

HYDROLOGY REPORT

for

Proposed Commercial Building

APN:0132-021-18

**935 S. Lilac Avenue
in the City of
Rialto, California**

**Prepared for:
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180 S. Quintana Drive,
Anaheim, CA 92807**

**Prepared by:
E&A Engineers
20505 E. Valley Blvd., Ste 110,
Walnut, CA 91789**

February 15, 2023

PREPARED UNDER THE DIRECT SUPERVISION OF:

GIL EVANGELISTA

DATE

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METHODOLOGY

The proposed drainage area was analyzed by utilizing the County of San Bernardino Public Works Department Flood Control District Hydrology Manual. The site consists of 1 drainage area as demonstrated on the enclosed Hydrology Exhibits. This drainage area was analyzed for acreage, land-use and time of concentration according to the Rational Method.

PURPOSE OF THE STUDY

The study will determine the amount of storm water run-off generated from the project in the existing and post development conditions. The Hydraulic analysis portion of this study will determine the minimum size of pipes used for the site.

SITE DESCRIPTION

The project site in consideration is located at 935 S. Lilac Avenue, in the City of Rialto, California. The entire property has a total area of 1.56 acres. The project currently consist of 2 existing buildings, asphalt driveways and concrete paths/areas. The existing drainage relies on sheet flow over pavement in a southerly to easterly direction.

The project will remove the existing asphalt/concrete pavement and demolish the existing buildings. The proposed development proposes to construct the two office buildings and parking areas. Landscape areas will be constructed at the perimeter of the site.

The project site will have 1 drainage areas. DA 1 has an area of 68079.95 sf / 1.56 ac, runoff from this area is conveyed through sheet flow over pavement towards V-gutters that lead to catchbasins. Runoff drains towards the Cultec underground chambers.

DESIGN PARAMETERS:

1. The property is located in the City of Rialto, San Bernardino County rainfall, Valley Region.
2. 25 year storm event flood level protection analysis required for pipe conveyance sizing along major street travelways.
3. Flow rates calculated based on the County of San Bernardino Hydrology Manual Dated August 1986.
4. One hour point rainfall data derived from NOAA Atlas 14 point precipitation frequency estimates.

CONCLUSION

Based upon the results of this study there will be an increase in the runoff discharge generated by the proposed condition due to the increase of the impervious areas.

The following tables are provided to summarize the 2 year, 25 year and 100 year pre-development and post development runoffs:

Pre Development Summary:

DRAINAGE AREA	Control Point	Acre (ac)	Qp, cfs (2 yr)	Qp, cfs (25 yr)	Qp, cfs (100 yr)
DA1	CP#1	1.560	1.46	3.96	5.83

Post Development Summary:

Catchment	Control Point	Acre (ac)	Qp, cfs (2 yr)	Qp, cfs (25 yr)	Qp, cfs (100 yr)
DA 1	CP#1	1.560	3.06	6.03	7.97

25 year Runoff Volume Summary:

	25 Year Runoff Volume
Pre Developed	4,675.21 cf
Post Developed	21,636.43 cf

APPENDIX A

APPENDIX B

PRE DEVELOPED CONDITION

RATIONAL METHOD STUDY FORM

SAN BERNARDINO COUNTY			STUDY NAME: PROPOSED COMMERCIAL BUILDING							CALCULATED BY: RR		DATE:			
HYDROLOGY MANUAL			2-year STORM RATIONAL METHOD STUDY							CHECKED BY: JR		DATE:			
CONCENTRATION POINT	AREA acres		SOIL TYPE	DEV. TYPE	T_t min	T_c min	I in/hr	F_p in/hr	a_p	F_m in/hr	Q_{TOTAL} cfs				HYDRAULICS & NOTES
	Subarea	Total													
DA1	1.560	1.560	A	COM	-	8.00	1.90	1.02	0.841	0.86	1.46				PRE DEVELOPED

RATIONAL METHOD STUDY FORM

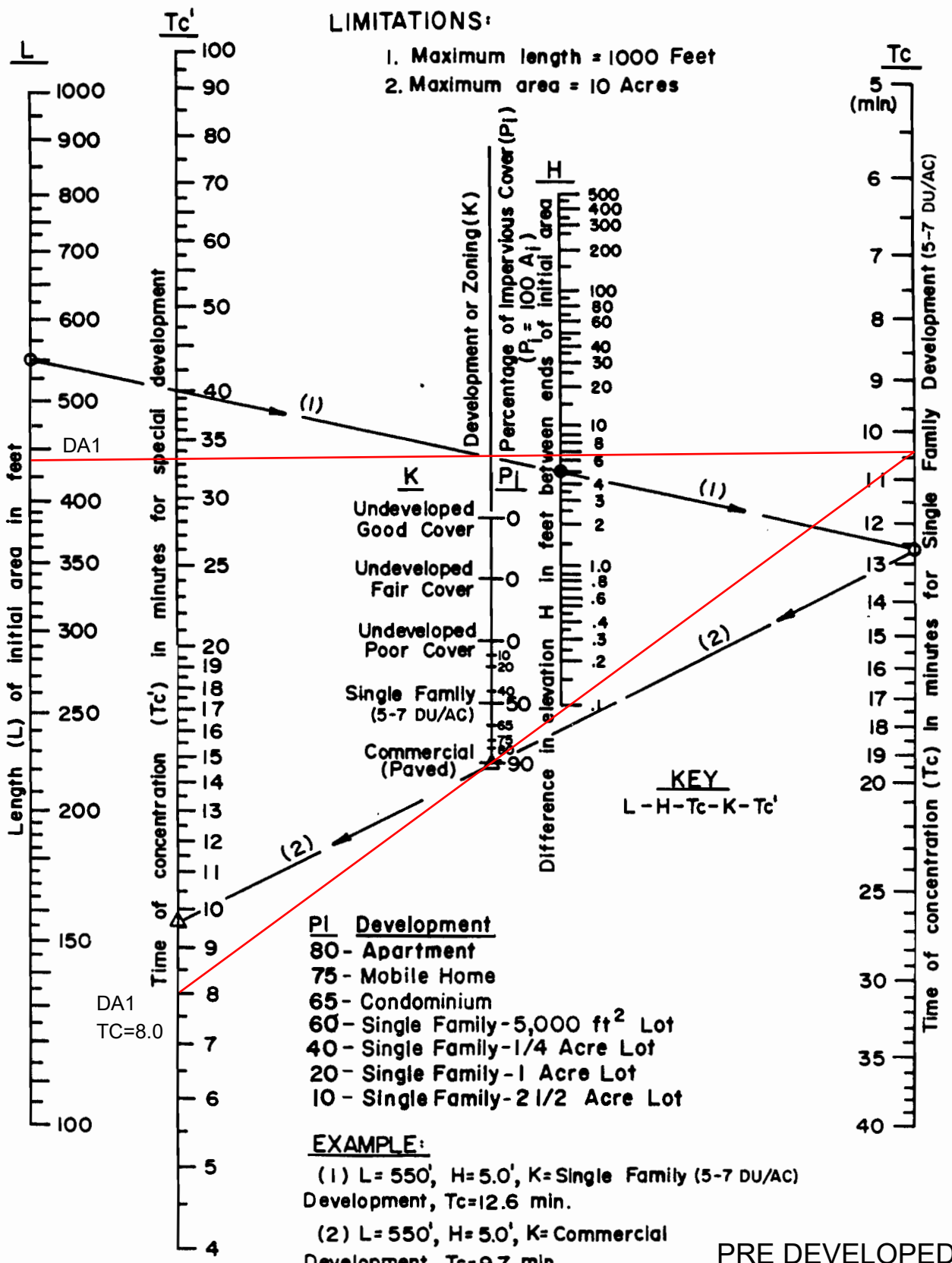
SAN BERNARDINO COUNTY			STUDY NAME: PROPOSED COMMERCIAL BUILDING							CALCULATED BY: RR		DATE:			
HYDROLOGY MANUAL			25-year STORM RATIONAL METHOD STUDY							CHECKED BY: JR		DATE:			
CONCENTRATION POINT	acres		SOIL TYPE	DEV. TYPE	T_t min	T_c min	I in/hr	F_p in/hr	a_p	F_m in/hr	Q_{TOTAL} cfs				HYDRAULICS & NOTES
	Subarea	Total													
DA1	1.560	1.560	A	COM	-	8.00	3.60	0.93	0.841	0.78	3.96				PRE DEVELOPED

RATIONAL METHOD STUDY FORM

SAN BERNARDINO COUNTY			STUDY NAME: PROPOSED COMMERCIAL BUILDING							CALCULATED BY: RR		DATE:			
HYDROLOGY MANUAL			100-year STORM RATIONAL METHOD STUDY							CHECKED BY: JR		DATE:			
CONCENTRATION POINT	acres		SOIL TYPE	DEV. TYPE	T_t min	T_c min	I in/hr	F_p in/hr	a_p	F_m in/hr	Q_{TOTAL} cfs				HYDRAULICS & NOTES
	Subarea	Total													
DA1	1.560	1.560	A	COM	-	8.00	4.70	0.65	0.841	0.55	5.83				PRE DEVELOPED

LIMITATIONS:

1. Maximum length = 1000 Feet
2. Maximum area = 10 Acres



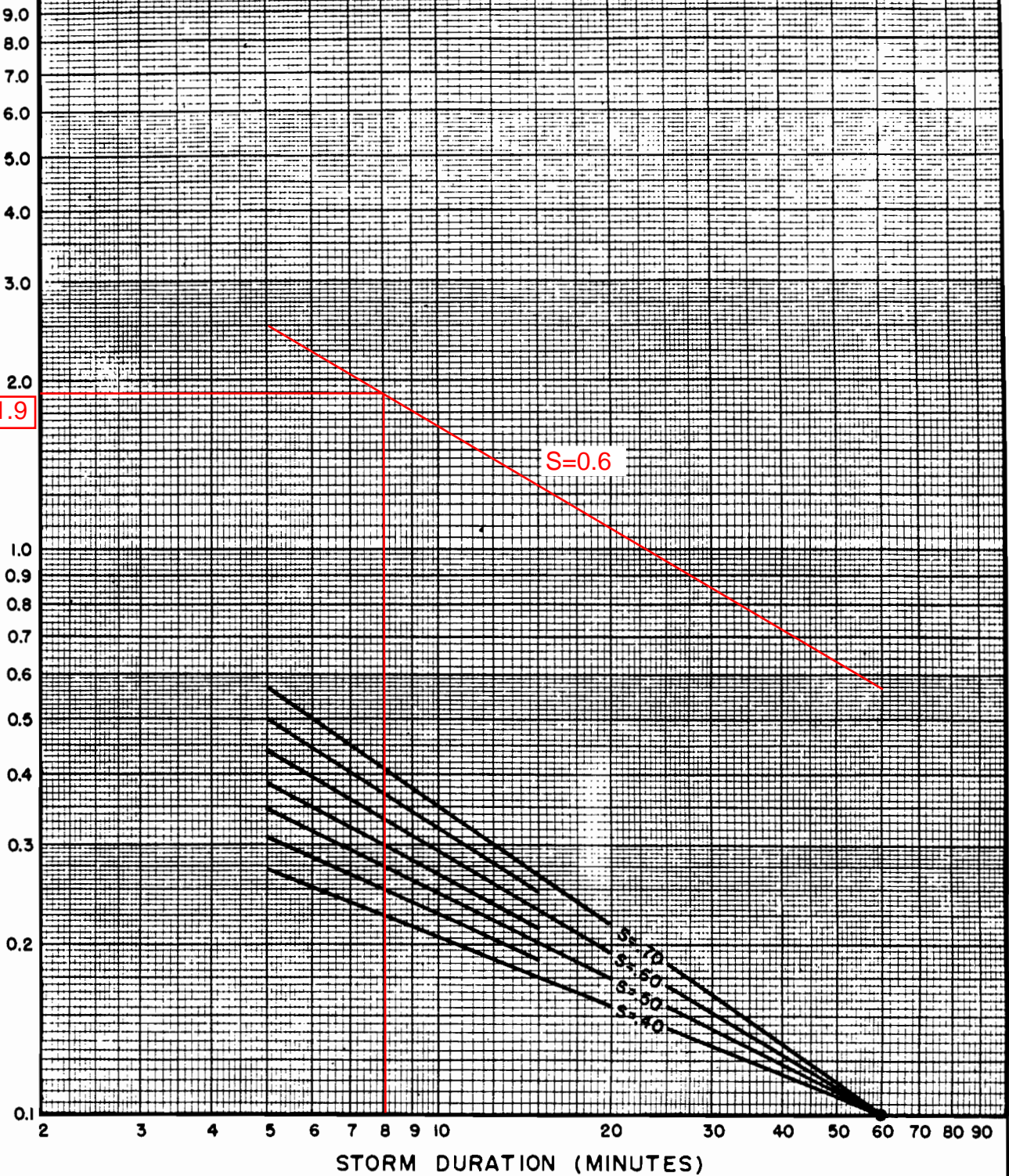
SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

TIME OF CONCENTRATION
NOMOGRAPH
FOR INITIAL SUBAREA

RAINFALL INTENSITY (INCHES / HOUR)

1.9

S=0.6

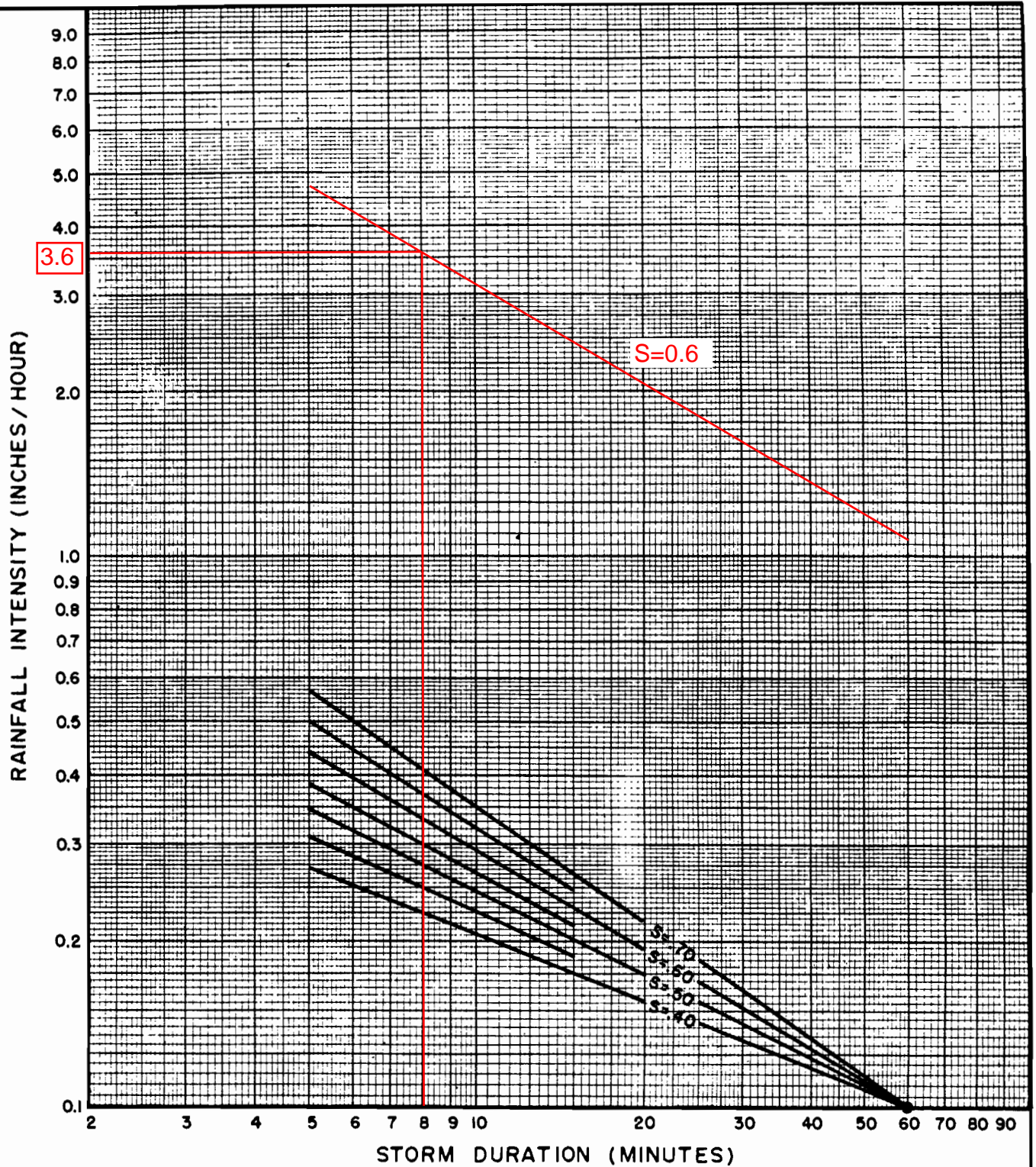


DESIGN STORM FREQUENCY = 2 YEARS
ONE HOUR POINT RAINFALL = 0.566 INCHES
LOG-LOG SLOPE = 0.6
PROJECT LOCATION = LILAC AVE, RIALTO

PRE DEVELOPED

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

INTENSITY - DURATION
CURVES
CALCULATION SHEET

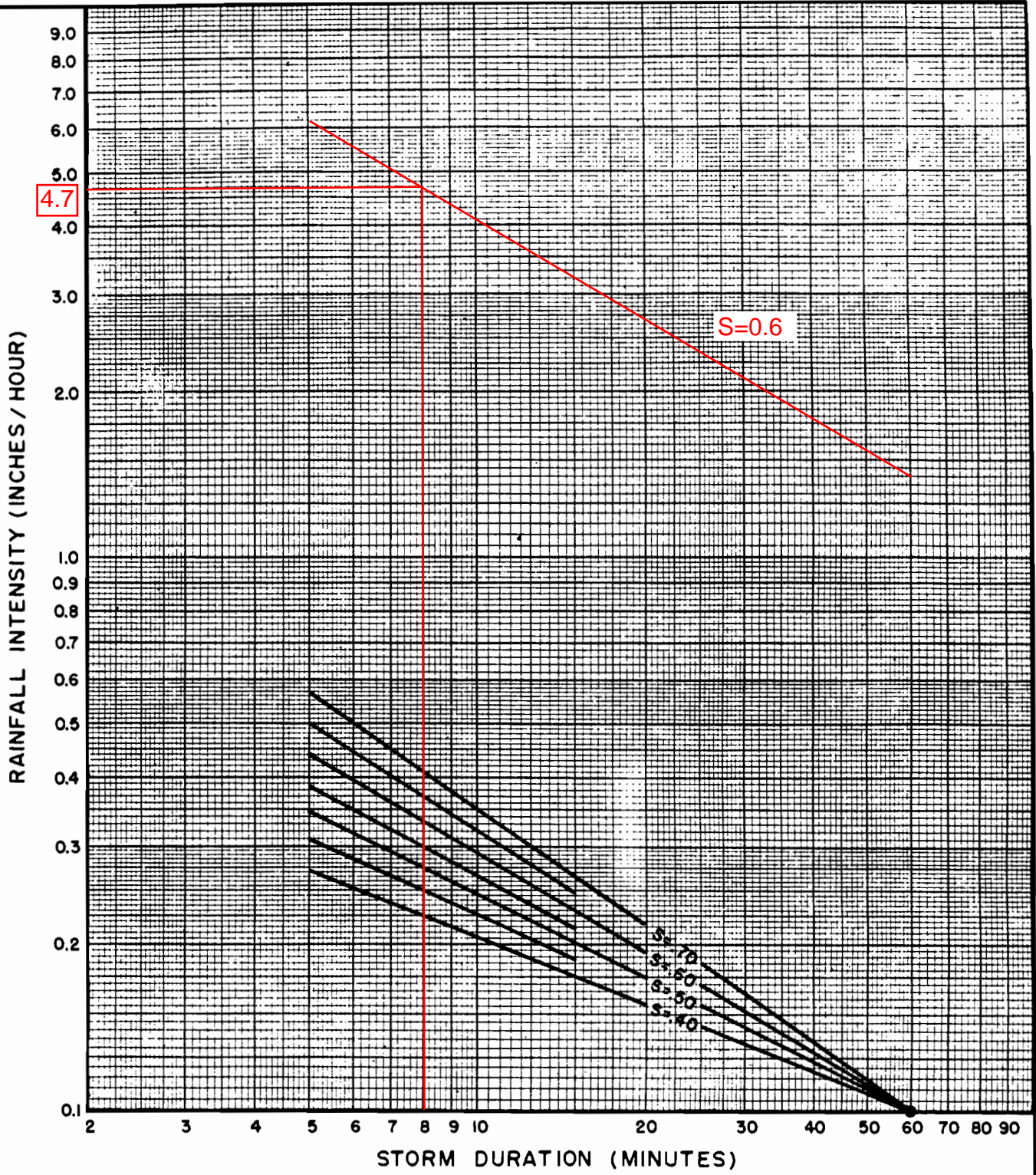


DESIGN STORM FREQUENCY = 25 YEARS
 ONE HOUR POINT RAINFALL = 1.08 INCHES
 LOG-LOG SLOPE = 0.6
 PROJECT LOCATION = LILAC AVE, RIALTO

PRE DEVELOPED

SAN BERNARDINO COUNTY
 HYDROLOGY MANUAL

INTENSITY - DURATION
 CURVES
 CALCULATION SHEET

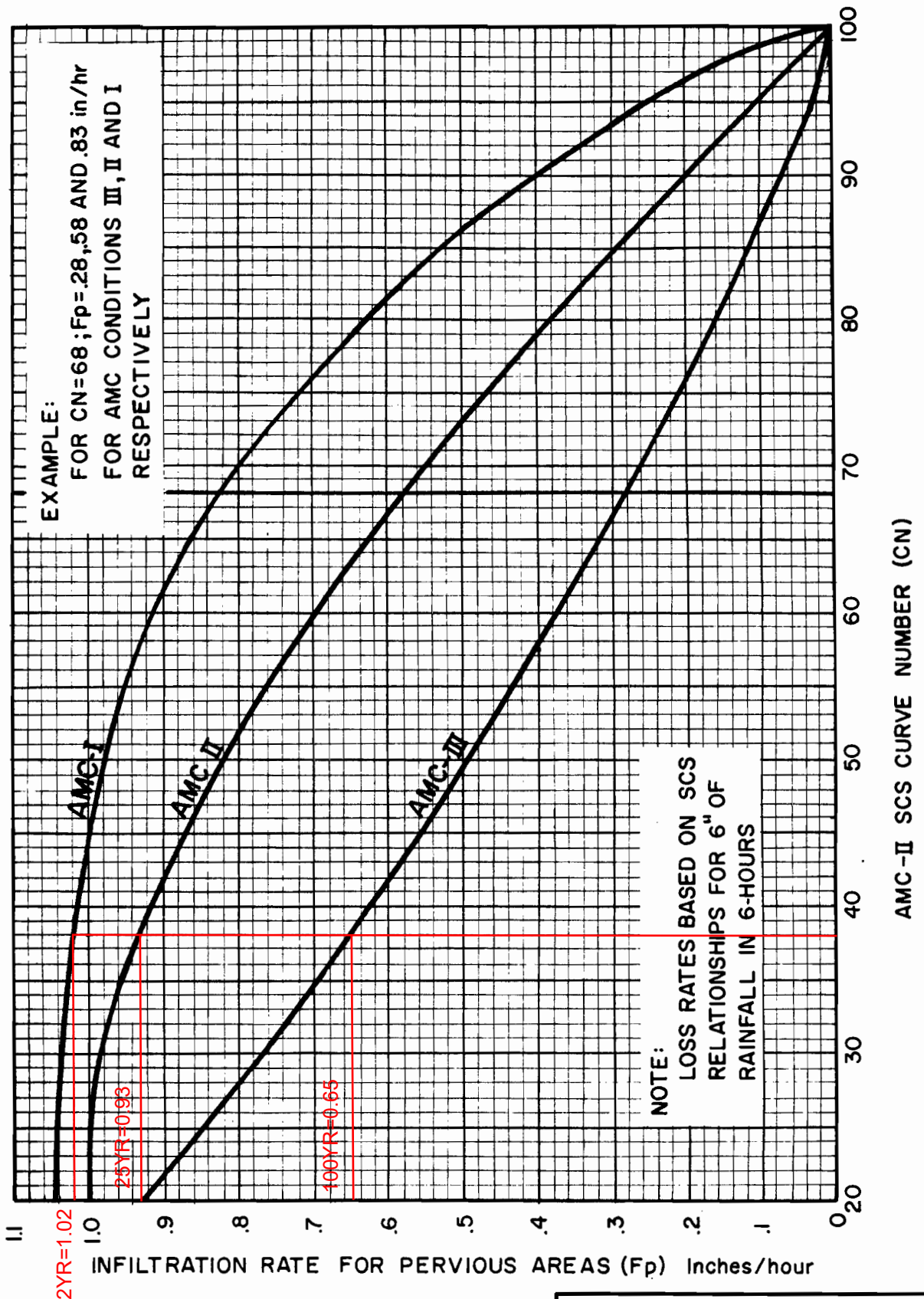


DESIGN STORM FREQUENCY = 100 YEARS
 ONE HOUR POINT RAINFALL = 1.39 INCHES
 LOG-LOG SLOPE = 0.6
 PROJECT LOCATION = LILAC AVE, RIALTO

PRE DEVELOPED

SAN BERNARDINO COUNTY
 HYDROLOGY MANUAL

INTENSITY - DURATION
 CURVES
 CALCULATION SHEET



**SAN BERNARDINO COUNTY
 HYDROLOGY MANUAL**

**INFILTRATION RATE FOR
 PERVIOUS AREAS VERSUS
 SCS CURVE NUMBERS**

PRE DEVELOPED

Curve (I) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group			
		A	B	C	D
<u>NATURAL COVERS -</u>					
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
<u>URBAN COVERS -</u>					
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
<u>AGRICULTURAL COVERS -</u>					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

CURVE NUMBERS
FOR
PERVIOUS AREAS

POST DEVELOPED CONDITION

RATIONAL METHOD STUDY FORM

SAN BERNARDINO COUNTY			STUDY NAME: PROPOSED COMMERCIAL BUILDING							CALCULATED BY: RR		DATE:			
HYDROLOGY MANUAL			2-year STORM RATIONAL METHOD STUDY							CHECKED BY: JR		DATE:			
CONCENTRATION POINT	AREA acres		SOIL TYPE	DEV. TYPE	T_t min	T_c min	I in/hr	F_p in/hr	a_p	F_m in/hr	Q_{TOTAL} cfs				HYDRAULICS & NOTES
	Subarea	Total													
DA 1	1.560	1.560	A	COM	-	5.50	2.35	1.03	0.163	0.17	3.06				POST DEVELOPED

RATIONAL METHOD STUDY FORM

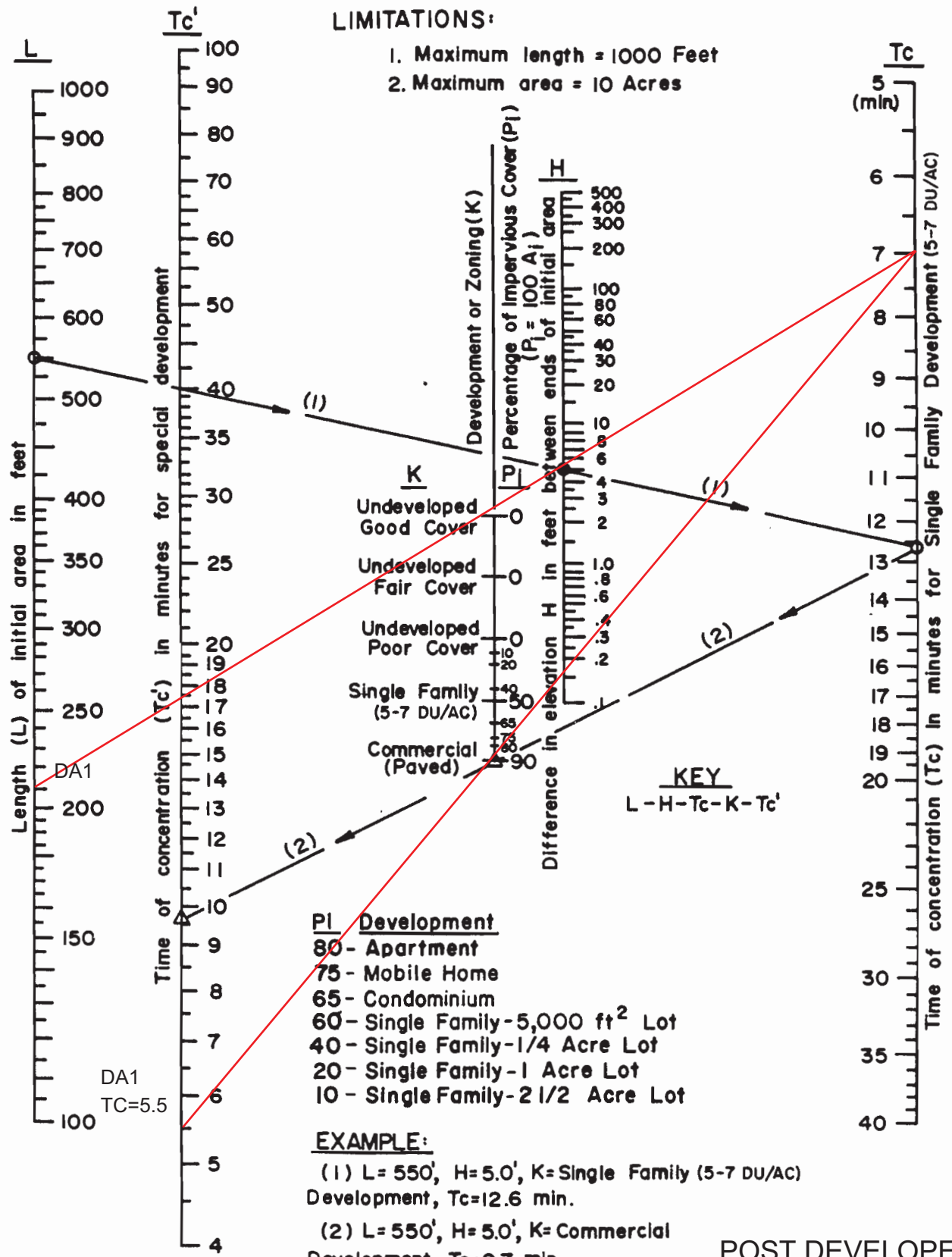
SAN BERNARDINO COUNTY			STUDY NAME: PROPOSED COMMERCIAL BUILDING							CALCULATED BY: RR		DATE:			
HYDROLOGY MANUAL			25-year STORM RATIONAL METHOD STUDY							CHECKED BY: JR		DATE:			
CONCENTRATION POINT	acres		SOIL TYPE	DEV. TYPE	T_t min	T_c min	I in/hr	F_p in/hr	a_p	F_m in/hr	Q_{TOTAL} cfs				HYDRAULICS & NOTES
	Subarea	Total													
DA 1	1.560	1.560	A	COM	-	5.50	4.45	0.97	0.163	0.16	6.03				POST DEVELOPED

RATIONAL METHOD STUDY FORM

SAN BERNARDINO COUNTY			STUDY NAME: PROPOSED COMMERCIAL BUILDING							CALCULATED BY: RR		DATE:			
HYDROLOGY MANUAL			100-year STORM RATIONAL METHOD STUDY							CHECKED BY: JR		DATE:			
CONCENTRATION POINT	acres		SOIL TYPE	DEV. TYPE	T_t min	T_c min	I in/hr	F_p in/hr	a_p	F_m in/hr	Q_{TOTAL} cfs				HYDRAULICS & NOTES
	Subarea	Total													
DA 1	1.560	1.560	A	COM	-	5.50	5.80	0.74	0.163	0.12	7.97				POST DEVELOPED

LIMITATIONS:

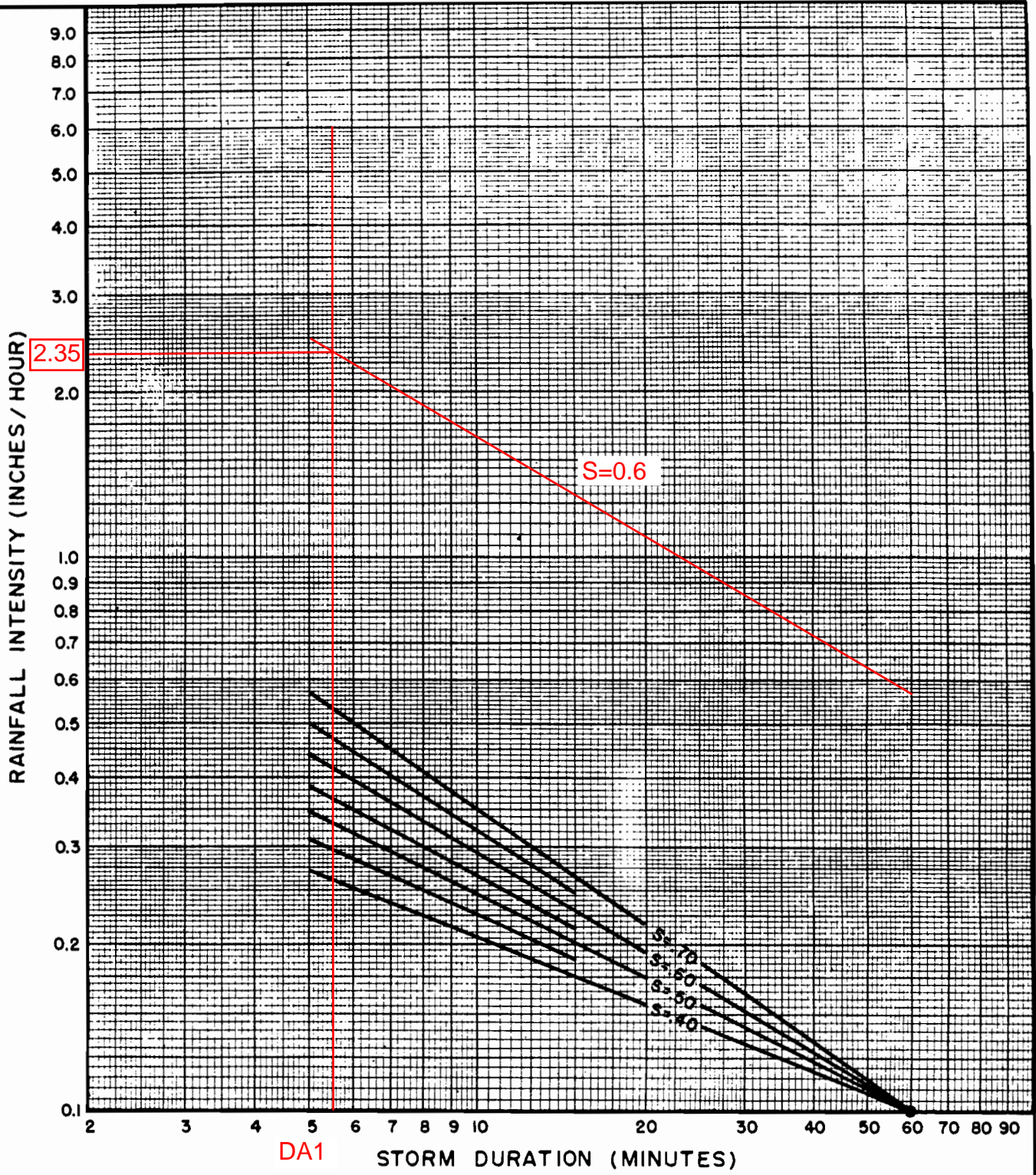
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SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

TIME OF CONCENTRATION
NOMOGRAPH
FOR INITIAL SUBAREA

POST DEVELOPED

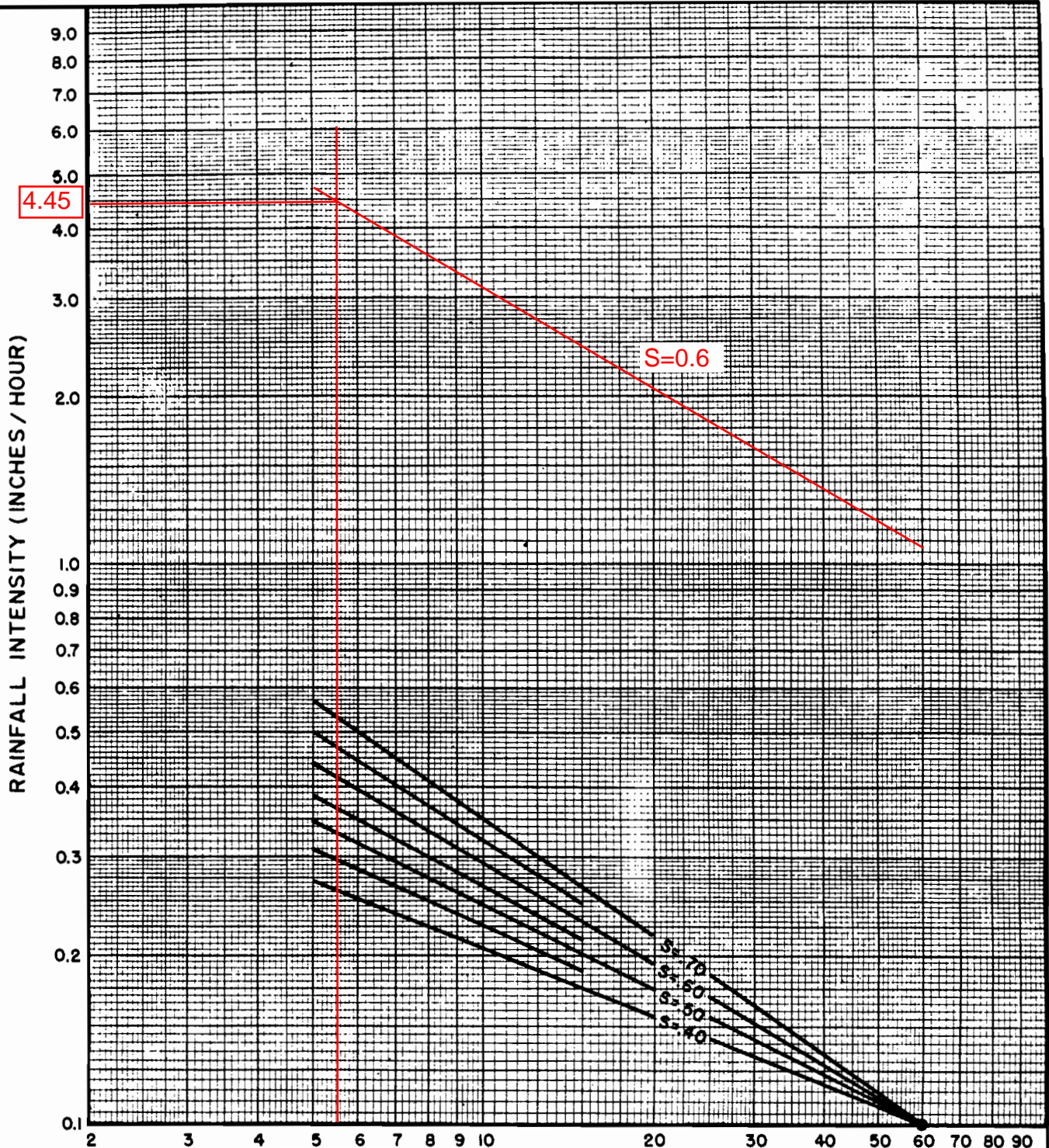


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POST DEVELOPED

SAN BERNARDINO COUNTY
 HYDROLOGY MANUAL

**INTENSITY - DURATION
 CURVES
 CALCULATION SHEET**



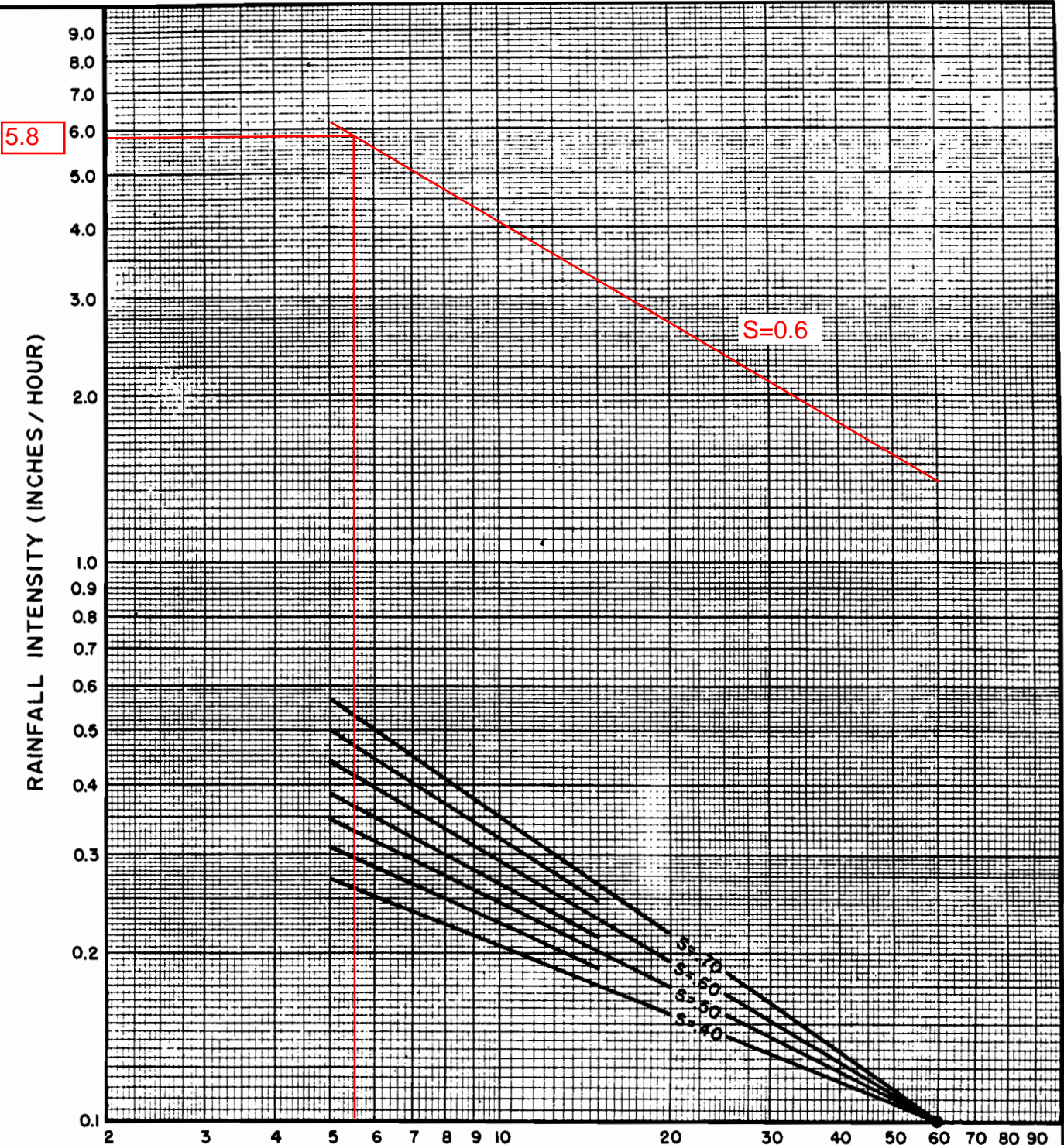
DA1
TC=5.5

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 HYDROLOGY MANUAL

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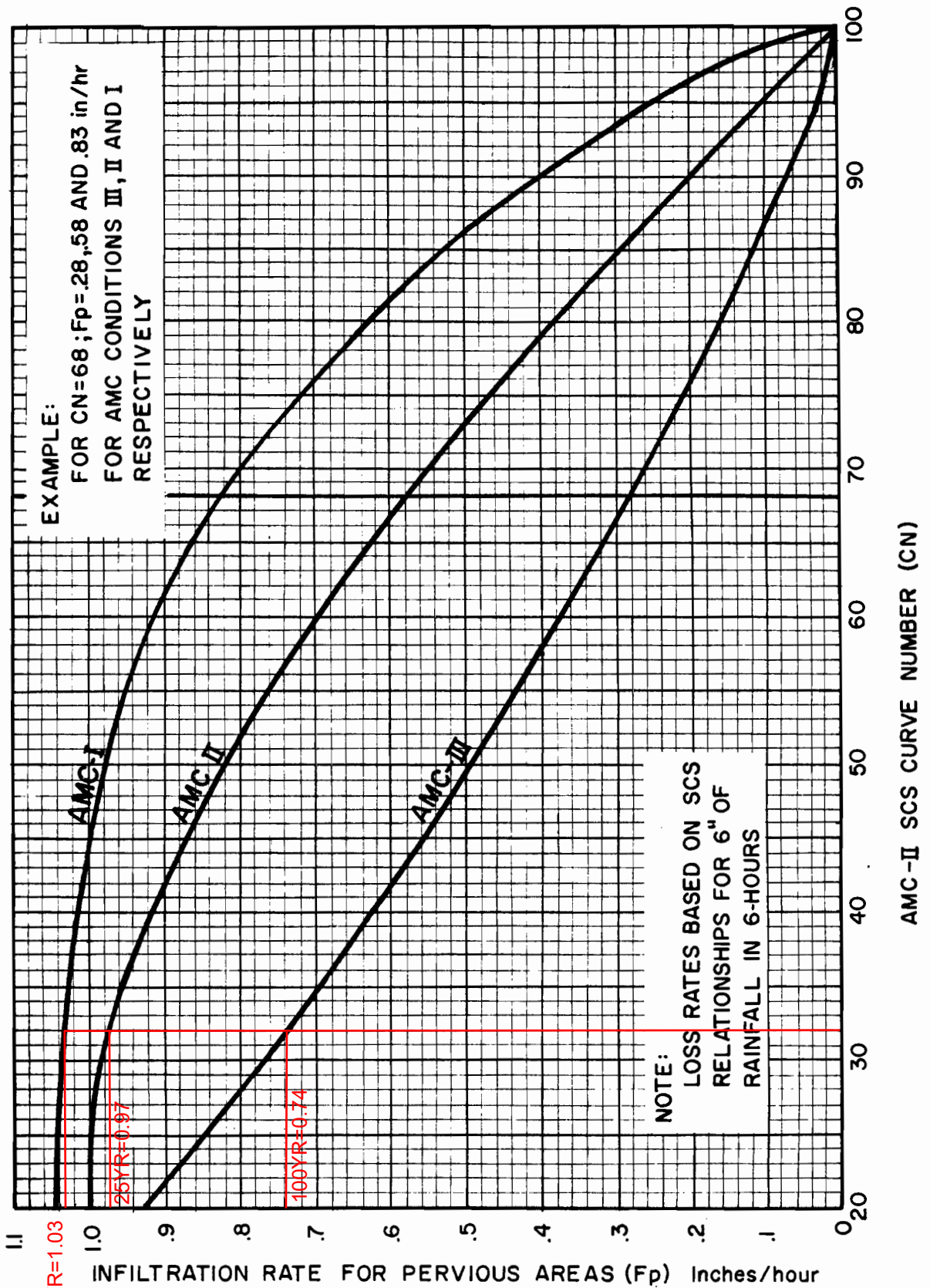
DA1
 TC=5.5
 STORM DURATION (MINUTES)

DESIGN STORM FREQUENCY = 100 YEARS
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POST-DEVELOPED

SAN BERNARDINO COUNTY
 HYDROLOGY MANUAL

**INTENSITY - DURATION
 CURVES
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**SAN BERNARDINO COUNTY
 HYDROLOGY MANUAL**

**INFILTRATION RATE FOR
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	Fair	44	65	77	82
	Good	33	58	72	79
<u>AGRICULTURAL COVERS -</u>					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

**CURVE NUMBERS
FOR
PERVIOUS AREAS**

APPENDIX C



NOAA Atlas 14, Volume 6, Version 2
Location name: Rialto, California, USA*
Latitude: 34.0844°, Longitude: -117.3785°
Elevation: 1143.3 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	0.118 (0.098-0.143)	0.153 (0.127-0.185)	0.199 (0.165-0.242)	0.237 (0.195-0.291)	0.290 (0.230-0.369)	0.331 (0.258-0.430)	0.374 (0.283-0.498)	0.419 (0.308-0.574)	0.481 (0.340-0.689)	0.531 (0.362-0.787)
10-min	0.169 (0.141-0.205)	0.219 (0.182-0.266)	0.285 (0.236-0.347)	0.340 (0.280-0.417)	0.416 (0.330-0.528)	0.475 (0.369-0.617)	0.536 (0.406-0.714)	0.600 (0.442-0.823)	0.690 (0.487-0.987)	0.761 (0.518-1.13)
15-min	0.204 (0.170-0.248)	0.265 (0.220-0.321)	0.345 (0.286-0.420)	0.411 (0.338-0.505)	0.503 (0.399-0.639)	0.574 (0.447-0.746)	0.648 (0.491-0.863)	0.726 (0.535-0.995)	0.834 (0.589-1.19)	0.920 (0.627-1.37)
30-min	0.303 (0.252-0.367)	0.393 (0.327-0.477)	0.512 (0.424-0.623)	0.610 (0.502-0.749)	0.746 (0.593-0.948)	0.852 (0.663-1.11)	0.962 (0.729-1.28)	1.08 (0.794-1.48)	1.24 (0.873-1.77)	1.37 (0.930-2.03)
60-min	0.437 (0.364-0.530)	0.566 (0.471-0.687)	0.737 (0.612-0.898)	0.879 (0.723-1.08)	1.08 (0.854-1.37)	1.23 (0.955-1.60)	1.39 (1.05-1.85)	1.55 (1.14-2.13)	1.78 (1.26-2.55)	1.97 (1.34-2.92)
2-hr	0.636 (0.530-0.772)	0.818 (0.681-0.994)	1.06 (0.877-1.29)	1.25 (1.03-1.54)	1.52 (1.21-1.94)	1.73 (1.35-2.25)	1.95 (1.48-2.59)	2.17 (1.60-2.98)	2.48 (1.75-3.55)	2.72 (1.85-4.03)
3-hr	0.793 (0.661-0.962)	1.02 (0.846-1.24)	1.31 (1.09-1.60)	1.55 (1.27-1.90)	1.88 (1.49-2.39)	2.13 (1.66-2.77)	2.39 (1.81-3.18)	2.66 (1.96-3.65)	3.03 (2.14-4.33)	3.32 (2.26-4.92)
6-hr	1.12 (0.935-1.36)	1.44 (1.20-1.75)	1.85 (1.53-2.25)	2.18 (1.80-2.68)	2.64 (2.10-3.35)	2.98 (2.32-3.88)	3.34 (2.53-4.45)	3.70 (2.73-5.08)	4.20 (2.96-6.01)	4.59 (3.13-6.80)
12-hr	1.51 (1.25-1.83)	1.93 (1.61-2.35)	2.49 (2.06-3.03)	2.93 (2.41-3.60)	3.53 (2.81-4.49)	3.99 (3.10-5.19)	4.45 (3.38-5.93)	4.93 (3.63-6.76)	5.57 (3.93-7.97)	6.07 (4.13-8.99)
24-hr	2.02 (1.78-2.32)	2.61 (2.31-3.01)	3.37 (2.97-3.90)	3.98 (3.49-4.65)	4.80 (4.07-5.79)	5.43 (4.50-6.67)	6.05 (4.90-7.62)	6.69 (5.27-8.66)	7.54 (5.71-10.2)	8.20 (6.00-11.4)
2-day	2.45 (2.17-2.83)	3.23 (2.86-3.73)	4.24 (3.74-4.90)	5.06 (4.42-5.90)	6.16 (5.22-7.43)	7.01 (5.82-8.62)	7.87 (6.37-9.91)	8.75 (6.90-11.3)	9.94 (7.52-13.4)	10.9 (7.95-15.2)
3-day	2.61 (2.31-3.00)	3.49 (3.09-4.03)	4.66 (4.11-5.39)	5.62 (4.92-6.56)	6.94 (5.88-8.37)	7.97 (6.61-9.80)	9.02 (7.31-11.4)	10.1 (7.97-13.1)	11.6 (8.79-15.7)	12.8 (9.36-17.8)
4-day	2.79 (2.47-3.21)	3.77 (3.34-4.36)	5.09 (4.49-5.88)	6.17 (5.40-7.20)	7.68 (6.50-9.25)	8.86 (7.35-10.9)	10.1 (8.16-12.7)	11.3 (8.94-14.7)	13.1 (9.92-17.7)	14.5 (10.6-20.2)
7-day	3.17 (2.81-3.66)	4.33 (3.83-5.00)	5.88 (5.18-6.80)	7.16 (6.27-8.35)	8.95 (7.58-10.8)	10.4 (8.59-12.7)	11.8 (9.57-14.9)	13.3 (10.5-17.3)	15.5 (11.7-20.9)	17.2 (12.6-24.0)
10-day	3.45 (3.05-3.97)	4.73 (4.18-5.46)	6.44 (5.68-7.46)	7.87 (6.89-9.18)	9.86 (8.35-11.9)	11.4 (9.49-14.1)	13.1 (10.6-16.5)	14.8 (11.7-19.2)	17.2 (13.0-23.2)	19.1 (14.0-26.7)
20-day	4.18 (3.70-4.82)	5.79 (5.12-6.68)	7.95 (7.01-9.19)	9.76 (8.54-11.4)	12.3 (10.4-14.8)	14.3 (11.9-17.6)	16.4 (13.3-20.7)	18.7 (14.7-24.2)	21.8 (16.5-29.5)	24.4 (17.8-34.0)
30-day	4.94 (4.38-5.70)	6.86 (6.06-7.91)	9.44 (8.33-10.9)	11.6 (10.2-13.6)	14.7 (12.4-17.7)	17.1 (14.2-21.1)	19.7 (16.0-24.8)	22.5 (17.7-29.1)	26.4 (20.0-35.6)	29.5 (21.6-41.2)
45-day	5.88 (5.21-6.78)	8.14 (7.20-9.39)	11.2 (9.88-13.0)	13.8 (12.1-16.1)	17.4 (14.8-21.0)	20.4 (16.9-25.0)	23.5 (19.0-29.5)	26.8 (21.1-34.7)	31.5 (23.8-42.5)	35.4 (25.9-49.4)
60-day	6.86 (6.07-7.90)	9.43 (8.34-10.9)	12.9 (11.4-15.0)	15.9 (13.9-18.5)	20.1 (17.0-24.2)	23.4 (19.5-28.8)	27.0 (21.9-34.0)	30.9 (24.3-39.9)	36.3 (27.5-49.0)	40.8 (29.9-57.0)

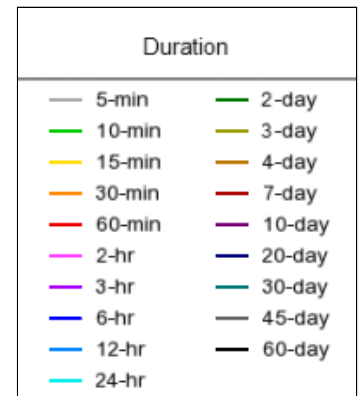
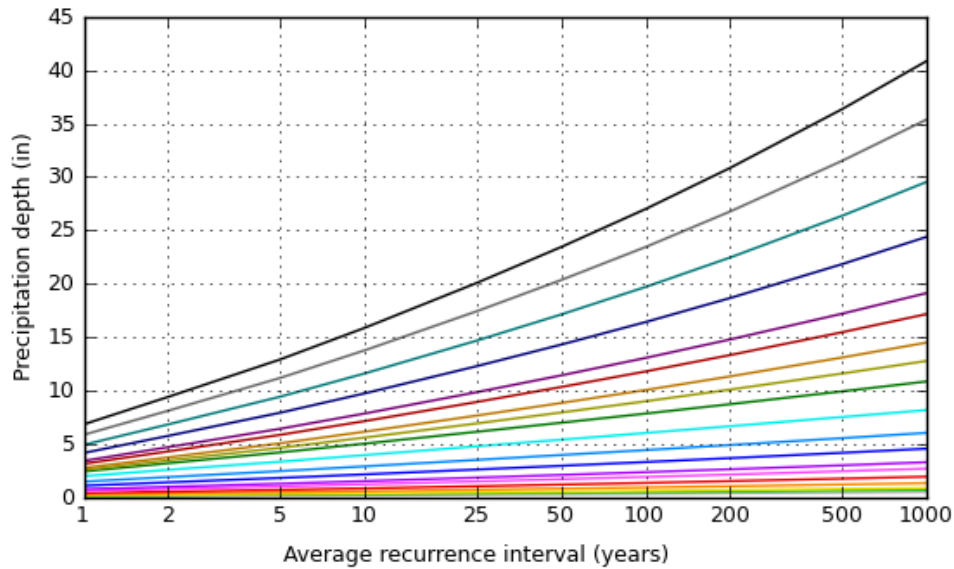
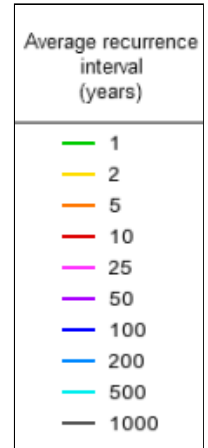
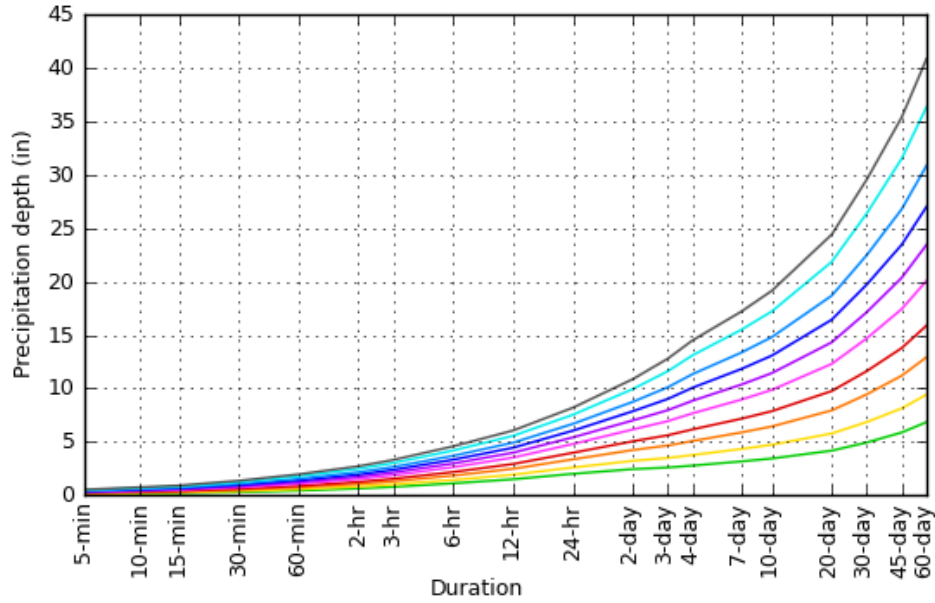
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average 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

PDS-based depth-duration-frequency (DDF) curves

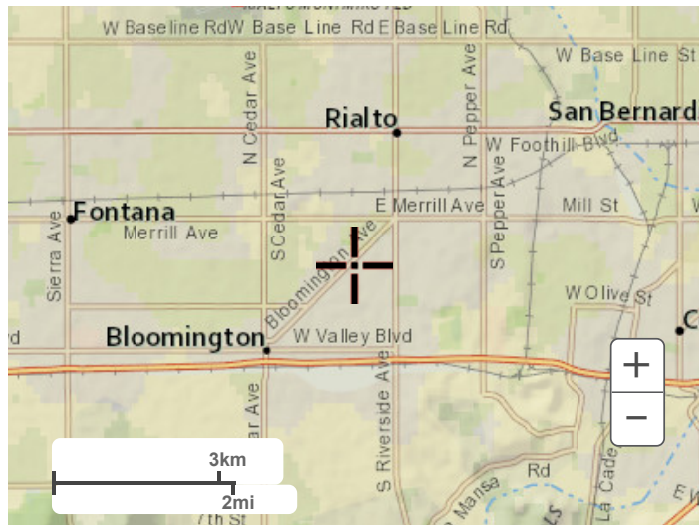
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Maps & aerials

Small scale terrain



Large scale terrain



Large scale map



Large scale aerial

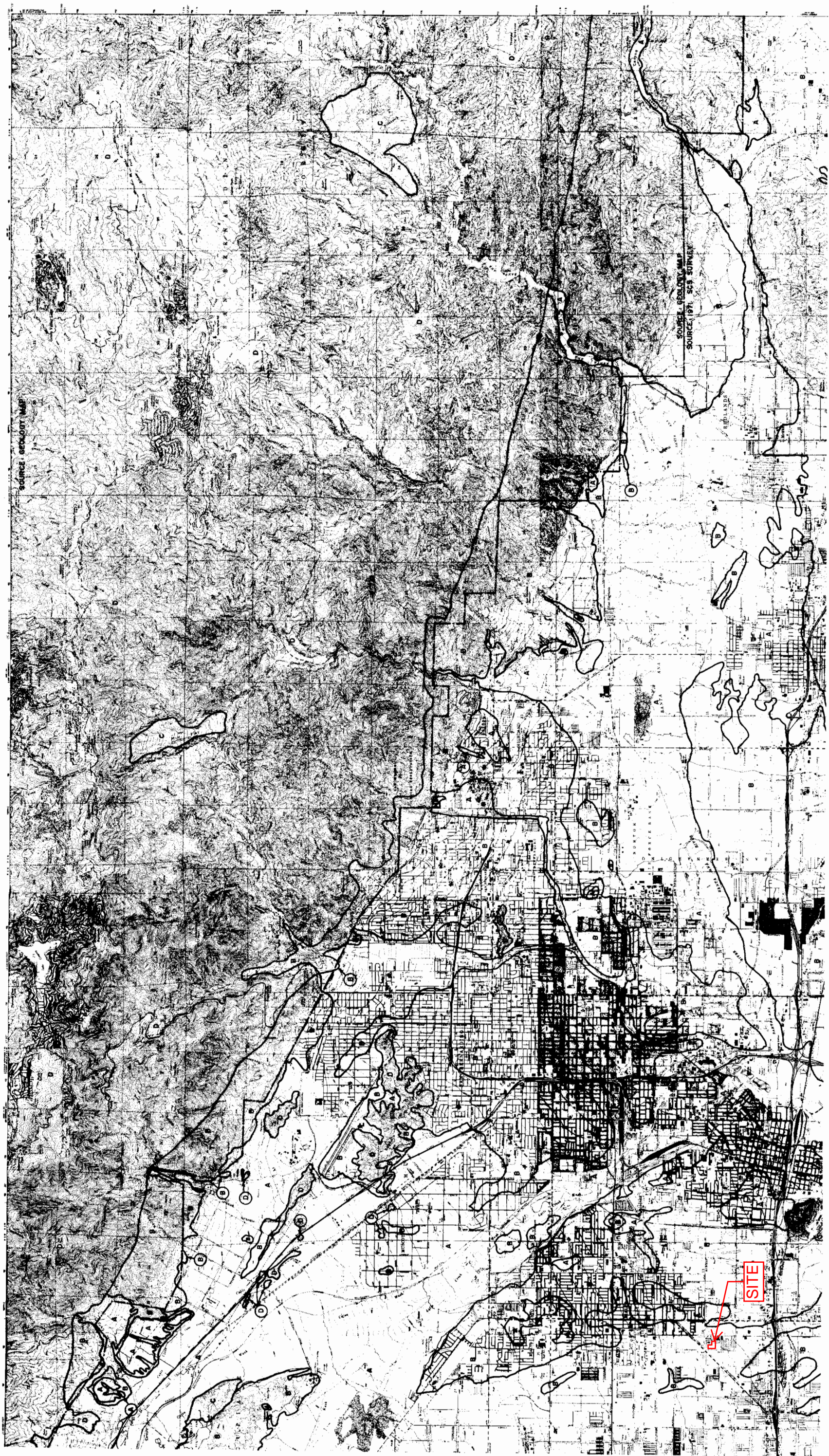


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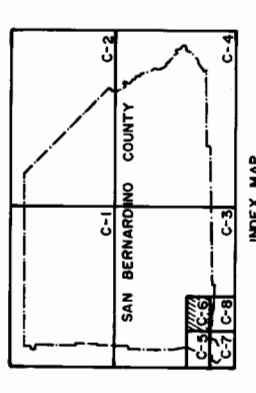
APPENDIX D



SCALE 1:48,000

SCALE REDUCED BY 1/2

LEGEND
 SOIL GROUP BOUNDARY
 SOIL GROUP DESIGNATION
 BOUNDARY OF INDICATED SOURCE



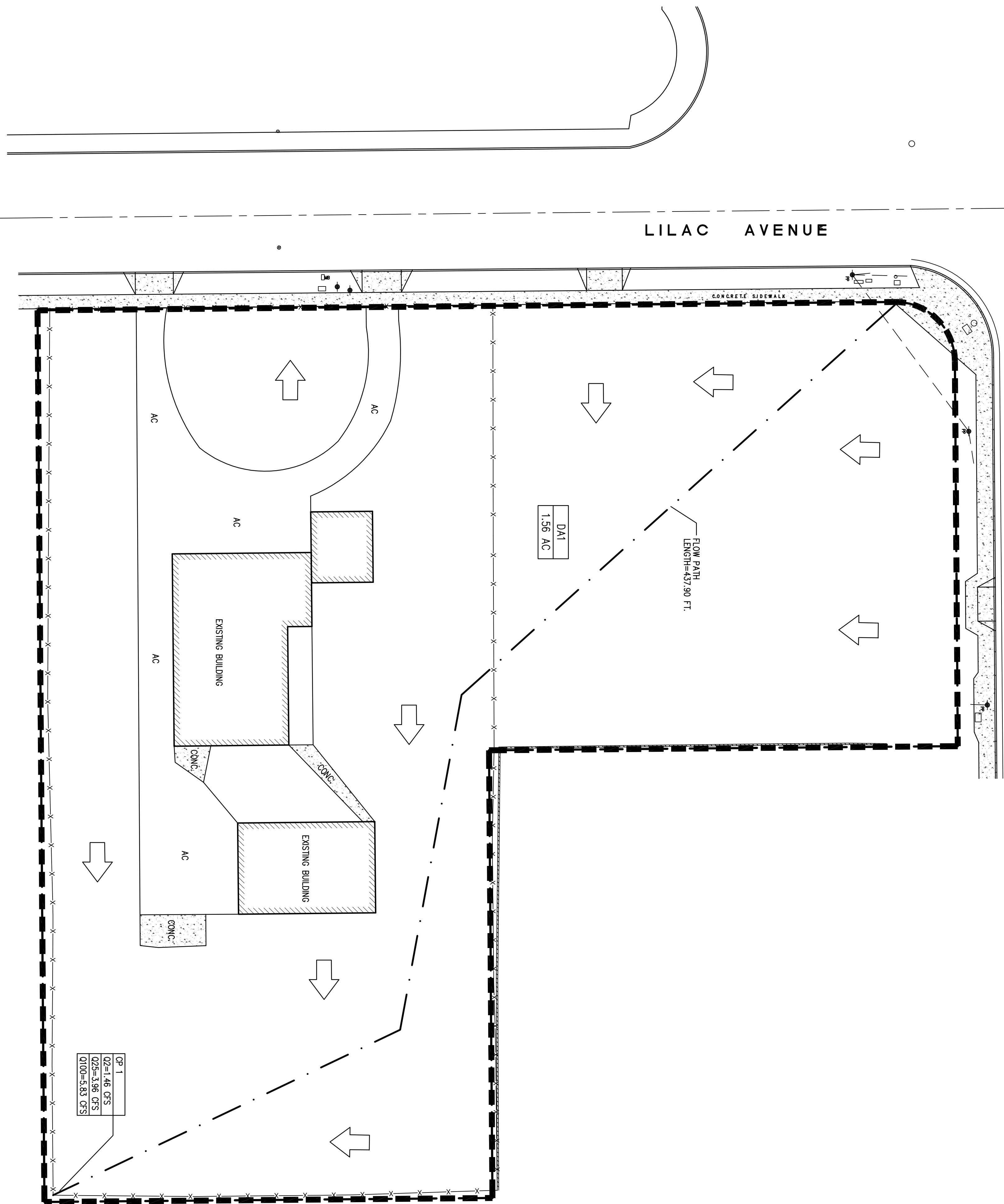
SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

HYDROLOGIC SOILS GROUP MAP
FOR
SOUTHWEST - B AREA

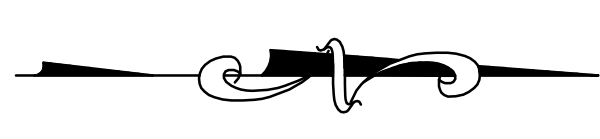
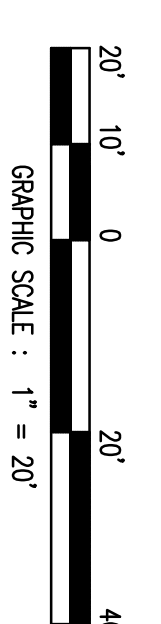
APPENDIX E

W RANDALL AVENUE

LILAC AVENUE



GP 1	Q2=1.46 CFS
	Q25=3.96 CFS
	Q100=5.83 CFS

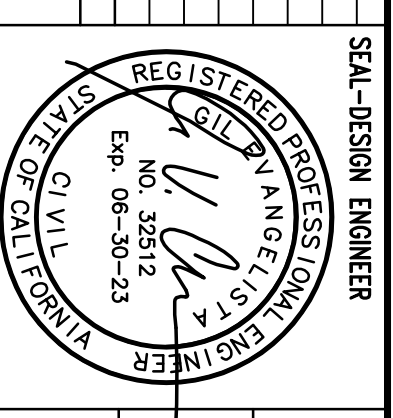


LEGEND

- DRAINAGE FLOW
- CATCHMENT BOUNDARY
- AREA X**
XXXXAC
- CATCHMENT ID
AREA, IN ACRES
- GP
- XXX
- XXX
- XXX
- CONTROL POINT ID
2 YR. FLOW, IN CFS
25 YR. FLOW, IN CFS
100 YR. FLOW, IN CFS

UNDERGROUND SERVICE ALERT
CALL TOLL FREE 1-800-277-2800
TWO WORKING DAYS BEFORE YOU DIG

DESIGNED BY: JR	DRAWN BY: RR	CHECKED BY: GE
REVISIONS		
MARK	APPR. DATE	



PREPARED UNDER THE SUPERVISION OF:
 THE ENGINEER: REC 32512, EXP. 06/30/2023
 RECOMMENDED FOR APPROVAL BY LOCKWOOD ENGINEERING:
 CALETON W. LOCKWOOD, JR., REC 45835
 APPROVED BY:
 ROBERT G. EISEBRECHT, PUBLIC WORKS DIRECTOR/CITY ENGINEER, REC 54031

E&A ENGINEERS
 ENGINEERING • PLANNING
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 Tel: (909) 598-5045 Fax: (909) 598-8585

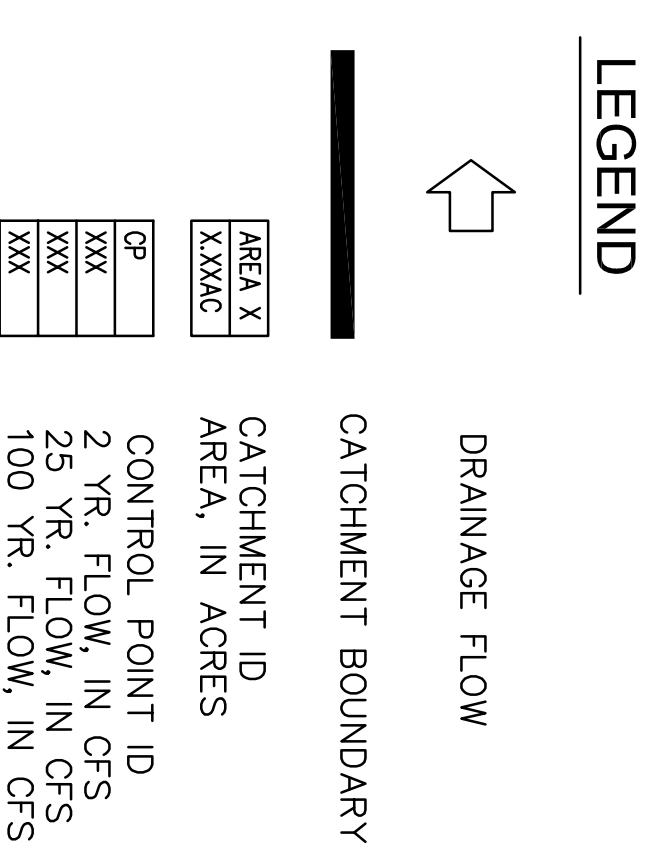
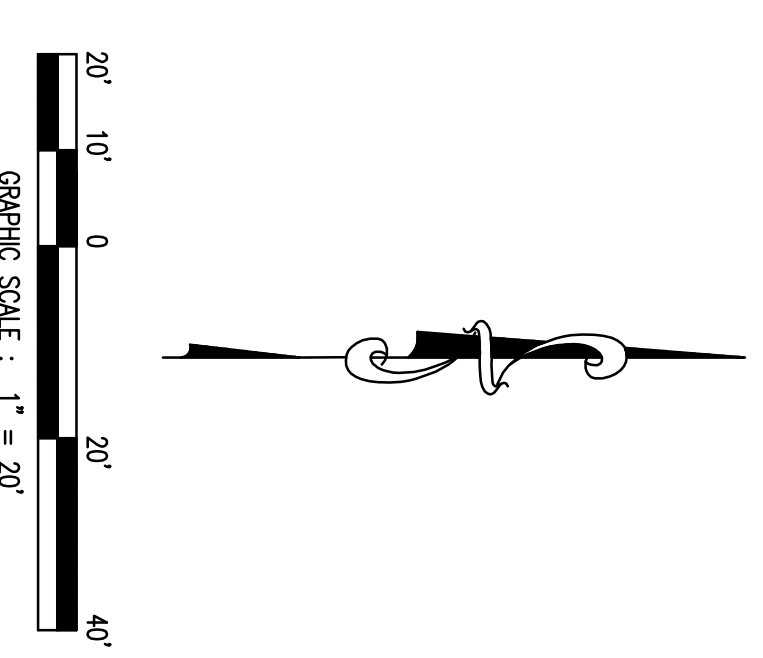
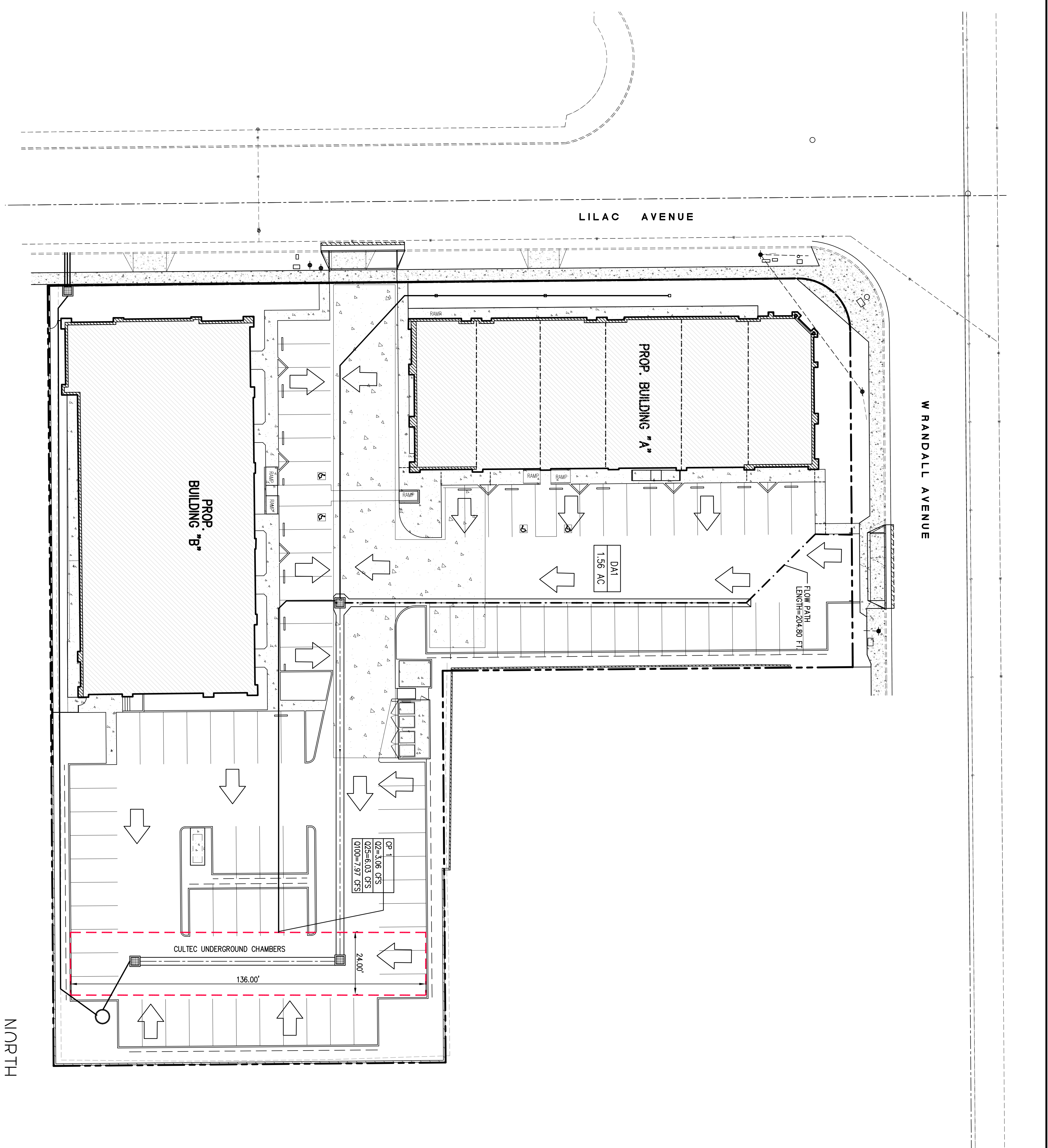
CITY OF RIALTO
 PROPOSED COMMERCIAL BUILDING
 HYDROLOGY MAP PRE DEVELOPED
 935 S. LILAC AVENUE, CA 92376

FOR: MR. GENORC MARTIROSIAN

PPD No. 2021-_____ PLAN No. _____

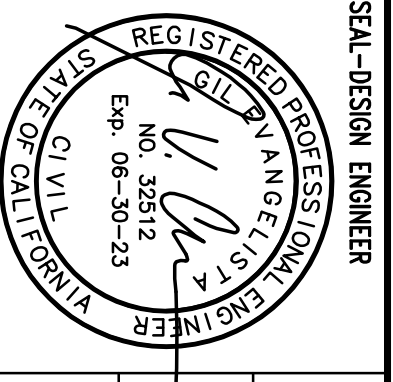
1
 of 1 SHEETS

APPENDIX F



UNDERGROUND SERVICE ALERT
 CALL TOLL FREE
 1-800-277-2800
 TWO WORKING DAYS BEFORE YOU DIG

DESIGNED BY: JR	DRAWN BY: RR	CHECKED BY: GE
REVISIONS		
MARK	APPR. DATE	



PREPARED UNDER THE SUPERVISION OF:
 THE ENGINEER: REC 32812, EXP. 06/30/2023
 RECOMMENDED FOR APPROVAL BY LOCKWOOD ENGINEERING:
 CALETON W. LOCKWOOD, JR., REC 45835
 APPROVED BY:
 ROBERT G. EISENBERG, PUBLIC WORKS DIRECTOR/CITY ENGINEER, REC 54031

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CITY OF RIALTO
 PROPOSED COMMERCIAL BUILDING
 PRELIMINARY GRADING PLAN
 935 S. LILAC AVENUE, CA 92376
 HYDROLOGY MAP POST DEVELOPED

FOR: MR. GENOK MARTIROSIAN

PPD No. 2021-____ PLAN No. ____

1 of 1 SHEETS

APPENDIX G

PIPE SIZE CALCULATIONS:

On-site storm drainage pipes will be sized for 25 year frequency storm. The Qs are derived from the Rational Method from the San Bernardino Hydrology Manual. Pipes are sized to flow in an open flow condition.

$$Q_{max} = \frac{k'}{n} d^{8/3} S^{1/2} \text{ per King's Handbook}$$

$k'=0.463$; d =pipe diameter (ft)

$n=0.013$
 $S=0.005$

Pipe Diameter	Max Q (cfs)
8"	0.866
12"	2.518
15"	4.566
18"	7.425
24"	15.99
36"	47.15

$n=0.013$
 $S=0.010$

Pipe Diameter	Max Q (cfs)
8"	1.224
12"	3.561
15"	6.457
18"	10.5
24"	22.61
36"	66.67

APPENDIX H

25 Year Volume Calculation:

Pre-Developed	CN	S	la	Y	Area Fraction	P24(25yr)
DA1 Pervious	38	16.32	3.26	0.028	0.841	4.8
DA1 Impervious	98	0.204	0.041	0.951	0.159	4.8

DA1 Pervious

$$S=(1000/CN)-10 = (1000/38)-10 = 16.32$$

$$la=0.2S = 0.2 \times 16.32 = 3.26$$

$$Y=(P24-la)^2/(P24-la+S) \times P24$$

$$=(4.8-3.26)^2/(4.8-3.26+16.32) \times 4.8$$

$$=0.028$$

DA1 Impervious

$$S=(1000/CN)-10 = (1000/98)-10 = 0.204$$

$$la=0.2S = 0.2 \times 0.204 = 0.041$$

$$Y=(P24-la)^2/(P24-la+S) \times P24$$

$$=(4.8-0.041)^2/(4.8-0.041+0.204) \times 4.8$$

$$=0.951$$

$$\bar{Y}=(0.028 \times 0.841)+(0.951 \times 0.159) = 0.175$$

Volume

$$V=4.8 \times 0.175 \times 1.56 \times 43560 \times 1/12$$

$$V(\text{pre})=4,675.21 \text{ cf}$$

25 Year Volume Calculation:

Post-Developed	CN	S	la	Y	Area Fraction	P24(25yr)
DA1 Pervious	32	21.25	4.25	0.003	0.163	4.8
DA1 Impervious	98	0.204	0.041	0.951	0.837	4.8

DA1 Pervious

$$S=(1000/CN)-10 = (1000/32)-10 = 21.25$$

$$la=0.2S = 0.2 \times 21.25 = 4.25$$

$$Y=(P24-la)^2/(P24-la+S) \times P24$$

$$=(4.8-4.25)^2/(4.8-4.25+21.25) \times 4.8$$

$$=0.003$$

DA1 Impervious

$$S=(1000/CN)-10 = (1000/98)-10 = 0.204$$

$$la=0.2S = 0.2 \times 0.204 = 0.041$$

$$Y=(P24-la)^2/(P24-la+S) \times P24$$

$$=(4.8-0.041)^2/(4.8-0.041+0.204) \times 4.8$$

$$=0.951$$

$$\bar{Y}=(0.003 \times 0.134)+(0.951 \times 0.866) = 0.796$$

Volume

$$V=4.8 \times 0.796 \times 1.56 \times 43560 \times 1/12$$

$$V(\text{post})=21,636.43 \text{ cf}$$