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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Santa Fe, New Mexico

Record of water-supply well PM-3

Los Alamos, New Mexico

By

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Open-file report

Prepared in cooperation with the U.S. Atomic Energy Commission

June 1967

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Introduction

This report contains data on the geology and hydrology at the site of construction of supply well PM-3 which was drilled in 1966 to supplement the water supply at Los Alamos, New Mexico. The well is in Sandia Canyon about 7,000 feet west of the junction of the Laboratory Truck Route and State Highway 4 (fig. 1).

The location was chosen by the U.S. Atomic Energy Commission as the first of five well locations suggested by the Geological Survey. The well has a capability of supplying either of the communities of Los Alamos or White Rock through the 16-inch water line that parallels State Highway 4.

The drilling and construction of the well was divided into 2 main phases: 1) drilling a 9-inch pilot hole to a depth of 2,552 feet, logging by geophysical methods the formations penetrated, and preparation of a geologic log of the formations; and 2) reaming the pilot hole to 2,552 feet, casing, gravel-packing, and developing by swabbing, bailing, and pumping.

Well construction and development was supervised by Gordon Herkenhoff and Associates, Consulting Engineers, Albuquerque, New Mexico.

Geology and construction

Well PM-3 is completed at a depth of 2,552 feet, and penetrates the Bandelier Tuff, basaltic rocks of Chino Mesa, Puye Conglomerate and the Tesuque Formation. The static water level stands at 740 feet below land surface. Units of the Puye Conglomerate and Tesuque Formation are in the zone of saturation.

The descriptive log of the formations penetrated by the pilot hole is given in table 1. Figures 2, 3, 4, and 5 are geophysical logs of the well. Examination and interpretation of the geologic and geophysical logs indicate that the greater part of the formations in the zone of saturation (740 to 2,552 feet) are permeable and would yield water to the well. A high yield well (1,000 to 1,500 gallons per minute) could be developed by completing the well to the total depth of the pilot hole (2,552 feet).

The well, gravel packed, is cased with 2,552 feet of 14-inch casing. The lower 1,596 feet is perforated.

Table 2 contains the construction record.

Table 1.--Geologic log of well PM-3

Location: NW½,NW¼,SW¼,sec.19,T.19N., R.7 E

Altitude: 6,640 feet above sea-level datum

Total depth: 2,552 feet

Date drilled: 1966

Tools Mud rotary

Driller: Perry and Faast Drilling Co.; Grand Junction, Colo.

Material	Thickness (feet)	Depth (feet)
Alluvium:		
Sand, silty, composed of quartz and sanidine crystals and crystal fragments and occasional rock fragment of latite and pumice; latite as much as one-inch in length.	30	30
Bandelier Tuff, Otowi Member:		
Tuff, light pinkish gray, composed of quartz and sanidine crystals and crystal fragments; small rock fragments of pumice, latite and rhyolite.	140	170

Table 1.--Geologic log of well PM-3 - Continued

Material	Thickness (feet)	Depth (feet)
Bandelier Tuff, Guaje Member:		
Pumice, light gray, composed of quartz and sanidine crystals and crystal fragments; some latite rock fragments in a cellular glassy matrix.	20	190
Puye Conglomerate, fanglomerate member:		
Siltstone, light pink, composed of silt and clay; rock fragments of latite, rhyolite, and basalt; gray pumice fragments from 190 to 200 feet; increasing basalt fragments from 200 to 215 feet.	25	215
Unit 3 of the basaltic rocks of Chino Mesa:		
Basalt, dark gray, dense, some iron staining with olive crystals; basalt light red, composed of basalt fragments in clay, silt, and gravel from 330 to 350 feet and from 410 to 420 feet.	325	540

Table 1.--Geologic log of well PM-3 - Continued

Material	Thickness (feet)	Depth (feet)
Puye Conglomerate, fanglomerate member:		
Conglomerate, light gray, composed of gravel and boulders; fine fraction is composed of quartz, sanidine orthoclase, and some mafic minerals; gravel and boulders are composed of latite, rhyolite, and occasional fragments of basalt and pumice; boulders increase from 625 to 745 feet.	205	745
Puye Conglomerate, Totavi Lentil:		
Conglomerate, gray, composed of gravel and boulders of latite, rhyolite and quartzsite; and some mafic minerals.	60	805
Tesuque Formation:		
Sandstone, silty, light gray, composed of medium to coarse sand consisting chiefly of quartz and feldspar and some mafic minerals.	300	1,105
Basalt, dark gray, dense, containing some pyroxine and olivine; clay, light orange 1,210-1,215 feet; some red vesicular basalt from 1,250 to 1,280 feet.	175	1,280

Table 1.--Geologic log of well PM-3 - Continued

Material	Thickness (feet)	Depth (feet)
Basalt, dark gray, dense, angular, some clay, sand and gravel, subrounded; probably alternating thin basalts and interbedded sediments.	35	1,315
Conglomerate, dark gray, composed mostly of sand with occasional cobble or boulders of rhyolite; some thin flows of gray basalt, some light pinkish clay and silt.	125	1,440
Siltstone, light brown, contains a small amount of subrounded sand; sand size fraction increases from 1,460 to 1,470 feet.	55	1,495
Basalt, dark gray dense, with some phenocrysts of pryoxine and olivine.	45	1,540
Sandstone, dark gray, composed of medium to coarse sand, subrounded, with some rock fragments of basalt and a few subrounded pebble fragments of quartzsite.	220	1,760

Table 1.--Geologic log of well PM-3 - Continued

Material	Thickness (feet)	Depth (feet)
Sandstone, silty, light pinkish gray, fine to medium sand, subrounded to well rounded, a few subrounded pebbles.	130	1,890
Siltstone, light brown, with an occasional lense of pebbly conglomerate; some basalt fragments 2,030 to 2,060.	170	2,060
Sandstone, silty, light pinkish brown, predominately fine to medium sand, subrounded to well rounded; coarse sand increases from 2,320 to 2,410 feet; clay and silt, light pink, from 2,470 to 2,490 feet and 2,530 to 2,540 ft.	492	2,552

Table 2.--Construction record of well PM-3

Total depth: 2,552 feet.

Date completed: November 1966.

Casing and hole record: 30-inch hole from 0 to 552 feet, cased with 26-inch pipe, cemented in hole.

24-inch hole from 552 to 2,552 feet. Cased with 14-inch ID blank pipe from 0 to 956 feet and with 14-inch ID pipe slotted with 3/32-inch louver openings from 956 to 2,552 feet.

Annulus between 14-inch and 24-inch hole was filled from 2,552 to 0 feet with washed and graded gravel ranging in size from about 1/32-inch to ¼-inch.

Gage lines: Two steel-pipe gage lines each of 2-inch diameter installed on outside of 14-inch pipe and enter the casing at a depth of 960 feet. An airline will be installed in one gage line; the other is used for entry of mechanical water-level measuring devices.

Well development: The well was swabbed and bailed for 418 hours. Further development consisted of pumping for about 99 hours at rates of 780 to 1,500 gpm.

Yield: Data obtained during the step test indicated that specific capacity of the well is about 37 gpm per foot of drawdown after 12 hours of pumping at 1,400 gpm.

Specific capacity and coefficient of transmissibility

A step test to determine the size and capacity of the permanent pump was made near the end of the test pumping and development period. The well had been pumped 22 hours out of past 24 prior to the step test. The results indicate specific capacities (ratio of pumping rate to water level drawdown) ranging from about 45 gpm per foot of drawdown after 4 hours of pumping at about 900 gpm (gallons per minute) to about 37 gpm per ft. of drawdown after 12 hours of pumping at about 1,400 gpm (table 3). The specific capacities are the highest obtained during the testing of any well in the Los Alamos area.

Table 3.--Step test of well PM-3, November 4 and 5, 1966.

Date	Time (hours)	Water level (feet)	Discharge (gpm)	Specific Capacity (gpm per ft. of drawdown)
11-4-66	11:00	740.0	-	-
	12:00	774.9	1,401	40.1
	13:00	775.5	1,401	39.5
	14:00	775.8	1,401	39.1
	15:00	776.2	1,409	38.9
	16:00	776.6	1,409	38.4
	17:00	776.6	1,401	38.3
	18:00	776.7	1,401	38.2
	19:00	777.1	1,401	37.8
	20:00	777.3	1,401	37.6
	21:00	777.8	1,401	37.1
	22:00	777.8	1,401	37.1
	23:00[a/]	777.9	1,401	37.0
	24:00	770.0	1,311	43.7
11-5-66	01:00	769.7	1,295	43.6
	02:00	771.0	1,295	41.8
	03:00[a/]	771.1	1,295	41.6
	04:00	767.5	1,134	41.2
	05:00	767.7	1,143	41.3
	06:00	767.8	1,143	41.1
	07:00[a/]	767.8	1,153	41.5
	08:00	760.0	899	45.0
	09:00	759.0	887	46.7
	10:00	759.5	899	46.1
	11:00	759.8	899	45.4

a/ Reduce gpm

Note: The amount of sand in discharge was too small to measure, less than 0.1 ppm.

The projected drawdowns and specific capacities at a pumping rate of 1,400 gpm are shown below for periods at the end of one, ten, and thirty days.

	Drawdown (feet)	Specific Capacity (gpm per ft. of drawdown)
1 day	39	36
10 days	42	33
30 days	45	31

The above drawdowns and specific capacities were obtained by projecting drawdown trends during the segment of step test of 12 hours at a pumping rate of 1,400 gpm. The projected values are valid if there were no geologic features that would affect the rate of flow of ground water into the well after prolonged pumping. These data indicate that the well can be equipped with a pump capable of producing as much as 1,400 gpm.

Chemical and radiochemical quality of water

Three water samples were collected at intervals during the test pumping and development of the well. The analyses indicated no significant changes in chemical or radiochemical quality of water with increased pumpage (table 4). The quality of the water is similar to that of well PM-1, which is in Sandia Canyon about 7,000 feet to the east (figure 1). The concentrations of calcium and magnesium in water from both wells is high and results in a water that is moderately hard (98 to 104 ppm) as compared to the other supply wells (range 8 to 54 ppm in 1966),

The water samples were not analyzed for silica, however, four water samples bailed from selected depths in February 1967 had the following silica concentrations:

Depth (feet)	Silica (ppm)
1,000	50
1,500	67
2,000	74
2,400	58

Pumping of the well will probably result in silica concentrations similar to that in water from well PM-1 which range from 65 ppm to 89 ppm.

Table 4.--Chemical and radiochemical analyses of water from well PM-3

(Analyses by the Los Alamos Scientific Laboratory)

Chemical		Date		
		10-31-66	11-3-66	11-4-66
Parts per million	Calcium	26	30	26
	Magnesium	9	7	8
	Sodium	23	24	24
	Carbonate	0	0	0
	Bicarbonate	128	132	126
	Chloride	16	18	16
	Fluoride	0.2	0.	0
	Nitrate	0.2	0.3	0.3
	Dissolved solids	242	166	268
	Total hardness as C_aCO_3	102	104	98
Conductivity in micromhos at 25°C		240	260	240
pH		7.7	7.7	7.7
Radio-chemical				
	Plutonium d/m/l [1/]	< 0.4	< 0.4	< 0.4
	Uranium $\mu g/l$ [2/]	5.1	0.8	1.2
	Beta-gamma emitters d/m/l [1/]	Bq.	Bq.	Bq.
Prepumped (hours)		30	54	67
Estimated pumpage (millions of gallons)		3	4.5	5.1

1/ Disintegration per minute per liter.

2/ Microgram per liter.

The coefficient of transmissibility "T" was determined by analyzing the rate of water level recovery after 12 hours of pumping at a rate of 1,235 gpm by using the method described by Wenzel (p.96, 1942). The indicated "T" is about 320,000 gallons per day per foot (figure 6).

The amount of sand produced with pumpage during the step and aquifer tests was collected and measured at 30 minute intervals. The amount of sand produced during the step test and during the aquifer test was too small to measure--it was less than 0.1 ppm (part per million).

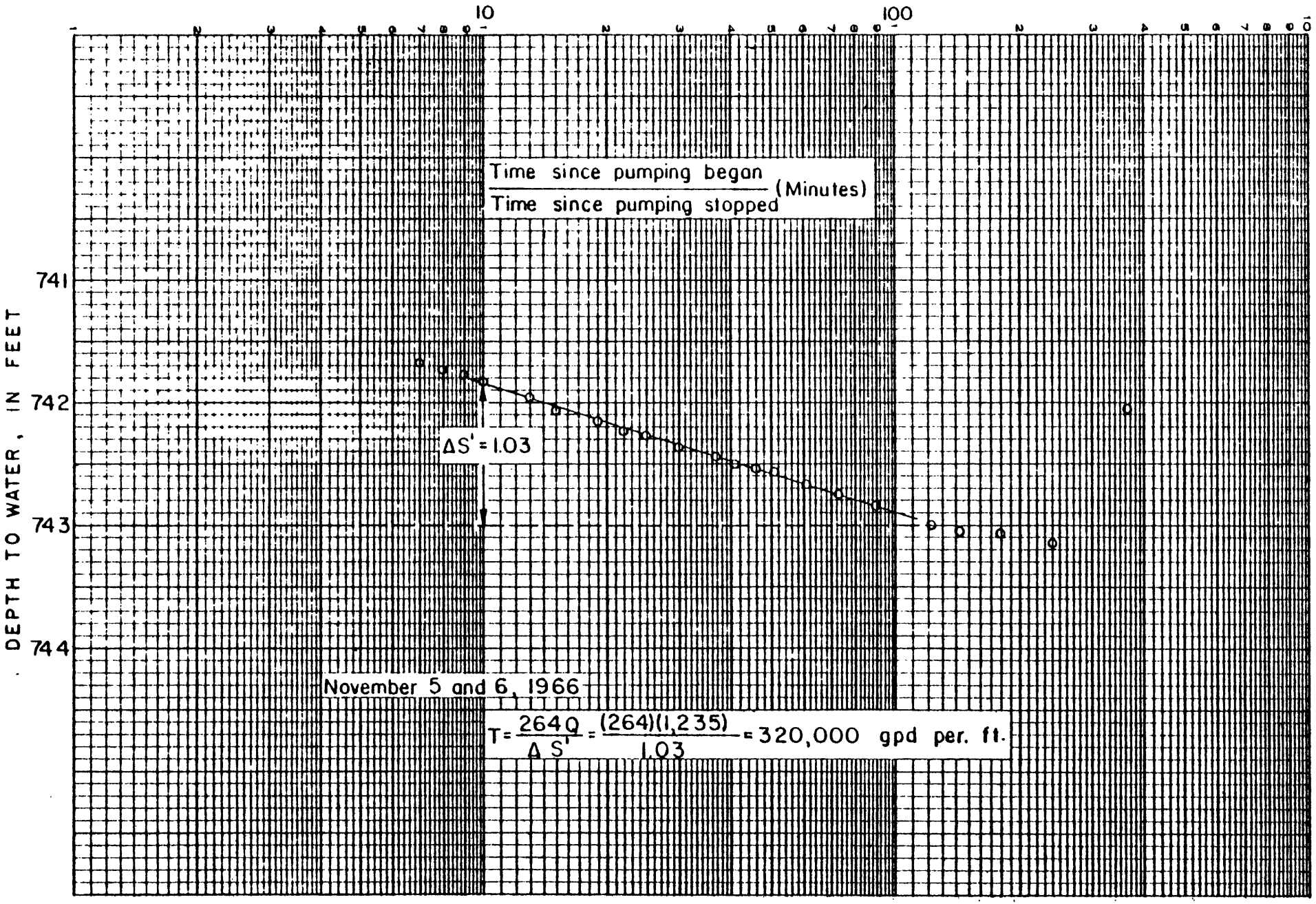

Figure 6.--Water level recovery plot of well PM-3

Radiochemical analyses of water from the well shows less than the lower detectable limit of plutonium and only background levels of beta-gama activity. Uranium activity reported is low, and occurs naturally in the aquifer. It is not the result of contamination.

Conclusions

The well was completed at a depth of 2,552 feet and based on interpretations of geologic and geophysical logs a high yield well (1,000 to 1,500 gpm) could be developed. The data collected during the step test indicate that the well can supply a pump capable of producing 1,400 gpm. The methods used in construction (size of gravel, size of louver openings in casing, and development by swabbing, bailing, and pumping), were satisfactory. Little or no sand was produced with the water pumped during the squifer and step test, thus sand should cause no difficulties when water from the well is added to the supply system.

The water is of good quality for domestic and most industrial use; however, the relatively high concentrations of silica, calcium, and magnesium will contribute scale formation when the water is heated and may be objectionable for some industrial use.

Reference

Wenzel, L. K., 1952, Methods for determining permeability of water-bearing materials with special reference to discharging-well methods: U.S. Geol. Survey Water-Supply Paper 887, 192 p. 17 figs.

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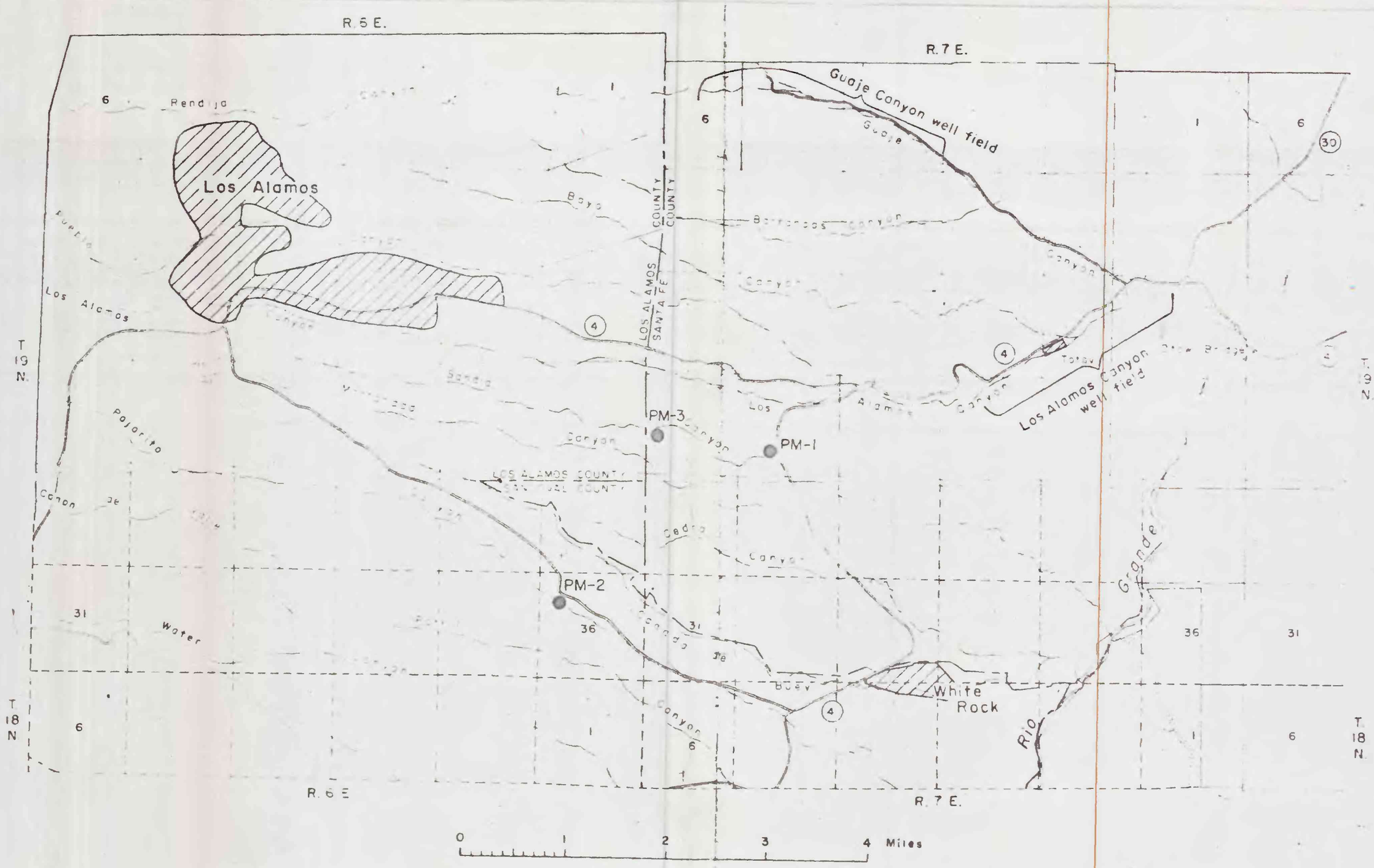

Figure 1.--Map of the Los Alamos area showing locations of supply wells on the Pajarito Plateau and locations of the Los Alamos and Guaje Canyon well fields.

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Figure 2.--Temperature log of well PH-3.

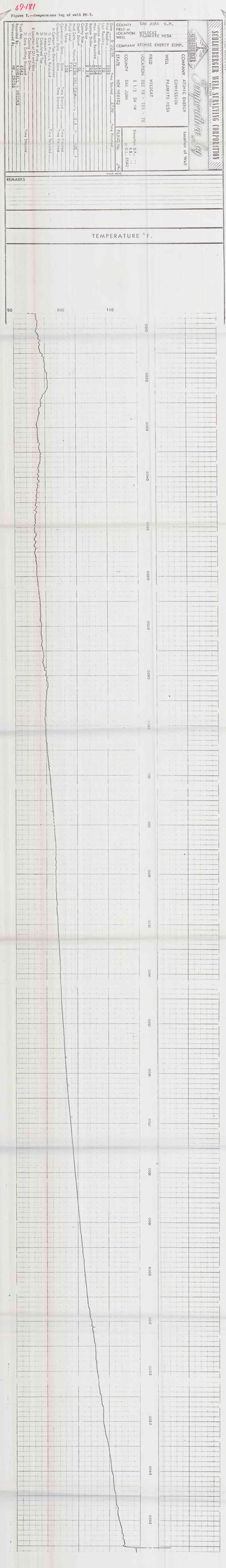

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Figure 3.--Gamma Ray - Neutron log of well PM-3.

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Figure 4.—Induction electrical log of well No.3