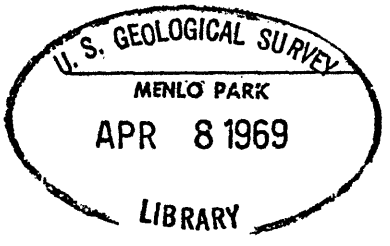
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division

GROUND-WATER INVENTORY FOR 1967

EDWARDS AIR FORCE BASE, CALIFORNIA

By

J. H. Koehler



Prepared in cooperation with the
Department of the Air Force

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Menlo Park, California
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GROUND-WATER INVENTORY FOR 1967, EDWARDS AIR FORCE BASE, CALIFORNIA

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SUMMARY AND CONCLUSIONS

This report is the 11th and final annual ground-water inventory made by the Geological Survey in cooperation with the Department of the Air Force. The results are summarized below.

1. Pumpage.--The total metered pumpage from the base wells during 1967 was 6,022 acre-feet, ranging from an August high of 830 acre-feet to a December low of 228 acre-feet.

2. Water levels.--The annual rate of water-level decline has remained relatively constant throughout 1967 and can be expected to continue, providing the annual pumpage remains constant.

3. Ground-water depletion.--The estimated depletion of ground water in storage during the period April 1, 1967, to March 31, 1968, is 13,000 acre-feet. The quantity remaining in storage is about 1,300,000 acre-feet.

4. Chemical quality of water.--The fluoride content, 2.2 mg/l (milligrams per liter), of water from well 9N/8W-6H2 (EC-1) exceeds the Public Health Service recommended limit for rejection which is 1.6 mg/l. The water from this well should be mixed with water from another source having a low-fluoride content. The nitrate content in water from well 9N/10W-24G1 (MB-8) increased slightly in 1967. A continuing increase may indicate that sewage is infiltrating to the ground water.

5. Conditions of wells.--Wells 9N/9W-18C1 (MB-7) and 9N/10W-24C1 (MB-9) have a much lower specific capacity[1] than the other wells in the Main Base well field.

[1]Specific capacity: The discharge-drawdown ratio in a well, used as a measure of well performance. It is obtained by dividing discharge (yield), in gallons per minute, by drawdown, in feet.

PURPOSE AND SCOPE OF THE CONTINUING INVENTORY

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 desirable. This report is the 11th and, because of a restriction in funds, final annual inventory made by the Geological Survey in cooperation with the Department of the Air Force. Presumably, the surveillance will again be continued when funds become available. The area of the 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 (1963). Basic data are contained in a report by Dutcher and others (1962). The geology and the location of selected 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 inventory 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; (3) to monitor water levels in the Edwards Air Force Base area 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, and under the general supervision of R. Stanley Lord, district chief in charge of water-resources investigations in California.

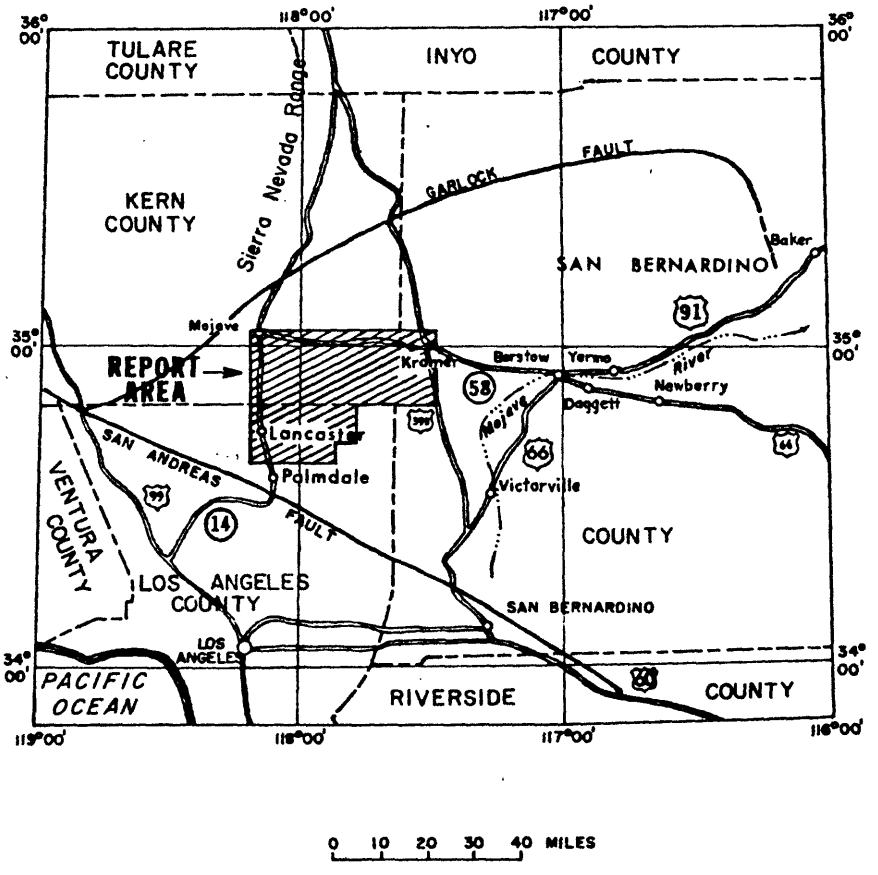

FIGURE 1.--Area of this report.

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
			Lancaster basin	
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-24G1	Main Base	(a)
9	MB-9	9N/10W-24C1	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-B	9N/9W-14P2	East Camp	(a)
2	NASA-C	9N/9W-23B1	East Camp	(a)
3	NASA-D	9N/9W-13N1	East Camp	(a)
4	NASA-A	9N/9W-15J1	East Camp	(a)
			North Muroc basin	
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)

[1]Symbol used in text.

a. Supply well.
b. Unused well.
c. Recorder well.

PUMPAGE

The total metered pumpage from the base wells during 1967 was 6,022 acre-feet, ranging from an August high of 830 acre-feet to a December low of 228 acre-feet. 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 1967 is shown in table 2. North Base wells 1 and 2, used only for emergencies, are not included in the tabulation because the use, if any, would be small.

The total annual pumpage has decreased about 700 acre-feet since 1965 (fig. 3), due to the decrease in pumpage from the East Camp and NASA supply wells. The pumpage from the Main Base supply wells has increased slightly since 1966.

TABLE 2.--*Pumpage from base supply wells for calendar year 1967*

Basin and well field	Pumpage[1]	
	1,000 gallons	Acre-feet[2]
Lancaster basin		
Main Base wells 6A, 7, 8, 9, and 11	1,034,000	3,173
Main Base wells 1 and 5[3]	9,172	28.1
East Camp wells 1, 2, and 3	261,600	802.3
NASA wells A, B, C, and D	93,020	285.5
Red Barn wells[4] 1 and 2	1,200	4
Well C-2	545	1.7
South Track well E	21,560	66.2
Subtotal:	1,421,000	4,361
North Muroc basin		
North Base wells 3, 4, and 5	542,500	1,665
Total:	1,963,000	6,026

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

[2]One acre-foot equals 325,851 gallons.

[3]Pumped July through September only.

[4]Pumpage is estimated; the water is not used for base supply, and the pumpage is not shown in figure 3.

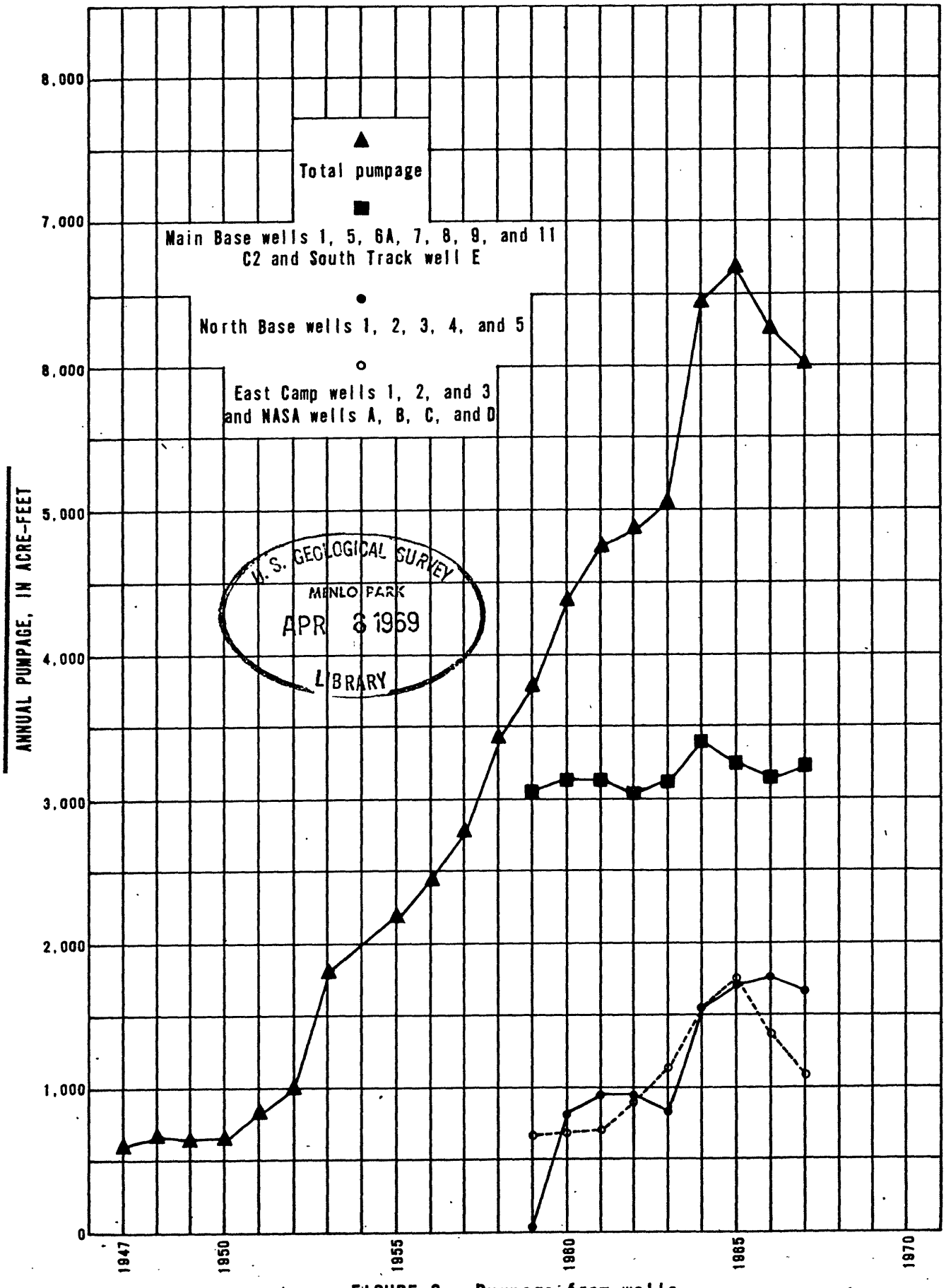

FIGURE 3.—Pumpage from wells.

WATER LEVELS

Water-level measurements were made in 80 wells in the Edwards Air Force Base area in the spring of 1968. These measurements represent the water level after recovery from the pumping during the 1967 calendar year and the recharge, if any, from precipitation during the winter of 1967-68. They were used to construct the water-level contour map (fig. 4) and to monitor the annual water-level change in the area. In addition to the measurements, continuous water-level recorders were operated in four wells on the base to monitor seasonal fluctuations (figs. 5 and 6).

Several pumping depressions are shown on the map (fig. 4); most notable are the depressions south of the base boundary. The depression around the town of Lancaster does not directly affect the water supply of the base. The depressions east of Lancaster are the result of heavy ground-water draft for irrigating alfalfa. The pumping in that area affects the base water supply to a small degree, by lowering the water table in the southern part of the base. The decline in the water level in well 8N/10W-8R3, approximately 1.5 feet per year (fig. 5), can be partly attributed to that pumping and partly to the pumping of the wells in the Main Base well field.

A ground-water depression has developed around the Main Base well field as a result of large ground-water withdrawals.

Water-level decline in the Main Base well field area is illustrated by the hydrographs of wells 9N/10W-12R1 (MB-6) and 9N/10W-34H1 (fig. 6). The water-level decline is about 2.5 feet per year in well MB-6 and about 3 feet per year in well 34H1. These declines have remained relatively constant throughout 1967 and can be expected to continue at the same rate providing the annual pumpage from the Main Base wells remains constant.

Well 10N/9W-4D1 (TW-4) is being used to monitor the water-level decline in the North Base well field area. The average annual water-level decline in that area is about 1 foot per year (fig. 5). The water-level elevation in the well is also used as a control point in drawing the water-level contour map. Correction of an error in the altitude of land surface at TW-4 from 2,280 to 2,304 feet above land surface has considerably lessened the apparent pumping depression in the North Base well field area (fig. 4).

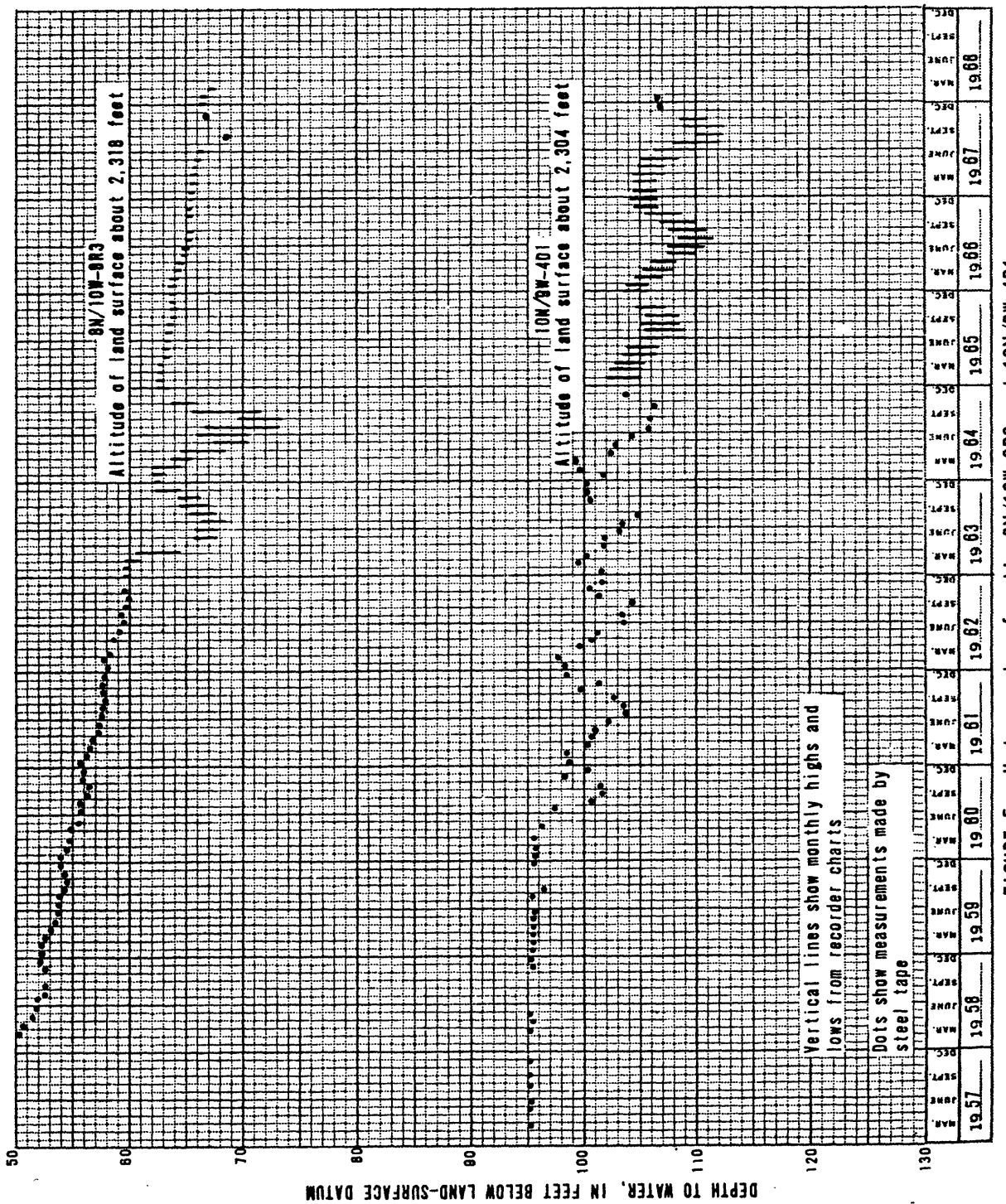

FIGURE 5.—Hydrographs of wells 8N/10W-8R3 and 10N/9W-4D1.

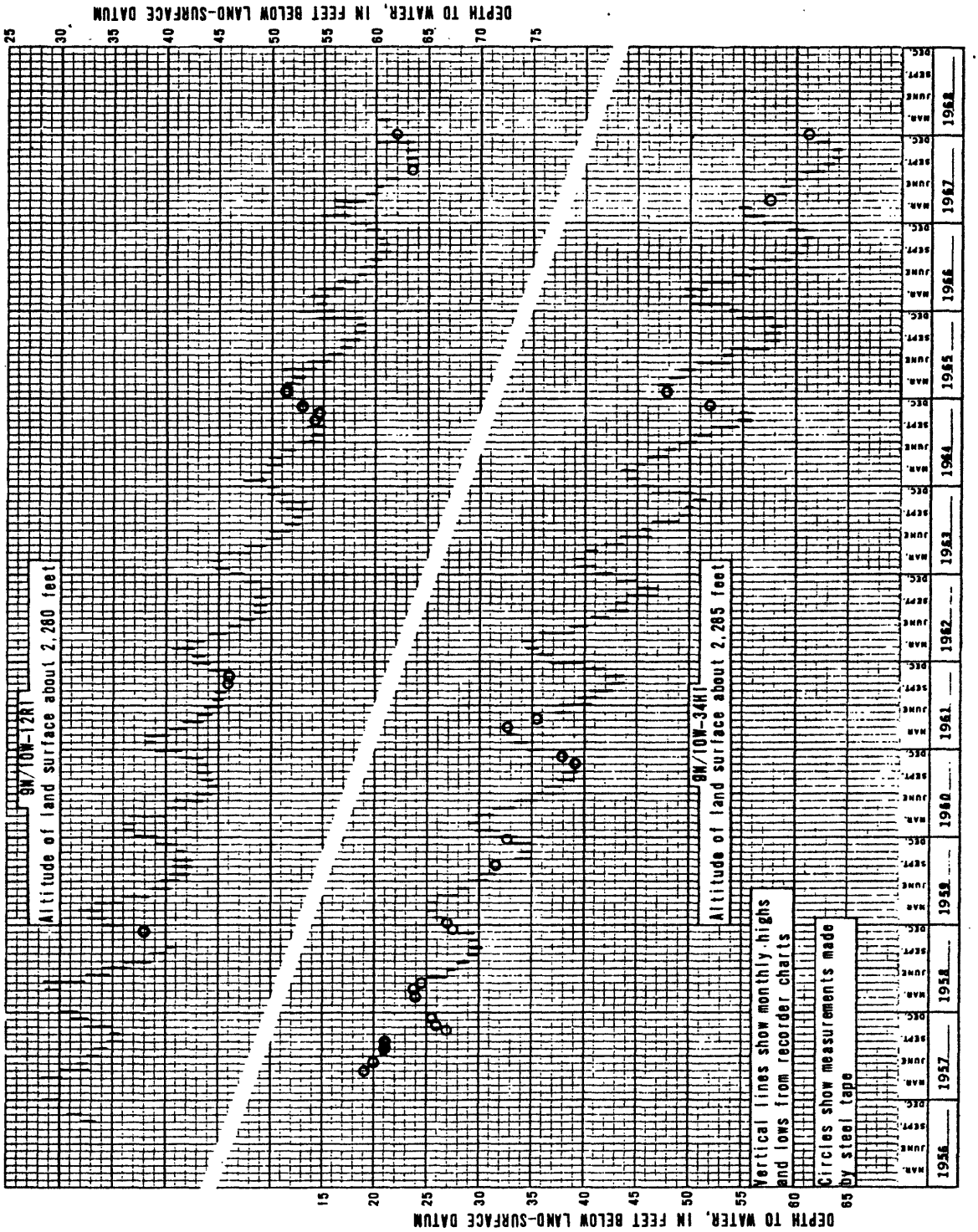

FIGURE 6.--Hydrographs of wells 9N/10W-12R1 and 9N/10W-34H1.

GROUND-WATER DEPLETION

Ground water in storage beneath and adjacent to the base in 1952 was estimated by L. C. Dutcher (written commun., 1958) 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 (Tyley, 1967, p. 7). Because no large changes in pumping patterns have occurred, a reasonable estimate for ground-water depletion during the period April 1, 1967, to March 31, 1968, is 13,000 acre-feet.

The total ground-water depletion since 1952 is about 170,000 acre-feet, or about 11 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 uneconomical when compared to the cost of alternative sources of water. Nevertheless, assuming no large-scale increase in the use of ground water in the Edwards Air Force Base area, the quantity of usable ground water in storage is probably adequate to meet the needs of the Air Force for at least the next 25 to 50 years.

CHEMICAL QUALITY OF WATER

Water samples for chemical analysis are collected annually from base supply wells to determine if any significant changes have occurred in the chemical quality of the ground water. The analyses (table 3) indicate no significant changes have occurred during 1967.

Table 3 shows the fluoride content of water from three of the wells monitored exceeds 1.0 mg/l, the average upper limit recommended for drinking water in the area by the U.S. Public Health Service (1962, p. 8). The fluoride content (2.2 mg/l) of water from well 9N/8W-6H2 (EC-1) exceeds the Public Health Service limit for rejection (1.6 mg/l) (1962, p. 8) which is twice the optimum value of 0.8 mg/l. The water from this well should be mixed with water from another source having a low-fluoride content.

Figure 7 is a graph of the chloride, nitrate, and potassium content in water from well 9N/10W-24G1 (MB-8). A large increase in either chloride or nitrate may indicate ground-water contamination by sewage. Well MB-8 was chosen to be monitored because of its proximity to the sewage ponds (fig. 2).

TABLE 3.—*Chemical analyses of water*

Values for dissolved solids have been calculated (sum of determined constituents).

Laboratory and sample number: GS, U.S. Geological Survey, Water Resources Division, Sacramento, Calif.

Well number	Date of collection	Depth of well (feet)	Water temperature (°C)	Results in milligrams per liter																				
				Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Specific conductance (micromhos at 25°C)	pH	Laboratory and sample number
U.S. Public Health Service drinking-water standards (1962)					0.3							250	250	1.0	45		500							
9N/8W-6H1 (EC-2)	3-15-67	467				18	6.4	208	1.8	288	4	136	91		8.1			72	0	86	1,070	8.4	GS 55250
9N/8W-6H2	1-24-67	354		31	0	22	8.4	212	1.4	300	0	139	100	2.2	8.2	0.9	673	90	0	83	1,100	8.1	GS 54801
(EC-1)	10-25-67	354		37	.02	25	9.4	213	3.0	302	0	119	112	2.1	17	.7	687	101	0	82	1,130	7.7	GS 56302
9N/9W-15J1 (NASA-A)	3- 6-68	534		32	0	28	3.2	46	3.1	132	0	65	6.6	.3	3.4	.1	253	83	0	53	374	7.9	GS 56654
9N/9W-18C1 (MB-7)	10-24-67	360		27	0	31	3.0	52	2.7	140	0	61	21	.3	2.0	0	269	90	0	55	399	7.5	GS 56299
9N/10W-24C1 (MB-9)	10-24-67	750	20	27	0	16	1.5	80	1.5	153	0	68	18	.6	1.8	.1	290	46	0	78	449	7.6	GS 56297
9N/10W-24E1 (MB-11)	10-24-67	700	20	28	.02	20	1.9	93	1.3	160	0	67	34	.7	1.6	.2	327	51	0	77	518	7.6	GS 56303
9N/10W-24F1 (MB-6A)	10-24-67	430	18	26	0	25	2.3	47	2.3	136	0	51	6.1	.4	2.2	0	229	72	0	58	341	7.7	GS 56298
9N/10W-24G1 (MB-8)	10-24-67	750	21	26	0	37	2.4	63	2.4	137	0	65	42	.3	2.3	0	307	102	0	56	490	7.7	GS 56296
10N/9W-4D2 (NB-4)	10-23-67	500		21	.10	4.3	.6	110	.7	200	0	61	16	1.1	1.6	.1	315	13	0	94	504	8.1	GS 56304
10N/9W-5B1 (NB-5)	10-24-67	500		28	.04	25	5.6	268	3.9	328	0	122	192	.8	1.7	.7	810	86	0	87	1,360	7.8	GS 56301
11N/9W-32Q1 (NB-3)	10-23-67	450		24	0	9.3	2.3	154	1.2	244	0	75	58	1.2	1.0	.3	446	32	0	91	736	7.6	GS 56300

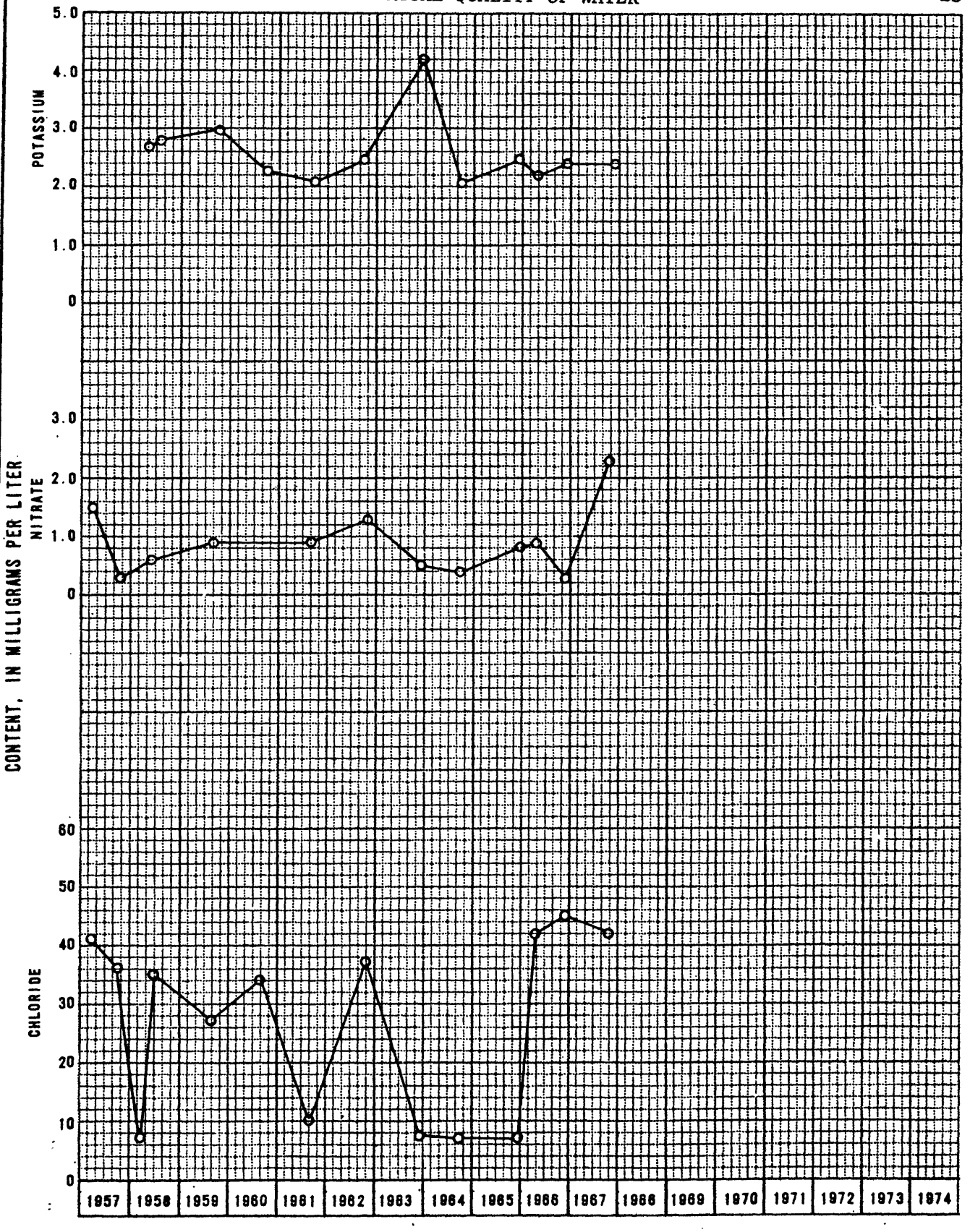

FIGURE 7.—Chloride, nitrate, and potassium content in water from well 9N/10W-24G1(MB-8).

CONDITION OF WELLS

Pumping tests were made on eight base supply wells in January 1968 (table 4). The wells in the North Base well field show no significant change in specific capacity since the previous test. Wells 9N/9W-18C1 (MB-7) and 9N/10W-24C1 (MB-9) have a much lower specific capacity than the other wells in the Main Base well field.

The casing in well MB-9 was photographed in July 1966 to determine if it was properly perforated. The photographs showed that much of the casing was not perforated. In July 1967 the well was reperforated with a Mills knife from 125 feet to 733 feet below land surface. A subsequent pumping test was made on the well, and the specific capacity at that time ranged between 3.2 gpm (gallons per minute) per foot of drawdown to 2.0 gpm per foot of drawdown (table 4) indicating no improvement. The casing was again photographed to determine if the recent perforations were adequate. The photographs seemed to indicate good perforations; however, because of the angle of view it could not be determined definitely whether or not the perforator cut through the casing or just dented it.

A pumping test of well MB-9 in January 1968 indicated a specific capacity of 9.1 gpm per foot of drawdown. If this specific capacity is accurate, it indicates the well has undergone further development by normal usage, and it may indicate that the well was not completely developed at the time of drilling.

Plans are now in progress to acidize the well in an effort to remove the drilling mud which may be clogging the gravel pack. If the acid treatment proves effective in increasing the specific capacity, the same treatment should be used on well MB-7 to improve its specific capacity.

TABLE 4.--*Specific capacity of selected wells*

Well number	Date of test	Yield (gpm)	Drawdown (ft)	Specific capacity (gpm/ft drawdown)
9N/9W-18C1 (MB-7)	1- 9-68	658	73.9	8.9
9N/10W-16C2 (C-2)	1-11-68	887	12.4	71.3
9N/10W-24G1 (MB-8)	1- 9-68	1,312	67.3	19.5
9N/10W-24E1 (MB-11)	1-10-68	1,201	75.6	15.9
9N/10W-24C1 (MB-9)	7-31-67	350	110	3.2
	7-31-67	580	185	3.1
	7-31-67	635	260	2.4
	7-31-67	680	310	2.1
	7-31-67	700	350	2.0
	1-10-68	442	48.9	9.1
10N/9W-4D2 (NB-4)	1-10-68	613	15.0	40.9
10N/9W-5B1 (NB-5)	1-11-68	1,224	24.8	49.3
11N/9W-32Q1 (NB-3)	1-11-68	923	23.8	35.8

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