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Water Supply at Los Alamos during 1997

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WATER SUPPLY AT LOS ALAMOS DURING 1997

by

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ABSTRACT

Production of potable municipal water supplies during 1997 totaled about 1,285.9 million gallons from wells in the Guaje, Pajarito, and Otowi well fields. There was no water used from the spring gallery in Water Canyon or from Guaje Reservoir during 1997. About 2.4 million gallons of water from Los Alamos Reservoir was used to irrigate public parks and recreational lands. The total water usage in 1997 was about 1,288.3 million gallons, or about 135 gallons per day per person living in Los Alamos County. Groundwater pumpage was down about 82.2 million gallons in 1997 compared with the pumpage in 1996. Four new replacement wells were drilled and cased in Guaje Canyon between October 1997 and March 1998. These wells are currently being developed and aquifer tests are being performed. A special report summarizing the geological, geophysical, and well construction logs will be issued in the near future for these new wells.

I. INTRODUCTION

This report fulfills requirements specified in U.S. Department of Energy (DOE) Order 5400.1 (Groundwater Protection Management Program), which requires Los Alamos National Laboratory (the Laboratory) to monitor and document groundwater conditions below Pajarito Plateau and to protect the regional aquifer from contamination associated with Laboratory operations. Furthermore, this report also fulfills special conditions outlined in Module VIII of the Laboratory's Hazardous and Solid Waste Amendments (HSWA) portion of the Resource Conservation and Recovery Act (RCRA) operating permit (NM-0890010515), which was jointly issued by the U.S. Environmental Protection Agency and the New Mexico Environment Department to the Laboratory and DOE. This report satisfies portions of those requirements by providing information on hydrologic characteristics of the regional aquifer, including operating conditions of the municipal water supply system.

This report summarizes production statistics and aquifer conditions for water wells in the Guaje, Pajarito, and Otowi well fields (Fig. 1). During 1997 these wells supplied all of the potable water used for municipal and some industrial purposes in Los Alamos County, Los Alamos National Laboratory, and Bandelier National Monument. Only one of two wells in the Otowi well field was routinely pumped during 1997. In 1992 some of the wells in the Los Alamos well field were plugged and abandoned in accordance with New Mexico State Engineer Office requirements, and ownership of the remaining wells in the field was transferred from DOE to San Ildefonso Pueblo. Hence, no hydrological data were available from the Los Alamos well field in 1997. The spring gallery in Water Canyon did not supply any nonpotable water for industrial use during 1997, while Los Alamos Reservoir supplied some water for lawn irrigation at the County golf course and several athletic fields. In 1997, no water was used from Guaje Reservoir. Due to high

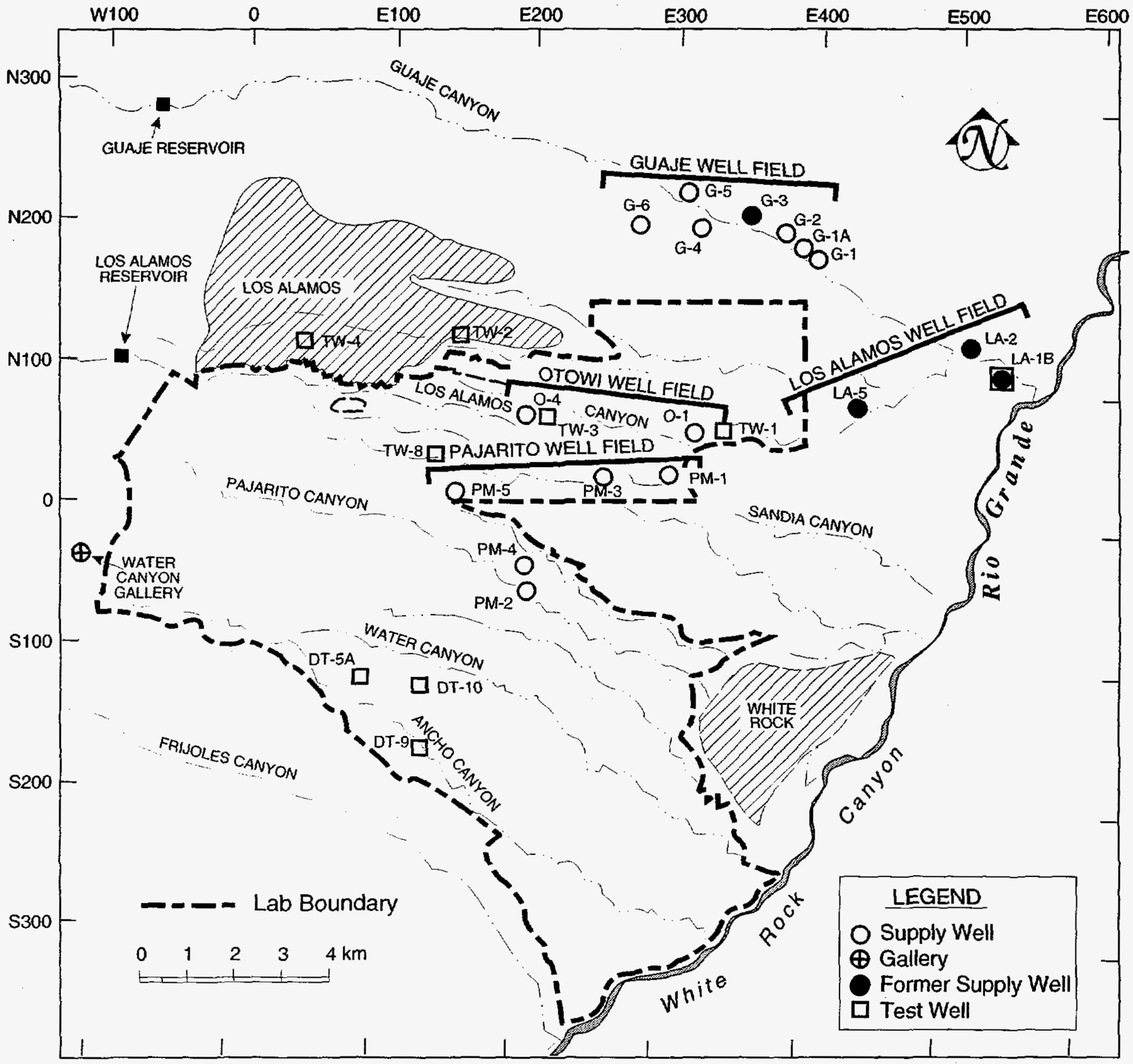

Fig. 1. Locations of reservoirs, well fields, water supply wells, and the water gallery supply. Letter designations indicate wells in the Guaje (G), Pajarito Mesa (PM), and Otowi (O) well fields. Ownership of the Los Alamos (LA) well field was transferred to San Ildefonso Pueblo in 1992.

maintenance and operating costs associated with diverting surface water from these reservoirs, it is not economically feasible to continue their use for irrigation.

This report is a joint effort between the Laboratory's Water Quality and Hydrology Group (ESH-18) and the Utilities Department of Johnson Controls Northern New Mexico, Inc. (JCNNM). This report has three primary objectives. First, it provides a continuing historical record of metered well pumpage and overall water usage. Second, it provides data to management for long-range water resources planning and operation of the water supply system. Third, it provides water level data from regional aquifer production and test wells, detailed results of pump test analyses, water quality data, and other important summaries of aquifer drilling and hydrological testing programs. One summary report [1] has been issued for the period of 1947 to 1971. Since then, 26 annual reports that contain the results of past water supply studies [2–27] have been published. An additional report summarized the hydrology of the regional aquifer and made recommendations for future development of groundwater supplies [28]. A 1988 report examined the status of wells and future water supply [29]. Finally, a 1995 report described individual drilling logs from water supply and test wells [30].

JCNNM, the support contractor to the Laboratory and DOE at Los Alamos, maintains and operates the water supply system. DOE sells water to Los Alamos County for the communities of Los Alamos and White Rock. DOE also sells water to the National Park Service for water supply at Bandelier National Monument. Annual water production statistics and data representing aquifer characteristics for the Guaje, Pajarito, and Otowi wells are contained in Appendix A. Historical water level data from regional aquifer test wells are summarized in Appendix B. Historical water production and aquifer characteristics data for the Los Alamos well field were previously reported [26]. Beginning in 1997, water quality data for the regional aquifer also is in the water supply reports. Historically, these data have been reported in the annual environmental surveillance reports [31, 32].

Potable water is pumped from the wells into the distribution lines. Booster pumps lift this water to reservoir storage tanks for distribution to the Laboratory and the community. The entire water supply is disinfected with chlorine before distribution to Los Alamos, White Rock, Bandelier National Monument, and Laboratory areas (Fig. 1). When needed, the nonpotable water for industrial use at TA-16 flows by gravity from the gallery in Water Canyon to the steam plant. The transmission line from the gallery to the steam plant is separate from the potable supply.

JCNNM maintains a record of the hours of operation for each well, along with records of daily and monthly water production, using in-line flow meters. Monthly averages of nonpumping and pumping water levels are computed from air-line bubble-pressure measurements or pressure transducer data recorded at each well. These data are used to determine individual well pumping rates, drawdown, and other important well field performance statistics. Appendix A contains all annual pumping and production information for all active water supply wells.

Guaje, Pajarito, and Otowi well fields are located in Guaje Canyon and on Pajarito Plateau (Fig. 1). The supply wells are all completed into the regional aquifer located below the Los Alamos area. This is the only local aquifer capable of municipal and industrial water supply. The piezometric surface for the regional aquifer ranges from about 20 ft above ground level (artesian) in portions of the old well field in lower Los Alamos Canyon (i.e., near Los Alamos Well 1B [LA-1B]), to about 753 ft below ground surface along the eastern edge of the plateau near Pajarito Mesa Well 1 (PM-1), and to more than 1,230 ft below ground surface near the center of the plateau at PM-5. Water in the regional aquifer generally moves eastward to southeastward beneath the plateau toward the Rio Grande, where at least a portion is discharged into the river through seeps and springs [26, 28–30]. Most of these seeps and springs are located adjacent to the western side of the Rio Grande between Otowi Bridge and Frijoles Canyon above Cochiti Reservoir.

The Water Canyon Gallery, which is located west of the Laboratory on the eastern flanks of the Sierra de los Valles, discharges water from a small, shallow, perched aquifer located in the volcanic rocks (Fig. 1). Both Guaje and Los Alamos Reservoirs are man-made. These reservoirs are located on the eastern flanks of the Sierra de los Valles to the northwest and west of Los Alamos (Fig. 1). They are replenished by rainfall and snowmelt runoff and by shallow ephemeral spring flows.

II. WELL FIELD CHARACTERISTICS

Total water production from the three well fields decreased about 82.2 million gallons from 1,368.1 million gallons in 1996 to about 1,285.9 million gallons in 1997 (Table 1). The months of heaviest production in 1997 were June, July, and August. The production during these months was 451.7 million gallons, a decrease of 60.6 million gallons from a similar period of heavy production in 1996. The months of lightest production were January, February, and November with a production of 230.9 million gallons, a decrease of 1.5 million gallons from a similar period in 1996.

The difference in demand between periods of heavy and light production (i.e., summer and winter demands) is mainly due to water usage for landscape irrigation. Nonpumping water levels in the wells respond accordingly, with the highest water levels observed during months of least production and the lowest water levels occurring during months of greatest production. The 1997 growing season, which required irrigation, occurred from May through October. About 58% (749.2 million gallons) of the total water (1,285.9 million gallons) used was during this time. The annual and monthly variation in water usage, however, was not correlated with annual or monthly precipitation.

Table 1. Potable Water Production from Wells and Gallery: 1947–1997 (in millions of gallons)

Year	Los Alamos Field	Guaje Field	Pajarito Field	Otowi Field	Water Canyon Gallery[a]	Annual Total
1947	147	0	0	0	84	231
1948	264	0	0	0	97	361
1949	302	0	0	0	92	394
1950	547	3	0	0	54	604
1951	702	68	0	0	39	809
1952	448	350	0	0	48	846
1953	444	372	0	0	39	855
1954	380	374	0	0	40	794
1955	407	375	0	0	33	815
1956	437	506	0	0	23	966
1957	350	378	0	0	40	768
1958	372	395	0	0	60	827
1959	391	478	0	0	54	923
1960	530	533	0	0	48	1,111
1961	546	624	0	0	54	1,224
1962	577	597	0	0	67	1,241
1963	539	654	0	0	51	1,244
1964	627	665	0	0	45	1,337
1965	447	571	99	0	72	1,189
1966	450	613	127	0	82	1,272
1967	373	464	481	0	56	1,374
1968	345	474	584	0	65	1,468
1969	331	435	569	0	80	1,415
1970	360	423	595	0	65	1,443
1971	412	484	657	0	37	1,590
1972	380	467	662	0	40	1,549
1973	406	475	685	0	49	1,615
1974	369	453	802	0	35	1,659
1975	356	431	749	0	42	1,578
1976	343	531	817	0	41	1,732
1977	345	515	614	0	57	1,531
1978	302	444	690	0	45	1,481
1979	289	456	662	0	44	1,451
1980	339	485	743	0	32	1,599
1981	336	469	701	0	45	1,551
1982	317	422	773	0	46	1,558
1983	221	338	904	0	38	1,501
1984	326	460	780	0	34	1,600
1985	290	456	841	0	37	1,624
1986	179	460	858	0	28	1,525
1987	217	485	892	0	34	1,628
1988	158	477	824	0	0	1,459
1989	219	506	961	0	0	1,686
1990	187	532	923	0	0	1,642
1991	125	502	820	0	0	1,447
1992	13	472	1,044	0	0	1,529
1993	0	298	876	284	0	1,458
1994	0	179	1,042	206	0	1,427
1995	0	230	1,126	0	0	1,356
1996	0	269	889	210	0	1,368
1997	0	272	798	216	0	1,286
Total	16,445	20,920	24,588	916	2,072	64,941

[a]Water Canyon Gallery not used as potable water supply after 1987; see nonpotable production, Table 7.

Peak-demand periods generally occur in the late spring or early summer between mid-June and mid-July. For the past 10 years (1988–1997), these periods have ranged from 6 to 34 days in length (Table 2). The average daily production during these peak-demand periods has varied from 6.7 million gallons per day (mgpd) to 9.0 mgpd. In 1997, the peak-demand period occurred in July. This period encompassed a 21-day interval from July 1 through July 21 with a total production of 140.3 million gallons (Table 2). The average daily pumpage during this period was 6.7 mgpd as compared with 7.5 mgpd in 1996. This peak demand period resulted from lawn irrigation due to a typically dry spring and early summer. Municipal supply wells were heavily pumped during this period to keep storage tanks filled to capacity for local fire protection.

The annual production and use of water at the Laboratory and in the community increased from about 231 million gallons in 1947, to 1,732 million gallons in 1976. Water usage in 1977 declined to about 1,531 million gallons. Since then, the annual usage has ranged from about 1,286 million gallons in 1997, to about 1,686 million gallons in 1989 (Fig. 2). The 1976 maximum has not been approached in recent years.

Over the past twenty years, the long-term water use pattern reflects a gradual decline in per-capita water use by Los Alamos County and by the Laboratory. Per-capita use in 1997 has declined to about 49,250 gallons per year (135 gpd/person) since 1980, after reaching a peak of about 74,100 gallons per year (203 gpd/person) in 1974. Some of this decline may be related to the cost of water, which has increased by a factor of about 10 in the last 20 years. Since 1979, Laboratory use has averaged about 455 million gallons per year (mgpy) (1.25 mgpd), or approximately 30% of total annual water production. The estimated annual residential water consumption from 1979 through 1997 in Los Alamos County is summarized in Table 3.

A projection of future water use is plotted along with observed total water production in Fig. 2. This projection is an extrapolation of a least-squares linear regression curve fit of water production versus time, using the 21-year interval from 1977 through 1997. This trend line shows a slight decline of about 8.01 mgpy (21,945 gpd). Annual production is separately plotted for the four well fields to show a comparison of the distribution of production (Fig. 2). The production from any individual well field peaks as another well field is brought on-line. For example, the production from the Los Alamos well field peaked in 1951 as the Guaje well field became operational. Similarly, the production from the Guaje well field peaked in 1964 as the Pajarito well field was phased into use. The last year of municipal supply from the Los Alamos well field occurred in 1991. As a result, the loss of production from the Los Alamos well field has been offset by an increase in production from the Pajarito well field. This expansion of well fields is necessary as older wells deteriorate with age and their production rates decrease. New wells must be added to the system to keep up with demand.

Table 2. Peak-Demand Periods for the Years 1988–1997 (pumpage in millions of gallons)

Start Date **End Date** **Year**	**6/18** **6/26** **1988**	**6/18** **7/11** **1989**	**5/31** **7/3** **1990**	**6/24** **6/29** **1991**	**7/1** **7/9** **1992**	**6/25** **7/12** **1993**	**7/1** **7/18** **1994**	**7/8** **7/14** **1995**	**5/11** **5/23** **1996**	**7/1** **7/21** **1997**
Total No. of Days	9	24	34	6	9	18	18	7	13	21
Total Pumpage	63.0	216.0	296.8	45.8	73.9	145.8	140.4	49.3	97.8	140.3
Average Daily Pumpage	7.0	9.0	8.7	7.6	8.2	8.1	7.8	7.1	7.5	6.7
No. of Days When Pumpage Was										
$>10 \times 10^6$ gal.	0	4	8	0	0	0	0	0	0	0
$>9 \times 10^6$ gal.	0	9	13	0	2	2	0	0	0	0
$>8 \times 10^6$ gal.	2	10	3	4	3	12	8	1	3	0
$>7 \times 10^6$ gal.	3	0	4	0	4	2	9	2	8	8
$<7 \times 10^6$ gal.	4	1	6	2	0	2	1	4	2	13

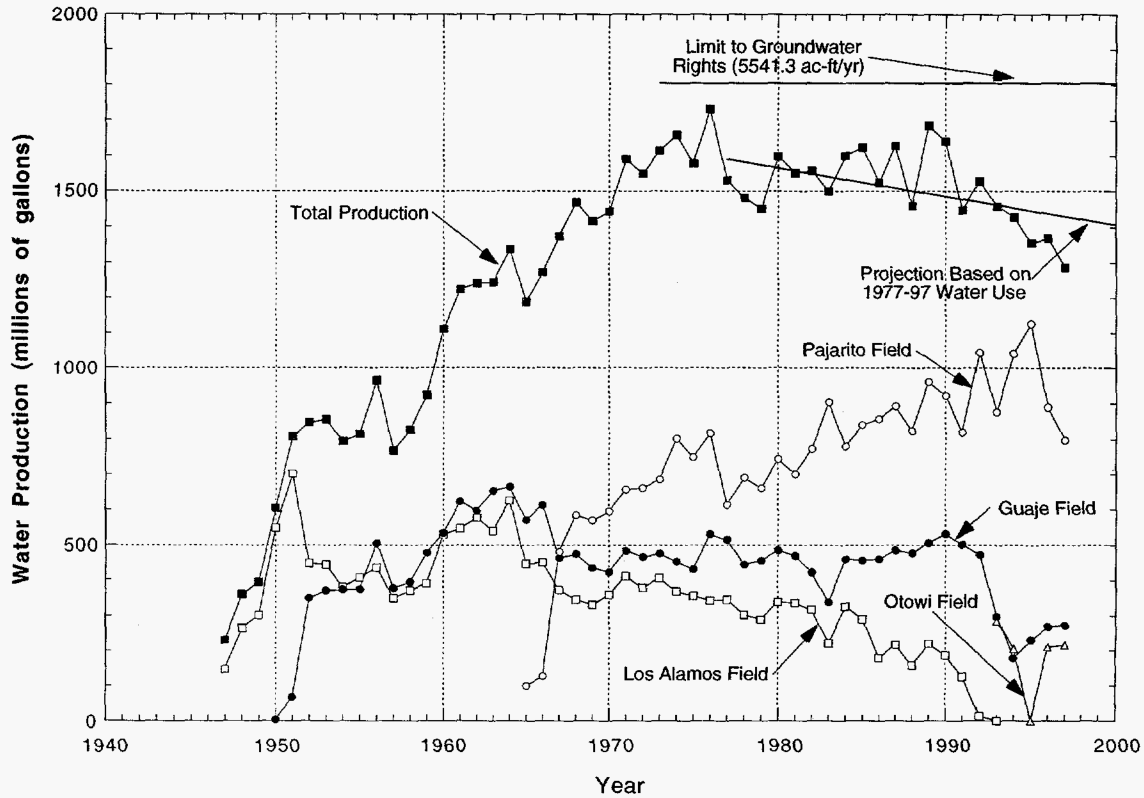

Fig. 2. Water production and usage from 1947 to 1997, along with projected water demands.

The present annual aquifer water yields reflect the distribution of production among the various well fields, routine cyclical pumping operations, and occasional shutdowns for pump maintenance. In addition, Guaje Well 3 (G-3) was nonoperational during all of 1997, while G-1 and G-4 were on-line only part of the year. A new submersible pump was installed in Otowi Well 1 (O-1), and the well entered routine service as a water supply well during the spring of 1997. During 1997, about 21% of total water production came from the Guaje well field, about 62% from the Pajarito well field, and 17% from the Otowi well field. In 1996 the percentage of production was about 20% from the Guaje well field, 65% from the Pajarito well field, and 15% from the Otowi well field (Table 4).

A. Guaje Well Field

The Guaje well field consists of seven wells ranging in depths from 1,500 to 2,000 ft. Wells G-1, G-2, G-3, G-4, and G-5 were completed in 1950. Well G-1A was completed in 1954, and G-6 was placed in service in 1964. Almost all of the 1997 Guaje well field production came from only four of these wells (G-1A, G-2, G-5, and G-6). Attempted rehabilitation of G-3 in 1986 damaged the casing beyond repair and the well was permanently taken out of production. Hence no water levels have been collected from G-3 since 1986. Wells G-1 and G-4 were pumped sparingly during 1997, and nonpumping water levels were reported for only five months in these wells. Well G-5 was heavily pumped during 1997, but no water level records are available. Because of deteriorating well casings, screens, and gravel packs, most individual water yields in the Guaje well field have declined to the point where it is not economically feasible to routinely pump them. Except for G-1A, the entire well field is scheduled to be replaced with four new production wells by the end of 1998. Well G-1A will be retained for additional water production capacity for emergency fire protection. As these new wells are completed and enter routine water production, the older wells will be plugged and abandoned in accordance with New Mexico State Engineer Office regulations.

Table 3. Estimated Residential Water Consumption in Los Alamos County

Year	Los Alamos County Population[a] (people)	Total Annual Water Use (mgpy)	LANL Water Use (estimated)[b] (mgpy)	Residential Water Consumption (gpd/person)
1979	17,500	1,451	435	159
1980	17,599	1,599	480	174
1981	17,555	1,551	465	169
1982	17,795	1,558	467	168
1983	17,492	1,501	450	165
1984	17,817	1,600	480	172
1985	17,928	1,624	487	174
1986	18,066	1,525	458	162
1987	18,120	1,628	488	172
1988	18,097	1,459	438	155
1989	18,112	1,686	506	179
1990	18,134	1,642	493	174
1991	18,017	1,447	434	154
1992	18,047	1,529	459	162
1993	18,322	1,458	437	153
1994	18,487	1,427	428	148
1995	18,605	1,356	407	140
1996	18,209	1,368	410	144
1997	18,275	1,286	386	135

[a]U.S. Bureau of the Census, 1998. Also see http://www.unm.edu/~bber/demo/cntypop.htm.
[b]Estimated Laboratory water use is about 30% of total annual water production.

The total production from the Guaje well field increased about 2 million gallons from 269.6 million gallons in 1996 to 272.0 million gallons in 1997. The well field contributed about 21% of the total production in 1997 (Table 4). The total well field pumping rate increased to 1,878 gallons per minute (gpm) in 1997 from 1,866 gpm in 1996 because G-4 was used for several months during the year (Table 5). However, a comparison of average annual pumping rates for individual wells in the Guaje field continues to reflect long-term declining yields of this aging well field. There were no significant changes in the specific capacities of individual pumped wells in 1997 compared with the previous year.

A comparison of the average nonpumping water levels in G-4 indicates slightly lower levels in 1997 compared with 1996, while G-1, G-1A, G-2, and G-6 showed about the same water levels (Table 6). These water level changes are due to changes in total pumped volume from individual wells in the field during 1997 compared with the previous year. Such changes are normal and indicate some decline in response to increases in pumped volumes (Fig. 3 and Table 6).

B. Pajarito Well Field

The Pajarito well field consists of five wells. The wells were completed over an 18-year period, from 1965 through 1982, and range in depths from 2,300 to 3,100 ft. Because they are located on Pajarito Plateau, the depths to water range from about 753 ft at PM-1 to more than 1,250 ft at PM-5. In late 1995 the pump assembly in PM-2 was reset approximately 60 ft lower, at a depth of 1,060 ft below the top of the surface casing. During this operation the water level measuring device was broken. Hence no water level records were collected during 1997. This water level recording device should be repaired or replaced as soon as possible.

Table 4. Well Production Characteristics for 1996 and 1997

	Production					
	Amount (10^6 gal.)		Well Field (%)		Total Production (%)	
	1996	1997	1996	1997	1996	1997
Guaje Field						
Well G-1	12.9	13.6	5	5	1	1
Well G-1A	71.3	71.5	26	26	5	6
Well G-2	75.3	80.5	28	30	6	6
Well G-3	0.0	0.0	0	0	0	0
Well G-4	7.2	5.4	3	2	<1	<1
Well G-5	66.9	81.5	25	30	5	6
Well G-6	36.0	19.5	13	7	3	<1
Subtotal	269.6	272.0	100	100	20	21
Pajarito Field						
Well PM-1	36.3	47.7	4	6	3	4
Well PM-2	302.2	162.9	34	20	22	13
Well PM-3	118.5	80.6	13	10	9	6
Well PM-4	207.4	414.5	24	52	15	32
Well PM-5	224.6	91.8	25	12	16	7
Subtotal	889.0	797.5	100	100	65	62
Otowi Field						
Well O-1	0.0	0.0	0	0	0	0
Well O-4	209.6	216.4	100	100	15	17
Subtotal	209.6	216.4	0.0	100	15	17
Total Potable	1,368.1	1,285.9	—	—	100	100
Water C. Gallery	0.0	0.0	0	0	0	0
Guaje Reservoir	0.0	0.0	0	0	0	0
Los Alamos Res.	2.6	2.4	100	100	<1	<1
Total Nonpotable	2.6	2.4	100	100	<1	<1
Total Production from Permitted Sources	1,370.7	1,288.3	—	—	100	100

The 1997 production from the Pajarito well field was about 797.5 million gallons, a decrease of 91.5 million gallons from the 889.0 million gallons produced in 1996 (Table 4). The field contributed about 62% of the total 1997 production. The production from PM-4 represented about 32% of the total water produced at Los Alamos in 1997 (Table 4).

The average pumping rates of the Pajarito wells ranged from 560 to 1,398 gpm (Table 5). Four of the wells (PM-2, PM-3, PM-4, and PM-5) are high-yield wells with pumping rates over 1,000 gpm (Table 5). The pumping rates from the individual wells varied only slightly from 1996 to 1997. There were no significant changes in the specific capacities of the wells from 1996 to 1997 in wells where data were available (Table 5).

The water levels in these wells fluctuated as would be expected from the amount of pumpage (Fig. 4). However where data are available, there were no significant changes in nonpumping and pumping water levels in 1997 compared with 1996.

Table 5. Average Pumping Rate and Specific Capacity, 1996 and 1997

	Average Pumping Rate (gpm)		Average Specific Capacity (gpm/ft of drawdown)	
	1996	1997	1996	1997
Guaje Field				
Well G-1	191	191	1.1	1.1
Well G-1A	417	416	13.0	13.4
Well G-2	417	420	16.0	16.2
Well G-3	0[a]	0[a]	0.0	0.0
Well G-4	166	174	0.8	0.9
Well G-5	415	419	—	—
Well G-6	260	258	3.3	3.4
Total for Field	1,866	1,878		
Pajarito Field				
Well PM-1	560	560	24.3	23.3
Well PM-2	1,252	1,260	—	—
Well PM-3	1,410	1,398	54.2	53.8
Well PM-4	1,270	1,323	26.5	27.0
Well PM-5	1,257	1,213	13.5	13.8
Total for Field	5,749	5,754		
Otowi Field				
Well O-1	0[a]	0[a]	—	—
Well O-4	1,499	1,505	—	—
Total for Field	1,499	1,505		

[a]Well not in service during all or part of year.

C. Otowi Well Field

The Otowi well field consists of two wells that were completed in 1990. Well O-1 was completed at a depth of 2,497 ft and showed a regional aquifer static depth-to-water reading at about 695 ft. Well O-4 was completed at a depth of 2,585 ft and showed a static depth-to-water level at 790 ft.

Well O-1 was operational in 1997 but contributed no water production to the system during the year. However, this well should enter routine service in 1998. Well O-4 pumped a total of 216.4 million gallons during 1997. The Otowi well field volume was about 17% of the combined water demand for the year. The average annual pumping rate in 1997 was 1,505 gpm. There is no functioning transducer line in O-4, so water level readings cannot be made.

III. WATER CANYON GALLERY AND GUAJE AND LOS ALAMOS RESERVOIRS

Water Canyon Gallery was a source of potable water from the early days of the Manhattan Project until 1988 (Table 1). However, seasonal recharge to the gallery caused heavy sediment loads to enter the water supply system. In order to keep these sediments out of the distribution system, the use of the gallery as a potable supply was discontinued in 1988. Since then, water from the gallery has been occasionally used as a nonpotable supply for the steam plant at TA-16.

Table 6. Average Depth to Water in Wells during Nonpumping and Pumping Periods and Average Drawdowns, 1996 and 1997

	Average Depth to Water					
	Nonpumping (ft)		Pumping (ft)		Drawdown (ft)	
	1996	1997	1996	1997	1996	1997
Guaje Field						
Well G-1	274	274	449	454	175	180
Well G-1A	310	309	342	340	32	31
Well G-2	364	358	390	384	26	26
Well G-3	—	—	—	—	—	—
Well G-4	374	375	570	560	196	185
Well G-5	—	—	—	—	—	—
Well G-6	581	581	661	658	80	77
Pajarito Field						
Well PM-1	755	760	778	784	23	24
Well PM-2	—	—	—	—	—	—
Well PM-3	776	779	802	805	26	26
Well PM-4	1,091	1,093	1,139	1,142	48	49
Well PM-5	1,258	1,254	1,351	1,342	93	88
Otowi Field						
Well O-1	675	676	—	—	—	—
Well O-4	—	—	—	—	—	—

The spring gallery in Water Canyon is dug about 30 ft into the Bandelier Tuff. The gallery, or tunnel, is framed with timbers and sheet metal to keep the walls and overhead from collapsing. The floor of the gallery is constructed to form a basin to collect the spring flow. About one mile of water line connects the gallery to the power plant at TA-16 (S-Site). The water line is not part of the potable system.

The water occurs in the fractures of a welded tuff, which is underlain by a nonwelded tuff (the fractures in the welded tuff contain the water which is perched on the nonwelded tuff). The gallery furnished no water to the power plant during 1997. Instead the entire discharge was released back into the environment. For the period 1947–1988, the annual potable use is shown in Table 1, while the nonpotable use is shown in Table 7.

Water from Guaje and Los Alamos Reservoirs was used for municipal and industrial water supply at Los Alamos during the early days of the Manhattan Project. Use of the reservoirs for potable water supply was discontinued in 1959 because of intermittent periods of turbidity caused by summer thunderstorm runoff. In addition, there were difficulties in maintaining bacteriological levels below allowable limits for a municipal water supply system because of excessive turbidity.

Today the water from the reservoirs is available for irrigation of lawns and shrubs in the community and at the Laboratory. Parts of the water lines are above ground and are subject to freezing; thus, water use from the reservoirs is limited to the period from late spring to early fall. During 1997 about 2.4 million gallons of water was diverted from Los Alamos Reservoir for lawn irrigation; no water was diverted from Guaje Reservoir for any purpose. The age of the distribution system and need for rehabilitation, along with operation costs, may cause the Laboratory to eventually abandon the irrigation system since it is not economically feasible to operate. The total diverted production from the Guaje and Los Alamos Reservoirs for the period of record is shown in Table 7.

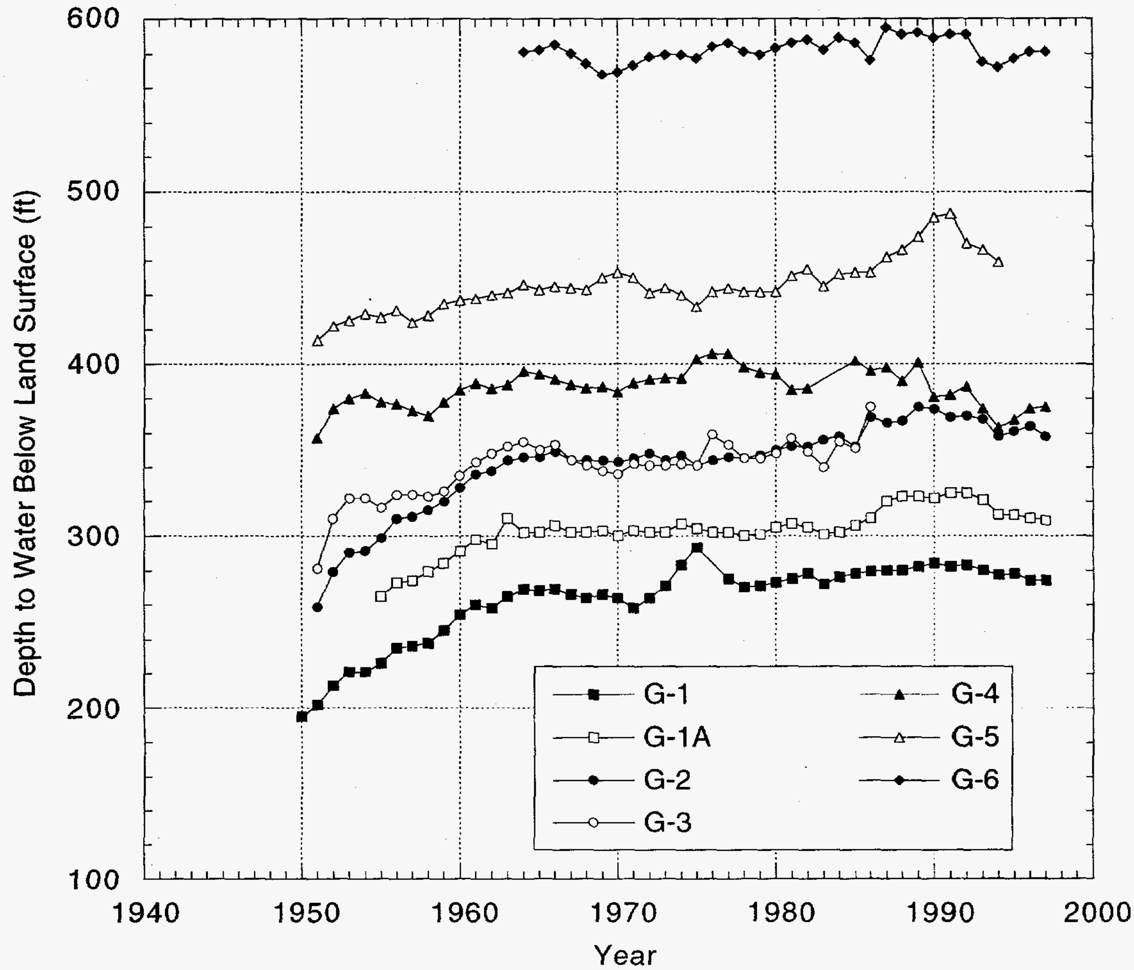

Fig. 3. Nonpumping water levels in wells from the Guaje well field.

IV. LONG-TERM WATER LEVEL TRENDS

Water levels have been measured in wells tapping the regional aquifer since the late 1940s when the first exploratory wells were drilled by the U.S. Geological Survey (USGS). These data have been documented in various reports over the years. They are summarized here in Appendices A and B. Appendix A lists all historical water production and aquifer characteristics data for active wells. Appendix B summarizes all historical water level data collected from regional aquifer test (observation) wells. This portion of the water supply report compiles all available water level data for the regional aquifer and summarizes the changes in graphic form.

The annual summary data on each water supply well has been documented since 1971 in this series of water supply reports. There is one table in Appendix A for each of the wells used as a water supply well at Los Alamos. Each table includes annual average information on the water levels obtained from both nonpumping and pumping conditions. Notes on each table provide information about the water level at the time of completion of the well. Data from the now-abandoned Los Alamos well field are reported elsewhere [26].

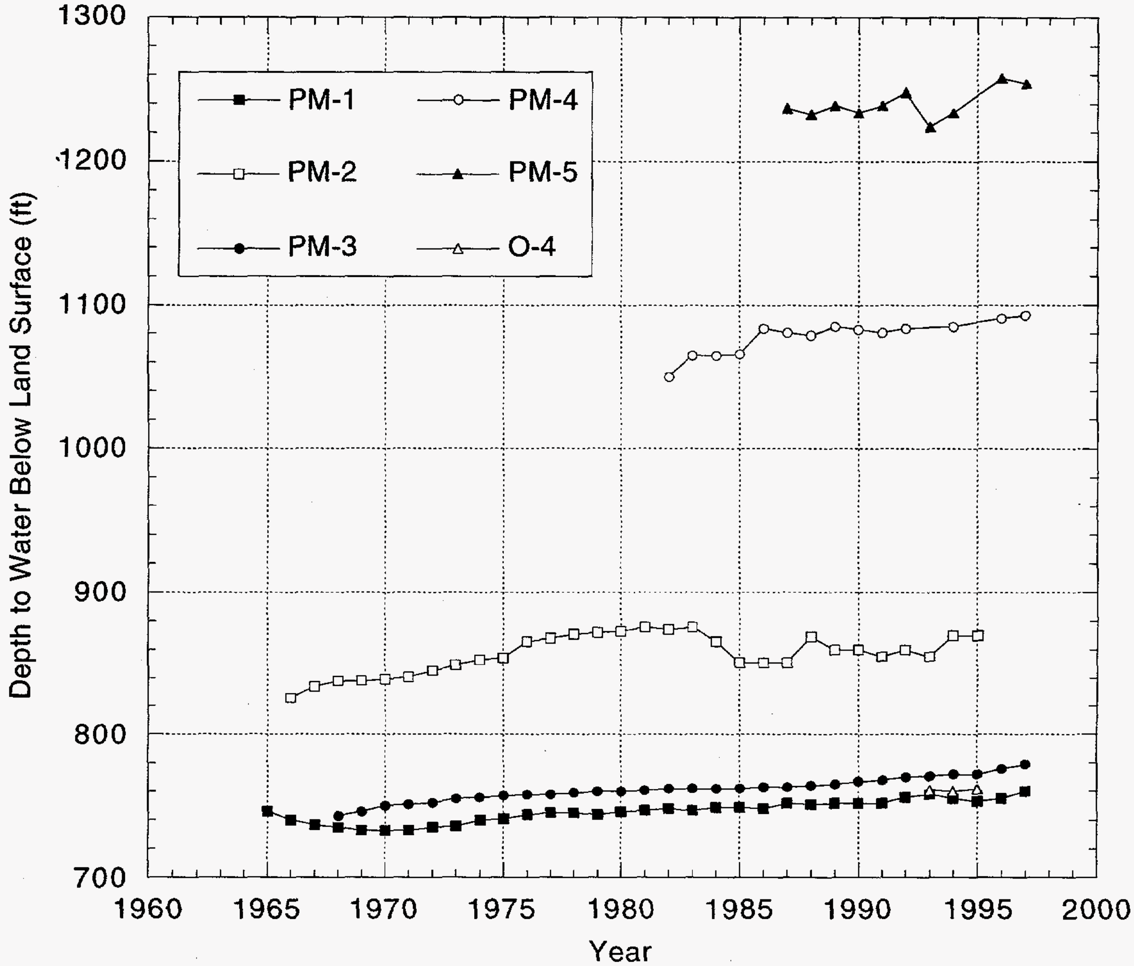

Fig. 4. Nonpumping water levels in wells from the Pajarito and Otowi well fields.

One additional table summarizes the data for the test wells reaching the regional aquifer (see Appendix B). This table includes completion information, initial static water levels, and annual average water levels in regional aquifer test wells. The test well water level data were compiled from the original records in the files of the Water Quality and Hydrology Group. Some of the data in the table represent averages when more than one measurement was made during a given year. Since 1992, the Water Quality and Hydrology Group has conducted a program designed to equip and maintain each test well with an automatic water level recording device. The data from this program are briefly summarized in Appendix B. A more comprehensive data listing will be available on the World Wide Web at http://www.drambuie.lanl.gov/~esh18/teams/hydrology/Welldata.htm or by following these links from http://www.lanl.gov: Organization; Environment, Safety, and Health Division (ESH); Groups; ESH-18 Water Quality and Hydrology; Water Level Data. Website data are periodically updated; in addition, the website data may be downloaded in text format by the user.

A summary of the water level changes since the late 1940s is presented in several graphs (Figs. 5–7). For the most part, these figures are self-explanatory. Nonpumping water level data are presented for Guaje (Fig. 5), Pajarito (Fig. 6), and Otowi (Fig. 6) water supply well fields. Trends in the regional aquifer test wells are depicted in a separate graph (Fig. 7). Collectively, all of these individual trends reflect a plateau-wide decline in regional aquifer water levels in response to municipal water production. This decline is gradual and does not appear to exceed 1 to 2 ft/yr for most production wells. When production wells are taken off-line for pump replacement or repair, nonpumping water levels typically return to initial static levels within 6 to 12 months. Hence, these long-term declines are not currently viewed as a regional threat to the municipal water supply system. However, continued monitoring of regional aquifer water levels in both production and test wells is highly recommended.

Table 7. Production from Water Canyon Gallery and Guaje and Los Alamos Reservoirs

Year	Water Canyon Gallery[a] (10^6 gal.)	Guaje Reservoir[b] (10^6 gal.)	Los Alamos Reservoir (10^6 gal.)
Production for Municipal Water-Supply			
1947		87.8	21.7
1948		119.8	21.9
1949		116.1	14.7
1950		79.9	20.6
1951		41.0	10.5
1952		131.0	33.6
1953		58.0	14.8
1954		66.0	16.9
1955		71.0	18.1
1956		24.0	4.8
1957		213.0	54.8
1958		193.0	49.4
Production for Irrigation (Nonpotable Water)			
1972		5.8	0.0
1973		9.7	0.0
1974		4.9	0.0
1975		5.3	0.0
1976		4.4	0.0
1977		4.1	0.0
1978		2.8	0.0
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
1985		2.8	0.9
1986		2.4	1.5
1987		2.8	3.2
1988	0.0	2.4	1.4
1989	0.0	4.6	3.3
1990	9.3	2.2	4.6
1991	12.0	1.5	2.4
1992	0.1	0.0	0.0
1993	6.4	0.0	0.5
1994	11.6	0.0	0.0
1995	1.6	0.0	1.6
1996	0.0	0.0	2.6
1997	0.0	0.0	2.4

[a] Water Canyon Gallery used as a municipal supply 1947–1987 (see Table 1) and as an industrial supply 1988–1997.
[b] Production from Guaje Reservoir is estimated for 1951–1958.

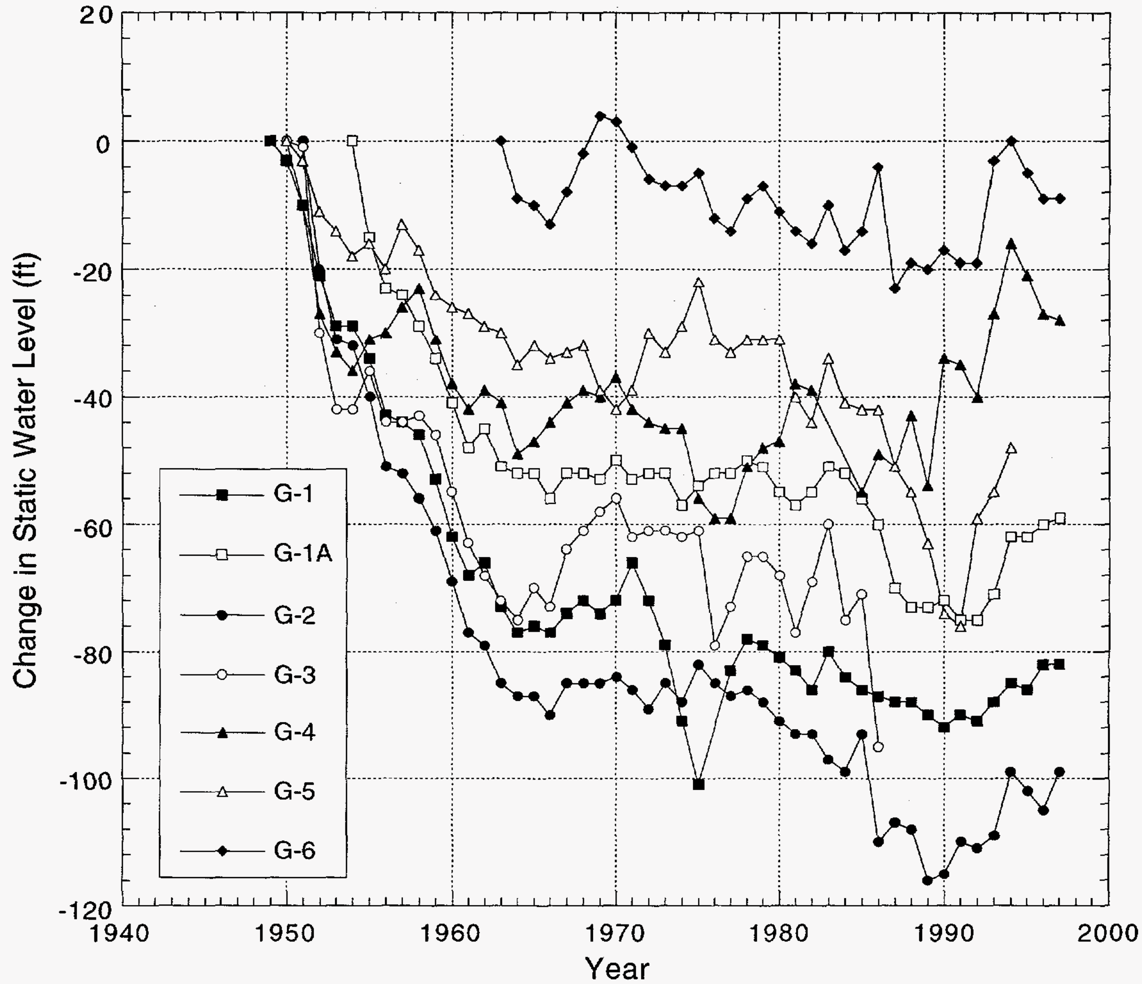

Fig. 5. Change from initial static water levels in wells from the Guaje well field.

The levels in the Los Alamos well field (see Fig. 5 in [27]) generally ranged from about 40 to 140 ft below initial levels until 1992 when the well field was taken out of production. Since then, levels have trended back toward conditions similar to those recorded at the time the wells were first drilled. The easternmost wells, which were artesian at completion, have regained much of their original artesian water levels. Furthermore, local springs near LA-1B have begun to flow again. Well LA-1B, with an installed mechanical packer and recording pressure transducer, has again become artesian. This well currently shows a packed-off water level that has an equivalent hydraulic head that is about 20 ft above ground surface (i.e., the wellhead shows a shut-in pressure of about 8.7 psig). In other words, if the packer were removed, then the well would naturally flow water at the surface even though the pump has been removed.

The levels in the Guaje field (Fig. 5) have ranged from almost no decline to about 120 ft of decline since 1950. In this field the westernmost wells show the least decline overall and have recovered significantly in recent years with somewhat lower production. Wells G-4 and G-6 recovered significantly in 1997, since they were not heavily pumped.

Wells in the Pajarito and Otowi well fields (Fig. 6) have always been the best producers, with generally much higher specific capacities. As expected, they show the least declines in water levels. Since 1990 these declines have varied between about 20 and 50 ft.

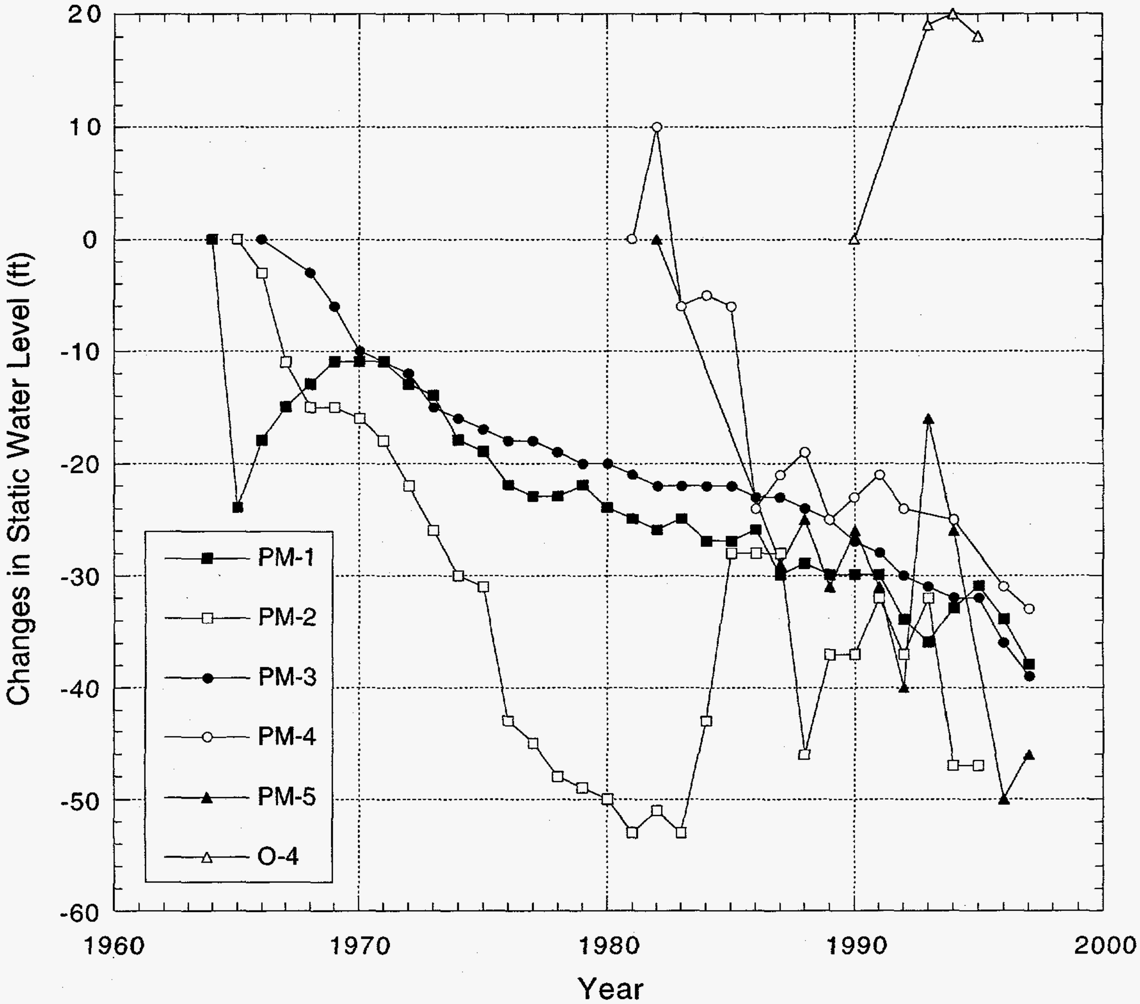

Fig. 6. Change from initial static water levels in wells from the Pajarito and Otowi well fields.

The test wells penetrating to the regional aquifer show declines ranging from less than 10 to about 40 ft over the 49-year period of record (Fig. 7). They fall into geographic groups. The westernmost well, TW-4, shows less than 10 ft of change. The southernmost group of wells, DT-5A, DT-9, and DT-10, all located within TA-49, show a decline of about 7 to 14 ft since 1960. The one well in the central part of the plateau, TW-8, shows a decline of about 27 ft and is within the range of declines shown by the Pajarito supply wells. The north-central wells, TW-2 and TW-3, both show about 40 ft of decline over the 49-year period of record. It is important to note that these declines in test well water levels are gradual and have not been observed during intensive short-term pump testing of production wells [20–23].

Only one test well (TW-1) has shown an increase in recent water levels after many years of no measurements (see Appendix B). Hence, water level data from TW-1 were not included in Fig. 7. The anomalous behavior of water level and water quality data in this well has been related to seasonal infiltration of streamflow in Pueblo Canyon. Water occurs seasonally in the shallow alluvium of this reach of Pueblo Canyon caused by seasonal variations in snowmelt and thunderstorm runoff and by sanitary discharges from the Los Alamos County Bayo Sewage Treatment Plant. This sewage effluent enters the Pueblo Canyon watercourse approximately 1.6 miles upstream of TW-1. Tritium, nitrate, and chloride contained in natural runoff, industrial releases, and municipal sewage effluent discharges have infiltrated into the shallow alluvium adjacent to the Pueblo Canyon watercourse. In addition, an intermediate perched aquifer, located at depths of 120 to 190 ft below ground surface at TW-1A, and the regional aquifer, located approximately 590 ft below ground surface at TW-1, show these same elevated contaminants in groundwater samples.

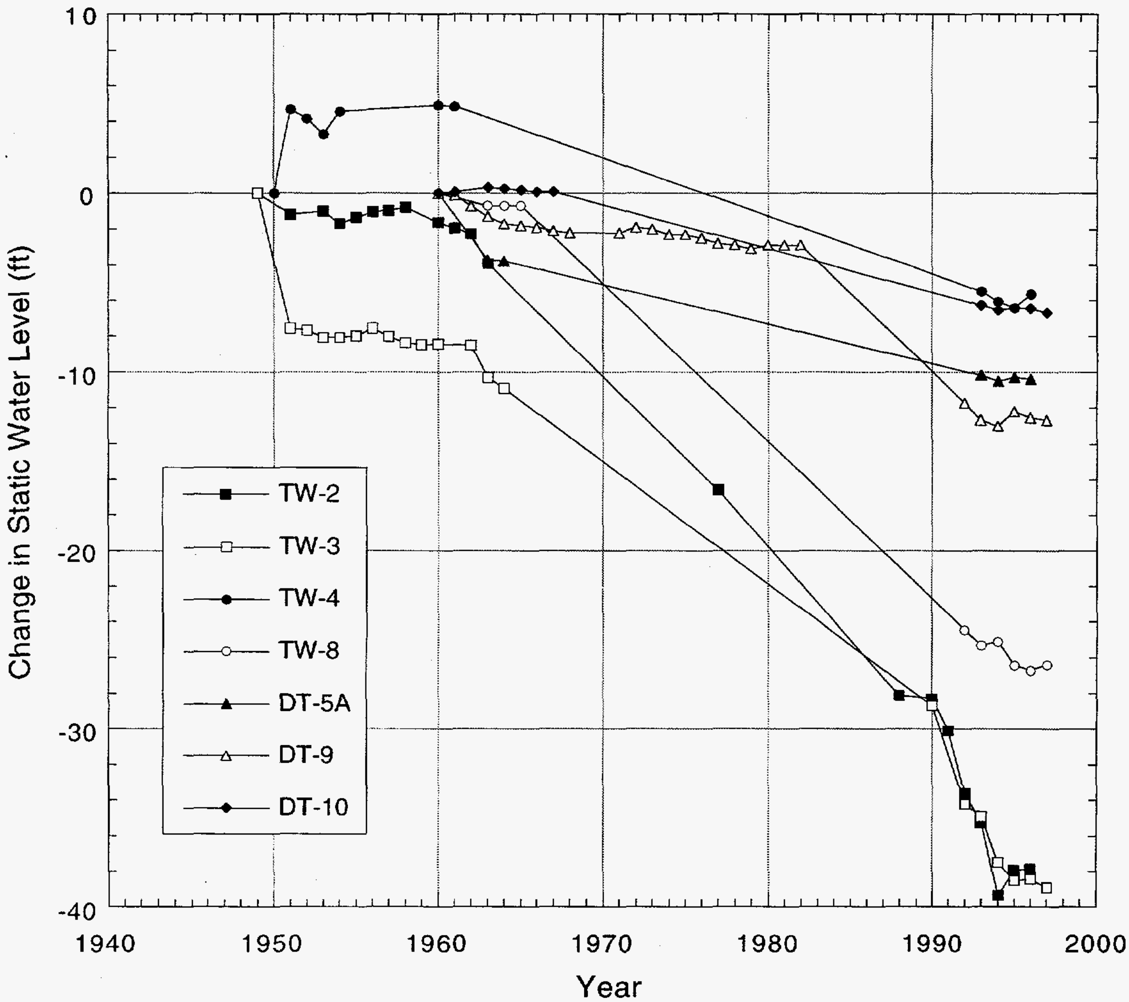

Fig. 7. Change from initial static water levels in regional aquifer test wells.

Water level fluctuations in TW-1 and TW-1A have also been correlated to seasonal water levels in shallow alluvial wells [33]. Historical water quality data documenting the hydraulic and geochemical intercommunication between Pueblo Canyon surface waters and groundwaters can be found in recent environmental surveillance reports [31, 32]. Groundwater samples collected from the municipal water supply well O-1, located approximately 1,000 ft west of TW-1, do not show elevated levels for these same contaminants because this well produces water from much lower in the regional aquifer. In addition, this well contains a protective wellhead surface conductor casing embedded in cement from the surface down to 664 ft. Finally, the production casing runs from the surface down to 1,017 ft, and the water intake screen is located between 1,017 and 2,477 ft below ground surface [21]. Thus, water from the regional aquifer enters O-1 between the depths of 1,017 and 2,477 ft below ground surface.

V. QUALITY OF WATER

The Laboratory conducts two separate programs to monitor the quality of both surface water and groundwater in the area and to meet multiple federal and state regulatory requirements. The first program, under the Laboratory's long-term environmental surveillance program, includes monitoring the quality of water from the supply wells, test wells, numerous springs, the gallery in Water Canyon, surface waters, and reservoirs in Guaje and Los Alamos Canyons. Complete analytical results for this program are reported in a series of annual environmental surveillance reports. The most recent reports [31, 32] contain data for 1996 and 1997, respectively. Standard laboratory procedures were followed in all analyses [34, 35].

Results from analyses of water samples from regional aquifer production and test wells are summarized here in Tables 8–10. The general inorganic chemical analyses are contained in Table 8, while total recoverable trace metals are summarized in Table 9. Radionuclide analyses are summarized in Table 10. All of these unfiltered samples were analyzed by the Laboratory's Chemical Science and Technology (CST) analytical laboratory. For comparison, the water quality standards issued by the U.S. Environmental Protection Agency (EPA) and the New Mexico Water Quality Control Commission (NMWQCC) are also listed. Overall, these results indicate that the regional aquifer below Pajarito Plateau is generally of very high quality and meets or exceeds all applicable water quality standards. Figures 8–10 depict the Piper plots of major ion water quality from each production well that is used for municipal water supply. These Piper plots reveal that waters from the Pajarito well field (Fig. 8) are predominately a calcium and sodium bicarbonate type. In addition, the bicarbonate analysis for PM-1 in 1997 is apparently in error because historical water quality data from PM-1 suggest bicarbonate values similar to those of other wells in this well field. The Piper plot (Fig. 9) for waters from the western margin of the Guaje well field (i.e., G-4, G-5, and G-6) shows that these waters resemble those from the Pajarito well field. However, waters from the eastern portion of the Guaje well field (i.e., G-1, G-1A, and G-2) are primarily a sodium bicarbonate type. Furthermore, the Piper plot (Fig. 10) for waters from the Otowi well field shows that these waters resemble those from the Pajarito well field (i.e., O-4) and the eastern portions of the Guaje well field (i.e., O-1). Finally, the Piper plots for test wells and other water sources (Figs. 10–12) reveal complex similarities (i.e., TW-2, TW-3, TW-4, DT-5A, DT-9, DT-10, LA-5, LA-1B, and Water Canyon Gallery) and differences (i.e., TW-1A, TW-1, TW-2A, and Basalt Spring) in major ion water quality between regional aquifer waters and near-surface water sources. These similarities and differences are undoubtedly related to differences in source strengths of recharge waters or to subsurface interactions between the flowing groundwater and the porous media.

The second program monitors the quality of water in the Laboratory and county distribution systems to ensure compliance with the Safe Drinking Water Act (SDWA). Water samples are collected from the water distribution systems located at the Laboratory, Los Alamos County, and Bandelier National Monument on a routine basis. Furthermore, water samples are also routinely collected at individual wells before the water is chlorinated and pumped into the distribution system. This sampling methodology is designed to monitor the water at both the source and within the distribution system. These samples are analyzed for microbiological organisms, organic and inorganic chemical constituents, and radioactivity in the drinking water. During 1997, more than 500 samples were analyzed for microbiological organisms. All parameters regulated under the SDWA were in compliance with maximum contamination levels (MCLs) established by regulation. Historically, the Los Alamos water system has never incurred a violation for a SDWA-regulated chemical or radiological contaminant. On occasion, however, the water distribution system has yielded samples that have shown the presence of total coliforms or other noncoliform bacteria. On rare occasions, fecal coliforms have been historically detected. Furthermore, the water supply wells have, on occasion, exceeded the proposed SDWA MCLs for arsenic (1997 MCL of 50 ppb; proposed MCL of 5 ppb) and radon (1997 MCL of 1,000 pCi/l; proposed MCL of 300 pCi/l). Both of these constituents are naturally occurring in regional aquifer waters below Pajarito Plateau. Detailed results of this program are documented in the report, "Environmental Surveillance at Los Alamos during 1997" [32].

Complete chemical and radiochemical analyses, along with an interpretation of data related to the chemical quality in individual wells in the Los Alamos, Guaje, Pajarito, and Otowi well fields and in Water Canyon Gallery and Guaje and Los Alamos Reservoirs were presented in the report, "Water Supply at Los Alamos during 1991" [22].

VI. SUMMARY

Operation of wells and well fields in 1997 was satisfactory. Pumpage declined below 1.3 billion gallons for the first time since 1966. Water level trends in the wells were as expected under the current amount of annual pumpage. Since the Los Alamos well field was abandoned in 1992, however, there are fewer wells that supply a larger percentage of the total water production for the system. Hence, efforts must be made to keep each of these high-yield wells on-line. The water quality of these existing wells continues to reflect the generally excellent water quality in the regional aquifer below Pajarito Plateau. Four new replacement wells in Guaje Canyon were drilled and cased during the period from October 1997 to March 1998.

Table 8. Chemical Quality of Groundwater (unfiltered) in 1997 (mg/l)

Station Name	Date	Code[a]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN[b]	TDS[c]	TSS[d]	Hardness as $CaCO_3$	pH (std)	Conductance (µS/cm)
Test Wells (Regional Aquifer):																				
TW-1	08/11	1	44	43.3	9.0	2.4	15.2	31.8	21.0	<5[e]	110	0.45	<0.02	5.52	<0.01	253		145.1	8.0	405
TW-2	12/11	1	6	7.4	1.9	1.6	20.7	3.8	1.4	<5	89	0.45	0.02	<0.02	<0.01	64	<1	26.2	7.9	139
TW-3	08/11	1	80	14.9	4.8	1.3	10.5	4.6	4.0	<5	84	0.48	<0.02	0.69	<0.01	159		57.0	7.6	173
TW-4	08/11	1	36	9.9	5.4	1.5	9.4	3.6	2.0	<5	72	0.25	<0.02	0.16	<0.01	108		47.0	8.1	144
DT-5A	03/07	1	73	7.2	2.2	1.0	9.8	3.5	3.0	<5	52	0.22	<0.02	0.33	<0.01	130	<1	27.0	7.9	113
DT-5A	03/07	R		7.2	2.2	1.2	9.8	3.6	2.8		53		<0.02	0.34	<0.01	144		27.0		
DT-5A	05/13	1	48	7.0	2.2	<1.0	10.2	4.0	3.0	<5	47	0.24	<0.02	<0.02	<0.01	100	2	26.5	7.9	102
DT-5A	10/16	1	67	6.6	1.9	1.6	8.5	2.7	2.7	<5	59	0.22	<0.02	0.12	0.01	162	<1	24.3	8.0	110
DT-9	05/13	1	72	9.1	2.6	<1.0	10.0	4.1	3.3	<5	56	0.31	0.05	0.37	<0.01	142	1	33.4	8.2	115
DT-9	10/15	1	77	11.8	3.4	<1.0	10.3	2.7	2.7	<5	53	0.29	<0.02	0.37	0.01	175	<1	43.5	7.6	116
DT-10	05/14	1	72	8.6	2.5	<1.0	9.3	4.0	3.0	<5	53	0.31	0.02	0.41	<0.01	108	3	31.4	8.2	115
DT-10	10/16	1	70	11.3	3.5	1.3	11.1	2.7	2.6	<5	64	0.26	<0.02	0.23	0.01	176	<1	42.6	7.4	131
Municipal Water Supply Wells (Regional Aquifer):																				
O-1	01/08	1	38	3.5	0.8	<1.0	63.8	6.0	6.0	5	144	0.35			<0.01	224	17	12.0	8.7	285
O-1	01/08	R	39	3.0	0.3	<1.0	63.9					0.37			<0.01	218	19	9.0		
O-4	06/25	1	97	21.4	8.1	3.8	19.5	8.1	6.2	<5	113	0.30	0.08	0.72	<0.01	190		86.8	7.9	256
PM-1	06/25	1	79	26.3	6.4	3.9	19.7	8.8	9.0	<5	<5	0.23	0.04	0.48	<0.01	280		92.0	1.7	12,000
PM-2	06/25	1	83	9.0	2.7	1.5	9.4	3.4	2.8	<5	49	0.22	0.05	0.32	<0.01	84		33.6	8.0	111
PM-3	06/25	1	92	23.9	7.7	3.6	16.9	7.5	5.9	<5	116	0.34	0.04	0.45	<0.01	138		91.4	8.3	254
PM-4	06/25	1	90	11.4	3.9	2.9	12.5	3.9	3.5	<5	66	0.29	0.06	0.34	<0.01	72		44.5	8.1	143
PM-5	06/25	1	94	11.1	3.6	2.7	12.5	3.6	3.1	<5	61	0.26	0.04	0.35	<0.01	64		42.5	8.1	131
G-1	12/08	1	79	12.5	0.5	2.5	20.9	3.6	4.4	<5	74	0.40	<0.02	0.48	<0.01	136	<1	33.2	7.3	164
G-1A	06/25	1	75	9.9	0.4	2.9	30.8	4.8	5.3	<5	84	0.63	0.04	0.45	<0.01	74		26.5	8.5	188
G-2	06/25	1	76	10.3	0.5	3.0	34.0	4.2	4.9	<5	92	0.81	0.02	0.46	<0.01	150		27.8	8.5	205
G-4	06/25	1	63	18.2	3.7	2.3	11.5	4.2	4.4	<5	76	0.28	<0.02	0.63	<0.01	84		60.7	8.3	168
G-5	06/25	1	63	17.2	3.7	2.9	11.3	4.2	4.5	<5	75	0.31	<0.02	0.64	<0.01	86		58.2	8.3	164
G-6	06/25	1	62	17.5	2.9	2.7	14.8	4.0	4.2	<5	68	0.27	<0.02	0.47	<0.01	110		55.6	8.3	162

Table 8. Chemical Quality of Groundwater (unfiltered) in 1997 (mg/l) (Cont.)

Station Name	Date	Code[a]	SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3-N	CN[b]	TDS[c]	TSS[d]	Hardness as $CaCO_3$	pH (std)	Conductance (µS/cm)
San Ildefonso Pueblo Wells (Regional Aquifer):																				
LA-1B	10/06	1	2	2.3	<0.1	1.6	134.7	23.4	29.2	50	278	3.24	<0.02	0.05	0.01	354		6.0	9.5	650
LA-5	07/07	1	42	18.6	0.8	1.1	14.4	4.2	6.2	<5	79	0.35	<0.02	0.60	<0.01	162		49.8	8.3	175
Other Selected Perched Groundwater and Springs:																				
Test Well 1A	08/11	1	1	11.0	3.2	3.6	40.4	66.6	5.0	<5	50	0.98	0.42	<0.02	<0.01	196		40.3	8.8	330
Test Well 2A	12/11	1	16	2.1	0.4	<1.0	1.1	45.8	10.9	<5	82	0.19	0.07	<0.02	<0.01	196	<1	6.9	8.0	337
Basalt Spring	08/14	1	65	16.0	4.0	8.1	44.6	27.7	22.0	<5	92	0.47	<0.02	2.36	<0.01	306	<1	57.0	7.3	353
Water Canyon Gallery	12/01	1	47	6.7	3.1	<1.0	5.4	3.4	2.0	<5	43	0.06	<0.02	0.24	<0.01	70	<1	31.0	7.6	89
Water Quality Standards (for comparison only):																				
EPA Primary Drinking Water Standard									500.0			4.00		10.00	0.20					
EPA Secondary Drinking Water Standard								250.0	250.0							500			6.8–8.5	
NMWQCC Groundwater Limit								250.0	600.0			1.60		10.00	0.20	1,000			6–9	

[a] Codes: 1–primary analysis, R–lab replicate, D–lab duplicate.
[b] CN–cyanide.
[c] TDS–total dissolved solids.
[d] TSS–total suspended solids.
[e] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.

Table 9. Total Recoverable Trace Metals in Groundwater (unfiltered) for 1997 (μg/l)

Station Name	Date	Code[a]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Test Wells (Regional Aquifer):														
TW-1	08/11	1	<10[b]	243	<2	51	84	<3	<7	<8	<7	11	1,340	<0.2
TW-2	12/11	1	<10	96	<2	<20	16	<3	<7	<8	<7	<10	4,783	<0.2
TW-3	08/11	1	<10	107	2	41	28	<3	<7	<8	<7	15	708	<0.2
TW-4	08/11	1	<10	163	<2	<20	79	<3	<7	<8	12	73	9,120	<0.2
DT-5A	03/07	1	<10	<50	<5	<20	21	<3	<7	<8	<7	13	293	<0.4
DT-5A	03/07	R	<10	<50	<4	<20	21	<3	<7	<8	<7	13	67	<0.4
DT-5A	05/13	1	<10	103	<2	21	16	<3	<7	<8	<7	<10	1,437	<0.3
DT-5A	10/16	1	<10	<50	<6	26	16	<3	<7	<8	<7	<10	52	<0.2
DT-9	05/13	1	<10	<50	<2	<20	15	<3	<7	<8	<7	<10	206	<0.3
DT-9	10/15	1	<10	<50	<6	<20	6	<3	<7	<8	<7	<10	207	<0.2
DT-10	05/14	1	<10	<50	<2	<20	14	<3	<7	<8	<7	<10	55	<0.3
DT-10	10/16	1	<10	<50	<2	34	8	<3	<7	<8	<7	<10	502	<0.2
Municipal Water Supply Wells (Regional Aquifer):														
O-1	01/08	1	<10	1,000	6	71	34	<3	<7	<8	16	<10	4,483	<0.3
O-1	01/08	R	<10	<500	6	71	30	<3	<7	<8	15	<10	4,104	<0.3
O-4	06/25	1	<10	61	<2	55	48	<3	<7	<8	<8	<10	<40	<0.2
PM-1	06/25	1	<10	101	<2	63	78	<3	<7	<8	<7	<10	<40	<0.2
PM-2	06/25	1	<10	<50	<2	<20	32	<3	<7	<8	10	313	7,418	<0.2
PM-3	06/25	1	11	131	2	47	53	<3	<7	<8	<7	<10	57	<0.2
PM-4	06/25	1	<10	<50	2	<20	31	<3	<7	<8	7	<10	<40	<0.2
PM-5	06/25	1	<10	359	<2	46	33	<3	<7	<10	28	<10	252	<0.2
G-1A	06/25	1	<10	<50	14	32	40	<3	<7	<8	9	<10	<40	<0.2
G-2	06/25	1	<10	<50	35	36	68	<3	<7	<8	10	<10	<40	<0.2
G-4	06/25	1	<10	<50	2	<33	20	<3	<7	<8	<7	<10	<40	<0.2
G-5	06/25	1	<10	<50	2	<20	15	<3	<7	<8	<7	<10	<40	<0.2
G-6	06/25	1	<10	59	3	<34	14	<3	<7	<8	<7	<10	58	<0.2
San Ildefonso Pueblo Wells (Regional Aquifer):														
LA-1B	10/06	1	<10	<50	7	272	23	<3	<7	<8	<7	<10	103	<0.2
LA-5	07/07	1	<10	<50	<2	<20	65	<3	<7	<8	<7	<10	119	<0.2

Table 9. Total Recoverable Trace Metals in Groundwater (unfiltered) for 1997 (µg/l) (Cont.)

Station Name	Date	Code[a]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Other Selected Perched Groundwater and Springs:														
Test Well 1A	08/11	1	<10	<50	<2	140	68	<3	<7	<8	<7	10	3,032	<0.2
Test Well 2A	12/11	1	<10	<50	<2	<20	2	<3	<7	<8	<7	<10	54	<0.2
Basalt Spring	08/14	1	<10	<50	<6	186	61	<3	<7	<8	<7	<10	42	<0.2
Water Canyon Gallery	12/01	1	<10	100	6	<20	11	<3	<7	<8	<7	<10	51	<0.2
Water Quality Standards (for comparison only):														
EPA Primary Drinking Water Standard					50		2,000	4	5		100			2.0
EPA Secondary Drinking Water Standard				50–200									300	
NMWQCC Groundwater Limit			50	5,000	100	750	1,000		10	50	50	1,000	1,000	2.0

[a]Codes: 1–primary analysis, R–lab replicate, D–lab duplicate.
[b]Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.

Table 9. Total Recoverable Trace Metals in Groundwater (unfiltered) for 1997 (µg/l) (Cont.)

Station Name	Date	Code[a]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Test Wells (Regional Aquifer):													
TW-1	08/11	1	63	<30	<20	88	9	<3	<50	269	<3	<8	1,167
TW-2	12/11	1	83	<30	<20	45	<3	<2	<30	35	<3	<8	1,111
TW-3	08/11	1	23	<30	<20	15	<6	<3	<30	71	<3	10	126
TW-4	08/11	1	81	<30	<20	101	<6	<3	53	53	<3	<8	2,825
DT-5A	03/07	1	<2	<30	30	4	<3	<2	37	41	<3	14	193
DT-5A	03/07	R	<2	<30	<20	<3	<3	<2	<30	42	<3	12	191
DT-5A	05/13	1	55	<30	<20	4	4	<3	<31	38	<3	<8	573
DT-5A	10/16	1	<2	<30	<20	<3	<3	<3	38	36	<3	12	1,537
DT-9	05/13	1	<2	<30	<20	5	<3	<3	<32	47	<3	<8	204
DT-9	10/15	1	4	<30	<20	3	<3	<3	<37	49	<3	<8	93
DT-10	05/14	1	<2	<30	<20	3	<3	<3	<30	44	<3	<8	188
DT-10	10/16	1	5	<30	<20	3	<3	<3	<30	49	<3	<8	99
Municipal Water Supply Wells (Regional Aquifer):													
O-1	01/08	1	300	<30	<20	3	<3	14	<30	26	<3	37	172
O-1	01/08	R	277	<30	<20	<3	<3	5	<30	24	<3	43	135
O-4	06/25	1	<2	<30	<20	3	<3	<3	<30	112	<3	14	76
PM-1	06/25	1	<2	<30	<20	<3	<3	<3	<30	142	<3	11	<50
PM-2	06/25	1	25	<30	<20	19	<3	<3	<43	40	<3	<8	173
PM-3	06/25	1	<2	<30	<20	<3	<3	<3	<30	123	<3	14	<50
PM-4	06/25	1	<2	<30	<20	<3	<3	<3	<30	53	<3	12	<50
PM-5	06/25	1	<2	<34	<29	4	<3	<3	<30	47	<3	<8	<50
G-1A	06/25	1	<2	<30	<20	<3	<3	<3	<30	74	<3	42	<50
G-2	06/25	1	<2	<30	<20	<3	<3	<3	<65	80	<3	71	<50
G-4	06/25	1	<2	<30	<20	<3	<3	<3	<30	102	<3	15	<50
G-5	06/25	1	<2	<30	<20	<3	<3	<3	<30	80	<3	15	<50
G-6	06/25	1	<2	<30	<20	<3	<3	<3	<30	79	<3	15	<50
San Ildefonso Pueblo Wells (Regional Aquifer):													
LA-1B	10/06	1	12	<30	33	<3	<3	<3	<30	64	<3	<8	<50
LA-5	07/07	1	4	<30	<20	<3	<5	<3	<30	222	<3	12	<50

Table 9. Total Recoverable Trace Metals in Groundwater (unfiltered) for 1997 (μg/l) (Cont.)

Station Name	Date	Code[a]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Other Selected Perched Groundwater and Springs:													
Test Well 1A	08/11	1	70	<30	<20	5	<6	<3	<45	87	<3	<8	8,136
Test Well 2A	12/11	1	6	<30	<20	<3	<3	<2	<30	11	<3	<8	229
Basalt Spring	08/14	1	<2	<30	<34	<3	<3	<4	<30	98	<3	<8	<50
Water Canyon Gallery	12/01	1	<2	<30	<20	<3	<3	<3	<30	49	<3	<8	<50
Water Quality Standards (for comparison only):													
EPA Primary Drinking Water Standard					100		6	50			2		
EPA Secondary DrinkingWater Standard			50										5,000
NMWQCC Groundwater Limit			200	1,000	200	50		50					10,000

[a]Codes: 1–primary analysis, R–lab replicate, D–lab duplicate.
[b]Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.

Table 10. Radiochemical Analyses of Groundwater (unfiltered) for 1997 (pCi/l)

Station Name	Date	Code[a]	^{3}H	^{90}Sr	^{137}Cs	U (µg/l)	^{238}Pu	$^{239,240}Pu$	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Test Wells (Regional Aquifer):												
T-W-1	08/11	1	468 (690)[b]	0.08 (0.94)	0.26 (0.29)	1.90 (0.19)	0.008 (0.012)	0.012 (0.012)	−0.015 (0.013)	0.5 (1.6)	3.0 (2.9)	−39.8 (47.2)
T-W-2	12/11	1	−162 (670)	0.80 (0.98)	0.74 (2.33)	0.00 (0.01)	−0.012 (0.017)	−0.016 (0.023)	−0.047 (0.017)	0.2 (0.8)	0.7 (1.5)	51.5 (48.7)
TW-3	08/11	1	−2,052 (500)	1.02 (1.25)	−0.92 (0.36)	0.73 (0.08)	−0.023 (0.004)	0.009 (0.012)	0.002 (0.029)	0.1 (0.7)	2.2 (1.7)	−59.1 (47.1)
TW-4	08/11	1	−302 (640)	1.33 (1.67)	0.21 (0.24)	0.45 (0.05)	−0.008 (0.009)	0.010 (0.011)	−0.001 (0.014)	0.2 (0.9)	1.6 (1.6)	−11.3 (47.4)
DT-5A	03/07	1	104 (216)	−0.07 (0.38)	0.35 (0.53)	0.45 (0.05)	0.001 (0.020)	−0.009 (0.004)	−0.016 (0.012)	0.4 (0.6)	1.3 (0.5)	−27.8 (50.0)
DT-5A	03/07	R	69 (188)									160.0 (50.0)
DT-5A	05/13	1	185 (201)	0.81 (1.80)	0.96 (2.67)	0.08 (0.01)	−0.007 (0.009)	−0.010 (0.009)	−0.019 (0.014)	0.4 (0.4)	−0.2 (0.4)	−52.4 (47.1)
DT-5A	10/16	1	−222 (700)	−1.07 (1.27)	0.10 (1.39)	0.49 (0.05)	0.011 (0.013)	0.012 (0.012)	−0.006 (0.013)	0.3 (1.1)	0.7 (0.5)	−114.9 (48.0)
DT-9	05/13	1	1 (166)	0.91 (1.63)	1.10 (0.42)	0.43 (0.05)	0.003 (0.010)	0.000 (0.010)	−0.014 (0.016)	0.0 (0.2)	0.2 (0.4)	−31.2 (47.2)
DT-9	10/15	1	−172 (700)	−1.58 (1.45)	−0.82 (0.80)	0.61 (0.06)	−0.007 (0.011)	0.004 (0.012)	−0.015 (0.011)	0.1 (0.7)	0.3 (1.4)	−123.0 (47.9)
DT-10	05/14	1	−59 (148)	−0.58 (1.20)	0.02 (0.24)	0.46 (0.05)	−0.025 (0.007)	−0.020 (0.010)	−0.005 (0.018)	−0.2 (0.2)	−1.3 (0.3)	−26.6 (47.3)
DT-10	10/16	1	−232 (700)	−3.39 (2.23)	−0.91 (0.80)	0.74 (0.08)	0.021 (0.014)	−0.002 (0.010)	0.019 (0.030)	0.9 (3.1)	1.7 (1.6)	−28.3 (48.6)
Municipal Water Supply Wells (Regional Aquifer):												
O-1	01/08	1	169 (136)	0.10 (0.40)	0.31 (0.48)	1.72 (0.17)	0.005 (0.018)	−0.012 (0.011)	−0.033 (0.014)	2.8 (1.0)	0.6 (0.5)	62.2 (50.0)
O-1	01/08	R	−144 (133)		0.13 (0.18)		−0.018 (0.010)	−0.016 (0.009)	0.025 (0.027)	2.8 (1.0)	0.3 (0.4)	
O-1	04/19	1		0.03 (0.33)								
O-1	04/19	D		0.60 (0.32)								
O-4	06/25	1	288 (710)	0.20 (2.04)	−0.85 (0.80)	0.85 (0.09)	−0.014 (0.022)	−0.014 (0.017)	0.022 (0.021)	0.5 (4.0)	2.5 (1.8)	−10.3 (46.8)
PM-1	06/25	1	88 (700)	−0.92 (1.81)	−0.74 (0.12)	1.87 (0.19)	0.018 (0.015)	0.029 (0.019)	−0.045 (0.022)	2.5 (6.1)	3.8 (1.9)	0.9 (46.9)
PM-2	06/25	1	368 (720)	−1.16 (1.79)	−0.76 (0.08)	0.47 (0.05)	−0.006 (0.019)	−0.005 (0.020)	−0.003 (0.019)	0.0 (0.7)	1.5 (0.6)	−9.0 (46.8)
PM-3	06/25	1	658 (730)	0.13 (2.24)	−0.88 (0.80)	1.03 (0.11)	−0.035 (0.007)	−0.017 (0.010)	0.000 (0.016)	−0.3 (0.3)	2.3 (1.8)	16.7 (47.0)
PM-4	06/25	1	58 (700)	−1.17 (2.23)	−1.08 (0.80)	0.35 (0.04)	−0.007 (0.011)	0.019 (0.016)	−0.035 (0.026)	0.5 (4.5)	1.4 (1.6)	8.1 (47.0)
PM-5	06/25	1	−2 (690)	−0.53 (2.55)	−0.72 (0.16)	0.55 (0.06)	−0.026 (0.008)	0.001 (0.014)	0.004 (0.017)	0.1 (0.9)	1.2 (1.6)	−6.4 (46.9)
G-1	12/08	1	198 (720)	5.19 (1.39)	−0.13 (1.03)	0.64 (0.07)	0.005 (0.010)	0.015 (0.012)	−0.008 (0.020)	−0.2 (0.1)	2.1 (1.7)	28.7 (48.7)
G-1A	06/25	1	−82 (690)	−1.10 (2.66)	−1.00 (0.80)	0.43 (0.05)	−0.023 (0.007)	0.011 (0.015)	−0.001 (0.034)	0.0 (0.4)	1.7 (1.7)	15.4 (47.0)
G-2	06/25	1	388 (720)	−0.04 (1.33)	−0.93 (0.80)	0.92 (0.09)	−0.029 (0.005)	0.010 (0.013)	−0.004 (0.017)	−0.3 (0.2)	1.5 (1.6)	20.6 (47.0)
G-4	06/25	1	−52 (690)	−0.20 (1.00)	−0.59 (0.36)	0.91 (0.09)	−0.032 (0.010)	0.006 (0.012)	−0.015 (0.015)	0.2 (1.5)	1.5 (1.6)	−15.6 (46.8)
G-5	06/25	1	458 (720)	−0.74 (1.35)	−0.70 (0.18)	0.98 (0.10)	−0.005 (0.010)	−0.001 (0.011)	−0.015 (0.014)	0.5 (2.9)	0.9 (1.5)	8.8 (47.0)
G-6	06/25	1	158 (700)	−4.41 (2.74)	−1.01 (0.80)	0.59 (0.06)	−0.014 (0.011)	0.012 (0.015)	−0.003 (0.044)	−0.4 (0.4)	1.4 (1.6)	4.2 (46.9)

Table 10. Radiochemical Analyses of Groundwater (unfiltered) for 1997 (pCi/l) (Cont.)

Station Name	Date	Code[a]	^{3}H	^{90}Sr	^{137}Cs	U (µg/l)	^{238}Pu	$^{239,240}Pu$	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
San Ildefonso Pueblo Wells (Regional Aquifer):												
LA-1B	10/06	1	408 (680)	−0.16 (1.02)	1.29 (0.42)	0.00 (0.01)	−0.020 (0.007)	−0.014 (0.008)	−0.046 (0.013)	4.6 (1.0)	6.1 (0.7)	22.4 (47.7)
LA-5	07/07	1	−492 (740)	−0.18 (1.74)	−0.63 (0.29)	1.10 (0.11)	−0.006 (0.009)	−0.009 (0.007)	0.015 (0.045)	1.2 (3.2)	2.3 (1.7)	−7.6 (46.7)
Other Selected Perched Groundwater and Springs:												
Test Well 1A	08/11	1	−272 (640)	1.23 (1.34)	0.61 (0.33)	0.24 (0.03)	0.001 (0.010)	0.003 (0.011)	−0.014 (0.013)	−0.7 (0.7)	3.2 (3.0)	−75.0 (47.0)
Test Well 2A	12/11	1	1,778 (790)	0.36 (1.05)	1.33 (0.48)	0.00 (0.01)	−0.009 (0.007)	0.013 (0.011)	−0.004 (0.013)	0.0 (0.3)	1.0 (1.5)	73.7 (48.9)
Basalt Spring	08/14	1	18 (710)	2.64 (2.38)	−0.83 (0.36)	2.22 (0.23)	−0.014 (0.006)	0.476 (0.050)	−0.007 (0.015)	8.4 (7.6)	22.1 (4.1)	−55.1 (47.1)
Water Canyon Gallery	12/01	1	38 (670)	−0.21 (1.04)	−0.75 (0.10)	0.19 (0.02)	−0.025 (0.007)	−0.017 (0.009)	0.039 (0.029)	−0.3 (0.2)	0.7 (1.5)	−7.4 (48.4)
Limits of Detection			700	3.00	4.00	0.10	0.040	0.040	0.040	3.0	3.0	120.0
Water Quality Standards												
DOE Drinking Water System DCG			80,000	40	120	30	1.6	1.2	1.2	1.2	40	
EPA Primary Drinking Water Standard			20,000	8		20				15		
NMWQCC Groundwater Limit						5,000						

[a]Codes: 1–primary analysis, R–lab replicate, 1–lab duplicate.

[b]Two columns are listed for each analyte: the first is the value; the second (contained in parentheses) is the radioactive counting uncertainty (±1 standard deviation).

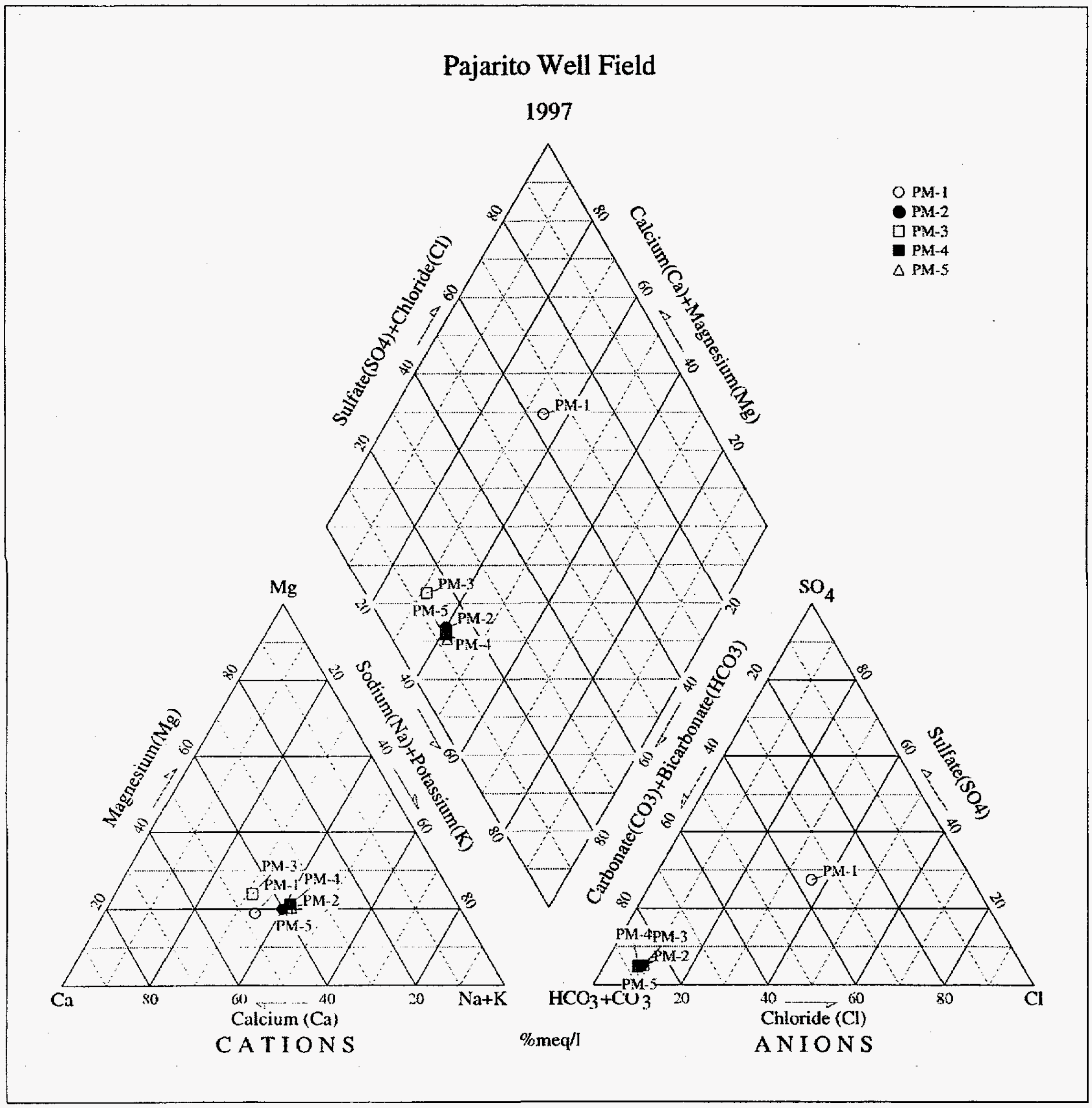

Fig. 8. Piper plot showing variations in major ion water quality from wells in the Pajarito field.

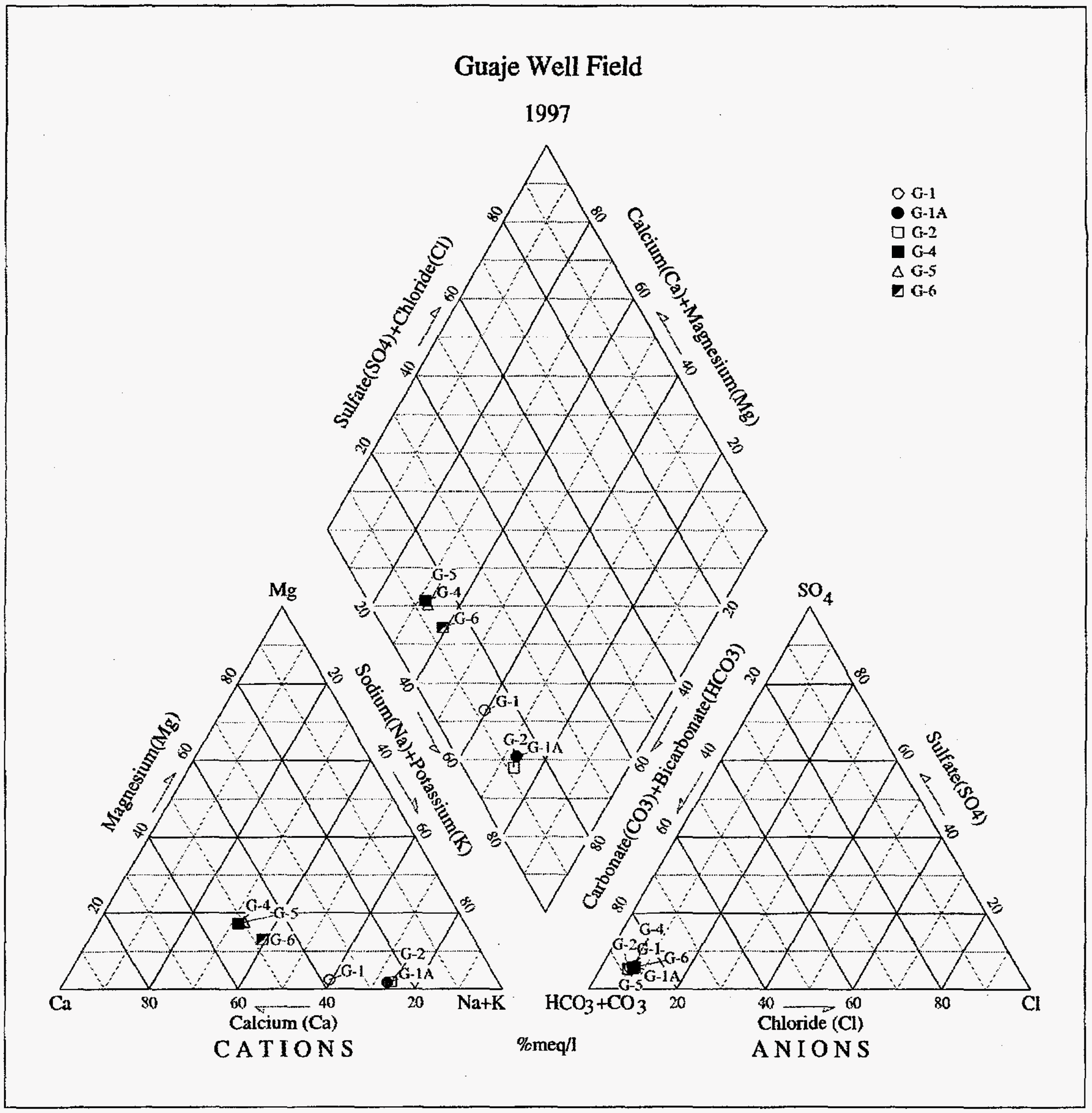

Fig. 9. Piper plot showing variations in major ion water quality from wells in the Guaje field.

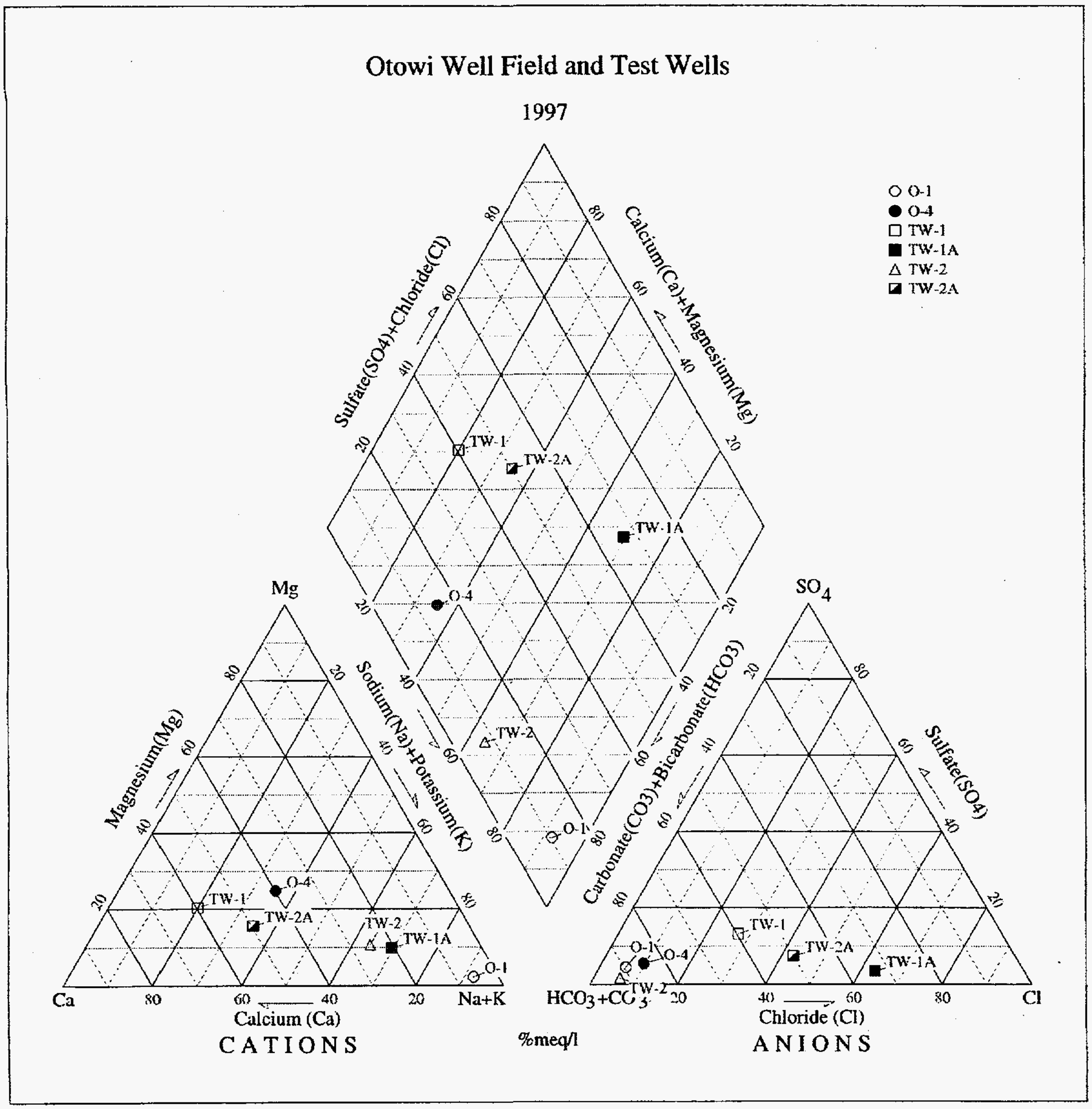

Fig. 10. Piper plot showing variations in major ion water quality from wells in the Otowi field and from four test wells.

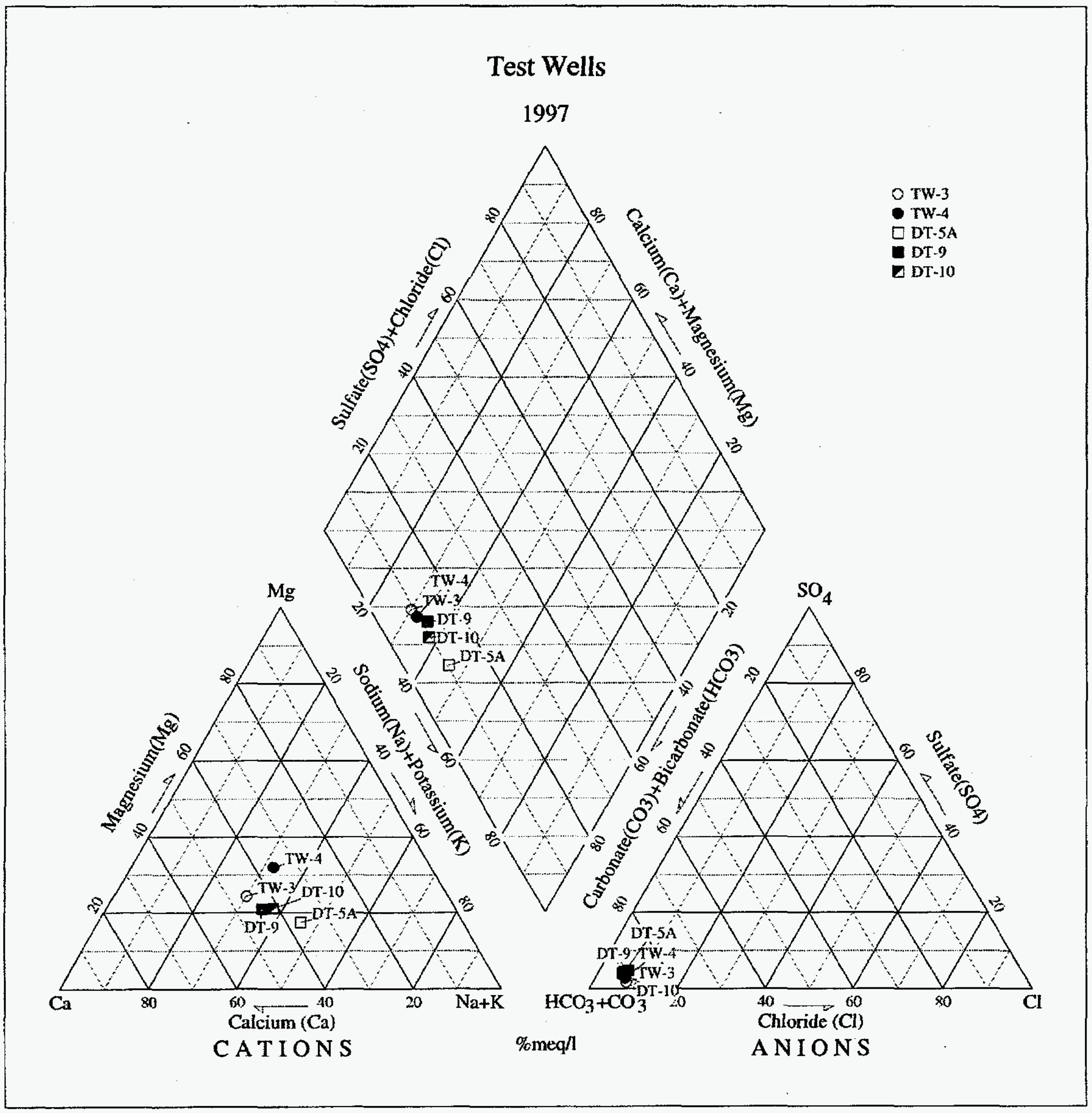

Fig. 11. Piper plot showing variations in major ion water quality from five test wells.

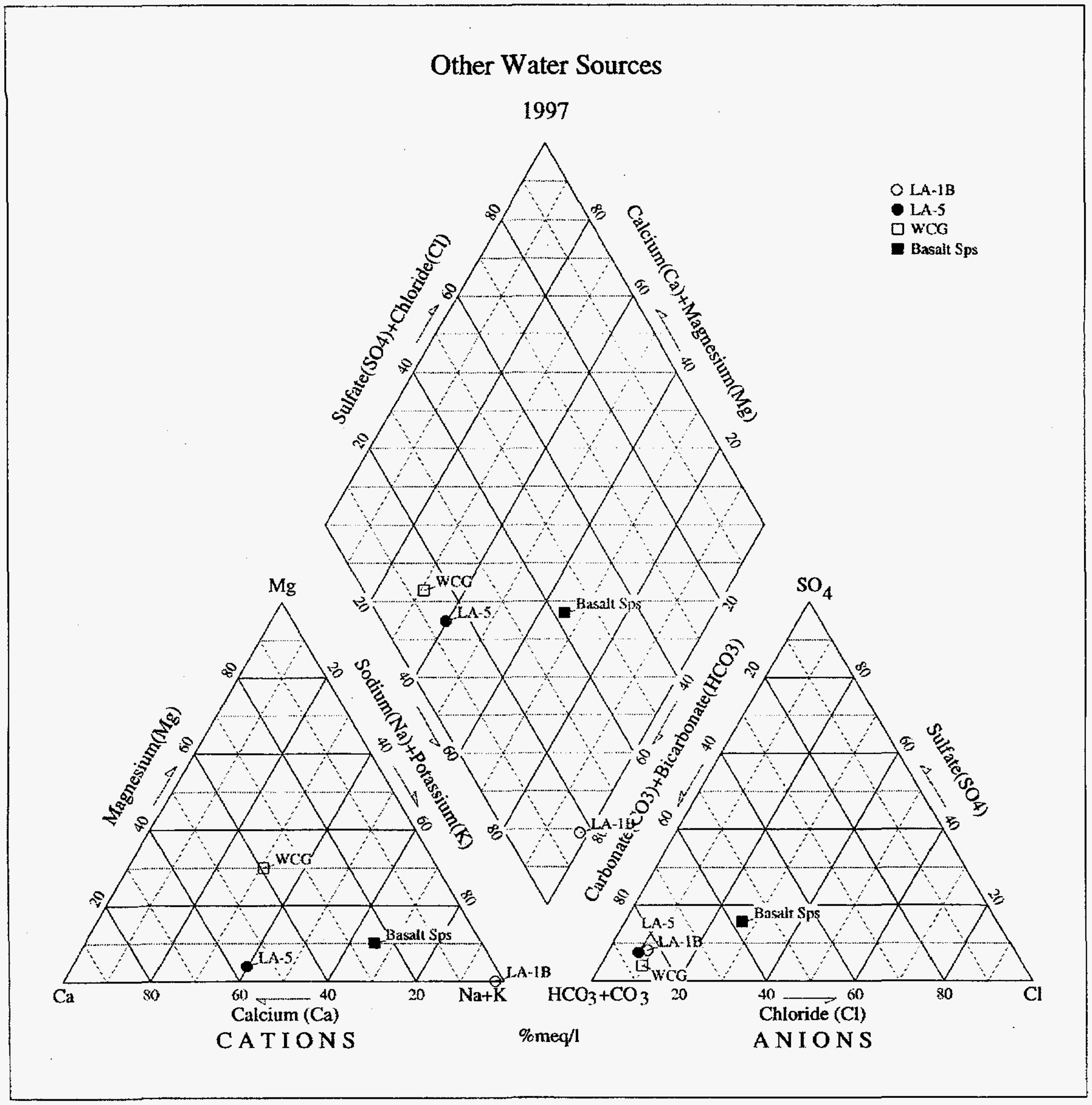

Fig. 12. Piper plot showing variations in major ion water quality from other water sources (Los Alamos well field, Water Canyon Gallery, and Basalt Spring).

These wells have been developed and aquifer pump tests were conducted to establish a safe yield. A special summary report will be issued that summarizes important geological, geophysical, and hydrological information from these new wells.

Some effort should be made to ensure that all water level recorders and wellhead flow meters are operational. Currently, water level recorders are not operational in PM-2, O-4, and G-5; these recorders should be repaired as soon as possible. Both nonpumping and pumping water level data are essential in documenting the operation of individual wells and summarizing well field performance characteristics. Furthermore, these data are vital in planning future well field operations and expansions.

ACKNOWLEDGMENTS

Summary statistics on well production rates were collected by personnel from the Utilities Department of Johnson Controls Northern New Mexico, Inc.; these data were compiled for this report by the Laboratory's Water Quality and Hydrology Group.

REFERENCES

1. W. D. Purtymun and J. E. Herceg, "Summary of the 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 M. N. 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 M. N. 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. N. 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. N. Maes, "Water Supply at Los Alamos During 1983"; Los Alamos National Laboratory report LA-10327-PR (1985).

15. W. D. Purtymun, N. M. Becker, and M. N. Maes, "Water Supply at Los Alamos During 1984"; Los Alamos National Laboratory report LA-10584-PR (1986).

16. W. D. Purtymun, N. M. Becker, and M. N. Maes, "Water Supply at Los Alamos During 1985"; Los Alamos National Laboratory report LA-10835-PR (1986).

17. W. D. Purtymun, A. K. Stoker, and M. N. Maes, "Water Supply at Los Alamos During 1986"; Los Alamos National Laboratory report LA-11046-PR (1987).

18. W. D. Purtymun, A. K. Stoker, and M. N. Maes, "Water Supply at Los Alamos During 1987"; Los Alamos National Laboratory report LA-11478-PR (1989).

19. W. D. Purtymun, M. N. Maes, and S. G. McLin, "Water Supply at Los Alamos During 1988"; Los Alamos National Laboratory report LA-11679-PR (1989).

20. A. K. Stoker, S. G. McLin, W. D. Purtymun, M. N. Maes, and B. G. Hammock, "Water Supply at Los Alamos During 1989"; Los Alamos National Laboratory report LA-12276-PR (1992).

21. W. D. Purtymun, S. G. McLin, A. K. Stoker, M. N. Maes, and B. G. Hammock, "Water Supply at Los Alamos During 1990"; Los Alamos National Laboratory report LA-12471-PR (1993).

22. W. D. Purtymun, S. G. McLin, A. K. Stoker, and M. N. Maes, "Water Supply at Los Alamos during 1991"; Los Alamos National Laboratory report LA-12770-PR (1994).

23. W. D. Purtymun, S. G. McLin, A. K. Stoker, and M. N. Maes, "Water Supply at Los Alamos during 1992"; Los Alamos National Laboratory report LA-12926-PR (1995).

24. W. D. Purtymun, A. K. Stoker, S. G. McLin, M. N. Maes, and T. A. Glasco, "Water Supply at Los Alamos during 1993"; Los Alamos National Laboratory report LA-12951-PR (1995).

25. S. G. McLin, W. D. Purtymun, A. K. Stoker, and M. N. Maes, "Water Supply at Los Alamos during 1994"; Los Alamos National Laboratory report LA-13057-PR (1996).

26. S. G. McLin, W. D. Purtymun, and M. N. Maes, "Water Supply at Los Alamos during 1995"; Los Alamos National Laboratory report LA-13216-PR (April 1997).

27. S. G. McLin, W. D. Purtymun, M. N. Maes, and P. A. Longmire, "Water Supply at Los Alamos during 1996"; Los Alamos National Laboratory report LA-13371-PR (December 1997).

28. 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).

29. W. D. Purtymun and A. K. Stoker, "Current Status of Wells and Future Water Supply"; Los Alamos National Laboratory report LA-11332-MS (1988).

30. W. D. Purtymun, "Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area"; Los Alamos National Laboratory report LA-12883-MS (1995).

31. Environmental Surveillance and Compliance Programs, "Environmental Surveillance and Compliance at Los Alamos during 1996"; Los Alamos National Laboratory report LA-13343-ENV (September 1997).

32. Environmental Surveillance Program, "Environmental Surveillance at Los Alamos during 1997"; Los Alamos National Laboratory report LA-13487-ENV (September 1998).

33. S. G. McLin, "Analysis of Water Level Fluctuations in Pajarito Plateau Wells"; in *New Mexico Geological Society, 47th Guidebook to the Jemez Mountains Region*; New Mexico Bureau of Mines and Mineral Resources, Socorro, NM (September 1996); pp. 421–426.

34. U.S. Environmental Protection Agency, "Test Methods for Evaluating Solid Waste" (3rd edition); Office of Solid Waste and Emergency Response report SW-846 (1987).

35. M. C. Williams, "Handbook for Sample Collection, Preservation, and Instrument Techniques"; Los Alamos National Laboratory report LA-11738-MS (1990).

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APPENDIX A

ANNUAL STATISTICS ON AQUIFER CHARACTERISTICS

Well G-1

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1950	0	2.8	0.0	195.0	—	—	—
1951	1,168	37.7	538.0	202.0	309.0	107.0	5.0
1952	2,476	75.5	508.2	213.0	295.0	82.0	6.2
1953	3,275	97.3	495.2	221.0	292.0	71.0	7.0
1954	2,616	77.8	495.7	221.0	290.0	69.0	7.2
1955	2,406	70.5	448.4	226.0	295.0	69.0	7.1
1956	2,958	83.2	468.8	235.0	303.0	68.0	6.9
1957	2,098	55.9	444.1	236.0	307.0	71.0	6.3
1958	2,460	68.1	461.4	238.0	308.0	70.0	6.6
1959	2,952	82.4	465.2	245.0	314.0	69.0	6.7
1960	3,564	96.0	448.9	254.0	325.0	71.0	6.3
1961	4,236	112.4	442.2	260.0	333.0	73.0	6.1
1962	3,431	93.6	454.7	258.0	342.0	84.0	5.4
1963	4,519	114.9	423.8	265.0	348.0	83.0	5.1
1964	4,374	113.8	433.6	269.0	352.0	83.0	5.2
1965	3,530	90.7	428.2	268.0	352.0	84.0	5.1
1966	4,074	102.6	419.7	269.0	363.0	94.0	4.5
1967	2,615	69.9	445.5	266.0	362.0	96.0	4.6
1968	2,996	78.9	438.9	264.0	366.0	102.0	4.3
1969	2,657	68.3	428.4	266.0	376.0	110.0	3.9
1970	2,712	64.7	397.6	264.0	377.0	113.0	3.5
1971	2,908	67.9	389.2	258.0	378.0	120.0	3.2
1972	2,865	66.1	384.5	264.0	389.0	125.0	3.1
1973	2,997	67.5	375.4	271.0	403.0	132.0	2.8
1974	2,767	62.3	375.3	283.0	412.0	129.0	2.9
1975	2,467	55.7	376.3	293.0	411.0	118.0	3.2
1976	2,962	65.1	366.3	—	—	—	—
1977	2,734	57.9	353.0	275.0	426.0	151.0	2.3
1978	2,656	56.0	351.4	270.0	419.0	149.0	2.4
1979	2,998	61.7	342.9	271.0	422.0	151.0	2.3
1980	3,459	68.3	329.0	273.0	428.0	155.0	2.1
1981	4,427	81.6	307.2	275.0	444.0	169.0	1.8
1982	3,678	69.0	313.0	278.0	443.0	165.0	1.9
1983	2,871	52.2	303.0	272.0	443.0	171.0	1.8
1984	3,804	62.8	275.0	276.0	448.0	172.0	1.5
1985	3,004	48.3	268.0	278.0	450.0	172.0	1.6
1986	2,027	30.3	249.0	279.0	450.0	171.0	1.5
1987	2,070	29.2	235.0	280.0	451.0	171.0	1.4
1988	395	5.4	227.0	280.0	445.0	165.0	1.4
1989	2,010	26.9	223.0	282.0	451.0	169.0	1.3
1990	2,121	30.8	242.0	284.0	454.0	170.0	1.4
1991	1,730	20.9	201.0	282.0	451.0	169.0	1.2
1992	1,077	12.0	186.0	283.0	439.0	156.0	1.2
1993	2.5	0.03	200.0	280.0	—	—	—
1994	1,585	18.5	194.5	277.0	451.0	174.0	1.1
1995	2,542	28.5	186.9	278.0	450.0	172.0	1.1
1996	1,128	12.9	190.6	274.0	449.0	175.0	1.1
1997	897	13.6	190.8	274.0	454.0	180.0	1.1

NOTE: Well completed July 1950; initial depth to water: 192 ft; surface elev. 5,973 ft.

Well G-1A

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1954	108	4.6	709.0	—	—	—	—
1955	1,531	53.0	577.0	265.0	316.0	51.0	11.3
1956	3,130	107.7	573.5	273.0	323.0	50.0	11.5
1957	2,470	87.0	587.0	274.0	327.0	53.0	11.1
1958	2,670	92.5	577.4	279.0	331.0	52.0	11.1
1959	2,965	102.7	577.3	284.0	333.0	49.0	11.8
1960	3,641	122.8	562.1	291.0	342.0	51.0	11.0
1961	4,297	147.3	571.3	298.0	350.0	52.0	11.0
1962	3,972	136.1	571.1	295.0	344.0	49.0	11.7
1963	4,525	149.7	551.4	301.0	350.0	49.0	11.3
1964	3,852	129.3	559.4	302.0	353.0	51.0	11.0
1965	3,505	116.5	554.0	302.0	353.0	51.0	10.9
1966	3,964	133.4	560.9	306.0	355.0	49.0	11.4
1967	2,720	91.3	559.4	302.0	351.0	49.0	11.4
1968	3,089	103.2	556.8	302.0	352.0	50.0	11.1
1969	2,695	90.7	560.9	303.0	356.0	53.0	10.6
1970	2,772	92.5	556.2	300.0	357.0	57.0	9.8
1971	3,313	111.8	562.4	303.0	361.0	58.0	9.7
1972	2,879	94.0	544.2	302.0	361.0	59.0	9.2
1973	2,760	87.9	530.8	302.0	362.0	60.0	8.8
1974	2,974	92.7	519.5	307.0	355.0	48.0	10.8
1975	2,740	85.3	518.9	304.0	351.0	47.0	11.0
1976	2,983	91.6	511.8	302.0	350.0	48.0	10.7
1977	2,942	88.7	502.5	302.0	350.0	48.0	10.5
1978	2,631	77.9	493.5	300.0	345.0	45.0	11.0
1979	2,974	88.0	493.9	301.0	345.0	44.0	11.0
1980	3,480	103.2	494.4	305.0	345.0	40.0	12.4
1981	4,212	131.2	519.1	307.0	347.0	40.0	13.0
1982	3,618	109.7	505.0	305.0	347.0	42.0	12.0
1983	2,901	86.7	498.0	301.0	336.0	35.0	14.2
1984	3,789	113.9	501.0	302.0	345.0	43.0	11.7
1985	4,430	128.4	483.0	306.0	348.0	42.0	11.5
1986	4,644	130.4	468.0	310.0	351.0	41.0	11.4
1987	4,468	122.5	457.0	320.0	362.0	42.0	10.9
1988	5,016	133.5	443.0	323.0	364.0	41.0	10.8
1989	4,663	131.5	470.0	323.0	359.0	36.0	13.1
1990	4,860	145.5	499.0	322.0	362.0	40.0	12.5
1991	5,120	150.2	489.0	325.0	361.0	36.0	13.6
1992	4,676	134.1	478.0	325.0	361.0	36.0	13.3
1993	3,862	108.2	467.0	321.0	355.0	34.0	13.7
1994	2,629	68.2	432.3	312.0	347.0	35.0	12.3
1995	2,736	67.2	409.4	312.0	346.0	34.0	12.0
1996	2,853	71.3	416.5	310.0	342.0	32.0	13.0
1997	2,864	71.5	416.0	309.0	340.0	31.0	13.4

NOTE: Well completed Dec. 1954; initial depth to water: 250 ft; surface elev. 6,014 ft.

Well G-2

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1951	123	3.9	528.5	259.0	—	—	—
1952	2,372	78.3	550.2	279.0	327.0	48.0	11.5
1953	3,254	105.6	540.9	290.0	334.0	44.0	12.3
1954	2,682	86.3	536.3	291.0	335.0	44.0	12.2
1955	2,487	78.8	528.1	299.0	345.0	46.0	11.5
1956	3,109	95.8	513.6	310.0	357.0	47.0	10.9
1957	2,458	76.1	516.0	311.0	360.0	49.0	10.5
1958	2,707	80.1	493.2	315.0	361.0	46.0	10.7
1959	2,938	84.6	479.9	320.0	363.0	43.0	11.2
1960	3,535	96.6	455.4	328.0	370.0	42.0	10.8
1961	3,982	105.3	440.7	336.0	375.0	39.0	11.3
1962	4,076	99.8	408.1	338.0	374.0	36.0	11.3
1963	4,563	105.7	386.1	344.0	379.0	35.0	11.0
1964	4,541	105.3	386.5	346.0	380.0	34.0	11.4
1965	3,535	82.6	389.4	346.0	381.0	35.0	11.1
1966	3,994	94.7	395.2	349.0	383.0	34.0	11.6
1967	2,743	67.6	410.7	344.0	379.0	35.0	11.7
1968	2,732	66.5	405.7	344.0	379.0	35.0	11.6
1969	2,679	68.6	426.8	344.0	381.0	37.0	11.5
1970	2,431	62.8	430.5	343.0	381.0	38.0	11.3
1971	3,420	87.4	425.9	345.0	384.0	39.0	10.9
1972	2,887	73.4	423.7	348.0	388.0	40.0	10.6
1973	2,816	72.4	428.5	344.0	385.0	41.0	10.5
1974	3,056	82.0	447.2	347.0	390.0	43.0	10.4
1975	2,724	74.5	455.8	341.0	384.0	43.0	10.6
1976	2,990	81.1	452.1	344.0	388.0	44.0	10.3
1977	2,981	80.4	449.5	346.0	388.0	42.0	10.7
1978	2,562	71.6	451.9	345.0	386.0	41.0	11.0
1979	2,975	80.0	448.0	347.0	388.0	41.0	11.0
1980	3,478	92.4	443.0	350.0	389.0	39.0	11.4
1981	1,432	38.3	445.8	352.0	390.0	38.0	11.7
1982	2,833	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	2,018	43.7	361.0	358.0	385.0	27.0	13.4
1985	4,339	96.6	371.0	352.0	381.0	29.0	12.8
1986	4,769	109.3	382.0	369.0	395.0	26.0	14.7
1987	4,526	109.7	404.0	366.0	399.0	33.0	12.2
1988	4,836	132.8	457.0	367.0	400.0	33.0	13.9
1989	4,820	133.9	463.0	375.0	408.0	33.0	14.0
1990	5,060	134.5	443.0	374.0	407.0	33.0	13.4
1991	4,792	123.3	428.0	369.0	401.0	32.0	13.4
1992	5,075	129.0	424.0	370.0	401.0	31.0	13.7
1993	3,871	97.1	418.0	368.0	399.0	31.0	13.5
1994	2,450	62.7	426.4	358.0	389.0	31.0	13.7
1995	2,829	70.1	413.0	361.0	390.0	29.0	14.2
1996	3,007	75.3	417.3	364.0	390.0	26.0	16.0
1997	3,195	80.5	419.9	358.0	384.0	26.0	16.2

NOTE: Well completed Aug. 1951; initial depth to water: 259 ft; surface elev. 6,056 ft.

Well G-3

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1951	192	7.3	633.7	281.0	—	—	—
1952	2,379	65.4	458.2	310.0	358.0	48.0	9.5
1953	3,192	76.4	398.9	322.0	360.0	38.0	10.5
1954	2,675	66.1	411.8	322.0	370.0	48.0	8.6
1955	2,369	69.4	488.3	316.0	368.0	52.0	9.4
1956	3,149	87.9	465.2	324.0	380.0	56.0	8.3
1957	2,517	70.2	464.8	324.0	385.0	61.0	7.6
1958	2,562	69.5	452.1	323.0	386.0	63.0	7.2
1959	2,931	74.6	424.2	326.0	395.0	69.0	6.1
1960	3,591	82.5	382.9	335.0	407.0	72.0	5.3
1961	3,612	79.9	368.7	343.0	414.0	71.0	5.2
1962	4,057	83.7	343.9	348.0	418.0	70.0	4.9
1963	4,555	86.7	317.2	352.0	422.0	70.0	4.5
1964	4,487	78.6	292.0	355.0	424.0	69.0	4.2
1965	3,498	65.6	312.6	350.0	419.0	69.0	4.5
1966	3,991	73.7	307.8	353.0	420.0	67.0	4.6
1967	2,752	52.9	320.4	344.0	418.0	74.0	4.3
1968	3,086	56.5	305.1	341.0	418.0	77.0	4.0
1969	2,672	50.8	316.9	338.0	417.0	79.0	4.0
1970	2,736	55.4	337.5	336.0	419.0	83.0	4.1
1971	3,337	64.2	320.6	342.0	423.0	81.0	4.0
1972	2,838	50.9	298.9	341.0	421.0	80.0	3.7
1973	2,843	47.3	277.3	341.0	418.0	77.0	3.6
1974	3,006	49.3	273.3	342.0	424.0	82.0	3.3
1975	2,632	43.1	272.9	341.0	428.0	87.0	3.1
1976	2,971	82.6	463.4	359.0	447.0	88.0	5.3
1977	2,961	78.9	444.1	353.0	448.0	95.0	4.7
1978	2,590	66.4	427.5	345.0	443.0	98.0	4.4
1979	3,014	69.0	381.0	345.0	450.0	105.0	3.6
1980	3,448	61.8	298.6	348.0	453.0	105.0	2.8
1981	4,315	66.6	257.2	357.0	467.0	110.0	2.3
1982	3,550	51.0	239.0	349.0	459.0	110.0	2.2
1983	2,183	31.3	239.0	340.0	463.0	123.0	1.9
1984	1,211	19.0	267.0	355.0	475.0	120.0	2.2
1985	1,587	22.1	232.0	351.0	470.0	119.0	2.0
1986	2,266	26.7	196.0	375.0	492.0	117.0	1.7
1987	—	<0.1	—	—	—	—	—
1988	—	3.4	—	—	—	—	—
1989	—	<0.1	—	—	—	—	—
1990	—	—	—	—	—	—	—
1991	—	—	—	—	—	—	—

NOTE: Well completed July 1951; initial depth to water: 280 ft; surface elev. 6,139 ft.
Well out of service in 1989 due to pumpage of excessive sand.

Well G-4

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1951	—	12.5	—	357.0	477.0	120.0	—
1952	2,401	56.9	395.0	374.0	474.0	100.0	3.9
1953	2,677	55.2	343.7	380.0	472.0	92.0	3.7
1954	2,256	58.8	434.4	383.0	526.0	143.0	3.0
1955	1,172	22.7	322.8	378.0	481.0	103.0	3.1
1956	1,800	33.9	313.9	377.0	491.0	114.0	2.8
1957	1,324	24.2	304.6	373.0	498.0	125.0	2.4
1958	1,970	35.9	303.7	370.0	490.0	120.0	2.5
1959	1,819	31.6	289.5	378.0	494.0	116.0	2.5
1960	2,457	37.0	251.0	385.0	509.0	124.0	2.0
1961	2,787	45.0	269.1	389.0	512.0	123.0	2.2
1962	2,738	41.7	253.8	386.0	505.0	119.0	2.1
1963	3,519	46.4	219.8	388.0	504.0	116.0	1.9
1964	3,561	42.9	200.8	396.0	499.0	103.0	1.9
1965	2,100	23.8	188.9	394.0	492.0	98.0	1.9
1966	2,219	33.6	252.4	391.0	498.0	107.0	2.4
1967	2,690	44.8	277.6	388.0	509.0	121.0	2.3
1968	2,083	31.4	251.2	386.0	509.0	123.0	2.0
1969	1,309	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	1,640	21.0	213.4	389.0	503.0	114.0	1.9
1972	2,840	33.3	195.4	391.0	507.0	116.0	1.7
1973	3,006	37.2	206.3	392.0	521.0	129.0	1.6
1974	2,672	34.3	213.9	392.0	519.0	127.0	1.7
1975	1,977	41.0	345.6	403.0	559.0	156.0	2.2
1976	2,859	57.8	336.9	406.0	571.0	165.0	2.0
1977	2,954	62.4	352.1	406.0	589.0	183.0	1.9
1978	2,607	49.5	316.5	398.0	589.0	191.0	1.7
1979	2,974	52.9	296.4	395.0	586.0	191.0	1.6
1980	2,235	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	3,657	65.2	297.0	386.0	578.0	192.0	1.5
1983	2,604	42.2	270.0	—	—	—	—
1984	3,766	49.7	220.0	—	—	—	—
1985	1,747	21.7	207.0	402.0	572.0	170.0	1.2
1986	2,678	33.9	211.0	396.0	574.0	178.0	1.2
1987	2,011	25.1	208.0	398.0	573.0	175.0	1.2
1988	301	4.1	227.0	390.0	545.0	155.0	1.4
1989	1,739	21.6	207.0	401.0	562.0	161.0	1.3
1990	1,539	16.8	182.0	381.0	564.0	183.0	1.0
1991	1,254	13.7	181.0	382.0	559.0	177.0	1.0
1992	1,116	12.0	179.0	387.0	544.0	157.0	1.1
1993	0	0.0	0.0	374.0	—	—	—
1994	8	<0.1	162.5	363.0	525.0	162.0	1.0
1995	0	0.0	0.0	368.0	—	—	0.0
1996	721	7.2	166.4	374.0	570.0	196.0	0.8
1997	518	5.4	173.7	375.0	560.0	185.0	0.9

NOTE: Well completed May 1951; initial depth to water: 347 ft; surface elev. 6,229 ft.

Well G-5

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1951	—	6.7	—	414.0	—	—	—
1952	2,579	73.8	476.9	422.0	480.0	58.0	8.2
1953	1,433	37.8	439.6	425.0	467.0	42.0	10.5
1954	2,617	80.9	515.2	429.0	473.0	44.0	11.7
1955	2,529	80.4	529.9	427.0	472.0	45.0	11.8
1956	3,052	97.0	529.7	431.0	478.0	47.0	11.3
1957	2,385	64.1	447.9	424.0	466.0	42.0	10.7
1958	1,523	49.1	537.3	428.0	477.0	49.0	11.0
1959	2,917	101.7	581.1	435.0	495.0	60.0	9.7
1960	2,828	98.0	577.6	437.0	501.0	64.0	9.0
1961	3,908	134.0	571.5	438.0	507.0	69.0	8.3
1962	4,186	142.0	565.4	440.0	511.0	71.0	8.0
1963	4,528	151.0	555.8	441.0	513.0	72.0	7.7
1964	4,532	150.4	553.1	446.0	516.0	70.0	7.9
1965	3,520	117.1	554.5	443.0	516.0	73.0	7.6
1966	2,555	83.2	542.7	445.0	520.0	75.0	7.2
1967	2,405	80.0	554.4	444.0	519.0	75.0	7.4
1968	2,513	81.2	538.5	443.0	517.0	74.0	7.3
1969	2,649	83.3	524.1	450.0	520.0	70.0	7.5
1970	2,771	88.9	534.7	453.0	521.0	68.0	7.9
1971	2,657	88.3	553.9	450.0	521.0	71.0	7.8
1972	2,902	92.4	530.7	441.0	514.0	73.0	7.3
1973	3,003	97.5	541.1	444.0	515.0	71.0	7.6
1974	2,054	69.0	559.9	440.0	513.0	73.0	7.7
1975	2,266	74.7	549.4	433.0	500.0	67.0	8.2
1976	2,955	95.0	535.8	442.0	504.0	62.0	8.6
1977	2,836	92.1	541.3	444.0	504.0	60.0	9.0
1978	2,608	84.2	538.4	442.0	502.0	60.0	9.0
1979	2,766	86.5	521.5	442.0	502.0	60.0	8.7
1980	2,896	89.0	512.4	442.0	502.0	60.0	8.5
1981	2,124	66.7	523.4	451.0	528.0	77.0	6.8
1982	1,219	38.2	522.0	455.0	510.0	55.0	9.5
1983	2,904	73.2	420.0	445.0	492.0	47.0	8.9
1984	3,838	115.4	501.0	452.0	507.0	55.0	9.4
1985	2,193	67.9	516.0	453.0	509.0	56.0	9.2
1986	2,219	52.5	394.0	453.0	494.0	41.0	9.6
1987	5,732	116.7	379.0	462.0	504.0	42.0	9.0
1988	4,841	115.3	396.0	466.0	507.0	41.0	9.7
1989	4,715	110.9	392.0	474.0	514.0	40.0	9.8
1990	5,094	119.2	390.0	485.0	526.0	41.0	9.5
1991	4,981	113.0	378.0	487.0	534.0	47.0	8.0
1992	5,006	114.4	376.0	470.0	508.0	38.0	9.9
1993	3,859	92.2	398.0	466.0	503.0	37.0	10.8
1994	109	2.5	388.0	459.0	494.0	35.0	11.1
1995	807	17.6	363.5	—	—	—	—
1996	2,686	66.9	415.1	—	—	—	—
1997	3,238	81.5	419.4	—	—	—	—

NOTE: Well completed May 1951; initial depth to water: 411 ft; surface elev. 6,306 ft.

Well G-6

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1964	1,912	45.0	392.3	581.0	659.0	78.0	5.0
1965	3,200	74.9	390.1	582.0	660.0	78.0	5.0
1966	3,931	92.2	390.9	585.0	658.0	73.0	5.4
1967	2,454	57.8	392.6	580.0	653.0	73.0	5.4
1968	2,597	56.2	360.7	574.0	647.0	73.0	4.9
1969	2,698	55.6	343.5	568.0	636.0	68.0	5.1
1970	2,765	51.0	307.4	569.0	634.0	65.0	4.7
1971	2,932	42.8	243.3	573.0	629.0	56.0	4.3
1972	2,516	57.0	377.6	578.0	670.0	92.0	4.1
1973	2,991	65.3	363.9	579.0	667.0	88.0	4.1
1974	2,950	63.8	360.5	579.0	665.0	86.0	4.2
1975	2,717	56.7	347.8	577.0	659.0	82.0	4.2
1976	2,966	57.8	324.8	584.0	662.0	78.0	4.2
1977	2,954	54.4	306.9	586.0	659.0	73.0	4.2
1978	2,218	38.4	288.9	581.0	645.0	64.0	4.5
1979	1,030	18.2	295.1	579.0	645.0	66.0	4.8
1980	1,789	34.5	321.5	583.0	670.0	87.0	3.7
1981	4,302	76.5	296.4	586.0	673.0	87.0	3.4
1982	3,763	63.6	281.0	588.0	669.0	81.0	3.5
1983	1,960	35.4	301.0	582.0	668.0	86.0	3.5
1984	3,010	55.3	306.0	589.0	666.0	77.0	3.9
1985	3,980	71.4	299.0	586.0	664.0	78.0	3.8
1986	4,420	76.7	293.0	576.0	654.0	78.0	3.8
1987	5,100	81.4	266.0	595.0	671.0	76.0	3.5
1988	5,121	82.1	267.0	591.0	669.0	78.0	3.4
1989	5,000	81.6	272.0	592.0	669.0	77.0	3.5
1990	5,202	84.9	272.0	589.0	670.0	81.0	3.4
1991	5,063	81.2	267.0	591.0	674.0	83.0	3.2
1992	4,382	70.2	268.0	591.0	673.0	82.0	3.3
1993	—	—	—	575.0	—	—	—
1994	1,660	27.5	276.0	572.0	652.0	80.0	3.5
1995	2,892	46.4	267.4	577.0	660.0	83.0	3.2
1996	2,311	36.0	259.6	581.0	661.0	80.0	3.3
1997	1,262	19.5	257.5	581.0	658.0	77.0	3.4

NOTE: Well completed Mar. 1964; initial depth to water: 572 ft; surface elev. 6,422 ft.

Well PM-1

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1965	2,754	99.2	600.3	746.0	786.0	40.0	15.0
1966	3,086	108.0	583.3	740.0	779.0	39.0	15.0
1967	2,870	111.0	644.6	737.0	781.0	44.0	14.6
1968	1,846	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	1,781	66.2	619.5	733.0	769.0	36.0	17.2
1971	2,728	101.0	617.1	733.0	766.0	33.0	18.7
1972	2,415	84.9	585.9	735.0	762.0	27.0	21.7
1973	1,688	46.5	459.1	736.0	755.0	19.0	24.2
1974	2,649	96.3	605.9	740.0	768.0	28.0	21.6
1975	2,567	94.8	615.5	741.0	766.0	25.0	24.6
1976	2,933	106.8	606.9	744.0	767.0	23.0	26.4
1977	2,969	105.4	591.7	745.0	767.0	22.0	26.9
1978	2,544	90.6	593.3	745.0	767.0	22.0	27.0
1979	2,350	83.4	591.5	744.0	766.0	22.0	26.9
1980	2,786	98.5	588.6	746.0	769.0	23.0	25.7
1981	2,789	98.5	588.6	747.0	769.0	22.0	26.8
1982	2,820	99.6	589.0	748.0	770.0	22.0	26.8
1983	2,464	86.5	585.0	747.0	769.0	22.0	26.6
1984	2,667	92.8	580.0	749.0	772.0	23.0	25.6
1985	2,760	95.4	576.0	749.0	770.0	21.0	27.4
1986	2,130	73.9	578.0	748.0	770.0	22.0	26.3
1987	2,912	102.4	586.0	752.0	773.0	21.0	27.9
1988	2,758	98.0	592.0	751.0	775.0	24.0	24.7
1989	3,014	104.9	580.0	752.0	774.0	22.0	26.4
1990	2,620	88.2	561.0	752.0	772.0	20.0	28.0
1991	2,600	88.6	568.0	752.0	774.0	22.0	25.8
1992	2,503	92.7	617.0	756.0	780.0	24.0	25.7
1993	1,802	63.9	591.0	758.0	779.0	21.0	28.1
1994	1,254	43.4	576.9	755.0	778.0	23.0	25.1
1995	870	29.7	569.0	753.0	776.0	23.0	24.7
1996	1,084	36.3	559.6	755.0	778.0	23.0	24.3
1997	1,406	47.7	560.0	760.0	784.0	24.0	23.3

NOTE: Well completed Mar. 1965; initial depth to water: 722.1 ft; surface elev. 6,520 ft.

Well PM-2

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1966	221	18.9	1,425.3	826.0	889.0	63.0	22.6
1967	4,336	370.0	1,422.2	834.0	888.0	54.0	26.3
1968	3,865	328.2	1,415.3	838.0	889.0	51.0	27.8
1969	3,304	279.9	1,411.9	838.0	890.0	52.0	27.2
1970	3,529	300.6	1,419.7	839.0	893.0	54.0	26.3
1971	4,035	339.5	1,402.3	841.0	898.0	57.0	24.6
1972	4,611	385.3	1,392.7	845.0	902.0	57.0	24.4
1973	4,571	380.6	1,387.7	849.0	907.0	58.0	23.9
1974	5,443	450.9	1,380.7	853.0	912.0	59.0	23.4
1975	4,644	385.3	1,382.8	854.0	913.0	59.0	23.4
1976	5,382	442.0	1,368.8	866.0	924.0	58.0	23.6
1977	3,306	272.8	1,375.3	868.0	924.0	56.0	24.6
1978	4,743	388.4	1,364.9	871.0	928.0	57.0	23.9
1979	4,671	381.8	1,262.2	872.0	924.0	52.0	26.2
1980	5,023	409.6	1,359.2	873.0	931.0	58.0	23.4
1981	4,551	370.1	1,355.4	876.0	934.0	58.0	23.4
1982	4,319	359.3	1,386.0	874.0	934.0	60.0	23.1
1983	1,922	157.9	1,369.0	876.0	935.0	59.0	23.2
1984	996	81.6	1,365.0	866.0	930.0	64.0	21.7
1985	1,749	143.3	1,365.0	851.0	916.0	65.0	21.0
1986	1,036	84.4	1,359.0	851.0	915.0	64.0	21.2
1987	351	28.3	1,340.0	851.0	907.0	56.0	23.9
1988	1,843	146.8	1,328.0	869.0	931.0	62.0	21.4
1989	1,639	130.0	1,322.0	860.0	920.0	60.0	22.0
1990	3,164	250.4	1,319.0	860.0	928.0	68.0	19.4
1991	2,141	170.7	1,329.0	855.0	918.0	63.0	21.1
1992	3,486	277.7	1,328.0	860.0	929.0	69.0	19.2
1993	3,420	267.8	1,305.0	855.0	924.0	69.0	18.9
1994	3,922	298.9	1,270.3	870.0	934.0	64.0	19.8
1995	2,778	217.7	1,306.1	870.0	934.0	64.0	20.4
1996	4,023	302.2	1,250.0	—	—	—	—
1997	2,154	162.9	1,260.0	—	—	—	—

NOTE: Well completed July 1965; initial depth to water: 823 ft; surface elev. 6,715 ft.

Well PM-3

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1968	2,327	187.4	1,342.2	743.0	771.0	28.0	47.9
1969	3,241	254.7	1,309.8	746.0	772.0	26.0	50.4
1970	2,905	227.8	1,306.9	750.0	774.0	24.0	54.5
1971	2,774	216.3	1,299.6	751.0	774.0	23.0	56.5
1972	2,445	192.1	1,309.5	752.0	775.0	23.0	56.9
1973	3,256	257.8	1,319.6	755.0	778.0	23.0	57.4
1974	3,241	255.3	1,312.9	756.0	779.0	23.0	57.1
1975	3,421	269.3	1,312.0	757.0	780.0	23.0	57.0
1976	3,171	268.3	1,410.2	758.0	784.0	26.0	54.2
1977	2,792	235.5	1,405.8	758.0	784.0	26.0	54.1
1978	2,516	211.0	1,397.6	759.0	784.0	25.0	55.9
1979	2,359	197.2	1,393.0	760.0	784.0	24.0	58.0
1980	2,796	234.4	1,397.2	760.0	785.0	25.0	55.9
1981	2,784	232.4	1,391.3	761.0	786.0	25.0	55.6
1982	2,831	238.1	1,402.0	762.0	785.0	23.0	60.9
1983	2,496	207.6	1,386.0	762.0	785.0	23.0	60.3
1984	3,317	275.6	1,385.0	762.0	787.0	25.0	55.4
1985	2,643	221.2	1,395.0	762.0	784.0	22.0	63.4
1986	2,920	244.8	1,397.0	763.0	787.0	24.0	58.2
1987	2,984	250.2	1,397.0	763.0	788.0	25.0	55.9
1988	2,766	232.0	1,397.0	764.0	788.0	24.0	58.2
1989	2,656	221.0	1,386.0	765.0	791.0	26.0	53.3
1990	2,949	244.6	1,382.0	767.0	790.0	23.0	60.0
1991	2,752	229.5	1,385.0	768.0	791.0	23.0	60.2
1992	3,610	307.4	1,419.0	770.0	794.0	24.0	59.1
1993	2,018	168.5	1,391.0	771.0	797.0	26.0	53.5
1994	966	78.8	1,358.9	772.0	796.0	24.0	56.6
1995	1,971	159.7	1,350.4	772.0	796.0	24.0	56.3
1996	1,401	118.5	1,409.7	776.0	802.0	26.0	54.2
1997	961	80.6	1,397.8	779.0	805.0	26.0	53.8

NOTE: Well completed Nov. 1966; initial depth to water: 740 ft; surface elev. 6,640 ft.

Well PM-4

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1982	869	76.2	1,460	1,050	1,091	41	35.6
1983	5,267	452.5	1,432	1,066	1,101	35	40.9
1984	4,059	325.8	1,338	1,065	1,104	39	34.3
1985	4,759	379.2	1,328	1,066	1,101	35	37.9
1986	3,925	307.4	1,305	1,084	1,119	35	37.3
1987	5,071	392.2	1,289	1,081	1,117	36	35.8
1988	2,435	218.7	1,313	1,079	1,117	38	34.6
1989	5,387	418.9	1,296	1,085	1,122	37	35.0
1990	2,827	219.3	1,293	1,083	1,123	40	32.3
1991	2,832	219.5	1,292	1,081	1,123	42	30.8
1992	2,064	158.3	1,278	1,084	1,125	41	31.2
1993	3,901	249.7	1,295	—	—	—	—
1994	6,178	463.5	1,250	1,085	1,128	43	29.1
1995	5,736	428.2	1,244	—	—	—	—
1996	2,721	207.4	1,270	1,091	1,139	48	26.5
1997	5,222	414.5	1,323	1,093	1,142	49	27.0

NOTE: Well completed Aug. 1981; initial depth to water: 1,060 ft; surface elev. 6,920 ft.

Well PM-5

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1985	—	2.0	—	—	—	—	—
1986	2,047	147.3	1,199	—	—	—	—
1987	1,620	118.6	1,220	1,237	1,345	108	11.3
1988	1,754	128.6	1,221	1,233	1,345	112	10.9
1989	1,184	86.2	1,213	1,239	1,352	113	10.7
1990	1,611	121.0	1,252	1,234	1,347	113	11.1
1991	1,497	112.1	1,248	1,239	1,346	107	11.7
1992	2,823	208.4	1,233	1,248	1,345	97	12.7
1993	1,709	126.0	1,229	1,224	1,321	97	12.6
1994	2,131	156.9	1,227	1,234	1,314	80	15.3
1995	3,948	291.0	1,228	—	—	—	—
1996	2,978	224.6	1,257	1,258	1,351	93	13.5
1997	1,261	91.8	1,213	1,254	1,342	88	13.8

NOTE: Well completed Sept. 1982; initial depth to water: 1,208 ft; surface elev. 7,095 ft.

Well O-1

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1995	0	0.0	0	675	—	—	—
1996	0	0.0	0	675	—	—	—
1997	0	0.0	0	676	—	—	—

NOTE: Well completed Aug. 1990; initial depth to water: 675 ft; surface elev. 6,396 ft.

Well O-4

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level Nonpumping (ft)	Water Level Pumping (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)
1993	2,942	283.8	1,603	761	789	28	57.3
1994	2,456	205.7	1,396	760	781	21	66.5
1995	0	0.0	0	762	—	—	0.0
1996	2,330	209.6	1,499	—	—	—	—
1997	2,396	216.4	1,505	—	—	—	—

NOTE: Well completed Mar. 1990; initial depth to water: 780 ft; surface elev. 6,627 ft.

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APPENDIX B

STATIC WATER LEVELS IN REGIONAL AQUIFER TEST WELLS

Depth-to-Water Measurements from Regional Aquifer Test Wells (feet below surface elevation datum)

Year	TW-1	TW-2	TW-3	TW-4	TW-8	DT-5A	DT-9	DT-10	LA-1B
Drilled:	**1950**	**1949**	**1949**	**1950**	**1960**	**1959**	**1960**	**1960**	**1960**
Datum:	**6,369.19**	**6,647.63**	**6,595.31**	**7,244.56**	**6,877.62**	**7,143.86**	**6,936.71**	**7,019.92**	**5,622.00**
Init WL	**584.9**	**758.9**	**743.3**	**1,170.8**	**968.0**	**1,173.2**	**1,003.3**	**1,090.6**	**–34.0**[a]
1949		758.9	743.3						
1950	584.9			1,170.8					
1951	592.3	760.1	750.9	1,166.1					
1952	591.4		751.0	1,166.6					
1953	591.2	759.9	751.4	1,167.5					
1954	591.8	760.6	751.4	1,166.2					
1955		760.2	751.3						
1956	592.0	759.9	750.9						
1957	593.1	759.9	751.3						
1958	593.8	759.7	751.7						
1959	593.9		751.8						
1960	593.4	760.5	751.8	1,165.9	968.0	1173.2	1,003.3	1,090.6	–34.0[a]
1961	591.8	760.8		1,165.9			1,003.4	1,090.6	54.0
1962	590.0	761.2	751.8				1,004.0		72.0
1963	588.3	762.8	753.6		968.7	1176.9	1,004.6	1,090.3	74.0
1964	587.8		754.2		968.7	1177.0	1,005.0	1,090.4	81.0
1965	588.4				968.7		1,005.1	1,090.5	63.0
1966							1,005.2	1,090.6	50.0
1967							1,005.4	1,090.6	39.0
1968							1,005.5		32.0
1969									22.0
1970									22.0
1971							1,005.5		31.0
1972							1,005.2		31.0
1973							1,005.3		37.0
1974							1,005.6		35.0
1975							1,005.6		42.0
1976							1,005.8		50.0
1977		775.5					1,006.1		47.0
1978							1,006.2		42.0
1979							1,006.4		13.0
1980							1,006.2		21.0
1981							1,006.2		26.0
1982							1,006.2		71.0
1983									61.0
1984									75.0
1985									55.0
1986									25.0
1987									66.0
1988		787.0							60.0
1989									73.0
1990	508.4	787.2	772.0						70.0
1991	507.0	789.0							55.0
1992	536.5	792.5	777.5						
1993	545.8	794.2	778.2	1,176.3	993.3	1,183.4	1,016.0	1,096.9	–14.8[a]
1994	548.7	798.3	780.8	1,176.9	993.1	1,183.7	1,016.3	1,097.2	–18.7[a]
1995	550.2	795.8	781.8	1,177.2	994.4	1,183.5	1,015.5	1,097.0	–19.3[a]
1996	551.9	796.8	781.7	1,176.4	994.7	1,183.6	1,015.8	1,097.1	–18.4[a]
1997	528.8	—	782.2	—	994.4	—	1,016.0	1,097.3	—

[a]Negative values indicate feet above surface elevation datum.