

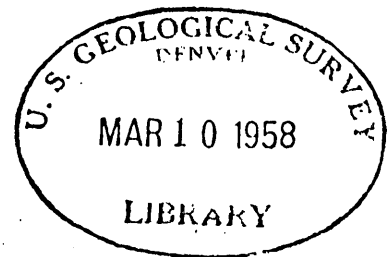
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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

AVAILABILITY OF GROUND WATER AT PROPOSED RANGE WELL
SITES FOR DRILLING PROGRAM IN 1956 FISCAL YEAR,
UNITED PUEBLOS INDIAN LANDS, NEW MEXICO

By

B. W. Maxwell, S. W. West
and I. J. Winograd



Prepared for
DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS

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Maxwell, West, Winograd

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INTRODUCTION

The United States Bureau of Indian Affairs, United Pueblos Agency, plans an extensive drilling program on Indian lands to provide water for stock, as a part of the Bureau's range improvement program. These wells are to be drilled during the fiscal years 1956 to 1958. This report has been prepared by the United States Geological Survey, at the request of the United Pueblos Agency, to describe the conditions at nine range well sites in northwestern New Mexico (see fig. 1) where drilling was scheduled for fiscal year 1956. Specific locations of the well sites are listed in table 1. The site on the Zuni Reservation is about 30 miles southwest of Gallup and 9 miles west of Zuni Pueblo; the site of the Laguna Eleven Townships Purchase area is about 60 miles southwest of Albuquerque; and the remaining 7 sites are in the main valley of the Rio Grande between Isleta and Taos.

Field investigations were made by I. J. Winograd, S. W. West, and B. W. Maxwell of the U. S. Geological Survey during October and November 1955. Each proposed well site was visited and the geology and wells in the surrounding area were inspected. Mr. Winograd prepared the section on the Isleta well site and Mr. West prepared the section on the Zuni well site. The remainder of the report was prepared by Mr. Maxwell.

The report is based on a reconnaissance of each well site for the purpose of determining the necessary depths of wells and the types of materials that will be encountered in drilling. Information on the geologic age and water-bearing characteristics of formations and the conditions at individual well sites are briefly described in the following parts of the report.

Table 1.--Location of well sites discussed

Reservation or pueblo	Tract	Location
Zuni	North Purchase area	SE1/4 sec. 23, T. 10 N., R. 21 W.
Laguna	Eleven Townships Purchase area	Sec. 14, T. 6 N., R. 7 W.
Isleta	Isleta Pueblo Grant	Sec. 7, T. 8 N., R. 2 E.
San Felipe	San Felipe Pueblo Grant	Sec. 35, T. 14 N., R. 5 E., and Sec. 4, T. 13 N., R. 5 E.
Santo Domingo	Santo Domingo Pueblo Grant	SE1/4NE1/4 sec. 14, T. 16 N., R. 4 E.
Tesuque	Tesuque Pueblo Grant	Sec. 2, T. 18 N., R. 9 E.
Santa Clara	Santa Clara Pueblo Reservation	SE1/4 sec. 36, T. 21 N., R. 6 E.
San Juan	San Juan Pueblo Grant	SE1/4 sec. 25, T. 21 N., R. 8 E.
Taos	Tract A	Sec. 31, T. 26 N., R. 12 E. (Unsurveyed)

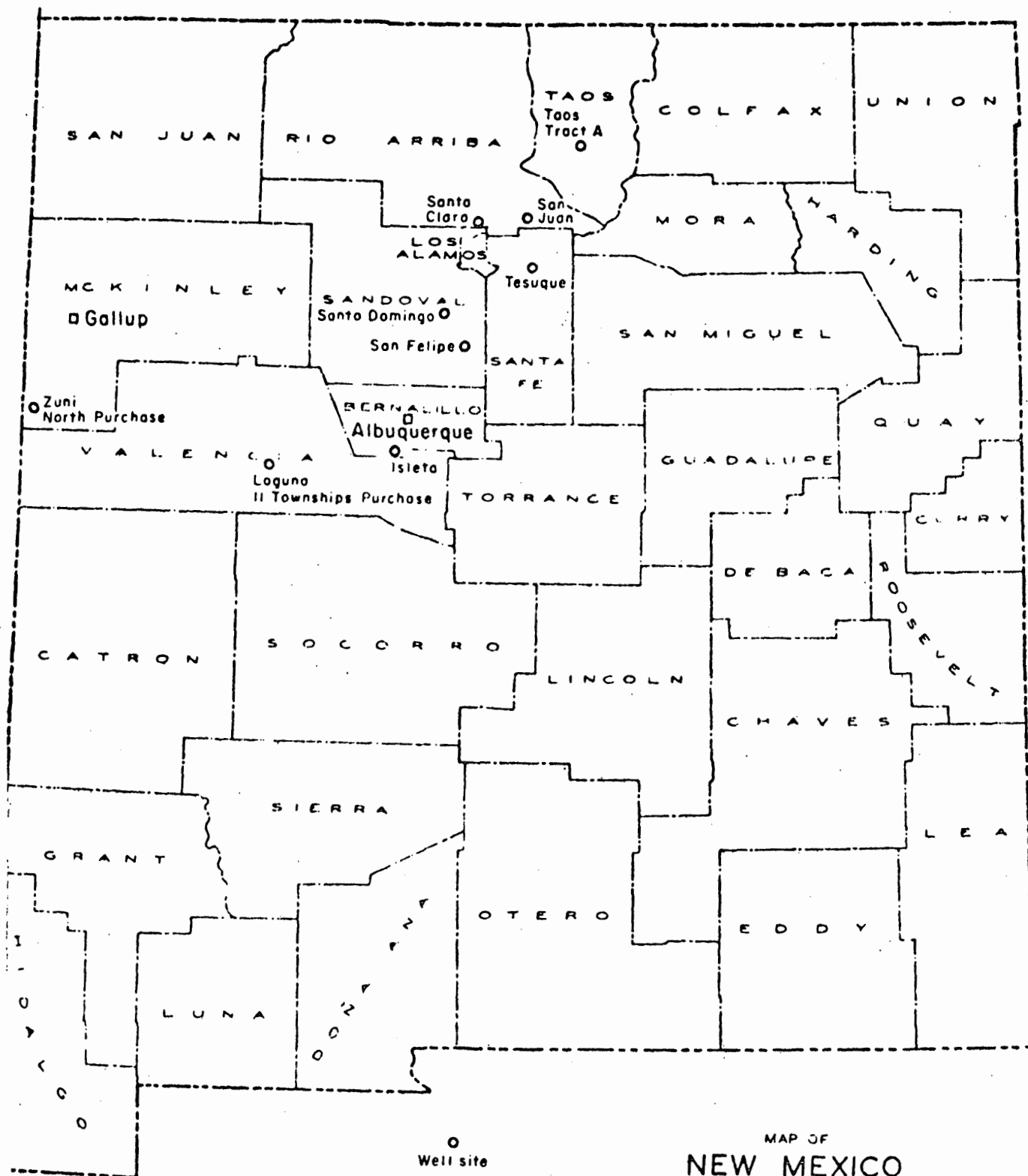


Figure 1.--Map of New Mexico showing location of proposed well sites described in this report.

PROPOSED WELL SITES

North Purchase Area, Zuni Indian Reservation SE1/4 Sec. 23, T. 10 N., R. 21 W.

The subsurface conditions at the proposed well site in the North Purchase area, Zuni Indian Reservation have been interpreted from an inspection of the area and from logs of wells in nearby areas. The geologic and hydrologic conditions are summarized in table 2, and the areal geology is shown in figure 2.

The uppermost geologic unit is the Bidahochi formation of Tertiary age. This formation comprises yellow to red, unconsolidated to partially cemented sand and gravel, and poorly compacted clay. The sand in the lower part of the formation may be water bearing. The thickness of the Bidahochi formation in the area ranges from 100 to 250 feet or more. The sandy character of the formation at the surface is conducive to ground-water recharge from precipitation on the area.

The Wingate sandstone, Triassic in age, crops out about 5 miles to the east of the site and is presumed to underlie the Bidahochi formation in the vicinity of the well site. The Wingate comprises thin to thick beds of red sandstone, siltstone, and claystone. The Wingate supplies water to some existing wells in the western part of the Zuni Reservation, and it is assumed to be a potential source of water at the proposed well location. The thickness of the formation ranges widely in the area. Logs of wells in nearby areas indicate a thickness of 100 to 150 feet, at the proposed well site.

The Chinle formation of Triassic age underlies the Wingate sandstone. The upper part of the Chinle comprises beds of red shale, shaly sandstone, and thin-bedded limestone. The upper shaly part of the Chinle is 450 to 500 feet thick and supplies little water to wells. Beneath the shale is a middle unit consisting of light-colored sandstone, containing some gravel, which is 50 to 100 feet thick and is the most productive aquifer in the area. The lower part of the Chinle formation is chiefly shale with little possibility of water production.

The geologic data indicate that in order to assure an adequate supply of water, minimum drilling depth of 400 feet should be expected, because of the maximum thicknesses of the Bidahochi and Wingate formations as indicated by the surface topography in the vicinity of section 23. The necessary depth of drilling probably will not exceed 700 feet, the greatest depth of any well in the North Purchase area, but it might be as much as 900 feet. It would, of course, be less than 400 feet if an adequate supply were found in the Bidahochi formation or the Wingate sandstone.

Assuming that the well will tap the middle part of the Chinle formation, the depth below land surface to the nonpumping water level in the proposed well probably will be 175 to 275 feet. Data on other wells indicate that the drawdown caused by pumping at a rate of about 10 gallons per minute will be 100 to 150 feet.

At least one reduction in the diameter of well casing should be expected, because the unconsolidated sediments in the Bidahochi formation are likely to cave unless they are cased out as the drilling progresses. Perforated casing should be installed adjacent to the water-bearing sands. Some surging and bailing, after the casing is installed, should improve the yield of the well.

The geologic conditions in the vicinity of the proposed well location are such that considerable latitude is permissible in selecting the most desirable location for utilization of a well, without appreciably influencing the cost of construction or the yield of the well.

Table 2.--Generalized geologic section of the Zuni area.

System	Formation	Thickness (feet)	Lithology	Area of outcrop	Water-bearing characteristics
T E R T I A R Y	Bidahochi	100 to 250 or more	Yellow to red sand, with some gravel and clay.	In the vicinity of the proposed well site.	Sands in lower part of for- mation, if saturated, should provide adequate supplies of water for stock wells.
T R I A S S I C	Wingate	100 to 150	Red sandstone with some clay.	About 5 miles east of proposed well site.	Provides adequate supplies of water for stock wells in adjacent parts of the Zuni reservation.
	Chinle	450 to 500	Red shale, shaly sandstone and thin limestone.	About 10 miles to east and south of proposed well site.	Yields little water to wells.
		50 to 100	Light-colored sand- stone and some conglomerate.	About 15 miles south of proposed well site.	Most productive aquifer in the area.

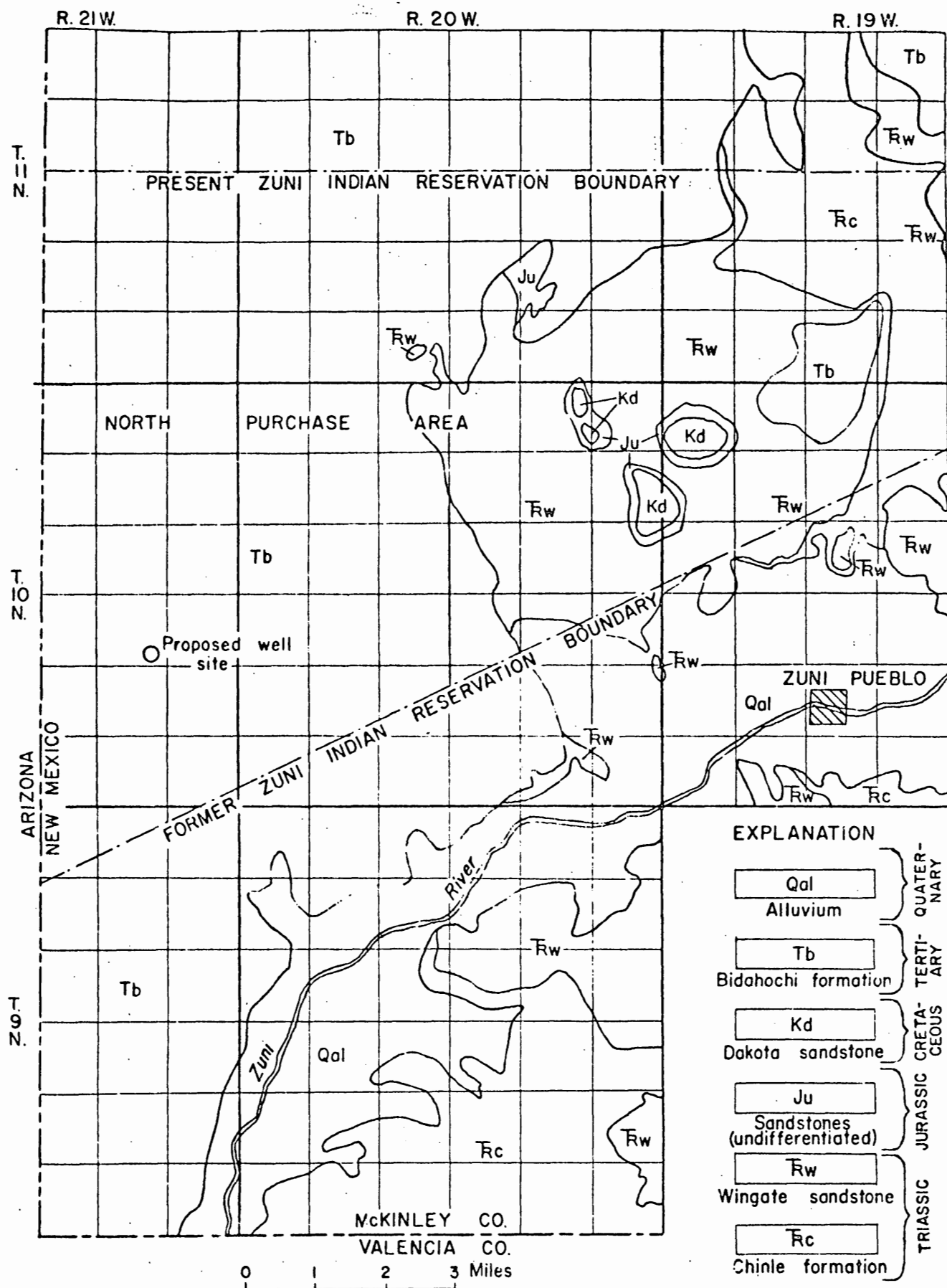


Figure 2.--Map of a part of the Zuni Indian Reservation, McKinley County, N. Mex., showing the areal geology and the location of the proposed well site. From pl. 2, U. S. Geol. Survey Bull. 767, 1925, modified by S. W. West.

Eleven Townships Purchase Area
Laguna Indian Reservation
Sec. 14, T. 6 N., R. 7 W.

The proposed well site in the Eleven Townships Purchase area is about 12 miles south of the Indian village of Acoma, on the west half of the line between the NW1/4 and the SW1/4 of sec. 14, T. 6 N., R. 7 W., (see fig. 3) and at an altitude slightly above 7,000 feet. The site is about a mile west of the eastward-facing escarpment of the mesa. The land surface slopes northwestward.

No detailed geologic work has been done in the immediate area. To the north of Acoma, the Dakota group is correctly indicated on the State Geologic map (Darton, 1928) as capping Woods Mesa. In the vicinity of Acoma, however, the Dakota thins abruptly, possibly because of change from a sandstone to a shale facies. From Acoma southward the Dakota is either absent or very thin except in sec. 23, T. 7 N., R. 7 W., where a 30- to 40-foot thick sandstone lens may belong in the Dakota group. The Bluff sandstone, about 150 feet thick, forms the cliffs bounding the mesa on which Acoma is built. The Bluff sandstone was mapped by Darton as the Dakota sandstone in the vicinity of and southward from Acoma.

Rocks exposed in the escarpment east of the proposed well site range from late Triassic to Jurassic in age. The Bluff sandstone forms a cliff in the upper part of the escarpment. Below the Bluff sandstone are approximately 350 feet of sandstone, shale, and limestone of the Summerville, Todilto, Entrada, and Wingate formations. Red beds of the Chinle formation form the basal part of the escarpment and the floor of the valley to the east. The strata dip approximately 3 to 5 degrees northwestward from the escarpment in the area of the proposed well site.

A small part of the precipitation which falls on the area enters the sandstones in the mesa and is discharged from springs along the base of the escarpment south of Acoma and in the stream valley west of Acoma. Some of the water in the sandstones under the mesa may move westward and northward to the Rio San Jose. Facies changes, as well as igneous dikes and sills that occur in the area, probably affect the movement of water. The character and magnitude of these effects have not been determined.

The water-bearing characteristics of formations in the Eleven Townships Purchase area are summarized in table 3.

The Wilson well (sec. 18, T. 6 N., R. 7 W.) and the Ward well (sec. 32, T. 6 N., R. 7 W.) 4 miles west and southwest, respectively, of the proposed well site obtain water from sandstones at a depth of less than 200 feet below the surface. Water may possibly be obtained at the proposed site from the Bluff sandstone at a depth of less than 200 feet. If sufficient water is not obtained in this sandstone it would be desirable to deepen the hole to the top of the Chinle red beds, which should be encountered at a depth of approximately 500 feet, to test the Entrada and Wingate sandstones. Little water is available in the upper part of the Chinle formation. If sufficient water is not obtained above the Chinle, a well could be drilled about a mile to the west, where hydrologic conditions are believed to be more favorable for obtaining an adequate supply of water. The alternate site has a much larger potential recharge area and is down dip from the proposed site. The possibility of encountering a saturated sandstone formation is greatly increased with increased distance from the escarpment.

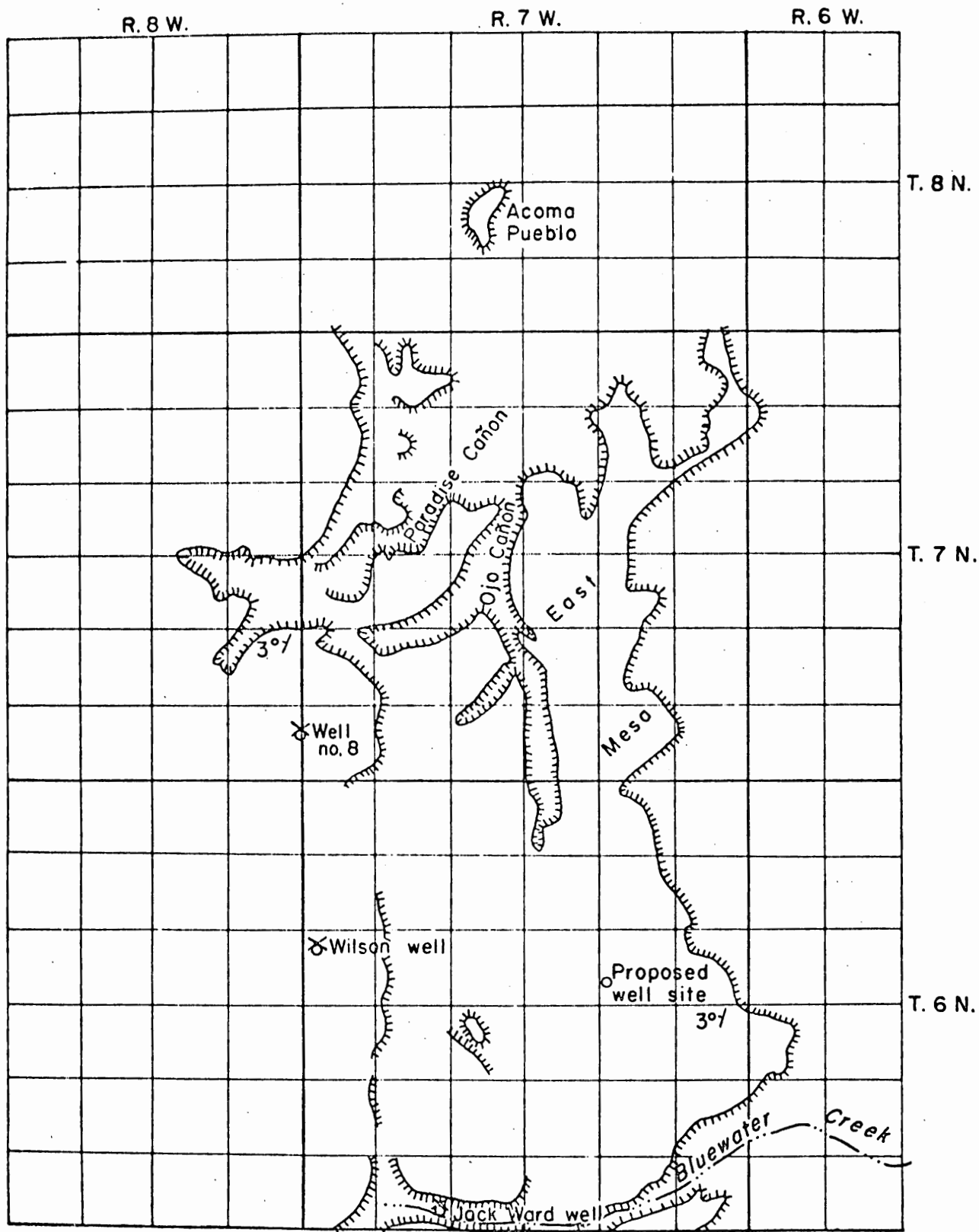


Figure 3.--Map of a part of the Eleventh Townships Purchase are of the Laguna Indian Reservation, Valencia County, N. Mex., showing the location of the proposed well site.

Table 3.--Generalized geologic section of the Eleven Townships well site area

System	Stratigraphic unit	Estimated thickness (feet)	Lithology	Area of outcrop	Water-bearing characteristics
Q U A T E R N A R Y	Alluvium	Feather edge to 30	Gray sand and silt.	Thin deposits along the streams.	The alluvium is too thin in the Acoma area to yield much water to wells.
T E R T I A R Y	Basalt	Feather edge to 220	Black basalt.	Caps Mesa del Oro and Cebolleta Mesa.	Because of topographic situation the basalt probably does not contain much water.
C R E T A C E O U S	Mesaverde group	Less than 400	Gray, black, and buff shale, sandstone, and coal.	South of Cebolleta Mesa and north of Highway 66.	Some sandstone members will probably yield water to wells in the vicinity of Cebolleta Mesa.
	Mancos shale	± 750	Gray, black, and buff shale with several sandstone members.	Caps the mesa south of Acoma.	The Tres Hermanos sandstone member may yield water to wells in R. 8 W. and westward.

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	Dakota group	Feather edge to 75	Buff to gray sandstone and shale, lensing into shale south of Acoma.	Forms the rim north of Acoma; if present, is represented by a sandstone lens and shale in the mesa south of Acoma.	Yields water to wells on Woods Mesa north of Acoma but is too shaly south of Acoma to yield water to wells.
J U R A S S I C	Morrison formation	50 to 100	Gray, green, and red sandstone and shale.	Forms cliff under the Dakota rim rock north of Acoma. Is probably thin south of Acoma.	Will yield little water to wells.
	Bluff sandstone	75 to 150	Gray to buff sandstone.	At base of cliffs north of Acoma; forms the mesa upon which Acoma is built.	Yields water to range wells in the Acoma area.
	Summerville formation	± 100	Red silty sandstone and siltstone.	In cliffs in the eastern part of T. 6 N., R. 7 W.	Will yield little water to wells.
	Todilto formation	Feather edge to 20	Light gray to white limestone, and calcareous siltstone.	In cliffs in the eastern part of T. 6 N., R. 7 W.	Do.
	Entrada sandstone	Feather edge to 200	Gray to red sandstone.	In cliffs in the eastern part of T. 6 N., R. 7 W.	Will probably yield sufficient water for stock wells where saturated.
T R I A S S I C	Wingate sandstone	50 to 100	Red sandstone.	In cliffs in the eastern part of T. 6 N., R. 7 W.	Will probably yield sufficient water for stock wells where saturated
	Chinle formation	Upper 200 feet exposed.	Red shale and sandy shale with minor amounts of sandstone.	In valleys east of T. 6 N., R. 7 W.	Will yield little water to wells.

Well Sites in the Rio Grande Valley

The Rio Grande valley in New Mexico is in a long graben or rift valley usually referred to as the Rio Grande trough. The graben was formed during Tertiary and Quaternary(?) time and has been partially filled with stream-deposited sand, gravel, silt, and clay, and with volcanic tuff and lava. Because of the lenticular and discontinuous nature of the strata and because of the wide range in types of material and formations present at the various sites, no generalized geologic section is included for the sites in the Rio Grande valley.

Sediments of the Santa Fe group of middle(?) Miocene to Pleistocene(?) age compose most of the fill in the Rio Grande trough. These sediments were deposited by streams flowing into the trough from the bordering highlands and by a through-flowing stream which existed for at least a part of this time.

Zane Spiegel of the New Mexico State Engineer office, formerly with the U. S. Geological Survey, and Brewster Baldwin of the New Mexico Bureau of Mines have named two formations in the Santa Fe group (personal communication, 1956). The lower of these has been assigned the name Tesuque from exposures near Tesuque, north of Santa Fe. The Tesuque formation of middle(?) Miocene to early Pliocene age consists of gray to salmon-colored silt, sand, and gravel with some interbedded basalt. The sediments are present throughout the middle Rio Grande valley. The material of this formation is generally poorly consolidated although in some areas the formation is tightly cemented with carbonate and stands in vertical cliffs. The Tesuque usually ranges from 1,000 to more than 5,000 feet in thickness. In most areas the formation will yield sufficient water for stock, and in many areas will yield enough for irrigation wells.

The Ancha formation, of late Pliocene or Pleistocene age, which unconformably overlies the Tesuque formation, is less well consolidated and is generally coarser grained than the Tesuque formation. In the Otowi-Espanola area west of the Rio Grande 200 to 1,500 feet of conglomerate is present. In other areas in the valley the conglomerate is less well developed or absent. This conglomerate is probably correlative with the Ancha formation. In those areas where the lower strata of the Ancha formation are saturated, wells will yield sufficient water for stock use. No attempt has been made to differentiate between Tesuque and Ancha in this report because of the uncertainty of correlation from one area to another.

The Bandelier tuff, which overlies the Santa Fe group west of the Rio Grande north of Santo Domingo, ranges from 200 to 600 feet in thickness. This formation comprises buff, gray, and white tuff, breccia, and pumice. The tuff is water bearing at none of the proposed sites.

The most recent material deposited in the valley is the alluvium, which ranges in thickness from a feather edge up to about 150 feet. The alluvium consists of unconsolidated sand, gravel, and silt with a small amount of clay. At none of the proposed well sites is the alluvium water bearing.

Wells at all of the proposed sites in the Rio Grande valley will be completed in the rocks of the Santa Fe group. In general, all wells in the valley should be drilled 50 feet or more below the point at which water is encountered. The wells should be screened or gravel packed and developed by over-pumping, surging, or bailing to control the entrance of sand. Excessive pump wear and even well failure may result if a well is not properly developed. The yields of wells that penetrate unconsolidated sediments, such as the Santa Fe group, are greatly improved by proper development and screening.

Isleta Pueblo Grant
Sec. 7, T. 8 N., R. 2 E.

The proposed well site in the Isleta Pueblo Grant is on a plain which slopes to the east and southeast, developed on rocks of the Santa Fe group. The site is about 5 miles west of the Rio Grande (see fig. 4). Parea Mesa and Wind Mesa, two volcanic cones, rise conspicuously above the surrounding plain respectively 2 miles east and $3\frac{1}{2}$ miles west of the well site. Although basalt covers a large area on the plain south and southwest of Wind Mesa it does not cap the plain between the two volcanoes.

Logs of wells in the area show that the strata beneath the plain are largely clay, sand, and gravel of the Santa Fe group, interbedded in many localities with basaltic lava flows. The thickness of the Santa Fe group and associated basalt has not been determined at the well site, but is believed to be several thousand feet. Isleta well 861 (sec. 24, T. 8 N., R. 1 W.), about 7 miles west-southwest from the proposed well site, penetrated 685 feet of the Santa Fe group. Isleta well ECW 8 (sec. 21, T. 8 N., R. 1 E.), about 4 miles southwest of the proposed well site and 1 mile south of Wind Mesa, is 612 feet deep and penetrates 410 feet of basalt below alternating sedimentary and basalt strata.

The water table in the vicinity of the proposed well site is essentially horizontal and at about the elevation of the Rio Grande. Information on wells south of section 7 indicate that the water table slopes southward with a gradient of about 7 feet per mile. In general, the depth to ground water increases to the west and northwest on the west side of the Rio Grande. The depth to ground water in Isleta well 540 (sec. 29, T. 8 N., R. 2 E.) is 133 feet below the surface. The depth to water in Isleta well 861, which is $7\frac{1}{2}$ miles west of Isleta well 540, is 658 feet below the surface. Logs of wells on the reservation show that the water usually occurs within the sands and gravels of the Santa Fe group; however, water is obtained from basalt in wells ECW 8 and in ECW 6 (sec. 2, T. 7 N., R. 1 W.).

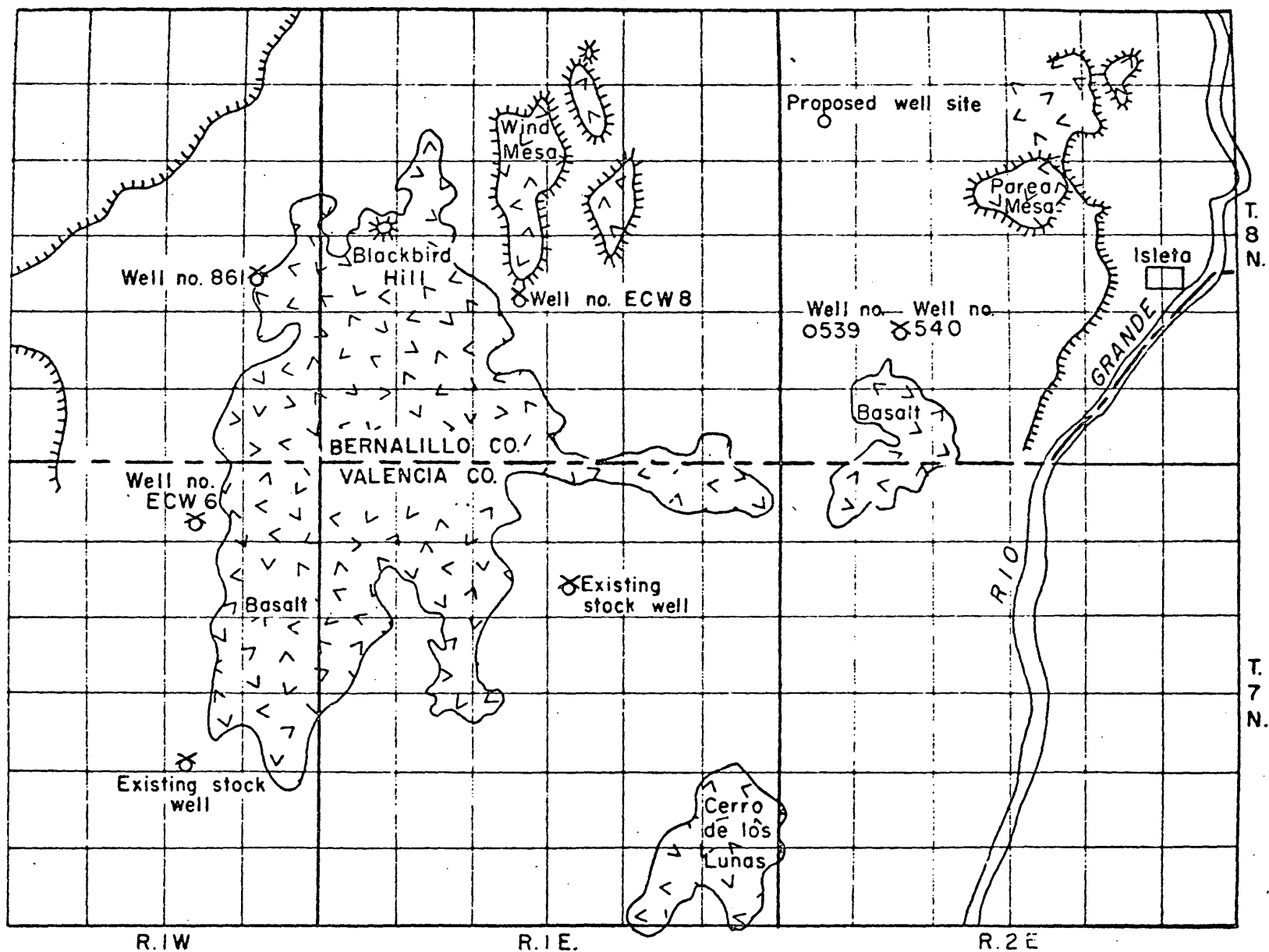


Figure 4.--Map of a part of the Isleta Pueblo Grant, Bernalillo County, N. Mex., showing the location of the proposed well site.

The altitude of the water surface in the wells nearest the proposed site is approximately 4,870 feet. The altitude of the land surface in section 7 ranges from 5,180 feet in the southwest corner of the section to 5,255 feet in the northeast corner. Ground water should be encountered at depths ranging from about 310 feet in the southwest corner of section 7 to about 385 feet in the north part of section 7. Some basalt may be encountered in the drilling of the well. Due to the variable nature of the clay layers in the Santa Fe group, the exact well depth cannot be predicted. A successful well can probably be completed at a depth of 360 to 500 feet.

The depth to water in sec. 1, T. 8 N., R. 1 E., an alternate site, ranges from approximately 370 feet in the southeast corner to 450 feet in the northwest corner of the section.

If a quicksand or fine-grained sand aquifer is penetrated by the well, it may be necessary to use a well screen to prevent the sand from entering the well. Screens were used in both Isleta well ECW 7 (sec. 24, T. 8 N., R. 2 W.) and Antonio Sedillo Grant well 8 (sec. 10, T. 9 N., R. 2 W.)

San Felipe Pueblo Grant

Sec. 33, T. 14 N., R. 5 E., and Sec. 4, T. 13 N., R. 5 E.

The proposed site for a range well in the San Felipe Pueblo Grant is about 3 miles east of Algodones on the center-third of the section line between sec. 33, T. 14 N., R. 5 E., and sec. 4, T. 13 N., R. 5 E. (see fig. 5). The well site is at an altitude of 5,340 feet in a flat area on the north side of a small arroyo.

The well site is underlain by strata of the Santa Fe group, which probably is more than 1,000 feet thick in this vicinity and consists of beds of silt, sand, and gravel. The beds exposed in Maria Chavez Arroyo, to the south of the site, dip northward about 15°, indicating some deformation in the area. This deformation may be associated with a north-trending fault along Tonque Arroyo to the east of the proposed well site.

A spring in sandstone of Jurassic(?) age in Tonque Arroyo, 2½ miles east of the proposed well site, is at an altitude of about 5,380 feet. In a well in Tonque Arroyo, 2 miles north of the site and about a quarter of a mile west of U. S. Highway 85, the water table is at an altitude of 5,155 feet. In a well about 1 mile southwest of the site, in Maria Chavez Arroyo, the water table is at 5,310 feet. These water levels indicate that the water table at the proposed well site is at an altitude of about 5,250 feet.

A well constructed at this site should encounter water between 75 and 150 feet and probably at about 110 feet. If fine sand is encountered, it may be necessary to deepen the well to a bed of coarser material or to use a well screen.

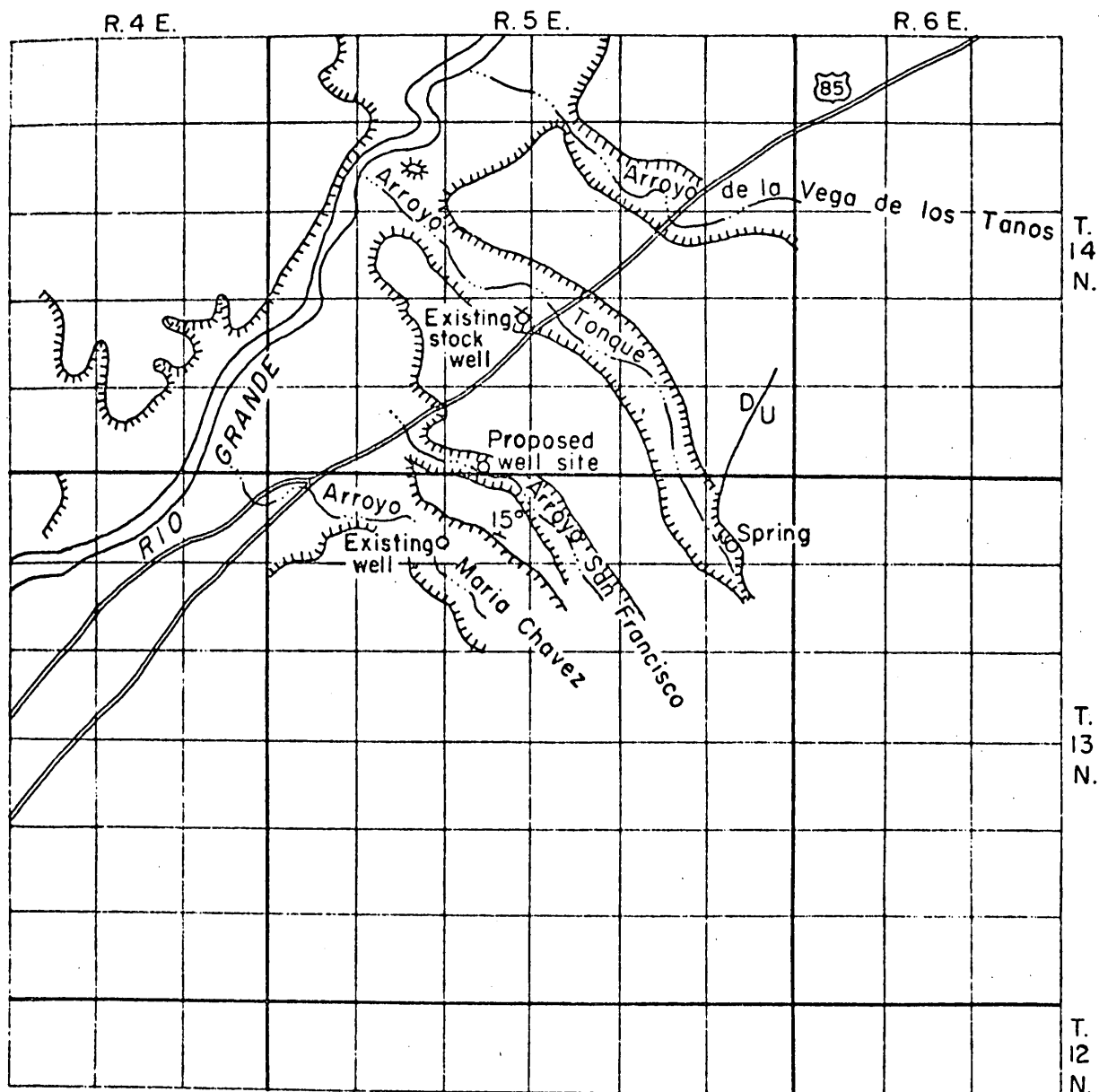


Figure 5.--Map of a part of the San Felipe Pueblo Grant, Sandoval County, N. Mex., showing the location of the proposed well site.

If an alternate site is desired, a well less than 150 feet deep might be constructed along Tonque Arroyo in sec. 36, T. 14 N., R. 5 E.

Santo Domingo Pueblo Grant
SE1/4NE1/4 Sec. 14, T. 15 N., R. 4 E.

The proposed site for a range well in the Santo Domingo Pueblo Grant is at the intersection of two canyons, approximately 10 miles northwest of Santo Domingo Pueblo and 8 miles west of the Rio Grande (see fig. 6). The altitude at the well site is approximately 6,100 feet above sea level and about 900 feet higher than the Rio Grande.

This site is underlain by strata of the Santa Fe group, which probably is several thousand feet thick in this vicinity. The Santa Fe group is composed of beds of clay, silt, sand, and gravel, interbedded with layers of basalt. The mesas to the southwest and north are capped by the Bandelier tuff, which is composed of volcanic ash.

Water levels in wells at Cochiti Pueblo are reported to be at or slightly above the level of the Rio Grande which is at an altitude of about 5,215 feet opposite the Pueblo. The water level in the well in NE1/4 sec. 5, T. 15 N., R. 5 E. is reported as 510 feet and the altitude of the water level in the well is about 5,140 feet. The water level in the well in NW1/4 sec. 18, T. 15 N., R. 5 E. is measured at 521 feet below the surface and is at an altitude of 5,120 feet. The elevation of the Rio Grande west of Santo Domingo Pueblo is 5,160 feet.

The water table in this area probably slopes southward or southeastward, but the gradient of the water table has not been determined. The altitude of the water table at the proposed well site is between 5,200 and 5,500 feet, and probably is about 5,300 feet.

A well drilled at the proposed site should encounter water between 600 and 900 feet below the surface, and probably between 800 and 850 feet below the surface.

Tesuque Pueblo Grant
Sec. 2, T. 18 N., R. 9 E.

The site proposed for a range well in the Tesuque Pueblo Grant is approximately 4 miles north-northwest of the Town of Tesuque and is west of an escarpment which trends northwest through sec. 2,

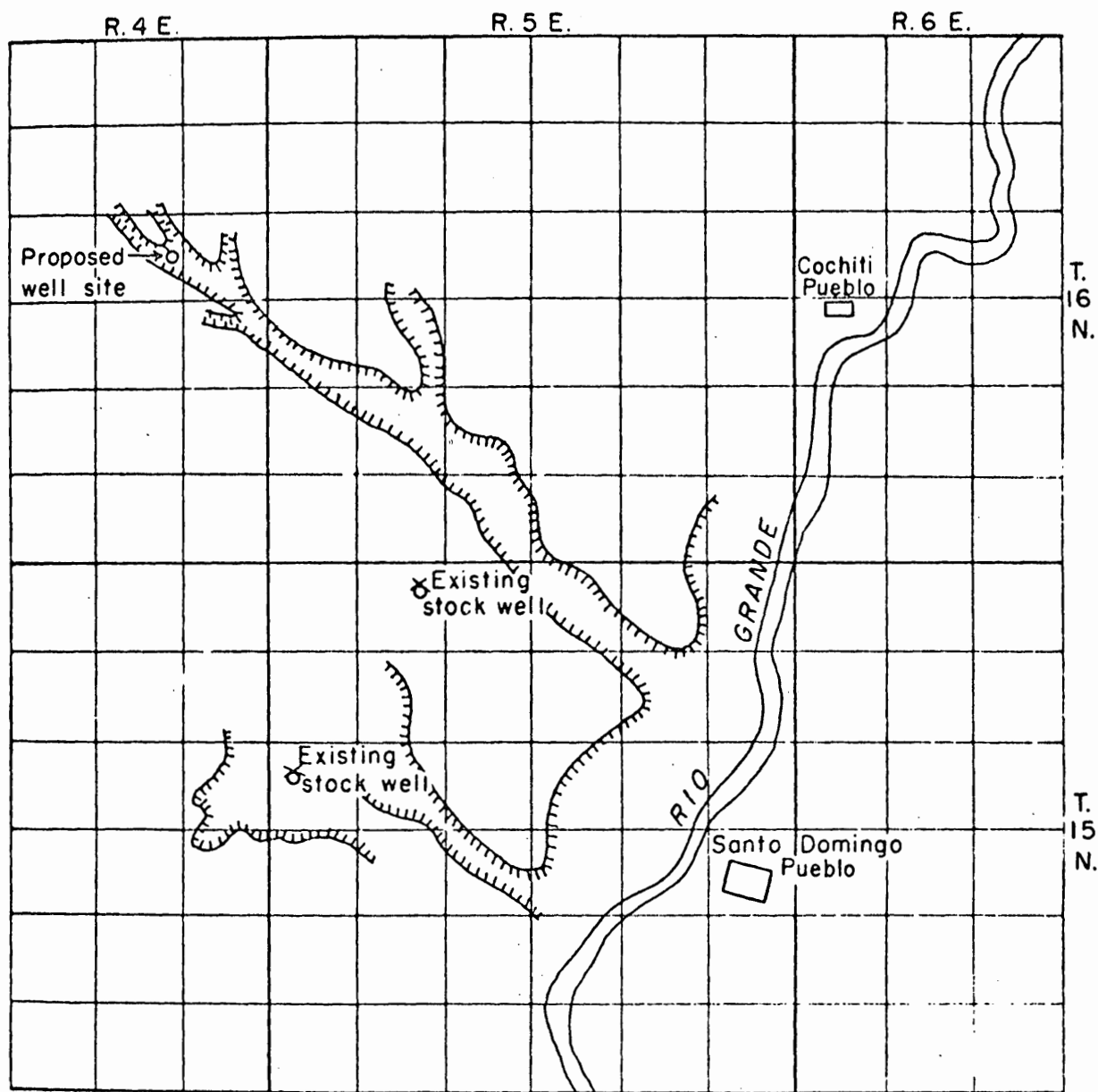


Figure 6.--Map of a part of the Santo Domingo Pueblo Grant, Sandoval County, N. Mex., showing the location of the proposed well site.

T. 18 N., R. 9 E. (fig 7). The area west of the escarpment, in section 2, slopes to the southwest from an altitude of about 6,560 feet to 6,500 feet.

The area is underlain by unconsolidated silt, sand, and gravel strata of the Santa Fe group to a depth of several thousand feet. A well in this area probably will not encounter basalt.

The water table in the stream valleys is near the surface in the NW1/4 sec. 6, T. 18 N., R. 10 E., near Chupadero, at an altitude of about 6,700 feet, and is at the surface in the SW1/4 sec. 24, T. 18 N., R. 9 E., near Tesuque, at an altitude of about 6,600 feet. However, spring sites at both these locations were dry when visited during the investigation. Downstream from these two places the water table is near the surface in the Rio Chupadero and the Rio Tesuque. The water table slopes westward toward the Rio Grande and at the proposed well site it is probably at an altitude of between 6,350 and 6,400 feet.

The water table will be encountered between 100 and 200 feet below the surface, depending on the location of the well. The minimum depth to water is in the southwest corner of the section. Some thin zones of perched water may underlie the area. However, if perched water zones are present they are unlikely to produce an adequate supply of water on a permanent basis.

Santa Clara Pueblo Reservation
SE1/4 Sec. 36, T. 21 N., R. 6 E.

The proposed site for a range well in the Santa Clara Pueblo Reservation is approximately 1,500 feet southwest of the intersection of the Clara Peak and the Santa Clara Indian Reservation roads, approximately 10 miles west of Española, New Mexico (see fig. 8). This site is on the mesa north of Santa Clara Cañon, about 480 feet higher than Santa Clara Creek, and about 1,000 feet higher than the Rio Grande at Española. The elevation of the land surface at the site is about 7,100 feet above sea level.

The mesas north and south of Santa Clara Cañon are capped by 100 to 200 feet of the Bandelier tuff. At least 2,000 feet of silt, sand, and gravel of the Santa Fe group underlies the tuff. The uppermost part of the Santa Fe group in this locality is a conglomerate 200 to 600 feet thick, that is characterized by a wide range in the size of particles. The zones that appear to be most permeable and porous are composed of fine gravel. The beds that contain the coarsest material (boulders 6 feet or more in diameter) also contain much silt, which makes the beds relatively impermeable.

Santa Clara Creek, a perennial stream, appears to gain water or maintain a constant flow in the area south of the proposed well site. There appear to be several porous zones in the conglomerate at

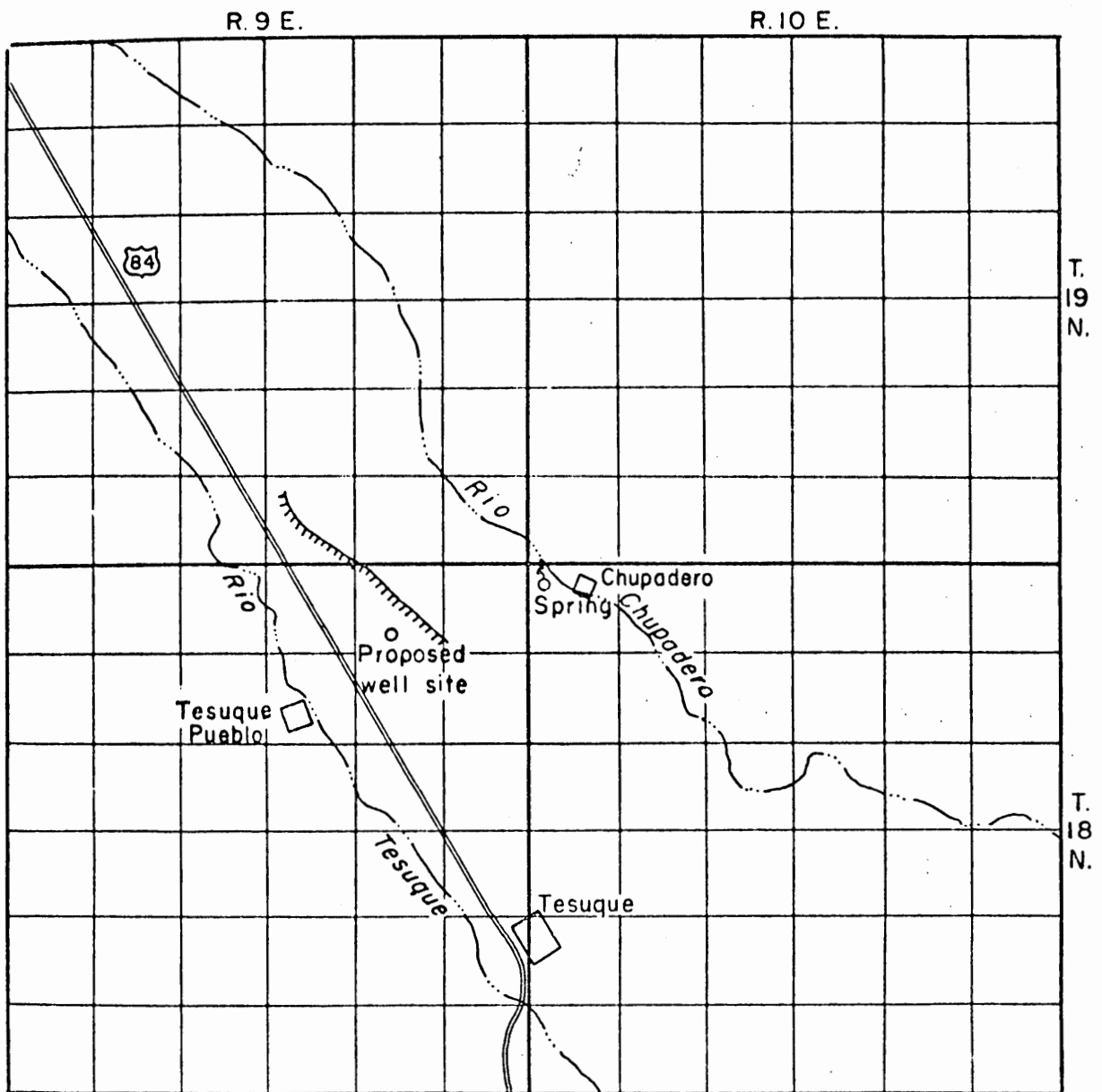


Figure 7.--Map of a part of the Tesuque Pueblo Grant, Santa Fe County, N. Mex., showing the location of the proposed well site.

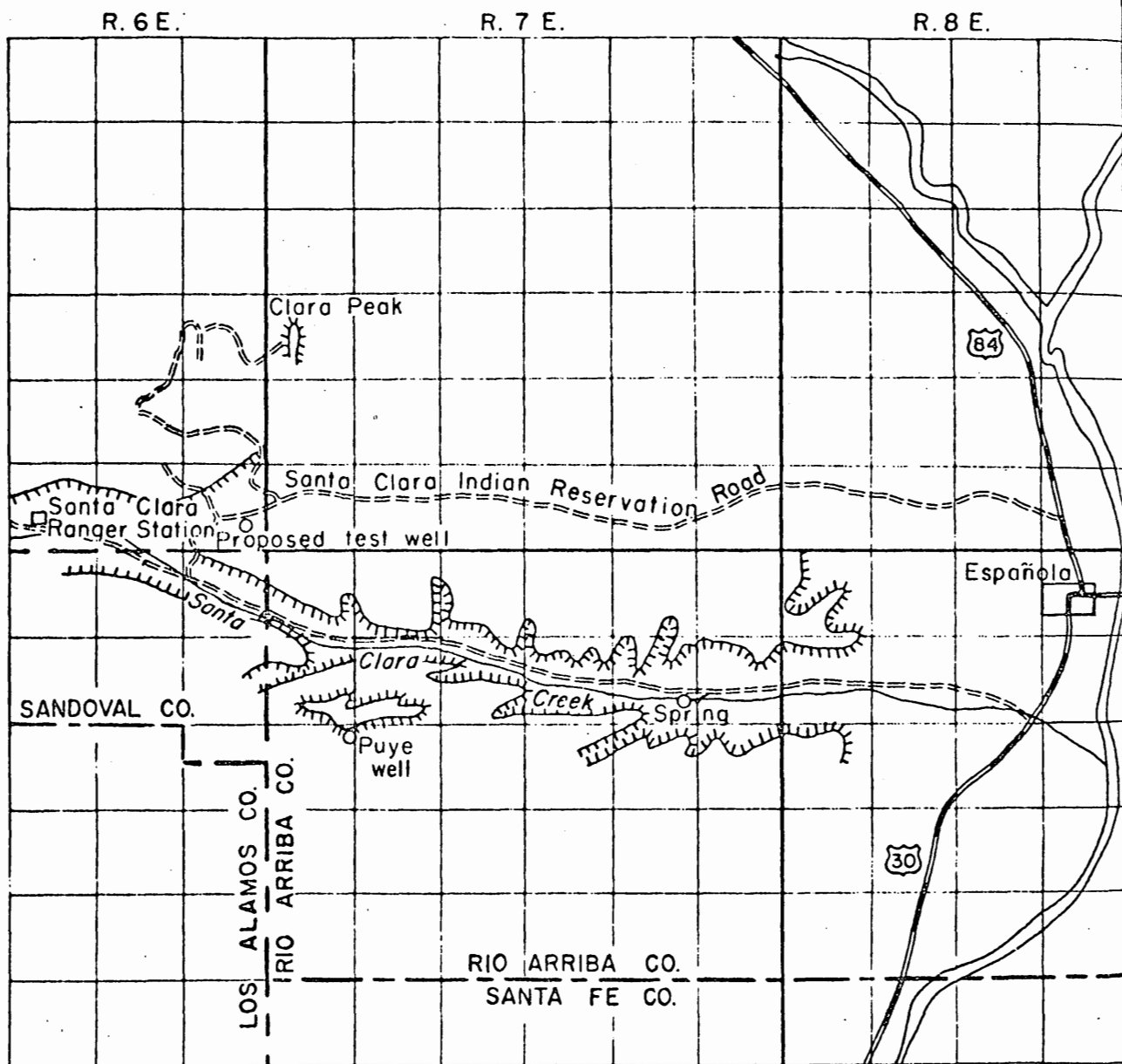


Figure 8.--Map of a part of the Santa Clara Pueblo Reservation, Rio Arriba County, N. Mex., showing the location of the proposed well site.

the level of the creek. These zones are probably saturated and should yield water to wells. A small spring on the valley floor a few feet higher than Santa Clara Creek in the SE1/4 sec. 11, T. 20 N., R. 7 E. may derive water from conglomerate of the Santa Fe group. However, the spring is located in the alluvium near the confluence of Santa Clara Creek and a small dry tributary, and it is probable that the water in the alluvium is underflow from Santa Clara Creek. The length of tubing in the well at Puye, located in NE1/4 sec. 18, T. 20 N., R. 7 E., indicates a depth to water of more than 900 feet. Two zones of saturation probably exist at the proposed well site; one in the conglomerate at a depth of 600 feet and one about 500 feet lower in the Santa Fe group. In both of these zones the water is moving slowly eastward toward the Rio Grande.

A well constructed at the proposed site will penetrate 100 to 200 feet of tuff and probably would obtain an adequate supply of water from the conglomerate at a depth of 450 to 600 feet below the surface. If the well is dry at 600 feet, it will be necessary to drill to the next water-bearing zone at a depth of about 1,100 to 1,200 feet below the surface to obtain water. Approximately 600 feet of conglomerate, in which some beds contain large boulders, may be penetrated by a well at this site.

San Juan Pueblo Grant
SE1/4 Sec. 25, T. 21 N., R. 8 E.

The proposed well site in the San Juan Pueblo Grant is about half a mile east of the community of El Llano (see fig. 9). The land surface slopes from an altitude of 5,780 feet above sea level along the east line of the section to 5,730 feet along the El Llano-Ranchitos road.

This site is underlain by strata of the Santa Fe group to a depth of at least 600 feet and possibly several thousand feet. The Santa Fe group is composed of sand, gravel, and clay, which are mostly unconsolidated. Basalt probably is not present within the depth to be reached by the proposed well.

Part of the precipitation on the high ground east of the proposed well site percolates to the water table, and moves westward under the well site toward the Rio Grande. The water level in the well at El Llano is 108 feet below the surface and is at an altitude of 5,612 feet. At the well in sec. 23, T. 21 N., R. 8 E. the water level is reported to be 88 feet below the surface, at an altitude of 5,604 feet. The water levels measured at El Llano and north of Arroyo Ranchitos show that the water table is at an altitude of between 5,600 and 5,650 feet in that vicinity.

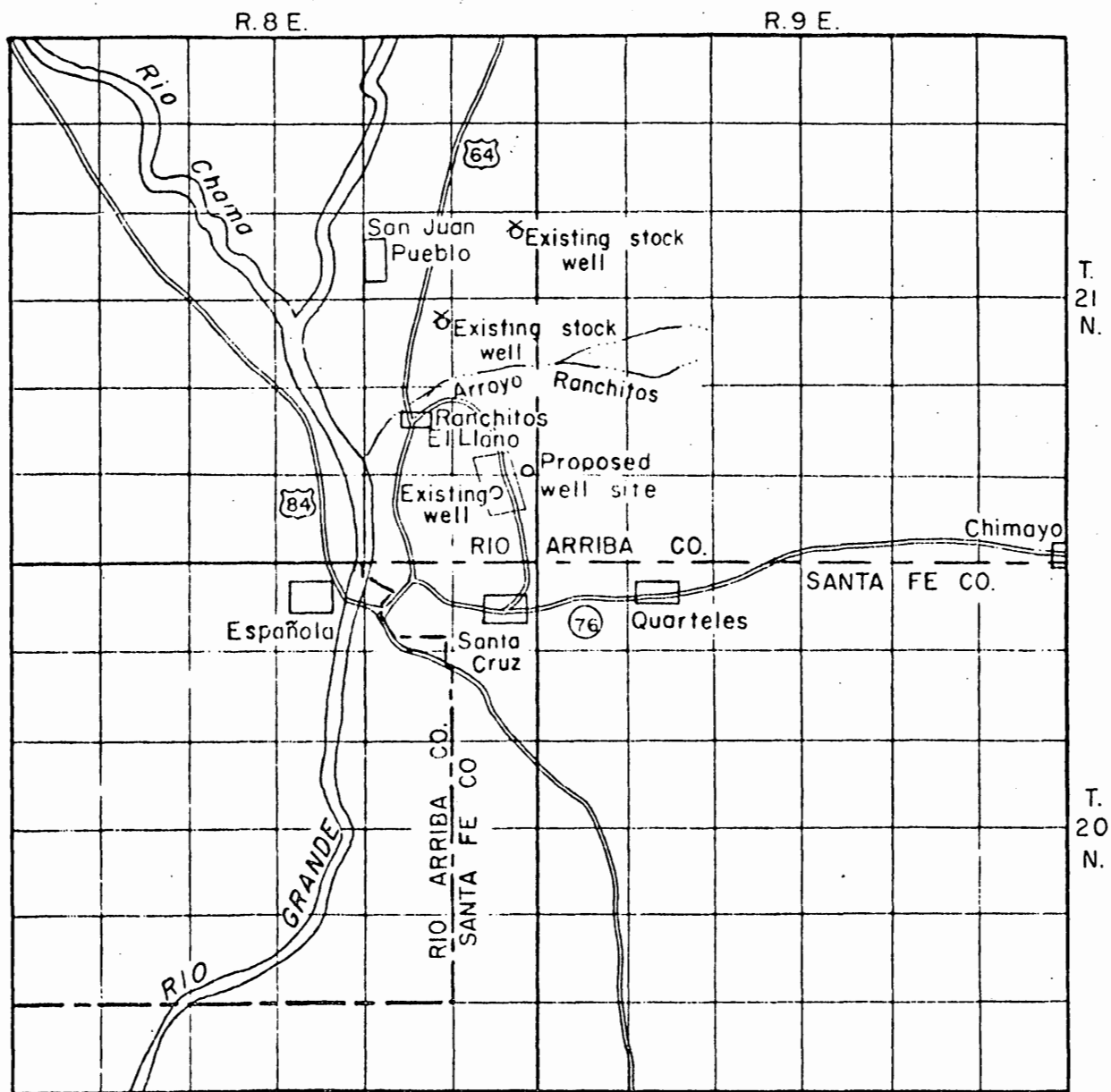


Figure 9.--Map of a part of the San Juan Pueblo Grant, Rio Arriba County, N. Mex., showing the location of the proposed well site.

The water table should be encountered between 100 and 130 feet below the surface, depending on the location of the well. The depth to water will probably be somewhat less near the El Llano-Ranchitos road than it is farther east.

Fine sand may be encountered, making it necessary to complete the well with a screen. In any event, it will be desirable to develop the well thoroughly in order to lessen the amount of sand pumped and to increase the yield.

Taos, Tract A
Sec. 31, T. 26 N., R. 12 E. (unsurveyed)

The site proposed for a range well on the Taos Indian land is on a basalt covered plain about 1 mile east of the Rio Grande and 6 miles south of the village of Arroyo Hondo, in sec. 31, T. 26 N., R. 12 E. (unsurveyed) (see fig. 10). The altitude of the site is about 7,000 feet above sea level and about 650 feet above the Rio Grande at its closest point.

The site is underlain by basalt, locally known as malpais, and by unconsolidated silty sands and gravels. The latter are probably equivalent to part of the Santa Fe group. Basalt is the principal material that will be penetrated by the well. The basalt may be highly porous in some areas because of gas cavities and fractures.

The streams emerging from the mountains east of Taos carry water onto an alluvial fan along the base of the mountains. Part of the water runs off in the Rio Lucero, Rio Pueblo de Taos, and Rio Hondo, and part goes underground into the material composing the fan. The water that enters the ground reappears in springs farther down the Rio Lucero, Rio Pueblo de Taos, and Rio Hondo, or moves under the mesa and rises in the bed of the Rio Grande.

The only known well in the area is a stock well in NW1/4 sec. 17, T. 25 N., R. 12 E. about 3 miles south of the proposed well site. The existing well, which yields 5 gpm, was drilled to a depth of 456 feet, mostly through basalt. The water rose 60 feet in the hole, indicating that artesian conditions exist.

The water level in the well is about 200 feet higher than the Rio Grande at its nearest point. The water table, therefore, slopes from the base of the mountains toward the Rio Grande. However, the slope of the water table to the Rio Grande probably is not uniform. Because of differences in permeability between the sediments and the basalts and differences in permeability within the basalts, the water table probably descends from the east in a series of steps.

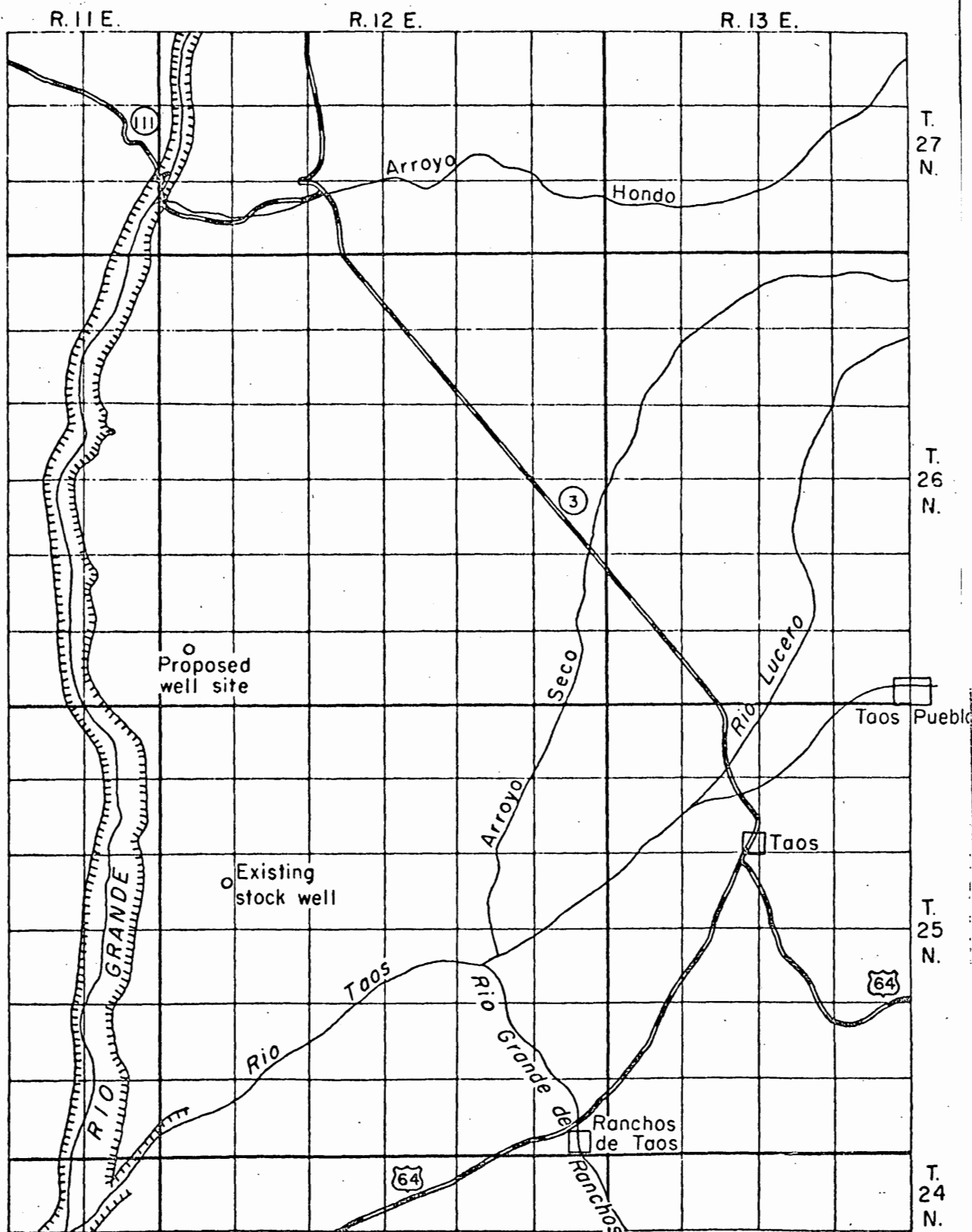


Figure 10.--Map of the Taos Pueblo Tract A land, Taos County, N. Mex., showing the location of the proposed well site.

The altitude of the water level at the proposed well site is probably between 6,450 and 6,500 feet. The water may be confined between impermeable beds. If the water is confined, it will be encountered at a greater depth, but should rise in the hole to between 6,450 and 6,500 feet in elevation.

Available evidence indicates that water in quantity sufficient for a range well cannot be obtained at shallower depths. The necessary depth of the well probably will be between 550 and 600 feet.

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