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GEOLOGICAL SURVEY

ANNUAL WATER-RESOURCES REVIEW

WHITE SANDS MISSILE RANGE, NEW MEXICO, 1977

By R. R, Cruz

Open-File Report 78-553

Prepared in cooperation with

White Sands Missile Range

Albuquerque, New Mexico

May 1978

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U.S. CUSTOMARY TO METRIC UNIT CONVERSION FACTORS

In this report figures are given in U.S. Customary units only. Water temperatures are expressed in degrees Celsius. Below is a list for converting to metric units.

Multiply U.S. Customary units	By	To obtain metric units
°F (Fahrenheit)	(°F-32)/1.8	°C (Celsius)
in (inch)	25.4	mm (millimeter)
ft (foot)	.3048	m (meter)
mi (mile)	1.609	km (kilometer)
gal (gallon)	.003785	m^3 (cubic meter)
acre-foot (acre-foot)	1233	m^3 (cubic meter)

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ABSTRACT

Ground-water data were collected in 1977 at White Sands Missile Range in south-central New Mexico. Near the Post Headquarters, water-level declines for the period 1968-77 declined about 20 feet.

Total ground-water pumpage at White Sands Missile Range for 1977 was 2,146 acre-feet or 93 acre-feet more than in 1976. Wells at the Post Headquarters produced 2,112 acre-feet of the total volume. Specific conductance of ground water ranged from 277 to 2,410 micromhos per centimeter at 25 degrees celcius for wells T-4 and T-14 respectively at Post Headquarters.

INTRODUCTION

This report presents water-resources information that was collected at White Sands Missile Range during 1977 by personnel of the U.S. Geological Survey. Ground-water pumpage, water-level measurements, and chemical-quality data are summarized in the report. The data were obtained as a result of the continuing water resources hydrologic-data collection program sponsored by the Facilities Engineering Directorate, White Sands Missile Range.

The 1967 report and reports prior to 1967 received administrative release only. The 1968 report and subsequent annual reports are open-file reports and are available for inspection at the U.S. Geological Survey, Water Resources Division, District Office in Albuquerque.

CONTINUING OBSERVATIONS

The program to collect water-resources data at White Sands Missile Range has been continuous since 1953. Over the years the program has changed and expanded in response to the addition of new installations in widely scattered areas on the missile range (fig. 1). The original program consisted of water-level observations in five test wells in the Post Headquarters area. By the end of Fiscal Year 1977 the program had been expanded to include semiannual water sampling in eight test wells for complete chemical analysis; annual water-level measurements in 16 supply wells, quarterly water-level measurements in 24 test and observation wells, and annual water-level measurements in 23 boreholes.

On October 1, 1977 the cooperative program was revised. The water-sampling part of the program now consists of 10 collections annually for complete chemical analysis, rotating the sampling points to include supply wells, test wells, boreholes, and desalinized water from Stallion Range Center (SRC 1 and 2). In addition, 41 samples from other collection points will be obtained annually (in February or August) for laboratory specific-conductance measurements. Water-level measurements in 16 supply wells, 27 test and observation wells, and 31 boreholes will now be made semiannually during the periods of least (February) and greatest (August) demand of the water-supply systems.

Pumpage and water-level fluctuations

Total ground-water pumpage* at White Sands Missile Range in 1977, according to records provided by the Facilities Engineering Directorate, was 699,294,000 gallons. The Post Headquarters well field produced 688,039,000 gallons; well 1 Hazardous Test Area (HTA-1), 491,900 gallons; wells at Multifunction Array Radar (MAR-1 and 2), 907,900 gallons; Small Missile Range (SMR-1), 1,696,700 gallons; and wells SRC-1 and 2, 8,159,000 gallons.

Figure 2 shows pumpage by month and total gallons pumped per year, 1963-77, and the corresponding fluctuation of water level in the Main Gate well. Hydrographs on figure 3 show water-level fluctuations in test wells T-7, T-8, T-10, and T-11, 1968-77; hourly water-level fluctuations are recorded in these wells. The location of all WSMR supply wells, test wells, and boreholes is shown on figures 4, 5, and 6.

*The pumpage figures used in this report are to be considered as preliminary figures and may be subject to revision.

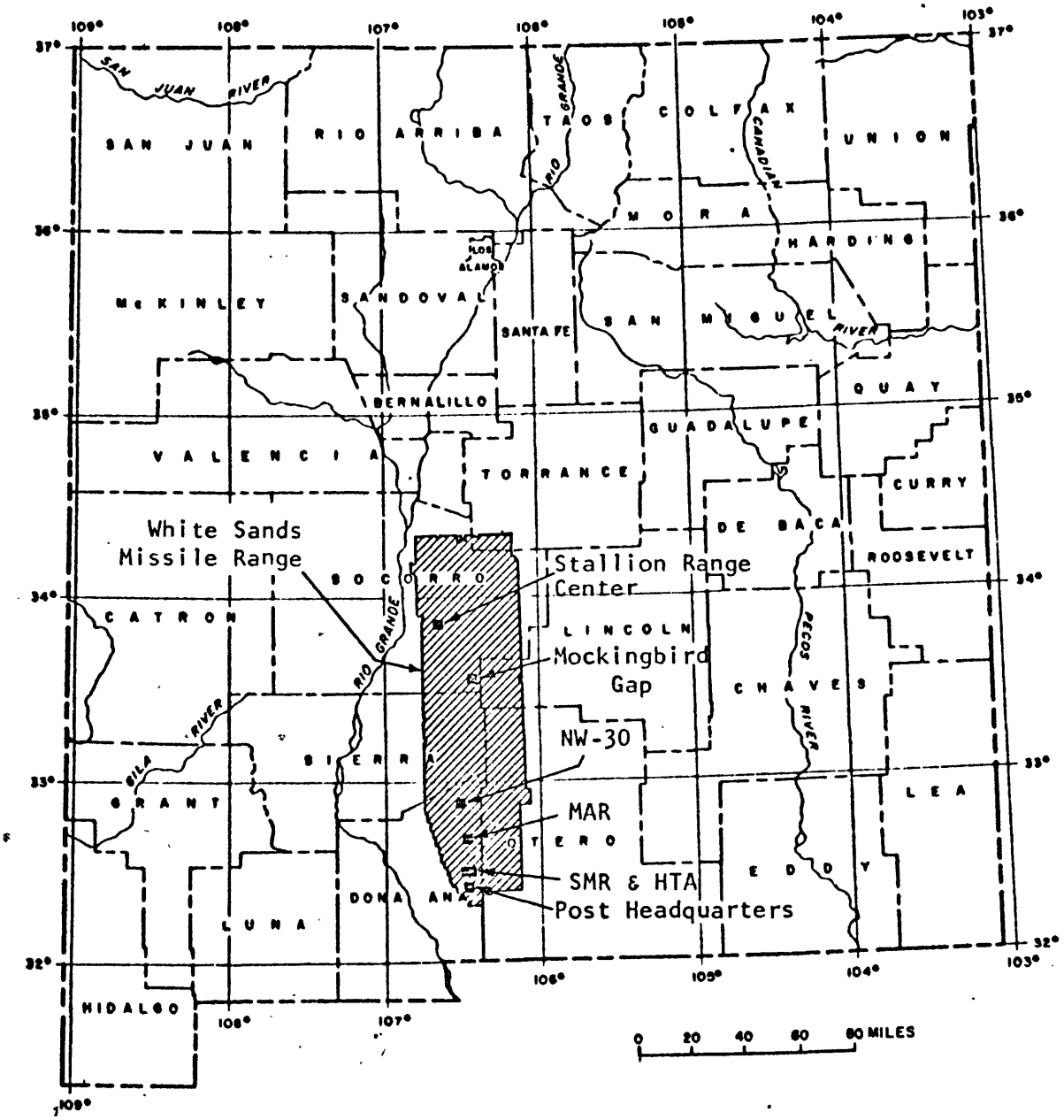


Figure 1.--White Sands Missile Range and areas of hydrologic observations.

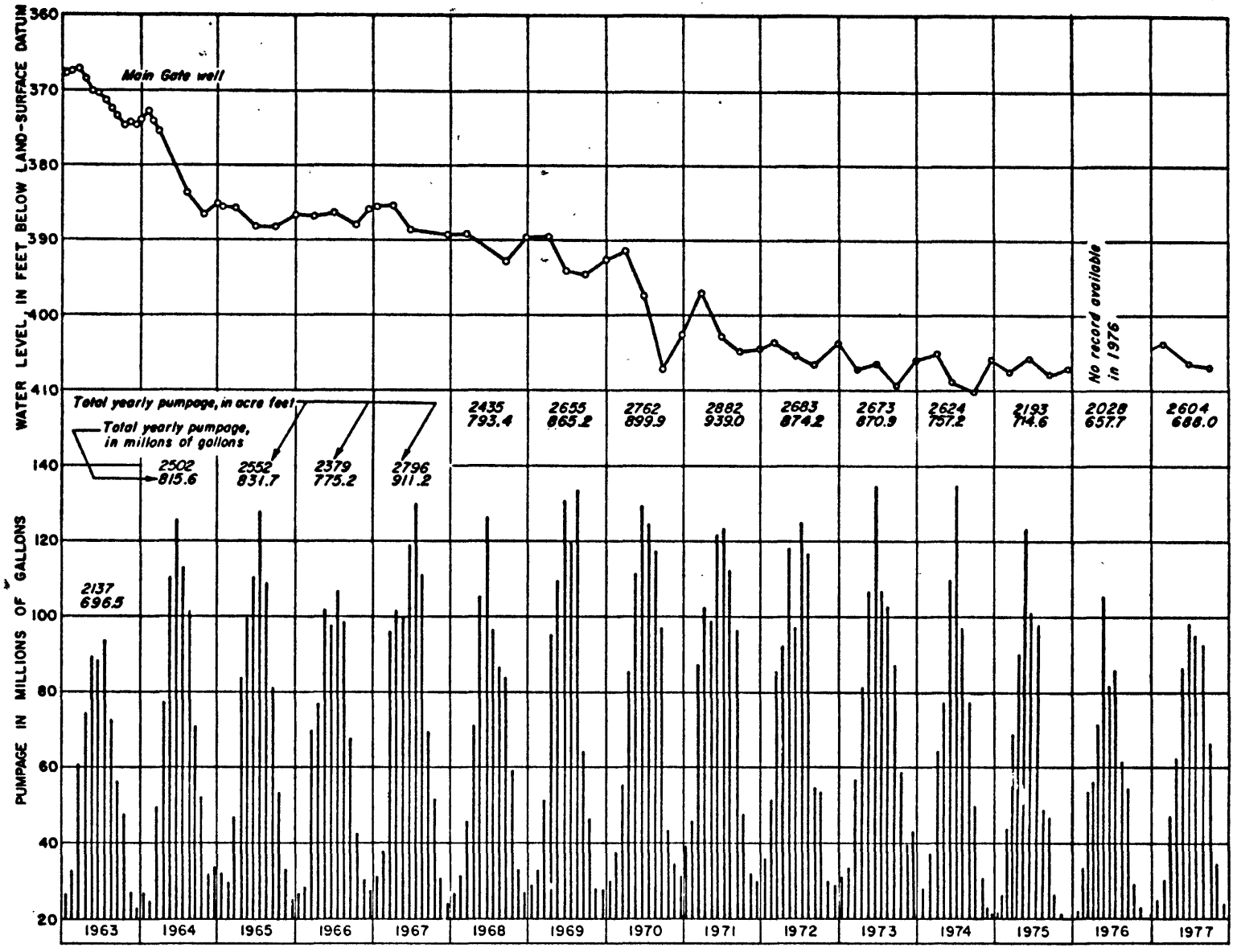


Figure 2.--Monthly and yearly pumpage in the Post Headquarters well field, and water-level fluctuations in the Main Gate well, 1963-77.

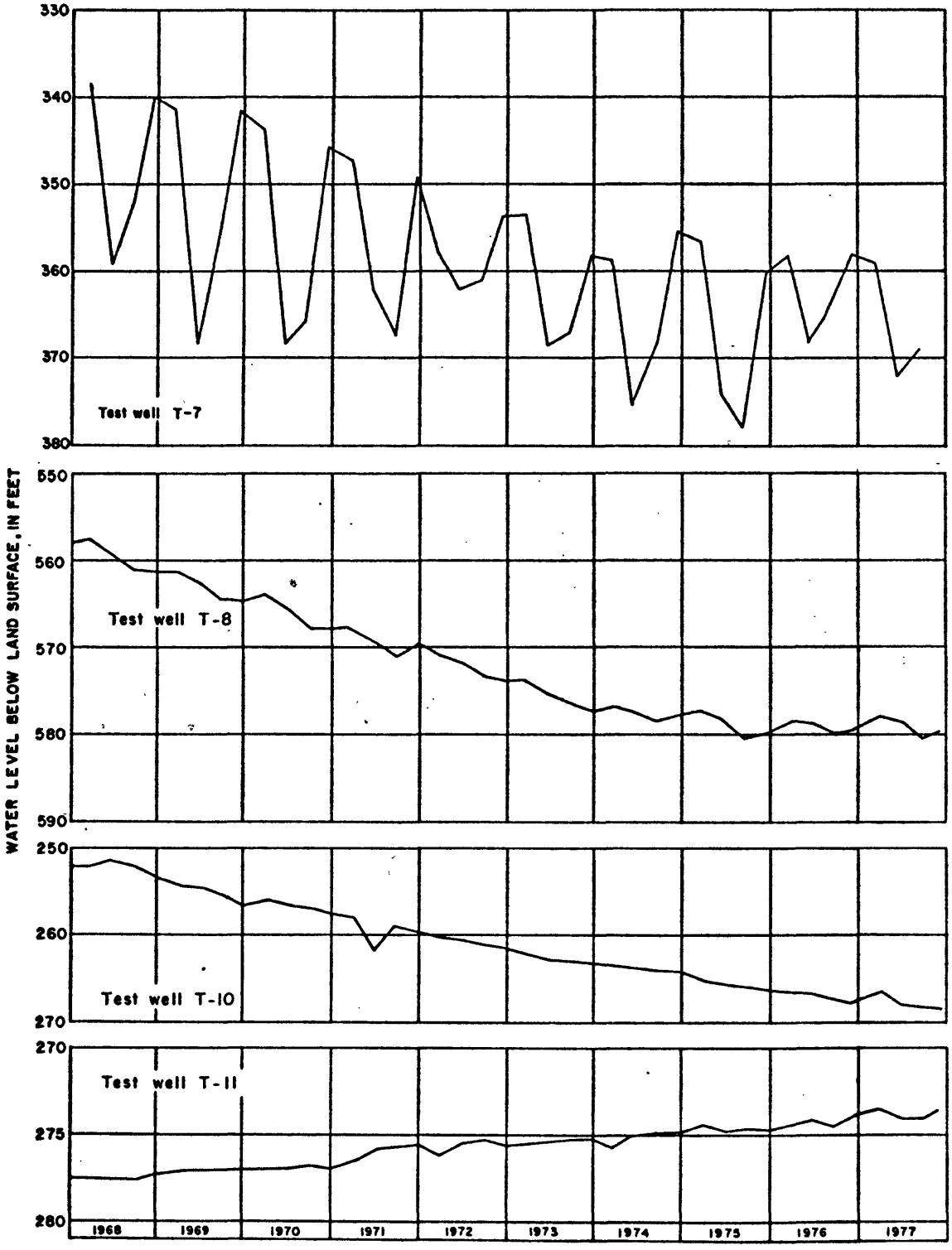


Figure 3.--Water-level fluctuations in test wells T-7, T-8, T-10, and T-11, 1968-77.

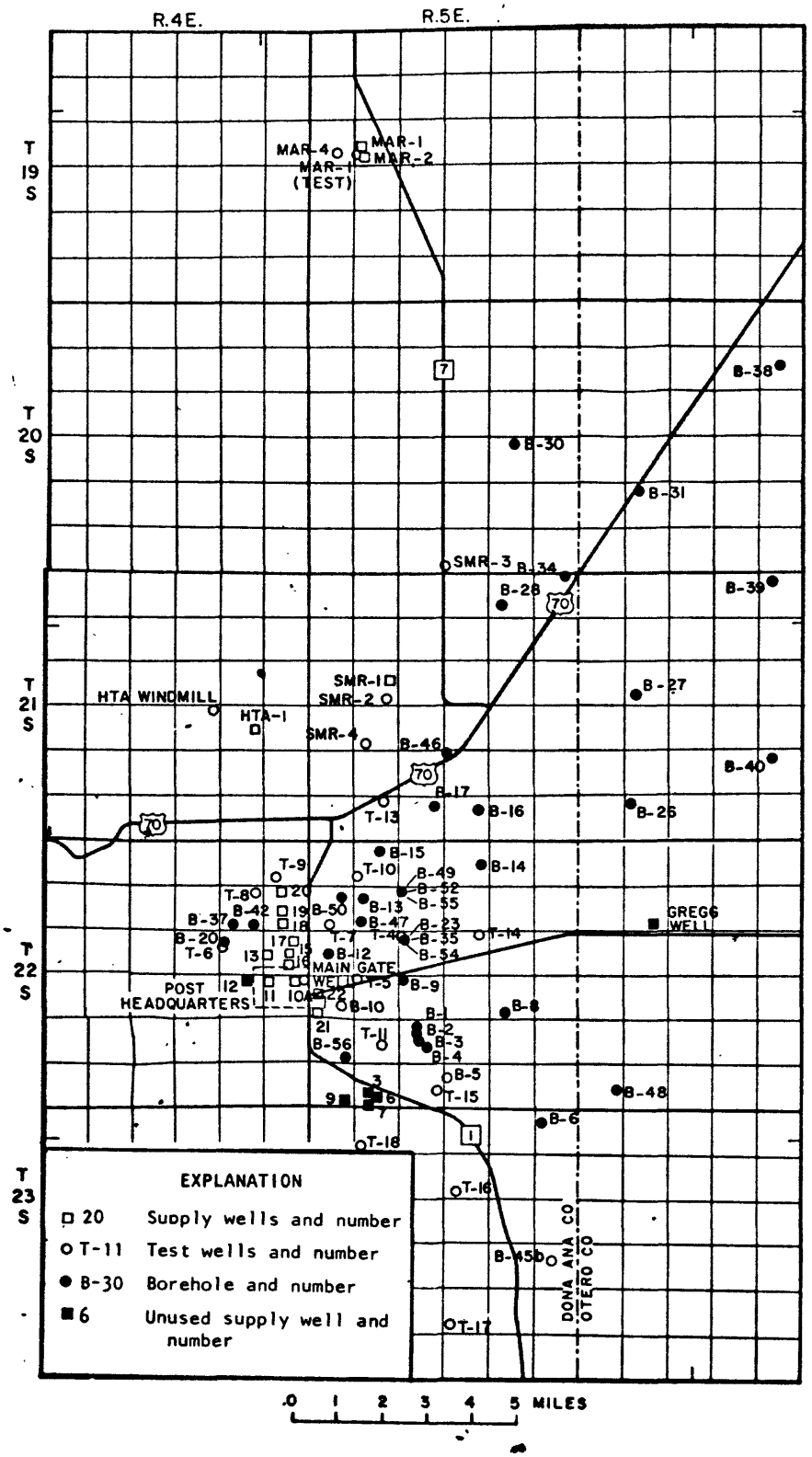


Figure 4.--Location of supply wells, test wells, observation wells, and boreholes in the Post Headquarters and adjacent areas.

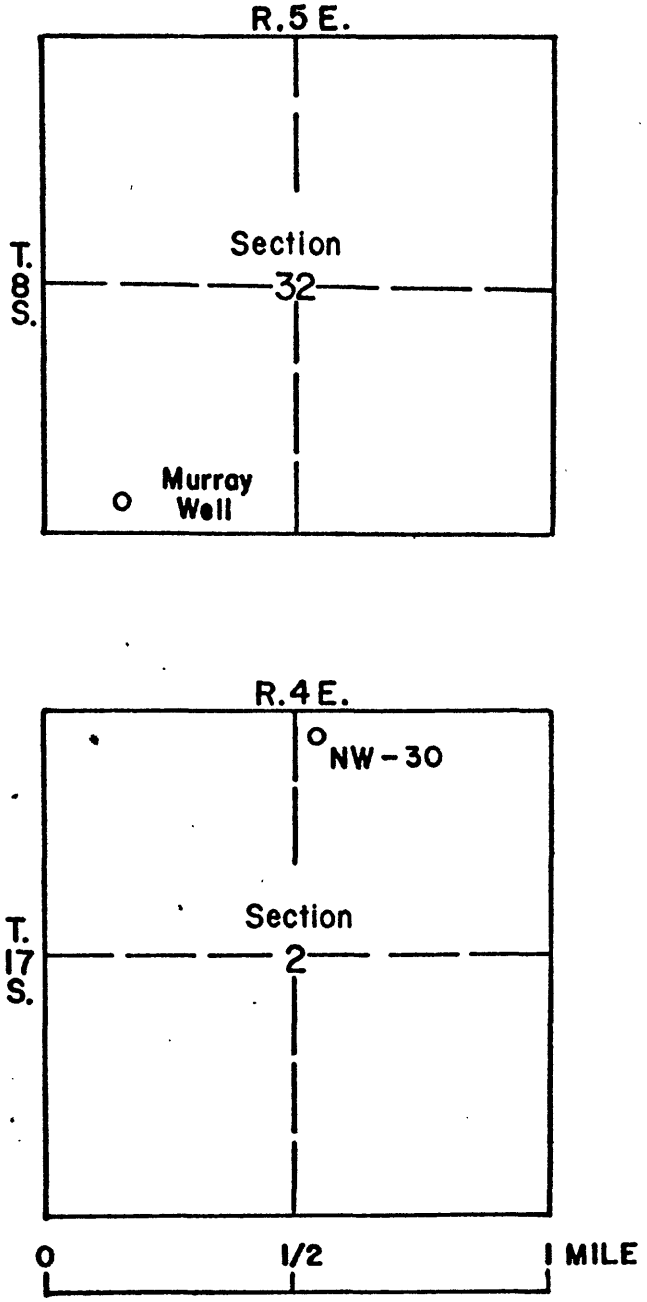
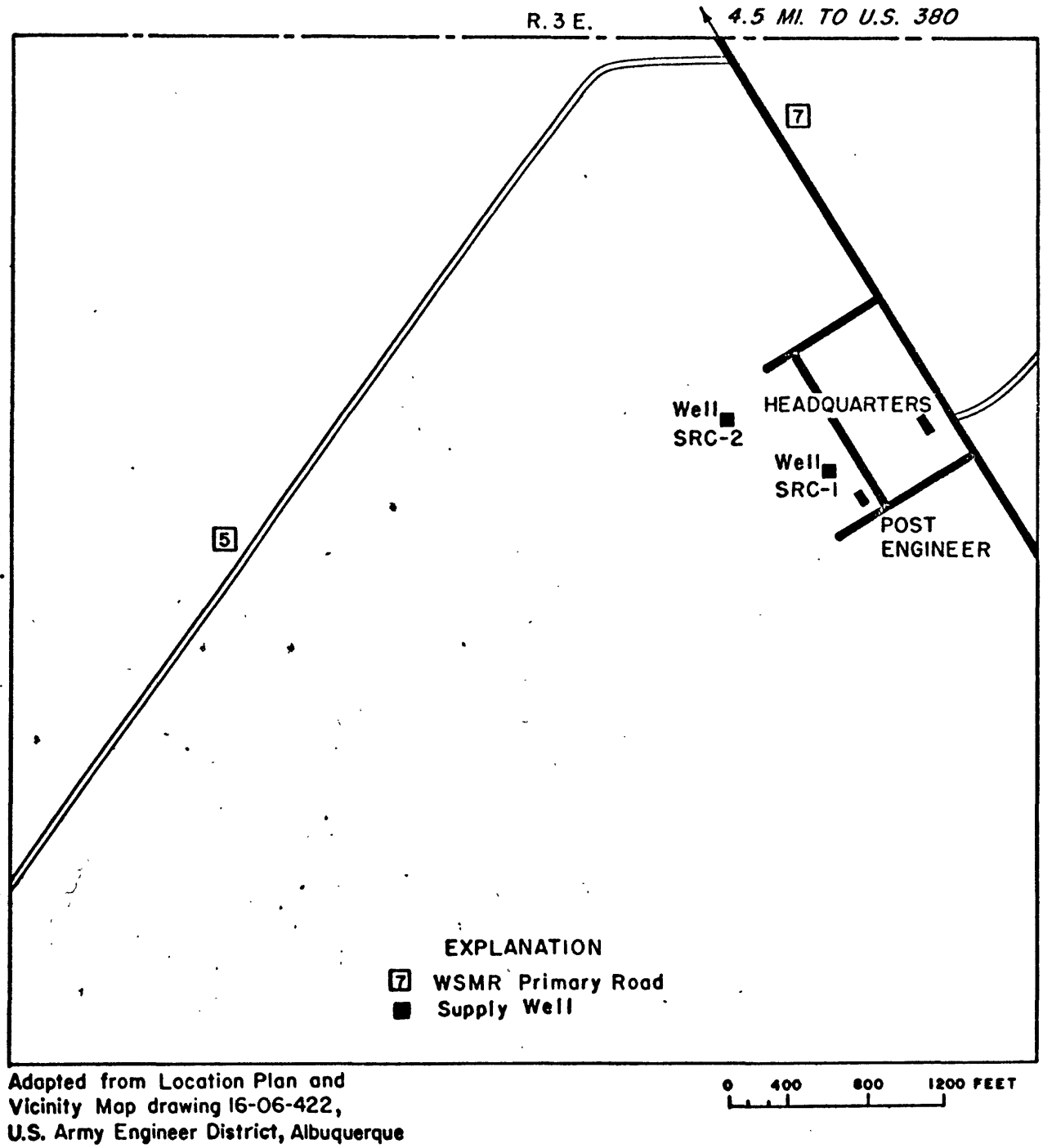


Figure 5.--Location of test wells in Mockingbird Gap and NW-30 areas.



Adapted from Location Plan and Vicinity Map drawing 16-06-422, U.S. Army Engineer District, Albuquerque

Figure 6.--Location of supply wells, Stallion Range Center.

Water-level measurements in supply wells

Depth-to-water measurements made in December 1976 and in various months in 1977 are listed in table 1. Figures 7 through 11 show hydrographs and other information for supply wells 10a, 11, 13, 15, 16, 17, 18, 19, and 20 in the Post Headquarters well field from the time each well was drilled through 1977. The two new Post Headquarters supply wells 21 and 22, which were put into operation in April 1977, show a water-level decline of 6.94 feet in well 21 and 9.32 feet in well 22 from December 1976 through September 1977.

Water-level measurements in test wells, observation wells, and boreholes

Water-level measurements were made in 21 test wells in the Post Headquarters area, one well in the HTA area, three wells in the SMR area, and two wells in the MAR area (fig. 4), one well in the NW-30 area, and one well in the Mockingbird Gap area (fig. 5).

Depth-to-water measurements in test and observation wells are shown in two tables. Table 2 shows the 1977 water levels and the water-level change since the same month in 1976. Table 3 shows the March and September 1977 water levels and the change in water-level between these two periods of high and low withdrawal rates of ground water. Four of the test wells in the Post Headquarters area are equipped with continuous recording gages; hydrographs of these wells are shown on figure 3.

Water levels, change in water levels, perforated intervals, and total depth of boreholes are given in table 4. The total depth of each of the boreholes was measured in March 1977, as shown in table 4. Some of the boreholes may no longer be open to the formation because of fill above the perforations.

Figure 12 shows the water-table elevation contours.

Table 1.--Depth to water in supply wells, Post Headquarters and Range areas

Well	December 1976 (feet below land surface)	March 1977 (feet below land surface)	September 1977 (feet below land surface)
10a	423.79	423.00	426.04
11	1/ *357.63	*274.00	346.06
13	297.63	*312.00	303.93
15	*432.95	*431.00	*450.30
16	*447.95	*448.00	*460.70
17	438.32	421.00	455.95
18	424.38	429.00	438.71
19	449.63	450.00	453.43
20	509.47	-	513.70
21	351.22	2/ 352.00	358.16
22	372.21	2/ 371.00	381.53
MAR-1	213.99	1/ 217.00	-
MAR-2	218.67	1/ 224.00	-
SMR-1	294.37	3/ 298.00	-
SRC-1	204.84	-	4/ 207.00
SRC-2	212.20	-	4/ 214.00

*Airline gage reading
1/ January 1977 reading
2/ April 1977 reading
3/ May 1977 reading
4/ November 1977 reading

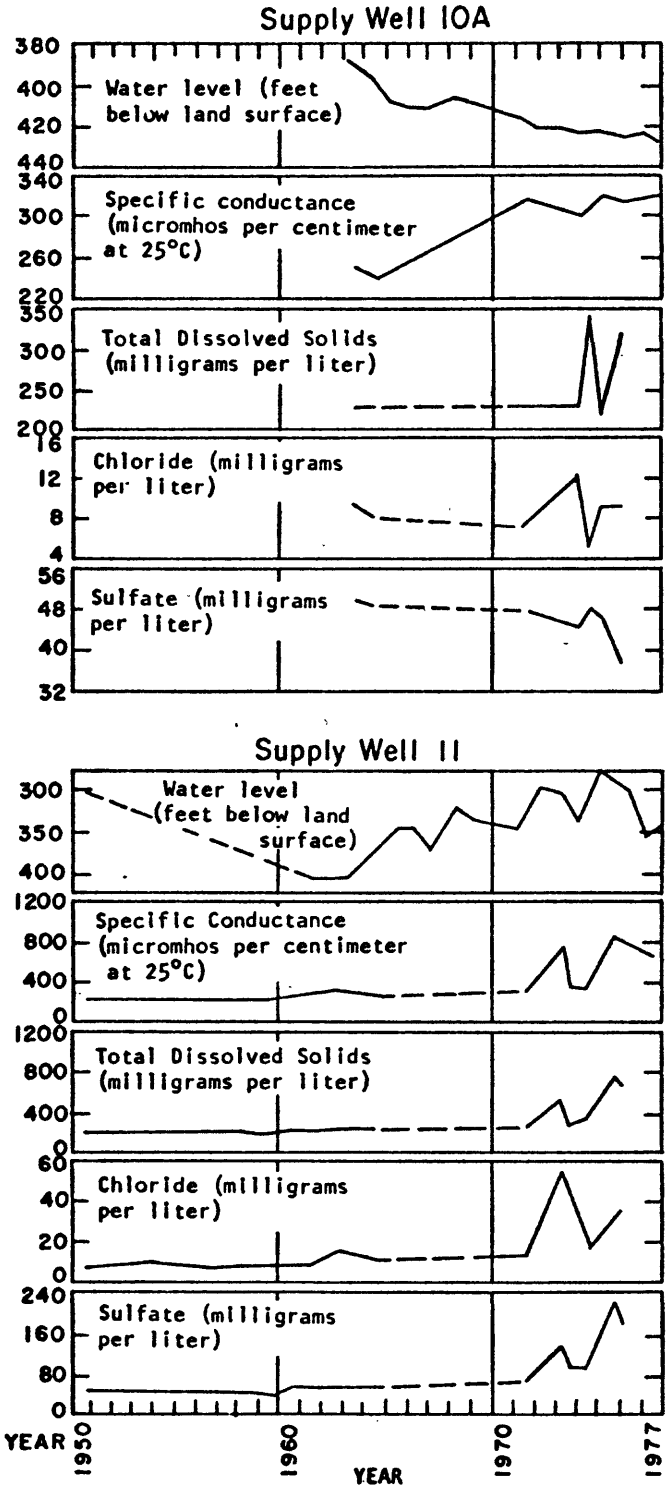


Figure 7.--Water level, specific conductance, dissolved solids, chloride, and sulfate values, for period of record available, in supply wells 10a and 11.

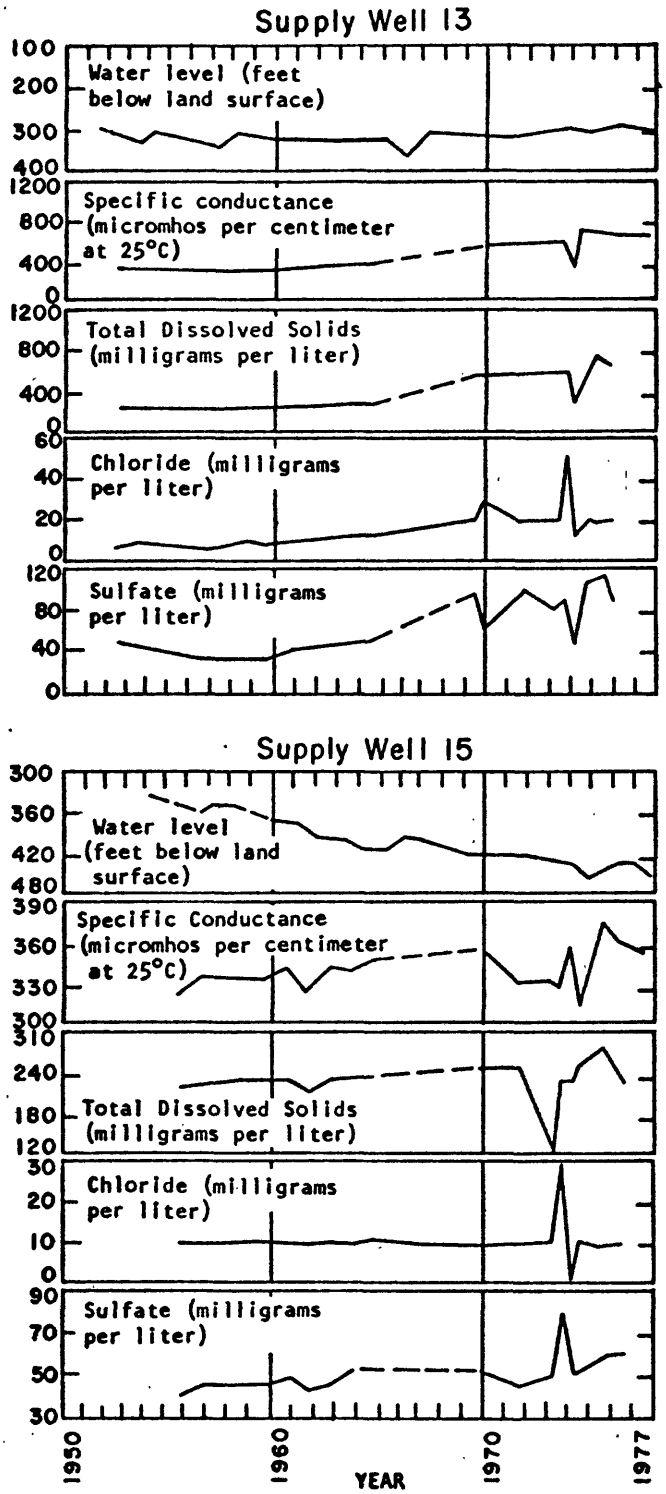


Figure 8.--Water level, specific conductance, dissolved solids, chloride, and sulfate values, for period of record available, in supply wells 13 and 15.

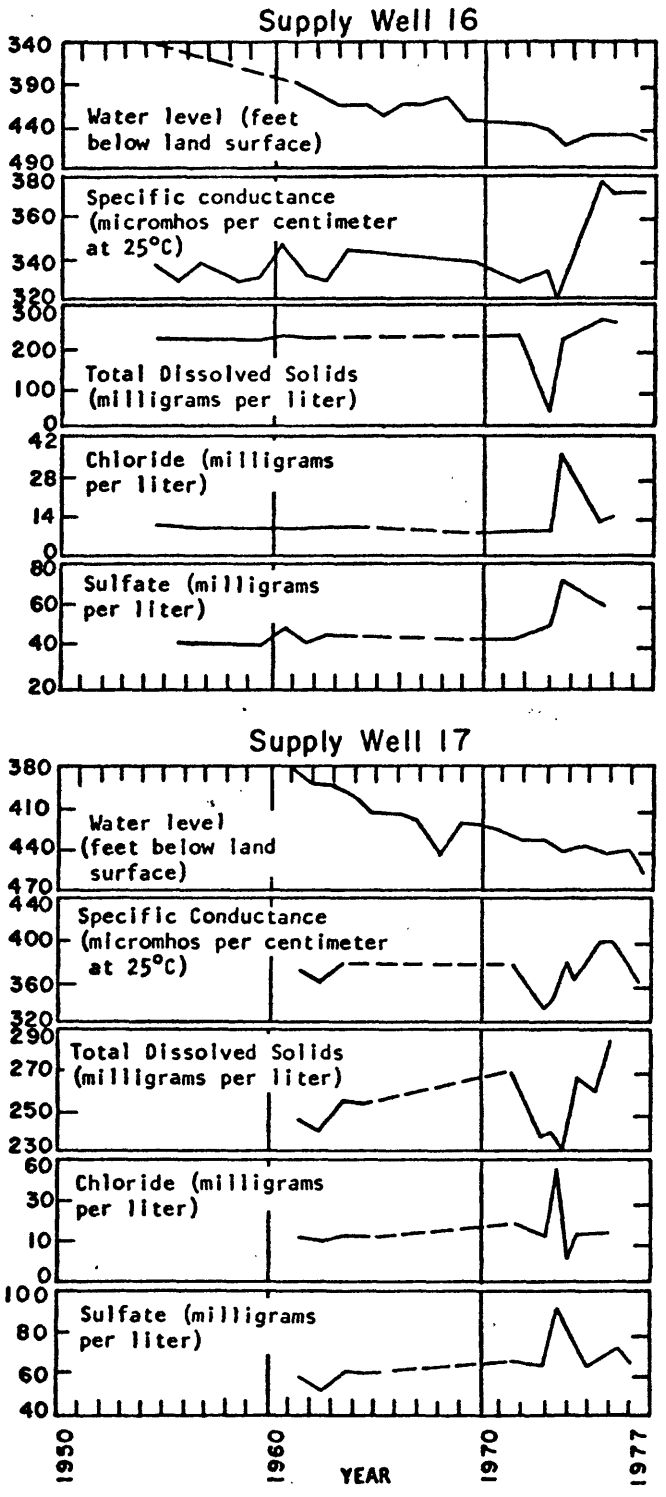


Figure 9.--Water level, specific conductance, dissolved solids, chloride, and sulfate values, for period of record available, in supply wells 16 and 17.

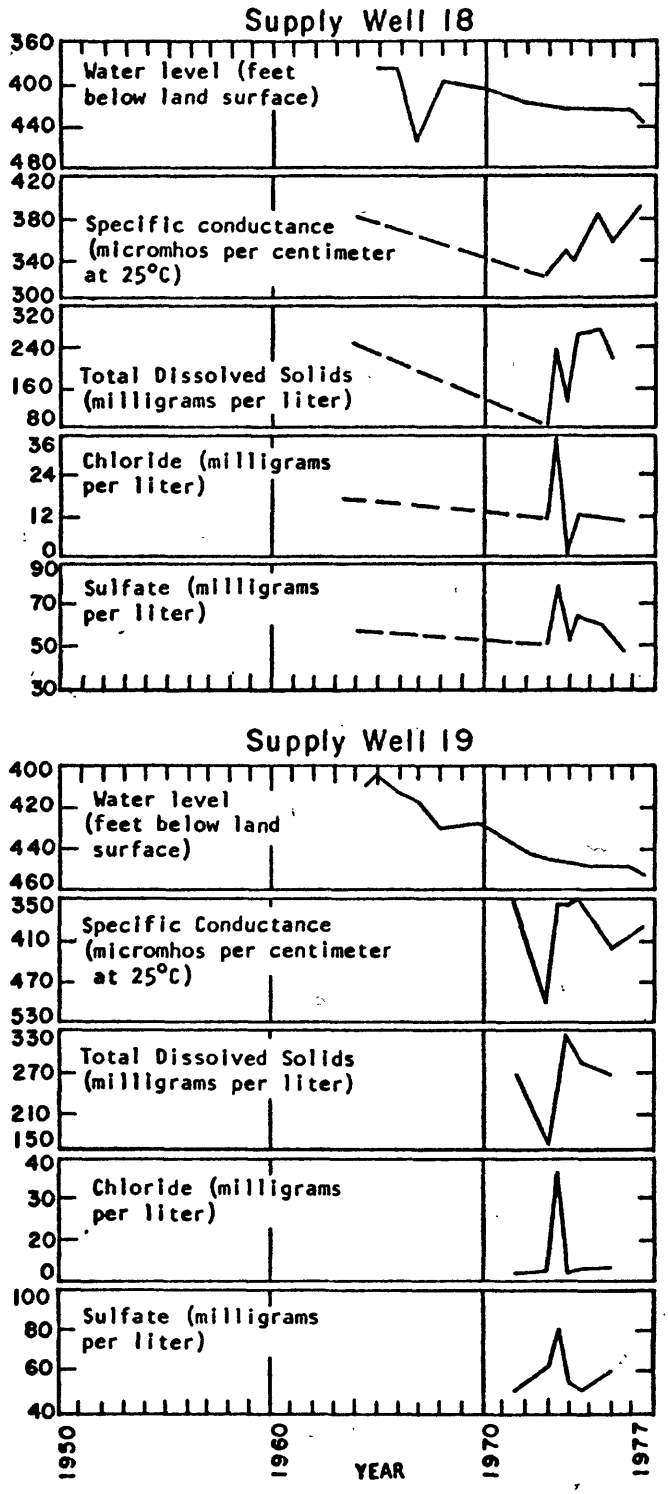


Figure 10.--Water level, specific conductance, dissolved solids, chloride, and sulfate values, for period of record available, in supply wells 18 and 19.

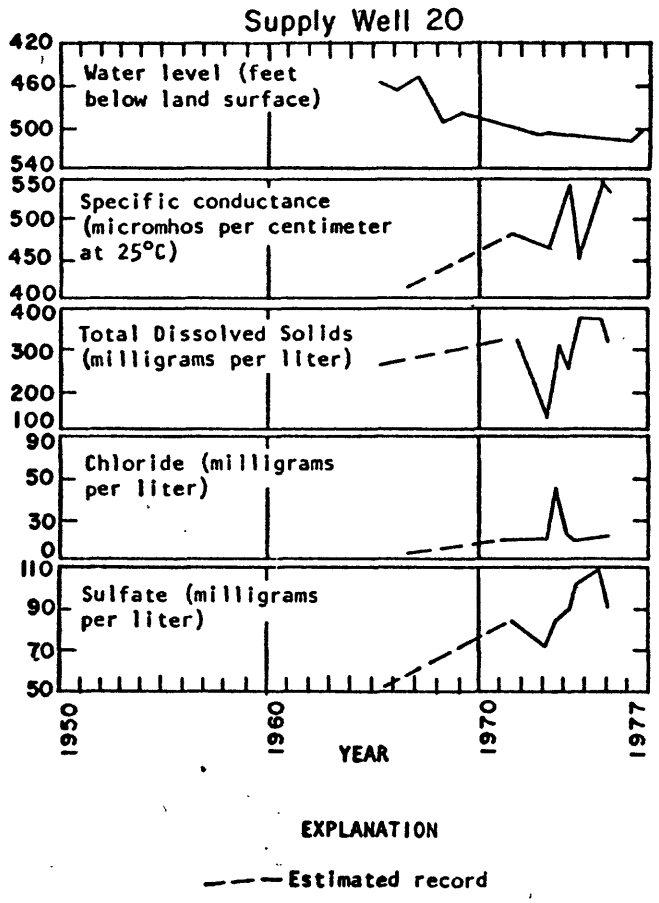


Figure 11.--Water level, specific conductance, dissolved solids, chloride, and sulfate values, for period of record available, in supply well 20.

Table 2.--Depth to water in test and observation wells, and change in water level, 1976-77

Well number	Date of measurement	Depth to water (feet below land surface)	Change in water level, 1976-77 (feet)	Remarks
T-4	3- 2-77	225.75	+0.12	-
	6-15-77	225.95	+ .68	-
	9-13-77	225.91	- .08	-
T-5	3- 2-77	274.89	+ .09	-
	6-15-77	275.34	+ .25	-
	9-13-77	275.28	- .15	-
T-6	3- 2-77	209.95	- .38	-
	6-15-77	209.90	- .36	-
	9-13-77	209.82	- .02	-
T-7	3- 2-77	358.65	+ .32	Equipped with recorder
	6-15-77	372.69	-4.38	-
	9-13-77	369.67	-4.38	-
T-8	3- 2-77	577.97	+ .35	Equipped with recorder
	6-15-77	578.92	- .28	-
	9-13-77	580.51	- .43	-
T-9	3- 3-77	397.87	-1.11	-
	6-15-77	398.66	-1.59	-
	9-13-77	399.03	-1.98	-
T-10	3- 2-77	266.47	+ .12	Equipped with recorder
	6-15-77	267.90	-1.00	-
	9-13-77	268.25	-1.03	-

Table 2.--Depth to water in test and observation wells, and change in water level, 1976-77 - Continued

Well number	Date of measurement	Depth to water (feet below land surface)	Change in water level, 1976-77 (feet)	Remarks
T-11	3- 1-77	273.66	+0.54	Equipped with recorder
	6-15-77	273.83	+ .29	-
	9-13-77	273.70	+ .42	-
T-13	3- 1-77	211.39	- .85	-
	6-15-77	211.02	- .38	-
	9-13-77	211.05	- .38	-
T-14	3- 1-77	131.23	+ .60	-
	6-15-77	131.90	- .48	-
	9-12-77	132.08	- .21	-
T-15	3- 1-77	178.65	+ .15	-
	6-15-77	178.66	- .14	-
	9-13-77	178.65	+ .13	-
T-16	3- 1-77	186.00	+ .38	-
	6-15-77	186.14	+ .14	-
	9-13-77	186.02	- .04	-
T-17	3- 1-77	242.17	+ .23	-
	6-15-77	242.29	- .05	-
	9-13-77	242.21	- .04	-
T-18	3- 1-77	240.30	+1.07	-
	6-15-77	240.44	+ .93	-
	9-13-77	240.45	+ .37	-

Table 2.--Depth to water in test and observation wells, and change in water level, 1976-77 - Continued

Well number	Date of measurement	Depth to water (feet below land surface)	Change in water level, 1976-77 (feet)	Remarks
Old supply well 12	3- 3-77	248.95	+0.64	-
	6-15-77	249.14	+ .23	-
	9-13-77	249.19	+ .50	-
Main gate well	3- 2-77	404.28	-	Not able to measure in 1976
	6-29-77	406.57	-	-
	9-12-77	407.16	-	-
Gregg well	3- 1-77	214.20	+ .16	-
	6-15-77	214.36	- .04	-
	9-12-77	214.45	- .08	-
HTA windmill	2-28-77	43.90	-3.06	-
	6-14-77	42.31	-1.01	-
	9-14-77	41.42	+ .49	-
SMR-2	3- 3-77	315.98	-1.01	-
	6-14-77	315.94	- .97	-
	9-13-77	316.11	- .87	-
SMR-3	3- 3-77	296.06	- .89	-
	6-14-77	296.10	+ .05	-
	9-13-77	296.22	- .23	-
SMR-4	2-28-77	283.58	- .72	-
	6-14-77	283.91	- .94	-
	9-14-77	284.26	- .86	-

Table 2.--Depth to water in test and observation wells, and change in water level, 1976-77 - Concluded

Well number	Date of measurement	Depth to water (feet below land surface)	Change in water level, 1976-77 (feet)	Remarks
MAR-1 (test)	3- 3-77	223.26	-2.31	-
	6-14-77	220.60	+ .31	-
	9-12-77	220.43	+ .30	-
MAR-4	3- 3-77	303.64	+ .39	-
	6-14-77	303.59	+ .24	-
	9-12-77	303.36	+ .38	-
NW-30	3- 3-77	212.18	- .26	-
	6-14-77	212.13	- .15	-
	9-12-77	212.08	- .13	-
Murray test well	2-28-77	176.85	- .09	-
	6-14-77	176.80	- .21	-
	9-12-77	176.59	+ .01	-

Table 3.--Depth to water in test and observation wells, and change in water level March 1977 - September 1977

Well number	March 1977 (feet below land surface)	September 1977 (feet below land surface)	Change in water level (feet)
Test and observation wells			
T-4	225.75	225.91	- 0.16
T-5	274.89	275.28	- .39
T-6	209.95	209.82	+ .13
T-7	358.65	369.67	-11.02
T-8	577.97	580.51	- 2.54
T-9	397.87	399.03	- 1.16
T-10	266.47	268.25	- 1.78
T-11	273.66	273.70	- .04
T-13	211.39	211.05	+ .34
T-14	131.23	132.08	- .85
T-15	178.65	178.65	0
T-16	186.00	186.02	- .02
T-17	242.29	242.21	+ .08
T-18	240.30	240.45	- .15
Old supply well 12	248.95	249.19	- .24
Main Gate well	404.28	407.16	- 2.88
Gregg well	214.20	214.45	- .45
HTA windmill	43.90	40.12	+ 3.78
SMR-2	315.98	316.11	- .13

Table 3.--Depth to water in test and observation wells, and change in water level March 1977 - September 1977 - Concluded

Well number	March 1977 (feet below land surface)	September 1977 (feet below land surface)	Change in water level (feet)
Test and observation wells			
SMR-3	296.06	296.22	- .16
SMR-4	283.58	284.26	- .68
MAR-1 (test)	223.26	220.43	- 2.83
MAR-4	303.64	303.36	- .28
NW-30	212.18	212.08	+ .10
Murray test	176.85	176.59	+ .26
Old well field			
3	224.94	225.00	- .04
6	237.23	237.34	- .11
7	231.93	232.10	- .17
9	248.80	248.77	+ .03

Table 4.—Depth to water in boreholes, and change in water level March 1977 - September 1977

[Perforated intervals from T. E. Kelly (1973, p. 12-14) and total depth of borehole measured in March 1977.]

Borehole number	Water level (feet below land surface)		Change in water level (feet)	Perforated intervals (feet below land surface)	Total depth (feet below land surface)	Remarks
	Mar. 1977	Sept. 1977				
1	194.78	-	-	210-250	250	-
2	196.63	194.18	+2.45	220-260	253	1¼-inch metal pipe
3	204.46	-	-	220-380	380	-
4	198.28	198.54	- .26	220-260	251	-
5	188.21	188.43	- .22	210-249	243	-
6	133.98	134.23	- .25	150-175	183	-
9	225.46	225.78	- .32	240-250	255	1¼-inch metal pipe
10	303.88	307.50	-3.62	370-375 390-395	384	Do
11	Dry	Dry	-	275-285	290	Abandoned
12	260.83	262.08	-1.25	355-365	301*	1¼-inch metal pipe
13	238.75	239.49	- .74	250-285	287	-

Table 4.--Depth to water in boreholes, and change in water level March 1977 - September 1977 - Continued

Borehole number	Water level (feet below land surface) Mar. 1977	Water level (feet below land surface) Sept. 1977	Change in water level (feet)	Perforated intervals (feet below land surface)	Total depth (feet below land surface)	Remarks
14	111.35	111.50	-0.15	180-220 240-258	211	1¼-inch metal pipe
15	170.25	170.68	- .43	200-220	221	-
16	108.30	108.44	- .14	235-245	241	1¼-inch metal pipe
17	110.19	110.44	- .25	230-275	243	Do
18	103.87	103.92	- .05	180-220	214	Do
20	347.34	347.38	- .01	410-440	421	Do
21 A and B	Dry	Dry	-	-	-	Plugged and abandoned
22	Dry	Dry	-	-	-	Destroyed June 1972
23	223.80	224.05	- .25	220-250	252	1¼-inch metal pipe
24	Dry	Dry	-	180-260	256	Abandoned
25	Dry	Dry	-	260-270	264	Do
26	140.61	140.87	- .26	180-185	187	1¼-inch metal pipe
27	119.60	119.86	- .26	163-167	177	-

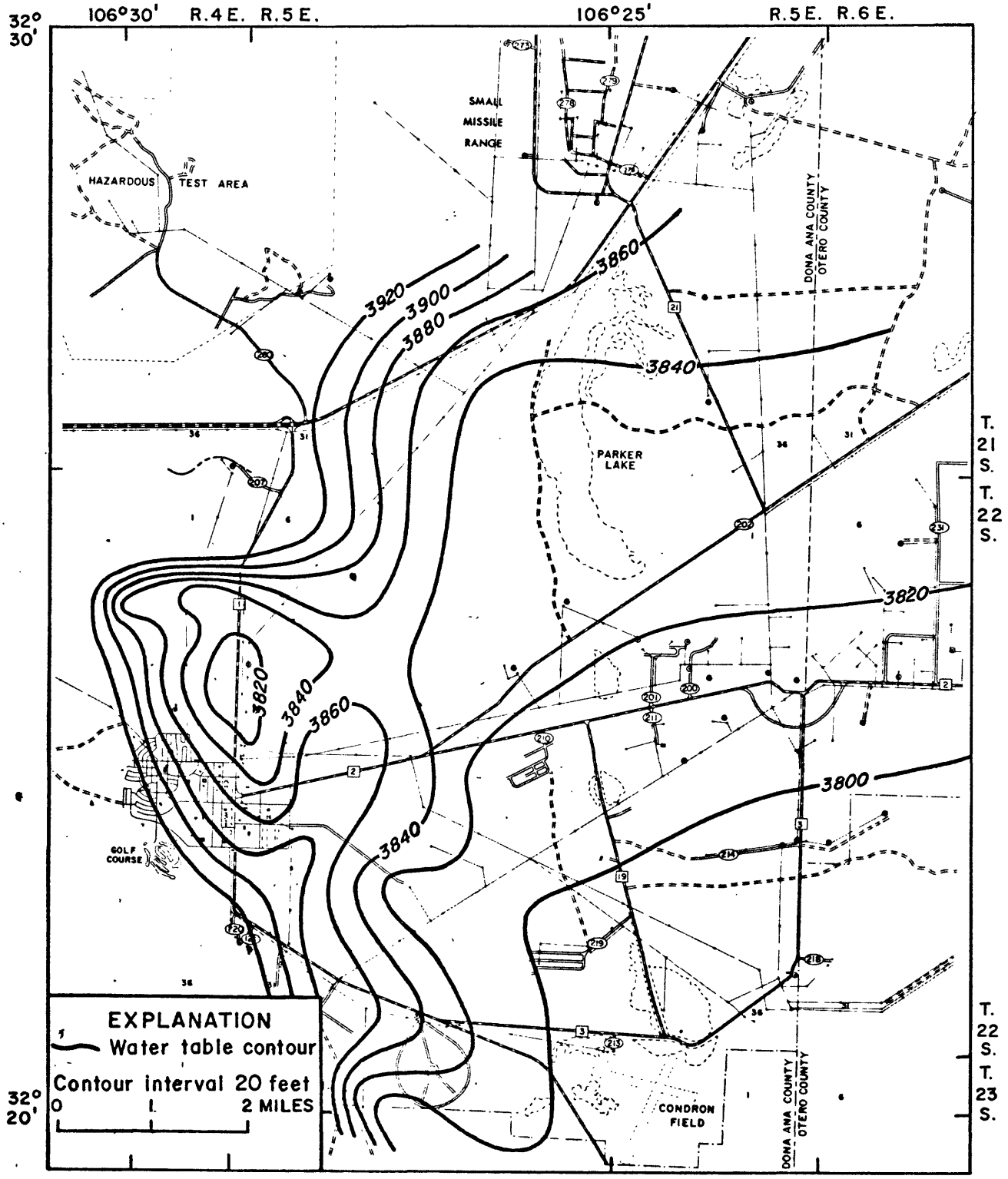
Table 4.--Depth to water in boreholes, and change in water level March 1977 - September 1977 - Continued

Borehole number	Water level (feet below land surface) Mar. 1977	Water level (feet below land surface) Sept. 1977	Change in water level (feet)	Perforated intervals (feet below land surface)	Total depth (feet below land surface)	Remarks
28	139.72	139.71	+0.01	125-145 165-190	209	-
29	Dry	Dry	-	150-184	134	-
30	89.45	89.50	- .05	182-191	200	-
31	123.05	123.21	- .16	170-190 220-240	215	-
34	126.02	125.98	+ .04	-	173	-
35	226.98	227.10	- .12	370-400	380	1¼-inch metal pipe
36	214.36	213.90	+ .46	210-240	235	-
37	410.38	410.13	+ .25	510-540	498+	1¼-inch metal pipe
38	-	129.44	-	185-200	211	-
39	155.00	156.40	-1.40	157-177 158-165	218	-
40	189.44	-	-	183-194 189-199	227	-
41	Dry	Dry	-	229-244	245	Abandoned

Table 4.--Depth to water in boreholes, and change in water level March 1977 - September 1977 - Concluded

Borehole number	Water level (feet below land surface)		Change in water level (feet)	Perforated intervals (feet below land surface)	Total depth (feet below land surface)	Remarks
	Mar. 1977	Sept. 1977				
42	385.79	386.44	-0.65	490-520	498+	1¼-inch metal pipe
45B	186.90	187.88	- .98	240-270	254	-
46	134.30	134.44	- .14	220-250	164*	1¼-inch metal pipe
47	270.93	-	-	320-350	343	Do
48	204.33	204.47	- .14	270-300	286	Do
49	197.04	197.88	- .84	170-200	203	Do
50	299.21	299.80	- .59	-	353	Do
51	146.95	147.04	- .09	370-400	321*	Do
52	208.84	209.32	-	-	298	Do
53	Dry	Dry	-	370-400	402	Abandoned
54	228.32	228.44	- .12	470-500	475	1¼-inch metal pipe
55	213.55	213.97	- .42	470-500	456*	Do
56	279.31	279.66	- .35	320-350	344	-

*Perforations below total depth measured.



Base from White Sands Missile Range Master Plan Basic Information Maps, 1972

Compiled by J.D. Hudson and R.R. Cruz, 1977

Figure 12.--Water-table contours in the Post Headquarters area, March 1977.

Chemical quality

Fourteen water samples from 11 test wells (fig. 13) were collected in June 1977 to monitor any changes in the chemical quality of ground water that may have occurred in the area around the Post Headquarters well field. Six water samples from five test wells were collected for complete chemical analyses (table 5); laboratory specific conductance was determined for the rest of the samples collected. Graphs of conductance, total dissolved solids, chlorides, sulfates, and water levels for the period of record in supply wells 10a, 11, 13, 15, 16, 17, 18, 19, and 20 are shown in figures 7 through 11 (Department of Army analyses, 1973-76; all other analyses, U.S. Geological Survey [USGS]).

The water samples collected in 1977 were obtained using the USGS New Mexico District's geophysical-logging equipment. An electrically controlled stainless-steel sampling tube was lowered to the desired depth in each well with the sampler ports closed. The entry ports at the top of the tube were then opened and remained open until the tube was filled; the ports were then closed and the tube raised to the surface. Each sample was then put in appropriate containers for transportation to the laboratory. This technique was used for collection of all the water samples.

The chemical quality of the water samples collected during 1977 was similar to that of the samples collected from the same sources in 1976. The laboratory specific conductance of water samples collected from eight test wells in June 1976 and June 1977 is compared in the table below.

Test well number	Specific conductance (micromhos per centimeter at 25°C)	
	1976	1977
T-4	257	277
T-5	383	370
T-7	314	351
T-10	322	357
T-11	314	396
T-13	487	505
T-14	2,500	2,410
T-15	725	707

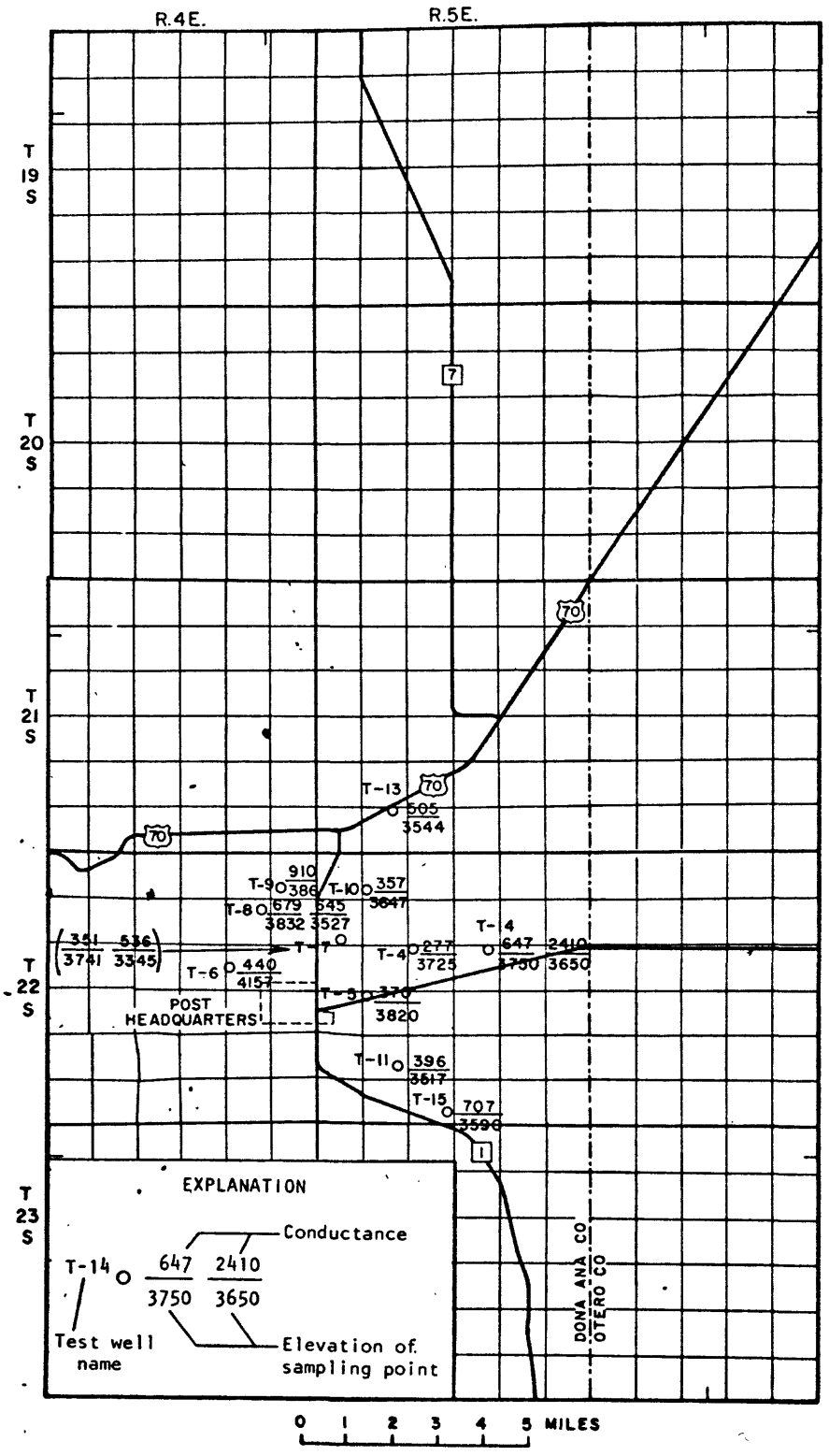


Figure 13.--Specific conductances and elevations of sampling points in selected wells, Post Headquarters area, 1977.

Table 5.--Chemical analyses of water from test wells, Post Headquarters area, 1977

[Analyses by Geological Survey, United States Department of the Interior, all concentrations reported in milligrams per liter unless otherwise noted.]

Test well	T-6	T-7	T-8	T-8		
Laboratory No	771117	771114	771118	771119		
Date of collection	6-16-77	6-15-77	6-15-77	6-15-77		
Depth sampled (feet)	350	840	610	915		
Silica (SiO_2)	36	30	38	28		
Iron* (Fe)	10	110	10	50		
Manganese* (Mn)	0	0	0	40		
Calcium (Ca)	49	38	67	60		
Magnesium (Mg)	11	4.6	21	20		
Sodium (Na)	28	70	44	45		
Potassium (K)	2.3	2.9	3.1	3.2		
Bicarbonate (HCO_3)	190	120	140	130		
Carbonate (CO_3)	0	0	0	0		
Alkalinity as $CaCO_3$	160	98	110	110		
Sulfate (SO_4)	50	120	160	150		
Chloride (Cl)	16	31	39	37		
Fluoride (F)	.7	.4	.8	.7		
Nitrate (NO_3) / Nitrite (NO_2)	.30	2.4	4.2	1.8		
Phosphorous, ortho, Dissolved as P	.04	.02	.02	.02		
Boron* (B)	-	-	-	-		
Dissolved Solids (calculated)	288	367	461	416		
Hardness as $CaCO_3$	170	110	250	230		
Noncarbonate hardness as $CaCO_3$	12	15	140	130		
Sodium Adsorption Ratio (SAR)	.9	2.9	1.2	1.3		
Specific conductance (micromhos at 25°C)	440	536	679	645		
pH	6.6	7.2	7.2	7.3		
Temperature, °Celsius (C)	23.5	26	-	-		
Carbon dioxide (CO_2)	-	12	14	10		

* Microgram per liter

Table 5.--Chemical analyses of water from test wells, Post Headquarters area, 1977 - Concluded

Test well	T-9	T-14				
Laboratory No	771135	771115				
Date of collection	6-16-77	6-15-77				
Depth sampled (feet)	550	200				
Silica (SiO_2)	18	5.3				
Iron* (Fe)	20	30				
Manganese* (Mn)	60	0				
Calcium (Ca)	100	6.1				
Magnesium (Mg)	23	1.1				
Sodium (Na)	47	120				
Potassium (K)	4.0	4.7				
Bicarbonate (HCO_3)	130	71				
Carbonate (CO_3)	0	0				
Alkalinity as $CaCO_3$	-	58				
Sulfate (SO_4)	200	62				
Chloride (Cl)	82	110				
Fluoride (F)	2.3	.4				
Nitrate (NO_3) / Nitrite (NO_2)	7.3	.09				
Phosphorous, ortho, Dissolved as P	.04	.01				
Boron* (B)	-	-				
Dissolved Solids (calculated)	573	345				
Hardness as $CaCO_3$	340	20				
Noncarbonate hardness as $CaCO_3$	240	0				
Sodium Adsorption Ratio (SAR)	1.1	12				
Specific conductance (micromhos at 25°C)	910	647				
pH	6.5	8.1				
Temperature, °Celsius (C)	26.0	23.0				
Carbon dioxide (CO_2)	66	.1				

* Microgram per liter

SUMMARY

Ground-water pumpage* totaled 688,039,000 gallons or 2,112 acre-feet at the Post Headquarters well field in 1977. This was 30,384,000 gallons or 93 acre-feet more pumpage than in 1976. Well SMR-1 produced 1,696,000 gallons or 5.2 acre-feet in 1977; 280,200 gallons or 0.9 acre-feet more than in 1976. Wells MAR-1 and MAR-2 produced 907,900 gallons or 2.8 acre-feet in 1977; 54,900 gallons or 0.2 acre-feet less than in 1976. Wells SRC-1 and SRC-2 produced 8,159,000 gallons or 25.0 acre-feet in 1977; 255,000 gallons or 0.8 acre-feet less than in 1976. Total pumpage at White Sands Missile Range in 1977, including 491,900 gallons or 1.5 acre-feet by the HTA well, was 699,294,000 gallons or 2,146 acre-feet.

Depth-to-water measurements made in test wells, observation wells, and boreholes during 1977 indicate that the greatest water-level declines occurred within a radius of about 1 mile from the approximate center of the Post Headquarters well field.

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*The pumpage figures in this report are to be considered as preliminary figures and may be subject to revision.