UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Ground Water Branch

SUMMARY OF HYDROLOGIC CONDITIONS AT JOSHUA TREE NATIONAL MONUMENT, RIVERSIDE COUNTY, CALIF., 1956-59

Prepared at the request of the
National Park Service
Department of the Interior

OPEN-FILE REPORT

Long Beach, California
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SUMMARY OF HYDROLOGIC CONDITIONS AT JOSHUA TREE NATIONAL MONUMENT, 1956-59

By Fred Kunkel

INTRODUCTION

At the request of the National Park Service, U.S. Department of the Interior, the U.S. Geological Survey, since 1956, has made a continuing study in the Pinto Basin area of the Joshua Tree National Monument to determine if the pumping of water from wells in the Pinto Basin area is causing a lowering of water levels that might be adverse to the interests of the Park Service by altering the native conditions of the area.

This report describes the results of drilling and testing two water wells, tabulates and analyzes periodic measurements of water levels, and describes the effects of ground-water pumping on water levels in the area. This report supplements through March 1959 a previous report by Kunkel (1956) which summarized the results of an earlier study in the Pinto Basin area.

The Pinto Basin area is in the north-central part of Riverside County, Calif., between long 115°20' and 116°00' W. (pl. 1). It in-

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Plate 1. Vicinity map of southern California.

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cludes the alluviated or valley-floor part of a drainage system that discharges to the south between the Eagle and Coxcomb Mountains. The area is shown on the Corps of Engineers Eagle Tank and Pinkham Well quadrangles (pls. 2 and 3).

Plate 2. Part of the Pinkham Well quadrangle.

Plate 3. Map of Pinto Basin and vicinity, Riverside County, Calif.

The investigation was made by personnel of the Long Beach, Calif., subdistrict office of the Geological Survey under the general supervision of H. D. Wilson, Jr., district engineer, Sacramento, Calif.

DRILLING AND TESTING OF WELLS

Smoke Tree Wash

In December 1958 a water well was drilled for the National Park Service in Smoke Tree Wash northwest of the Cottonwood Pass Road (pl. 2) at a site suggested by the Geological Survey. This well was drilled to a depth of 403 feet and was test pumped at a rate of approximately 45 gpm (gallons per minute) at a pumping level of about 257 feet below the measuring point. The drawdown at this pumping rate was 85 feet below the static water level of about 171.6 feet below the measuring point, indicating a specific capacity of about 0.5 gpm per foot of drawdown. The driller's log and results of test pumping for the Cottonwood Pass well are shown below.

Cottonwood Pass well. Owner, National Park Service. Altitude about 2,975 ft. Cable-tool well drilled by Clifford Suffdy in 1958. 12-3/4 inch casing from zero to 232 ft, perforated with Mills perforator from 212 to 228 ft; 10-3/4 inch casing preperforated from 208.75 to 402.75 ft. Log by driller.

	Thickness (feet)	Depth (feet)
Sand, gravel	60	60
Boulders, clay content	55	115
Sand, clay content	20	135
Clay, boulders	43	178
Clay, pure	5	183
Boulders, clay, very rough, water showed	32	215
Boulders, clay	16	231
Gravel, boulders, clay	54	285
Soft, probably more water	20	305
Clay, some gravel	98	403

SUMMARY OF TEST PUMPING

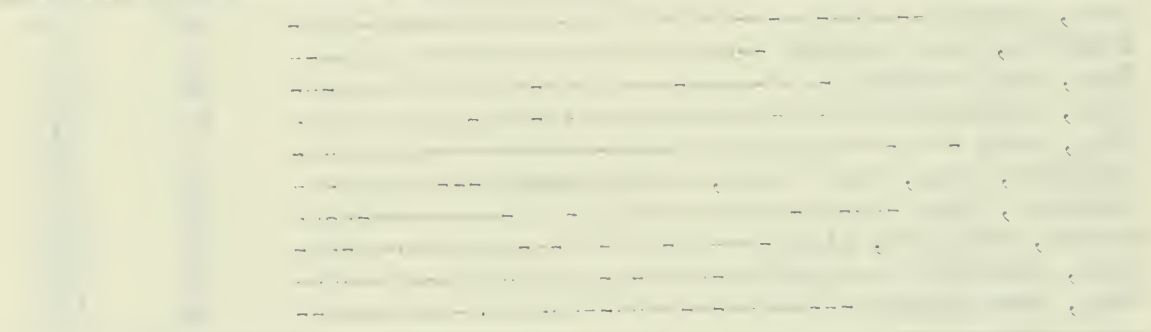
Cottonwood Pass Well

(Data by Clifford Suffdy, driller, except as indicated)

Date	Time	Pumping rate (gpm)	Depth to water (feet)	Drawdown (feet)	Specific capacity 1/
Nov. 21, 1958	8:00 a.m.	-	171.6	-	-
	2:30 p.m.	40	-	-	-
Dec. 1	-	-	171.6	-	-
	-	45	257	85	0.5
Mar. 12, 1959	-	-	a171.29	-	-

a. Measurement by Geological Survey. Measurement is from top of access pipe which is 1.0 ft above land-surface datum.

1. Specific capacity is the yield of the well in gallons per minute per foot of drawdown of the water level below the static or nonpumping level.



Pinto Basin

In April and May 1957 a water well was drilled for the Kaiser Steel Corp. to a depth of 675 feet at the site in Pinto Basin shown as well 9 on plate 3. Well 9 was developed and test pumped from May 17 through 20, 1957. On June 20, after 8 hours of continuous pumping, the yield of the well was 1,200 gpm at a drawdown of 64 feet. The driller's log and results of test pumping are shown below.

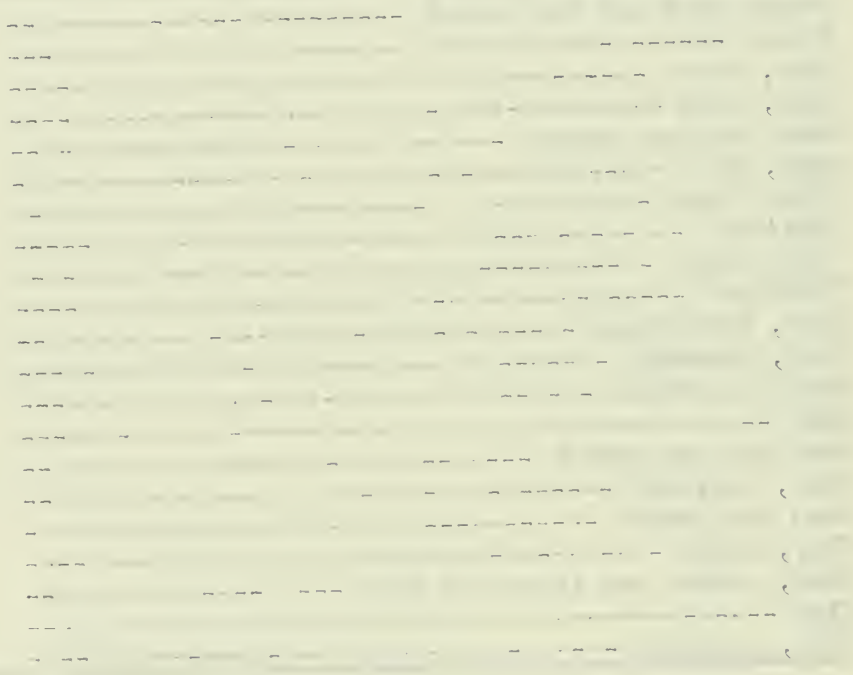
Pinto well 9 (Kaiser well 3). Owner, Kaiser Steel Corp., Eagle Mountain Mine. Altitude about 1,058 ft. Cable-tool well drilled by Ray Roberts Drilling Co. in April-May 1957. 20-inch casing, perforated with Mills perforator from 449 to 658 ft. Log by James Cahill, driller.

	Thickness (feet)	Depth (feet)
Coarse sand and pea gravel	47	47
Gravel	8	55
Clay, brown	60	115
Sand, fine	28	143
Sand and some gravel	48	191
Sand, fine	53	244
"Pack" sand	6	250
"Caliche"	22	272
"Sand clay"	78	350
"Caliche"	41	391
Clay, hard brown	58	449
Clay, gravelly	72	521
Sand and gravel	6	527
Clay	4	531
Sand and pea gravel	15	546
Clay, gravelly	45	591
Sand and gravel	19	610
Clay, sandy	6	616
Sand, gravel and layers of clay	42	658
Clay	15	673
Sand, cemented	2	675

SUMMARY OF PUMPING TEST
Pinto Well 9
(Data collected by U.S. Geological Survey)

Date	Time	Pumping rate (gpm)	Depth to water (feet) [1]	Drawdown (feet)	Specific capacity
June 20, 1957	6:00 a.m.	-	126	-	-
	6:05	1,209	156	30	40
	6:20	1,209	176	50	24
	7:00	1,209	179	53	23
	8:00	1,209	182	56	22
	9:00	1,209	184	58	21
	10:00	1,209	184	58	21
	11:00	1,209	184	58	21
	12:00	1,200	184	58	21
	1:00 p.m.	1,200	190	64	19
	2:00	1,200	190	64	19

1. Depth-to-water measurements are by air line from an unspecified measuring point. These measurements are comparable with each other but will not be comparable with measurements made by a steel tape or electric sounder from a specified measuring point.



CHEMICAL QUALITY OF WATER

Water from the Cottonwood Pass well is shown by the chemical analysis (table 1) to be a calcium sodium bicarbonate type. It is relatively low in dissolved solids and contains no constituent detrimental for irrigation use. The fluoride content of 2.7 ppm (parts per million), however, restricts its use for domestic purposes.

Table 1.--Chemical analyses of waters from wells in Joshua Tree National Monument, Calif.

	Cottonwood Pass well[1]	Pinto well 1[2]	Pinto well 2[3]	Pinto wells 1 and 9[1]
Constituents in parts per million				
Silica	24	-	20	12
Iron	-	-	0	-
Calcium	36	10	14	11
Magnesium	8	.7	.7	2
Sodium	41	208	199	200
Potassium	1.9	3.2		3.5
Bicarbonate	142	118	77	102
Carbonate	0	0	8	0
Sulfate	23	a215	245	216
Chloride	44	102	97	104
Fluoride	2.7	2.0	-	2.5
Nitrate	4	18	-	22
Boron	.2	.44	-	.38
Sum[4]	a255	a617	a622	a624
Dissolved solids[5]	314	-	571	598
Hardness as $CaCO_3$	a123	28	a38	a36
Percent sodium	42	93	87	92
Specific conductance (micromhos at 77°F)	473	1,010	-	1,024
pH	7.0	8.2	8.1	7.7
Temperature (°F)	-	-	-	79
Date collected	12-4-58	2-11-56	12-5-54	11-30-57

1. Analysis by California Department of Water Resources.
2. Analysis by Geological Survey, Quality of Water Branch, Sacramento, Calif.
3. Analysis from records of Kaiser Steel Corp. Analyst unknown.
4. The sum of determined constituents is the arithmetic total in parts per million of all constituents determined, except for bicarbonate which is divided by 2.03 (Collins, W. D., Water-Supply Paper 596-H, p. 253). Where the sulfate is calculated by difference the sum includes that quantity and is approximate only.
5. Residue on evaporation. This value, analytically determined, should be about the same as the sum of determined constituents.

a. Calculated by the Ground Water Branch.

Although a fluoride content of about 1.0 ppm is considered to be beneficial in the reduction of dental decay among children, frequent use of a drinking water containing a significantly higher concentration may cause mottling of tooth enamel among children. The U.S. Public Health Service (1946) sets a mandatory upper limit of 1.5 ppm of fluoride for drinking and culinary water supplied by interstate carriers subject to Federal quarantine regulations. The U.S. Navy, Bureau of Medicine (1957) has set the upper limits for optimum fluoride concentrations at 0.7 to 1.2 ppm, the range being dependent upon the temperature of the region.

As it was not possible to collect water directly from Pinto well 9 (Kaiser 3), the chemical analysis (table 1) represents a mixture of water from well 9 and a small percentage from well 1. This sample, collected on November 30, 1957, from a storage tank was reported by personnel of the Kaiser Steel Corp. to be principally from well 9. Chemical analyses given in table 1 show that water from Pinto wells 1, 2, and the mixture from 1 and 9 is of the sodium sulfate type. Compared with water in many other desert basins, these waters are relatively low in dissolved solids. However, the fluoride concentration of 2.0 ppm in water from well 1 and 2.5 ppm in water from well 9 is greater than the mandatory limit for drinking water.

The percent sodium of 93, 87, and 92 in water from wells 1, 2, and 9, respectively, is greater than the recommended limits for irrigation water, which according to Wilcox (1948) should be less than 65 percent. The sodium ions in water tend to disperse the colloidal clay particles in a soil, resulting in a relatively impermeable soil of poor texture for the cultivation of plants.

FLUCTUATIONS OF WATER LEVEL IN PINTO BASIN

The Geological Survey has made periodic measurements of water level in wells 1 and 2 since 1955 and in well 9 since 1957. A measurement was made in well 1 by the Metropolitan Water District of Southern California in 1933 and periodic measurements have been made by the Kaiser Steel Corp. since 1949. Measurements prior to March 24, 1956, are tabulated in the report by Kunkel (1956), and measurements from March 24, 1956, through March 1959 are shown in table 2. These water-level records, shown graphically on plate 4, indicate a long-term net

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Plate 4. Hydrographs of wells 1, 2, and 9 in Pinto Basin, Calif.

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decline of the water level in well 1 of nearly 2 feet from 1952 to February 1956, about 2.5 feet from 1933 to February 1956, and a seasonal fluctuation of 1 to 3 feet during this period. From February 1956 to March 1959 a decline of about 12 feet has been observed in well 1. The altitude of the water surface in well 9 is virtually the same as that in well 1. Pumping in either well has a direct and almost immediate effect on the other.

Table 2.--Water levels in wells in Pinto Basin, Calif.[1/]

(Water levels are in feet below land-surface datum)

Pinto well 1, Kaiser Steel Corp., well 1. Altitude of land-surface datum is 1,048.1 ft. Depth of well on July 18, 1956, was 482 ft.

Date	Water level	Date	Water level	Date	Water level
May 27, 1956	100.93	May 19, 1957	b115.5	May 31, 1958	107.77
28	100.19	19	a231.9	Sept.15	108.08
Aug. 18	102.65	Nov. 30	102.8	Jan. 7, 1959	110.88
May 18, 1957	a232.3	May 3, 1958	103.18	Mar. 12	110.78

Pinto well 2, Kaiser Steel Corp., well 2. Altitude of land-surface datum is 1,080.6 ft. Depth of well on December 22, 1955, was 445 ft.

May 27, 1956	154.88	May 19, 1957	155.65	Mar. 2, 1958	155.1
July 27	c155.3	June 26	d155.48	May 30	155.4
Aug. 18	155.3	Aug. 21	c155.49	Sept.15	155.6
Sept.19	155.7	Sept.18	c155.37	Jan. 7, 1959	155.7
May 18, 1957	155.21	Nov. 30	155.0	Mar. 12	155.6

Pinto well 9, Kaiser Steel Corp., well 3. Altitude of land-surface datum is 1,059.4 ft. Well depth is about 675 ft.

May 16, 1957	e117	May 31, 1958	118.64	Jan. 7, 1959	121.89
Nov. 30	114.22	Sept.15	118.89	Mar. 12	121.58
Mar. 2, 1958	114.27				

1. For records of water level for 1933-March 24, 1956, see Kunkel (1956).

a. Pumping 532 gpm.

b. Pump off less than 1 hour; because of heavy pumping schedule it was impossible to allow sufficient time for a complete recovery.

c. Measurement by Kaiser Steel Corp.

d. Measurement from recorder chart.

e. Reported by driller from measuring point, not referred to land surface.

The decline in wells 1 and 9 has been caused by withdrawal of ground water by the Kaiser Steel Corp. which has increased from about 130 acre-feet per year in 1952 to about 1,700 acre-feet per year in 1958 (table 3).

Table 3.--Pumpage from wells in Pinto Basin by the Kaiser Steel Corp. for the calendar years 1952-58

(Pumpage metered in gallons by Kaiser Steel Corp., except as indicated)

	1952	1953	1954	1955	1956	1957	1958	1959
Jan.	1,915,700	2,745,624	4,693,830	a8,000,000	7,336,750	10,690,040	36,455,100	
Feb.	2,179,436	3,141,180	a5,000,000	a7,000,000	9,523,000	9,655,520	29,039,550	
Mar.	2,381,092	4,490,723	a5,500,000	6,764,280	9,867,800	9,700,000	38,358,253	
Apr.	2,373,336	2,668,064	6,034,197	6,607,440	10,012,700	10,345,200	37,120,890	
May	3,049,108	a3,800,000	7,666,723	7,242,000	16,775,500	10,780,000	41,490,107	
June	a3,800,000	4,827,738	10,030,310	9,300,100	9,916,700	10,455,000	40,500,400	
July	4,630,332	4,847,620	7,939,670	10,326,500	11,897,000	11,134,300	46,029,916	
Aug.	4,793,208	5,685,418	8,807,000	12,925,900	13,968,000	26,950,000	45,545,080	
Sept.	4,622,576	5,578,526	8,724,830	11,405,818	13,724,000	28,350,000	46,029,916	
Oct.	4,300,000	6,341,786	8,183,370	9,367,682	12,141,000	27,875,200	64,135,001	
Nov.	4,297,000	4,513,400	a8,000,000	9,310,000	11,085,000	26,064,860	59,997,259	
Dec.	3,017,000	3,927,808	a8,000,000	8,428,000	9,664,000	30,879,200	63,100,566	
Total[1/] (gallons)	41,400,000	52,600,000	88,600,000	107,000,000	136,000,000	213,000,000	548,000,000	
Total[2/] (acre-ft)	130	160	270	330	420	650	1,700	

1. Totals rounded to three significant figures.
2. Totals rounded to two significant figures.
a. Meter not in operation. Quantity estimated by Kaiser Steel Corp.

For the period of record, beginning in 1955, there has been no appreciable decline in the water level at well 2 (pl. 4). Well 2, on which a continuous water-level recorder was operated from May 18 to June 26, 1957, is about 1,500 feet east of well 9 and is on the opposite side of a fault. The fault, shown as concealed on plate 3, lies along the north side of the Eagle Mountains. Plates 5 and 6 are graphs of the water level in well 2. The recorder was installed after test pumping had started at well 9; therefore, the graph on plate 5

Plate 5. Hydrograph of well 2 in Pinto Basin for May 18-19, 1957.

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does not show the highest water level in well 2 before pumping began. However, the graph shows a water-level decline of about 0.15 foot for that part of the drawdown period during which the recorder was in operation. Plate 6 shows a recovery of water level of about 0.2 foot

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Plate 6. Hydrograph of well 2 in Pinto Basin for May 19-June 26, 1957.

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after the cessation of test pumping of well 9 and a daily fluctuation of about 0.15 foot caused by changes in atmospheric pressure.

For the period 1952-58 the quantity of water pumped in Pinto Basin totaled about 3,700 acre-feet and is reflected in the long term water-level decline in wells 1 and 9 as described on page 12 and shown on plate 4. In relation to the total quantity of ground water stored in Pinto Basin the 3,700 acre-feet pumped during 1952-58 is very small. As indicated by Kunkel (1956, p. 23-24) the upper 100 feet of saturated deposits in only the central part of Pinto Basin contains roughly 230,000 acre-feet of ground water in storage. The total quantity of ground water stored in the entire basin probably is several times that amount. Because the ground water in storage in Pinto Basin is too deep for use by native vegetation the pumping of water and lowering of water levels, except for a relatively minor depletion in storage, is not adverse to maintaining Pinto Basin in the native state.

In conclusion, because the effect of pumping from existing wells in Pinto Basin cannot upset the ecologic balance within the Monument, because the quantity of stored water in Pinto Basin is very great, and because the natural subsurface ground-water outflow is relatively small, any attempt to limit pumping to an estimate of perennial yield will not allow full utilization of this important natural resource of stored water.

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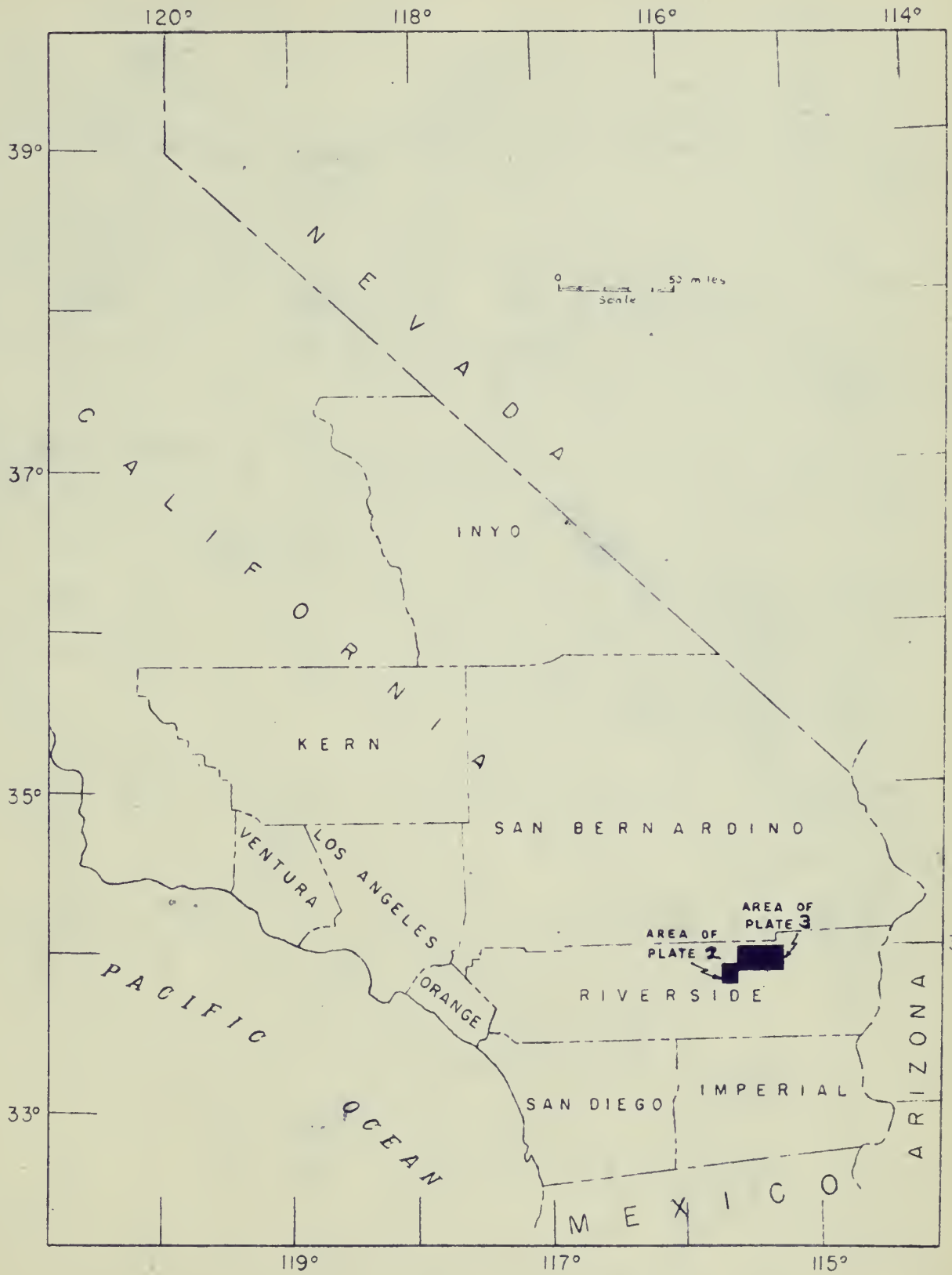
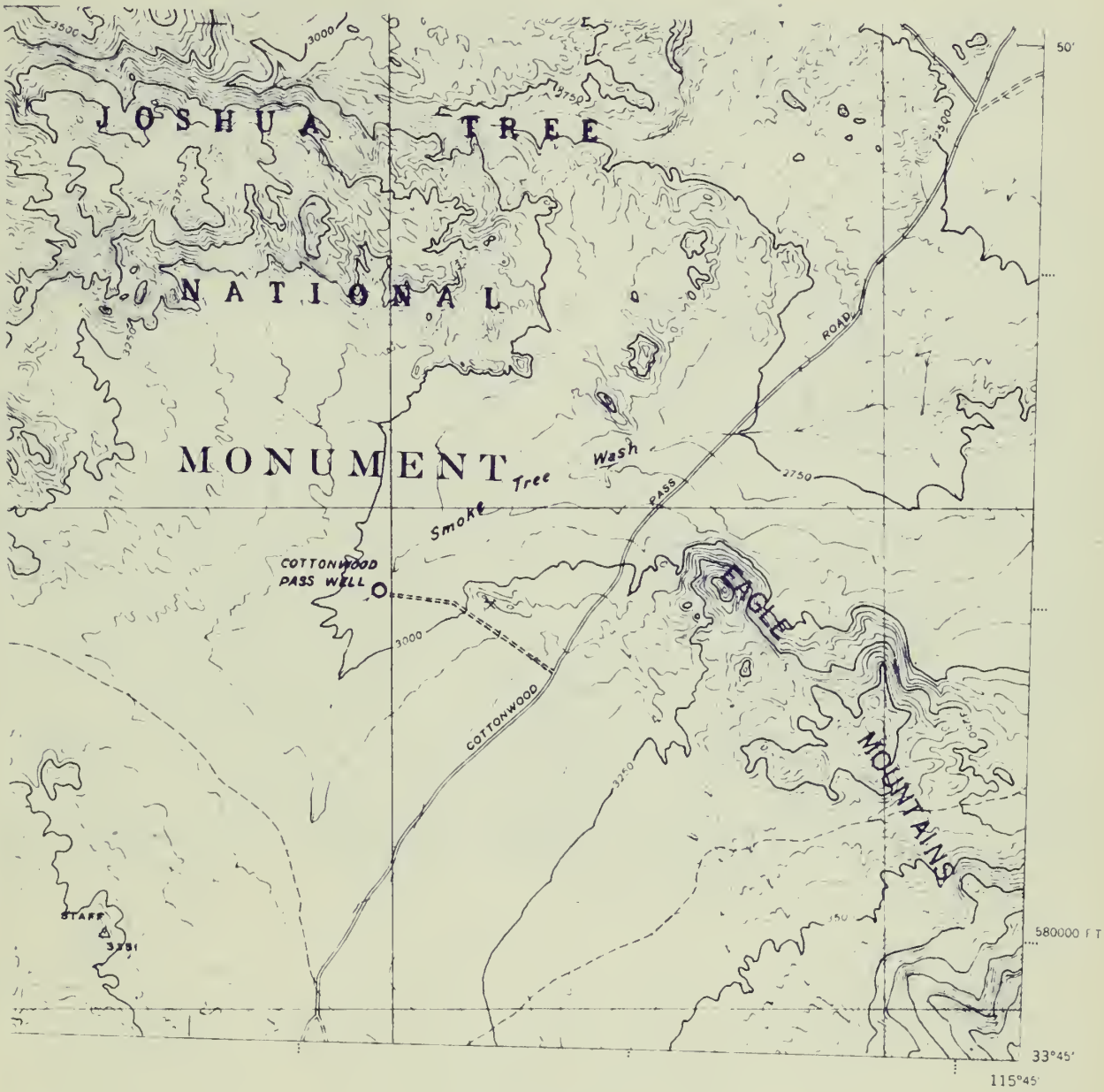


VICINITY MAP OF
SOUTHERN CALIFORNIA
SHOWING AREAS OF THIS REPORT



Scale $\frac{1}{62500}$

1 0 1 2 3 Miles

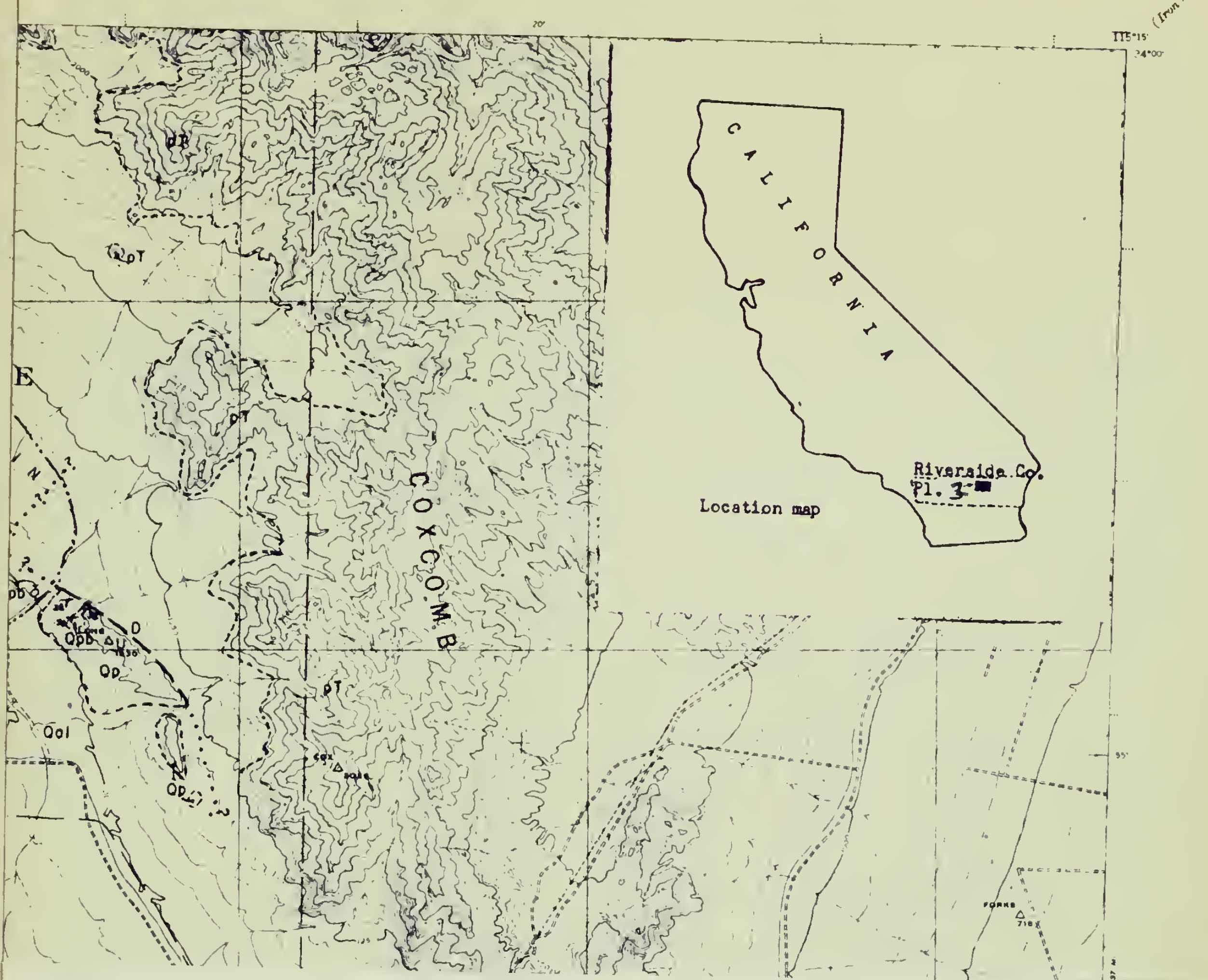
1000 500 0 1000 2000 3000 4000 5000 Yards

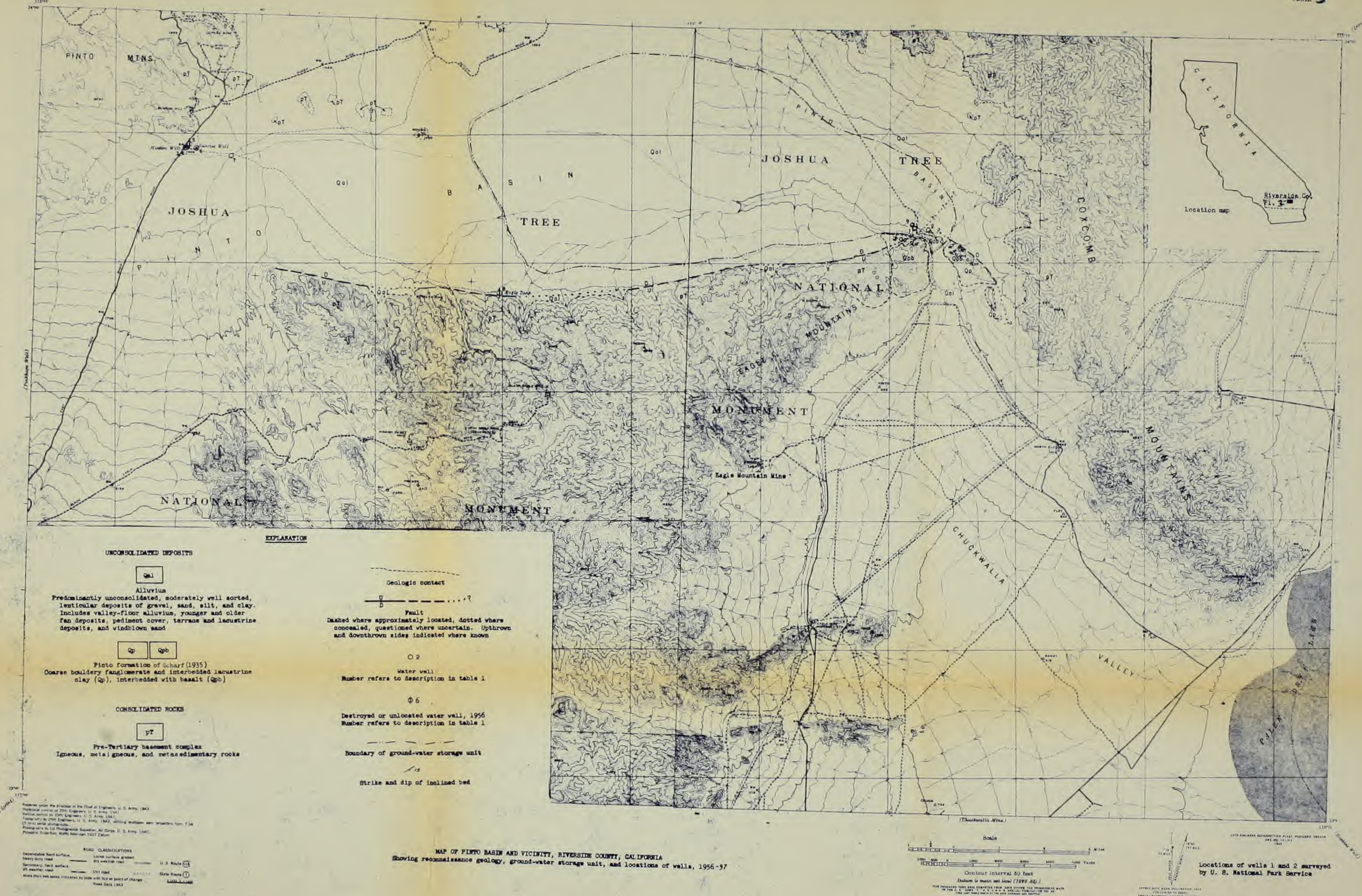
Contour interval 50 feet

Datum is mean sea level (1929 Adj.)

PART OF THE PINKHAM WELL QUADRANGLE MAP SHOWING
THE LOCATION OF THE COTTONWOOD PASS WELL

PLATE 3





MAP OF PINTO BASIN AND VICINITY, RIVERSIDE COUNTY, CALIFORNIA
Showing reconnaissance geology, ground-water storage unit, and locations of wells, 1956-57

U. S. GEOLOGICAL SUR

PLATE 4

ALTITUDE OF WATER SURFACE, IN FEET ABOVE SEA LEVEL

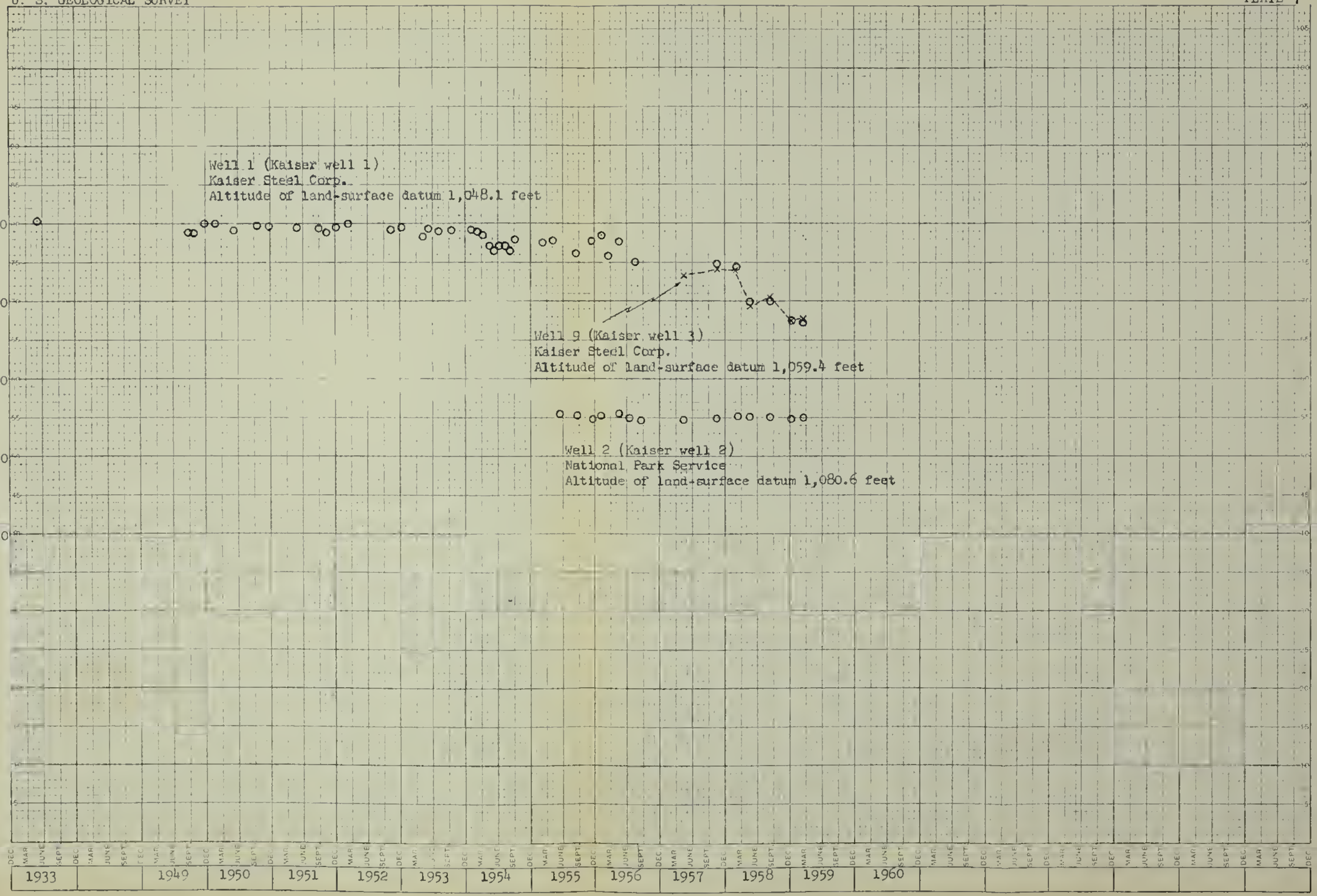
950
940
930
920
910

DEC. MAR. JUNE SEPT. DEC. MAR. JUNE SEPT. DEC. MAR. JUNE

1933

194

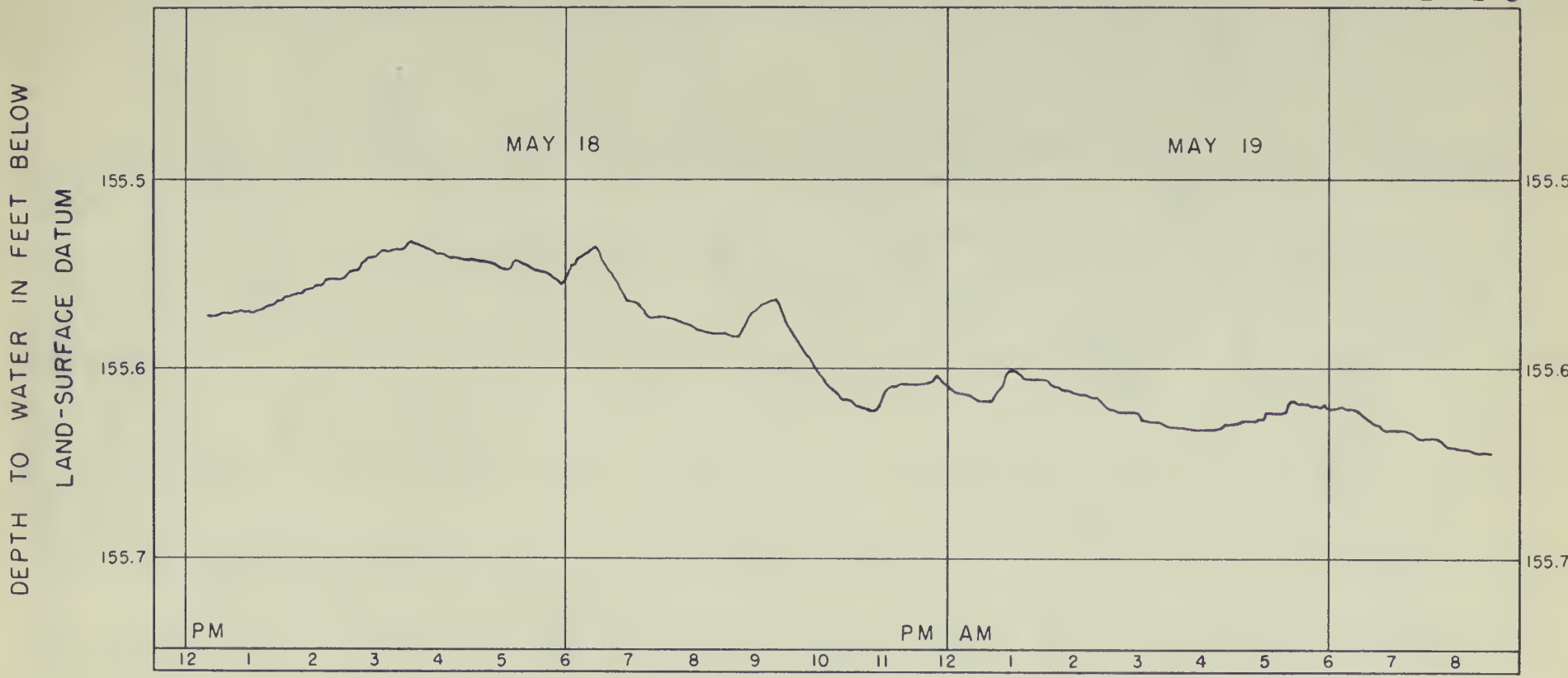
JUNE SEPT. DEC. MAR. JUNE SEPT. DEC. MAR. JUNE SEPT. DEC. MAR. JUNE SEPT. DEC. MAR. JUNE SEPT. DEC.



HYDROGRAPHS OF WELLS 1, 2, AND 9 IN PINTO BASIN, CALIFORNIA

U. S. GEOLOGICAL SURVEY

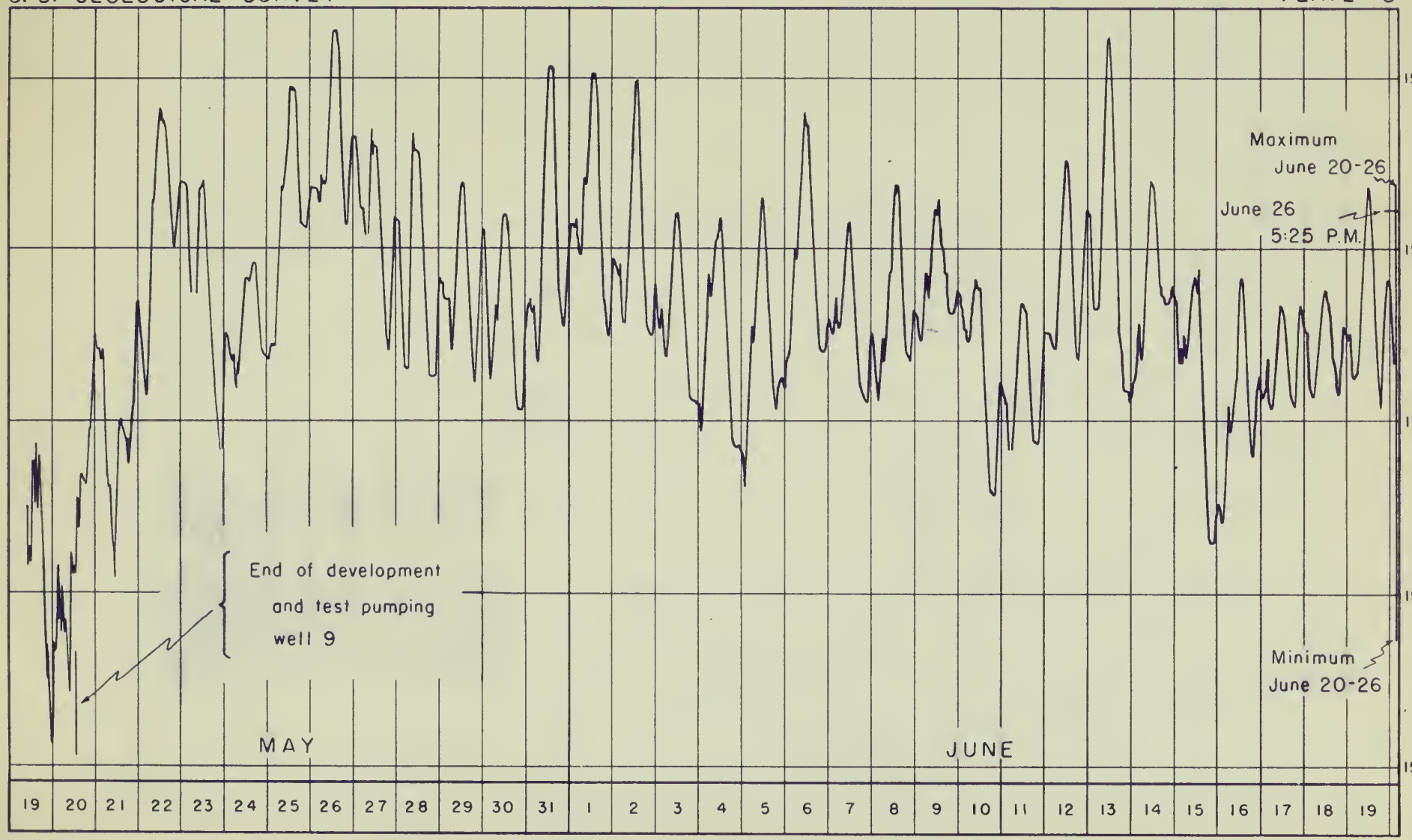
PLATE 5



HYDROGRAPH OF WELL 2 IN PINTO BASIN FOR MAY 18-19, 1957,
DURING PERIOD OF WELL DEVELOPMENT AND TEST
PUMPING OF WELL 9

U. S. GEOLOGICAL SURVEY

PLATE 6



HYDROGRAPH OF WELL 2 IN PINTO BASIN FOR MAY 19 - JUNE 26, 1957