PACE technical memorandum, Estimate of January 20, 2010, Discharge Event on Santa Clara River at the Vista Canyon Project Site (February 24, 2010)

PACE
Advanced Water Engineering

Technical Memorandum

Date: February 24, 2010

To: Susan Tebo, Impact Sciences, Inc.

From: David Jaffe, PhD, PE

Re: Estimate of January 20, 2010 Discharge event on Santa Clara River at the Vista Canyon project site # 8587E

Introduction:

The 2009-2010 rainy season has so far produced higher-than-average rainfall. The increase in rainfall has been attributed to the presence of El Nino oceanic patterns in the Central Pacific.

On January 22, 2010, the Vista Canyon project applicant observed and photographed flows in Santa Clara River within the Vista Canyon (VC) project site. Flows within this portion of the River were photographed from several vantage points along the River corridor.

This memorandum estimates the discharge in the River at VC around the time of the photographs. Further, this memorandum estimates the discharge based on the photographic evidence provided by the project applicant and available rain gage data.

Photographic Evidence:

Photographs of the active River channel taken along the River corridor on the VC site were provided to PACE for review. Two of the photos and their approximate locations are shown in Figure 1. Picture A (the western most photograph) shows the debris fence which borders the active channel of the River along the south bank. This debris fence is approximately 15 feet high. Scaling this photograph based upon the approximate fence height provides an estimate of the flow width, which varies between 20 to 40 feet. It is important to note that only one braid within the river channel is shown to be flowing. It is not clear from the provided photographs, however, if other braids in the channel experienced discharges during the same event. It is also unclear where in time the photographs were taken with respect to the hydrograph. Picture B shows the active channel of the River generally upstream from the VC site.

The estimated flow width (20 to 40 feet) is then compared to the HEC-RAS numerical model output as presented in the EIR Flood Technical Report. The model shows that the width of flow in the active channel of the river varies between 20 and 60 feet at Section 14400, the approximate photo location. The observed width corresponds to approximately the 2-year storm event. The model, however, shows several braids with flows during 2-year storm event. This observation again highlights the uncertainty as to where the photographs reside in the hydrograph with respect to time.

Rainfall Gage Evidence:

Several sources of rainfall gage data were checked for available gage data for the week of January 22, 2010.

NOAA gage data for Camp 9, approximately 3.9 miles to the south of the project site, shows that the total rainfall at the gage for the month of January, 2010 was 6.19 inches. The period immediately preceding and up to the 22nd shows a total rainfall of 5.87 inches (see attached). No long term data is available for the gage. The peak daily rainfall occurred on the 21st with a total rainfall of 1.62 inches.

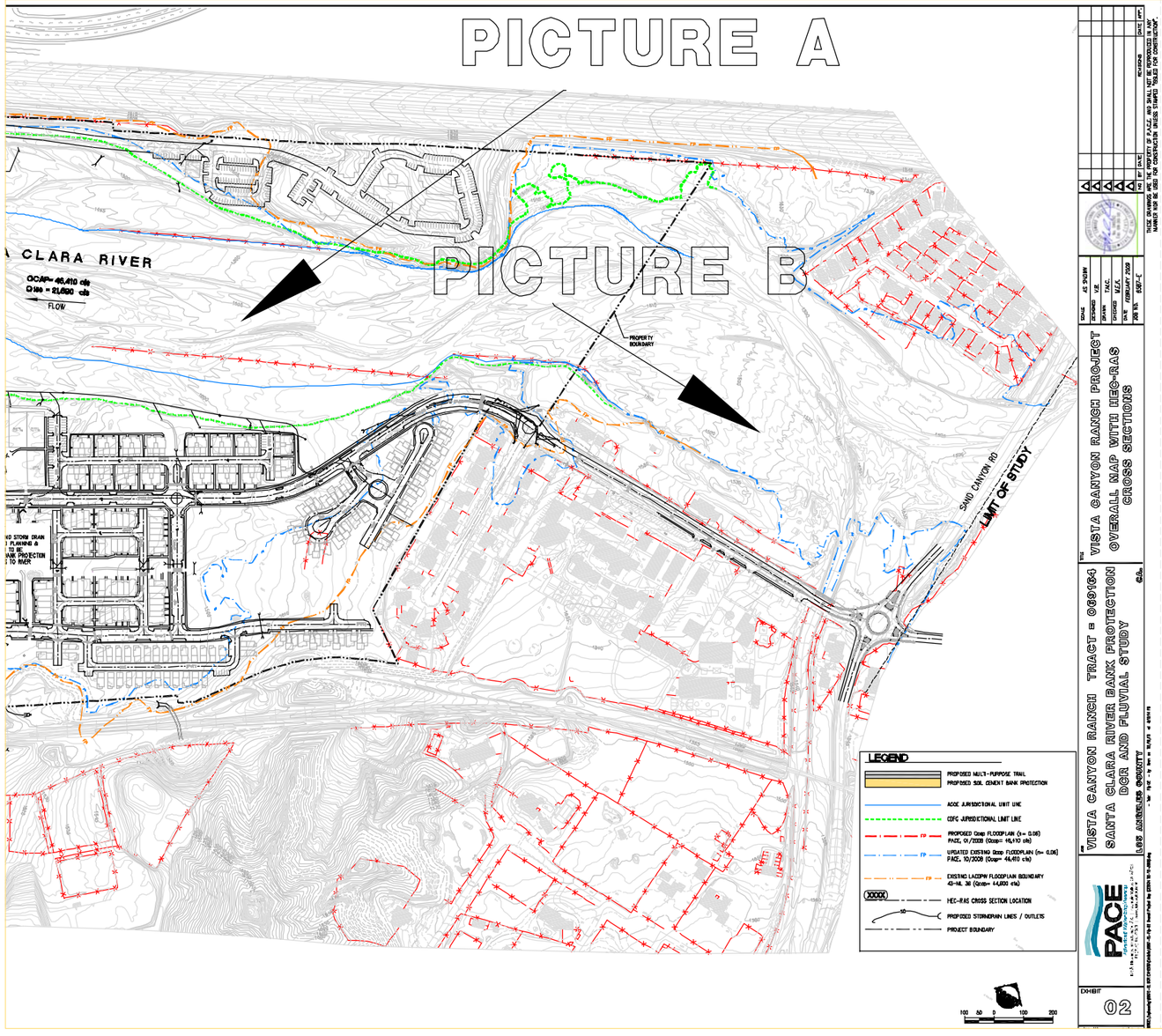
Since no long-term statistics are available for the Camp 9 gage, the measured data was compared to NOAA Atlas data for the region. The regional 7 day total indicates that the rainfall at the gage corresponds to an event between the 2- and 5-year return periods.

A comparison was also made with historic gage data at Dry Canyon Reservoir, located 6.9 miles to the north-west of the project site. While it is recognized that Camp 9 and Dry Canyon gages are not in close proximity, data was available at both stations and is useful for this analysis. In comparison with the Dry Canyon statistics, the Camp 9 measured data indicates a multi-day rainfall between 2- and 5- years, similar to that suggested by the NOAA 14 data set (see attached).

Based on the data collected and photographs, PACE estimates that the multi-day rainfall event that occurred during the week of January 18, 2010 was a 2-5 year storm event. Events with a magnitude of five (5) years that have occurred over the period of record (approximately 80 years), based on a downstream stream gage, is 9 (see attached). Therefore, events similar to the one during the study period have occurred approximately once every 10 years.

Conclusion:

In examining the available photographs and gage data, the preliminary estimate of the magnitude of the event that occurred during the week of January 18, 2010 is a multi-day rainfall with a return period between 2- and 5-years in duration with an active channel width of 20-40 feet. It should be noted that the Vista Canyon project would retain an average River corridor width of 700 feet.



PICTURE A

LOOKING SOUTH
SHOWING 15' HIGH EXISTING FENCE ON THE SOUTH BANK....FLOW WITH SHOWN= 20'±

PICTURE B

LOOKING EAST (u/s)
....FLOW WITH SHOWN= 20'±

FIGURE 1

Station Summary

Camp 9 California

Monthly Summary for

January, 2010

Day of Month	Day of Year	Total Solar Rad. ly.	Wind Ave. V. mph	Wind Dir. Deg	Wind Max. mph	Air Temperature Mean Deg.	Air Temperature Max Fahrenheit	Air Temperature Min	Fuel Temperature Mean Deg.	Fuel Temperature Max Fahrenheit	Fuel Temperature Min	Humidity Mean Percent	Humidity Max	Humidity Min	Dew Point Deg.	Wet Bulb Fahrenheit	Baro. Press. in. HG.	Total Precip. inches
1	1	245	27.5	351	50.0	52	56	48	51	62	45	28	42	19	19	38	30.23	0.00
2	2	322	19.4	347	59.0	53	61	46	53	69	45	34	46	16	24	40	30.15	0.00
3	3	291	7.6	31	18.0	59	70	55	58	79	50	9	18	2	-3	38	30.17	0.00
4	4	258	8.8	351	20.0	55	59	53	54	61	50	10	20	5	-1	36	30.16	0.00
5	5	329	10.0	354	24.0	55	63	48	55	71	44	14	19	8	6	37	30.14	0.00
6	6	321	8.3	353	37.0	59	67	53	59	75	51	15	21	8	10	39	30.11	0.00
7	7				24.0		68	52		76	50		28	20				
8	8	251	6.8	17	18.0	57	65	52	57	74	49	31	35	27	26	42	30.18	0.00
9	9	207	11.0	359	32.0	55	64	49	55	71	45	29	34	24	23	41	30.21	0.00
10	10	235	12.1	351	25.0	58	63	53	57	69	50	27	30	23	24	42	30.20	0.00
11	11	264	8.2	355	33.0	58	69	53	58	77	51	23	28	20	20	41	30.22	0.00
12	12	223	15.3	131	34.0	53	61	46	54	68	44	36	70	26	25	40	30.19	0.00
13	13	197	17.4	331	51.0	43	47	40	45	54	39	73	99	40	35	39	30.14	0.09
14	14	294	26.7	352	56.0	47	53	41	48	57	39	35	58	13	18	36	30.18	0.00
15	15	219	8.4	7	60.0	54	60	50	54	65	49	15	20	10	6	36	30.20	0.00
16	16	234	12.3	128	31.0	48	56	41	49	62	40	35	62	20	20	37	30.02	0.00
17	17	130	17.5	135	39.0	42	48	39	43	54	38	83	100	52	37	40	29.95	0.62
18	18	30	23.5	152	81.0	43	47	39	44	47	40	100	100	100	43	43	29.78	1.55
19	19	50	19.6	187	82.0	38	40	36	39	42	36	100	100	100	38	38	29.63	0.41
20	20	12	18.8	127	75.0	38	41	36	39	42	37	100	100	100	38	38	29.55	1.42
21	21	23	18.4	143	60.0	38	42	34	38	43	33	100	100	100	38	38	29.21	1.62
22	22	69	13.9	185	199.0	33	36	32	33	36	32	100	100	100	33	33	29.41	0.25
23	23	275	13.0	286	87.0		135	30	37	52	29	90	100	68			29.92	0.18
24	24	285	7.3	15	17.0	42	52	36	43	61	32	58	73	44	28	36	30.14	0.00
25	25	225	7.8	108	24.0	45	51	41	45	59	38	53	70	36	29	38	30.04	0.00
26	26	135	10.7	100	34.0	43	48	39	43	54	37	76	100	43	35	39	29.93	0.05
27	27	304	21.3	347	44.0	41	47	37	43	53	37	87	100	68	37	39	29.91	0.00
28	28	303	16.8	355	45.0	45	51	39	45	58	38	51	83	37	27	37	30.02	0.00
29	29	255	8.3	170	21.0	47	55	42	47	67	39	59	100	41	33	40	30.05	0.00
30	30	288	9.5	136	51.0	45	51	39	46	61	37	70	100	51	35	40	29.97	0.00
31	31	283	8.7	18	26.0	45	55	39	45	62	36	60	67	47	32	39	29.95	0.00

MONTHLY STATISTICS

	Total Solar Rad. ly.	Wind Ave. V. mph	Wind Dir. Deg	Wind Max. mph	Air Temperature Mean Deg.	Air Temperature Max Fahrenheit	Air Temperature Min	Fuel Temperature Mean Deg.	Fuel Temperature Max Fahrenheit	Fuel Temperature Min	Humidity Mean Percent	Humidity Max	Humidity Min	Dew Point Deg.	Wet Bulb Fahrenheit	Baro. Press. in. Hg.	Total Precip. inches

Total	6553															6.19
Ave.	218	13.8	25	47.0	48.0	57.5	43.2	47.9	60.7	41.3	53	65	41	25	39	30.00	
Max.	329	27.5		199.0	59	135	55	59	79	51	100	100	100	43	43	30.23	1.62
Min.	12	6.8		17.0	33	36	30	33	36	29	9	18	2	-3	33	29.21	0.00

Data are subject to further review and editing. Please refer any questions to the Western Regional Climate Center.

° 1 ly = 1 cal/cm² = 4.1855 J/cm² = 3.6855 BTU/ft² = .01163 KW-hr/m²

 Return to previous form.

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POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

California 34.684 N 118.402 W 3133 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Tue Feb 16 2010

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Docs | Return to State Map

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.12	0.18	0.23	0.31	0.38	0.57	0.72	1.07	1.48	1.98	2.30	2.72	3.16	3.51	4.29	5.03	5.72	6.30
2	0.16	0.24	0.29	0.40	0.49	0.72	0.91	1.37	1.91	2.62	3.06	3.65	4.26	4.73	5.81	6.83	7.85	8.62
5	0.21	0.32	0.39	0.53	0.66	0.96	1.20	1.81	2.55	3.63	4.30	5.24	6.19	6.85	8.43	9.94	11.71	12.82
10	0.26	0.39	0.48	0.65	0.80	1.16	1.44	2.15	3.03	4.38	5.24	6.47	7.67	8.45	10.36	12.21	14.65	16.05
25	0.33	0.50	0.61	0.83	1.02	1.44	1.77	2.62	3.69	5.40	6.51	8.16	9.73	10.63	12.96	15.27	18.74	20.54
50	0.39	0.59	0.73	0.98	1.21	1.68	2.04	2.99	4.21	6.20	7.51	9.52	11.38	12.37	14.98	17.61	22.02	24.15
100	0.45	0.69	0.85	1.15	1.42	1.93	2.33	3.39	4.74	7.02	8.56	10.95	13.13	14.18	17.07	20.03	25.50	28.00
200	0.53	0.80	0.99	1.34	1.66	2.21	2.64	3.80	5.28	7.86	9.64	12.45	14.97	16.06	19.22	22.50	29.17	32.08
500	0.64	0.97	1.20	1.62	2.00	2.61	3.08	4.37	6.03	9.00	11.12	14.55	17.55	18.67	22.15	25.84	34.35	37.83
1000	0.73	1.11	1.38	1.85	2.29	2.94	3.44	4.82	6.61	9.89	12.28	16.23	19.63	20.75	24.44	28.43	38.53	42.51

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

* Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.14	0.22	0.27	0.36	0.45	0.65	0.82	1.21	1.68	2.30	2.68	3.19	3.75	4.18	5.08	5.90	6.95	7.61
2	0.18	0.28	0.35	0.47	0.58	0.83	1.04	1.56	2.18	3.03	3.55	4.26	5.04	5.62	6.88	8.02	9.52	10.38
5	0.24	0.37	0.46	0.62	0.77	1.10	1.37	2.05	2.90	4.20	4.98	6.14	7.31	8.14	9.98	11.64	14.18	15.41
10	0.30	0.46	0.56	0.76	0.94	1.32	1.64	2.43	3.45	5.06	6.05	7.56	9.06	10.04	12.27	14.30	17.71	19.30
25	0.38	0.58	0.72	0.97	1.20	1.64	2.01	2.96	4.19	6.25	7.53	9.53	11.47	12.62	15.36	17.88	22.67	24.66
50	0.45	0.69	0.85	1.14	1.42	1.91	2.32	3.38	4.77	7.17	8.70	11.12	13.41	14.67	17.73	20.63	26.67	29.03
100	0.53	0.81	1.00	1.34	1.66	2.20	2.65	3.82	5.37	8.13	9.93	12.81	15.49	16.84	20.23	23.51	30.89	33.69
200	0.62	0.94	1.16	1.56	1.94	2.52	3.01	4.30	6.00	9.11	11.22	14.58	17.67	19.12	22.82	26.44	35.43	38.63
500	0.75	1.14	1.41	1.90	2.35	2.98	3.52	4.97	6.88	10.45	13.02	17.12	20.81	22.30	26.40	30.47	41.78	45.83
1000	0.86	1.30	1.62	2.18	2.69	3.37	3.94	5.50	7.57	11.53	14.45	19.17	23.38	24.90	29.23	33.67	47.03	51.64

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
** These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

* Lower bound of the 90% confidence interval Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.10	0.16	0.20	0.27	0.33	0.50	0.63	0.95	1.29	1.71	1.98	2.31	2.66	2.93	3.59	4.23	4.75	5.25

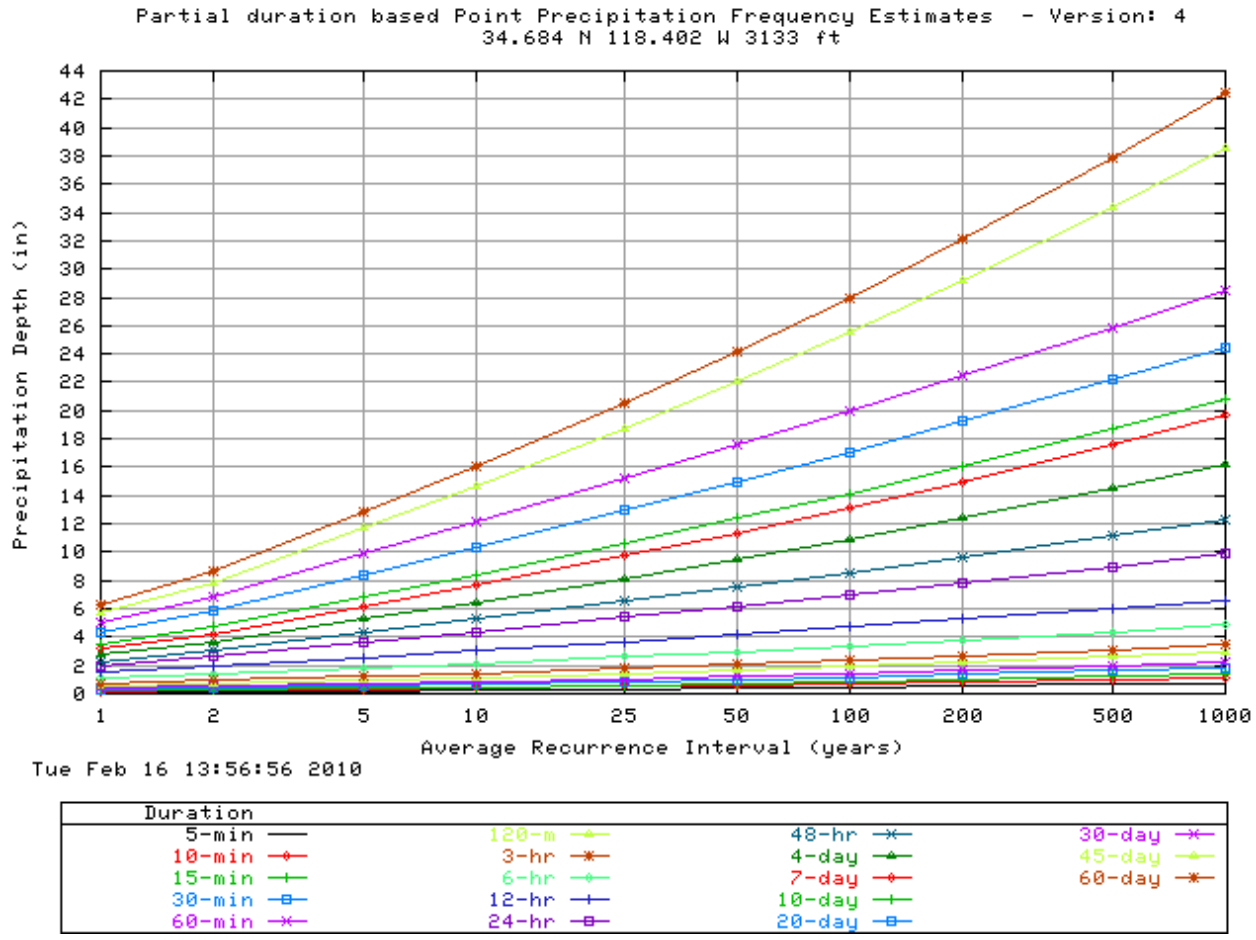
2	0.13	0.20	0.25	0.34	0.42	0.63	0.81	1.21	1.67	2.26	2.62	3.10	3.58	3.96	4.87	5.76	6.52	7.19
5	0.18	0.27	0.34	0.46	0.57	0.84	1.06	1.59	2.22	3.13	3.67	4.44	5.19	5.71	7.04	8.37	9.69	10.67
10	0.22	0.33	0.41	0.56	0.69	1.01	1.26	1.89	2.64	3.78	4.46	5.46	6.42	7.03	8.65	10.27	12.08	13.30
25	0.28	0.42	0.52	0.70	0.87	1.24	1.54	2.29	3.20	4.64	5.52	6.84	8.10	8.80	10.77	12.78	15.38	16.90
50	0.33	0.49	0.61	0.82	1.02	1.44	1.77	2.60	3.63	5.29	6.33	7.92	9.41	10.18	12.40	14.70	17.94	19.75
100	0.38	0.57	0.71	0.96	1.19	1.64	2.00	2.92	4.06	5.98	7.17	9.05	10.79	11.59	14.06	16.61	20.60	22.71
200	0.43	0.66	0.82	1.10	1.36	1.86	2.25	3.25	4.50	6.65	8.03	10.21	12.20	13.05	15.71	18.56	23.36	25.73
500	0.51	0.78	0.97	1.31	1.62	2.16	2.59	3.70	5.09	7.55	9.16	11.79	14.14	14.99	17.93	21.11	27.10	29.95
1000	0.58	0.88	1.09	1.47	1.82	2.40	2.85	4.04	5.53	8.23	10.03	13.01	15.64	16.52	19.62	23.08	30.07	33.27

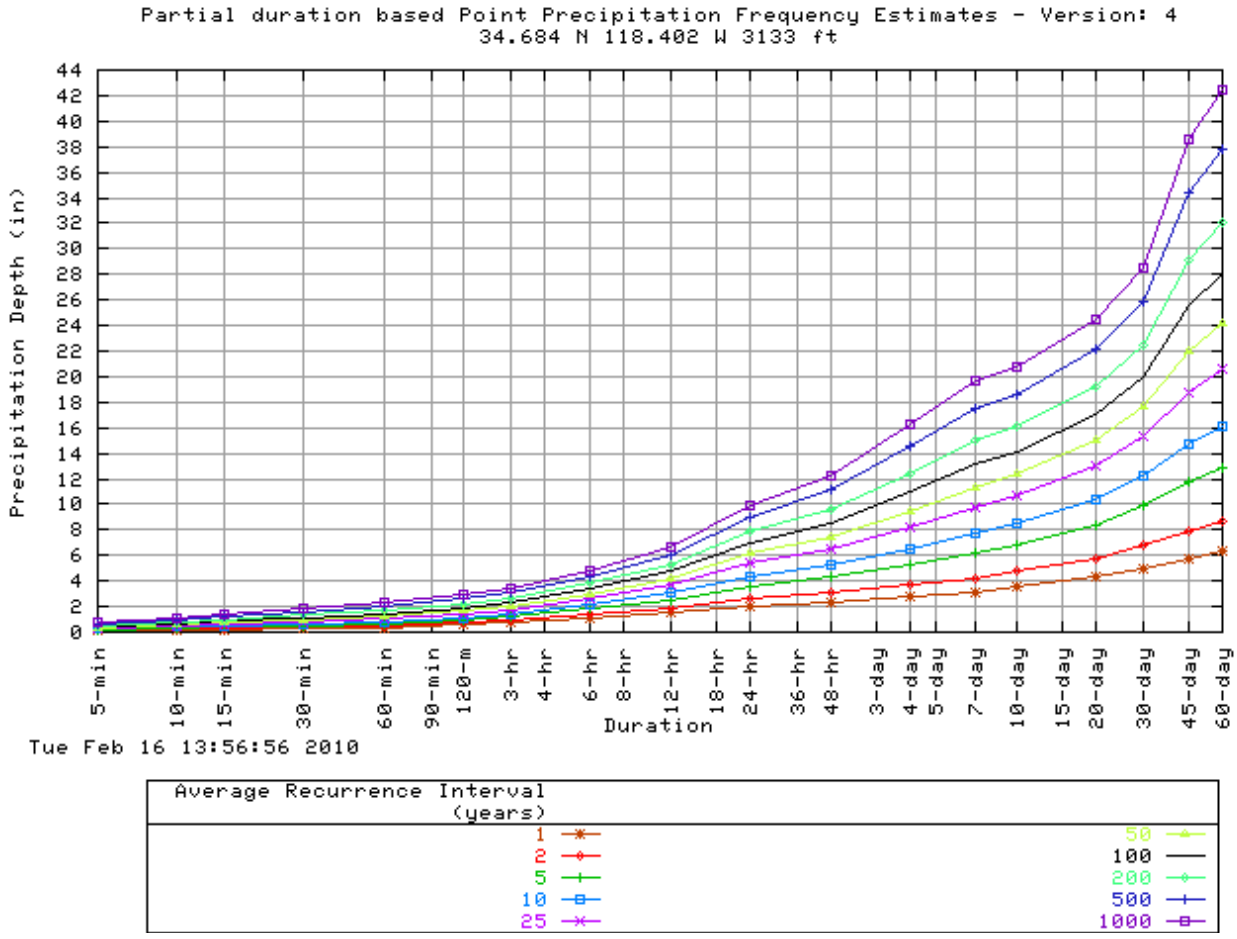
* The **lower** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **less** than.

** These precipitation frequency estimates are based on a partial duration maxima series. **ARI** is the Average Recurrence Interval.

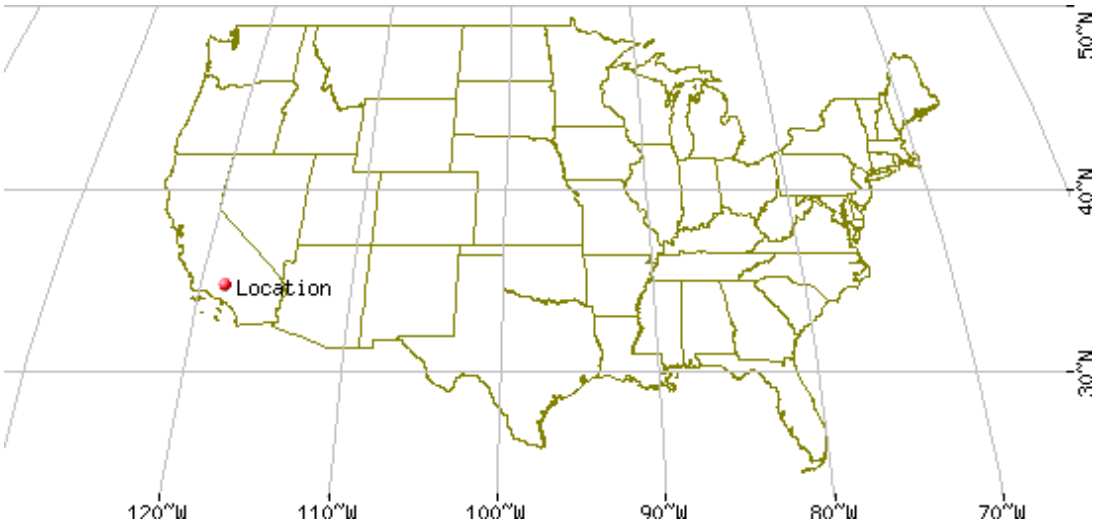
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Text version of tables




Partial duration based Point Precipitation Frequency Estimates - Version: 4
34.684 N 118.402 W 3133 ft
Precipitation Depth (in)
Duration
5-min
10-min
15-min
30-min
60-min
90-min
120-m
3-hr
4-hr
6-hr
8-hr
12-hr
18-hr
24-hr
36-hr
48-hr
3-day
4-day
5-day
7-day
10-day
15-day
20-day
30-day
45-day
60-day
Tue Feb 16 13:56:56 2010
Average Recurrence Interval (years)
1
2
5
10
25
50
100
200
500
1000

Maps -


Location
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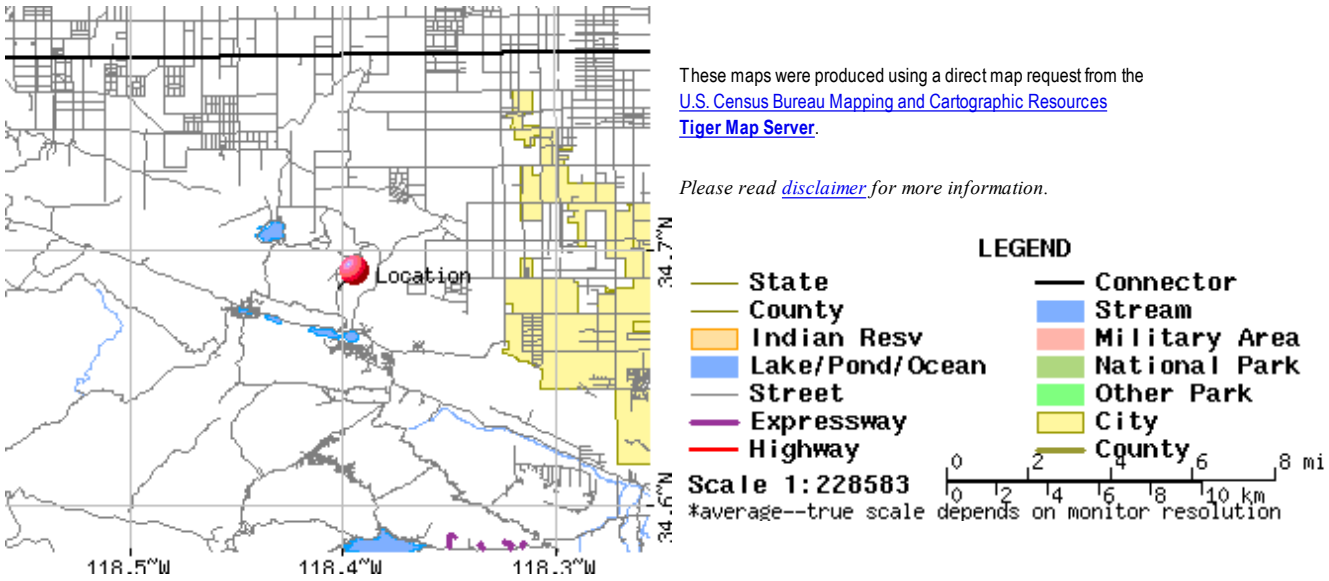
40°N
30°N
120°W
110°W
100°W
90°W
80°W
70°W



Other Maps/Photographs -

View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; **USGS Aerial Photograph** may also be available
from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera
tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

Watershed/Stream Flow Information -

Find the Watershed for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

*Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information
about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study,
please refer to NOAA Atlas 14 Document.*

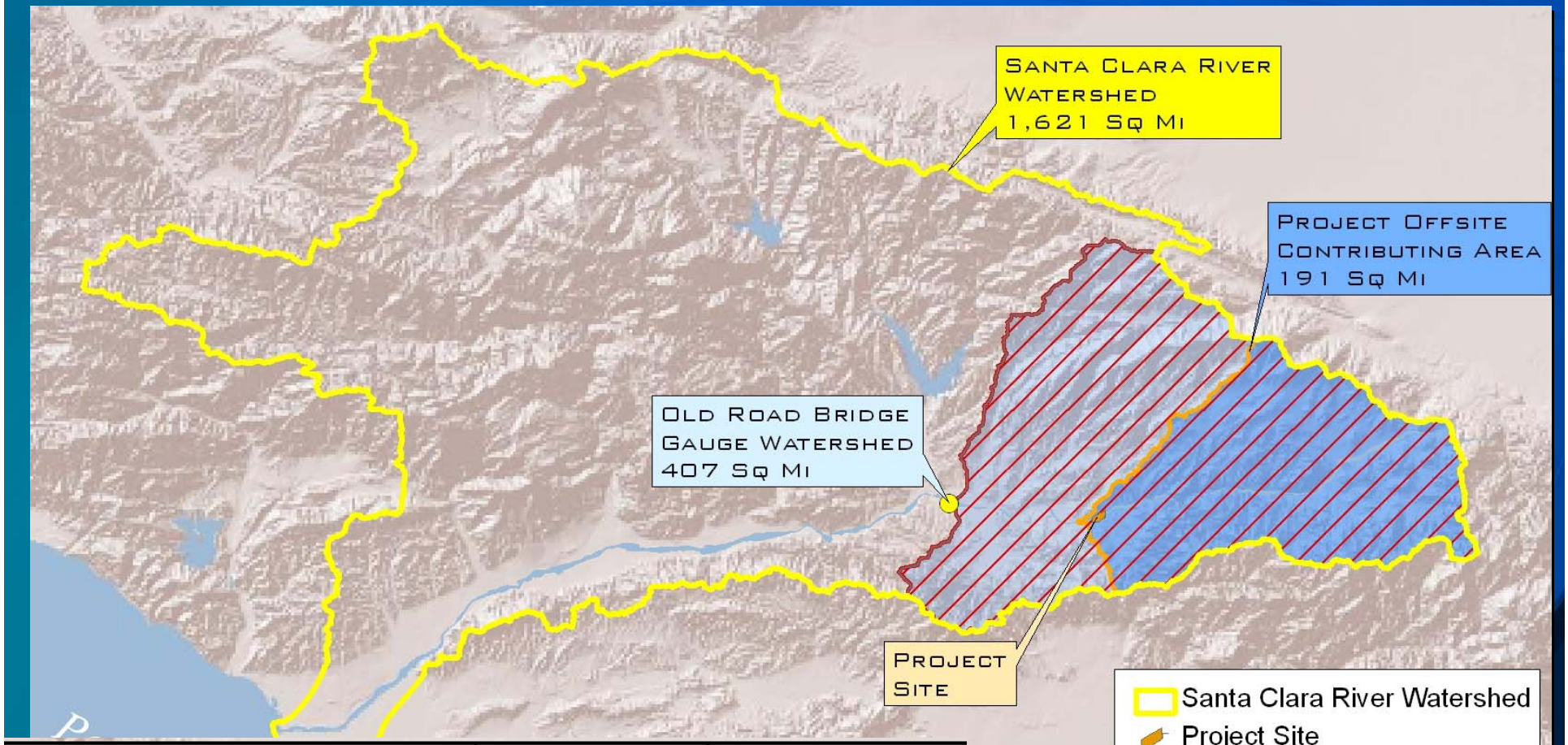
Using the **National Climatic Data Center's (NCDC)** station search engine, locate other climate stations within:
+/-30 minutes ...OR... +/-1 degree of this location (34.684/-118.402). Digital ASCII data can be obtained directly from **NCDC**.

Find Natural Resources Conservation Service (NRCS) SNOTEL (SNOwpack TELemetry) stations by visiting the
Western Regional Climate Center's state-specific SNOTEL station maps.

Hydrometeorological Design Studies Center
DOC/NOAA/National Weather Service
1325 East-West Highway
Silver Spring, MD 20910
(301) 713-1669
Questions?: HDSC.Questions@noaa.gov

Disclaimer

River Watershed Evaluation



Flood Event	Flow Rate (cfs)	Number of Occurances*
5-year (or greater)	3,633	9
25-year (or greater)	7,600	4
100-year (or greater)	21,690	0

*Historic data available for gage located at Santa Clara River at Old Road Bridge. Data range from 1930-2003

PACE