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Availability of ground water for irrigation near Zia Pueblo, Sandoval County, New Mexico

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Introduction

This report presents an evaluation of the availability of ground water for irrigation of land in the Zia Pueblo Grant north of State Highway 44 in secs. 19 and 20, T. 15 N., R. 2 E. Some water is diverted from the Jemez River near San Ysidro for irrigation, but the supply is inadequate to irrigate all of the arable land. The land for which additional irrigation water is desired lies on a flat terrace south of the Jemez River, upstream from Zia Pueblo.

The Zia area has been included in several geologic studies. (See "References" at end of report.) The water resources of this area, however, have not been investigated previously. At request of the U. S. Bureau of Indian Affairs, J. R. Rapp and B. W. Maxwell of the U. S. Geological Survey made a study of the potential for irrigation wells in May and June 1959.

Zia Pueblo is in central Sandoval County, N. Mex., about 5 miles southeast of San Ysidro. Santa Ana Pueblo is 8 miles to the southeast of Zia. These three towns are small, each having less than 1,000 inhabitants.

The Jemez River, the principal stream in the area, bisects the Zia Pueblo Grant as it flows southeastward to join the Rio Grande near Bernalillo, 12 miles southeast of Zia. The river and its floodplain range from one-eighth to five-eighths of a mile in width. Low flat terraces rise to 30 feet above the river bed on each side. Most of the people of the area live and farm on these terraces. Dissected slopes rise from the low terraces to adjoining uplands.

The largest tributary to the Jemez River is the Rio Salado which flows into the Jemez from the west at San Ysidro. Arroyo Chamisa, Arroyo Piedra Parada, and other smaller streams are tributary to the Jemez in the area. Both the Jemez River and the Rio Salado in this area are dry for extended periods. The smaller arroyos flow for short periods only in direct response to precipitation.

Geologic formations and their water-bearing properties

Rocks ranging in age from Mesozoic to Recent crop out in the area shown in figure 1. The water-bearing characteristics of these rocks

Figure 1.--Map showing geology and locations of wells in and near the Zia Indian Reservation, Sandoval County, N. Mex.

are summarized in table 1. Pre-Mesozoic rocks were not considered,

Table 1.--Geologic formations and their water-bearing characteristics in the Zia area.

because generally their yield is small, the quality of water in them is poor, and they are too deep for practicable use.

Mesozoic rocks

Rocks of Mesozoic age, including the Triassic, Jurassic, and Cretaceous systems, crop out west of a fault which lies approximately on the line between Rs. 1 and 2 E. East of the fault they are buried beneath rocks of the Santa Fe group.

The Mesozoic rocks are not important as aquifers because their fine texture and tight cementation restrict the movement of water. Wells completed in these rocks generally yield less than 20 gpm (gallons per minute).

Tertiary and Quaternary rocks

Rocks of Tertiary and Quaternary age overlie the Mesozoic strata unconformably. On the map these rocks are shown as the Santa Fe group, which is middle(?) Miocene, Pliocene, and early Pleistocene in age, and alluvium, which is Pleistocene and Recent in age.

The Santa Fe group in this area consists predominantly of about 1,000 feet of loosely consolidated brown to gray, arkosic sand. Locally it contains beds of gravel, silt, and clay, as described in the log of well 15.2.6.222. (See table 2.)

Table 2.--Logs of wells.

The alluvium lies in channels cut into the Santa Fe group and the Mesozoic rocks. It consists of beds of unconsolidated silt, sand, and gravel. The beds are brown, gray, black, and red depending on the source of the material. The thickness of the alluvium probably does not exceed about 100 feet in the Zia area.

Ground water

The source of recharge to the Mesozoic rocks is precipitation on outcrop and by interformational leakage along faults. Water from precipitation contains little or no dissolved solids as it enters the rocks, but it becomes highly mineralized by solution of minerals in the rocks, as it moves through them. Water migrating along faults in the area generally is highly mineralized.

The source of recharge to the alluvium and the Santa Fe group is precipitation and runoff and by underflow from older rocks across the fault. The water from precipitation is low in dissolved solids as it enters the rocks, but the runoff water varies greatly in dissolved solids. Some is too highly mineralized for irrigation. Water in the Rio Salado generally is highly mineralized except during brief periods of floodflow. Water from the Jemez River generally is suitable for irrigation but at low flow it becomes more mineralized. (See analysis 16.1.29.310, Jemez River at San Ysidro diversion, table 4.) Underflow from the older rocks across the fault is highly mineralized.

Ground water is present in the pores between the grains of silt, sand, and gravel in the alluvium and the Santa Fe group. The coarser material has large interconnected pore spaces, and it yields water readily to wells.

The alluvium and the Santa Fe group are hydraulically connected in R. 2 E. (east of the fault), where the alluvium is underlain by the Santa Fe group. The water table in these units slopes 20 to 30 feet per mile, approximately the same as the slope of the river, southeastward from San Ysidro toward Zia, and the water moves in that direction. The depth to water in the alluvium is less than 30 feet between Zia and San Ysidro.

The yields of existing wells in the area are small (table 3). Well

Table 3.--Records of wells in and near the Zia Indian Reservation, Sandoval County, N. Mex.

15.2.6.222 yielded 60 gpm. Other wells are utilized only for small quantities of water for stock and domestic use. Wells constructed in similar material in the nearby Rio Grande valley yield more than 500 gpm. The L. Gross well in Bernalillo, which is only 110 feet deep, reportedly yields 1,200 gpm from the alluvium with a drawdown of 31 feet. The Plains Electric Company well 3, at Algodones, which penetrates about 200 feet of saturated material, produces 700 gpm from the alluvium and Santa Fe group with a drawdown of 13 feet. The material penetrated in these areas, however, may be coarser than that at Zia, and it may produce more water. Test holes will be necessary to determine the potential yield in the Zia area. The log of well 15.2.6.222 indicates coarser material was penetrated in it than in well 15.2.7.422. Therefore, a well in section 6 at the site of 15.2.6.222 would be expected to yield larger quantities of water than one at the site of 15.2.7.422 in sec. 7.

Two test wells are not enough to delineate the potentialities of the area since each samples only a point source. Well 15.2.7.422 is so far from the center of the valley that it penetrated little or no alluvium. Because the texture of the alluvium generally is coarser than that of the Santa Fe group, a test well near the center of the valley would probably penetrate more coarse material in the alluvium and yield more water than the previous test hole.

Chemical analyses of water from wells and streams are presented in table 4. The suitability of these waters for irrigation is shown

Table 4.—Chemical analyses of water from wells and streams in and near the Zia Indian Reservation, Sandoval County, N. Mex.

graphically in figure 2, a standard diagram for the classification of

Figure 2.—Suitability of ground water for irrigation in and near the Zia Indian Reservation, Sandoval County, N. Mex.

waters according to salinity and sodium hazards. Waters of best quality for irrigation plot in the lower left part of the figure in the space labeled C1-S1. Waters least suitable for irrigation plot in the upper right part of the figure (U. S. Department of Agriculture, 1954, p. 71 and 81). Only six analyses from the Zia area will plot on the diagram; several of the analyses shown in table 4 were not plotted because they fell to the right of the standard diagram. One analysis falls in the class C2-S1, two in class C3-S1, one in class C3-S2, one in class C4-S1, and one in class C4-S2. The sample that plots in class C2-S1, the best sample, was collected from well 14.2.5.320, which is about 3 miles southwest of Zia Pueblo. The pertinent classes are described below.

According to the U. S. Department of Agriculture (1954, p. 71 and 81), "Waters in the range of 750 to 2,250 micromhos/cm are widely used, and satisfactory crop growth is obtained under good management and favorable drainage conditions, but saline conditions will develop if leaching and drainage are inadequate. Use of waters with conductivity values above 2,250 micromhos/cm is the exception, and very few instances can be cited where such waters have been used successfully."....

"High salinity water (C3) cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected."

"Low sodium water (S1) can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium. However, sodium-sensitive crops such as stone-fruit trees and avocados may accumulate injurious concentrations of sodium."

"Medium sodium water (S2) will present an appreciable sodium hazard in fine textured soils having high cation-exchange-capacity, especially under low leaching conditions, unless gypsum is present in the soil. This water may be used on coarse-textured or organic soils with good permeability."

The quality of water in the Mesozoic rocks is poor, as shown by the analysis of water from well 15.1.26.222 and of water from the Rio Salado, which drains an area of Mesozoic rocks (table 2). The specific conductances of these samples were 6,510 and 10,300 micromhos, respectively. Both are unsuitable for irrigation. Water moving eastward from the Mesozoic rocks into Area 1 (fig. 1) will tend to make water there unsatisfactory for irrigation. As the water moves eastward, it will be diluted by local recharge with water low in dissolved solids and will become more suitable for irrigation.

Water in Area 2 (fig. 1) is probably of somewhat better quality for irrigation than that in the western part of Area 1 because of recharge with water of better quality from the Jemez River. The analysis of water from well 15.2.6.222 indicates, however, that at least part of the water east of the Jemez is not suitable for irrigation.

Water in Area 3 (fig. 1) is more suitable for irrigation than that in Areas 1 or 2, although wells 15.2.36.314 and 15.2.22.330 yield water of poor quality. The deeper water from well 15.2.22.300 is of much better quality for irrigation.

Summary

Water is desired for irrigation in secs. 19 and 20, T. 15 N., R. 2 E., between the Jemez River and State Highway 44. (See Area 1, fig. 1.) A well capable of yielding 500 gpm probably can be constructed in this area, but the quality of the water may not be suitable for irrigation. Logs of wells northeast of the river in secs. 6, 7, 17, and 18, T. 15 N., R. 2 E., (Area 2, fig. 1) indicate that coarse material was penetrated. The quality of the water in Area 2 may be somewhat better than in Area 1 because of dilution by recharge from the Jemez River and from precipitation. Area 3 between the abandoned railroad and the river in secs. 35 and 36, T. 15 N., R. 2 E., and sec. 1, T. 14 N., R. 2 E., is suggested as an alternate area if water of suitable quality cannot be obtained in Areas 1 or 2.

In all three areas 1,000 feet or more of the Santa Fe group and alluvium probably is saturated. Wells having yields of 500 gpm or more each and drawdowns of less than 100 feet could be expected in these localities.

Suggestions

One or two test wells should be drilled in Area 1 south of the Jemez River in order to evaluate the potential supply of water in this area and to obtain samples to determine the suitability of the water for irrigation. If in Area 1 the quantity is too small or the quality is unsuitable, a test well should be constructed north of the river in Area 2 in the SW¼ sec. 17 or the NE¼ sec. 18, T. 15 N., R. 2 E., near the present canal. If wells in Areas 1 or 2 are not suitable for irrigation, similar tests should be conducted in Area 3, if the land is suitable for irrigation.

All test wells should be drilled at least 300 feet deep. The holes should be logged and the cuttings examined thoroughly in order to plan the details of construction of the production well, such as the size of gravel for gravel packs, the size of openings in the well screen, and the best places to install screens, and to evaluate the potential yield of wells at each site. Samples of water from several depths in each test hole should be collected for chemical analysis, because the water in the area varies in suitability for irrigation.

Table 2.--Logs of wells.

Well 15.2.7.422

	From - To
Alluvium:	
Sand	0 - 5
Gravel and sand	5 - 12
Gravel	12 - 15
Sand	15 - 80
Gravel	80 - 85

Well 15.2.6.222

Alluvium:	
Sand, white	0 - 22
Sand, black, small gravel	22 - 80
Gravel, black	80 - 102
Santa Fe group:	
Gravel, medium	102 - 122
Boulders	122 - 126
Gravel, large	126 - 142
Boulder bed	142 - 150
Gravel, large	150 - 175
Boulders	175 - 177

References

Bryan, Kirk, and McCann, F. T., 1937, The Ceja del Rio Puerco, A border feature of the Basin and Range province in New Mexico; pt. 1, Stratigraphy and Structure: Jour. Geology, v. 45, p. 801-828.

Soister, Paul E., 1952, Geology of Santa Ana Mesa and adjoining areas, Sandoval County, New Mexico: Univ. New Mexico thesis, 126 p.

U. S. Department of Agriculture, 1954, Diagnosis and Improvement of Saline and Alkali Soils: Agriculture Handbook no. 60, p. 71 and 81.

Wood, G. H., and Northrop, S. A., 1946, Geology of Nacimiento Mountains, San Pedro Mountains, and Adjacent Plateaus in parts of Sandoval and Rio Arriba Counties, New Mexico: U. S. Geological Survey Oil and Gas Inv. Prelim. Map 57.

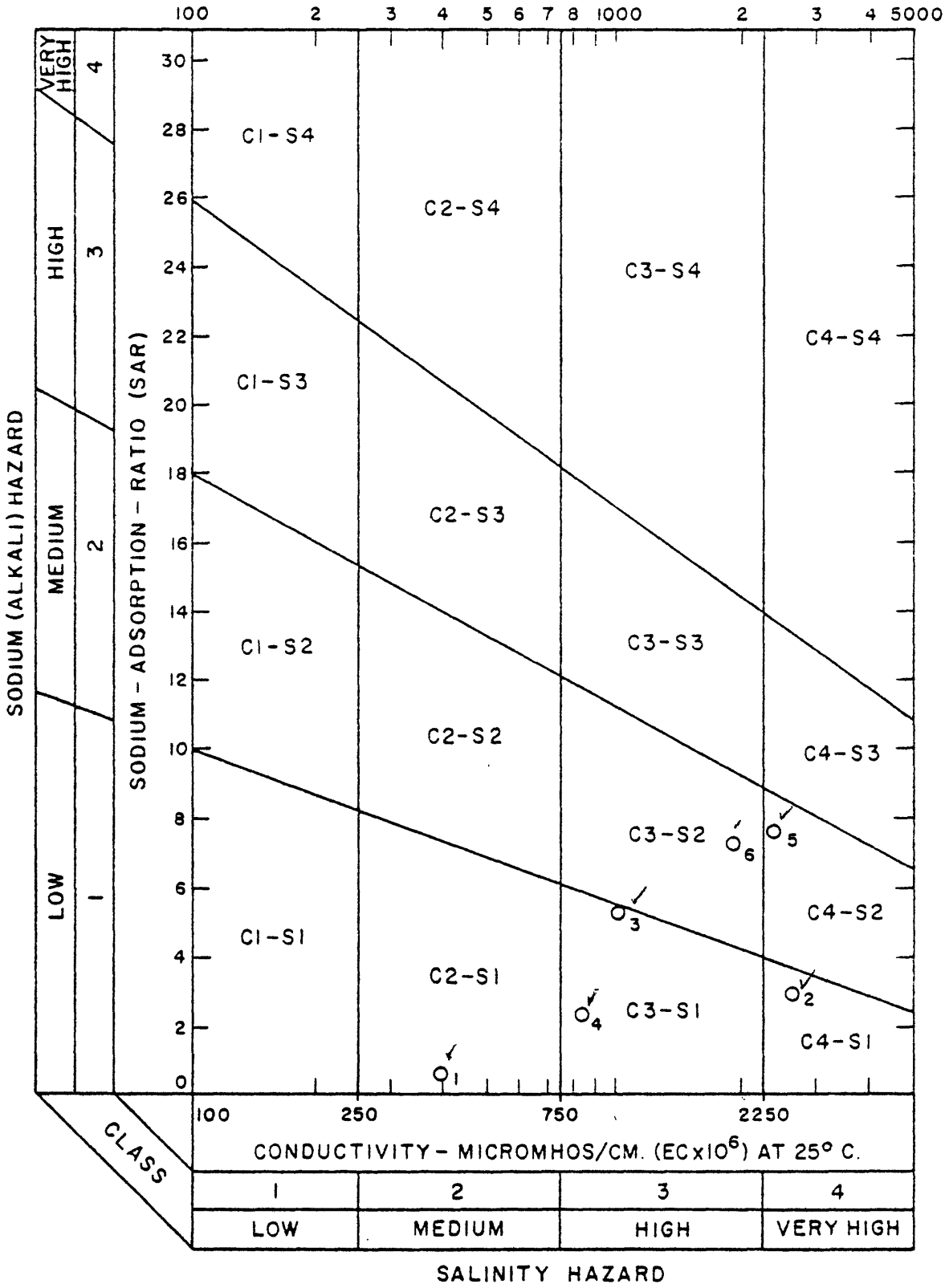

Figure 2.--Suitability of ground water for irrigation in and near the Zia Indian Reservation, Sandoval County, N. Mex.

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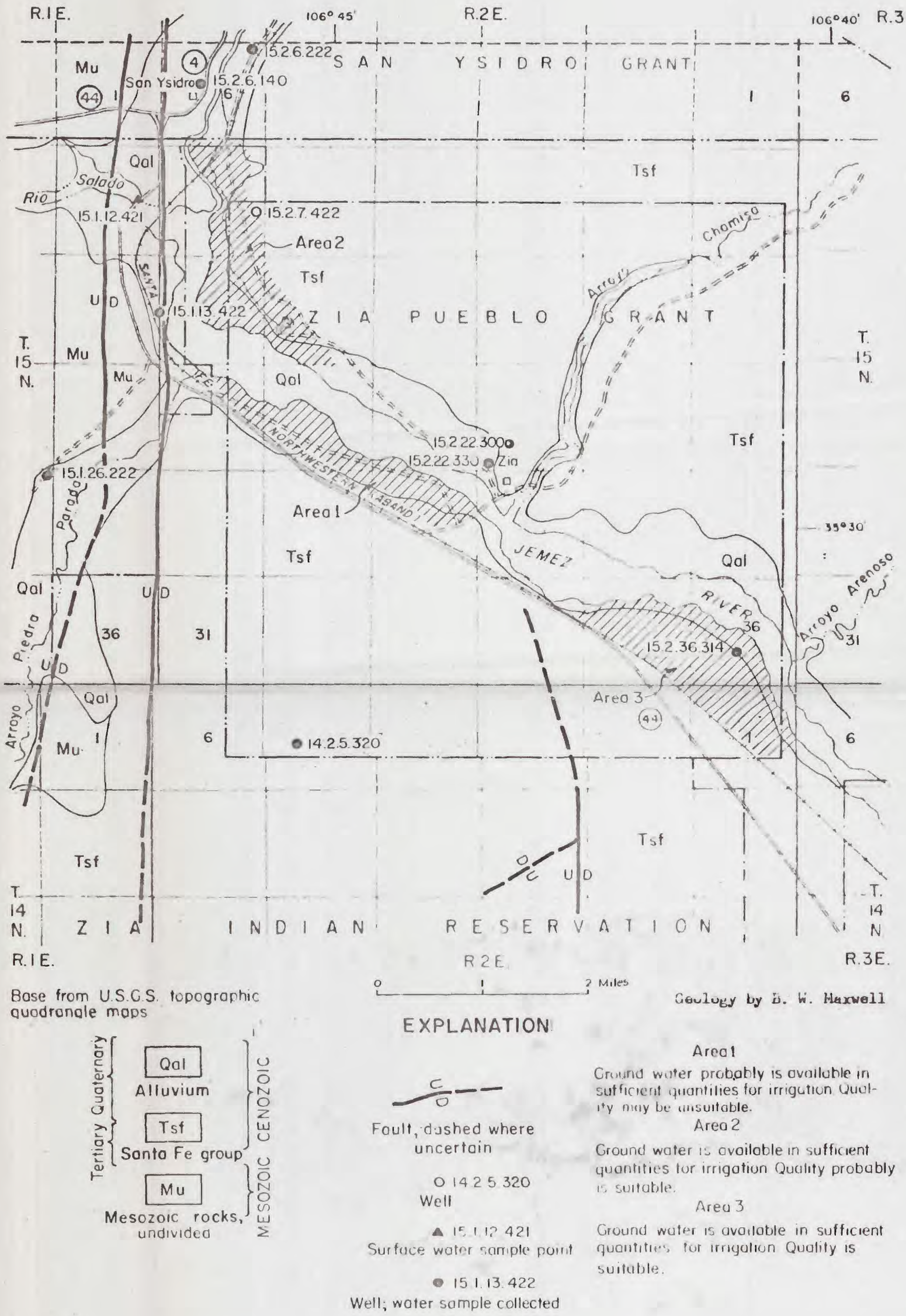

Base from U.S.G.S. topographic quadrangle maps

Geology by B. W. Maxwell

EXPLANATION

Tertiary Quaternary
- Qal — Alluvium
- Tsf — Santa Fe group

MESOZOIC CENOZOIC
- Mu — Mesozoic rocks, undivided

C D — Fault, dashed where uncertain

O 14.2.5.320 — Well

▲ 15.1.12.421 — Surface water sample point

● 15.1.13.422 — Well; water sample collected

Area 1

Ground water probably is available in sufficient quantities for irrigation. Quality may be unsuitable.

Area 2

Ground water is available in sufficient quantities for irrigation. Quality probably is suitable.

Area 3

Ground water is available in sufficient quantities for irrigation. Quality is suitable.

Figure 1.--Map showing geology and locations of wells in and near the Zia Indian Reservation, Sandoval County, N. Mex.

Table 3.--Records of wells in and near the Zia Indian Reservation, Sandoval County, N. Mex.

Geologic unit: Qal, alluvium; Tsf, Santa Fe group; Jm, Morrison formation.

Method of lift: Dcy, cylinder pump with cylinder in well near or below water level; Scy, cylinder pump with cylinder above land surface.
Use of water: S, stock; D, domestic; T, test well, N, none.

Location	Owner or Name	Driller	Year completed	Topographic situation	Altitude above sea level (feet)	Depth of well (feet)	Diameter of well (in.)	Geologic unit	Water level: Below land-surface (feet)	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above (+) or below (-) land surface (feet)	Yield (gpm)	Method of lift	Use of water	Remarks
14.2.7.320	Bureau of Indian Affairs	Bureau of Indian Affairs	1939	Arroyo Bank	5,550	130	8	Tsf	116	-	-	-	7	Dcy	S	
14.2.23.321	do.	do.	1939	Valley	5,395	360+	-	do.	362.0	3-24-59	Top of casing	+ 2	-	Dcy	S	
14.3.18.344	do.	do.	1939	Terrace	5,370	130	-	do.	104.0	4-22-58	do.	+ 1	6	Dcy	S	
15.1.13.422	do.	do.	-	do.	5,345	12	30 feet	Qal	4	6- 3-59	Edge of pit	at	-	-	N	
15.1.26.222	do.	do.	-	do.	5,515	117	-	Qal or Jm	101.7	3-24-59	Top of casing	+ 0.5	-	Dcy	S	
15.2.6.140	J. W. Miller	-	-	do.	-	13	3.5 feet	Qal	10.7	9-27-24	-	-	-	-	-	
15.2.6.222	Bureau of Indian Affairs	V. Turner	1954	do.	5,490	177	16	Qal or Tsf	-	-	-	-	60	-	T	Drilled as irrigation test. See log.
15.2.7.422	do.	do.	1954	do.	5,500	25	-	do.	-	-	-	-	-	-	T	Do.
15.2.22.300	Zia Pueblo	Bureau of Indian Affairs	1952	do.	-	170	-	Tsf	-	-	-	-	-	-	D	
15.2.22.330	do.	do.	1930	do.	5,390	3	-	Qal	5.1	12-13-51	-	-	-	Scy	D	
15.2.36.314	do.	do.	1943	do.	5,340	13	-	do.	10.6	12-19-51	-	-	-	Scy	D,S	

Table 4.--Chemical analyses of water from wells and streams in and near the Zia Indian Reservation, Sandoval County, N. Mex.

Principal water-bearing formation: Qal, alluvium; Tsf, Santa Fe group; Jm, Morrison formation.
Use of water: S, stock; N, none; T, test well; D, domestic.

Location number	Owner or name	Depth of well (feet)	Depth of casing (feet)	Principal water-bearing formation	Use of water	Date collected	Temperature (°F)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) and Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids: Parts per million	Dissolved solids: Tons per acre-foot	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Non carbonate	Percent sodium	Sodium adsorption ratio (SAR)	Specific conductance (micromhos at 25° C)	pH	Remarks
											GROUND WATER													
14.2.5.320	Bureau of Indian Affairs	130	130	Tsf	S	4-18-57	58	48	11	13	132	29	3	0.4	62	247	0.34	165	57	15	0.4	399	7.8	Silica (SiO_2) 18; no. 1, figure 2.
14.2.23.321	do.	360+	-	do.	S	4-18-57	-	-	-	-	134	98	110	-	-	-	-	134	24	-	-	783	7.4	-
14.3.18.344	do.	130	130	do.	S	4-18-57	62	248	49	219	191	449	475	0.0	3.4	1,650	2.14	820	664	37	3.3	2,570	7.3	Silica (SiO_2) 32; no. 2, figure 2.
15.1.13.422	do.	12	0	Qal	N	6- 3-59	-	582	148	5,820	395	7,580	4,590	5.7	1.3	19,000	25	2,060	1,740	86	56	23,000	8.0	Silica (SiO_2) 29; Boron (B) 8.1
15.1.26.222	do.	117	-	Qal or Jm	S	3-24-59	61	250	14	1,490	416	3,050	275	1.2	1.8	5,320	7.21	680	339	83	25	6,510	7.7	Silica (SiO_2) 11
15.2.6.140	J. W. Miller	13	-	Qal	-	9-27-24	-	58	15	180	473	41	106	-	6.0	693	-	206	-	65	5.3	1,000±	-	Silica (SiO_2) 48; no. 3, figure 2.
15.2.6.222	Bureau of Indian Affairs	177	-	Qal or Tsf	T	4- 4-54	-	184	31	1,190	1,530	285	1,140	5.0	4.6	3,680	5.00	586	0	82	21	5,920	-	Silica (SiO_2) 91
15.2.22.300	Zia Pueblo	170	-	Tsf	D	5-19-52	-	71	15	86	158	194	60	0.62	10	-	0.73	238	109	44	2.4	848	7.9	Silica (SiO_2) 23; no. 4, figure 2.
15.2.22.330	do.	8	-	Qal	D	12-18-51	-	113	23	354	436	202	375	1.4	5.3	-	1.84	376	0	67	7.9	2,260	-	Silica (SiO_2) 42; no. 5, figure 2.
15.2.36.314	do.	18	-	do.	D,S	12-19-51	-	92	17	310	293	347	258	1.7	0.7	-	1.60	300	56	69	7.7	1,910	-	Silica (SiO_2) 2.5; no. 6, figure 2.
											SURFACE WATER													
15.1.12.421	Rio Salado	-	-	-	-	8- 8-57	-	-	-	2,050	209	-	1,880	-	-	-	-	1,480	1,310	75	23	10,300	7.8	Silica (SiO_2) 9.3 Collected at N. Mex. Hwy. 44
16.1.29.310	Jemez River	-	-	-	-	3-20-50	-	23	11	575	461	158	486	-	0.8	1,600	2.18	102	0	92	71	2,700	-	Collected at San Ysidro Diversion (drainage from swampy area).