

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
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GROUND-WATER INVENTORY FOR 1966
EDWARDS AIR FORCE BASE, CALIFORNIA

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Prepared in cooperation with the
Department of the Air Force

OPEN-FILE REPORT

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SUMMARY AND CONCLUSIONS

The water supply for Edwards Air Force Base is ground water pumped from wells. Because annual recharge to the ground-water supply is very small, constant surveillance of the quantity and quality of the water stored in the underground basin is maintained. This report is the tenth annual inventory made in cooperation with the Department of the Air Force. The results of the current study are summarized below.

1. Pumpage.--Pumpage by the base for all uses during 1966 was about 6,280 acre-feet, most of which was pumped from the Main Base, East Camp, and North Base wells.

2. Water-level fluctuations.--During the period March 1961 to March 1967, four pumping depressions have formed in which water levels declined as much as 100 feet.

3. Ground-water depletion.--The estimated depletion of ground water in storage during the period April 1, 1966, to March 31, 1967, is 13,000 acre-feet. The quantity remaining in storage is about 1,300,000 acre-feet.

4. Quality of water.--Chemical analyses of water collected from the principal base-supply wells indicate no appreciable deterioration of the ground-water quality during the period April 1, 1966, to March 31, 1967. Because the dissolved-solids content of well 10N/9W-7A2 changes during pumping, determination should be made as to how long this well needs to be pumped to obtain potable water. Partial chemical analyses may be adequate to monitor changes in the quality of the ground water.

5. Condition of wells.--Specific-capacity tests made at wells 9N/8W-6H1, 9N/9W-14P2, 9N/9W-15J1, and 9N/10W-24G1 indicate no deterioration in their condition. Specific-capacity tests should be standardized.

PURPOSE AND SCOPE OF THE CONTINUING INVENTORY

This report is the tenth annual inventory of ground-water conditions at Edwards Air Force Base, Los Angeles, Kern, and San Bernardino Counties, Calif. It was prepared by the Geological Survey in cooperation with the Air Force. The area of investigation is shown in figure 1.

The geology and ground-water resources of the Edwards Air Force Base area were described by Dutcher and Worts (1962). Basic data are contained in a report by Dutcher and others (1962). The geology and the location of wells are shown in figure 2.

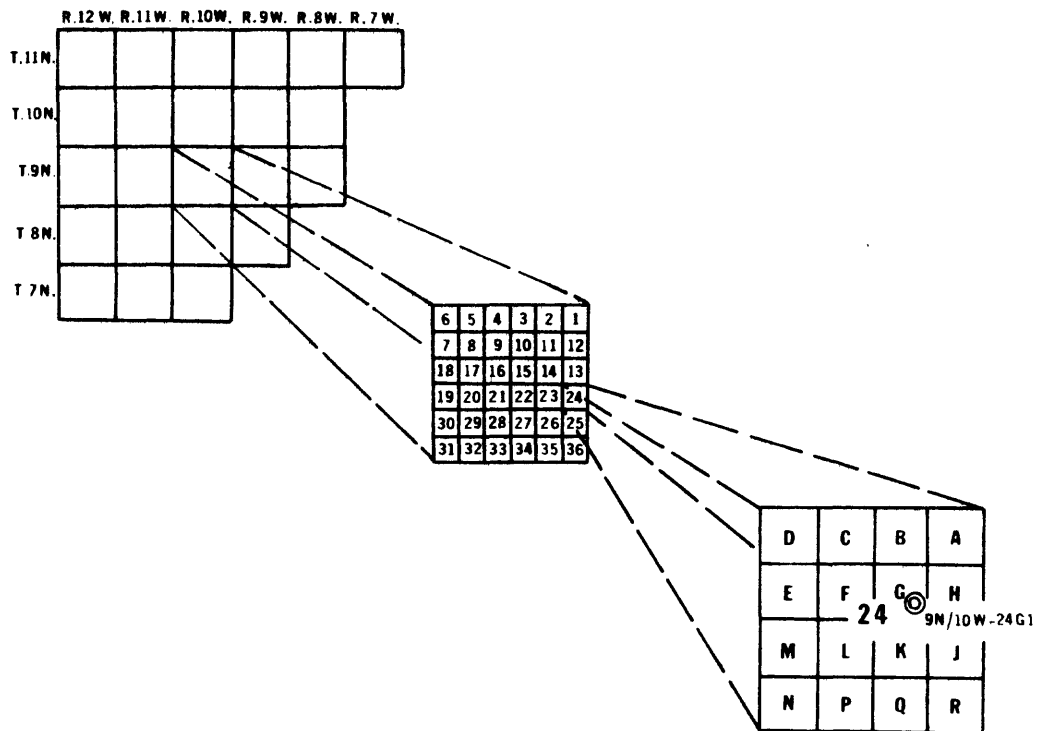
The purpose of this continuing inventory is to collect and analyze the hydrologic data necessary to advise the Air Force on the current water-supply conditions on the base.

The scope of the program requested by the Air Force is: (1) To advise on the water-supply problems of the base; (2) to detect changes in the chemical quality of the ground water by interpretation of chemical analyses of the water pumped from the base wells; (3) to monitor water levels in the Edwards Air Force vicinity by periodically measuring water levels and interpreting hydrographs from automatic water-level recorders; and (4) to prepare an annual report incorporating and analyzing the findings made during the year.

The work was done by the U.S. Geological Survey, Water Resources Division, under the immediate supervision of L. C. Dutcher, chief of the Garden Grove subdistrict office, and under the general supervision of R. Stanley Lord, district chief in charge of water-resources investigations in California.

WELL-NUMBERING SYSTEM

Wells are numbered according to their location in the rectangular system for subdivision of public land. That part of the number preceding the slash (as in 9N/10W-24G1) indicates the township (T. 9 N.); the number following the slash indicates the range (R. 10 W.); the number following the hyphen indicates the section (sec. 24); the letter following the section number indicates the 40-acre subdivision of the section according to the lettered diagram below. The final digit is a serial number for wells in each 40-acre subdivision. The area covered by the report lies entirely in the northwest quadrant of the San Bernardino base line and meridian.



For well numbers where the letter Z has been substituted for the letter designating the 40-acre tract, the Z indicates that the well is plotted from unverified location descriptions; the indicated sites of such wells were visited but no evidence of a well could be found.

Table 1 is a cross index of the well numbers used by the U.S. Air Force and those used by the U.S. Geological Survey.

TABLE 1.--Cross index of Edwards Air Force Base and Geological Survey well numbers

Base number or name	Abbreviated base number ¹	USGS number	Basin and ground-water storage unit	Use
<u>Lancaster basin</u>				
Main Base well 1	MB-1	9N/9W-6L1	Main Base (adjacent)	(a)
3	MB-3	9N/9W-6E1	Main Base (adjacent)	(b)
5	MB-5	9N/9W-6A1	Main Base (adjacent)	(a)
6	MB-6	9N/10W-12R1	Main Base (adjacent)	(c)
6A	MB-6A	9N/10W-24F1	Main Base	(a)
7	MB-7	9N/9W-18C1	Main Base	(a)
8	MB-8	9N/10W-24C1	Main Base	(a)
9	MB-9	9N/10W-24G1	Main Base	(a)
11	MB-11	9N/10W-24E1	Main Base	(a)
Well C-2	C-2	9N/10W-16C2	---	(a)
Telemeter Station well 10	TS-10	9N/10W-8P1	---	(b)
South Track well A	ST-A	8N/10W-2F1	Main Base	(b)
D	ST-D	8N/10W-2N2	Main Base	(b)
E	ST-E	8N/10W-1C1	Main Base	(a)
East Camp well 1	EC-1	9N/8W-6H2	East Camp	(a)
2	EC-2	9N/8W-6H1	East Camp	(a)
3	EC-3	9N/8W-6J1	East Camp	(a)
NASA well 1	NASA-1(B)	9N/9W-14P2	East Camp	(a)
2	NASA-2(C)	9N/9W-23B1	East Camp	(a)
3	NASA-3(D)	9N/9W-13N1	East Camp	(a)
4	NASA-4(A)	9N/9W-15J1	East Camp	(a)
<u>North Muroc basin</u>				
North Base well 1	NB-1	10N/9W-7A1	North Muroc	(a)
2	NB-2	10N/9W-7A2	North Muroc	(a)
3	NB-3	11N/9W-32Q1	North Muroc	(a)
4	NB-4	10N/9W-4D2	North Muroc	(a)
5	NB-5	10N/9W-5B1	North Muroc	(a)
Test well 4	TW-4	10N/9W-4D1	North Muroc	(c)
Graham Ranch well		9N/10W-16P1	---	(b)
Red Barn well	20	9N/10W-34Q1	---	(b)
Red Barn well 1	21	9N/10W-34Q2	---	(a)
Red Barn well 2	22	9N/10W-34P3	---	(a)

¹Symbol used in text.

a. Supply well..

b. Unused well.

c. Recorder well.

PUMPAGE

The total metered pumpage from the base wells during 1966 was 6,273 acre-feet, ranging from an August high of 839 acre-feet (273,390,000 gallons) to a December low of 255 acre-feet (83,092,000 gallons). (See fig. 3.) In addition to the metered pumpage, an estimated 4 acre-feet was pumped from Red Barn wells 1 and 2. Pumpage for all uses by the base in 1966 is shown in table 2. Pumpage, if any, from North Base wells 1 and 2, used only for emergencies, is small, is not considered significant, and was not included in the tabulation. Nearly 80 percent of the pumpage from South Track well E occurred in December 1966.

TABLE 2.--Pumpage from base-supply wells for calendar year 1966

Basin and well field	Pumpage ¹	
	1,000 gallons	Acre-feet ²
<u>Lancaster basin</u>		
Main Base wells 6A, 7, 8, 9, and 11	1,004,000	3,081
Main Base wells 1 and 5 ³	15,800	48.5
East Camp wells 1, 2, and 3	293,200	899.7
NASA wells 1, 2, 3, and 4	145,200	445.6
Red Barn wells ⁴	1,200	4
Well C-2	966	3.0
South Track well E	5,409	16.6
Subtotal:	1,466,000	4,498
<u>North Muroc basin</u>		
North Base wells 3, 4, and 5	579,500	1,779
Total:	2,046,000	6,277

¹All metered values rounded to four significant figures, or the nearest 0.1 acre-foot.

²One acre-foot equals 325,851 gallons.

³Pumped May through September only.

⁴Pumpage is estimated; the wells are not part of the domestic distribution system, and the pumpage is not shown in figure 3.

WATER-LEVEL FLUCTUATIONS

The water-level contour map (fig. 4) shows four pumping depressions in the Edwards Air Force Base vicinity. The locations of these four depressions are listed below in order of decreasing magnitude of water-level gradient:

1. About 12 miles east of Lancaster (secs. 11 and 14, T. 7 N., R. 10 W.).
2. About 5 miles northeast of Lancaster (centered in secs. 2 and 11, T. 7 N., R. 11 W.).
3. Main Base well field (sec. 24, T. 9 N., R. 10 W.).
4. Northern edge of Rogers dry lake (sec. 4, T. 10 N., R. 9 W.).

The hydrographs (figs. 5 and 6) show that water levels begin to decline in March to a low in late summer or early autumn when recovery begins. As in previous years, new low-water levels were reached in three of the recorder wells. However, the rates of decline continue to be fairly constant. Figure 5 shows hydrographs of wells 8N/10W-8R3 and 10N/9W-4D1 not previously included in the annual inventory. These two additional hydrographs give a more complete coverage of the hydrologic conditions at Edwards Air Force Base. Although pumping occurred in wells near well 8N/10W-8R3 during 1963 and 1964, the overall rate of decline of the water level has remained constant. The best possible conditions for monitoring the North Base well field water-level fluctuations are not met because a heavily pumped supply well is about 300 feet west of the recorder well 10N/9W-4D1; however, this is the only well available for recorder use in that area. Further investigation is required to determine if a more suitable well exists for monitoring the water-level fluctuations in that area.

Figure 7 shows the water-level changes that occurred from March 1961 to March 1967. Water levels have declined very little near the southern boundary of the base; however, about 4 miles south of the base boundary, water levels have declined as much as 50 feet in the last 6 years. The largest water-level decline, 90 feet, has occurred 12 miles east of Lancaster (secs. 11 and 14, T. 7 N., R. 10 W.). A possible explanation for these large declines is that heavy pumping has occurred in an area bounded on the east by consolidated rocks and a probable fault that may impede the eastward expansion of the cone of depression. The hydrograph of well 8N/10W-8R3 will indicate the extent to which the heavy irrigation pumping may affect the water levels in the southern part of the base.

GROUND-WATER DEPLETION

Ground water in storage beneath and adjacent to the base in 1952 was estimated by Dutcher (1958, p. 40) to be 1,500,000 acre-feet. Giessner and Westphal (1966, p. 16) estimated ground-water depletion for the period 1952-66 to total 146,000 acre-feet, an average of approximately 10,000 acre-feet per year. However, since 1960 the average rate of depletion has been nearly 13,000 acre-feet per year. Because no large changes in pumping patterns have occurred, a reasonable estimate for ground-water depletion during the period April 1, 1966, to March 31, 1967, is 13,000 acre-feet.

The total ground-water depletion since 1952 is about 160,000 acre-feet, or only slightly more than 10 percent of the 1,500,000 acre-feet in storage in 1952. Assuming no change in the present rate of use, the estimated 1,300,000 acre-feet of water remaining in storage is sufficient for about 100 years. However, prior to that time pumping lifts may become great enough to be uneconomic when compared to the cost of alternative sources of water. Nevertheless, assuming no large-scale increase in the use of ground water at Edwards Air Force Base and vicinity, the quantity of usable ground water in storage probably is adequate to meet the needs of the Air Force for at least the next 25 to 50 years. In the future an estimate of the maximum possible economic, or physical pumping lift, or both, should be made to more accurately predict how long the usable ground water in storage will adequately meet these needs.

CHEMICAL QUALITY OF WATER

Water samples for chemical analysis are collected annually from base wells to determine if any significant changes have occurred in the quality of the ground water. The analyses, shown in table 3, indicate no significant changes since April 1966.

Table 3 shows that the fluoride content of water from eight of the wells monitored exceeds 1.0 ppm (parts per million)--the upper limit recommended for domestic use in this area by the U.S. Public Health Service (1962, p. 8). However, the fluoride content of water from seven of the wells is less than the Public Health Service limit for rejection which is twice the optimum of 0.8 ppm (1.6 ppm). The fluoride content of water from well 9N/8W-6H2 is 1.9 ppm. Therefore, we suggest that the water from well 9N/8W-6H2 be mixed with water from another source having a low fluoride content. A continuing program should be maintained to monitor the quality of water from these wells.

Complete chemical analyses may not be needed for each well sampled. The constituents that need to be analyzed may vary from well to well depending on the use of the well, the length of service, and the hydrologic and geologic environment. Therefore, the use of partial chemical analyses for selected areas might be adequate to monitor continuing changes in water quality. In addition, the chemical quality of the sewage effluent should be monitored.

TABLE 3.—Chemical analyses of water
[Analyzing laboratory: GS U.S. Geological Survey, Water Resources Division, Sacramento, Calif.]

Well number	Date of collection	Depth of well (feet)	Results in parts per million (ppm)															pH	Specific conductance (microhm at 25°C)	Analyzing laboratory and sample number	
			Silica (SiO ₂)	Iron (Fe) dissolved	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Carbonate (CO ₃)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Boron (B)	Dissolved solids		Hardness as CaCO ₃				Noncarbonate hardness as CaCO ₃
															Colloidal (Sum of determined constituents)	Residue on evaporation at 180°C					
U.S. Public Health Service drinking-water standards (1962)																					
9N/10W-1C1	10-25-66	500	42	0.01	9.0	0.8	84	1.4	172	0	250	1.0	45	0.9	288	294	26	0	87	459	GS 54359
	10-25-66	354	13	0	22	8.3	208	1.9	306	0	136	1.9	8.4	.8	651	668	89	0	83	1,090	GS 54350
	4-28-66	360	27	0	28	3.1	52	2.5	140	0	59	13	.3	.8	255	260	83	0	57	397	GS 52808
	10-25-66	360	28	0	29	3.0	52	2.4	142	0	62	15	.3	.6	264	263	85	0	56	398	GS 54360
9N/10W-12R1	4-28-66	187	25	0	21	2.4	60	2.0	150	0	57	8.5	.4	.5	251	258	62	0	67	385	GS 52805
	10-25-66	216	13	0	41	12	92	2.2	156	0	133	64	1.2	1.6	437	452	152	24	56	933	GS 54347
24C1	4-28-66	750	25	0	14	1.7	86	1.0	161	0	66	19	.6	0	293	298	42	0	81	461	GS 52806
	10-25-66	750	27	.01	12	1.5	76	1.0	150	0	62	12	.7	.3	267	270	36	0	82	409	GS 54357
24E1	10-25-66	700	11	0	17	1.7	86	1.4	160	0	69	28	.7	.4	294	316	50	0	78	498	GS 54348
24F1	10-25-66	430	27	0	23	2.4	50	2.1	141	0	54	6.5	.4	.4	235	242	68	0	61	353	GS 54362
24G1	4-28-66	750	25	0	35	2.7	65	2.2	138	0	61	42	.3	.9	302	314	98	0	58	492	GS 52802
	10-25-66	750	10	0	35	2.6	64	2.4	137	0	70	45	.4	.3	297	326	98	0	58	516	GS 54349
10N/9W-12D2	4-28-66	500	19	0	2.5	1.1	113	.4	204	0	59	16	1.1	.5	313	332	10	0	96	510	GS 52804
	10-25-66	500	21	.02	3.9	1.0	110	.5	205	0	64	16	1.2	.2	320	328	14	1.0	94	505	GS 54358
10N/9W-5B1	4-28-66	500	26	0	19	4.5	236	.8	302	0	105	148	.9	0	690	688	66	0	88	1,173	GS 52801
	10-25-66	500	27	0	11	2.6	221	1.5	310	0	103	110	1.1	.4	632	672	38	0	92	1,346	GS 54361
11N/9W-2A.1	4-28-66	450	24	0	8.0	2.3	160	.8	244	0	75	60	1.1	0	452	464	30	0	92	751	GS 52803
	10-25-66	450	10	0	8.5	2.1	161	1.3	252	0	84	65	1.2	.2	458	460	30	0	92	781	GS 54346

CONDITION OF WELLS

Specific capacity tests were made at four selected wells 9N/8W-6H1, 9N/9W-14P2, 9N/9W-15J1, and 9N/10W-24G1 (table 4). Comparison of the results of the tests with the results of previous tests on the same wells indicates no significant changes of specific capacities.

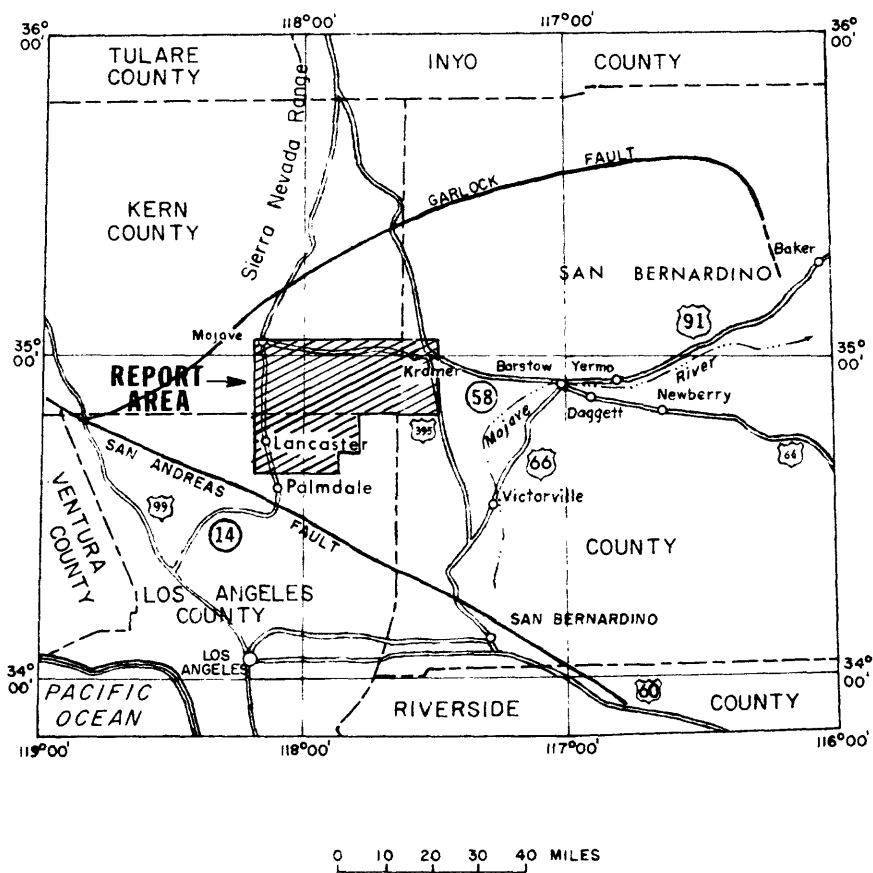
To accurately monitor the condition of wells, standard procedures must be adopted. Test period, time of year, and selection of test wells should be standardized to better determine any change in the condition of the wells. In the future all specific capacity tests will be made at the same time of the year.

TABLE 4.--*Specific capacity of selected wells at Edwards Air Force Base*

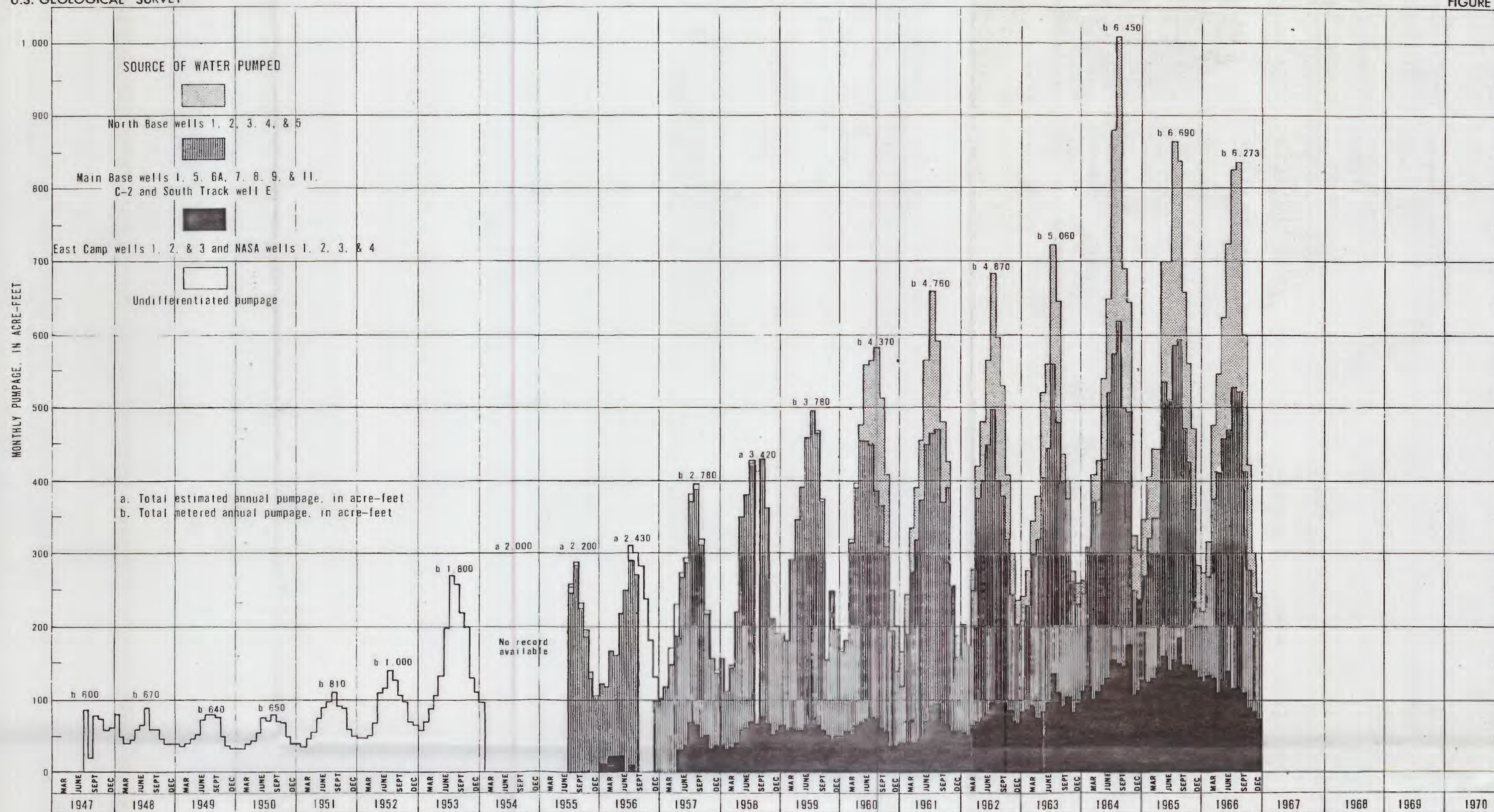
Well number	Date of test	Test period (min)	Yield (gpm)	Drawdown (ft)	Specific capacity (gpm/ft drawdown)
9N/8W-6H1 (EC-2)	3-15-67	15	1,000	6.4	156
9N/9W-14P2 (NASA-1(B))	10-26-66	14	500	3.6	139
9N/9W-15J1 (NASA-4(A))	10-26-66	12	490	4.1	120
9N/10W-24G1 (MB-9)	10-25-66	12	1,000	57.8	17.3

REFERENCES CITED

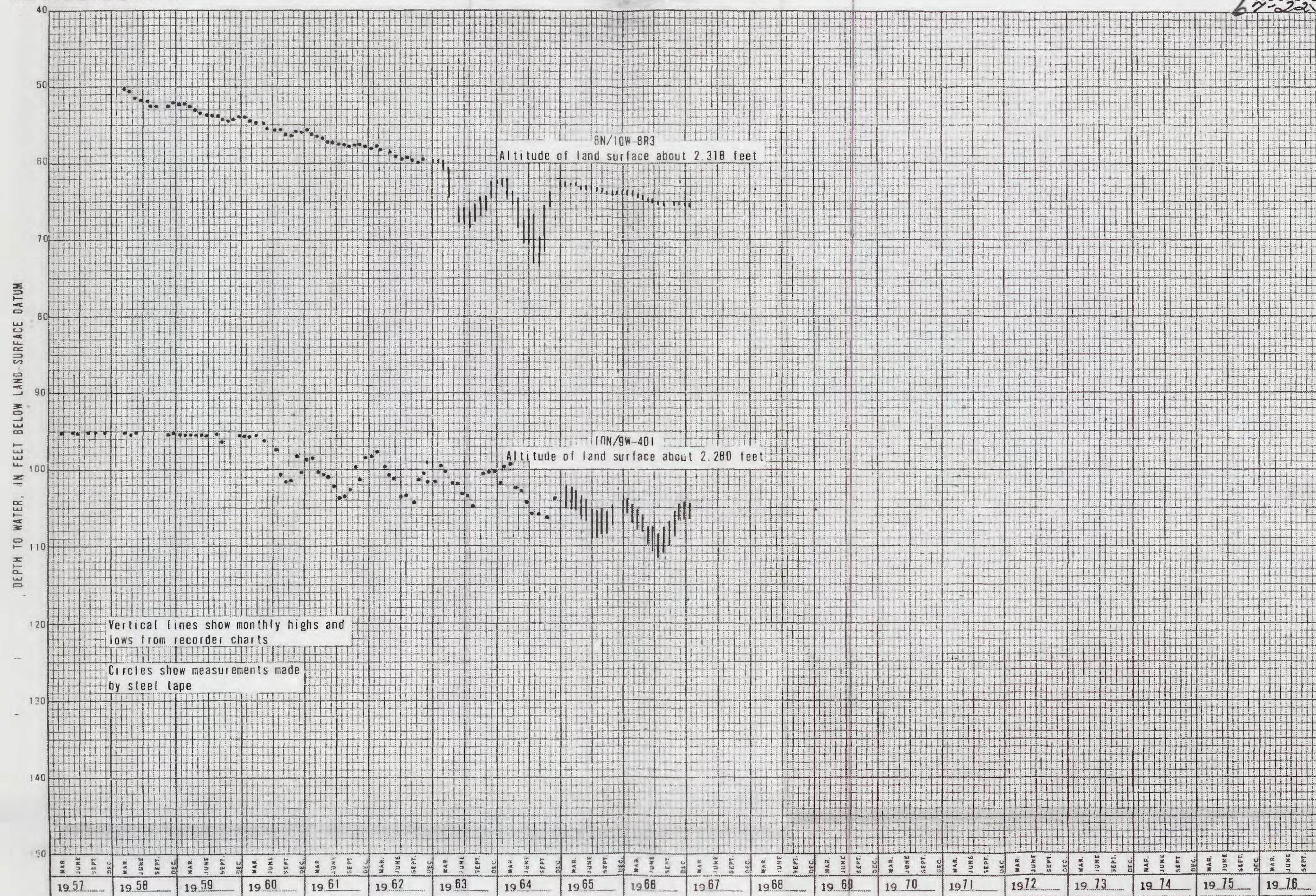
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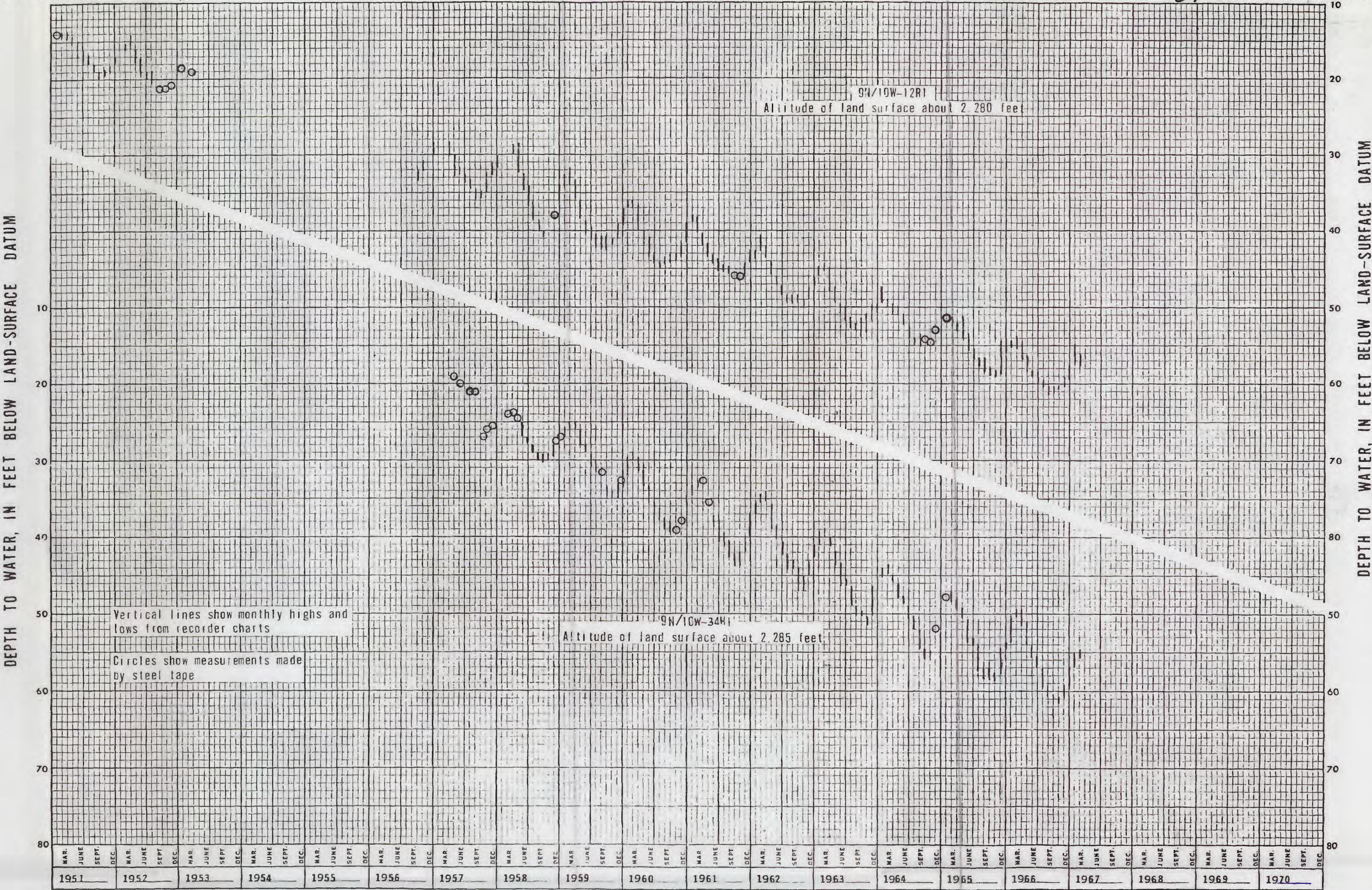
MAP OF PART OF SOUTHERN CALIFORNIA SHOWING
AREA OF THIS REPORT



PUMPAGE FROM WELLS AT EDWARDS AIR FORCE BASE, CALIFORNIA



HYDROGRAPHS OF WELLS 8N/10W-8R3 AND 10N/9W-4D1



HYDROGRAPHS OF WELLS 9N/10W-12R1 AND 9N/10W-34H1