CUBIT ENGINEERING

LAND SURVEYING | CIVIL ENGINEERING | CONSTRUCTION

Drainage Study

PRELIMINARY APPROVED
By Osvaldo Roque at 3:13 pm, Jan 15, 2019
Additional comments can be addressed in the final submittal

*Address comments in final report.

For:

George Wanis

9128 Green Rd.
Pinon Hills, CA 92397

Impacting a 3.01 Acre Development

Located On:

NW Corner of Beekley Rd & HWY 138
Pinon Hills CA 92372
San Bernardino County

APN: 3066-191-04

REGISTERED PROFESSIONAL ENGINEER
TIMOTHY ALAN STARK
12/14/18
C76523
CIVIL
STATE OF CALIFORNIA

Job No. 2016.0225

December 4, 2018

Purpose:

This report is to provide a drainage study based on the San Bernardino County guidelines for a proposed Commercial Development. The owner of APN 3066-191-04 has applied to build a Fuel Station with Convenience store impacting 1.65 acres of the approximately 3.01 acres parcel. The purpose of this study is to determine whether this site is impacted by off-site drainage flows, and what measures are necessary to protect the development from these flows. Additionally, this study will determine the expected on-site flows produced because of the proposed development.

Site Description

The total property area is approximately 3.01 acres and is located on the NW corner of Beekley Rd. and HWY 138 in the unincorporated community of Pinon Hills, San Bernardino CA. The fully developed site will be composed of directly connected and non-directly connected impervious areas that will drain into an onsite storm water detention or retention system before it leaves the project site. The impervious area will be composed of the structures, driveway, walkways, and parking spaces. Some of this area may drain onto pervious areas such as landscaped planters or bare earth. Runoff from these pervious areas will not enter the storm water retention system until they become saturated.

A review of the NOAA 14 Point Precipitation Point Frequency data for the 2-year, 10-year, 25-year and 100-year storms is as follow:

2-year 24hr Storm (inches):	1.71
10-year 24hr Storm (inches):	3.01
25-year 24hr Storm (inches):	3.83
100-year 24hr Storm (inches):	5.10

Already assumed. See Antecedent moisture content in hydrology manual.

... that will capture the full difference in post development runoff volume.

The topographical data that was obtained for the site plan shows that this site slopes to the north at a grade of 6% to 8% with a drop off of the very north east corner of the property down to Beekley Rd.

Research Data:

A review of the Phelan Quad Map, portion attached, finds there is a drainage course that flows near the site although it by-passes the site to the east flowing north east away from the site in a natural drainage facility. There appears to be no impact to the subject project.

A review of FEMA Firm 06071C64500H found the project site was located within a Zone X overlay. (see attached map)

Explain that any other tributary drainage is intercepted by State Hwy 138 and does not impact site.

Use USDA websoils survey, see attached addendum.

Based on the San Bernardino County Drainage Manual Hydraulic Soils Group map, Figure C-11 the hydrologic soils group for this site is identified as Soil Group C. See attached Figure C-11.

Field Review:

A field review was performed to determine the extent of the drainage area that impacts this site. This review found that the site is not impacted from off-site drainage. The site is relatively flat and slopes to the north with sparse vegetation. The development proposed on the southernmost 1.65 acres of the property remains on the most elevated portion of the property. Current flows within the road right of way appears to remain contained therein due to ac dike and or roadway ditch that carry water by the project. Additional improvements from development of this project will enhance protections from potential storm water generated on the roadways. Beekley Rd. is at such a grade that little impact can be expected and likewise improvements on HWY 138 will direct roadway flows away from the project.

Can use this to explain why off-site drainage is not analyzed and does not impact site.

Runoff Calculations:

The following are the results of the pre-developed and post-developed on-site drainage contribution. Results determined based on the San Bernardino County Hydrology Manual. Peak Runoff analysis is a comparison of the 100yr 1hr for pre-and post-conditions using the Rational Method. Results of a Rational Method analysis shows a post developed TC of 15.1 minutes. See attached Calculation Sheet "A".

	2yr24hr Storm (cf)	10yr24hr Storm (cf)	100yr24hr Storm (cf)	Time of Concentration (min)	Peak Runoff (cfs)
Pre	4,250	22,791	61,298	13.1	10.6
Post	6,332	22,107	58,798	15.1	8.7
Increase	1,924	-684	-2,411	2.0	-1.9

On-Site Retention:

To determine the amount of run-off generated by the development of this site, analysis for the existing and developed conditions for four different storm events. These four events are for 2yr24hr, 10yr24hr, 25yr24hr, and 100yr24hr and show a maximum increase in runoff occurs in the 2yr24hr storm event with a total increase in runoff of 1,924 cubic feet. This volume will be captured by an infiltration basin as designated on the site grading plan. The total capacity of the basins must be greater than 1,924 cf. As designed, the basin will overflow and drain to the existing conditions when capacity is reached.

Mitigation:

The proposed project will include construction of a proposed commercial development including built parking, landscape, curb, gutters, ribbon gutters and design grades to direct

Specify basin detail including retention volume, dimensions, features, etc.

flows from storm water to on-site infiltration basin. Preliminary calculations determined that the on-site peak runoff for a 100-year 1-hour storm would not be increased over pre-developed conditions. It is proposed that retention be provided by above ground retention ponds as shown on the site grading plan in order to mitigate flow and reduce volume by a minimum of 1,924 cubic feet.

Conclusion:

This site can be developed as proposed with the mitigation measures stated above and meet the on-site drainage requirements of the County of San Bernardino.

Timothy A. Stark, PE 76523

This report was preliminarily approved on the following findings:
**Curve numbers and associated soil loss rates are determined using conservative HSG.
**Proposed retention of ΔV_{100} for mitigation.
**Proposed retention basin dimensions seem to retain larger volume than recommended.

CALCULATION SHEET "A"

(All calculations from S.B. County Hydrology Manual)

SITE INFORMATION

DRAINAGE AREA COVERAGE

	Pre		Post	
	S.F.	%	S.F.	%
Imperv.	0	0.0%	44,152	33.6%
Landscpd	0	0.0%	27,760	21.1%
Native	131,454	100.0%	59,542	45.3%
Total	131,454		131,454	

PRECIPITATION DATA, NOAA (INCHES)

2yr-24hr	1.17
10yr-24hr	3.01
25yr-24hr	3.83
100yr-24hr	5.10
2yr-1hr	0.274
10yr-1hr	0.704
25yr-1hr	0.914
100yr-1hr	1.270

SOILS INFORMATION, WSS

Desert	Region
C	Soils Group
Barren	Native Land Cover Type

Verify, USDA websoils survey indicates HSG A

98 Assumed for all AMC

CURVE NUMBERS, Cn

HSG C	AMC I	AMC II	AMC III
Imperv.	95	98	100
Landscpd	50	69	86
Native	80	91	98

Verify, Cn for residential landscaping is 32 for AMC II, HSG A. Modify Cn for AMC I and III.

Barren natural cover seems inappropriate. Vegetation visible on site.

CALCULATION SHEET "A"

(All calculations from S.B. County Hydrology Manual)

(1000/Cn)-10

VOLUME OF RUNOFF (CF)

RUNOFF FRACTION YIELD (Y)

S = 1000/Cn-1 Ia = 0.2 X S Y = (P24 - Ia)^2 / (P24 - Ia + S) (P24)

2 YEAR - 24 HOUR STORM

Land Cover	P24 (Inches)	Cn	S	Ia	Y
Impervious	1.17	94.8	0.55	0.11	0.60
Landscaped	1.17	49.8	10.08	2.02	0.07
Native	1.17	79.8	2.53	0.51	0.12

UnDeveloped			Developed		
Y	% Coverage	(Y) By Cover	Y	% Coverage	(Y) By Cover
0.60	0%	0.00	0.60	0.34	0.20
0.07	0%	0.00	0.07	0.21	0.01
0.12	100%	0.12	0.12	0.45	0.05
UnDev Combined (Y)		**0.12**	Dev Combined (Y)		**0.27**

See comments on page 5

10 YEAR - 24 HOUR STORM

Land Cover	P24 (Inches)	Cn	S	Ia	Y
Impervious	3.01	98.0	0.20	0.04	0.92
Landscaped	3.01	69.0	4.49	0.90	0.22
Native	3.01	91.0	0.99	0.20	0.69

UnDeveloped			Developed		
Y	% Coverage	(Y) By Cover	Y	% Coverage	(Y) By Cover
0.92	0%	0.00	0.92	0.34	0.31
0.22	0%	0.00	0.22	0.21	0.05
0.69	100%	0.69	0.69	0.45	0.31
UnDev Combined (Y)		**0.69**	Dev Combined (Y)		**0.67**

CALCULATION SHEET "A"

(All calculations from S.B. County Hydrology Manual)

(1000/Cn)-10

VOLUME OF RUNOFF (CF)

RUNOFF FRACTION YIELD (Y)

S = 1000/Cn-1 Ia = 0.2 X S Y = (P24 - Ia)^2 / (P24 - Ia + S) (P24)

25 YEAR - 24 HOUR STORM

Land Cover	P24 (Inches)	Cn	S	Ia	Y
Impervious	3.83	98.0	0.20	0.04	0.94
Landscaped	3.83	69.0	4.49	0.90	0.30
Native	3.83	91.0	0.99	0.20	0.75

UnDeveloped			Developed		
Y	% Coverage	(Y) By Cover	Y	% Coverage	(Y) By Cover
0.94	0%	0%	0.94	0.34	0.32
0.30	0%	0%	0.30	0.21	0.06
0.75	100%	75%	0.75	0.45	0.34
UnDev Combined (Y)		**0.75**	Dev Combined (Y)		**0.72**

100 YEAR - 24 HOUR STORM

See comments on page 5

Land Cover	P24 (Inches)	Cn	S	Ia	Y
Impervious	5.10	99.6	0.04	0.01	0.99
Landscaped	5.10	86.2	1.60	0.32	0.70
Native	5.10	98.2	0.18	0.04	0.96

UnDeveloped			Developed		
Y	% Coverage	(Y) By Cover	Y	% Coverage	(Y) By Cover
0.99	0%	0%	0.99	0.34	0.33
0.70	0%	0%	0.70	0.21	0.15
0.96	100%	96%	0.96	0.45	0.43
UnDev Combined (Y)		**0.96**	Dev Combined (Y)		**0.91**

CALCULATION SHEET "A"

(All calculations from S.B. County Hydrology Manual)

TOTAL VOLUME RUN-OFF (CF)

Vol = Y X P24 X Area / 12

UNDEVELOPED RUN-OFF VOLUME = Y X P24 X Area / 12

	Y	P24 (Inches)	Area (Sq. Ft.)	Run-Off (Cu. Ft.)
2 Year	0.12	1.17	131,454	1,510
10 Year	0.69	3.01	131,454	22,791
25 Year	0.75	3.83	131,454	31,273
100 Year	0.96	5.10	131,454	53,529

DEVELOPED RUN-OFF VOLUME = Y X P24 X Area / 12

	Y	P24 (Inches)	Area (Sq. Ft.)	Run-Off (Cu. Ft.)
2 Year	0.27	1.17	131,454	3,435
10 Year	0.67	3.01	131,454	22,107
25 Year	0.72	3.83	131,454	30,072
100 Year	0.91	5.10	131,454	51,117

Revise

RUN-OFF CHANGE

	2yr	10yr	25yr	100yr
Pre	1,510	22,791	31,273	53,529
Post	3,435	22,107	30,072	51,117
Increase	1,924	-684	-1,201	-2,411
			Largest Increase	**1,924**

CALCULATION SHEET "A"

(All calculations from S.B. County Hydrology Manual)

100 YEAR STORM - PEAK RUNOFF FLOW, Q (CFS)

LOSS RATE, Fm (IN/HR)

Fm = Ap X Fp, (See Plate C-6 Attached for Fp)

These are area averaged values. Perviousness was not factored in.

Fm Pre Development Area (Native)

	Fp(InfilCap)	Pre Ap (S.F. %)	Pre Fm (In/hr)
Imperv.	0.00	0.0%	0.000
Landscpd	0.59	0.0%	0.000
Native	0.18	100.0%	0.180
	Total Site PreDev Fm		0.180

See comments on page 5

Revised Fp is ok, existing assumed to be 100% pervious. $F_m=F_p x1=F_p$

ment (Impervious/Landscaped/Native)

	Fp(InfilCap)	Post Ap (S.F. %)	Post Fm (In/hr)
Imperv.	0.00	33.6%	0.000
Landscpd	0.59	21.1%	0.125
Native	0.18	45.3%	0.082
	Total Site PostDev Fm		0.206

Revise

This is not pervious factor a_p. This is the composition of land cover as percentage of total site area.

RAINFALL INTENSITY, I (IN/HR)

	I, 100yr	
PreDev	4.1	(See Plate D-3 Attached)
PostDev	3.4	(See Plate D-3 Attached)

TIME OF CONCENTRATION, Tc (MINUTES)

PreDev (min)	**13.1**	(See Plate D-1 Attached)

PostDev Tc = Tc Area 1 + Tc Area 2

PostDev Tc = 6.8 + 8.3

PostDev (min)	**15.1**	(See Plates D-1 Attached)

See comment in intensity-duration graph.

CALCULATION SHEET "A"

(All calculations from S.B. County Hydrology Manual)

100 YEAR STORM - PEAK RUNOFF FLOW, Q (CFS)

Pre Developed Q (CFS)

Q = Area X 0.9 X (I - Fm)

Q_{PreDev}= 131,454 / 43,560 X 0.9 X (4.1 - 0.180)

Q_{PreDev} = 10.6 CFS

Post Developed Q (CFS)

Q = Area X 0.9 X (I - Fm)

$Q_{PostDev1}$ = (131,454) / 43,560 X 0.9 X (3.4 - 0.206)

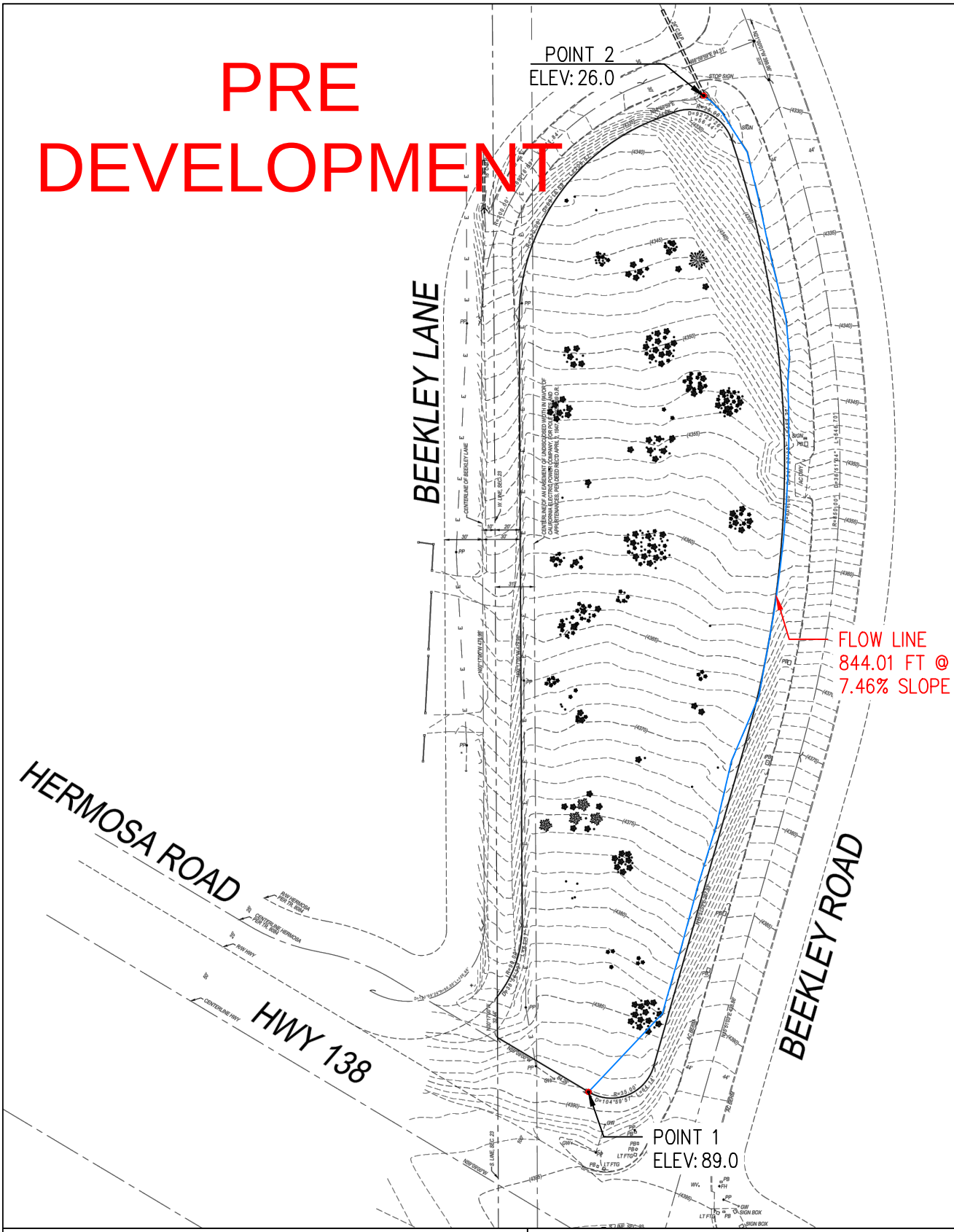
$Q_{PostDev1}$ = 8.7 CFS

Post development plan has two separate drainage areas. Follow Hydrology Manual Section D.11 for methodology on determining total site peak flow rate.

Change in Q = -1.9 CFS

The above referenced equations should **increase** the post development peak flow rate. However, the proposed site improvements will capture the full difference in storm runoff volume from pre and post development conditions. The report should make statement that no increase in peak flow rate is expected because the difference in runoff volume generated in the post development condition will be retained on site.

PRE DEVELOPMENT



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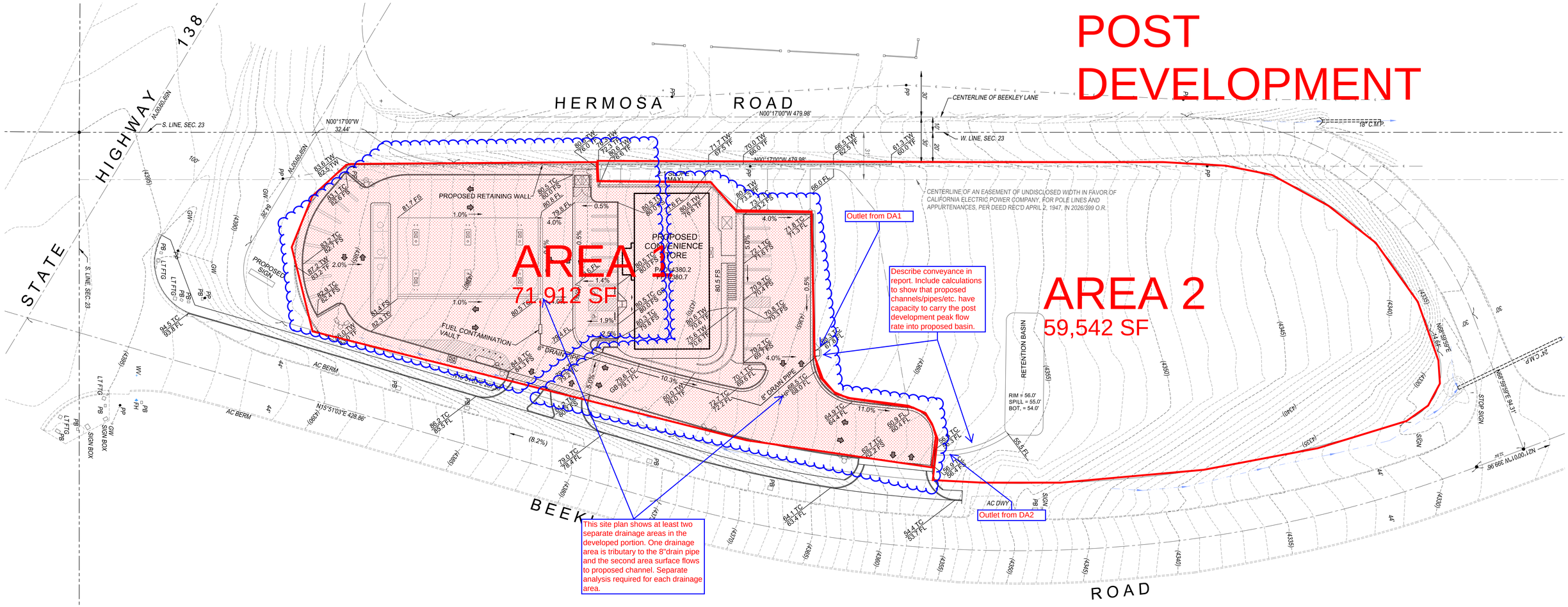
UNDEVELOPED SITE
DMA1–PRE

APN 3066–191–04

2016.0225

DMA1–PRE

POST DEVELOPMENT



OWNER:

GEORGE WANIS
9128 GREEN ROAD
PINON HILLS, CA 92372
(661) 860-0226

ARCHITECT:

STEENO DESIGN STUDIO, INC.
11774 HESPERIA ROAD #B2
HESPERIA, CA 92345
(760) 244-5001

ENGINEER:

HIGH DESERT MAPPING
16704 NEENACH ROAD
APPLE VALLEY, CA 92307
(760) 508-8555

REGISTERED PROFESSIONAL ENGINEER
RAYMOND J. ALLARD
No. 36052
Exp. 6/30/18
CIVIL
STATE OF CALIFORNIA

UTILITY SUPPLIERS:

WATER _____ SHEEP CREEK WATER
4200 SUNNYSLOPE ROAD
PHELAN, CA 92371
(760) 868-3755

SEWER _____ NONE
(SEPTIC SYSTEMS)

ELECTRIC _____ SOUTHERN CALIFORNIA EDISON
12353 HESPERIA ROAD
VICTORVILLE, CA 92392
(760) 951-3237

TELEPHONE _____ VERIZON
15055 LA PAZ DRIVE
VICTORVILLE, CA
(800) 772-5153

GAS _____ THE GAS COMPANY
CONTACT: STEVE VARGAS
(909) 335-7836

811 Know what's below. Call before you dig.

STATISTICS:

APN 3066-191-04
3.02 AC (NET)

LEGAL DESCRIPTION:

BEING A PORTION OF THE SOUTHWEST ONE-QUARTER OF SECTION 23, T4N, R7W, SBM.

BENCHMARK:

COUNTY OF SAN BERNARDINO BM

A 2" BRASS CAP FOR THE W 1/4 CORNER OF SECTION 23, LOCATED AT THE INTERSECTION OF BEEKLEY ROAD AND NIELSON ROAD, PER CSFB 4150/850

ELEVATION: 4250.85

PROJECT LOCATION

N

VICINITY MAP
NOT TO SCALE

N

30 0 15 30 60 120
(IN FEET)
1 inch = 30 ft.

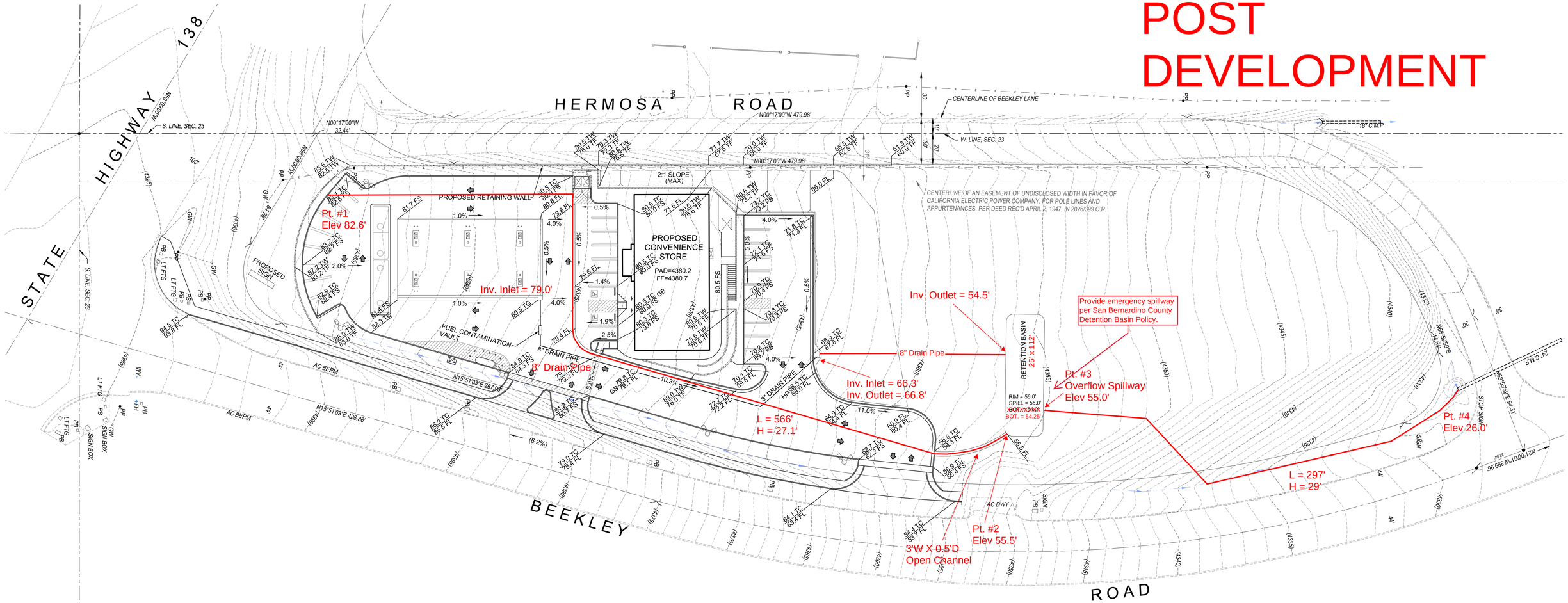
IN THE COUNTY OF SAN BERNARDINO

CONCEPTUAL GRADING PLAN

PROPOSED GAS STATION & CONVENIENCE STORE

BEEKLEY ROAD, PHELAN

POST DEVELOPMENT



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STATISTICS:

APN 3066-191-04
3.02 AC (NET)

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BEING A PORTION OF THE SOUTHWEST ONE-QUARTER OF SECTION 23, T4N, R7W, SBM.

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COUNTY OF SAN BERNARDINO BM

A 2" BRASS CAP FOR THE W 1/4 CORNER OF SECTION 23, LOCATED AT THE INTERSECTION OF BEEKLEY ROAD AND NIELSON ROAD, PER CSFB 4150/850

ELEVATION: 4250.85

N

VICINITY MAP
NOT TO SCALE

N

30 0 15 30 60 120
(IN FEET)
1 inch = 30 ft.

IN THE COUNTY OF SAN BERNARDINO

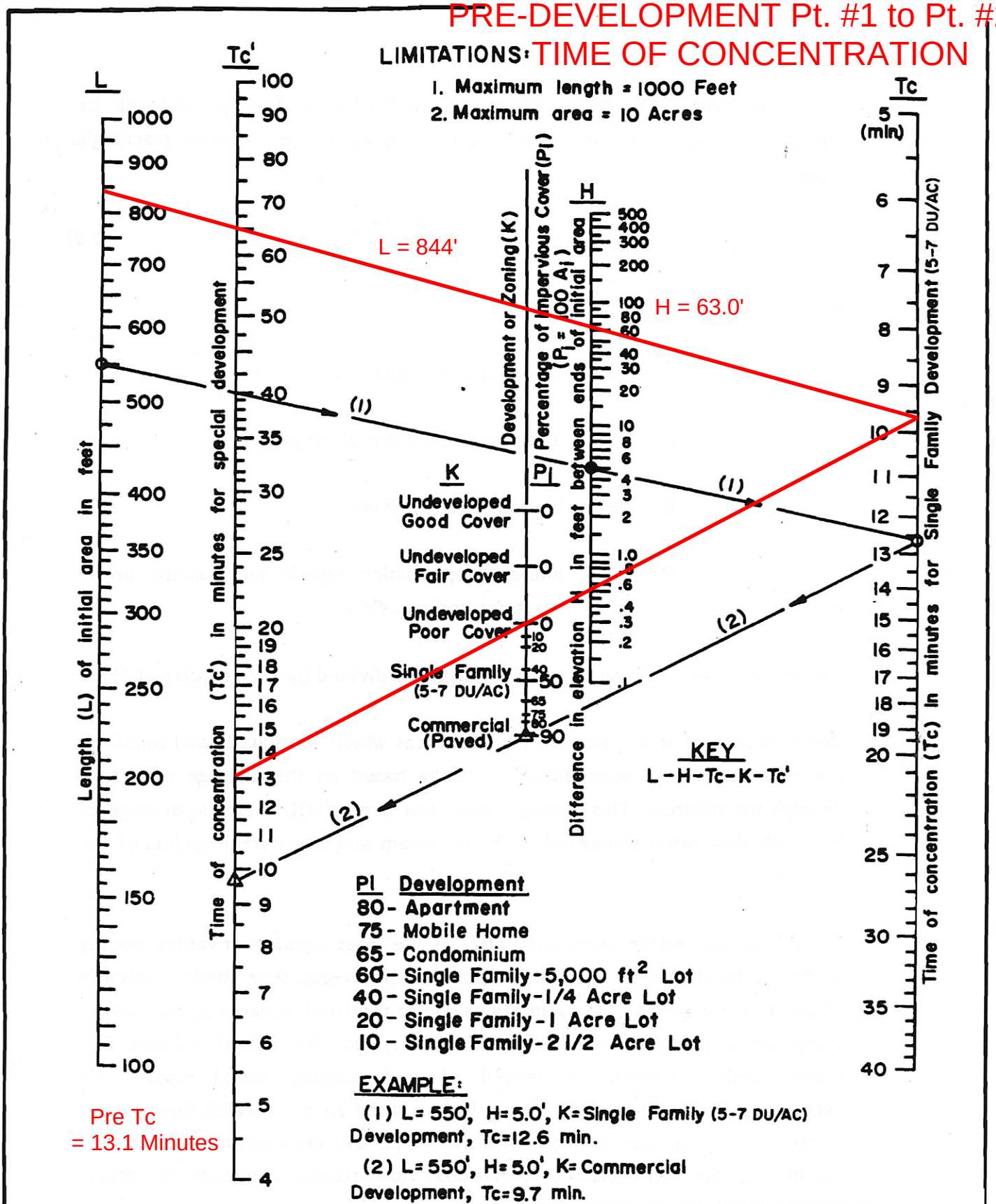
CONCEPTUAL GRADING PLAN

PROPOSED GAS STATION & CONVENIENCE STORE

BEEKLEY ROAD, PHELAN

PRE-DEVELOPMENT Pt. #1 to Pt. #2

TIME OF CONCENTRATION

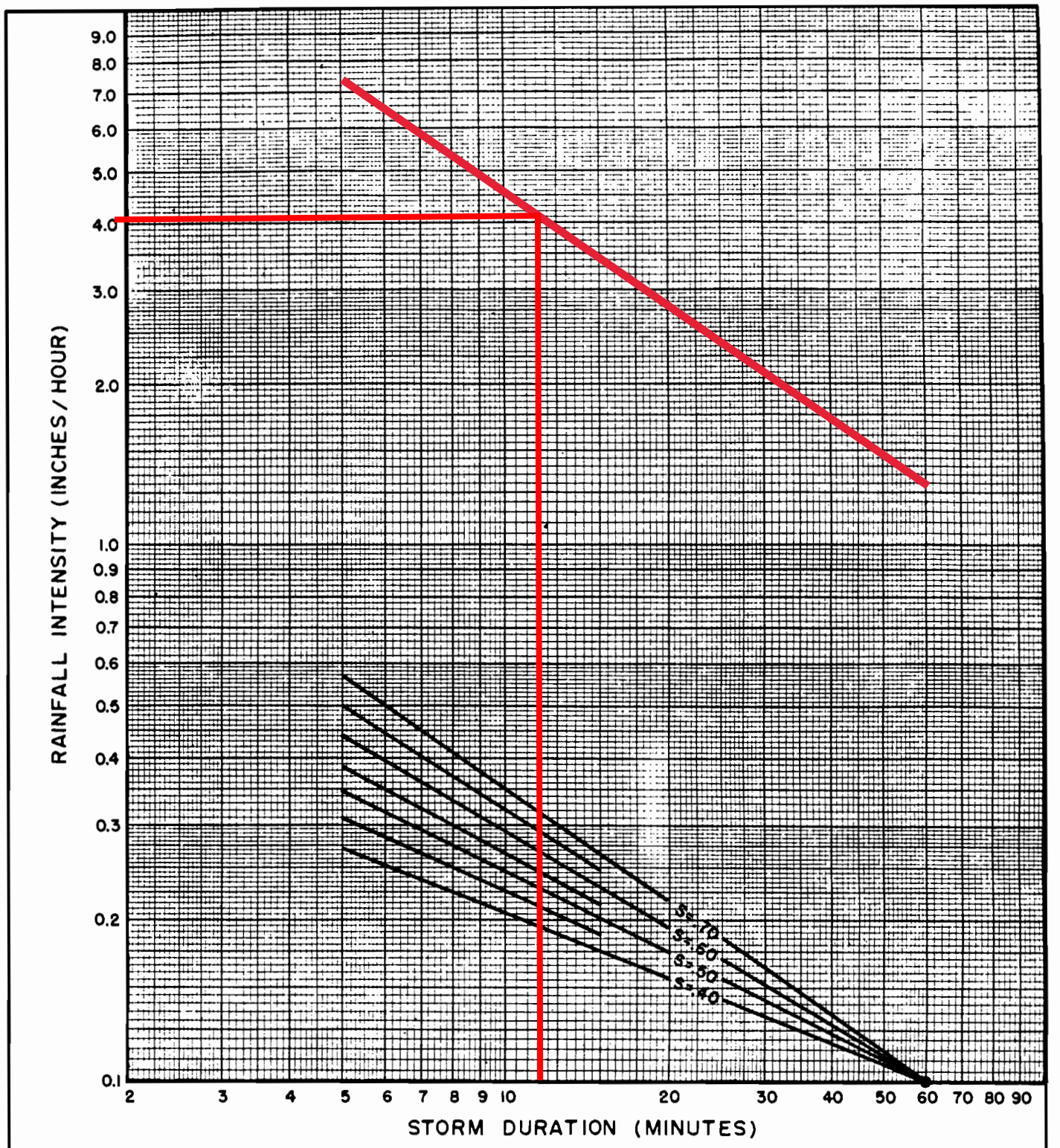


Pre Tc = 13.1 Minutes

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1



PRE-DEVELOPMENT

Design Storm Frequency = 100 year
One Hour Point Rainfall = 1.27 inches
LOG-LOG Slope = 0.7
Tc = 13.1 mins
Project Location = Apple Valley CA.

I = 4.1 in/hr

SAN BERNARDINO COUNTY

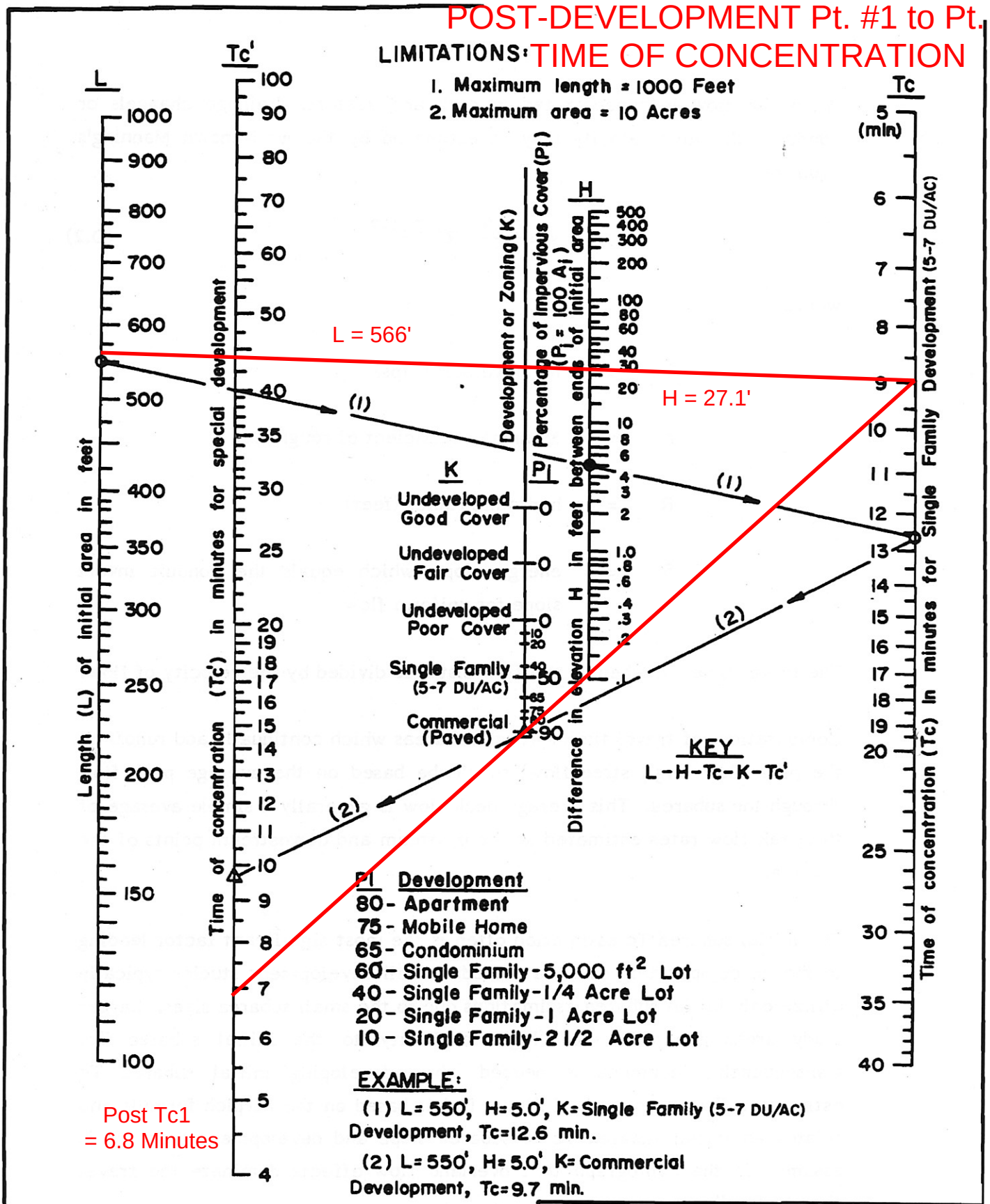
HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3

POST-DEVELOPMENT Pt. #1 to Pt. #2

TIME OF CONCENTRATION



Post Tc1 = 6.8 Minutes

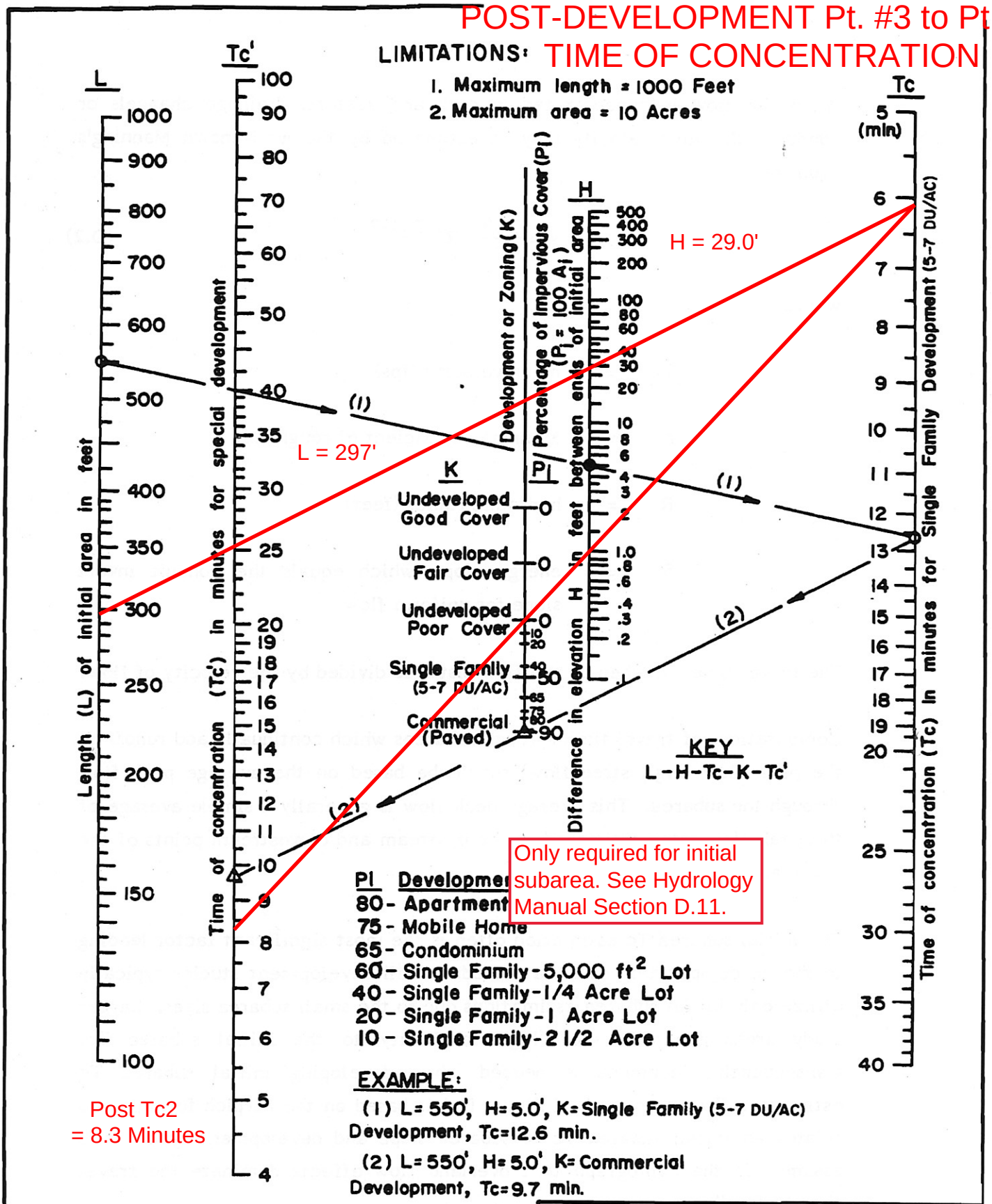
SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

POST-DEVELOPMENT Pt. #3 to Pt. #4

TIME OF CONCENTRATION



Post Tc2 = 8.3 Minutes

Only required for initial subarea. See Hydrology Manual Section D.11.

SAN ... ITY

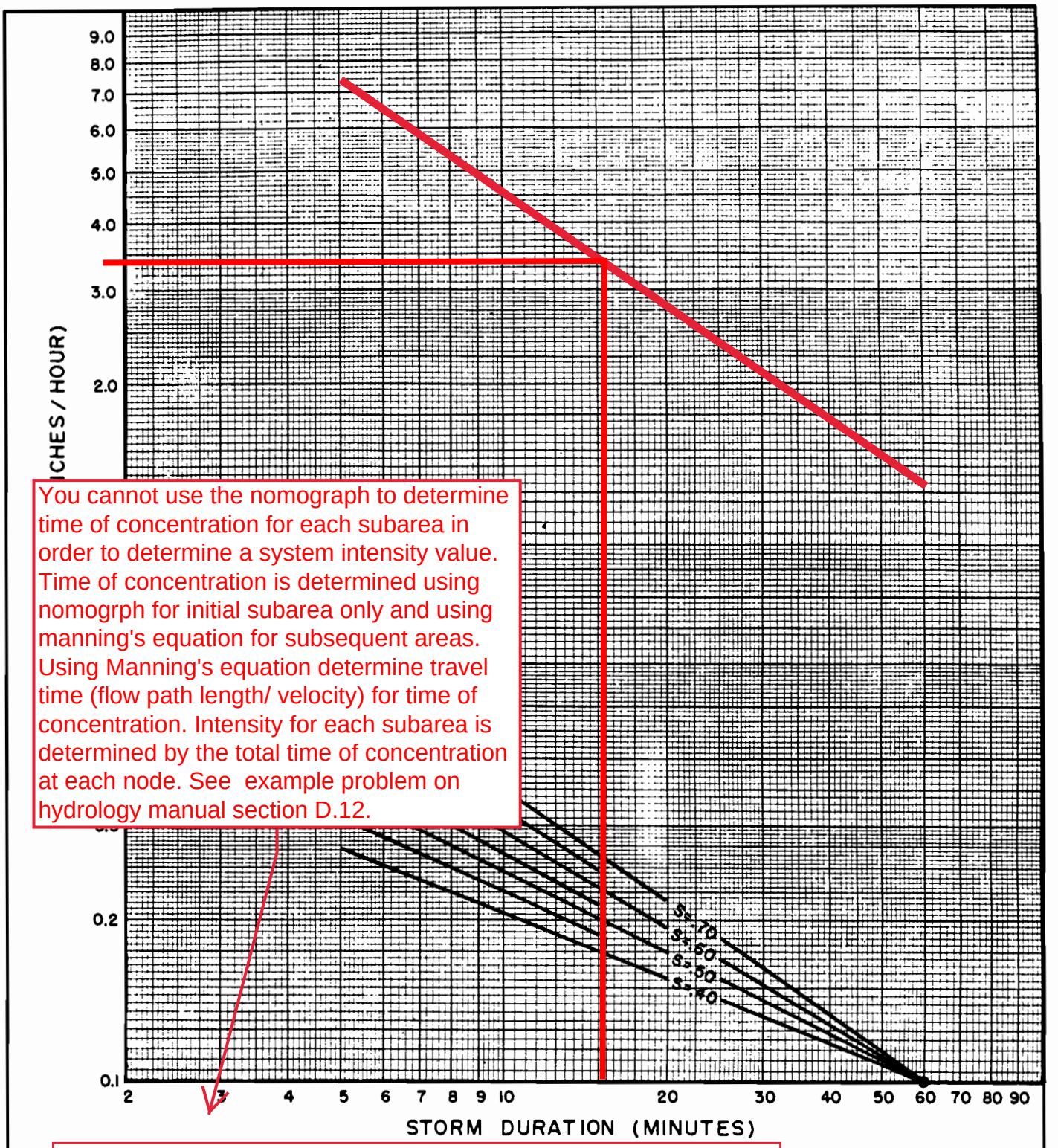
HYDR...

TIME OF CONCENTRATION NOMOGRAPH

FOR INITIAL SUBAREA

This nomograph is for initial subarea only. Follow section D.11 of hydrology manual for methodology to determine peak flow rate at different points of concentration.

Figure D-1



You cannot use the nomograph to determine time of concentration for each subarea in order to determine a system intensity value. Time of concentration is determined using nomogrph for initial subarea only and using manning's equation for subsequent areas. Using Manning's equation determine travel time (flow path length/ velocity) for time of concentration. Intensity for each subarea is determined by the total time of concentration at each node. See example problem on hydrology manual section D.12.

POST-DEVELOPMENT Design Storm Frequency = 100 yearOne Hour Point Rainfall = 1.27 inchesLOG-LOG Slope = 0.7Tc = 6.8 min + 8.3 min = 15.1 minProject Location = Pinion Hills, CA.

I = 3.4 in/hr

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

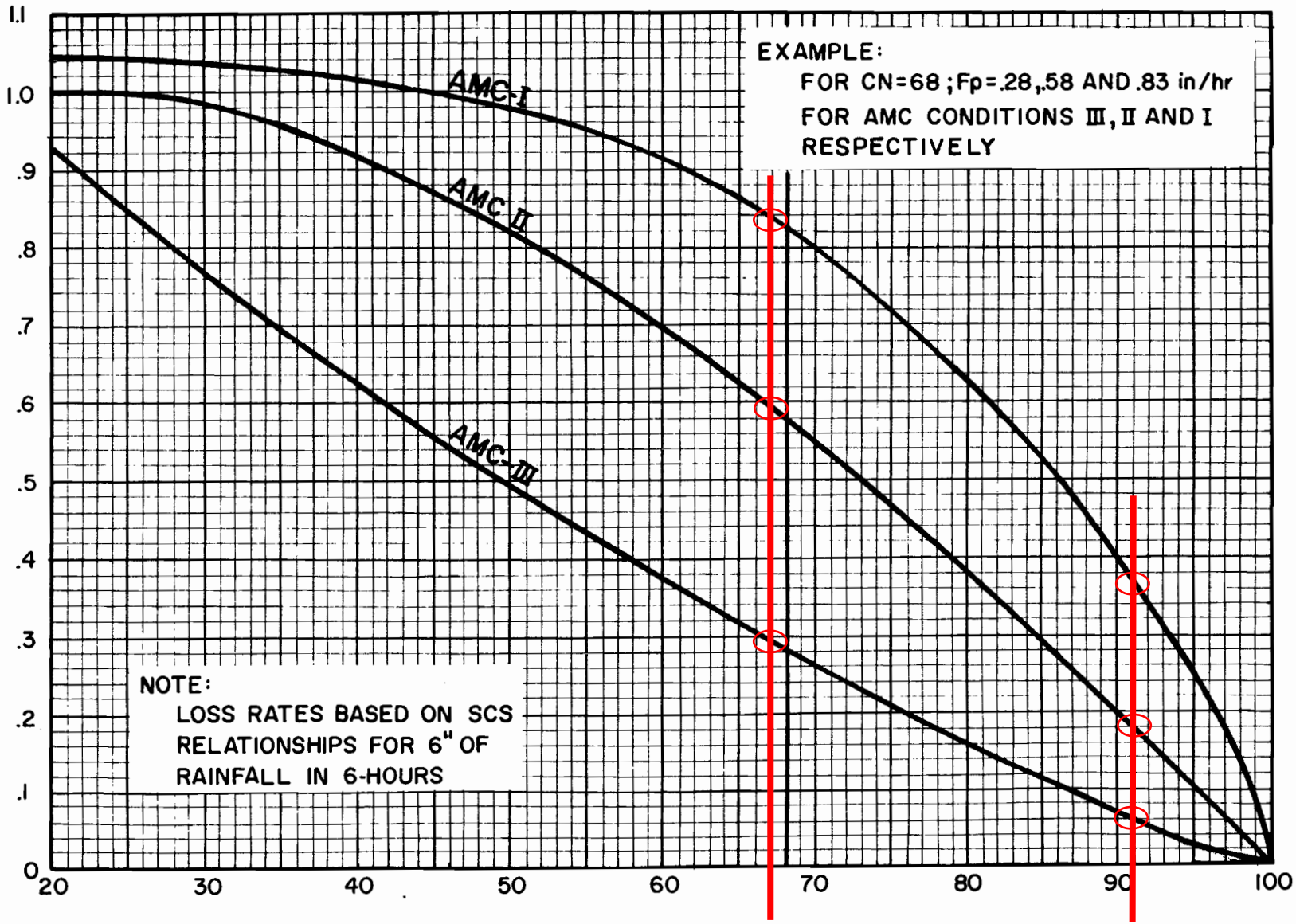
INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3

Revise for HSG A

Landscape
Fp=0.84 , I
Fp=0.59 , II
Fp=0.29 , III

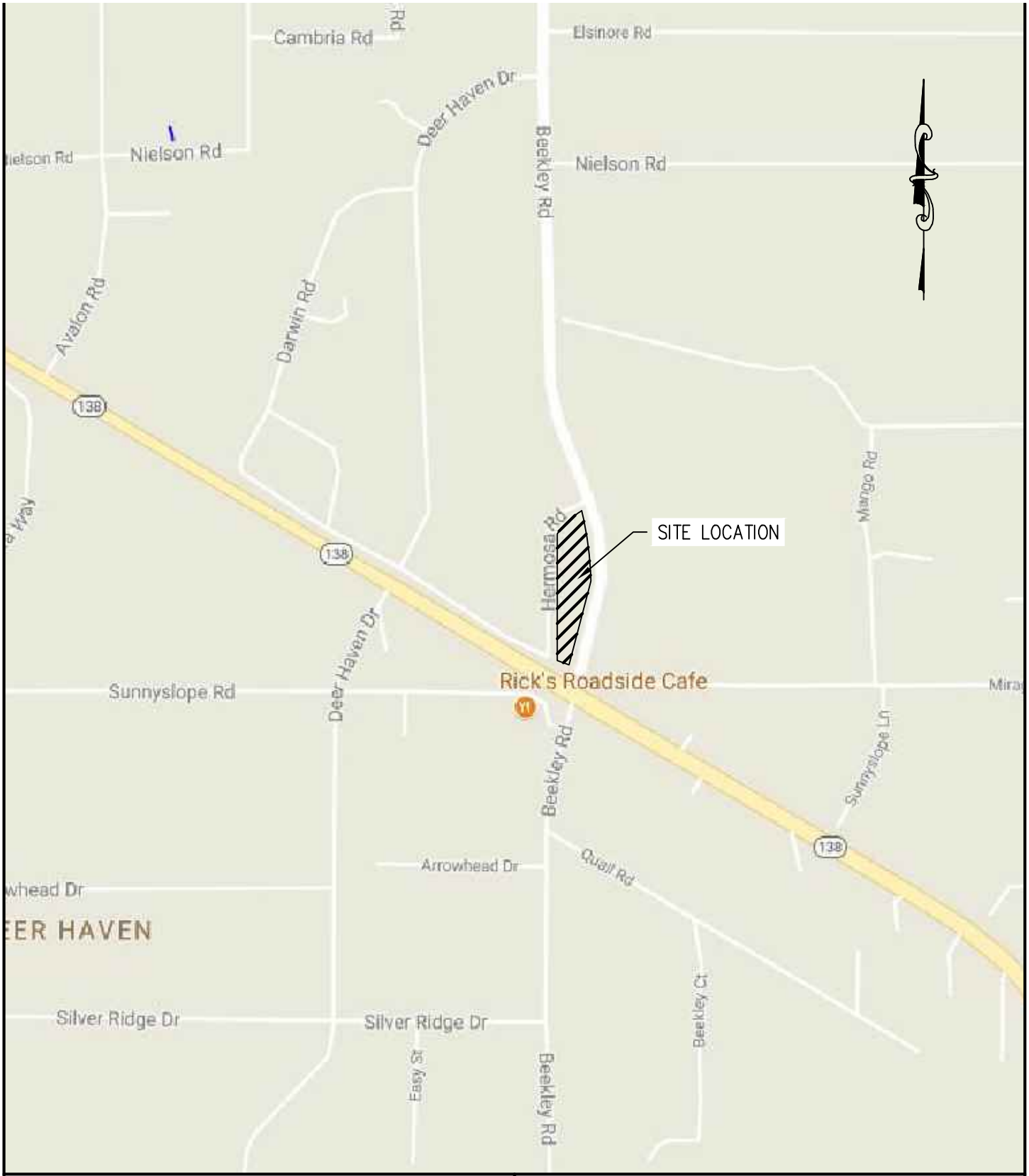
Native
Fp=0.36 , I
Fp=0.18 , II
Fp=0.06 , III



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Figure C-6



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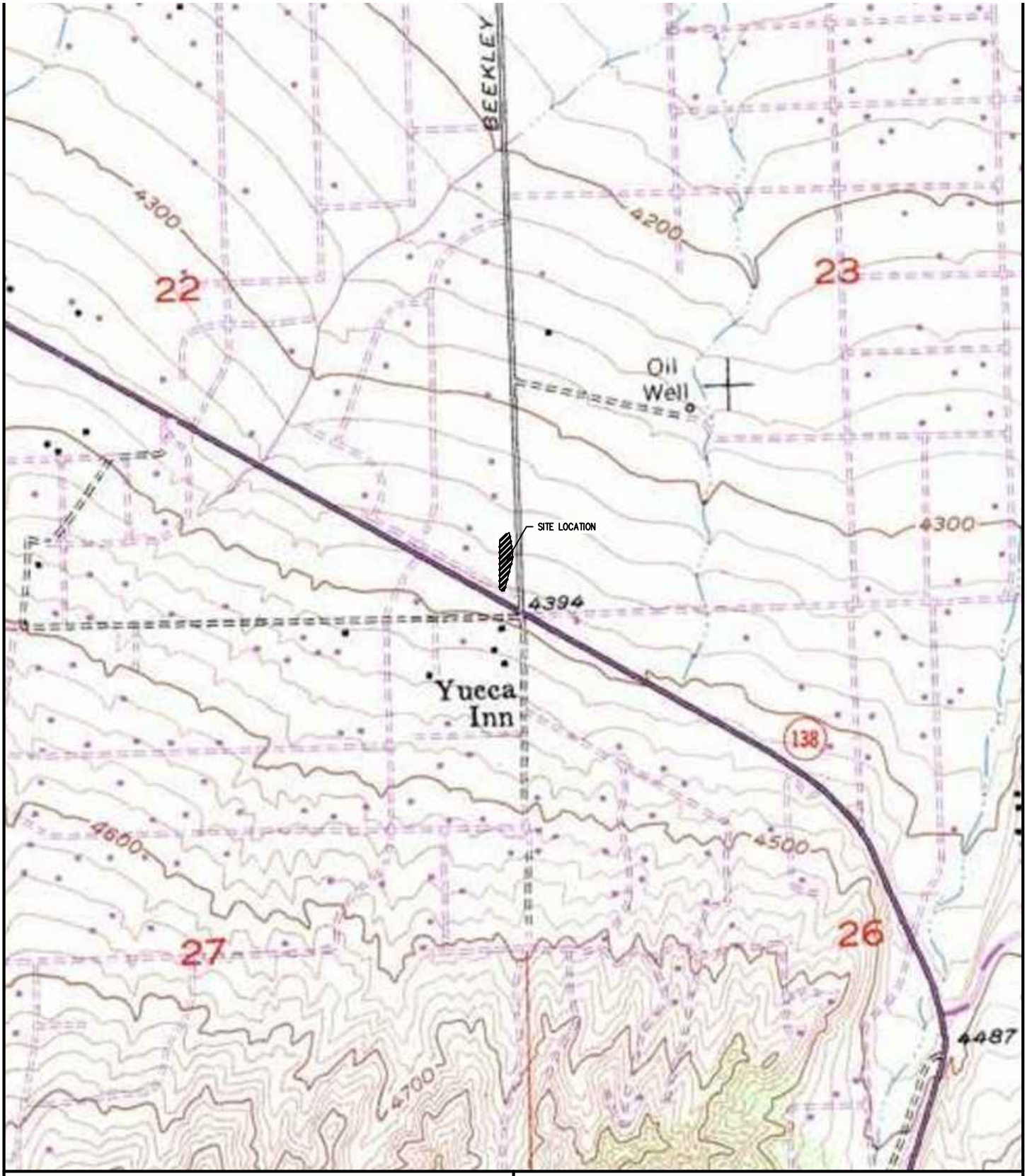
VICINITY MAP
NOT TO SCALE

APN 3066-191-04

2016.0225

MAP – 1



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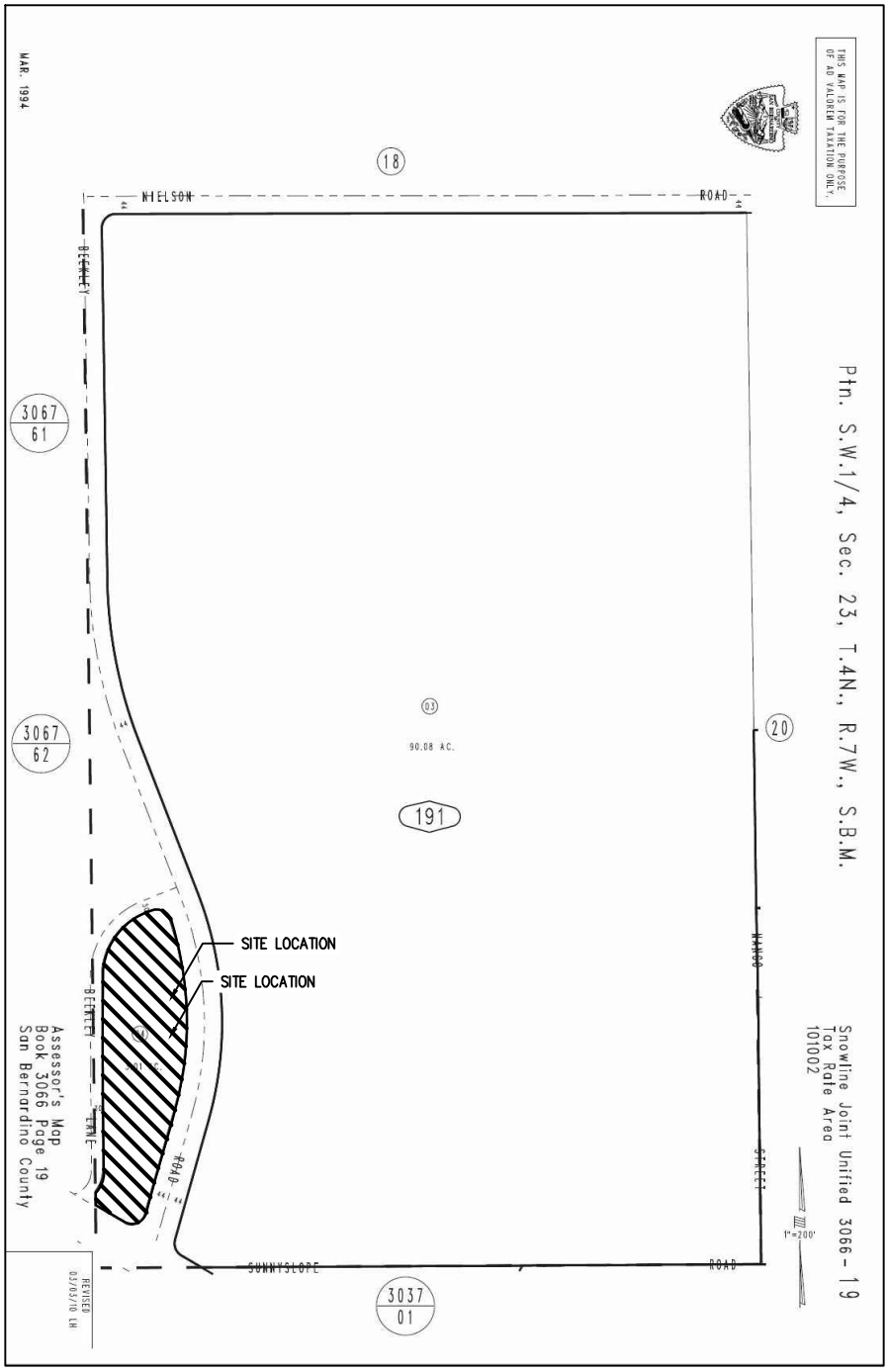
cubitengineering.com

TOPOGRAPHIC MAP
NOT TO SCALE

APN 3066-191-04

2016.0225

MAP – 2



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ASSESSOR'S MAP
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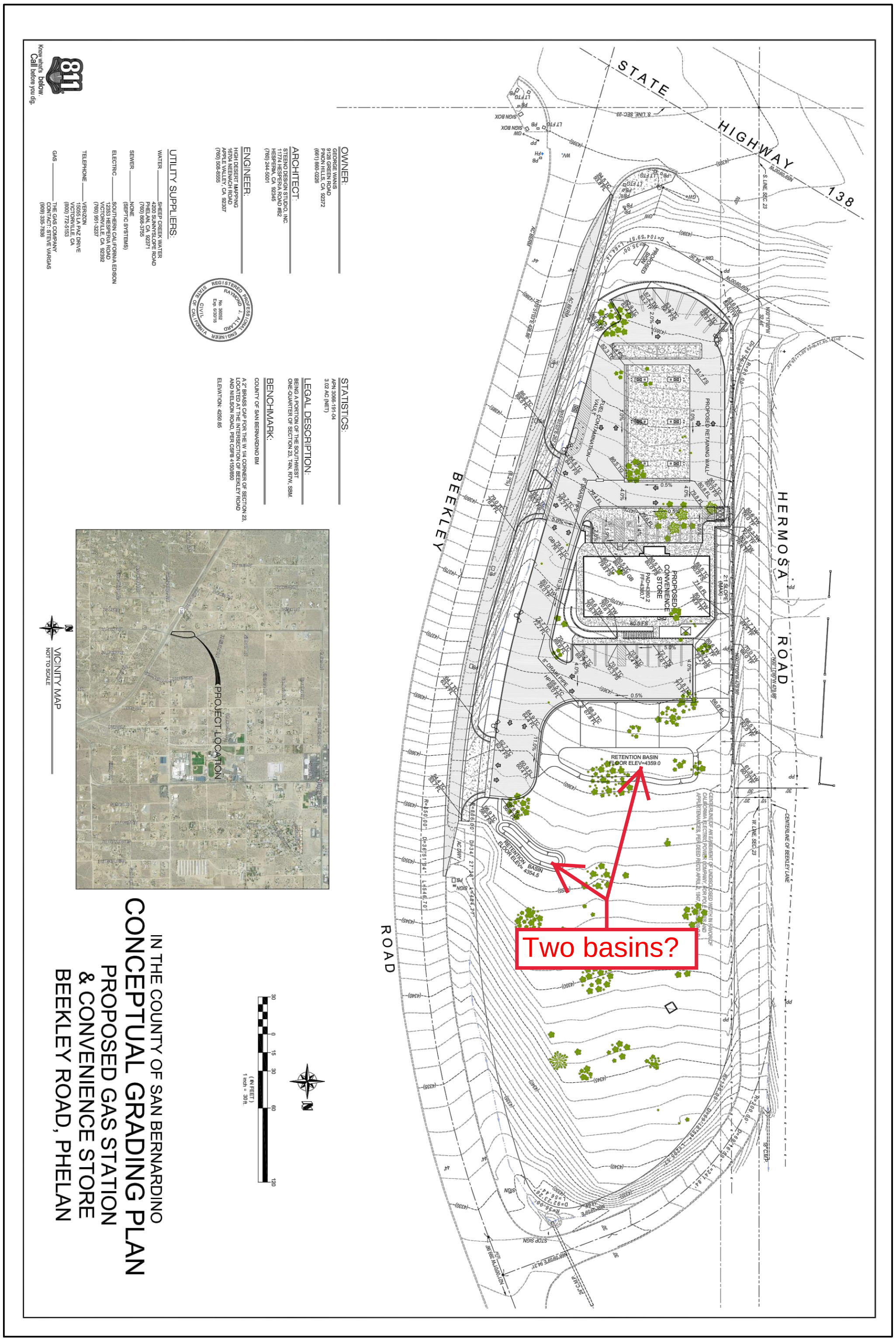
APN 3066-191-04

2016.0225

MAP - 3



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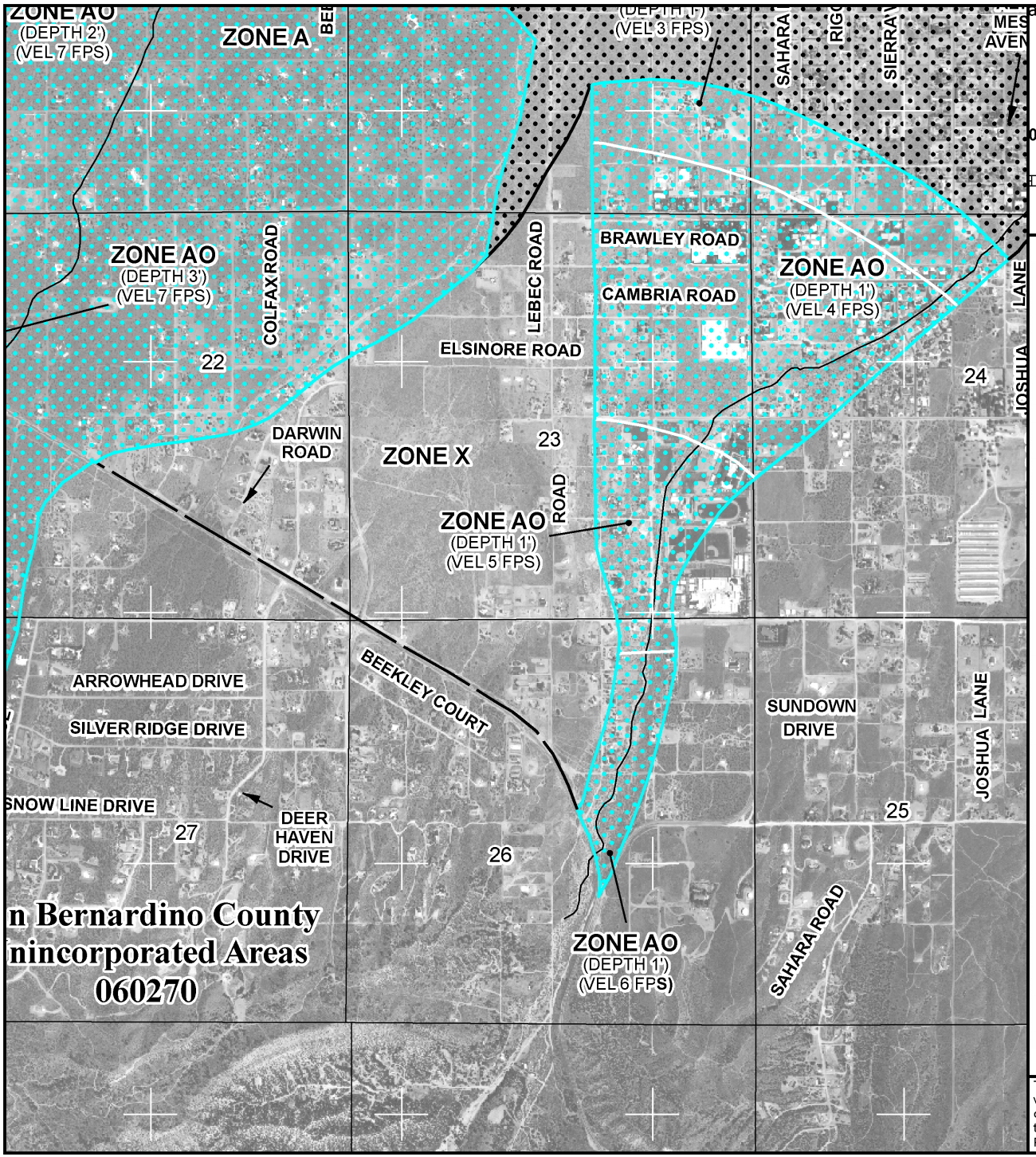
CONCEPT GRADING PLAN
NOT TO SCALE

APN 3066-191-04

2016.0225

MAP - 4



ational Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'

000 0 2000 4000

FEET

METER

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 6450H

FIRM

FLOOD INSURANCE RATE MAP

SAN BERNARDINO COUNTY, CALIFORNIA
AND INCORPORATED AREAS
PANEL 6450 OF 9400

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SAN BERNARDINO COUNTY	060270	6450	H

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06071C6450H

MAP REVISED
AUGUST 28, 2008

Federal Emergency Management Agency

NOAA Atlas 14, Volume 6, Version 2
Location name: Phelan, California, USA*
Latitude: 34.413°, Longitude: -117.5896°
Elevation: 4365.27 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	**0.081** (0.067-0.098)	**0.115** (0.095-0.141)	**0.165** (0.136-0.201)	**0.207** (0.169-0.255)	**0.268** (0.212-0.343)	**0.319** (0.247-0.416)	**0.373** (0.282-0.498)	**0.431** (0.317-0.592)	**0.514** (0.362-0.737)	**0.581** (0.396-0.863)
10-min	**0.115** (0.096-0.141)	**0.165** (0.137-0.202)	**0.236** (0.195-0.289)	**0.296** (0.243-0.366)	**0.385** (0.305-0.491)	**0.457** (0.354-0.596)	**0.534** (0.404-0.714)	**0.618** (0.454-0.849)	**0.737** (0.519-1.06)	**0.833** (0.567-1.24)
15-min	**0.140** (0.116-0.170)	**0.200** (0.166-0.244)	**0.285** (0.235-0.349)	**0.359** (0.293-0.442)	**0.465** (0.368-0.594)	**0.553** (0.428-0.721)	**0.646** (0.488-0.864)	**0.747** (0.549-1.03)	**0.891** (0.628-1.28)	**1.01** (0.686-1.50)
30-min	**0.200** (0.166-0.244)	**0.286** (0.237-0.350)	**0.408** (0.337-0.500)	**0.513** (0.420-0.634)	**0.666** (0.527-0.851)	**0.791** (0.613-1.03)	**0.925** (0.699-1.24)	**1.07** (0.786-1.47)	**1.28** (0.899-1.83)	**1.44** (0.982-2.14)
60-min	**0.274** (0.227-0.334)	**0.393** (0.325-0.480)	**0.560** (0.462-0.686)	**0.704** (0.576-0.869)	**0.914** (0.723-1.17)	**1.09** (0.841-1.42)	**1.27** (0.960-1.70)	**1.47** (1.08-2.02)	**1.75** (1.23-2.51)	**1.98** (1.35-2.94)
2-hr	**0.405** (0.335-0.493)	**0.556** (0.460-0.678)	**0.765** (0.632-0.937)	**0.945** (0.773-1.17)	**1.20** (0.952-1.54)	**1.41** (1.09-1.84)	**1.63** (1.23-2.18)	**1.87** (1.37-2.57)	**2.20** (1.55-3.15)	**2.46** (1.68-3.66)
3-hr	**0.500** (0.414-0.609)	**0.676** (0.560-0.825)	**0.919** (0.759-1.13)	**1.13** (0.922-1.39)	**1.42** (1.13-1.81)	**1.66** (1.29-2.16)	**1.91** (1.44-2.55)	**2.18** (1.60-2.99)	**2.55** (1.80-3.66)	**2.84** (1.93-4.22)
6-hr	**0.709** (0.588-0.864)	**0.951** (0.787-1.16)	**1.28** (1.06-1.57)	**1.56** (1.28-1.92)	**1.95** (1.54-2.49)	**2.26** (1.75-2.95)	**2.59** (1.96-3.46)	**2.93** (2.15-4.03)	**3.41** (2.40-4.89)	**3.79** (2.58-5.62)
12-hr	**0.932** (0.773-1.14)	**1.30** (1.08-1.59)	**1.79** (1.48-2.19)	**2.20** (1.80-2.71)	**2.76** (2.19-3.53)	**3.21** (2.48-4.18)	**3.66** (2.77-4.89)	**4.14** (3.04-5.69)	**4.79** (3.37-6.87)	**5.30** (3.60-7.86)
24-hr	**1.17** (1.03-1.34)	**1.71** (1.51-1.97)	**2.42** (2.14-2.80)	**3.01** (2.64-3.51)	**3.83** (3.24-4.61)	**4.46** (3.70-5.48)	**5.10** (4.13-6.43)	**5.77** (4.55-7.48)	**6.69** (5.06-9.03)	**7.40** (5.41-10.3)
2-day	**1.34** (1.19-1.54)	**1.99** (1.76-2.29)	**2.85** (2.52-3.29)	**3.56** (3.12-4.15)	**4.55** (3.85-5.47)	**5.31** (4.41-6.53)	**6.10** (4.94-7.68)	**6.92** (5.45-8.96)	**8.03** (6.07-10.8)	**8.90** (6.50-12.4)
3-day	**1.45** (1.28-1.67)	**2.15** (1.90-2.48)	**3.11** (2.75-3.59)	**3.90** (3.42-4.55)	**5.00** (4.23-6.02)	**5.85** (4.86-7.20)	**6.73** (5.45-8.48)	**7.66** (6.03-9.92)	**8.92** (6.74-12.0)	**9.92** (7.25-13.9)
4-day	**1.53** (1.35-1.76)	**2.28** (2.02-2.63)	**3.32** (2.93-3.84)	**4.18** (3.66-4.87)	**5.38** (4.56-6.48)	**6.32** (5.24-7.77)	**7.30** (5.91-9.19)	**8.32** (6.55-10.8)	**9.74** (7.36-13.1)	**10.9** (7.93-15.2)
7-day	**1.67** (1.48-1.92)	**2.51** (2.22-2.90)	**3.70** (3.27-4.28)	**4.72** (4.13-5.50)	**6.16** (5.22-7.42)	**7.31** (6.06-8.99)	**8.51** (6.89-10.7)	**9.79** (7.71-12.7)	**11.6** (8.76-15.7)	**13.0** (9.51-18.2)
10-day	**1.68** (1.49-1.94)	**2.54** (2.25-2.93)	**3.78** (3.34-4.37)	**4.85** (4.25-5.65)	**6.40** (5.43-7.71)	**7.65** (6.35-9.41)	**8.97** (7.27-11.3)	**10.4** (8.18-13.5)	**12.4** (9.38-16.7)	**14.0** (10.2-19.6)
20-day	**1.89** (1.67-2.17)	**2.93** (2.59-3.38)	**4.47** (3.95-5.17)	**5.84** (5.11-6.80)	**7.87** (6.67-9.48)	**9.55** (7.93-11.7)	**11.4** (9.21-14.3)	**13.3** (10.5-17.3)	**16.2** (12.2-21.8)	**18.5** (13.5-25.8)
30-day	**2.28** (2.02-2.63)	**3.53** (3.12-4.07)	**5.40** (4.77-6.24)	**7.08** (6.20-8.25)	**9.62** (8.15-11.6)	**11.7** (9.75-14.4)	**14.0** (11.4-17.7)	**16.6** (13.0-21.5)	**20.2** (15.3-27.3)	**23.2** (17.0-32.4)
45-day	**2.56** (2.27-2.95)	**3.96** (3.51-4.57)	**6.09** (5.37-7.04)	**8.03** (7.03-9.35)	**11.0** (9.32-13.3)	**13.5** (11.2-16.6)	**16.3** (13.2-20.5)	**19.3** (15.2-24.9)	**23.6** (17.8-31.9)	**27.2** (19.9-38.0)
60-day	**2.81** (2.49-3.23)	**4.29** (3.80-4.95)	**6.59** (5.82-7.62)	**8.70** (7.62-10.1)	**11.9** (10.1-14.4)	**14.7** (12.2-18.1)	**17.8** (14.4-22.4)	**21.1** (16.6-27.3)	**25.9** (19.6-34.9)	**29.8** (21.8-41.6)

[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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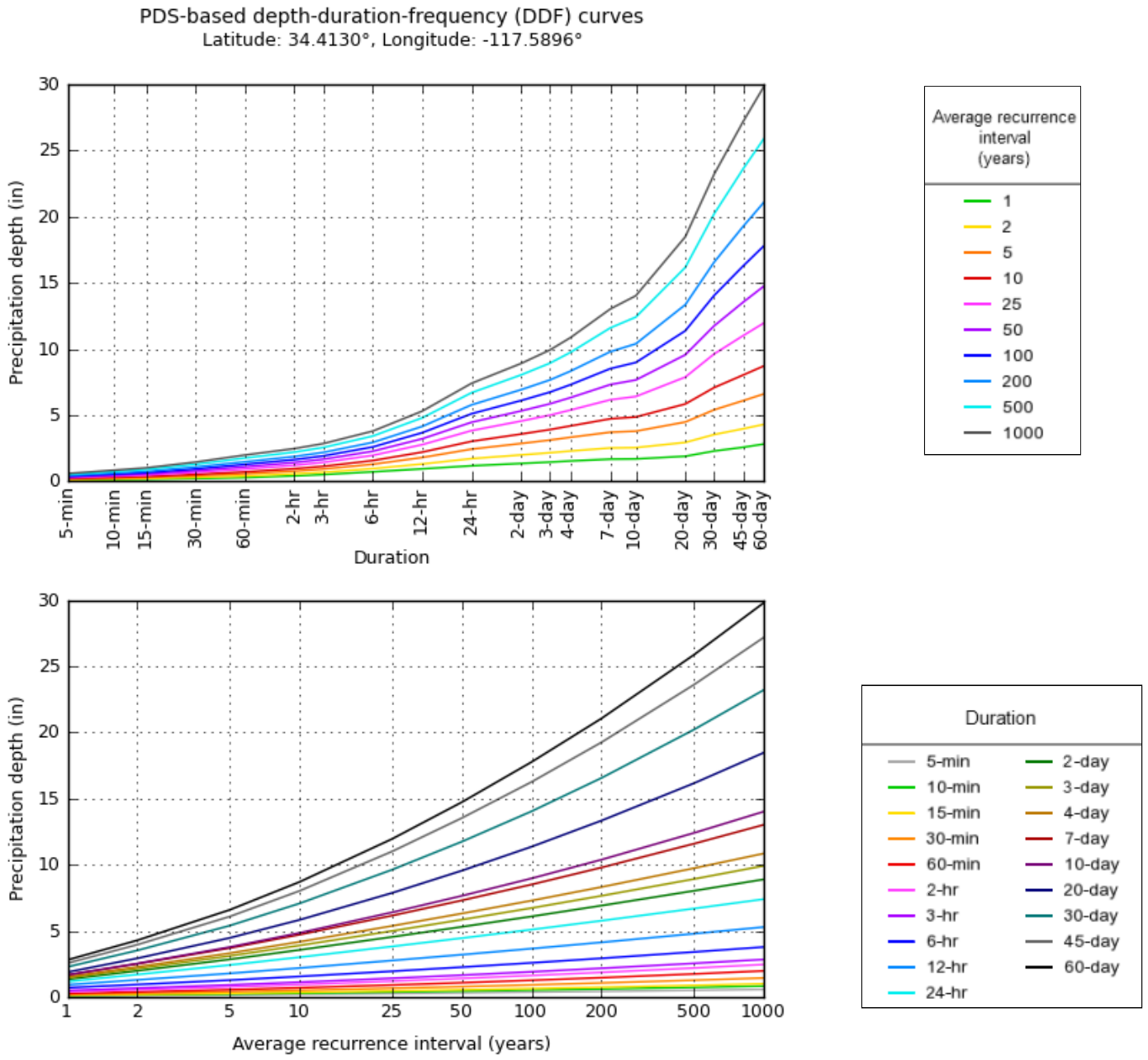
PF graphical



NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Tue Dec 4 17:40:51 2018

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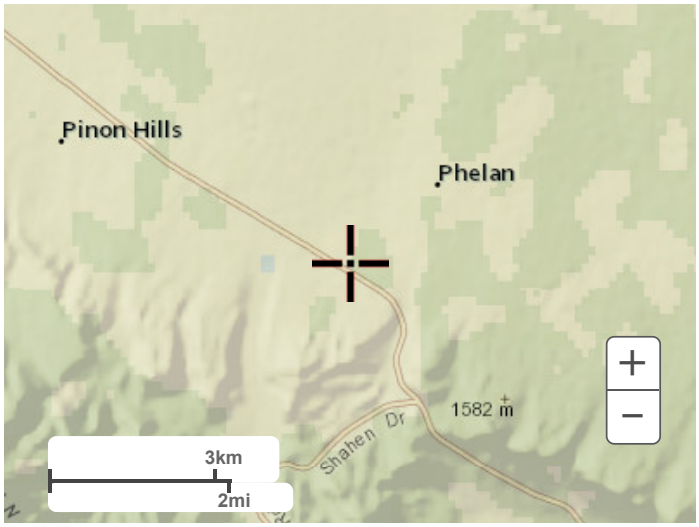
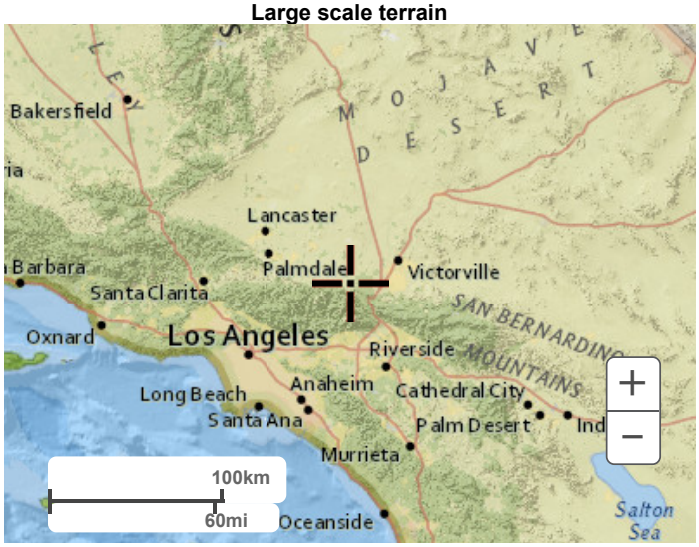
Maps & aerials

Small scale terrain

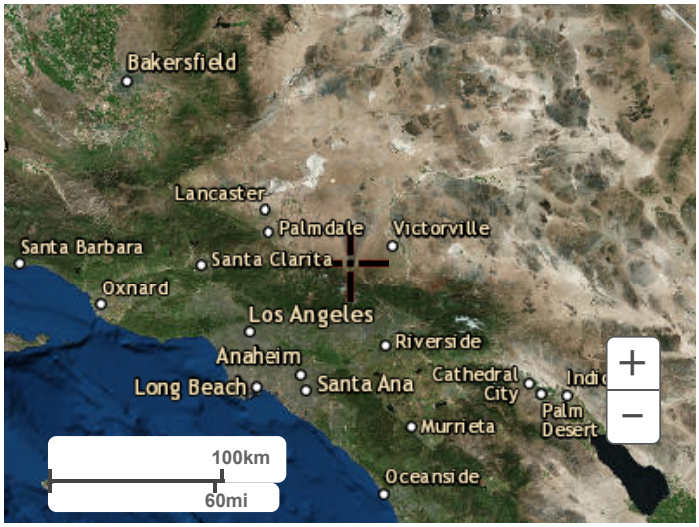


Large scale terrain



Large scale map

Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

R1W | R2W | R3W

T4N T3N T2N T1N T1S

SOURCE: GEOLOGY MAP

SOURCE: 1970 SCS SURVEY

EDWARDS AIR FORCE BASE

MOJAVE DESERT

Site

Use USDA websoils survey. See attached addendum to hydrology manual.

MARINE CORPS BASE

JOSHUA TREE NATIONAL MONUMENT

LEGEND

SOIL GROUP BOUNDARY

A SOIL GROUP DESIGNATION

BOUNDARY OF INDICATED SOURCE

INDEX MAP

Scale 1:250,000

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

BLACK NUMBERED LINES INDICATE THE 10,000 METER UNIVERSAL TRANSVERSE MERCATOR GRID, ZONE 11

1985 MAGNETIC DECLINATION FROM TRUE NORTH VARIES FROM 15½° (280 MILS) EASTERLY FOR THE CENTER OF THE WEST EDGE TO 16° (270 MILS) EASTERLY FOR THE CENTER OF THE EAST EDGE

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

SCALE REDUCED BY 1/2

LOCATION DIAGRAM

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

HYDROLOGIC SOILS GROUP MAP FOR SOUTHCENTRAL AREA

DEPARTMENT OF PUBLIC WORKS

FLOOD CONTROL ● LAND DEVELOPMENT & CONSTRUCTION
SOLID WASTE MANAGEMENT ● SURVEYOR ● TRANSPORTATION

COUNTY OF SAN BERNARDINO

825 East Third Street ● San Bernardino, CA 92415-0835 ● (909) 387-8104
Fax (909) 387-8130

GRANVILLE M. "BOW" BOWMAN, P.E., P.L.S.
Director of Public Works

April 6, 2010 File: 1(FC)-27.09-01

Hydrology Manual User:

Our San Bernardino County Hydrology Manual was developed in 1983 and revised in 1986 by our consultant Dr. Ted Hromadka. The best available data at the time was the National Oceanic and Atmospheric Administration (NOAA) Atlas II rainfall records and statistics published in 1973; it was the basis of our manual. The County participated with NOAA by providing a portion of the funding to study an additional 30 years of rainfall records. NOAA Atlas XIV was published in 2004 and revised 2006. We asked Dr. Hromadka to review the new rainfall numbers and assess any impacts to our manual. We looked at all areas of the County to see if any changes or revisions were justified. Only the arid desert regions were affected.

We are pleased to announce the new rainfall numbers led to updating our manual with an addendum. Briefly, this addendum addresses the Antecedent Moisture Condition (AMC) for arid regions of the County. The attached map, ADD-1, identifies where AMC I may now be used.

Please use the attached link to our website to access the addendum (March 2010); also included is a list of Frequently Asked Questions (FAQ's) and a map of the affected area. A GIS version of the map is also available.

If you have any questions, please contact Mike Fox, Chief-Water Resources Division at (909) 387-8213.

Sincerely,

KEVIN B. BLAKESLEE, P.E.
Deputy Director-Flood Control

KBB:MJF:bfb

County of San Bernardino Hydrology Manual Addendum for Arid Regions

April 2010

I. INTRODUCTION

After publication of the NOAA Atlas 14 rainfall atlas and the associated data base (NOAA, 2004, revised 2006), the County of San Bernardino Water Resources Division assessed the new publication towards the possibility of updating its Hydrology Manual (1983, revised 1986), particularly in the arid regions of the County. NOAA Atlas 2 (NOAA, 1973) served as the basis for the San Bernardino Hydrology Manual dated 1986. The updated NOAA Atlas 14 publication includes data from several rain gages which were not available at the time of the prior publication of NOAA Atlas 2, as well as 25 years of additional data at several of the rain gages used in NOAA Atlas 2. Consequently, thousands of additional station years of data are included in the updated NOAA Atlas 14. Upon assessing the new NOAA Atlas 14 rainfall statistics and mapping, the County updated their Hydrology Manual criteria to reflect the changes in rainfall statistics and trends developed with NOAA Atlas 14. This Addendum provides a summary of these updated criteria.

It is noted that numerous rain gages found in the NOAA Atlas 14 study area are not included in the NOAA Atlas 14 update and therefore care is needed when applying the updated Hydrology Manual criteria. Hydrology studies need to consider all available rainfall data by identifying rain gages located near or in the vicinity of the study area and need to obtain and review the relevant rainfall data. Such additional rainfall information includes, but is by no means limited to: NOAA (http://www.nws.noaa.gov/), CA-DWR (http://cdec.water.ca.gov/), CIMIS (http://wwwcimis.water.ca.gov/cimis/welcome.jsp), as well as gage data available from San Bernardino County. The results of such a review should be compared with the NOAA Atlas 14 results and a determination made as to the appropriateness in using the NOAA Atlas 14 results or whether a re-assessment of all rainfall data relevant to the study area should be made. Such determinations and reviews must be coordinated with the County in order to conclude the most appropriate rainfall statistics to use, including assessments of station record length and quality, among other factors.

The primary topics considered in the Addendum are:

1. Rainfall quantities for various peak durations of rainfall, and related return periods;
2. Antecedent Moisture Conditions (or "AMC") used in hydrology studies for design and planning;
3. Soil Grouping designations and related maps.

II. RAINFALL STATISTICS

The County of San Bernardino Hydrology Manual (1986) contains isohyetal curves developed for estimating the 2-year return frequency values for the peak 6- and 24-hour durations of rainfall, the 10-year 1-hour rainfalls, and the 100-year 1-hour, 6-hour and 24-hour rainfalls. These isohyetal maps are based upon use of the NOAA Atlas 2 (1973) information. The NOAA Atlas 14 provides information for various peak durations of rainfall depths and for various return periods (return frequencies), including all of the key durations and return periods detailed in the Hydrology Manual.

Access to the NOAA Atlas 14 information is found at http://hdsc.nws.noaa.gov/hdsc/pfds/.

Another resource available for assessing rainfall for hydrology studies is the depth duration frequency studies developed by the California Department of Water Resources (DWR). Some of the gages analyzed by DWR are not included in the NOAA Atlas 14 and should be considered for appropriateness in studies submitted to the county. The depth-duration frequency tables can be obtained as Microsoft Excel files from the DWR website at the following address:

http://www.water.ca.gov/floodmgmt/hafoo/csc/climate_data/.

It is noted that the Hydrology Manual provides interpolation methods for development of rainfall estimates for the 5-minute, 30-minute, 1-, 3-, 6-, and 24-hours of peak rainfall, including recommendations regarding log-log slopes of the relevant mass rainfall plots (for example, see Hydrology Manual Figures E-36 through E-45). The NOAA Atlas 14 provides estimates for these peak durations of rainfall depths directly in tabular form, on a rain gage by rain gage basis (for those gages used in the NOAA Atlas 14 analysis). Hydrology studies prepared using this Addendum should develop the relevant rainfall quantities required for the Hydrology Manual using the newer NOAA Atlas 14 estimates and, if available, the DWR estimates to assess the appropriate rainfall quantities to be used. Additionally, the study should consider all other rain gage information available in the proximity of the study watershed. The submittal should consider these several forms of rainfall information and provide a recommendation as to the appropriate rainfall information to use.

III. ANTECEDENT MOISTURE CONDITIONS (AMC)

The Antecedent Moisture Condition (AMC) concept is a classification of the watershed runoff conditions and is related to the prior five-day precipitation. By examining this prior five-day rainfall, the watershed can be categorized as being wet, average or dry. This classification of the watershed impacts the runoff which can be expected during a particular storm event. Original literature regarding AMC conditions were published by the Soil Conservation Service (SCS) in 1964 in the National Engineering Handbook,

Section 4. (The SCS had since changed to be the Natural Resources Conservation Service (NRSC).) In the 1993 update to the National Engineering handbook, the NRSC revised the AMC concept to that of Antecedent Runoff Condition (ARC), where ARC values correspond to statistical envelopments of the relevant rainfall-runoff information, versus the AMC concept correlating to contemplated prior moisture conditions of the watershed. Similar to many other agencies, the County continues to use the AMC approach in order to determine runoff quantities appropriate for design and planning purposes. The AMC approach should be used in all hydrologic studies prepared for County review or approval as presented in the Hydrology Manual (1986), without modification.

Based on the NOAA Atlas 14 statistical data, updated AMC designations for use in arid region hydrology studies are as shown in Addendum Figures ADD-1. It is noted that the NOAA Atlas 14 did not include all available rain gages, and therefore the hydrology study should examine other relevant rainfall gages to assess the appropriateness of the AMC designations shown in Addendum Figures ADD-1. Regional or Master Plan studies should consider all sources of information. The AMC condition used for these studies must be approved by the County.

IV. SOIL GROUPING DESIGNATIONS

The soil grouping information contained in Section C of the Hydrology Manual (1986) has been updated and can be accessed at http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx. Use of this information follows the directions provided in the Hydrology Manual (1986).

V. REFERENCES

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