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WEATHER BUREAU

CLIMATOLOGICAL SERVICE

DISTRICT No. 11. CALIFORNIA

PROF. ALEXANDER G. McADIE
DISTRICT EDITOR

REPORT FOR JULY, 1911

Prepared under direction of WILLIS L. MOORE, Chief U. S. Weather Bureau



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CLIMATOLOGICAL DATA FOR JULY, 1911.

DISTRICT No. 11, CALIFORNIA.

Prof. ALEXANDER G. McADIE, District Editor.

GENERAL SUMMARY.

With the exception of a period of about 10 days during the first half of July, 1911, the month was cool. In other portions of the United States, particularly the central and eastern portions, the month will long be remembered for high temperatures and protracted heat. In a special bulletin it was stated that—

An examination of the weather conditions in the United States during the past 40 years does not disclose another period in the late spring and early summer when the temperatures have been so uniformly high for so long a period and over such a large portion of the country.

Doubtless in the separate reports published in this issue of the Monthly Weather Review attention is called by the various editors to this condition of excessive heat. So far as the Pacific coast is concerned, the condition has been just the opposite. The spring months have been marked by cool weather and the summer thus far, with the exception of the one short period referred to above, has also been cool. At San Francisco, where the range in temperature is small and departures are seldom noticeable, the month was the coolest since 1901. In fact, along the coast north of Point Conception low temperatures and fog were so much in evidence that instead of favorable comment on cool conditions there was general remark on the unpleasant and disagreeable character of the weather. Along the coast south of Point Conception, however, while there was much high fog, the temperatures were moderate and at most points above normal. In the interior there were few excessively hot days, and on the whole the summer has been a pleasant one.

Little rain fell, and what did was in the form of afternoon showers in the Sierra and southern mountains of the State. Water was plentiful, and, while streams fell gradually, there was no lack of fresh running water in the foothills and mountains and no apprehension of scarcity for irrigation or power. The season has been a good one for all interests. Fruit ripened nicely and there was no damage by hot north winds or dry periods. The soil contained plenty of water and the snow disappeared from the 7,000-foot level by July 10. This date, however, is later by at least two weeks than the normal. July was an unusually favorable month for travel in the mountains. Tourists and pleasure seekers were able to enjoy full streams and magnificent effects in waterfalls, owing to the large volume of water from the heavy snow cover of the higher levels. Usually this condition is restricted to the month of June, and often a noticeable reduction in the volume of water occurs before the middle of that month.

One of the features of the month was a period of thunderstorm frequency, July 15 to 17. Elsewhere are given details of damage done by lightning in these mountain storms. Frequent thunderstorms were reported

also in southeastern California, one especially severe in Imperial County on July 15.

From an engineering point of view the most interesting feature of the month's weather was the abundance of water for power purposes. July, 1911, was in marked contrast with July, 1910, in this respect. Then the section reports foreshadowed a scarcity of water early in the season. There was less snow in sight than at any previous similar date since the settlement of the country and water courses contained little water. This year the run-off is excessive and streams are carrying a full head. Taken together the two months furnish important data bearing on the question of the influence of forested areas upon rainfall and run-off. The marked deficiency in run-off last summer and the marked excess this summer afford a definite and clear demonstration that in the main variations in rainfall and run-off are not controlled by or materially affected by such artificial conditions as deforestation or settlement of area, but are primarily and effectually determined by natural causes acting over large areas. It is plain that there was no change in the forest conditions or in the reclamation of land during the two years, and yet we have the extreme conditions of run-off, and rainfall or snowfall.

TEMPERATURE.

The mean temperature for the State was 74.1°, or slightly above the normal. This mean value, however, gives no indication of the unusually cool condition prevailing in the coast counties north of Point Conception during most of the month. Also it gives no clew to the generally cool character of the month in certain parts of the interior.

The following table gives the means and departures for each July from 1897 to 1911, inclusive:

Years.	Mean.	Departure.	Years.	Mean.	Departure.
	°F.	°F.		°F.	°F.
1897.....	74.5	+0.9	1905.....	74.8	+1.2
1898.....	81.4	+7.8	1906.....	76.8	+3.2
1899.....	77.9	+4.3	1907.....	73.1	- .5
1900.....	75.9	+2.3	1908.....	76.4	+2.8
1901.....	76.0	+2.4	1909.....	71.2	-2.4
1902.....	72.8	- .8	1910.....	75.5	+1.9
1903.....	71.2	-2.4	1911.....	74.1	+ .9
1904.....	72.2	-1.4			

The highest temperature reported at any station was 117°, which occurred at Indio on the 15th and Palm Springs on the 30th. This was 2° lower than the highest temperature recorded during July, 1910. The lowest temperature was 28° at Tamarack on July 1. This was 6° warmer than the lowest temperature recorded during July, 1910.

PRECIPITATION.

The average monthly precipitation for the State was 0.10 of an inch. This is slightly above the normal.

The following table gives the average and departure from the normal for each July from 1897 to 1911, inclusive:

Years.	Mean.	Departure.	Years.	Mean.	Departure.
	<i>Inches.</i>	<i>Inches.</i>		<i>Inches.</i>	<i>Inches.</i>
1897.....	0.01	-0.05	1905.....	0.01	-0.05
1898.....	T.	-0.06	1906.....	.04	-0.02
1899.....	T.	-0.06	1907.....	.03	-0.03
1900.....	.03	-0.03	1908.....	.04	-0.02
1901.....	.01	-0.05	1909.....	.05	-0.01
1902.....	.70	+0.64	1910.....	.10	+0.04
1903.....	.03	-0.03	1911.....	.10	+0.04
1904.....	.09	+0.03			

The greatest monthly rainfall was 2.50 inches, at Mammoth Tank. One-half of the stations reporting had no rainfall during the month. The distribution of the rain geographically was far from uniform. Afternoon thundershowers in the mountains and a few misting rains along the north coast made up the rainfall.

Snowfall.—No snow was reported at any station in California. There probably were, however, some light falls at elevations above 10,000 feet.

SUNSHINE.

The following table gives the total hours of sunshine and percentages of the possible:

Stations.	Hours.	Percentage of possible.	Stations.	Hours.	Percentage of possible.
Eureka.....	163	36	Sacramento.....	414	92
Fresno.....	421	94	San Diego.....	251	57
Los Angeles.....	315	72	San Francisco.....	264	59
Mount Tamalpais.....	435	97	San Jose.....	361	81
Red Bluff.....	424	93	San Luis Obispo.....	295	67

THUNDERSTORMS.

Lightning struck Glacier Point in the Yosemite Valley during the afternoon of July 16 and killed 9 out of 18 horses tethered under a tree near the hotel. Over a score of tourists were in the hotel and had just dismounted. The storm was severe in the Wawona section, and the rainfall was so heavy that the Merced River rose to a height of 12 feet and did some damage in the Mariposa Big Tree Grove. On July 14 another thunderstorm and heavy rainfall raised the Merced River 4 feet, causing, it is said, greater flood conditions than during June, when melting snow caused an overflow over a portion of the valley. The flume carrying water to the electric-light station was put out of commission, crippling the power plant and leaving the Valley hotel and camp in darkness on July 14 and until repairs could be made.

On July 15, at El Centro, a storm of some violence, moving from the southeast, struck the section about 3.20 p. m. While the storm lasted only a few minutes, it damaged property to the extent of \$30,000. Two lives were lost by falling walls. Many people were injured. The First Presbyterian Church was entirely demolished; the warehouse of the California Cotton Co. collapsed, burying beneath its heavy timbers three Hindoolaborers, two of whom subsequently died. A feed and fuel shed collapsed and several storage and drying sheds and small

office buildings, together with some residences, were destroyed.

At Campo thunderstorms and at Sonora rains prevailed from the 3d to the 29th. On the morning of the 27th a severe electrical storm from Campo west to the coast foothills knocked down telegraph poles, killed two mules, and stunned children leaning on fences. In the afternoon a similar storm occurred from Campo east, causing heavy rain in the valleys to the east and on the desert.

At Downieville on the 15th a severe thunderstorm north and northeast was reported, with a cloudburst at Bassetts, causing a rise in the South Fork of the Yuba of about 2 feet.

At Hornbrook on the 24th a heavy thunderstorm with 2 inches of rain occurred, and on the 25th a thunderstorm with a trace of rain.

EARTHQUAKES.

July 1, San Francisco: A severe shock occurred at 2.00:05 p. m. to 2.00:25 p. m., one hundred and twentieth meridian time. It was felt in the Weather Bureau office and the time noted by Observers Scholl and Rogers. No tremulous motion was felt before the principal disturbance, and there was no rocking motion at the end. There were two well-marked vibrations, with an interval of about five seconds. The vertical motion was perceptible, the apparent direction from west to east, and the duration of sensible motion was about 20 seconds. The intensity was No. 7 on the Rossi-Forel scale. No sounds were heard and few objects were overturned.

San Jose, July 1 (Mr. Maurice Connell, observer), reports that one of the severest shocks since the memorable quake of 1906 occurred at 2.00:30 p. m. The movement seemed to be entirely vertical, which would indicate that the locus of the disturbance centered near San Jose. There was a loud roaring-like noise, but the period of active disturbance lasted not over 10 seconds. Damage was not great, plastering being loosened and some brick walls cracked.

Santa Clara, July 1, seismographic station of the Jesuit seismologic service, Rev. J. S. Rickard, S. J., director; Mr. A. J. Newlin, assistant: Most severe shock since April 18, 1906. Tracer thrown off paper, but quickly replaced. Apparently little damage done in this vicinity.

Dr. A. O. Leuschner, professor of astronomy and director of the Students' Observatory, and Mr. Strula Einarsson, instructor in practical astronomy in the University of California, Berkeley, issued a report on the earthquake of July 1, of which the following is a part:

The earthquake began without preliminary tremor at 2^h 00^m 28^s ±. The period of vertical vibration was approximately 3 seconds, indicating that the center of the earthquake was not as close as one might be tempted to suspect.

The total duration of the motion as shown by the records was roughly 27 minutes, of which 18 minutes were marked by perceptibly strong motion, 10 minutes as heavy motion, and 5 minutes by great intensity. The intensity was 5 on the Rossi-Forel scale; it was a smart shock, generally felt; furniture was shaken, and some clocks were stopped, notably the time clock of the Students' Observatory, this for the first time since the earthquake of April 18, 1906.

NOTE ON EARTHQUAKE OF JULY 1, 1911, AT MOUNT HAMILTON.

The earthquake of July 1, 1911, was in some respects the most severe one experienced since the observatory was founded. The amplitude of vibration was less than

in the shock of April 18, 1906, and the duration was much less, but the motion was more violent.

Fortunately the telescopes and other instruments of the observatory suffered no injury, with the exception of the Riefler clock. The steel springs in the pendulum support of this clock were broken, allowing the pendulum to fall and break the airtight glass case. The 36-inch telescope was moved about three-quarters of an inch to the south, the great base plate slipping on the masonry pier. The telescope was put into position again promptly and without difficulty and has suffered no harm whatever.—*Prof. R. G. Aitken, Acting Director, Lick Observatory.*

NOTES ON THE RIVERS OF THE SACRAMENTO AND SAN JOAQUIN WATERSHEDS.

By N. R. TAYLOR, Local Forecaster.

SACRAMENTO WATERSHED.

There was a gradual diminution in the run-off of all streams in this watershed during the month, but all of the important watercourses carried more water than for any corresponding month during the past five years.

In the Sacramento River, above Red Bluff, there was only a slight range between the highest and lowest stages of the month, and in many of the reaches above Redding the river was practically stationary during the last half of the month. From Knights Landing, however, to the tide limits the difference between the stages of the 1st and those of the 31st of the month were more or less marked.

In the Feather-Yuba territory the rivers averaged from 2 to 2.5 feet higher than during the preceding July, and the Yuba River at Marysville was higher than in any July since 1907.

The American River averaged about 1 foot above the usual July stage and was the highest for any like month since 1907. It receded gradually from the 1st to the 31st with a range of 3 feet.

SAN JOAQUIN WATERSHED.

Except the Stanislaus, Mokelumne, and the San Joaquin, in the vicinity of Lathrop, all rivers in this watershed carried more water than for any July since the establishment of Weather Bureau gaging stations in the San Joaquin Valley. The San Joaquin in the vicinity of Firebaugh and Mendota continued above the flood stage until the 8th, but fell rapidly after this date and by the last of the month had fallen nearly 6 feet. Some lands in the vicinity of Mendota were flooded, but all interests were amply protected by the river forecasts from day to day.

PRECIPITATION AND ALTITUDE IN THE SIERRA.

By Mr. CHARLES H. LEE.

NOTE.—This article is published by courtesy of the editor of the Journal of Electricity, Power, and Gas. Mr. Lee, as one of the engineering staff of the Los Angeles Aqueduct, has carried on extensive measurements of rainfall and depth of snow on the eastern side of the high Sierra, in Inyo County, in the watershed of the Owens River. Mr. Lee has been in touch with the Weather Bureau throughout the period covered by these measurements and has in every way tried to further its work.

Precipitation studies made by the Los Angeles Aqueduct officials in connection with a general investigation of water supply conditions in the Owens Valley have led to some interesting results regarding the relation of precipitation and altitude in the Sierra Nevada. The portion of the range considered extends from Lake Tahoe to the

Mojave Desert. Data gathered and published by the United States Weather Bureau were used where available and were supplemented on the east slope of the Sierra adjacent to the Owens Valley with records kept by the aqueduct officials. The investigations were carried on by the writer under the direction of William Mulholland, chief engineer of the Los Angeles Aqueduct.

The phenomenon of increase of precipitation with altitude is fully recognized by hydraulic engineers who have had occasion to investigate the subject of precipitation. As a basis for engineering computations the relation is often assumed to be a simple ratio, which may be applied without regard to any factor but difference of elevation. As a matter of fact, however, topography, prevailing winds, latitude, and conditions of the atmosphere have a marked effect upon the geographic distribution of rainfall as well as altitude. The straight line relation, even when used as a convenient approximation, has a limited use, and should not be employed indiscriminately, as is shown by the studies herewith presented.

The general area within which precipitation data were considered is shown by the accompanying map. Upon this are indicated the principal rivers and their drainage area, stream gaging and precipitation stations, and isohyets or lines of equal annual rainfall. The isohyets are those of the Water and Forest Association as amended in 1908 by Edwin Duryea, jr. The dotted isohyets in the southeastern portion of the area are revisions proposed by the writer, based on all data available to date. The southern and eastern extension of the 30-inch and 20-inch isohyets is the most radical change, and is justified by the aqueduct observations in Owens Valley.

The relations of precipitation and topography are shown in a general manner by the position of the isohyets. A more instructive method is by graphical study of observations made in and near cross sections of the Sierra, laid out at right angles to the trend of the range. Five such were chosen and are shown on the map as the Central Pacific, Mokelumne, Taboose, Oak, and Bairs sections. There are sufficient observations taken along the two most northerly of these to indicate the relations upon both slopes of the range, but records applying to the three southerly sections are confined to the east slope.

A list of stations along the Central Pacific and Mokelumne sections is given in Table 1, together with elevation, distance from the Great Valley, length of record, observed and computed mean seasonal precipitations, and observed precipitations during the season 1909-10. The stations selected were all within 12 miles of the sections, and their elevations were such that they lay in the average profile of ground surface. (See diagrams 3 and 6.) Of stations in the Central Pacific group, Sacramento, Newcastle, Iowa Hill, Reno (1888-89 to 1909-10) and Wadsworth (1890-91 to 1909-10) are maintained by the Weather Bureau. Observations at other stations are made by agents of the Southern Pacific Co. Stations in the Mokelumne group are all maintained by the Weather Bureau. Elevations are those published in Weather Bureau reports, and where possible were compared with those given on Government topographic sheets. Distances from the Great Valley were scaled from the Government topographic or from the general land office map of California. Observed mean seasonal precipitation was computed for the season, September 1 to August 31. The observed means are for periods of differing length, and to obtain values more strictly comparable the records were computed so as to apply to a single definite period. That selected for the Central Pacific group extended over the

40 seasons, 1870-71 to 1909-10; and for the Mokelumne group, the 28 seasons, 1882-83 to 1909-10. The method of correcting a short record was the common one of comparison with an adjacent station having a complete record.

Stations in the Taboose, Oak, and Bairs groups were established and maintained by the aqueduct officials. They are listed on Table 3 with elevation, distance from the Sierra crest, with observed and computed mean seasonal precipitation. The gages were located on or near the sections at the approximate crossings of 500-foot contours. The immediate surroundings were selected with respect to accessibility from roads and trails, and the recognized requirements for good exposure were observed. The highest level on the slope of the Sierra which can be reached from the Owens Valley after the winter snowstorms is approximately the 6,500-foot contour. Gages were distributed between this contour and the valley floor, which, near Independence, has an average elevation of 3,800 feet. The type of gage used was the ordinary 8-inch cylindrical gage of the Weather Bureau. The funnel-shape receiver, however, was dispensed with, so that the catch fell directly into the 8-inch cylinder. The mounted observer carried the inner tube and cedar measuring stick and poured the catch from the container into the small tube for measuring. Snow was reduced to equivalent water by weighing the catch with a spring balance.¹ The gages were visited after each storm, an observer being detailed to each group, and snowshoes were part of the necessary equipment in winter. The exact elevation and location of the gages were determined by ordinary engineering methods. Distances from the Sierra crest were scaled from the Mount Whitney quadrangle of the United States Geological Survey. The 26-year record at Independence, which was used as a basis for computing long-term means, is given in Table 4. The portion of this record from September, 1866, to August, 1877, was obtained under the direction of United States Army officers stationed at Fort Independence, and under conditions sufficiently similar to permit

of its being combined with the more recent Weather Bureau record at the present town of Independence.

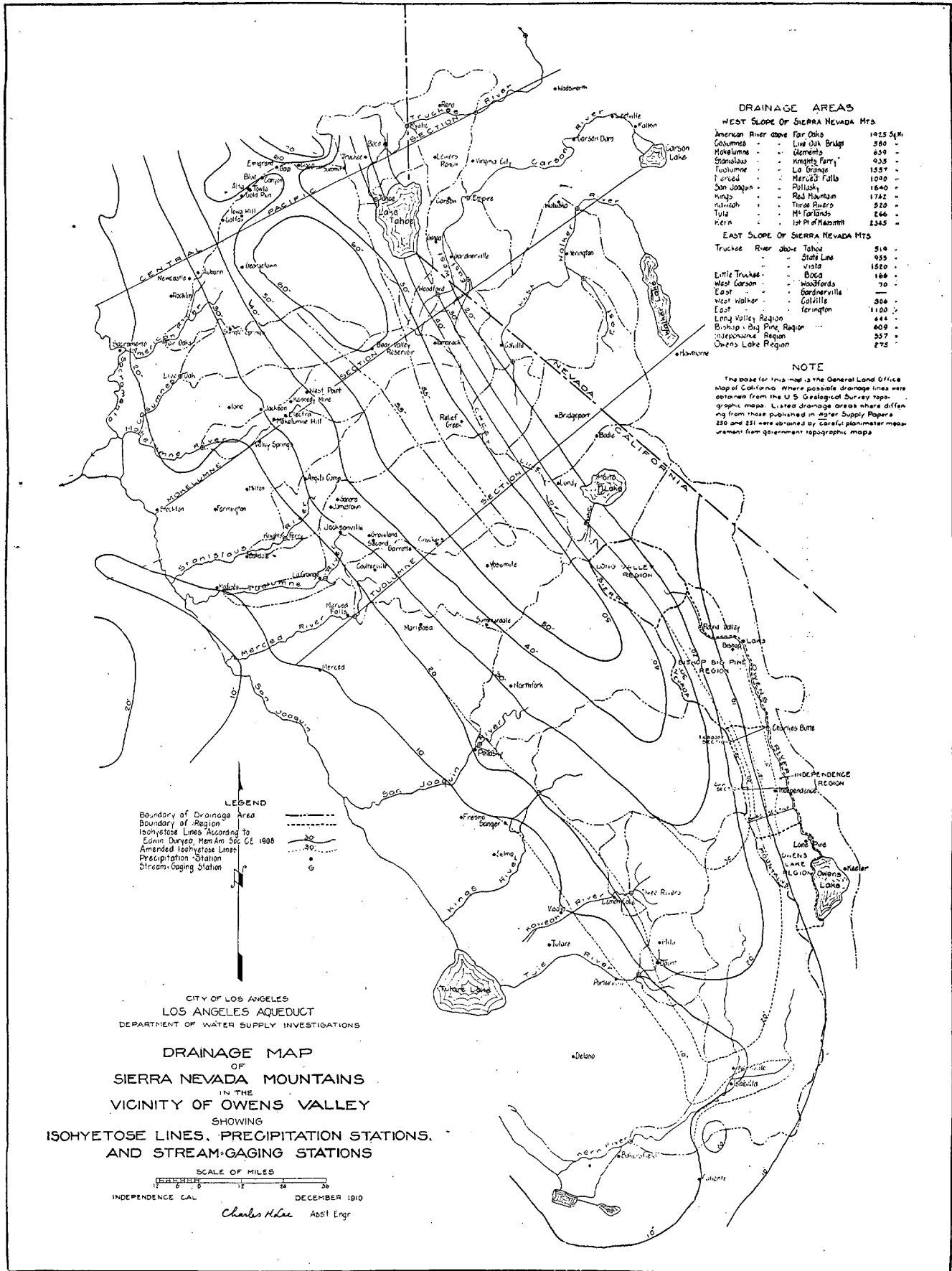
The relations of precipitation, altitude, and topographic position, and also profiles of ground surface, are based on United States Geological Survey topographic maps and are shown for each of the accompanying charts. The values represented by numbered points are those given in Tables 1, 2, and 3. The points at the upper end of curves for Taboose, Oak, and Bairs sections need further explanation, however. As previously noted, it was not practical to make complete precipitation observations above the 6,500-foot contour in Owens Valley. An attempt has been made, however, to arrive at approximate values for precipitation along the adjacent Sierra crest from computations based on measured stream flow. Data available were the true run-off from the east slope of the Sierra, measured at mouths of canyons, and an approximate value of the run-off factor. The mean seasonal discharge per square mile of mountain drainage areas crossed by the Taboose and Oak sections is 1.75 second-feet, and by the Bairs section, 1.36 second-feet. The run-off factor for Kings River, which is adjacent to Owens Valley drainage on the west, is 0.59. Computations for the latter are based on the isohyets of Plate 1; observed variation in precipitation at Merced, Fresno, Sanger, Selma, Visalia, and Summerdale, and the discharge measurements of Kings River at Red Mountain, covering 20 seasons. Run-off factors for the small drainage areas tributary to Owens Valley are probably larger than for Kings River, for the following reasons: The greater average elevation of drainage areas tributary to Owens Valley; nonporous character of the granite bedrock; the universal occurrence of deep cirques and canyons which favor the collection of snow in protected drifts; the snow dust carried over the Sierra crest into the cirque basins by prevailing west and northwest winds; and the absence of lake surfaces or extensive areas supporting vegetation. All of these characteristics tend to make the run-off greater than for Kings River by decreasing evaporation and percolation losses. A value of 0.75 is thought to correctly represent run-off conditions for the Owens Valley streams.

¹ The editor is under the impression that this is the Marvin density bucket, which was furnished to Mr. Lee by the San Francisco office.

TABLE 1.—DESCRIPTION AND MEAN PRECIPITATION FOR STATIONS IN CENTRAL PACIFIC GROUP.

No. of gage.	Station.	Elevation above sea level.	Distance from Sacramento.	Length of record years.	Observed mean seasonal precipitation.	Computed mean seasonal precipitation.			Observed precipitation, 1909-10.
						Base station.	Number of years covered.	Precipitation.	
		<i>Feet.</i>	<i>Miles.</i>		<i>Inches.</i>			<i>Inches.</i>	<i>Inches.</i>
1	Sacramento.....	71		61	19.50	Sacramento.....	40	19.36	12.18
2	Rocklin.....	249	18.9	8	28.45	Auburn.....	40	24.65	21.06
3	New Castle.....	956	26.3	15	32.32	do.....	40	28.20	26.92
4	Auburn.....	1,363	30.0	40	34.93	do.....	40	34.93	36.12
5	Colfax.....	2,421	42.1	40	49.01	Colfax.....	40	49.01	49.69
6	Iowa Hill.....	2,825	46.8	31	52.64	do.....	40	50.53	50.68
7	Gold Run.....	3,222	48.8	11	54.49	Alta-Towle.....	40	43.05	48.34
8	Towle (Alta).....	3,612	52.8	40	49.15	do.....	40	49.15	53.02
9	Blue Canyon.....	4,695	58.5	11	72.82	do.....	40	57.55	64.11
10	Emigrant Gap.....	5,230	61.7	30	53.50	Cisco.....	40	54.50	56.28
11	Cisco.....	5,939	67.9	40	51.96	do.....	40	51.96	58.85
12	Summit.....	7,017	78.6	39	48.00	do.....	40	47.60	37.00
13	Truckee.....	5,820	85.8	39	27.65	Truckee.....	39	27.65	25.01
14	Boca.....	5,531	92.0	38	20.47	Boca.....	38	20.47	25.93
15	Reno.....	4,484	110.1	39	7.05	Reno.....	39	7.05	7.52
16	Wadsworth (Fernley).....	4,084	138.4	35	4.59	Wadsworth.....	35	4.59	5.17

Stations 1 to 12, inclusive, seasonal totals (Sept. 1 to Aug. 31).
Stations 13 to 16, inclusive, calendar year totals, except last column.



DISTRICT NO. 11. CLIMATOLOGICAL SUMMARY.

JULY, 1911

TABLE 2.—DESCRIPTION AND MEAN PRECIPITATION FOR STATIONS IN MOKELUMNE GROUP.

No. of gage.	Station.	Elevation above sea level.	Distance from Stockton.	Length of record years.	Observed mean seasonal precipitation.	Computed mean seasonal precipitation.			Observed precipitation 1909-10.
						Base station.	Number of years covered.	Precipitation.	
		Feet.	Miles.		Inches.			Inches.	Inches.
1	Stockton.....	23		60	15.31	Stockton.....	28	14.82	13.81
2	Farmington.....	111	13.0	33	16.47	Farmington.....	28	16.73	15.91
3	Ione.....	287	33.0	32	21.03	Ione.....	28	21.33	20.39
4	Valley Springs.....	673	31.2	22	24.71	Stockton.....	28	24.18	23.28
5	Jackson.....	1,200	40.0	20	33.19	Jackson.....	20	33.19	33.19
6	Mokelumne Hill.....	1,550	41.0	28	32.53	Mokelumne Hill.....	28	32.53	32.93
7	West Point.....	2,800	52.8	16	42.50	do.....	28	41.15	39.56
8	Bear Valley Reservoir.....	5,800	72.5	7	63.35	do.....	28	57.65	.....
9	Tamarack.....	8,012	89.5	11	57.23	do.....	28	54.73	48.94
10	Gardnerville.....	4,830	108.5	11	8.93	do.....	28	9.08	16.57
11	Wabuska.....	4,347	141.5	7	3.70	do.....	28	.....	3.49

TABLE 3.—PRECIPITATION STATIONS IN OWEN VALLEY.

No. of gage.	Group.	Elevation above sea level.	Distance from crest of Sierra Nevada Mountains.	Observed precipitation, in inches.		Computed mean seasonal precipitation based on 26-year record at Independence.
				Season 1908-9.	Season 1909-10.	
		Feet.	Miles.			
2	Taboose.....	4,070	8.1	9.09	6.65	6.56
3	do.....	4,460	6.9	10.40	7.61	7.51
4	do.....	5,040	5.5	11.74	8.69	8.53
5	do.....	5,550	4.7	16.53	9.26	10.48
6	do.....	6,190	4.2	23.24	12.94	14.69
18	Oak.....	3,735	13.8	.....	3.15	3.25
17	do.....	3,775	12.5	.....	4.25	4.38
7	do.....	3,940	9.6	7.22	4.45	4.78
8	do.....	4,300	8.4	9.24	.....	6.37
8A	do.....	4,500	8.0	.....	5.27	5.43
9	do.....	5,030	6.6	11.35	6.42	7.22
10	do.....	5,590	5.7	14.47	7.67	8.94
11	do.....	6,120	4.8	21.04	10.19	12.51
12	Bairs.....	4,100	10.2	4.28	3.74	3.40
13	do.....	4,500	9.0	6.09	3.63	3.97
14	do.....	5,000	7.7	7.63	5.34	5.38
15	do.....	5,500	6.6	11.67	5.94	7.08
16	do.....	6,100	5.7	14.34	7.24	8.68

TABLE 4.—PRECIPITATION, IN INCHES, AT INDEPENDENCE, CAL.

1865-1877, United States War Department, Fort Independence. Elevation, 3,930 feet.
 1892-1895 and 1898-1910, United States Weather Bureau, Independence. Elevation, 3,920 feet.

Season.	Septem-ber.	October.	Novem-ber.	Decem-ber.	January.	February.	March.	April.	May.	June.	July.	August.	Total.
1865-66.....			0	.65	2.42	0	0	.16					.....
1866-67.....	0	.32	0	2.27	0	1.63	4.76	.53	.76	0	.01	1.15	11.43
1867-68.....	.07	.32	.21	12.19	5.46	0	0	.40	.71	0	.10	0	19.46
1868-69.....	0	.74	.44	1.17	.16	0	.32	.11	.36	0	.03	0	3.33
1869-70.....	0	0	.14	0	.20	1.36	0	.21	.27	0	.35	.10	2.63
1870-71.....	0	1.10	0	1.00	0	1.28	0	0	0	.30	0	0	3.68
1871-72.....	0	0	.65	4.70	0	.30	.28	.55	.18	0	.28	.12	7.06
1872-73.....	0	0	0	1.18	0	.40	0	0	0	0	0	.05	1.63
1873-74.....	.10	0	0	3.40	2.40	1.00	0	0	0	.01	.15	0	7.06
1874-75.....	.40	.80	.40	0	1.73	0	0	0	0	0	0	0	3.33
1875-76.....	.01	0	.66	.62	1.51	.70	.87	0	0	.15	.19	.56	5.27
1876-77.....	.16	.26	0	0	.76	0	0	.59	.69	0	0	0	2.46
1891-92.....							.62	.....	.96	.07	T.	T.	.....
1892-93.....	0	.35	.23	1.61	1.51	2.91	.98	.02	T.	0	.77	T.	8.38
1893-94.....	T.	0	.10	.75	.12	.42	.09	.02	.10	.11	.12	.51	2.34
1894-95.....	T.	0	0	1.89	1.24	1.18	.12	T.	.01	T.	T.	.04	4.48
1895-96.....	T.	.83	.67	.08	1.67	0	0	0	0	0	0	0	.....
1896-97.....													.....
1897-98.....							0	.16	.23	T.	T.	.11	.....
1898-99.....	.20	0	.10	.20	.54	T.	.01	.02	.03	.37	.01	.06	1.54
1899-1900.....	T.	.30	.85	.56	.31	.05	.67	.62	.22	.04	.08	T.	3.70
1900-1901.....	.75	.01	1.34	.13	2.81	.64	.05	T.	.36	0	.10	.32	6.51
1901-2.....	0	.65	.22	.06	.04	1.69	1.05	.17	.04	.01	.17	.13	4.23
1902-3.....	T.	.08	.41	.04	.71	.27	.34	.19	T.	.02	0	0	2.06
1903-4.....	T.	.42	T.	0	T.	1.20	.95	T.	.02	0	T.	.07	2.66
1904-5.....	.32	.06	0	T.	.54	.73	2.08	T.	.25	0	0	T.	3.98
1905-6.....	.25	0	.43	T.	2.89	.13	1.86	.36	.42	.10	.31	.04	6.79
1906-7.....	0	0	.02	.84	.95	.56	1.10	.14	T.	.55	T.	.41	4.17
1907-8.....	0	2.12	T.	.42	1.63	.98	.14	T.	.01	T.	.26	.46	6.01
1908-9.....	.84	.03	.01	.20	3.27	2.73	.16	.12	T.	T.	0	.25	7.61
1909-10.....	.07	.01	.19	3.90	.25	T.	.10	.31	0	0	.27	0	5.10
26-year mean.....	.12	.29	.25	1.43	1.12	.77	.61	.17	.17	.06	.12	.15	5.26

CENTRAL PACIFIC GROUP OF PRECIPITATION GAGES.

MOKELUMNE GROUP of PRECIPITATION GAGES.

DIAGRAM N° 1- RELATION OF ALTITUDE AND PRECIPITATION

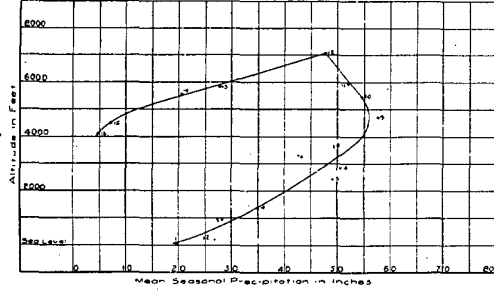


DIAGRAM N° 4 - RELATION OF ALTITUDE AND PRECIPITATION

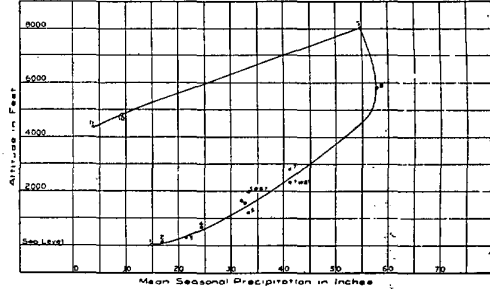


DIAGRAM N° 2- RELATION OF TOPOGRAPHIC LOCATION AND PRECIPITATION

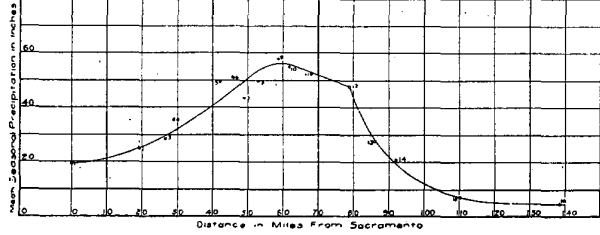


DIAGRAM N° 5 - RELATION OF TOPOGRAPHIC LOCATION AND PRECIPITATION

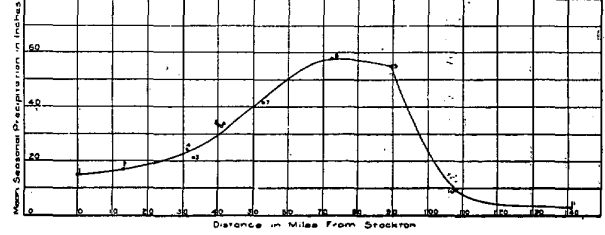


DIAGRAM N° 3- PROFILE OF CENTRAL PACIFIC SECTION

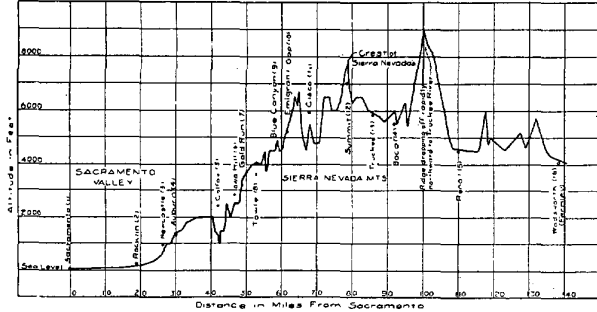
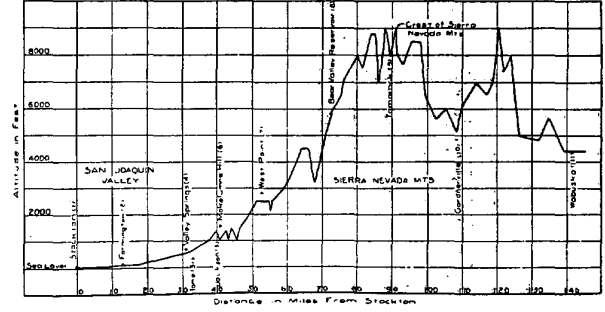


DIAGRAM N° 6- PROFILE OF MOKELUMNE SECTION



TABOOSE GROUP OF PRECIPITATION GAGES.

DIAGRAM N° 7 - RELATION OF ALTITUDE AND PRECIPITATION

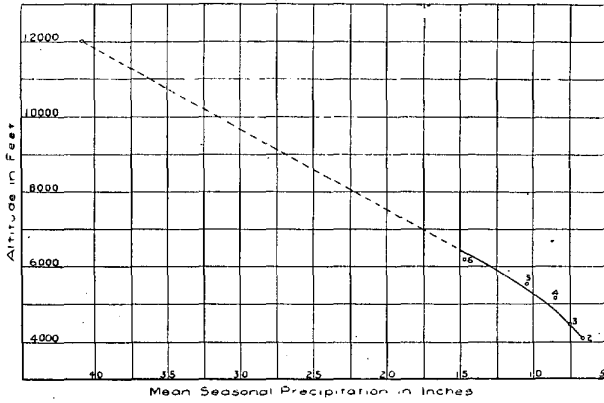


DIAGRAM N° 8
RELATION OF TOPOGRAPHIC LOCATION AND PRECIPITATION

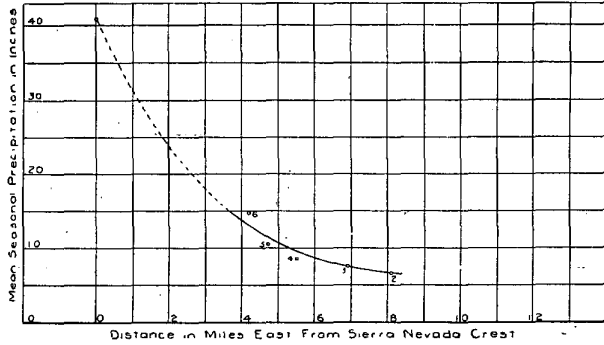
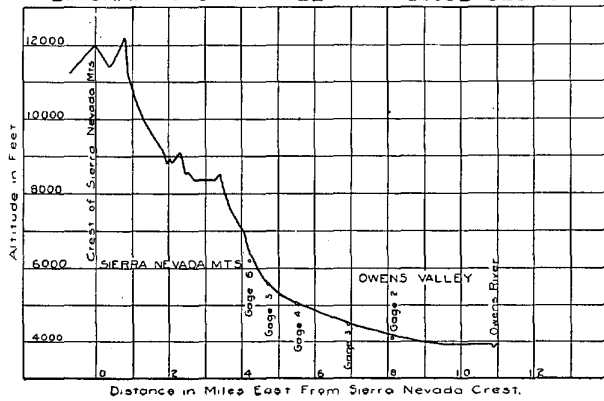


DIAGRAM N° 9 - PROFILE OF TABOOSE SECTION.



OAK GROUP OF PRECIPITATION GAGES.

DIAGRAM N° 10 - RELATION OF ALTITUDE AND PRECIPITATION

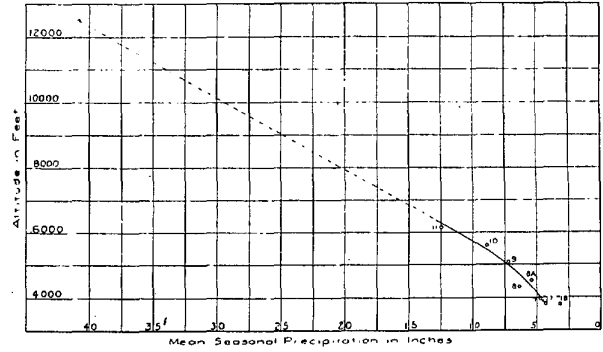


DIAGRAM N° 11
RELATION OF TOPOGRAPHIC LOCATION AND PRECIPITATION

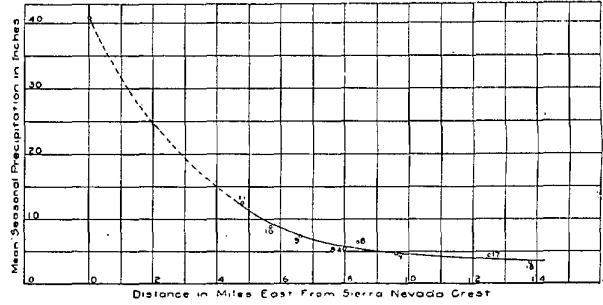
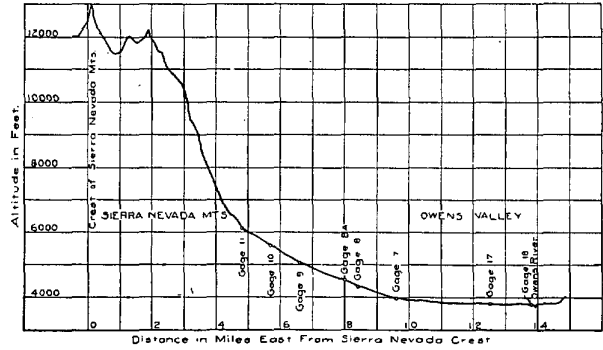


DIAGRAM N° 12 - PROFILE OF OAK SECTION



BAIRS GROUP OF PRECIPITATION GAGES.

DIAGRAM N^o 13 - RELATION OF ALTITUDE AND PRECIPITATION

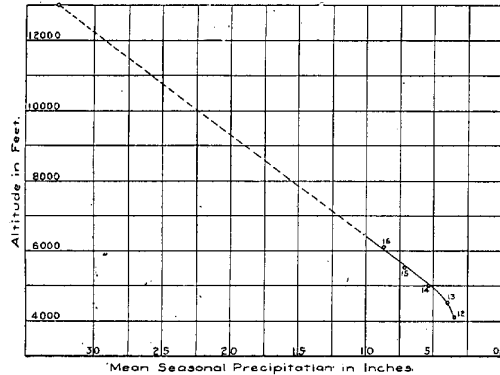


DIAGRAM N^o 14
RELATION OF TOPOGRAPHIC LOCATION AND PRECIPITATION

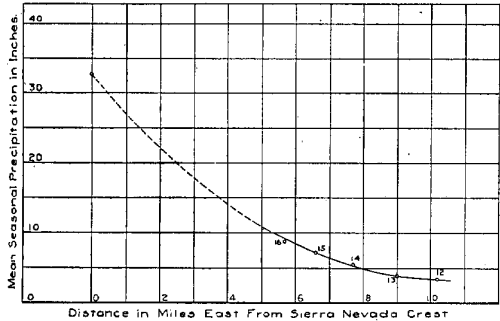
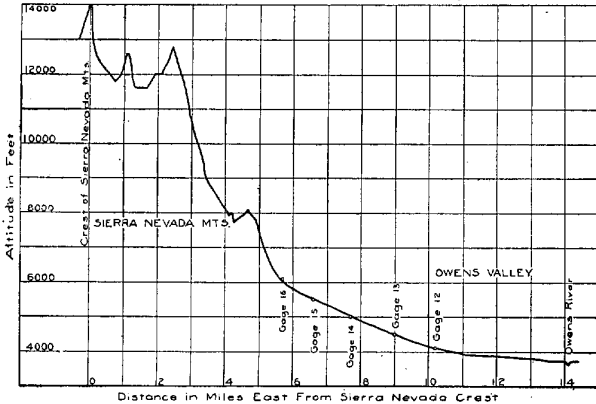


DIAGRAM N^o 15 - PROFILE OF BAIRS SECTION



The shape of many of the mountain drainage areas tributary to the Owens Valley is that of an isosceles triangle with apex at canyon mouth and base lying along the Sierra crest. Measuring from the Sierra crest and assuming a uniform rate of change of precipitation from crest to canyon mouth, as indicated by the observations in the Central Pacific and Mokelumne sections, the average precipitation over one of these triangles equals the true precipitation at one-third the distance between these two points. The observed precipitation at canyon mouths being available, it is therefore a matter of simple proportion to compute that at the crest. The average depth of precipitation over drainage areas having run-off factors of 0.75 and discharges per square mile of 1.75 and 1.36 second-feet is 31.7 and 24.6 inches, respectively. Employing the method of computation outlined

above, the values for precipitation at the Sierra crest are 40.8 inches for the Taboose and Oak sections and 32.7 for the Bairs section. These are the points not numbered on diagrams 7, 8, 10, 11, 13, and 14.

The study of the data presented in Tables 1, 2, and 3 involves a graphical analysis of the relation of: (1) Precipitation to altitude; and (2) horizontal position to precipitation in connection with topography. See diagrams 1, 4, 10, 13 and diagrams 2, 3, 5, 6, 8, 9, 11, 12, 14, and 15.

In general the shape of the curves which fit the plotted points is similar throughout each set of diagrams. Examining the precipitation and altitude curves in detail it appears that there is an increase of precipitation with altitude from the floor of the Great Valley up the western slope of the Sierra to about the 5,000-foot level. The rate of increase for this portion of the curve is greatest in the lower foothills and steadily decreases with increase of elevation. Above 5,000 feet there is a moderate decrease in precipitation with increase of altitude, the rate being practically constant.¹

East of the Sierra crest precipitation decreases rapidly with decrease in altitude, maintaining a constant rate to the 5,000-foot level and a decreasing rate below this elevation. The distance and precipitation curves conform to the profile in general shape, except that their maxima are west of the topographic crest, occupying the same relative position with respect to the Great Valley as the 5,000-foot level. They have a tendency to become horizontal over the level portion of the profile, to rise over western slopes below the 5,000-foot contour, to fall over western slopes above this, and to fall over eastern slopes. In other words, the general slope of the country seems to have more to do with the amount of precipitation than does altitude.

Precipitation upon the plains of northern India and the southern slope of the Himalayas exhibits a similar variation. An empirical equation giving the relation of precipitation and elevation has been developed from observations in that region, as follows: $R = 1 + 1.92 h - 0.40 h^2 + 0.02 h^3$, in which R represents the amount of rain and h the relative height in units of a thousand feet above an assumed plane, which was itself 1,000 feet above sea level. The critical elevation was 4,160 feet above sea level and observations were sufficient to determine that the form of the curve above this elevation was similar to that below, the complete curve approximating a cubic parabola whose axis is the line represented by the critical elevation.

The curves on diagrams 1 and 4 suggest a similar relation for the west slope of the Sierra, with a critical elevation of about 5,000 feet. The relatively low crest of the latter range, however, breaks the relation just above the critical elevation, so that the upper arm of the curve is incomplete and a discontinuity is introduced. The relation of precipitation to elevation upon the Sierra is therefore not unique, but conforms to some general law.

The condition met with is the broad slope of a long mountain range presented to a prevailing moisture-laden wind. The movement of a body of moist air up such a slope results in expansion and cooling of the air. When the temperature reaches the dew point condensation of the aqueous vapor occurs. The latent heat thus liberated tends to warm the air and raises its temperature

¹ Reference should be made to various papers by McAdie and Willson, in Monthly Weather Review and Climatology of California; also to papers by Lippincott, Clapp, and others in various Water Supply Papers.

above the dew point. The descent on the leeward slope of the range is accompanied by a rapid compression and rising temperature of a body of air. Hence, precipitation is greatest along the lower windward slopes of the Sierra and reaches its maxima at the lower cloud limit, the 5,000-foot contour, decreasing slowly from here to the crest of the range and decreasing rapidly down the leeward slope to the desert. It is, therefore, not increasing elevation alone which causes increase in precipitation; but broad rising slopes which give an upward movement to bodies of moist air driven by prevailing winds.

The conclusions from this study which can be applied in practical computations are as follows:

1. The precipitation upon the west slope of the Sierra between the Yuba and Tuolumne Rivers increases at a variable rate, which, expressed as an average, is 0.85 inch per hundred-foot rise from the floor of the Great Valley to the 5,000-foot contour.

2. Above the 5,000-foot contour it decreases approximately at the rate of 0.40 inch per hundred-foot rise to the crest of the Sierra.

3. Precipitation upon the east slope of the Sierra decreases at differing rates, depending upon the elevation of the crest and depth of precipitation at the summit. The rate is constant above the 5,000-foot contour, and for the sections studied is as follows:

Central Pacific, 1.74 inches per hundred foot fall.

Mokelumne, 1.43 inches per hundred foot fall.

Taboose and Oak, 0.46 inch per hundred foot fall.

Bairs, 0.34 inch per hundred foot fall.

Mr. Fred G. Plummer, in a bulletin on chaparral, No. 85, of the Forest Service, gives the following estimate of the average annual precipitation over the chaparral area in southern California:

At sea level.....	13 inches.
At 2,000 feet:	
West and south slopes, 25)	
East and north slopes, 9)	17 inches.
At 5,000 feet:	
West and south slopes, 43)	
East and north slopes, 27)	35 inches.
At 8,000 feet:	
West and south slopes, 61)	
East and north slopes, 45)	53 inches.

TABLE 1.—Climatological data for July, 1911. District No. 11, Oregon.

Table with columns: Stations, Counties, Elevation, Length of record, Temperature (Mean, Departure from normal, Highest, Date, Lowest, Date, Greatest daily range), Precipitation (Total, Departure from normal, Greatest in 24 hours, Total snowfall, Number of rainy days, Number of clear days, Number of partly cloudy days, Number of cloudy days), Sky, Prevailing wind direction, Observers.

TABLE 1.—Climatological data for July, 1911. District No. 11—Continued.

Table with columns: Stations, Counties, Elevation, Length of record, Temperature (Mean, Departure from normal, Highest, Date, Lowest, Date, Greatest daily range), Precipitation (Total, Departure from normal, Greatest in 24 hours, Total snowfall), Sky (Number of rainy days, Number of clear days, Number of partly cloudy days, Number of cloudy days), Prevailing wind direction, Observers.

TABLE 1.—Climatological data for July, 1911. District No. 11—Continued.

Stations.	Counties.	Elevation, feet.	Length of record, years.	Temperature, in degrees Fahrenheit.							Precipitation, in inches.				Sky.				Observers.	
				Mean.	Departure from the normal.	Highest.	Date.	Lowest.	Date.	Greatest daily range.	Total.	Departure from the normal.	Greatest in 24 hours.	Total snowfall, unmelted.	Number of rainy days, 0.01 inch or more.	Number of clear days.	Number of partly cloudy days.	Number of cloudy days.		Prevailing wind direction.
California—Continued.																				
Sierraville.....	Sierra.....	5,000	1	65.0	.....	93	16	32	22	55	0.30	.....	0.12	0	3	25	1	5	.....	C. D. Johnson.
Sisson.....	Siskiyou.....	3,555	22	67.8	- 1.9	94	12†	42	4†	46	0.72	+ 0.67	0.60	0	2	28	0	3	n.	Southern Pacific Co.
Soledad**	Monterey.....	188	37	66.2	+ 0.1	85	7	52	22	.....	0.00	0.00	0.00	0	0	31	0	0	n.	Do.
Southeast Farallon.....	San Francisco.....	30	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	U. S. Weather Bureau.
Sonora.....	Tuolumne.....	1,825	23	78.6	.....	104	16	53	1†	42	0.00	- 0.02	0.00	0	0	30	1	0	sw.	Chas. P. Jones.
Squirrel Inn.....	San Bernardino.....	5,280	1	66.4	.....	88	30	52	1†	35	T.	.....	T.	0	0	31	0	0	s.	A. D. Frantz.
Stirling City.....	Butte.....	3,525	7	74.3	.....	101	16	51	21	40	0.00	.....	0.00	0	0	28	2	1	se.	Butte County R. R. Co.
Stockton (S. H.).....	San Joaquin.....	23	40	73.9	+ 1.3	98	25	51	20	40	0.00	- 0.02	0.00	0	0	31	0	0	nw.	State Hospital.
Storey.....	Madera.....	296	11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Santa Fe Co.
Suisun**	Solano.....	20	31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Southern Pacific Co.
Sumnerdale.....	Mariposa.....	5,270	15	70.0	+ 1.5	96	15	43	1	34	0.00	- 0.03	0.63	0	0	26	5	0	.....	Mrs. J. E. Lowry.
Summit.....	Placer.....	7,017	38	58.8	- 2.2	80	16	36	25	35	0.00	- 0.20	0.00	0	0	29	0	2	sw.	Southern Pacific Co.
Susanville.....	Lassen.....	4,175	22	68.2	- 3.6	96	17	39	1†	44	0.77	+ 0.65	0.42	0	3	19	12	0	sw.	James Branham.
Tamarack.....	Alpine.....	8,000	5	55.8	.....	86	18	28	1†	45	0.83	.....	0.22	0	8	17	14	0	sw.	William Bennett.
Tehachapi**	Kern.....	3,964	34	81.3	+ 4.9	99	16	69	23†	.....	0.00	- 0.01	0.00	0	0	.....	.....	.....	.....	Southern Pacific Co.
Tehama**	Tehama.....	220	40	86.8	+ 2.7	111	16	70	1	.....	0.00	- 0.08	0.00	0	0	29	1	1	n.	Do.
Tejon Rancho.....	Kern.....	1,500	9	78.3	.....	95	17	55	1	24	T.	.....	T.	0	0	23	7	1	n.	S. E. Bailey.
Three Rivers.....	Tulare.....	870	1	81.4	.....	108	16	54	1	45	T.	.....	T.	0	0	19	10	2	sw.	E. D. Barton.
Towle.....	Placer.....	3,704	25	69.9	- 1.2	93	8	39	4	44	T.	- 0.11	T.	0	0	30	1	0	sw.	Southern Pacific Co.
Tracy**	San Joaquin.....	64	31	84.9	+ 5.0	105	16	64	20	.....	0.00	- 0.01	0.00	0	0	26	5	0	nw.	Do.
Ukiah.....	Mendocino.....	620	18	75.4	+ 2.0	110	16	43	21	58	0.00	- 0.03	0.00	0	0	31	0	0	nw.	Dr. Geo. McCowen.
Upland.....	San Bernardino.....	1,750	14	74.2	+ 1.1	104	25	49	7	44	0.00	- 0.01	0.00	0	0	29	2	0	w.	A. P. Harwood.
Upper Lake.....	Lake.....	1,350	26	77.4	+ 4.3	108	15	49	1	46	0.00	- 0.03	0.00	0	0	30	1	0	nw.	C. M. Hammond.
Vacaville.....	Solano.....	175	23	74.6	- 1.8	106	16	43	26	62	0.00	0.00	0.00	0	0	27	4	0	sw.	G. O. Coburn.
Valley Springs**	Calaveras.....	673	22	80.4	- 0.6	109	16	58	20	.....	0.00	- 0.03	0.00	0	0	31	0	0	nw.	Southern Pacific Co.
Visalia.....	Tulare.....	334	23	79.4	- 1.6	107	16	52	22	44	T.	- 0.03	T.	0	0	26	4	1	.....	Santa Fe Co.
Warner Springs.....	San Diego.....	3,165	3	73.5	.....	97	30	51	1†	41	0.14	.....	0.14	0	1	19	7	5	.....	Mrs. F. S. Sandford.
Wasco.....	Kern.....	336	11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Santa Fe Co.
Watsonville.....	Santa Cruz.....	23	15	59.2	- 4.1	82	1	39	1	43	0.00	0.00	0.00	0	0	5	25	1	sw.	Spreckels Sugar Co.
Weitchpec.....	Humboldt.....	1,700	1	71.2	.....	102	16	41	7	42	0.03	.....	0.03	0	1	29	1	1	ne.	M. E. Lathrop.
Westley**	Stanislaus.....	90	22	81.6	- 1.5	108	16	60	24	.....	0.00	.....	0.00	0	0	31	0	0	n.	Southern Pacific Co.
Wheatland.....	Yuba.....	84	24	77.4	+ 0.2	106	16	52	20	40	T.	- 0.01	T.	0	0	27	3	1	s.	Wm. Lumbard.
Willows.....	Glenn.....	136	32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	L. C. Stiles.
Yosemite.....	Mariposa.....	3,945	7	71.8	.....	98	13†	42	1	50	0.39	.....	0.37	0	2	26	5	0	s.	J. P. Kelly.

a, b, c, etc., indicate respectively 1, 2, 3, etc., days missing from the record.
 ** Temperature extremes are from observed readings of the dry bulb; means are computed from observed readings.
 † Also on other dates.
 T. Precipitation is less than 0.01 inch rain or melted snow.

TABLE 2.—Daily precipitation for July, 1911. District No. 11—Continued.

Stations.	Watershed.	Day of month.																														Total.		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		31	
<i>California—Con.</i>																																		
Upper Lake.....	Sacramento.																																	0.00
Upper Mattole.....	Coast.....																																	0.00
Vacaville.....	Sacramento.																																	0.00
Valley Springs.....	San Joaquin.																																	0.00
Visalia.....	do.....																																	T.
Warner Springs.....	Coast.....																																	0.14
Wasco.....	San Joaquin.																																	0.00
Watsonville.....	Coast.....																																	0.03
Weitchpec.....	Klamath.....																																	0.03
West Branch.....	Sacramento.																																	6.00
Westley.....	San Joaquin.																																	T.
West Point.....	do.....																																	T.
West Saticoy.....	Coast.....																																	0.00
Wheatland.....	Sacramento.																																	T.
Willows.....	do.....																																	T.
Yosemite.....	San Joaquin.																																	0.39

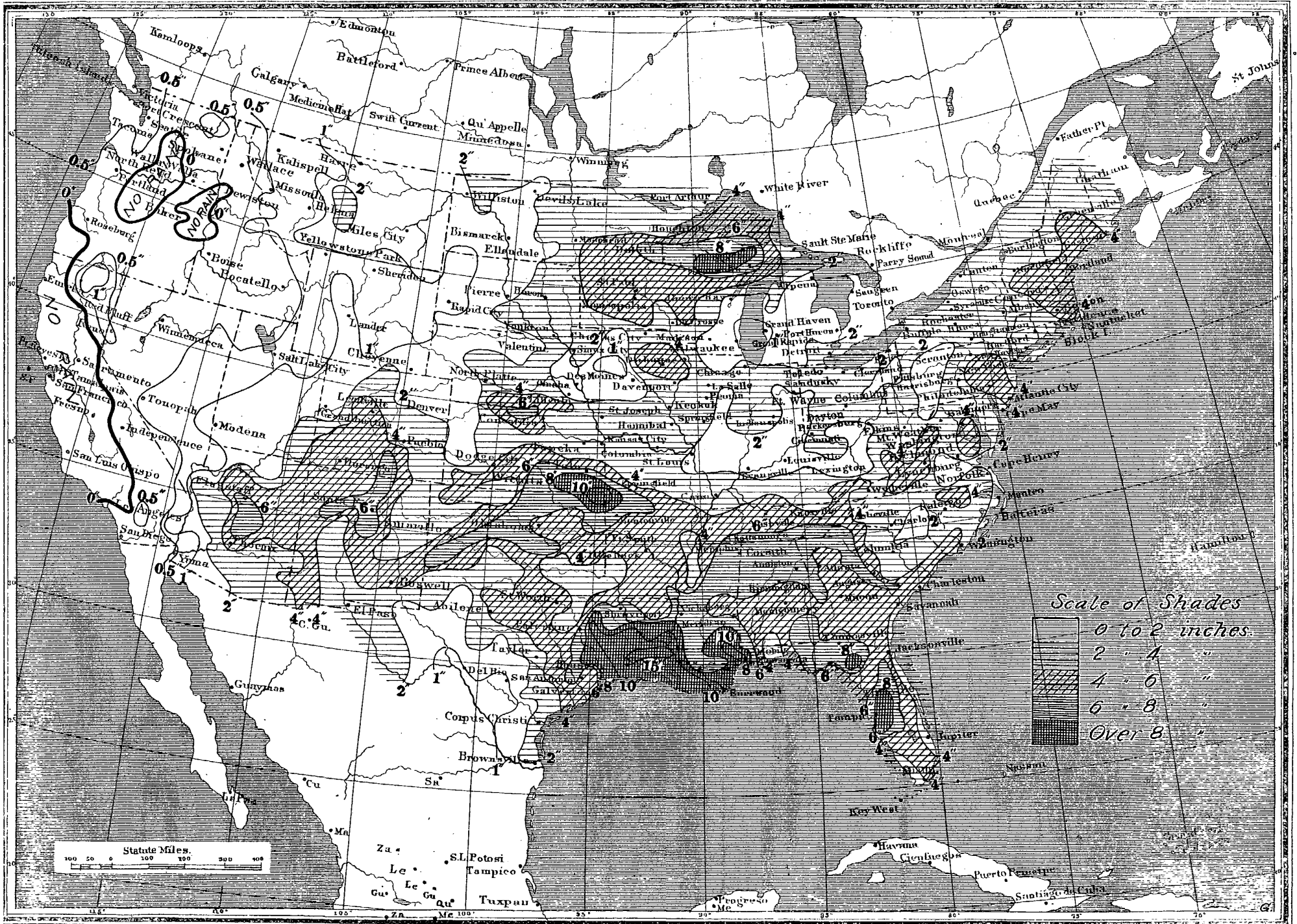
* Precipitation included in that of the next measurement.
 † Separate dates of falls not recorded.
 ‡ Precipitation for the 24 hours ending on the morning when it is measured.
 T. Precipitation is less than 0.01 inch rain or melted snow.

TABLE 3.—Maximum and minimum temperatures for July, 1911. District No. 11, California.

Table with columns for Date, Lakeview, Oreg., and various California locations: Alturas, Barstow, Branscomb, Brawley, Colusa, Eureka, Fresno, Independence, Los Angeles, Mount Tamalpais, Nevada City, Porterville, Red Bluff. Each location has Max. and Min. temperature columns.

Table with columns for Date and various California locations: Redlands, Sacramento, San Diego, San Francisco, San Jose, San Luis Obispo, Santa Barbara, Santa Rosa, Sisson, Stockton, Summit, Susanville, Yosemite. Each location has Max. and Min. temperature columns.

a, b, c, etc., indicate respectively 1, 2, 3, etc., days missing from the record.
§ Data are from standard instruments not supplied by the U. S. Weather Bureau.
§§ Instruments are read in the morning; the maximum temperature then read is charged to the preceding day, on which it almost always occurs.



Scale of Shades
 0 to 2 inches.
 2 " 4 "
 4 " 6 "
 6 " 8 "
 Over 8 "

Statute Miles.
 0 100 200 300 400

