GEOLOGY AND GROUND-WATER RESOURCES OF SAN MIGUEL COUNTY, NEW MEXICO

GROUND-WATER REPORT 2

Geology and Ground-Water Resources of San Miguel County, New Mexico

BY *R. L. GRIGGS AND G. E. HENDRICKSON*

Prepared in cooperation with
The United States Bureau of Reclamation
New Mexico Bureau of Mines & Mineral Resources
and the New Mexico State Engineer

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GEOLOGY AND GROUND-WATER RESOURCES OF SAN MIGUEL COUNTY, NEW MEXICO

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Abstract

This report describes the occurrence and availability of ground water in San Miguel County and the geology of the county in relation to the occurrence of ground water. The study was made by the United States Geological Survey in cooperation with the United States Bureau of Reclamation, the New Mexico Bureau of Mines and Mineral Resources, and the New Mexico State engineer.

Topographically, San Miguel County includes the plains, the Las Vegas Plateau, Glorieta Mesa, and the Sangre de Cristo Mountains. The exposed formations include pre-Cambrian crystalline rocks, sediments of Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Tertiary, and Quaternary age, and Quaternary extrusive rocks. The chief use of ground water in the county is for livestock and domestic supplies, and it is unlikely that enough ground water for large-scale irrigation is available anywhere in the county.

The chief sources of ground water in the plains area are the sandstone beds in the Santa Rosa and Chinle formations. Quantities of water are generally sufficient for stock and domestic supplies, and the quality of the water is generally fair. Depth to water is generally less than 200 feet.

The chief source of ground water on the Las Vegas Plateau is the Dakota (7) and Purgatoire formations, although some water is obtained from the Graneros shale and the Greenhorn limestone north and northeast of Las Vegas. Enough water for stock and domestic supplies is available in most places. The water in the Dakota (?) and Purgatoire is generally of fairly good quality, but the water in the Graneros and Greenhorn is generally unfit for domestic use. Depth to water on the plateau is generally less than 200 feet.

Most wells on Glorieta Mesa obtain water from the Y eso formation, although some reach the underlying Sangre de Cristo formation, and a few obtain perched water from the Glorieta sandstone member of the San Andres formation. The quality of water is generally fair, but some of the wells yield water too high in sulfate for domestic use. Over most of the broad upland, depth to water is more than 300 feet.

Over most of the area in the Sangre de Cristo Mountains, water can be obtained from alluvium in the valleys or from the limestones and sandstones of the Magdalena group and sandstones of the Sangre de Cristo formation. In areas where the pre-Cambrian crystalline rocks crop out, thy holes may *be encountered. Drilling more than 10 feet into hard, unweathered crystalline rocks is generally not recommended. Quality of water is generally good. Depth to water ranges from a few feet in the valleys to more than 400 feet in the uplands.*

Introduction

LOCATION, AREA, AND ACCESSIBILITY

San Miguel County, in northeastern New Mexico, lies mainly between the meridians 103° 50' and 105° 40' west, and the parallels 35° 10' and 35° 50' north. Las Vegas, the county seat, situated in the west-central part of the county, is approximately 40 miles east of Santa Fe by direct line and about 90 miles northeast of Albuquerque. The area of the county is about 4,750 square miles or 3,040,000 acres. Its greatest north-south dimension is 57 miles, and its greatest east-west dimension, 117 miles.

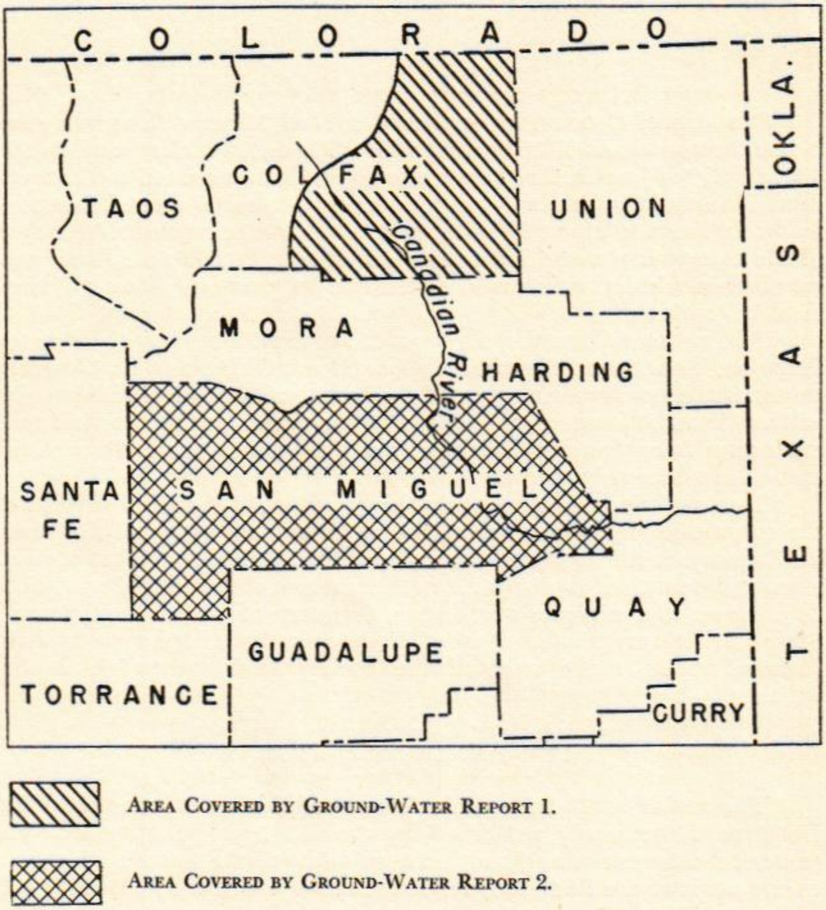
Two railroad lines pass through the county. The main line of the Atchison, Topeka and Santa Fe Railway, from Chicago to Los Angeles, traverses the northwestern part of the county and has a division point at Las Vegas. A branch freight line of the Southern Pacific Railroad, extending from Dawson, N. Mex., to the main line at Tucumcari, crosses the eastern part of the county.

Two asphalt-surfaced Federal highways cross the western part of the county. Highway 85 approximately follows the route of the Santa Fe Railway, and it is joined from the south by Highway 84 at a point a few miles south of Las Vegas. Another asphalt-surfaced highway, U. S. 285, crosses the extreme southwestern corner of the county. Several State and county roads, ranging from unimproved dirt to asphalt-surfaced roads, make most of the county fairly accessible in dry weather.

PREVIOUS INVESTIGATIONS AND ACKNOWLEDGMENTS

The major part of the geologic map of the county was compiled from maps previously published by the Geological Survey. For the central, southwestern and southeastern parts of the county, recent accurate maps of the Fuels Branch of the Survey were used (Read, 1944; Northrop, 1946; Dobrovolny, Summerson, and Bates, 1946). For the eastern and northwestern parts of the county the geologic map of New Mexico compiled by N. H. Darton was used; this map, in large part made by reconnaissance methods, is locally inaccurate. Minor changes have been made on the map accompanying the report in the location of the boundaries of the pre-Cambrian rocks in the northwestern part of the county. In the eastern part of the county the Santa Rosa and Chinle contact, not shown on the State map, was sketched in from field observation.

All water analyses in Table 3 were made under the direction of Mr. J. D. Hem, District Chemist in charge of Quality of Water Branch,



AREAS IN NEW MEXICO COVERED BY GROUND-WATER REPORTS PUBLISHED BY NEW MEXICO BUREAU OF MINES AND MINERAL RESOURCES

Fig. 1

Albuquerque, N. Alex. Mr. Hem also reviewed the sections on quality of water.

A general survey of the geology of this region was made prior to 1928 by Darton (1928). The ground-water conditions in parts of the county have been previously investigated by Murray (1943, 1948) .

During the early part of the investigations, funds were furnished by the U. S. Bureau of Reclamation which was interested in obtaining an evaluation of the ground-water resources of the Upper Pecos Valley. Later, in cooperation with the Survey, and as part of a long-range program of ground-water investigations in New Mexico, the State Bureau of Mines, which is a division of the New Mexico Institute of Mining and Technology, and the State engineer furnished half the funds.

The investigation was done under the general supervision of A. N. Sayre, Geologist in Charge, Ground Water Branch, United States Geological Survey, and under the direct supervision of C. V. Theis, District Geologist, in charge of ground-water investigations in New Mexico.

The writers are indebted to Mr. C. B. Read, Supervising Geologist, Fuels Branch of the U. S. Geological Survey, Albuquerque, New Mexico, for the assistance in revising the geologic map in the northwest part of the county and for his review of this report. Dr. Fred W. Emerson of Highlands University and Mr. E. C. Nord of the Soil Conservation Service, Las Vegas, N. Mex. also reviewed the report and supplied information concerning the vegetation of the county.

FIELD WORK

The field work upon which this report is based was begun by Mr. Griggs in May of 1947 and continued to December of that year. During this time the stratigraphy, particularly in regard to water-bearing properties, was studied, and about 250 wells were visited to determine which formations supply water to these wells. The depth to water in the wells was measured where practicable, and a representative number of water samples were taken for analysis by the Quality of Water Branch of the U. S. Geological Survey to determine the quality of water produced by the various stratigraphic units.

Later, during the period March to May 1948, Mr. Hendrickson continued the field work to fill in some gaps in the ground-water information and to make minor changes in the geologic map of the county. Mr. Hendrickson wrote the present report from a rough draft and field notes prepared by Mr. Griggs previous to his transfer to another project.

Physiography

San Miguel County is naturally divided into four physiographic areas: the plains, the Las Vegas Plateau, Glorieta Mesa, and the Sangre de Cristo Mountains. Essentially all of the county is drained by two river systems, the Pecos and the Canadian.

Elevations range from about 3,900 feet, where the Canadian River leaves the county, to more than 11,000 feet in the mountains. The plains lie between about 4,000 and 6,000 feet; the Las Vegas Plateau, between about 4,500 and 6,800 feet; and Glorieta Mesa, between about 6,000 and 8,000 feet. The mountain province extends from about 6,000 feet to more than 11,600 feet at Elk Mountain (Rincon Peak) .

To illustrate the surface features of the county, we shall imagine a trip by plane from Tucumcari to Santa Fe, by way of Las Vegas.

Taking off from Tucumcari, we are soon over the San Miguel County line. We are flying over Mesa Rica, an outlier of the Las Vegas Plateau. On our right is a steep cliff descending to the level of the plains, and beyond this, across the valley of the Canadian River, another cliff rises to the altitude of Carpenters Point, a long, peninsula-like, southern extension of the Las Vegas Plateau. Far to the north, just beyond the northeast corner of the county, is the village of Mosquero, county seat of Harding County, perched on top of this peninsula.

As we continue our flight to the northwest, we leave Mesa Rica behind us, and we are now over plains which extend both north and south beyond the limits of the county. These plains are a part of the Pecos Valley section of Fenneman (1931) . A few mesas and cuestas are above the general level of the plains, for the plains are the somewhat irregular surface that has been formed by erosion by the Canadian, Conchas, and Pecos Rivers of a higher surface once continuous with Mesa Rica and the Las Vegas Plateau. We cross the southern tip of Conchas Reservoir, a body of water covering about 600 square miles, at the confluence of the Canadian and Conchas Rivers. The Canadian River empties into this reservoir from the north and its tributary, the Conchas River, enters from the west. East of the dam, the Canadian River continues its course to the east, beyond the county line.

We cross the Conchas River at Variadero, and now ahead of us looms the Canadian escarpment, a cliff rising more than 1,000 feet above the plains at this point and marking the southern limit of the Las Vegas Plateau. As we cross the escarpment, we see the broad, gently rolling surface of the Las Vegas Plateau which stretches out in monotonous regularity ahead of us and to our right. We cross the Conchas River again where it has cut a canyon in the Las Vegas Plateau as it descends to the level of the plains on our left.

As we approach Las Vegas, we see the Gallinas River which flows southeastward from the mountains through Las Vegas to the Pecos River. In the foothills of the mountains, a series of reservoirs on the Gallinas provides the municipal water supply for the city of Las Vegas. On our right, the Sapello River flows southeastward out of the mountains and then turns northeastward to its junction with the Mora River in Mora County. The Mora River enters the Canadian River just north of Sabinoso, in northern San Miguel County.

At Las Vegas we change our course a little to the south to avoid flying over the highest ridges of the mountains, and we are now heading almost directly west to the village of Pecos. As we leave Las Vegas, we cross the hogback ridges of upturned strata which mark the eastern boundary of the Sangre de Cristo Mountains. On our right the hogbacks continue northward beyond the county line, but on our left, southward, they become less conspicuous where they grade into the Canadian escarpment southeast of Los Montoyas.

We leave the hogback zone and gain altitude to clear the mountains ahead. We are now approaching the crest of the eastern of two prongs that are the southern terminations of the Sangre de Cristo Mountains which rise to an altitude of about 13,300 feet at Truchas Peak, just north of San Miguel County. The crest of the western prong lies beyond the county line to the west. The mountain slopes are steep, and here the forest cover is heavy. We pass the crest of the east ridge, and ahead of us lies the valley of the Pecos River which flows southward between the two prongs of the mountains.

On our left is the steep escarpment, about 1,000 feet high, which marks the northern limit of Glorieta Mesa. This mesa is moderately dissected in places and locally entrenched by canyons, but it generally is characterized by gentle slopes developed on the Glorieta sandstone. The general surface of the mesa slopes to the south, east, and west, and the mesa grades eastward indistinctly into the plains of southern San Miguel County.

We cross the Pecos River at Pecos and change our course to the north to head for Santa Fe. Immediately beyond Pecos, we leave San Miguel County, cross the western fork of the mountains, and land in Santa Fe.

Climate

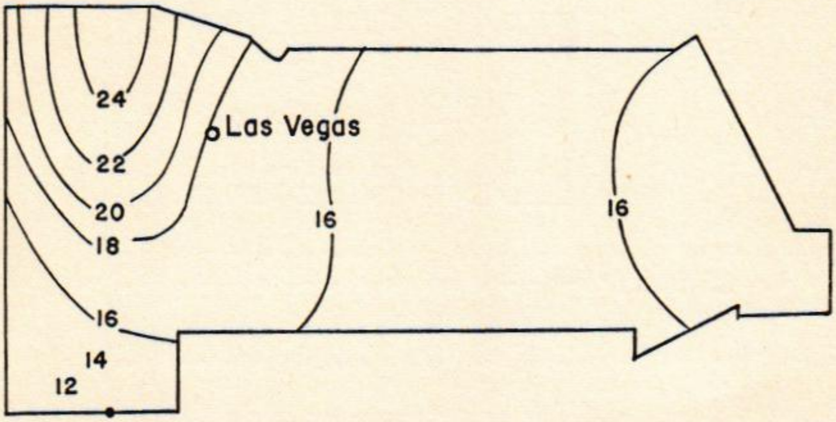
Most of the following climatological data, including tables and maps, are taken from the 1941 Yearbook of Agriculture "Climate and Man." (Hardy, 1941) . The climate of San Miguel County is semi-arid. The plains receive an average annual precipitation of about 15.5 inches. The Las Vegas Plateau receives from about 15.5 inches on its southern prolongation in the eastern part of the county, where the plateau is lowest, to more than 17.5 inches at Las Vegas, near the edge of the mountains. In the mountains the precipitation is much heavier. Winsor's station, in the northwest corner of the county, receives an average of more than 24 inches. Glorieta Mesa receives less precipitation than might be expected. The records of the weather station near Rencona show, over a 14-year period, an average of about 15.5 inches. At the southwest corner of the county the precipitation is about 12 inches. (See fig. 2.)

The above figures are averages only. In San Miguel County, as in other semi-arid regions, the variation from year to year is great, both in total annual precipitation and in the seasonal distribution.

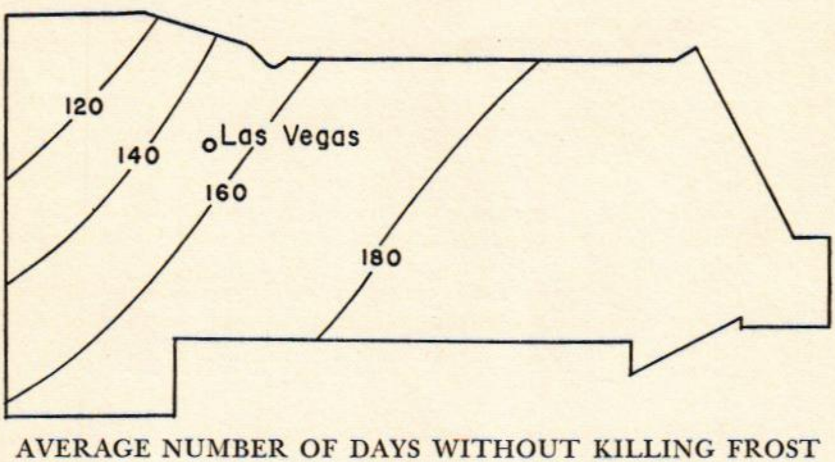
The greatest precipitation, normally, falls during the warm season from April to September, inclusive. Most of the rainfall is from thunderstorms and is heaviest during July and August. Such storms may cover only a small area, and it is not uncommon for one section of the county to receive 2 inches of rainfall in a single storm while another section receives none. Only the mountains receive a considerable amount of precipitation from snowfall.

The temperatures are usually mild throughout the year. In the mountains the average January temperature is a few degrees below freezing and on the plains it is a few degrees above freezing. The average July temperature ranges from about 60° F. in the mountains to 80° F. on the plains.

The length of growing season ranges from approximately 100 days in the mountains to 180 days in the plains area in the southeast section of the county.



AVERAGE ANNUAL PRECIPITATION (INCHES)



AVERAGE NUMBER OF DAYS WITHOUT KILLING FROST

Fig. 2

MEAN MONTHLY AND MEAN ANNUAL PRECIPITATIONS IN SAN MIGUEL COUNTY

	LENGTH OF RECORD *Yrs.*	JAN. *In.*	FEB. *In.*	MAR. *In.*	APR. *In.*	MAY *In.*	JUNE *In.*	JULY *In.*	AUG. *In.*	SEPT. *In.*	OCT. *In.*	NOV. *In.*	DEC. *In.*	TOTAL FOR YEAR *In.*
Bell Ranch	40	0.24	0.42	0.59	1.35	1.90	2.00	2.56	2.19	1.65	1.28	0.60	0.47	15.25
Cabeza	13	.31	.46	.55	1.40	1.66	1.40	3.02	2.53	1.53	1.39	.40	.50	15.15
Campana	20	.25	.39	.62	1.36	2.06	1.88	2.18	2.49	1.48	1.50	.52	.62	15.35
Doretta	21	.60	.63	1.09	.97	1.90	1.43	2.86	2.35	2.07	1.01	.42	.45	15.78
Harvey's Upper Ranch	15	1.51	1.84	2.37	2.52	2.41	3.43	5.96	6.10	2.16	2.49	1.10	1.54	33.43
Gallinas Plant Station	31	.64	1.20	1.42	1.72	2.12	2.27	4.85	3.81	2.11	1.42	.79	.83	23.18
Las Vegas	40	.42	.64	.74	1.17	1.86	2.09	3.47	3.16	2.07	1.03	.60	.52	17.67
Mineral Hill	20	.70	.99	.98	2.03	1.33	2.42	4.21	3.52	1.72	1.53	.88	.75	21.06
Onava	31	.39	.65	.68	.97	1.70	1.86	2.73	3.19	1.55	1.13	.44	.47	15.76
Pecos Ranger Station	21	.67	.79	.99	1.02	1.71	1.18	2.63	2.72	2.09	1.15	.51	.53	15.99
Rencona (near) ...	14	.57	.82	.80	.55	1.96	1.33	2.60	3.01	1.82	.97	.51	.63	15.57
Rociada	23	.68	.98	1.42	2.26	1.72	2.04	4.61	3.76	1.76	1.51	.96	1.05	22.75
Trementina	22	.29	.49	.67	1.38	2.09	1.92	2.12	2.41	1.51	1.50	.66	.64	15.68
Trujillo	16	.41	.52	1.25	1.23	2.23	2.07	2.83	2.52	1.66	1.91	.84	.61	18.08
Winsor's	40	1.12	1.69	1.76	1.67	1.91	2.04	4.33	3.74	2.45	1.72	1.07	1.06	24.56

TEMPERATURE RECORDS OF SAN MIGUEL COUNTY

	LENGTH OF RECORD *Yr.*	AVERAGE JAN. TEMPERATURE °F	AVERAGE JULY TEMPERATURE °F	HIGHEST TEMPERATURE RECORD °F	LOWEST TEMPERATURE RECORD °F		LENGTH OF RECORD *Yr.*	AVERAGE DATE OF LAST KILLING FROST	AVERAGE DATE OF FIRST KILLING FROST	LENGTH OF GROWING SEASON *Days*
Bell Ranch	34	36.3	77.7	107	–26	:	34	Apr. 19	Oct. 23	187
Campana	15	35.8	79.0	108	–16	:	15	Apr. 20	Oct. 24	187
Harvey's Upper Ranch	11	26.4	58.2	85	–18	:	15	May 25	Sept. 21	119
Gallinas Plant Station	20	30.1	63.2	93	–24	:	20	May 20	Oct. 2	135
Las Vegas	40	32.4	70.3	99	–31	:	40	May 6	Oct. 8	155
Rociada	20	31.0	62.0	93	–32	:	22	May 28	Sept. 23	118
Winsor's	38	26.7	59.4	90	–27	:	40	June 11	Sept 19	100

Vegetation

The following discussion is based largely on information supplied by Dr. F. W. Emerson of the Highlands University and Mr. E. C. Nord of the Soil Conservation Service, Las Vegas, N. Mex.

The types of vegetation of the county range widely. There is a progression from some desert forms on the lowlands to spruce and fir in the higher parts of the mountains. The plains are chiefly grasslands of blue grama and some buffalo and Galleta grass. Juniper and pinyon trees grow in scattered patches in the higher and more rugged parts of the plains, and mesquite grows in the lower parts. Cane cactus and several species of prickly pear are abundant locally.

The Las Vegas Plateau is largely grassland, of blue grama and western wheat grass. Juniper and pinyon trees grow along the dry arroyos and in scattered patches elsewhere on the plateau, and some ponderosa pine grows in the higher parts of the plateau.

The lower parts of Glorieta Mesa are mixed grassland and pinyon-juniper woodland, and the higher parts are forested by ponderosa pine.

The mountains are largely covered by coniferous, aspen and poplar forest, and a few small areas of open grasslands. The lower slopes are covered by pinyon, juniper, and ponderosa, the ponderosa predominating at altitudes above 6,800 feet. White and Douglas fir grow above 7,500 feet. And still higher, Blue and Engleman spruce and Cork-bark and Alpine fir are prominent.

Industry and Population

The chief industry of the county is ranching. Farming is second in importance, and some income is derived from the tourist trade and a small timbering industry.

About 340,000 acres of the county is in national forest. Of the remaining 2,700,000 acres, about 95 percent is devoted to ranches and about 5 percent to farms. About 75,000 head of beef cattle, 2,000 head of dairy cattle, and 20,000 head of sheep are in the county (U. S. Census of Agriculture, 1945) .

Dry farming is practiced on Glorieta Mesa and in the vicinity of Trujillo and Maes, where pinto beans, small grains, and corn are raised. Irrigation is practiced along the Pecos River and its tributaries. Most of the farms are small, and, except in the Storie Project northeast of Las Vegas and in an area near Lake Isabel and Lake David, most are narrow, elongate plots adjacent to community ditches. The irrigated crops are alfalfa, native hay, small grains, and corn.

In 1940, according to census reports, 27,910 people lived in San Miguel County. Of this total number, 12,362 lived in Las Vegas, about 6,000 in small villages, and about 10,000 on ranches and farms.

Geology

STRATIGRAPHY

Pre-Cambrian

The Southern Rocky Mountains, terminating in two high prong-like ridges which are separated by the upper Pecos Valley, owe their ridgelike expression to two southerly trending belts of pre-Cambrian rock which form the resistant cores of the two ridges. The pre-Cambrian core of the western ridge locally extends into San Miguel County north of the village of Pecos, but the crest of this ridge, trending slightly east of north, lies 2 to 5 miles west of the county. The pre-Cambrian core of the eastern ridge enters the county from the north in Rs. 14 and 15 E. From the county line, it trends almost due south, lying mainly in R. 14 E., as far as T. 15 N. From here its trend is southeast to a point about 1½ miles northwest of Bernal, where it is overlain by sediments. Pre-Cambrian rocks crop out in a fairly large area just west of this main ridge in T. 17 N., Rs. 12 and 13 E. and in places in the valley of the Pecos and its tributaries. A few small areas of pre-Cambrian rocks also crop out along a north-south zone at the east edge of the mountains. From north to south these exposures are on a hill north of Montezuma, in Gallinas Canyon west of Montezuma, and near Agua Zarca about 4 miles southwest of Las Vegas. The pre-Cambrian rocks consist of gneiss, schist, quartzite, granitic rocks, and pegmatite.

Carboniferous system

Magdalena group. Resting unconformably on the pre-Cambrian rocks and cropping out over the greater part of the mountainous area of the county is a thick sequence of beds referred to as the Magdalena group. These beds extend from the pre-Cambrian cores approximately to the edge of the mountains. Their subsurface distribution is not well known. The log of an oil test well drilled in the NE¼ sec. 34, T. 17 N., R. 21 E., shows that beds of Permian age rest directly on pre-Cambrian rocks in that locality. A recently drilled oil test well about 10 miles east of Las Vegas, is said also to have gone through Permian strata directly into pre-Cambrian rocks.

The lithologic composition of the Magdalena group ranges from sandstone and arkosic sandstone through shale to limestone, with the limestone predominating. The thickness of the Magdalena group ranges from the vanishing point locally to more than 2,000 feet in the upper Pecos Valley, between the two main ridges of the mountains composed of pre-Cambrian rocks. The log of the oil test well of the Toltec Oil Co., in sec. 2, T. 13 N., R. 10 E., indicates the thickness of the Magdalena group to be about 2,350 feet at this point. This thickening away from the pre-Cambrian rocks indicates that the pre-Cambrian ridges of today were highs during Magdalena time.

The Magdalena group is commonly divided into the Sandia formation and overlying Madera limestone, and Read (1944) has recently subdivided each of these formations in north-central New Mexico into members.

Sandia formation. The Sandia formation, cropping out in a narrow, discontinuous belt around the pre-Cambrian rocks, consists of a lower limestone member and an upper member of predominantly dastic materials. The lower limestone member, which may be of Pennsylvanian or pre-Pennsylvanian age (Read, 1944) , consists of coarsely crystalline light-gray limestone containing light-gray to gray nodular chert. In places a small amount of shale and/or sandstone is at the base. This member, absent in many places, is as much as 100 feet thick. The upper member, also absent in places, is as much as 300 feet thick. It consists largely of carbonaceous shale and sandstone. Read's sections of this member show some thin beds of limestone.

Madera limestone. The Madera limestone consisting of two limestone members forms the greater part of the surface exposure of the Magdalena group. The lower member, where present, is as much as 800 feet thick and consists of tan to light-gray to dark-gray fine-grained cherty limestone interbedded with shale. The chert bodies, which have irregular boundaries, weather a dirty yellow or orange color which is conspicuous against the gray limestone. The interbedded shale is dark gray to black, but much of it weathers toga drab color. The upper member of the Madera limestone, where present, may be more than 1,000 *feet* thick. It consists of medium to coarsely crystalline light-gray commonly feldspathic limestone, and interbedded coarse feldspathic sandstone. In places, near the top of the member, some maroon shale is interbedded.

Carboniferous and Permian (?) systems

Sangre de Cristo formation. Resting on the Magdalena group, or locally, as northwest of Romeroville, overlapping onto the pre-Cambrian rocks, is the Sangre de Cristo formation. This formation ranges in thickness from about 600 to 1,000 feet and consists of alternating dark-maroon shale and coarse pink feldspathic sandstone. Locally, there is some greenish-gray shale. Read (1944) has assigned the beds in this area to the Sangre de Cristo formation and their partial equivalent in the area to the west to the Abo formation. The contact with the Magdalena appears conformable or gradational in most places, although, according to Northrop (1946) the contact is locally disconformable. Most of the strata assigned to the Sangre de Cristo formation are probably of Permian age, but the lower part of the formation, as it grades into the Magdalena, is of Pennsylvanian age.

The formation crops out around the edges of the mountains and in the lower slopes of the escarpment marking the northern limit of

Glorieta Mesa. All of the deep oil tests that have been drilled in the county encountered this formation. It is probable that the Sangre de Cristo formation is present in the subsurface through most of the county.

Permian system

Yeso formation. The Sangre de Cristo formation grades upward into the Yeso formation. The Yeso is exposed along the west side of the hogback ridges at the east edge of the mountains from Sapello to near Tecolote, in the north slope of Glorieta Mesa west of Tecolote, and on Glorieta Mesa as in Canyon Blanco.

On the north slope of Glorieta Mesa, near Rowe, the Yeso formation is about 400 feet thick. Eastward toward Tecolote it thickens to about 500 feet, and from there northward, along the hogbacks toward Sapello, it thins to about 300 feet. In the southwestern part of the county, a well in the SE¼ sec. 20, T. 10 N., R. 14 E., logs about 600 feet of Yeso. In the southeastern part of the county, the log of an oil test well drilled 5 miles northwest of Canadian indicates the Yeso to be 1,000 feet thick.

The Yeso formation is fairly uniform in lithology. It is predominantly light-red or orange-red siltstone with some thin lensing zones of silty sandstone. Some very thin beds of light-gray fine-grained dolomitic limestone crop out along the north edge of Glorieta Mesa. These beds disappear to the north toward Sapello, but near the south boundary of the county in R. 13 E. there is at least one zone of thinly bedded limestone about 15 feet thick. Beds of gypsum are practically absent from the formation in its outcrop area in the county, but some water analyses suggest the local presence of calcium sulfate in the subsurface.

San Andres formation. The San Andres formation, resting conformably on the Yeso formation, consists of three members in San Miguel County: the Glorieta sandstone member at the base, a thin middle limestone member, and an upper clastic member.

The Glorieta sandstone member of the San Andres formation, named from Glorieta Mesa, forms the westernmost of the hogback ridges from Sapello to a short distance south of Romeroville. It forms the resistant cap rock over most of Glorieta Mesa in the southwest part of the county, although overlain in several places by younger units. The Glorieta member, ranging from about 150 to more than 200 feet in thickness, is massive to thin-bedded fine-grained quartzitic sandstone containing some thin beds of yellow to red clay and silt. The sandstone is white to light gray on a fresh fracture, but it is buff or brown on a weathered surface. The interbedded red siltstone is noticeable through the lower 25 feet of the unit where the sandstone grades into the Yeso formation.

The limestone of the middle member of the San Andres formation is thin in its exposure belt in San Miguel County, and its exposures are inconspicuous. On Glorieta Mesa, where the limestone covers a considerable area it ranges in thickness from 20 feet on the west to about 30 feet on the eastern slope of the mesa. Northward, it thins to 18 feet west of Romeroville and to about 10 feet at Montezuma. North of Montezuma, it disappears. The limestone is generally separated from the underlying Glorieta sandstone by 5 to 10 feet of yellow to blue clay which is also assigned to the middle member of the San Andres. The limestone of the middle member is predominantly fine-grained and gray in color commonly mottled with red. In sec. 7, T. 12 N., R. 12 E., on Glorieta Mesa, and in some other localities, it is a slightly argillaceous dolomite. It is commonly fractured and locally brecciated. At many places parts of the member show interconnected, more or less tubular holes. Another common feature is an open box-work structure, with the walls of the box-work composed of calcite and the openings empty or partly filled with a very fine-grained spongy mixture of calcite and clay. This texture has apparently originated through the filling of closely spaced fractures by calcite and clay and the later solution of the intervening more soluble material. Fiedler and Nye (1933) have shown that similar cavities have been developed by the solution of small amounts of gypsum in the limestone of the San Andres in the Roswell artesian basin.

The upper clastic member of the San Andres formation, consisting of dark-red shale and siltstone, crops out in the hogback ridges west of Las Vegas, and along both the east and west sides of Glorieta Mesa. South of Romeroville, where the hogback ridges die out, the outcrop area of the member extends along the east margin of the mesa, and south of Villanueva it is exposed on the flank of the mesa, in the slopes of cuestas. West of Rowe to the south boundary of the county it is exposed well up on the mesa. This member thickens southeastward and ranges in thickness from 75 to 150 feet.

Triassic system

Dockum group. The Dockum group, overlying the upper clastic member of the San Andres formation with apparent conformity, consists of the Santa Rosa sandstone of Upper (?) Triassic age at the base and the overlying Chinle formation of Upper Triassic age. The total thickness of the group apparently ranges from about 1,000 to 1,200 feet.

Santa Rosa sandstone. The Santa Rosa sandstone is exposed in several areas of the county. It forms a poorly developed ridge in the hogback zone between the mountains and the Las Vegas Plateau. Farther south, it is exposed on Glorieta Mesa north of Rencona and along the west flank of the mesa. Another exposure area continuous with the latter belt extends eastward from near Tecolotito and covers a large part of the plains. The upper boundary of this area trends northeast from Tecolotito until it reaches the Canadian River near Sabinoso. From this place it follows the river southward to Conchas Dam, and there it swings abruptly southwestward to the vicinity of the southeast corner of T. 12 N., R. 23 E. Between Tecolotito and Sabinoso, this upper boundary, although trending generally northeast, extends up the Gallinas River to north of Park Springs, up the Conchas River to near the Conchas Ranch headquarters, and up Corazon Creek to the town of Corazon. Farther eastward it extends up Trementina Creek for several miles above Trementina, and from there northward almost to Sabinoso.

The Santa Rosa sandstone is slightly silty, fine-grained gray sandstone containing some thin beds of conglomerate and some thin to thick beds of red shale. Much of it is massive, weathering to rounded forms, but some is thin-bedded cross-bedded material. The sandstone weathers to a dirty buff color which is stained locally by manganese and darker iron oxide. The interbedded red shale is lenticular and ranges considerably in thickness. In places it is more than 100 feet thick. As the material is identical in character with the overlying Chinle formation, it is locally difficult to determine the upper limit of the Santa Rosa. For example, a few miles north of Conchas Dam, along the Canadian arm of the Conchas Reservoir, a sandstone rim along the top of the canyon overlies a thick shale which extends down to the pool line of the reservoir. Whether this shale should be included in the Santa Rosa, with the sandstone that forms the top of the rim marking the top of the unit, was not definitely determined. A similar thick zone of shale is present a few miles north of Cabra Springs. At that place the shale appears to be a part of the Santa Rosa sandstone, as the overlying sandstone apparently grades, in all directions, into thicker zones of typical Santa Rosa. It is possible that some zones of sandstone, identical in lithology with the Santa Rosa, should be included in the lower part of the Chinle.

The thickness of the Santa Rosa formation is about 400 feet in the hogback zone west of Las Vegas. In the oil test well drilled in the southeast part of the county, about 5 miles northwest of Canadian, it is either about 200 or 500 feet thick, depending on, how the log is interpreted.

Chinle formation. The Chinle formation, ranging from approximately 800 to 1,000 feet in thickness and consisting of three members, is exposed in the hogback zone from Sapello southward to the vicinity of Romeroville. From Romeroville, the upper boundary of the Chinle follows the lower slope of the Canadian escarpment eastward across the county. The lower contact of the Chinle approximately follows the tracks of the Santa Fe Railway to the vicinity of Myers. From this place southward to within a few miles of the boundary of the county, the lower contact is west of U. S. Highway 84. In this area the lower contact swings eastward and the Chinle covers essentially all of the plains country between the boundary of the Santa Rosa sandstone and the Canadian escarpment.

The upper and lower members of the Chinle formation are identical in lithology and consist of clay, shale, siltstone, and some fine-grained, silty sandstone. There are also some thin zones of conglomerate containing pebbles of limestone. These members are brownish red to purplish red, locally mottled with grayish green. In a few places they contain greenish to bluish gray beds. The thickness of the lower member ranges from about 200 to 350 feet. The upper member is about 350 feet thick at most places, but it reaches a greater thickness locally.

Separating the upper and lower members of the Chinle formation is a sandstone which is similar in lithology to the Santa Rosa sandstone. It is a massive to thin-bedded, fine-grained gray sandstone which weathers to a dirty buff color. In places red shale is interbedded. This sandstone forms a cuesta, first on the west and then on the east of U. S. Highway 84, from Romeroville southeast to the vicinity of Apache Springs. From there it follows the steep slopes of the Canadian escarpment, and it caps low mesas on the plains such as Mesa Montosa, Mesa Pino, and the mesas and cuestas southeast of Variadero. It leaves the escarpment east of Sabinoso, and from there southward it caps a low cuesta which extends across the Pablo Montoya grant.

The middle sandstone member of the Chinle formation is more than 100 feet thick near Sapello. It decreases to 45 feet about 2 miles south of Romeroville, then thickens to nearly 100 feet west of Chaperito. Farther east, at Corazon Butte, it is very thin or is represented by two thin zones of sandstone which are separated by about 100 feet of red shale. However, southwestward, it is the upper of these sandstones which thickens, while the lower one remains thin and possibly wedges out. Southwest of Gate City the sandstone member is about 165 feet thick.

Jurassic system

Entrada sandstone. The Entrada sandstone, inconspicuous in the hogback zone west of Las Vegas, is very prominent in the Canadian escarpment a short distance south of Romeroville. Farther south and also eastward it is present in the middle slope of the escarpment as far as T. 18 N., R. 26 E. From this place southeastward it generally is close to the edge of the plains in the lower slopes of the escarpment and of such outliers as Mesa Rica and La Cinta Mesa. It is also exposed on the plains in a north-south belt in the vicinity of Canadian.

The Entrada sandstone is a fine- to medium-grained poorly cemented sandstone. In the western part of its exposure area it is white to light buff; in the central part it is pink; and in the eastern part it is pink and has a buff zone at the top. In all its exposures around the Canadian escarpment, it can be recognized from a considerable distance because of its massiveness and distinctive color. At Corazon Butte and westward it is essentially a single massive bed about 50 to 65 feet thick, which commonly shows sweeping cross-bedding. At places west of Corazon Butte, however, a thin horizontal bed is separable from the massive bed at both the top and bottom of the Entrada. In the eastern part of the county, some horizontal bedding is present in the main part of this formation, but the sandstone retains its general massive character. Be-

Las Vegas Plateau has been mapped as Dakota (?) sandstone by Northrop and others (Northrop, 1946). The cap rock of Mesa Rica is undoubtedly Purgatoire, as the Lower Cretaceous fauna of the Purgatoire formation is present, but elsewhere no fossils have been found in the cap rock. The upper part of the cap rock in northern San Miguel County and as far southwest as Romeroville is identical in lithology with the Dakota sandstone of northern New Mexico and southeastern Colorado. The Purgatoire, if present over most of the Canadian Plateau, immediately underlies the Dakota, and both appear to act as one hydrologic unit. The stratigraphic question was therefore not investigated during the course of this hydrologic investigation.

At Mesa Rica the Purgatoire formation is represented by three members (Dobrovolny, Summerson, and Bates, 1946): a lower member of shale and sandstone, a middle member of sandstone, and an upper member of sandstone and shale. The lower member, predominantly a bluish-gray shale, has some white to light-buff sandstone at the base interbedded with shale. The sandstone weathers to buff, and the shale weathers to a lighter bluish gray mottled with yellow. This lower member is between 25 and 50 feet thick. The middle member, about 75 feet or more thick, is massive cross-bedded white sandstone and thin lenses of conglomerate containing quartz pebbles. This member is moderately cemented. It weathers light buff to tan. The upper member consists of slightly quartzitic brown sandstone and interbedded bluish gray shale.

The lower member of the Purgatoire formation has been identified only at Mesa Rica, although it is probably present in Carpenters Point, a short distance north of Mesa Rica. The middle member is exposed on top of the Morrison formation over a small area south of Campana. Elsewhere on the Las Vegas Plateau, the middle member is believed to be represented by the lower part (approximately the lower half) of the cap rock, around the main part of the Canadian escarpment. It is a massive, cross-bedded quartzitic sandstone which weathers to a buff or tan color slightly darker than at Mesa Rica. At Romeroville this zone contains thin lenses of conglomerate similar to those at Mesa Rica. Little is known of the extent of the upper member of the Purgatoire away from Mesa Rica. A shaly zone is in the central part of the cap rock of the Las Vegas Plateau in the northwest part of the county, and drillers' logs indicate local shale zones elsewhere. At Romeroville a conspicuous zone of dark bluish-gray shale is slightly above the central part of the sandstone sequence.

The upper part of the cap rock of the Las Vegas Plateau is composed of fine-grained highly quartzitic sandstone. This sandstone, commonly containing pebbles of quartz and of chalcedonic silica, weathers to rough surfaces. The sandstone is white to buff on a fresh break and weathers to brown or reddish-brown. Cross-bedding and ripple marks are common. This upper part of the cap rock is much thinner-bedded than the lower part.

The total thickness of the Dakota (?) and Purgatoire sequence is 220 feet at Las Vegas, as indicated by the log of one of the Santa Fe Railway wells. The log of the Los Vigiles well, 3½ miles northwest of Las Vegas, shows a thickness of about 200 feet. Farther east, in Mosquero, just east of San Miguel County, wells are reported to penetrate about 250 feet of the Dakota (?) and Purgatoire sequence before entering the Morrison formation. The present thickness on the Las Vegas Plateau ranges from more than 200 feet where erosion has had little effect to the vanishing point where erosion has been active.

Graneros shale. The Graneros shale is poorly exposed in the north-central part of the county in two areas. One area extends from about 2 miles southeast of Romeroville north and northeast on the west and east limbs of a very asymmetric, northward-plunging syncline. On the east limb of this syncline, the outcrop area of the Graneros is from 1 to 3 miles wide. On the west limb, the outcrop area is very narrow, and exposures are inconspicuous. Another exposure area is crossed by State Highway 65 about 19 miles east of Las Vegas. Here it has been preserved on the Las Vegas Plateau on the downthrow or downwarped east side of a northward-trending fault or monocline.

The Graneros shale is predominantly black fissile shale on which grassy slopes have formed along its exposure belt. Several thin beds of bentonite, as much as 1 foot thick, are at the top of the formation, immediately below the Greenhorn limestone. These beds are well exposed along the railroad tracks immediately north of the Las Vegas railroad station. Some drillers' logs indicate the presence of thin beds of both limestone and sandstone interbedded in the shale, but neither of these rock types has been noted at the surface.

The thickness of the Graneros shale has not been measured on the surface. A thickness of 215 feet is indicated by the log of the Los Vigiles well, 3½ miles northwest of Las Vegas.

The formation lies conformably on the Dakota (?) and Purgatoire sequence.

Greenhorn limestone. The Greenhorn limestone is exposed in approximately the same two areas as the Graneros shale. In the north-central part of the county the exposures are associated with the northward-plunging syncline near Las Vegas. The exposure belt on the west side of the syncline is a narrow strip a short distance east of the hogbacks. The beds flatten out around the south end of the syncline in the immediate vicinity of Las Vegas, and the exposure belt widens. Northeastward from Las Vegas, on the gently dipping east limb of the syncline, the exposure belt widens to about 8 or 9 miles. In this area, northeast of Las Vegas, the Greenhorn limestone caps nearly flat topped hills and gently sloping plains on the Las Vegas Plateau. About 19 miles east of Las Vegas is another small outcrop area of the Greenhorn.

The Greenhorn limestone consists of thin beds of limestone and interbedded shale. The limestone, in beds as much as 2 feet thick, is fine-grained and argillaceous. It is gray to black on a fresh exposure but weathers to a light-cream color. The interbedded shale is dark gray and calcareous, and at the base of the unit, which is gradational with the underlying Graneros shale, are a few beds of calcareous shale, which weather to a light color and, from a short distance, appear to be limestone. No exposure suitable for measuring the thickness of the Greenhorn limestone was noted. The log of the Los Vigiles well indicates it to be about 45 feet thick.

Carlile shale. The main exposure area of the Carlile shale extends northward from Las Vegas within the belt of Greenhorn limestone in the synclinal area previously referred to. In this area outcrops are poor and scattered as grassy slopes have formed on most of the soft shale. The few local outcrops are mainly along shallow road cuts and low pediment escarpments. Another small outcrop of the lower part of the Carlile shale is in a pediment remnant 4 miles east of Las Vegas.

The Carlile shale lies conformably on the Greenhorn limestone. It is a dark-gray shale containing large calcareous concretions, as much as 3 feet in diameter, near the top of the unit. A few feet above the concretions is a highly fossiliferous zone in which small clams, cephalopods, and shark teeth are abundant. This fossiliferous zone is a valuable marker horizon in working out the stratigraphy of the area.

Niobrara formation. Presence of strata of the Niobrara formation in San Miguel County has not been verified by fossil evidence, although it is indicated by the geologic structure and by one well log. The beds are in a narrow belt north and west of Storrie Lake, along the axis of the asymmetric syncline east of the hogback zone between the mountains and the Las Vegas Plateau. They are the youngest beds in the syncline. Only the lower part of the Niobrara formation is present.

The log of the well, 3½ miles northwest of Las Vegas, indicates 250 feet of Niobrara formation at the top of the hole. The beds consist of 15 feet of limestone (Fort Hays limestone member) at the base and 235 feet of overlying gray shale. As the syncline plunges northward, the thickness of the beds remaining in the syncline increases to the north.

Tertiary system

Ogallala formation of Miocene and Pliocene series. The Ogallala formation has been almost completely removed by erosion in San Miguel County, but remnants up to 50 feet thick are over part of Mesa Rica in the southeast, and on Glorieta Mesa in the southwest part of the county. In these areas the Ogallala consists of silt, sand, gravel, and some concretionary limestone. The color of the material ranges from tan to pink.

Quaternary system

Alluvium and pediment gravel. Alluvium, although present in places along streams, is not well developed along most of the streams of the county. In general, it is present in fairly large amounts only along the larger streams, and there it is not continuous. The best development of stream alluvium is along the Canadian River, particularly in the southeastern part of the county; along the Pecos River between the limits of the Magdalena group and the Glorieta sandstone member of the San Andres formation; and along the Sapello River, below the village of Sapello. The alluvial material consists mainly of silt and sand and less abundant gravel. It is as much as 35 feet thick.

In addition to the alluvium along streams, an unknown thickness of alluvium is in a broad valley, ½ to 1 mile wide, between Lower Rociada and the county line in T. 19 N., Rs. 14 and 15 E.

Pediment gravel caps pediment remnants in the north-central part of the county, near Las Vegas, and also in the southeastern part of the county, adjacent to La Cinta Creek and the Canadian River (Ts. 13 and 14 N., R. 27 E.) . All the pediment remnants in the north-central part of the county are small except one located near the county line, southeast of Sapello and north of Storrie Lake, which covers about 8 square miles. The remnants near La Cinta Creek in the southeastern part of the county are also small. East of Conchas Dam for several miles along the Canadian River are narrow pediment remnants, considerably dissected by transverse arroyos. The material capping the pediment remnants is largely gravel, which is as much as 25 feet thick. On one small remnant about 2 miles north of Las Vegas the gravel has been quarried for road material.

Igneous rocks. The igneous rocks of San Miguel County, exclusive of those of pre-Cambrian age, are remnants of one lava flow, two volcanic plugs, and one dike. The lava flow, a basalt of Quaternary age, originated at a volcano a few miles north of San Miguel County in Mora County. The lava flowed down the Mora River Valley to the Canadian River and then down the valley of the Canadian at least as far as T. 16 N., R. 25 E. Near its point of origin, this flow rests on the Las Vegas Plateau but the flow has been strongly dissected by the Mora and Canadian Rivers, and south of Sabinoso it rests on a terrace or pediment remnant which is about 300 feet above the Canadian River. The lava is dark gray to black and fine- to medium-grained. Much of the material is vesicular. The two plugs and the dike are of similar material though nonvesicular. Both plugs are small and subcircular in plan view. One is just north of State Highway 65, about 4 miles east of Las Vegas, and the other is near the center of sec. 15, T. 12 N., R. 23 E. The dike, trending slightly east of north, crosses State Highway 3 about 1½ miles north of Storrie Lake (T. 17 N., R. 16 E.) . It is assumed that the two plugs and the dike, like the flow, are of Quaternary age.

STRUCTURE

Las Vegas Plateau and the Plains

Over most of the county east of Las Vegas, which includes the Las Vegas Plateau and the Plains area, the rocks are nearly horizontal, although slightly warped and faulted. (See geologic map of San Miguel County, P1. 1) .

The log of an oil test well, the Conchas well in the NE¼ sec. 34, T. 17 N., R. 21 E., shows Permian strata resting directly on the pre-Cambrian rocks (Northrop, 1946) . This suggests a buried pre-Cambrian high which may be continuous with the Sierra Grande arch, a pre-Cambrian high which has been determined from subsurface data in the area to the northeast. Between this pre-Cambrian high and the foothills of the Sangre de Cristo Mountains is the northward-pitching Las Vegas syncline. The beds dip westward at a very low angle on the east limb of this syncline, but those on the west limb of the syncline dip vertically or nearly vertically in the north part of the county, and in some places are slightly overturned. These steeply dipping beds form the hogback ridges which are the eastern foothills of the Sangre de Cristo Mountains.

Northrop's map (1946) shows a fault crossing State Highway 65, about 18 miles east of Las Vegas. East of this fault, on the downthrown side, the Graneros shale and the Greenhorn limestone are exposed. The Greenhorn limestone is exposed at about the same altitude as the Dakota (?) and Purgatoire sequence both to the east and west. In an exposure just west of the mapped fault, and about 600 feet south of State Highway 65, the Dakota sandstone dips about 30° east. This dip would explain the offset without faulting. However, about 8 miles southeast of the highway, the offsetting of the middle sandstone member of the Chinle formation indicates a definite fault at this point. It is probable that this fault continues to the north in the lower rocks and the upper sediments are warped over the buried fault. East of this exposure of the Graneros shales and Greenhorn limestone, the beds of Dakota (?) and Purgatoire (?) sequence dip about 5° west, northwest, and southwest.

Several closed depressions in the Dakota sandstone (?) and Purgatoire formation are on the surface of the Las Vegas Plateau. In Harding County, about 4 miles northeast of the village of Mosquero, one of these closed depressions covers an area of about 30 square miles. A driller's report indicates that the base of the Dakota (?) and Purgatoire sequence is more than 125 feet lower at a well near the center of this depression than at the village wells just north of Mosquero. As no records were available of the altitude of the base at other points on the rim of the depression, evidence here is not sufficient to prove the depression a structural basin. At two other closed depressions, about 10 and 16 miles east of Las Vegas respectively, the beds of the Dakota (?) and Purgatoire exposed on the west sides of the depressions are nearly horizontal or dip gently west, away from the depression. No good exposures of the formations are on the east side of these depressions. Some of these also may be structural basins caused by solution of salt or gypsum lower in the stratigraphic section.

Glorieta Mesa. In the southwest part of the county, the beds of the Glorieta Plateau are uplifted in a broad, nearly flat topped arch. The axis of this arch trends slightly west of north. In addition to this arch, the beds have been warped slightly.

Sangre de Cristo Mountains. The greatest complexity of structure in the county is in the mountains. Here the strata have been warped over the ridges of pre-Cambrian rock that extend into the county from the north. The hogback zone at the eastern margin of the mountains extends from about 3 miles south of Los Montoyas (T. 14 N., R. 17 E.) northward beyond the county line. Northwest of Las Vegas and north to the county line the hogbacks are nearly vertical and in places slightly overturned. South of Las Vegas the hogbacks dip more gently, and they merge south and east into the nearly horizontal beds of the Las Vegas Plateau and the Plains.

Along the canyon of the Gallinas River, the hogbacks are terminated on the west by a thrust fault, which brings the pre-Cambrian rocks to the surface. Northwestward from this outcrop of pre-Cambrian rocks, the strata have a general dip of about 5° to 15° west, although in minor warpings the dip is reversed; and within about 3 miles of the large outcrop of the pre-Cambrian rocks, which form the core of the east fork of the mountains, the general dip becomes southeasterly. This southeast dip steepens as the pre-Cambrian rocks are approached, and a dip of 30° southeast was measured just east of the contact of the sedimentary beds with the pre-Cambrian rocks.

West of the east ridge composed of pre-Cambrian rocks, are a series of minor folds whose axes are a little west of north, but the regional dip over most of this area is southwest.

Ground Water

PRINCIPLES

All water obtained from wells is taken from open spaces, large or small, in the rocks of the earth's crust. The percentage of the volume of void space to the total volume of the rock is called the porosity of the rock. A high porosity does not necessarily indicate that the rock will yield much water to a well. In order to transmit water readily to the well, the pore spaces must be interconnected. In general, the larger the interconnected pore spaces, the greater is the ability of the rock to transmit water to a well. Primary interstices, or pore spaces, are those which were present at the time the rock was formed. The intergranular pore spaces in sandstones and bedding planes in all sediments are primary interstices. Secondary interstices are those which have been developed after the rock was formed. Fractures in the rocks and solution channels in limestone are examples of secondary interstices.

The ability of rock materials to transmit water is called the permeability of the material. The coefficient of permeability of a material is defined as the number of gallons of water which can pass in one day through a square foot cross-sectional area of the rock at right angles to the direction of flow under a unit hydraulic gradient of a temperature of 60° F. The number of gallons of water which will pass in one day through a vertical strip of the aquifer one foot wide under unit hydraulic gradient and at the prevailing ground-water temperature is called the coefficient of transmissibility of the aquifer.

In sandstones and unconsolidated sands and gravels the effective pore spaces are generally the small openings between the sand grains or large particles. Coarse-grained sandstones are more permeable than fine-grained sandstones because their pore spaces are larger. Poorly cemented sandstones are more permeable than well-cemented sandstones as the latter have a large part of their pore space filled by cementing material. Well-sorted sandstones are more permeable than sandstones which have a wide variation in grain size. Shales and siltstones, because the interconnected pore spaces are very small, have very low permeability. In some limestones, the interstices, largely fractures and bedding planes, are affected little by solution, but in most limestones these have been more or less enlarged by solution and thus water flows more freely.

Precipitation falling on the earth supplies the water yielded by aquifers to wells. Recharge to the aquifer may occur directly from precipitation on the outcrop area, or indirectly, by loss from surface-water bodies or from other aquifers (Theis, 1940) . The area in which a given formation takes in water from the surface is called the recharge area. Part of the water entering the rocks descends until it reaches the water table, the horizon below which all the pore spaces in the rocks are saturated with water. If the water is held up by an impermeable bed beneath it, and the underlying rocks are not saturated, the water is said to be perched, and the water table here is a perched water table. Over parts of the Las Vegas Plateau, in the eastern part of San Miguel County, the water in the Dakota (?) and Purgatoire sequence is perched on top of the Morrison shale.

The movement of ground water after it is received by the rocks is determined by the structure and hydrologic characteristics of the water-bearing and associated rocks. A rock formation that will yield water to wells is called an aquifer. Where an aquifer overlain by an impermeable bed dips away from the area of recharge, confined water may exist in the down-dip part of the aquifer. The hydrostatic pressure, called artesian pressure, of the confined water is caused by the weight of the water up dip in the aquifer. When a well penetrates an aquifer carrying confined water, the water will rise in the well to a point determined by the hydrostatic pressure. Where this point lies above the land surface, the well will flow. To complete the cycle, the water in the rocks is eventually discharged to lakes, streams, springs, the atmosphere, or the sea.

When a well is pumped a cone of depression is formed in the water table. This cone of depression deepens and widens at a decreasing rate. When the well is shut off, the water level rises again in the well at a rate which decreases, and the cone of depression becomes shallower until it approaches the vanishing point. The drawdown, or lowering of the water level, in most wells is approximately proportional to the rate of pumping. The specific capacity of a well is the number of gallons a minute it will yield per foot of drawdown.

GENERAL CONDITIONS IN SAN MIGUEL COUNTY

Quantitatively, the greatest use of ground water in San Miguel County is for watering livestock. With an estimated daily requirement (Morrison, 1946) of 10 gallons a day per head of beef cattle, 15 gallons a day per head of dairy cattle, and ½ gallon a day per head of sheep, about 790,000 gallons a day are required to water the livestock in the county. Estimating that about half of the livestock takes its water from surface streams or ponds, about 400,000 gallons of ground water a day are required for livestock.

Excluding the population of Las Vegas, which takes its water from the Gallinas River, about 15,000 persons in San Miguel County use 150,000 gallons of water a day, estimating an average use of 10 gallons a day per person for the predominantly rural population. Many of the smaller villages obtain their domestic water supplies from streams. Inasmuch as some surface water is used for domestic purposes outside the city of Las Vegas it is probable that about 100,000 gallons a day of ground water is used for domestic purposes in San Miguel County.

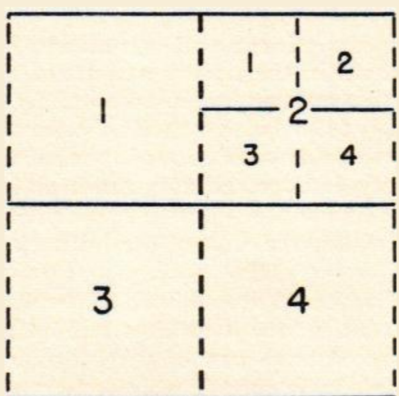
The quantity of ground water used in small-scale irrigation is very small in comparison to other uses of ground water in this county.

The quality of water in San Miguel County varies widely from aquifer to aquifer and also, to a lesser extent, from one locality to another in the same aquifer.

More than 250 wells, from 50 to 75 percent of the total number of wells in the county, were visited to determine the ground-water conditions in the county. A general summary of the factual information acquired by this survey can be obtained by studying the maps, well tables, and the tables of water analyses. For the majority of the wells visited, no report has been made concerning strength or adequacy of the wells. It can generally be assumed that a well reported "weak" or "inadequate," cannot constantly supply the minimum amount of water pumped by a windmill. This is ordinarily 2 to 4 gallons a minute.

The wells investigated for this report are numbered on the basis of townships, ranges, sections, and fractions of the section. The first three parts of the well number, separated by decimal points, are the townships north, ranges east, and section numbers, respectively. Thus, well 13.23.27 is in sec. 27, T. 13 N., R. 23 E. For convenience, the quarters of a section are numbered 1, 2, 3, 4, as indicated in the diagram below. The first digit of the last part of the number gives the quarter section, the second digit gives the quarter of that quarter section, etc. This subdivision is carried out as far as the accuracy of the location of the well permits. Thus, well 13.23.27.321 is in the NW¼NE¼SW¼ sec. 27, T. 13 N., R. 23 E.

Although parts of the county have not been surveyed in sections, townships, and ranges, this grid has been extended by dashed lines to cover the entire county. This extension of the grid system is arbitrary and has been done only to simplify the numbering system of wells and to aid in the location of wells on the map.



WATER IN GEOLOGIC UNITS

Pre-Cambrian rocks

The pre-Cambrian rocks, which crop out in the main part of the mountains and at places in the foothills immediately west of the hogback zone between Sapello and Romeroville, contain little available water. A few seeps and wet-weather springs emerge from them, but the total quantity of water discharged is relatively small. Most of the water moving through these rocks follows fractures, as the rocks themselves are practically impermeable. Locally, superficial weathering has opened the boundaries between the grains, thus increasing the permeability of the rock.

No wells are known to produce from the pre-Cambrian rocks. A recently drilled well as El Porvenir, 17.14.12.810, penetrated these rocks to a depth of about 60 feet and then was abandoned after finding only about 1 gallon of water per minute. Wells in the pre-Cambrian rocks should be located where fracturing is prominent or where the rock is noticeably weathered. However, the best procedure in locating water in the areas underlain by pre-Cambrian rocks is to drill along a stream valley where alluvium is known to be present. After the abandonment of the above-mentioned hole at El Porvenir, a well was drilled in alluvium in a nearby valley. This well was bailed at a rate of about 10 gallons a minute. In areas near exposures of pre-Cambrian rock, water generally can be obtained in the overlying limestone of the Magdalena group. Where the base of the Magdalena lies above the water table, it is generally hopeless to continue drilling more than a few feet into the pre-Cambrian rocks. Open fractures in the pre-Cambrian rocks become less abundant with depth and are almost entirely absent at depths of more than 100 feet. Along the Gallinas River canyon, northwest of Las Vegas, weathered pre-Cambrian rock lies immediately below the Magdalena strata. Where this weathered zone is below the water table it will probably yield some water to wells.

Magdalena group

The Magdalena group is exposed over an area of about 500 square miles in the mountains in the northwest part of the county (pl. 1) . The continuity of this exposure is interrupted by the eastern of the two main masses of pre-Cambrian rock of the Southern Rocky Mountains. The group is probably continuous in the subsurface over most of the rest of the county, but for ordinary ranch or farm supply, it generally would not be economically feasible to drill to the depth of the Magdalena except in the area west of the hogback zone and north of the Glorieta Mesa.

Most of the recharge and probably all of the discharge of the Magdalena group are local. About 8 million acre-inches of precipitation per year falls on the outcrop area of the Magdalena in San Miguel County. The Magdalena is considerably recharged where it extends to high altitudes between the two pre-Cambrian prongs of the Southern Rocky Mountains in the westernmost two tiers of townships in the county. The two pre-Cambrian belts direct the flow of the ground water and probably very little water escapes the Pecos drainage system. The discharge occurs as springs and other effluent seepage in valleys that cut into the limestone. In San Miguel County, essentially all of the normal flow of the Pecos River and its upper tributaries comes from the Magdalena strata. East of the east ridge of pre-Cambrian rock, most of the discharge from the Magdalena strata is to the Sapello, Gallinas, and Tecolote Rivers.

It is doubtful that much, if any, water taken into the Magdalena group in this place is discharged outside the outcrop area. To the east, the next outcrops of Pennsylvanian rocks are in eastern Kansas and Oklahoma. Between San Miguel County and these points connate water is known to be in the Pennsylvanian rocks, but the position of the contact between fresh and connate water in the subsurface east of the exposures in San Miguel County is unknown. It is possible that this contact is no great distance downdip from the outcrop area in San Miguel County. Some discharge from the limestone of the Magdalena group may occur to the south, in Estancia Valley.

The outcrop area of the Sandia formation, the basal formation of the Magdalena group, is limited to a narrow discontinuous belt around the pre-Cambrian outcrop area. Little is known of the ground water in this unit. Its lower member is a discontinuous, thin coarsely crystalline limestone and has very little intergranular pore space. Because it is moderately fractured at exposures, and at places somewhat cavernous, some movement of water must take place in this member, at least in the immediate vicinity of exposures.

The surface distribution of the upper clastic member of the Sandia formation is also limited, though less so than that of the lower limestone member. It is predominantly a carbonaceous shale of low permeability, and of little potential value as an aquifer. Thin sandy zones and thin interbedded limestones might yield sufficient water to supply stock wells in the small exposure area in the mountains.

The Madera limestone constitutes the bulk of the Magdalena group and covers the greater part of the exposure area. The lower limestone member of this formation contains no original interstices other than bedding planes, as the grains of the predominantly fine-grained material are tightly packed. The bedding planes are closely spaced, but most of the ground water moves through fractures probably somewhat enlarged by solution. These are fairly well developed in the exposure area of the member. Both fractures and bedding planes apparently are capable of supplying water to wells of small capacity in the exposure area of the unit. Along well-developed fracture zones it is probable that wells of moderate capacity could be obtained at shallow to moderate depths. At shallow depths, the water is under water-table conditions; at greater depths, because of the interbedded shale, the water is under artesian pressure. One of the Diamond K wells, 14.14.23.200, flows at a rate of 2 gallons per minute. This well is collared in the upper arkosic member of the Madera limestone, but the water probably comes from the lower limestone member of the formation.

Pumping or bailing records of three wells which produce from the lower limestone member of the Madera limestone indicate a range of specific capacities from 0.6 to 1.0 gallon a minute per foot of drawdown. The T. R. Wyles well, 16.12.16.300, has a specific capacity of 0.6. The G. E. Hays well, 14.15.34.420, has a specific capacity of 1.0, and the bailing record of a well a short distance west of Bernal indicates a specific capacity of approximately 1.0.

In the upper arkosic limestone member of the Madera limestone, ground water occurs in fractures and in interconnected pore space in the arkosic sandstones and in fractures and solution cavities in the limestones. The arkosic sandstones, which are interbedded in the limestone, range from medium- to coarse-grained, are relatively clean, and are composed of more or less angular grains. Fracturing, in general, seems less well-developed than in the lower limestone member of the Madera. Along zones of fracturing, especially where limestone beds are in contact with *beds* of arkosic sandstone, circulating ground water may have dissolved large openings in the limestone. At shallow depths, water table conditions exist in this aquifer. At greater depths, even in the outcrop area of the unit, confined water undoubtedly exists, and the less permeable zones act as confining beds to the more permeable zones. Where the aquifer is overlain by the Sangre de Cristo formation, the shale of the Sangre de Cristo acts as a confining bed. A flowing well near the town of San Miguel, 13.14.9.320, is collared at an altitude of about 6,050 feet in the Sangre de Cristo formation. This well is described in detail by Conover and Murray (1939) . The chief aquifer is probably the upper member of the Madera limestone which was entered at a depth of 400 to 500 feet. The total depth of the well is reported to be 700 feet. It flows at a rate of about 85 gallons per minute. Other wells comparable to this could be drilled at similar altitudes in this area. At lower places in this area the additional head would be expected to produce a somewhat greater flow. However, it would not be advisable to space wells too closely, as their cones of depression would probably interfere. Nor would a large number of wells in the area be advisable. As the water is confined, the cones of depression of the wells would spread rapidly. It is probable that the cones of depression would reach the outcrop area of the Madera limestone along the Pecos River in a short time, and a large number of wells probably would affect the flow of the river. The Santa Fe Railway well at Rowe, 15.12.33.100, 338 feet deep and also collared in the Sangre de Cristo formation, struck confined water in the Magdalena group at 264 feet, and the water rose to 112 feet below the surface.

Pumping records on two wells which produce from the upper, arkosic limestone member of the Madera limestone show higher specific capacities than wells from the lower limestone member. The Gonzales well, 16.12.28., at Pecos, has a specific capacity of about 2.0, and the Santa Fe Railway well at Rowe, 15.12.33.100, has a specific capacity of 4.5. The driller's log of the latter well indicates that most of the water comes from arkosic sandstone beds which is also suggested by the low calcium carbonate content of the water (Table 3) . These data, though meager, tend to corroborate the visual study of the interstices of the two members, which indicates that the pore spaces of the upper member are better connected than those of the lower. Along definite zones of fracturing, wells in both members probably would have higher specific capacities than those shown above.

Farmers and stockmen ranchers whose property is in the outcrop area of the Madera limestone are comparatively fortunate in regard to ground water. Sufficient water for stock or domestic supplies can be obtained at most places within a depth of 150 feet. In some places sufficient water is available for small-scale irrigation.

Springs and seeps are fairly numerous over much of the surface extent of the Madera limestone. Those noted by R. **L.** Griggs are all small. Many are not shown on the accompanying map or in the spring tables, and only three merit specific mention. One of these, Lisboa Springs, 16.12.16.300, is said to flow 400 gallons per minute from several closely spaced openings. The nature of the openings from which the flow emerges cannot be determined, but they probably are enlarged fractures at the lower contact of the upper member of the Madera limestone. Two other springs, 15.13.5.100 and 18.14.3.100, each flow an estimated 150 gallons per minute. The points of emergence of these two springs are obscured by soil, but the former is apparently a contact spring, emerging at the base of the upper member of the Madera.

The quality of the water from the Madera limestone is generally good. Of the eleven samples analyzed, only two, one from a well at Manuelitas, 18.16.8.300, and the other from a well at Arrott ranch, 18.15.24.200, contained more than 500 parts per million of dissolved solids. The water from these wells is very hard and has a high concentration of calcium bicarbonate. Other wells, which obtain their water only from limestone parts of the aquifer, have moderate amounts of calcium bicarbonate. As greater parts of the water are obtained from the arkosic sandstones of the upper member of the formation, the amount of sodium bicarbonate and potassium bicarbonate increases, and the quantity of calcium bicarbonate decreases. The Santa Fe Railway well at Rowe, 15.12.33.100, which obtains all or nearly all of its water from arkosic sandstone, has water that is very low in calcium bicarbonate. The water from this well is essentially a sodium bicarbonate water. (See analyses in Table 3.)

One of the springs in the Madera limestone, 15.15.12.200, was the source of a sample containing 5.0 parts per million of fluoride, the highest concentration found in the county. It is generally recognized that waters containing 1.5 parts per million or more of fluoride may cause mottling of the tooth enamel of young children who drink the water. Other waters from the Madera which were sampled contained much smaller amounts of fluoride.

Sangre de Cristo formation

The Sangre de Cristo formation crops out in a narrow band along the east side of the mountains and in a somewhat wider zone on the south side of the mountains. It is important as an aquifer for stock wells and small domestic supplies where it is exposed on the south side of the mountains and in places to the south, even over parts of Glorieta Mesa, where it is necessary to drill to the Sangre de Cristo formation to obtain an adequate supply of water of fair to good quality.

The beds that contain water are the arkosic sandstones, which are commonly 25 to 50 feet thick and composed largely of angular grains of feldspar and quartz. The admixed maroon clay, the type that forms the predominant shales of the formation, makes these arkosic beds less permeable than the similar beds in the upper member of the Madera limestone. The arkosic sandstones receive recharge at their high exposures near the mountains, but receive little recharge at the upper clifflike exposures along the north side of the Glorieta Mesa. No visible discharge has been noted, and it is probable that most of it takes place by evaporation and transpiration at lower exposures between the mountains and the Glorieta Mesa.

Most of the wells in the Sangre de Cristo formation are in the area of outcrop around the southern end of the mountains, between Pecos and Romeroville. Well 10.14.20.400 is on Glorieta Mesa. Nearly all the wells are equipped with windmills, and all except one are used for stock or domestic supplies. One well at Pecos, which may obtain part of its water from the upper part of Madera limestone, supplies a part of the populace of that village. Two wells have been tested for specific capacity. The Robert Martin well at Pecos, 16.12.33.110, had a specific capacity of 0.18 gallons per minute per foot.of drawdown. The well at the Diamond K ranch house, 14.14.25., had a specific capacity of only 0.04. It is possible that both of these wells penetrate materials in the Sangre de Cristo of below average permeability. The James C. Ellis well, 15.15.22., is reported to have been bailed at 11 gallons per minute with a lowering of water level of 25 feet. This indicates a specific capacity of about 0.4. Another well owned by Mr. Ellis, 15.15.27., was bailed at the rate of 15 gallons per minute. The driller's bailing record of a well owned by Nicolas Madrid, 15.16.29.310, indicates that this well has a specific capacity of about 0.6. Inasmuch as the duration of these bailing tests are not known, the figures given are only approximate. Well 15.16.32.110, located on Highway 85, 2 miles north of Tecolote, owned by J. C. Rayburn, is used for domestic supply, livestock, and small-scale irrigation. This well is reported strong and will produce 3 to 5 gallons per minute for 12 hours or more of continuous pumping.

In the outcrop area of the Sangre de Cristo formation, water can be obtained from wells less than 200 feet deep. Where overlain by the Yeso formation or the Glorieta sandstone member of the San Andres formation at the surface, water can be obtained in the Sangre de Cristo at depths less than about 800 feet. The Ortiz well, 10.14.20.400, on the Glorieta Mesa, is 670 feet deep. This well, collared in the Yeso formation, encountered water in the Sangre de Cristo at 630 feet. The water rose in the well to about 325 feet below the land surface.

Water from the Sangre de Cristo formation has a rather wide range of hardness. Some of the wells obtain water containing mostly sodium bicarbonate. The Robert Martin well at Pecos, for example, has soft water with only 38 parts per million hardness. By way of contrast, the water from well 10.14.20.400 has a total hardness of 693 parts per million and contains considerable amounts of calcium bicarbonate and sulfate. On the whole, however, water from this formation does not appear to contain excessive dissolved solids concentrations. The two samples which had low hardness contained more fluoride than other samples from this formation, and one of them had 1.7 parts per million.

Yeso formation

The Yeso formation, overlying the Sangre de Cristo formation, is not a good aquifer. Many of the wells are reported to be weak, and in some places it is necessary to go to the underlying Sangre de Cristo to obtain enough water even for domestic or stock supplies. The Yeso is largely an argillaceous siltstone, but it contains some lensing beds of fine-grained silty sandstone. The sandstone beds are capable of supplying small quantities of water to wells, as indicated by several wells on Glorieta Mesa. Two of these wells, 12.14.22.100 and 12.14.32.300, are very weak, and well 10.14.20.400 is said to have encountered only insignificant quantities of water before reaching the Sangre de Cristo formation. However, the large sulfate content of the water suggests that the Yeso formation is yielding some water to the well. The wells in the Yeso near Rencona are capable of furnishing small domestic and stock supplies, and one well at Villanueva supplies the small community with drinking water. An abandoned well, 13.16.30.200, about 5 miles southeast of Bernal on the Anton Chico grant, is reported to have been fairly strong. It was abandoned because fine sands and silt washing into the well rapidly destroyed pump leathers.

The quality of the water from the Yeso formation, as shown by analyses in Table 3, ranges widely. The water from the well at Villanueva and from well 12.12.11.200 is of fair quality, but some wells, such as 12.12.4.110, have water which is very high in sulfate and unsuitable for domestic use. The sulfate is probably derived from small quantities of local primary gypsum. Fluoride concentrations in all samples of water from this formation were below 1.5 parts per million.

Glorieta sandstone member of San Andres formation

The Glorieta sandstone member of the San Andres formation is a buff quartzitic sandstone which forms the conspicuous cap of Glorieta Mesa. Where exposed, the quartzitic sandstone contains little intergranular pore space, and movement of ground water is probably largely in bedding planes and fractures in the sandstone. •

The Glorieta receives some recharge from rain and snow, but over nearly the entire mesa it lies above the water table. Therefore, much of the recharge it receives probably is lost to the underlying Yeso formation and perhaps lost by evaporation at walls of canyons that cut down through the Glorieta sandstone. Downdip beyond its most easterly exposures, a northerly trending zone in the sandstone may be saturated and yet not too deep for use as an aquifer. However, a recently drilled well at Upper Anton Chico, in Guadalupe County, was abandoned as a dry hole at 200 feet in sandstone which is probably Glorieta.

A few wells in San Miguel County produce from the Glorieta sandstone member. Well 12.12.9.330 and another not shown on the map, about a quarter of a mile to the south, are in a shallow syncline which is also a topographic basin. Both furnish water of good quality. Another well, 14.16.34.100, recently drilled, had not been equipped with a pump, but according to the driller the sandstone was highly quartzitic, and the well could be bailed at a continuous rate of about 1 gallon per minute. Two other wells in San Miguel County, 10.15.23.-400 and 11.15.25.200, are believed to obtain at least part of their water from the Glorieta.

Two small springs from the Glorieta sandstone member were noted. One, 13.15.36.400, on the Anton Chico grant, about 2 miles northeast of Cerritos (T. 12 N., R. 15 E.) , flows 3 to 5 gallons per minute. The water is perched on one of the thin clay zones in the sandstone. Another, Los Diegos Spring, 12.14.20.300, emerges near the base of a cliff of the sandstone and flows about 5 gallons per minute.

Water analyses were made from a well, a spring, and a seep in the Glorieta sandstone member (Table 3) . The water from well 12.12.9.-330, and from Los Diegos Spring, is moderately hard, the total hardness as calcium carbonate being about 240 parts per million. The water from the seep at the Forest Service headquarters, El Pueblo Project, is very soft, having a total hardness of only 22 parts per million. The recharge here is probably local, and this water is not representative of the quality to be expected in wells in the Glorieta. Fluoride was not present in significant concentrations in any samples from this formation.

Middle limestone member of the San Andres formation

The limestone of the San Andres formation overlies the Glorieta sandstone member and generally is separated from it by a thin layer of yellow to blue clay included with the limestone in the middle member. The limestone member of the San Andres varies considerably in permeability. The connected void spaces consist of fractures, openings in brecciated limestone, and small tubular openings which were perhaps developed by the solution of gypsum or gypsum-rich areas. Some of the openings of the latter type, where well developed, cause the rock to have a sponge-like appearance.

The exposure area of the limestone member of the San Andres formation is small in San Miguel County, and recharge to this member is correspondingly small. However, in Guadalupe County all the low-stage flow remaining in the Pecos River south of Anton Chico and above Colonias is lost to the limestone member (Theis, Sayre, Morgan, Hale, and Loeltz, 1942) .

A few wells draw water from the limestone member of the San Andres formation in the vicinity of Chapelle, Tps. 13 and 14 N., Rs. 15 and 16 E., and two others, in T. 11 N., R. 15 E. probably obtain part of their water from the San Andres. Some springs are at, and west of, Lagunita. The deepest well reported is 65 feet deep. All the wells are equipped with windmills or hand pumps, and all are used for stock and small domestic supplies. Los Chupaderos Springs, 13.16.8.100, yield about 40 gallons per minute from 15 openings in fractured, spongy limestone immediately above the clay which lies between the limestone and the Glorieta sandstone. These springs are used for irrigation.

La Ojita Springs, 13.16.6.400, yield about 3 gallons per minute, and the springs at Lagunita, 13.16.9.200, yield about 6 gallons per minute.

The middle limestone member of the San Andres may be worthy of exploration for ground water where it underlies the exposure area of the upper member of the San Andres formation. One such general area lies southeast of Lagunita; another lies northeast and southwest of San Juan. In these areas the well sites should be at a tributary-recharge area. If no water is obtained in the limestone, the hole can be deepened and the Glorieta sandstone member tested.

The quality of the water from the limestone member of the San Andres formation is good, although hard. Of four samples collected, (see analyses in Table 3) all the analyses show a total hardness as calcium carbonate of more than 250 parts per million. Two analyses show considerable sulfate, indicating that, in places, a small amount of gypsum remains in the limestone. Excessive quantities of flouride were not found in any of these samples.

Upper clastic member of the San Andres formation

A few wells in San Miguel County may receive some water from the upper clastic member of the San Andres formation. Well 10.15.23.400, on Glorieta Mesa, penetrates this member and may receive small quantities of water from it. In the outcrop area of the upper clastic member of the San Andres and in areas where the overlying Santa Rosa sandstone is dry, it may be possible to obtain small quantities of water from the upper member of the San Andres. None of the wells investigated in San Miguel County are known to receive their entire supply of water from this upper member of the San Andres.

Santa Rosa sandstone

The Santa Rosa sandstone is the basal formation of the Dockum group. It consists of slightly silty, fine-grained gray, buff-weathering sandstone and interbedded red shale. The sandstone beds contain water over most of their extent, and the formation is an important aquifer for stock and small domestic supplies over a large area of the plains in San Miguel County.

Nearly all the wells in the Santa Rosa sandstone are in a belt which extends eastward from near Highway 84, south of Los Montoyas (T. 14 N., R. 16 E.), across the plains of the county to near the Bell ranch headquarters (T. 15 N., R. 27 E.) . Most of the wells on the plains are shallow. All except two are equipped with windmills and are used for stock or domestic supplies. These two exceptions, 14.23.34.- 300 and 14.23.34.300a, were recently drilled about 10 feet apart and equipped with rotary pumps. Together they produce about 75 gallons per minute and are used for small-scale irrigation. Two small springs from the Santa Rosa sandstone, Park Springs, 12.19.16., and Cabra Springs, 13.21.25.400, are also used for small-scale irrigation.

The Los Vigiles well, 16.16.4., 3½ miles northwest of Las Vegas, which was drilled as an oil test, is on the Las Vegas Plateau. It is bottomed at a depth of 2,400 feet in the Santa Rosa sandstone, but it obtains only part of its water from this formation. Well 10.15.27.330, on the edge of the Glorieta Mesa, is apparently west of the margin of general saturation in the Santa Rosa at this latitude. Nearby holes (one deep well in sec. 23 and one dry hole in sec. 36, T. 10 N., R. 15 E.) have found the Santa Rosa dry. Well 10.15.27.330 probably produces water from the Santa Rosa because an adjacent stock reservoir in the nearby valley loses water to the underlying sandstone and thus produces a local mound of ground water beneath it.

The permeability of the Santa Rosa sandstone is low. The Daniel Simpson well, 14.22.17.430, reported as weak, after being pumped for 1½ hours had a specific capacity of only 0.15 gallons per minute per foot of drawdown. Judging from the bailing records of drillers, most wells in this sandstone have a higher specific capacity than this. Well 14.23.34.300 is reported to produce 50 gallons per minute. As the bowls of the turbine pump are set at 100 feet and the static water level is about 3 feet below land surface, this well has a minimum specific capacity of 0.52 gallons per minute per foot of drawdown.

The Santa Rosa sandstone is recharged at the exposures on the plains and also along the hogback ridges at the east side of the mountains where these ridges are cut by streams. The discharge goes to the south beyond the limits of the county and to the east to Conchas Reservoir. The water levels in the vicinity of Variadero (T. 13 N., R. 23 E.)

indicate that some ground-water discharges to the Conchas River and other streams tributary to Conchas Reservoir. (See availability map, P1. 2) . At shallow' depths in the exposure areas of the Santa Rosa, water-table conditions exist, but at greater depths, because of the inter-bedded shale or overlying shale of *the* Chinle formation, the water is under artesian pressure. Well 14.23.34.300 encountered confined water at an unknown depth, and the water rose to within 3 feet of the surface. In the vicinity of Variadero, several wells encountered water under artesian pressure in the Santa Rosa sandstone. Well 12.24.1.100, collared in the lower member of the Chinle formation, struck water in the Santa Rosa sandstone at a depth of 185 feet and the water rose to within 30 feet of the *surface.*

Where exposed at the surface in the plains of the county, the Santa Rosa sandstone yields water to wells at depths as shallow as 25 feet. Where it is necessary to drill through the overlying lower shale member of the Chinle formation, wells taking water from the Santa Rosa would be as much as 350 feet deep. Some low mesas on the plains are capped by the middle sandstone member of the Chinle. Where these low mesas cover sufficient area, as does Mesa Montosa (T. 13 N., R. 20 E.) , water can be obtained at relatively shallow depths from the Chinle. Across the eastern part of the plains, east of the Canadian River and Conchas Reservoir, the middle sandstone member of the Chinle formation marks the eastern limit of the area where the Santa Rosa sandstone is within ordinary drilling depth. At the north edge of the plains in T. 17 N., R. 26 E., the middle member of the Chinle leaves the Canadian escarpment and swings southward across the Pablo Montoya grant, passing a short distance west of the Bell ranch headquarters, and on southward toward Gate City. East of this limit, on the plains, small quantities of water generally can be obtained at a relatively shallow depth from the Chinle formation or, in places, from the Entrada sandstone. West of this limit, water generally should be obtainable in the Santa Rosa sandstone at reasonable depths. However, dry holes are reported to have been drilled on the western part of the Pablo Montoya grant, west of the Canadian River and north of the Conchas River arm of the Conchas Reservoir. It is presumed that these holes, which are variously reported to have reached depths ranging from more than 100 to more than 200 feet, were abandoned in one of the thicker shale zones of the Santa Rosa.

The water from the Santa Rosa sandstone varies from fair to poor in quality. In general, it contains mainly bicarbonate and sulfate of sodium, calcium, and magnesium. Sodium bicarbonate is commonly present in sufficient amount to be tasted. Well 12.22.22.110, 5 miles southeast of Cabra Springs, has a high sulfate content, which gives this water a bitter, "gyppy" taste. Some of the more highly mineralized waters from this formation are soft, and a few samples contain objectionable amounts of flouride.

Chinle formation

The Chinle formation consists of three members. The upper and lower members are predominantly shale and are identical in lithology. The middle member is a sandstone which is identical in lithology with the Santa Rosa sandstone. The lower member is about 200 to 350 feet thick, the middle member 45 to 165 feet, and the upper member about 350 feet.

Both the upper and lower shale members of the Chinle formation contain lensing beds of siltstone and fine-grained silty sandstone which yield some water. Well 16.16.32., 1 mile east of Agua Zarca is in the lower member and is said to be fairly strong. Well 15.28.5., on the Bell ranch, 6 miles east of the ranch headquarters, is a strong well producing from the upper member. All the other wells in the upper member of the Chinle on the Bell ranch are weak, and at least one dry hole has been drilled in the unit on this ranch. The wells in the lower member of the Chinle in Tps. 17 N., Rs. 25 and 26 E., are all very weak.

Most of the strong wells in the Chinle formation produce from the Sandstone member near the middle of the formation. Wells 14.27.-2.40, 14.27.3., and 14.27.12., all on the Bell ranch, pump 4 gallons per minute or more. Other wells in the middle member of the Chinle, reported strong or adequate, probably produce like quantities. Not all of the wells in the middle member of the Chinle are shown on the accompanying map. Some are near Highway 84, south of Romeroville in an area east of the cuesta formed by this sandstone; two are on Mesa Montosa, a low mesa on the plains east of Chaperito which is capped by this sandstone; and several are in the eastern part of the county. Most of the wells in the eastern part of the county are on the Pablo Montoya grant. One is on the Baca location, and at least two are south of Gate City.

South of Romeroville, the middle sandstone member of the Chinle formation is recharged along the cuesta exposure immediately west of U. S. Highway 84. Downdip from this place the sandstone is overlain by the upper member of the Chinle, and the water is confined. Discharge occurs at exposures farther southeast, around the edge of the Canadian escarpment.

On Mesa Montosa the middle sandstone member of the Chinle formation is recharged over the entire surface of the sandstone-capped mesa, which covers an area of about 30 square miles. This water moves downward through the sandstone to the top of the lower shale member of the Chinle. As the water cannot readily penetrate the shale, a flat-lying, lens-shaped body of perched water has collected on top of the shale. Discharge from this lens of water takes place on the south and southeast sides of the mesa, at the contact between the sandstone and the underlying shale. Other similar mesas on the plains probably have some perched water at the base of their sandstone cap, but most of these mesas are too small in area to receive enough recharge to support a lens of water of sufficient thickness to supply wells.

In the eastern part of the country, the middle sandstone member of the Chinle formation leaves the Canadian escarpment in T. 17 N., R. 26 E. From here southward, across the Pablo Montoya grant, it forms a low-dipping cuesta. This cuesta passes west of the Bell ranch headquarters, crosses the Canadian River east of Conchas Dam, and then extends southeastward to the vicinity of Gate City, where it joins with the cuestas lying to the south. East of this cuesta, across the Montoya grant, the strata generally dip southeastward for several miles, and a short distance away from the edge of the cuesta the middle sandstone member is overlain by the upper shale member of the Chinle. Most of the recharge to the sandstone member of the Chinle in this area is received along the narrow exposure belt immediately east of the edge of the cuesta. Downdip the sandstone is overlain by shale, and the water is confined. However, as a result of a north-trending synclinal axis near Canadian (T. 13 N., R. 30 E.) the sandstone member of the Chinle caps a westerly dipping cuesta, immediately beyond the edge of the Baca location. Recharge to the sandstone in the eastern part of the Baca location is received on the sandstone-capped cuesta lying east of the county. Discharge from the sandstone in the eastern part of the county probably occurs at exposures south of the county line.

In the outcrop area of the middle sandstone member of the Chinle formation, and in most of the outcrop area of the other members of the Chinle, water frequently can be obtained from the member exposed at the surface. Where either the upper or the lower shale member does not yield sufficient water, the wells should be deepened to the underlying sandstone of the middle member of the Chinle formation or the Santa Rosa formation.

The quality of the water from the shale of the Chinle formation ranges from fair to poor. Most of it is moderately hard, and some of it so highly mineralized as to have a slightly disagreeable taste. The analysis of the water from well 17.26.7.300 is believed to be typical of the water in the shale members. This water has 973 parts per million of dissolved solids, and a total hardness of 202 parts per million.

The water from the middle sandstone member of the Chinle formation is moderately hard and similar to that from the Santa Rosa sandstone, although it lacks the slightly astringent taste noticeable in the water of some wells in the Santa Rosa.

Entrada sandstone

The Entrada sandstone is exposed in the zone of hogback ridges west of Las Vegas between the Las Vegas Plateau and the mountains, and it is conspicuous as a white to pink band in the slope of the Canadian escarpment. It underlies the Las Vegas Plateau at depths of a few hundred feet. Over part of the Baca location, where its exposure band drops below the base of the Canadian escarpment, it is the bedrock immediately below the surface of the plains.

As the Entrada sandstone has no widespread, flat-lying exposures, the total quantity of recharge received is probably small. The shale in the overlying Morrison formation cuts off most recharge from overlying rocks. Water is lost to the sandstone from streams which cross its upturned edge in the hogback zone between the Las Vegas Plateau and the mountains. Some water may also be lost to the Entrada from the Canadian River north of the county. Near the southeastern corner of the county, the main outlet canal from Conchas Reservoir is in the Entrada for a few miles. Losses from this canal will probably effect wells lying south of the county. No recharge can be received from rain and snow at the cliff exposures around most of the Canadian escarpment. At places along the eastern boundary of the county, the Entrada extends below the level of the plains. At these places a small amount of recharge is received from rain and snow.

Discharge occurs at the cliff exposures around the Canadian escarpment. Most of it apparently escapes by evaporation, but one small spring in the southern part of the Baca location was reported.

A few wells in the county produce from the Entrada sandstone. Wells 16.16.23. and 16.16.23a, owned by the Santa Fe Railway, are on the east limb of the syncline which extends northward from the vicinity of Las Vegas. They are collared 180 feet above the top of the Dakota (?) and Purgatoire formations and are bottomed at a depth of about 850 feet, immediately below the Entrada, which is 66 feet thick at this place. Three other wells on the Las Vegas Plateau probably obtain some water from the Entrada. (See Table 1.) One is the Los Vigiles well, 16.16.4., 3 miles northwest of Las Vegas, another is the "Hoover well," 17.17.18.400, and the third is the "Shellabarger well," 18.18.33.- 100, 1 mile north of Kroenig's switch. All three of these wells, each of which flows a few gallons per minute, cut across two or more aquifers and, except possibly for the Shellabarger well, probably obtain only a subordinate amount of their water from the Entrada.

In general, drilling to the Entrada sandstone is not recommended over most of the Las Vegas Plateau area. In nearly all parts of this area small supplies of water can be obtained from the Dakota (?) and Purgatoire formations. Where the Dakota (?) and Purgatoire sequence has been eroded away or is dry, it may be feasible to drill to the Entrada. The stratigraphic interval between the base of the Dakota (?) and the top of the Entrada ranges from about 250 to 400 feet.

In the eastern part of the county a few shallow stock wells produce from the Entrada sandstone. Wells 16.28.20. and 16.28.19., northeast of the Bell ranch headquarters, are at the mouths of small canyons that cut into the escarpment. The wells enter the easterly dipping Entrada, which crops out a short distance west along the outer edge of the escarpment, at a depth of about 50 feet. Wells 12.29.13., 12.30.20., 13.29.3., and 13.30.2., on the Baca location, are where the Entrada is exposed at the surface of the plains. The deepest of these wells extends 165 feet, and, although no section of the Entrada has been measured in the area, it probably extends below the base of the sandstone, which is estimated to be less than 150 feet thick in the area.

None of the investigated stock wells in the Entrada sandstone were reported weak or inadequate. One of the Santa Fe Railway wells at Las Vegas, 16.16.23. (Santa Fe well No. 1) , had a drawdown of 120 feet while pumping 48 gallons per minute, indicating a specific capacity of 0.4 gallon per minute per foot of drawdown. The other Santa Fe well, 16.16.23a (Santa Fe well No. 2) , had a drawdown of 187 feet while pumping 56 gallons per minute, indicating a specific capacity of 0.3 gallon per minuts per foot of drawdown. The length of time these wells had pumped when the drawdown was measured is not known.

No samples of water from wells in the Entrada were obtained during this investigation. However, the quality of the water from the wells in the Entrada sandstone is reported to be good. All users of the water report it to be very soft, and an unpublished analysis of the water from one of the Santa Fe Railway wells shows this water to have bicarbonate of sodium as its main dissolved constituent.

Morrison formation

The Morrison formation is a poor source of ground water. The upper part of the formation consists essentially of fine-grained shale. This part of the formation can yield little water, but it does supply to a dug well, 17.22.22.200, a small amount of water for domestic use. This water is moderately hard, having a total hardness as calcium carbonate of 282 parts per million. Another well, 18.24.31., is drilled through the Dakota (?) and Purgatoire sequence and into the upper part of the Morrison. This well is said to be very weak, and the water is of poor quality.

The lower part of the Morrison formation contains interbedded sandstones which appear to be slightly permeable at their exposures. These sandstones probably would yield some water at most places, but the driller's log of the "Hoover well," 17.17.18.400, indicates that only two of these zones yielded any water to that well.

South of Mosquero, in the Atarque Canyon drainage area, the lower sandstone beds of the Morrison formation are at valley level over a considerable area and probably could furnish enough water for livestock.

Dakota (?) and Purgatoire formations

As noted in the section on stratigraphy, it is believed that both the Dakota sandstone and the underlying Purgatoire formation are present on at least parts of the Las Vegas Plateau. As these two formations can be distinguished only by paleontologic evidence, the water-bearing sandstones which cap the plateau are here referred to as the Dakota (?) and Purgatoire formations.

These quartzitic sandstone beds, with some interbedded shale, form the resistant cap over most of the Las Vegas Plateau. However, east and northeast of Las Vegas the Dakota (?) and Purgatoire sequence is overlain by the Graneros shale and Greenhorn limestone, and farther west, in the syncline that extends northward from Las Vegas, the overlying rocks range up in the section through the Niobrara formation. A thin veneer of Ogallala formation overlies the Purgatoire formation on top of Mesa Rica, an outlier of the Las Vegas Plateau, and the Graneros shale and Greenhorn limestone overlie it on the downthrow side of a fault about 18 miles east of Las Vegas. In the hogback zone between the Las Vegas Plateau and the mountains, the Dakota (?) and Purgatoire sequence forms the easternmost hogback.

Over an area of about 1,000 square miles, which includes more than one-fifth of the total area of San Miguel County, the Dakota (?) and Purgatoire sequence is the best source of ground water for stock and domestic supply. (See Pl. 2.)

Recharge is received by the aquifer at its surface exposures on the Las Vegas Plateau, and some recharge may be received where streams cross the upturned edge of the beds between the Las Vegas Plateau and the mountains. About 10 million acre-inches of precipitation per year is received over the outcrop area of the Dakota (?) and Purgatoire formations in San Miguel County. Most of the recharge probably takes place in the closed depressions on the plateau where some runoff collects and is slowly lost to the underlying bedrock. These closed depressions, as much as 1 mile in diameter, are especially numerous in an area on both sides of State Highway 65 extending from about 8 to 15 miles east of Las Vegas.

The recharging water that enters the aquifer moves downward until it strikes impervious beds. Locally, zones of water are perched on the interbedded shale within the aquifer as at the town of Mosquero. However, the interbedded shale zones seem to be lenticular, and the main body of water in the aquifer apparently rests on the underlying shale of the Morrison formation.

Discharge from the main body of the aquifer east of Las Vegas and west of the Canadian River, takes place to the north, south, and east. Water-level measurements indicate gradients to the Mora River on the north, and to the Gallinas River, above San Augustin (T. 14 N., R. 17 E.) , on the south. Visible discharge to the south was noted in seeps and springs where the upper part of the Conchas River leaves the Canadian escarpment. On the east, seeps and springs were noted along Canyon Largo (T. 16 N., R. 22 E.) and one of its tributaries. In the eastern part of the county, where an arm of the Las Vegas Plateau extends southward from Mosquero to Carpenters Point (T. 13 N., R. 29 E.) , discharge by springs and wet-weather seeps was noted in some of the canyons on the west side of this arm. Discharge by springs was also noted in Atarque Creek south of Campana.

Many wells in the county produce small domestic and stock supplies from the Dakota (?) and Purgatoire formations. One well in the Dakota (?) and Purgatoire at Campana is used by the Southern Pacific Railroad. Mosquero, just beyond the northeastern corner of San Miguel County, in Harding County, is also supplied, although inadequately, by water from this aquifer.

Pumping tests and bailing records on these wells indicate specific capacities ranging from less than 0.005 to more than 1.0 gallon per minute per foot of drawdown. A record of a 10-hour pumping test on well 15.21.15.222 indicates that this well has a specific capacity of about 1 gallon per minute per foot of drawdown. This well produces from the lower part of the aquifer which field observations indicate to be more permeable than the upper, more quartzitic portion. The Southern Pacific Railroad well at Campana, 16.29.31., is reported to draw down about 18 feet in 4 hours pumping at a rate of 66 gallons per minute. This well obtains water from the lower part of the Dakota (?) and Purgatoire and may also receive some water from the overlying alluvium. The bailing record of well 16.28.23., on the arm of the Las Vegas Plateau, extending southward from Mosquero, shows a drawdown of 5 feet when bailed at a rate of 7 gallons per minute. This well is near the head of a draw which empties into Atarque Canyon to the east. Bailing tests on other wells on this arm of the plateau indicate lower capacities. Bailing tests on well 16.28.27. indicate a maximum yield of 3 gallons per minute; well 16.28.15. yielded slightly more than 1½ gallons per minute; and well 16.28.14. yielded only ¼ gallon per minute. Well 16.19.13.300, on the main body of the Las Vegas Plateau, about 20 miles east of Las Vegas, had a drawdown of about 22 feet after pumping 4 gallons per minute for more than 6 hours, indicating a specific capacity of about 0.18. Bailing records on three recently drilled wells, about 4 miles east of Las Vegas, wells 16.17.21.- 304a, 16.17.21.340b, and 16.17.21.400, indicate yields of only a half to three-fourths gallon per minute per well. The two wells of the Santa Fe Railway at Las Vegas, 16.16.23. and 16.16.23a, obtained little water in the Dakota (?) and Purgatoire sequence.

Over the main body of the Las Vegas Plateau, west of the Canadian River, where the Dakota (?) and Purgatoire formations are at the surface, water can be obtained at most places at depths up to slightly more than 200 feet. The places to be especially avoided as well sites are within ½ to 1 mile of the Canadian escarpment or within this distance of canyons which cut through the aquifer. In these areas, near the discharge from the formation, the zone of saturation is generally too thin to support a well. In one area on the plateau which has a northeast trend and an axis which crosses State Highway 65, about 12 miles east of Las Vegas, the base of the Dakota (?) and Purgatoire is too high to contain water. The width of this dry area is apparently about a mile. Its length is unknown.

Especially favorable sites for wells are the closed surface depressions on the Las Vegas Plateau. There is evidence that some of the closed depressions are also structural basins. (See p. 32.) If this is true, a considerable amount of ground water should be stored in these basins. In Harding County, about 5 miles northeast of Mosquero, a well in a closed depression area is reported to have been pumped at a rate of 50 gallons per minute. This depression covers an area of about 30 square miles.

Where the Graneros shale or Greenhorn limestone is present at the surface on the Las Vegas Plateau, water generally can be obtained in the Dakota (?) Purgatoire formation at depths of less than 300 feet. However, well 16.17.21.340a, 4 miles east of Las Vegas, penetrated the Dakota (?) and Purgatoire at a depth of about 180 feet, was abandoned at 350 feet because of insufficient water. The well could be bailed at a rate of only 20 gallons per hour. Caving sand prevented further deepening of the well. Down dip from the exposure belt of the Greenhorn limestone, in the Las Vegas syncline wells in the Dakota (?) Purgatoire sequence would have to be deeper.

The part of the Las Vegas Plateau that extends into the northern part of the county just east of Canadian River is small and entrenched by numerous canyons. These canyons carry away precipitation rapidly, thereby reducing the local recharge, and in addition, expose a large area for discharge from the aquifer. Several dry holes have been reported here, and it is probable that the zone of saturation is thin throughout the area.

East of Highway 65, near Mosquero, is an arm of the Las Vegas Plateau which extends down the eastern edge of the county following the axis of a north trending syncline. The beds on the western part of this arm dip southeast. The beds on the eastern part, which lies largely in Harding County, dip southwest. On this arm of the plateau, within San Miguel County, are a *few* wells between Mosquero and Campana. Some dry holes are reported to have been drilled in the Dakota (?) and Purgatoire sequence in this area including one at the school in Mosquero which was abandoned in the Morrison formation at a depth of 350 feet. Several holes were drilled on this arm of the plateau in 1949. About half of these were abandoned as dry holes. The others produced from 1½ to 10 gallons per minute. It probably is not advisable to drill for water near the western margin of this arm of the plateau as it appears that the water has been largely drained at the adjacent canyons. It would also be advisable generally to avoid the vicinity of smaller tributary canyons which cut through the aquifer. However, well 16.28.23. is a strong well near the head of a draw which empties into Atarque Canyon to the east, and well 16.28.27.100 is a strong well at the head of one fork of Medio Canyon on the west side of this arm of the plateau. Where the dip of the beds is toward the plateau, recharge may be concentrated in these canyons.

At places in this arm of the plateau, a zone of water is perched in the upper part of the Dakota (?) and Purgatoire aquifer. Well 18.28.-34., 2 miles south of Mosquero, produces from water perched on a zone of interbedded shale. Several wells in Mosquero, immediately east of San Miguel County, obtain water from a perched zone which is about 100 feet below land surface. This zone of perched water, as indicated by three recently drilled village wells, is absent a mile north of Mosquero, where it was necessary to drill 250 feet to the base of the aquifer to obtain water.

Four wells on Mesa Rica obtain their water from the Purgatoire formation. The beds dip southeast on this mesa and therefore, as a collecting area is necessary, it would not be advisable to attempt to find water near the northwest corner of the mesa. Other localities to be avoided are those near side canyons which cut through the aquifer and the south edge of the mesa where most of the discharge probably occurs. Before abandoning a hole as dry on the inner part of the mesa, it should be made certain that the top of the underlying Morrison formation has been reached.

Analyses of water from 16 wells producing from the Dakota (?) and Purgatoire formations are given in Table 3. At least three of these wells probably take some water from the overlying Graneros shale and are not included in the following discussion. Dissolved solids range from 270 to 830 parts per million. Total hardness as calcium carbonate ranges from 190 to 628 parts per million. The quality of water generally is better than that from either the Santa Rosa or Chinle formations and is much better than that from the overlying Graneros and Greenhorn formations. The recently drilled well at the Las Vegas airport reportedly encountered a high sulfate water in the Dakota which is unfit for drinking. This water is high in sodium bicarbonate and contains hydrogen sulfide. It is probable that most of this bad water is coming from the overlying Graneros shale.

Graneros shale

The Graneros shale immediately overlies the Dakota (?) and Purgatoire sequence in places on the Las Vegas Plateau, (Pl. 1) . This shale is relatively impermeable, but it yields a small quantity of water to some wells, especially from the interbedded sandstone near the base of the shale. Of the few wells in the county that produce from the Graneros shale, well 16.19.11.200 is reported to have been bailed at a rate of 10 gallons per minute at the time drilling was completed. Well 16.17.4.110, at the Las Vegas airport, which penetrates the greater part of the Graneros, is reported to "pump dry" in 2 or 3 hours when pumped at the rate of 5 gallons per minute. Well 16.17.21.340, owned by John F. Bell, is reported to be weak. Bailing records on two other wells owned by John F. Bell, 16.17.21.340a, and 16.17.21.340b, which penetrate both the Graneros shale and the Dakota (?) and Purgatoire (?) formations indicate maximum yields of less than three-fourths gallon per minute. Another well in the Graneros on the Bell place, well 16.17.21.310, is slightly stronger. It is probable that in some places the Graneros would not yield any water to wells.

The quality of water from all wells in the Graneros shale visited is poor. Some of the water has the odor of hydrogen sulfide, and all of it has a disagreeable taste. However, the water appears to be suitable for livestock. Analyses of three water samples from wells in the Graneros show dissolved solids of 885 to 1,090 parts per million. Two analyses show more than 3 parts per million of flouride. The water from some of the wells has a cloudy appearance, and some sediment settles in the bottom of containers after the water has been standing for a few hours.

The water from the York ranch, well 17.17.4., which penetrates the Graneros, leaves a black stain on cooking utensils and bathroom fixtures.

Greenhorn limestone

The Greenhorn limestone, composed of thin beds of limestone and interbedded shale, extends over a fairly large area on the east limb of the Las Vegas syncline from Las Vegas northeastward to the Mora County line. A few wells produce water from the Greenhorn limestone in this area. The water in the Greenhorn is yielded almost entirely from fractures in the rock.

Additional wells can probably be obtained in the Greenhorn limestone northwest of U. S. Highway 85 on both sides of the contact with the Carlile shale. Locally within a distance of 2 to 3 miles northwest of the Carlile and Greenhorn contact, it may prove profitable to drill to the Greenhorn through the Carlile shale. (See Pl. 1.)

Southeast of U. S. Highway 85 the base of the Greenhorn limestone is likely to be above the water table in most places, and small areas of perched water would be the only likely source of ground water from the Greenhorn.

The permeability of the Greenhorn limestone is probably low. Well 17.17.31.100 has a reported drawdown of 110 feet when pumping 2 gallons per minute.

Analyses were made of water from one well producing from the Greenhorn limestone and from one well producing from both the Greenhorn limestone and Graneros shale. These analyses indicate water of similar quality to that of the wells in the Graneros. The analysis of water from well, 17.17.31.100, in the Greenhorn limestone showed 1,290 parts per million of dissolved solids, nearly all sodium bicarbonate, which is greater than that of any water analyzed from wells in the Graneros.

Carlile shale

The Carlile shale overlies the Greenhorn limestone within a triangular-shaped area extending north and northeast of Las Vegas to the county line.

A few wells north of Las Vegas obtain a fair supply of water from the Carlile shale. Well 17.17.15., owned by Earl Chambers, is a strong well producing water of good quality. The high water table at this place is probably due to local recharge from surface-water irrigation. Some interest has been shown in the possibility of irrigating from wells in this area. However, the shale is too impermeable to produce enough water for any large-scale irrigation. Three of the five wells in the Carlile that were investigated were reported weak or inadequate.

In the outcrop area of the Carlile shale in San Miguel County, where the shale yields insufficient water, wells should be deepened to the underlying Greenhorn limestone. If the quantity or quality of the water from the Greenhorn is not favorable, it may be necessary to deepen the well to the Dakota (?) and Purgatoire sequence. Well 17.17.5.410, on the York ranch, collared in the Carlile shale, probably takes most of its water from the Dakota (?) and Purgatoire. This well is strong. The poor quality of the water at that place is probably due to water coming from the Graneros shale, which is not cased off.

Niobrara formation

Only one well in the county is known to penetrate the Niobrara formation. This is the Los Vigiles well, 3½ miles northwest of Las Vegas. This well, which flows at the rate of 3 gallons a minute, probably receives very little, if any, water from the Niobrara.

Quaternary alluvium

Although the area covered by Quaternary alluvium is small in this county, a number of strong wells produce from this alluvium. Of the 31 wells visited, only one is reported inadequate. This well, about 2 miles north of Tierra Mone in Mora County, is reported to have gone dry in June 1946.

Most of the above-mentioned wells are in alluvium along streams but eight of them are in a broad valley about a half to one mile wide, which extends from Lower Rociada (T. 19 N., R. 14 E.) northeastward beyond the county line. This valley, lying between exposures of the Magdalena group on the southeast, and the pre-Cambrian rocks on the northwest, is floored with alluvium from the adjacent valley walls. The depth of this valley fill is not known. The drainage divide in the valley is about 2 miles northeast of Lower Rociada, and there is effluent seepage to Manuelita Creek on the southwest and to Cebolla Creek in Mora County on the northeast. Along the axis of the valley, near Rociada and also near the Mora County line, the water table is very close to the surface. A specific capacity of about 4.0 gallons per minute per foot of drawdown was indicated in a test on well 19.15.29.- 200, about 3 miles east of Rociada. It is suggested that the possibilities of small-scale irrigation from wells in this valley should be investigated.

No wells are known to take water from the gravel which caps pediment remnants in the county.

Water from alluvium near Lower Rociada is low in dissolved solids but hard. Waters from alluvium in other parts of the county is higher in dissolved solids. Some of these waters contain near or slightly over 1,000 parts per million of dissolved solids consisting mainly of calcium and sodium sulfate and bicarbonate. One sample contained 1.7 parts per million of fluoride, but all others collected contained less than one part per million.

Future Possibilities of Use of Ground Water

IRRIGATION

It is unlikely that any large-scale ground-water irrigation can be developed in San Miguel County. The water requirement for a small irrigation pumping plant is discussed in Farmers Bulletin 1857 (U. S. Department of Agriculture, 1940) as follows:

> The small irrigation pumping plant should be large enough to supply at least 2 inches of water over the irrigated area every week during dry periods. For example, if the plant is to be operated 7 days a week and 24 hours a day, its capacity must be about 5½ gallons per minute per acre irrigated.

To irrigate 40 acres of land would require a well producing about 220 gallons per minute. Few of the wells in San Miguel County are known to produce as much as 50 gallons per minute.

Several areas in San Miguel County have possibilities for small-scale ground-water irrigation. One is in the outcrop area of the Sangre de Cristo formation north of Glorieta Mesa. Well 13.14.9.320, near San Miguel, flows at the rate of 85 gallons per minute (Table 1) . It is probable that other wells of similar capacity could be developed in this area.

In the alluvium-filled valley, northeast of Lower Rociada, about 18 miles northwest of Las Vegas, are several relatively strong wells. It is probable that sufficient water for small-scale irrigation could be developed here. About 2,500 acres of land are in this valley, most of which is probably irrigable.

Sufficient ground water for small-scale irrigation may also be available in valleys in the outcrop areas of the Magdalena group. However, the amount of irrigable land in these areas is small.

In the Las Vegas Plateau and the plains area, few of the wells produce as much as 20 gallons per minute. Ground-water irrigation over most of this area is impossible except for family gardens and orchards. Two wells on the plains, just west of Variadero (T. 13 N., R. 23 E.) , are reported to have a combined capacity of 75 gallons per minute and are used to irrigate a few acres. It is possible that other wells of similar capacity could be developed in this vicinity. A number of wells in the alluvium on the plains in T. 17 N., Rs. 25 and 26 E. produce several gallons of water a minute. Small-scale ground-water irrigation may be possible here.

LIVESTOCK

The largest use of ground water in San Miguel County is for watering livestock. It is generally considered by ranchers that stock wells should not be more than 3 miles apart so that cattle will not have to walk an excessive distance to obtain water. A well pumping 4 gallons per minute, 24 hours a day, would water about 500 cows, but inasmuch as nearly all stock wells are pumped by windmills which are idle about half of the time, only 250 cattle could be watered by such a well. Storage facilities should be enough to supply the stock during periods when the windmills are idle.

DOMESTIC AND PUBLIC SUPPLY

The village of Mosquero, which straddles the county line in the northeast corner of the county, is the only community in San Miguel County which uses ground water for the public supply. Ground water is used by individuals for domestic supply in the village of Pecos and in several other small communities. However, residents of many communities in the county, including Sapello, Tecolotito, Villanueva, and others, take their domestic water from streams and irrigation ditches. A considerable improvement in the general health of residents of these communities might be *effected* by the use of water from wells. In many of these communities shallow dug wells, which could be cheaply constructed, would supply enough water for all present needs.

At present, the New Mexico Health Department is encouraging, by financial aid, the development of ground-water supplies for small communities.

A Summary of Ground Water Availability in San Miguel County

The summary of ground-water availability in San Miguel County is given by areas which are shown on plate 2.

In the discussion of the quality of water, the following arbitrary standard has been used: good, less than 500 parts per million of dissolved solids; fair, 500 to 1,000 parts per million of dissolved solids; and poor, more than 1,000 parts per million of dissolved solids.

Escarpment edges, small buttes, and other areas are generally unfavorable as well sites. Although small quantities of water are obtained locally in these shaded areas, they generally should be avoided where other sites are available.

MOUNTAINS (AREA 1)

In areas of pre-Cambrian rocks, la, water generally can be obtained from shallow wells in the alluvium in the stream valleys. Small quantities of water may be available locally in the upper weathered zone of the pre-Cambrian rocks. Drilling more than 10 feet into unweathered pre-Cambrian rocks is generally not recommended. Quality of water is generally good.

Over most of the area lb strong wells (several gallons per minute) producing from the limestones or arkosic sandstones of the Magdalena group or from the alluvium can be obtained in the valleys at shallow depths. Springs and seeps are numerous. Enough water for small-scale irrigation is available locally, as in the alluvium-filled valley northeast of Lower Rociada. As in la, drilling more than 10 feet into unweathered pre-Cambrian crystalline rocks is generally unprofitable. Quality of water is generally good.

In lc, small quantities of water generally can be obtained from shallow wells in the Sangre de Cristo formation in the stream valleys in the northern part of this area. Stronger wells can be obtained locally in the valley alluvium. In the southern part of this area, water generally can be obtained from wells in the limestone or sandstone (Glorieta sandstone member) of the San Andres formation or in the Yeso formation. Depth of wells ranges from less than 100 feet in the valleys to more than 400 feet in the highlands. Quality of water is generally fair to good.

Over most of the area Id, water sufficient for stock and domestic use can be obtained from wells in the Sangre de Cristo formation at depths of less than 200 feet. Stronger wells can generally be obtained from the underlying Magdalena group. Depth to the Magdalena ranges from a few feet at the north edge of this area to about 1,000 feet at the base of the Glorieta escarpment. Flowing wells producing from the Magdalena, as at the town of San Miguel, may provide enough water for small-scale irrigation. Quality of water is fair to good.

In le, the hogback area, nearly vertical beds make a wide variety of ground-water conditions over this narrow hogback area. In the lowlands, where streams cut across the hogbacks, water sufficient for stock and domestic use generally can be obtained at shallow depths.

GLORIETA MESA (AREA 2)

Depths of wells in area 2a range from less than 100 feet to more than 1,100 feet. Most wells are more than 100 feet deep. Depth to water is as much as 500 feet. Depth to water in most wells is more than 300 feet. Most of the wells take water from the Yeso formation, although some reach the underlying Sangre de Cristo formation, and a few shallow wells obtain perched water from the Glorieta sandstone member of the San Andres formation. In the eastern part of this area, where the mesa merges with the plains, water may be available locally at relatively shallow depths from the limestone or sandstone of the San Andres formation or from the overlying Santa Rosa sandstone. Quality of water is generally fair, although water from some of the wells in the Yeso formation is unsuitable for domestic use because of the high sulfate content.

In area 2b water generally can be obtained within 200 feet of the surface from wells in the Yeso or San Andres formations, the Dockum group, or the alluvium. Most wells are less than 100 feet deep. Quality of water is similar to 2a.

PLAINS AND SOUTHERN HOGBACK (AREA 3)

Over most of area 3, water in sufficient quantity for stock and domestic supplies can be obtained from wells in the Santa Rosa and Chinle formations. In the eastern part of the county, in Atarque Canyon and near Canadian, some wells obtain water from the Entrada and Morrison formations. Over a small area, north and southwest of Waggoner (T. 17 N., R. 27 E.) , strong stock and domestic wells are obtainable in the Quaternary alluvium. Depth of wells is generally 100 to 300 feet. Quality of water from the Santa Rosa and Chinle formations is generally fair to poor. Quality of water from the Entrada, Morrison, or alluvium is generally fair to good.

In the eastern part of the county no topographic maps are available, and the boundary between areas 3 and 4 (plains and plateau) on the map is only approximated.

LAS VEGAS PLATEAU AND OUTLIERS (AREA 4)

Over most of area 4a, water of sufficient quantity for stock and domestic use generally can be obtained from wells in the Dakota (?) and Purgatoire formations within a depth of 250 feet. Some dry holes have been drilled in the area east of Las Vegas. The strongest wells generally penetrate the full thickness of the Dakota (?) and Purgatoire, although some wells produce from perched horizons above the base of the sandstone. A few wells produce from the underlying Morrison formation. Quality of water is fair to good.

Over most of area 4b, water can be obtained from the Graneros shale or the Greenhorn limestone within a depth of 250 feet. Wells in the Graneros shale are generally weak. Quality of water is generally poor. Water of better quality and greater quantity can be obtained by drilling to the underlying Dakota (?) and Purgatoire formations. Depth to the Dakota (?) and Purgatoire ranges from a few feet at the southeast edge to about 250 feet at the northwest edge of this area.

Over most of area 4c, water can be obtained from wells in the Carlile or Niobrara formations. Where the Carlile or Niobrara fail to yield enough water, wells should be deepened to the underlying Greenhorn limestone. Where the quality or quantity of water from the Greenhorn is unsatisfactory, it may be necessary to drill to the Dakota (?) and Purgatoire formations. Depth to the top of the Dakota (?) and Purgatoire ranges from about 250 feet at the southeast edge of this area to more than 500 feet at the northwest in the synclinal axis of the Las Vegas basin.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO

EXPLANATION OF COLUMN HEADINGS

Location number: See p. 37 for explanation.

Type of well: Dr, drilled; Du, dug.

Water level: measured depth to water given to nearest 1/10 or 1/100 foot. Reported depth to water to nearest foot.

Method of lift: B, bucket; H, hand pump; N, none; Pl, plunger; P, pump jack; S, shallow well; T, turbine pump; W, windmill.

Use of water: D, domestic; I, irrigation; N, none; R, railroad; S, stock; U, unused.

See tables which follow:

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF * WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
10.12.33.300	Lowery Hagerman.	High area.	Dr.	1,100	6	–	–
10.14.20.400	Frank Ortiz.	Glorieta Mesa.	Dr.	670	6	Sandstone	Sangre de Cristo (?).
10.15.23.400	Victor Parrish.	Valley.	Dr.	1,064	6	–	–
26.300	W. A. Thompson.	do.	Du.	33	–	Alluvium.	Quaternary.
27.330	do.	do.	Dr.	180	–	Sandstone.	Santa Rosa (?).
32.222	do.	do.	Du.	14	–	Alluvium.	Quaternary.
36.220	do.	do.	Du.	10	–	do.	do.
11.13.4.100	Justiniana Leyba.	Canyon Blanco.	Du.	65	–	Silty sandstone.	Yeso.
10.100	Francisco Leyba.	do.	Du.	15.3	–	Alluvium.	Quaternary.
11.100	C. Baca.	do.	Du.	16.7	–	do.	do.
12.110	Ray Lopez.	do.	Du.	15	–	do.	do.
11.14.21.340	Frank Ortiz.	do.	Dr.	120	6	Silty sandstone.	Yeso.
11.15.21.110	I. V. Lucero.	Swale on mesa.	Dr.	60	6	Limestone.	San Andres.
25.200	do.	Mesa	Dr.	348	–	Sandstone.	Glorieta.
29.444	Juan T. Gallegos.	Valley	Du.	37	–	Silty sandstone.	Yeso.

LOCATION NUMBER	WATER LEVEL BELOW LAND SURFACE (FEET)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
10.12.33.300	300+	Aug. 13, 1947	W	S	Very hard	Weak well.
10.14.20.400	300+	Aug. 12, 1947	W	D & S	*	Hit water at 630 feet. Water rose to about 325 feet. Cased to 660 feet.
10.15.23.400	–	–	W	S	–	
26.300	13.74	Aug. 11, 1947	W	D & S	Good *	Adequate.
27.330	143.54	do.	W	S	*	
32.222	11.99	do.	N	U	–	
36.220	8.5	do.	W	S	–	Adequate.
11.13.4.100	–	–	W	–	Fair	
10.100	13.3	Aug. 8, 1947	W	S	*	
11.100	15.45	do.	W	D & S	Good	
12.110	13.20	do.	N	I	Fair	Rectangular well, 4 by 5 feet.
11.14.21.340	76.25	Oct. 24, 1947	W	D & S	do.	
11.15.21.110	42.10	Sept. 24, 1947	W	S	*	
25.200	300+	–	W	S	–	Driller: Barney Isabel.
29.444	23	–	W	D & S	*	Reported adequate.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
11.27.17.000	T-4 ranch.	Mesa Rica.	Dr.	25	6	Sandstone.	Purgatoire.
12.12.4.110	P. G. Huddleston.	Mesa	Dr.	470	5	Silty sandstone.	Yeso.
5.200	Unknown.	do.	Du.	80	–	Sandstone.	Glorieta.
9.330	Perry Huddleston.	do.	Dr.	160	6	Alluvium.	Quaternary (?)
11.200	Ray Cannon.	do.	Dr.	519	–	Silty sandstone.	Yeso.
13.300	Milton Smith.	Glorieta Mesa.	Dr.	420	6	do.	do.
23.200	Crosby.	do.	Dr.	350	6	do.	do.
36.100	J. C. Crosby.	Canyon Blanco.	Dr.	196	5	do.	do.
12.13.36.300	Macario Leyba.	–	Dr.	72	–	–	–
12.14.22.100	V. Lopez.	Glorieta Mesa.	Du. & Dr.	88	–	Silty sandstone.	Yeso.
32.300	Bruno Lobato.	Valley.	Dr.	62	–	do.	do.
12.15.16.100	Villanueva community.	do.	Dr.	285	–	Sandstone.	Sangre de Cristo (?)
12.17.4.220	Carlos Sandoval.	–	Dr.	120	6	do.	Santa Rosa.
15.400	G. Lucero.	Plains.	Du.	45	–	do.	do.
12.18.24.100	H. A. Thomson.	do.	Dr.	180	–	do.	do.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
11.27.17.000	6.05	November 1947	W	S	–	
12.12.4.110	300+	1947	W	S	Poor "Gypy." *	
5.200	58.38	August 1947	N	–	–	
9.330	118.26	Oct. 4, 1947	W	S	Good.*	
11.200	–	–	W	D & S	*	
13.300	385	–	N	–	–	
23.200	305	–	N	–	–	
36.100	123	–	W	D & S	Hard.*	
12.13.36.300	–	–	N	–	–	
12.14.22.100	87.3	Aug. 8, 1947	W	D & S	*	Weak well.
32.300	41.01	–	W	–	Poor.	
12.15.16.100	–	–	W	–	Good.*	
12.17.4.220	–	–	W	D & S	–	
15.400	35.61	Aug. 2, 1947	W	S	–	
12.18.24.100	–	–	W	–	–	Strong well.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
12.22.1.220	Felix Chavez.	Valley.	Dr.	80	–	Sandstone.	Santa Rosa.
18.200	W. R. Thompson.	Plains.	Dr.	85	10	do.	do.
22.110	Cabra Springs ranch.	do.	Dr.	185	–	do.	do.
12.23.21.100	Gene Monsimer.	do.	Dr.	70	6	do.	do.
22.400	–	do.	Du.	35	–	do.	do.
26.100	Gene Monsimer.	do.	Dr.	70	10	do.	do.
27.100	do.	do.	Du.	14	–	do.	do.
12.24.1.100	Jose G. Lucero.	do.	Dr.	195	6	do.	do.
5.220	H. G. Gonzales.	do.	Du.	25	–	do.	do.
12.25.8.400	Henry Priddy.	do.	Dr.	34	6	"Quicksand."	Quaternary.
17.400	do.	do.	Dr.	355	6	Sandstone.	Santa Rosa.
21.400	do.	Valley.	Dr.	50	6	"Quicksand."	Quaternary.
26.200	Max Lopez.	Mesa.	Dr.	150	6	Sandstone.	Chinle.
36.110	Louis Monsimer.	Plains.	Dr.	–	6	do.	do.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
12.22.1.220	40	–	W	D	–	Very weak well.
18.200	21.32	Nov. 19, 1947	W	S	–	
22.110	165	–	W	S	Poor.*	
12.23.21.100	59.63	Sept. 22, 1947	N	–	–	
22.400	18.24	do.	N	–	*	Abandoned.
26.100	31.95	do.	N	–	Good.	Reported weak.
27.100	10.65	do.	N	–	do.	Reported adequate.
12.24.1.100	30	–	W	D & S	–	Hit water at 185 feet.
5.220	19.22	Sept. 23, 1947	W	D & S	–	
12.25.8.400	15.83	do.	W	D & S	Good.	
17.400	155± (?)	–	W	S	Fair.	Collared 20 feet below base of middle sandstone of Chinle.
21.400	37.79	Sept. 23, 1947	W	S	Good.	Collared about 40 feet below base of middle santstone member of Chinle.
26.200	43.97	Oct. 30, 1947	W	S	do.	
36.110	34.25	do.	W	S	do.	Could be Quaternary.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
12.27.25.400	T-4 ranch.	Mesa Rica.	Dr.	120	6	Sandstone.	Purgatoire.
33.300	do.	do.	Dr.	75	6	do.	do.
12.28.18.200	do.	do.	Dr.	21	6	do.	do.
12.29.13.000	Chappel ranch.	Plains.	Dr.	75	6	do.	Entrada.
12.30.20.000	do.	do.	Dr.	165	6	do.	do.
13.12.26.200	D. Padilla.	Glorieta Mesa.	Dr.	592	6	Silty sandstone.	Yeso.
29.200	Marcus Witte.	–	Dr.	690	4	–	–
13.14.9.320	Pablo Lopez.	Valley.	Dr.	700±	–	Limestone.	Madera.
26.300	–	do.	Dr.	80	–	Sandstone.	Sangre de Cristo.
13.15.2.100	Cleafes Ortiz.	do.	Du.	38	–	do.	do.
13.16.5.100	Antonio Salazar.	Plain.	Du.	35	–	Limestone.	San Andres (?).
5.300	Camillo Baca.	Valley.	Dr.	37	6	–	–
6.200	Eufrasio Salazar.	do.	Dr.	65	6	Limestone.	San Andres (?).
30.200	Farmer Home Administration.	Mesa.	Dr.	600 or 1,000	6	Silty sandstone.	Yeso (?).
13.17.32.220	Nathan Lloyd.	–	–	100±	–	Sandstone.	Santa Rosa.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
12.27.25.400	65.84	November 1947	W	S	–	
33.300	–	–	W	–	–	
12.28.18.200	16±	–	W	S	–	
12.29.13.000	41.69	1947	W	S	Excellent.	
12.30.20.000	78.10	do.	W	S	–	Two wells here. This is southwest well. Northeast well is 110 feet deep.
13.12.26.200	524	–	W	S	Fair.*	
29.200	450	–	W	S	Poor.	Driller: Hegy.
13.14.9.320	–	–	–	I	Good.*	Well flows about 85 gallons per minute.
26.300	–	–	H	–	Good.	
13.15.2.100	30	–	W	D & S	do.	
13.16.5.100	30	–	W	D & S	–	
5.300	25	–	–	D & S	–	
6.200	35	–	W	D & S	*	
30.200	–	–	N	–	–	
13.17.32.220	–	–	W	–	–	

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
13.17.33.300	N. M. Davis.	Plains.	Dr.	60	6	Sandstone.	Santa Rosa.
13.19.8.000	Chaperito School.	do.	Dr.	250	6	do.	do.
13.20.1.200	Chapman ranch.	do.	Dr.	100	6	do.	do.
13.21.20.000	do.	do.	Dr.	–	4	do.	do.
13.23.11.230	Manuel Quintanas.	do.	Dr.	60	6	do.	do.
27.220	Chester Clark.	do.	Dr.	40	8	do.	do.
33.310	L. P. Reynolds.	do.	Dr.	100+	5	do.	do.
13.24.23.330	H. H. Elam.	do.	Dr.	90	6	do.	do.
13.29.3.000	Chappel ranch.	do.	Dr.	142	–	do.	Entrada.
13.30.2.000	George Sims.	do.	Dr.	61	6	do.	do.
13.31.21.000	do.	Valley.	Dr.	31	6	Alluvium.	Quaternary.
30.000	do.	do.	Dr.	35	6	do.	do.
14.13.18.000	Safarina Quintana.	do.	Dr.	125	6	Limestone.	Madera.
21.210	–	do.	Du.	12	–	Sandstone.	Sangre de Cristo.
22.400	Florence Gilmartin.	Hill.	Dr.	500	4	Sandstone or limestone.	Sangre de Cristo or Magdalena.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
13.17.33.300	30.23	June 30, 1947	N	D & S	Good.	
13.19.8.000	–	–	W	D	–	
13.20.1.200	77.45	Nov. 4, 1947	W	S	*	Strong well.
13.21.20.000	60.25	do.	W	S	Good.	
13.23.11.230	39.44	Sept. 22, 1947	W	S	–	
27.220	23.61	do.	W	S	Good.*	Pumping when measured.
33.310	54.20	do.	W	S	*	Mill broken.
13.24.23.330	19.46	Sept. 23, 1947	W	D & S	*	
13.29.3.000	88.35	1947	W	S	–	Strong well.
13.30.2.000	47.21	November 1947	W	S	Good.	do.
13.31.21.000	20	do.	W	S	–	
30.000	20.05	do.	W	S	Fair.	Strong well.
14.13.18.000	60	–	W	S	do.	
21.210	9	–	B	S	–	
22.400	–	–	N	–	–	Abandoned. Driller: Hegy.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
14.13.25.120	W. S. Wilson.	Hilly.	Dr.	270	5	Sandstone.	Sangre de Cristo.
14.14.23.200	D. W. Blauvelt.	–	Dr.	–	$5\frac{3}{16}$	Limestone.	Magdalena.
25.000	R. W. Blauvelt.	–	Dr.	251	6	Sandstone.	Sangre de Cristo.
29.330	Felipe Tafoya.	–	Dr.	–	4	do.	do.
29.340	Ambrosia Tafoya.	–	Dr.	–	4	do.	do.
30.300	Adela Cook.	Hilly.	Dr.	255	4	do.	do.
30.400	Ramon Salazar.	–	Dr.	250	4	do.	do.
31.200	Torvio Aragon.	–	Dr.	155	–	do.	do.
34.110	Lamberto Trujillo.	Flat area.	Dr.	160	5	do.	do.
34.130	Fred Bustamante.	Valley.	Du.	34	–	do.	do.
14.15.2.000	James C. Ellis.	–	Dr.	138	6	do.	do.
3.300	do.	Mesa.	Dr.	432	6	Silty sandstone.	Yeso (?).
11.200	do.	Plains.	Dr.	325	–	Sandstone.	Sangre de Cristo.
24.400	Cruz Martinas.	Valley.	Dr.	365	6	do.	do.
34.420	G. F. Hays.	Hill.	Dr.	101	–	Limestone.	Magdalena.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
14.13.25.120	100	–	W	D & S	Good, soft.	
14.14.23.200	–	–	N	S	–	Flowing well.
25.000	76.95	July 8, 1947	W & P	D & S	Hard.*	Specific capacity 0.044.
29.330	52.67	July 25, 1947	W	D	Good.	
29.340	–	–	W	–	–	
30.300	171.28	July 25, 1947	W	D & S	Good.*	Driller: Hegy.
30.400	–	–	W	–	Good.	
31.200	55	–	W	–	do.	Driller: Hegy.
34.110	100	–	W	D & S	do.	
34.130	25	–	W	D & S	Good.*	
14.15.2.000	100±	–	W	S	–	Bailed at 20 gallons per minute.
3.300	372	–	W	S	–	Bailed 10 to 12 gallons per hour. Driller: O. E. Allen.
11.200	150	–	W	S	Good.	Driller: James Trambly.
24.400	275.38	June 24, 1947	W	–	–	Bailed at 5 gallons per minute. Hit first water at 320 feet. Driller: James Trambly.
34.420	85.54	do.	P	D & S	Good.	

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
14.15.36.440	Tomas Pinosa.	Valley.	Dr.	120	6	Sandstone.	Glorieta (?).
14.16.7.000	Tecolote School.	do.	Dr.	32	–	Silty sandstone.	Yeso (?).
11.400	A. M. Gallegos.	Mesa slope.	Dr.	–	6	Sandstone.	Middle member of the Chinle.
32.320	Ciprano Aguilar.	Valley.	Dr.	48	5	Limestone.	San Andres.
32.330	Esquel Romero.	do.	Dr.	52	5	do.	do.
34.100	Anton Pacheco.	do.	Dr.	150	6	Sandstone.	Glorieta.
14.18.5.400	Reynolds ranch.	Plains.	Dr.	164	–	do.	Middle member of the Chinle.
14.20.21.000	Chapman ranch.	Valley.	Dr.	100+	–	do.	Santa Rosa.
23.000	do.	Low mesa.	Dr.	–	–	do.	Middle member of the Chinle.
14.21.5.110	Tuloso community.	Plateau.	Dr.	–	–	do.	Dakota (?) and Purgatoire.
36.000	W. R. Thompson.	Plains.	Dr.	85	6	do.	Santa Rosa.
14.22.5.100	Lorenzo Gonzales.	Valley.	Dr.	57	–	do.	do.
6.200	Benigno Gonzales.	do.	Dr.	70	6	do.	do.
7.110	Tony Garcia.	Plains.	Dr.	150	–	do.	do.
7.410	Daniel N. Simpson.	do.	Dr.	132	–	do.	do.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
14.15.36.440	81.40	1947	H	D & S	–	
14.16.7.000	30	–	H	–	Fair.	Five wells at Tecolote, all 30 feet deep.
11.400	73.62	Aug. 1, 1947	W	S	–	
32.320	31	–	H	S	–	
32.330	25	–	H	S	–	
34.100	–	–	N	U	–	Reported weak.
14.18.5.400	120	May 1, 1947	W	D & S	Good.	
14.20.21.000	–	–	W	–	–	Two wells at this locality.
23.000	–	–	W	–	*	Weak well.
14.21.5.110	–	–	W	D	Good.*	
36.000	18.96	November 1947	W	S	–	
14.22.5.100	28.97	1947	W	S	–	Weak well.
6.200	12	–	W	D & S	Good.	Strong well.
7.110	60	–	W	–	–	
7.410	35	–	W	–	–	Very weak well.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
14.22.13.300	–	Plains.	Dr.	65	–	Sandstone or shale.	Santa Rosa or Chinle.
17.430	Daniel Simpson.	do.	Dr.	113	6	Sandstone.	Santa Rosa.
14.23.9.220	Isabel Encinias.	do.	Dr.	98	–	do.	do.
34.300	Elijio Quintana.	Valley.	Dr.	150	6	do.	do.
35.200	Benny Lucero.	Plains.	Dr.	35	–	do.	do.
35.440	Gene Monsimer.	Valley.	Dr.	50	6	do.	do.
14.24.8.100	Tremintina community.	Plains.	Dr.	75	6	do.	do.
25.130	Reducindo Roybal.	Valley.	Dr.	150	5	do.	do.
14.25.8.430	4-V ranch.	Plains.	Dr.	435	5½	Sandstone and shale.	do.
11.400	do.	do.	Dr.	210	7	do.	do.
14.26.13.200	Bell ranch.	Shadow valley.	Dr.	22	6	Alluvium.	Quaternary.
18.300	4-V ranch.	Plains.	Dr.	402	5½	Sandstone and shale.	Santa Rosa.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
14.22.13.300	25.85	Sept. 23, 1947	W	S	–	
17.430	28.35	Nov. 5, 1947	W	S	Good.*	Bailed at 6 gallons per minute. Driller: O. E. Allen.
14.23.9.220	52.98	Sept. 24, 1947	W	S	Poor.	Driller: O. E. Allen.
34.300	3.36	May 26, 1947	T	I	Good.	North well of two wells. North well reported to pump 50 gallons per minute. South well 25 gallons per minute.
35.200	25	–	W	–	do.	
35.440	22.85	May 26, 1947	N	–	–	Pump not yet installed. Driller: O. E. Allen.
14.24.8.100	37.77	Oct. 3, 1947	W	D	*	Recharge is local.
25.130	50.62	do.	W	S	–	Driller: Tony Ortiz.
14.25.8.430	265	1949	W	S	Poor.	Drawdown 70 feet. Bailing 20 gallons per minute. Driller: Charles Lamb.
11.400	125	1949	W	S	Fair.	Bailed 50 gallons per minute. Driller: Charles Lamb.
14.26.13.200	8.66	Oct. 30, 1947	W	S	Good.	
18.300	300±	1950	W	S	Fair.	Driller: Charles Lamb.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
14.27.2.400	Bell ranch.	Plains.	Dr.	67	–	Sandstone.	Middle member of the Chinle.
3.000	do.	do.	Dr.	80	6	do.	do.
12.000	do.	do.	Dr.	145	6	do.	do.
14.28.18.200	do.	do.	Dr.	145	6	do.	do.
18.400	do.	do.	Dr.	52	8	Sandstone (?).	Chinle (?).
30.000	Arnett.	Valley.	Dr.	50	6	Alluvium (?).	Quaternary (?).
14.30.19.330	Dan Trigg.	do.	Dr.	150	6	Sandstone and shale.	Dakota (?) and Purgatoire or Morrison.
19.340	do.	Hill.	Dr.	42	6	do.	do.
14.31.29.300	George Sims.	Plains.	Dr.	30	6	Shale and sandstone.	Upper member of the Chinle (?).
15.12.33.100	Santa Fe Railroad.	–	Dr.	330	8	Limestone.	Upper part of Magdalena.
15.15.7.310	San Pablo.	Valley.	Du.	21	–	Sandstone.	Sangre de Cristo.
12.140	James Ellis.	Edge of valley.	Dr.	45	6	Limestone.	Madera.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
14.27.2.400	30	–	W	S	Good.	
3.000	21.40	Oct. 29, 1947	W	S	do.	Measured while pumping.
12.000	23.01	do.	W	S	Fair.	
14.28.18.200	58.19	Nov. 24, 1947	W	S	Poor.	
18.400	26.70	Oct. 29, 1947	W	N	–	
30.000	25.50	Oct. 31, 1947	W	S	–	
14.30.19.330	–	–	W	S	–	Reported strong. West well of two wells.
19.340	36.78	Oct. 17, 1947	W	D & S	Good.	Reported weak. East well of two wells.
14.31.29.300	12.70	November 1947	W	D & S	–	
15.12.33.100	111.75	September 1946	–	R	Good.*	Specific capacity: 4.54. First two holes lost. Drillers: Taylor and Cox.
15.15.7.310	10.15	Aug. 1, 1947	H	D	Good.	
12.140	15	–	–	–	–	Driller: James Trambly.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
15.15.22.000	James Ellis.	–	Dr.	45	6	Sandstone.	Sangre de Cristo.
23.200	Daniel Lucero.	Valley.	Dr.	50	6	Limestone.	Magdalena.
27.000	James C. Ellis.	Plateau.	Dr.	102	6	Sandstone.	Sangre de Cristo.
15.16.10.220	Laurence Hanway.	do.	Dr.	–	–	do.	Dakota (?) and Purgatoire.
22.400	Cruse.	do.	Dr.	215	5	do.	do.
26.100	A. M. Gallegos.	do.	Dr.	150	6	do.	do.
27.200	Cruse.	do.	Du.	–	–	do.	do.
29.310	Nicolas Madrid.	Hilly.	Dr.	76	11	do.	Sangre de Cristo.
32.110	J. C. Raybun.	Hill.	Dr.	75	6	do.	do.
35.330	–	Slope of mesa.	Dr.	–	6	do.	Middle member of the Chinle.
35.400	H. T. Sowell.	Plateau.	Dr.	210	6	do.	Dakota (?) and Purgatoire.
15.17.6.120	Lew Monsimer.	do.	Dr.	–	6 (?)	do.	do.
18.220	Lyle Hosford.	do.	Dr.	60	6	do.	do.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
15.15.22.000	15	–	W	–	–	Driller: James Trambly.
23.200	–	–	W	–	Good.	
27.000	50	–	W	S	do.	Hit water in sandstone at 75 feet. Driller: O. E. Allen.
15.16.10.220	150	–	W	D & S	Good.*	
22.400	81.94	Sept. 2, 1947	W	–	–	
26.100	20	–	W	S	–	
27.200	5.25	Sept. 2, 1947	–	D	–	Perched water; goes dry in dry weather.
29.310	39.26	July 3, 1947	–	–	–	Specific capacity: 0.6. Driller: James Trambly.
32.110	44.95	Apr. 24, 1949	W	D, I, & S	Good.*	Strong well. Hit water in sandstone at 70 feet. Driller: Tom Stump.
35.330	72.16	Aug. 1, 1947	W	S	–	
35.400	130	–	W	–	*	
15.17.6.120	15.27	Mar. 26, 1948	W	–	–	
18.220	14.95	do.	W	D & S	–	

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
15.18.5.000	John Leatherwood.	Plateau.	Dr.	–	6	Sandstone.	Dakota (?) and Purgatoire.
30.300	Reynolds ranch.	do.	Dr.	–	5	do.	do.
15.19.5.400	George Lingman.	Plains.	Dr.	110	–	do.	do.
6.210	do.	do.	Dr.	160	–	do.	do.
24.200	Elliott Phillips.	Small valley.	Dr.	55	6	do.	do.
15.21.7.440	Flavio Baca.	Plateau.	Dr.	207	6	do.	do.
12.400	–	do.	Dr.	318	5	do.	do.
15.122	Trujillo community.	do.	Dr.	200	–	do.	do.
15.222	Meguel Crespen.	Arroyo.	Dr.	86	6	do.	do.
19.400	Manuel Lucero.	Plateau.	Dr.	170	6	do.	do.
15.22.4.400	Flavio Baca.	do.	Dr.	250	–	Sandstone and shale.	Dakota (?) and Purgatoire and Morrison.
19.300	Alexandro Lucero.	Plains.	Dr.	70	–	Sandstone.	Santa Rosa.
15.23.14.100	Candelario Sena.	Valley.	Dr.	86	6	do.	do.
25.300	Rafael Sanchez.	do.	Dr.	95	–	do.	do.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
15.18.5.000	80.58	Oct. 6, 1947	W	D & S	*	
30.300	59.80	Oct. 1, 1947	N	–	–	
15.19.5.400	100	–	W	D	Good, soft.	Strong well.
6.210	25.30	Apr. 28, 1947	W	D	do.	Fairly strong well.
24.200	27.5	Apr. 29, 1947	W	D & S	Good.	
15.21.7.440	149.59	Apr. 30, 1947	W	D & S	Good.*	
12.400	145	–	W	S	–	
15.122	–	–	W	D	–	Reported drilled by Federal or State government.
15.222	37.07	Apr. 30, 1947	W	D & S	Good.	
19.400	145.53	do.	–	D & S	do.	
15.22.4.400	190	–	W	–	–	
19.300	60	–	W	–	–	Strong well.
15.23.14.100	37.05	Sept. 24, 1947	N	–	Fair.	
25.300	26	–	–	D	do.	Two windmill wells at this locality.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
15.24.8.210	Juan Maldonado.	Plains.	Dr.	69	6	Sandstone.	Santa Rosa.
9.000	Amalia Romero.	do.	Dr.	59	6	do.	do.
25.100	4-V ranch.	do.	Dr.	43	–	–	–
25.240	do.	do.	Dr.	170	6	Sandstone and shale.	Santa Rosa.
27.210	Pete Gonzales.	do.	Dr.	115	6	Sandstone.	do.
15.25.14.140	4-V ranch.	do.	Dr.	167	7	Sandstone and shale.	do.
19.200	do.	do.	Dr.	180	7	do.	do.
32.100	do.	do.	Dr.	158	7	do.	do.
34.210	do.	do.	Dr.	464	5½	do.	do.
15.26.1.000	Bell ranch.	Valley.	Dr.	66	12	Alluvium.	Quaternary.
25.000	do.	do.	Dr.	25–30	6	Sandstone.	Santa Rosa (?)
15.27.17.000	do.	La Cinta Valley.	Du.	20	–	Alluvium.	Quaternary.
15.28.5.000	do.	Plains.	Dr.	66	6	Sandstone and shale.	Upper member of the Chinle.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
15.24.8.210	7.74	Oct. 3, 1947	W	S	*	
9.000	21.87	do.	W	D & S	–	
25.100	–	–	W	S	Good.	Bailed at 25 gallons per minute. Driller: Charles Lamb.
25.240	27.10	June 2, 1950	W	S	do.	Driller: Charles Lamb.
27.210	23.85	Oct. 3, 1947	W	S	Poor.*	
15.25.14.140	50±	1950	W	S	–	Driller: Charles Lamb.
19.200	160±	do.	W	S	–	do.
32.100	45±	do.	W	S	–	do.
34.210	–	–	W	S	Poor.	Bailed 30 gallons per minute. Driller: Charles Lamb.
15.26.1.000	9.91	Oct. 30, 1947	W	S	Good.	
25.000	24	–	W	S	do.	
15.27.17.000	15.87	Oct. 29, 1947	W	D	Good.*	Strong well.
15.28.5.000	22.85	November 1947	W	S	–	

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
15.28.32.000	Bell ranch.	Plains.	Dr.	50	6	Sandstone and shale.	Upper member of the Chinle.
15.29.9.100	Mrs. Trigg.	Atarque Canyon.	Dr.	40	4	Sandstone, sand, and gravel.	Morrison or Alluvium.
14.400	do.	Valley.	Dr.	–	6	Alluvium (?).	Quaternary (?).
24.200	do.	do.	Dr.	120+	6	Sandstone and shale.	Morrison (?).
15.30.32.000	do.	Plateau.	Dr.	140	4	do.	do.
16.12.16.300	Tom R. Wyles.	Valley.	Dr.	87	6	Limestone.	Magdalena.
28.000	Geronomo Gonzales.	do.	Dr.	52	–	do.	do.
33.110	Robert Martin.	do.	Dr.	251	–	Sandstone.	Sangre de Cristo.
33.140	Mr. Benson.	do.	Dr.	515	5	do.	do.
16.15.5.000	Pat Timm.	Mountains.	Dr.	210	6	Limestone.	Magdalena.
31.000	Fred Axtell.	Tecolote Valley.	Dr.	50	6	–	–
16.16.4.000	Agua Pura Co.	–	–	–	–	–	–

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
15.28.32.000	28.94	November 1947	W	S	–	
15.29.9.100	23.22	Apr. 23, 1949	W	S	Good.	
14.400	14.30	Oct. 17, 1947	W	S	do.	Reported strong.
24.200	30.98	do.	W	S	do.	Reported weak. Water levels reported lowering since 1941.
15.30.32.000	32.50	June 12, 1950	W	S	do.	
16.12.16.300	43.29	July 24, 1947	–	D	*	Drawdown 8 feet, pumping 2 hours at about 5 gallons per minute.
28.000	30.50	July 9, 1947	W	D	–	Drawdown 5 feet, pumping 1½ hours at about 10 gallons per minute. Driller: Hegy.
33.110	55.65	July 8, 1947	W	–	*	Hit first water at 150 feet in arkosic sand. Driller: Hegy.
33.140	1.5	–	Pl	D	*	Drawdown 80 feet after pumping 14 hours at the rate of 8 gallons per minute. Driller: Hegy.
16.15.5.000	40	–	W	S	Good.	Driller: Trambly.
31.000	18.75	Aug. 1, 1947	H	D	–	
16.16.4.000	–	–	–	–	–	Flows 3 gallons per minute.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
16.16.10.000	–	Plains.	Dr.	100	6	Shale.	Carlile.
21.000	–	do.	Dr.	–	10	Sandstone.	Dakota (?) and Purgatoire or Entrada.
22.400	–	–	Dr.	300	–	do.	Dakota (?) and Purgatoire.
23.300	Santa Fe Railway.	–	Dr.	850	–	do.	Entrada.
23.300a	do.	–	Dr.	854	–	do.	do.
32.400	Ed. Fitzimmons.	Valley.	Dr.	95	6	Sandstone and shale.	Lower member of the Chinle.
16.17.4.110	Civil Aero. Admin.	Plains.	Dr.	–	4	Shale.	Lower part of Graneros.
21.310	John Bell.	Plateau.	Dr.	100	6	do.	Graneros.
21.340	do.	do.	Dr.	175	6	do.	do.
21.340a	do.	do.	Dr.	350	–	Shale and sandstone.	Graneros and Dakota (?) and Purgatoire.
21.340b	do.	do.	Dr.	–	–	do.	do.
21.400	–	Draw in plateau.	Dr.	200	–	Sandstone.	Dakota.

LOCATION NUMBER	WATER LEVEL BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
16.16.10.000	21.38	May 2, 1947	–	S	–	
21.000	–	–	–	–	–	Reported pumped at 50 gallons per minute. Plugged.
22.400	160	–	–	–	–	Abandoned.
23.300	60	–	–	R	Excellent.	Reported drawdown 120 feet while pumping 48 gallons per minute.
23.300a	–	–	–	R	do.	Reported drawdown 187 feet while pumping 56 gallons per minute.
32.400	30	–	–	D & S	Good.*	Fairly strong. Driller: Trambly.
16.17.4.110	110+	Apr. 24, 1947	–	–	Poor.*	Pumps dry in 2 to 3 hours at 5 gallons per minute.
21.310	50	Aug. 18, 1947	W	S	Poor.	
21.340	100±	–	W	D & S	Poor.*	Weak well. South well of three wells.
21.340a	136.0	Apr. 24, 1949	N	–	–	Bailed at only 20 gallons per hour. Middle well of three wells.
21.340b	72.0	do.	N	–	–	Reported very weak. North well of three wells.
21.400	37.0	do.	–	U	–	Bailed at ½ to ¾ gallons per minute.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
16.17.22.400	J. H. Leatherwood.	Plateau.	Dr.	210	–	Sandstone.	Dakota.
26.100	Dan Craig.	do.	Dr.	100	6	do.	do.
31.440	Lew Monsimer.	Gentle slope.	Du.	70+	–	do.	Dakota (?) and Purgatoire.
16.18.9.400	Robert Turner.	Plateau.	Dr.	160	–	do.	do.
13.400	John Leatherwood.	do.	Dr.	440	–	–	–
15.200	do.	do.	Dr.	–	6	Sandstone.	Dakota (?) and Purgatoire.
18.330	do.	do.	Dr.	–	6	do.	do.
18.440	Robert Turner.	do.	Dr.	100	–	do.	do.
16.19.6.100	Mr. Goetsch.	do.	Dr.	–	–	do.	do.
11.200	do.	do.	Dr.	168	6	Shale.	Lower part of Graneros.
13.300	–	Valley.	Dr.	–	6	Sandstone.	Dakota (?) and Purgatoire.
29.300	–	Plateau.	Dr.	–	–	do.	do.
31.100	–	do.	Dr.	–	6	do.	do.
36.300	Elliot W. Phillips.	do.	Dr.	80	6	do.	do.
16.20.1.100	John Leatherwood.	do.	Dr.	–	–	do.	do.
20.200	–	do.	Dr.	–	6	do.	do.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
16.17.22.400	35	–	W	D, I, & S	*	Three wells at this site.
26.100	17.04	August 1947	W	S	*	
31.440	34.20	Mar. 26, 1948	W	S	–	Pumps dry after few hours.
16.18.9.400	50	–	W	S	Good.	Hit Dakota sandstone at 70 feet. Fairly strong. Driller: Isabel.
13.400	–	–	–	–	–	Dry hole. Abandoned in Morrison.
15.200	34.82	Oct. 1, 1947	W	S	–	
18.330	101.89	Oct. 6, 1947	W	S	–	
18.440	60	–	W	S	Good.	Tested at 6 gallons per minute. Driller: Mortimer.
16.19.6.100	–	–	W	–	*	
11.200	72.98	Apr. 28, 1947	W	S	*	Bailed 10 gallons per minute. Driller: Trambly.
13.300	12.72	Apr. 29, 1947	W	S	Good.*	
29.300	34.05	September 1947	N	U	–	
31.100	70.50	Apr. 23, 1949	W	S	–	Drawdown about 10 feet after pumping ½ hour at the rate of 1½ to 2 gallons per minute.
36.300	55.90	Apr. 29, 1947	W	S	–	Driller: Mortimer.
16.20.1.100	119.68	do.	–	–	*	
20.200	71.67	September 1947	W	S	–	

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
16.20.26.100	–	Plateau.	Dr.	–	6	Sandstone.	Dakota (?) and Purgatoire.
16.21.4.420	M. H. Lewis.	do.	Dr.	160	–	do.	do.
16.22.6.220	do.	do.	Dr.	135	6	do.	do.
16.24.7.420	Antonio Sanchez.	Plains.	Dr.	87	6	do.	Santa Rosa.
19.100	do.	do.	Dr.	70	5	do.	do.
29.310	C. E. Jackson.	do.	Dr.	60	6	do.	do.
16.26.1.120	Waggoner ranch.	do.	Dr.	70	6	do.	Middle member of the Chinle.
1.140	do.	do.	Dr.	40	6	do.	do.
16.300	do.	Valley.	Dr.	20	6	Alluvium.	Quaternary.
28.000	Bell ranch.	do.	Dr.	50	6	Sandstone and sand.	Chinle and Quaternary.
16.27.27.200	do.	Plains.	Dr.	70	6	Sandstone and shale.	Chinle.
34.300	do.	do.	Dr.	100	6 (?)	Sandstone.	Middle member of the Chinle.
36.200	do.	Valley.	Dr.	47	8	Alluvium.	Quaternary.
16.28.14.000	R. L. White.	Plateau.	Dr.	255	–	Sandstone and shale.	Dakota (?) and Purgatoire.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
16.20.26.100	100±	–	W	S	Good.	
16.21.4.420	98.27	Apr. 29, 1947	W	S	do.	Strong well.
16.22.6.220	82.13	May 29, 1947	–	D & S	Good.*	
16.24.7.420	30±	–	W	–	Fair.*	
19.100	30.40	Oct. 13, 1947	W	–	–	
29.310	45±	–	Broken windmill	U	–	
16.26.1.120	40	–	W	S	–	Hit water at 45 feet, rose to 40 feet.
1.140	0	–	W	–	*	Hit water at 30 feet, rose to surface.
16.300	15	–	W	S	Good.	
28.000	30.40	Oct. 30, 1947	W	S	Fair.	
16.27.27.200	47.10	Oct. 28, 1947	W	S	–	Collared 200 feet below Entrada.
34.300	–	–	W	S	Poor.	
36.200	16.95	Oct. 28, 1947	W	S	Fair.	Strong well.
16.28.14.000	85.0	Apr. 22, 1949	N	–	–	Bailed about ¼ gallon per minute. Driller: Randle.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
16.28.15.000	Bell ranch.	Plateau.	Dr.	210	–	Sandstone.	Dakota (?) and Purgatoire.
20.000	do.	Canyon.	Dr.	55	6	do.	Entrada (?).
23.000	R. L. White.	Mesa.	Dr.	70	6	do.	Dakota (?) and Purgatoire.
27.100	Bell ranch.	Plateau.	Dr.	107	–	do.	do.
27.200	R. L. White.	–	Dr.	152	–	do.	do.
29.000	Bell ranch.	Plains.	Dr.	64	6	do.	Entrada.
16.29.30.200	Mrs. Steve Trigg.	Plateau.	Dr.	38	6	do.	Dakota (?) and Purgatoire.
31.200	Southern Pacific Railroad.	Canyon.	Du.	32	–	Sandstone and sand.	Dakota (?) and Purgatoire and Quaternary.
31.400	R. L. White.	Edge of valley.	Dr.	23	6	Sand and/or sandstone.	Alluvium and/or Dakota (?) and Purgatoire.
17.14.12.310	–	do.	Dr.	100+	–	Alluvium.	Quaternary.
17.15.4.200	Las Dispensas.	Broad, shallow valley.	Du.	4	–	Arkosic sandstone.	Magdalena.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
16.28.15.000	180	April 1949	W	S	–	Bailed about 1½ gallons per minute. Driller: Randle.
20.000	28.14	Oct. 28, 1947	W	S	Good.	
23.000	65	April 1949	–	S	–	Bailed 7 gallons per minute, lowered water 5 feet; specific capacity: 1.4. Driller: Randle.
27.100	96	–	W	S	–	Bailed 10 gallons per minute.
27.200	–	–	W	S	–	Bailed at 3 gallons per minute. Driller: Randle.
29.000	45.87	October 1947	W	S	–	Strong well.
16.29.30.200	27.80	June 12, 1950	W	S	Good.	Strong well. Pumping 2 gallons per minute when measured depth to water.
31.200	6.50	Oct. 16, 1947	–	R	Good.*	Capacity 150 gallons per minute.
31.400	20	–	W	D & S	Strong.	
17.14.12.310	15	–	–	D	–	
17.15.4.200	0.32	June 20, 1947	N	D & S	Good.	

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
17.16.21.200	Fred Gerk.	Broad, shallow valley.	Dr.	105	–	Shale.	Carlile.
22.440	Wm. Sedberry.	Plateau.	Dr.	42	–	do.	do.
17.17.4.240	R. C. York.	–	Du.	45±	–	Limestone and shale (?).	Greenhorn and Graneros (?).
5.100	Lee Mayhan.	North slope of hill.	Dr.	130	6	Shale.	Carlile.
5.410	R. C. York.	do.	Dr.	330	–	Limestone, shale, and sandstone.	Greenhorn, Graneros, and Dakota (?) and Purgatoire.
15.000	Earl Chambers.	Plateau.	Dr.	187	6	Limestone and shale.	Greenhorn and Graneros.
18.400	Hoover.	do.	Dr.	–	–	Sandstone.	Dakota (?) and Purgatoire, Entrada, and Dockum.
24.100	J. W. Shoemaker.	do.	Dr.	106	6	Limestone and shale.	Greenhorn and Graneros.
31.100	W. T. Bookout.	do.	Dr.	134	6	Limestone.	Greenhorn.
17.18.17.400	J. W. Shoemaker.	Valley.	Dr.	–	6	Shale (?) and sandstone.	Graneros (?) and Dakota (?) and Purgatoire.
23.000	do.	Plateau.	Dr.	335	6	do.	do.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
17.16.21.200	–	–	W	D & S	Fairly good.	Weak well.
22.440	–	–	W	S	–	
17.17.4.240	22.90	Apr. 1, 1947	S	D	–	Weak well.
5.100	–	–	W	D & S	–	
5.410	39.10	May 1, 1948	W	D & S	Poor.	
15.000	18.39	May 2, 1947	W	S	–	Strong well.
18.400	–	–	N	S	*	Flowing 2.5 gallons per minute.
24.100	–	–	W	S	Poor.*	
31.100	72.44	Oct. 23, 1947	W	S	*	Draws down to 110 feet when pumping 2 gallons per minute.
17.18.17.400	–	–	W	–	*	Well collared 150 feet below base of Greenhorn.
23.000	120+	–	W	S	*	Collared 10 feet below base of Greenhorn.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
17.19.35.100	Edwin Goetsch.	Plateau.	Dr.	110	6	Shale and sandstone.	Graneros and Dakota (?) and Purgatoire.
17.20.27.200	–	do.	Dr.	–	6	–	–
17.21.20.200	Chas. Crews.	Valley arroyo.	Dr.	–	–	Sandstone.	Dakota (?) and Purgatoire.
27.440	do.	Plateau.	Dr.	–	–	do.	do.
17.22.14.000	Alex Griego.	Valley.	Dr.	67	6	Alluvium (?).	Quaternary (?).
22.200	Hipalito Salazar.	do.	Du.	32	–	Shale and sandstone.	Morrison.
22.330	Maes.	do.	Du.	25	–	–	–
24.400	Cecilia Sena.	Plateau.	Dr.	140	–	Sandstone.	Dakota (?) and Purgatoire.
33.240	Ramon Grano.	do.	Dr.	102	6	do.	do.
17.23.6.400	Abran Romero.	do.	Dr.	153	–	do.	do.
17.200	Maestas School.	do.	Dr.	236	–	–	–
17.24.6.120	Vicente Gallegos.	do.	Dr.	–	6	Sandstone.	Dakota (?) and Purgatoire.
32.200	C. E. Jackson.	Valley.	Du. & Dr.	28	6	do.	Santa Rosa.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
17.19.35.100	90	–	W	D	–	Black shale reported to 100+ feet Graneros. Driller: Smith.
17.20.27.200	69+	September 1947	W	S	*	
17.21.20.200	28.17	Apr. 29, 1947	W	S	Good.	
27.440	113.31	do.	W	S	do.	
17.22.14.000	34.18	Aug. 19, 1947	W	D & S	do.	May get some water from Morrison formation under alluvium.
22.200	29.85	do.	B	D	*	
22.330	15.79	do.	B	D	–	
24.400	90	–	W	D & S	*	
33.240	61.76	Aug. 19, 1947	N	D	Good.	
17.23.6.400	90.14	Sept. 3, 1947	N	–	–	Drillers: Hubbel and Waggoner.
17.200	180	–	W	–	Good.	
17.24.6.120	65.45	Sept. 5, 1947	N	–	–	
32.200	14.67	Oct. 13, 1947	Broken mill	U	–	Very weak well.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
17.25.10.330	O. H. Kidd.	Valley.	Dr.	25	6	Alluvium.	Quaternary.
11.320	J. Laumbach.	Arroyo.	Du.	20	–	do.	do.
11.340	do.	Valley.	Du.	20	–	do.	do.
13.000	O. H. Kidd.	Plains.	Dr.	50	–	Shale.	Chinle.
15.130	do.	do.	Dr.	35	6	do.	do.
30.200	Miguel Lujan.	do.	Dr.	43	6	do.	do.
31.240	do.	Arroyo.	Dr.	17	5	Alluvium.	Quaternary.
17.26.1.200	Waggoner ranch.	Valley:	Dr.	40	6	do.	do.
7.300	Rudolph Laumbach.	Plains.	Du.	50	–	Shale.	Chinle.
16.100	Waggoner ranch.	do.	Dr.	85	6	Sandstone.	do.
18.400	O. H. Kidd.	–	Du.	20	–	Alluvium.	Quaternary.
28.200	Waggoner ranch.	Plains.	Dr.	120	5¾	Shale and sand-stone.	Chinle.
17.27.10.100	do.	do.	Dr.	300	6⅝	Sandstone.	do.
18.14.1.000	Ed. Mosimann	Edge of valley.	Dr.	141	8	–	–

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
17.25.10.330	15	–	W	–	Good.	Strong well.
11.320	12.48	Oct. 15, 1947	W	D & S	Fair.	
11.340	14.15	do.	W	S	*	Strong well.
13.000	30	–	W	S	–	Weak well.
15.130	15.33	Oct. 15, 1947	W	S	Fair.	
30.200	23.84	Oct. 14, 1947	W	D & S	do.	
31.240	10.65	do.	W	S	do.	
17.26.1.200	28	–	W	D & S	Good.	Three wells here.
7.300	31.58	Oct. 15, 1947	W	–	*	Weak well.
16.100	35	–	W	S	Alkaline.	do.
18.400	15.75	Oct. 15, 1947	W	S	do.	Strong well.
28.200	80	–	–	S	–	
17.27.10.100	–	–	–	D	Good.*	
18.14.1.000	40	–	W	–	Good.	Sandy gravel to about 30 feet above rock.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
18.15.24.100	Ignacio Pacheco.	Edge of valley.	Du.	25	–	Limestone.	Magdalena.
24.200	Arrott ranch.	Valley.	Dr.	70	6	do.	do.
27.100	Richard Pritzlaff.	Edge of valley.	Dr.	150	6	do.	do.
36.100	–	Valley.	Du.	45	–	–	–
18.16.6.300	Salome Aregog.	Hill.	Dr.	100	6	Limestone.	Madera.
8.300	Manuelitas community.	do.	Dr.	138	6	do.	Magdalena.
19.300	Dr. Esther Eymer.	Valley.	Dr.	80	–	do.	do.
27.000	Bookout.	Plateau.	Dr.	–	6	Shale.	Carlile.
18.18.33.100	R. C. York.	Valley.	Dr.	–	12	–	–
33.400	do.	do.	Dr.	–	6	Shale and sandstone.	Graneros (?) and Dakota (?) and Purgatoire.
18.20.27.000	J. A. Chapman.	Plateau.	Dr.	200	–	Sandstone.	Dakota (?) and Purgatoire.
18.23.29.100	Pocomio Romerio.	do.	Dr.	208	–	Sandstone or shale.	Dakota (?) and Purgatoire or Morrison.
18.24.31.400	Juan Gallegos.	do.	Dr.	202	6	Sandstone and shale.	Morrison.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
18.15.24.100	20±	–	W	–	–	Strong well.
24.200	–	–	W	D & S	*	Weak well.
27.100	41.38	June 20, 1947	W	D & S	Good.*	Strong well.
36.100	37.87	do.	B	–	–	
18.16.6.300	41.53	June 1947	W	D & S	*	
8.300	80	–	W	D	Good.*	Driller: Matson.
19.300	30	–	W	D & S	Good.	Strong well. Driller: Isabel.
27.000	16.58	Mar. 29, 1948	W	D & S	–	Reported adequate. Driller: Mutter.
18.18.33.100	0.99	June 26, 1947	N	S	*	
33.400	37.15	Sept. 30, 1947	W	S	*	
18.20.27.000	175	–	W	S	–	
18.23.29.100	185.37	Sept. 3, 1947	N	–	–	Very weak well.
18.24.31.400	136.80	Sept. 5, 1947	N	–	–	Dry hole 200 feet deep is 200 yards north of well. Driller: Hubbell and Waggoner.

* See footnote at end of table.

TABLE 1. RECORDS OF WELLS IN SAN MIGUEL COUNTY, NEW MEXICO. (Continued).

LOCATION NUMBER	OWNER	TOPOGRAPHIC SITUATION	TYPE OF WELL	DEPTH OF WELL (FEET)	DIAMETER OF WELL (INCHES)	PRINCIPAL WATER-BEARING BED	
						CHARACTER OF MATERIAL	GEOLOGIC HORIZON
18.25.29.400	Frank Hartley.	Plateau.	Dr.	45	6	Sandstone.	Dakota (?) and Purgatoire.
33.200	do.	do.	Dr.	77	6	do.	do.
18.26.24.430	H. D. Upton.	Valley.	Dr.	50	–	Alluvium.	Quaternary.
35.420	Waggoner ranch.	–	Dr.	50	–	Sandstone.	Chinle.
18.28.17.000	do.	Plateau.	Dr.	–	6	do.	Dakota (?) and Purgatoire.
34.000	do.	do.	Dr.	90	6	do.	do.
19.14.36.100	Manuel Martines.	Valley.	Dr.	84	12	Alluvium.	Quaternary.
19.15.15.300	S. A. Garcia.	do.	Du.	14	–	do.	do.
26.300	Eusebio Sándoval.	do.	Du.	45	–	Alluvium and limestone.	Quaternary and Magdalena.
27.000	Elisea Quintana.	do.	Du.	18	–	Limestone.	Magdalena.
28.100	Faustine Silva.	do.	Du.	55	–	Alluvium.	Quaternary.
28.200	Manuel Silva.	do.	Du.	25	–	do.	do.
29.200	Henry Thgesen.	do.	Dr.	112	8	do.	do.
30.100	do.	do.	Dr.	149	6	–	–
35.000	Sofero Montoya.	do.	Du.	12	–	Limestone.	Madera.

LOCATION NUMBER	WATER LEVEL		METHOD OF LIFT	USE OF WATER	QUALITY	REMARKS
	BELOW LAND SURFACE (FEET)	DATE OF MEASUREMENT				
18.25.29.400	35	–	W	S	–	Well located 500 feet from deep canyon. Fair well.
33.200	59.70	Oct. 23, 1947	W	S	Good.	Only very strong well in area.
18.26.24.430	20.35	Oct. 17, 1947	W	D & S	Good.*	
35.420	–	–	W	–	Good.	Fairly strong.
18.28.17.000	150	–	–	–	–	Two wells here–same depth. One reported dry hole.
34.000	30.70	Oct. 16, 1947	W	S	–	Strong well.
19.14.36.100	70	June 11, 1947	H	D	Good.*	Driller: Smith.
19.15.15.300	8.13	June 12, 1947	H	D & S	*	
26.300	14.91	do.	H	D	–	Goes dry in summer.
27.000	15.	–	B	D	–	Water level varies from 12 to 16 feet.
28.100	43.81	June 12, 1947	B	D	Good.	
28.200	17.11	do.	B	D & S	do.	
29.200	74.84	June 13, 1947	W	–	do.	
30.100	102.68	do.	W	–	–	Sand and gravel to 15 feet, then hard rock.
35.000	11.00	June 1947	B	D	–	

* See chemical analyses table 3.

TABLE 2. RECORDS OF SPRINGS IN SAN MIGUEL COUNTY, NEW MEXICO

(SHOWN ON PL. 2)

EXPLANATION OF COLUMN HEADINGS:

LOCATION SPRING NUMBER: See p. 37 for explanation. USE OF WATER: D, domestic; FH, fish hatchery; I, irrigation; R, refrigeration; S, stock.

LOCATION SPRING NUMBER	OWNER	NAME	TOPOGRAPHIC SITUATION	KIND OF ROCK	NUMBER OF OPENINGS	SOURCE OF WATER	IMPROVEMENTS; ACCOMMODATIONS	YIELD (g.p.m.)	USE OF WATER
12.14.20.300[1]	Gonzales ranch	Los Diegos	Valley	Sandstone	2	Glorieta	None	5	D, S
12.19.16.[1]	H. A. Thomson	Park Springs	do.	do.	1	Santa Rosa	Spring house	5–10	D, S, I
13.15.2.100	–	–	do.	Limestone	–	Madera	None	5	I
13.15.36.400	Farmers Home Administration	–	Plateau	Sandstone	–	Glorieta	Tank reservoir	3–5	S
13.16.6.400	–	La Ojita	Valley	Limestone	2	San Andres	None	3	D
13.16.8.100[1]	–	Los Chupaderas	do.	do.	15	do.	do.	40	I
13.16.9.200	–	–	do.	do.	2	do.	do.	6	I
13.16.23.400	–	Aurupa Springs	Edge of cuesta	Sandstone	2	Santa Rosa	do.	5–8	D, S, I
13.17.17	–	Apache Springs	Edge of plateau	Shale and Sandstone	6	Chinle	do.	3–5	D, S, I
13.21.25.400[1]	W. R. Thompson	Cabra Springs	Valley	Sandstone	1	Santa Rosa	Spring house	8	D, S, I
14.12.3.200	–	Pajarita Spring	do.	Limestone	1	Madera	None	3	D, S
14.16.25.100	–	Los Montoyas	Edge of plateau	Shale and sandstone	2	Chinle	do.	2–3	D, S
15.13.5.100	J. Rodriguez	–	Valley	Limestone	2	Madera	do.	150	I
15.15.12.200[1]	Walter Young	Ojito Frio No. 1	do.	do.	2	do.	do.	15	D, I
15.15.12.200[a]	do.	Ojito Frio No. 2	do.	do.	1	do.	do.	4	S, I
15.15.12.300[1]	James C. Ellis	–	do.	do.	1	do.	do.	10	I
16.12.16.300	State of N. Mex.	Lisboa Springs	do.	do.	17 (?)	do.	Fish hatchery	400 (?)	FH
18.14.3.100	H. A. Mosiman	Blue Spring	do.	do.	–	do.	None	150	–
18.14.5.200	do.	–	do.	do.	–	do.	Spring house	4	D
18.15.23.200[1]	Arcado Leger	–	do.	do.	–	do.	None	50	I
19.14.28.400	Hilton Lodge	–	do.	do.	–	do.	Reservoir	100	D
19.14.33.300[1]	H. A. Mosiman	"Refrigeration" Springs	do.	do.	–	do.	Cooling tank	12	R

[1] Chemical analysis in Table 3.

TABLE 3. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN SAN MIGUEL COUNTY, NEW MEXICO. NUMBERS CORRESPOND TO NUMBERS IN TABLE 1.

Analyses by Geological Survey (Parts per million)

WELL (SPRING) NUMBER	DATE OF COLLECTION	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C.)	SILICA (SiO_2)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM AND POTASSIUM (Na + K)	BICARBONATE (HCO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	DISSOLVED SOLIDS	TOTAL HARDNESS AS $CaCO_3$	PER CENT SODIUM
10.14.20.400	8-12-47	1,400	24	169	66	65	205	629	6.0	.7	1.7	1,060	693	–
10.15.26.300	8-11-47	1,330	21	142	54	84	288	420	58	.4	4.1	925	576	–
27.330	Do.	1,420	–	286	34	14	264	620	15	.7	.1	1,100	854	–
11.13.10.100	8- 8-47	1,210	28	154	60	41	299	416	21	.4	14	882	630	–
11.15.21.110	9-26-47	511	–	68	22	14	302	19	6	.4	17	295	260	–
29.444	7-11-47	527	–	73	20	5.5	244	23	18	0	33	264	293	–
12.12.4.110	8- 4-47	2,550	23	486	135	18	152	1,610	4	.3	.2	2,350	1,770	–
9.330	Do.	506	20	61	22	10	203	36	36	.4	11	296	242	–
11.200	8- 6-47	723	23	67	28	60	331	130	3	.3	.3	475	282	–
36.100	10-24-47	1,990	–	351	91	43	186	1,130	9	.2	.3	1,720	1,250	–
12.14.22.100	8- 8-47	575	28	92	12	18	294	26	11	.2	42	374	279	–
12.15.16.100	7-22-47	561	18	68	23	19	253	84	7.0	.2	.6	344	264	–
12.22.22.110	5-21-47	2,970	–	125	184	379	880	1,030	70	.5	0	2,220	1,070	44
12.23.22.400	11-14-47	2,280	24	172	97	230	313	788	168	.2	17	1,650	828	–
13.12.26.200	10-22-47	533	–	46	32	24	218	102	6	.5	4.2	322	246	–
13.14.9.320	5-27-47	617	–	24	13	106	326	53	13	1.0	1.4	372	114	–
13.16.6.200	9- 4-47	680	18	88	19	30	204	144	24	.5	12	436	298	–
13.20.1.200	5-21-47	1,290	–	135	48	95	350	385	37	.6	.8	874	534	28
13.23.27.220	11- 5-47	1,150	19	60	50	133	404	211	60	1.5	7.1	741	355	–
33.310	11-14-47	1,490	19	51	71	200	521	278	90	1.9	6.2	974	419	–
13.24.23.330	11- 5-47	2,170	13	26	16	485	658	458	118	1.3	.2	1,440	131	–
14.14.25.	7- 8-47	645	14	73	29	29	360	51	10	.4	.9	385	301	–
30.300	7-25-47	1,120	–	26	20	224	548	163	9.0	.5	.5	712	147	–
34.130	7- 7-47	1,140	9.2	8.5	2.8	264	418	177	53	1.7	.1	722	32	–
14.20.23.	5-21-47	768	–	52	20	69	284	91	21	.3	5.2	398	212	41
14.21.5.110	11- 5-47	760	–	84	10	41	228	81	41	.4	11	381	250	–
14.22.17.430	Do.	918	–	53	25	126	372	153	30	.7	.4	571	235	–
14.24.8.100	10- 3-47	1,420	16	60	103	127	658	228	45	.9	8.4	912	573	–

TABLE 3. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN SAN MIGUEL COUNTY, NEW MEXICO (Continued). NUMBERS CORRESPOND TO NUMBERS IN TABLE 1.

Analyses by Geological Survey (Parts per million)

WELL (SPRING) NUMBER	DATE OF COLLECTION	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C.)	SILICA (SiO_2)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM AND POTASSIUM (Na+K)	BICARBONATE (HCO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	DISSOLVED SOLIDS	TOTAL HARDNESS AS $CaCO_3$	PER CENT SODIUM
15.12.33.100	5-20-47	1,040	12	2.2	3.4	247	469	113	35	1.5	.1	645	20	96
15.16.10.220	6- 8-47	1,370	7.4	93	64	142	400	432	19	0	0	954	495	38
32.110	7- 7-47	994	20	122	38	43	422	107	57	.1	18	613	460	17
35.400	9- 2-47	878	–	86	16	86	242	186	52	.5	.4	546	280	–
15.18.5.	10- 6-47	942	–	78	43	72	246	279	22	.6	5.4	621	372	–
15.21.7.440	5-21-47	538	–	80	8.8	27	228	58	28	.2	8.3	323	236	–
15.24.8.210	10- 3-47	1,680	10	33	19	343	473	425	52	1.0	.3	1,120	160	–
27.210	10- 3-47	2,090	12	5.2	4.3	513	759	416	62	1.2	.4	1,380	30	–
15.27.17.000	10-29-47	1,680	30	97	46	241	498	398	92	.4	2.1	1,150	431	–
16.12.16.300	7-24-47	358	–	60	8.4	3.9	185	34	3.5	.0	.7	202	184	–
33.110	7-22-47	783	11	9.8	3.3	184	391	90	15	1.4	.2	507	38	91
33.140	7- 3-47	496	13	51	10	46	248	52	7.0	.2	1.9	303	168	–
16.16.32.400	8- 1-47	464	19	65	7.5	28	250	30	6.0	.6	9.6	289	193	–
16.17.4.110	5-22-47	1,380	7.4	5.5	2.1	358	885	26	28	3.6	.1	868	22	97
21.340	8-18-47	1,590	9.4	6.8	2.3	421	1,090	12	19	3.6	.6	1,010	26	–
22.400	Do.	2,150	–	21	6.6	499	583	627	23	.7	.8	1,470	80	–
26.100	10-15-47	1,370	18	27	27	279	634	188	46	1.3	1.1	900	178	–
16.19.6.100	10- 1-47	1,190	–	166	52	34	267	393	47	.8	6.0	830	628	–
11.200	8-18-47	1,470	–	10	4.6	364	748	195	12	.7	.2	955	44	–
13.300	Do.	1,400	–	178	49	77	310	440	69	.4	2.0	968	646	–
16.20.1.100	Do.	536	–	80	9.0	19	214	64	22	.2	6.3	306	236	–
16.22.6.220	9- 5-47	533	–	75	8.3	27	234	51	20	.8	6.3	304	221	–
16.24.7.420	10-10-47	2,240	7.2	98	39	419	750	600	53	.7	.3	1,590	405	–
16.26.1.140	10-15-47	1,400	16	33	34	265	612	180	72	.3	9.7	912	222	–
16.29.31.200	10-16-47	1,120	–	75	34	131	289	255	73	.5	5.7	717	327	–
17.17.18.400	6-25-47	1,200	12	4.0	1.1	288	357	210	26	1.3	.2	772	14	–
24.100	Do.	1,280	10	36	15	266	654	153	21	2.1	.2	826	152	–
31.100	11- 3-47	2,120	–	9.0	5.9	534	1,360	34	36	–	.5	1,290	47	–

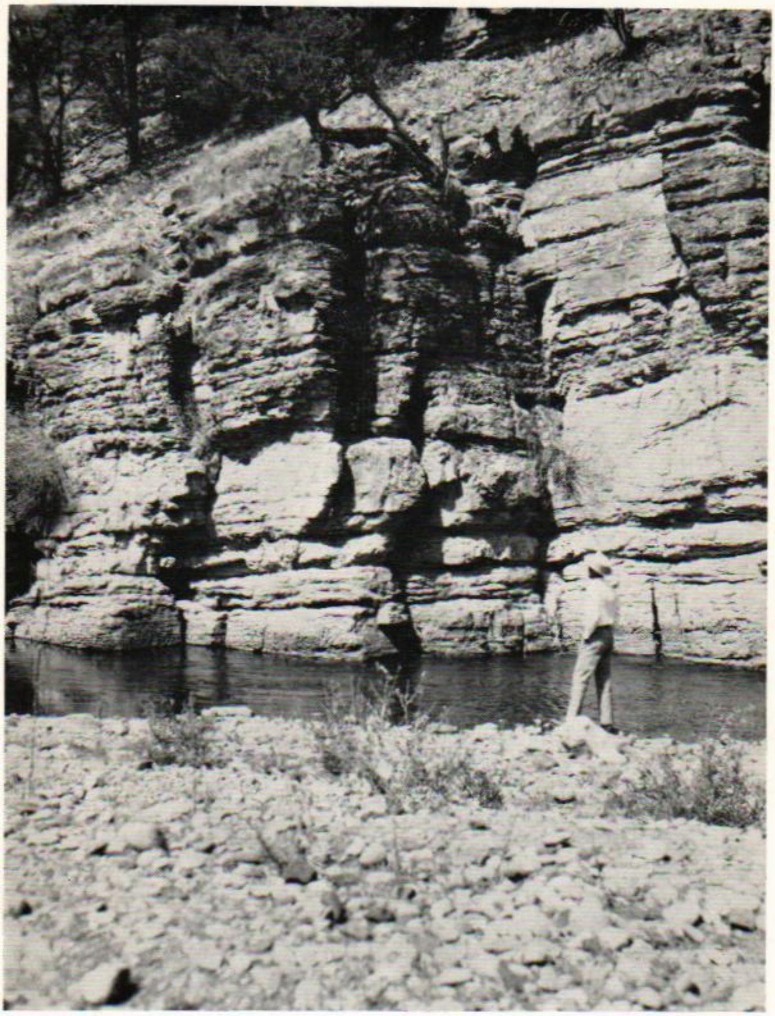
TABLE 3. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN SAN MIGUEL COUNTY, NEW MEXICO (Continued). NUMBERS CORRESPOND TO NUMBERS IN TABLE 1.

Analyses by Geological Survey (Parts per million)

WELL (SPRING) NUMBER	DATE OF COLLECTION	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C.)	SILICA (SiO_2)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM AND POTASSIUM (Na+K)	BICARBONATE (HCO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	DISSOLVED SOLIDS	TOTAL HARDNESS AS $CaCO_3$	PER CENT SODIUM
17.18.17.400	9-30-47	3,820	–	359	171	414	358	1,990	88	.1	11	3,210	1,600	–
23.000	Do.	1,110	–	116	52	60	307	333	23	.8	3.2	739	504	–
17.20.27.200	8-18-47	679	–	72	17	55	288	79	31	1.0	6.1	403	250	–
17.22.22.200	8-19-47	744	–	85	17	57	331	88	26	.8	6.1	443	282	–
24.400	9- 5-47	482	–	68	4.9	28	227	38	12	.6	6.6	270	190	–
17.25.11.340	10-15-47	1,020	19	33	37	161	480	131	34	1.7	1.5	655	234	–
17.26.7.300	Do.	1,510	13	30	31	279	445	303	80	1.2	17	973	202	–
17.27.10.100	Do.	7,110	–	58	34	49	338	60	26	.4	17	411	284	–
18.15.24.200	6-20-47	1,570	–	244	41	17	390	303	78	.7	85	961	778	5
27.100	Do.	539	–	42	12	75	330	37	5	.8	0	334	155	51
18.16.6.300	5-12-47	712	–	113	17	26	300	94	23	.3	37	458	352	14
8.300	6-13-47	1,140	–	216	19	15	373	254	48	.1	15	751	617	–
18.18.33.100	6-25-47	782	8.7	2.8	1.1	190	393	86	8.0	.8	.4	491	12	–
33.400	9-30-47	2,190	–	214	77	219	367	891	68	.7	.2	1,650	850	–
18.26.24.430	10-17-47	662	–	73	21	47	274	115	15	.5	5.9	412	268	–
19.14.36.100	6-13-47	691	–	96	17	8.7	229	28	49	.8	51	363	310	6
19.15.15.300	6-12-47	380	–	58	8.7	14	218	23	3	.6	2.5	217	180	14

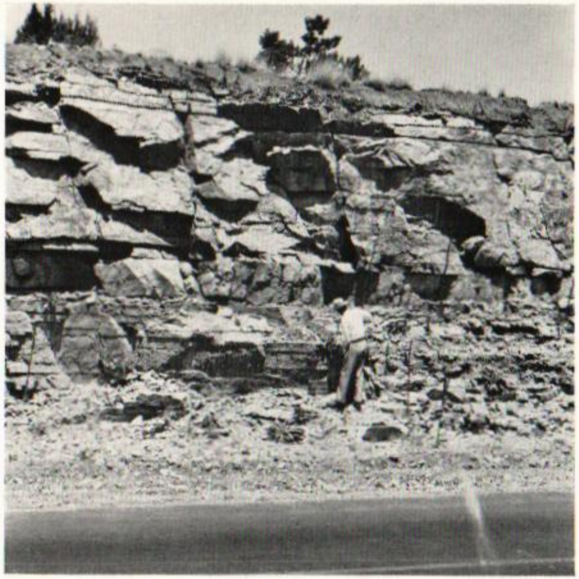
SPRINGS

12.14.20.300	8- 8-47	433	–	74	11	4.6	261	11	8.0	0	3.3	240	230	–
12.19.16.	5-22-47	944	14	80	25	101	304	215	32	.3	3.6	621	302	42
13.16.8.100	9- 4-47	607	–	87	18	16	207	123	16	.3	6.4	369	291	–
13.21.25.400	5-21-47	1,100	–	78	30	138	366	261	32	.7	.2	720	318	49
15.15.12.200	6-27-47	525	19	61	3.6	128	416	54	24	5.0	.4	500	167	62
12.300	Do.	499	16	85	7.4	3.2	213	56	11	.4	.3	284	242	3
18.15.23.200	6-13-47	388	–	66	6.9	12	233	17	7.0	.2	1.2	225	193	–
19.14.33.300	6-20-47	306	–	52	7.0	2.1	171	18	2	.4	.6	166	158	3



Madera limestone of the Magdalena group along the Pecos river north of the town of Pecos.

Plate 3



A. GLORIETA SANDSTONE IN A ROAD CUT ON U. S. HIGHWAY 85 SOUTHWEST OF LAS VEGAS.

B. CORAZON BUTTE, AN OUTLIER OF THE LAS VEGAS PLATEAU NEAR STATE HIGHWAY 65. DAKOTA (?) AND PURGATOIRE FORMATIONS AT THE TOP, MORRISON FORMATION, ENTRADA SANDSTONE, AND CHINLE FORMATION.

Plate 4

A. Contact of the Morrison formation overlying the Entrada sandstone in a road cut on State Highway 65 south of Trujillo.

B. Contact of the Dakota (?) and Purgatoire formations overlying the Morrison formation in a road cut on State Highway 65 south of Trujillo.

Plate 5

A. GREENHORN LIMESTONE IN A ROAD CUT SOUTH OF LAS VEGAS.

B. GRANEROS SHALE IN A ROAD CUT SOUTHEAST OF LAS VEGAS.

Plate 6

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Figures in italics indicate main references.