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Water Supply at Los Alamos During 1984

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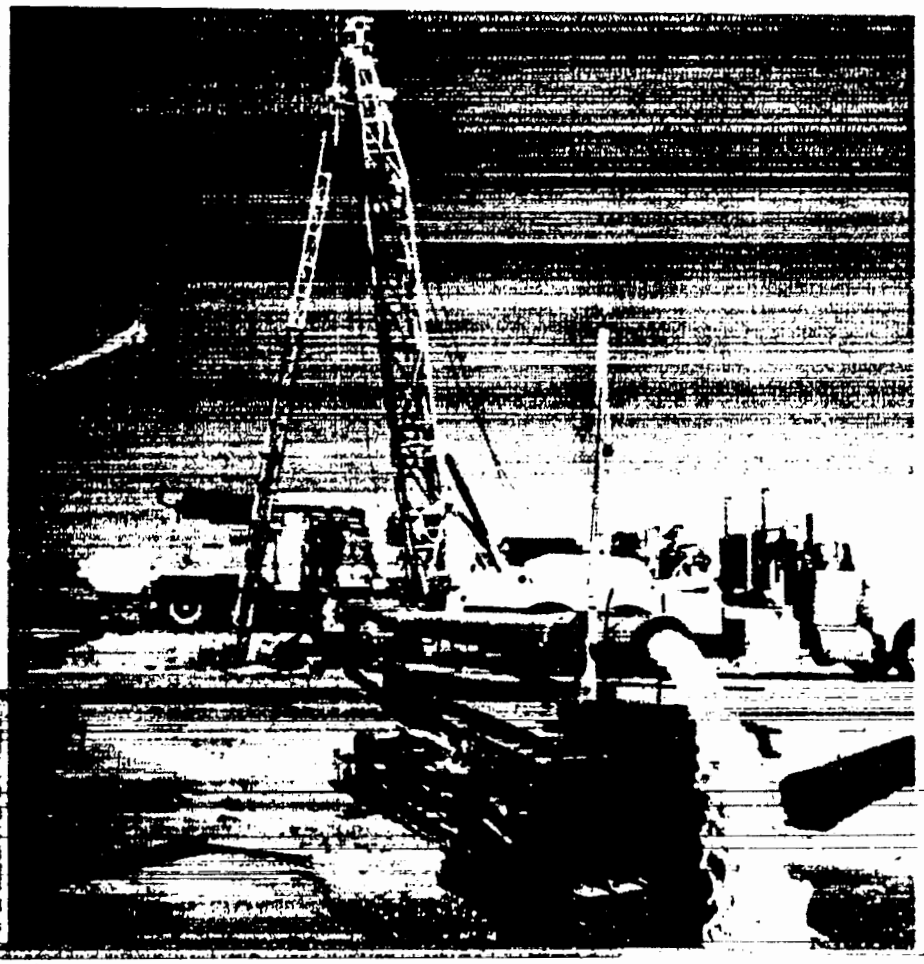

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Water Supply at Los Alamos During 1984

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WATER SUPPLY AT LOS ALAMOS DURING 1984

by

W. D. Purtymun, N. M. Becker, and M. Maes

ABSTRACT

Municipal and industrial water supply for Los Alamos during 1984 consisted of 1566×10^6 gal from wells in three well fields and 34×10^6 gal from the gallery in Water Canyon. About 3×10^6 gal of water from Guaje Reservoir and 1.3×10^6 gal from Los Alamos Reservoir were used for irrigation; thus, the total water use in 1984 was about 1604×10^6 gal. Well field operations were satisfactory with pumping schedules resulting in a uniform decline of water level in the fields. Primary and secondary chemical quality of water in the distribution system is in compliance with federal regulations. Fluoride in water from Well LA-1B and arsenic in water from Well G-2 exceeded the standards; however, mixing of water from these wells with the water pumped from other wells in the field reduced the concentration to below acceptable level in the distribution system.

I. INTRODUCTION

This report summarizes pumpage and aquifer conditions for wells in the Los Alamos, Guaje, and Pajarito well fields (Fig. 1). These wells supply most of the water used for municipal purposes in Los Alamos County and the Los Alamos National Laboratory. The gallery in Water Canyon supplies the balance of the water to the system. A summary of surface water from Guaje and Los Alamos Reservoirs used for irrigation is included in the report. Chemical quality of water from wells, gallery, and surface water sources is also discussed.

This report is a joint effort between the Environmental Surveillance Group (HSE-8) of the Los Alamos National Laboratory and the Water, Gas, and Waste Water Department of the Zia Company Utility Division. Its purpose is to ensure a continuing historical record and to provide guidance for management of water resources and long-range planning for the water supply system. We have issued one summary report (1947-1971) and thirteen annual reports as a result of these studies[1-14]. An additional report summarizes the hydrology of the Main Aquifer with reference to future development of ground water supplies.[15] During 1984 there were three reports prepared by outside contractors that are related to water supply. They are (1) Los Alamos Bacteriological Studies of Groundwater,[16] (2) Long-Range Utilities Development Plan,[17] and (3) Los Alamos Water Supply Study-Long Range Plan.[18] A brief summary of these reports will be presented as part of this report.

The Zia Company Utility Division is the support contractor to Los Alamos National Laboratory. The Zia Company maintains and operates the water supply system. Water is pumped from wells, through distribution lines, and lifted by booster pumps through chlorination stations into reservoirs for storage and distribution to the community and Laboratory areas (Fig. 1). Water from the gallery flows by gravity through microfilter and chlorination stations and is pumped into one of the system reservoirs for distribution. The Zia Company Utility Division maintains monthly records of hours of operation on each well, along with daily and monthly production records. Monthly average nonpumping and pumping water levels are computed from air-line pressure or

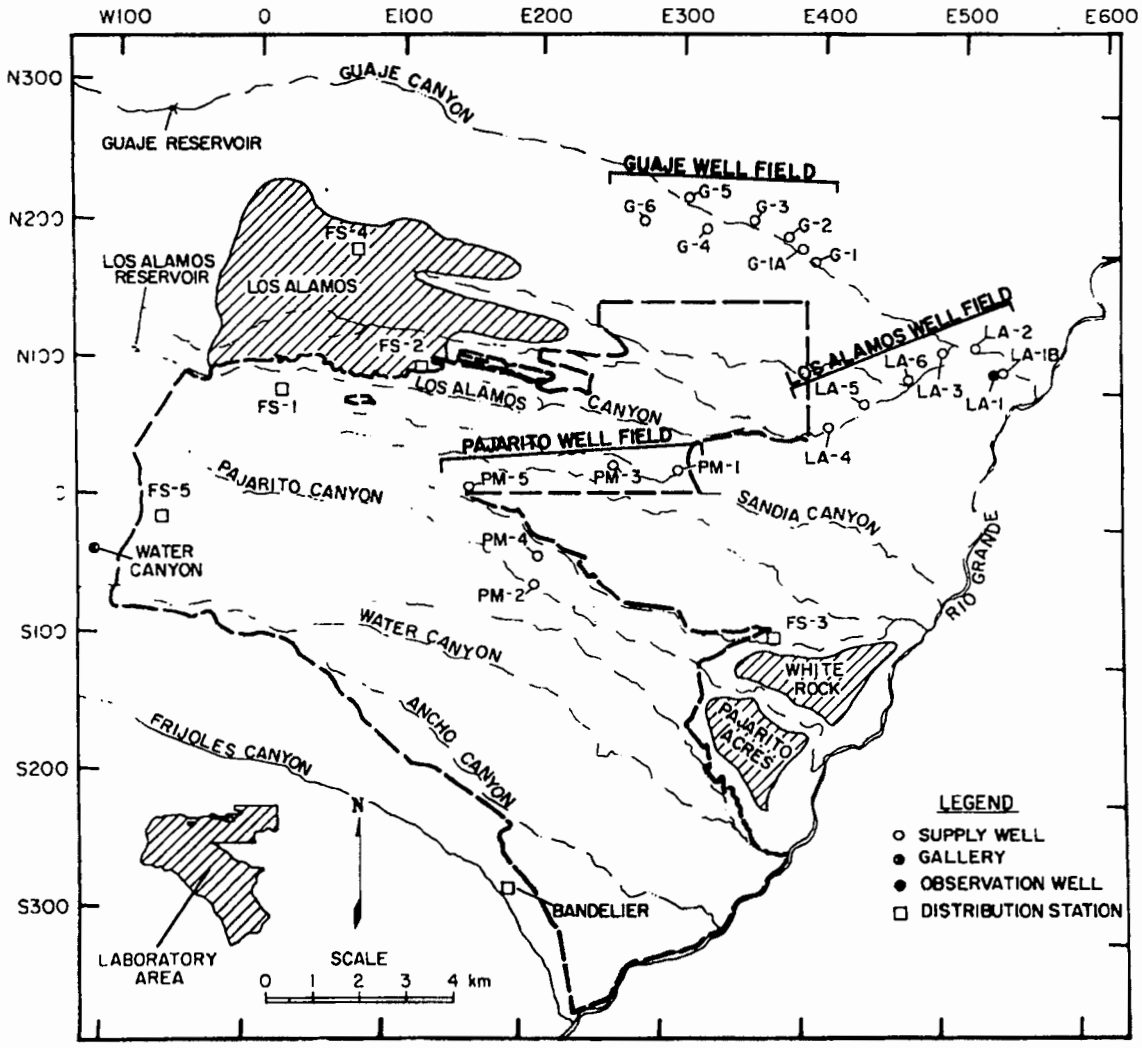

Fig. 1. Location of reservoirs, well fields, supply wells, and gallery water supply.

transducer data recorded continuously at each well. These data provide input for calculating pumping rates, drawdown (difference between nonpumping and pumping water levels), specific capacity (pumping rate per unit drawdown), and other well-field statistics that are included in this report.

Appendix A contains annual pumping and production information for each supply well and the gallery for the period of record. Appendix B contains hydrographs showing nonpumping and pumping water levels, specific capacity, production from wells, and average annual discharge and production from the gallery in Water Canyon.

II. WELL FIELD CHARACTERISTICS

Production from the three well fields increased 103.5×10^6 gal, from 1462.9×10^6 gal in 1983 to 1566.4×10^6 gal in 1984 (Table I). The months of heaviest pumpage in 1984 were May, June, and July. The production during these months was 546×10^6 gal, an increase from 523×10^6 gal for a similar period in 1983. The months of lightest pumpage were February, March, and December. The production for these months was 242×10^6 gal, down from 247×10^6 gal for a similar period in 1983.

Table I

Production in Millions of Gallons from Wells and Gallery 1947-1984

Year	Los Alamos Field	Guaje Field	Pajarito Field	Water Canyon Gallery	Production Total
1947	147	0	0	84	231
1948	264	0	0	97	361
1949	302	0	0	92	394
1950	547	3	0	54	604
1951	702	68	0	39	809
1952	448	350	0	48	846
1953	444	372	0	39	855
1954	380	374	0	40	794
1955	407	375	0	33	815
1956	437	506	0	23	966
1957	350	378	0	40	768
1958	372	395	0	60	827
1959	391	478	0	54	923
1960	530	533	0	48	1 111
1961	546	624	0	54	1 224
1962	577	597	0	67	1 241
1963	539	654	0	51	1 244
1964	627	665	0	45	1 337
1965	447	571	99	72	1 189
1966	450	613	127	82	1 272
1967	373	464	481	56	1 374
1968	345	474	584	65	1 468
1969	331	435	569	80	1 415
1970	360	423	595	65	1 443
1971	412	484	657	37	1 590
1972	380	467	662	40	1 549
1973	406	475	685	49	1 615
1974	369	453	802	35	1 659
1975	356	431	749	42	1 578
1976	343	531	817	41	1 732
1977	345	515	614	57	1 531
1978	302	444	690	45	1 481
1979	289	456	662	44	1 451
1980	339	485	743	32	1 599
1981	336	469	701	45	1 551
1982	317	422	773	46	1 558
1983	221	338	904	38	1 501
1984	326	460	780	34	1 600
Total	15 057	15 782	12 694	1973	45 506

The difference in demand between periods of heavy to light production (late spring/early summer to winter) is mainly due to the use of water for lawn and yard irrigation. The water levels respond accordingly, with the highest water levels during the months of least pumpage. The lowest water levels occurred during the months of greatest production.

The projected demand of the Laboratory and community was made for the period 1981 through 1990 based on past production (Fig. 2). The projected demand shows an annual increase of about 25×10^6 gal. The actual annual amount of water used is variable, dependent mainly upon the weather. A cool summer with abundant precipitation will result in a reduced water demand, whereas a hot, dry summer will require additional water production. The 1984 production fell below the projected demand by about 200×10^6 gal.

A long-range study by the Corp of Engineers projects water usage until the year 2030. They projected an average annual increase of about 17×10^6 gal/yr with conservation and about 20×10^6 gal/yr without conservation. Conservation includes education of the public to encourage water use conservation. It also reflects use of conservation devices such as shower flow controls, toilet inserts, and modified lawn sprinkling devices. It also would include a revision of the County plumbing codes to require new construction to implement water saving devices.[18]

The peak demand period for 1984 was an 11-day period, June 8 to June 18, when pumpage was 81×10^6 or about 7.4×10^6 gal/day. The peak demand was down about 10×10^6 gal from the peak demand period in 1983 (Table II).

The total production from the well fields and gallery has been $45{,}506 \times 10^6$ gal. Of this amount, the wells have produced $43{,}533 \times 10^6$ gal, or about 96% of the total production used for water supply (Table I). The gallery in Water Canyon has produced the remaining 4% or about 1973×10^6 gal. The annual production, percentage of production by individual wells by well field and by total production for 1984, is compared with similar data for 1983 (Table III). Similarly, the pumping rate and specific capacity of individual wells (Table IV) and the annual average nonpumping and pumping water levels and drawdown for 1984 (Table V) are compared with similar data for 1983.

A. Los Alamos Well Field

The Los Alamos Well Field is composed of six supply wells and one observation well. The production in 1984 was from five wells. Well LA-6 is on standby status because of an excessive amount of naturally occurring arsenic in the water.[19] Pumpage from the well field increased about 105×10^6 gal, from 221×10^6 in 1983 to 326×10^6 gal in 1984 (Table III). The well field produced about 20% of the total production in 1984.

The average annual water level in Observation Well LA-1 was about 25 feet lower in 1984 than in 1983. The decline in the water level is due to the increased production from Well LA-1B. This well is located about 150 feet northeast of LA-1.

Pumpage from Well LA-1B increased from 12×10^6 gal in 1983 to about 97×10^6 gal in 1984. The pump in the well was removed for repairs in 1983,

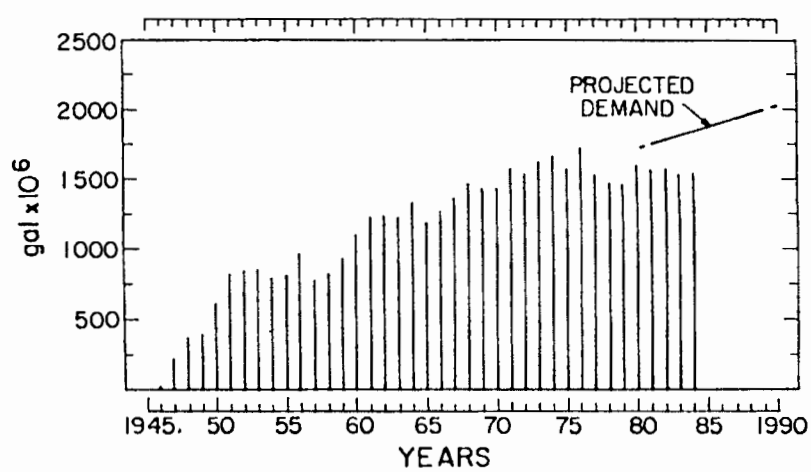

Fig. 2. Water production and use, 1947 to 1984, and projected demand 1981 to 1990.

Table II

Peak Demand Periods
1976-1984

	Demand Period				
	June 11-July 12 1976	**May 31-June 18 1977**	**June 9-June 28 1978**	**July 24-August 7 1979**	**June 15-July 18 1980**
No. of Days	32	19	20	15	33
Total Production (gal)	299×10^6	149×10^6	149×10^6	115×10^6	269×10^6
Av Daily Production (gal)	9.3×10^6	7.8×10^6	7.4×10^6	7.7×10^6	8.2×10^6
No. of Days Exceeding (gal)					
10×10^6	14	2	—	—	—
9×10^6	9	4	—	—	7
8×19^6	4	4	7	4	15
7×10^6	3	4	8	6	6
$<7 \times 10^6$	2	5	5	5	5

	Demand Period			
	June 8-June 28 1981	**June 23-July11 1982**	**June 30-July 11 1983**	**June 8-June 18 1984**
No. of Days	21	19	12	11
Total Production (gal)	167×10^6	145×10^6	91×10^6	81×10^6
Av Daily Production (gal)	7.9×10^6	8.1×10^6	7.6×10^6	7.4×10^6
No. of Days Exceeding (gal)				
10×10^6	—	—	—	—
9×10^6	3	1	—	—
8×19^6	7	9	6	2
7×10^6	8	9	2	6
$<7 \times 10^6$	3	0	4	3

Table III

Production Characteristics for 1983 and 1984

	Production					
	Pumpage (10^6 gal)		Well Field (per cent)		Total Pumpage (per cent)	
	1983	1984	1983	1984	1983	1984
Los Alamos Field						
Well LA-1	---	---	---	---	---	---
Well LA-1B	12.1	96.9	6	30	1	6
Well LA-2	54.5	53.7	25	16	4	3
Well LA-3	14.7	16.6	6	5	1	1
Well LA-4	61.5	87.1	28	27	4	5
Well LA-5	78.1	72.1	35	22	5	5
Well LA-6	---	---	---	---	--	---
Subtotal	220.9	326.4	100	100	15	20
Guaje Field						
Well G-1	52.2	62.8	16	13	3	4
Well G-1A	86.7	113.9	26	25	6	7
Well G-2	16.5	43.7	5	10	1	3
Well G-3	31.3	19.0	9	4	2	1
Well G-4	42.2	49.7	12	11	3	3
Well G-5	73.2	115.4	22	25	5	7
Well G-6	35.4	55.3	10	12	2	4
Subtotal	337.5	459.8	100	100	22	29
Pajarito Field						
Well PM-1	86.5	92.8	10	12	6	6
Well PM-2	157.9	81.6	17	10	10	5
Well PM-3	207.6	275.6	23	35	14	17
Well PM-4	452.5	325.8	50	42	30	21
Well PM-5	---	4.4	---	1	---	<1
Subtotal	904.5	780.2	100	100	60	49
Water Canyon (Gallery)						
Subtotal	38.2	34.0	100	100	3	2
Total	1501.1	1600.4	---	---	100	100

Table IV

Average Pumping Rate and Specific Capacity
1983 and 1984

	Pumping Rate (gpm)			Specific Capacity (gpm/ft/drawdown)	
	1983	**1984**		**1983**	**1984**
Los Alamos Field					
Well LA-1	---	---		---	---
Well LA-1B	495	604		5.0	4.8
Well LA-2	330	325		1.6	1.7
Well LA-3	258	329		2.0	2.0
Well LA-4	557	539		5.3	5.8
Well LA-5	458	416		3.2	3.1
Subtotal	2098	2213	Average	3.4	3.5
Guaje Field					
Well G-1	303	275		1.8	1.5
Well G-1A	498	501		14.2	11.7
Well G-2	441	361		10.3	13.4
Well G-3	239	267		1.9	2.3
Well G-4	270	220		---	---
Well G-5	420	501		8.9	9.4
Well G-6	301	306		3.5	3.9
Subtotal	2472	2431	Average	6.8	7.0
Pajarito Field					
Well PM-1	585	580		26.6	25.6
Well PM-2	1369	1365		23.2	21.7
Well PM-3	1386	1385		60.3	56.8
Well PM-4	1432	1338		40.9	34.3
Well PM-5	---	---		---	---
Subtotal	4772	4668	Average	37.8	34.6
Water Canyon (Gallery)					
Subtotal	73	65		---	---
Total	9415	9377		---	---

Table V

Average Nonpumping and Pumping Water Levels and Drawdown, 1983 and 1984

	Water Levels					
	Nonpumping (ft)		Pumping (ft)		Drawdown (ft)	
	1983	1984	1983	1984	1983	1984
Los Alamos Field						
Well LA-1	46	71	---	---	---	---
Well LA-1B	61	75	160	201	99	126
Well LA-2	121	130	321	323	200	193
Well LA-3	89	142	203	301	114	159
Well LA-4	287	290	392	383	105	93
Well LA-5	154	156	295	281	141	125
Well LA-6	81	83	---	---	---	---
Guaje Field						
Well G-1	272	276	443	448	171	172
Well G-1A	301	302	336	345	35	43
Well G-2	356	358	399	385	43	27
Well G-3	340	355	463	475	123	112
Well G-4	---	---	---	---	--	---
Well G-5	445	452	492	507	47	55
Well G-6	582	589	668	666	86	77
Pajarito Field						
Well PM-1	747	749	769	772	22	23
Well PM-2	876	866	935	930	59	64
Well PM-3	762	762	785	787	23	25
Well PM-4	1066	1065	1101	1104	35	39
Well PM-5	---	---	---	---	---	---

thus the pumpage was low for the year. The pumping rate increased from about 500 gpm (gal/min) to 600 gpm, and the increased pumpage resulted in a decline of both the pumping and nonpumping water levels (Table V). There was no significant change in the specific capacity of the well (Table IV).

Pumpage from Well LA-2 remained at about 54×10^6 gal, the same amount that was pumped in 1983. There was no change in pumping rate of about 330 gpm or specific capacity of 1.6 gpm/ft in 1984 when compared with 1983 (Table IV). There was no significant change in the nonpumping or pumping water level from the previous year.

The pumpage from Well LA-3 remained low again in 1984 because the well was down for repairs most of the year. The well produced about 17×10^6 gal or about 5% of the field's production (Table III). The pumping rate increased 70 gpm from 1983 to 1984 when the new pump was placed in service.

The specific capacity remained the same in 1984 at 2.0 gpm/ft when compared with the previous year (Table IV). The water level declined slightly in 1984

because the data were collected only during the pumped period near the end of the year and do not take into account the higher water levels that occurred when the well was out of service.

The pumpage from Well LA-4 increased about 25 $\times 10^6$ gal from 1983 to 1984 while the percentage of pumpage for the field from the well remained about the same at 27% (Table III). The pumping rate declined slightly while the specific capacity increased (Table IV). The nonpumping level remained about the same in 1984 when compared with the previous year. In comparison, there was a rise of about 9 ft in the pumping level.

The pumpage from Well LA-5 decreased 6×10^6 gal in 1984 when compared with the previous year (Table III). The percentage of production of the well in the field declined from 35% to 22% in 1984. The decrease in production is due to the increase in pumpage from Well LA-1B after it was put back online. (The percentage of pumpage of LA-1B increased from 6% to 30% in 1984.) The pumping rate of LA-5 declined about 42 gpm in 1984 to an average rate of 416 gpm (Table IV). The average nonpumping water level remained about the same in 1984 as the previous year, while the pumping level rose about 14 ft in response to the decreased pumpage (Table V).

Well LA-6 was not pumped into the distribution system in 1984. The well was pumped for about 15 min to collect a sample for radiochemical and chemical analyses. The water level in the well remained about the same as in previous years.

The distribution of pumpage should be about 40% from the lower field (Wells LA-1B, LA-2, and LA-3) and about 60% from the upper field (Wells LA-4 and LA-5). The distribution of pumpage in this manner will allow uniform water level declines throughout the well field. Uniform water levels result in the most efficient and economic method of operation and conservation of the aquifer. In 1984 the distribution of pumpage was 51% from the lower field and 49% from the upper field.

B. Guaje Well Field

The Guaje Well Field is composed of seven wells (Fig. 1). The pumpage from the field increased 122×10^6 gal from 338×10^6 gal in 1983 to 460×10^6 gal in 1984 (Table III). The well field produced 29% of the total production in 1984. The total production from the field since 1950 has been $15{,}782 \times 10^6$ gal (Table I).

The pumpage from Well G-1 increased about 11×10^6 gal from 1983 to 1984 (Table III). The well produced about 13% of the field's pumpage. The average pumping rate declined 28 gpm with only a slight decrease in the specific capacity (Table IV). The nonpumping and pumping water levels declined about 4 ft in 1984 in response to the increased pumpage during the year (Table V).

The pumpage from Well G-1A increased 27×10^6 gal from 1983 to 1984. The well produced 25% of the field's pumpage. The pumping rate remained the same, while the specific capacity decreased slightly. There was no significant change in the nonpumping water level, whereas the pumping level declined about 9 ft (Table V).

The pumpage from Well G-2 increased 27×10^6 gal from 1983 to 1984, whereas the well produced 10% of the field pumpage in 1984. The pumping rate declined about 80 gpm, whereas the specific capacity increased 3 gpm/ft. There was little change in the nonpumping level, while with the decrease in the gpm the pumping level rose (Table V).

The pumpage from Well G-3 decreased 12×10^6 gal from 1983 to 1984. The well produced only 4% of the field production in 1984. The well was out of service about 4 months due to bacterial contamination (noncoliform), testing, and disinfecting of the well. The bacterial testing is discussed in a following section and should not be construed as a health problem. The average pumping rate and the specific capacity of the well increased slightly with the decreased pumpage. The average nonpumping level declined about 15 ft from the previous year, while the pumping level only declined about 12 ft.

The pumpage from Well G-4 increased 7×10^6 gal from 1983 to 1984. The well produced 11% of the production from the field. The pumping rate continued to decline from 270 gpm in 1983 to 220 gpm in 1984 (Table IV). No water level data have been available since 1982 when the transducer in the well failed.

The pumpage from Well G-5 increased 42×10^6 gal from 1983 to 1984. The well furnished 25% of the production from the field. The pumping rate and specific capacity in 1984 increased when compared with the previous year. The nonpumping and the pumping water levels both declined under the increased pumpage (Table V).

The pumpage from Well G-6 increased about 20×10^6 gal from 1983 to 1984. The well produced 12% of the field production. There was no change in production rate, while the specific capacity increased slightly. The nonpumping water level declined only 7 ft while the pumping level remained about the same as in the previous year.

C. Pajarito Well Field

The Pajarito Well Field is composed of five wells (Fig. 1). The production in 1984 was from only four of the wells. Well PM-5, completed in 1982, has not been added to the system because of electrical problems. The pumpage from the field decreased 124×10^6 gal from 904×10^6 gal in 1983 to 780×10^6 gal in 1984 (Table 1). The field produced 49% of the total production at Los Alamos in 1984.

The production from Well PM-1 increased about 7×10^6 gal from 1983 to 1984 (Table III). The well produced 12% of the field production. There was no significant change in the pumping rate or the specific capacity during 1984 from the preceding year. The nonpumping and pumping water levels did not change from the previous year.

The production from Well PM-2 decreased 76×10^6 gal from 1983 to 1984. The decrease was due to an electrical fire in the control panel. The fire occurred in November 1983 and the well was not placed back in service until May 1984. The well produced 10% of the pumpage from the field in 1984. The pumping rate and specific capacity of the well did not change during 1984 when compared with the previous year. Nonpumping and pumping water levels in 1984 were slightly higher than in 1983 due to the reduced pumpage.

The pumpage from Well PM-3 increased 68×10^6 gal from 1983 to 1984 (Table III). The well produced 35% of the production from the field in 1984. There was no significant change in the pumping rate or the specific capacity in 1984 when compared with the previous year. There was no significant change in the nonpumping or pumping water level from 1983 to 1984.

The production from Well PM-4 decreased about 126×10^6 gal from 1983 to 1984. The production from the well was high at 326×10^6 gal, which represents 42% of the pumpage from the field or 21% of the total amount of water produced at Los Alamos during 1984. The pumping rate declined from 1432 gpm in 1983 to 1338 gpm in 1984. The decline was not due to pump deterioration. It was due to the reduction of the rpm of the gas engine, the prime mover of the pump. The rpm were reduced from 1000 to 975 rpm. The specific capacity of the well declined about 6 gpm/ft from the previous year. The nonpumping and pumping water levels remained about the same in 1984 as in 1983.

The pumpage from Well PM-5 was 4.4×10^6 gal in 1984. The water from the well was used to flush the new water lines and storage tank. The flush water was discharged to the environment.

D. Pump Failure and Rehabilitation

The pump in Well LA-3 failed in August 1983. The pump was pulled and sediments were cleaned out of the well to a depth of 816 ft. The pump was replaced and the well was placed back in service in December 1984.

Bacteria (noncoliform) in Wells LA-3 and G-3 restricted the pumpage in 1984 into the distribution system. These wells had an excess of noncoliform bacteria in the pumpage after the pumps were removed and replaced after repair. The bacteria were the result of the well rehabilitation. Corrective measures were taken by using chlorine to disinfect the well casing, line shaft, pump, and pump column (a discussion of bacteria and occurrence is found in a following section of this report).

III. WATER CANYON

The gallery in Water Canyon is dug back about 30 ft into the Bandelier Tuff. The gallery or tunnel is framed to keep the walls and ceilings from collapsing. The floor of the tunnel is constructed to form a catchment basin for the distribution line to the microfilter station. The microfilter station is located near S-Site along the northwestern edge of the Laboratory property.

The water occurs in a fractured, moderately welded to a welded tuff. Beneath the welded tuff is a nonwelded tuff (few fractures) that tends to perch the water in the overlying fractured tuff. Recharge to the aquifer is rapid. In the spring when snowmelt occurs, the discharge of the gallery increases. The increase in discharge results in a large suspended sediment load. When the sediment load in the water reaches the limits for municipal water supply, a turbidity control switches the flow to waste to keep it out of the distribution system.

The gallery is a valuable source of water supply. During 1984, about 2% of the total municipal and industrial supply was obtained from the gallery. The production decreased about 4×10^6 gal from 38×10^6 gal in 1983 to 34×10^6 gal in 1984 (Table III). The average annual discharge rate decreased from 73 gpm to 65 gpm (Table IV). Since 1947, the total production from the gallery has been 1973×10^6 gal (Table I).

IV. GUAJE AND LOS ALAMOS RESERVOIRS

Water from Guaje and Los Alamos Reservoirs was used for municipal and industrial supply at Los Alamos during the early days of the Manhattan Project. Use of the water from the reservoirs for municipal supply was discontinued about 1959 because of intermittent periods of turbidity caused by run-off and difficulties in maintaining bacteriological levels that were below limits for municipal water supply. Both of the areas are open for recreational use. Water from the reservoirs has been and is available for irrigation of lawns and shrubs in the community and Laboratory through a separate distribution line. As the lines are above ground, they are subject to freezing; thus water use from the reservoirs is limited to late spring to early fall.

Guaje Reservoir in upper Guaje Canyon has a capacity of 0.25×10^6 gal, with a drainage area of 5.6 mi^2. The reservoir is for diversion rather than storage, as perennial flow is maintained by springs in the canyon above the reservoir. The water flows by gravity through 6.8 mi of distribution lines for irrigation of lawns and shrubs at Cumbres Junior High School and Guaje Pines Cemetery. The line from the reservoir is not a part of or connected to the municipal water distribution system.

Annual production from Guaje Reservoir when used for municipal supply from 1947 through 1958 ranged from an estimated 24×10^6 gal to 213×10^6 gal (Table VI). There is no record of water used or if water was used for irrigation from 1959 through 1971. Since 1972 the amount of water used for irrigation has ranged from 2.7×10^6 gal to 9.7×10^6 gal. The amount used in 1984 was 3×10^6 gal, a decrease from the 3.4×10^6 gal used in 1983.

Los Alamos Reservoir in upper Los Alamos Canyon has a capacity of 13.4×10^6 gal, with a drainage area of 6.4 mi^2. The reservoir is used for storage and recreation. The water flows by gravity through about 2.6 miles of distribution lines for irrigation of lawns and shrubs at the Laboratory's Health Research Building, Los Alamos High School, and Mesa School. The line from the reservoir is not a part of or connected to the municipal distribution system.

Annual production from the Los Alamos Reservoir used for municipal supply from 1947 through 1958 ranged from 4.8×10^6 gal to 54.8×10^6 gal (Table VI). There is no record of water from the reservoir being used for irrigation from 1959 through 1978. Since 1978 the amount used has ranged from 1.3×10^6 gal to 2.8×10^6 gal. The amount of water from the reservoir used for irrigation in 1984 was 1.3 $\times 10^6$ gal, a decrease of 0.1×10^6 gal from the 1.4×10^6 gal used in 1983.

Table VI

Production from Guaje and Los Alamos Reservoirs (1947-1958 and 1972-1984)

Year	Guaje Reservoir[a] (10^6 gal)	Los Alamos Reservoir (10^6 gal)
1947	87.8	21.7
1948	119.8	31.9
1949	116.1	14.7
1950	79.9	20.6
1951	41	10.5
1952	131	33.6
1953	58	14.8
1954	66	16.9
1955	71	18.1
1956	24	4.8
1957	213	54.8
1958	193	49.4
1972	5.8	---
1973	9.7	---
1974	4.9	---
1975	5.3	---
1976	4.4	---
1977	4.1	---
1978	2.8	---
1979	3.7	1.3
1980	4.7	2.3
1981	2.7	2.1
1982	3.4	2.8
1983	3.4	1.4
1984	3.0	1.3

[a]Production Guaje Reservoir 1951-1958 estimated.

Note: Municipal supply production, 1947-1958; irrigation production, 1972-1984.

V. QUALITY OF WATER

The quality of water is monitored to determine if the water from wells and in the distribution system

meets federal requirements (Standards) for municipal supply. Water samples were collected at wells and at six stations in the distribution system (five stations and at Bandelier National Monument).

Primary drinking water standards are related directly to safety of drinking water supplies.[20] Listed in Table VII are 10 primary chemical constituents (Standards). Arsenic in water from Well G-2 and fluoride in water from Well LA-1B were above the primary standards as shown in Table VII. However, the mixing of the water in the system reduces the concentrations to acceptable levels. The arsenic and fluoride are natural in the aquifer. The quality of water in the distribution system shows that all constituents were below the standards.

Secondary standards are not related to the safety of drinking water, but to the aesthetic quality. Listed in Table VII are eight secondary standards.[21] All water from wells and gallery and the distribution system stations are below secondary drinking water standards.

Radiochemical standards are related to safety of drinking water.[22] Radioactivity in water from the wells, gallery, and the distribution stations are low, below limits of detection or reflect natural radioactivity in ground water (gross alpha, gross beta, or total uranium).

The chemical and radiochemical qualities of water in individual wells have slight variations in the amount of constituents. These slight variations reflect the characteristics of the slightly different lithology of the aquifer adjacent to the well.

Water from Well LA-6 is not used as part of the municipal supply because the arsenic concentration in the water exceeds the primary standards. The arsenic is of natural origin in the aquifer. Water cannot be mixed with other water in the distribution system to reduce the concentration to a level below the standards. The arsenic concentrations in 1984 were still high at 0.116 mg/ℓ.

Individual radiochemical analyses, primary and secondary standards, and miscellaneous chemical constituents for each well, the gallery, and stations in the distribution system are presented in "Environmental Surveillance at Los Alamos During 1984."[23]

VI. WATER SUPPLY RELATED REPORTS 1984

Three reports dealing with some facet of water supply were completed in 1984. The reports were prepared under contract for the Department of Energy or the Laboratory. The reports are (1) "Los Alamos Bacteriological Studies of Groundwater" prepared by Dr. Betty H. Olson, (2) "Long-Range Utilities Development Plan," compiled by Raymond Kaiser Engineers and Kentron International, and (3) "Los Alamos Water Supply Study" by the Albuquerque District, Corp of Engineers.

A. Los Alamos Bacteriological Study

This study was undertaken to determine whether there was a microbiologial problem of public health concern in water from the supply wells at Los Alamos.[16] All the wells were tested and six were found to contain coliform bacteria above recommended levels for water supply. Though the water from the wells contained an excess of bacteria, the water in the system is in compliance for drinking water supply due to chlorination practices at the booster stations. In the instances that bacteria were found, identification did not indicate fecal contamination but rather the bacterial species were typical of those found in soil and in distribution systems. The only exception was at Well LA-3 where an open test well adjacent to the supply well was the possible source of contamination. The test well has since been sealed and the well chlorinated and returned to service. Other wells containing bacteria have also been disinfected and noncoliform bacteria reduced to acceptable levels. The report also recommends specific procedures for disinfecting wells that are in service that may contain coliform bacteria and wells in which the pumps are removed for repairs and the wells are subject to rehabilitation. Also recommended was the establishment of operating procedures that standardize sampling, analysis, and maintain a data base on each supply well. The report specifically recommends that the nonpumping hours of a well should be lowered to minimize the natural bacterial growth in a well. Even after short periods of downtime in pumping, the bacterial growth can become so extensive as to interfere with the standard plate counts and can cause expensive rehabilitation, which requires extensive disinfectant operations.

B. Long-Range Utilities Study

This report presents the conceptual plans for each of the utility systems at the Laboratory, and will be a companion volume to the Laboratory's Long-Range Site Development Plan.[17]. As a part of the long-range plans, the report on the water system provides a system distribution description, future water demands, a section on conceptual plan/proposed improvements, and water system criteria.

Table VII

Comparison of Maximum Chemical and Radiochemical Quality of Water Supply with Standards for Drinking Water

	Standards	Maximum Concentration: Supply Well and Gallery	Maximum Concentration: Distribution System
Primary Standards[a] (mg/ℓ)			
Ag	0.05	<0.001	<0.001
As	0.05	0.110	0.022
Ba	1.0	0.09	0.07
Cd	0.01	<0.0002	<0.0002
Cr	0.05	0.020	0.015
F	2.0	3.2	1.5
Hg	0.002	<0.0001	<0.0001
NO_3	45	2.1	2.1
Pb	0.05	0.016	<0.004
Se	0.01	<0.003	<0.003
Secondary Standards[b] (mg/ℓ)			
Cl	250	17	20
Cr	1.0	0.08	<0.01
Fe	0.3	0.047	0.012
Mn	0.05	0.003	<0.001
SO_4	250	39	8
Zn	5.0	0.06	0.27
TDS[c]	500	461	246
pH[d]	6.5-8.5	8.5	8.2
Radiochemical Standards[e] (10^{-9} μCi/mℓ)			
^{137}Cs	200	89 ± 138	91 ± 138
^{238}Pu	15	0.050 ± 0.040	0.040 ± 0.040
$^{239,240}Pu$	15	0.160 ± 0.100	0.040 ± 0.060
Gross alpha	15	6.7 ± 3.8	6.2 ± 3.6
Gross beta	15	37 ± 80	6.4 ± 1.6
Total U[e]	1800	7.3 ± 14	4.7 ± 0.5
^{3}H[f]	20	1.0 ± 0.8	1.2 ± 0.8

[a]Reference 20.
[b]Reference 21.
[c]Total dissolved solids.
[d]No units.
[e]μg/ℓ.
[f]10^{-6} μCi/mℓ.

During the 10-year period 1972-1981, the average annual production was 1574.6×10^6 gal or about 4.3×10^6 gal/day. In 1983 the production was 1501×10^6 gal, distributed 36% to the Laboratory, 42% to the Los Alamos Townsite, and 22% to the community of White Rock. The firm yield from the three well fields is 12.6×10^6 gal/day with 2.9×10^6 gal/day from the Los Alamos Field, 3.0×10^6 gal/day from the Guaje Field, and 6.6×10^6 gal/day from the Pajarito Field.

The peak day demand period for the Laboratory Technical Areas and water subsystems for 1983 was 4.1×10^6 gal. The peak day demand projected to year 2005 would be increased to about 7×10^6 gal. In terms of annual consumption by the year 2005, the annual consumption will be 2421×10^6 gal distributed 48% to the Laboratory, 37% to the townsite, and 15% to White Rock.

The wells in the Los Alamos Field will be over 50 years old by the year 2005. As the wells get older, the yield will decline as the wells deteriorate. To increase the yield, this field should be abandoned and replaced with three new wells to be located in lower Pueblo Canyon. A replacement well for Well G-4 is needed because of G-4's decreasing pumping rate that is due to well deterioration. These four wells and one additional well in the Pajarito Field should be able to meet the increased water demand with the existing wells in the Guaje and Pajarito Fields. Storage reservoirs and distribution lines will have to be upgraded or replaced to keep up with increased demand.

C. Water Supply Study by the Corp of Engineers

This report by the Corp of Engineers was prepared to project the future water use at Los Alamos in regards to the Department of Energy's water rights and present alternative plans to use the surface water rights of the San Juan-Chama Diversion.[18] The report also deals with the storage requirements at Abiquiu Reservoir, evaluates the hydropower potential of the Chama Basin, and outlines the water market in regards to the San Juan-Chama water.

The existing water rights at Los Alamos (present water supply, wells, gallery, and two reservoirs) as set by the New Mexico State Engineer are 5541.3 acre-ft annually or about 1805.6×10^6 gal. In addition, DOE has contracted for 1200 acre-ft annually or about 391×10^6 gal of San Juan-Chama Transmountain Diversion Water from the Bureau of Reclamation.

The most probable projection of water use without conservation indicates that from the year 1980 to the year 2030 water use will increase from about 1600×10^6 in 1980 to 2605×10^6 gal in the year 2030 or at an annual increase of 20×10^6 gal/yr. With conservation the annual usage will increase from 1600×10^6 gal in 1980 to 2462×10^6 in 2030 or at an annual increase of 17×10^6 gal/yr.

These projections were used to determine when the existing surface and ground water rights would be exceeded. The projected water requirements without conservation indicate that the existing water rights (1805.6×10^6 gal) will be exceeded by 1990. At that time a permit from the State Engineer's Office will be required to use the San Juan-Chama water. Using the existing rights (1805.6×10^6 gal) and the San Juan-Chama water (391×10^6 gal), additional water will not be needed until the year 2007. Return flow credit could extend the combined water rights as above until the year 2030. The return flow credit facet of the water rights question has not been investigated.

Three plans were presented for the use of the San Juan-Chama water. The recommended plan by the Corp of Engineers was to use the San Juan-Chama water to offset the effect on the Rio Grande caused by pumping ground water in excess of the existing water rights (1805.6×10^6 gal). The other two plans were to utilize surface water either from Abiquiu Reservoir to Los Alamos through a transmission line into a treatment plant and then the distribution system, or pumping directly from the Rio Grande at White Rock into a water treatment plant and from the plant into the distribution system.

VII. SUMMARY AND CONCLUSIONS

Well and well fields operations have been very satisfactory. The wells have been pumped on a schedule to maintain fairly uniform decline in water levels. Operation of wells in a field becomes difficult when wells are down for repair; however, if possible, the distribution of pumpage from the Los Alamos Field (60% from Wells LA-4 and LA-5; 40% from Wells LA-1B, LA-2, and LA-3) should be continued. This will stabilize the water level decline and result in more efficient well field operation. Wells that have had decline in yield (pumping rate) are wells G-1, G-2, and G-4. A continued decline in pumping rate may require that these pumps be pulled for rehabilitation. The specific capacities of the wells have remained about the same for the past few years; thus it appears that the pumps are worn and that there is little, if any, deterioration of the well that would cause the pump rate to decline.

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REFERENCES

1. W. D. Purtymun and J. E. Herceg, Compilers, "Summary of Los Alamos Municipal Well-Field Characteristics, 1947-1971," Los Alamos Scientific Laboratory report LA-5040-MS (1972).

2. W. D. Purtymun and J. E. Herceg, "Water Supply at Los Alamos During 1971," Los Alamos Scientific Laboratory report LA-5039-MS (1972).

3. W. D. Purtymun and J. E. Herceg, "Water Supply at Los Alamos During 1972," Los Alamos Scientific Laboratory report LA-5296-MS (1973).

4. W. D. Purtymun and J. E. Herceg, "Water Supply at Los Alamos During 1973," Los Alamos Scientific Laboratory report LA-5636-MS (1974).

5. W. D. Purtymun, "Water Supply at Los Alamos During 1974," Los Alamos Scientific Laboratory report LA-5998-MS (1975).

6. W. D. Purtymun, "Water Supply at Los Alamos During 1975," Los Alamos Scientific Laboratory report LA-6461-PR (1976).

7. W. D. Purtymun, "Water Supply at Los Alamos During 1976," Los Alamos Scientific Laboratory report LA-6814-PR (1977).

8. W. D. Purtymun, "Water Supply at Los Alamos During 1977," Los Alamos Scientific Laboratory report LA-7436-MS (1978).

9. W. D. Purtymun, "Water Supply at Los Alamos During 1978," Los Alamos Scientific Laboratory report LA-8074-PR (1979).

10. W. D. Purtymun, "Water Supply at Los Alamos During 1979," Los Alamos Scientific Laboratory report LA-8504-PR (1980).

11. W. D. Purtymun and Max Maes, "Water Supply at Los Alamos During 1980," Los Alamos National Laboratory report LA-8977-PR (1981).

12. W. D. Purtymun, N. M. Becker, and Max Maes, "Water Supply at Los Alamos During 1981," Los Alamos National Laboratory report LA-9734-PR (1983).

13. W. D. Purtymun, N. M. Becker, and M. Maes, "Water Supply at Los Alamos During 1982," Los Alamos National Laboratory report LA-9896-PR (1984).

14. W. D. Purtymun, N. M. Becker, and M. Maes, "Water Supply at Los Alamos During 1983," Los Alamos National Laboratory report LA-10327-PR (1985).

15. W. D. Purtymun, "Hydrologic Characteristics of the Main Aquifer in the Los Alamos Area: Development of Ground Water Supplies," Los Alamos National Laboratory report LA-9957-MS (1984).

16. Betty H. Olsen, "Los Alamos Bacteriological Studies of Groundwater," Programs in Social Ecology, University of California, Irvine, California (1984).

17. Raymond Kaiser Engineers and Kentron International, "Los Alamos National Laboratory Long-Range Utilities Development Plan," Preliminary Conceptual Plan, Los Alamos, New Mexico (September 1984).

18. Corp of Engineers, "Los Alamos Water Supply Study," U.S. Army Corp of Engineers, Albuquerque District, Albuquerque, New Mexico (October 1984).

19. W. D. Purtymun, "Hydrologic Characteristics of the Los Alamos Well Field with Reference to the Occurrence of Arsenic in Well LA-6," Los Alamos Scientific Laboratory report LA-7012-MS (1977).

20. US Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," EPA-570/9-76-003, US Government Printing Office, Washington, DC (1976).

21. US Environmental Protection Agency, "National Secondary Drinking Water Regulations," Fed. Reg. **44**, No. 140 (July 19, 1979).

22. International Commission on Radiological Protection, "Recommendations of the International Commission on Radiological Protection," adopted January 17, 1977, Annals at the ICRP (3) (1977).

23. Environmental Surveillance Group, HSE-8, "Environmental Surveillance at Los Alamos During 1984," Los Alamos National Laboratory report LA-10421-ENV (1985).

APPENDIX A

ANNUAL AQUIFER CHARACTERISTICS

Well LA-1

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)
1947	3468	54.0	259.5	--
1948	2988	34.7	193.6	--
1949	1361	26.7	327.0	--
1950	563	10.5	310.8	19.0
1951	1215	14.6	200.3	59.0
1952	286	3.4	198.1	40.0
1953	0	0.0	0.0	36.0
1954	0	0.0	0.0	44.0
1955	690	9.7	234.3	51.0
1956	39	0.0	0.0	33.0
1957	0	0.0	0.0	33.0
1958	0	0.0	0.0	10.0
1959	0	0.0	0.0	13.0
1960	0	0.0	0.0	13.0
1961	0	0.0	0.0	59.0
1962	0	0.0	0.0	84.0
1963	0	0.0	0.0	90.0
1964	0	0.0	0.0	95.0
1965	0	0.0	0.0	76.0
1966	0	0.0	0.0	70.0
1967	0	0.0	0.0	52.0
1968	0	0.0	0.0	42.0
1969	0	0.0	0.0	38.0
1970	0	0.0	0.0	37.0
1971	0	0.0	0.0	51.0
1972	0	0.0	0.0	49.0
1973	0	0.0	0.0	55.0
1974	0	0.0	0.0	53.0
1975	0	0.0	0.0	58.0
1976	0	0.0	0.0	69.0
1977	0	0.0	0.0	74.0
1978	0	0.0	0.0	68.0
1979	0	0.0	0.0	38.0
1980	0	0.0	0.0	40.0
1981	0	0.0	0.0	51.0
1982	0	0.0	0.0	98.0
1983	0	0.0	0.0	46.0
1984	0	0.0	0.0	71.0

APPENDIX A (cont)

Well LA-1B

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1960	415	36.3	1457.8	7.0	111.0	104.0	14.0
1961	3727	124.7	557.6	54.0	154.0	100.0	5.6
1962	3936	129.1	546.7	72.0	169.0	97.0	5.6
1963	3649	117.4	536.2	74.0	170.0	96.0	5.6
1964	4174	130.3	520.3	81.0	183.0	102.0	5.1
1965	3007	97.9	542.6	63.0	170.0	107.0	5.1
1966	2589	83.9	540.1	50.0	169.0	119.0	4.5
1967	2519	84.9	561.7	39.0	153.0	114.0	4.9
1968	2183	74.0	565.0	32.0	147.0	115.0	4.9
1969	2244	75.7	562.2	22.0	142.0	120.0	4.7
1970	2369	79.7	560.7	22.0	143.0	121.0	4.6
1971	2633	89.1	564.0	31.0	162.0	131.0	4.3
1972	2215	75.3	566.6	31.0	163.0	132.0	4.3
1973	2628	87.2	553.0	37.0	170.0	133.0	4.2
1974	2282	73.9	539.7	35.0	161.0	126.0	4.3
1975	2308	74.4	537.3	42.0	168.0	126.0	4.3
1976	2521	79.6	526.2	50.0	176.0	126.0	4.2
1977	2782	84.2	504.4	47.0	167.0	120.0	4.2
1978	2306	75.6	546.3	42.0	162.0	120.0	4.6
1979	1354	45.9	564.6	13.0	134.0	121.0	4.7
1980	1955	62.9	536.3	21.0	146.0	125.0	4.3
1981	2299	73.9	537.7	26.0	144.0	118.0	4.5
1982	3707	108.1	486.0	71.0	180.0	109.0	4.5
1983	407	12.1	495.0	61.0	160.0	99.0	5.0
1984	2673	96.9	604.0	75.0	201.0	126.0	4.8

APPENDIX A (cont)

Well LA-2

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1947	963	27.6	477.7	---	—	—	—
1948	3659	59.3	270.1	---	---	—	—
1949	1654	41.8	421.2	---	—	—	—
1950	614	15.6	423.5	59.0	285.0	226.0	1.9
1951	2415	57.7	398.2	111.0	305.0	194.0	2.1
1952	1980	46.3	389.7	101.0	300.0	199.0	2.0
1953	2201	47.2	357.4	100.0	301.0	201.0	1.8
1954	2601	56.8	364.0	116.0	---	—	—
1955	2223	49.4	370.4	110.0	---	---	—
1956	1805	44.2	408.1	84.0	---	—	—
1957	1066	29.6	462.8	53.0	277.0	224.0	2.1
1958	1166	31.1	444.5	60.0	270.0	210.0	2.1
1959	1599	40.7	424.2	71.0	303.0	232.0	1.8
1960	2169	51.6	396.5	76.0	305.0	229.0	1.7
1961	2149	44.4	344.3	101.0	313.0	212.0	1.6
1962	1823	35.7	326.4	111.0	314.0	203.0	1.6
1963	1999	40.7	339.3	127.0	332.0	205.0	1.7
1964	1924	34.2	296.3	137.0	347.0	210.0	1.4
1965	1911	39.8	347.1	121.0	330.0	209.0	1.7
1966	1070	21.4	333.3	108.0	340.0	232.0	1.4
1967	238	4.9	343.1	78.0	304.0	226.0	1.5
1968	502	11.3	375.2	64.0	305.0	241.0	1.6
1969	155	3.8	408.6	50.0	297.0	247.0	1.7
1970	341	7.2	351.9	59.0	310.0	251.0	1.4
1971	1787	31.8	296.6	88.0	318.0	230.0	1.3
1972	2189	39.3	299.2	96.0	322.0	226.0	1.3
1973	2625	46.7	296.5	106.0	334.0	228.0	1.3
1974	2033	36.8	301.7	109.0	325.0	216.0	1.4
1975	2310	40.2	290.0	103.0	320.0	217.0	1.3
1976	2488	39.9	267.3	113.0	322.0	209.0	1.3
1977	2775	42.5	255.3	118.0	314.0	196.0	1.3
1978	2299	39.5	286.4	112.0	338.0	226.0	1.3
1979	1353	26.2	323.0	75.0	316.0	241.0	1.3
1980	1960	33.8	287.4	84.0	318.0	234.0	1.2
1981	1911	34.4	300.0	94.0	336.0	242.0	1.2
1982	3174	51.2	269.0	161.0	348.0	187.0	1.4
1983	2752	54.5	330.0	121.0	321.0	200.0	1.6
1984	2753	53.7	325.0	130.0	323.0	193.0	1.7

APPENDIX A (cont)

Well LA-3

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1947	1476	64.9	732.8	---	---	---	---
1948	3647	82.5	377.0	---	---	---	---
1949	1505	41.7	461.8	---	---	---	---
1950	2793	57.8	344.9	97.0	231.0	134.0	2.6
1951	3554	66.9	313.7	116.0	233.0	117.0	2.7
1952	2514	58.6	388.5	94.0	218.0	124.0	3.1
1953	3104	69.7	374.2	103.0	229.0	126.0	3.0
1954	2595	57.3	368.0	101.0	225.0	124.0	3.0
1955	2195	48.7	369.8	91.0	226.0	135.0	2.7
1956	1849	42.1	379.5	74.0	222.0	148.0	2.6
1957	1080	26.1	402.8	56.0	219.0	163.0	2.5
1958	1612	33.6	347.4	49.0	225.0	176.0	2.0
1959	1821	35.0	320.3	54.0	231.0	177.0	1.8
1960	2174	38.4	294.4	68.0	230.0	162.0	1.8
1961	1939	34.7	298.3	85.0	189.0	104.0	2.9
1962	2361	45.4	320.5	93.0	192.0	99.0	3.2
1963	2128	42.5	332.9	81.0	197.0	116.0	2.9
1964	2574	50.4	326.3	104.0	217.0	113.0	2.9
1965	1961	43.4	368.9	79.0	220.0	141.0	2.6
1966	2236	46.1	343.6	81.0	219.0	138.0	2.5
1967	2274	47.4	347.4	86.0	218.0	132.0	2.6
1968	2127	42.7	334.6	82.0	251.0	169.0	2.0
1969	2072	40.1	322.6	58.0	246.0	188.0	1.7
1970	2303	44.0	318.4	55.0	241.0	186.0	1.7
1971	2556	45.4	296.0	77.0	250.0	173.0	1.7
1972	2205	39.7	300.1	73.0	251.0	178.0	1.7
1973	977	20.3	346.3	65.0	248.0	183.0	1.9
1974	2291	43.5	316.5	73.0	244.0	171.0	1.9
1975	2306	43.3	313.0	80.0	253.0	173.0	1.8
1976	2474	42.3	285.0	88.0	260.0	172.0	1.7
1977	2779	47.3	283.7	89.0	248.0	159.0	1.8
1978	2308	42.4	306.4	87.0	250.0	163.0	1.9
1979	1343	28.1	348.1	58.0	243.0	185.0	1.9
1980	1952	35.1	299.9	61.0	237.0	176.0	1.7
1981	2297	41.5	301.1	70.0	240.0	170.0	1.8
1982	3691	54.9	247.0	118.0	246.0	128.0	1.9
1983	949	14.7	258.0	89.0	203.0	129.0	2.0
1984	838	16.6	329.0	142.0	301.0	159.0	2.0

APPENDIX A (cont)

Well LA-4

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1948	1570	42.7	453.3	---	---	---	---
1949	940	37.5	664.9	---	---	---	---
1950	4350	164.9	631.8	278.0	353.0	75.0	8.4
1951	4909	173.6	589.4	285.0	357.0	72.0	8.2
1952	3429	119.6	581.3	267.0	339.0	72.0	8.1
1953	3034	109.1	599.3	264.0	335.0	71.0	8.4
1954	2133	78.2	611.0	255.0	329.0	74.0	8.3
1955	2647	94.5	595.0	268.0	341.0	73.0	8.2
1956	3402	120.2	588.9	273.0	346.0	73.0	8.1
1957	2844	105.4	617.7	270.0	345.0	75.0	8.2
1958	2973	110.3	618.3	270.0	342.0	72.0	8.6
1959	3084	113.5	613.4	275.0	346.0	71.0	8.6
1960	4084	145.6	594.2	296.0	365.0	69.0	8.6
1961	3687	129.7	586.3	296.0	365.0	69.0	8.5
1962	3688	129.3	584.3	286.0	359.0	73.0	8.0
1963	3718	130.5	585.0	280.0	351.0	71.0	8.2
1964	4500	155.0	574.1	291.0	361.0	70.0	8.2
1965	3110	111.4	597.0	279.0	349.0	70.0	8.5
1966	3279	115.6	587.6	285.0	356.0	71.0	8.3
1967	2127	77.1	604.1	278.0	350.0	72.0	8.4
1968	2276	81.7	598.3	280.0	351.0	71.0	8.4
1969	1694	61.8	608.0	282.0	358.0	76.0	8.0
1970	2333	83.5	596.5	286.0	363.0	77.0	7.7
1971	2519	89.0	588.9	287.0	373.0	86.0	6.8
1972	2322	82.6	592.9	282.0	367.0	85.0	7.0
1973	2616	92.4	588.7	294.0	377.0	83.0	7.1
1974	2306	82.2	594.1	286.0	367.0	81.0	7.3
1975	2319	82.3	591.5	272.0	355.0	83.0	7.1
1976	2802	98.2	584.1	277.0	373.0	96.0	6.1
1977	2741	96.4	586.2	278.0	374.0	96.0	6.1
1978	2248	80.1	594.2	271.0	368.0	97.0	6.1
1979	2964	104.6	587.9	280.0	376.0	96.0	6.1
1980	3322	115.3	578.5	284.0	385.0	101.0	5.7
1981	2573	89.4	579.1	289.0	393.0	104.0	5.6
1982	0	0	0	---	---	---	---
1983	1840	61.5	557.0	287.0	392.0	105.0	5.3
1984	2695	87.1	539.0	290.0	383.0	93.0	5.8

APPENDIX A (cont)

Well LA-5

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1948	1171	40.4	575.0	---	---	---	---
1949	1763	58.5	553.0	---	---	---	---
1950	4052	130.1	535.1	131.0	254.0	123.0	4.4
1951	6004	187.4	520.2	162.0	272.0	110.0	4.7
1952	3425	109.6	533.3	147.0	259.0	112.0	4.8
1953	3278	103.9	528.3	141.0	257.0	116.0	4.6
1954	2546	80.1	524.4	137.0	259.0	122.0	4.3
1955	3158	97.3	513.5	145.0	267.0	122.0	4.2
1956	3476	104.5	501.1	150.0	276.0	126.0	4.0
1957	2868	86.0	499.8	150.0	277.0	127.0	3.9
1958	3009	89.9	498.0	151.0	277.0	126.0	4.0
1959	3088	93.5	504.6	155.0	280.0	125.0	4.0
1960	4088	119.1	485.6	168.0	288.0	120.0	4.0
1961	3534	100.3	473.0	165.0	288.0	123.0	3.8
1962	3735	107.7	480.6	172.0	---	---	---
1963	3726	105.0	469.7	171.0	---	---	---
1964	4236	118.8	467.4	184.0	---	---	—
1965	1740	50.5	483.7	180.0	---	---	---
1966	2817	79.3	469.2	180.0	---	---	---
1967	2533	73.7	484.9	168.0	---	---	—
1968	2233	63.3	472.5	161.0	300.0	139.0	3.4
1969	2402	68.5	475.3	161.0	298.0	137.0	3.5
1970	2353	66.1	468.2	157.0	300.0	143.0	3.3
1971	2659	74.4	466.3	155.0	302.0	147.0	3.2
1972	2301	64.4	466.5	153.0	304.0	151.0	3.1
1973	2476	68.3	459.7	156.0	308.0	152.0	3.0
1974	1903	52.5	459.8	154.0	306.0	152.0	3.0
1975	2318	63.9	459.4	149.0	309.0	160.0	2.9
1976	2799	77.6	462.1	150.0	310.0	160.0	2.9
1977	2665	74.8	467.8	147.0	303.0	156.0	3.0
1978	2274	64.9	475.8	145.0	299.0	154.0	3.1
1979	2964	84.0	472.4	149.0	301.0	152.0	3.1
1980	3316	92.2	463.6	153.0	300.0	147.0	3.2
1981	3523	96.5	456.5	158.0	304.0	146.0	3.1
1982	3654	102.3	467.0	168.0	299.0	136.0	3.4
1983	2842	78.1	458.0	154.0	295.0	141.0	3.2
1984	2889	72.1	416.0	156.0	281.0	125.0	3.1

APPENDIX A (cont)

Well LA-6

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1948	116	4.9	704.0	---	---	---	---
1949	2451	95.8	651.4	---	---	---	---
1950	4490	167.9	623.2	83.0	136.0	53.0	11.8
1951	5882	201.6	571.2	115.0	160.0	45.0	12.7
1952	3168	110.3	580.3	108.0	151.0	43.0	13.5
1953	3177	113.8	597.0	95.0	139.0	44.0	13.6
1954	2894	107.1	616.8	92.0	135.0	43.0	14.3
1955	2911	108.0	618.3	97.0	140.0	43.0	14.4
1956	3438	125.8	609.9	106.0	149.0	43.0	14.2
1957	2833	102.4	602.4	107.0	152.0	45.0	13.4
1958	2957	106.9	602.5	108.0	131.0	43.0	14.0
1959	3096	108.3	583.0	115.0	158.0	43.0	13.6
1960	4084	138.6	565.6	130.0	172.0	42.0	13.5
1961	3284	112.5	571.0	129.0	171.0	42.0	13.6
1962	3886	129.4	555.0	135.0	175.0	40.0	13.9
1963	2953	102.9	580.8	125.0	171.0	46.0	12.6
1964	4244	138.3	543.1	132.0	172.0	40.0	13.6
1965	3145	103.8	550.1	120.0	160.0	40.0	13.8
1966	3173	104.0	546.3	129.0	169.0	40.0	13.7
1967	2511	85.4	566.8	118.0	158.0	40.0	14.2
1968	2111	71.6	565.3	109.0	150.0	41.0	13.8
1969	2402	81.6	566.2	109.0	151.0	42.0	13.5
1970	2337	79.1	564.1	106.0	149.0	43.0	13.1
1971	2472	82.5	556.2	119.0	160.0	41.0	13.6
1972	2317	79.2	569.7	117.0	155.0	38.0	15.0
1973	2638	90.6	572.4	118.0	155.0	37.0	15.5
1974	2337	79.8	569.1	120.0	156.0	36.0	15.8
1975	1571	51.9	550.6	113.0	151.0	38.0	14.5
1976	175	5.1	485.7	96.0	---	---	---
1977	---	---	---	82.0	---	---	---
1978	33	1.1	572.7	77.0	142.0	65.0	8.8
1979	6	0.2	555.6	80.0	146.0	66.0	8.4
1980	4	0.1	520.8	82.0	142.0	60.0	8.7
1981	2.3	0.08	579.8	84.0	141.0	57.0	10.2
1982	---	---	---	90.0	---	---	---
1983	---	---	---	81.0	---	---	---
1984	---	---	---	83.0	---	---	---

APPENDIX A (cont)

Well G-1

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1950	0	2.8	0.0	195.0	---	---	---
1951	1168	37.7	538.0	202.0	309.0	107.0	5.0
1952	2476	75.5	508.2	213.0	295.0	82.0	6.2
1953	3275	97.3	495.2	221.0	292.0	71.0	7.0
1954	2616	77.8	495.7	221.0	290.0	69.0	7.2
1955	2406	70.5	488.4	226.0	295.0	69.0	7.1
1956	2958	83.2	468.8	235.0	303.0	68.0	6.9
1957	2098	55.9	444.1	236.0	307.0	71.0	6.3
1958	2460	68.1	461.4	238.0	308.0	70.0	6.6
1959	2952	82.4	465.2	245.0	314.0	69.0	6.7
1960	3564	96.0	448.9	254.0	325.0	71.0	6.3
1961	4236	112.4	442.2	260.0	333.0	73.0	6.1
1962	3431	93.6	454.7	258.0	342.0	84.0	5.4
1963	4519	114.9	423.8	265.0	348.0	83.0	5.1
1964	4374	113.8	433.6	269.0	352.0	83.0	5.2
1965	3530	90.7	428.2	268.0	352.0	84.0	5.1
1966	4074	102.6	419.7	269.0	363.0	94.0	4.5
1967	2615	69.9	445.5	266.0	362.0	96.0	4.6
1968	2996	78.9	438.9	264.0	366.0	102.0	4.3
1969	2657	68.3	428.4	266.0	376.0	110.0	3.9
1970	2712	64.7	397.6	264.0	377.0	113.0	3.5
1971	2908	67.9	389.2	258.0	378.0	120.0	3.2
1972	2865	66.1	384.5	264.0	389.0	125.0	3.1
1973	2997	67.5	375.4	271.0	403.0	132.0	2.8
1974	2767	62.3	375.3	283.0	412.0	129.0	2.9
1975	2467	55.7	376.3	293.0	411.0	118.0	3.2
1976	2962	65.1	366.3	---	---	---	---
1977	2734	57.9	353.0	275.0	426.0	151.0	2.3
1978	2656	56.0	351.4	270.0	419.0	149.0	2.4
1979	2998	61.7	342.9	271.0	422.0	151.0	2.3
1980	3459	68.3	329.0	273.0	428.0	155.0	2.1
1981	4427	81.6	307.2	275.0	444.0	169.0	1.8
1982	3678	69.0	313.0	278.0	443.0	165.0	1.9
1983	2871	52.2	303.0	272.0	443.0	171.0	1.8
1984	3804	62.8	275.0	276.0	448.0	172.0	1.5

APPENDIX A (cont)

Well G-1A

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1954	108	4.6	709.9	--	--	--	--
1955	1531	53.0	577.0	265.0	316.0	51.0	11.3
1956	3130	107.7	573.5	273.0	323.0	50.0	11.5
1957	2470	87.0	587.0	274.0	327.0	53.0	11.1
1958	2670	92.5	577.4	279.0	331.0	52.0	11.1
1959	2965	102.7	577.3	284.0	333.0	49.0	11.8
1960	3641	122.8	562.1	291.0	342.0	51.0	11.0
1961	4297	147.3	571.3	298.0	350.0	52.0	11.0
1962	3972	136.1	571.1	295.0	344.0	49.0	11.7
1963	4525	149.7	551.4	301.0	350.0	49.0	11.3
1964	3852	129.3	559.4	302.0	353.0	51.0	11.0
1965	3505	116.5	554.0	302.0	353.0	51.0	10.9
1966	3964	133.4	560.9	306.0	355.0	49.0	11.4
1967	2720	91.3	559.4	302.0	351.0	49.0	11.4
1968	3089	103.2	556.8	302.0	352.0	50.0	11.1
1969	2695	90.7	560.9	303.0	356.0	53.0	10.6
1970	2772	92.5	556.2	300.0	357.0	57.0	9.8
1971	3313	111.8	562.4	303.0	361.0	58.0	9.7
1972	2879	94.0	544.2	302.0	361.0	59.0	9.2
1973	2760	87.9	530.8	302.0	362.0	60.0	8.8
1974	2974	92.7	519.5	307.0	355.0	48.0	10.8
1975	2740	85.3	518.9	304.0	351.0	47.0	11.0
1976	2983	91.6	511.8	302.0	350.0	48.0	10.7
1977	2942	88.7	502.5	302.0	350.0	48.0	10.5
1978	2631	77.9	493.5	300.0	345.0	45.0	11.0
1979	2974	88.0	493.9	301.0	345.0	44.0	11.0
1980	3480	103.2	494.4	305.0	345.0	40.0	12.4
1981	4212	131.2	519.1	307.0	347.0	40.0	13.0
1982	3618	109.7	505.0	305.0	347.0	42.0	12.0
1983	2901	86.7	498.0	301.0	336.0	35.0	14.2
1984	3789	113.9	501.0	302.0	345.0	43.0	11.7

APPENDIX A (cont)

Well G-2

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1951	123	3.9	528.5	259.0	---	---	---
1952	2372	78.3	550.2	279.0	327.0	48.0	11.5
1953	3254	105.6	540.9	290.0	334.0	44.0	12.3
1954	2682	86.3	536.3	291.0	335.0	44.0	12.2
1955	2487	78.8	528.1	299.0	345.0	46.0	11.5
1956	3109	95.8	513.6	310.0	357.0	47.0	10.9
1957	2458	76.1	516.0	311.0	360.0	49.0	10.5
1958	2707	80.1	493.2	315.0	361.0	46.0	10.7
1959	2938	84.6	479.9	320.0	363.0	43.0	11.2
1960	3535	96.6	455.4	328.0	370.0	42.0	10.8
1961	3982	105.3	440.7	336.0	375.0	39.0	11.3
1962	4076	99.8	408.1	338.0	374.0	36.0	11.3
1963	4563	105.7	386.1	344.0	379.0	35.0	11.0
1964	4541	105.3	386.5	346.0	380.0	34.0	11.4
1965	3535	82.6	389.4	346.0	381.0	35.0	11.1
1966	3994	94.7	395.2	349.0	383.0	34.0	11.6
1967	2743	67.6	410.7	344.0	379.0	35.0	11.7
1968	2732	66.5	405.7	344.0	379.0	35.0	11.6
1969	2679	68.6	426.8	344.0	381.0	37.0	11.5
1970	2431	62.8	430.5	343.0	381.0	38.0	11.3
1971	3420	87.4	425.9	345.0	384.0	39.0	10.9
1972	2887	73.4	423.7	348.0	388.0	40.0	10.6
1973	2816	72.4	428.5	344.0	385.0	41.0	10.5
1974	3056	82.0	447.2	347.0	390.0	43.0	10.4
1975	2724	74.5	455.8	341.0	384.0	43.0	10.6
1976	2990	81.1	452.1	344.0	388.0	44.0	10.3
1977	2981	80.4	449.5	346.0	388.0	42.0	10.7
1978	2562	71.6	451.9	345.0	386.0	41.0	11.0
1979	2975	80.0	448.0	347.0	388.0	41.0	11.0
1980	3478	92.4	443.0	350.0	389.0	39.0	11.4
1981	1432	38.3	445.8	352.0	390.0	38.0	11.7
1982	2833	25.7	476.0	352.0	399.0	47.0	10.1
1983	624	16.5	441.0	356.0	399.0	43.0	10.3
1984	2018	43.7	361.0	358.0	385.0	27.0	13.4

APPENDIX A (cont)

Well G-3

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1951	192	7.3	633.7	281.0	--	--	--
1952	2379	65.4	458.2	310.0	358.0	48.0	9.5
1953	3192	76.4	398.9	322.0	360.0	38.0	10.5
1954	2675	66.1	411.8	322.0	370.0	48.0	8.6
1955	2369	69.4	488.3	316.0	368.0	52.0	9.4
1956	3149	87.9	465.2	324.0	380.0	56.0	8.3
1957	2517	70.2	464.8	324.0	385.0	61.0	7.6
1958	2562	69.5	452.1	323.0	386.0	63.0	7.2
1959	2931	74.6	424.2	326.0	395.0	69.0	6.1
1960	3591	82.5	382.9	335.0	407.0	72.0	5.3
1961	3612	79.9	368.7	343.0	414.0	71.0	5.2
1962	4057	83.7	343.9	348.0	418.0	70.0	4.9
1963	4555	86.7	317.2	352.0	422.0	70.0	4.5
1964	4487	78.6	292.0	355.0	424.0	69.0	4.2
1965	3498	65.6	312.6	350.0	419.0	69.0	4.5
1966	3991	73.7	307.8	353.0	420.0	67.0	4.6
1967	2752	52.9	320.4	344.0	418.0	74.0	4.3
1968	3086	56.5	305.1	341.0	418.0	77.0	4.0
1969	2672	50.8	316.9	338.0	417.0	79.0	4.0
1970	2736	55.4	337.5	336.0	419.0	83.0	4.1
1971	3337	64.2	320.6	342.0	423.0	81.0	4.0
1972	2838	50.9	298.9	341.0	421.0	80.0	3.7
1973	2843	47.3	277.3	341.0	418.0	77.0	3.6
1974	3006	49.3	273.3	342.0	424.0	82.0	3.3
1975	2632	43.1	272.9	341.0	428.0	87.0	3.1
1976	2971	82.6	463.4	359.0	447.0	88.0	5.3
1977	2961	78.9	444.1	353.0	448.0	95.0	4.7
1978	2590	66.4	427.5	345.0	443.0	98.0	4.4
1979	3014	69.0	381.0	345.0	450.0	105.0	3.6
1980	3448	61.8	298.6	348.0	453.0	105.0	2.8
1981	4315	66.6	257.2	357.0	467.0	110.0	2.3
1982	3550	51.0	239.0	349.0	459.0	110.0	2.2
1983	2183	31.3	239.0	340.0	463.0	123.0	1.9
1984	1211	19.0	267.0	355.0	475.0	120.0	2.2

APPENDIX A (cont)

Well G-4

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1951	---	12.5	---	357.0	477.0	120.0	---
1952	2401	56.9	395.0	374.0	474.0	100.0	3.9
1953	2677	55.2	343.7	380.0	472.0	92.0	3.7
1954	2256	58.8	434.4	383.0	526.0	143.0	3.0
1955	1172	22.7	322.8	378.0	481.0	103.0	3.1
1956	1800	33.9	313.9	377.0	491.0	114.0	2.8
1957	1324	24.2	304.6	373.0	498.0	125.0	2.4
1958	1970	35.9	303.7	370.0	490.0	120.0	2.5
1959	1819	31.6	289.5	378.0	494.0	116.0	2.5
1960	2457	37.0	251.0	385.0	509.0	124.0	2.0
1961	2787	45.0	269.1	389.0	512.0	123.0	2.2
1962	2738	41.7	253.8	386.0	505.0	119.0	2.1
1963	3519	46.4	219.8	388.0	504.0	116.0	1.9
1964	3561	42.9	200.8	396.0	499.0	103.0	1.9
1965	2100	23.8	188.9	394.0	492.0	98.0	1.9
1966	2219	33.6	252.4	391.0	498.0	107.0	2.4
1967	2690	44.8	277.6	388.0	509.0	121.0	2.3
1968	2083	31.4	251.2	386.0	509.0	123.0	2.0
1969	1309	17.4	221.5	387.0	505.0	118.0	1.9
1970	606	7.7	211.8	384.0	504.0	120.0	1.8
1971	1640	21.0	213.4	389.0	503.0	114.0	1.9
1972	2840	33.3	195.4	391.0	507.0	116.0	1.7
1973	3006	37.2	206.3	392.0	521.0	129.0	1.6
1974	2672	34.3	213.9	392.0	519.0	127.0	1.7
1975	1977	41.0	345.6	403.0	559.0	156.0	2.2
1976	2859	57.8	336.9	406.0	571.0	165.0	2.0
1977	2954	62.4	352.1	406.0	589.0	183.0	1.9
1978	2607	49.5	316.5	398.0	589.0	191.0	1.7
1979	2974	52.9	296.4	395.0	586.0	191.0	1.6
1980	2235	35.6	265.7	394.0	580.0	186.0	1.4
1981	432	8.2	316.4	385.0	573.0	188.0	1.7
1982	3657	65.2	297.0	386.0	578.0	192.0	1.5
1983	2604	42.2	270.0	---	---	---	---
1984	3766	49.7	220.0	---	---	---	---

APPENDIX A (cont)

Well G-5

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1951	---	6.7	---	414.0	---	---	—
1952	2579	73.8	476.9	422.0	480.0	58.0	8.2
1953	1433	37.8	439.6	425.0	467.0	42.0	10.5
1954	2617	80.9	515.2	429.0	473.0	44.0	11.7
1955	2529	80.4	529.9	427.0	472.0	45.0	11.8
1956	3052	97.0	529.7	431.0	478.0	47.0	11.3
1957	2385	64.1	447.9	424.0	466.0	42.0	10.7
1958	1523	49.1	537.3	428.0	477.0	49.0	11.0
1959	2917	101.7	581.1	435.0	495.0	60.0	9.7
1960	2828	98.0	577.6	437.0	501.0	64.0	9.0
1961	3908	134.0	571.5	438.0	507.0	69.0	8.3
1962	4186	142.0	565.4	440.0	511.0	71.0	8.0
1963	4528	151.0	555.8	441.0	513.0	72.0	7.7
1964	4532	150.4	553.1	446.0	516.0	70.0	7.9
1965	3520	117.1	554.5	443.0	516.0	73.0	7.6
1966	2555	83.2	542.7	445.0	520.0	75.0	7.2
1967	2405	80.0	554.4	444.0	519.0	75.0	7.4
1968	2513	81.2	538.5	443.0	517.0	74.0	7.3
1969	2649	83.3	524.1	450.0	520.0	70.0	7.5
1970	2771	88.9	534.7	453.0	521.0	68.0	7.9
1971	2657	88.3	553.9	450.0	521.0	71.0	7.8
1972	2902	92.4	530.7	441.0	514.0	73.0	7.3
1973	3003	97.5	541.1	444.0	515.0	71.0	7.6
1974	2054	69.0	559.9	440.0	513.0	73.0	7.7
1975	2266	74.7	549.4	433.0	500.0	67.0	8.2
1976	2955	95.0	535.8	442.0	504.0	62.0	8.6
1977	2836	92.1	541.3	444.0	504.0	60.0	9.0
1978	2608	84.2	538.4	442.0	502.0	60.0	9.0
1979	2766	86.5	521.5	442.0	502.0	60.0	8.7
1980	2896	89.0	512.4	442.0	502.0	60.0	8.5
1981	2124	66.7	523.4	451.0	528.0	77.0	6.8
1982	1219	38.2	522.0	455.0	510.0	55.0	9.5
1983	2904	73.2	420.0	445.0	492.0	47.0	8.9
1984	3838	115.4	501.0	452.0	507.0	55.0	9.4

APPENDIX A (cont)

Well G-6

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1964	1912	45.0	392.3	581.0	659.0	78.0	5.0
1965	3200	74.9	390.1	582.0	660.0	78.0	5.0
1966	3931	92.2	390.9	585.0	658.0	73.0	5.4
1967	2454	57.8	392.6	580.0	653.0	73.0	5.4
1968	2597	56.2	360.7	574.0	647.0	73.0	4.9
1969	2698	55.6	343.5	568.0	636.0	68.0	5.1
1970	2765	51.0	307.4	569.0	634.0	65.0	4.7
1971	2932	42.8	243.3	573.0	629.0	56.0	4.3
1972	2516	57.0	377.6	578.0	670.0	92.0	4.1
1973	2991	65.3	363.9	579.0	667.0	88.0	4.1
1974	2950	63.8	360.5	579.0	665.0	86.0	4.2
1975	2717	56.7	347.8	577.0	659.0	82.0	4.2
1976	2966	57.8	324.8	584.0	662.0	78.0	4.2
1977	2954	54.4	306.9	586.0	659.0	73.0	4.2
1978	2218	38.4	288.9	581.0	645.0	64.0	4.5
1979	1030	18.2	295.1	579.0	645.0	66.0	4.8
1980	1789	34.5	321.5	583.0	670.0	87.0	3.7
1981	4302	76.5	296.4	586.0	673.0	87.0	3.4
1982	3763	63.6	281.0	588.0	669.0	81.0	3.5
1983	1960	35.4	301.0	582.0	668.0	86.0	3.5
1984	3010	55.3	306.0	589.0	666.0	77.0	3.9

APPENDIX A (cont)

Well PM-1

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1965	2754	99.2	600.3	746.0	786.0	40.0	15.0
1966	3086	108.0	583.3	740.0	779.0	39.0	15.0
1967	2870	111.0	644.6	737.0	781.0	44.0	14.6
1968	1846	68.1	614.8	735.0	769.0	34.0	18.1
1969	951	34.4	602.9	733.0	766.0	33.0	18.3
1970	1781	66.2	619.5	733.0	769.0	36.0	17.2
1971	2728	101.0	617.1	733.0	766.0	33.0	18.7
1972	2415	84.9	585.9	735.0	762.0	27.0	21.7
1973	1688	46.5	459.1	736.0	755.0	19.0	24.2
1974	2649	96.3	605.9	740.0	768.0	28.0	21.6
1975	2567	94.8	615.5	741.0	766.0	25.0	24.6
1976	2933	106.8	606.9	744.0	767.0	23.0	26.4
1977	2969	105.4	591.7	745.0	767.0	22.0	26.9
1978	2544	90.6	593.3	745.0	767.0	22.0	27.0
1979	2350	83.4	591.5	744.0	766.0	22.0	26.9
1980	2786	98.7	590.7	746.0	769.0	23.0	25.7
1981	2789	98.5	588.6	747.0	769.0	22.0	26.8
1982	2820	99.6	589.0	748.0	770.0	22.0	26.8
1983	2464	86.5	585.0	747.0	769.0	22.0	26.6
1984	2667	92.8	580.0	749.0	772.0	23.0	25.6

APPENDIX A (cont)

Well PM-2

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1966	221	18.9	1425.3	826.0	889.0	63.0	22.6
1967	4336	370.0	1422.2	834.0	888.0	54.0	26.3
1968	3865	328.2	1415.3	838.0	889.0	51.0	27.8
1969	3304	279.9	1411.9	838.0	890.0	52.0	27.2
1970	3529	300.6	1419.7	839.0	893.0	54.0	26.3
1971	4035	339.5	1402.3	841.0	898.0	57.0	24.6
1972	4611	385.3	1392.7	845.0	902.0	57.0	24.4
1973	4571	380.6	1387.7	849.0	907.0	58.0	23.9
1974	5443	450.9	1380.7	853.0	912.0	59.0	23.4
1975	4644	385.3	1382.8	854.0	913.0	59.0	23.4
1976	5382	442.0	1368.8	866.0	924.0	58.0	23.6
1977	3306	272.8	1375.3	868.0	924.0	56.0	24.6
1978	4743	388.4	1364.9	871.0	928.0	57.0	23.9
1979	4671	381.8	1362.2	872.0	924.0	52.0	26.2
1980	5023	409.6	1359.2	873.0	931.0	58.0	23.4
1981	4551	370.1	1355.4	876.0	934.0	58.0	23.4
1982	4319	359.3	1386.0	874.0	934.0	60.0	23.1
1983	1922	157.9	1369.0	876.0	935.0	59.0	23.2
1984	996	81.6	1365.0	866.0	930.0	64.0	21.7

APPENDIX A (cont)

Well PM-3

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1968	2327	187.4	1342.2	743.0	771.0	28.0	47.9
1969	3241	254.7	1309.8	746.0	772.0	26.0	50.4
1970	2905	227.8	1306.9	750.0	774.0	24.0	54.5
1971	2774	216.3	1299.6	751.0	774.0	23.0	56.5
1972	2445	192.1	1309.5	752.0	775.0	23.0	56.9
1973	3256	257.8	1319.6	755.0	778.0	23.0	57.4
1974	3241	255.3	1312.9	756.0	779.0	23.0	57.1
1975	3421	269.3	1312.0	757.0	780.0	23.0	57.0
1976	3171	268.3	1410.2	758.0	784.0	26.0	54.2
1977	2792	235.5	1405.8	758.0	784.0	26.0	54.1
1978	2516	211.0	1397.6	759.0	784.0	25.0	55.9
1979	2359	197.2	1393.0	760.0	784.0	24.0	58.0
1980	2796	234.4	1397.2	760.0	785.0	25.0	55.9
1981	2784	232.4	1391.3	761.0	786.0	25.0	55.6
1982	2831	238.1	1402.0	762.0	785.0	23.0	60.9
1983	2496	207.6	1386.0	762.0	785.0	23.0	60.3
1984	3317	275.6	1385.0	762.0	787.0	23.0	56.8

APPENDIX A (cont)

Well PM-4

Year	Pump Time (h)	Pumpage (million (gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1982	869	76.2	1460	1050	1091	41	35.6
1983	5267	452.5	1432	1066	1101	35	40.9
1984	4059	325.8	1338	1065	1104	39	34.3

APPENDIX A (cont)

Water Canyon Gallery

Year	Time (h)	Production (million gal)	Discharge Rate (gpm)
1947	8760	84.0	159.8
1948	8784	97.0	184.0
1949	8760	92.0	175.0
1950	8760	54.0	102.7
1951	8760	39.0	74.2
1952	8784	48.0	91.1
1953	8760	39.0	74.2
1954	8760	40.0	76.1
1955	8760	33.0	62.8
1956	8784	23.0	43.6
1957	8760	40.0	76.1
1958	8760	60.0	114.2
1959	8760	54.0	102.7
1960	8784	48.0	91.1
1961	8760	54.0	102.7
1962	8760	67.0	127.5
1963	8760	51.0	97.0
1964	8784	45.0	85.4
1965	8760	72.0	137.0
1966	8760	82.0	156.0
1967	8760	56.0	106.5
1968	8784	65.0	123.3
1969	8760	80.0	152.2
1970	8760	65.0	123.7
1971	8760	37.0	70.4
1972	8784	40.0	75.9
1973	8760	49.0	93.2
1974	8760	35.0	66.6
1975	8760	42.0	79.9
1976	8784	41.0	77.8
1977	8760	57.0	108.4
1978	8760	45.0	86.2
1979	8760	44.0	83.7
1980	8784	32.0	60.7
1981	8760	45.5	86.6
1982	8760	45.9	94.9
1983	8760	38.2	72.7
1984	8784	34.5	65.4

APPENDIX B

ANNUAL AVERAGE WATER LEVELS

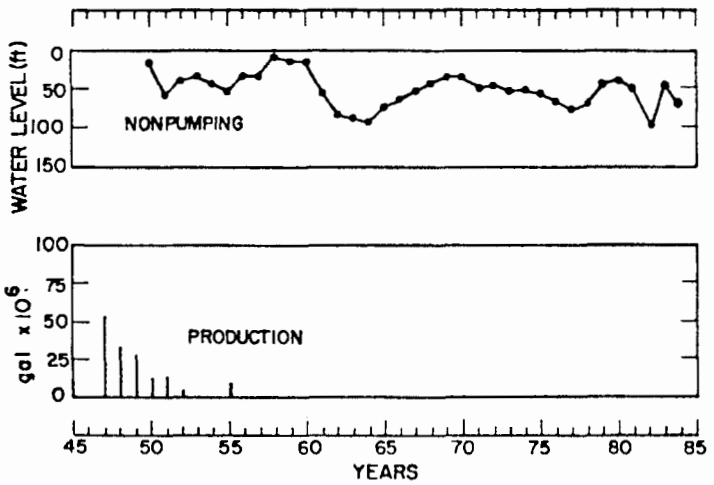

Fig. B1. Annual average nonpumping water level and annual production, Los Alamos Well LA-1.

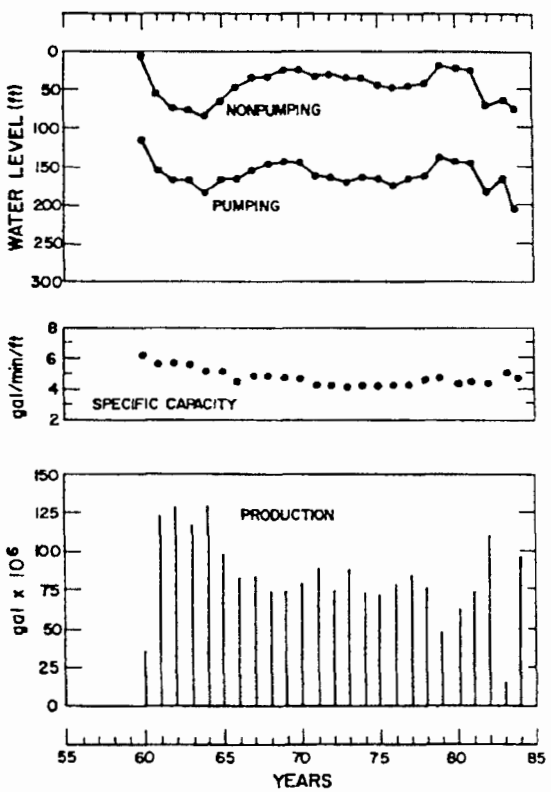

Fig. B2. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-1B.

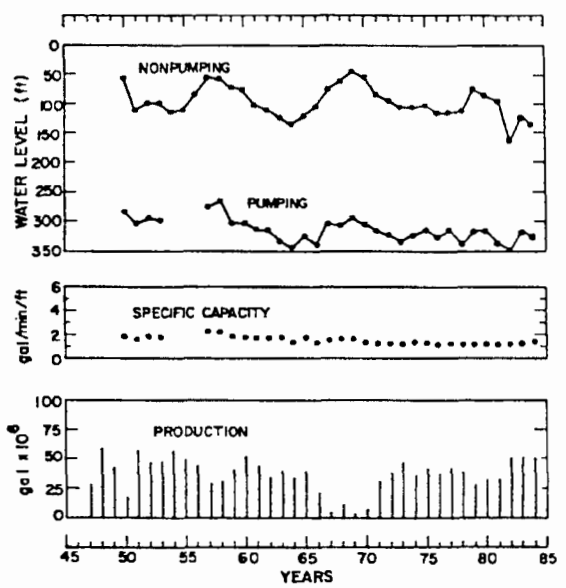

Fig. B3. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-2.

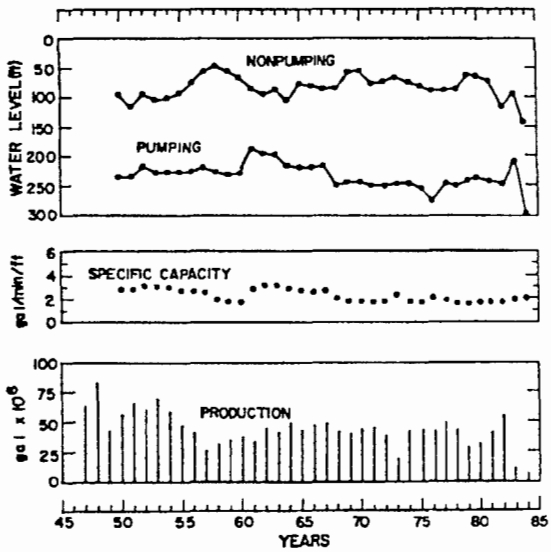

Fig. 4. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-3.

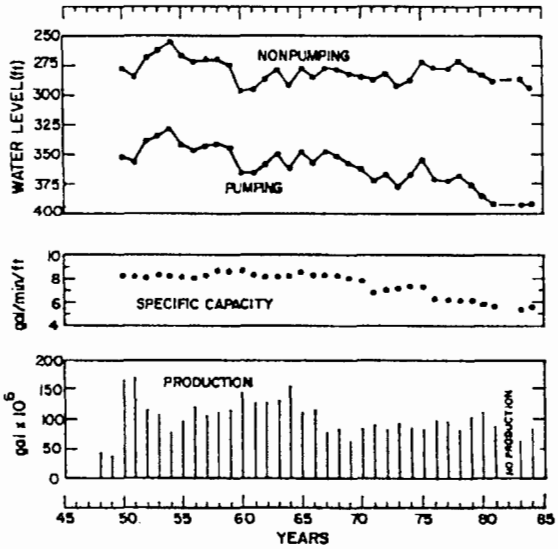

Fig. B5. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-4.

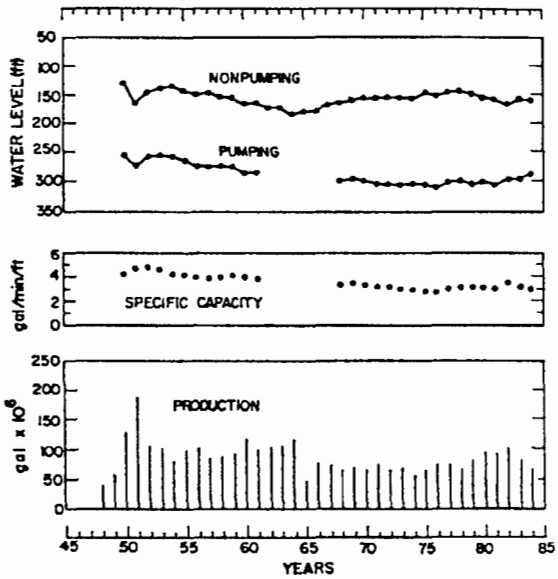

Fig. B6. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-5.

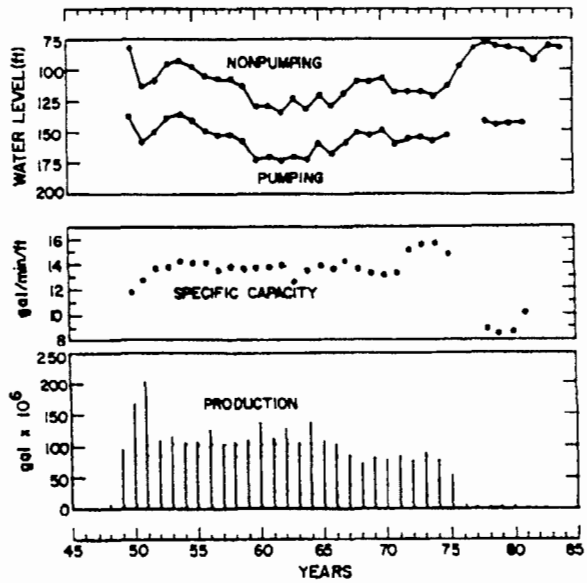

Fig. B7. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-6.

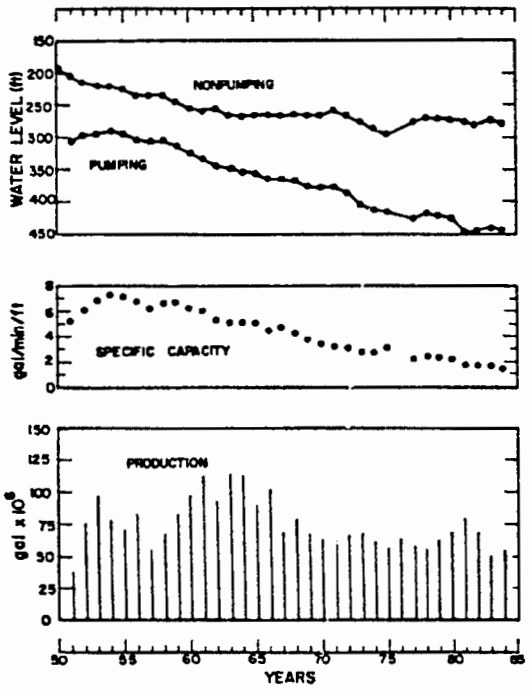

Fig. B8. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-1.

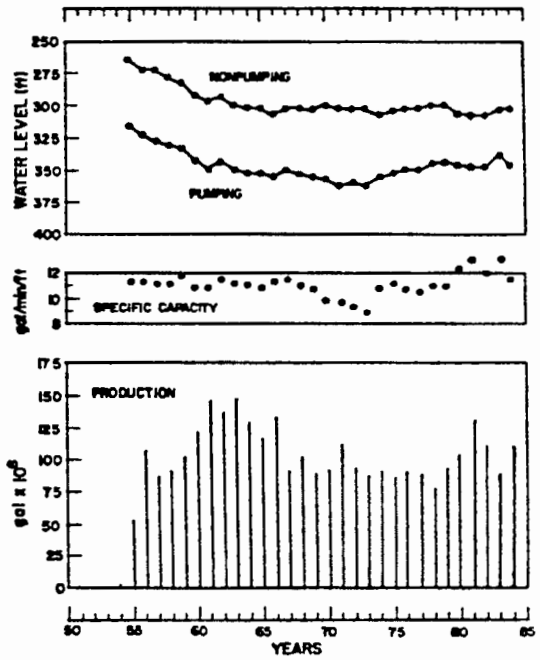

Fig. B9. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-1A.

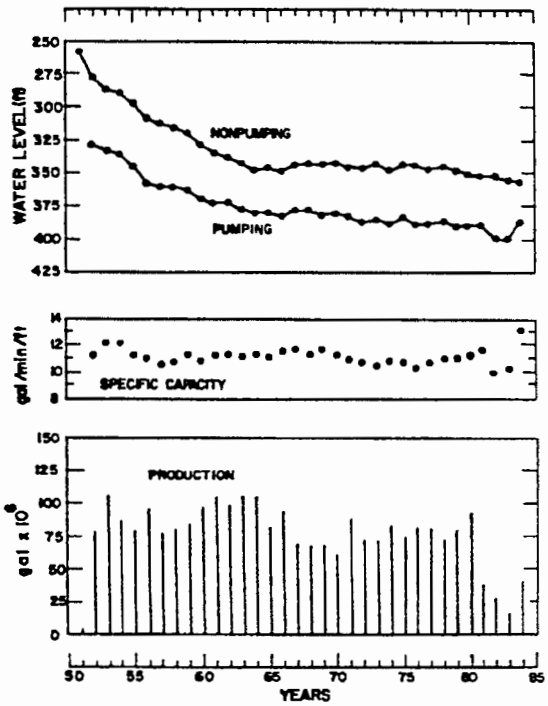

Fig. B10. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-2.

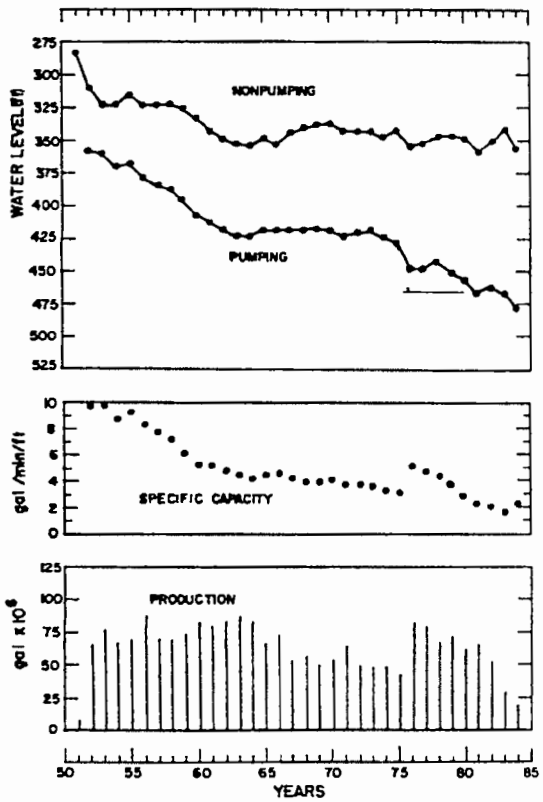

Fig. B11. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-3.

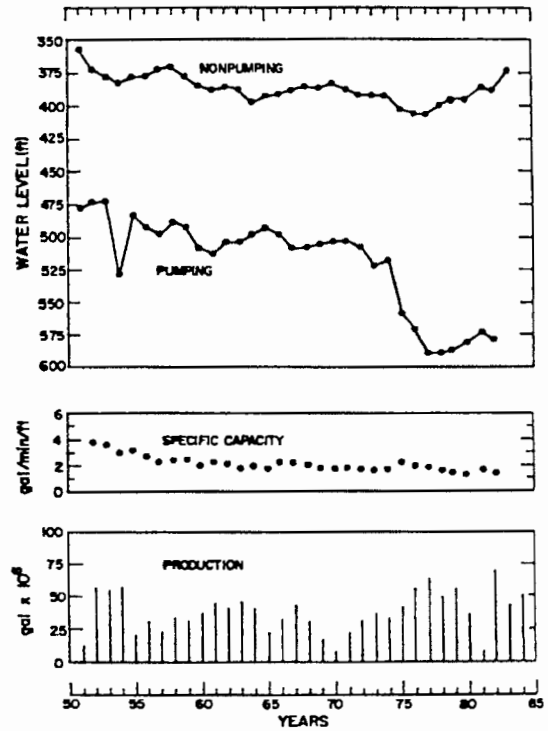

Fig. B12. Annual average nonpumping and pumping water level, annual average specific capacity, and annual production, Guaje Well G-4.

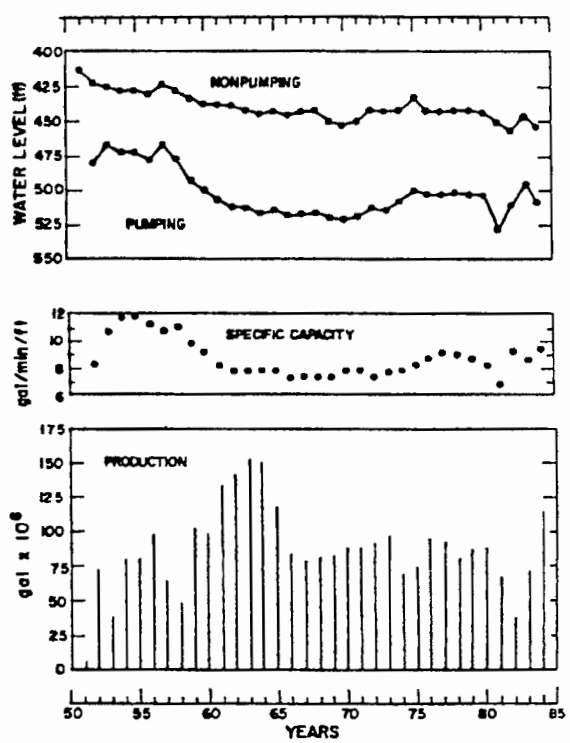

Fig. B13. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-5.

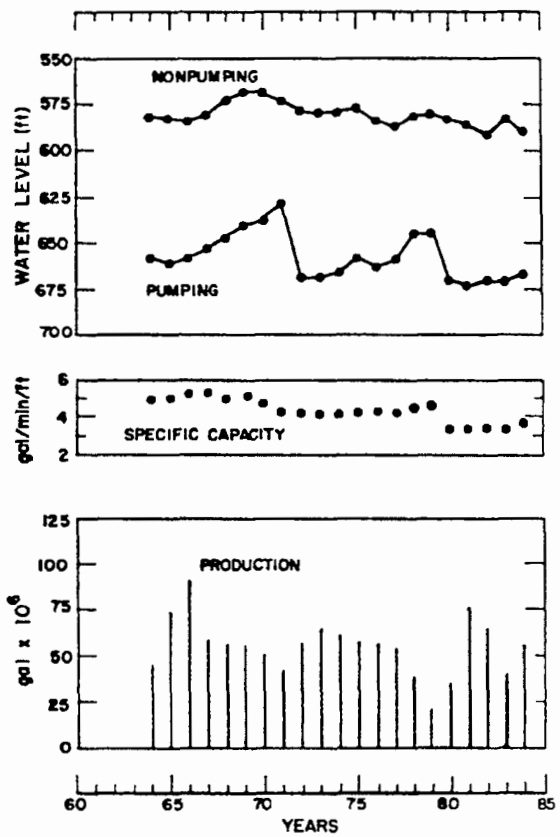

Fig. B14. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-6.

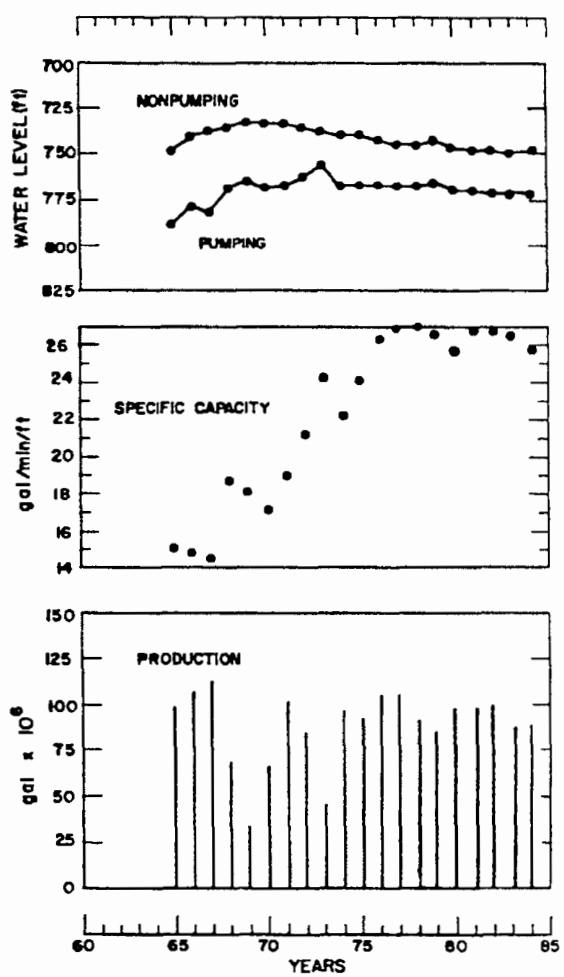

Fig. B15. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Pajarito Well PM-1.

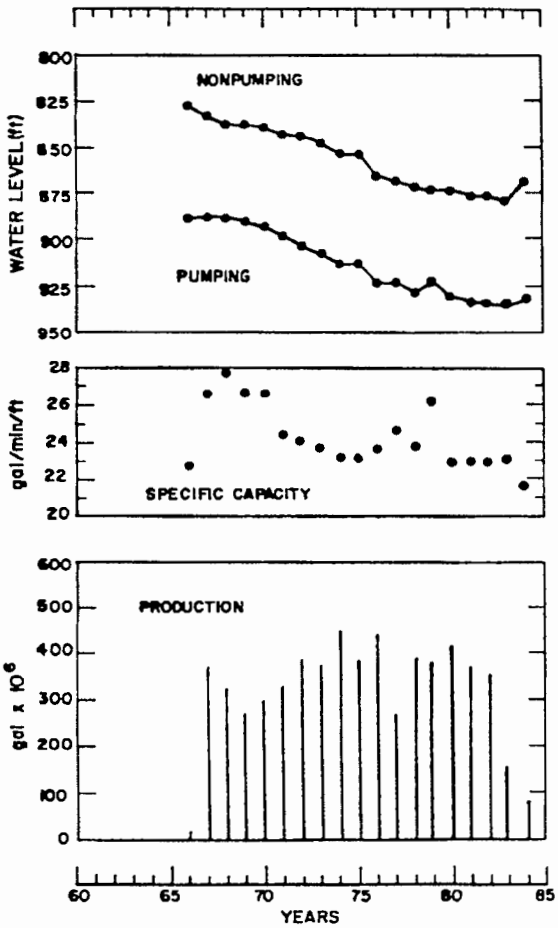

Fig. B16. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Pajarito Well PM-2.

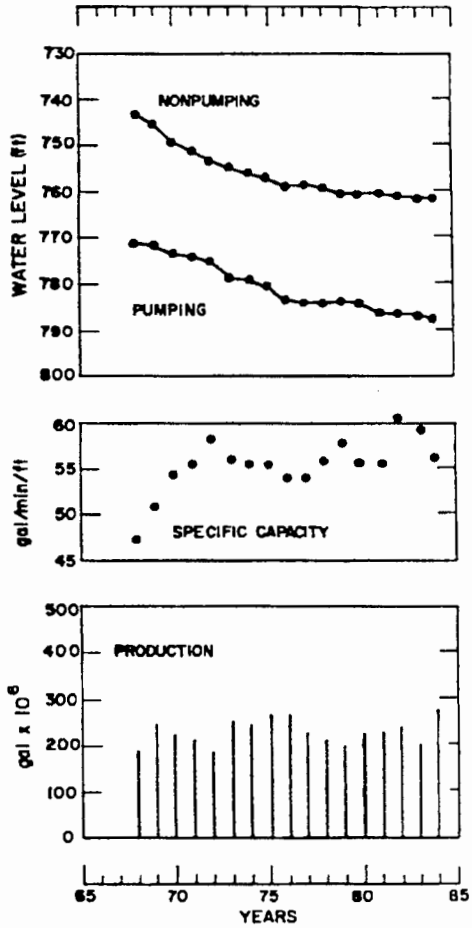

Fig. B17. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Pajarito Well PM-3.

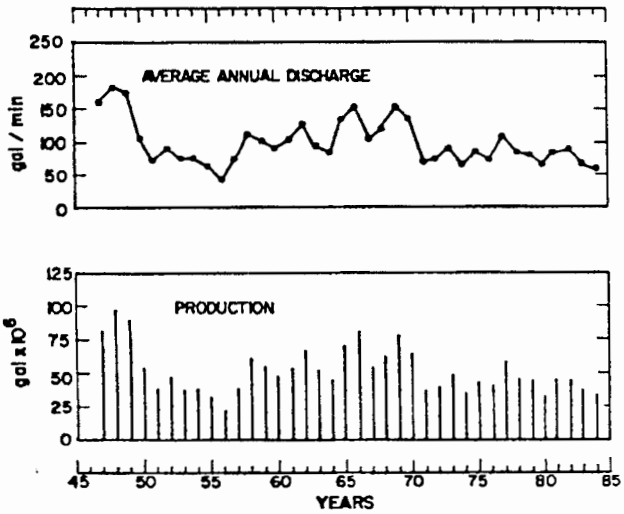

Fig. B18. Annual average discharge and annual production from the gallery in Water Canyon.

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