SUNBURST PRELIMINARY DRAINAGE STUDY

UPDATED: AUGUST 2025

DRNSTY-2023-00025
County of San Bernardino
Sunburst Subdivision
Sunburst Street (APN 060-01-1104)
Joshua Tree, CA 92252

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1.0 Introduction

MADM Development LLC proposes a Six (6)-Lot Subdivision (Subdivision) on Sunburst Avenue. The Subdivision will include six lots with an average lot area of 2.77 acres (excluding proposed rights-of-way) and a total site footprint of 19.68 acres. The Subdivision is located in Joshua Tree at APN 060-01-1104, within the County of San Bernardino (County). Figure 1 presents a vicinity map.

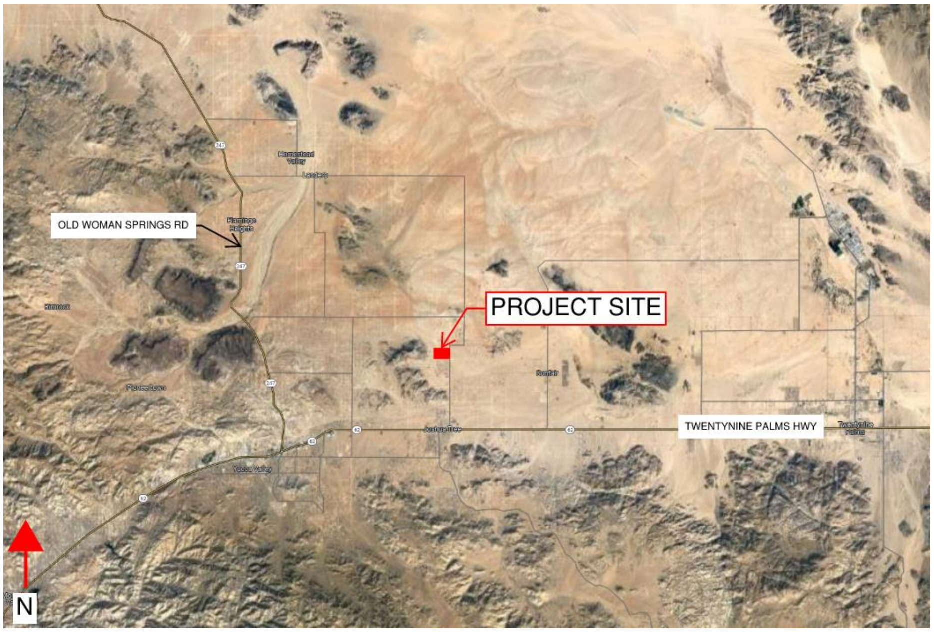


Figure 1: Vicinity Map

The Subdivision is located south of Golden Street, west of Sunburst Avenue, north of Calle del Rio, and east of Avenida la Candela. Figure 2 presents the site area.

Figure 2: Site Map

2.0 Purpose

The purpose of this Drainage Study (Study) is to examine existing and proposed hydrologic conditions in order to identify the Subdivision's impact on existing drainage characteristics, and to confirm that the project meets all applicable County requirements and standards.

3.0 Watershed Description

The Subdivision is located within the Southern Mojave Watershed which encompasses nearly 8,870 square miles of mountains, foothills, and valleys. This watershed contains portions of San Bernardino, Riverside and Imperial Counties. The Southern Mojave Watershed is characterized by the flat, arid basin of southern San Bernardino and eastern Riverside Counties, and is bisected by the San Bernardino Mountains, which runs northwest to southeast. There are over fifty major tributaries contributing to the Southern Mojave Watershed.

The Subdivision is located in FEMA Flood Zone X (Area of Minimal Flood Hazard), within FEMA FIRM Panel Number 06071C8145J. The Effective Date is September 2nd, 2016. Appendix E contains the FEMA FIRMette for the project location, as well as an exhibit from the California Department of Water Resources Best Available Map (BAM) program, highlighting the property's proximity to DWR Awareness (Non-Regulatory) Floodplains.

The Subdivision will include six lots, each containing a two-story home with detached car port, infiltration basin, septic tank, and leach field. The existing parcel to be subdivided is approximately 19.68 acres. The drainage area includes the project footprint and additional run-on area to the north and west of the site. Figure 3 presents the approximate extents of the drainage area analyzed. Appendices B and C include Drainage Condition Exhibits which depict the drainage area in greater detail.

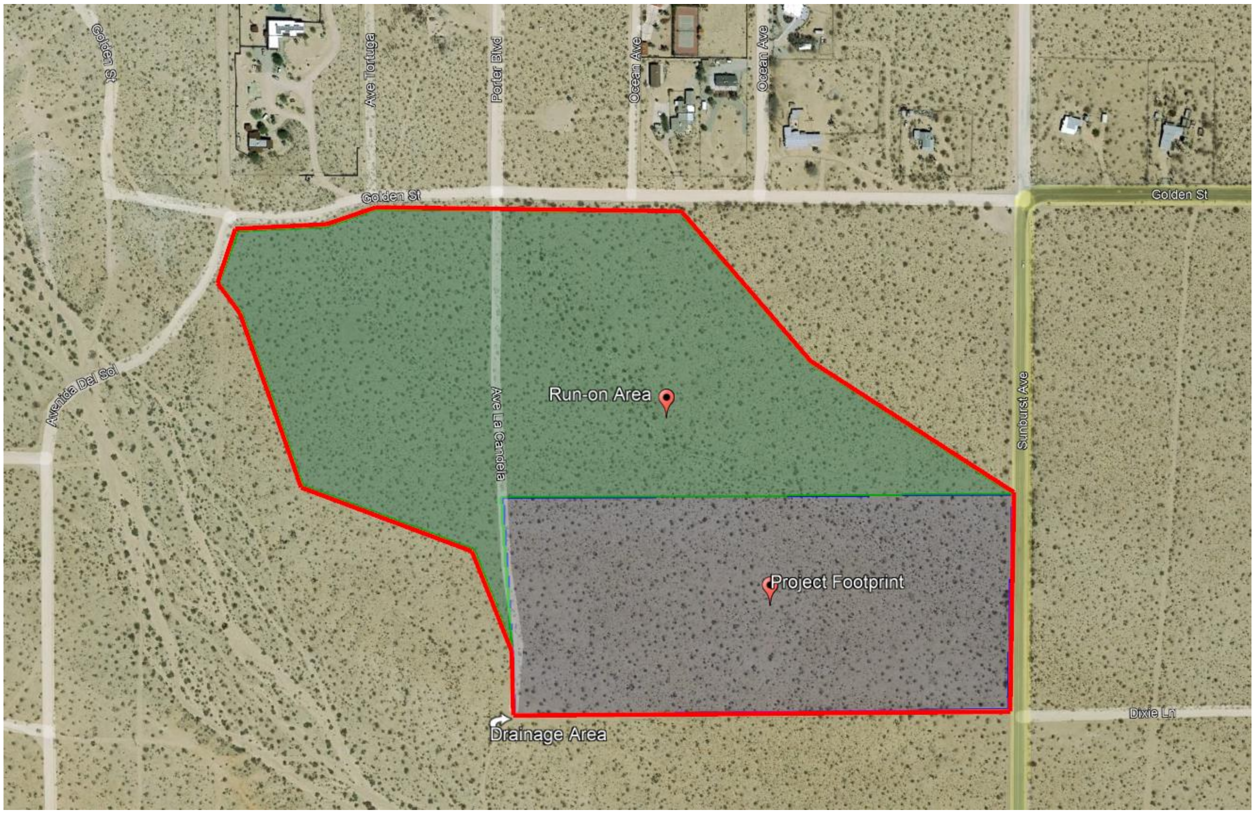


Figure 3: Drainage Area

4.0 Methodology

This Study utilizes the San Bernardino County Hydrology Manual (SBCHM), dated August 1986, as well as the County of San Bernardino Hydrology Manual Addendum, dated April 2010, as references for all hydrologic analyses. Considering the relatively small project area of 19.68 acres, the Study utilizes the Rational Method as defined in Section D of SBCHM. Rational Method analysis procedures are outlined on page D-17, which provides instructions for completing a "Rational Method Study Form," provided as Figure D-6 in the SBCHM.

25-year and 100-year frequency design storms were used for the peak flow analysis of existing and proposed conditions, respectively. The Peak Flow Rate formula estimates the peak rate of runoff at any location in a watershed as a function of the watershed basin area (A), maximum catchment loss rate (F_m), and rainfall intensity (I) for a duration equal to the time of concentration (Tc). Time of concentration is the time required for water to flow from the most remote point of the drainage area to a drainage design point. The Peak Flow Rate formula is expressed as follows:

$$Q = 0.9*(I - F_m)*A$$

Q = rate of runoff in cubic feet per second (cfs)
I = average rainfall intensity in inches per hour (in/hr)
F_m = loss rate for the total watershed tributary to the point of concentration (in./hr.)
A = drainage area contributing to the design location (acres)

Appendix A includes excerpts from the San Bernardino County Hydrology Manual for reference.

5.0 Existing Conditions

The existing site generally drains from the northwest to the southeast at an average grade of 3.0%. The existing site is classified as barren, made up of NRCS hydrologic group C soils with poor coverage of native shrubbery. The existing site is impacted by run-on draining from offsite undeveloped area to the north and west that are within the watershed basin boundary. Appendix B illustrates existing drainage concentration points and subbasins with flow conditions identified throughout the basin.

A "Rational Method Study Form" for the existing runoff conditions under a 25-year design storm was prepared. Existing runoff conditions at the design discharge point were calculated as follows:

Total Drainage Area (watershed basin boundary) = 39.8 acres

Weighted F_m = 0.38

> The weighted F_m value was calculated using the percentage of the existing pervious and impervious areas for each subbasin. In the existing condition, all cover is assumed as pervious. The F_m value for pervious cover was developed by determining a Curve Number (CN) for the site using Figure C-3 of the SBCHM and plotting this value in Figure C-6 of the SBCHM to find an appropriate F_m value. This Study identified the cover type to be Poor Natural Cover of Broadleaf Chaparral within Soil Group C to determine the CN value, and assumed AMC-II Conditions to determine F_m value. SBCHM excerpts for the determined values are included in Appendix A.

I_{25} = 3.1 in/hr

> Rainfall Intensity values were selected graphically from the SBCHM Intensity-Duration Calculation Sheet, Figure D-3. A 1-hour design storm intensity was determined from NOAA Atlas 14 Precipitation Data within the Joshua Tree region. The design intensity is based on a design storm duration equal to the Tc for the existing watershed basin boundary. SBCHM excerpts for the determined values are included in Appendix A.

Therefore:

$Q_{25\text{-Existing}}$ = (0.9*((3.1 (in/hr)-0.38 (in/hr))/ 12 in/ft)*1,732,632 ft^2) / 3,600 sec/hr)= 98.1 cfs

Additional peak flow, velocity and travel time calculations can be found in Appendix D

6.0 Proposed Conditions

The Subdivision includes six lots, each containing a two-story home with detached car port, infiltration basin, and septic tank within the 19.68-acre site footprint. On average, each lot has an area of 2.77 acres with 1500 square feet of impervious area. This development will increase impervious area by approximately 1% under proposed conditions. A 36' wide access roadway will be constructed through the middle of the project using recompacted native material. Additionally, 18' wide roadways will be constructed along the western and southern boundaries of the properties using recompacted native material. These roadways will be constructed within dedicated right-of-way halfwidths and connect to Sunburst Avenue at the southeast corner of the property and Avenida La Candela at the northwest corner of the property. Recompacted native driveways will also connect the access roadway to each home and carport. Each lot will include an infiltration basin with an earthen swale designed to convey stormwater from impervious areas to each lot's respective basin

Similar to the existing conditions, the proposed site is also subject to run-on draining from offsite undeveloped area to the north and west that are within the watershed basin boundary. To divert run-on volumes away from the site, V-Ditch swales will be constructed along the northern, western, and southern site boundaries. Storm drain culverts with headwall and outfall structures are proposed along the western roadway to allow the southwest swale to cross the access roadway, and along the southern roadway, at the terminus of the southwest swale, to allow for vehicular access to Sunburst Avenue from the development. Appendix C illustrates proposed drainage conditions for the Subdivision.

7.0 Stormwater Capture

Each lot will include an infiltration basin designed to capture the runoff from proposed impervious area within the development, as well as from upstream drainage areas within each lot's subbasin boundary. Infiltration basins were sized to capture the entire 100-year design storm volume for a duration equal to the time of concentration for each subbasin.

Design Capture Volume (DCV) requirements per subbasin are outlined in Table 1 using the following equation:

$DCV = Q_{100\text{-proposed}} * \text{Storm Duration}$

Table 1: Infiltration Basin DCV

Subbasin ID	Infiltration Basin ID	Concentration Point	Subbasin Area (Ac)	$Q_{100\text{-Proposed}}$	Tc (min.)	DCV (CF)	Design Percolation Rate (in./hr.)	Drawdown Time (hrs)
Lot 1	IB-1	13	1.5	7.3	12.3	5402.3	20.0	6.8
Lot 2	IB-2	14	0.8	4.3	10.2	2619.7	20.0	3.3
Lot 3	IB-3	15	1.9	8.3	14.1	7027.7	20.0	8.9
Lot 4	IB-4	16	2.3	9.8	14.2	8351.9	20.0	10.5
Lot 5	IB-5	17	2.0	8.4	14.9	7473.0	20.0	9.4
Lot 6	IB-6	18	1.5	5.1	15.9	4873.2	20.0	6.2

Additionally, a geotechnical survey was prepared for the Subdivision and determined the design percolation rate on site to be 20 inches per hour. This value was used to estimate the drawdown time based on each basin's DCV and confirm that all basins meet the County's maximum drawdown time requirement of 48 hours. Drawdown time was calculated using the following equation:

$T_{drawdown}$ (hr) = (DCV (cf) / $A_{bottom*}$ (sf) * (12 in/ 1 ft)) / Design Percolation Rate (in/hr)

*Basin Bottom Area (A_{bottom}) assumed to be the only surface in basin capable of infiltrating stormwater flows

The drawdown times for each lot's infiltration basin are outlined above in Table 1, and excerpts from the geotechnical survey and County standards are provided in Appendix H for reference.

8.0 Peak Flow Analysis

Section 8.0 analyzes peak outflow from the Subdivision at the Design Point by incorporating infiltration basin storage into the flow analysis.

Per County of San Bernardino requirements, this study compares the 100-year design storm under proposed conditions to 90-percent of the 25-year design storm under existing conditions in order to confirm that the proposed conditions of the Subdivision will prevent flooding and damage to adjacent properties and infrastructure. The infiltration basins analyzed in Section 7.0 have been incorporated into the design to capture all post-development flow and maintain discharge rates less than existing conditions.

The following expression was developed to confirm proposed runoff flows are less than or equal to existing runoff flows (Peak Flow Analysis):

$$0.9 * Q_{25\text{-Existing}} \geq Q_{100\text{-Proposed}}$$

Table 2 outlines results from the Peak Flow Analysis for the proposed conditions. The net runoff discharge was determined by dividing the project footprint and run-on area into subbasins and identifying flow paths between subbasins, throughout the proposed swales, and to the design point. Additionally, Confluence Analysis was performed in accordance with SBCHM Section D.8.

Table 2: Proposed Conditions Peak Flow Analysis

CAPTURED FLOW					
Concentration Point	**Flow Characteristics**	**Subbasin Area (ac)**	**Weighted Fm (in./hr)**	**Tc (min.)**	**$Q_{100\text{-Proposed}}$ (cfs)**
13a	Subbasin Runoff, Sheet Flow	0.6	0.375	12.0	2.8
13b	Subbasin Runoff, Channel Flow	1.0	0.375	12.3	7.3
Lot 1 Stream Summary	**Lot 1 Stream Summary**	**1.5**		**12.3**	**7.3**
14a	Subbasin Runoff, Sheet Flow	0.6	0.375	10.0	3.5
14b	Subbasin Runoff, Channel Flow	0.14	0.375	10.2	4.3
Lot 2 Stream Summary	**Lot 2 Stream Summary**	**0.8**		**10.2**	**4.3**
15a	Subbasin Runoff, Sheet Flow	1.6	0.375	13.5	7.0
15b	Subbasin Runoff, Channel Flow	0.4	0.375	14.2	8.3
Lot 3 Stream Summary	**Lot 3 Stream Summary**	1.9		**14.2**	**8.3**
16a	Subbasin Runoff, Sheet Flow	1.9	0.375	13.5	8.5
16b	Subbasin Runoff, Channel Flow	0.4	0.375	14.2	9.8
Lot 4 Stream Summary	**Lot 4 Stream Summary**	**2.3**		**14.2**	**9.8**
17a	Subbasin Runoff, Sheet Flow	1.5	0.375	14.5	6.4
17b	Subbasin Runoff, Channel Flow	0.5	0.375	14.9	8.4
Lot 5 Stream Summary	**Lot 5 Stream Summary**	**2.0**		**14.9**	**8.4**
18a	Subbasin Runoff, Sheet Flow	1.2	0.375	15.5	4.7
18b	Subbasin Runoff, Channel Flow	0.3	0.375	15.9	5.1
Lot 6 Stream Summary	**Lot 6 Stream Summary**	**1.5**		**15.9**	**5.1**
RUN-ON FLOW					
Concentration Point	**Flow Characteristics**	**Subbasin Area (ac)**	**Weighted Fm (in./hr)**	**Tc (min.)**	**$Q_{100\text{-Proposed}}$ (cfs)**
2	Run-On, Sheet Flow	4.1	0.38	11.0	20.8
3	Run-On, Sheet Flow	7.8	0.38	23.0	31.4
4	Run-On, Channel Flow	6.5	0.38	25.2	43.7
5	Run-On, Channel Flow	2.0	0.38	27.6	44.7
Offsite Run-On: Stream Summary 1	**Offsite Run-On: Stream 1 Summary**	**20.4**		**27.6**	**44.7**
8	Run-On, Channel Flow	0.8	0.38	2.7	2.7
9	Run-On, Channel Flow	0.4	0.38	4.6	3.8
Offsite Run-On: Stream Summary 2	**Offsite Run-On: Stream 2 Summary**	**1.2**		**4.6**	**3.8**
RUNOFF FLOW					
Concentration Point	**Flow Characteristics**	**Subbasin Area (ac)**	**Weighted Fm (in./hr)**	**Tc (min.)**	**$Q_{100\text{-Proposed}}$ (cfs)**
9	Confluence, Channel Flow	1.1	0.38	4.6	4.9
19	Confluence, Channel Flow	0.7	0.38	4.6	5.5
20	Confluence, Channel Flow	0.9	0.38	4.6	6.6
21	Confluence, Channel Flow	1.5	0.38	27.6	48.1
22	Confluence, Channel Flow	2.2	0.38	27.6	53.0
23	Confluence, Channel Flow	0.9	0.38	27.6	55.0
10	Confluence, Sheet Flow	0.07	0.38	27.6	59.8
Total Runoff to Discharge Point		**28.9**		**27.6**	**59.8**

Reduction in peak outflow from the Subdivision compared to the pre-construction condition will be achieved by completely capturing stormwater flows in the six infiltration basins. The cumulative storage volume of the basins results in flows leaving the site that are lower than 90-percent of the existing 25-year storm runoff. Generally, stormwater flow to the discharge point will generate from uncaptured on-site subbasins and the recompacted native roadways along the property border, as well as from run-on that has been conveyed around the site boundary through the proposed swales and culverts.

Table 3 compares peak flow under existing and proposed conditions to confirm that the Subdivision's proposed peak flow rate meets County development requirements.

Table 3: Peak Flow Comparison

$0.9*Q_{25\text{-Existing}}$ at Design point (cfs)	88.4
$Q_{100\text{-Proposed}}$ at Design point (cfs)	59.8

9.0 Flood Control

The homes, carport, and sound walls will be graded to convey runoff from each area via a drainage ditch to a local infiltration basin for each lot. Grading is planned to direct flows of developed area to the infiltration basin while limiting grading of existing area as much as possible. Flows from undisturbed areas will remain in their preconstruction condition, flowing generally northeast to southwest and collecting in existing earthen flow paths to the discharge point at the southeast of the Subdivision. Additionally, proposed structures will be protected from stormwater flows by grading away from all structures at a minimum of 2% grade for a minimum of 5-feet.

The recompacted native roadways along the western and southern property boundaries will be graded at a minimum of 2% grade to convey flow into the proposed southwest swale. Culverts with headwall and outfall structures within the southwest swale will be sized with a Depth over Diameter (d/d) ratio of no greater than 75% under 100-year peak flow conditions. A culvert with headwall and outfall structures is also proposed within County right-of-way along Sunburst Ave to maintain existing flow conditions. A storm drain manhole structure will be required at the confluence of the culvert conveying flows from the southwest swale and the culvert proposed within County right-of-way.

10.0 Proposed Swale Velocity Analysis

As stated in Section 6.0, the proposed condition will include swales along the northern, western, and southern boundaries of the proposed site to capture run-on and prevent comingling of off-site and on-site flows. Swale dimensions will be approximately 1.5-feet-deep by 15-feet-wide for the northern boundary swale, and 1-foot-deep by 12-feet-wide for the southern and western swales. An analysis of velocities at various concentration points along the swales was performed and results are presented in Table 4. In order to maintain velocities under 5 feet per second and provide effective energy dissipation, the north swale will be lined with river cobbles.

Table 4: Velocity Analysis

Concentration Point	Swale	Material	Manning's n Value	Velocity (fps)
4	North	River Cobble	0.04	4.5
5	North	River Cobble	0.04	4.9
8	Southwest	Gravel	0.025	2.9
9	Southwest	Gravel	0.025	3.2
19	Southwest	Gravel	0.025	4.1
20	Southwest	Gravel	0.025	4.2

11.0 Conclusions

Based on peak flow analysis of a 25-year design storm scenario under existing conditions, and a 100-year design storm scenario under proposed conditions, stormwater infrastructure incorporated into the Subdivision design meets County requirements to maintain proposed runoff levels below 90-percent of the 25-year existing design storm. Additionally, proposed swales designed to divert run-on flow around the site boundary have been designed to provide effective energy dissipation. Per County development requirements, the Subdivision will provide sufficient stormwater management and prevent flooding and damage to the project footprint and adjacent property.

Appendix A

San Bernardino County Hydrology Manual Excerpts

A.1: Miscellaneous Excerpts
A.2: Intensity-Duration Curves
A.3: Time of Concentration Nomographs

Appendix A.1

Miscellaneous Excerpts

D.11. INSTRUCTIONS FOR RATIONAL METHOD HYDROLOGY CALCULATIONS

1. On a topographic map of the drainage area, draw the study drainage system and designate subareas tributary to the various points of concentration (see example problem).

2. Determine the initial time of concentration, (Tc), using Figure D-1. The initial subarea should be less than 10 acres, have a flow path of less than 1,000 feet, and generally should be the most upstream subarea of the watershed drainage system.

3. Using the time of concentration, determine (I) (intensity of rainfall in inches per hour) from the appropriate intensity-duration curve for the particular area under study using Figure D-3.

4. Calculate the area-averaged maximum loss rate, F_m, which corresponds to the soil group, cover complex, and imperviousness of the drainage subarea. Loss rates for the pervious area, F_p, follow from section C.6.4.

5. Determine the area (A, acres) of the total watershed tributary to the point of concentration. Because the rational method computational results are sensitive to the subarea size definitions (especially in the most upstream reaches of the watershed), limit the size of subareas to allow for a gradual increase in subarea size as the study progresses downstream. The method is sensitive to large differences in successive subarea shapes, and lengths of reaches where travel times are estimated. Points of concentration should be selected downstream of the initial subarea such that subarea travel times are less than 3-minutes and 5-minutes for Tc values of 30-minutes and 60-minutes, respectively. After a Tc of 1-hour, subarea travel times should be limited to less than 10-minutes.

6a. Compute $Q = .90 (I-F_m)A$ for the point of concentration.

6b. Should the computed Q be less than the previous upstream point of concentration Q, use the upstream Q value.

7. Measure the length that the peak runoff must travel to the point of concentration of the next downstream subarea. Determine the average velocity of flow in this reach using the peak Q in the appropriate type of conveyance being considered (natural channel, street, pipe, or open channel) using Manning's formula. Where necessary, the mean flow in the conveyance (e.g., streetflow) should be used to compute mean flow velocity.

Using the reach length and average flow velocity, compute the travel time and add to the time of concentration from the upstream subarea to determine a new time of concentration.

8. Calculate Q for the new point of concentration using steps 3 through 6 and the new time of concentration. Determine the time of concentration for the next downstream subarea using Step 7. Continue the above computation procedure downstream until a junction with a lateral drain is reached.

9. Start at the upstream end of the lateral and compute its Q down to the junction with the main line, using the methods outlined in the previous steps.

10. Compute the peak Q at the junction (confluence analysis--see Section D.8) and evaluate the sensitivity of the computed results to using the other Q and Tc values determined. That is, the downstream estimated peak Q values may be higher had a lower Q and lower Tc value been used at an upstream confluence point. The largest Q is, therefore, estimated along the entire watershed main channel.

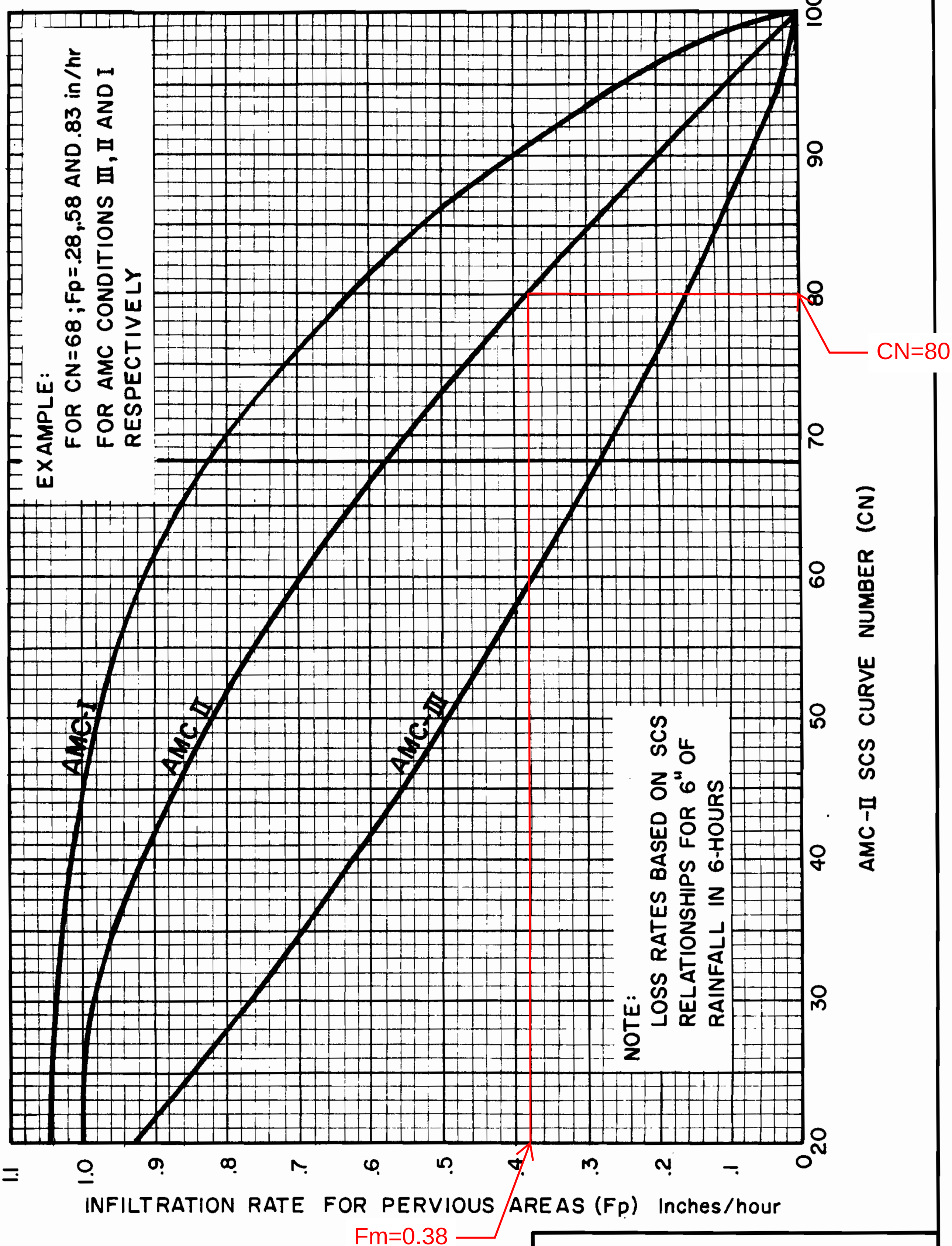
Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II					
Cover Type (3)	Quality of Cover (2)	Soil Group			
		A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (1 of 2)

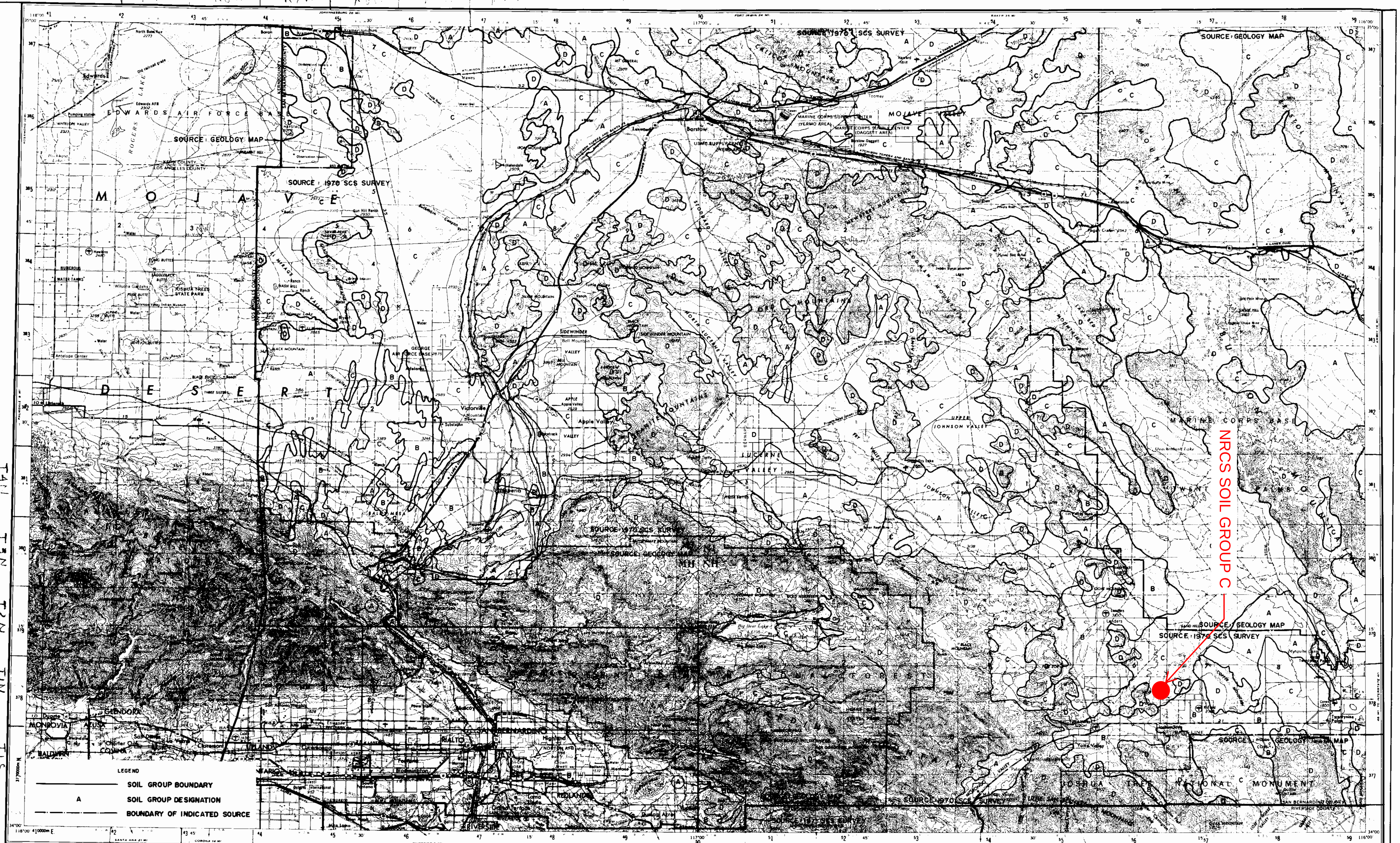


SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Figure C-6

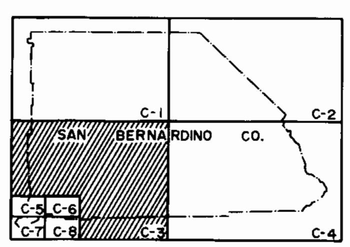


Scale 1:250,000

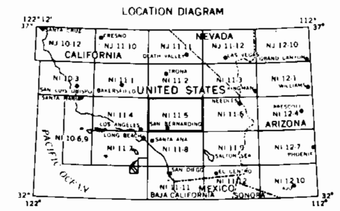
CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION

BASE MAP REPRODUCED FROM U.S.G.S. "SAN BERNARDINO" TOPOGRAPHIC MAP

SCALE REDUCED BY 1/2



INDEX MAP



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

HYDROLOGIC SOILS GROUP MAP FOR SOUTHCENTRAL AREA

FIGURE C-11

TABLE D.1. AREA - AVERAGED F_m COMPUTATION

Subarea Number (1)	a_p (2)	F_p (inch/hour) (3)	Area (acres) (4)	Area Weighting (5)
1	0.60	0.40	8	1.92
2	0.80	0.30	12	2.88
3	0.75	0.25	11	2.06
4	0.10	0.20	15	0.30
5	0.50	0.25	16	2.00
			62	9.16

From Table D.1, the area-averaged maximum loss rate, F_m, is given by F_m = (9.16)/(62) = 0.147 inch/hour, say 0.15.

D.7. DRAINAGE AREA

The contributing drainage area may be determined from topographic contour maps, aerial photos, and field surveys. Watershed divides are then drawn on a suitable topographic map and the enclosed drainage area is determined by planimeter or other methods. In areas where lateral and transverse slopes on the watershed are very mild, the nominal watershed area (or drainage subdivision) runoff may "cascade" under severe rainfall. That is, when the divide between one watershed and another is defined by a low relief feature such as the crown of a road, the runoff from such a watershed may "spill over" into the adjacent watershed or watershed subdivision. This may occur, for example, when gutter capacity is exceeded thereby increasing runoff contributions at downstream or adjacent concentration points above those anticipated by analysis of the nominal or "low flow" drainage boundaries. The possibility of such cascading shall be considered and accounted for by the hydrologist.

D.8. RATIONAL METHOD CONFLUENCE ANALYSIS

In most studies, the calculation of peak flow rates along a main channel or stream involves only the direct application of (D.4). Such studies typically involve the inclusion of subarea runoff to the stream where the effect on the stream peak flow rate is relatively minor and, consequently, only (D.4) is needed for the analysis.

At the junction of two or more streams, however, the estimation of the peak flow rate involves a confluence analysis of the associated runoff hydrographs (see Appendix I).

For the confluence of two streams, let T_1, I_1, Fm_1, A_1, and Q_1, be the time of concentration, rainfall intensity, area-averaged loss rate, catchment area, and peak flow rate for stream #1 while T_2, I_2, Fm_2, A_2 and Q_2 correspond to stream #2. Also, let Q_1 be less than Q_2. Finally, let T_p, A_p, and Q_p be the resulting confluence estimates for Tc, area, and peak flow rate, respectively. Then two cases are possible:

*Case 1: $T_1 = T_2$. The runoff hydrographs must both peak at $T_p = T_1 = T_2$. And $Q_p = Q_1+Q_2$ for a total contributing area of $A_p = A_1+A_2$.

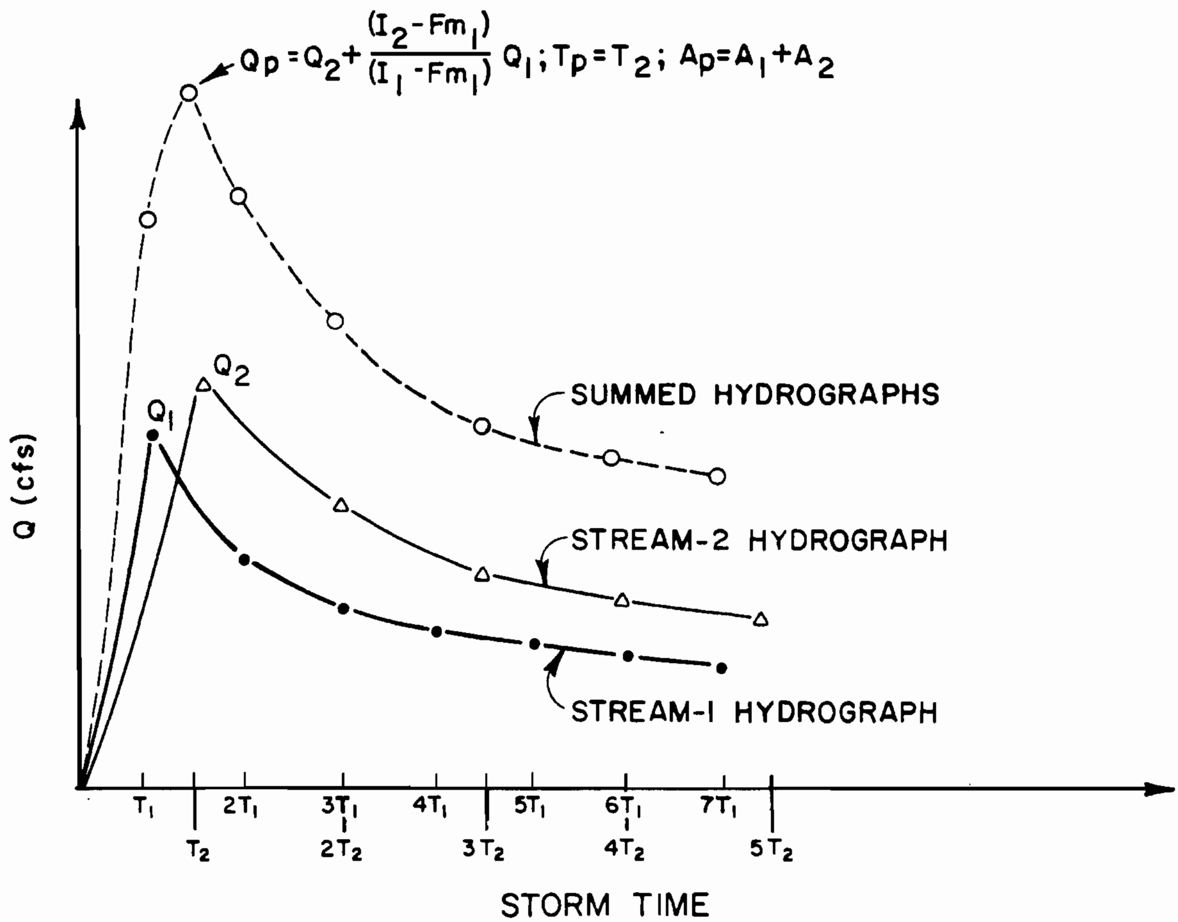
*Case 2: $T_1 \neq T_2$. In this case, the sum of the two runoff hydrographs must be considered. Except in very unusual conditions, flow rates of the summed runoff hydrograph typically achieve a maximum at either T_1 or T_2, and the peak flow rate estimates are calculated as follows:

Case 2a: T_1 is less than T_2. In this case, the stream with the largest Q has the longest Tc. The flow rate of the summed runoff hydrograph at time T_2 is estimated by

$$Q_p = Q_2 + \frac{(I_2-Fm_1)}{(I_1-Fm_1)} Q_1 \tag{D.5}$$

and $T_p = T_2$ (see Figure D-4). It is noted that the confluence peak Q of (D.5) equals the peak flow rate estimated from direct use of (D.4). Additionally, the total contributing area is $A_p=A_1+A_2$.

Case 2b: T_1 is greater than T_2. In this case, the stream with the largest Q has the shortest Tc. The flow rate of the summed runoff hydrograph at time T_1 is estimated using a ratio of



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

RATIONAL METHOD
CONFLUENCE ANALYSIS
(Summation of Runoff Hydrographs)

Figure D-4

stream 1 effective rainfall intensities and Tc values corresponding to times T_2 and T_1 giving

$$Q_p = Q_2 + \frac{(I_2 - Fm_1)}{(I_1 - Fm_1)} \frac{(T_2)}{(T_1)} Q_1 \qquad \text{(D.6)}$$

and $T_p = T_2$. Equation (D.6) indicates that the peak flow rate at time T_2 is the result of the high peak discharge from stream 2 and the runoff contribution from a fraction of the stream 1 catchment area.

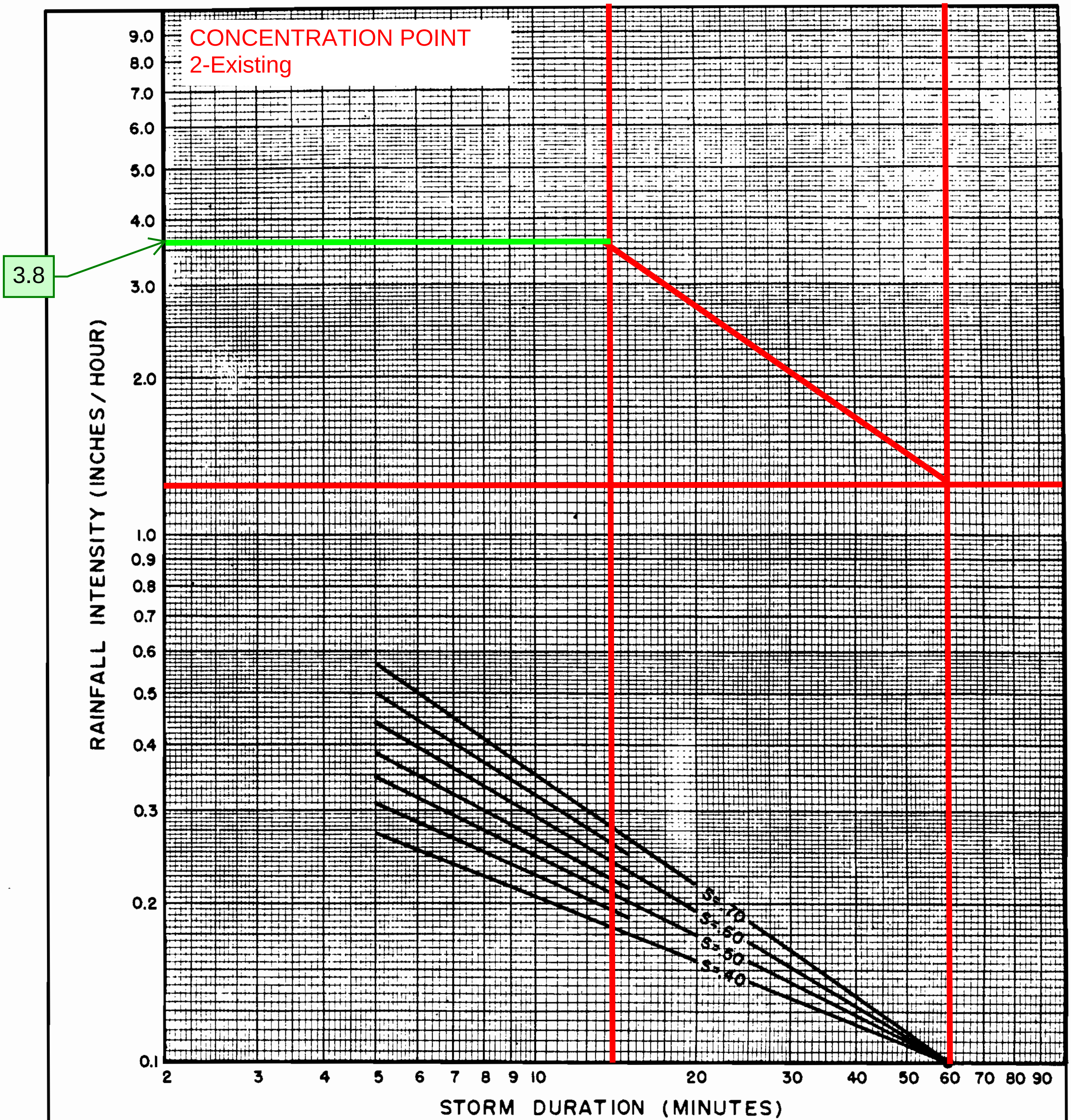
That is, a portion of the catchment tributary to stream 1 is not contributing at time T_2 and, in the general case, only $(T_2/T_1)A_1$ of the stream 1 catchment area is contributing to the peak flow rate (at time T_2). Consequently for downstream study purposes, the "effective" catchment area corresponding to the subject peak flow rate is

$$A_p = A_2 + (T_2/T_1)A_1 \qquad \text{(D.7)}$$

It is noted that in the confluence peak flow rate estimate of (D.6), the critical duration is $T_p = T_2$ which corresponds to the effective catchment area of (D.7). Consequently, the peak flow rate contribution from the effective catchment area of stream 1 must reflect the higher rainfall intensity corresponding to time T_2 rather than time T_1. Use of (D.6) results in a peak flow which equals the governing rational method peak flow rate estimate from (D.4) applied to the effective catchment area computed by (D.7). It is noted that the estimation of the effective catchment area is only an approximation, and shall be verified by the hydrologist.

Appendix A.2

Intensity-Duration Curves



DESIGN STORM FREQUENCY = 25 YEARS

ONE HOUR POINT RAINFALL = 1.23 INCHES

LOG-LOG SLOPE = 0.7

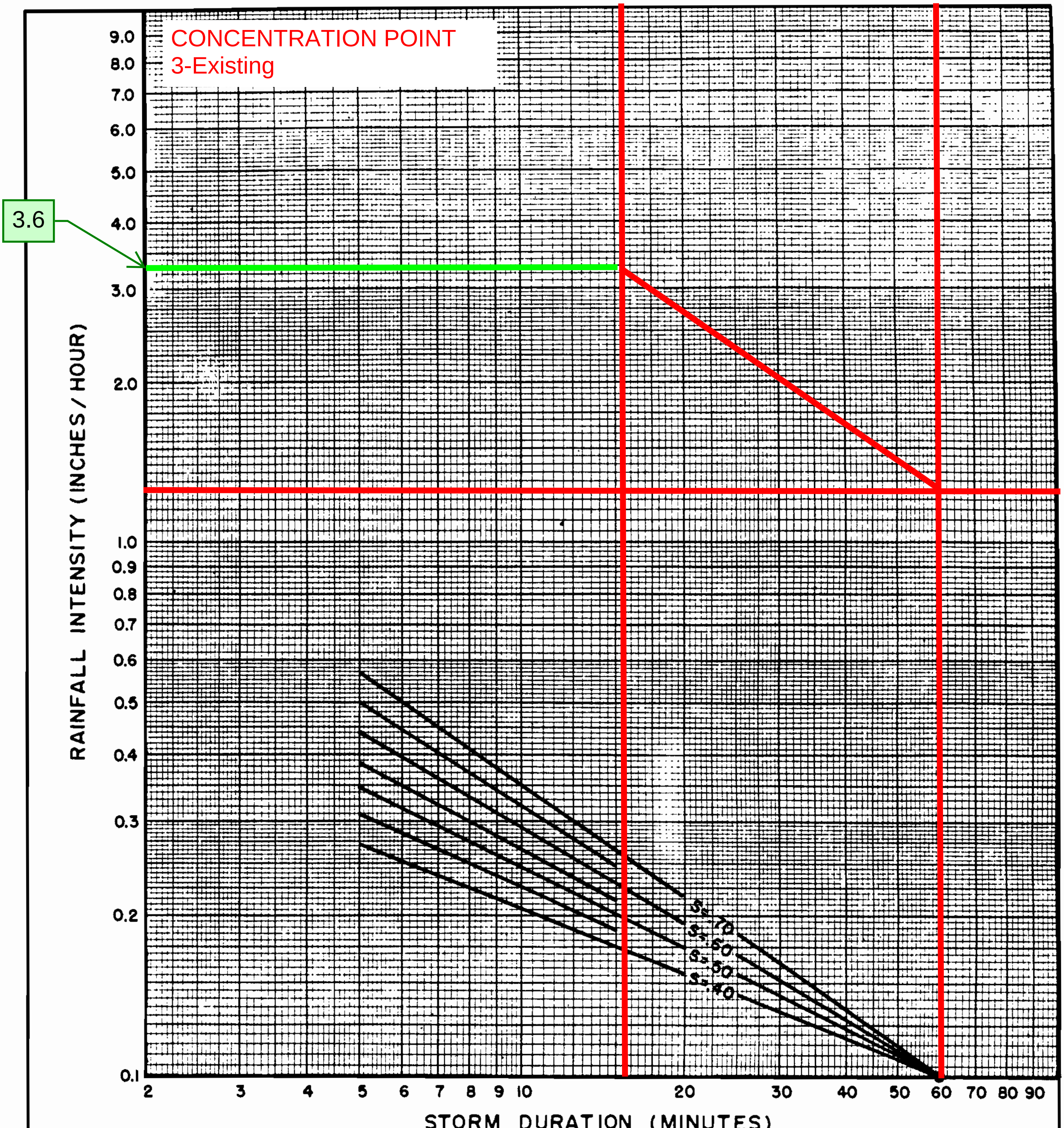
PROJECT LOCATION = Joshua Tree

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY – DURATION CURVES CALCULATION SHEET

FIGURE D-3



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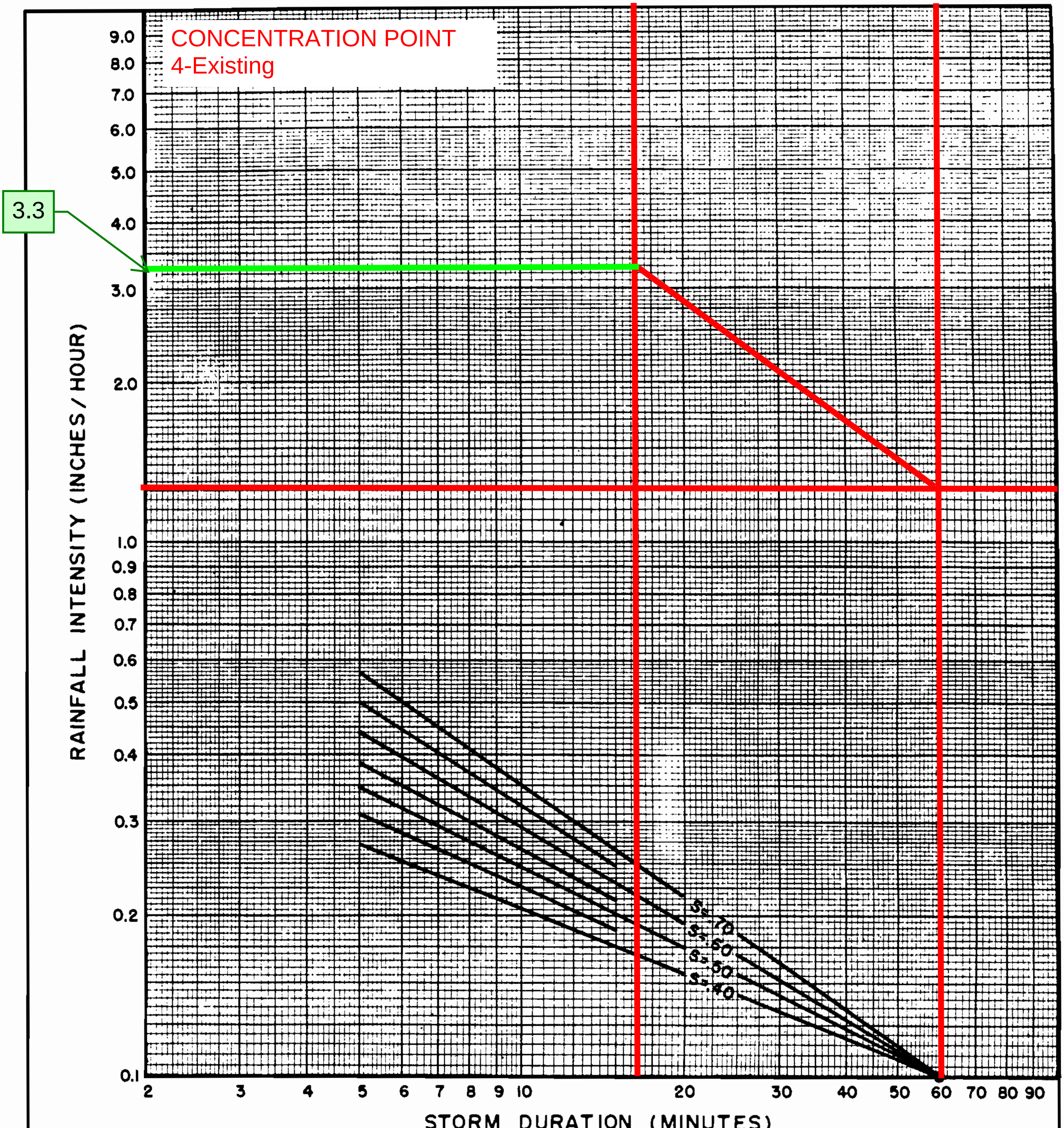
HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET



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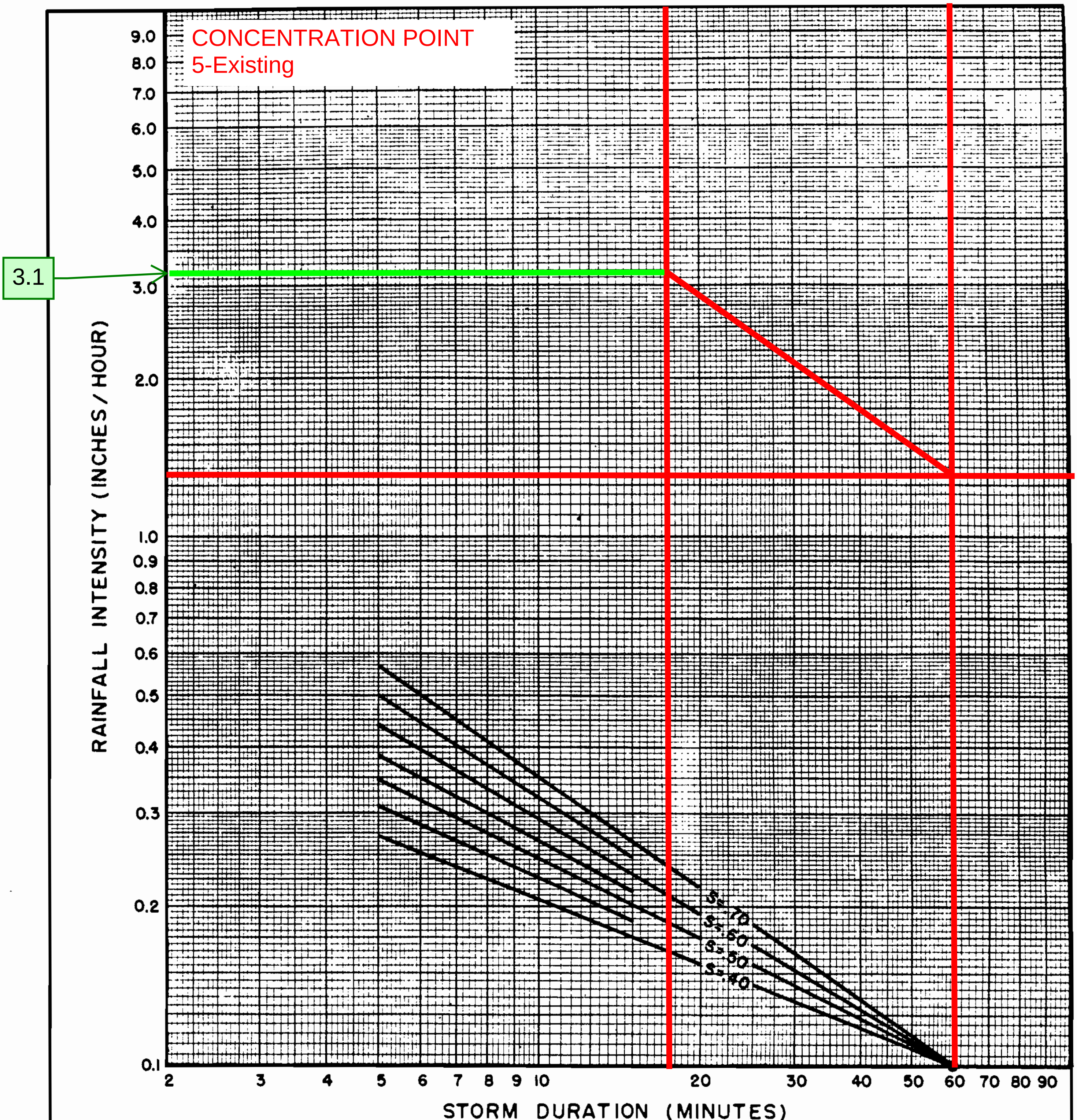
HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



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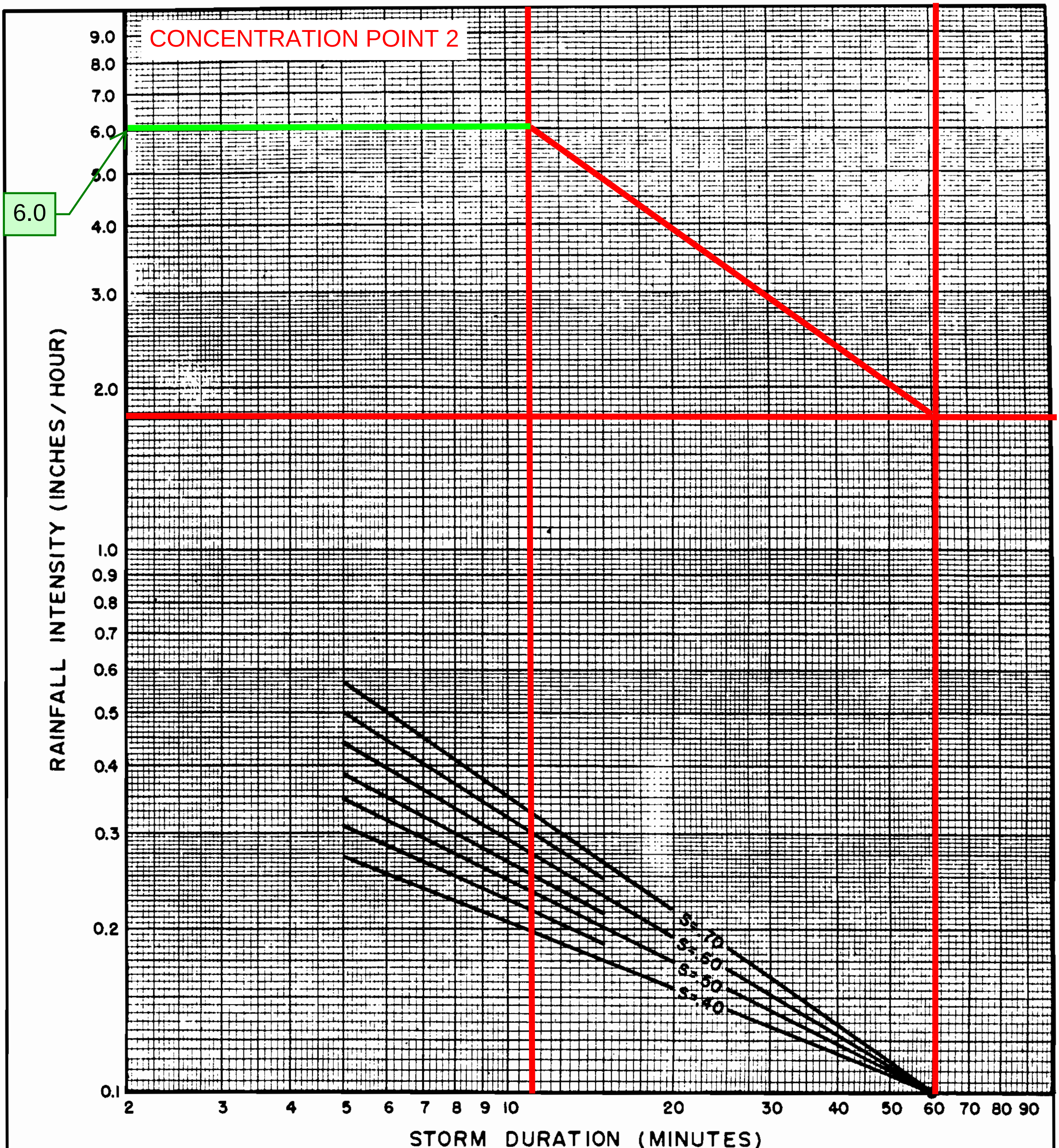
HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET



DESIGN STORM FREQUENCY = 100 YEARS

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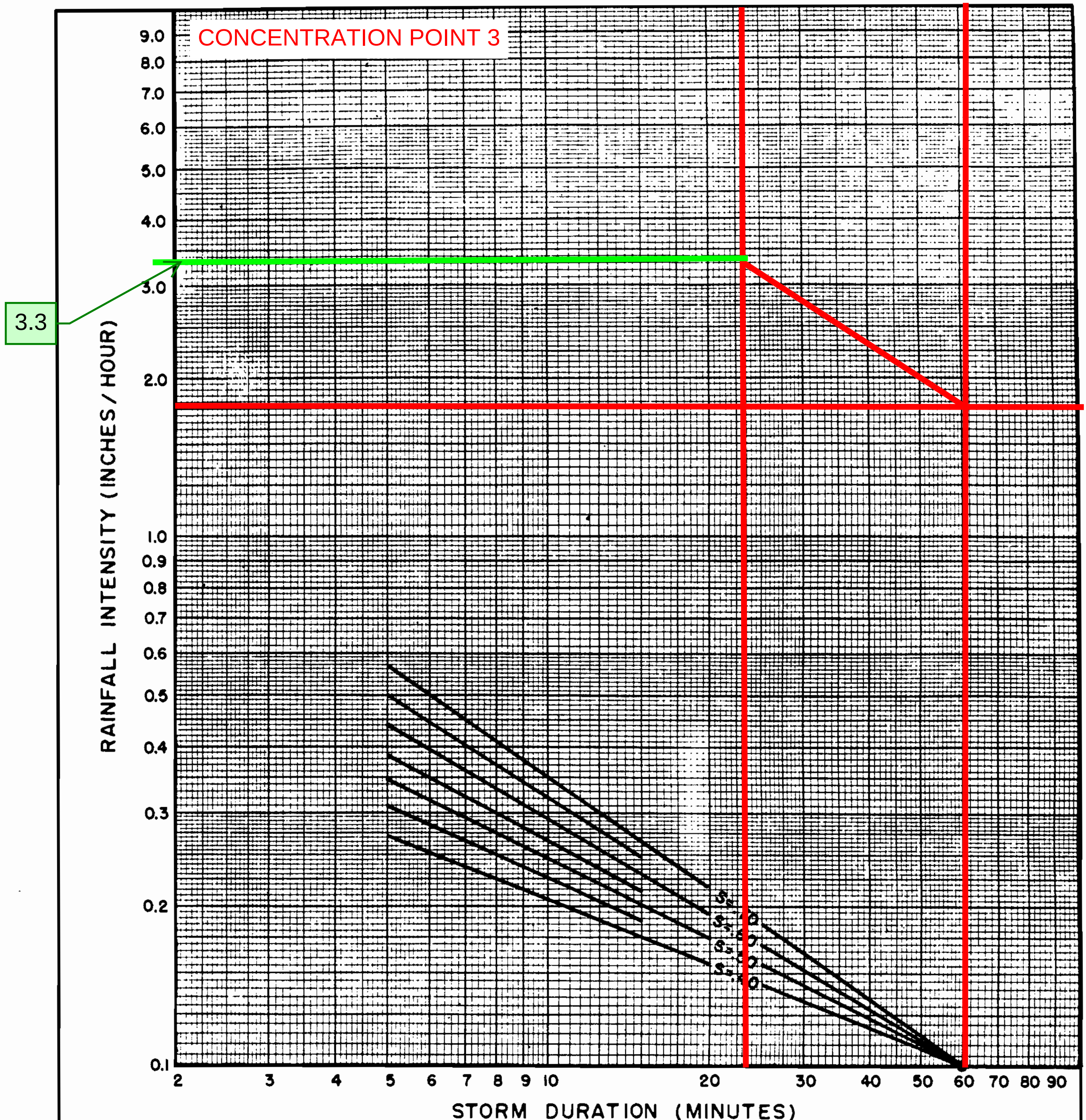
HYDROLOGY MANUAL

INTENSITY – DURATION CURVES CALCULATION SHEET



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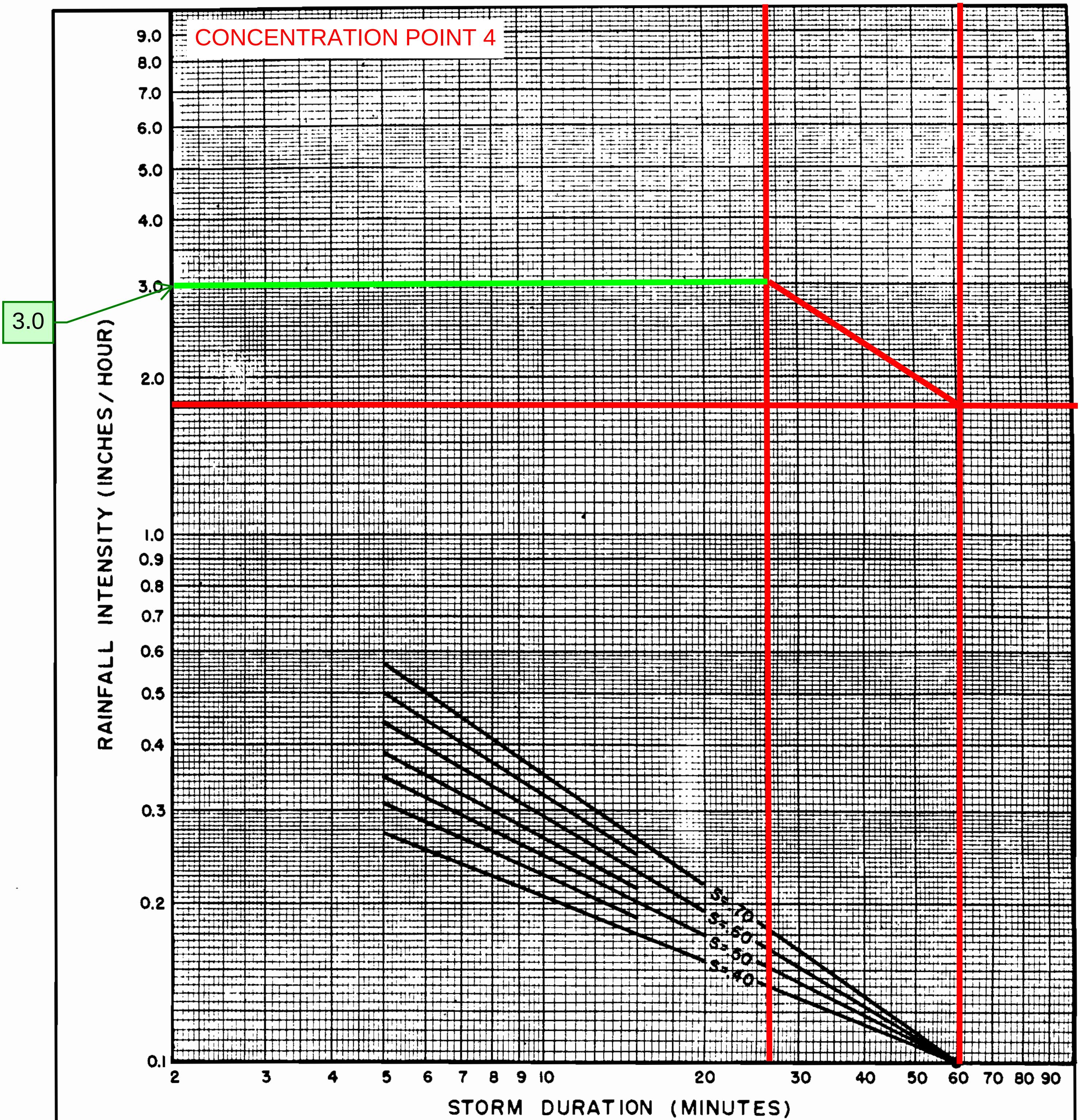
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3

71



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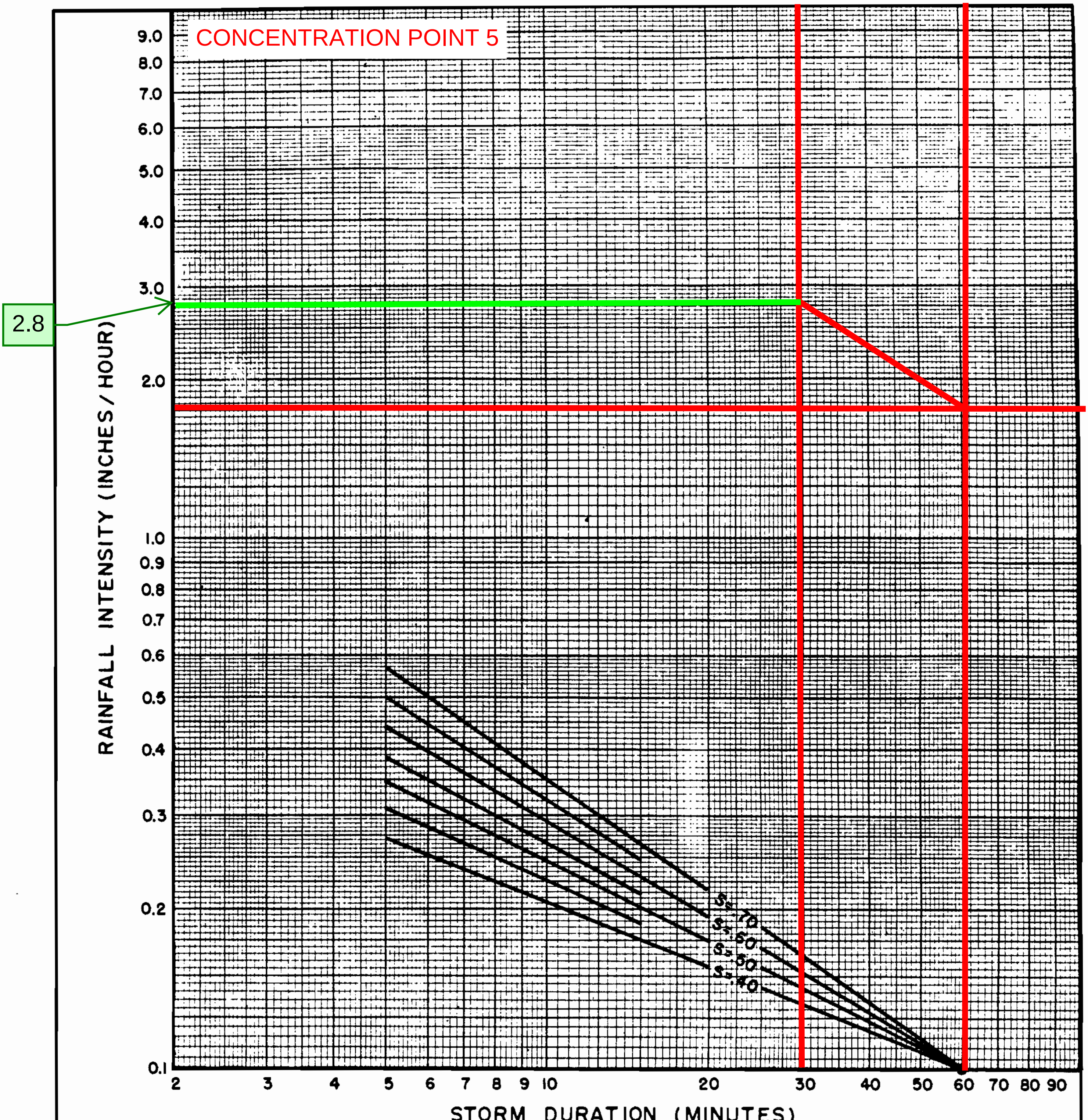
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET



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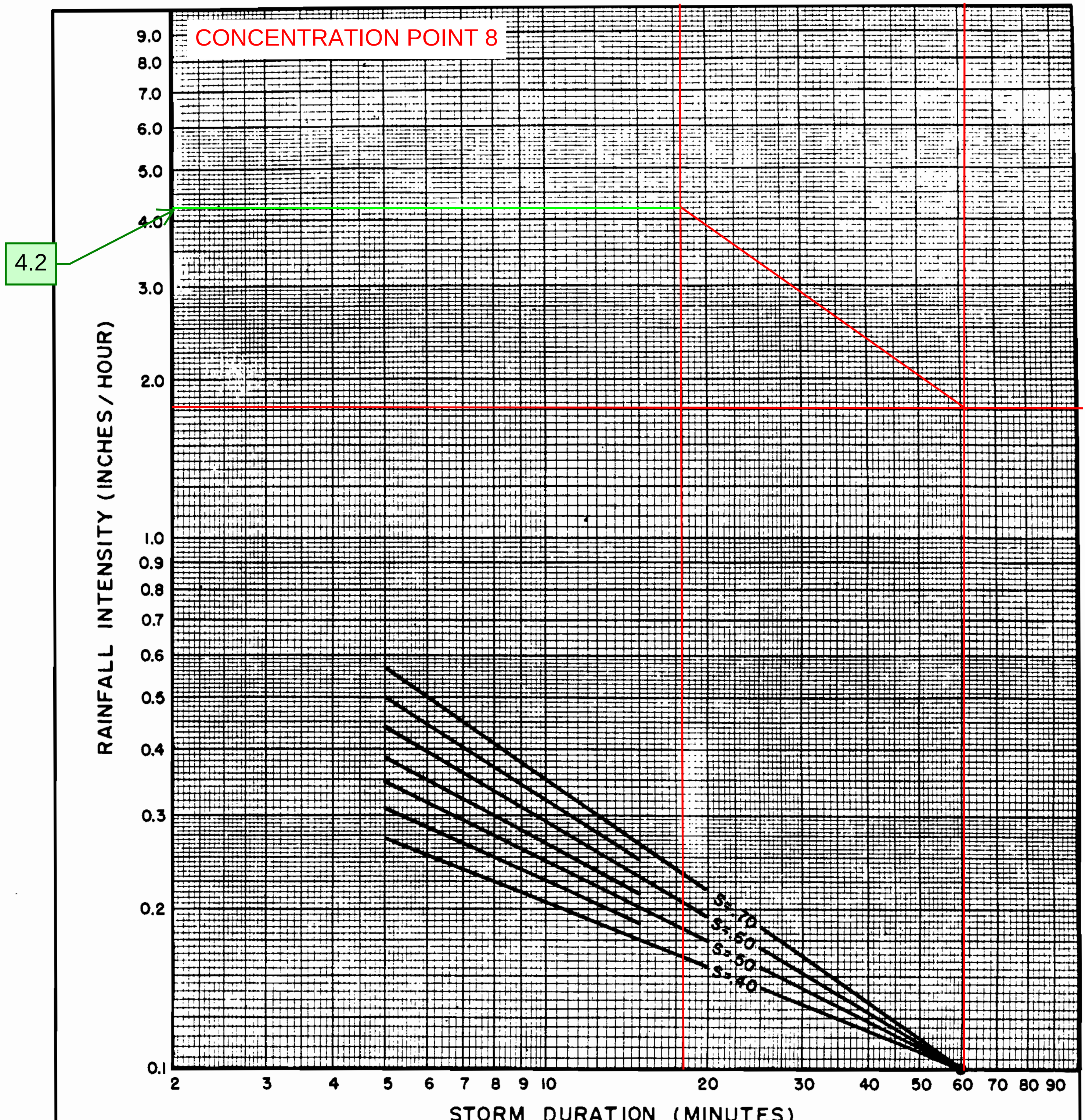
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET



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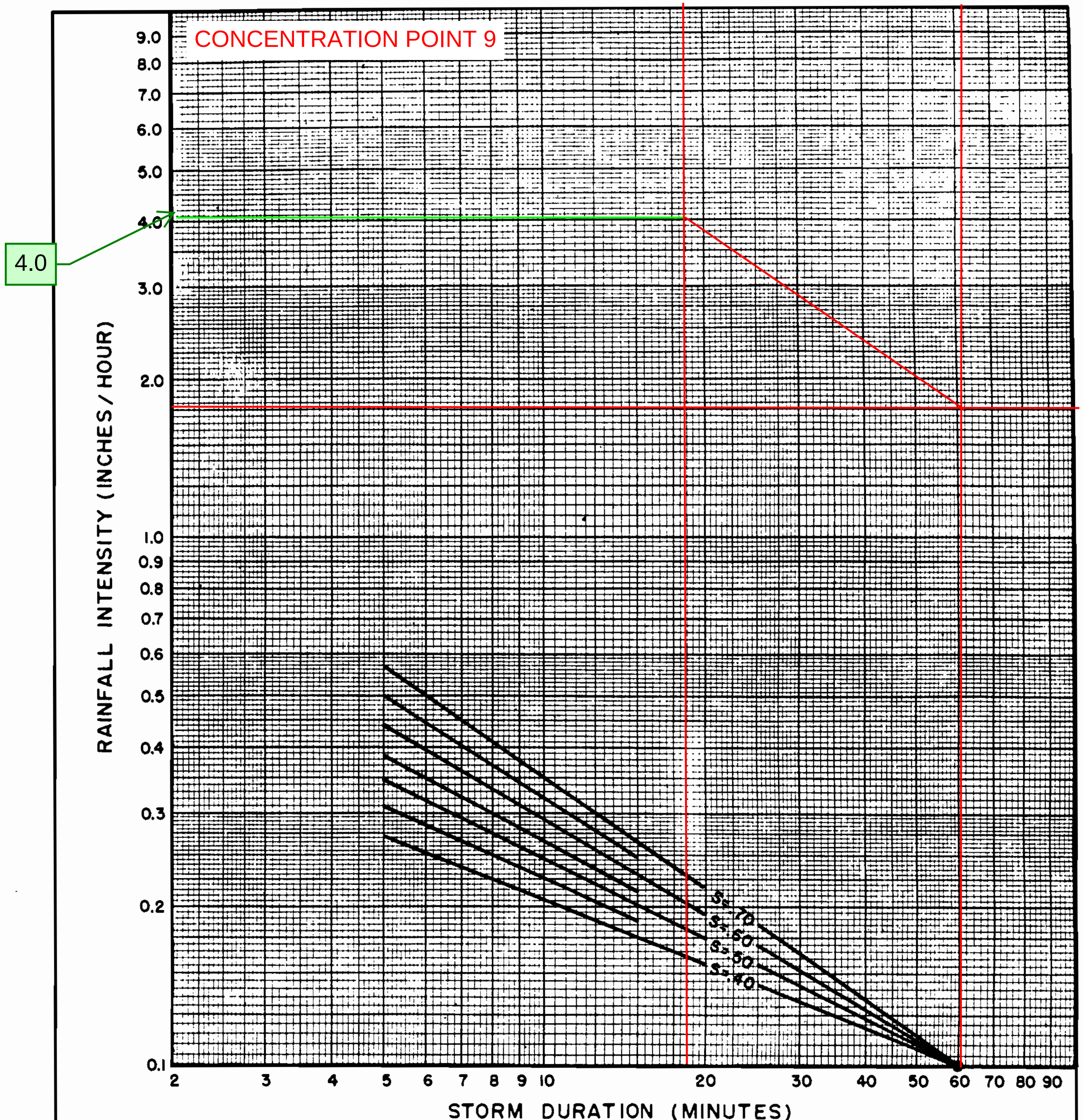
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY – DURATION CURVES CALCULATION SHEET

FIGURE D-3



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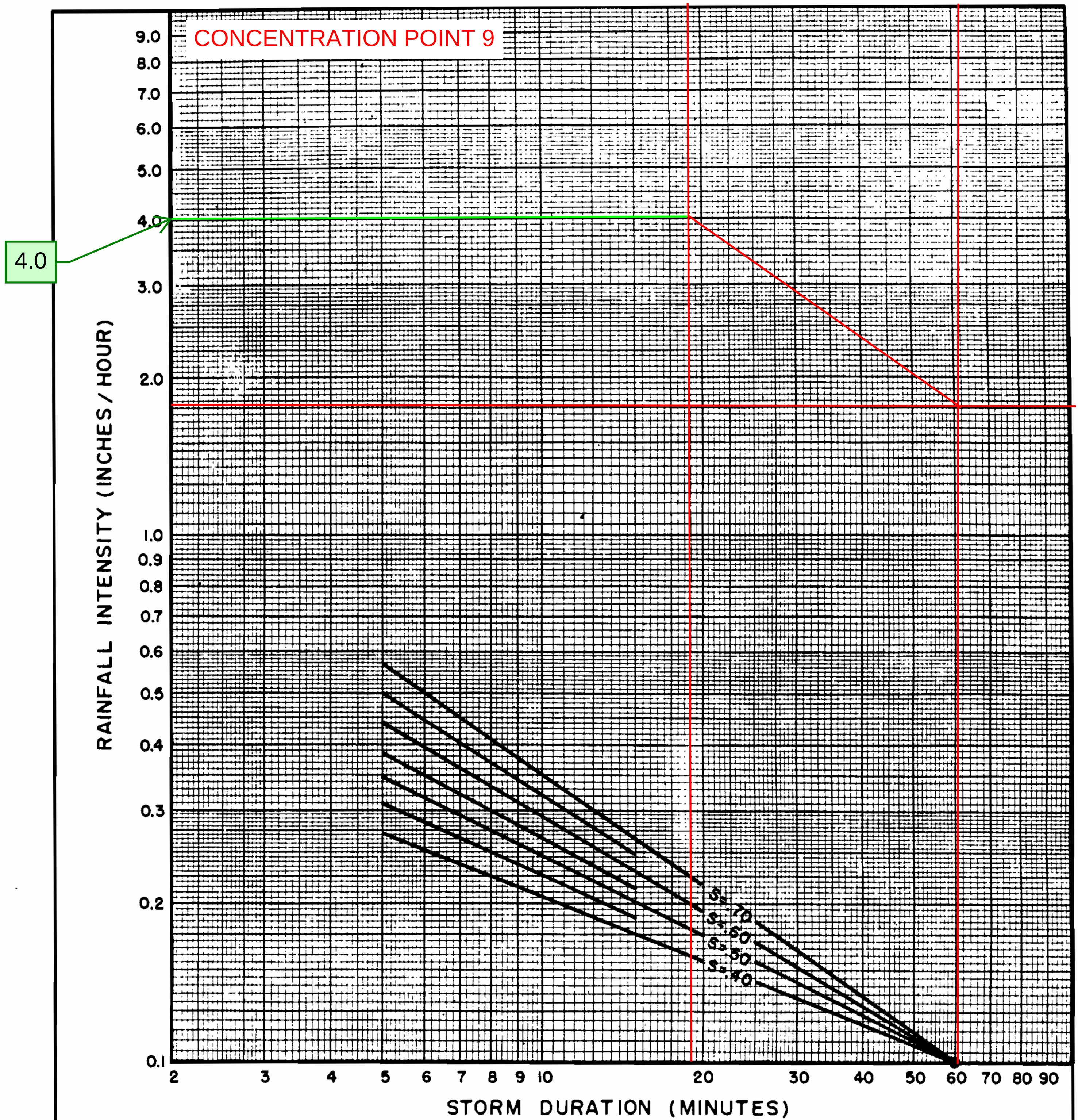
HYDROLOGY MANUAL

INTENSITY – DURATION CURVES CALCULATION SHEET



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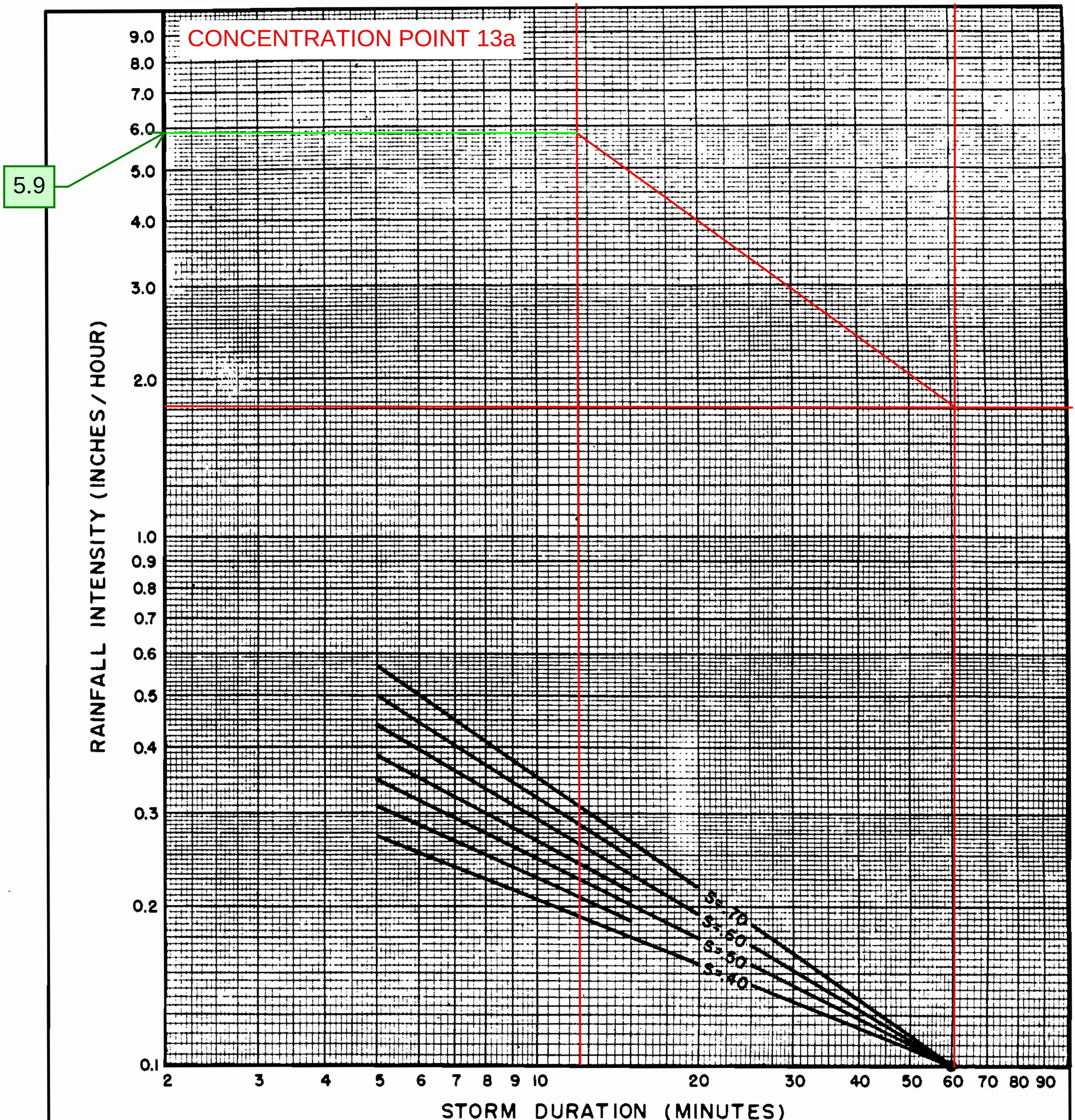
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



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SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

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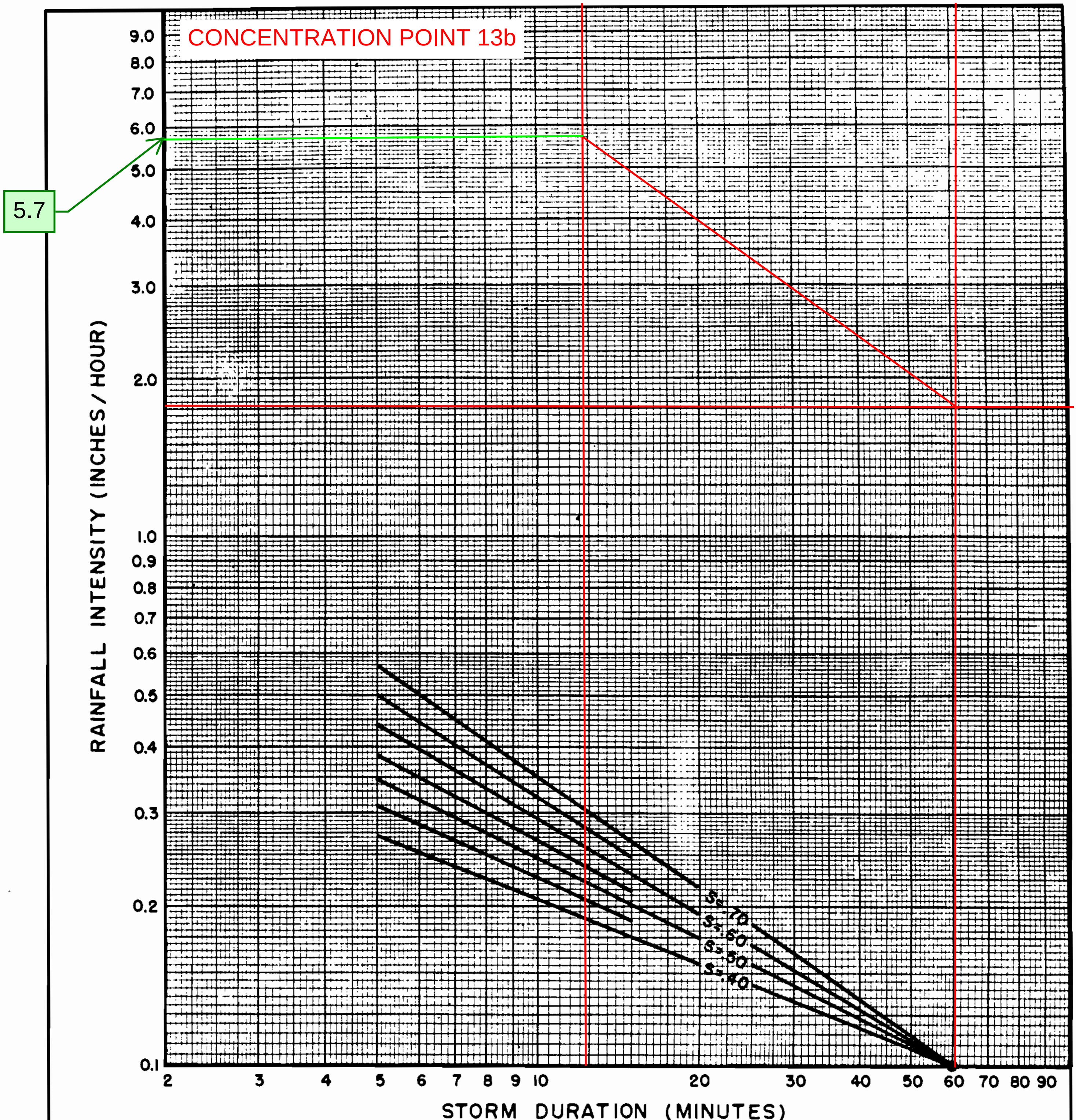

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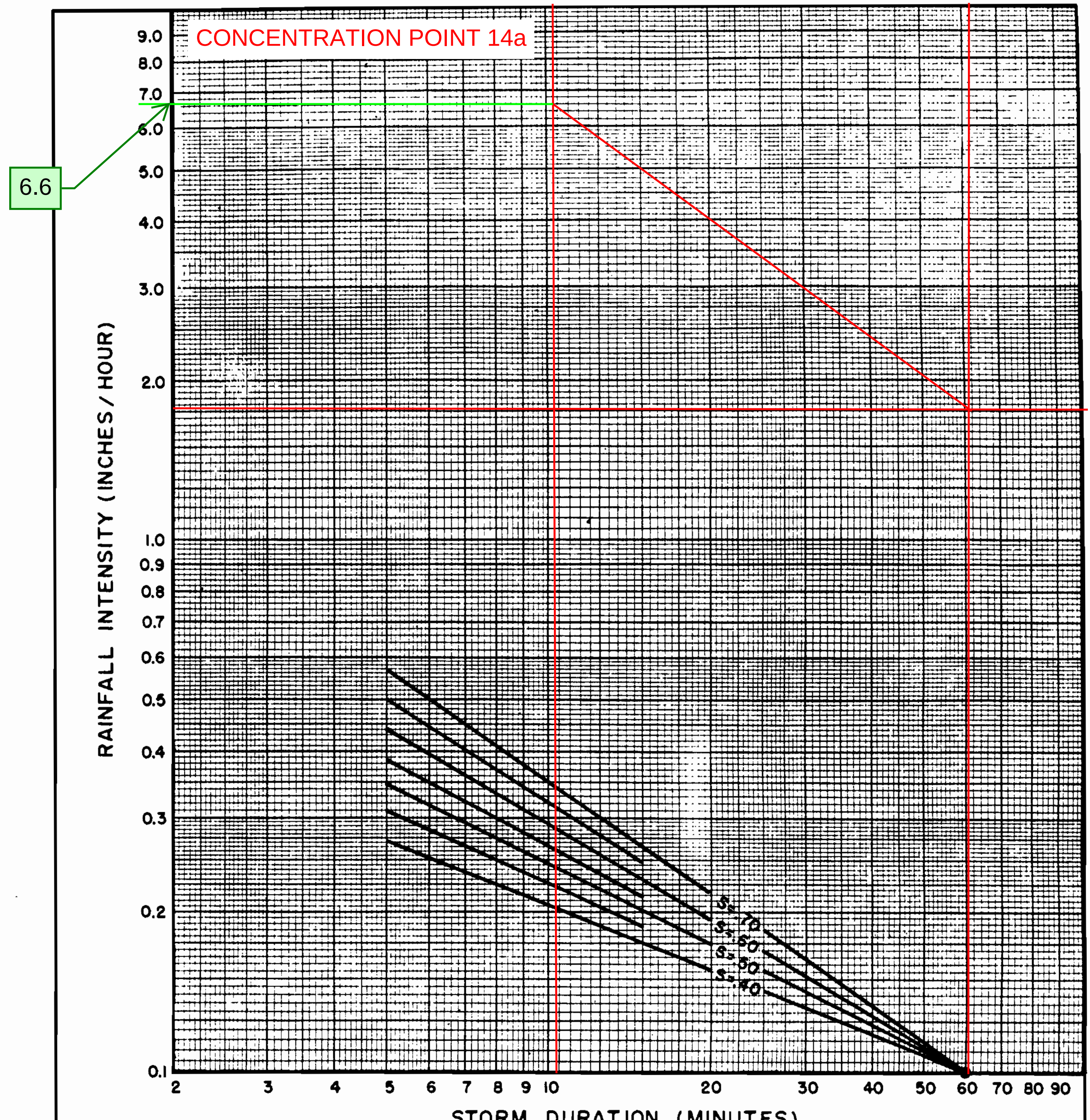

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INTENSITY – DURATION CURVES CALCULATION SHEET

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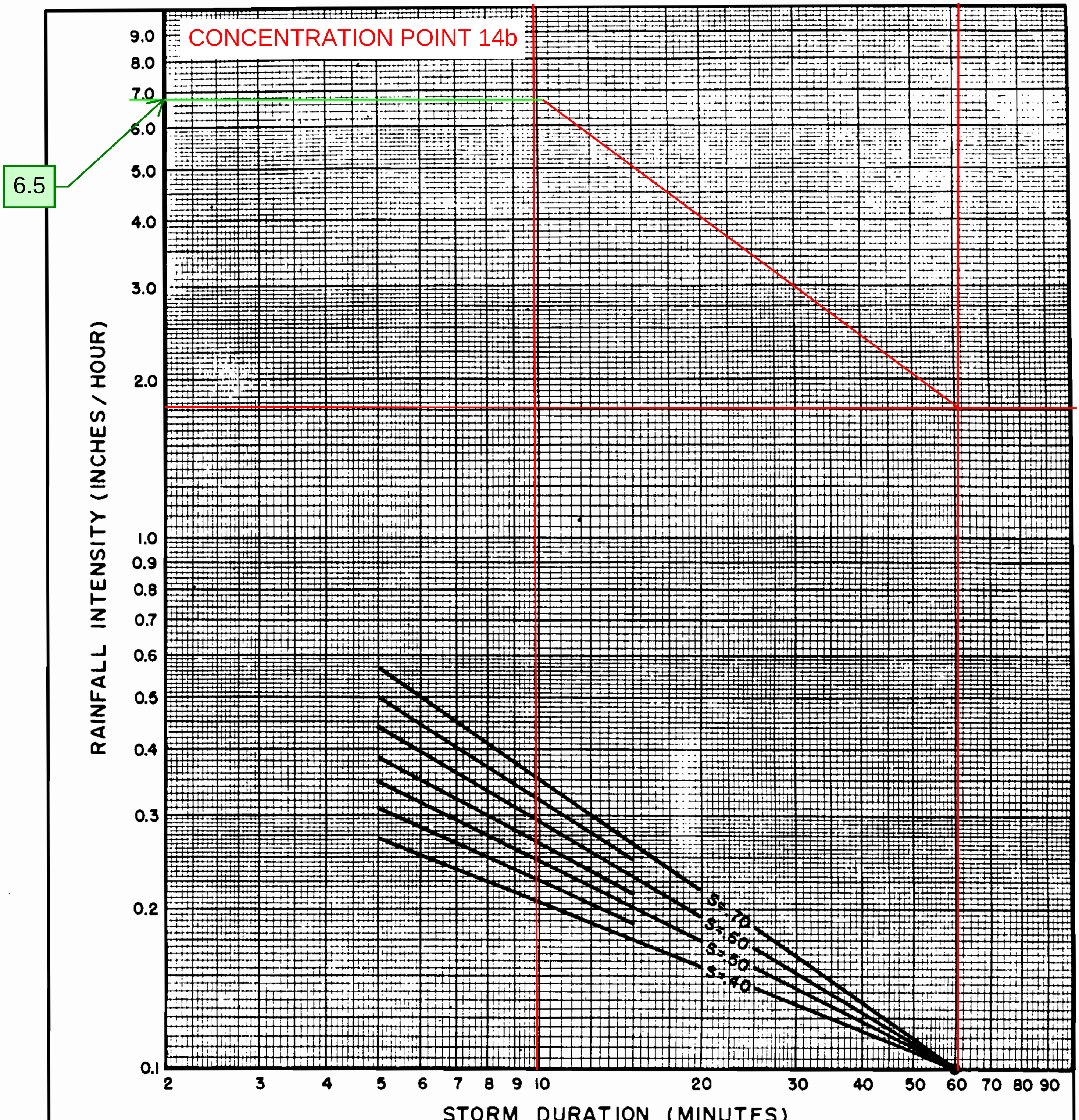

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INTENSITY – DURATION CURVES CALCULATION SHEET

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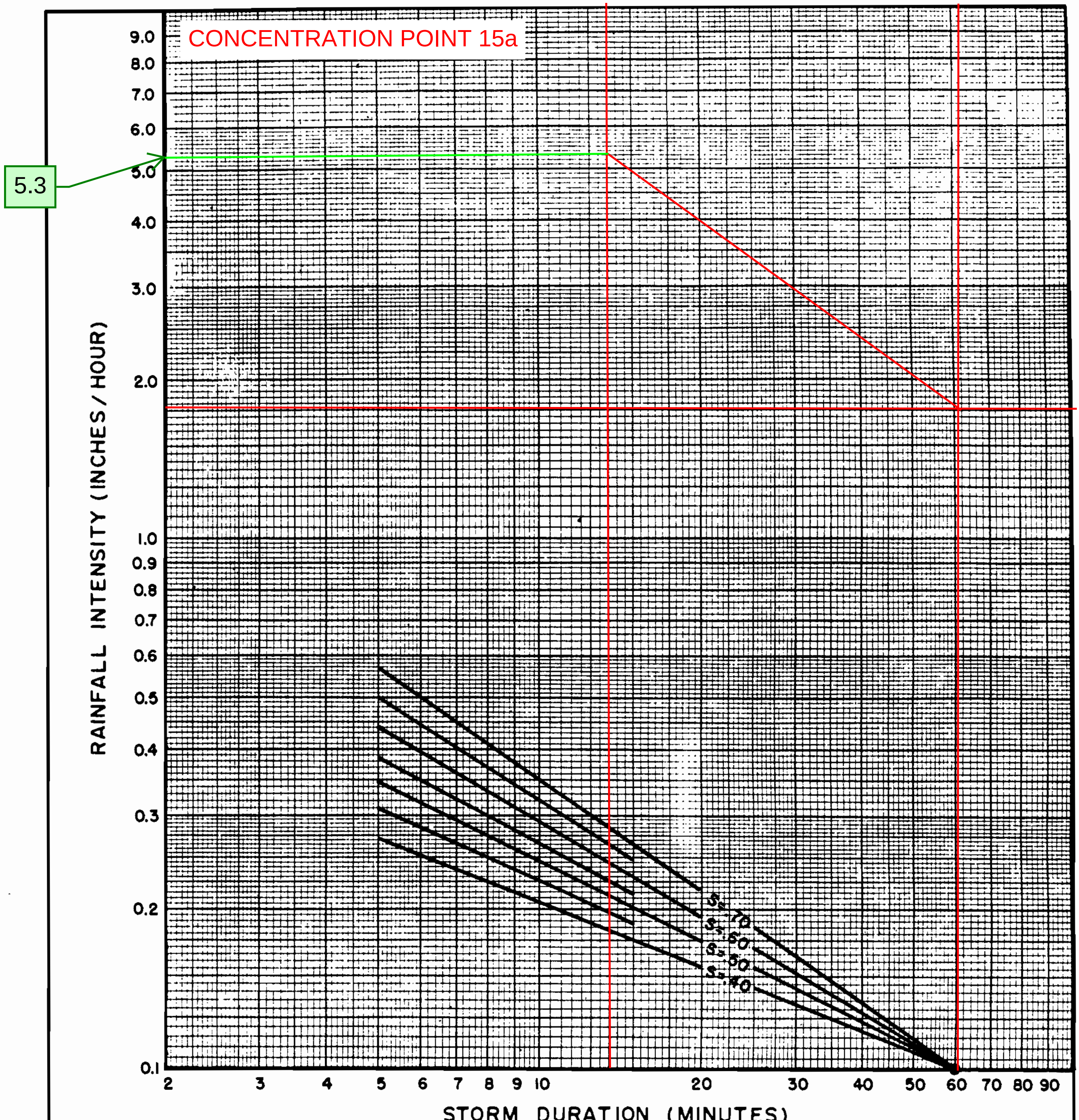

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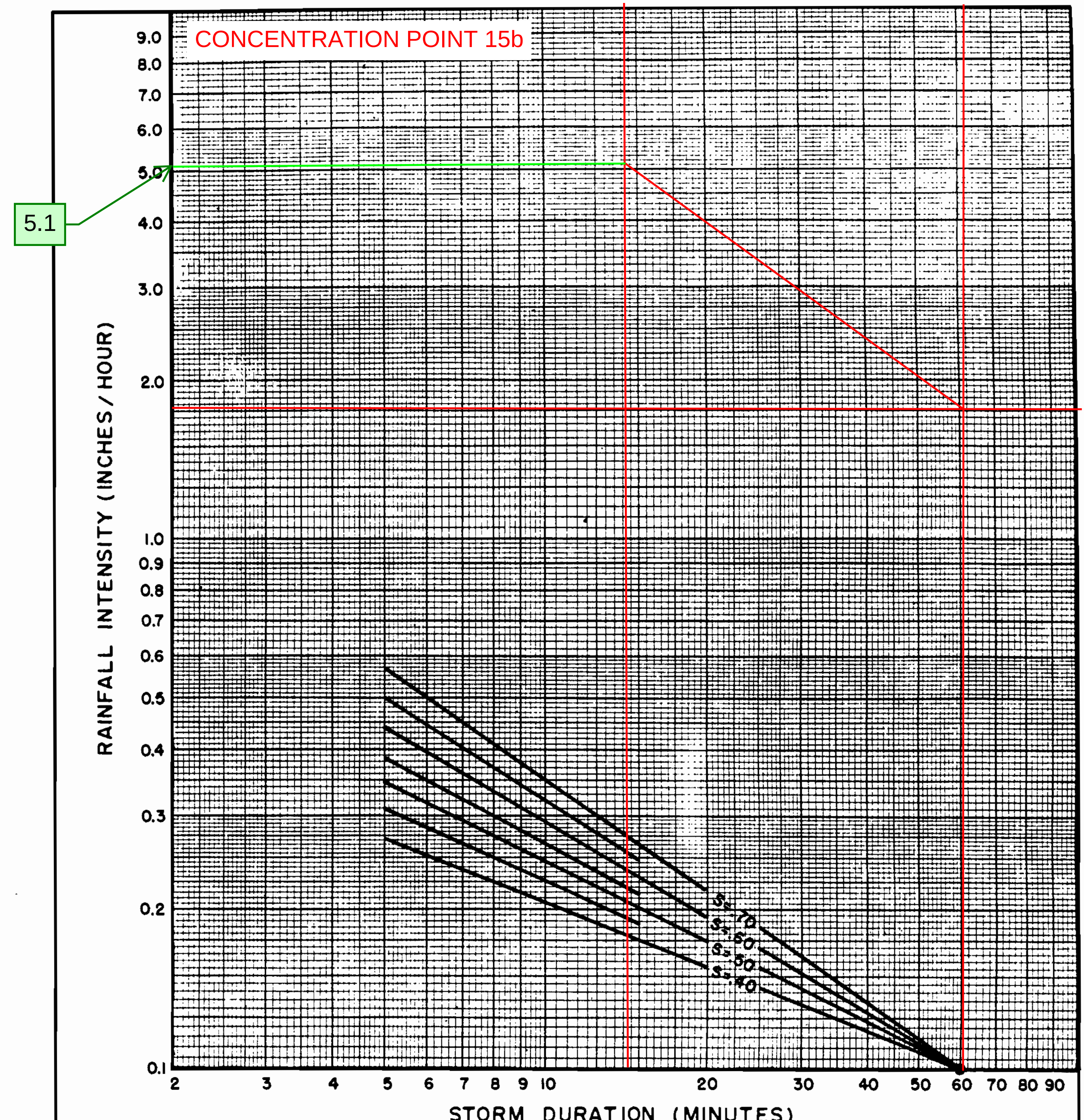

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HYDROLOGY MANUAL

INTENSITY – DURATION CURVES CALCULATION SHEET

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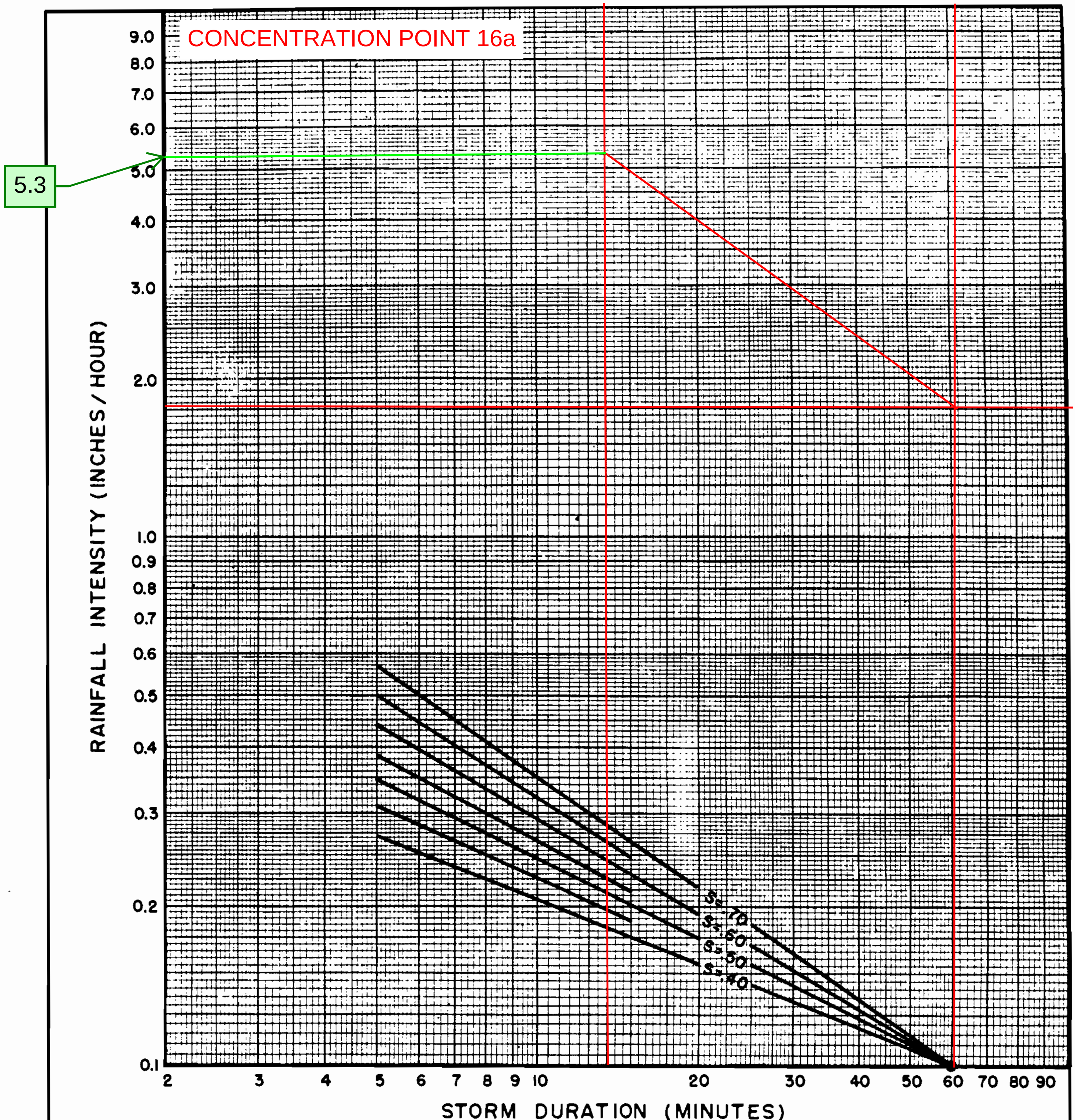

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HYDROLOGY MANUAL

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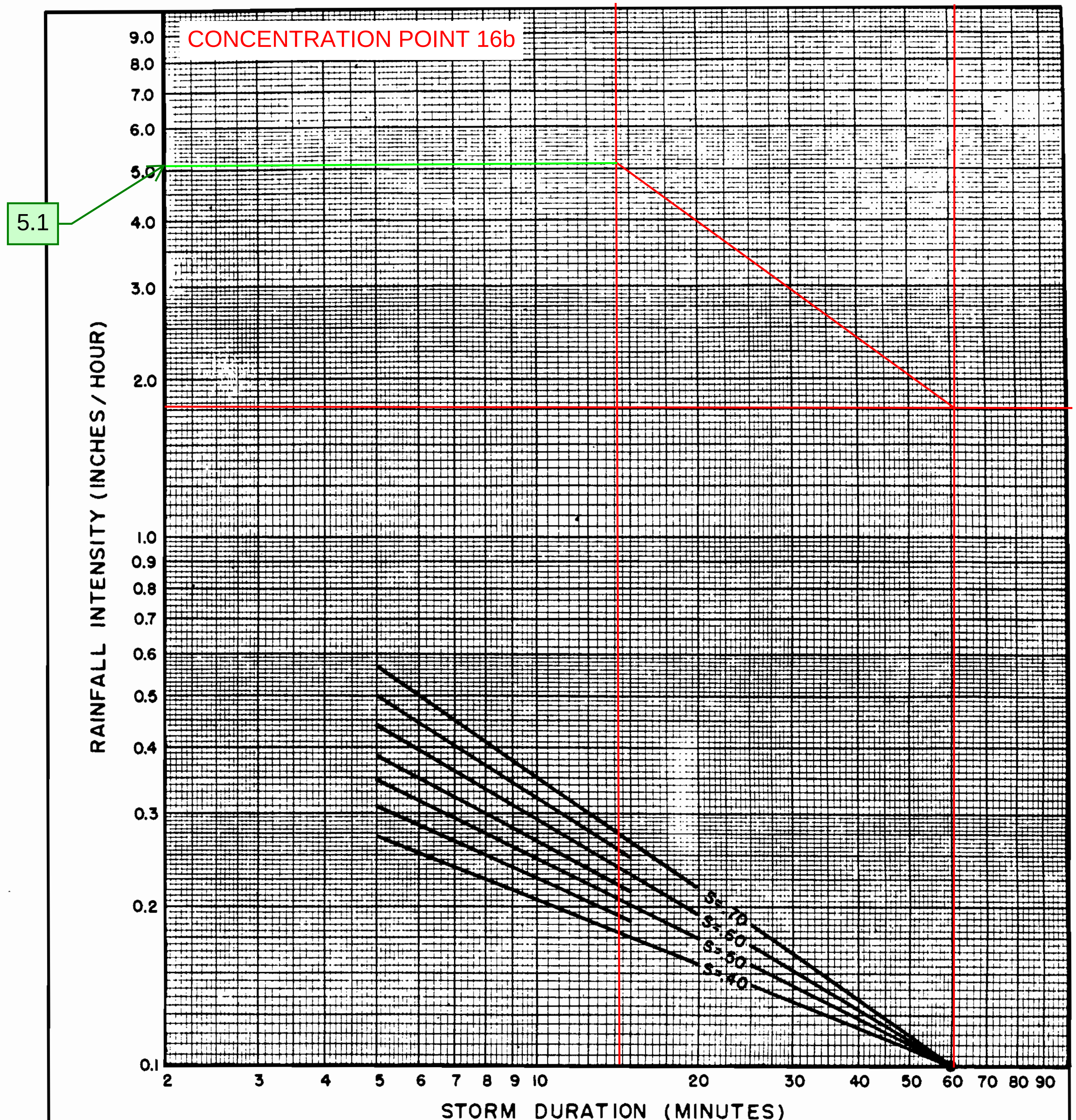

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SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

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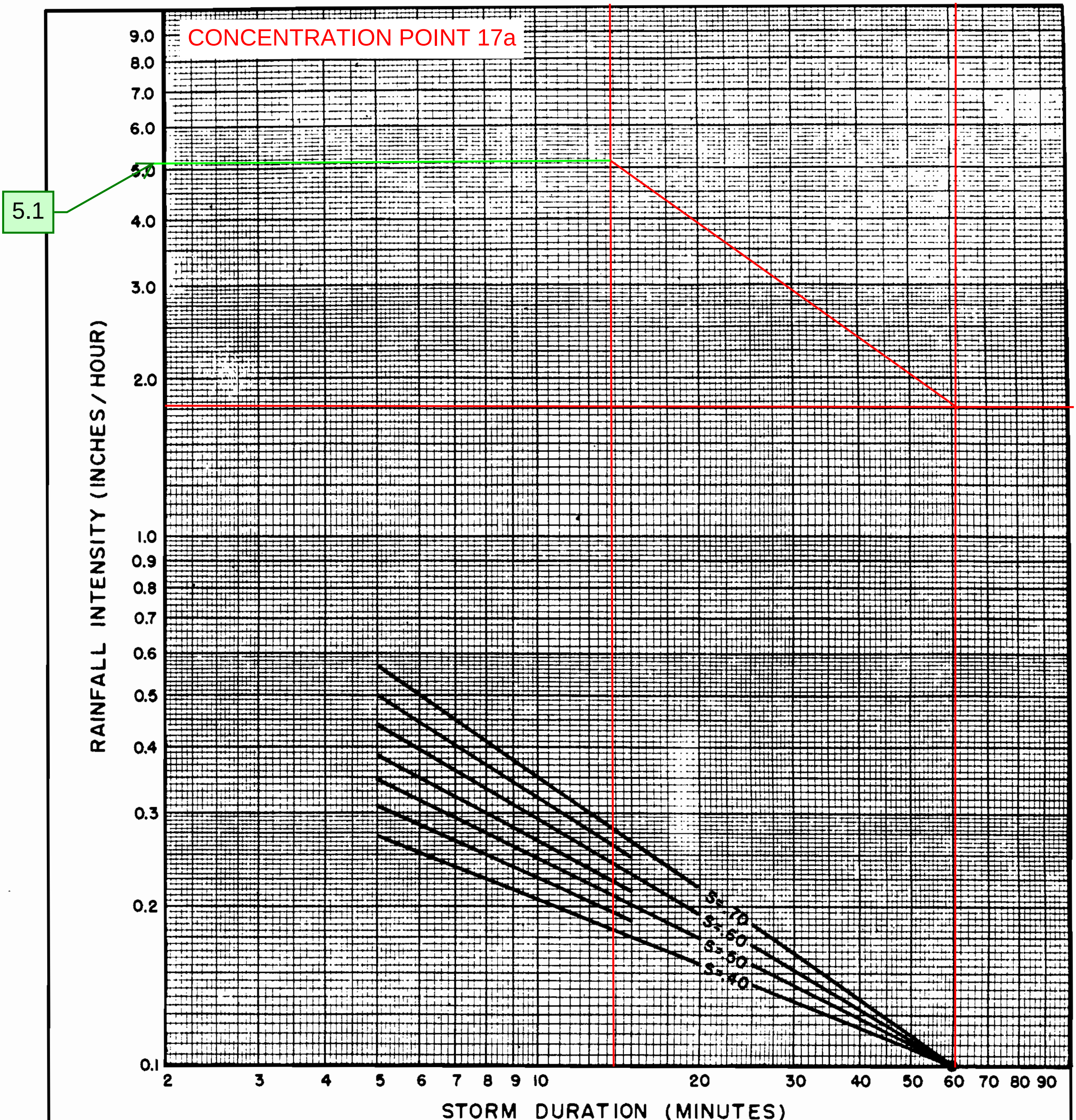

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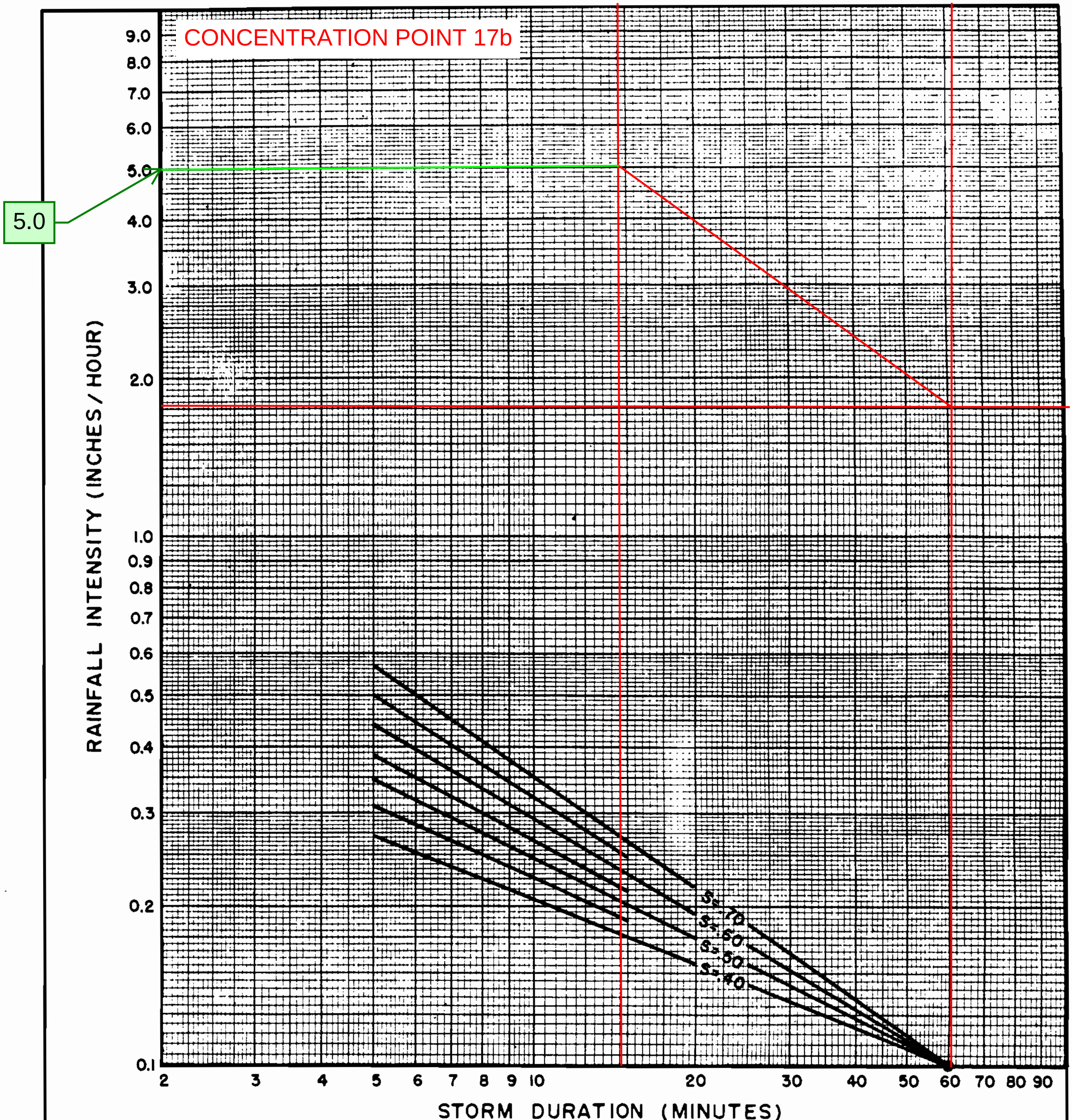

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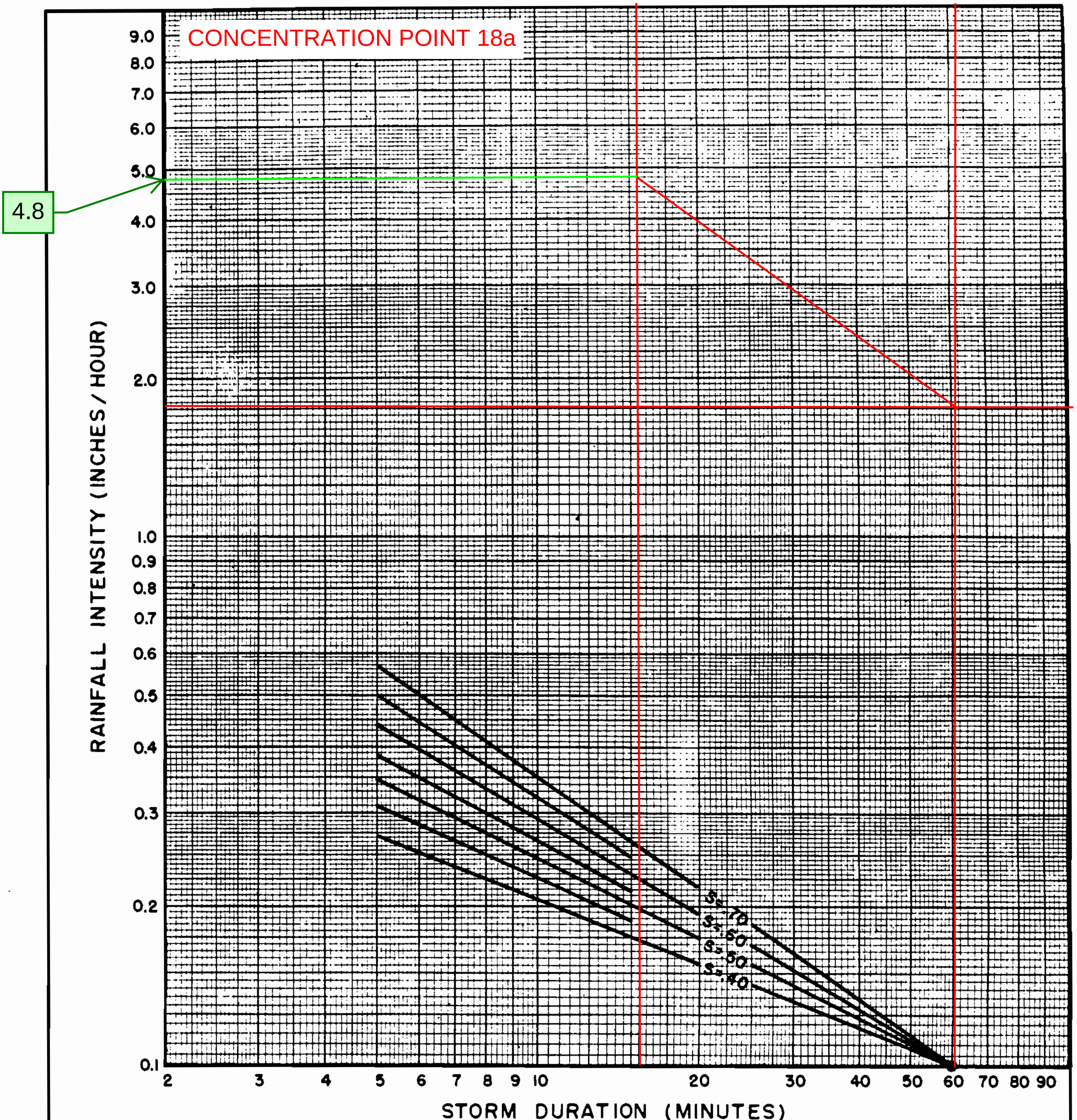
HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET



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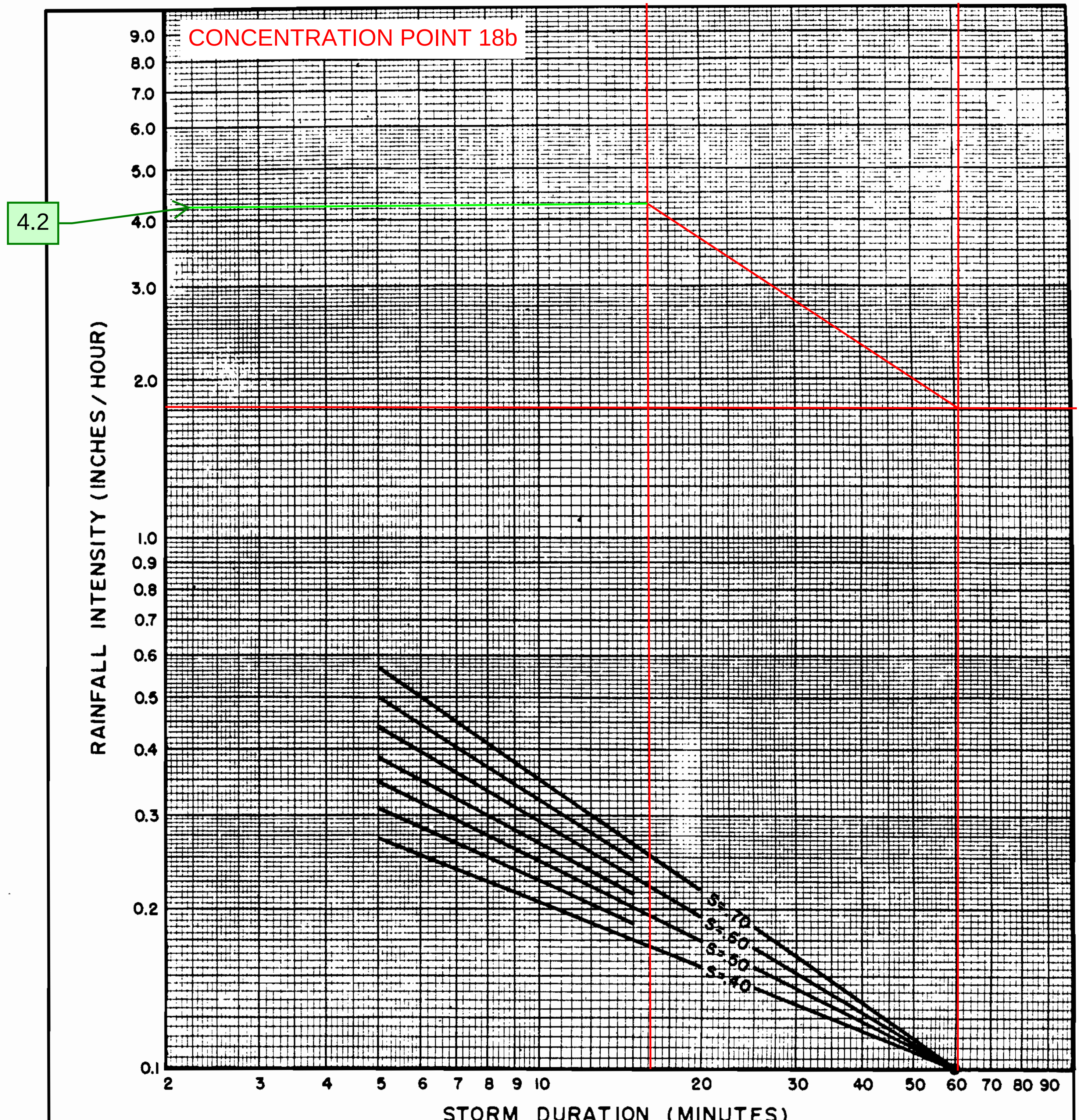
SAN BERNARDINO COUNTY HYDROLOGY MANUAL	INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



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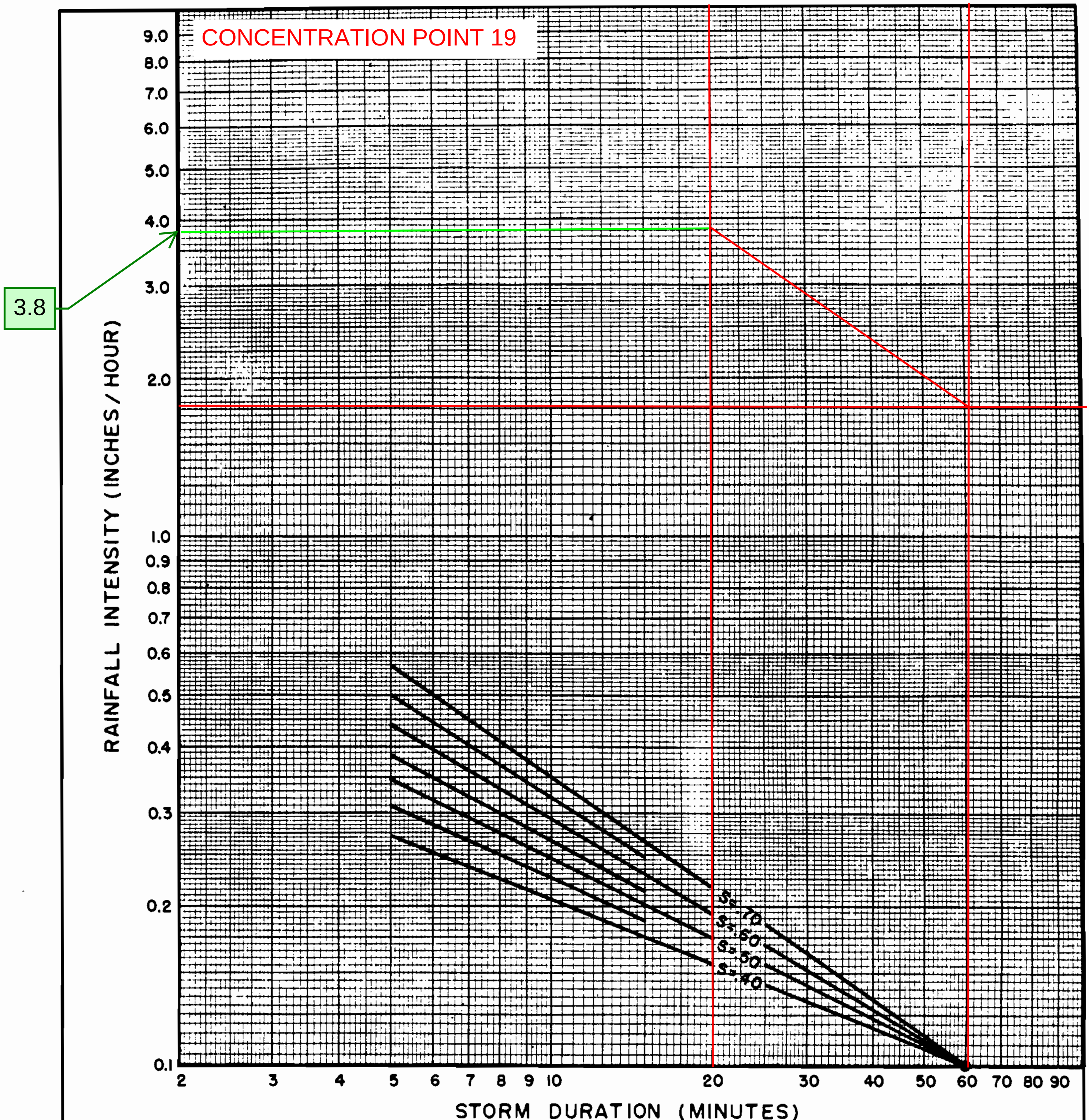
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



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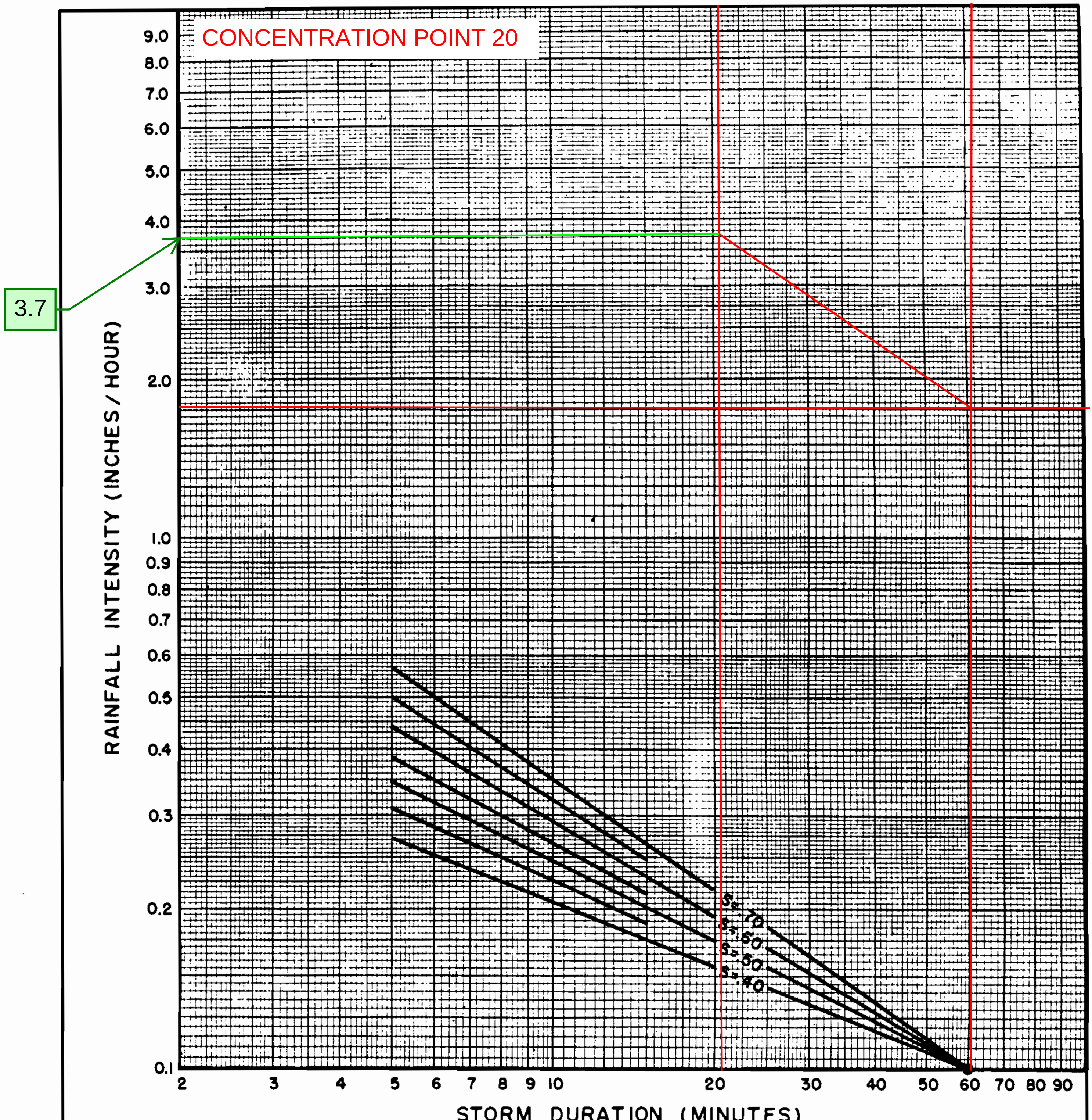
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET



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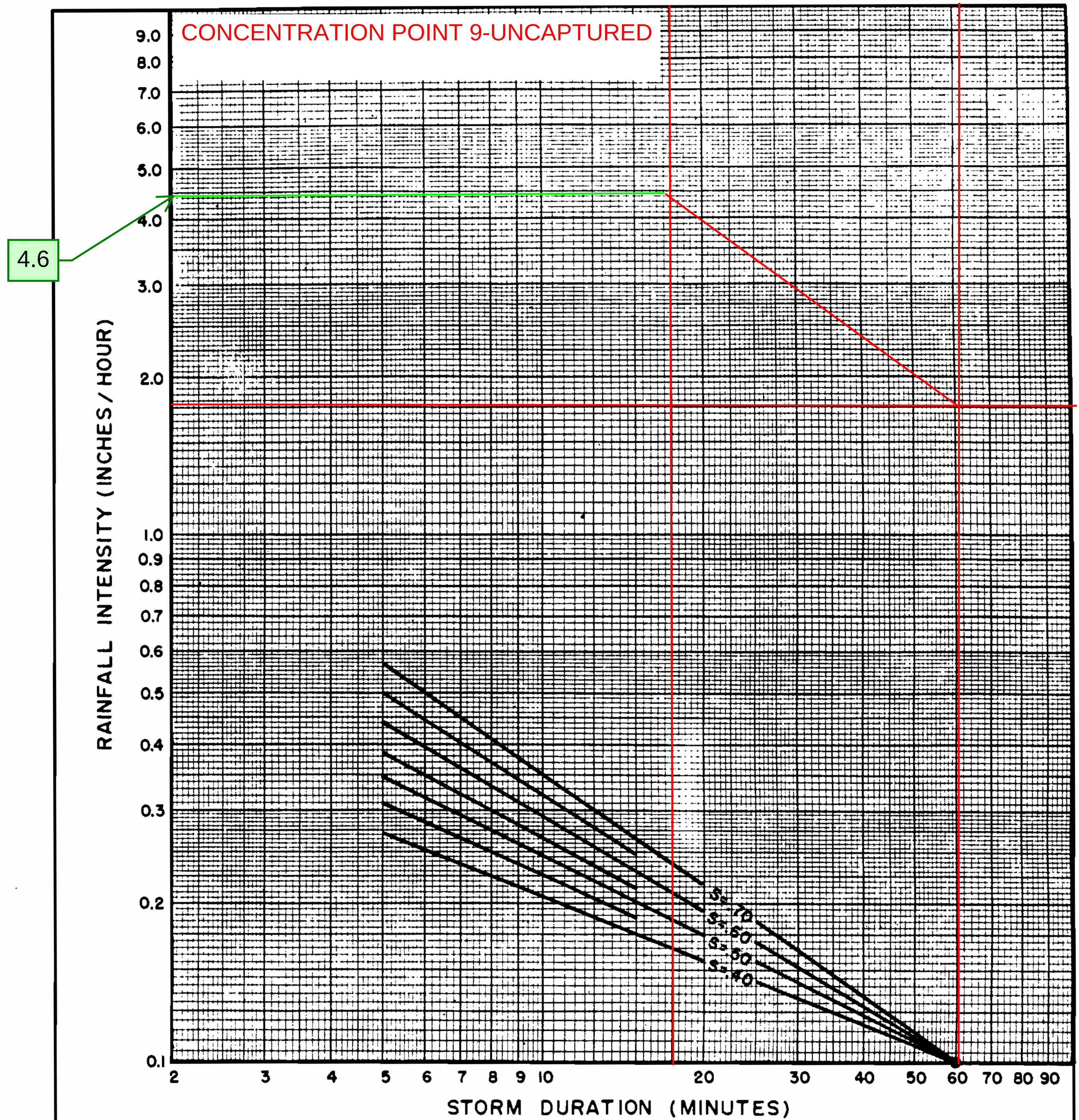
INTENSITY - DURATION CURVES CALCULATION SHEET



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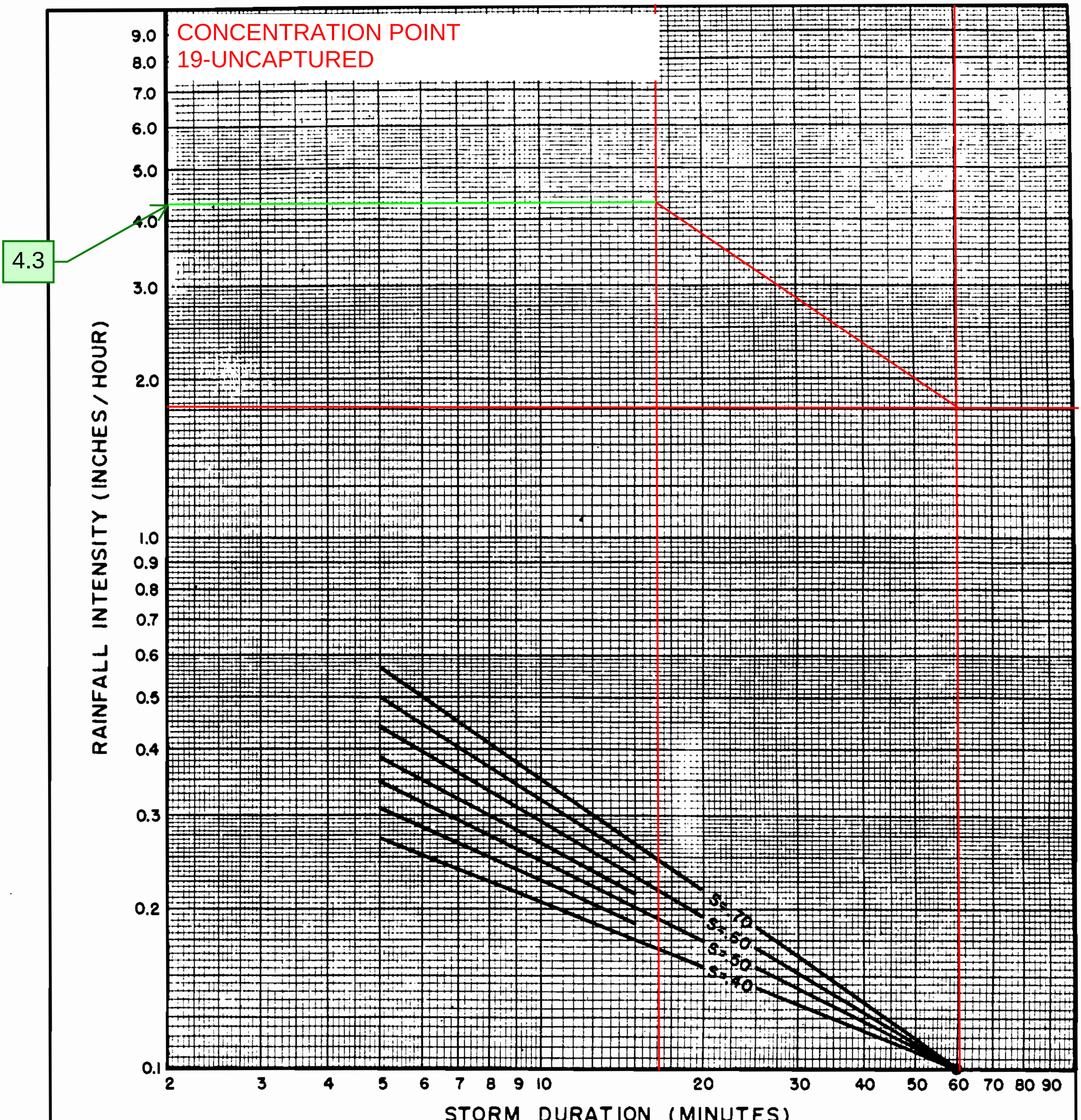
HYDROLOGY MANUAL

INTENSITY – DURATION CURVES CALCULATION SHEET



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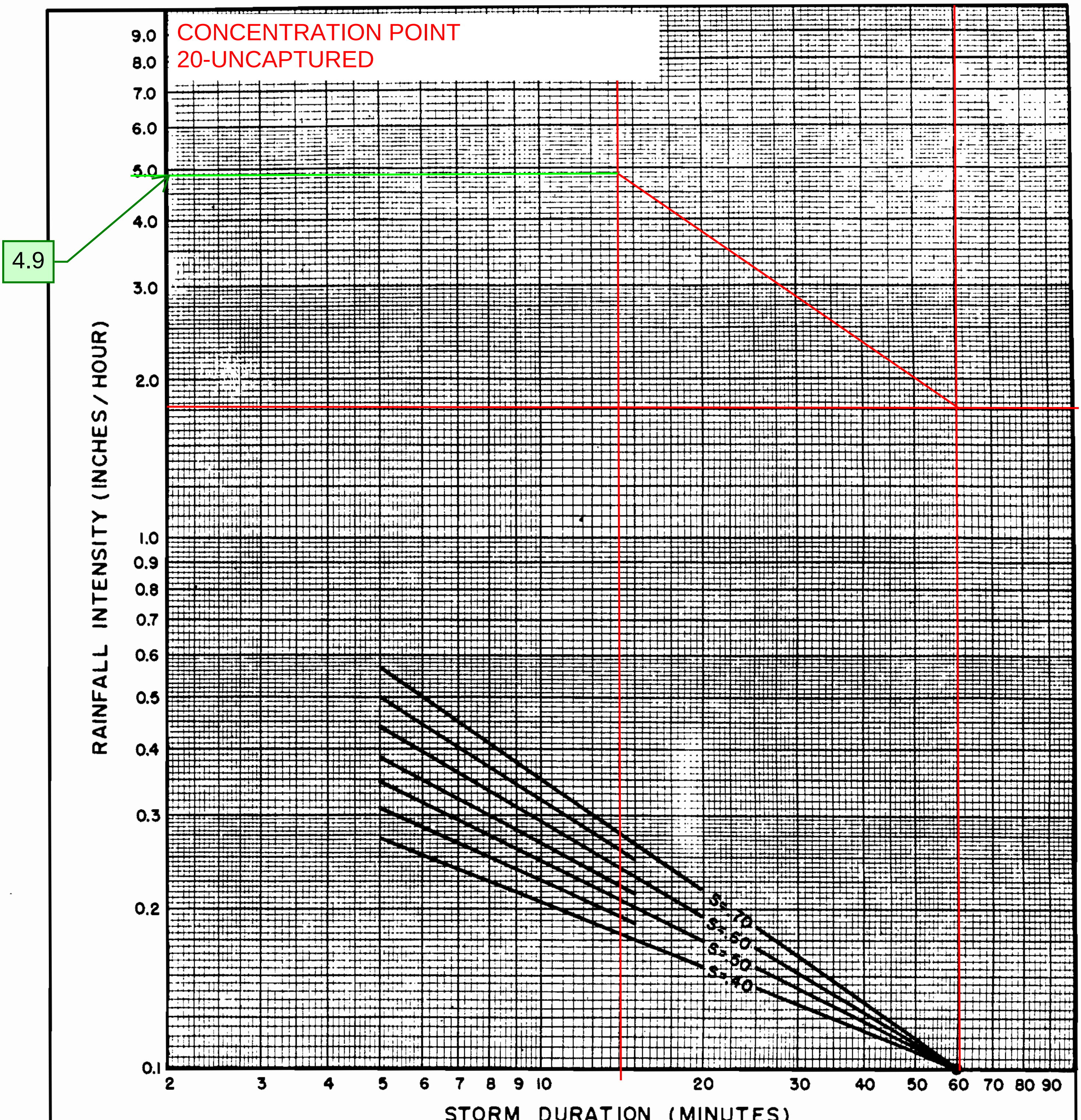
SAN BERNARDINO COUNTY HYDROLOGY MANUAL	INTENSITY - DURATION CURVES CALCULATION SHEET



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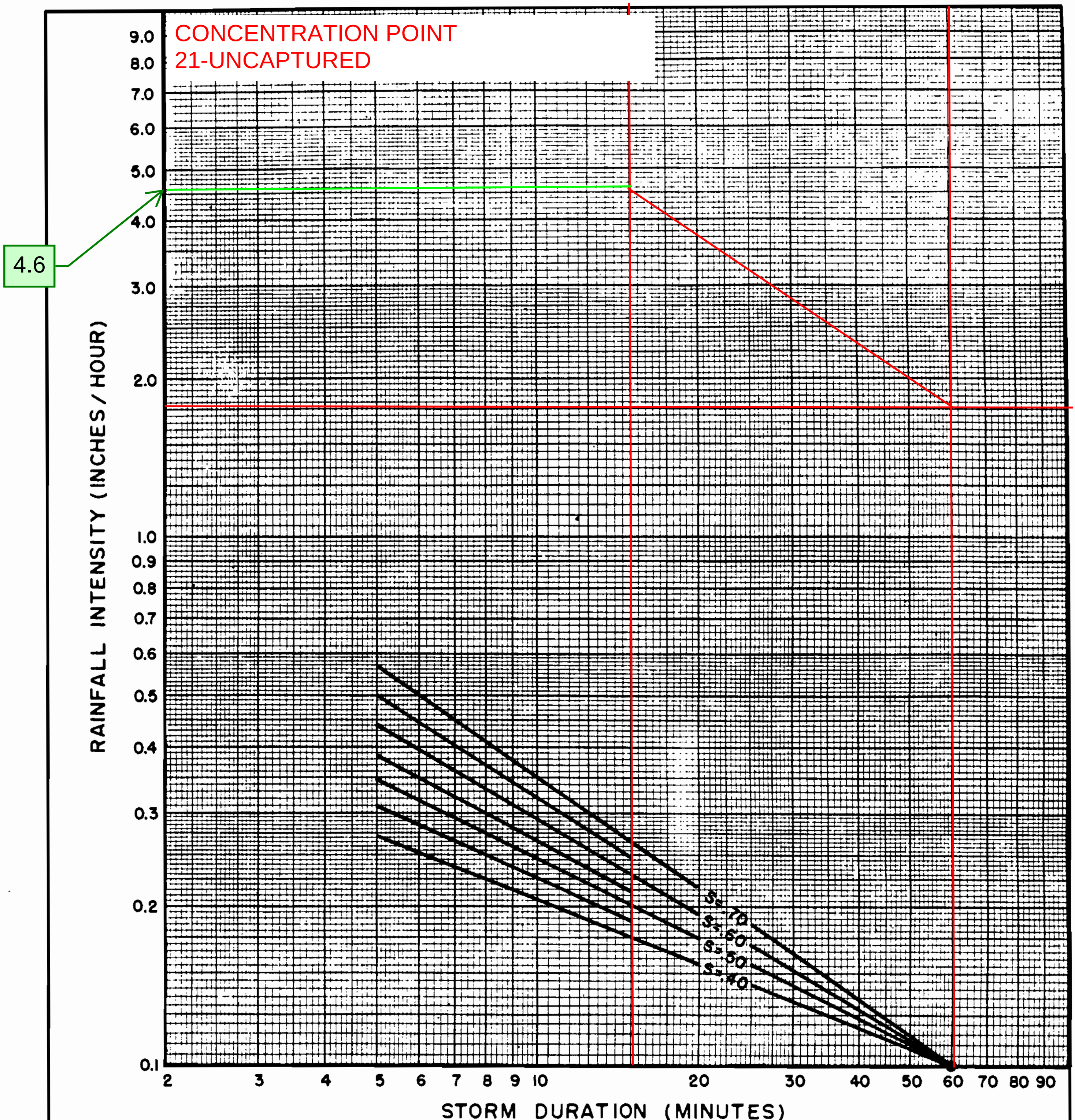
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



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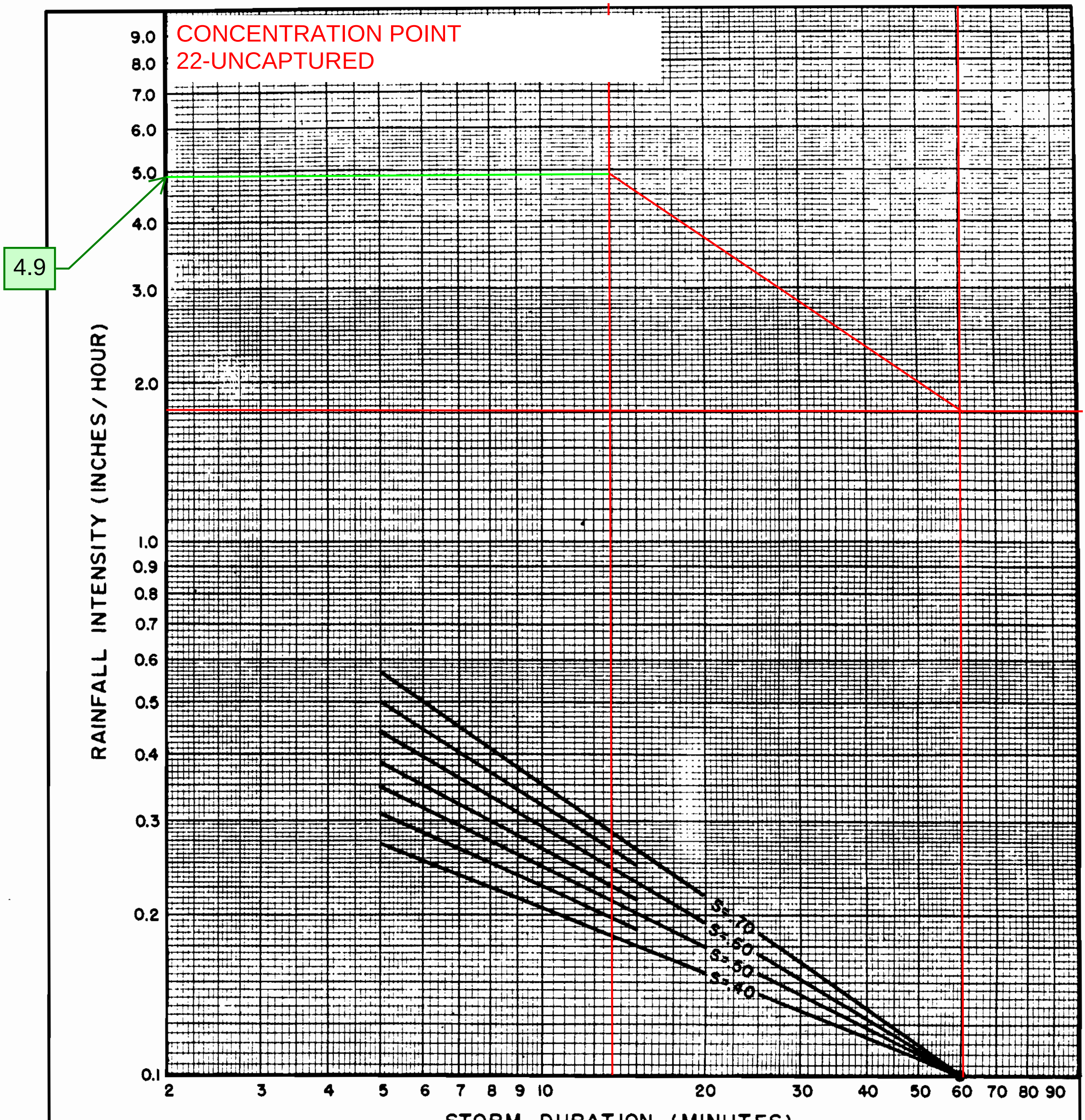
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

CONCENTRATION POINT
22-UNCAPTURED



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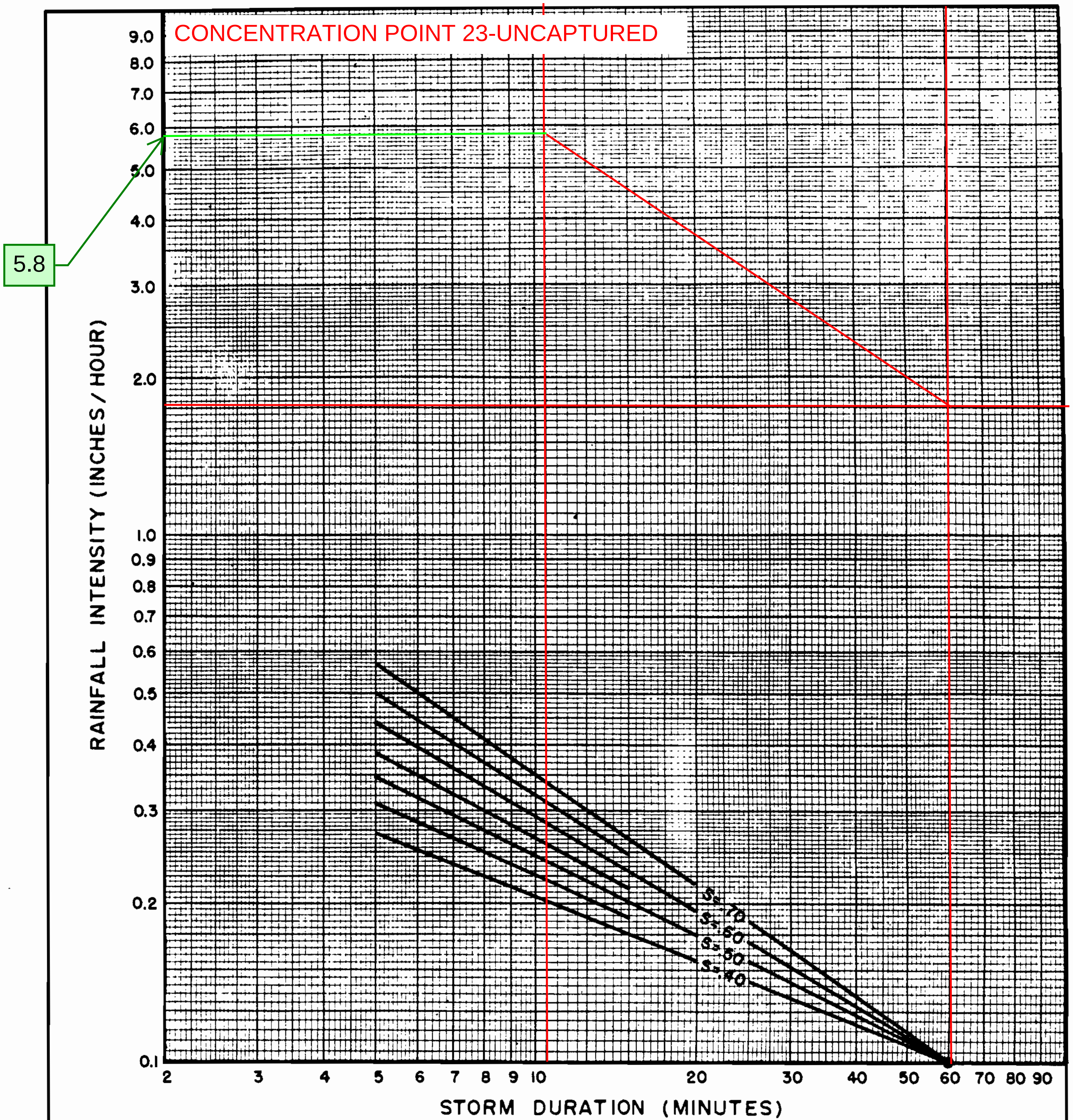
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY – DURATION CURVES CALCULATION SHEET



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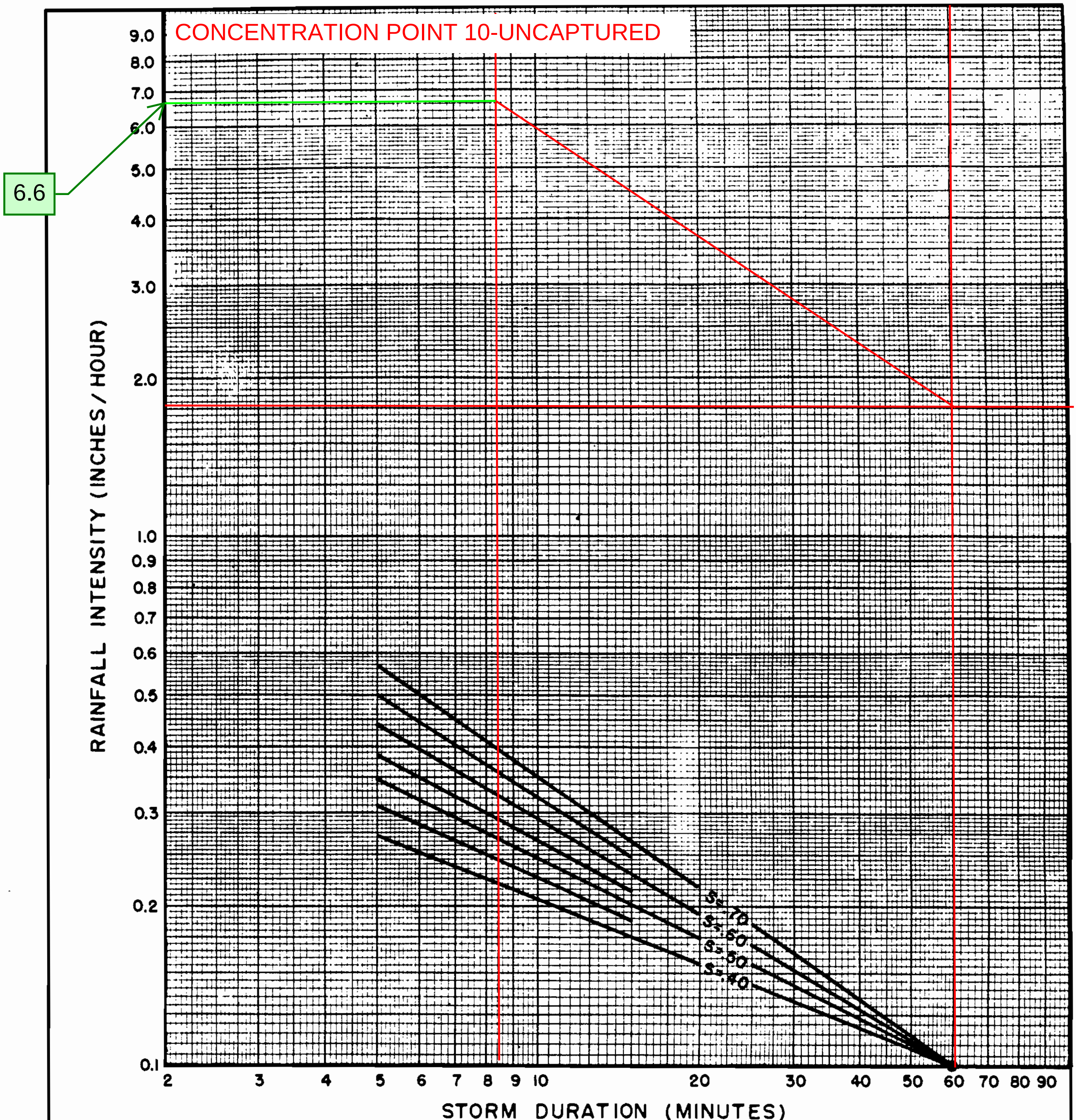
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3



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SAN BERNARDINO COUNTY

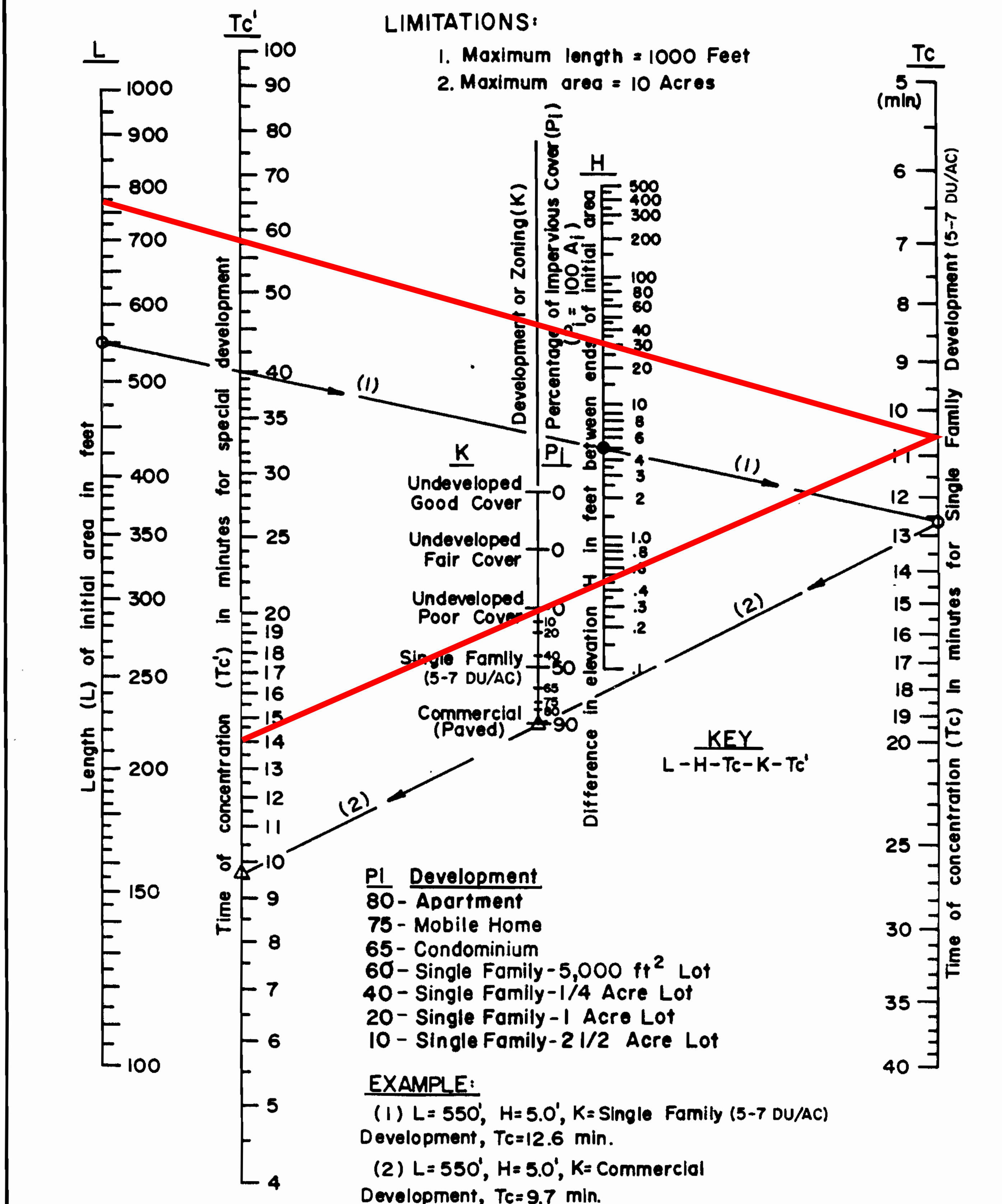
HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

Appendix A.3

Time of Concentration Nomographs

CONCENTRATION POINT 2-Existing



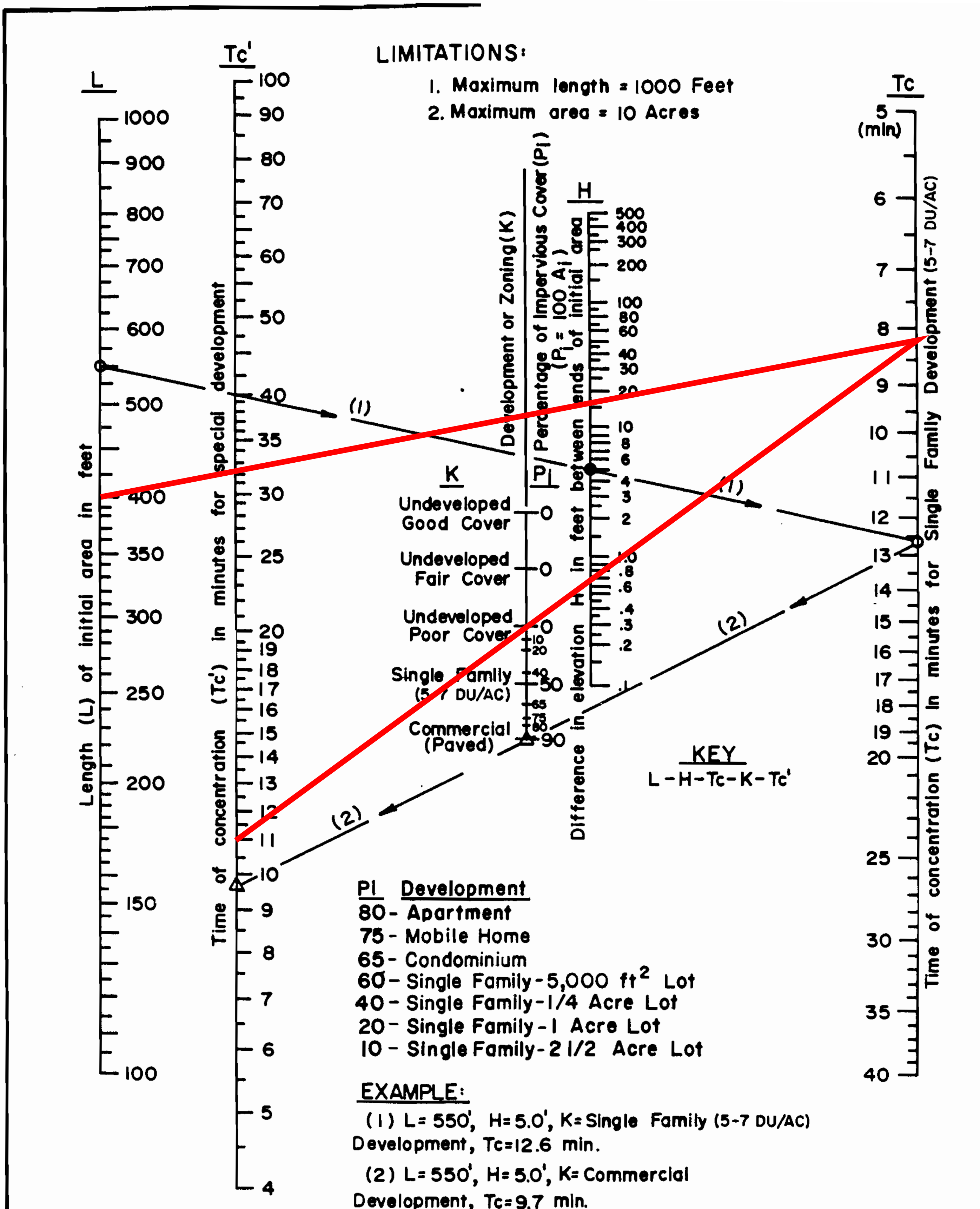
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 2



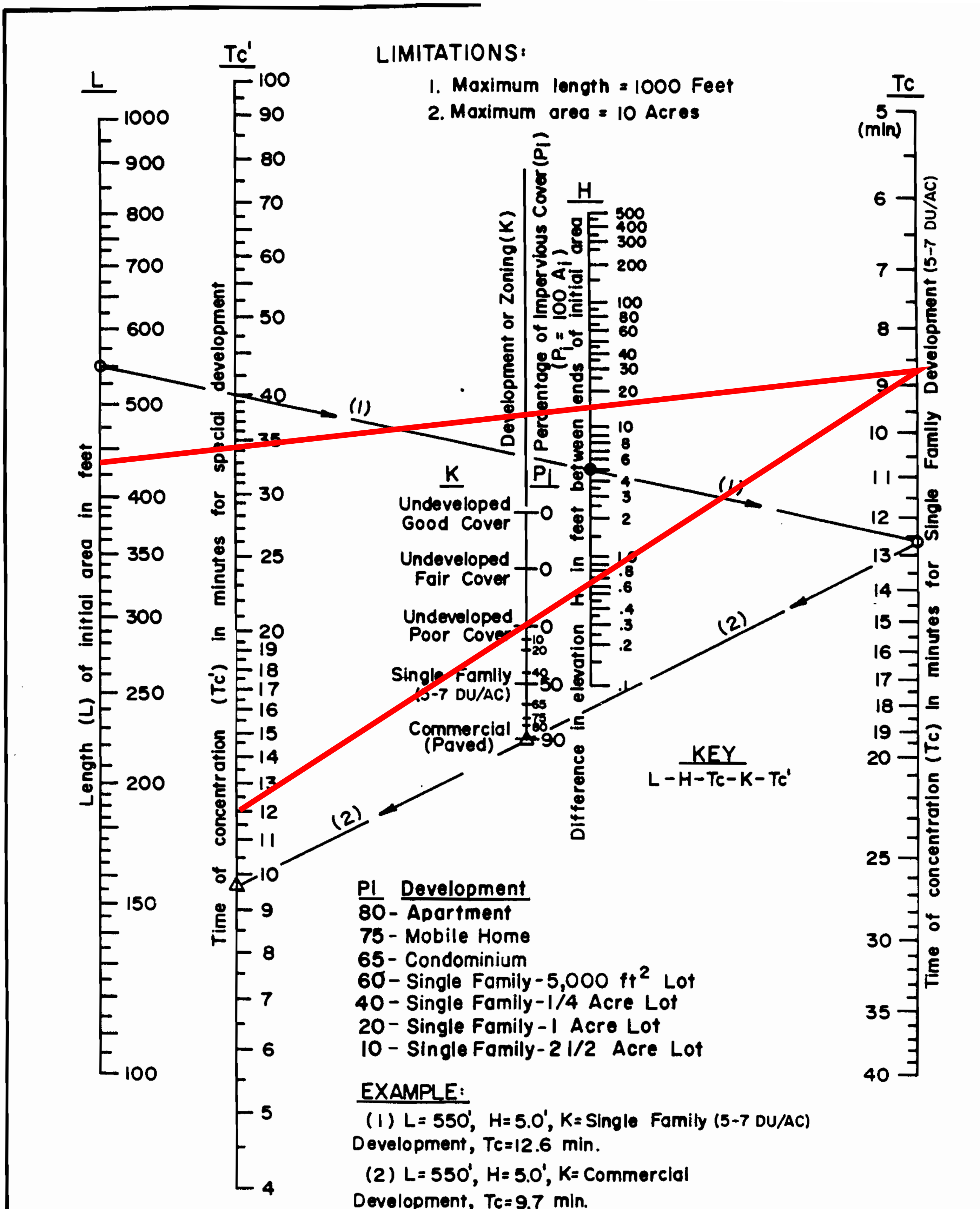
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 3



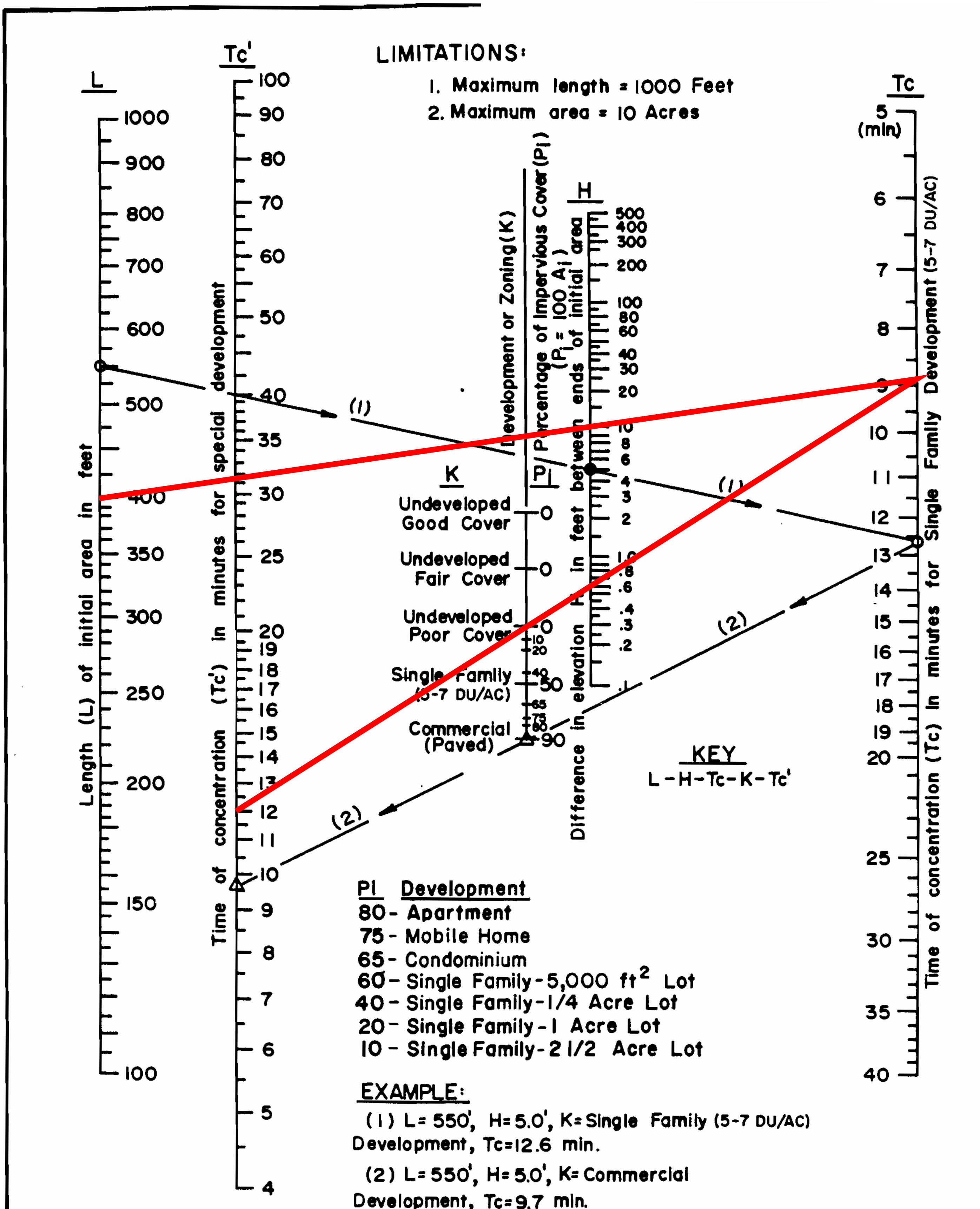
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 13a



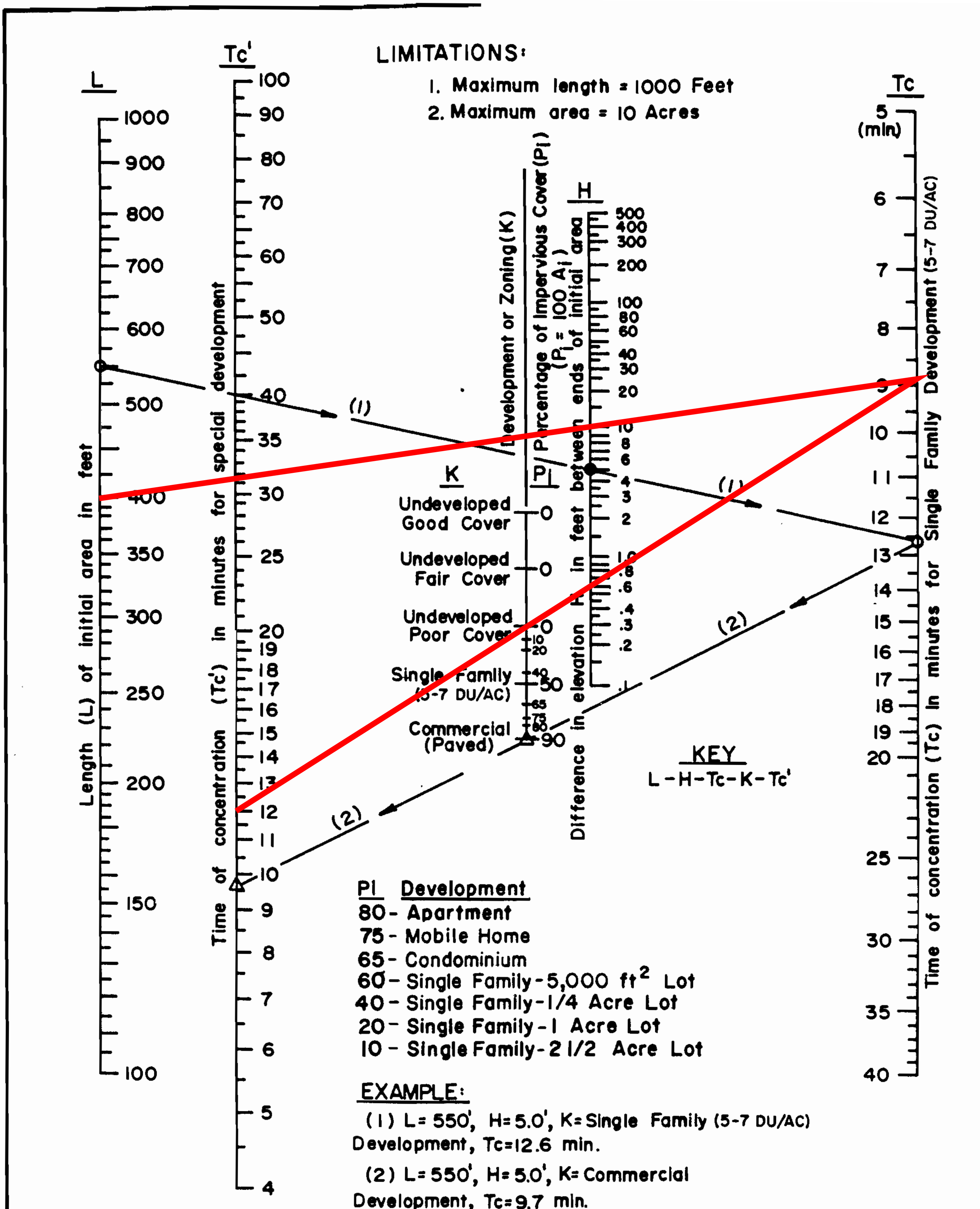
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 14a



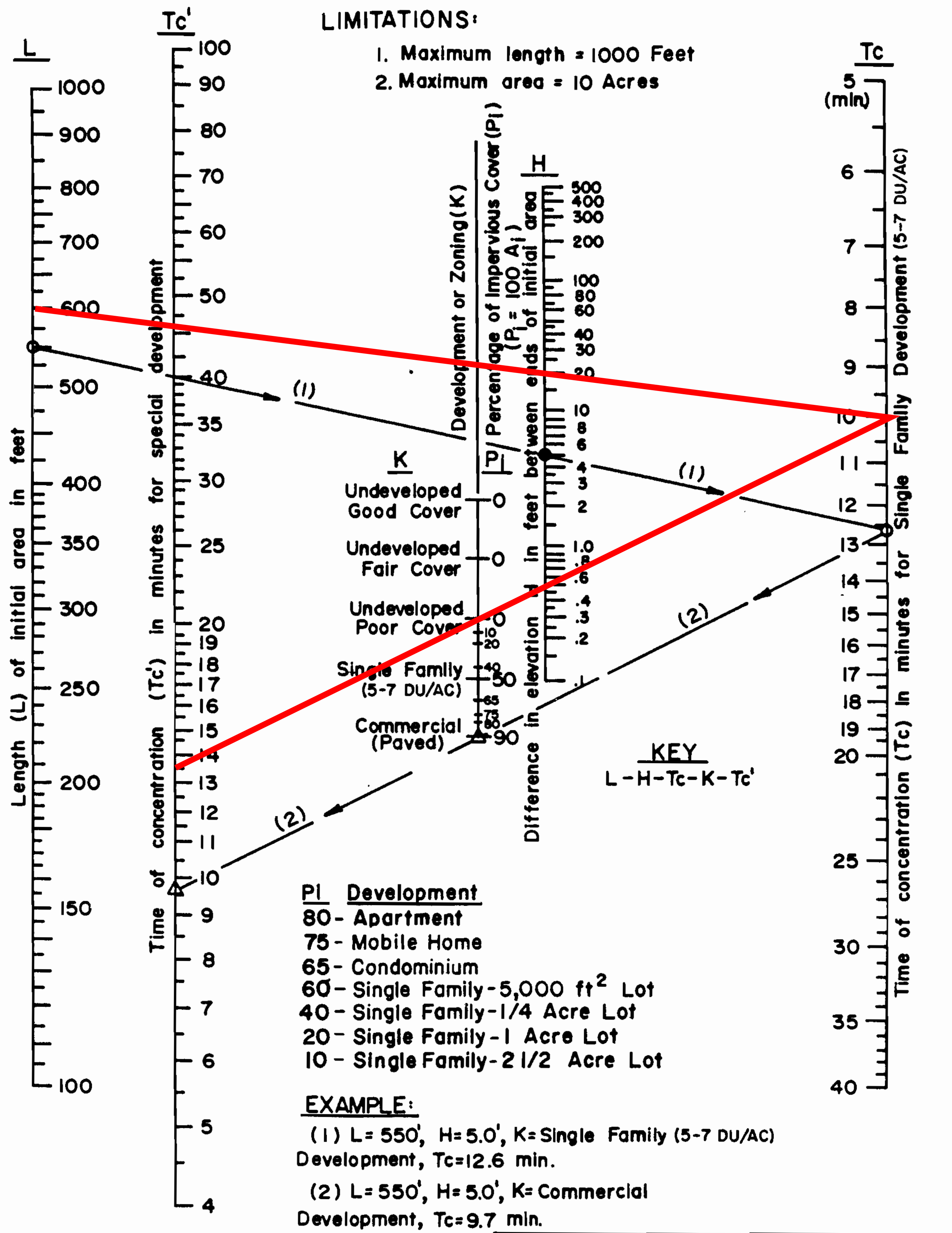
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 15a

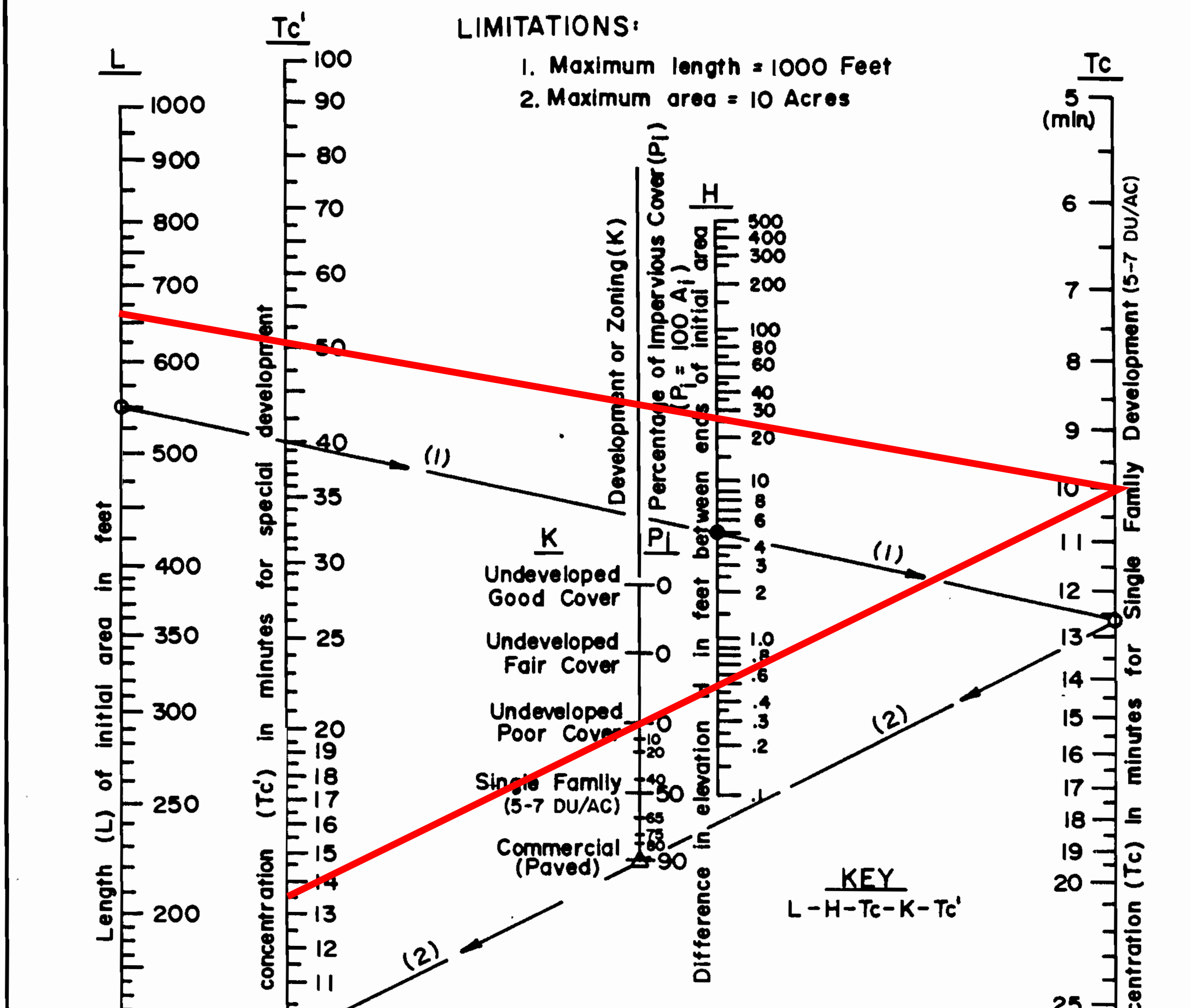


SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 16a



Pi Development
80- Apartment
75- Mobile Home
65- Condominium
60- Single Family-5,000 ft^2 Lot
40- Single Family-1/4 Acre Lot
20- Single Family-1 Acre Lot
10- Single Family-2 1/2 Acre Lot

EXAMPLE:

(1) L= 550', H= 5.0', K= Single Family (5-7 DU/AC) Development, Tc=12.6 min.

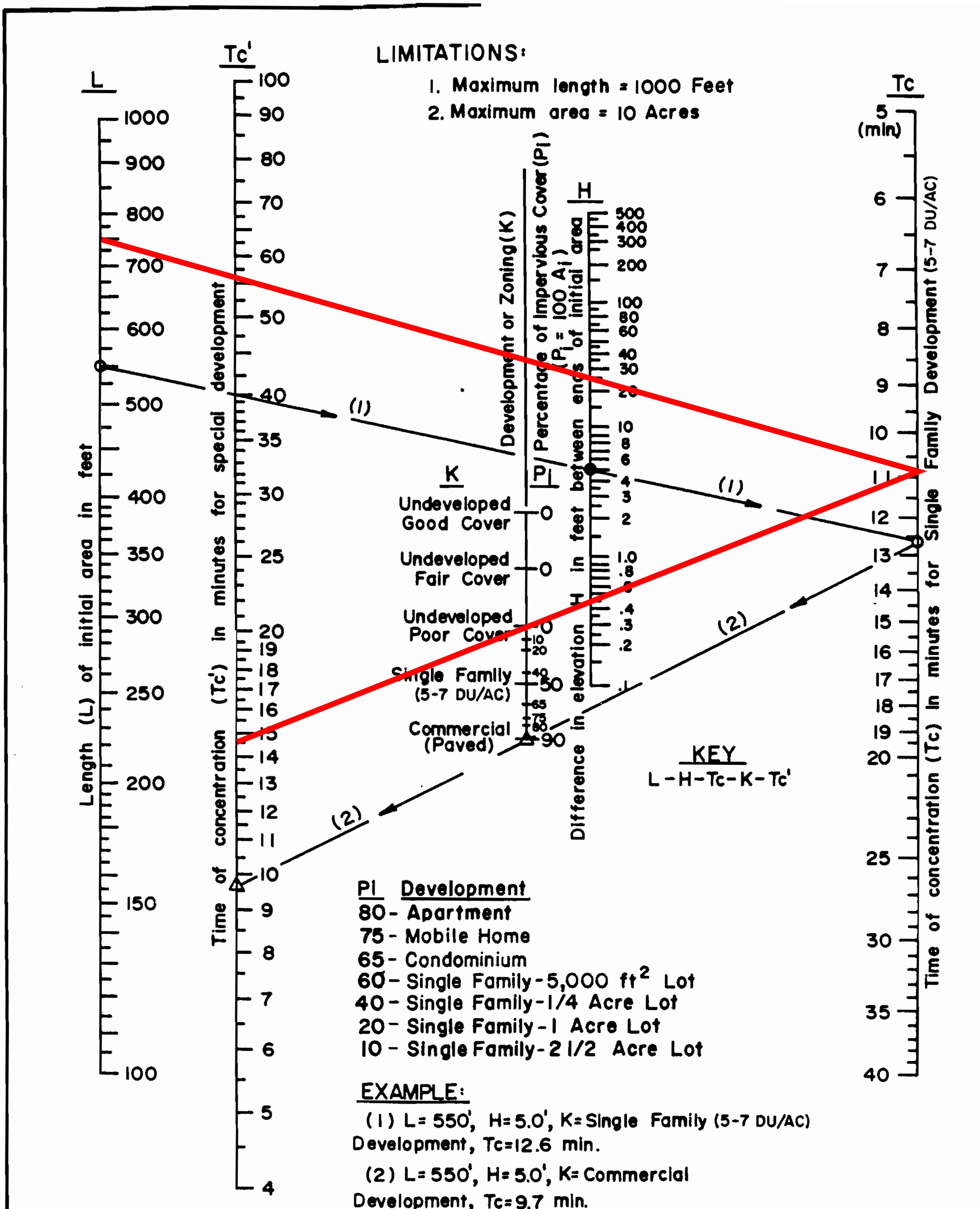
(2) L= 550', H= 5.0', K= Commercial Development, Tc= 9.7 min.

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 17a



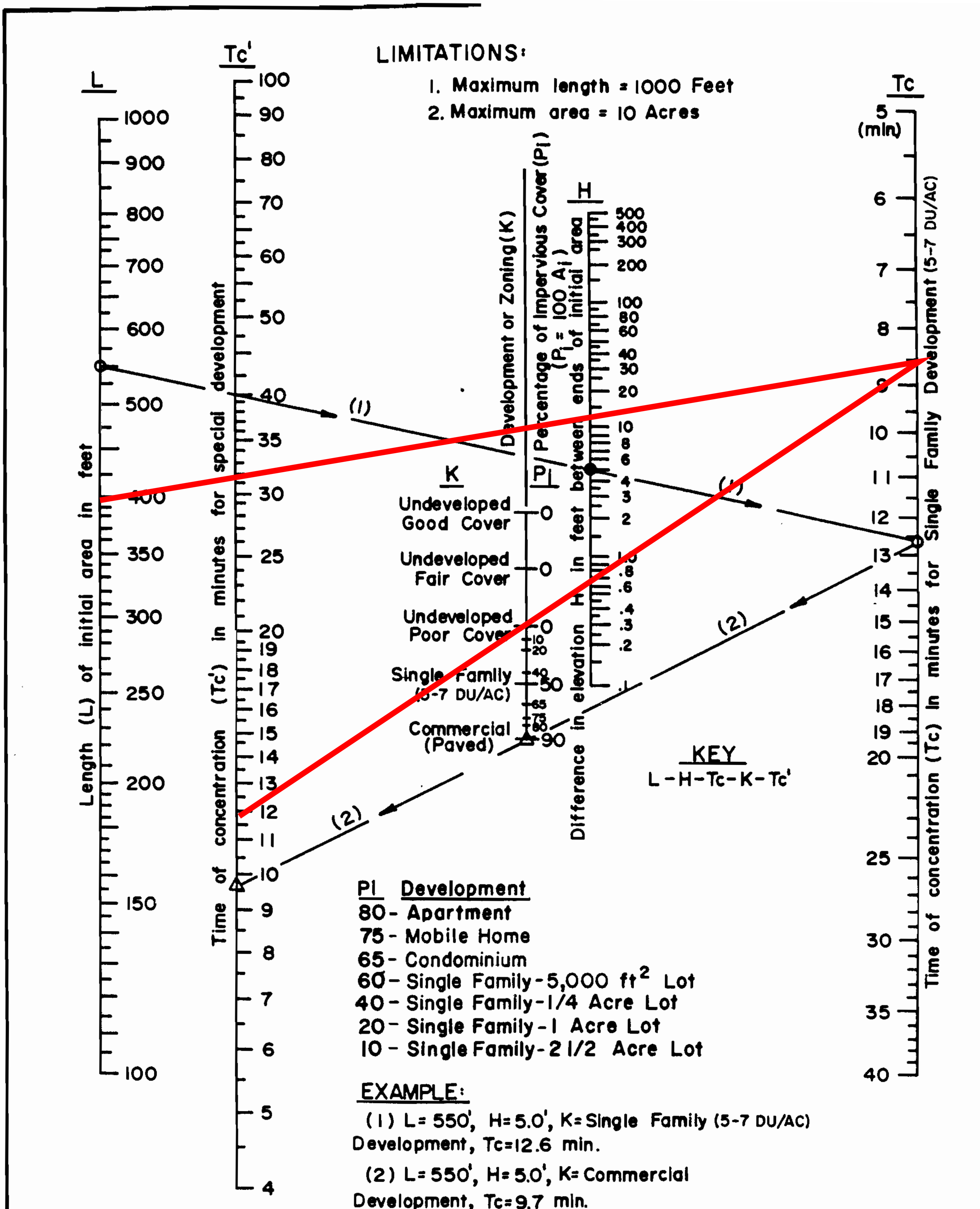
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 18a



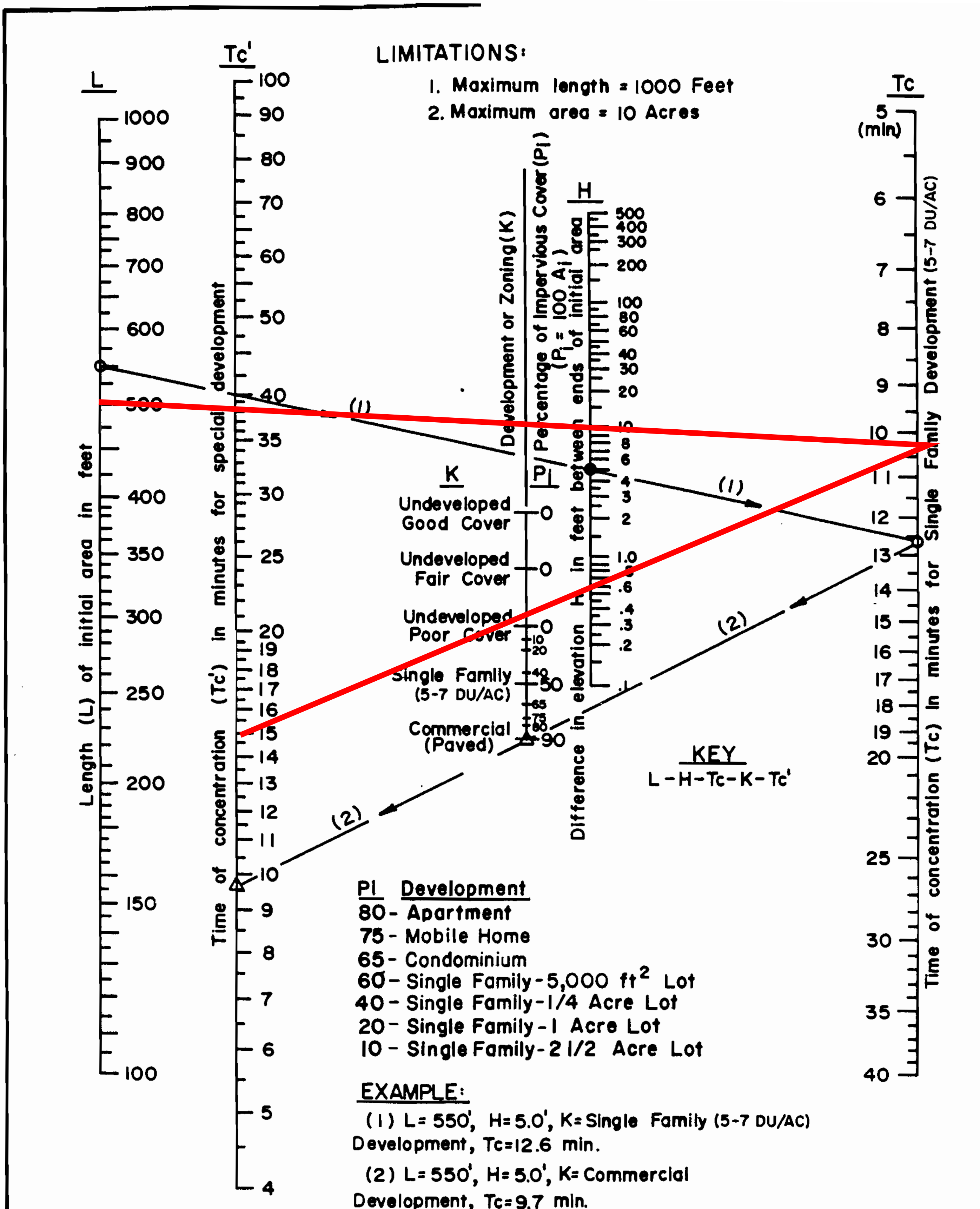
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 9-Uncaptured



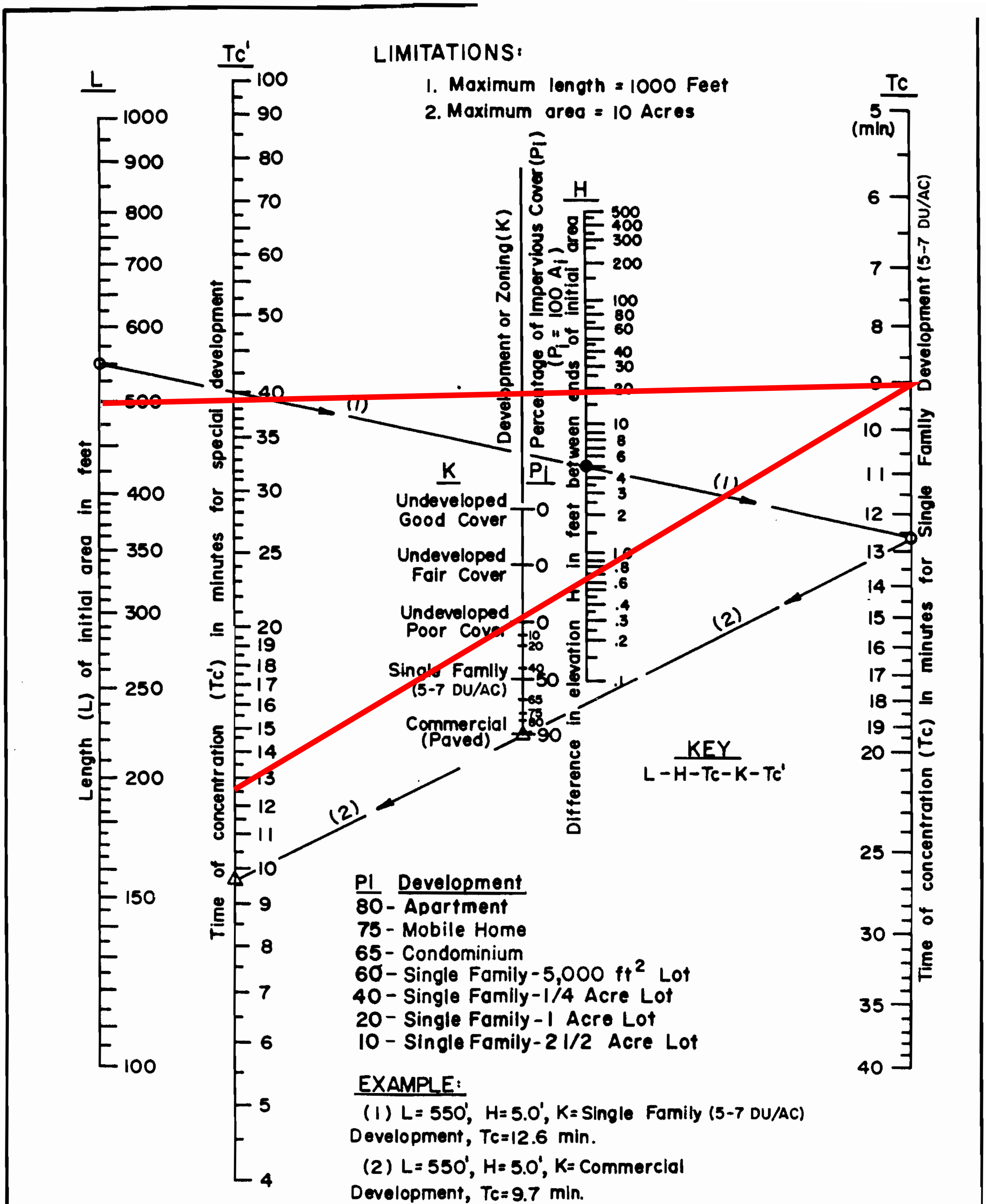
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 19-Uncaptured



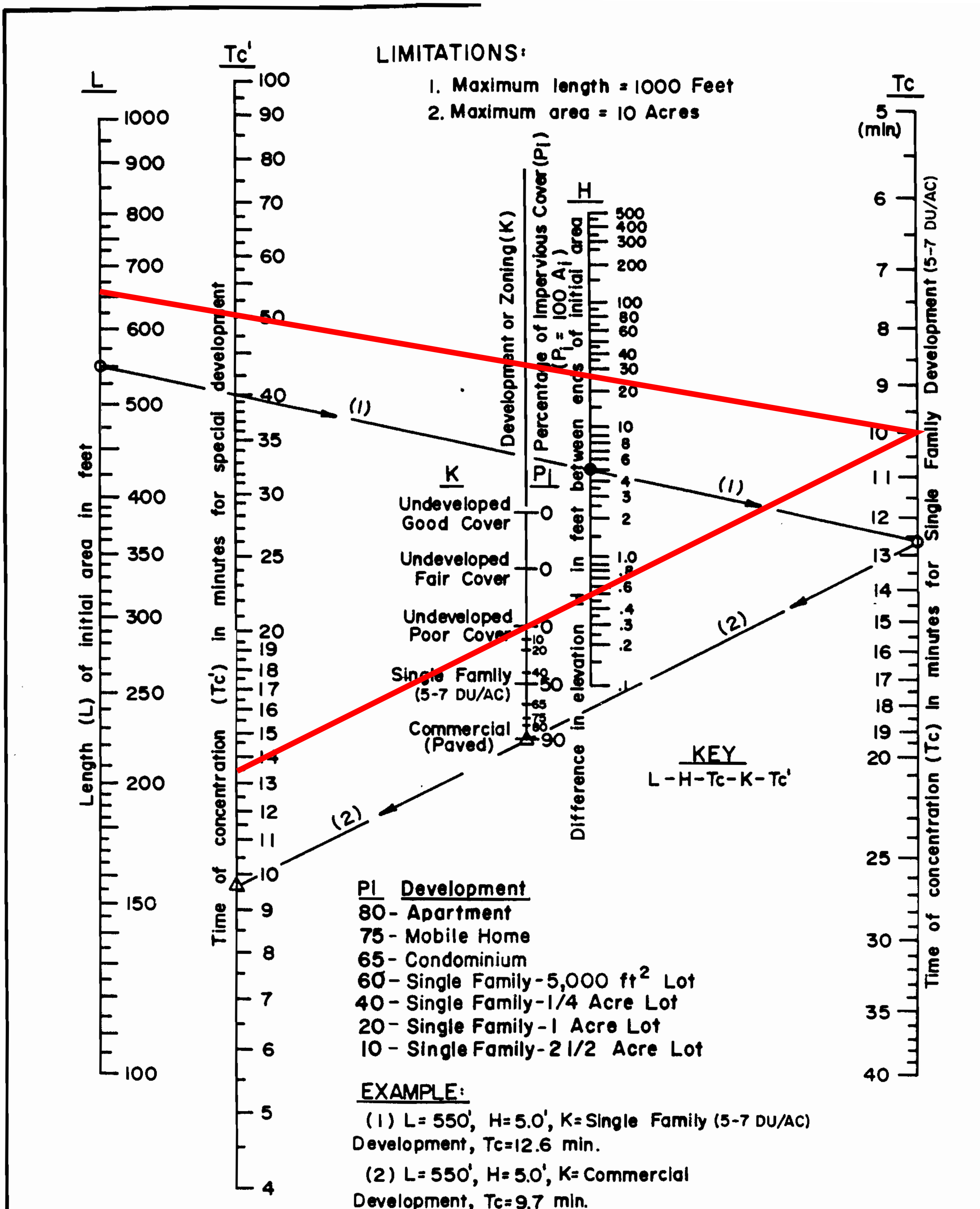
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 20-Uncaptured



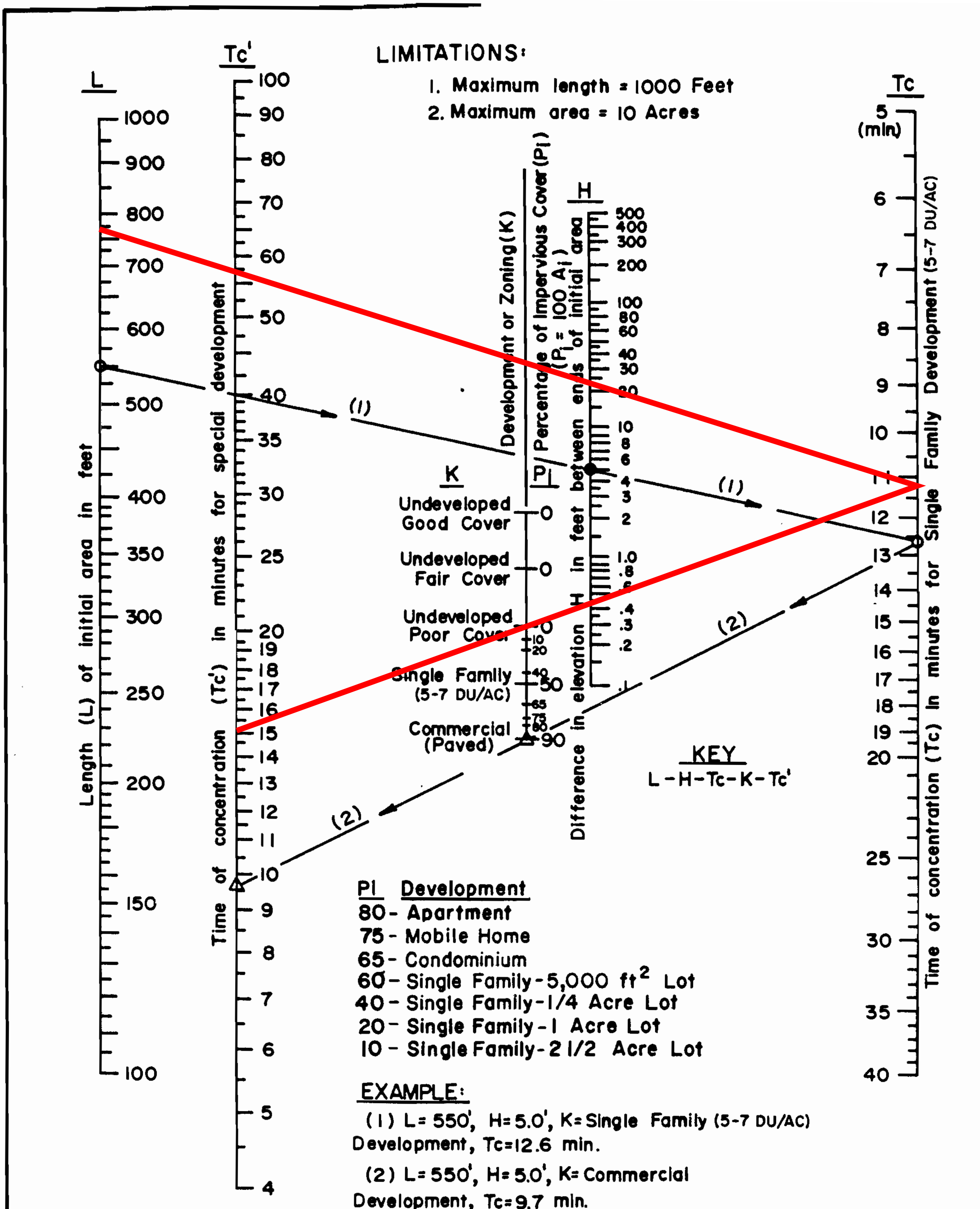
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 21-uncaptured



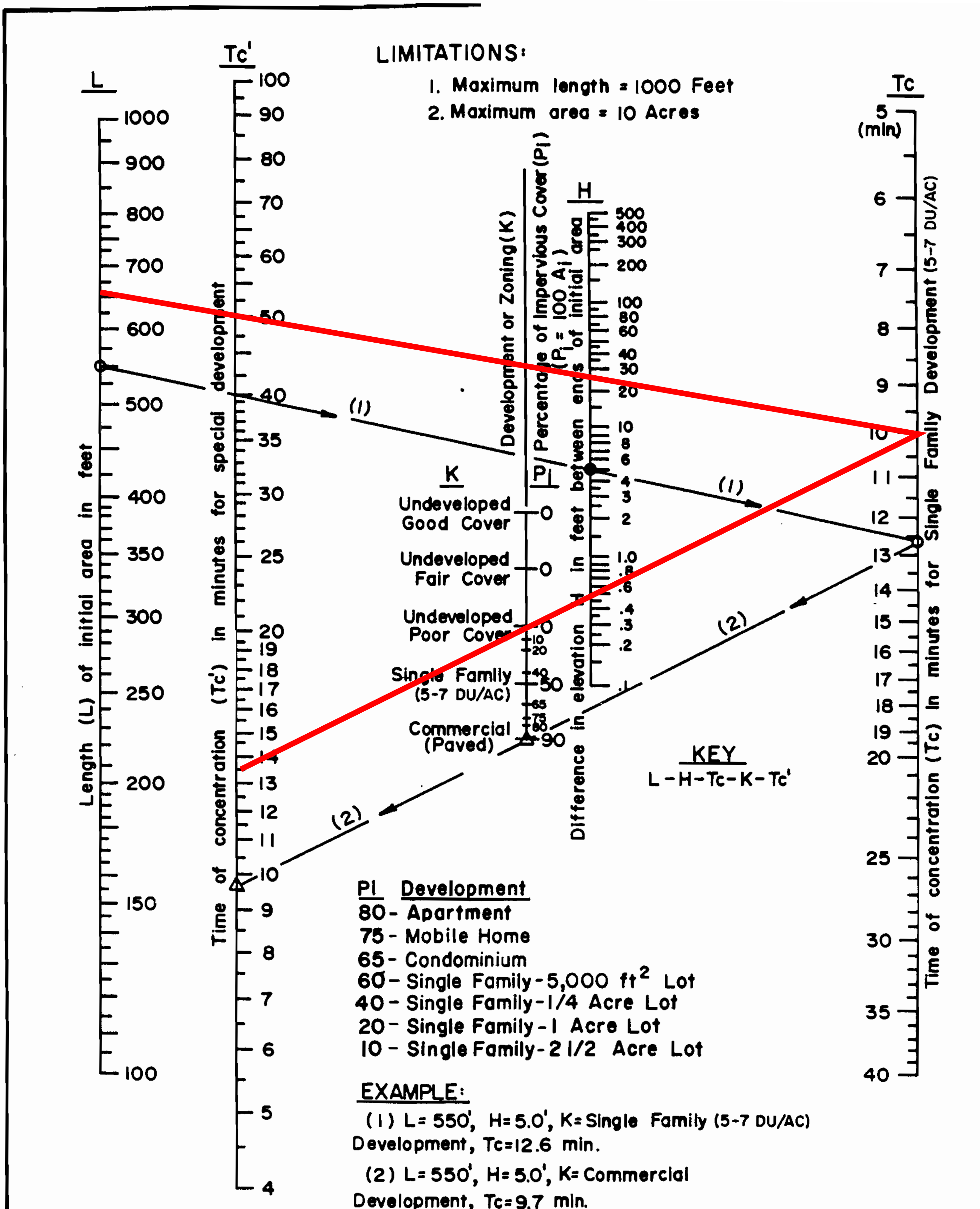
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 22-uncaptured



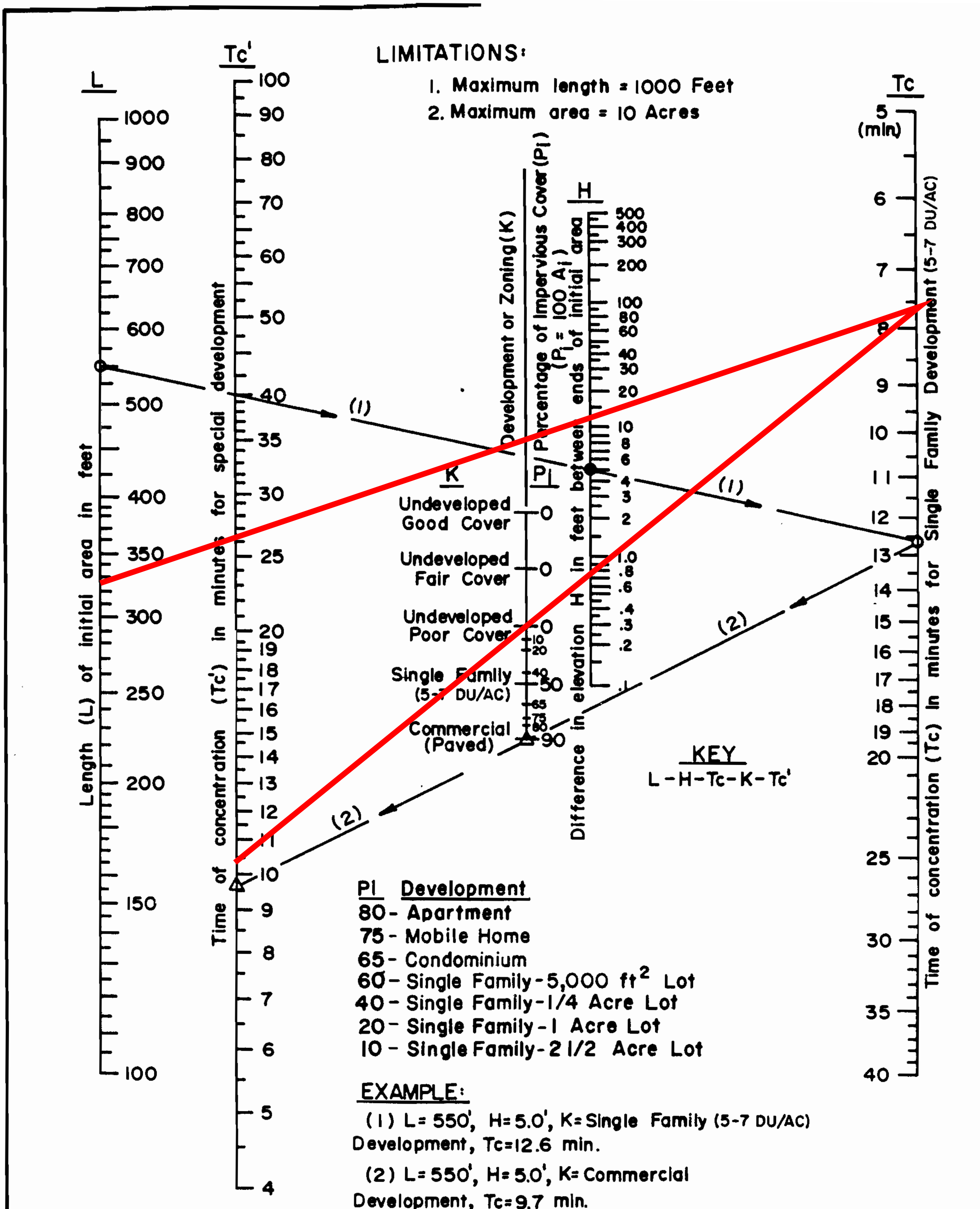
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 23-uncaptured



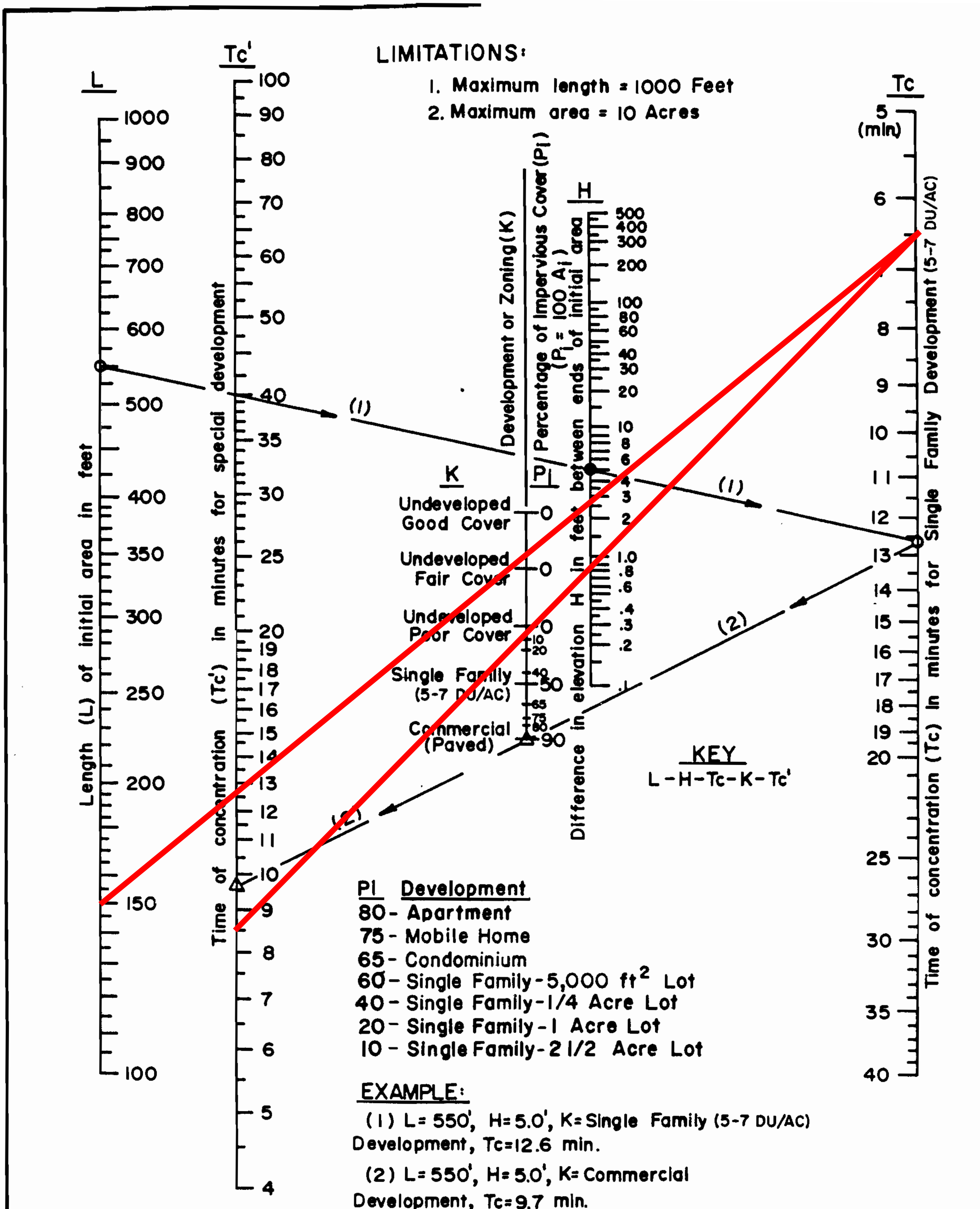
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

CONCENTRATION POINT 10-uncaptured



SAN BERNARDINO COUNTY

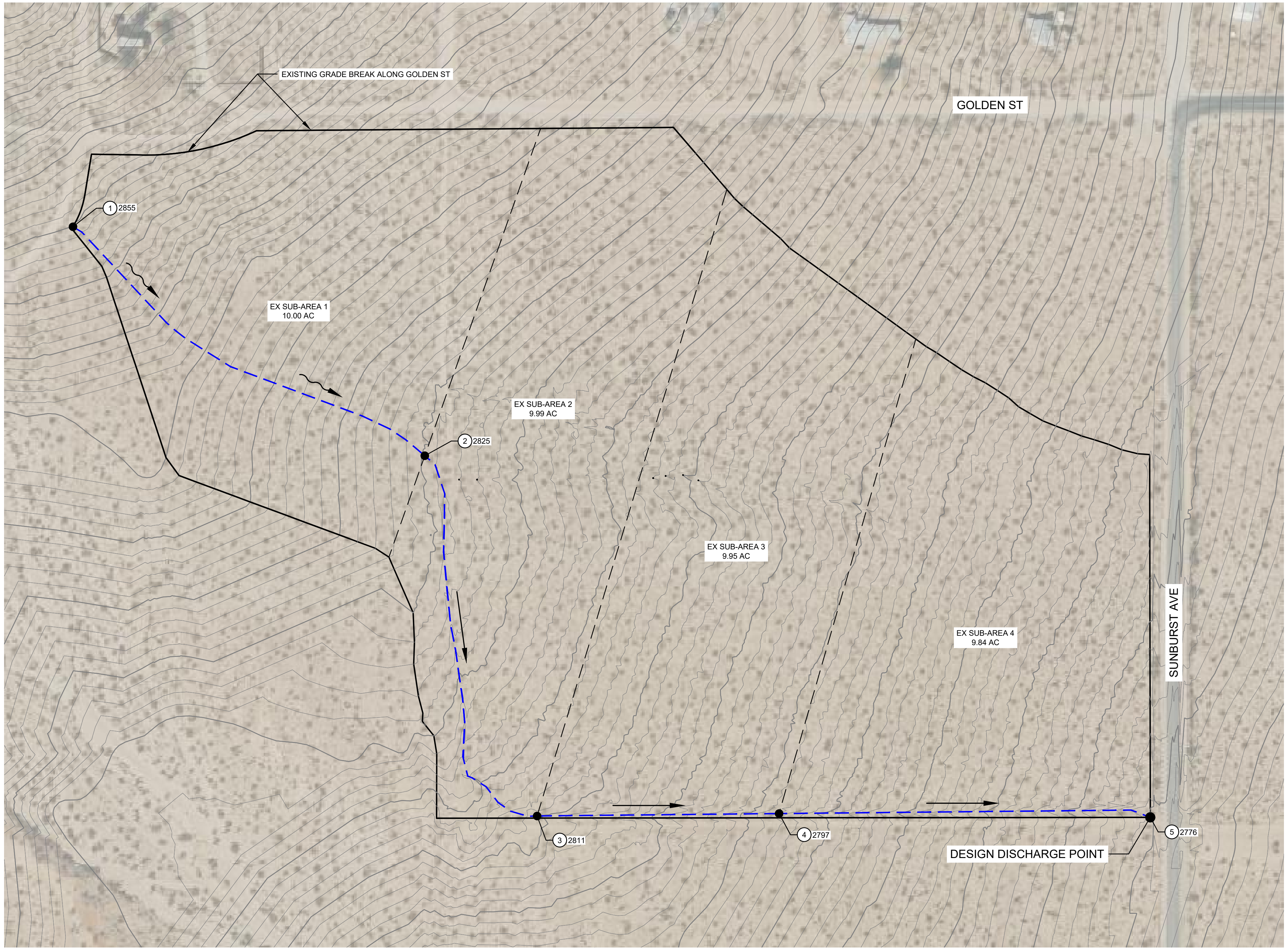
HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

Appendix B

Existing Drainage Conditions Exhibit



DRAINAGE AREA PLAN VIEW
SCALE: 1" = 80'

EXISTING SITE DRAINAGE ANALYSIS			
LOCATION ID	TOTAL AREA (AC)	WEIGHTED Fm (in./hr.)	Q_{25} (cfs)
EX-SUBAREA 1	10.00	0.38	31.0
EX-SUBAREA 2	9.99	0.38	58.4
EX-SUBAREA 3	9.95	0.38	79.3
EX-SUBAREA 4	9.84	0.38	98.2

90% of Q_{25} AT DESIGN POINT (cfs)	88.4

LEGEND:

SHEET FLOW DIRECTION	
CONCENTRATED FLOW DIRECTION	
FLOWPATH	
SUBBASIN BOUNDARY	
BASIN BOUNDARY	
NODE	(XX)
ELEVATION (FEET)	(XXXX)

N

0' 80' 160'
SCALE: 1"=80'

Underground Service Alert
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BENCHMARK
N/A

PREPARED BY:
WEST COAST CIVIL
9740 APPALOOSA RD, SUITE 200
SAN DIEGO, CA 92131
TEL: 858-869-1332
WWW.WESTCOASTCIVIL.COM

MARK	REVISIONS	APPR	DATE

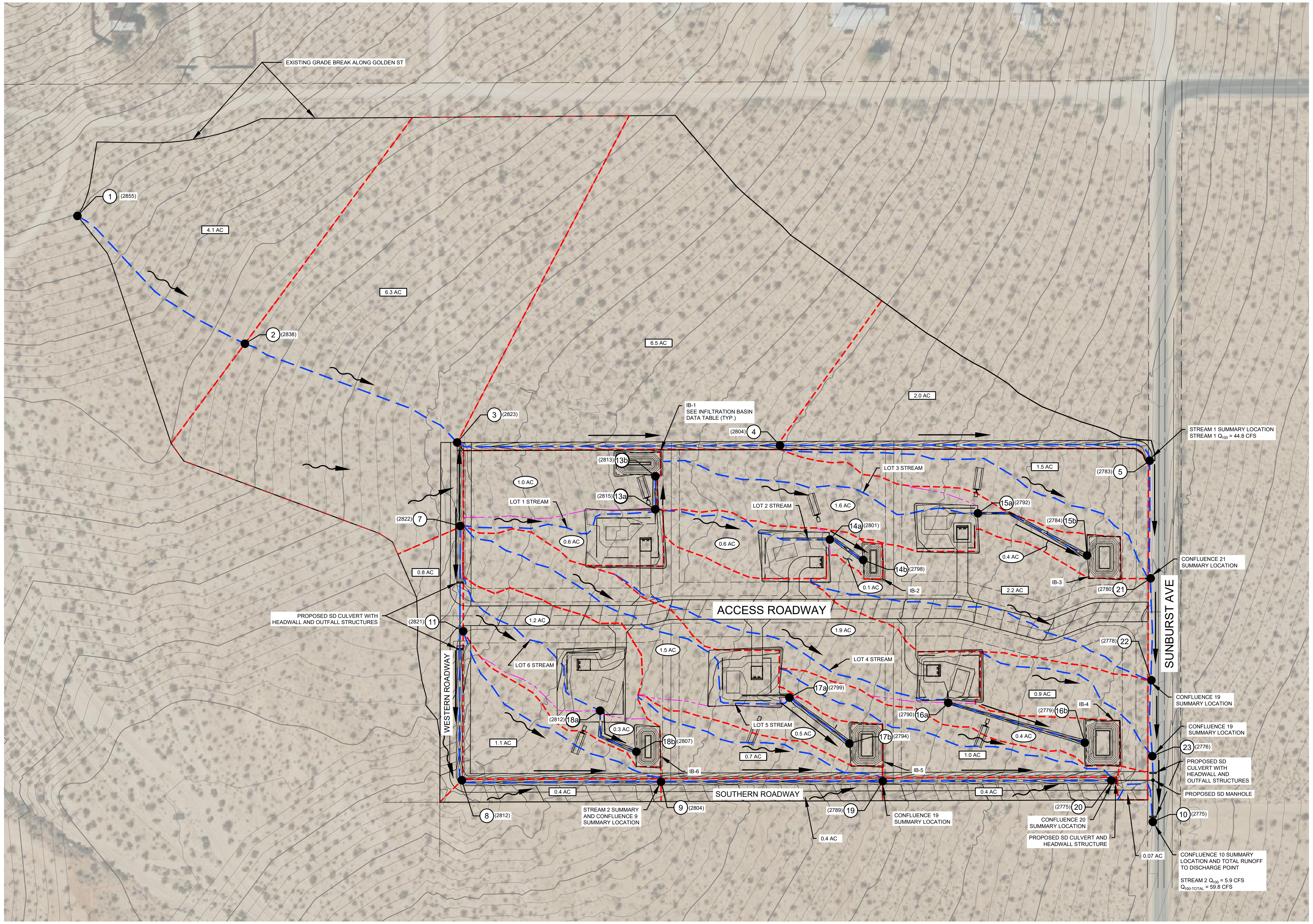
SAN BERNARDINO COUNTY
DEPT OF PULIC WORKS | LAND USE SERVICES
RECOMMENDED BY:
OSVALDO ROQUE DATE
SUPERVISING ENGINEER, TRAFFIC DIVISION
APPROVED BY:
JEREMY JOHNSON DATE
ENGINEERING MANAGER, TRAFFIC DIVISION
MICHELE MARTIN DATE
ENGINEERING MANAGER, LAND DEVELOPMENT

EXISTING DRAINAGE EXHBIT
SUNBURST SUBDIVISION
JOSHUA TREE, CA

ROAD NO.
FILE NO.
SHEET 2 OF 2

Appendix C

Proposed Drainage Conditions Exhibit



DRAINAGE AREA PLAN VIEW
SCALE: 1" = 200'

INFILTRATION DATA TABLE

Subbasin ID	Infiltration Basin ID	Concentration Point	Subbasin Area (Ac)	$Q_{100\text{-}Proposed}$ (cfs)	Tc (min.)	DCV (CF)	Design Percolation Rate (in./hr.)	Drawdown Time (hrs)
Lot 1	IB-1	13	1.5	7.3	12.3	5402.2	20.0	6.8
Lot 2	IB-2	14	0.8	4.3	10.2	2624.9	20.0	3.3
Lot 3	IB-3	15	1.9	8.3	14.2	7052.3	20.0	8.9
Lot 4	IB-4	16	2.3	9.8	14.2	8382.2	20.0	10.6
Lot 5	IB-5	17	2.0	8.4	14.9	7495.4	20.0	9.5
Lot 6	IB-6	18	1.5	5.1	15.9	4884.6	20.0	6.2

STREAM FLOW DATA TABLE

Concentration Point	Flow Characteristics	Subbasin Area (ac)	Weighted Fm (in./hr)	Tc (min.)	$Q_{100\text{-}Proposed}$ (cfs)
CAPTURED FLOW					
13a	Subbasin Runoff, Sheet Flow	0.6	0.375	12.0	2.8
13b	Subbasin Runoff, Channel Flow	1.0	0.375	12.3	7.3
Lot 1 Stream Summary	**Lot 1 Stream Summary**	**1.5**		**12.3**	**7.3**
14a	Subbasin Runoff, Sheet Flow	0.6	0.375	10.0	3.5
14b	Subbasin Runoff, Channel Flow	0.14	0.375	10.2	4.3
Lot 2 Stream Summary	**Lot 2 Stream Summary**	**0.8**		**10.2**	**4.3**
15a	Subbasin Runoff, Sheet Flow	1.6	0.375	13.5	7.0
15b	Subbasin Runoff, Channel Flow	0.4	0.375	14.2	8.3
Lot 3 Stream Summary	**Lot 3 Stream Summary**	**1.9**		**14.2**	**8.3**
16a	Subbasin Runoff, Sheet Flow	1.9	0.375	13.5	8.5
16b	Subbasin Runoff, Channel Flow	0.4	0.375	14.2	9.8
Lot 4 Stream Summary	**Lot 4 Stream Summary**	**2.3**		**14.2**	**9.8**
17a	Subbasin Runoff, Sheet Flow	1.5	0.375	14.5	6.4
17b	Subbasin Runoff, Channel Flow	0.5	0.375	14.9	8.4
Lot 5 Stream Summary	**Lot 5 Stream Summary**	**2.0**		**14.9**	**8.4**
18a	Subbasin Runoff, Sheet Flow	1.2	0.375	15.5	4.7
18b	Subbasin Runoff, Channel Flow	0.3	0.375	15.9	5.1
Lot 6 Stream Summary	**Lot 6 Stream Summary**	**1.5**		**15.9**	**5.1**
RUN-ON FLOW					
Concentration Point	**Flow Characteristics**	**Subbasin Area (ac)**	**Weighted Fm (in./hr)**	**Tc (min.)**	**$Q_{100\text{-}Proposed}$ (cfs)**
2	Run-On, Sheet Flow	4.1	0.38	11.0	20.8
3	Run-On, Sheet Flow	7.8	0.38	23.0	31.4
4	Run-On, Channel Flow	6.5	0.38	25.2	43.7
5	Run-On, Channel Flow	2.0	0.38	27.6	44.7
Offsite Run-On: Stream Summary 1	**Offsite Run-On: Stream 1 Summary**	**20.4**		**27.6**	**44.7**
8	Run-On, Channel Flow	0.8	0.38	2.7	2.7
9	Run-On, Channel Flow	0.4	0.38	4.6	3.8
Offsite Run-On: Stream Summary 2	**Offsite Run-On: Stream 2 Summary**	**1.2**		**4.6**	**3.8**
RUNOFF FLOW					
Concentration Point	**Flow Characteristics**	**Subbasin Area (ac)**	**Weighted Fm (in./hr)**	**Tc (min.)**	**$Q_{100\text{-}Proposed}$ (cfs)**
9	Confluence, Channel Flow	1.1	0.38	4.6	4.9
19	Confluence, Channel Flow	0.7	0.38	4.6	5.5
20	Confluence, Channel Flow	0.9	0.38	4.6	6.6
21	Confluence, Channel Flow	1.5	0.38	27.6	48.1
22	Confluence, Channel Flow	2.2	0.38	27.6	53.0
23	Confluence, Channel Flow	0.9	0.38	27.6	55.0
10	Confluence, Sheet Flow	0.07	0.38	27.6	59.8
Total Runoff to Discharge Point		**28.9**		**27.6**	**59.8**

$0.9 \cdot Q_{25\text{-}Existing\ at\ Design\ Point}$ (cfs)	88.4
$Q_{100\text{-}Proposed\ at\ Design\ Point}$ (cfs)	59.8

LEGEND:

- SHEET FLOW DIRECTION
- CONCENTRATED FLOW DIRECTION
- FLOWPATH
- SUBBASIN BOUNDARY
- SUBBASIN SUB-BOUNDARY
- BASIN BOUNDARY
- CONCENTRATION POINT (XX)
- ELEVATION (FEET) (XXXX)
- SUBBASIN AREA XX AC
- SUB-SUBBASIN AREA (XX AC)
- LEACH FIELD

N
0' 200' 400'
SCALE: 1"=200'

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MARK	REVISIONS	APPR	DATE

SAN BERNARDINO COUNTY
DEPT OF PULIC WORKS
LAND USE SERVICES

RECOMMENDED BY:
OSVALDO ROQUE — DATE
SUPERVISING ENGINEER, TRAFFIC DIVISION
JEREMY JOHNSON — DATE
ENGINEERING MANAGER, TRAFFIC DIVISION
APPROVED BY:
MICHELE MARTIN — DATE
ENGINEERING MANAGER, LAND DEVELOPMENT

PROPOSED DRAINAGE EXHIBIT
SUNBURST SUBDIVISION
JOSHUA TREE, CA

ROAD NO.
FILE NO.
SHEET 1 OF 2

Appendix D

Peak Flow and Velocity Calculations

Study Name: Sunburst Preliminary Drainage Study	Calculated By: BS	Date: 2/22/24
100-Year Storm 1-Hour Rainfall (inches) = 1.83; 25-Year Storm 1-Hour Rainfall (inches) = 1.23; Slope = Varies	Checked By: EM	Date: 2/22/24

PROPOSED CONDITIONS

Concentration Point	Area (SF)		Area (Ac)		Soil Type	Dev. Type	Tt min.	TC min.	I100 in/hr	Fm in/hr	Fm avg.	Q Total	Capture Vol ft^3	Flow Path Length ft.	delta H	Slope ft./ft.	V ft./sec.	Hydraulics and Notes
	Subarea	Total	Subarea	Total														
2	177434	177434	4.073324	4.073324	C	Undev (Chaparral)		11	6	0.38	0.38	20.77456		398	17	0.042714		Initial Subbarea
3	338680	516114	7.775023	11.84835	C	Undev (Chaparral)	12	23	3.3	0.38	0.38	31.39694		436	15	0.034404		
4	284710	800824	6.536042	18.38439	C	Undev (Chaparral)	2.197997	25.198	3	0.38	0.38	43.71164		594	18	0.030303	4.504101	
5	86373	887197	1.982851	20.36724	C	Undev (Chaparral)	2.370099	27.5681	2.8	0.38	0.38	44.72952		695	21	0.030216	4.887277	
Runon - Stream Summary 1		**887197**		**20.36724**				**27.5681**				**44.72952**						
8	34179	34179	0.784642	0.784642	C	Undev (Chaparral)		2.684934	4.2	0.38	0.38	2.720079		470	10	0.021277	2.917515	Initial Subbarea
9	16160	50339	0.370983	1.155624	C	Undev (Chaparral)	1.90431	4.589244	4	0.38	0.38	3.7964		366	8	0.021858	3.203259	
19	17066	67405	0.391781	1.547406	C	Undev (Chaparral)	1.641403	6.230647	3.8	0.38	0.38	4.802606		407	15	0.036855	4.132643	
20	18025	85430	0.413797	1.961203	C	Undev (Chaparral)	1.708452	7.939099	3.7	0.38	0.38	5.908908		427	14	0.032787	4.165564	
Runon - Stream Summary 2		**85430**		**1.961203**				**7.939099**				**5.908908**						

Study Name: Sunburst Preliminary Drainage Study
100-Year Storm 1-Hour Rainfall (inches) = 1.83; 25-Year Storm 1-Hour Rainfall (inches) = 1.23; Slope = Varies

Calculated By: BS — Date: 2/22/24
Checked By: EM — Date: 2/22/24

PROPOSED CONDITIONS CONTINUED

Concentration Point	Area (SF)		Area (Ac)		Soil Type	Dev. Type	Tt min.	TC min.	I100 in/hr	Fm in/hr	Fm avg.	Q Total	Capture Vol ft^3	Flow Path Length ft.	delta H	Slope ft./ft.	V ft./sec.	Hydraulics and Notes
	Subarea	Total	Subarea	Total														
13a	24206	24206	0.555693	0.6	C	SF (2 AC)		12	5.9	0.38	0.37529198	2.786064		379	11	0.029024		Initial Subbarea
13b	41885	66091	0.961547	1.5			0.28061	12.28061	5.7	0.38	0.37529198	7.331568		65	1	0.015385	3.860637	
Lot 1 Stream Summary		**66091**		**1.5**				**12.28061**				**7.331568**	**5402.1678**					
14a	27299	27299	0.626699	0.626699	C	SF (2 AC)		10	6.6	0.38	0.37529198	3.540173		318	12	0.037736		Initial Subbarea
14b	6201	33500	0.142355	0.769054			0.234792	10.23479	6.5	0.38	0.37529198	4.274536		73	4	0.054795	5.181894	
Lot 2 Stream Summary		**33500**		**0.769054**				**10.23479**				**4.274536**	**2624.9391**					
15a	68465	68465	1.57174	1.57174	C	SF (2 AC)		13.5	5.3	0.38	0.37529198	7.024378		601	20	0.033278		Initial Subbarea
15b	15710	84175	0.360652	1.932392			0.686137	14.18614	5.1	0.38	0.37529198	8.285465		225	9	0.04	5.46538	
Lot 3 Stream Summary		**84175**		**1.932392**				**14.18614**				**8.285465**	**7052.3241**					
16a	82416	82416	1.892011	1.892011	C	SF (2 AC)		13.5	5.3	0.38	0.37529198	8.455724		667	25	0.037481		Initial Subbarea
16b	17218	99634	0.395271	2.287282			0.7451	14.2451	5.1	0.38	0.37529198	9.807116		261	11	0.042146	5.838143	
Lot 4 Stream Summary		**99634**		**2.287282**				**14.2451**				**9.807116**	**8382.2007**					
17a	65318	65318	1.499495	1.499495	C	SF (2 AC)		14.5	5.1	0.38	0.37529198	6.429343		745	25	0.033557		Initial Subbarea
17b	21529	86847	0.494238	1.993733			0.429519	14.92952	5	0.38	0.37529198	8.367542		141	6	0.042553	5.47124	
Lot 5 Stream Summary		**86847**		1.993733				**14.92952**				**8.367542**	**7495.4025**					
18a	51489	51489	1.182025	1.182025	C	SF (2 AC)		15.5	4.8	0.38	0.37529198	4.746329		377	12	0.03183		
18b	12659	64148	0.290611	1.472635			0.427229	15.92723	4.2	0.38	0.37529198	5.111404		119	4	0.033613	4.642322	
Lot 6 Stream Summary		**64148**		1.472635				**15.92723**				**5.111404**	**4884.6296**					

Study Name: Sunburst Preliminary Drainage Study
100-Year Storm 1-Hour Rainfall (inches) = 1.83; 25-Year Storm 1-Hour Rainfall (inches) = 1.23; Slope = Varies

Calculated By: BS Date: 2/22/24
Checked By: EM Date: 2/22/24

PROPOSED CONDITIONS CONTINUED

Concentration Point	Area (SF)		Area (Ac)		Soil Type	Dev. Type	Tt min.	TC min.	I100 in/hr	Fm in/hr	Fm avg.	Q Total	Qp	Flow Path Length ft.	delta H	Slope ft./ft.	V ft./sec.	Hydraulics and Notes
	Subarea	Total	Subarea	Total														
9 - Stream 2								4.589244	4	0.38	0.38	3.7964	4.8577898	476	16	0.033613		
9 - Uncaptured	46000	46000	1.056015	1.056015	C	Undev (Chaparral)		15	4.6	0.38	0.38	4.044167						
Confluence 9 Summary								**4.589244**					**4.8577898**					
Confluence 9								4.589244	4	0.38	0.38	4.85779	5.5288569	488	18	0.036885		
19-Uncaptured	31992	31992	0.734435	0.734435	C	Undev (Chaparral)		16.5	4.3	0.38	0.38	2.61268						
Confluence 19 Summary								**4.589244**					**5.5288569**					
Confluence 19								4.589244	4	0.38	0.38	5.528857	6.589683	663	25	0.037707		
20-Uncaptured	41378	41378	0.949908	0.949908	C	Undev (Chaparral)		13.5	4.9	0.38	0.38	3.896428						
Confluence 20 Summary								**4.589244**					**6.589683**					
21-Uncaptured	66037	66037	1.516001	1.516001	C	Undev (Chaparral)		15	4.6	0.38	0.38	5.805753	48.058881	769	23	0.029909		
5-Stream 1								27.5681	2.8	0.38	0.38	44.72952						
Confluence 21 Summary								**27.5681**					**48.058881**					
22-Uncaptured	97637	97637	2.241437	2.241437	C	Undev (Chaparral)		13.5	4.9	0.38	0.38	9.194151	52.981413	662	24	0.036254		
Confluence 21								27.5681	2.8	0.38	0.38	48.05888						
Confluence 22 Summary								**27.5681**					**52.981413**					
23-Uncaptured	39775	39775	0.913108	0.913108	C	Undev (Chaparral)		10.5	5.8	0.38	0.38	4.49126	54.986736	394	12	0.030457		
Confluence 22								27.5681	2.8	0.38	0.38	52.98141						
Confluence 23 Summary								**27.5681**					**54.986736**					
23 Confluence								27.5681	2.8	0.38	0.38	54.98674						
20 Confluence								4.589244	4	0.38	0.38	6.589683	59.807826	132	3	0.022727		
10-Uncaptured	3209	3209	0.073669	0.073669	C	Undev (Chaparral)		8.5	6.6	0.38	0.38	0.415833						
Confluence 10 Summary								**27.5681**					**59.807826**					

Study Name: Sunburst Preliminary Drainage Study																			
100-Year Storm 1-Hour Rainfall (inches) = 1.83; 25-Year Storm 1-Hour Rainfall (inches) = 1.23; Slope = Varies															Calculated By: BS Checked By: EM			Date: 2/22/24 Date: 2/22/24	
EXISTING CONDITIONS																			
Concentration Point	**Area (SF)**		**Area (Ac)**		**Soil Type**	**Dev. Type**	**Tt min.**	**TC min.**	**I25 in/hr**	**Fm in/hr**	**Fm avg.**	**Q Total**	**Capture Vol ft^3**	**Flow Path Length ft.**	**delta H**	**Slope ft./ft.**	**V ft./sec.**	**Hydraulics and Notes**	
	Subarea	**Total**	**Subarea**	**Total**															
2	435596	435596	10.00	10.00	C	Undev (Chaparral)		14	3.8	0.38	0.38	31.03622		776	30	0.03866			
3	435165	870761	9.99	19.99	C	Undev (Chaparral)	1.612628	15.61263	3.6	0.38	0.38	58.41355		637	14	0.021978	6.583455		
4	433413	1304174	9.95	29.94	C	Undev (Chaparral)	0.95317	16.5658	3.3	0.38	0.38	79.33725		441	14	0.031746	7.711108		
5	428458	1732632	9.84	39.78	C	Undev (Chaparral)	1.173769	17.73957	3.1	0.38	0.38	98.18248		678	17	0.025074	9.627111		
90% of 25-year Storm -Existing												**88.36423**							

100 year-Velocity at Concentration Point 4

Input		Constants	
A(ft^2)=	6.971	k=	1.49
P(ft)=	12.041		
n=	0.040	Mannings Equation	
S(ft/ft)=	0.030	V=(k/n)*(R^(2/3))*(S^(1/2))	
R_h(ft)=	0.578906308		
		R= A/P	
Continuity Velocity (fps)	4.504093059	Manning Velocity (ft/s)	4.5
		Manning Flow (cfs)	31.397

theta	78.69007
Depth	1.180742
Width	11.80742

Calculated Q= 31.397

100 year-Velocity Concentration Point 5

Input		Constants	
A(ft^2)=	8.944	k=	1.49
P(ft)=	13.640		
n=	0.040	Mannings Equation	
S(ft/ft)=	0.030	V=(k/n)*(R^(2/3))*(S^(1/2))	
R_h(ft)=	0.655745291		
		R= A/P	
Continuity Velocity (fps)	4.887237425	Manning Velocity (ft/s)	4.9
		Manning Flow (cfs)	43.712

theta	78.69007
Depth	1.337463
Width	13.37463

Calculated Q= 43.712

100 year-Velocity at Concentration Point 8

Input		Constants	
A(ft^2)=	0.932	k=	1.49
P(ft)=	4.796		
n=	0.025	Mannings Equation	
S(ft/ft)=	0.021	V=(k/n)*(R^(2/3))*(S^(1/2))	
R_h(ft)=	0.194412224		
		R= A/P	
Continuity Velocity (fps)	2.917587406	Manning Velocity (ft/s)	2.9
		Manning Flow (cfs)	2.720

theta	80.53768
Depth	0.394188
Width	4.730254

Calculated Q= 2.720

100 year-Velocity at Concentration Point 9

Input		Constants	
A(ft^2)=	1.185	k=	1.49
P(ft)=	5.407		
n=	0.025	Mannings Equation	
S(ft/ft)=	0.022	V=(k/n)*(R^(2/3))*(S^(1/2))	
R_h(ft)=	0.219185614		
		R= A/P	
Continuity Velocity (fps)	3.20359317	Manning Velocity (ft/s)	3.2
		Manning Flow (cfs)	3.796

theta	80.53768
Depth	0.444418
Width	5.333016

Calculated Q= 3.796

100 year-Velocity at Concentration Point 19

Input		Constants	
A(ft^2)=	1.162	k=	1.49
P(ft)=	5.354		
n=	0.025	Mannings Equation	
S(ft/ft)=	0.037	V=(k/n)*(R^(2/3))*(S^(1/2))	
R_h(ft)=	0.21707004		
		R= A/P	
Continuity Velocity (fps)	4.13206119	Manning Velocity (ft/s)	4.1
		Manning Flow (cfs)	4.803

theta	80.53768
Depth	0.440129
Width	5.281542

Calculated Q= 4.803

100 year-Velocity at Concentration Point 20

Input		Constants	
A(ft^2)=	1.419	k=	1.49
P(ft)=	5.915		
n=	0.025	Mannings Equation	
S(ft/ft)=	0.033	V=(k/n)*(R^(2/3))*(S^(1/2))	
R_h(ft)=	0.239809394		
		R= A/P	
Continuity Velocity (fps)	4.165473765	Manning Velocity (ft/s)	4.2
		Manning Flow (cfs)	5.909

theta	80.53768
Depth	0.486235
Width	5.834814

Calculated Q= 5.909

100 year-Velocity at Concentration Point 13a			
	Input		Constants
$A(ft^2)$=	1.899	k=	1.49
P(ft)=	5.032		
n=	0.025		Mannings Equation
S(ft/ft)=	0.015		V=(k/n)*(R^(2/3))*(S^(1/2))
R_h(ft)=	0.377401924		
			R= A/P
	Continuity Velocity (fps)		Manning Velocity (ft/s)
	3.860556631		3.9
			Manning Flow (cfs)
			7.332

theta	71.56505
Depth	0.795633
Width	4.773799

Calculated Q= 7.332

100 year-Velocity at Concentration Point 14a			
	Input		Constants
$A(ft^2)$=	0.683	k=	1.49
P(ft)=	3.018		
n=	0.025		Mannings Equation
S(ft/ft)=	0.055		V=(k/n)*(R^(2/3))*(S^(1/2))
R_h(ft)=	0.226365672		
			R= A/P
	Continuity Velocity (fps)		Manning Velocity (ft/s)
	5.181608727		5.2
			Manning Flow (cfs)
			3.540

theta	71.56505
Depth	0.477221
Width	2.863324

Calculated Q= 3.540

100 year-Velocity Concentration Point 15a			
	Input		Constants
$A(ft^2)$=	1.285	k=	1.49
P(ft)=	4.140		
n=	0.025		Mannings Equation
S(ft/ft)=	0.040		V=(k/n)*(R^(2/3))*(S^(1/2))
R_h(ft)=	0.310467548		
			R= A/P
	Continuity Velocity (fps)		Manning Velocity (ft/s)
	5.465585623		5.5
			Manning Flow (cfs)
			7.024

theta	71.56505
Depth	0.654523
Width	3.927138

Calculated Q= 7.024

100 year-Velocity at Concentration Point 16a			
	Input		Constants
$A(ft^2)$=	1.448	k=	1.49
P(ft)=	4.395		
n=	0.025		Mannings Equation
S(ft/ft)=	0.042		V=(k/n)*(R^(2/3))*(S^(1/2))
R_h(ft)=	0.329593445		
			R= A/P
	Continuity Velocity (fps)		Manning Velocity (ft/s)
	5.837876652		5.8
			Manning Flow (cfs)
			8.456

theta	71.56505
Depth	0.694844
Width	4.169064

Calculated Q= 8.456

100 year-Velocity at Concentration Point 17a			
	Input		Constants
$A(ft^2)$=	1.175	k=	1.49
P(ft)=	3.958		
n=	0.025		Mannings Equation
S(ft/ft)=	0.043		V=(k/n)*(R^(2/3))*(S^(1/2))
R_h(ft)=	0.296865787		
			R= A/P
	Continuity Velocity (fps)		Manning Velocity (ft/s)
	5.47151484		5.5
			Manning Flow (cfs)
			6.429

theta	71.56505
Depth	0.625848
Width	3.755088

Calculated Q= 6.429

100 year-Velocity at Concentration Point 18a			
	Input		Constants
$A(ft^2)$=	1.022	k=	1.49
P(ft)=	3.692		
n=	0.025		Mannings Equation
S(ft/ft)=	0.034		V=(k/n)*(R^(2/3))*(S^(1/2))
R_h(ft)=	0.276916402		
			R= A/P
	Continuity Velocity (fps)		Manning Velocity (ft/s)
	4.642177475		4.6
			Manning Flow (cfs)
			4.746

theta	71.56505
Depth	0.583791
Width	3.502746

Calculated Q= 4.746

25 year- Velocity at Concentration Point 2 (Existing)			
	Input		Constants
$A(ft^2)$=	4.714	k=	1.49
P(ft)=	11.998		
n=	0.018		Mannings Equation
S(ft/ft)=	0.022		V=(k/n)*(R^(2/3))*(S^(1/2))
R_h(ft)=	0.392933226		
			R= A/P
	Continuity Velocity (fps)		Manning Velocity (ft/s)
	6.583502812		6.6
			Manning Flow (cfs)
			31.036

theta	82.40536
Depth	0.792821
Width	11.89232

Calculated Q= 31.036

25 year-Velocity at Concentration Point 3 (Existing)			
	Input		Constants
$A(ft^2)$=	7.575	k=	1.49
P(ft)=	15.209		
n=	0.018		Mannings Equation
S(ft/ft)=	0.022		V=(k/n)*(R^(2/3))*(S^(1/2))
R_h(ft)=	0.498095988		
			R= A/P
	Continuity Velocity (fps)		Manning Velocity (ft/s)
	7.711046061		7.7
			Manning Flow (cfs)
			58.414

theta	82.40536
Depth	1.005008
Width	15.07512

Calculated Q= 58.414

25 year-Velocity at Concentration Point 4 (Existing)			
	Input		Constants
$A(ft^2)$=	8.241	k=	1.49
P(ft)=	13.092		
n=	0.018		Mannings Equation
S(ft/ft)=	0.025		V=(k/n)*(R^(2/3))*(S^(1/2))
R_h(ft)=	0.629446632		
			R= A/P
	Continuity Velocity (fps)		Manning Velocity (ft/s)
	9.627111218		9.6
			Manning Flow (cfs)
			79.337

theta	78.69007
Depth	1.283824
Width	12.83824

Calculated Q= 79.337

Appendix E
FEMA and BAM Maps

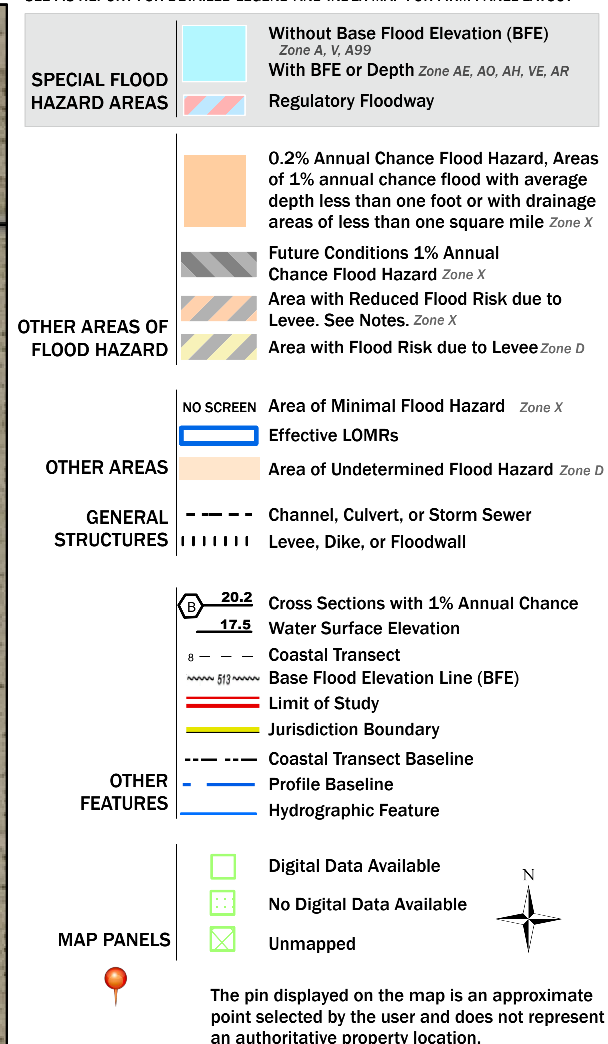
National Flood Hazard Layer FIRMette

FEMA

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT



This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

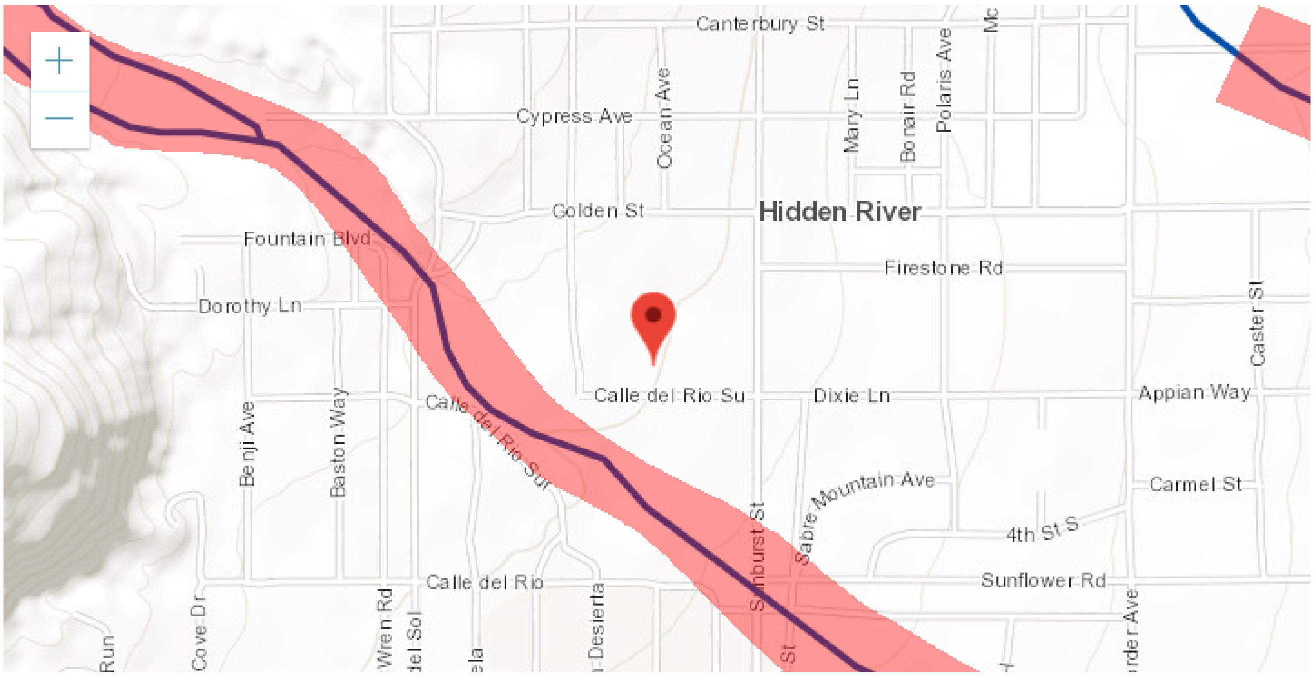
The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/19/2023 at 5:58 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

CALIFORNIA DEPARTMENT OF
WATER RESOURCES

Floodplain Information

Latitude: 34.17833, Longitude: -116.31467



Bureau of Land Management, Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, EPA, USDA Powered by Esri

County: San Bernardino (34.17833, -116.31467)

Floodplain Layer	100-YR	200-YR	500-YR
FEMA Effective	N✓	N/A	N✓
DWR Awareness	N✓	N/A	N/A
Regional/Special Studies	N✓	N/A	N✓
USACE Comp. Study	N✓	N✓	N✓

Y: The location is within the floodplain
N: The location is not within the floodplain
N/A: Data not available
✓ = Active Layer(s)

Floodplains are displayed using semi transparent colors. When viewing overlapping floodplains, the combination of multiple semi transparent colors will not match the legend colors. For accurate color representation, view floodplains individually.

Appendix F

NOAA Atlas 14 Precipitation Data

NOAA Atlas 14, Volume 6, Version 2
Location name: Joshua Tree, California, USA*
Latitude: 34.135°, Longitude: -116.3142°
Elevation: 2732.46 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.089** (0.073-0.108)	**0.131** (0.108-0.160)	**0.194** (0.160-0.237)	**0.251** (0.205-0.310)	**0.340** (0.269-0.434)	**0.419** (0.324-0.545)	**0.508** (0.384-0.678)	**0.611** (0.450-0.839)	**0.772** (0.545-1.10)	**1.01** (0.692-1.50)
10-min	**0.127** (0.105-0.155)	**0.188** (0.155-0.229)	**0.278** (0.229-0.340)	**0.360** (0.294-0.445)	**0.488** (0.386-0.623)	**0.600** (0.465-0.782)	**0.728** (0.551-0.972)	**0.876** (0.644-1.20)	**1.11** (0.781-1.58)	**1.45** (0.992-2.15)
15-min	**0.154** (0.127-0.188)	**0.227** (0.188-0.277)	**0.336** (0.277-0.411)	**0.435** (0.356-0.538)	**0.590** (0.467-0.753)	**0.726** (0.562-0.945)	**0.880** (0.666-1.18)	**1.06** (0.779-1.45)	**1.34** (0.944-1.91)	**1.76** (1.20-2.60)
30-min	**0.233** (0.193-0.284)	**0.343** (0.284-0.419)	**0.508** (0.419-0.622)	**0.658** (0.538-0.813)	**0.892** (0.706-1.14)	**1.10** (0.851-1.43)	**1.33** (1.01-1.78)	**1.60** (1.18-2.20)	**2.02** (1.43-2.89)	**2.66** (1.82-3.94)
60-min	**0.320** (0.265-0.391)	**0.472** (0.390-0.577)	**0.698** (0.576-0.856)	**0.906** (0.741-1.12)	**1.23** (0.971-1.57)	**1.51** (1.17-1.97)	**1.83** (1.39-2.44)	**2.20** (1.62-3.03)	**2.78** (1.97-3.98)	**3.66** (2.50-5.42)
2-hr	**0.435** (0.360-0.531)	**0.615** (0.509-0.752)	**0.877** (0.723-1.08)	**1.11** (0.909-1.37)	**1.47** (1.16-1.87)	**1.77** (1.37-2.30)	**2.10** (1.59-2.81)	**2.48** (1.83-3.40)	**3.05** (2.15-4.36)	**3.70** (2.52-5.47)
3-hr	**0.512** (0.424-0.625)	**0.715** (0.591-0.873)	**1.01** (0.829-1.23)	**1.26** (1.03-1.56)	**1.65** (1.30-2.10)	**1.97** (1.53-2.57)	**2.33** (1.76-3.11)	**2.73** (2.01-3.74)	**3.32** (2.34-4.75)	**3.82** (2.61-5.66)
6-hr	**0.660** (0.546-0.805)	**0.912** (0.754-1.11)	**1.27** (1.05-1.55)	**1.58** (1.29-1.95)	**2.03** (1.61-2.60)	**2.41** (1.87-3.14)	**2.82** (2.13-3.77)	**3.27** (2.41-4.49)	**3.93** (2.78-5.62)	**4.48** (3.06-6.64)
12-hr	**0.804** (0.666-0.981)	**1.12** (0.927-1.37)	**1.57** (1.29-1.92)	**1.96** (1.60-2.42)	**2.52** (2.00-3.22)	**2.99** (2.32-3.89)	**3.49** (2.64-4.66)	**4.04** (2.98-5.55)	**4.85** (3.42-6.94)	**5.52** (3.77-8.17)
24-hr	**0.986** (0.874-1.14)	**1.40** (1.24-1.62)	**1.99** (1.75-2.30)	**2.50** (2.19-2.91)	**3.24** (2.75-3.91)	**3.87** (3.21-4.75)	**4.54** (3.68-5.71)	**5.28** (4.17-6.83)	**6.37** (4.83-8.58)	**7.28** (5.34-10.1)
2-day	**1.10** (0.975-1.27)	**1.59** (1.41-1.83)	**2.29** (2.02-2.65)	**2.90** (2.54-3.38)	**3.80** (3.22-4.58)	**4.56** (3.78-5.60)	**5.38** (4.36-6.76)	**6.28** (4.96-8.12)	**7.62** (5.77-10.3)	**8.74** (6.41-12.2)
3-day	**1.18** (1.04-1.35)	**1.72** (1.52-1.98)	**2.50** (2.20-2.89)	**3.18** (2.79-3.71)	**4.19** (3.56-5.05)	**5.04** (4.19-6.20)	**5.97** (4.84-7.52)	**7.00** (5.53-9.06)	**8.53** (6.46-11.5)	**9.81** (7.19-13.7)
4-day	**1.23** (1.09-1.41)	**1.81** (1.60-2.08)	**2.64** (2.33-3.05)	**3.37** (2.95-3.93)	**4.47** (3.79-5.38)	**5.38** (4.47-6.61)	**6.38** (5.18-8.03)	**7.50** (5.92-9.70)	**9.15** (6.93-12.3)	**10.5** (7.73-14.7)
7-day	**1.34** (1.19-1.54)	**2.00** (1.77-2.31)	**2.96** (2.61-3.42)	**3.81** (3.33-4.44)	**5.06** (4.29-6.10)	**6.12** (5.08-7.52)	**7.28** (5.90-9.16)	**8.56** (6.76-11.1)	**10.5** (7.93-14.1)	**12.1** (8.85-16.8)
10-day	**1.42** (1.25-1.63)	**2.14** (1.89-2.46)	**3.17** (2.80-3.67)	**4.09** (3.58-4.77)	**5.45** (4.62-6.56)	**6.59** (5.48-8.10)	**7.84** (6.36-9.87)	**9.23** (7.29-11.9)	**11.3** (8.55-15.2)	**13.0** (9.54-18.1)
20-day	**1.60** (1.42-1.84)	**2.43** (2.15-2.80)	**3.61** (3.19-4.18)	**4.66** (4.08-5.43)	**6.20** (5.26-7.47)	**7.50** (6.23-9.22)	**8.92** (7.23-11.2)	**10.5** (8.27-13.6)	**12.8** (9.69-17.2)	**14.7** (10.8-20.5)
30-day	**1.78** (1.58-2.05)	**2.71** (2.40-3.12)	**4.03** (3.56-4.66)	**5.20** (4.55-6.06)	**6.92** (5.86-8.33)	**8.35** (6.94-10.3)	**9.92** (8.04-12.5)	**11.6** (9.18-15.1)	**14.2** (10.7-19.1)	**16.3** (11.9-22.7)
45-day	**2.05** (1.82-2.36)	**3.10** (2.74-3.57)	**4.59** (4.05-5.30)	**5.89** (5.16-6.86)	**7.81** (6.62-9.40)	**9.41** (7.82-11.6)	**11.1** (9.04-14.0)	**13.0** (10.3-16.9)	**15.8** (12.0-21.3)	**18.2** (13.3-25.3)
60-day	**2.32** (2.06-2.67)	**3.48** (3.08-4.01)	**5.12** (4.52-5.92)	**6.55** (5.74-7.64)	**8.66** (7.34-10.4)	**10.4** (8.64-12.8)	**12.3** (9.97-15.5)	**14.4** (11.3-18.6)	**17.4** (13.2-23.4)	**19.9** (14.6-27.7)

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

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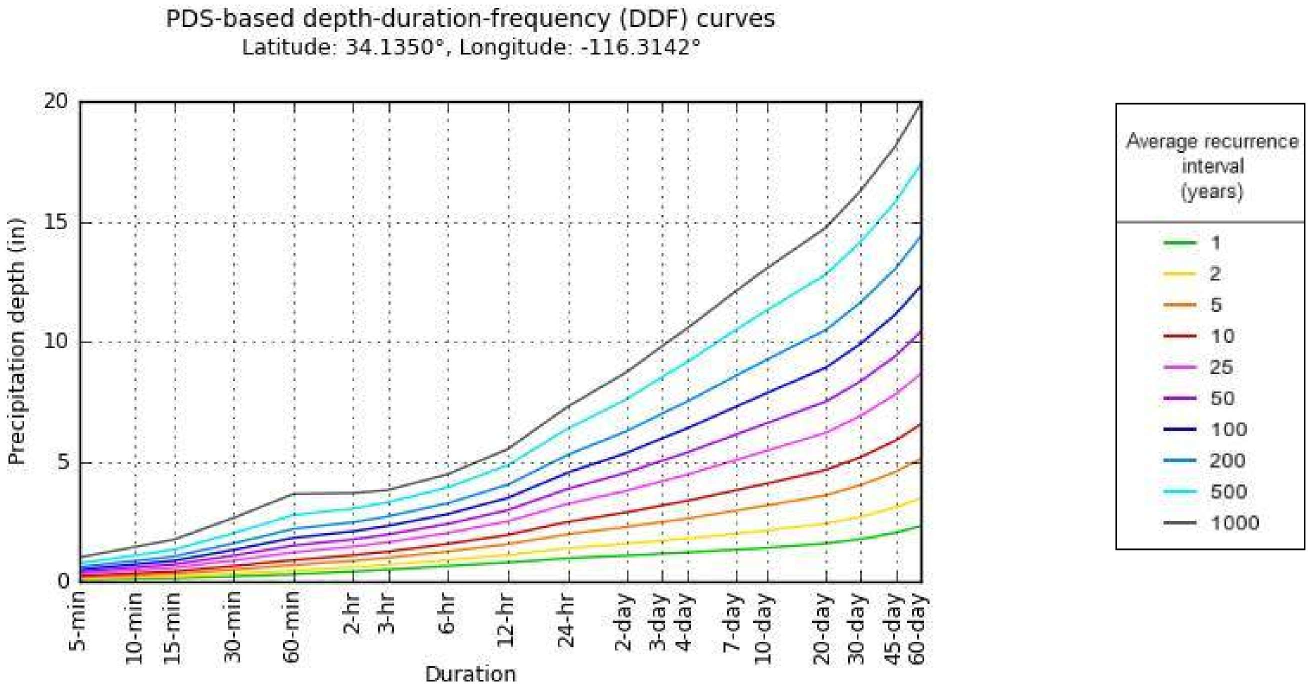
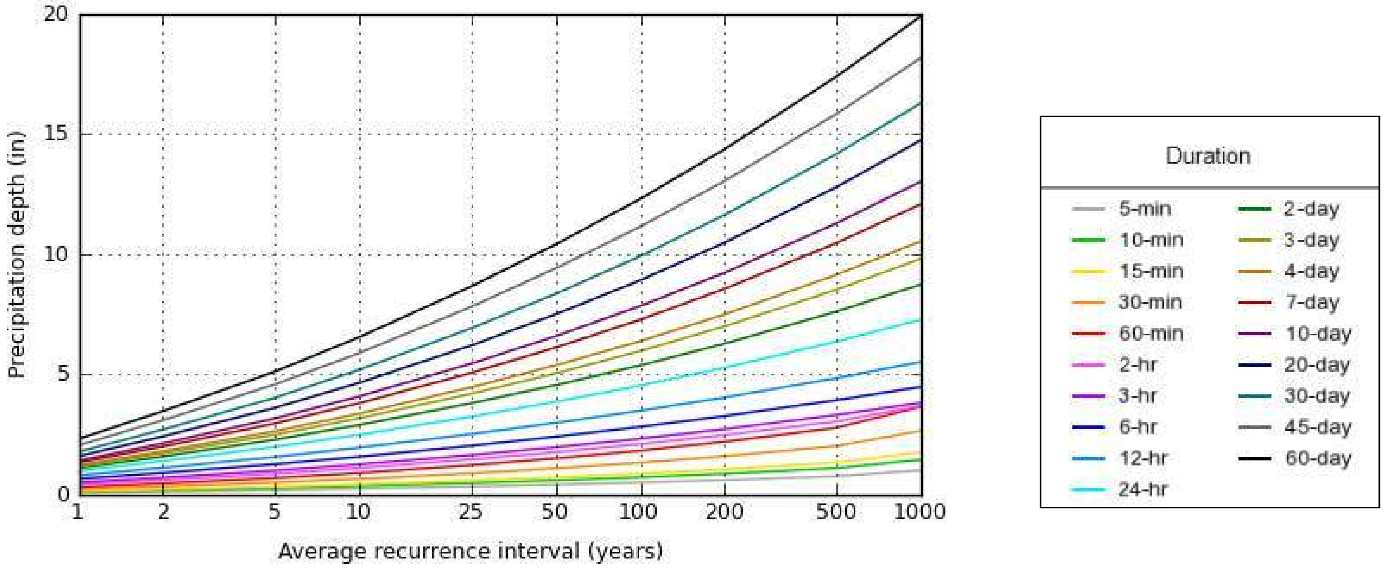
PF graphical





NOAA Atlas 14, Volume 6, Version 2 Created (GMT): Thu Dec 1 22:26:45 2022

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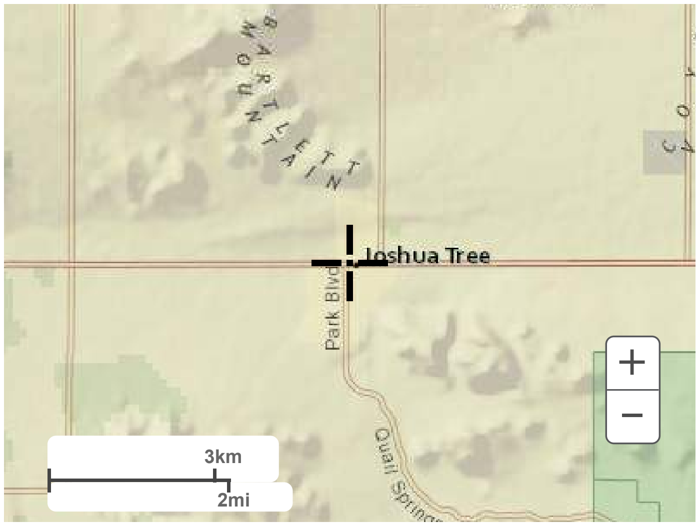
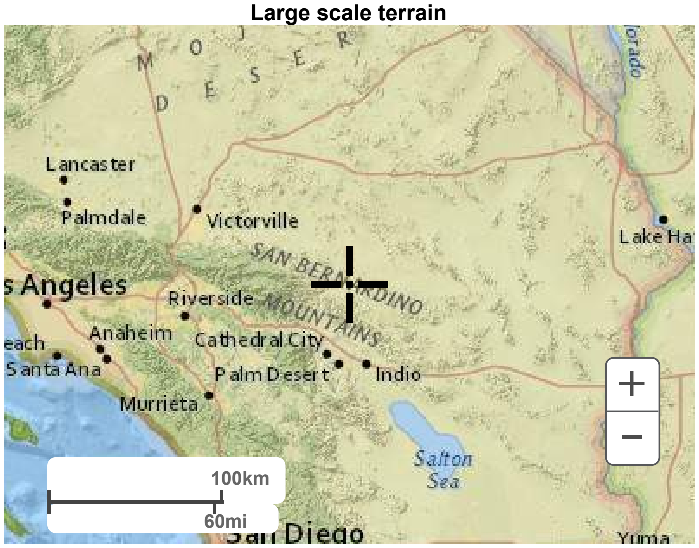
Maps & aerials

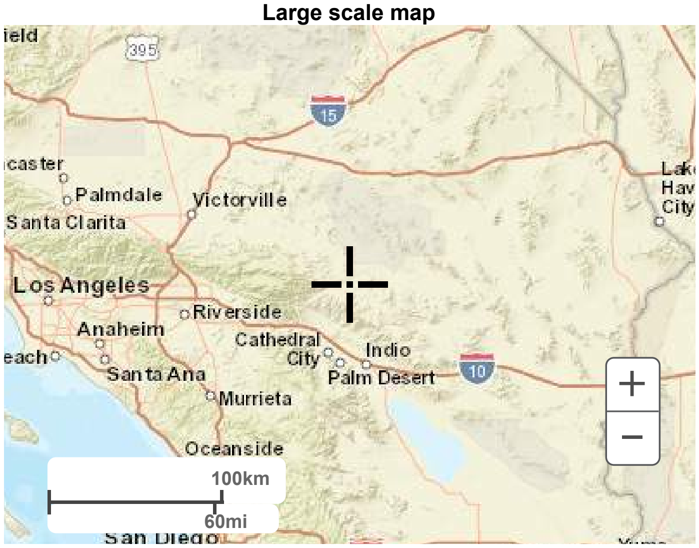
Small scale terrain



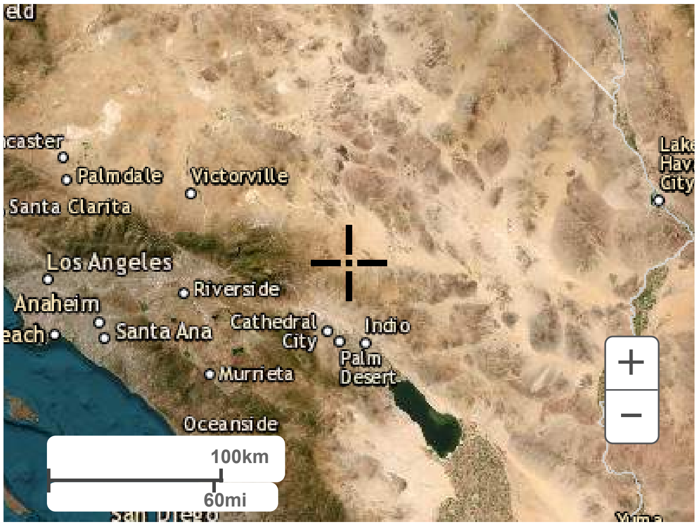
Large scale terrain



Large scale map



Large scale aerial



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Appendix G
Mannings n-Value Tables

(6) Critical Flow. A useful concept in hydraulic analysis is that of "specific energy". The specific energy at a given section is defined as the total energy, or total head, of the flowing water with respect to the channel bottom. For a channel of small slope;

$$E = d + \frac{V^2}{2g}$$

Table 866.3A

Average Values for Manning's Roughness Coefficient (n)

Type of Channel	n value
Unlined Channels:	
Clay Loam	0.023
Sand	0.020
Gravel	0.030
Rock	0.040
Lined Channels:	
Portland Cement Concrete	0.014
Air Blown Mortar (troweled)	0.012
Air Blown Mortar (untroweled)	0.016
Air Blown Mortar (roughened)	0.025
Asphalt Concrete	0.016-0.018
Sacked Concrete	0.025
Pavement and Gutters:	
Portland Cement Concrete	0.013-0.015
Hot Mix Asphalt Concrete	0.016-0.018
Depressed Medians:	
Earth (without growth)	0.016-0.025
Earth (with growth)	0.050
Gravel (d_{50} = 1 in. flow depth $\leq$ 6 in.)	0.040
Gravel (d_{50} = 2 in. flow depth $\leq$ 6 in.)	0.056

NOTES:

For additional values of n, see HEC No. 15, Tables 2.1 and 2.2, and "Introduction to Highway Hydraulics", Hydraulic Design Series No. 4, FHWA Table 14.

where:

E = Specific energy, in feet

d = Depth of flow, in feet

Excerpt from Federal Highway Authority: Guide For Selecting Mannings Roughness Coefficients in Natural Channels and Flood Plains

Proper values of n_b, n_1 to n_4, and m for various types of channels will be presented in detail in following sections.

Selection of Base n Values (n_b)

In the selection of a base n value for channel subsections, the channel must by classified as a stable channel or as a sand channel.

A stable channel is defined as a channel in which the bed is composed of firm soil, gravel, cobbles, boulders, or bedrock and which remains relatively unchanged through most of the range in flow. Table 1 (Aldridge and Garrett, 1973) lists base n_b values for stable channels and sand channels. The base values of Benson and Dalrymple (1967) generally apply to conditions that are close to average; whereas, Chow's (1959) base values are for the smoothest reach attainable for a given bed material.

Table 1.--Base values of Manning's n

[Modified from Aldridge and Garrett, 1973, table 1]

Channel or flood-plain type	Median size of bed material		Base n value	
	Millimeters	Inches	Benson and Dalrymple (1967)[1]	Chow (1959)[2]
Sand channels				
(Only for upper	0.2	---------	0.012	-----
regime flow where	.3	---------	.017	-----
grain roughness	.4	---------	.020	-----
is predominant.)	.5	---------	.022	-----
	.6	---------	.023	-----
	.8	---------	.025	-----
	1.0	---------	.026	-----
Stable channels and flood plains				
Concrete----------	------	---------	0.012-0.018	0.011
Rock cut----------	------	---------	-----------	.025
Firm soil---------	------	---------	.025- .032	.020
Coarse sand-------	1- 2	---------	.026- .035	-----
Fine gravel-------	------	---------	-----------	.024
Gravel------------	2- 64	0.08- 2.5	.028- .035	-----
Coarse gravel-----	------	---------	-----------	.026
Cobble------------	64-256	2.5 -10.1	.030- .050	-----
Boulder-----------	>256	>10.1	.040- .070	-----

1/Straight uniform channel.
2/Smoothest channel attainable in indicated material.

Appendix H

Drawdown Time Reference Materials

San Bernardino Technical Guidance for WQMP Excerpts
Sunburst Site Geotechnical and Percolation Test Result Excerpts

Note that while biotreatment BMPs promote and depend upon vegetation for effective performance, plant growth may damage facility infrastructure elements such as fencing, curbs, etc. This hazard can be mitigated by incorporating root barriers and/or through regular maintenance.

Biotreatment BMPs can be divided into two sub-categories:

- Volume-based biotreatment incorporating a significant amount of storage, maximizing evapotranspiration and infiltration, and delaying outflow of the remaining retained volume; and

- Flow-based biotreatment in which temporary storage is minimal, evapotranspiration and/or infiltration is limited to incidental losses, and most of the runoff is discharged following treatment by the combination of physical and biological processes inherent in the BMP design.

5.4.4.1 Volume-based biotreatment

Biotreatment achieved from implementing volume-based biotreatment BMPs is a function of the depth of water that is either treated over the course of the storm or stored within the BMP for evapotranspiration, infiltration and release following the storm (Table 5-6). Runoff stored in pore spaces, if applicable, can be detained for extended periods of time, which may be necessary to support the vegetation and maximize any potential infiltration. The outflow from the bioretention underdrains is sized to allow for 48 hour drawdown in retained water following a storm event. Allowable retention is limited by the requirement to drawdown retained water within 48 hours following a storm event in order to restore retention volume for a subsequent storm event. Several types of volume-based biotreatment BMPs may be considered when developing a Project WQMP, including:

- Bioretention / Planter Box with underdrains - Bioretention stormwater treatment facilities are shallow landscaped depressions that capture and filter stormwater runoff. The incorporation of an underdrain system that releases treated stormwater runoff changes the BMP from an on-site retention category to a biotreatment category. Use of underdrains is necessary in areas with low permeability native soils or steep slopes. The underdrain system routes the treated runoff not otherwise infiltrated or evapotranspirated to the storm drain system rather than depending entirely on infiltration or ET. These facilities function as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. The facilities normally consist of a ponding area, mulch layer, planting soils, and plants. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, biodegraded, and sequestered by the soil and plants. The volume of water that is stored includes pore water in the ammended soil and gravel layers (for bioretention areas) as well as up to 1.5 ft of allowable ponding above the amended soil layer.

The measured field percolation test rates ranged from 0.17 to 3.00 minutes per inch (MPI), for a mean average of 0.94 MPI with ¼ of the mean average being 0.24 MPI. According to SBCDPHEHS since all of the test results do not fall within ¼ of the mean average MPI or 0.70 MPI to 1.18 MPI the percolation rate of 3.00 MPI should be used for leach line system design.

9.1 Parameters and Calculations

The following calculations are based on a typical septic tank capacity and are for general reference only. For alternate tank size capacity design percolation rates, please refer to the SBDPHEHS standards to calculate the correct rate.

1 residence per lot
1,000 gallons of septic tank capacity per residence

Most Conservative Leach Line Field Percolation MPI = 3.00 min/inch
Design Percolation Rate = 3.00 min/inch = 20.00 inches/hour

10.0 EARTHWORK AND SITE GRADING RECOMMENDATIONS

Earthwork for the project will include grading, trench excavation, pipe subgrade preparation, pipeline bedding placement and trench backfill, as well as roadway pavement construction. Recommendations for earthwork are presented in the following subsections. General Earthwork Specifications are presented in Appendix D*, Liquefaction and Seismic Settlement.*

10.1 General

This section contains our general recommendations regarding earthwork for the proposed 8-lot residential development. These recommendations are based on the results of our field exploration and laboratory testing as well as our experience with similar projects, and data evaluation as presented in the preceding sections. These recommendations may require modification by the geotechnical consultant based on observation of the actual field conditions during remedial grading.

Prior to the start of construction, all underground existing utilities and appurtenances should be located at the project site. Such utilities should either be protected in-place or removed and replaced during construction as required by the project specifications. All excavations should be conducted in such a manner as not to cause loss of bearing and/or lateral support of existing structures or utilities.

All existing structures, debris, deleterious material and surficial soils containing roots and perishable materials should be stripped and removed from the project site.