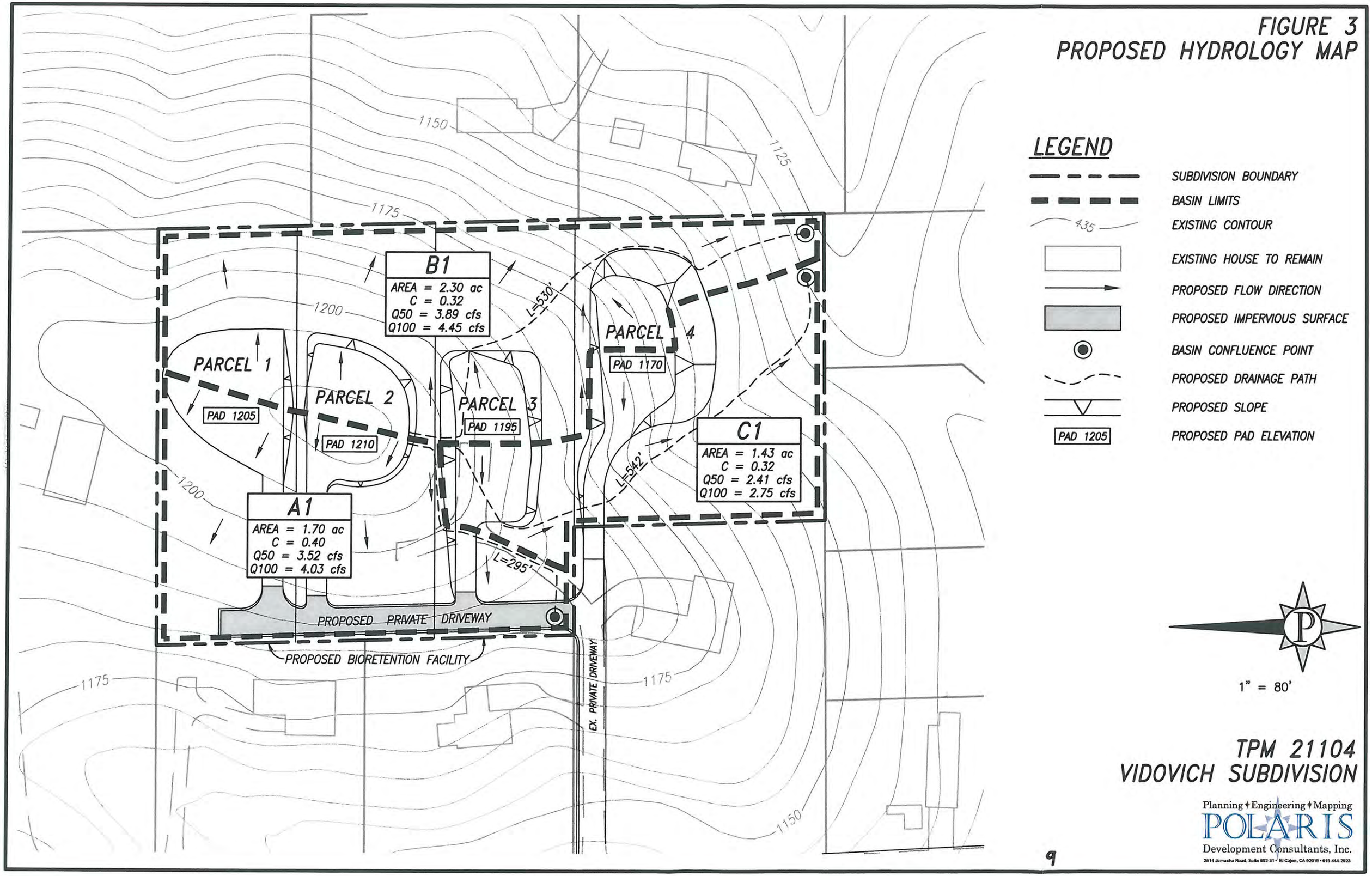
FIGURE 3
PROPOSED HYDROLOGY MAP



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APPENDIX 1

HYDROLOGICAL CALCULATIONS – EXISTING CONDITION

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HYDROLOGY CALCS

EXISTING CONDITION

BASIN EX-1

AREA = 1.70 AC

SOIL TYPE 'B'

'C' = 0.93(0.32) + 0.07(0.90) = 0.36

L = 300' (= 0.06 mi)

SLOPE = (1213 - 1185)/300' = 9.3%

$T_C = T_I + T_T$

T_I = 6.6 MIN. (TABLE 3-2; 1 DU/AC; INTERPOLATED)

$$T_T = \left(\frac{11.9L^3}{\Delta E}\right)^{.385}$$

$$T_T = \left(\frac{11.9(0.06)^3}{28}\right)^{.385} \times 60 = 1.67 \text{ MIN.}$$

T_C = 6.6 + 1.67 = 8.27 MIN.

$I_2 = 7.44 P_{62} T_C^{-.645}$ $\quad P_{62} = 1.5$

$I_2 = 7.44(1.5)8.27^{-.645}$ = 2.86 IN/HR

$I_{50} = 7.44 P_{650} T_C^{-.645}$ $\quad P_{650} = 2.8$

$I_{50} = 7.44(2.8)8.27^{-.645}$ = 5.33 IN/HR

$I_{100} = 7.44 P_{6100} T_C^{-.645}$ $\quad P_{6100} = 3.2$

$I_{100} = 7.44(3.2)8.27^{-.645}$ = 6.09 IN/HR

$$Q_2 = CAI_2$$
$$= (0.36)(1.70)(2.86)$$
$$\boxed{Q_2 = 1.75 \text{ CFS}}$$

$$Q_{50} = CAI_{50}$$
$$= (0.36)(1.70)(5.33)$$
$$\boxed{Q_{50} = 3.26 \text{ CFS}}$$

$$Q_{100} = CAI_{100}$$
$$= (0.36)(1.70)(6.09)$$
$$\boxed{Q_{100} = 3.73 \text{ CFS}}$$

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STAEDTLER® No. 937 811E Engineer's Computation Pad

BASIN EX-2

AREA = 2.30 AC

SOIL TYPE 'B'

$C = 0.99(0.32) + 0.01(0.90) = 0.33$

$L = 489'$ (= 0.09 mi)

$SLOPE = \frac{(1213 - 1125)}{489} = 18.0\%$

$T_C = T_i + T_T$

$T_i = 6.4$ MIN. (TABLE 3-2; 1 DU/AC)

$T_T = \left[\frac{11.9(0.09)^3}{88}\right]^{.385} \times 60 = 1.72$ MIN.

$T_C = 6.4 + 1.72 = 8.12$ MIN.

$I_2 = 7.44(1.5)\,8.12^{-.645} = 2.89$ IN/HR

$I_{50} = 7.44(2.8)\,8.12^{-.645} = 5.40$ IN/HR

$I_{100} = 7.44(3.2)\,8.12^{-.645} = 6.17$ IN/HR

$Q_2 = CAI_2 = (0.33)(2.30)(2.89) = 2.19$ CFS

$Q_{50} = CAI_{50} = (0.33)(2.30)(5.40) = 4.10$ CFS

$Q_{100} = CAI_{100} = (0.33)(2.30)(6.17) = 4.68$ CFS

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BASIN EX-3

AREA = 1.43 AC

SOIL TYPE 'B'

$C = 0.95(0.32) + 0.05(0.90) = 0.35$

$L = 451'$ (= 0.08 mi)

$SLOPE = \frac{(1210 - 1128)}{451} = 18\%$

$T_C = T_i + T_T$

$T_i = 6.4$ MIN. (TABLE 3-2; 1 DU/AC)

$T_T = \left[\frac{11.9\,(0.08)^3}{82}\right]^{.385} \times 60 = 1.54$ MIN.

$T_C = 6.4 + 1.54 = 7.94$ MIN.

$I_2 = 7.44(1.5)\,7.94^{-.645} = 2.93$ IN/HR

$I_{50} = 7.44(2.8)\,7.94^{-.645} = 5.47$ IN/HR

$I_{100} = 7.44(3.2)\,7.94^{-.645} = 6.25$ IN/HR

$Q_2 = CAI_2 = (0.35)(1.43)(2.93) = 1.47$ CFS

$Q_{50} = CAI_{50} = (0.35)(1.43)(5.47) = 2.74$ CFS

$Q_{100} = CAI_{100} = (0.35)(1.43)(6.25) = 3.13$ CFS

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EXISTING PLUS PROPOSED CONDITION

BASIN A1

AREA = 1.70 AC

SOIL TYPE 'B'

'C' = 0.87(0.32) + 0.13(0.90) = 0.40

(13% IMPERVIOUS)

L = 295' (0.06 mi)

SLOPE = $\left(\frac{1210 - 1185}{295}\right)$ = 8.5%

$T_C = T_i + T_T$

T_i = 6.9 MIN. (TABLE 3-2; 1 DU/AC; INTERPOLATED)

$T_T = \left[\frac{11.9\,(0.06)^3}{25}\right]^{.385} \times 60 = 1.75$ MIN.

$T_C = 6.9 + 1.75 = 8.65$ MIN.

$I_2 = 7.44(1.5)\,8.65^{-.645} = 2.78$ IN/HR

$I_{50} = 7.44(2.8)\,8.65^{-.645} = 5.18$ IN/HR

$I_{100} = 7.44(3.2)\,8.65^{-.645} = 5.92$ IN/HR

$Q_2 = CAI_2 = (0.40)(1.70)(2.78) = 1.89$ CFS

$Q_{50} = CAI_{50} = (0.40)(1.70)(5.18) = 3.52$ CFS

$Q_{100} = CAI_{100} = (0.40)(1.70)(5.92) = 4.03$ CFS

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BASIN B1

AREA = 2.30 AC

SOIL TYPE 'B'

'c' = 0.32 (NO IMPERVIOUS SURFACES)

L = 530' (0.10 mi)

SLOPE = $\frac{(1210-1125)}{530'}$ = 16.0%

$T_c = T_i + T_T$

T_i = 6.4 MIN. (TABLE 3-2; 1 DU/AC)

$T_T = \left[\frac{11.9(0.10)^3}{85}\right]^{.385} \times 60 = 1.97$ MIN.

$T_c = 6.4 + 1.97 = 8.37$ MIN.

$I_2 = 7.44(1.5)8.37^{-.645} = 2.83$ IN/HR

$I_{50} = 7.44(2.8)8.37^{-.645} = 5.29$ IN/HR

$I_{100} = 7.44(3.2)8.37^{-.645} = 6.05$ IN/HR

$Q_2 = CAI_2 = (0.32)(2.30)(2.83) = 2.08$ CFS

$Q_{50} = CAI_{50} = (0.32)(2.30)(5.29) = 3.89$ CFS

$Q_{100} = CAI_{100} = (0.32)(2.30)(6.05) = 4.45$ CFS

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BASIN C1

AREA = 1.43 AC

SOIL TYPE 'B'

C = 0.32 (NO IMPERVIOUS SURFACES)

L = 542' (= 0.10 mi)

SLOPE = $\frac{(1205-1128)}{542}$ = 14.2%

$T_c = T_i + T_T$

T_i = 6.4 MIN. (TABLE 3-2; 1 DU/AC)

$T_T = \left[\frac{11.9(0.10)^3}{77}\right]^{.385} \times 60 = 2.05$ MIN.

$T_c = 6.4 + 2.05 = 8.45$ MIN.

$I_2 = 7.44(1.5)\,8.45^{-.645} = 2.82$ IN/HR

$I_{50} = 7.44(2.8)\,8.45^{-.645} = 5.26$ IN/HR

$I_{100} = 7.44(3.2)\,8.45^{-.645} = 6.01$ IN/HR

$Q_2 = CAI_2 = (0.32)(1.43)(2.82) = 1.29$ CFS

$Q_{50} = CAI_{50} = (0.32)(1.43)(5.26) = 2.41$ CFS

$Q_{100} = CAI_{100} = (0.32)(1.43)(6.01) = 2.75$ CFS

APPENDIX 2

COUNTY OF SAN DIEGO DRAINAGE DESIGN MANUAL CHARTS/FIGURES/TABLES

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.

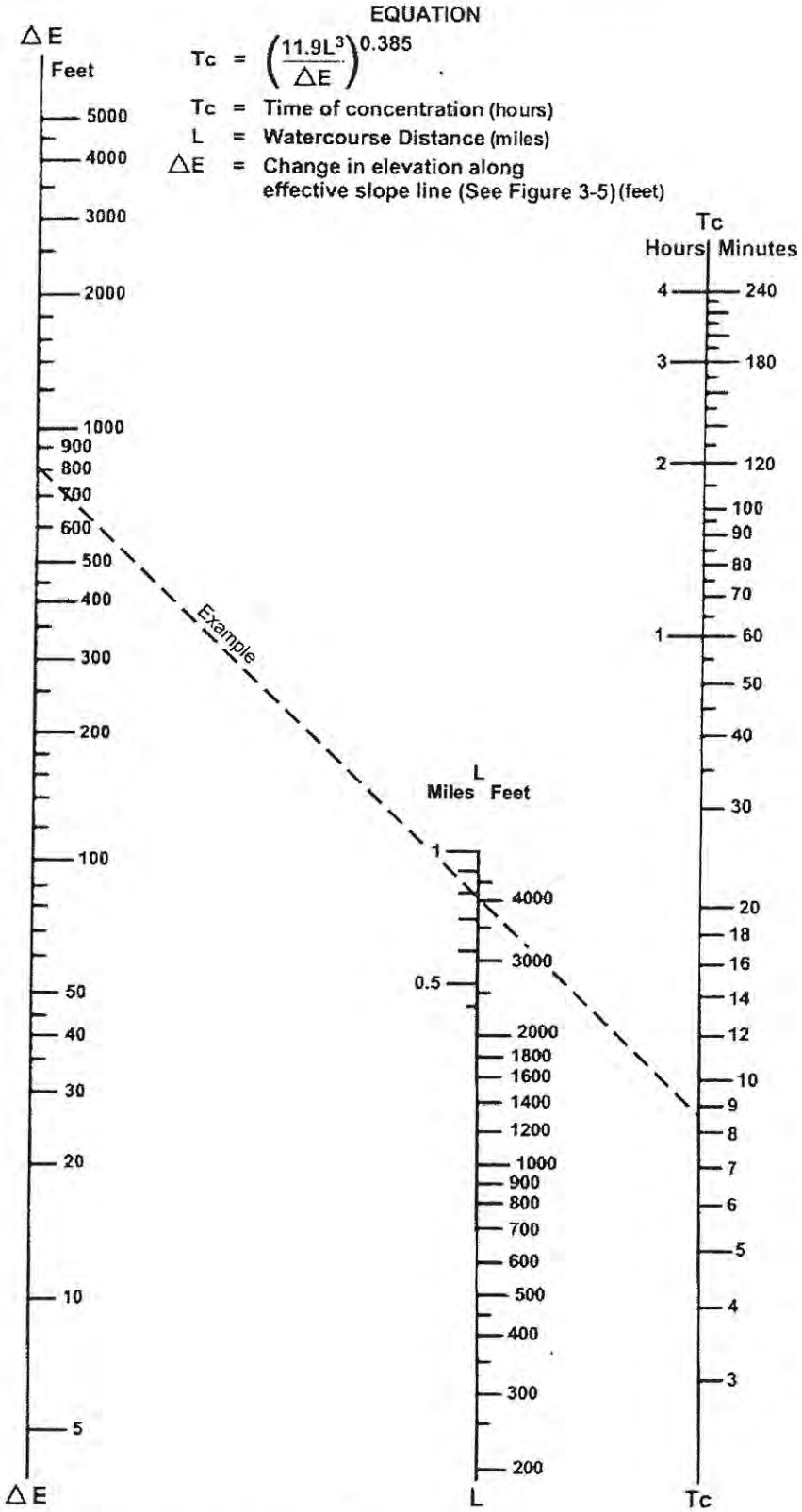
Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved 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/	.5%		1%		2%		3%		5%		10%	
	Acre	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

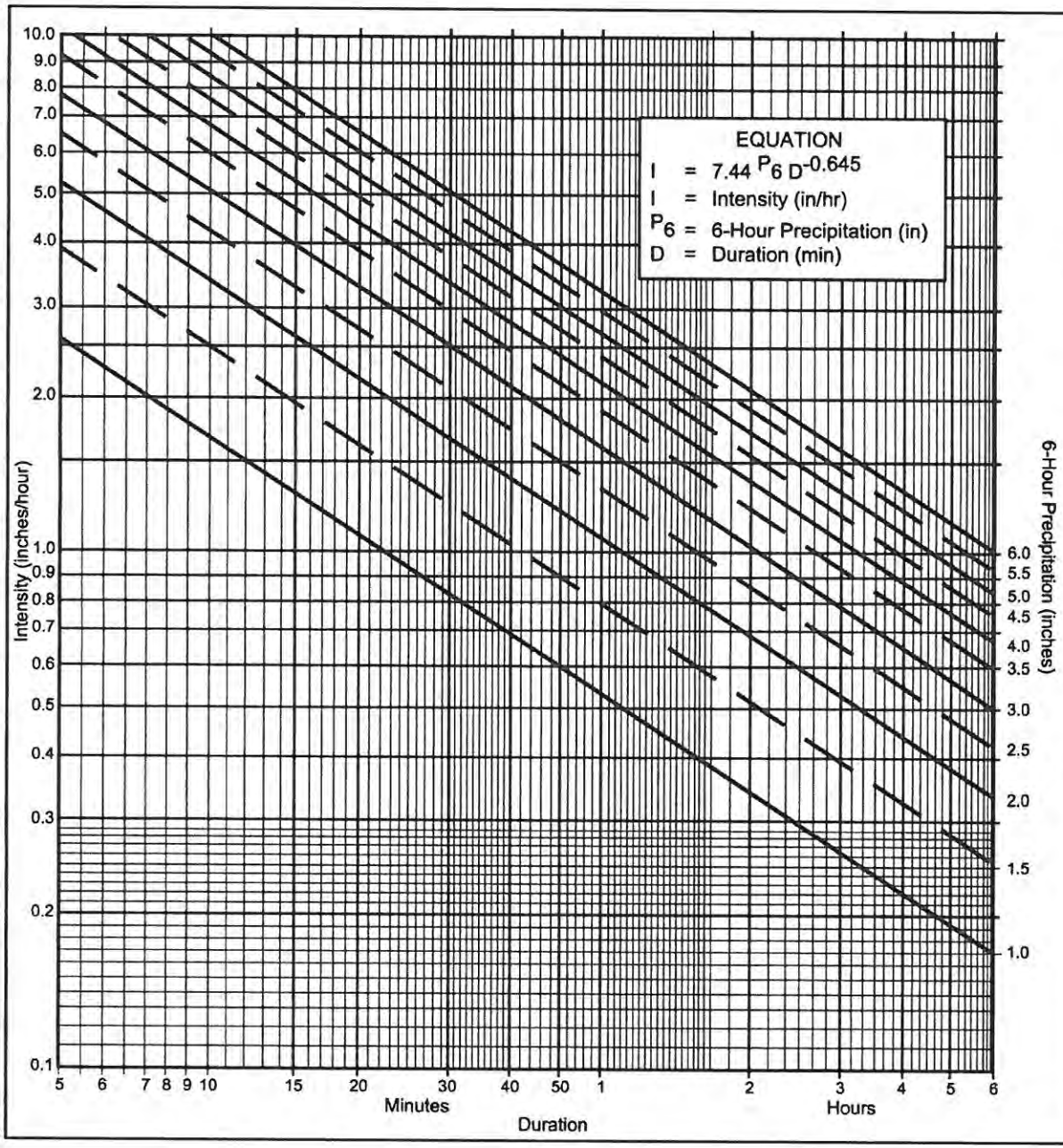


SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE

3-4

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



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 2 year

(b) P_6 = 1.5 in., P_{24} = 2.5, $\frac{P_6}{P_{24}}$ = 60 %(2)

(c) Adjusted $P_6^{(2)}$ = 1.5 in.

(d) t_x = _____ min.

(e) I = _____ in./hr.

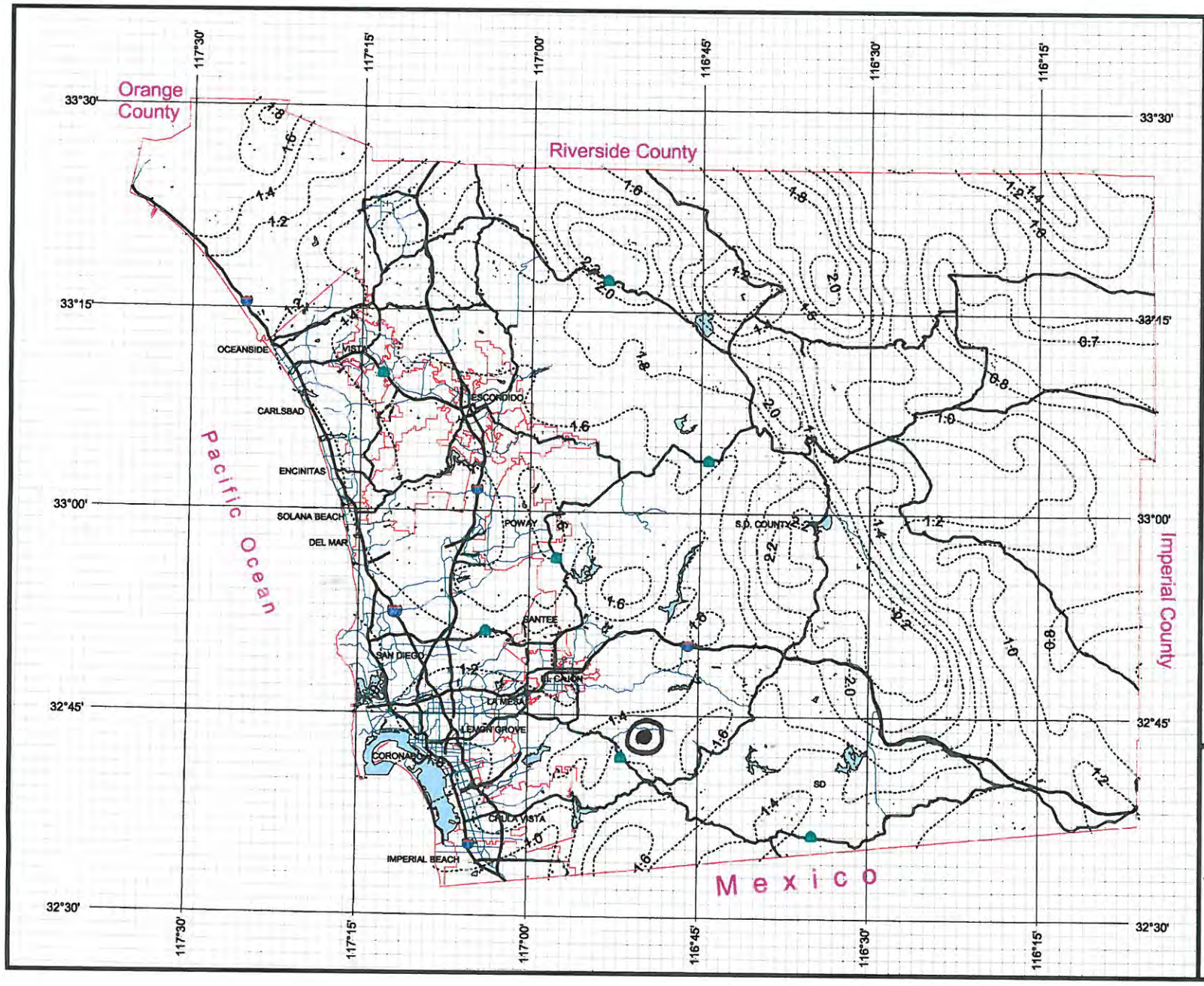
Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

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



County of San Diego Hydrology Manual

Rainfall Isopluvials

2 Year Rainfall Event - 6 Hours

Isopluvial (inches)

DPW GIS
Department of Public Works Geographic Information Solution

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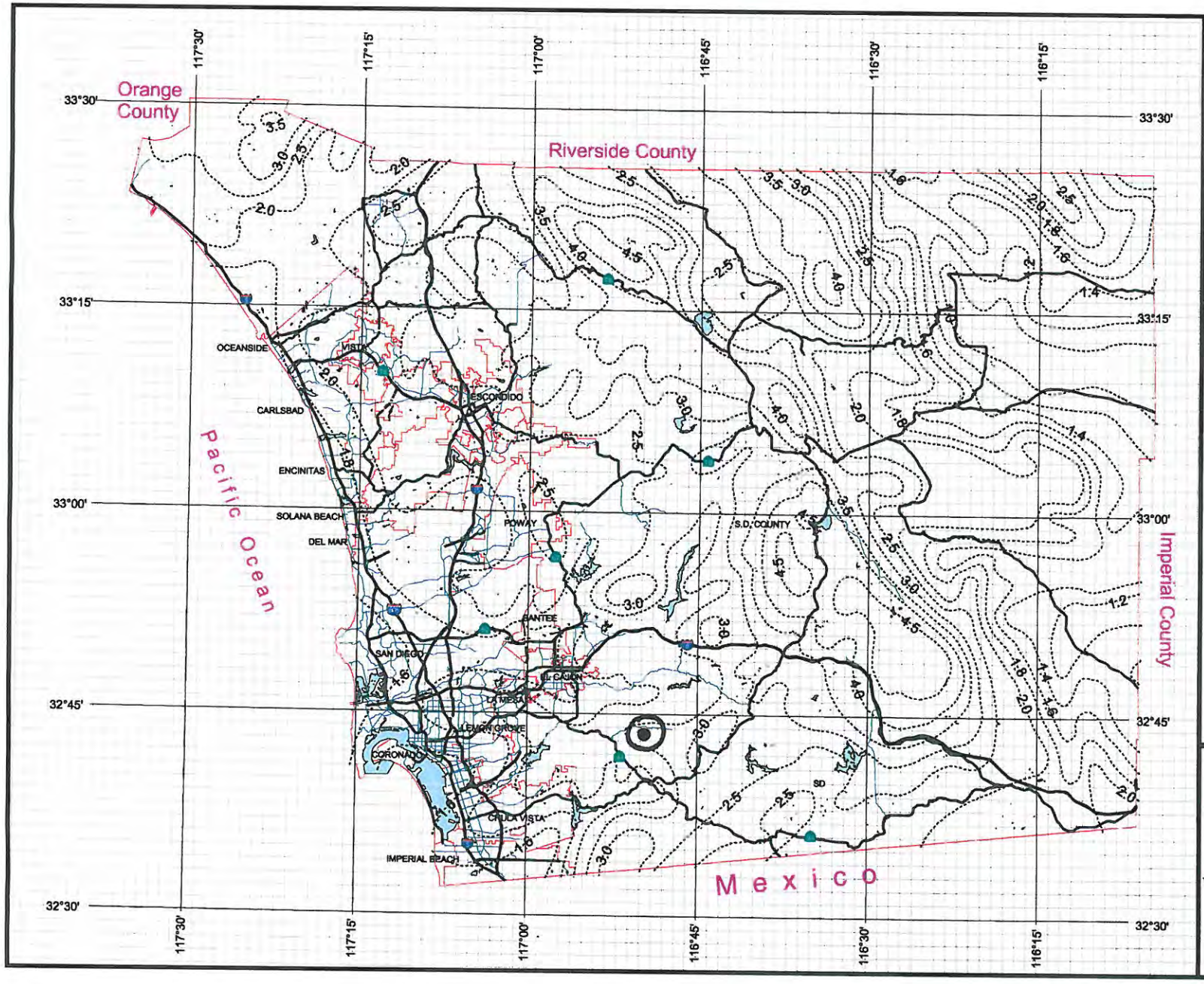

County of San Diego Hydrology Manual

Rainfall Isopluvials

2 Year Rainfall Event - 24 Hours

Isopluvial (inches)

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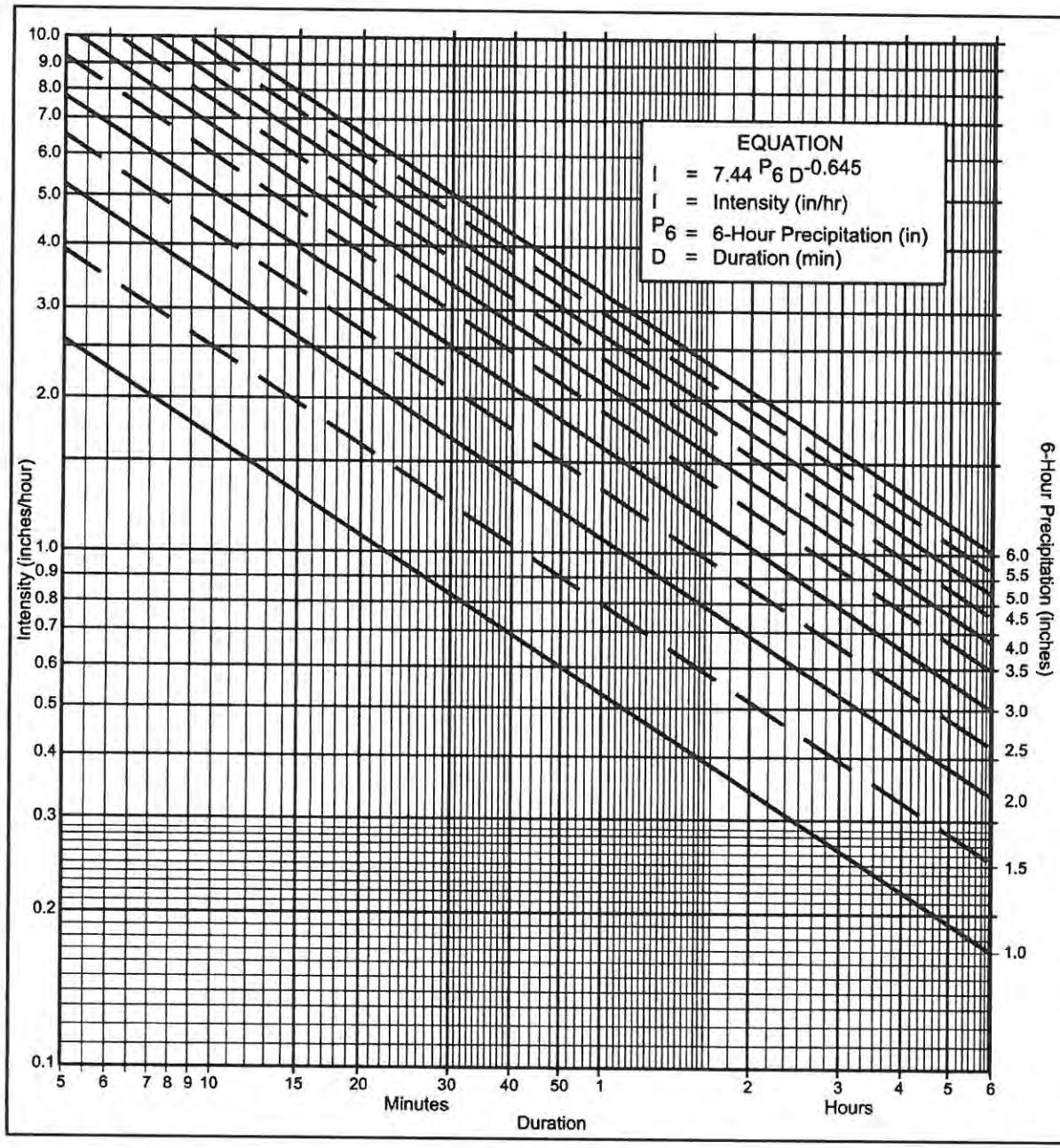


Directions for Application:

(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 50 year

(b) P_6 = 2.8 in., P_{24} = 6.0 , $\frac{P_6}{P_{24}}$ = 47 %(2)

(c) Adjusted P_6(2) = 2.8 in.

(d) t_x = _____ min.

(e) I = _____ in./hr.

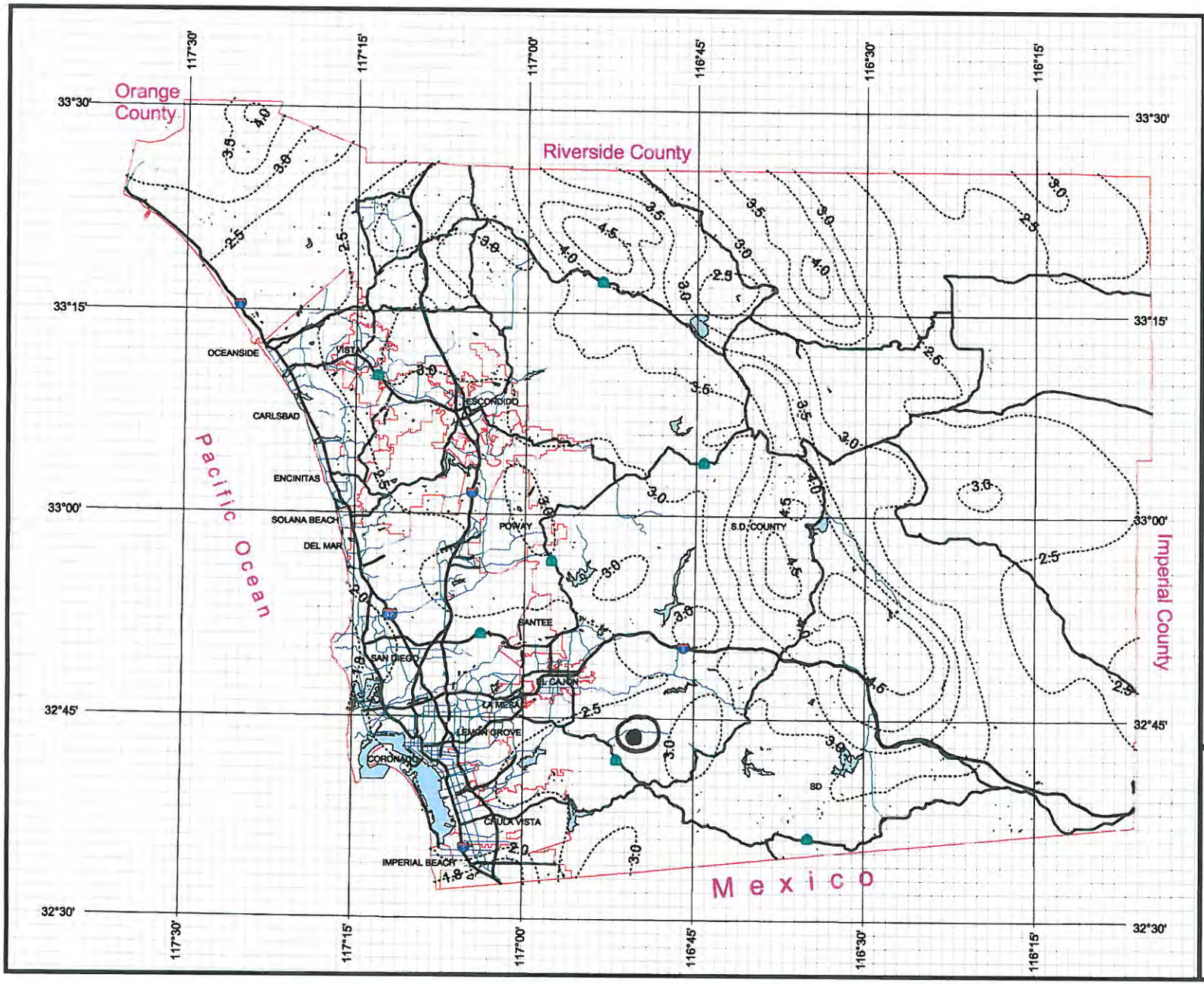
Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

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



County of San Diego Hydrology Manual

Rainfall Isopluvials

50 Year Rainfall Event - 6 Hours

Isopluvial (inches)

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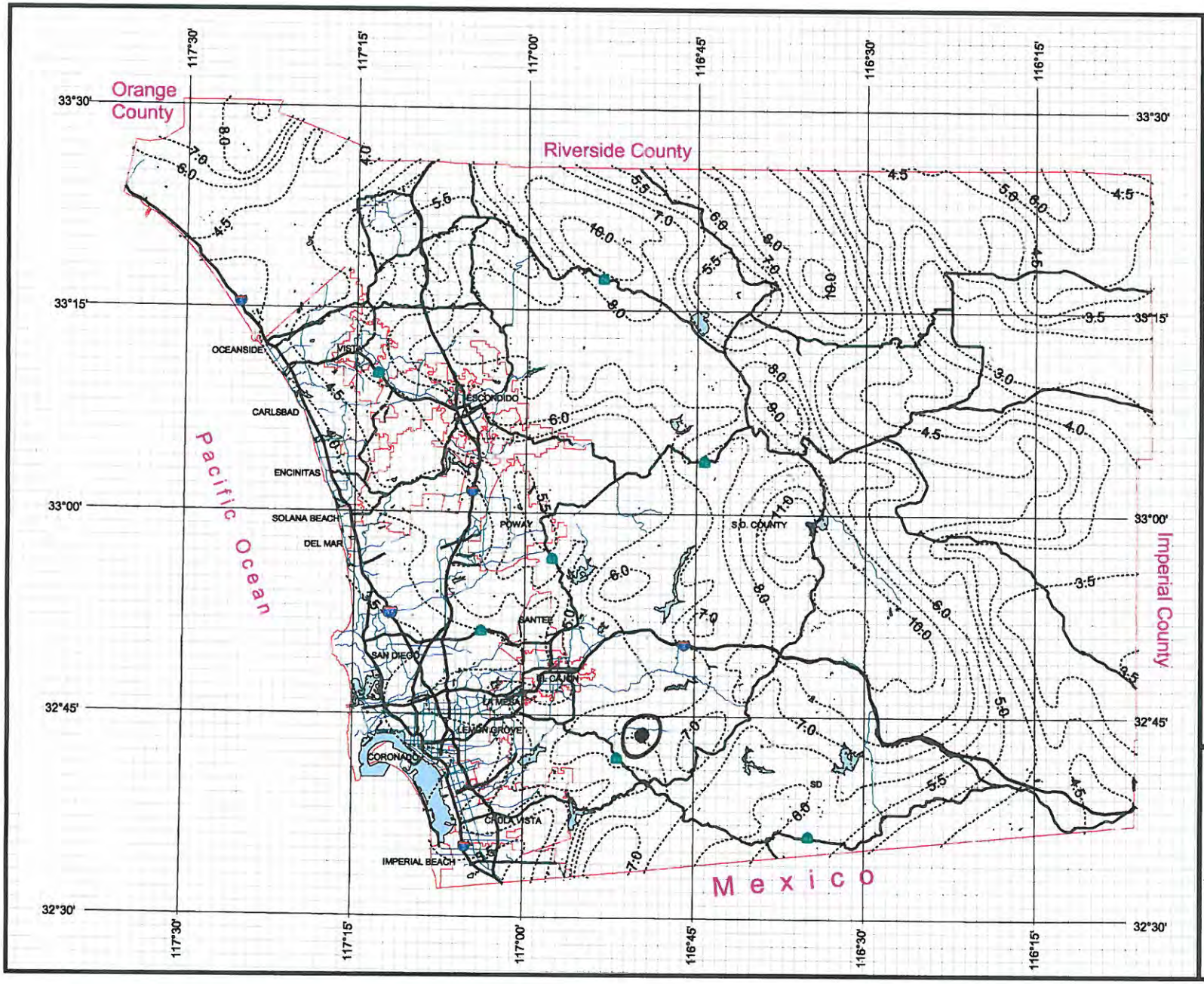

County of San Diego Hydrology Manual

Rainfall Isopluvials

50 Year Rainfall Event - 24 Hours

Isopluvial (inches)

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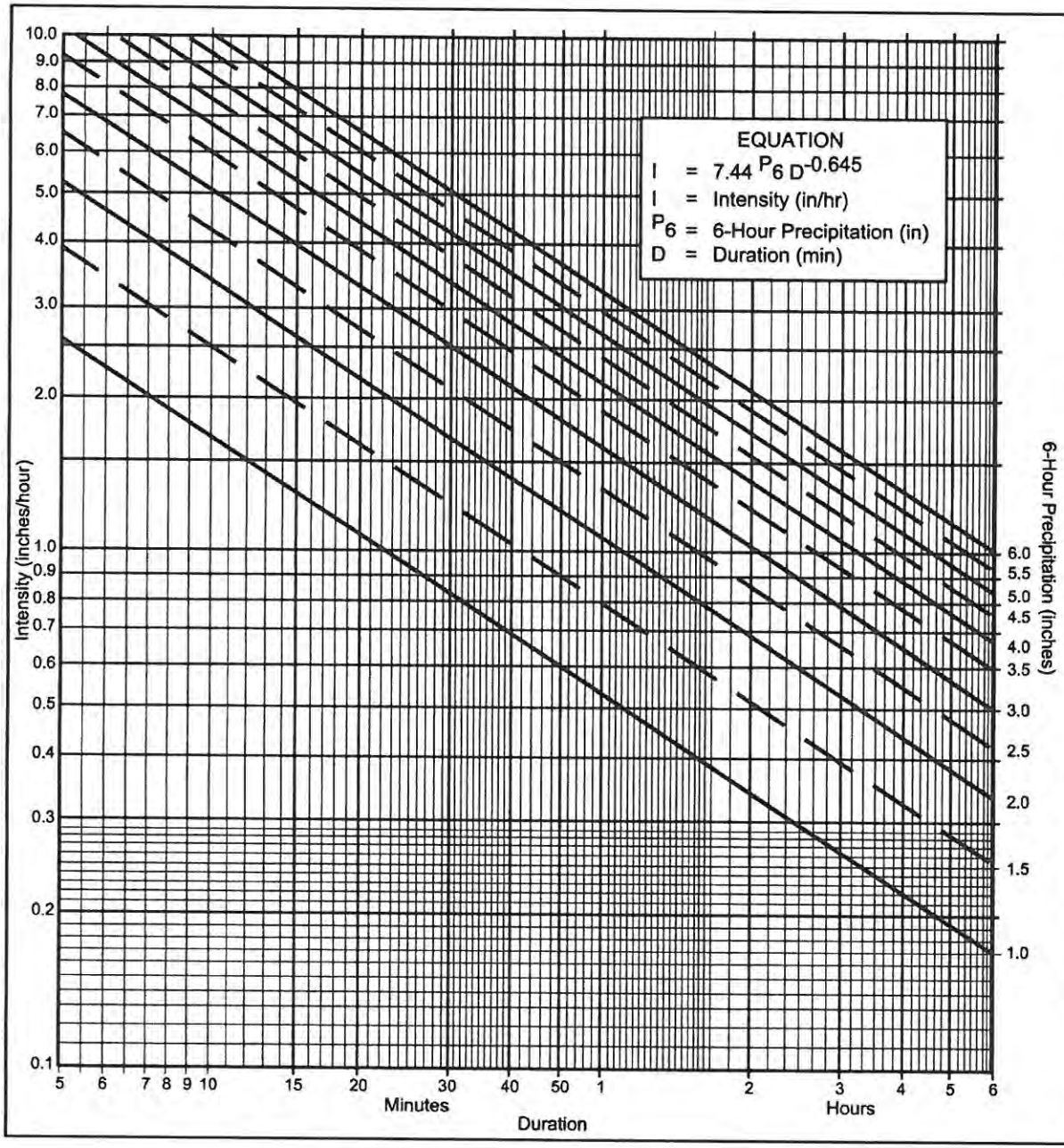


Directions for Application:

(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 100 year

(b) P_6 = 3.2 in., P_{24} = 7.0, $\frac{P_6}{P_{24}}$ = 46 %(2)

(c) Adjusted $P_6^{(2)}$ = 3.2 in.

(d) t_x = _____ min.

(e) I = _____ in./hr.

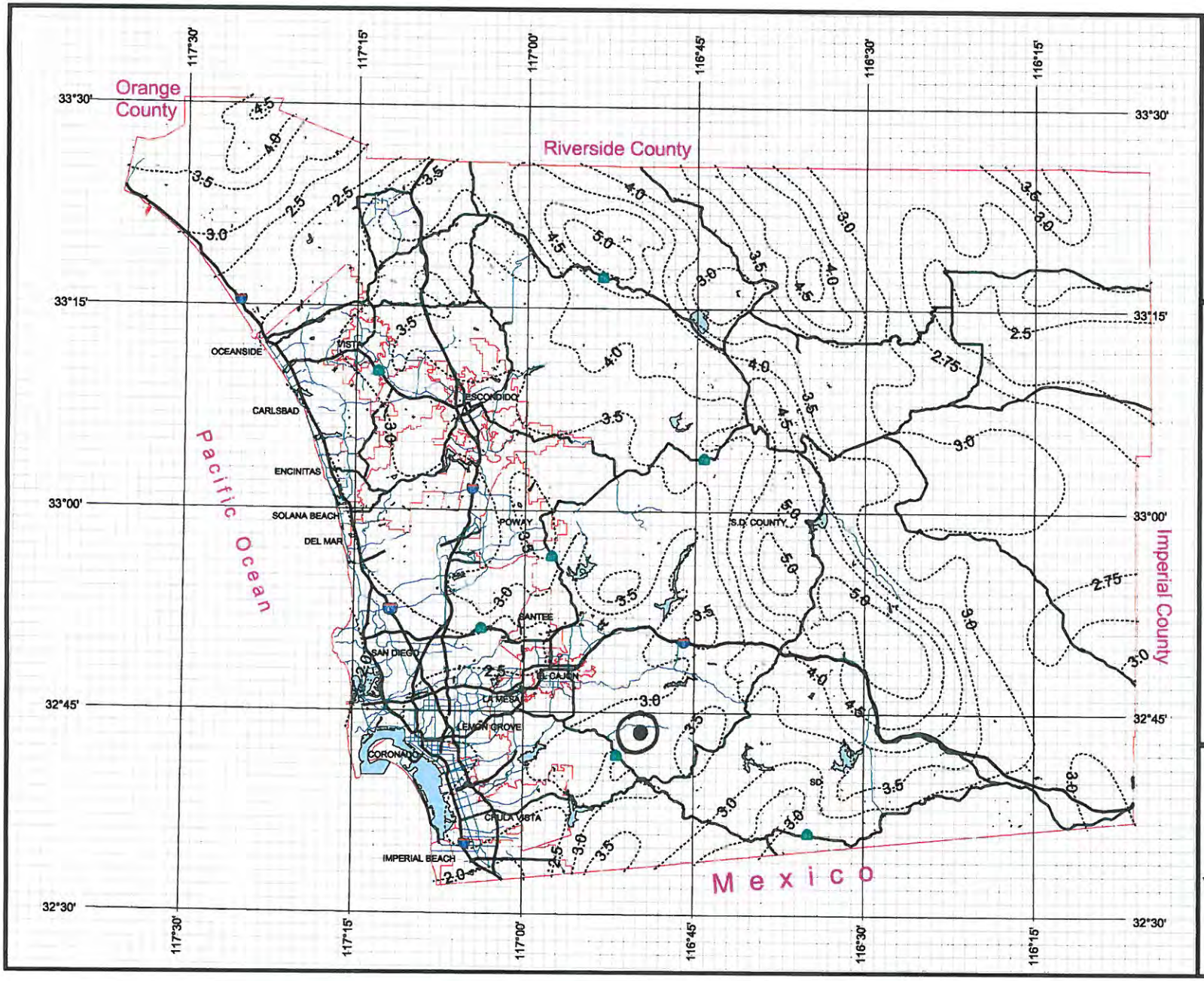
Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

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



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

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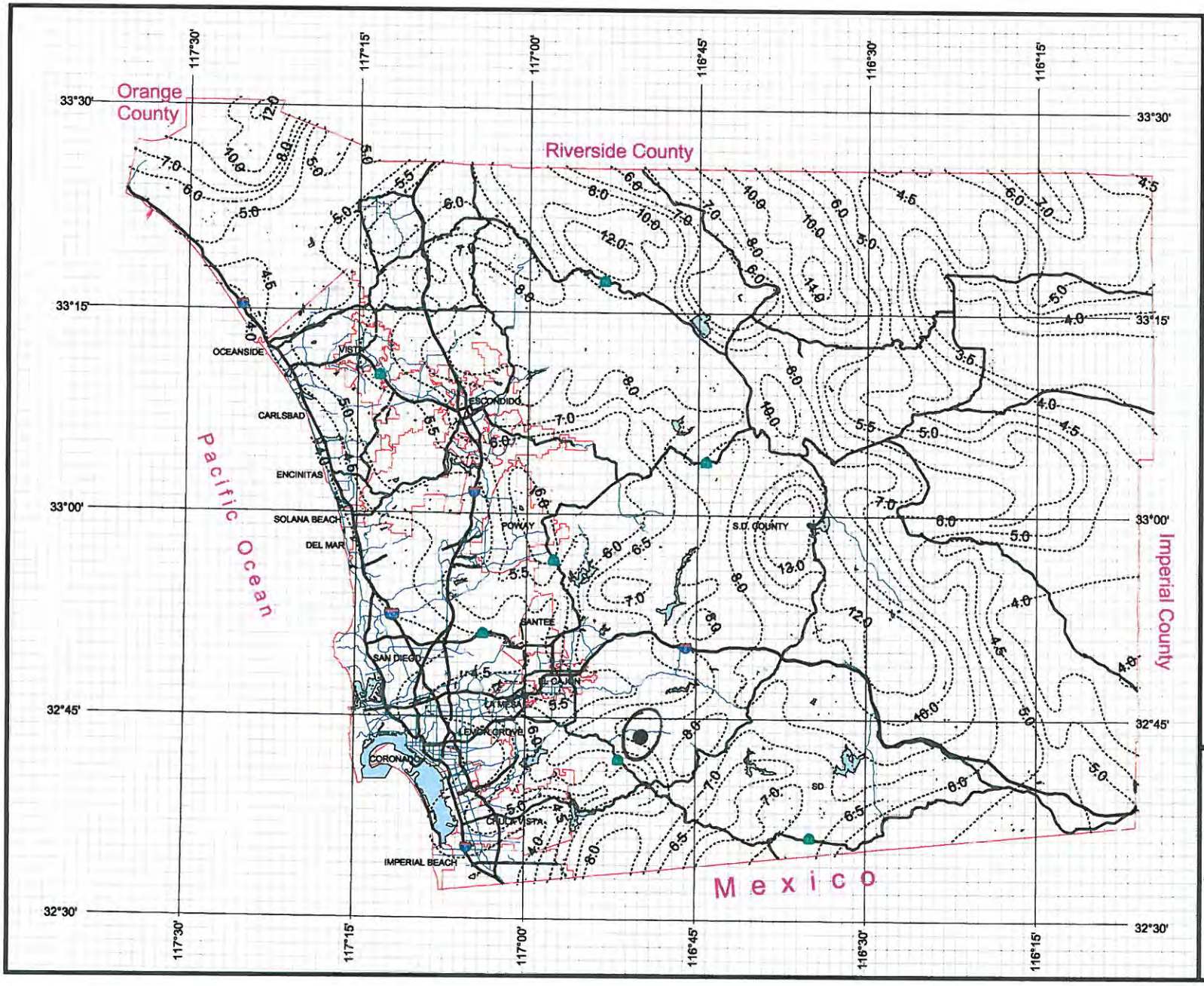

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

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APPENDIX 3

HYDROMODIFICATION REPORT